Technical and Bibliographic Notes / Notes techniques et bibliographiques

The Institute has attempted to obtain the best original copy available for filming. Features of this copy which may be bibliographically unique, which may alter any of the images in the reproduction, or which may significantly change the usual method of filming, are checked below.

☐ Coloured covers/
Couverture de couleur

☐ Covers damaged/
Couverture endommagée

☐ Covers restored and/or laminated/
Couverture restaurée et/ou pelliculée

☐ Cover title missing/
Le titre de couverture manque

☐ Coloured maps/
Cartes géographiques en couleur

☐ Coloured ink (i.e. other than blue or black)/
Encre de couleur (i.e. autre que bleue ou noire)

☐ Coloured plates and/or illustrations/
Planches et/ou illustrations en couleur

☑ Bound with other material/
Relié avec d'autres documents

☑ Tight binding may cause shadows or distortion along interior margin/
La reliure serrée peut causer de l'ombre ou de la distorsion le long de la marge intérieure

☐ Blank leaves added during restoration may appear within the text. Whenever possible, these have been omitted from filming/
Il se peut que certaines pages blanches ajoutées lors d'une restauration apparaissent dans le texte, mais, lorsque cela était possible, ces pages n'ont pas été filmées.

L'Institut a microfilmé le meilleur exemplaire qu'il lui a été possible de se procurer. Les détails de cet exemplaire qui sont peut-être uniques du point de vue bibliographique, qui peuvent modifier une image reproduite, ou qui peuvent exiger une modification dans la méthode normale de filmage sont indiqués ci-dessous.

☐ Coloured pages/
Pages de couleur

☐ Pages damaged/
Pages endommagées

☐ Pages restored and/or laminated/
Pages restaurées et/ou pelliculées

☑ Pages discoloured, stained or foxed/
Pages décolorées, tachetées ou piquées

☐ Pages detached/
Pages détachées

☑ Showthrough/
Transparence

☑ Quality of print varies/
Qualité inégale de l'impression

☑ Continuous pagination/
Pagination continue

☐ Includes index(es)/
Comprend un (des) index

Title on header taken from:/
Le titre de l'en-tête provient:

☐ Title page of issue/
Page de titre de la livraison

☐ Caption of issue/
Titre de départ de la livraison

☐ Masthead/
Générique (périodiques) de la livraison

☐ Additional comments:/
Commentaires supplémentaires:

This item is filmed at the reduction ratio checked below/
Ce document est filmé au taux de réduction indiqué ci-dessous.

10X 14X 18X 22X 26X 30X

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☑ ☐ ☐ ☐ ☐ ☐ ☐

12X 16X 20X 24X 28X 32X

The Canadian Patent Office Record and Mechanics' Magazine

Vol. 3.—No. 7.
JULY, 1875.
Price in Canada $2.00 per An.
United States - $2.50 "

SIR WILLIAM LOGAN LL.D., F.R.S., F.G.S.

DRILLS—FLAT AND TWIST.

Differences of opinion still exist amongst mechanics, with reference to the relative merits of the flat and twist drill. The following abstract from the "Mechanics' Tool Book," by Mr. W. B. Harrison, sums up the case for the twist drill. Perhaps some of our readers can show cause why the verdict should not be in favour of the twist as against the flat drill.

The machine-made twist drills are fast superseding the flat drill, and where they are once introduced into a machine-shop they are preferred to all other kinds. Let any mechanic compare the *cutting edge* of the flat with the twist drill, and the superiority of the latter will be apparent. The flat drill presents a *scraping* edge to the metal to be penetrated, while the twist drill has a *cutting* angle which very nearly approaches the form of the cutting edge of the lathe tool. When these tools are used in cast-iron it is observed with what ease and rapidity the twist drill penetrates, and when used in wrought-iron or brass, long and extended spiral chips will follow up the twist-drill grooves, showing that it is indeed a *cutting* tool; when if the same effort be made with the flat drill in the same material, no such spiral chips are the result, rough fragments of the metal being *forced* off, which shows that it is nothing more or less than the effect of a *scraping* process. It requires a nicely made flat drill to produce as true and smooth a hole as even a badly made twist drill will execute.

We have always found it advantageous and economical to cut up bars of ½ in. octagon steel into lengths of from six to eight inches and then turn up the shanks and fit to the chuck a dozen or two of these pieces at a time, and then they are ready fitted to be made into drills whenever occasion requires. If the drills are the size of the steel, they should be, when drawn down at the forge, of an average length of about eight inches. This length is a good proportion and better in practice than either a longer or shorter drill. If it be required to make a round or twist drill, it is convenient to take one of these pieces and turn the body to the size and then fashion it to suit the work

The flat drill should not only be flat at the point but have its body also flat, so that the chips or borings may be carried around with the rotation of the drill, and not be ground between its sides and the metal which the point is penetrating. The cutting point must be made thin so as to more easily penetrate, and in process of working this point must be kept thin and sharp, otherwise a ragged hole will be the result. The form of the point of the drill should be such that the two lines should meet at 90°, or, what is more explicit, exactly fit the inner angle of the fitting or try-square, which is an angle of 90°, or one-fourth of the circle. There is another advantage in shaping the points of drills in this way with the square; a measurement from the body of the drill to the arms of the square, when the square is applied, will give an index of the proportion of the lines of the point as regards their equal length, and this measurement is easily ascertained by the eye. This exactness is important in a good cutting drill, as both sides must perform their proportion of the work. The *cutting* angle should meet the face at 60°, but a variation may be made in regard to this according to the hardness or other characteristics of the metal to be penetrated; a harder metal requiring less acuteness of cutting angle. When the drills are dull and are ground, let the square be applied to ascertain the form of point.

Another method of using the drill is to insert the back or dead centre in the countersink at the end, and hold it fast with a wrench, and apply it to the work which rotates in the lathe chuck or some other fixture. These drills may conveniently be made of bars of flat steel about eight inches long and of a width and thickness to correspond with the work. The centre or countersink which is to enter the centre of the lathe should be made large, so that there will be no danger of its slipping out of place if it should be found necessary to slightly turn the centre back, as is often done to free the drill from chips. We have seen old files used for these drills, and also seen old files drawn down to make common flat drills, but we must express a hearty contempt for such a slovenly method of producing a tool, which when made may well be regarded with disgust by every mechanic of taste who has any pride in the appearance or working of his tools.

The step from the old-fashioned flat drill to that of the improved twist drill, is one of the boldest leaps in mechanical science, and may be compared to a single stride from a tool of an ignorant age to the finished implement of the enlightened period. When we take a look at their forms and compare them, we see at a glance the imperfections of the flat drill and the superior qualities of the twist drill In the flat drill, as it revolves in the metal that it has to penetrate, it *forces* a portion of the material before it by a direct action, rubbing it off, as it were, by the applied power; the cutting lip presenting an edge at a right angle with the work. Give a lathe tool to a mechanic, with the same form and angle, to "turn up" a piece of iron work, and if he understands the nature of the material he is to operate upon, he will throw the tool from him as if you had offered him a premeditated insult. He knows very well that there is no "cut" in that form of tool. It may, by *abrasion*, reduce the work upon which it is employed, but it will not cut it. But give the same mechanic a drill made with the very same angle of cutting lip, and he will use it in his work with no feeling of a detraction of his dignity. He probably never gave a thought to the *effect* of the form of the cutting edges, as presented to the resisting metal. He knows the best shape of a good turning tool, and his experience tells him that the point of the instrument *must* run under the metal like a wedge, and *lift it off* as the cutting point advances, and not *scrape* it away by direct applied force against the *resisting face*—not cutting edge—of the tool.

Show a twist drill to the mechanic, and compare the cutting angles of the two instruments, and he will readily see that the cutting lip of the twist drill is almost the exact shape of his well-made turning tool. In operation he will observe that, instead of the abraded chip of the flat drill, it will be a clean and smooth-cut ribbon of the metal that is thrown up the spiral grooves of the drill as it penetrates into the material The peculiar advantages of the twist drill are not generally known throughout the country, but where they are once introduced they are soon appreciated, and applied to the exclusion of the flat drill. Some of the advantages of the twist drill are that it will always bore a hole that is perfectly cylindrical, whereas the flat drill will not always do this. The ease with which a twist drill cuts is another recommendation, and its strength, compared to that of the flat drill, is still another good quality. When the twist drill is broken, it can be easily put in order at the grindstone, if it has been properly made, and will operate as well and be of the same size as when first employed.

The flat drill is quickly and easily made. The twist drill requires time and some skill to form. The flat drill can be made larger by *spreading* the cutting point by means of the forge fire, but the twist drill once made is a tool of a constant size; it cannot be enlarged or reduced without spoiling it So we see why, in many shops where miscellaneous work is done, the flat drill has the preference, but in shops where gauges and constant sizes of work are made and expedition is a requisite, the twist drill may be used to great advantage.

Within a few years the manufacture of twist drills has become an established business, and any one wishing such drills can purchase them at the stores where tools are kept and sold. Some of these drills increase by the sizes of the wire gauge, so that the holes made will fit the wire purchased if such a fit should be needed. They are also made to increase by sixty-fourths of the inch, but as an improvement on those sizes we would recommend that they be made of sizes increasing by the decimal divisions of the inch, or by tenths and hundredths, &c.

The larger sizes of these drills as manufactured have taper shanks which are inserted in chucks made to fit the lathe, but the smaller sizes are not thus made; the shanks are of cylindrical form, of the same size as the drill, and as they vary thus small concentric chucks are needed to hold them when used for drilling.

If the mechanic desires to make a twist drill for himself, there are two methods by which to accomplish it—by forging or by cutting it from the solid metal A good drill may be formed by either method. One thing must be borne in mind if too little twist be given, it will approach too near to the flat drill and will be but little more effective than that form, while, on the other hand, if too much twist be given, the cutting edge presented will be too acute—breaking or crumbling away before the resisting metal. Some years ago, a manufactory employed one of its workmen to make a set of costly twist drills which were intended as standards of size for the series of holes in a sewing machine; but unfortunately the mechanic who made them formed them with too much 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 reliefs, 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

FIG 1

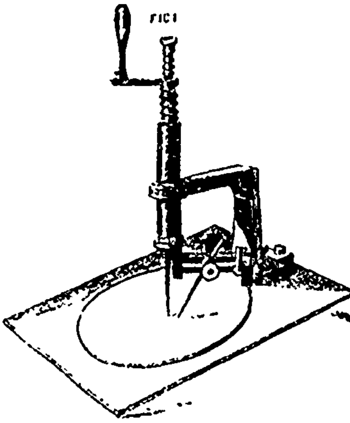


FIG 2

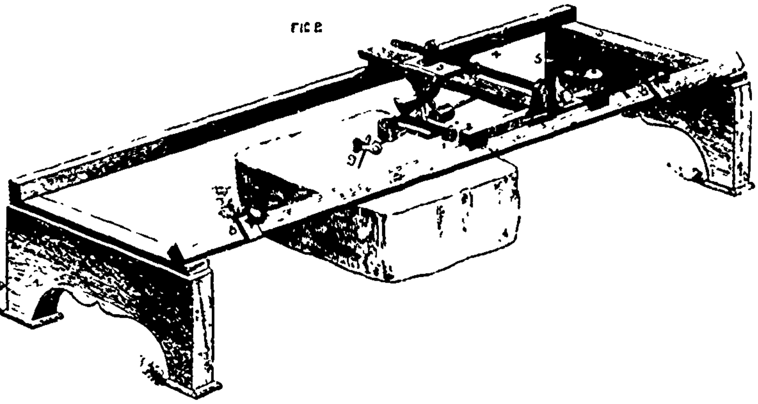


FIG 3

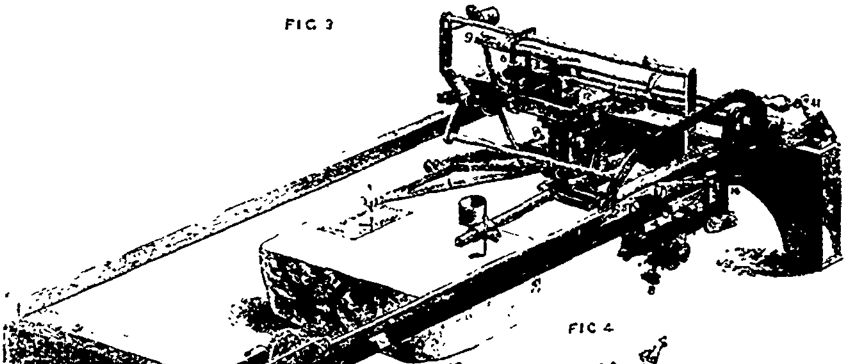


FIG 4

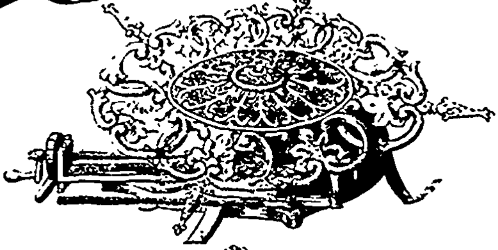
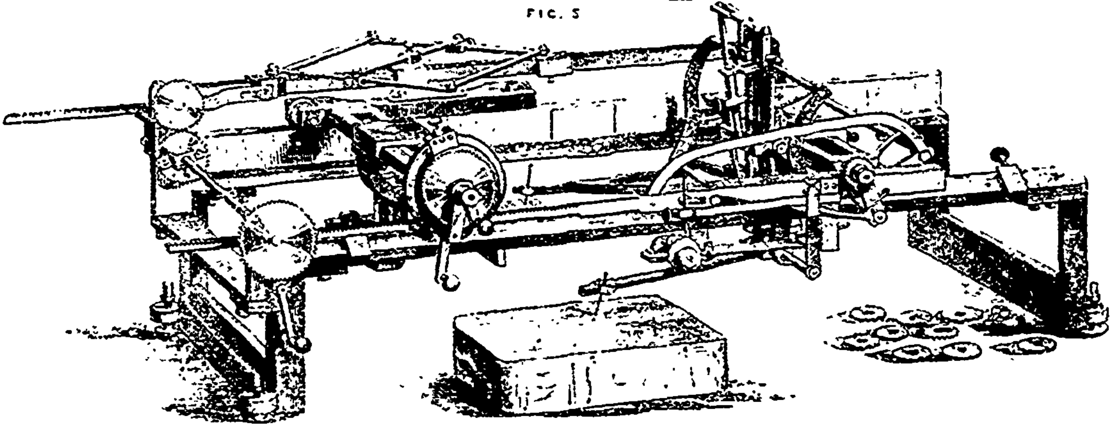


FIG. 5



COPYING MACHINES

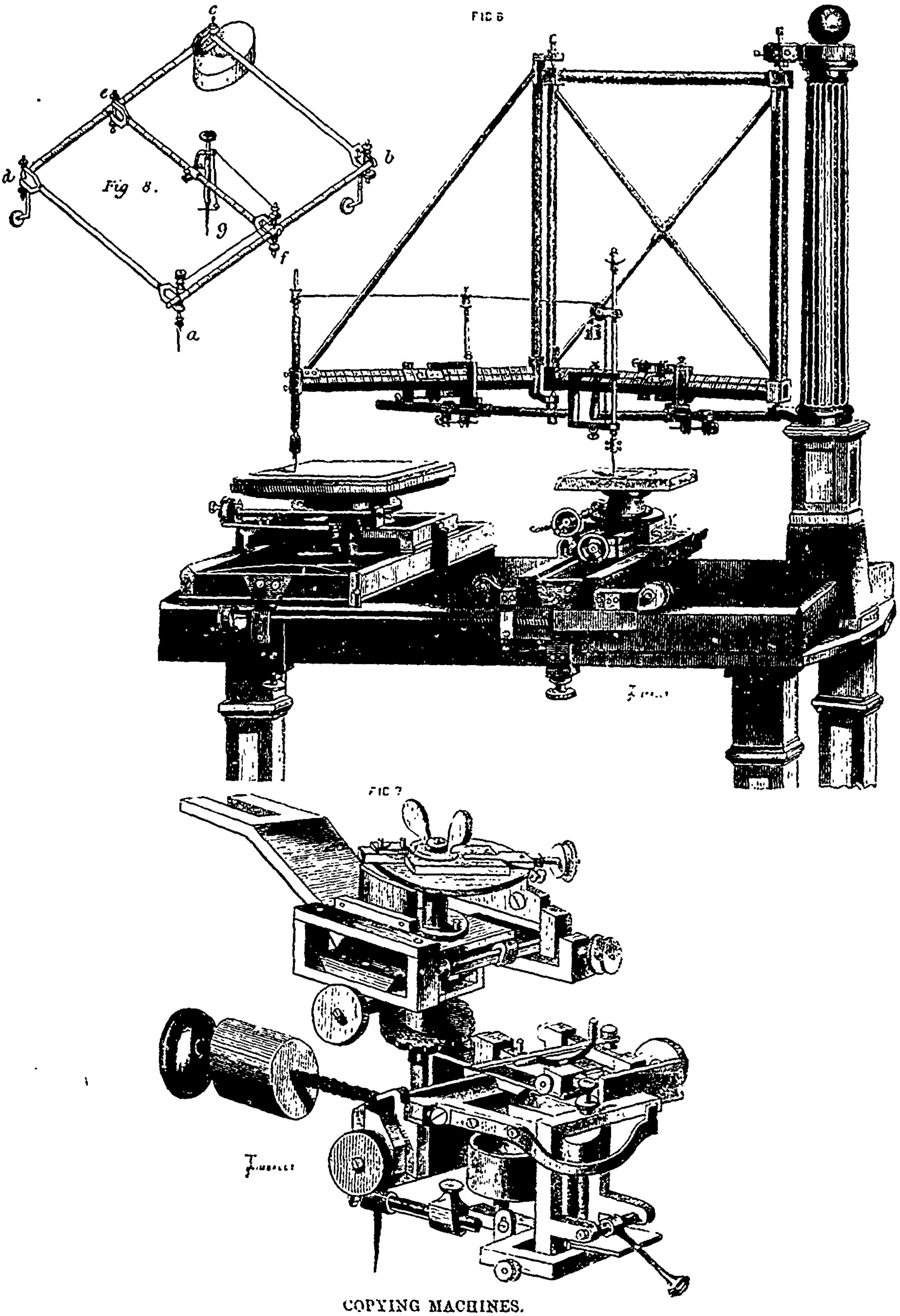


Fig 8.

FIG 6

FIG 7

COPYING MACHINES.

the square, thus giving points to form the second square. This is done, as may be seen, by keeping the long side of 15 against the T square The problem is now complete, making, as first stated, two equal squares, and also two octagons, without using the compasses. You will notice that from F to the upper side of the square is a distance by which to set a gauge that will form the octagon, simply by running it along the sides of a piece of timber, its square being equal to one of those we have just made.

Fig. 2. This is named the hexagon, which is a figure having six equal sides, and will also be produced much more neatly and quickly without the use of compasses. To execute the figure, the templet marked 60 against the square will be required, which may be used for various purposes. The method for making it is very simple, as may be seen in the upper corner of the plate to the right. Where a perpendicular is drawn, set the compasses to any distance, say A B; draw a circle, and intersect it from B with the same radius; then square over C D. This being ready, commence again from the edge of the board and square up A B. Take any point, say D, square out a line. Now suppose we make D C equal to one side of the hexagon, then, with the T square against the edge of the board, and the templet 60 in its present position, draw C A, reverse 60, and draw C B. Points are now obtained to draw the other two sides, and by drawing a line through D, the other points are given to complete the figure.

Fig. 4. THE PERPENDICULAR OR RIGHT ANGLE —This can be done off-hand and correctly with a two-foot rule. For example, suppose A B the edge of a board, and it is required to draw a line across its surface that shall be at a right angle with the edge. Take any point, say A, draw a line at any angle, say A C; lay the rule on and mark any number of inches, say 5; then make C B five inches, extend the line, and make B D measure ten inches. Then A D is the perpendicular required.

Fig. 5 illustrates a celebrated problem on proportions, meaning the comparative relation of any one thing to another. This may be better understood by supposing the square A to represent the end of a piece of timber, sides of which must be reduced in order to have its end A one-half the present size. The answer may be given in this way: Draw the line B C; then take D for centre, and for radius, a circle touching the line just made, and cutting B D, giving a point to produce F, which is one-half the size of A.

Fig. 6 further illustrates proportion in round bodies, such as a cylinder or a column. For example, let A be the base of a cylinder, and it is now required to produce another twice the size; draw the quadrant in A, the chord of which is the radius of B, giving at once the answer required.

Fig 7 represents the half-oval or semi-ellipse. the most beautiful of all curves. Those who are unacquainted with the drawing, will do well to learn at once, and also to remember the terms used in describing the diagrams. The line A B is called the major axis. and the perpendicular S N the minor axis. The figure may be readily drawn with a piece of linen thread, or fine twine, and two pins, by the following method: Take A S for radius, and N for centre; intersect the thread, or fine twine, major axis at 2 and 3; stick pins in these points, and tie the end of the thread to that in 3; bring it round 2. put the finger of the left hand on 2; now take the pencil and stretch the thread with its point touching N; then sweep the curve. File or cut a notch in the pencil in order to keep the thread from slipping. If the ellipse is large, use a piece of fine wire—copper is the best. The method given will be found not only quick, but correct and entirely practical.

Fig. 8 SECOND METHOD.—Let C K be a given distance, and L P a given height. Take the straight-edge, from the end of this set off 2 4 to equal C L, and again set off 2 3 to equal L P, now lay the straight edge on the line C K, with 2 at C, then, with the pencil, or any instrument, make any number of points, all of which will be in the curve, by moving the straight-edge, and keeping 4 on the line L P, and 3 on the line C K.

Fig 9 is a scale by which the side of any octagon may be obtained with great nicety, the square being given The following is the method: Let A C be three inches, and the perpendicular A R 1¼ inches From C draw a line through R. Now suppose B C one side of a square, say 35 feet, draw the perpendicular B D, which is one side of the octagon This may be proven by referring to Fig. 1, where B C correspond with similar letters at Fig. 9, and one side, the octagon being equal to B D. The scale may be 6 inches and 2½, or 12 and 5 inches, and so on.

Fig. 10 exhibits a method by which the segment of a circle, however large, may be found, the centre unknown or unattainable. Let D A E be the chord, divide D E into two equal parts, draw the perpendicular A B. Let this be the given rise Draw the quadrant A B C, which divide into any number of equal parts, say five, also, divide A C into the same number join the divisions. Now divide A E and A D each into five equal parts. Then draw lines to correspond with the angles made in the quadrant, the heights of which transfer, thus giving points to trace the curve. This may be done by bending a lath against nails fixed in the points. This principle for finding sweeps or curves being both neat and correct, and far preferable to the usual method of straight-edges and cross-pieces, which are generally adopted for such purposes

PLATE 2.—THE CUTS IN CARPENTRY.

In the absence of any fixed principle, it would be impossible to execute works where the ground plan makes the right, acute, and obtuse rugles, the sides of which incline from a perpendicular. This problem has always presented the greatest difficulty to the carpenter, joiner, and mason, who, in their practical experience, have long felt the want of a system by which wood or stone could be cut with such precision as to exactly answer the purpose intended. The solution of this will be clearly illustrated in a thorough and practical manner. The first example will show the bevels which produce the cuts for the work. To make this clearly understood, the hopper will at once convey the idea, the ground plan of which is seen at Fig. 1. The large square represents the upper edges, and the small its base. A line drawn from the small square, cutting at B, determines a point from which the side or end must incline. Suppose 2 A be the given height. Now join A B. This done, we have the exact elevation of a side or end. You perceive that the upper edge is square, and the bevel at B shows the lower edge, but in many cases both are square, as they should be in preparing the work. This is mentioned because it is the custom of some to bevel the edge, then apply a square across it for the purpose of finding the direction of only one cut. To say the least of this, it is both unnecessary and slovenly. The proper method to do this with neatness, is seen at Fig. 3, where the line B C is given as a base, and A B made to incline the same as A B in Fig. 1. Then anywhere on B C, say P, square down a line, cutting at H. (You will notice that A B is extended.) Make B S square with B A; now take P for centre, and for radius a circle touching the line B S, and cutting at E; join E H, and in the angle the bevel is seen for the edge of the stuff. We now want a bevel to cut the sides or ends. Again: Take P for a centre, and for radius a circle touching the line B H, and cutting at N; join N H, thus producing the bevel cuts for the sides and ends. The work is now complete, as far as the drawing is concerned. To test this in a practical way will take but a few minutes. Make one cut through a piece of board by the method given; bring the two pieces together, which will show the side and end. These must stand on the given slope, and the angle perfectly square; if otherwise the work is not correct. Fig. 2 is simply intended for the elevation of Fig 1.

Our next illustration is similar to that already done, with this difference—the corners are required to be mitred. This is seen at Fig. 4 which is the plan. You will notice the line drawn from the bottom of the box, cutting its upper edge at B. Suppose that 2 C is the given height, then B C is the width of the sides and ends. We will now find the cuts for these, and also the bevel for the edge of the stuff. Commence by making the drawing on a board, seen at Fig. 6. The line L D represents its edge, above which, say three or four inches, run on a gauge or pencil line, as A B. then through B draw B C to the same angle as that at Fig. 4, and cutting the edge L D; now square up B V, which forms the right angle A B V this bisect, and draw the mitre B S: then anywhere on A B, say P, square up a line cutting at H and Q; take P for centre and for radius a circle touching the line B H, and cutting at N and 3 E, join E R, and in the angle is seen the bevel which gives the mitre on the edge of the stuff, and by joining N H we have the bevel to apply on the face of the stuff, thus giving the cuts for the sides and ends of the work. The simplicity and utility of this beautiful system must be self-evident, and may be relied on for every description of work which inclines from a perpendicular. The student could not do better than give it a practical test at once. For example, draw the line H B C to any other angle than its present position. then find the bevels for the cuts by the method just given. Now take a piece of stuff, parallel in width and any thickness mark the mitre on its edge, also the direction of the cut on the face; then make one cut through the lines and bring the two pieces together The mitre will be perfect, and the sides incline to the exact angle required, and at the same time the two pieces will make the right angle A B V. You will notice that the bevels can be set from the edge of the drawing board L D. Fig 5 is simply intended to show the elevation of the work.

SHEFFIELD STEEL ITS MANUFACTURE AND USES.

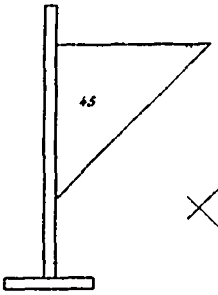
Bessemer steel is the most modern invention of any magnitude It was the invention of Mr. Henry Bessemer, one of the most remarkable men of this age in the department of applied arts — his Bessemer saloon steamer, to obviate sea-sickness in the Channel passage, being his latest discovery The process accomplishes most wonderful results, and, like all really great discoveries, is exceedingly simple. Formerly the time required for making bar steel, reckoning from the time when it was put into the furnace till it was cool enough to take out, was from fifteen to twenty days, and then another three hours were required, to change the bar into cast steel by the Huntsman process. Now, having looked on that picture, look on this. By the Bessemer process crude iron can be changed into steel in twenty eight hours. The process may be briefly described,as we have seen it repeatedly, the last occasion being when the Grand Duke Constantine of Russia and suite were at the Cyclops Works. The illustrious visitors were as much amazed at the Bessemer process of making steel as at anything they saw in these vast establishments. A vessel of strong boiler-plate, oval-shaped, is lined with a powdered stone called "ganister," found in the neighborhood of Sheffield At the top of the vessel there is an aperture for pouring the metal in and out, at the bottom there are inserted seven tuyeres of fire-clay, each having seven holes in it, and through these a blast from the engine enters. This vessel, though it contains several tons of metal is constructed so that it will readily swing about in any direction required It is first thoroughly heated with coke fuel. The pig iron has been melted in an adjoining furnace, and the converter (the vessel alluded to) is turned on one side, and the iron poured in through the aperture at the top The converter is then righted, and the blast having been turned on into the interior through the holes in the bottom, a most powerful combustion takes place The fire, increasing in intensity, causes a series of miniature explosions of sparks and flames; while a very pale and beautiful light illuminates the building. Then the vessel is swung down again, and the molten metal shoots forth a shower of brilliant sparks, which have all the beauty of fireworks on no inconsiderable scale. The different colors and shades blending together make the spectacle most attractive to the spectator, standing on one side, clear of danger The workman, watching for the moment that the metal [illegible] ipe, gives the signal, the vessel is tilted forward, and he puts in charcoal pig iron, containing the required portion of carbon. This carbon combines with the mass of molten metal, which then becomes steel. The work being finished, the Bessemer steel is run out, poured into a large ladle, and afterwards deposited in the ingot moulds, awaiting the uses to which it is to be applied.

Before steel can fairly be made into cutlery, tools, or the various other articles for which it is used, is undergoes the processes of rolling or tilting, both of which we have frequently been much interested to watch. In rolling, workmen may be seen pulling the red-hot bars of steel out of the furnace, using iron pincers for the purpose. Large rollers, revolving by steam-power, receive the bars, which, passing through with a peculiar hiss,as if they resented the squeezing, have the pores of the steel closed, and take a more perfect grain. At each side of the rollers stands a workman to turn the bar after it has passed between them. The steel is rolled into flat sheets for saws, shovels, plates, and all articles which have a broad surface, and into circular rods for wire. needles, and similar articles. The tilting process is simply hammering, but as now conducted at the great works is a striking sight Tilting is intended to still further improve the steel for such fine purposes as razors, knives, scissors, and general cutlery Both processes are conducted amidst the most deafening noise, the "whuff," "whuff" of the steam-hammer being one of the sounds which strikes every stranger who enters Sheffield by road or rail, by day or night. Large hammers are fastened to huge lengths of timber. There are "tilt" and "forge" hammers, precisely alike, except that the forge are heavier and larger The hammer is of iron with a piece of hard composite metal fastened on the under part where it strikes the steel Water is kept pouring on the frame work to keep it cool. The workman skilfully guides the steel under the hammer, moving it dexterously so that the blows shall be evenly distributed over the whole surface. A number of bars are welded together when necessary. A forge hammer delivers about 150 strokes per minute, and a tilt-hammer twice as many. All manageable masses of steel are subjected to the tilt and forge hammers, to get them to the required size and consistency. For very large work the Nasmyth hammer is used This wonderful invention has been productive of grand results in steel. The principle is too well known to require explanation, as the steel-workers have complete command over the monster, regulating its blow so nicely as to make a two ton delivery crack a nut or compress a mighty weight of metal.

The Sheffield steel trade is the backbone of Hallamshire industry Sheffield swears by her steel even more than by her "plate." Touch Sheffielders on that point, and you do most grievously offend them They have certainly shown a remarkable integrity in keeping up the quality of their article. The manufacturers have consented to lose contracts, in not a few profitable markets, rather than supply an article underneath the true Sheffield standard. The production of steel for tools, cutlery, springs, needles, pens, wire, files, saws, etc, etc, was for a long time the staple trade of Sheffield, and is still followed by all the leading firms. The more modern branch of the steel trade is the working of large masses and forgings for special purposes, for which steel has only recently come into favor. All the world knows how Sheffield steel works in tools and cutlery, but all the world does not know that when crinoline was in fashion Sheffield supplied the wire in which the ladies encased themselves. For a long time Sheffield produced all the crinoline steel that was used — the manufacture. even as far back as twenty years ago, being about 12,000 tons per year France, Germany, and America became competitors, but they did not seriously diminish the output It was exported in various shapes, from raw steel to the made-up skirts, to the various kingdoms on the Continent. to the colonies, and, indeed, to every portion of the civilized world, and to not a few of those parts of which Sydney Smith described the fashionable attire as "a judicious mixture of feathers and nothing" These primitive sisters came to crinolines—at all events, crinolines came to them. The great steel-pen trade, for which Birmingham has a splendid speciality, is largely indebted to Sheffield All the raw material is made at Sheffield, the quantity per annum reaching to thousands of tons. How many pens would a ton of steel make? People ask · Where do all the pins go to? It would be quite as interesting to know where all the pens go to.

The wire manufacture is one of the most interesting in steel. For the general kinds of wire the steel, having been "softened,' is reduced by rolling to a quarter of an inch in thickness; it is further reduced by being drawn through dies, graduating in size down to the fineness of hair. From pinion wire the cog-wheels used in watches and clocks are made; but the finest of all—finer even than the human hair — is the watch motion-wire Its price in weight exceeds that of gold A single pound weight will produce a length of nearly nine miles. Then there is steel for ladies' stays and ships stays, for telegraph wire, and for the strands of cables, and for countless other purposes, including needles, of which 5,000 may be had wrapped up in a packet to carry in your waistcoat pocket; steel springs for watches, steel ribs for the frame work of umbrellas and parasols, and steel wire rope. The latter is now a very important branch of manufacture; a rope of wire, strand upon strand, containing thirty-six thicknesses of steel, is lighter and more elastic, as well as stronger, than iron rope.

The second or heavy branch of the Sheffield steel trade is that in which the most remarkable development has taken place It is not so liable to fluctuation as the lighter branches.



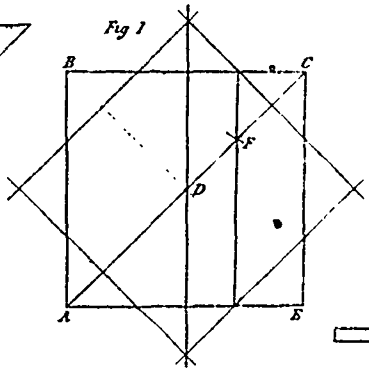
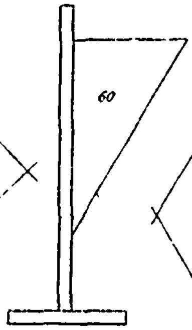


Fig 1



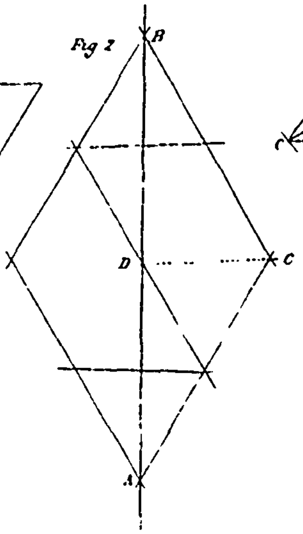
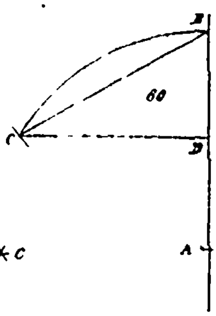


Fig 2



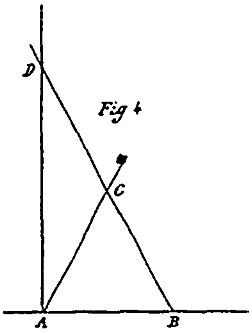


Fig 4

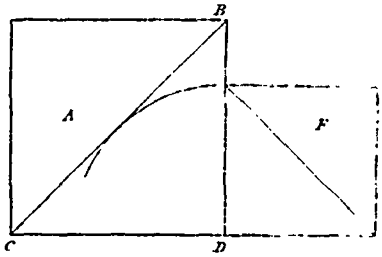


Fig 5

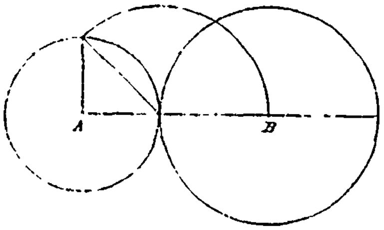


Fig 6

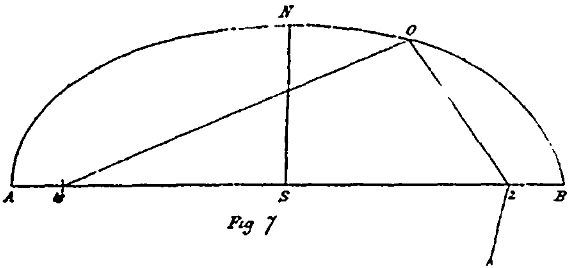


Fig 7

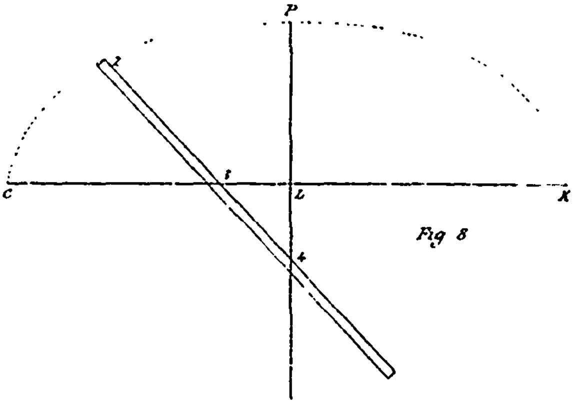


Fig 8

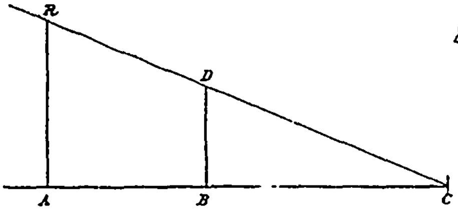


Fig. 9.

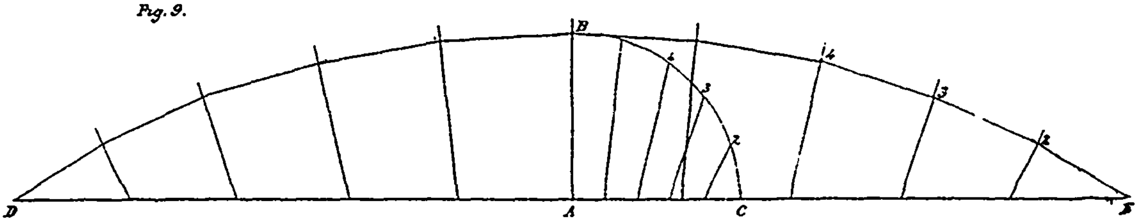


Fig 10

THE CARPENTER AND JOINER —PLATE .

Fig. 2.

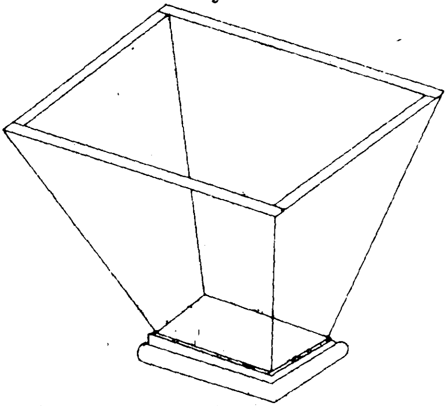
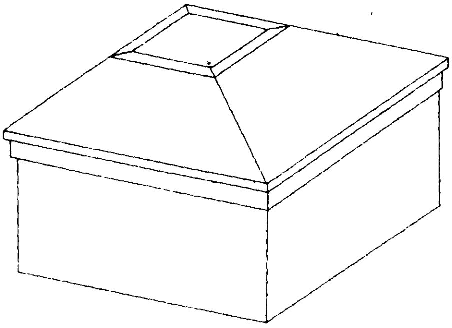
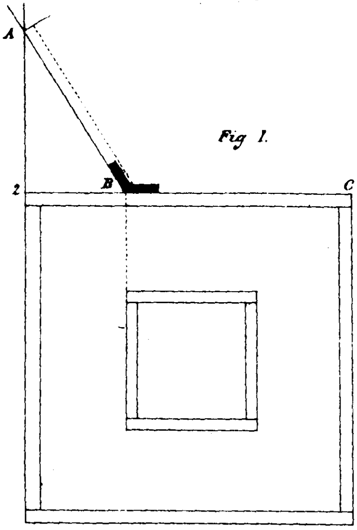
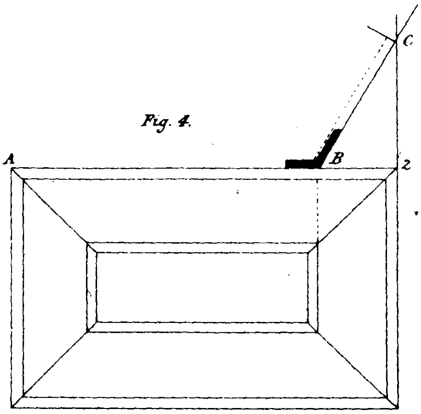
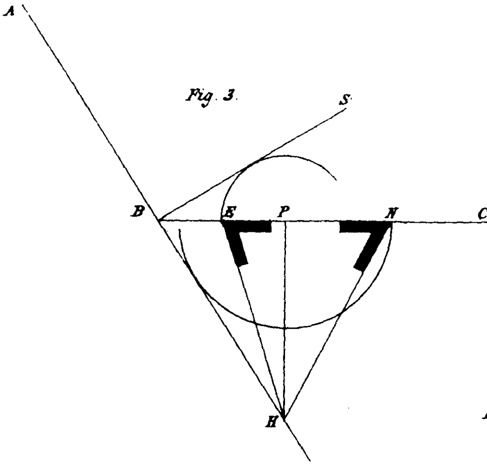


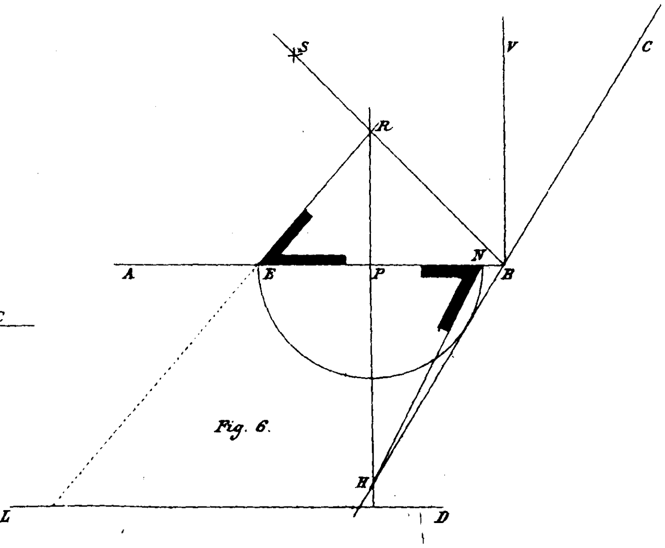
Fig. 5.











THE CARPENTER AND JOINER.—Plate II.

No freak of fashion—as when crinoline goes out—can suddenly all but extinguish an entire branch Not a single traveller by rail goes the shortest journey but he is indebted to Sheffield steel. If the company is wise, the rails upon which the carriages run are Bessemer rails. The wheels of the railway carriages have solid steel tires, the use of which has prevented many a railway disaster. Still, if it had not been for the Bessemer process, the application of steel to the permanent ways of railway companies would have been long delayed. The Caledonian Railway were amongst the first to use steel rails. They found that while the "lite" of iron rails rarely exceeded three months, steel rails were found at the end of a year to be nearly as good as new. Then there are cast-steel locomotive double-crank axles, tender and carriage axles, single crank and other marine shafts, cannon blocks, jackets, tubes, and hoops for ordnance and hydraulics, forged out of solid ingots of cast steel ; solid castings in steel, not forged or rolled, for railway wheels (with tires in one solid piece), railway crossings, horn blocks, or check-plates, and a multitude of other purposes. A branch of the Sheffield steel trade very little noticed is that of cast-steel bells, carried on by Messrs. Vickers, Sons & Co. (Limited), at Brightside. This manufacture was commenced in 1855, since which time they have made thousands of steel bells for all parts of the world. They sent one to the International Exhibition of 1851, which weighed nearly five tons, and required the contents of 176 crucibles of steel poured into the mould without a moment's cessation If the pouring ceased for one instant, cold would get in, and the bell would be worthless. Sheffield cast-steel bells are to-day ringing amid the frosts and snows of Russia and Canada, where the cold is so intense that bronze bells would crack This firm also make field-pieces from a solid block of cast steel; although in the military branch the greatest manufacturers are Messrs. Thomas Firth & Sons, who have a remarkable reputation for ordnance They supply the Woolwich authorities with the blocks, which are pierced at the arsenal.

LIVES OF THE ENGINEERS

There are few men of whom England has greater reason to be proud than her engineers, and among these none whose names are deserving of higher honour that Watt and Boulton To the former's inventive genius, to his unwearying patience through long years of difficulty and disappointment, we are indebted for all the advantages we derive from the steam-engine, while to the splendid energy and enterprise of the latter we owe it that Watt's grand invention was ultimately applied to practical uses. That the careers of such men as these are worth studying, that we cannot be too well versed in their history, is certain Mr. Smiles, too, has played his part of biographer with his usual ability. the lives of these men being told in a plain, unvarnished story, far more in consonance with their native modesty than a more pretentious kind of work would have been.

James Watt, born at Greenock of respectable parantage in 1736, was, in early life, of so fragile a constitution that he received most of his early education at home. He soon evinced great mechanical dexterity, and invariably spent his leisure time in making toys, drawing, etc. He was at length sent to school, where he could ill endure the rougher class of boys with whom he was then brought into contact. He was always ill, too, so that he cut a sorry figure either as a schoolboy or in his studies, till, at the age of fourteen, he entered the mathematical class Then he made rapid progress, and soon outstripped all his companions. Through far from a bookworm, the quantity and variety of reading which he got through at this period seems astonishing. "Before he was fifteen,' says Mr Smiles, "he had twice gone through, with great attention, 'S'Gravande's Elements of Natural Philosophy, a book belonging to his father. He tried many little experiments in chemistry, and even contrived an electrical machine. He read eagerly all books on surgery and medicine that came in his way He went so far as to practise dissection, and on one occasion he was found carrying off for this purpose the head of a child who had died of some uncommon disease." Then he was attracted to the study of botany by his love of wild flowers and plants, and to that of geology by noting the violent upheavings of the mountain ranges on the north shores of Loch Lomond He was also fond of fishing and of country rambles, where he picked up local traditions from the peasantry. At length his father sent him to Glasgow in 1754, when he was eighteen years of age, to learn the trade of a mathematical instrument maker Of Glasgow, as it then was, we are told, "Not a steam-engine was then at work in the place, not a steamboat disturbed the quiet of the Clyde. There was a rough quay along the Broomielaw, then—as the names implies—covered with broom. The quay was furnished with a solitary crane, for which there was very little use, as the river was full of sandbanks, and boats and gabberts of only six tons burden and under could ascend the Clyde. "In spring tides,' according to Smeaton in 1755, "only 3ft 8in. of water at Point house Ford, and salmon were so plentiful that servants and apprentices were accustomed to stipulate that they should not have it for dinner more than a certain number of days in the week" But Watt, when he arrived. could find no suitable master, there being no such man as a mathematical instrument maker For some time, however, he worked under a so-called optician, a nondescript-kind of tradesman, "who sold and mended spectacles, repaired fiddles, and sold spirits made and repaired the simpler instruments used in mechanical drawing, and eked out a slender living by making and selling fishing-tackle." But though Watt was handy at dressing trout and salmon-flies. there was nothing to learn in return for his services ; so he was advised by Professor Dick to go to London, and furnished with a letter of introduction. After some trouble he found employment in the shop of "Mr John Morgan, a respectable mathematical instrument maker in Cornhill, on the terms of receiving a year's instruction in return for a fee of twenty guineas and the proceeds of his labour during that time" He made rapid progress. "By the end of the month he was able to finish a Hadley's quadrant in better style than any apprentice in the shop.' He then passed on to azimuth compasses, theodolites, etc. At the end of a year, we are told, he wrote home to his father that he had made "a brass sector with a French joint, which is reckoned as nice a piece of framing work as is in the trade." His health failing, he returned to Greenock in the autumn of 1756, and on getting well again he proceeded to Glasgow, in order to set up on his own occount. However, the Corporation of Hammermen objected that he was neither the son of a burgess nor had served an apprenticeship, and the objection proved fatal At last Watt found an asylum within the precincts of the University, and there pursued his trade, but to no great profit. He devoted a part of his time to chemical and other experiments, but as these yielded little (if any) profit, he followed the example of his former master—the old spectacle maker—and took to making fiddles, flutes, and guitars. For these he found a readier sale. He made a barrel-organ for his friend Dr. Black, which was considered a great success. Then he made a finger-organ for a Mason's lodge, and "in the process of building this organ he devised a number of novel expedients such as a sustained monochord, indicators, and regulators of the strength of the blast, means of tuning the instrument according to any system of temperament, with sundry contrivances for improving the efficiency of the stops." The qualities of this instrument are said to have elicited the surprise and admiration of musicians, though Watt knew not a note of music, but had only studied the principles of harmony from the "Harmonics" of Dr. R Smith, of Cambridge. At this time Watt made the acquaintance of many celebrities of the day, such as Dr. Joseph Black, the distinguished chemist, Professor Simson, Dr. Dick, Professor Anderson, and Professor Robison.

Following this sketch of Watt's early life is a brief history of steam from the very earliest discoveries down to the engine of Thomas Savery and Thomas Newcomen, the latter being the immediate predecessor of Watt, and his engine being extensively used in Cornwall for pumping out the mines. His attention being early directed to the steam engine, he set about making a number of experiments, and, says Mr. Smiles, "His first apparatus was of the simplest possible kind He used common apothecaries' phials for his steam reservoirs, and canes hollowed out for his steam pipes." In 1773 the model of a Newcomen engine, which had been sent to London for repair, reached the Glasgow University, and was placed in Watt's hands. He continued to make a variety of experiments, but it was not till the spring of 1765 that he made the grand discovery to which he owes his fame We quote his words as given by Mr Smiles at p.79 :—

I had gone to take a walk on a fine Sabbath afternoon. I had entered the green by the gate at the foot of Charlottestreet, and had passed the old washing-house I was thinking upon the engine at the time, and had gone as far as the herd's house, when the idea came into my mind that as steam was an elastic body it would rush into a vacuum, and if a communication was made between the cylinder and an exhausted vessel, it would rush into it, and might be condensed without cooling the cylinder I then saw that I must get rid of the condensed steam and injection water if I used a jet, as in Newcomen's engine Two ways of doing this occurred to me First, the water might be run off by a descending pipe, if an off-let could be got at the depth of 35ft. or 36ft., and any air might be extracted by a small pump The second was to make the pump large enough to extract both water and air He continued: "I had not walked further than the Golf-house when the whole thing was arranged in my mind."

Thus, after long and patient study, the idea of a separate condenser flashed upon his mind He immediately set himself to work out the idea, by which what had been an atmospheric engine was now become a true steam engine.

Of the difficulties he encountered in constructing a model, some attributable to his inventive power, others to the want of skilled workmen, and proper tools, others to want of means, it is needless to speak at length Owing to these, his first model was only partially successful. Then his "old white-iron man died,' then the beam broke, and he had some difficulty in replacing it But though he persevered manfully, battling against all these difficulties, there still remained to be settled the question of ways and means "What he wanted was capital, or the help of a capitalist, willing to advance the necessary funds to perfect his invention." At length, through the friendly mediation of Dr. Black, Dr. Roebuck, the founder of the Carron Iron Works, and Watt, were brought into communication with each other A partnership was established between them The necessary steps were taken to secure a patent, and the specifications and drawings were lodged in the early part of 1769: Watt, in order to support himself, having in the meantime given up his business and taken to land surveying, devoting what leisure he could to improving the engine. Among this class of business, may be mentioned the survey of the Monkland Coal Canal, of the Crinan Canal, of a canal between Perth and Cupar Angus, and other engineering works. In 1773 he lost his wife, and at the same time Dr. Roebuck found himself in a hopeless state of bankruptcy. Then it was that Mathew Boulton, the son of a silver-stamper and piercer, born at Birmingham in 1728 who had succeeded to his father's business in 1759, and had greatly enlarged it by building the Soho works, took Dr. Roebuck's two-third share in Watt's engine, as a set off to a debt of £1,200. The model was accordingly packed up and removed to Soho, whither in May 1774, Watt, having completed the survey of the Caledonian Canal, followed likewise But before Boulton consented to launch his capital in the further prosecution of this enterprise, he was anxious to secure the invention from pirates, and after a time an Act of Parliament was passed in May. 1775, though not without opposition from the mining interest, extending the patent for a further term of twenty-four years Then the manufacture of engines was set about in earnest. But difficulties, chiefly of a financial character, beset them at the outset. The new plant required a vast outlay, and Boulton, we are told, expended quite £40,000, before a single penny of profit was returned Here it was that his wonderful energy, his fertility of resource, his good business capacity, stood the partners in such good stead. We never now read a line from Watt, which does not exhibit his querulousness, in striking contrast to the genial manner of Boulton, who once is provoked to write of his partner complainingly to his friend Matthews in London.

The firm, however, had overcome all difficulties. Attempts were made to upset or invade the patent, but inflicting little or no harm. The outlay on this and other inventions of Watt's, such as the rotary engine and the letter-copying machines, was amply reimbursed, the royalty was more and more remunerative, and orders still poured in for engines, and Boulton, later, applied them to coining with great success. Thus having reached a high state of prosperity, the partners Watt and Boulton afterwards take a less direct part in business, leaving the more active duties to the sons James Watt and Matthew Robinson Boulton At length Boulton dies in the autumn of 1809, at the age of eighty one, Watt surviving him till 1819. Both are buried in Handsworth Church, where also lie the remains of William Murdock, who plays no inconspicuous part in these pages—*Smiles' Lives of the Engineers.*

PRIZES FOR A NEW METHOD OF PRESERVING PLASTER CASTS

The Prussian Government has offered two prizes of the value of about £150 (3000 marks) and £500 (10,000 marks), respectively, for the discovery of a new method of cleansing plaster casts, statues, &c, and for the invention of a new material possessing the advantages of plaster, but which will not deteriorate by repeated washings.

The first prize of 3000 marks is offered for a method which will give plaster casts the power of resisting periodically repeated washings, without injuring in the least the delicacy of the form or the tint of the plaster.

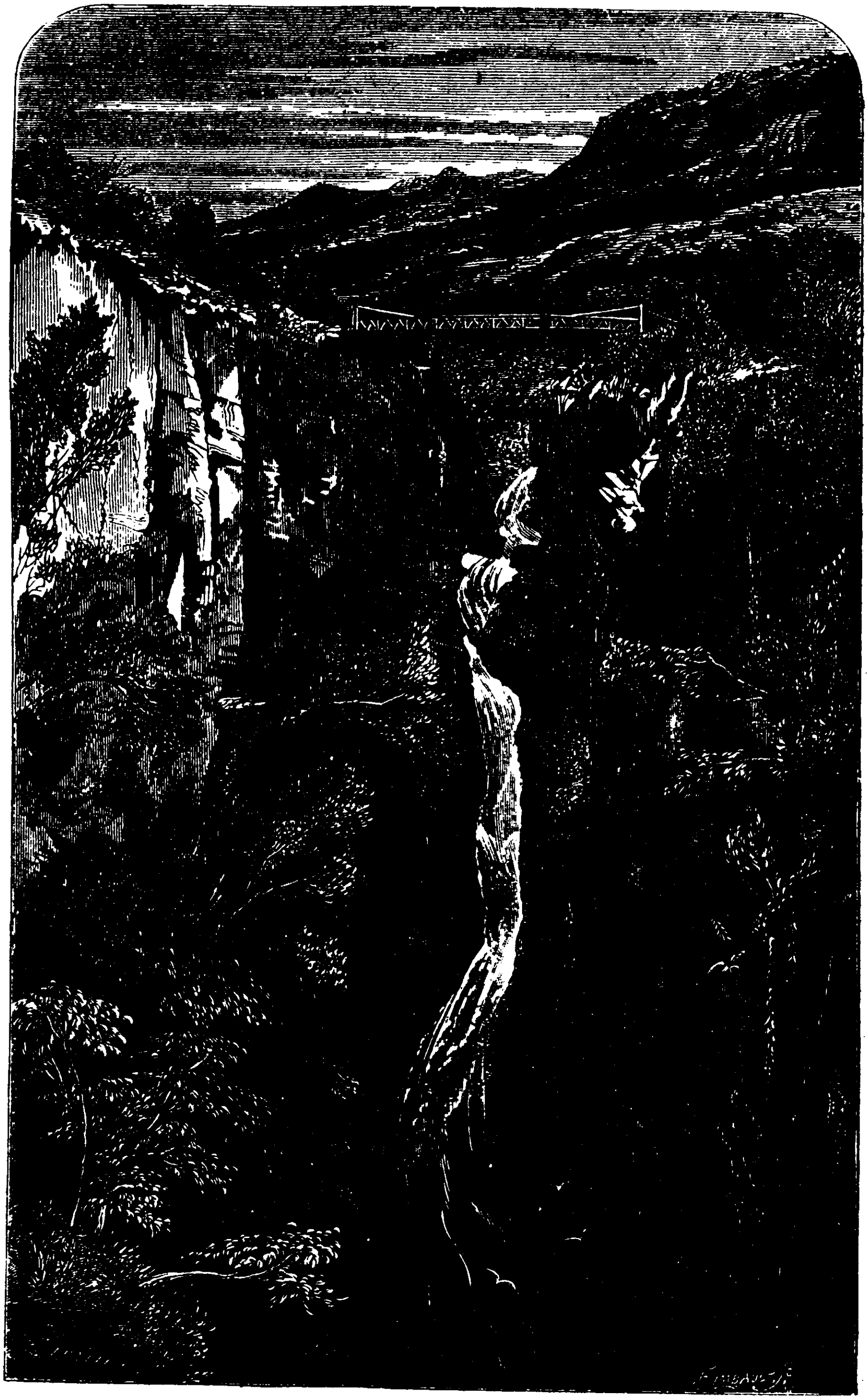
Special conditions—(*a*) The method must be applicable, in equal degree, to all kinds of plaster occurring in trade, and must not diminish the hardness of the cast (*b*) In order to entirely preserve the delicacy of the form, those materials are absolutely excluded which do not soak into the plaster. (*c*) It is not necessary to preserve the original colour of the plaster. a yellowish tint, or any warmer tint, may be allowed; but the evenness of the colour is, at any rate, indispensable. (*d*) Plaster casts prepared according to the method must stand repeated washings with soap and lukewarm water (*e*) The method must be applicable to plaster casts of any size and shape. (*f*) Competitors for this prize are to prove the practicability of their respective methods by sending samples; and, if desired, by preparing casts placed at their disposal.

The second prize of 10,000 marks (about £500) is offered for a material for making casts of art works possessing the advantages of plaster, but which, without any special preparation, will not deteriorate by periodically repeated washing.

Special Conditions.—(*a*) The new material must easily allow castings in original moulds without their becoming more injured than with plaster, and it must reproduce the mould as exactly as plaster. (*b*) It is not required that the material should have the colour of plaster; a yellowish tint, or any warmer tint, may be allowed, but the evenness of the colour is indispensable. (*c*) The solidity of the material must not be less than that of plaster, so that it may be used for the largest casts. (*d*) Casts made of this material must stand repeated washings with soap and lukewarm water. (*e*) The price of the material must not considerably exceed that of plaster, and the price of the moulds for casting must likewise not considerably differ from that of plaster moulds. (*f*) Competitors are to prove the practicability of their material by sending samples in applied and unapplied states, and also to give proof, if required, by the actual execution of casts.

General conditions referring to both of these prizes.—The Ministers reserve to themselves the nomination of a committee of experts, in order to examine the consignments which may be received Competitors are to send with their consignments sealed envelopes, provided with mottoes, and containing the names of the senders. On the outside of these envelopes also is to be written the address to which the returned samples or any communications are to be sent. The consignments which have been found to correspond with the conditions stated above will become the property of the Government, and the names of the successful competitors will be published. The remaining consignments will be returned to the addresses given on the envelopes. Competitors are to forward their consignments to the Royal Prussian Ministry of Public Worship, Instruction, and Health (Konigl. Preussisches Ministerium der geistlichen Unterrichts, und Medicinal Angelegenheiten), not later than 31st December, 1875.

INDIA-RUBBER SIDEWALKS.—The *National Car Builder*, U. S., says:—India-rubber sidewalks are coming into fashion out west. For small towns they are admirable—combining economy with durability. The first experiment was made in Danville, Iowa, where 300 yards were put down on one of the principal streets All the boys in the place ran over it, but there was no noise. A leading merchant stopped in front of his house, then jumped on his heels. The elastic forces hidden in the rubber threw him over the gate to the roof of the piazza. But after a few trials he was able to alight on the steps with the graceful accuracy of a flying squirrel. The chief drawback to the walk is its odorous familiarity in hot weather, but it can be neutralised by a weekly wash of borax and coal tar. Its principal advantage is that it can be stretched. As the town grows, it is pulled out toward the suburbs. Two yoke of cattle can lengthen it three miles a day.



MINIATURE FOOT BRIDGE.

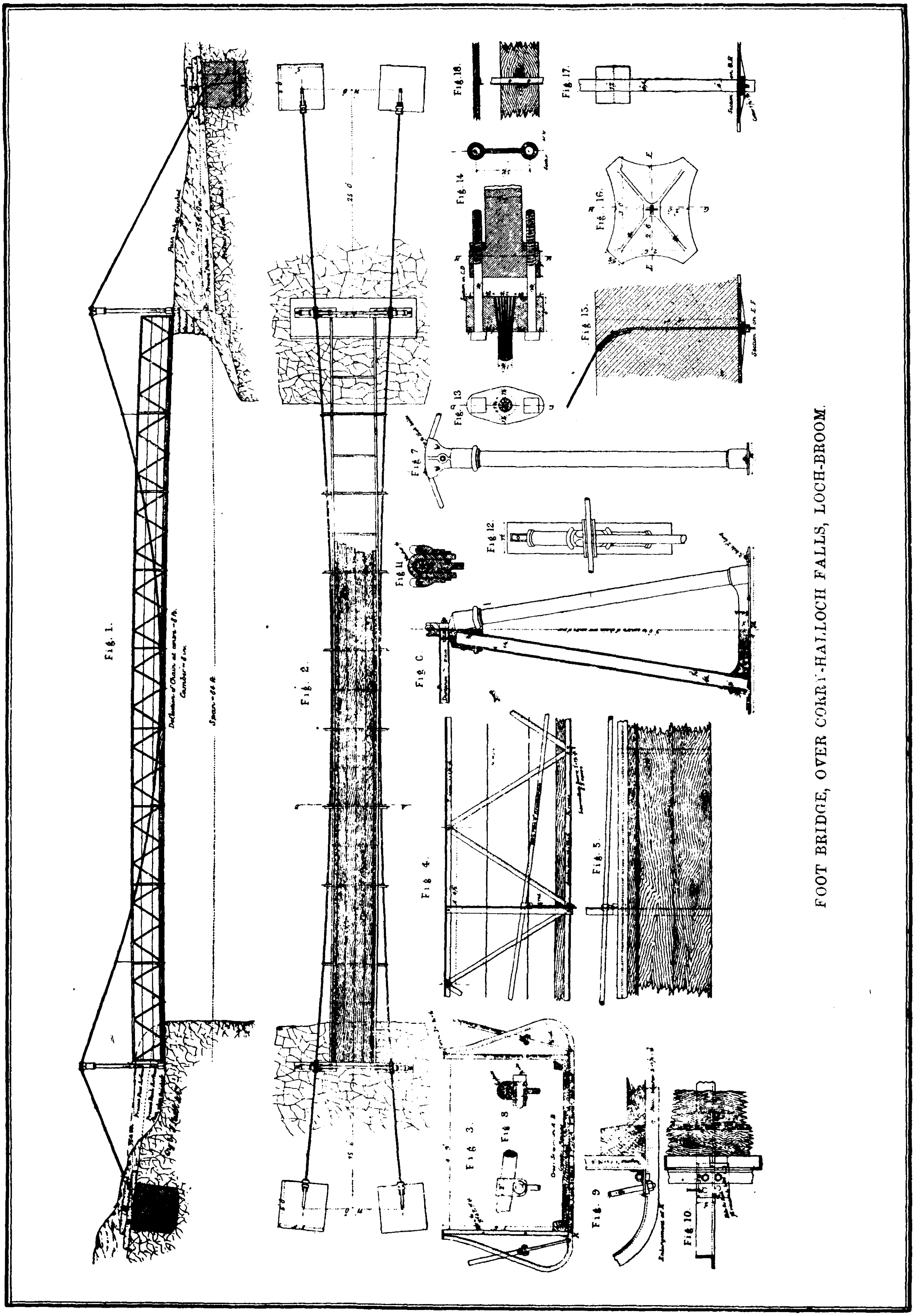
We illustrate from *Engineering* by a perspective view on this page and by an engraving on page 205 a small foot bridge recently erected over a gorge in Scotland.

The bridge, though small in size and cost, meets all the conditions of the case and of numberless other cases.

The little bridge forming the subject of the present notice is fortunate in being placed at a spot which, for combined picturesqueness and grandeur, is probably unsurpassed in the Highlands, rich though that district be in such associated charms. A huge longitudinal fissure in the mountain-side, a mile or more in length, and from two to three hundred feet in depth, forms the channel of the river Broom, and across the gorge—at the point where the river takes a sheer leap downwards of a hundred feet at least—the bridge is thrown. At such a height, and with such surroundings, the structure looks little more substantial than the telegraph wires which span our streets and leap from roof to roof in our cities. Indeed the local inhabitants for some time hesitated to entrust themselves to the apparently frail work, although at present experience has dissipated their doubts, and not unfrequently the passing coach pulls up to enable the passengers to run down to the bridge and view the boiling cauldron of water over which it is suspended. The rigidity of the bridge is, indeed, no less satisfactory to the nerves than are its general outlines and slight proportions pleasing to the eye. No sensible deflection or undulation is experienced, and it is probably to this consideration, coupled with the economy of the design, that the decision of the local authorities at Inverness to erect a similar bridge 200 feet in span across the river Ness is due.

The drawings given by us are in such detail as to enable us to dispense with a full verbal description of the design. It will be noted that the lateral stability required to enable the bridge to sustain the gusts of wind blowing up the gorge is attained by splaying out the wire ropes from the centre of the bridge to the anchorages. The necessary vertical rigidity is furnished by the triangulated handrail girder, and it will be seen from the drawings that the latter is stiffened to resist outward pressure by carrying up every alternate floor bearer in a curved form to the tee-iron top rail. The piers are very simply framed of ordinary cast-iron pipes, socketed into head and foot plates, and the end of the wire rope is secured in the tapered hole in the cast-iron crosshead partly by bending back or doubling the wire strands and partly by the insertion of wedges. The arrangements for taking up the slack of the rope and the other details are sufficiently obvious from the drawings, so we need only add that the weight of wrought iron in the bridge is 32 cwt., of cast iron 31 cwt., of wire rope 7 cwt.

THE members of the International Conference on the metric system assembled last week and signed the agreement between the various States, as well as that relating to the perpetual institute to be established at Paris.



FOOT BRIDGE, OVER CORRY-HALLOCH FALLS, LOCH-BROOM.

MECHANICS' MAGAZINE.

MONTREAL, JULY, 1875.

ILLUSTRATIONS:

CONTENTS:

DOMESTIC MOTORS.

No sooner is one human want supplied than another springs up to take its place. We have now our washing machines, our sewing machines and our patent knife cleaners but still unsatisfied we cry out for a small engine to work these useful servants and to be of use in many ways that will appear when once such an engine has been invented. At first sight it may seem a simple matter and one that would call for not much exercise of the inventive faculty but the fact is that it will be by no means an easy matter to fulfil all the conditions required to be fulfilled by a motor of this nature, and this may be argued to some extent by the failure of several attempts already made in this direction. We find the conditions clearly and briefly stated by a contemporary. They are as follows:

In the first place, then, a domestic motor must be safe—that is, it must be absolutely free from risk of explosion, or fire. In the second place, it must be generally applicable. In the third, it must not be likely to get out of order. Fourthly, it must be perfectly under control, and require no special skill to manage it. Fifthly, it must be cleanly in its operation, and lastly, it must be cheap. One or two minor requirements might be stated, but we believe we have enumerated all that are essential.

It is manifestly not impossible to accomplish all that is here demanded and under certain circumstances it would be by no means difficult. For instance, here in Montreal where we have a constant supply of water under pressure it would be no very difficult matter to use it for the purpose Small turbines might be built and placed in rooms where power was needed—they would take up but little room and would be the beau ideal of a domestic motor, cheap, noiseless, perfectly safe, under perfect control and absolutely clean and free from smell. This motor however would not be available in all towns or in country places For these an engine of some other kind would have to be devised. We have already, in these columns, described a petroleum motor designed to occupy a position somewhat analogous to that we are now considering but as yet it is not sufficiently tried to enable any decision on its merits to be arrived at. Small steam engines are now being constructed in London for driving sewing machines These little engines are on the oscillating principle and are said to be extremely simple, and well made. Steam is supplied by little vertical boilers, heated by a Bunsen burner or ring. No chimney is required, and the exhaust steam is carried off by india-rubber pipes. Although the pressure used is low and the boilers small, the arrangement cannot be pronounced quite free from danger, and the heat and smell inseparable from the use of steam and the difficulty of satisfactorily disposing of the exhaust, must always tell against the popularity of this, or any other form of steam engine, as a motor suitable for drawing-room use, although it would, no doubt, prove serviceable in tailoring establishments, and other places where a considerable number of sewing machines have to be worked, and it would probably do good service in small laundries.

Hot air seems to be the favourite motor at present suitable to the circumstances. It would be a safe, noiseless motor and the hot air discharged could easily be got rid of or even rendered serviciable in ventilation. These hot air engines could be made very small and yet quite powerful enough for the purpose and the cost need not be great. Once a pattern engine has been constructed and proved to be successful it can be reproduced at small cost, especially if the demand should grow, as it would in all probability, to dimensions rivalling those of the present sewing machine trade.

STANDARD MEASURES.

A very interesting and instructive lecture was given lately by Dr. Tyndall, on "Whitworth Planes, Standard Measures and Guns." The first part of the lecture was a sketch of Sir Joseph Whitworth's career, and in the course of this the lecturer stated that Sir Joseph had from the first kept one object steadily in view in the manufacture of machinery and tools, that object being mechanical veracity. The starting point in obtaining this veracity had been the making of a true plane which should serve as a primitive test by which to ascertain the untruthfulness of incorrect work. After the planes had been made perfectly true, if placed one on the other and pressed by the hand they would adhere. According to Sir Joseph's theory, the air was entirely displaced from between the metallic surfaces of the planes, and the two masses of metal were retained in contact by reason of the pressure of the external atmosphere. Dr. Tyndall stated that he had doubted that theory, and rather attributed the cohesion to molecular attraction, In order to test the correctness of his views, he had placed a pair of Whitworth planes in contact under the air-pump, and, after obtaining a perfect vacuum, the plates still remained in contact. This experiment the lecturer repeated before the audience. A pair of planes in contact each weighing 3 lb, were suspended in a vacuum which shown to be nearly perfect To the bottom of the lower plane 12 lb. of lead was attached, giving a total weight of 15 lb. suspended from the upper plane simply by molecular attraction arising from mechanical truth. The lecturer then explained to his audience the construction of two measuring machines, one of which measured to and recorded the ten-thousandth part of an inch, while the other was equally effectual in ascertaining the difference of the one-millionth part of an inch. Dr. Tyndall next proceeded to describe the Whitworth rifle, with its hexagonal bore and hardened bullet, and with which such splendid results of range, accuracy and penetration had been obtained. He pointed out the superiority of the modern elongated projectiles over the old spherical bullet and shot, and explained the reasons for the advantages gained. He described Sir Joseph's system of polygonal rifling for heavy guns, and illustrated the results of the system as applied to light artillery by some remarkable examples of iron penetrated in some cases partially and in others wholly by Whitworth shot. He concluded an interesting discourse by paying a tribute to the talent and genius of Sir Joseph Whitworth.

THE TEACHING OF PHYSICAL SCIENCE.

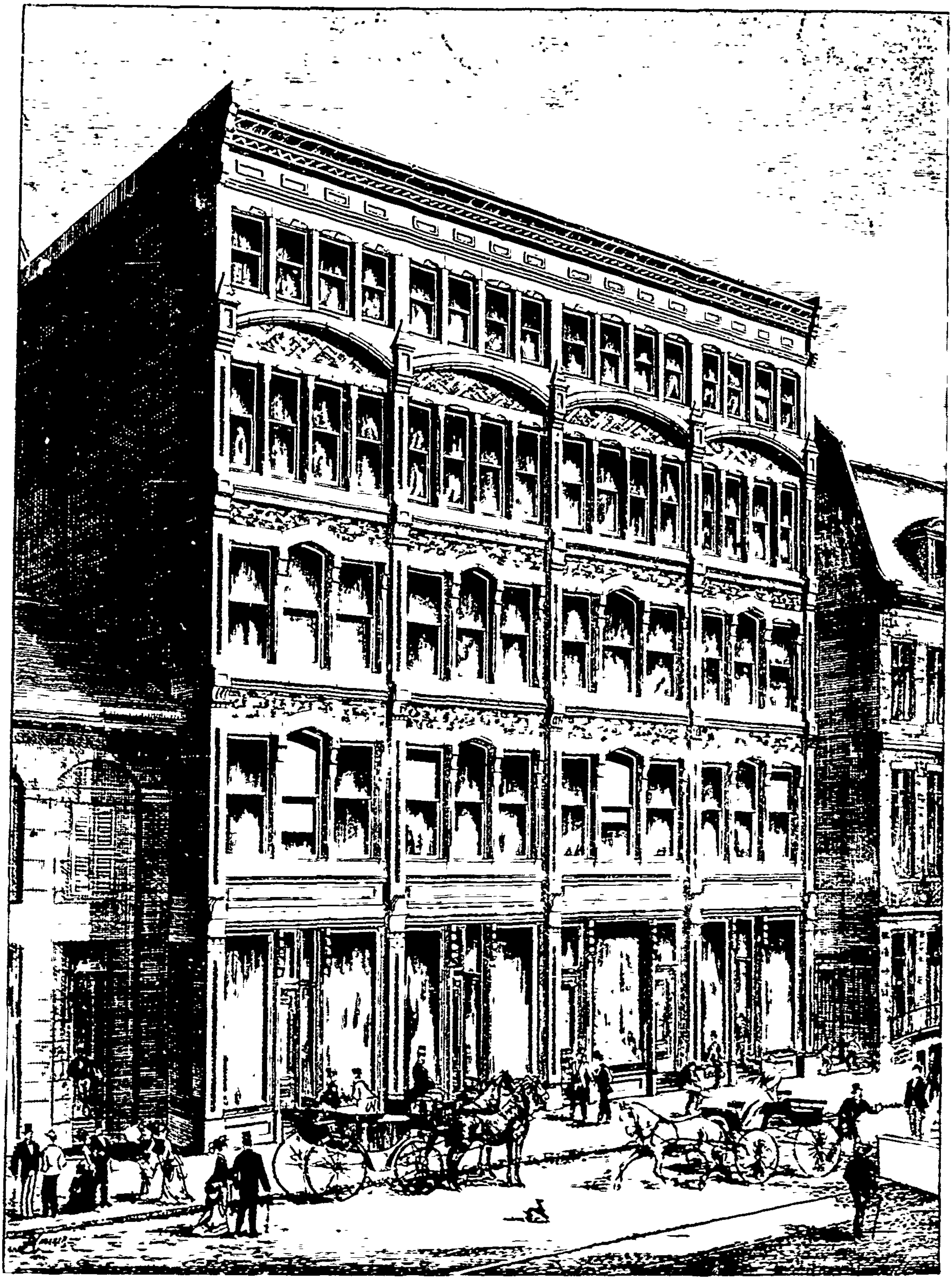
It is very reassuring to a student and a lover of the human race to note how much the present day is one of advancement for schools—how these foundation layers of the human mind are gradually being developed and improved—how the people jealous of what they recognise to be at least one of the most important trusts in any community are surely taking it from the hands of special bodies of men and making it part and parcel of their ordinary municipal institutions, with the avowed object of looking after it themselves and seeing that the work which they know decides the future of their race shall be thoroughly and properly done. It is, moreover, still more reassuring to one who watches these things closely to see how the people in doing this have not, as might have been expected from their technical ignorance of the subject, insisted on leaving undone many things which ought to have been done, or done many things which ought to have been left undone. Not long ago we showed what was being done in public schools in the way of free-hand drawing and designing. The study of this eminently practical and useful subject has been carefully attended to in municipal schools in England, in the New England States and here in Canada and we see in a daily contemporary of this city a long list of prizes given by citizens and awarded to successful competitors among very young children in the common schools of this city. This, however, was not the subject we wished to draw special attention to just now.

There is another subject which is taught to some extent in some of our schools, which is very useful and very interesting but somewhat difficult to teach. We allude to Physics or as it might be called the Laws of Nature. There is some little difficulty to be experienced in teaching this subject since it is not one of those directly practical subjects which when learnt enable the learner to convert his knowledge immediately into ready money, as in the case of bookkeeping,&c Its real practicability, however, and the necessity there exists for its being taught will be immediately recognised when one calls to mind the absurd statements and ridiculous arguments one is often forced to hear uttered by men and women who believe themselves to be pretty well educated. The writer can call to mind several cases of this kind, especially some having reference to floating bodies, any of which could have been refuted and explained by boys or girls of twelve years of age who had been for a few months in a class in which Physics was taught by a good teacher. The effect upon the minds of the scholars of a well arranged series of lessons, with simple experiments, the simpler the better, on this subject can hardly be imagined by an outsider The knowledge gained lies at the root of many other studies and sciences and enables the scholar to reason logically upwards to the elucidation of laws and facts which under other circumstances he would have had to accept on the ipse dixit of his teacher. This might easily be expected in the case of such subjects as physical geography, hygiene and others but its effect really reaches much further, and the mind accustomed to enquire into the innermost relations of things of one kind does so in the case of those of another kind with a certain amount of confidence. It is hard to say how soon this subject may not be taught to children, but as they go on and get old enough to make the tools and implements themselves for the class experiments, it becomes manifest how their knowledge is really part of themselves more than in any other subject, so interested do they become in the experimental enquiries wherein they find their answers for themselves. It is not easy to overestimate the value of training such as this for those who are to become the skilled handscraftsmen of a country. A clerk or a bookkeeper may get along well enough in his business without much or any knowledge of this kind but to the skilled mechanic the mental training and the knowledge acquired in investigating these laws is of very great importance—it lifts him at once from the condition of helpless dependence on rule of thumb and makes him, even in some of the most ordinary callings, a practical natural philosopher. In advocating the teaching of this subject in our common schools we speak from experience when we say that we know of no other subject in the curriculum of our schools which expands so fully and rapidly the mind of a child as this one—no other which seems to have so general an effect on the mind as shown by a quicker perception of relations of all kinds, and a more rapid and certain intuition of where to look for a cause of an effect, or for an effect of a cause. We should be glad to learn that the subject was taught more or less in every school in the land and there is no reason why it should not be so taught. The effects of these laws are manifest at all times and wherever we turn. Experiments quite sufficient for the purpose can be improvised with the most ordinary materials by any teacher who will take the trouble, and we are assured that he will find himself quickly repaid by an increased intelligence in his pupils greater in proportion to the amount of labour expended than he had anticipated, and greater also than experienced as the result of an equal amount of labour expended in teaching any other subject.

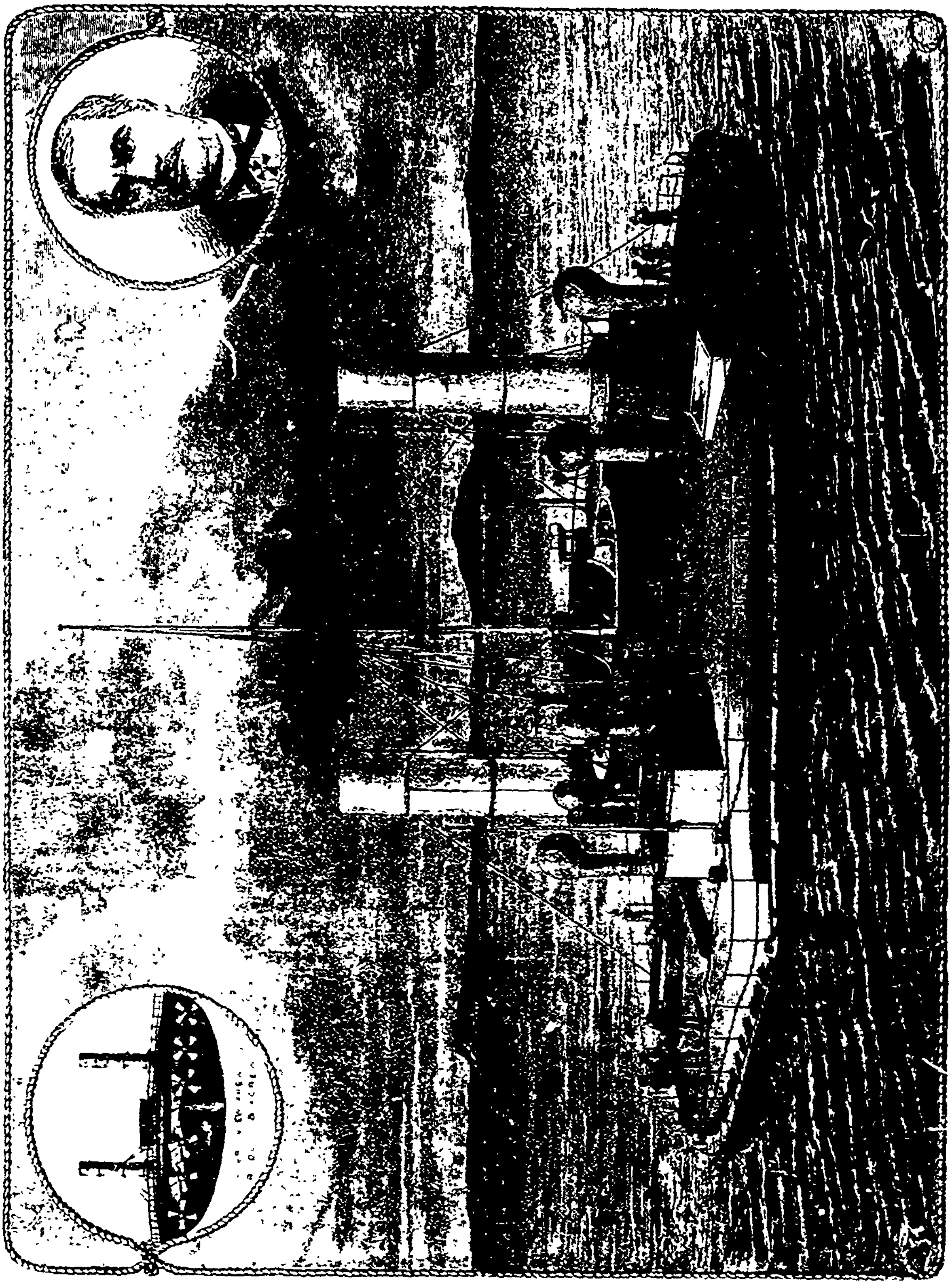
SIR WILLIAM LOGAN LL.D., F.R.S., F.G.S.

Canada has been fortunate beyond the lot of most young countries in profiting by the services of men of ability in science, but there is none to whom she owes a greater debt than to him who has just passed away. To Sir William Logan we owe much of the information we possess as to the hidden riches of the Dominion and to his abilities and to his energetic labours are mainly due the high condition of efficiency and usefulness of the Canadian Geological Survey.

The great importance of this Survey, and the high value of the results of Mr. Logan's investigations are too well appreciated to require further remark here than to say that the highest authorities have spoken of both in terms of unqualified praise. His "Geology of Canada," embracing the results of all explorations between 1858 and 1863, and the "Atlas and Maps to accompany the same" have been the subjects of much flattering comment in scientific circles. In acknowledging copies thereof, Sir Roderick Murchison, in a letter to the Hon. Mr McDougall, then Provincial Secretary, said. "In thanking "the Government of Canada for this mark of their consideration, I must assure you that those works are of the highest



NEW OFFICES OF THE BURLAND-DESBARATS LITHOGRAPHIC COMPANY.



THE RUSSIAN CIRCULAR IRONCLAD "POPOFFKA NOVGOROD" "importance in the advancement of Geological Science,as well "as of Physical Geography, and that in a new edition of my "work "Siluria," which is in press, I shall endeavour to ren- "der full justice to their merits." The London *Saturday Review* speaking of the work says .—"No other Colonial Survey has "ever yet assumed the same truly national character, and the "day may come—if ever the Imperial Colony shall claim "and attain independence—when the scientific public of a "great nation, looking back upon the earlier dawnings of "science in their land, shall regard the name of Logan, a na- "tive born, with the same affectionate interest with which "English geologists now regard the names of our great geolo- "gical map-makers, William Smith, and de la Beche."

William Edwards Logan was born in Montreal in 1789, where his education was commenced, and afterwards complet- ed at the University of Edinburgh. In 1829 he accepted the management of a Copper Smelting Work at Swansea and at the same time superintended his uncle's interest in a neigh- bouring coal mine. During his residence in South Wales he performed a work which was declared by the first scientific men in Europe, to be "unrivalled in its time, and never sur- passed since." This great work was his Geological Map and Sections of Glamorganshire Coal Field, the minuteness and ac- curacy of which were such that when the Government Survey, under Sir Henry de la Beche, came to South Wales not one single line drawn by Mr. Logan was found to be incorrect and the whole was approved and published without alteration."

Mr. Fleming also mentions that Mr Logan's system in fol- lowing out the details of the Coal Field was so much superior to any formerly in use, that it was adopted by the British Sur- vey, and "Mr. Logan's Map may be said to be the model one of the whole collection." Mr. Logan, with characteristic devotion to Science, and forgetfulness of self, presented these fruits of his labours to the British Government without fee or remuneration. About this time Mr. Logan also contributed some interesting papers to the Geological Society on "Stig- maria beds," or "under clays" of the Coal Fields, which had come under his observation; and shortly afterwards he visited the coal fields of Pennsylvania and Nova Scotia,and gave the re- sult of his observations in a paper read before the same Society. In 1842, appeared in the *Transactions of the Geological Society*, (Lond.) a paper from Mr. Logan "On the packing of the Ice, in the River St. Lawrence: on a Landship in the modern de- posits of its Valley: and on the existence of Marine Shells in these deposits as well as upon the Mountain of Montreal." So deeply was Mr. George Stephenson impressed with the impor- tance of Mr. Logan's remarks "On the packing of the Ice on the River St. Lawrence," that according to Mr. Sandford Fleming, he (Mr. Stephenson) was "materially guided thereby in reference to the construction of the great Victoria Bridge." It thus appears that nearly a generation since, Mr. Logan had reached a very high rank among men of Science.

In 1842, it having been resolved to institute a Geological Survey of the Province, and the Legislature having appropri- ated a sum of money for the purpose. Mr. Logan was recom- mended by the most eminent Geologist of Great Britain for the Directorship; and the late Earl Derby (then Colonial Se- cretary) applied to him to accept the office. Mr. Logan then came to Canada, and after making the necessary preliminary arrangements with the Government, returned again to Britain to complete his preparations for entering on the work. The following year, 1843, having completed his staff, he commen- ced the systematic prosecution of these Surveys which have since been uninterruptedly maintained up to the present time, to the advancement of Geological Science and the great benefit of Canada.

In 1851, Mr. Logan was appointed a Commissioner to the Great Exhibition in London where, by his display of Canadian Geological specimens, he attracted much attention to the Co- lony. He was again a Commissioner to the Paris Exhibition in 1855 when he received from the Imperial Commission the grand gold medal of honour, and was created a knight of the legion of honour. In 1856 he received the honour of knight- hood from the Queen, and the same year was awarded by the Geological Society, of which he was a member, the Wollaston Paladium medal for his eminent services in geology.

In 1862, he again represented Canada at the London Exhi- tion and was one of the jurors on the class devoted to miner- rals. Such were some of the labours and some of the honours of him who for twenty seven years directed the Geological Sur- vey of Canada.

For the above facts we are indebted to Morgan's Bibliotheca Canadensis and to Fennings Taylor's Biographical sketches. The portrait is from a recent photograph by Notman.

CARPENTER AND JOINER.

We call the attention of our readers to the very useful and practical information on this subject on page 195, and to that on page 222. The latter is more especially intended for home reading for children, but will be found to convey information useful to some children of a larger growth. For the former, we are indebted to a work reviewed by us some time ago. "The Carpenter, Joiner and Hand Railer, Dawson Bros., Montreal."

TORPEDO WARFARE.

A very interesting paper on the subject was recently read before the English Institution of Naval Architects by A. Sedgwick Woolley Esq.

Before discussing the nature of the plans now before the public, Mr. Woolley gave a short sketch of the origin and his- tory of this form of warfare.

The first idea of an offensive attack by means of a boat spe- cially constructed to carry a torpedo seems to have originated with Captain David Bushnell, of Connecticut, about the year 1775, but it had little in common with the boats now used for the same purpose. This boat, an account of which was read by the inventor before the American Philosophical Society in 1798, was only intended to accommodate one person, who sat in a water-tight chamber capable of containing sufficient air to support him for thirty minutes, and who could cause the vessel to descend and ascend at will by letting the water into a chamber below him, or expelling it thereform by means of two brass force pumps, at the same time letting fall about 200 lbs. of the lead by which the vessel was ballasted at the bottom. The boat was propelled by an oar and guided with a rudder, and had an iron tube fixed to its crown capable of slid ing up or down through a space of 6 inches. A rod passing through this tube carried a wood screw which could be fast- ened into the bottom of a ship by turning the rod, and then cast off by unscrewing the rod again. A rope was extended from this screw to a torpedo, placed on the top of the boat, which could also be cast off in a similar manner, and thus left hang ing below the ship. The torpedo was fitted with a clock which could be set so as to release a lock after any given time and fire the powder. An attempt was made with this boat to blow up the English 64-gun ship Eagle during the campaign of 1776, but the operator from some reason or other was un- able to fix in the screw and had to desist from the attempt. Soon after this, the ship on which the torpedo boat was carried was sunk by the British, and no other boat was built at that time on the same principle.

The celebrated Fulton was the next who devoted much attention to the subject. His plans, however, were not well received and nothing came of them.

Stationary torpedoes were employed during the Crimean War for the defence of Sebastopol and Cronstadt, but the Russians, probably deterred by the ill-success of all former offensive torpedo boats, did not attempt any trials with them, and it was not until during the Civil War of America, the Southern States, being overpowered by the force and resources of their adversaries, resorted to a most extensive employment of torpedoes, that the power of this species of attack was developed.

The first of these attacks was made off Charlestown, against the U S. war vessel Ironsides, by a cigar-shaped boat under the command of Lieutenant Glasselle, with a crew of three men carrying a torpedo containing 60lbs. of powder at the end of a spar. Not knowing the action of the explosion, and thinking that their boat would probably be sunk by it, her crew jumped overboard before ramming. The explosion, through severe, failed to effect any hole in the bottom of the Ironsides, the boat was also uninjured, and was found drifting half full of water by her engineer, who climbed into her, made up his fires, and steamed back safely to Charlestown.

The Housatonic also was sunk by a torpedo boat, the boat however, going down too Other successful attempts were made and both sides were employed in preparing special spar torpedo boats when the war terminated. Just before the close of it, however, a remarkable attack was made, in the James River, on the merchant vessels which had brought supplies to Grant's army, by the Confederate fleet of three iron-clad rams and seven gunboats, all armed with torpedoes, fixed on the end of spars, 30 ft. or 40 ft. long, which projected from their bows, and could be raised or lowered by a tackle. This fleet was stopped by a boom, and two of the iron-clads got aground, where they remained all night, under fire from the banks; but although their torpedoes were completely riddled with rifle shot, not one was exploded, as it so happened that the fuses were in no case struck The Southern States had throughout employed percussion fuses, which were exploded on contact, the shape of their torpedoes being cylindrical with hemispherical ends, into which seven fuses were inserted, as shown in Fig. 24, these fuses (shown in Fig. 3) consisted of a cap of lead *a*, containing a glass tube *b*, filled with sulphuric acid, and surrounded with a mixture of chloride of potash and white sugar *c*, communicating with a primer *d* of mealed powder, on contact, the lead cap being crushed, the glass bottle was broken, and the sulphuric acid ignited the chloride of potash and sugar, and fired the torpedo. The danger of a torpedo, furnished with these fuses, being exploded by contact with any floating log of wood or boom, before reaching the enemy's ship, and the extreme caution required in handling it, led the Federals to adopt a torpedo made as shown in Fig. 4, which could be detached from the spar, and having an air chamber provided to keep it nearly vertical when so detached, a tube being placed in its centre, at the upper end of which an iron ball was kept in position by a pin; this pin was released by means of a rope, leading into the boat, and dropped on to a cone of fulminate.

But, as it has been found that unless the torpedo is actually in contact with the side of a vessel, there is a great chance of the explosion failing to blow it in, since it will always take the line of least resistance, the plan of firing at will has the disadvantage of being left entirely to the discretion of the operator, who in the darkness of the night, under cover of which these attempts have to be made, may easily miscalculate the distance he is from a ship, and so fire his torpedo too soon. To obviate the evils of these forms of fuses, Captain McEvoy, of the London Ordnance Works, who had had great experience with the contact torpedo system of the Southern States, invented the mechanical fuse A, shown in Fig. 5, provided with the safety cap B; but being afterwards impressed with the advantage arising from the use of electric communication, he invented, in 1871, the plan shown in Fig 6 This consists of a metal bushing *a a*, having its upper end closed by a thin metal dome *b*, and a metal plug *c* screwed into its lower end. A metal spindle *d* is supported on a spiral spring *e*, inserted in a recess *f* in the plug *c*; a thin insulated bridge *g* is attached to the spindle *d*, under which are two terminals *h h* of insulated wires *i i*, one of these wires is connected with the battery, and the other, to which is attached the electric fuse, has either an earth or other connection with the battery. When the torpedo with this closer attached is projected against a vessel or other body, and receives a shock sufficient to crush in the thin metal dome *b*, the spindle *d* is forced down until the metal bridge *g* is brought into contact with the two terminals *h h* thus completing the circuit of the electric fluid, and firing the fuse. The wires would of course, only be connected to the battery just before the action of ramming It is, however, evident that the thin metal dome might be crushed in through some accident beforehand, and that then, as soon as the wires were connected, the torpedo would be fired at once. To overcome the difficulty there has been substituted for the metal dome *b* one made of india-rubber fixed in a peculiar manner, which would always retain its form and allow the spring *e* to keep the circuit uncompleted.

The torpedo is shaped as shown in Fig. 2, page 212, in order to insure the contact of the fuse with the vessel. Still it is apparent that cases might arise—such as in striking a vessel under the counter—where the closer might not operate In such cases it is very desirable that it should be possible for the operator in the boat to have the power of firing the torpedo at will. To effect this it would seem to be necessary to have a second fuse and two more insulated wires; but as mistakes might arise from unskilfulness on the part of the operator, and the wrong wires applied to the battery, and the torpedo thus be fired before contact, this plan has not been adopted. Captain McEvoy has, however, invented a fresh method, whereby with a single platinum fuse and battery, and one set of wires, the torpedo can be fired either on contact or at will. The details of this plan I am at present unable to give, as it is not considered advisable as yet to make it public. I may, however, state that it is extremely simple and ingenious, and I hope that I shall be able to give a full description of it in our volume of Transactions.

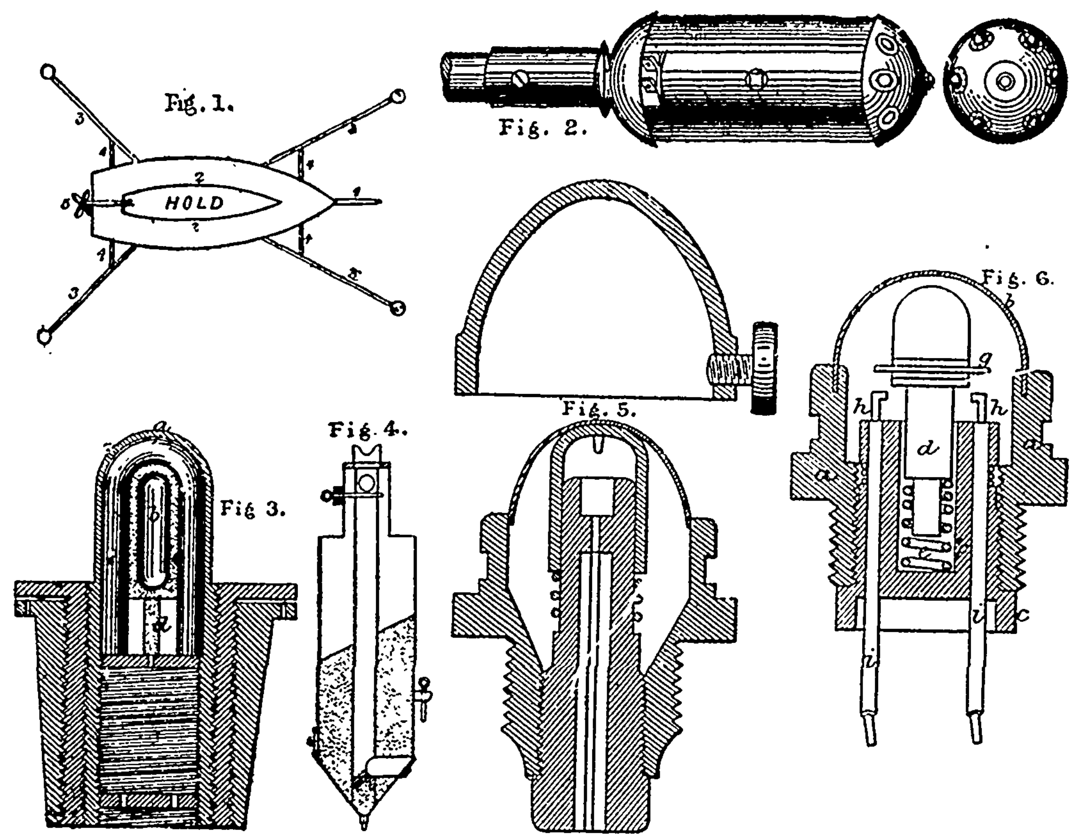
The system of firing shown in Fig 6, is that generally adopted with the torpedoes to be used with the launches which are being at present built for foreign countries. The launches may be divided into two classes, viz, those intended for river service, and those meant for ocean purposes. Fig. 7, page 213, represents a river launch similar to those constructed by Messrs. Yarrow and Hedley, of Poplar. The one shown is 45 feet long and 7 feet 6 inches beam, calculated to have a speed of 14 knots, built either of iron or steel, the plating being ⅛ in at the keel, and $\frac{3}{32}$-inch at the gunwale.

The draught is 3 ft. 6 in., and the freeboard 2 ft. There is a steel turtle-back shield (*g*) forward ⅛-in. full thick to afford protection to the men and steering wheel, and throw off the water which might come on board from the explosion of the torpedo. The engines and boilers are also provided with steel sliding covers The boilers are locomotive, with a total heating surface of 140 ft., the barrel plates being ¼-in. Lowmoor iron throughout, with ⅜-in butt straps inside and out, double riveted, and the engines non condensing direct acting of 55 horse-power, working up to 140 pounds pressure The diameter of cylinders is 6½ in., and length of stroke 7½in. The frames are made of 1-in. angle irons with ¾ in. reverse irons.

The spar *c* for the torpedo is shipped amidships, and can be run out over the roller *c*. A pocket *a*, suggested by Captain Davidson, is provided to allow the spar to have a greater depression than in the old plan of running it out over a roller on the top of the stem Two stanchions *f* provided with pinholes allow of the spar being depressed through an angle of 35 degrees, a noiseless exhaust chamber *k*, preventing the approach of the boat being heard. In this chamber the condensing is effected against a portion of the skin of the boat, the plates there being increased in thickness. It is surprising what a small effective surface is required to condense the steam in cases where the object is simply to condense it in order to avoid the noise, or to get the fresh water back into the boiler, and not with the object of obtaining a vacuum.

The boats built by Messrs. Yarrow & Hedley for ocean work and intended to be navigated in any weather short of an absolute storm, are made on exactly the same principle but with larger scantlings and a greater draught and height of freeboarp

The one at present building for the Dutch Government is 66 ft. long, 10 ft. broad, and 5½ ft. deep. She has a pair of direct-acting inverted engines of 200 horse-power, working up to 130 pounds pressure, diameter of cylinder 11 in., length of stroke 14 in. The boilers are locomotive, with 450 ft total heating surface. It is proposed to fit this boat with a small auxiliary donkey engine to facilitate the working of the spars Those, however, constructed by Messrs. Thorneycroft and Co., are completely covered with a steel deck $\frac{3}{16}$-in. thick over the central portion, and have bottom plating $\frac{3}{32}$ in thick They have surface condensing engines and are fitted with Messrs. Thorney-



TORPEDO WARFARE.

croft's new patent screw propeller. The one just finished for the Swedish Government is 58 ft. long, 7 ft. 6 in. beam and 3 ft. draught, and with an average number of 505.48 revolutions per minute obtained by a mean speed of 17.27 miles per hour.

In our own navy we have as yet not built any special torpedo launches; it being considered that it would be quite sufficient to fit up ordinary ship gigs and launches for this service. The method of fitting these launches hitherto used has been to cover the fore part of the boat with a canopy of canvas, and to work the torpedo spar on outriggers placed on either side of the boat, and to rig it out and in by means of a rope worked from the stern sheets, another rope being attached to the keel of the spar to ease it out and rig it in again.

We have also adopted the electric method of firing at will, and not by contact; but as has before been pointed out, in actual warfare, when attack is made under cover of darkness, it is a very difficult thing to judge exactly when to fire the torpedo; and if the approach of the boat were perceived, as in the majority of cases happened in the American Civil War, she would be met with a fire of small arms, against which the canvas cover would be no protection, and it would be doubly difficult for men in danger of being shot down every moment to keep cool enough to judge accurately the exact moment when to fire the fuse. An expedition with a spar torpedo boat will necessarily always be one of extreme danger, and partake of the nature of a forlorn hope; and it seems but right that everything should be done in such cases, not only to provide every element of success practicable, but also to protect as much as possible the lives of the volunteers who venture in such a service.

HOW TO MAKE AN ECCENTRIC CHUCK.

In the following description I have supposed the workman desirous of making for his own use an eccentric chuck not to be the possessor of a slide rest, but to be compelled to do his best with hand tools and a simple lathe. This will also serve as an answer to a query lately put on the subject, in which some one desired to have given in our paper the dimensions and details of an eccentric chuck for a 5in. lathe, suggesting that probably its extreme diameter will be 10in. Not so; because it must be at any rate less than this from the mandril centre to the end of the slide when fully drawn out. In short, for a 5in. lathe the entire length from the axial line of the mandril to the end of the slide when at its utmost eccentricity must be barely 5in., or it will strike the lathe-bed as it revolves. If, therefore, the chuck is 10in. diameter, the slide could not be drawn out at all. For a 5in. lathe I should be sorry to have an eccentric chuck over 6in. by 4in., and 5in. by 3in. would be, generally speaking, better, because these are heavy affairs, and cause an immense degree of vibration when thrown out of centre and made to revolve rapidly. A 6in. one can be thrown out 1¼in., which is quite sufficient. I once had an iron one of this size on a 5in. lathe, but I seldom used it preferring a 5in. one in brass. In either case solidity is needed, and every part must be accurately fitted, so that there shall be no shake. For a 5in. chuck, to give an eccentricity of an inch and a quarter to an inch and a half, I should use brass castings, the main plate being ¼in or $\frac{5}{16}$in. thick, exclusive, of course, of the boss at the back by which it will be eventually attached to the lathe. This is to be the thickness when faced up on both sides. The form is seldom circular, but similar to the drawing, a slice being cut off each side of the original circle, to reduce the weight. If to be turned on the edge by hand tools only, I should prefer having the plate cast as a circular one, and cutting off these pieces subsequently, owing to its being easier to turn without risk to the tools. If the plate, is cast in the form it is ultimately to have, it need not be turned on the edge at all, but filed up. The first thing to do is to bore and tap the boss, so that it can be mounted at once on the mandril Take care not to have the screw loose, and see to the fit of the shoulder where it abuts against the mandril. Take a point tool or graver, and, beginning at the centre, and working thence towards the edge, face the chuck perfectly true, testing it with a thin straight edge, or the blade of a

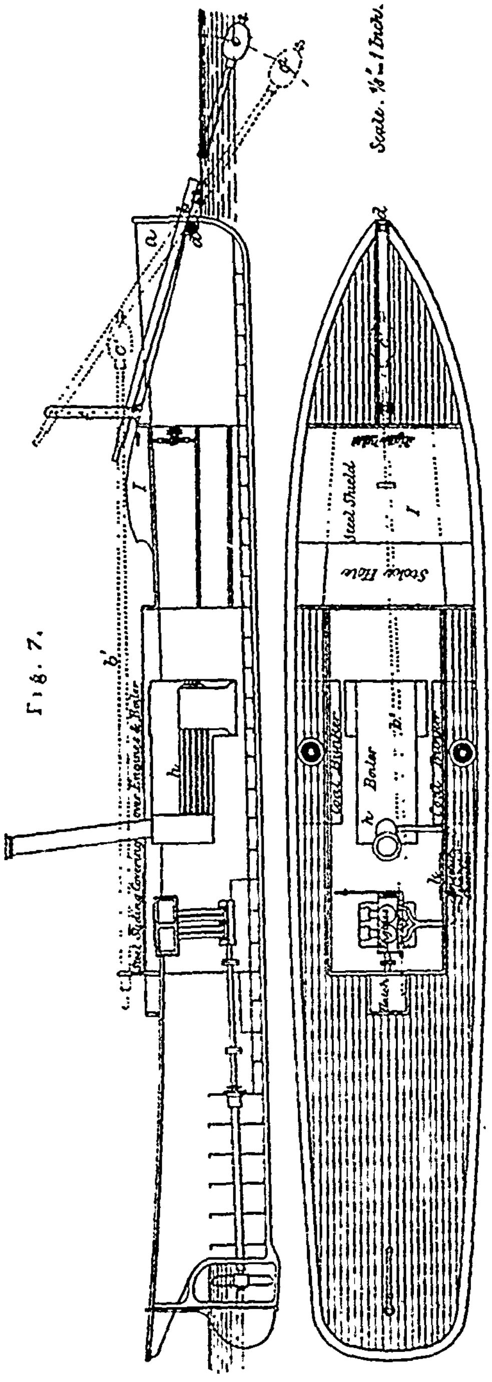


Fig. 7.

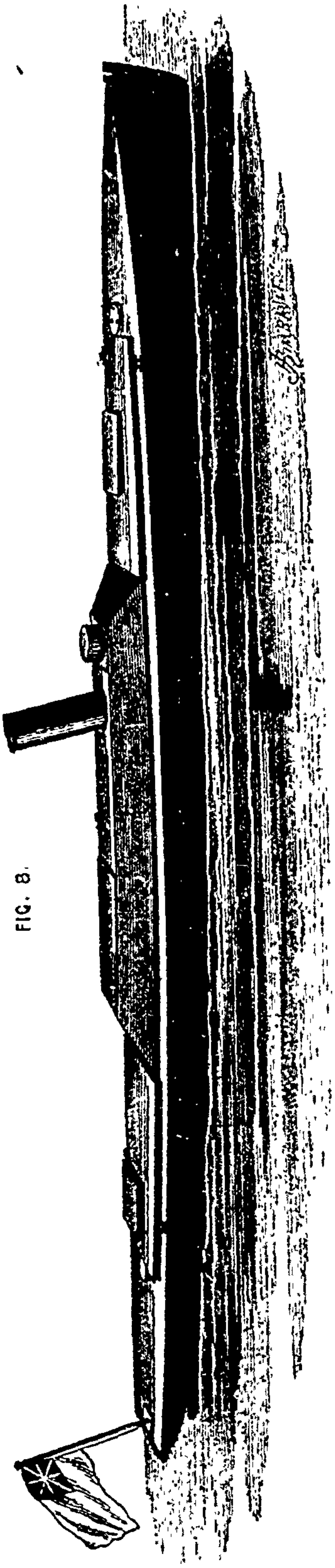


FIG. 8.

TORPEDO WARFARE.

square. Of course, with a slide-rest, this is easy work, but I have often done it with hand tools, finishing with a flat tool, or scraper, to take out the marks of the point tool, and reduce the whole to a level. You must now, with a tool bent over to the right, face up the back of this plate, and turn the outside of the boss, or, if you find it difficult to get at it, owing to its lying too close to the face of the poppit, take it off and mount it accurately upon a face-plate if you have one, and, if not, upon a temporary one of wood, laying the face already turned, upon the chuck, or hollow out a large chuck deep enough to take in the plate (*if you have turned the edge of the curved part at each end*), taking care to level the bottom of the recess, and you can mount it firmly and truly. You may also, if preferred, reverse the whole process thus· Level with a file the face of the casting sufficiently to make it bed "home" upon a face-plate, and clamp it down upon the latter securely, *taking care not to spring it.* Now face the back and boss, and bore and tap the latter before removing it from the lathe Then take it off, and screw it upon the mandril, and trim the other face of it In pursuing this course, should it be necessary to try the screw, take off the face-plate, and do so *without removing the work* ; but if you have a set of taps, and, what is useful in these cases, *a faux nez*, or false mandril, the exact size and pitch of the real one, you can test the fit without even removing the chuck If you intend to file up the curve, you can mark them on the face of the work as you turn it. Be very particular in this first work, and equally so at each step, and you will have your reward. Next prepare the two guide strips of iron or steel, ⅝ in wide and the length of the chuck where they are to be placed. These must be *perfectly* filed up, planed, or ground and scraped until parallel, and truly square at the edges. Take a whole day at one if necessary, but be satisfied with nothing short of accuracy. You can buy such strips as these direct from the rolls, very true and parallel on the broad faces, and by care in filing they may be finished to a uniform bright surface with no great difficulty, provided you take time. The easiest way to work them will be to grasp them by their broad faces in a large vice, *together* first of all, until the edges are somewhat reduced and then to take each separately, and imbed it to half its depth in a block of wood, placing this on the bench and securing it by driving round it into the bench, or gripping the block in a vice. Gauge the thickness with callipers or a plate gauge as you go on, and square up the edges as carefully as you can. One edge of each is now to be worked to a single or double chamfer. Which of the two is used will depend upon circumstances. A double chamfer will need an angular groove in the edges of the sliding-plate ; and these must be cut with a circular cutter mounted on the lathe centres, the plate being clamped in the slide-rest. Very likely my querist has not one of these, and, if not, he will use a single chamfer — Fig. 1, K on plate and guides—using the file only, and a gauge of tin or thin brass to test the angles. The bars may be $\frac{3}{16}$ in. thick, and chamfered to an angle of 45° Perhaps the easiest way to do this will be to file up first of all a length of ½ in. at each end, and then work the rest until even with these. Upon the accuracy of these chamfers and those of the slide the steadiness of the whole, when in use, will depend—and, if unsteady or shaky when complete, sell it to the first rag, bone, and metal merchant you meet, for it will be of no use as an eccentric chuck See, therefore, that these strips also bed well on the brass plate underneath, because it is easy to *force* them down by means of the screws , but if they do not bed level when simply laid upon the lower plate, you can but *bend* by forcing them down, and the sliding plate will not work properly Two screws will hold down these guides, but the holes in them must be lengthened in the direction of their width, to allow of adjustment. It is a common practice to make only one of them thus adjustable, but both ought to be so fitted, or the screw or nose of the chuck will be out of centre the first time the guide-bar is tightened against the slide.

We must now deal with the sliding-plate of brass, $\frac{3}{16}$ in. thick, so as to be flush with the guide-bars when in its place Face this first with file and scraper until quite level on one side at least, that which is to rest against the lower plate. File and square up also the edges, gauging from the face first made, and making the whole plate parallel, and wide enough to barely reach from the lower part of one guide bar to the other when these are in place. This plate will be best if cast with a circular boss upon one face, 1½ in diameter, which strengthens it, forms a bed for the divided circle and nose of the chuck, and can be easily trimmed up true when in its place upon the bed-plate. I have, therefore, drawn it thus, but in details of construction each can modify the design to his fancy. However, we have not as yet chamfered the edges of the sliding-plate. Set off again, as with the strips, a length of ½ in. at each end, and file to gauge, and then, using a new file, work up the whole to these, finishing at last with a very fine one, *but not a very thin one*, because these bend and round off the edges, which ought to be quite flat. If the edges of the plate are first made truly square to the sides, you can take off with a marking gauge the thickness of the plate, and draw a line at that distance from the edge upon the face of the plate. This will make the angle of 45°, and be of great assistance Screw the guides down, gauging their parallelism with finely-pointed compasses, and test the movement of the slide For this, however, let the bars stand as far apart as they are to go when at their greatest distance. When the fit is tolerable, grind with oilstone powder, moving the plate up and down between the bars, and tightening these by the set screws, until the slide works perfectly. Supposing this happily accomplished, a hole should now be drilled ¼ in. diameter, at each end of the plate, into and through the lower plate, and a steel pin should be tightly fitted into each to hold the plates firmly together while the remainder of the work is being done These pins are to be kept for permanent use, as they prevent strain on the leading screw, when any work is being turned up concentrically with the mandril. Into the centre of the slide is now to be drilled a hole to take the end of the central pin upon which the division plate is to turn. This pin should be as stout as there is room to make it, and the form shown, being screwed into the boss of the slide, which boss is made solely to stiffen it and the division plate. The sliding plate being thus held firmly by these two pins, its projecting top is to be nicely turned, the edge being made exactly square to the face If the hole for the centre pin is drilled, but not tapped the back centre may be run up to steady it, its point falling into this hole. Care, however, must be taken not to screw it up so tightly as to enlarge the hole. It should just assist to hold it, and no more. The brass wheel forming the latter is cast with a projecting stud or boss, on which the screw is to be cut, of the exact size and pitch as that on the nose of the mandril, and a hole drilled down its centre, allows it to slip over the pin just described, which it should fit very nicely. As regards the construction of the chuck, we have, as yet, only supposed this pin to be turned up and screwed into the plate below—viz , the sliding-plate by which eccentricity is to be produced. It will be observed that in unscrewing a chuck at any time from the nose of the eccentric there will be no tendency to unscrew the pin, but only to turn the division, or click-plate, and the spring catch will prevent this, so that the pin thus screwed in will hold tightly. This central pin is often made conical, but it is just as well cylindrical. The wear is slight in this part, and it is easy at any time to fit a new pin if the hole in the brass becomes enlarged sufficiently to need it. Let us, however, turn out attention to the click-wheel This has to be turned on all sides—first independently, and then in its place for final adjustment. As it has a projecting nose, it is easy to hold it either in a self-centring chuck or in a wooden one, which will serve the purpose very well. Hollow out the chuck, therefore, to receive the nose or projection, and see that the rest of the plate beds well down on the chuck, which it is quite as well to recess slightly to fit this part, as it will help to steady it. You can, however, run up the back centre while roughing it down and turning up the edge, which is to be square to the face. Turn it as shown, with a recess to fit very nicely over the top on the sliding-plate. You can now run a drill through it for the pin, although, perhaps, it is a safer practice to defer this until the casting has been reversed in the chuck. This is now to be done, either the same being recessed more deeply or a new one substituted. In this case, as the screw will have to be turned and chased in addition to the face of the casting, it will be decidedly safer practice to bring up the back centre. In recommending this I am obliged to presuppose an accuracy in the lathe itself that does not always exist, as it may happen either that the centre of the moveable poppit is not *exactly* on a level with that of the mandril, or that the axial line of the two is not coincident, owing to the poppits not being truly planed. In such case, if we make the work run partly on the back centre, and subsequently withdraw the latter, the casting will be seen to shift slightly and run out of truth. I have personally been thus annoyed by a bad lathe, and am probably not alone in the matter. If there is any such defect existing; the work had better depend upon the chuck alone; and if a little care is exercised until the casting is reduced to a fairly true surface, there is not much danger of its parting company with the chuck.

I must leave the conclusion of this paper to another article, which will be accompanied by the explanatory diagrams.

J. L. in the *English Mechanic.*

(*To be concluded.*)

NEW DISCOVERIES RELATING TO LIGHT.

Some new discoveries relating to light, and the most important since the day when the possibility of spectrum analysis was first made known, have been made by Mr. Wm. Crookes, and they excited a considerable amount of interest at a recent meeting of the Royal Society, as well as at the *soirée* held by the same body a few days previously The first discoveries by Mr. Crookes were made known to the Royal Society in August 1873, but his more recent discoveries, which are still more remarkable were first described there about three weeks since.

Mr Crookes began by stating that, in the paper which he had previously read to the society, he had made known how a lever arm of pith, delicately suspended in a very perfect vacuum, was repelled by the impact of light or radiant heat. A great condition of success in the experiments was to work with the highest possible rarefication, consequently the lever arms were suspended in glass bulbs from which the air had been exhausted by means of the Sprenged pump, which gives a far more perfect vacuum than can be obtained by the use of any other apparatus.

Until these experiments were made it was supposed that light had no action upon a lever arm of small ponderosity suspended in vacuo. Indeed, the circumstance that light could not turn a lever arm so suspended has been quoted in standard scientific text books, by Dr. Balfour Stewart and others, as one point in the long chain of evidence against the truth of Newton's emission theory of light. But Mr. Crookes last week exhibited a bar of pith suspended by a cocoon fibre in a large glass bulb very well exhausted. When a lighted candle was placed about 2 in. from this bulb the pith bar began to swing to and fro, the swing gradually increasing in amplitude until the dead centre was passed over, when several complete revolutions were made. The torsion of the suspended fibre then offered resistance to the revolutions, after which the bar began to turn in the opposite direction, and so on alternately. These movements were kept up with energy and regularity so long as the candle continued to burn. When instead of a candle a piece of ice was placed near the bulb, one end of the lever arm came towards it as if attracted; but the truth was, as explained by Mr. Crookes, that radiant heat was acting upon the pith bar from all parts of the room, and that the presentation of the piece of ice lowered the radiation on one side, consequently the movement was really caused by repulsion acting in the opposite direction.

In order to measure some of these effects Mr. Crookes uses a piece of tubular glass apparatus in the shape of an inverted T, Fig. 2, containing a horizontal glass beam, suspended by a very fine glass thread. At the extremities of the beam were attached the substances to be subjected to experiment. In the centre of the beam was a small mirror, from which a ray of light was reflected on to a graduated scale, just as in Sir William Thompson's reflecting galvanometer. Thus the amount of repulsion produced could be measured. The advantage which a glass thread possesses over a cocoon fibre is that the index always goes back to zero The fibres used to suspend the arms are so excessively fine that when the end of one of them is held in the hand the fibre usually curls upwards like a cobweb until the other end of it floats almost vertically in the air.

As the vacuum becomes less perfect the repulsion grows less until at last the neutral point is reached where there is no action at all. If still more air be then admitted, attraction instead of repulsion sets in. The barometric pressure of the neutral point varies with the density of the suspended substance on which the radiation falls, it varies also with the ratio of its mass to its surface, and with several other conditions Thus the neutral point for a thin surface of pith being low, whilst that for a moderately thick piece of platinum is high, it follows that, with a rarefication intermediate between these two points, pith will be repelled while platinum will be attracted by the same power of radiation. Mr. Crookes proved this experimentally, by showing simultaneous attraction and repulsion by the same ray of light.

When these experiments were first made known, some of the observers tried to account for the effects by the assumed action of feeble air currents or of electricity, but both these hypotheses were considered by Mr. Crookes to be abundantly disproved. Professor Osborne Reynolds suggested that the movement might be due to evaporation and condensation at the surface of the suspended body. Mr. Crooke had a thick and strong bulb blown at the end of a piece of difficultly fusible green glass, specially made for boiler gauges In it he supported a thin bar of aluminum at the end of a long platinum wire, the upper end of which wire was passed through the top of the tube and well sealed for electrical purposes. The apparatus was sealed by fusion to the Sprengel pump, and the exhaustion was kept going on for two days, until an induction spark refused to pass across the vacuum. During this time the bulb and its contents were several times raised to a dull red heat. At the end of the two days' exhaustion the aluminum bar was found to behave in the same manner as, but in a stronger degree, than it would be in a less perfectly exhausted apparatus, namely, it was repelled by heat of low intensity and attracted by cold.

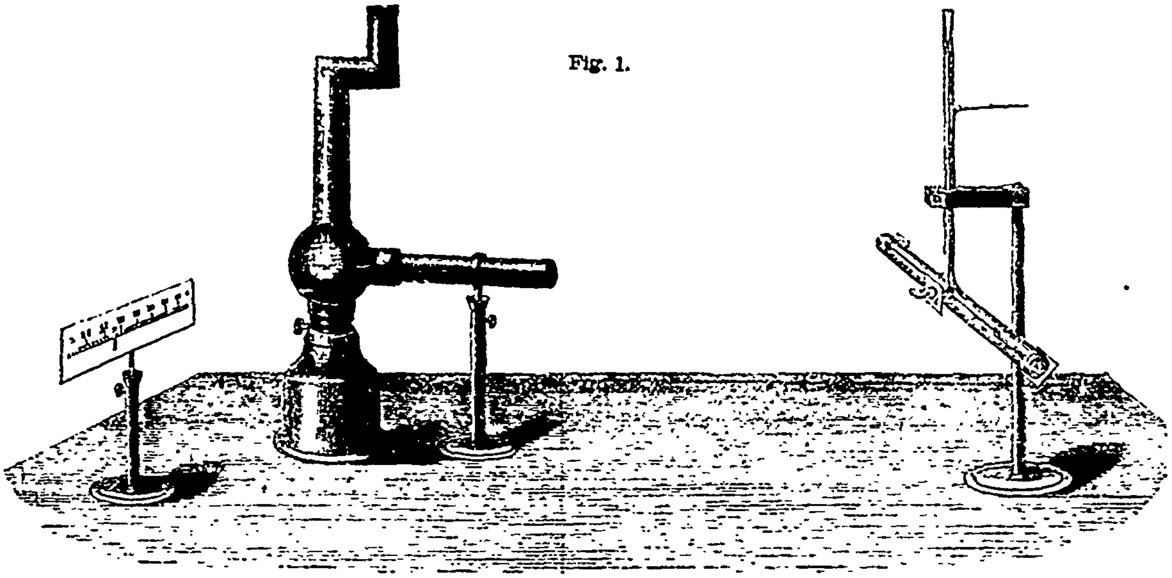
The most remarkable of all the facts made known by Mr. Crookes was an apparent difference between the action of radiant light and radiant heat. At the highest exhaustions dark heat appeared to act almost equally on white pith and on pith coated with lampblack, repelling either with about the same force; but, strange to say, the luminous rays repelled the black surface with more energy than the white one. This is all the more remarkable because light being reflected from a white surface, it might have been supposed that the consequent rebound would have repelled the white surface more than the black one But taking advantage of the facts as they exist, Mr. Crookes constructed an instrument which he calls a "radiometer," and which excited much attention and interest at the recent meeting of the Royal Society. The apparatus is shown in the illustration, Fig. 5, and consists of four arms suspended on a steel point resting on a cap, so that the arms are able to revolve horizontally upon their central pivot, just the same, in fact, as the arms of an anemometer revolve. To the extremity of each arm of straw in the apparatus made by Mr. Crookes is fastened a thin disc of pith white on one side and black on the other, the black surfaces of all the discs facing the same way, the pith discs are each about the size of a sixpence. The whole arrangement is enclosed in a glass globe which is then exhausted to the highest attainable point and hermetically sealed.

This arrangement rotates with more or less velocity under the action of light. With one of the instruments the arms revolved once in 182 seconds when a candle flame was placed at a distance of 20 in. When the same candle was placed at a distance of 10 in. one revolution in 45 seconds was the result and at 5 in. one revolution was given in 11 sec. Thus it will be seen that the mechanical effect varies almost exactly inversely with the square of the distance, so that theory and experiment coincide.

In these experiments Mr. Crookes had to be very careful to guard against the effects of undesired radiation. The lighted sun burners in the roof of the hall of the Royal Society interfered with some of the results, and a candle placed incautiously near his bulbs would send the contents of some of them spinning. As the velocity with which they spin varies with the intensity of the light, in these instruments we have a new form of actinometer. At present there is no good and scientifically exact method of making actinometrical measurements, but these discoveries may possibly result in the production of a more perfect instrument for this purpose. The action of the radiometer is at present inexplicable on any recognised or unrecognised scientific theory.

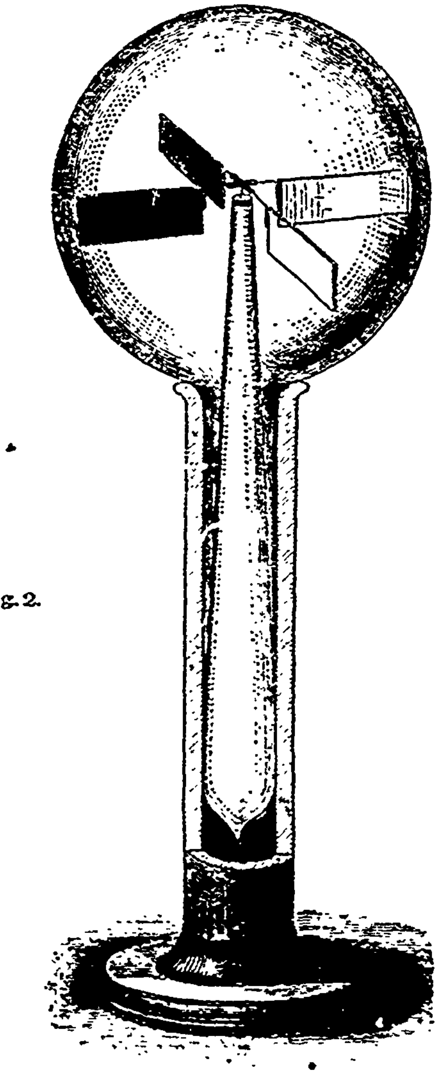
A Buffalo telegraph operator accidentally got locked in the office at dinner time a few days ago, and all other efforts to obtain his noon-tide meal proving unavailing he telegraphed to Canada, thence to Detroit and from there to another office in Buffalo, whence a messenger was dispatched to liberate him, and he secured his meal.

Fig. 1.



NEW DISCOVERIES RELATING TO LIGHT.

Fig. 2.



PLAN FOR A SUBURBAN RESIDENCE.

The accompanying plan for a suburban residence, for which we are indebted to the *American Agriculturist*, is from the designs of Mr. S. B. Reed, architect, Corona, N.Y.

Elevation, (*Fig.* 1.)—The front is irregular, having an angle, which narrows the parts, supplies more vertical lines, and adds to their length comparatively. These are important features, imparting a graceful appearance, and influencing the entire character of the house. The angle affords ample room for the Piazza, which can be built for much less cost than when its three sides are exposed. The next attractive features of the front are the bay windows below, and double windows above, with the ballustrade, and hood, so proportioned and arranged, that they conform with each other with pleasing effect.

Cellar, (*Fig.* 2.)—The foundation walls are of hard bricks laid in mortar, 8 in. thick, and 7 ft. high. In localities where the foundation rests on loose sand, care should be taken to provide a bedding, laid 4 in. below the cellar bottom, 16 in. wide, of brick, or better of large flat stones. Still greater care should be bestowed on the bedding for the chimney and girder supports, for they sustain the greatest proportionate weight, and any settlement of these parts will cause a depression of the floors, disarranging the whole house, and become an immediate and continuous source of anxiety and expense. The area in the rear is built of hard brick and mortar, with blue stone steps and coping. Blue stone sills are provided for each of the cellar windows.

First Story, (*Fig.* 3.)—The interior arrangement of the plan will be appreciated as making the best possible use of the room. The front hall is wider than is usual in houses of this character. The stairs are arranged with the "quarter circle" about midway of their hight, which brings the niche down where it becomes an important feature of the hall. The three principal rooms, the parlor, dining room and kitchen, can be entered from the hall. The latter two rooms have doors leading to the lobby. The lobby is built of 4½ in. tongued and grooved ceiling boards, with sashes made to swing. A shelf, 1½ ft. high, and another just above the sash, give sufficient framework to fasten the center of the boarding; the ends are nailed to the sill and plate; these shelves will be found useful for many purposes. Attached to the lobby, and built with it, is a good sized pantry *p*, for the dining room. The kitchen is provided with a closet at the side of the chimney, a sink, with small closet underneath, and a direct communication to the cellar stairs under the hall stairs. The window in the side of the dining room may be omitted, if the house is in a village and joins another, but this is desirable

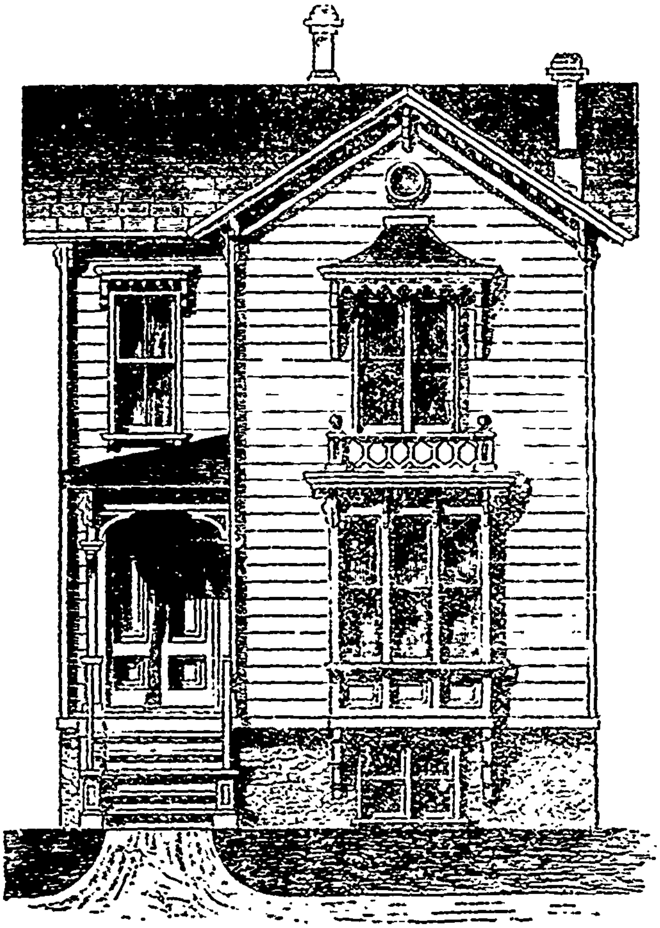


Fig. 1.—SUBURBAN RESIDENCE—ELEVATION.

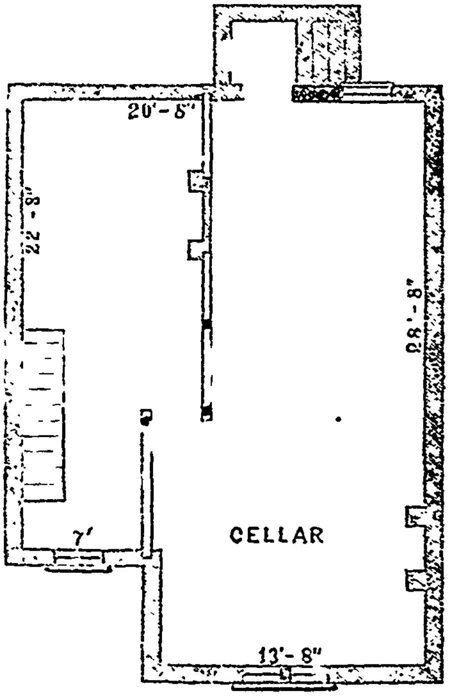


Fig. 2.—PLAN OF CELLAR.

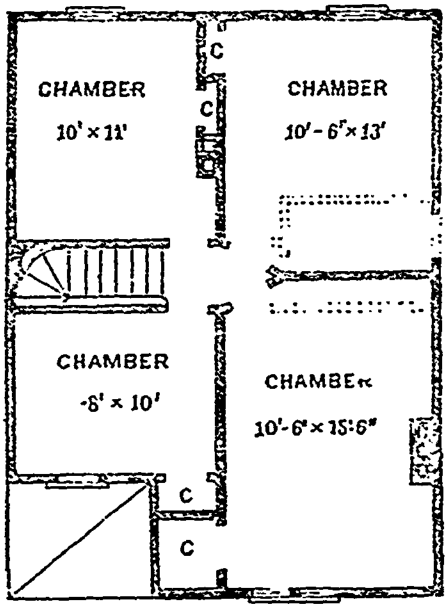


Fig. 4.—PLAN OF SECOND FLOOR.

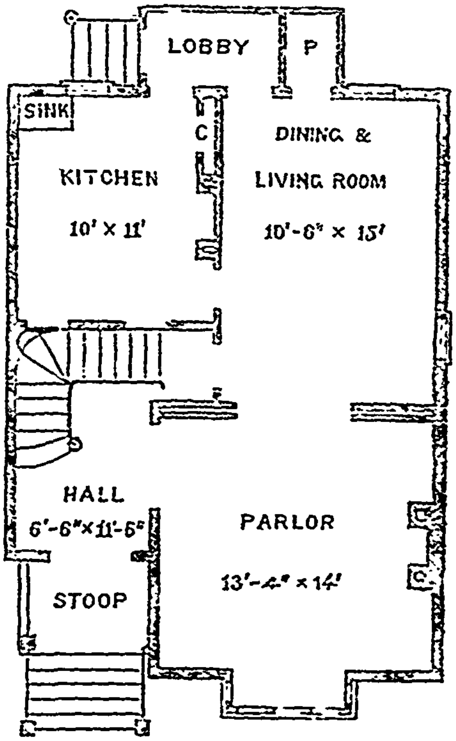


Fig. 3.—PLAN OF FIRST FLOOR.

PLAN FOR A SUBURBAN RESIDENCE.

to give abundant light in this, which is really the living room of the family.

SECOND STORY, (Fig. 4.—The peculiar manner of constructing the stairs, brings their landing nearly in the centre, so that all space sufficient only for four doors is necessary, leaving almost the entire floor to be laid off into rooms. The heavy lines show the most simple method of dividing this story into four rooms Should another room be desirable, it can be taken off from two rooms as shown by the dotted lines, In this case another window may be inserted as indicated. Every one's experience is that there cannot be too many closets, and we have added one to every room in the house, except the parlor.

CONSTRUCTION.—The bill of timber appended indicates a "regular" *frame*. It is a great satisfaction, and saving, to have the timber properly "laid out," and framed by and under the immediate direction of a master mechanic, so as to be quickly and substantially raised. Four good carpenters would easily frame all the timber in this house in two days, and raise it the next day. At least one man of well known ability and experience as a mechanic should be with and take charge of those employed to build a house. It is not economical for one about to build a *home* to trust such work to the caprice of an inexperienced man, who has "helped" around some job, until he has learned the names of tools, but who has no positive knowledge of the trade, and cou'd not for his life "lay out" the corner post for a two story house, yet is shrewd enough to screen his deficiencies by suggesting "balloon," or something indefinite, that requires little or no skill. It sometimes happens, in localities remote from cities or large towns, that persons are obliged to do with make-shifs, to get a home at all. It was such a condition of things that led the well disposed pioneer of the west to adopt the method called "balloon framing," which is really no framing at all, and required no skill to get up a kind of home, acceptable under such circumstances. But wherever skilled labor may be had, it is ridiculous to see a gang of intelligent (?) mechanics standing up pieces of diverse lengths, and propping them in a vertical position with rods running every way as braces, not one of which can be removed until the upper ends are secured by ties of some sort. A good frame in a house is equivalent to a good constitution in a man, and is of vital importance, it need not be clumsy, or overloaded, but should at least have the merit of being able to stand alone.

PAINTING.—The principal object in painting should be to protect and preserve the materials used in construction, as also to give a good appearance. All exterior wood work though executed with the greatest care and in the most substantial manner, if left exposed to climatic influences is very soon destroyed. It is economy to use only the *best lead* and *linseed oil* in painting exterior wook work. They will outlast all other compounds, present a better appearance, and in the end furnish a much better foundation for future painting. The difference in cost between the best materials and the imitations, for painting the exterior of a house built on these plans, would not exceed $12, and the cost of labor would be just the same in either case. The first coat or "priming" should be put on with the greatest care, so as to thoroughly cover and close all the pores in the exposed surface. All window and outside door frames, corner boards, window caps, water table, and stoop flooring, should be primed *before* setting, especially their edges, where joinings required to be made, as it will be the last opportunity to do justice to these parts, where moisture is liable to collect and remain. When priming is well done, it is best to let the building stand until thoroughly dried, be evident to any one that much of the water used in the plastering must percolate through and thoroughly saturate every part of a house. Sufficient time should be allowed for this moisture to pass off, and the whole house to become dried out. The nails should then be "set," which will tighten up permanently all the laps in the siding, after which the work should be properly puttied and the second coat applied. Autumn is the best season to paint, after the extreme heat has passed, and insects have disappeared; the process of drying will be slower, and more perfect, with less waste by evaporation, leaving a smooth solid surface I am often asked, *what colour to paint*? Notwithstanding much has been said against white for outside painting, and the assurance that there are many cases where white would not be suitable, or thought of, yet I believe that for suitability and good taste in nine cases out of ten very light colors, or pure white are indicated. I have known instances where much time has been spent to discover a suitable color for a house, where nearly all the different pigments were drawn from, and after much mixing and testing, the result has generally been an unknown and unnamed shade, as if everything depended on some sentimental "blending with the back ground," or in other words painting the house out of sight. As a rule paint so as to best reveal the true character of the building, and this is best done when the colors afford the foundation for the natural shadows that result from the true and actual projections.

COST.

57 yards excavation, at 20c per yard.	$ 11.40
13,000 bricks, furnished and laid, at $15 p. 1000	195.00
500 yds. lath and plastering, at 35 c. p. yd	175.00
28 ft. stone steps and coping, at 40 c. p. ft	11.20
16 ft stone sills, at 30 c. p. ft	4.80
2370 ft. timber, at 2¼ c. p, ft	53.32

viz. 2 sills,	4x7 in.	x30	ft. long.	6 posts,	4x7 in.	x20	ft. long
2 "	"	x22	"	2 ties,	4x6 "	x30	"
1 girt,	4x8 "	x16	"	2 "	" "	x22	"
1 "	" "	x18	"	2 plates,	" "	x30	"
26 beams,	3x7 "	x22	"	2 "	" "	x22	"
6 "	" "	x15	"	6 pieces,	3x7 "	x16	"

400 wall strips, 2x4 in. x13 ft. long, at 16 c. each.	64.00
200 novelty siding boards, 9½ in at 38 c. each	76.00
160 pounds tarred paper, at 5 c. p. lb	8.00
128 tongued and grooved flooring, 9½ in. at 35 c each	44.80
110 hemlock boards, at 20 c. each	22.00
9½ square of tin roofing at 9 c. p. ft	85.50
120 ft. cornice, 30 c. p. ft	36.00
111 ft. gutter and leader, 10 c. p. ft	11.10
1 bay window with blinds (complete)	75.00
Material in stoop, lobby, balcony, hood and corner boards	78.00
8 windows with blinds, (complete) at $16 each	128.00
4 cellar windows, (complete), at $4 each	16.00
24 doors, (complete), at $10 each	240.00
2 stairs, "	80.00
2 marble mantels and 4 pine mantles	75.00
Base-boards and shelving	25.00
Nails, sink, and pump	34.00
Cartage, average one mile	40.00
Carpenter's labor (not included above)	250.00
Painting, two coats	100.00
Extra for girder supports, grading, &c	60.80
Total cost of materials and construction	$2,000.00

The above items comprise all the materials and labor needed in the construction of this house, calculated at the present rate in the vicinity of New York. The cost in suburban districts of Canada, especially for raw materials and labour would be less.

HORSE GEAR AND THRASHING MACHINE.

We give on page 220 from *Engineering*, illustrations of a well-arranged horse gear and thrashing machine, constructed by Messrs. Wallis and Steevens, of Basingstoke, England. The horse gear is mounted on a carriage frame, upon which the thrashing machine may also be carried. The frame is of timber and to it are bolted a pair of cast-iron brackets, which carry the sockets for the poles, and receive the bearing of the main shaft. The large driving wheel has bevel teeth, and gears into a small pinion, on the shaft of which is a spur wheel actuating a pinion that in its turn drives a universal coupling, to which a shaft can be attached, and the power led off either to the work direct, or to an intermediate gearing, as shown in the small sketch. The arrangements of the thrashing machine will be clearly understood.

AN excellent bronze for small castings may be made by fusing together 95 parts of copper by weight and 36 parts of tin.

SCIENTIFIC NEWS.

There is some talk at Cambridge of establishing a professorship of mechanism and engineering

The advantage in tensile strength, when holes are drilled in steel rather than punched, is calculated to be 25·5 per cent.

A great variety of articles, such as mats, grain-bags, waggon covers, ropes, sails, &c., are made in Russia from the inner bark of the bass wood or linden tree It is estimated that upwards of a million trees are cut down annually for this purpose. The value of this manufacture amounts to about £480,000.

Mr V Mayer has recently shown at Berlin, samples of paper and cardboard made from peat. The paper is equal to that made from straw, and, when 15 to 20 per cent. of rags is added, the paper is declared to be "very good."

Water in Gas Meters.—Dr. Redner calculates that for every cubic metre of gas recorded as having passed through a wet gas meter, twenty-three litres of aqueous vapour or 2·3 per cent. by volume of the gas so recorded is aqueous vapour taken up by the passage of the gas through the water.

Electric science occupies a place of no mean importance in the new opera house in Paris. A special room is set apart as a battery room, in which 360 Bunsen's cells, arranged in sets of 60 on rough plate glass tables, are manipulated to pass a current to any part of the stage, so as to direct the electric light upon any point of the scenery.

"One or two of our exchanges," says the *American Manufacturer*, "seem half inclined to doubt the correctness of our statement that iron had been recently rolled in this city—Pittsburgh—so thin that it would require 10,000 sheets of it to make an inch in thickness. We have the word of the proprietors of the mill, men who stand high among their fellow-manufacturers and the community generally. We have also seen a sheet of it ourself. It is so light that an ordinary expiration of the breath will blow it away, and seems to be about as thin and soft as gold leaf We have no doubt that it is as thin as claimed"

A valuable method of lining a tube of one kind of metal with another of a more fusible nature is noticed in the London papers. It consists in first thoroughly cleaning the interior of the tube and plugging it up at both ends, and then fitting it into a lathe or other apparatus, by means of which a very rapid rotary motion in a horizontal position may be given to it. Through one of the plugs a sufficient quantity of the second or softer metal, which is to form the desired lining, is introduced in a melted state, a pan of ignited coals or a gas-burning apparatus being placed under the tube extending along its whole length and at a suitable distance, so as to keep the metal in that condition while a rotary motion of the tube is established. The melted metal is thus diffused uniformly around the interior of the tube, and, by removing the coals while the rotation is still continued, the temperature is gradually reduced, and the interior metal hardens, forming a permanent lining.

The Rate of Erosion at Niagara.—A recent visit to the Falls of Niagara has enabled Mr. T. Belt to suggest some modifications in the views usually entertained with respect to the time occupied in the excavation of the gorge. His argument is published in the April number of the *Quarterly Journal of Science* It is generally supposed that the entire gorge from Queenstown to the Falls, a distance of seven miles, has been excavated by the present river since the Glacial period. Sir Charles Lyell estimated that the river is cutting its way back at the rate of about one foot per annum, but Mr Belts believes that the retrocession does not proceed at more than one-tenth of this rate He maintains, too, that the gorge from the whirlpool to the Falls was cut out in pre-glacial times, and that the present river has excavated only that portion of the gorge which is worn out in the softer beds between the whirlpool and Queenstown; its work above that point having been confined to clearing out the bed of the old pre-glacial river in the harder rocks Mr Belt believes that the facts connected with Niagara lend support to his views, which refer the appearance of the Glacial epoch to a more recent period than that usually assumed.

NEW RECIPES.

To make silk which has been wrinkled appear like new, sponge on the surface with a weak solution of gum arabic of white glue, and iron on the wrong side.

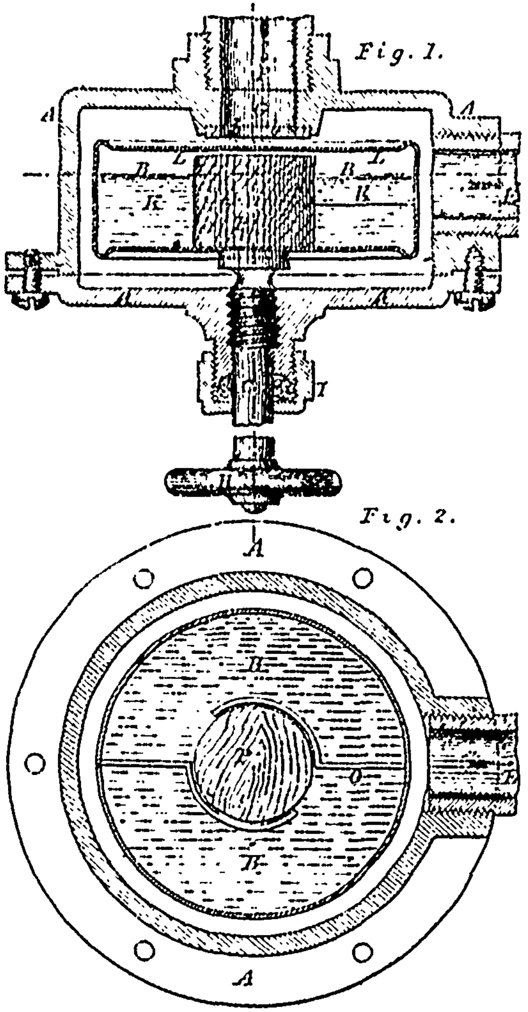
In order to close cracks in cast iron stoves good wood ashes are to be sifted through a fine sieve, to which is to be added the same quantity of clay finely pulverised, together with a little salt. The mixture is to be moistened with water enough to make a paste, and the crack of the stove filled with it. The cement does not peel off or break away, and assumes an extreme degree of hardness after being heated. The stove must be cool when the application is made. The same substance may be used in setting the plates of a stove, or in fitting stove pipes, serving to render all the joints perfectly tight.

A useful cement for mending broken crockery and for repairing various domestic articles, is made of the curds of milk mixed with lime. A similar compound is formed of cheese and lime mixed with water or skim-milk, and is used in Europe as a putty for joiners' work, and as a material for moulding. This is known as cheese lime. According to a Wurtemberg technical periodical, M. Brunschweiller has invented a preparation of skim-milk and lime in the form of a fine powder, which, when mixed with water, acts like plaster of Paris, setting quickly and hardening with age. The powder is very fine and dry, and keeps well.

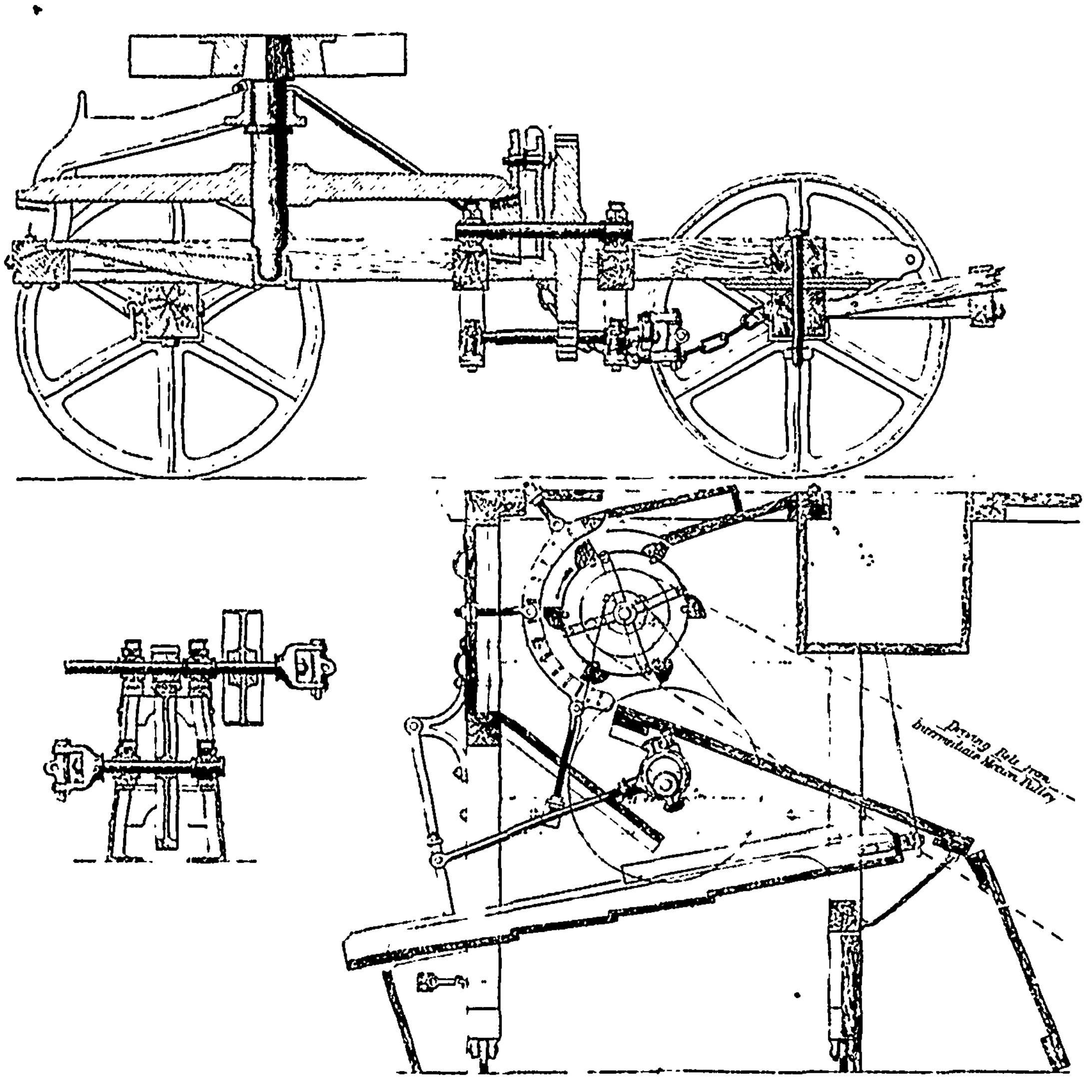
A varnish has been prepared from mica which promises to become a useful article in the workshop, thought at present it has been applied only to plaster casts and similar articles. Mica calcined by fire or cleansed by boiling in hydrochloric acid is reduced to as fine a powder as possible, and mixed with collodion, when it can be laid on in successive coats like paint, giving to the articles thus coated a silvery appearance. The varnish adheres well to porcelain, glass, metal, wood, and plaster, and any colour may be imparted to it by carefully grinding in the required pigment. In the case of coloured mica varnish, the colours may be affected by vapours in the atmosphere which have no effect on the plain mica varnish. Articles coated with mica varnish can be washed as frequently as necessary, without injury to the varnish.

A Bavarian serial contains a method of brightening iron recommended by Boden. The articles to be brightened are, when taken from the forge or the rolls, in the case of such articles as plates, wire, &c., placed in dilute sulphuric acid (1 to 20), cleansing the articles, which are then washed clean with water, and dried with sawdust. They are then dipped for a second or so in nitrous acid, washed carefully, dried in sawdust, and rubbed clean. It is said that iron goods thus treated acquire a bright surface, having a white glance, without undergoing any of the usual polishing operations. This is a process that those interested can easily test for themselves, but care should be taken with the nitrous acid, not to inhale any of its fumes. Boden states that the action of the sulphuric acid is increased by the addition of a little carbolic acid, but it is difficult to see what effect this can have, and it may very well be dispensed with.

To preserve flowers a vessel with a movable cover is provided, and having removed the cover from it, a piece of metallic gauze of moderate fineness is fixed over it and the cover replaced A quantity of sand is then taken, sufficient to fill the vessel and passed through a sieve into an iron pot, where it is heated, with the addition of a small quantity of stearine, carefully stirred, so as to thoroughly mix the ingredients The quantity of stearine to be added is at the rate of half a pound to 100lb. of sand. Care should be taken not to add too much, as it would sink to the bottom and injure the flowers The vessel with its cover on and the gauge beneath it, is then turned upside down, and the bottom being removed, the flowers to be operated upon are carefully placed on the gauze and the sand gently poured in, so as to cover the flowers entirely, the leaves being thus prevented from touching each other The vessel is then put in a hot place—such, for instance, as the top of a baker's oven—where it is left for 48 hours The flowers thus become dried, and they retain their natural colours. The vessel still remaining bottom upwards, the lid is taken off, and the sand runs away through the gauze, leaving the flowers uninjured.



HAWE'S STEAM TRAP.



HORSE GEAR AND THRASHING MACHINE.

LIFE-BOAT STATION,

LIFE BOATS.

In these days of tremendous catastrophes at sea it is a relief to look for a moment at the work which is being accomplished by the British National Life-boat institution. At the recent annual meeting the report showed that since the last meeting the Institution had placed twelve new life-boats on the coast,—five of them at new stations, and the others replacing old or inferior boats. Seven of them had been provided with transporting carriages, and six new boat-houses had been built. During the past year the society's life-boats, which are now 250 in number, had saved 543 persons, nearly all of them under perilous circumstances, when ordinary boats could not have effected their rescue, or could only have done so at extreme risk to those on board them. These invaluable services since the last annual meeting had happily been rendered without any loss of life among the brave men who had performed them. It was satisfactory to know that, as far as the operations of this institution were concerned, the violence of no storm appalled the brave men who manned the life-boats. The number of lives saved from its first establishment to the present time, either by its lifeboats or by special exertions, for which it had granted rewards, was 22,866.

In furnishing a life-boat's equipment, the first duty is to provide her with everything that can contribute to the safety of those employed on this dangerous service, and secondly, to make her as far as possible independent of all assistance from wrecked vessels, the crews of which are often in a helpless state, perhaps lashed to the rigging, and unable to throw a rope, or even to get from the wreck to the boat without help.

A life-boat is therefore provided with life-lines, some festooned round her sides, by the aid of which any one in the water using them as stirrups can get into her; others with corks attached are thrown from within her when along-side a wreck, and float on the water all around her. She is also furnished with a cork life-buoy, which, with a line attached, can be thrown, or floated, to any one in the water, who might be too distant to reach the life-lines of the boat She has likewise strong but light lines with grappling-irons attached, one at the bow and another at the stern, which, by being thrown into the rigging or on board a wreck fasten themselves, so that the boat can be at once held to the wreck without the assistance of any one in her. An anchor and cable, a good lantern for nightwork; a compass; and a drogue or water-bag, which is dragged behind a boat to prevent "broaching-to" when running before a heavy sea, are also necessary to a complete life-boat's equipment.

In choosing sites of ground on which the life-boat houses are to be built, regard is particularly taken to their convenience, so that they may be handy for launching the life-boat, and for her easy transport on her carriage along the coast to the scene of the wreck The house is usually 40 ft. long and 17 ft. wide; its doors are 14ft. wide, and their height about 12 ft. There are folding doors of the above dimensions facing the water and if it should be deemed an advantage to be able to take the boat on her carriage to the rear of the house, doors of the same dimensions are also placed at that end, otherwise a small door at the rear and suffices. The life-boat house is usually a substantial building, built of brick or stone, and having a slated roof. A boarding or flooring, about 6 ft. in length, is placed over the joists at the rear end of the house, to keep the spare stores on, and a batten with wooden pegs for hanging up the life-belts and small lines, is fixed at a convenient height along the side wall In some of the life-boat houses gas has been fitted.

The average expense of a complete life-boat station is 800*l*., in addition to 70*l* a year needed to keep the establishment in state of efficiency. The cost is made up as follows :—

Life boat and her equipment, including life-belts for the crew, and transporting carriage for the life-boat.	£550
Boat-house (average cost)........................	250
Total....................	£800

On page 221 we illustrate, from *The Builder*, a new life-boat station which has just been completed at Walmer. This house is built with Kentish rag and Bath stone Dressings, the verandahs and uprights, and all exposed woodwork, being stained and varnished. There are large doors about 14 ft. wide at the end opposite to that shown in the view. There is a loft at one end of the house for tackle, and the walls are fitted with pegs for life belts. Ventilation is secured by louvred openings in gables and sides of house by fixed louvres in casements, alternate with glazed windows The verandah, or covered ways, on each side are fitted up with seats, and afford comfort and shelter to the sailors.

THE CARPENTER AND JOINER.

It is the business of the carpenter to frame and put together roofs, partitions, floors and other necessary parts of the building. The joiner begins his work where the carpenter leaves off, for it is his business to supply and fit up stairs, cupboards, furniture, and other parts required for convenience. We may illustrate some of the most important terms used in carpentry by means of two kinds of roof represented in figs. 234, 235. Pieces of timber laid on the wall in order to distribute the pressure of the roof equally, and to bind the walls together, are called *wall-plates* or *raising-plates*, as at *a a*, while the horizontal piece of timber *b b*, connected to two opposite principal rafters, is called a *tie-beam*. It serves the purpose of preventing the walls from being pushed out by the thrust of the roof, and also of supporting the ceiling of the room below. When placed above the bottom of the rafters it is called a *collar beam*. The two pieces of timber in the sides of the truss which support a grated frame of timber over them for receiving the roof-covering or slating are called the *principal rafters*, as at *c c*. The horizontal pieces of timber *d d*, notched on the principal rafters on which, and on the pole-plates, the common rafters rest, are called *purlines*, while the pieces of timber *e e* placed at equal distances on the purlines, and parallel to the principal rafters, are called *common rafters*; their use is to support the boarding to which the slating is fixed The pieces of timber *f f*, which rest on the ends of the tie-beams and support the lower ends of the common rafters, are called *pole-plates*. At *g* (fig. 234,) is an upright piece of timber in the middle of a truss, framed at the upper end into the principal rafters, and at the lower end into the tie-beam; this is called a *king-post*, and its use is to prevent the tie-beam from sinking in the middle. *Queen posts i i*, fig 235, are two upright pieces of timber framed below into the tie-beam, and above into the principal rafters; they are placed at equal distances from the middle of the truss or its ends *Struts* or *braces*, *h h*, are oblique straining-pieces framed below into the queen-posts or king-posts, and above in the principal rafters, and supported by them *Puncheons* or *studs* are short transverse pieces of timber fixed between two others for supporting them equally. A *straining beam*, *k*, fig. 235, is a piece of timber placed between the queen-posts at their upper end so as to withstand the thrust of the principal rafters; while a similar piece placed upon the tie-beam at the bottom of the two queen posts for resisting the force of the braces which are acted on by the weight of the covering, is called a *straining-sill*, middle *i*, fig. 235 There are other terms, such as *camber-beams*, or horizontal pieces of timber made sloping on the upper edge from the middle towards each end, for discharging the water. *Auxiliary rafters*, *principal braces*, or *cushion rafters*, are pieces of timber framed in the same vertical plane with the principal rafters under, and parallel to them, for giving additional support.

An important part of the business of the carpenter is that of *joints*. These may be used for lenthening timbers, or they may be *framing* and *bearing* joints, used in trusses, flooring, &c., or joints for ties and braces. Timbers may be connected lengthwise by bringing the two beams end to end, placing a short piece on each side, and bolting through these short pieces and the main beams, but this is not a neat method, it is therefore more common to apply the operation of *scarfing*, in which case one-half of the substance of each beam is cut away for a short length, and the cut portions being brought together are fastened by means of screws, straps, bolts, or wedges. Thus the common *scarf-joint* (fig. 224) is made by halving each piece of timber for a certain length, and bolting or strapping the two pieces together; but where it is an object to secure strength in resisting longitudinal strains, such a joint as that shown at fig 230 is employed either with or without bolts. The French scarf joint (fig 231) is called, from its fancied resemblance to the form of a flash of lightning, *trait de Jupiter* this figure also shows the method of applying bolts and straps. Fig. 237 shows a *longitudinal joint* which may be used where a vertical pressure only is to be borne. Fig. 233 shows a *framing-joint* used in the construction of a principal rafter. Such joints are made on the principle of a *tenon* and *mortise*, in which one of the pieces to be joined is cut away so to leave a small projection or tenon, while a corresponding cavity or mortise is made in the other piece to receive the tenon.

There are many other particulars which might be given respecting floors and partitions, &c.; but enough has been said to show the nature of the house-carpenter's work. The various tools used by him are represented in the figures, not very accurately indeed, but they are all so well known that the defects of the figures may be supplied by the experience of the reader. In carpenters' work the timber remains rough, as left by the saw; but in joiners', it is brought to a smooth surface by means of the plane, wherever it is exposed to view. The chief cutting tools used by the joiner consist of saws, planes, and chisels. There are various kinds of saws, distinguished by their shape and the size of the teeth: thus the *ripper* has 8 teeth in a length of 3 inches; the *half-ripper* 3 teeth to the inch, the *hand* saw (fig. 239) 15 teeth in 4 inches, and the *panel* saw 6 teeth to the inch. The *tenon* saw (fig. 218), which is used for cutting tenons, has about 8 teeth to the inch, and the blade is prevented from *buckling* or bending by means of a thick piece of iron at the back. The *sash* saw has a brass back, and 13 teeth to the inch, while the *dove-tail* saw has 15. The *key-hole* saw (fig. 200) is used for cutting out small holes There are also various kinds of planes; those used for bringing the stuff to a plane surface are called *bench* planes, and of these the *jack* plane is used on the roughest work, while the *trying* plane (fig. 223) is used after the jack plane for *trying up*, or taking off shavings of the whole length of the stuff. There is also the *long* plane, 2 feet 3 inches in length, the *jointer*, 2 feet 6 inches in length, and the *smoothing* plane, 7½ inches in length, used for cleaning off finished work There are also various *moulding* planes for forming or *sticking* mouldings, as it is called. Chisels (figs. 215, 229) are also of various forms and uses, such as the *paring chisel*, which is used by the pressure of the hand only; the *socket-chisel*, used with the *mallet* (fig. 211). The *gouge* (fig. 227) is only a curved chisel The boring tools are the *brad-awl* (fig. 214), the *gimlet* (fig. 216), the *brace and bit* (fig. 236), the latter admitting into the handle or *stock* a variety of *steel bits* of different bores and shapes for boring and widening holes in wood and metal. The joiner also uses the *screw-driver* (fig. 220), the *pincers* (fig. 228), the *hammer* (fig. 208), the *axe* (fig. 219), and the *adze* (fig. 225). It may be remarked that the *glue-pot* (fig. 238) is not used by the house-carpenter or joiner, but belongs rather to the cabinet-maker.

HAWES' STEAM TRAP.

We give on page 220, from *Engineering*, views of an ingenious arrangement of steam trap designed and patented by Mr. Loring P. Hawes, of New York. The apparatus consists of an outer shell formed of two pieces, which are held together by suitable screws, which can be removed to repair or clean the inside of trap. B is an expansive vessel made of thin sheet metal, and supported in its position by the outer shell A, A, and adjusted by the stem C and wheel H. This vessel contains alcohol or other easily vaporised liquid combined with or standing on any thick or gummy substance like resin, this gum filling the vessel above the central joint and thus preventing any waste of alcohol at this joint. When the stem strikes the vessel the expansion of the liquid or the formation of vapour is sufficient to press out or expand its elastic top and bottom and stop the flow of steam by bringing one of its flat sides against the opening G from which the steam escapes.

When the accumulation of water of condensation allows the parts to cool sufficiently for the vessel B to collapse or lessen in thickness by the diminished pressure within it, the top of the expansive vessel which has formed the valve is drawn away from the steam inlet and the water is allowed to run out until the heat is sufficient to again expand or boil the alcohol, and produce a pressure in the vessel B, which again springs out its top or sides and then closes the opening as before. P is a cylindrical block of wood which is secured in its place by wires O, O, which are soldered to the sides of the expansive vessel, this block is of sufficient length to prevent the sides of the expansive vessel from being injured by collapsing by the external pressure, or from the face of the regulating stem C being screwed down upon it. E is the outlet pipe; F is the inlet pipe, G is the inlet valve or opening, and is composed of soft metal, being secured in its place by the concentric ring b, b. H is a hand wheel for turning the spindle or stem C; I is a stuffing nut; K, K, shows the top of the gum; and L, L, the top of the alcohol.

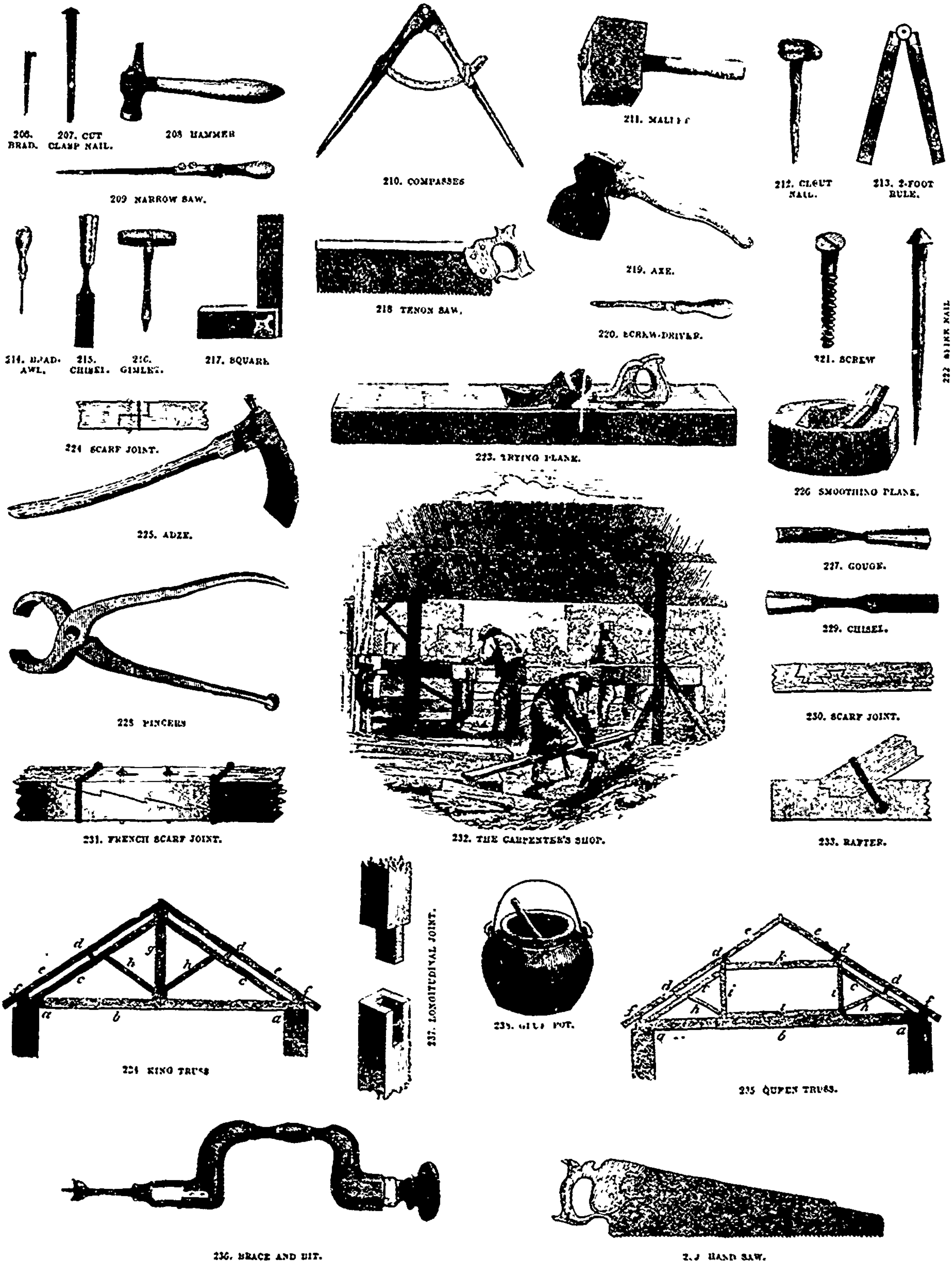
This trap is very compact and simple, and by a proper adjustment of the screw spindle C, water of any temperature from 100 deg. Fahr. to 212 Fahr. may be retained or discharged as desired, a certain temperature produces a certain pressure in vessel B, to which is due a corresponding expansion of said vessel; so if the screw spindle is so adjusted that it requires 200 degs. Fahr. to close the valve, the trap will continue to discharge water as fast as it accumulates at that temperature; if the water becomes hotter the valve closes, while if it cools the valve opens. The advantages of this feature are obvious. This trap will operate equally well either side up.

THE LATHE.

In the opening lecture, given before the Manchester Society for the promotion of Scientific Industry, Dr Anderson, discoursing of Tools, said:—To select for an example the familiar tool called a lathe,—it is chiefly intended to impart to materials true circles, straight lines and flat surfaces, and all of these conditions must first exist in the tool. The bearing surface of the spindle neck must itself be absolutely round in the strictest sense, otherwise the article operated upon will not derive a true circle from the revolution of the spindle. The mathematically true circle here referred to is practically very difficult to attain. There are many tools in the world that are supposed to be round, but which are not so in reality An examination of the Whitworth gauges will best convey the idea of what is meant by mechanical truth and a true circle, each part fitting accurately into the other, yet perfectly free in every position. Then again the lathe has to afford absolutely straight lines of movement for the guidance of the cutting instruments, whereby the true circle derived from the spindle and deadcentre point is developed into a true cylinder, but not so unless the parent circle and straight lines are correct in themselves If a perfectly flat surface is required from the lathe, the cutting instrument must pass in a straight line transversely to the axis of the revolving spindle, and if the two are set absolutely at right angles to each other, a correctly flat surface is the result. If, however, any of the conditions of accuracy are wanting, then imperfection in the produce will follow, as a matter of course. If the lathe is intended to afford screws, it must first have a perfect screw within itself to copy from, for if there is any imperfection in the screw copy, or in the divisions of the teeth of the wheels by which it receives collateral motion, the screw produced will contain a transferred copy of each imperfection. It will thus be seen that the lathe is simply a tool to transfer its own character to other things; hence the paramount importance of having the lathe perfect in itself. But unfortunately, the world, as a rule, does not sufficiently appreciate the difference between perfect tools and tools nearly perfect, but in the government of this portion of the world it is so arranged that those who do not are invariably punished, because the want of truth and accuracy entails greater cost in their production, both at the present time and hereafter.

Mr. John Adams, of Canboro, informs the Monck *Reform Press* that he has a receipt for keeping the potato bugs from doing damage, and says that since using it not a bug has been seen in his potato patch. He took about four pounds of coal tar and boiled it in three or four gallons of water, afterwards sprinkling the solution on the vines with a brush. The four pounds suffice for one acre, and the effect was all that could be desired.

The Ottawa *Times* says:—"We are glad to learn that the miscellaneous writings of the late Charles Dawson Shanly are about to be collected for publication in one or more volumes, accompanied by a suitable memoir, written by his brother, Mr. Walter Shanly, C. E, who has undertaken the editorship. We feel quite sure that this collection, forming as it will a most desirable *memento* of one long connected with the public service of Canada, as well as with its nascent literature, will be gladly welcomed throughout our country."



206. BRAD.
207. CUT CLASP NAIL.
208 HAMMER
209 NARROW SAW.
210. COMPASSES
211. MALLET
212. CLOUT NAIL.
213. 2-FOOT RULE.
214. BRAD-AWL.
215. CHISEL.
216. GIMLET.
217. SQUARE.
218 TENON SAW.
219. AXE.
220. SCREW-DRIVER.
221. SCREW
222 SPIKE NAIL
223. TRYING PLANE.
224 SCARF JOINT.
225. ADZE.
226 SMOOTHING PLANE.
227. GOUGE.
228 PINCERS
229. CHISEL.
230. SCARF JOINT.
231. FRENCH SCARF JOINT.
232. THE CARPENTER'S SHOP.
233. RAFTER.
234 KING TRUSS
237. LONGITUDINAL JOINT.
238. GLUE POT.
235 QUEEN TRUSS.
236. BRACE AND BIT.
239 HAND SAW.

THE CARPENTER AND JOINER.