

How to Make a Model Quick-Firing Gun.

By A. O. WOODWARD.

IN selecting a title for this article, I have refrained from using the name Maxim-Nordenfeldt; for, though it is in outward appearance and in essential working parts a Maxim-Nordenfeldt quick-firing gun, several details which, without costly tools, would be difficult to construct have been omitted. These omissions, by the way, will not interfere with the working and firing of the gun; and, where any part has been omitted, or simplified, it will be mentioned, so that, if wished, they may be inserted. It may not be out of place, before pro-

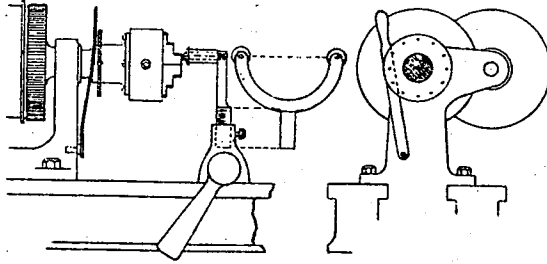


FIG. 1.

ceeding further, to give a brief account of guns since the early muzzle-loading type were used.

Breech-loading guns were first introduced in England in 1859, but were abandoned in favour of muzzle-loading some six years later. The type used at the former date was the Armstrong breech-loading system. This consisted of a hollow breech screw, through which the gun was loaded; a vent-piece, or plug, was then let down over the charge, and the breech screw brought up to keep it in place.

In 1880 the interrupted-screw system was adopted, and is, with some modifications, still used, though principally for heavy calibre guns. It consists of a solid steel breech furnished with a screw thread of the requisite pitch, fitting into a female screw in the gun. The surface of the block is divided longitudinally into either six or eight parts, and the thread planed away from alternate portions. In the gun the parts corresponding to the smooth portions on the breech block are left, and those between them slotted away. By this method, after introducing the breech block into the gun, a turn of one sixth or one-eighth sufficed to secure it, and, *vice versa*, enabled it to be drawn out, and a carrier, hinged to the gun, swings it clear of the bore.

The rapidity with which the charge could be repeated appeared to leave nothing to be desired, but the more recent introduction of quick-firing mechanism has been eagerly adopted. Guns of this latter description are made as large as 6 ins. in the bore, and fire a 14-lb. projectile at the rate of 30 or 40 rounds a minute.

In these guns, the recoil is utilised to open the breech, set the trigger, and extract the empty case. It is a model of the latter type of ordnance of which I propose to explain the construction. This gun, by the way, must not be confused with the Maxim machine gun, which is entirely automatic, and of a much smaller calibre.

A few words now regarding tools. The lathe, of course, comes first; this should be a screw-cutting lathe, with either 3½ in. or 4 in. centres, and a 4 ft. bed. This length of bed facilitates the boring of the gun, though a method for using a 3 ft. bed for the purpose will be ex-

plained later. Of files, a good variety will be required; among the larger a second-cut and a dead-smooth will be necessary; and of the small files a variety of flat, square, round, half-round, etc.

As there is a quantity of gun-metal and brass-work to be done, the reader will find it to his advantage to possess a vice with lignum vitae jaws. These can easily be affixed to a vice with removable jaws; should it be of the ordinary variety, a pair of jaws, of any hard wood, made to fit over the others, will be found useful. This is really necessary, for it is well known that work gets badly marked in a vice without any protection. The larger sized screws in the model can be made, but the smaller ones may be obtained from Grimshaw & Baxter, 33, and 35, Goswell Road, Clerkenwell, London, E.C. Their speciality in this line is known as the "Progress" screws, which are beautifully made and finished. Screw-plates and taps to gauge with the screws can also be obtained, as well as the steel wire, in foot lengths, emery buffs, etc.

Another implement, which may be obtained from the same firm is a Vernier gauge. For exact work this is indispensable, and will be readily appreciated by amateurs; it may be used for the purpose of gauging thicknesses, for testing squareness, measuring, marking out, &c. The following is a list of the screws required, together with the names by which they are classified:

- 1 doz. pillar screws (Progress, English) gauge 12
- 1 " " " (" Swiss) " 10
- 2 " bar " (" ") " 12
- ¼ " cock " (" English) " 18

The following cannot be obtained long enough in the Progress variety:—3 doz. pillar screws, gauge 14, thread of screw, 3-16ths in. long. When ordering Progress screws it should be mentioned that the longest screws made in each gauge are required.

In making the larger screws required, leave the heads perfectly flat; for slitting the heads use a fine hack saw in preference to a file; and in all cases harden and temper the screws.

The nuts and bolts can also be made, and there is infinitely more credit in doing so than buying them; and apart from this reason, those usually supplied for model work are of very inferior metal.

A good plan for cutting wire down for the thread,

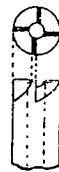


FIG. 2.

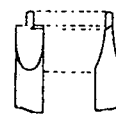


FIG. 3.

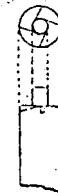


FIG. 5.



FIG. 4.

especially when several of the same gauge are required, is to drill down a piece of steel 2 ins. long, to the depth of an inch, and after turning the end up flat, form it into a cutter with four cutting edges. Fig. 2, under the heading of tools, will clearly show what is meant. A useful set for work on the model would consist of three cutters with 3-32nds in., ¼ in., 5-32nds in. holes respectively.

Nearly all the screws require the heads counter-sinking, and to do this nicely and leave the bottom of the

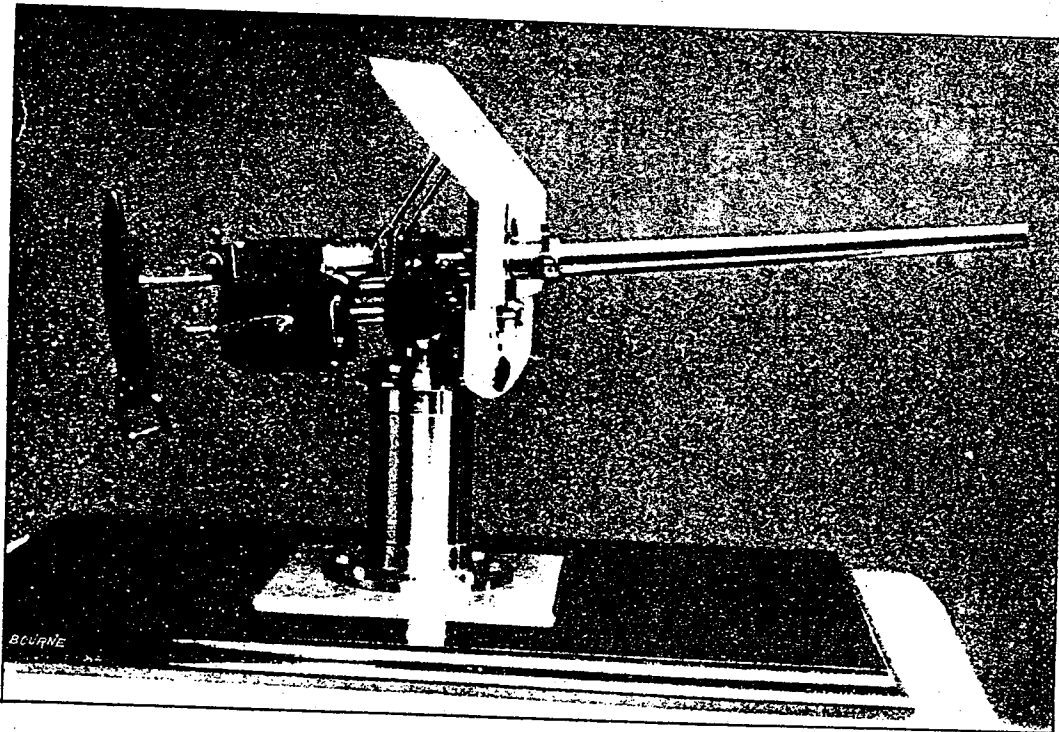
counter-sink square, cutters made in the following manner will be found useful:—Select a piece of steel slightly larger than the head of screw. At one end turn a small pivot, leaving the shoulder perfectly square, and then polish part of the steel to the diameter required. File away on two opposite sides, taking care that the pivot is not touched while doing so. It should then have the appearance of Fig. 3, and the edge of the shoulder left will require sharpening, and the cutter hardening and tempering to a straw-colour. Hardening, by the way, should be done in oil, and, after tempering, the cutter should be dipped in oil again to prevent further softening. The pivot must be made in proportion to the size of cutters, one third the whole diameter will be found to answer satisfactorily.

When fitting screws, drill a small hole the size of the

This may be made of spring steel $\frac{1}{8}$ in. to $\frac{3}{8}$ in., and about 6 ins. long, the length varying with height of centres. On one end rivet a pin, $\frac{3}{16}$ in. diameter and $\frac{1}{2}$ in. long, and if this be made with a shoulder, it will be more secure. A hole will be required in the headstock for the latter to fit into, and it should be drilled about an inch above the lathe bed.

Near the centre of the index another pin is fixed (the position of this will depend on height of centres) on the opposite side to the other, and must be tapered, to allow it to fit securely into the holes in disc. Fashion the other end into a handle for lifting the tapered pin out of one hole into another. The illustration Fig. 1, tools, will show this part, and its application to the disc, which is shaded.

A guide for filing level and accurately, in conjunction



MODEL QUICK-FIRING GUN (RIGHT-HAND VIEW).

pivot on cutter, and then countersink to the right depth, using oil in the operation, otherwise the pivot may be twisted off. Drill the rest of the hole to size required for tapping. As this usually leaves a bur at the bottom of the countersink, the cutter should be introduced again to clear it.

Should the reader possess a lathe with a divided headstock, the nuts, bolts, and squares required will be easily made. If not, the following will prove a useful adjunct to any lathe, and is easily removed or applied.

A piece of $\frac{1}{2}$ in. sheet brass must be turned into a disc $2\frac{1}{2}$ ins. or 3 ins. diameter, with a hole through the centre large enough to allow it to fit on the nose of headstock. The chuck, when screwed on, will keep it firmly in position. Drill twelve $\frac{1}{4}$ in. holes round at equal distances, about $\frac{3}{8}$ in. from edge of disc. An index for keeping the disc from moving, when filing, is now required.

with the former, is made as follows:—The general form of the rest is in the shape of the letter Y. Turn the lower part to fit into the tool-rest holder, and at each of the other ends drill and tap a hole to $\frac{1}{4}$ in. diam. Into these fit two screws, with heads $\frac{3}{8}$ in. diam. and shoulder 1 in. long by $\frac{5}{16}$ in. diam. Each screw supports a hardened steel roller, working freely on the shoulder. Make the latter of $\frac{1}{2}$ in. steel, with a shoulder at the end opposite to the rest, to prevent the file from slipping off the work, or on to the chuck.

Hexagonal heads and squares can be made to any size by either raising or lowering the rest, and if the bottom lug is graduated, any number can be made to one size.

When using this tool it will be found easier to file and polish one side before proceeding with another; for, after filing as far as the rest will allow, an emery buff will always

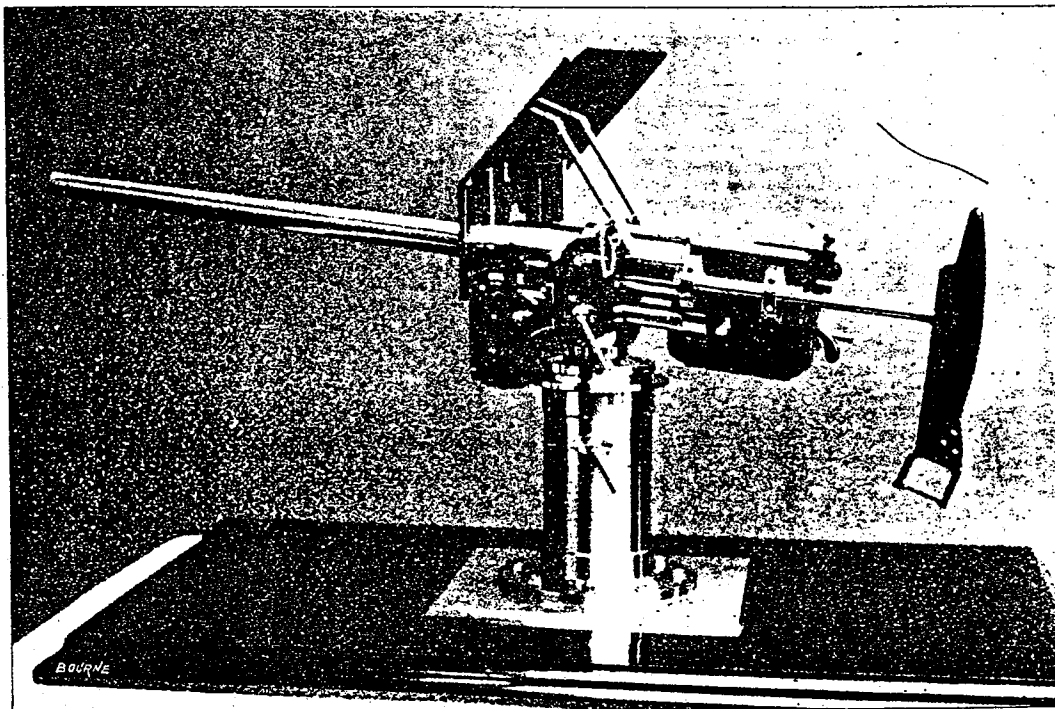
be found to give sufficiently to polish that side without lowering the rest.

And now, before commencing the actual work, may I draw the attention of the reader to the two illustrations of the model? It will be observed that it is a result worth working for, and one which, if properly constructed, cannot fail to please, owing to its very graceful appearance, and to the interest which a model, out of the ordinary run, naturally creates.

The working drawing should be done first, and as those given are to scale, they need only be copied or traced. The model has been designed to fire a .22'13'45 cartridge, this size being necessary to obtain the requisite recoil. A larger cartridge may be used if the gun is constructed in proportion to the bore. It would be as well, before commencing work, to obtain a specimen cartridge of the size you intend using.

H₁ is fixed will have been turned sufficiently to cock the hammer—which is effected by forcing back the cocking gear G, working between two cheeks on the firing pin F—to lower the breech block A and to extract the empty shell.

The large curved spring O (Fig. 9) is put in tension by the roller N, attached to and working in the cam M. The tendency of this spring is to close the breech, but the breech block cannot rise until the extractor (the shaded part above the rocking shaft H, Fig. 1) is pressed forward by the introduction of a fresh cartridge. When this is done the extractor moves forward and liberates the block A; then the spring O, from its action on the roller N, turns the rocking shaft and closes the breech. The patterns required for the gun will be eight in number. Those for carriage and mounting are described later, when that part of the gun is under consideration.



MODEL QUICK-FIRING GUN (LEFT-HAND VIEW).

Fig. 1 shows a vertical central section, when the breech is closed and the gun in the firing position. Fig. 9 shows the gun after recoiling to the full distance. In this figure, the outlines of the gun seen behind the box containing the recoil mechanism are not drawn in that position, for reasons given later, the centres H₁ in actual working being at M. The drawings here referred to will appear in the next issue.

The action of the gun is as follows:—C (Fig. 1) is the cradle or case in which the barrel B is free to recoil as far as the stop, on which, by the way, is fixed the foresight.

As the gun returns to the firing position—owing to the pressure of the spiral spring on the piston E—the pawl L (Fig. 9) rotates the cam M until M₁ is brought into contact with it, and removes it from the catch on M. At this stage the rocking shaft H (Fig. 1) on which the lever

Mahogany, with a good close grain, is the most suitable for patterns, and when the latter are finished, may be either coated with shellac varnish or enamelled. Allowance should be made for shrinkage and working, and care taken to slightly taper those parts which are pressed most deeply into the sand, so that much cleaner casting will result. The patterns may be either sent to a local firm, or if really good castings are required, send them to Broadbent, of Leeds, who do any quantity, however small. The barrel B, and the breech end D, are two separate castings, being united by a female screw in the barrel and a male screw on D. Make the pattern for the barrel an inch longer at the taper end. In turning, this end is apt to get marked, and so the extra piece can be cut off when finished. The breech end, in which the breech block slides, consists of three sides; the centre

one, to which the gun is screwed, being thicker than the other two and continued lower to hold the bearings of rocking shaft (see D, Fig. 1, and D D D, Fig. 5). In the left-hand corner of D, in the latter figure, is a small square of metal, D 2, which is continued vertically as far as the bottom edge of that side; Fig. 6 will show this clearly. Provision should be made in the pattern for this, and also for the male screw. The cradle C will require a core cast through it, $\frac{3}{4}$ in. in diameter, the shaded part (Fig. 1), being the section of same.

The cylinder E will be easier to construct if cast solid and drilled out after.

The plate T (Fig. 1, central section; Fig. 7, plan), will also be better if cast solid, for then the centres for C and E, which are secured to it, can be marked off, and the holes turned to size. To this plate, the box containing the recoil mechanism, is also fixed by means of a small bracket (A, Fig. 7). As this plate and the parts fixed to it do not recoil, it is necessary to keep the recoil-box clear of the breech end, and for this purpose, that side of T to which it is fixed is allowed to project a little, as shown in Fig. 7. The purpose is still more clearly given in Fig. 6, which shows the clearance between the box and the breech end. All the parts mentioned should be cast in gun-metal.

The recoil-box, consisting as it does of a good deal of sheet brass, will be better if the square frame P (Fig. 9) is cast in brass, and then the bracket A (Fig. 7), of which the horizontal section is also given, may be of the same material. Sheet brass $\frac{1}{8}$ in. thick, 16 ins. by $6\frac{1}{4}$ ins. and 3-16ths ins. thick, 4 ins. square, rolled perfectly flat; also three strips of good mild steel, 12 ins. long, $1\frac{1}{4}$ ins. wide, and $\frac{1}{4}$ in., 3-16ths in. and $\frac{1}{8}$ in. thick respectively. These should also be rolled, and, together with a strip of double shear steel, 12 ins. long, $\frac{1}{4}$ in. wide, and 1-16th in. thick, may be obtained through the local ironmonger.

The breech block, with which everything, more or less, is connected, will be made first. A A A (Fig. 1) shows the right-hand size of box (looking toward the muzzle), Fig. 3 the back, Fig. 4 the front and section of front, Fig. 4 1 the left hand side, and Fig. 5 the top. The block may be constructed entirely of steel, or, if desired, of brass, with the front plate of steel only. The latter method will give good results, and is, in the matter of fitting screws, easier to make. The back extends the whole width between the two sides of breech end 1 in. by 15-16ths in. vertically; the top of breech fitting over it, bringing the total height to $1\frac{1}{2}$ ins. Mark this out on whatever material, $\frac{1}{8}$ in. thick, it is decided to use, 1-16th in. larger all round. File to this size and true the inner face by filing, and then grinding on a small piece of plate glass, with emery and oil; do not cut away more metal than is necessary to obtain a flat surface.

The right-hand plate is next made; the size is 15-16ths in. vertically by $\frac{3}{4}$ in., the back, top and front plates being fitted to the three edges of it. Leave it also 1-16th in. larger, and proceed as with the back. Now the edge to which the back plate is fitted requires filing very square and straight, and to do this accurately use the following method.

A piece of boxwood $1\frac{1}{2}$ ins. square by 2 ins. long will be required. File two of the sides perfectly square with one another, gauging frequently; a file, dead smooth, is then laid on the bench, with the handle away from the worker, and firmly secured to prevent it from slipping. The metal, after the edge has been nearly filed to the size required, is held against one of the trued sides of the boxwood (the other being laid on the file) with the edge which requires filing, resting on the file. The whole is then rubbed against the latter, care being taken to put the pressure on the metal and as little as possible on the wood. Examine every few strokes, and test with the

gauge to see that all is proceeding satisfactorily. The boxwood will require trueing occasionally. The front edge is then done in a similar manner parallel with the back, the width being $\frac{3}{4}$ in., as mentioned previously. The two plates are next joined together by screws, the positions of which are shown in Fig. 3. Remember that the screws, both of the back and front, are tapped into the sides. The size required for the block are the bar screws, Swiss, gauge 12, and they must be tempered slightly, being rather hard, and likely to break with the concussion. The heads are counter-sunk slightly beneath the surface, otherwise they will be liable to catch on the breech end. The left hand plate is 15 16ths in. vertically by 1 in., the extra $\frac{1}{8}$ in. in the difference between this side and the other being allowed for the projection under the front plate (Fig. 4-1). The edge which is fitted to the back, is done as previously, though the inner face need not be touched. Now cut away the part shown by the dotted lines, for the front plate to fit into; the distance between the back and front should then be exactly $\frac{3}{4}$ in. Fix this plate to the back, spacing the screws as formerly, and particularly observe that the outer faces of each plate are parallel with one another, and slightly over 1 in. apart, so that they may be ground to that size after.

The front plate is made of $\frac{1}{8}$ in. steel, and is 1 in. by 11-16ths in. File 1-16th in. larger, as previously, and true the bottom edge and inner face to fit accurately in the recess cut in the left-hand side, the position of the screws which fasten it to that plate being in Fig. 4.

As the screw on the opposite side is the last one required to hold the four sides together, care should be taken in fitting it, so that all four sides may be square with one another. It is a good plan to file a piece of hard wood square to fit in between the sides accurately, and then, while keeping them pressed up to it, fitting the screw.

Before making the top, all the sides should be ground square with one another, in every way, using tripoli and oil, not emery, as it cuts into the metal, and is extremely difficult to get rid of after.

Mark off the top edges square with the sides, and file and grind it accurately to receive the top. This is of 3-16ths in. brass, and the size is shown in Fig. 5, the central vertical section in Fig. 1, and end view in Fig. 3. A circular groove is cut in it, in a sloping direction, shown by the dotted lines in Fig. 1, to free the cartridge, and to act as a guide when inserting.

As this weakens the plate at the front end, another one, of a triangular section, is fixed underneath it (Fig. 1). Cut the brass for the top slightly larger, and grind the inner face. Make the triangular plate of $\frac{1}{8}$ in. brass; it extends across between the two inner faces of the slide plates, and fits up against the front plate, as shown. It may be secured with soft solder, or brazed, if preferred.

The top is then screwed on, and while doing this keep the triangular piece pressed up against the front plate, to take part of the thrust that plate receives. Turn the block over and mark on the inner face of the top plate, both inside and out, where the edges of the four sides meet it. Mark the position of the screws (Fig. 5), and drill the holes in the top plate from that side, and thus ensure the screws being in the centre of the edges of the vertical plates.

The under edges are filed parallel with the top ones, and will be better if done while the box is together. A stay is fixed across from side to side at the bottom of the block, and the section of it is shown by the small shaded square in front of the trigger (Fig. 1). Make it of steel and let it into the sides, a small screw being then passed through each end of it, and the end finished flush with the sides.

(To be continued.)

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NOW take the block to pieces for the purpose of fitting a piece of brass into the back plate, with a vertical groove slightly under $\frac{1}{8}$ in. wide vertically, in which the trigger works. The size of the square to be cut for its reception is given in Fig. 3, and the section and plan of the bearing in Figs. 7 and 5, respectively.

Another piece, in the shape of the letter L, for holding the cocking sear is let into the top. It will be observed in Fig. 1 that the piece is fixed with one side above the level of the inner face of the top plate. This is done so that the screw on which the cocking sear works may be as high as possible. Figs. 1, 2 and 5 illustrate the shape of the latter piece.

Both, after being fitted tightly, may be secured by soldering, and filed and ground level with the outer faces of the plates.

The circular groove should be done with a $\frac{3}{8}$ -in. file, and to the curve and slope given. After filing as near as possible, fix the file true in the lathe, and while rotating hold the grooved part against it, giving the latter a circular motion from one edge of the groove to the other. Finish in a similar manner with a smooth file; the groove will be found more regular and level in its length, if done in this manner.

To clear the ejector when extracting a shell, a slot is cut in the front of the block to the size and section shown by the shaded lines in Fig. 4. Great care must be taken to leave as much metal as possible between the slots and the groove in top plate, for it is on the edge between the two, the ejector catches when holding the block down.

The right-hand side and part of the front one may next be filed away to the shape in Fig. 4. This is done to clear the block when down, and free it of the bearings of rocking shaft H. Do not file any further along the front plate than shown in the drawings, for the edge that is left is required to work the extraction, which it does by catching on the hook at the bottom end of the latter, and pulling it over.

The block is now laid aside till required, the barrel being constructed next.

Mark and drill the centres at each end, and then turn each end slightly for the distance of an inch, just sufficiently to take the roughness off the casting.

Fix the thick end in the chuck, and make a wood bearing to support the muzzle end while boring, in the following manner.

First, shape a piece of fairly hard wood to fit on the lathe bed, with a piece underneath to work in the opening, and about two inches above it. Screw a piece to it, vertically, at one end, about $5\frac{1}{2}$ ins. by $\frac{3}{4}$ in. thick (or higher, if the lathe centres are more than $4\frac{1}{2}$ ins. high), and drill a hole through the block to secure it to the lathe bed, in a similar manner to the footstock. Bring the centre of the footstock against the vertical piece to mark it, and cut a hole through it, the same diameter as the muzzle end has been turned to.

As the bore is to fit a .22 cartridge, which is slightly under $\frac{1}{4}$ in., drill down centrally, as far as possible, with a 5-32nds in. twist drill. Now make a D bit of the same gauge of steel wire about 10 ins. long, and, if not true, should be made so in the lathe. If the lathe is a screw-cutting one with 4-ft. bed, the following will be the easiest method for boring.

Turn a brass plug, tapered, to fit in footstock, and

through the centre drill a 5-32nds in. hole. The footstock must have the hand wheel and screw removed, and the slide tightened in place with the brass plug fixed in it firmly.

When the barrel is fixed in the lathe and the wood bearing in place, tighten the footstock to the bed, about 2 ins. from the barrel; it will then, owing to the brass plug, act as a support to the D bit, which otherwise, owing to its length, would either chatter or spring. In the tool-holder of the slide-rest fix a piece of wood to bear against the end of the cutter. The slide-rest is fixed, the top slide being utilised to press the cutter against the wood. In a screw-cutting lathe, the slide-rest having a quick traverse, the cuttings from the D bit can be cleared frequently.

The cutter can be prevented from turning by being screwed in a small hand-vice, and allowing the latter to rest against some part of the slide-rest.

If the lathe has only a 3-ft. bed, a series of D bits will be required, say, 4 ins., 6 ins., 8 ins., and 10 ins. long. After drilling with the 5-32nds in. drill in the same manner as previously, use the shortest cutter first, and so on, though when the larger ones are being used, the footstock will have to be moved each time to clear the hole of cuttings. In either case, after boring as far as cutter will allow, the gun-barrel must be reversed and done from the other end. Great care should be taken, when reversing, to have the barrel central, otherwise the two bores may not meet equally.

As D bits do not leave the hole very smooth, the following method has the additional advantage of being easily adjusted to a larger diameter, and will finish the bore smooth and accurately. In Fig. 4 (tools) it will be observed that the cutter consists of a piece of square steel (A), with three sides slightly convex and the fourth flat, and is screwed to a steel bar less in diameter than the width of square. It must be true, or it may chafe the bore whilst using the cutter. On the flat side of square a thin piece of hard wood, shaped as shown at B, is wedged, and this presses the two other curved edges against the bore, these being sharpened. A cutting through once, if the bore is not large enough, put a single piece of paper between A and B, and cut through again; and so on, till the correct size is obtained.

The barrel being in the lathe with the breech end towards the footstock, the female screw, into which the breech end is screwed, had better be cut. The depth and diameter is given in Fig. 1; turn the barrel first, using a small boring tool fixed in the slide-rest, and then set the change-wheels of lathe to cut sixteen threads to the inch. As this gauge will be used throughout the model, it will be as well to leave them on the lathe. Great care should be taken to have the bottom of the recess of female screw square, so that the end of the male screw may fit tight and square against it. Screw a piece of hard wood into the hole threaded, and turn a centre in it, leaving it projecting slightly so that it may be easily taken out when not required.

Remove the wood bearing, and use the footstock to support the barrel, and with the slide-rest turn that part of the barrel which works in the cradle as far as the stop, and finish to size with a fine file and oil. Then reverse the barrel and turn the taper, observing the shoulder and the small part left straight for the reception of the stop. The slide-rest should not be set at too great an angle at first for tapering, but gradually, till the correct proportion is obtained.

The barrel may now either be polished or left till the rest of the gun is made. In polishing use a fine file and oil, different grades of emery buff, and lastly, oil and tripoli.

The breech end must now be fixed in the lathe and the

male screw turned, and also that side on which it projects. The latter, being very flat, must be carefully turned.

Should the reader have a four-jaw chuck, the matter will be greatly simplified; otherwise it must be fixed on the face-plate. In either case, fix a piece of wood inside the casting, to prevent the side-plates being squeezed together.

Turn the male screw gradually till a close fit is obtained between it and the barrel, and when finished a set screw should be tapped in to lock it; the head must be countersunk to clear the cradle, and care taken not to penetrate the bore when drilling.

File the two outer faces of the breech end square with the front one, but do not, for the present, file them quite to the dimensions required; when finished true and parallel, they will act as a guide to work the inner faces, and these must be done very accurately and gauged frequently. The left hand inner face extends as far as the small square of brass, D 2, and the other forward to the thick end D (Fig. 5). When the breech block will nearly fit in, proceed to work with a fine file and oil until a perfectly accurate fit is obtained and the breech block works easily, but without any side shake. The piece of steel W will now claim attention, and the vertical central section, cross-section, and elevation are given in Figs. 1, 5, and 6 respectively. Use $\frac{1}{4}$ -in. steel in the construction, but, before fitting, make the face of D, to which it is secured, square with the inner sides, flat, and to the dimensions given.

It will be noticed that this piece is fitted in between one side of D2 and the right-hand side of the breech end. After the edges are filed square to fit (these may be filed in a similar manner to that employed when constructing the breech block), file the side which fits up to D, and, if necessary, grind the two together. Now file the front face very carefully, so that it may be square with the inner faces of the breech end, and it will be as well to put the block in occasionally to see that a good fit is obtained on all three sides.

The position of the screws for securing W is shown in Fig. 6. The heads—and it will be advisable to have these as broad as possible—must be countersunk, and as the holes to be tapped are some distance in between the two sides of the breech end, it may be necessary to make a tap which will reach, and strong enough to obviate breaking.

The whole of the work must now be fixed centrally in the lathe and the rest of the bore drilled—that is, through the male screw on D and the steel front W. Now reverse the work and make a wood bearing to support it near the breech end, and then cut the bore down to a sufficient depth and width to take the brass shell of the cartridge (Fig. 1). The countersink in W to receive the rim of the cartridge will be better if taken out of the breech and done separately in a four-jaw chuck, or screwed to a piece of wood with two wood screws through the holes already in it, and the wood fixed to the face-plate so that the bore in W is central. Then turn the countersink with a small, square graver, allowing the rim of the cartridge a very little freedom, both sideways and in depth. The piece of steel which forms the fourth side of the breech end is shown at D1 (Figs. 1 and 5).

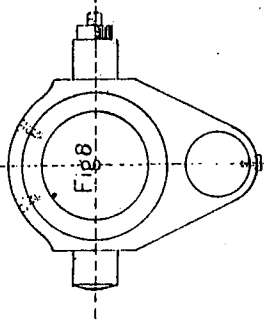
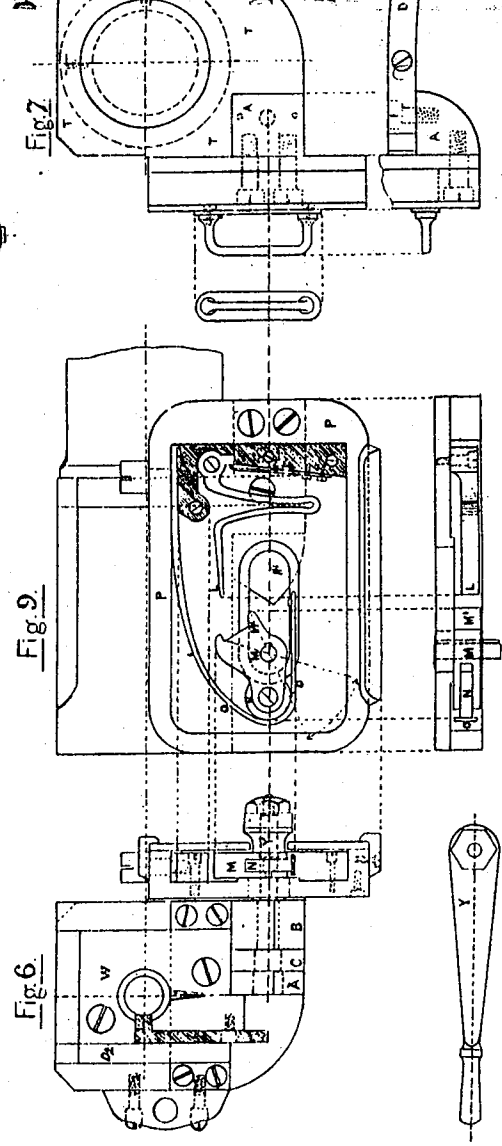
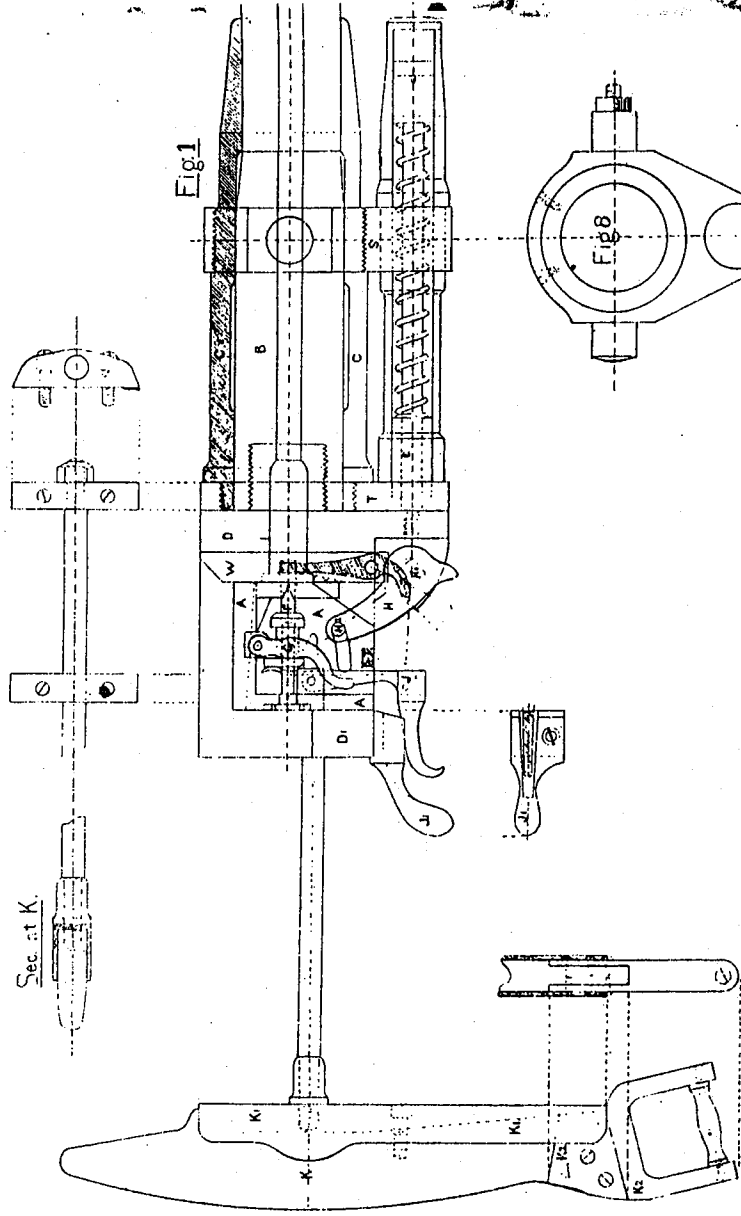
Use a piece of wrought steel, and work it to the proper dimensions, excepting the length, which can be done better when fixed. Grind the inner face true and smooth, and the upper one square with it, in a similar manner. Cut away the sides of the breech end for its reception first with a frame saw, and then file away carefully till the steel bar fits up against the breech block, allowing it to work smoothly, but, as before, without any shake.

This last matter is important, for the bar is narrower than the other three sides, being disguised so that the cartridge may be introduced without fouling it, and any side-shake will probably cause the breech to jam in action. The position for the screws is given in Fig. 6. They are preferable countersunk, and so arranged that they will not foul the screws holding the bearing which supports the heel-plate. The upper exposed edge of D1 is bevelled off between the two sides of the breech end, as shown in Fig. 5. The whole end may now be filed and finished to size. The projecting tip, which is a continuation of the thick part D, and holds the rocker shaft bearings, is thinner than the upper part, and is curved off from the centre to the left-hand side (Fig. 6), the whole section being given in Fig. 1. The under edges of the breech end are finished square, the upper ones being bevelled, though it will be advisable to leave the latter till the rest of the model is constructed, for being rather prominent, they are apt to get spoilt. The upper edges of W and D2 are also bevelled, and if done nice and flat, has a good effect. Do not bevel the steel to a sharp edge, but leave it as shown. The ends of the steel bar forming the fourth side of breech end are finished off flush with the sides, and the vertical ends should also be level with the outer face of this part.

The extractor being the next part to be constructed, the plate W must be prepared for its reception. The left-hand edge is cut away, the whole thickness of the plate, up as far as the position occupied by the extractor, which is shown shaded in Fig. 6, and is slightly under $\frac{1}{8}$ in. thick. The horizontal arm of the extractor, which catches under the rim of cartridge to extract it, and also, when out, hooks on to the edge of the breech block to keep it down, as described previously, must also have a slot to fit into when pressed back. This slot extends as far as the bore, and must be of a sufficient depth to accommodate the extractor when the rim of the cartridge is pressed home. This is shown in Fig. 1. Notice must be taken that the extractor moves in the arc of a circle, which is shown by dotted lines in the same figure, so that to clear the slot the horizontal arm should be bevelled slightly inwards on both edges.

Now to construct it. Use $\frac{1}{8}$ in. steel, forged to the shape required. This is easy, for the short arm only requires to be at right angles to the rest. The inner edge of the hook, against which the block catches, will be better if left slightly thicker than required to allow for adjustment later. This works on the head of a screw fixed in the plate W, and is kept in position by the part D2, and should work slightly stiffly between the two faces formed by those parts. The reader will do well to pay particular attention to the following explanation of the working of the extractor, otherwise trouble may ensue.

In the rocking-shaft H, a pin is fixed which works in a slot cut in the right-hand side of the breech block, and gives to it a rising and falling motion. The arc the pin follows is given by dotted lines in Fig. 1, and the distance between each end of the arc, measured vertically, is the full drop of the breech block. This is more than is requisite to bring the slot in the top of the block level with the bore, but just sufficient to extract the cartridge and bring the short arm of the extractor over the block to catch it in its upward course and stop it level with the bore. The necessity of this will be understood, for were the block to fall only as far as is necessary to clear the cartridge, the arm of the extractor would catch on the front of the block instead of above it. It may be as well to explain that this extractor is not exactly as used in the original guns. The latter have two arms, one on each side of the bore; but as this makes the work more complicated and difficult to do it has been omitted, one arm being sufficient to operate in a model. It is not necessary,

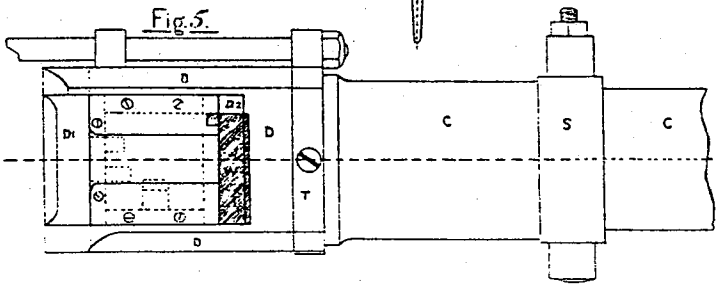
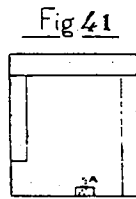
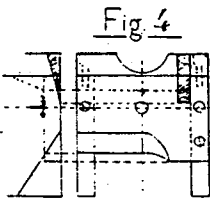
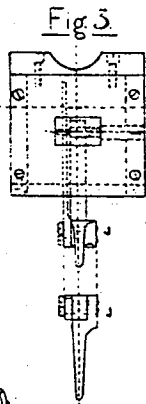
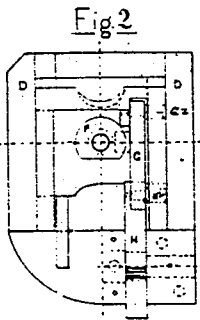
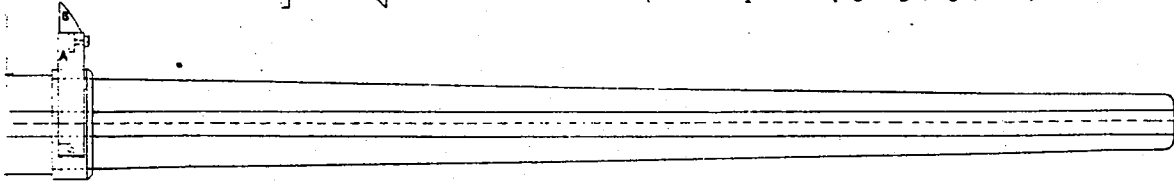
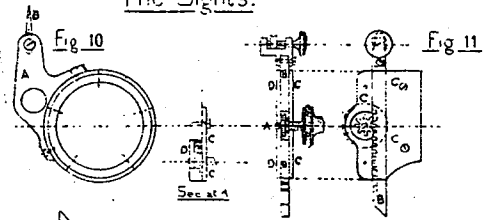


The Sights.

MODEL QUICK-FIRING GUN.

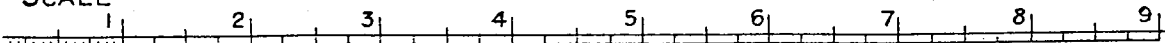
DETAIL DRAWINGS OF GUN AND BREECH MECHANISM.

(For description see pages 130, 131, &c.)



SCALE

INCHES



however, to adjust the extractor till the rocking shaft and bearings have been fitted, and these should be proceeded with next. The position of bearings is given in Fig. 6 (A and B) and the central section in Figs. 1 and 9. It is shown more clearly in the latter figure, and it is for this reason the centre (A1) is placed where it is instead of at M, which is the position it should occupy in relation to the other parts.

The bearing B, which receives most of the thrust on the shaft, is twice as thick as A. They may both be constructed of 3-16ths in. sheet brass, the thicker one being made by soldering or brazing two pieces together.

They are fitted into the corner formed by under projecting lip of D, to which they are fixed, and the bottom edge of the plate W. The tops of bearings must not be allowed to project beyond this plate, else they will foul the block when it descends. The angle formed by the projecting sides and tops of bearings should be carefully noted, for when the block is down, the bevel that was cut on the right-hand side, and partly across the front of it, will rest on these projecting sides, and so take the thrust off the rocking shaft.

The position of the screws will be seen in Fig. 2, the bearing B having two and one steady pin, and A one screw and two steady pins; the screw in the latter being rather short to clear the rocking shaft, which has its greatest diameter in this bearing.

File the bearings square to fit, and then drill the holes to receive the pins. These should fit tightly, and be slightly tapered on their projecting parts; then drill holes in the breech end as accurately as possible for the pins to fit into, and then, if the bearings do not fit quite closely into the breech end, the position of them may be adjusted by bending the pins a little. The screws should now be fitted, and the heads countersunk to clear the recoil plate. Mark the centres on each bearing for the rocking shaft, and drill each one separately with a 5-32nds in drill, which should afterwards be passed through both together when screwed in position. The hole in bearing A can now be enlarged to the requisite size.

The rocking shaft is made of steel, slightly larger than $\frac{1}{2}$ in. diam. The section is shown in Fig. 6 by the dotted lines; the part between the bearings is filed square for the lever H (Fig. 1). This square should be as large as the diameter of material will allow. The end of shaft is screwed for a nut, and is continued a little further than is necessary to accommodate the nut only, so that all the parts on the shaft may be brought firmly together. These parts are kept in position by a key on the shaft, which extends from the bearing B to the screwed end. The position of the key (Fig. 9) must be observed in relation to that of the square H1, so that the rocking lever and cam M may occupy the correct positions on the rocking shaft.

File the shaft down slightly till the key, made from a strip of thin steel, will fit flat and squarely on it, and then either braze or silver solder it on. The latter method is perhaps preferable, inasmuch as it requires less heat, and is equally strong. Powdered borax is used as a flux, cleanliness being essential.

The lever H is constructed of 3-16ths in. steel to the shape in Fig. 1. The stop at the lower end catches on D when the lever is drawn, and so takes part of the strain off the pin at the upper end. The position of the square H1 must be carefully marked out, and also the distance between centres H1 and the hole for the pin H2. The latter is tapped into the lever, and the dimensions are shown in Fig. 2. The upper end of the lever, it will be remembered, presses against the cocking gear G to set the firing pin, and so care should be taken to have these parts exactly the shape and dimensions given in the plan. After drilling the two holes, file out the square till it fits firmly

on the rocking shaft. If necessary, a screw can be tapped into the lever to further tighten it, though if a good fit has been obtained it will be unnecessary.

The edges of the lever, after being filed square and flat, should be finished with a fine emery buff, until a black polish is obtained. Mind that all edges in the working parts—or any other for that matter—are quite flat and square, for nothing looks worse than a bad and uneven piece of filing.

The flat surfaces after being filed till they nearly fit in between the bearings, should be ground till a perfect fit is obtained.

These surfaces can be left with a matt finish, which is obtained by grinding on glass with crocus powder and oil. This, with the polished edges, has a good appearance, and all flat steel parts can be finished in a similar manner. The pin H2 had better be made after the slot in the breech is cut, and this can be done next. Mark the centre first of the slot at the rear end of the block, and scribe an arc with a radius of $\frac{3}{4}$ in., the centre being vertically over the one marked. Pay attention to the size of the slot, as it is of great importance to have it the length and curvature shown in the drawings. When marked out, a series of holes near to one another should be cut with a 3-32nds in. drill, the centres, of course, being on the centre line of the slot. File the slot nearly to shape with a round file, and then make a small milling cutter the exact diameter of the slot. This is easily made by backing off a piece of wire the right size, leaving the part for the cutter about 3-16ths in. long. File a number of cuts longitudinally on it, leaving the metal between as sharp as possible, and then harden and temper to a straw colour. Fix the cutter in the lathe and work the side of the block in which the slot is being cut, to and fro, being careful to keep the plate square with the cutter, not to make the slot longer than is necessary, and not to keep the plate in one position too long. The plate can be kept square with the cutter by means of a brass plate with a lug attached to fit into the tail stock, or some similar device, which will often be found useful.

The pin H2 should fit and work smoothly in the slot, and is screwed into the lever H; the head should be slotted, for it is screwed in after the block and lever are in position. When finished, harden and temper it, and then polish as bright as possible. You can now test the work for correctness. When the block is down and resting on the rocking shaft bearings, the pin should be at the extreme end of the slot; if it does not go right down on to the bearings, the fault will probably lie in the slot not being long enough, and this will require correcting. The extractor, also, which was left a little thicker than required on the inner side, must be gradually filed and polished, till, as the block descends, it will pull the upper part over to catch on, and keep the block down. As stated previously, the block does not catch on the extractor, when at its lowest, but rises 1-16th in. to meet it. This also gives the empty shell greater freedom, as it enables it to clear the top of the block.

The case C will require little description, the section being so clearly shown by the shaded lines in Fig. 1. When the casting is firmly chucked, the wide end should be turned to the correct diameter and about $2\frac{1}{8}$ ins. deep, as there will be some metal to turn off at both ends. Then cut out the interior of the bore to the correct section; this is done to reduce the friction of the barrel as much as possible. The work is then reversed, and the other end bored out to $\frac{3}{4}$ in. diam.

The wood pattern of this part must now be turned down to fit tightly into the case, and allowed to project an inch at each end, the centres being accurately cut at both ends. By fixing the free ends of the wood, one in the chuck and the other supported by the tailstock, all dis-

figuring by chucking the work directly will be avoided, and we can also ensure the bore in the case being true with the outside. When turned outside to the dimensions shown, the screwed parts on which the plate T and the strap S fit should be done with the same pitch as previously. The work can then be polished while on the wood, and the latter extracted.

(To be continued.)

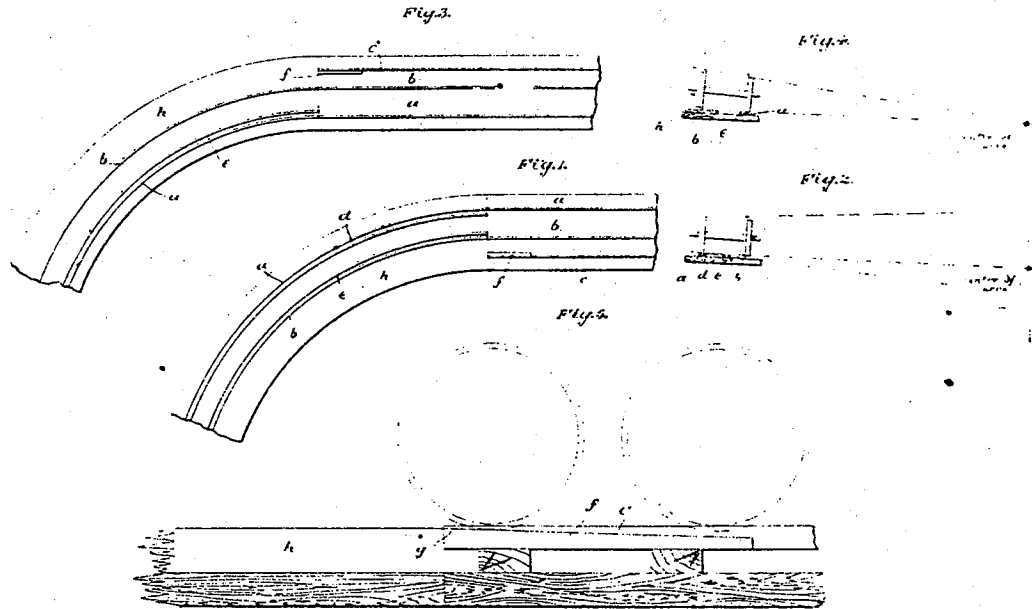
A Continuous Adjustable Model Railway Track.

THE present model railway track possessed by the Society of Model Engineers consists of a straight length pair of rails made to the Society's standard $3\frac{1}{2}$ -in. gauge, and an outer adjustable rail so that locomotives of other gauges can be also run on the track. It is proposed to convert the present limited track into a

continuous one, and various suggestions have been made to overcome the difficulty of making the gauge properly adjustable at the curves. One of the members, Mr. F. J. Burnham, has been devoting some time to the solution of his problem, and has furnished us with the accompanying drawings and descriptions of a method which he suggests should be adopted. We are glad to be able to put this before our readers, and we shall be pleased to receive any comments or criticisms on this idea. We believe Mr. Burnham does not himself regard it as perfect, but he brings it forward as a simple yet practical plan for overcoming what is admittedly a difficult point.

He writes:—Fig. 1 shows the construction first thought of. Here *a* and *b* represent the rails of the standard gauge and *c* the outside or adjustable rail, the rails *a* and *b* on the curve being provided with check rails *d* and *e*. It is obvious what the check rail *e* is for, but the rail *d* only comes into use when a broad gauge locomotive is running round the curve and not using the third rail *c*, thereby keeping the flanges of all wheels between rails *a* and *d*, or otherwise the hind part of the loco. would leave the rails. On reference to Fig. 2, it will be seen that this idea is open to a rather serious objection, that is:—the inner wheel, which would be travelling on its flange and running on its largest diameter, while the outer wheel which travels on the outer curve and moves the greatest distance, runs on the tread in the usual way, this being the reverse of what should happen, whereby causing excessive slipping, but it would have the advantage of having the outer rail *a* as a guide.

A reference to an alternative plan, drawn in Figs. 3 and 4, will show that the slipping difficulty can be greatly diminished (although perhaps not entirely, as the flanges of various locos. differ). In this case the adjustable rail *c* being on the outside and only one check rail *e* being required, so that all locos. running round the curve will be guided by the check rail *e* whatever gauge they may be. It will readily be understood how the slipping would be diminished, as in this case the outer wheels would be travelling on their flanges instead of their tread as before, which would tend to make the locomotive turn a curve



A CONTINUOUS ADJUSTABLE MODEL RAILWAY TRACK.

without the aid of the check rail *e*; Fig. 4 showing this. It is, however, open to this advantage, viz.:—that any centrifugal force of a loco. is only exerted on the inner rail where the wheels travel the shortest distance, and not on the outer rail as in Fig. 1, but I am of opinion that this would be the best arrangement as the track could be made to slant slightly at curves, as shown in Figs. 2 and 4.

Fig. 5 shows a simple arrangement by means of which the wheels of a locomotive can leave the third rail and run on their flanges round the curve, *c* being the rail which has fitted on the flange side of it a ramp *f* about 7 ins. long, and tapered off as shown, its highest surface *g* being nearly level with the top of the rail, and its lowest being sufficient to clear the deepest flange that is likely to run on the track, so that the wheels of a locomotive, in passing over it, are caused to leave the surface of the rail *c*. When the flanges touch the surface of the ramp *f*, they continue to run on it until the level surface *h* is reached, whereby causing no jerking to the locomotive, the same operation being repeated, but in the reverse manner, when leaving the curve for the straight track.

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Fig. 1 having been removed to show a side view of the contacts, etc.

Connecting up.—Charge the cell with 3 ozs. sal-ammoniac and allow it to stand for a while to get into working order. After putting the cell into the case connect up as follows:—Take one wire from the zinc of cell to one terminal of switch, one wire from the other switch terminal up the inside of battery case to one terminal of the bell, a wire from the other bell terminal to the terminal of fall-back contact, and another wire from the porous pot of cell to terminal of the back contact. When the contacts are touching and the lever of switch is at "On," the current is complete and the bell will ring. To set

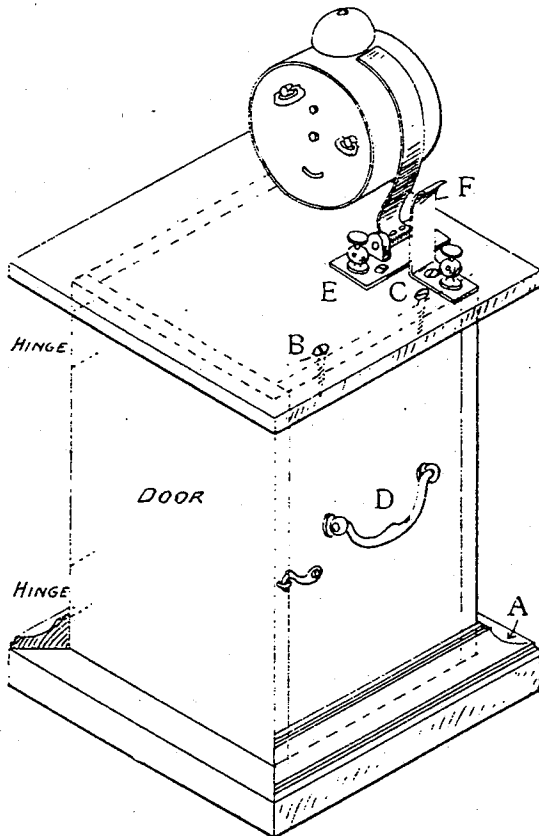


FIG. 2.

the alarm, after winding up both keys of clock and setting it at the time it is required to go off, put it on the case as in Fig. 1, place the fall-back contact against the alarm hammer and put the switch at "On." When the clock alarm goes the movable contact falls back and completes the circuit. Thus, both the clock and the electric bell are ringing at one time. The "faces" of the two contacts must be kept clean to make a good contact. During the four years the original alarm has been working the electric bell has never failed to ring when required.

Staining and Varnishing the woodwork must be done before any of the fittings are put on. No special description is necessary, a dark stain and varnish having a good effect.

How to Make a Model Quick-Firing Gun.

By A. O. WOODWARD.

(Continued from page 135.)

THE plate T (cross-section, Fig. 7) is screwed on to the case C, and then kept in position by the two locking screws. When the plate has been fitted to the correct thickness, the two centres for the cradle and the cylinder E are marked, both being in the same vertical line. The edges of the plate will be better if left till the piston-rod in E is fitted, for then they can be marked more accurately. If any of the screwed part of the case project beyond the plate, it should be filed level with it. Now, observe when the barrel is passed through the case that the plate T fits up flat and close to the front of the breech-end D, though, if everything has been done correctly, there should be no bother about this.

The strap (cross-section, Fig. 8) is made from a mild steel forging, having the large hole for the case forged in it. First mark the centres at both ends of the cradle pins, and turn them to the correct size, polishing both the pins and the shoulders at the same time, for after the ends are turned up it will be a difficult matter to centre them. The shoulders should be left just slightly convex, so that they may swing free in the stand. It will be noticed that the left-hand pin is left 1-16th in. longer than the other, irrespective of the square and screw. This is for the purpose of keeping the link, which adjusts the elevation of the gun, swung free of the carriage. The size and purpose of the square and screw is shown in the drawings of the carriage and mountings. That face of the forging—or to be more explicit, the one shown in Fig. 8—must be filed, observing that the surface is quite parallel with the pins. When filing the opposite side, leave it a little thicker, so that it may be done gradually, for a purpose explained presently. Now fix the work in the lathe, so that the shoulders of the pins are equally distant from the centre; it will then require the large hole boring and screw cutting to fit tightly on the case.

It is strictly necessary, both for appearance and utility, that the cradle pins, when on the case, should be at right angles with the vertical line on which the centres of the cradle and cylinder were marked on the plate T. When the strap is screwed on to the cradle they may not be exactly at right angles, and now the reason for leaving more metal on one side of the forging is obvious, for it can be filed down till the correct position is obtained. The edges can then be filed, and will afford a good filing practice, the upper part especially, which requires to be of equal curvature on each side. When finished they should be polished, and the two faces ground and finished with a small surface. The strap is secured in position on the case by the two cock screws, gauge 18 (Fig. 8), and have the heads countersunk. We can now pass on to the barrel E, though it will be advisable to cut the smaller hole in Fig. 8, and also the 5-32nds in. hole and countersink in the plate T (shown in Fig. 1) to receive it.

As it is rather difficult to drill a hole of the size required in the straps in one operation, and few amateurs possess drills large enough, it will be better to drill a 3-16ths hole first, and then make a cutter, the shape given in Fig. 5 (Tools), with a pivot corresponding to the hole drilled. Use this for the purpose, and it will be found to leave a clean and sharply cut hole.

The centre for the 5-32nds in. hole on the recoil plate T has been marked previously; after drilling, countersink it 1/8 in. deep with one of the cutters already made.

Fasten the cylinder casting as far as possible into the 3-jaw chuck, and after marking the centre at the projecting end, and cutting down for a short distance with a 3-16ths in. drill, bore through the whole length with one of 5-16ths in. diameter. A brass plug, $\frac{5}{8}$ in. long by 5-16ths in. diameter is now required. If the turning and drilling of this with a 5-32nds in. drill be done at one operation, it will ensure the hole being true with the rest. Fit the plug into the rear end of the cylinder, allowing $\frac{1}{8}$ in. to project; this is then soldered into place, and the projecting part turned to fit into the countersink on the recoil plate. Now turn a wooden plug to fit into the other end of the cylinder, and, without removing it from the lathe, mount the cylinder on it, and support the other end of it by means of a centre in the footstock. By the way, do not forget to use oil in any operation where the centre in the footstock is used to support work, otherwise the work may be injured. The reader can then proceed to turn the outside of the cylinder to the shape and dimensions given in Fig. 1.

Measurements must be taken frequently, so that the two shoulders, one in the centre, and the other, formed at the end by the brass plug, fitting on the strap S and the recoil plate T, respectively. There are two alternations for the interior mechanism of the cylinder. In the original guns, the spring and piston only occupy half the space, the rod being continued beyond the piston, and through a gland, into a watertight compartment, and there terminates in another piston with valves. The water acts as a buffer, and prevents the gun either recoiling or returning to the firing position too quickly. It can be introduced into the model if wished, in preference to the one already described, though it has been tried and found to be of very little advantage, and unsatisfactory, owing to the small recoiling power of the gun. The piston is formed like a large screw, and is most easily made by polishing a piece of 5-32nds in. steel for the length of $4\frac{1}{2}$ ins., and tapping both ends. One end will screw into the breech end, and on the other a piece of steel should be screwed and turned true with the rest to form the piston. Polish this to fit and work smoothly in the cylinder, and slit the end to form a screw, as shown.

A temporary spiral spring can be made to keep the gun in position, for the requisite strength cannot be estimated till the rest of the mechanism is finished.

The pole in the breech end D, into which the piston rod is screwed, will require to be most accurately marked, drilled, and then tapped. Make a prick punch of 5-32nds in. steel, and about $4\frac{1}{2}$ ins. long. When the whole of the gun is put together, the centre of the hole can be marked by passing the punch through the cylinder.

As it is absolutely necessary to have the breech end square with the cradle pins, and also with the centre of the cradle and cylinder, take care to have all in the correct position before marking. When the piston-rod is screwed into the breech end, do not allow it to project through, or else it will foul the rocking shaft bearing A.

The cylinder cover, of which the section is shown in Fig. 1, can be made of either steel or brass, the former for preference, as it gives a more handsome appearance to the gun. It is secured to the cylinder by three of the Swiss pillar screws (gauge 10). These are spaced equally and pass through the cylinder into the lug of the cover, which fits into it. The heads are countersunk, the position of them being one vertically underneath and two above. The cover can then be screwed on without fouling the cradle. As the cylinder is kept in position against the plate T by the pressure of the spiral spring, an English screw (gauge 18) passing through the strap S into the cylinder, as indicated in Fig. 8, will be sufficient to prevent it from turning round.

The edges of the recoil plate T can now be filed, while the gun is together, level with the sides of the breech end, the line of continuity being broken only where the right-hand side projects a little to give the recoil box clearance from the breech end, as indicated in Figs. 6 and 7. The recoil stop, which consists of a ring fastened on to the barrel, prevents the gun from recoiling further than the distance between it and the cradle. It may be made of brass or steel. Brass, of course, is the easiest to make; but steel, when the foresight (which is also of steel) is fixed on it, has by far the most handsome appearance. The casting or forging should be chucked, and the interior turned to fit nicely on that part of the barrel turned for it. One of the edges can also be turned at the same time. Now turn a piece of beech or some hard wood, slightly taper, and with a shoulder for the ring to fit tightly on to, with the edge already turned, next to the shoulder. The ring can then be turned, bevelled and finished, and the centre line for the screws marked. These are five in number, the position being shown by the dotted lines in Fig. 10 (Sights). Use the English screws (gauge 18); countersink the heads, observing that the head of that screw which comes underneath the sight is sunk a little below the surface of the ring.

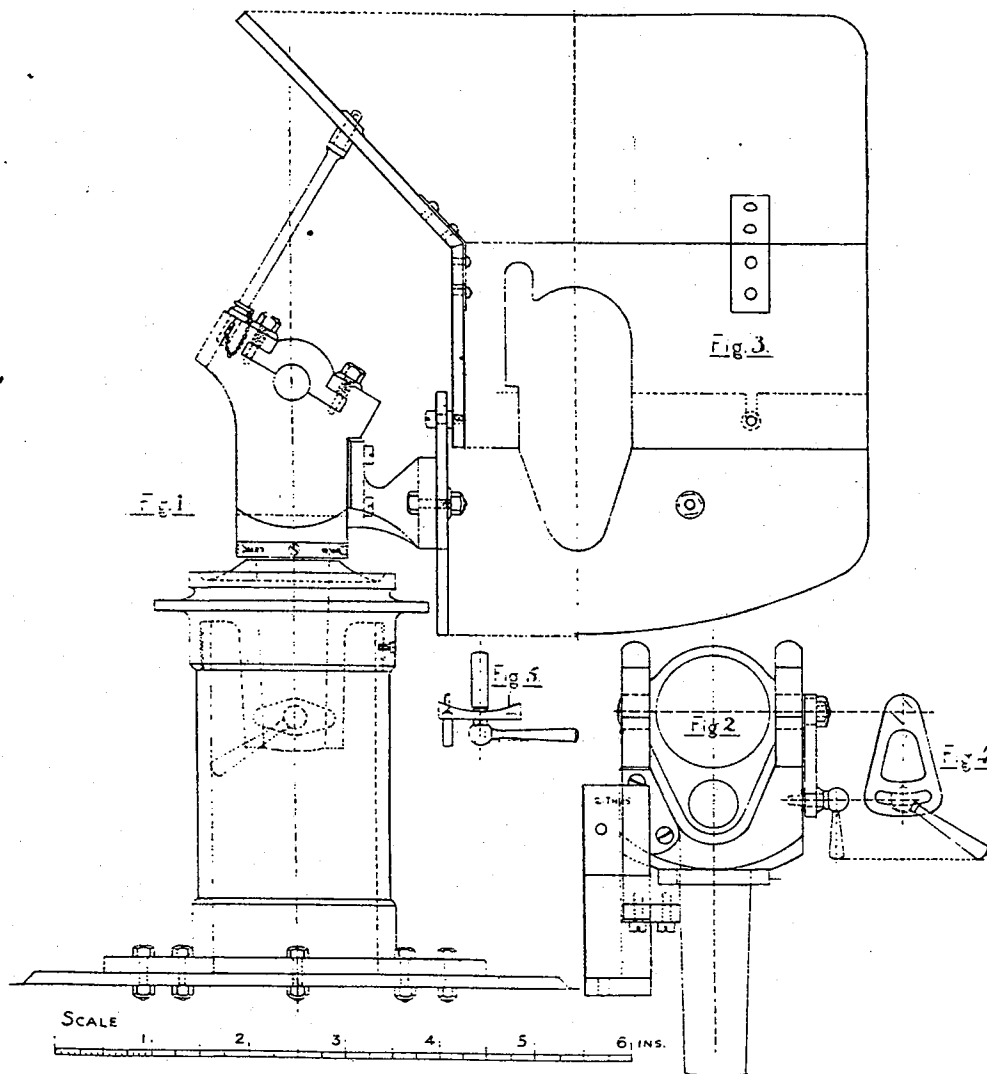
We will now proceed to finish the mechanism in the breech block, taking the firing pin, and the screw on which it slides, first. I may as well mention here that all the parts in the breech block and also in the recoil box will require hardening and tempering. The latter, of course, must be done with the springs, and is also advisable in regard to the other parts, to prevent breakage. In Fig. 1 is given a vertical central section of all the parts now under construction. The firing pin is turned out of steel, full $\frac{3}{8}$ in. diameter. Bore a hole down first $\frac{3}{8}$ in. deep with a 3-32nds in. drill, and then turn and polish to the shape drawn, which it will be noticed is something like a reel, the larger cheek at the back being $\frac{3}{8}$ in. diameter. When the two cheeks have been finished, fit a steel plug firmly into the hole and chuck it. The firing pin can then be turned and rounded off, as it is not necessary to pierce the cap, but to give it a blow. The cross-section of this piece of mechanism will be found in Fig. 2, which shows part of the rear cheek filed away to catch on the trigger. When this has been done, round it off slightly on the outer side of cheek, so that it may slide smoothly on to the catch of trigger. The shank between the two cheeks will also need filing (at right angles to the part filed off the rear cheek) sufficiently to clear the cocking gear, and allow the latter to have a firm hold. This is clearly shown by the dotted lines in Fig. 2. The pin or arm, on which the firing pin works, screws in from the back of the breech block, and the head of it, which is countersunk, is $\frac{3}{8}$ in. diameter; this width is necessary to keep it square with the block. As the back, into which the arm is screwed, is only $\frac{1}{8}$ in. thick, the head is left rather thin, so that the metal into which it screws may be as thick as possible.

It will be better to drill and countersink the block before making the arm. Mark the centres on both sides of the block, and then drill each one separately with a 3-32nds in. drill, being careful to keep the block perfectly square meanwhile. If the reader possesses a 4-jaw chuck, it will be as well to take the back off the block and countersink with a graver, and by this means ensure the bottom being true with the plate, or else it may be done with the same kind of tool as used previously.

The arm must now be turned to the dimensions given in the drawings, observing that it fits nicely into the firing pin. The head, owing to its thinness, cannot have a slot cut in it, and should therefore have two small holes drilled in it, at equal distances from the centre, and a key made to fit into them by which to screw it. The

trigger (Fig. 1) is constructed in three pieces, the upper vertical arm being fitted to the lower horizontal one by a single halved joint, and the firing pin, which is shown by dotted lines, the upper end pressing on the firing pin. The cross-section (Fig. 3) shows the spring on the left-hand side of the trigger, and also the method of joining the parts, the halving being done on the lower arm only. Make the upper part of the trigger first, out of steel $\frac{1}{4}$ in.

given; this is made of $\frac{1}{4}$ -in. steel, and will be found rather more difficult to make. It should first be filed to the shape given in Fig. 1, and then filed out squarely to receive the lower end of the vertical arm, which curves out to $\frac{3}{16}$ ths in. wide, the curve finishing level with the joint between the two parts (see Fig. 1). It should now be tapered down towards the part handled by the operator, which is the trigger proper. The taper is shown in



thick, file and grind it to fit into the bearing constructed in the breech block, and see that it has no shake sideways. The edges must be polished and left clean and square with the flat sides, which have a matted surface. Care must be taken to see that the face of the catch on which the firing pin slides is made the correct shape, otherwise, instead of working smoothly, it may be liable to jamb.

In Fig. 3 the end and top views of the lower arm are

the bottom view, Fig. 3, most of the metal being filed off on the right-hand side, and is curved out towards the thicker end. The left-hand side must not be tapered on the whole face, but left flat for a sufficient distance for the reception of the spring. The inner edges of the curved part handled by the operator are rounded off to the same shape as usually seen in firearms. The whole of the lower part is polished flat and bright, and need not, unlike the upper part, be hardened. We shall now require

a piece of double-shear steel, 12 ins. long and $\frac{1}{4}$ in. wide, and about 1-16th in. thick, out of which to construct the trigger spring and others, and also to allow for breakages, which are liable to happen when testing. I advise double-shear steel, as it is by far the most satisfactory for constructing springs, and, when once the right temper has been obtained, they rarely break. The shape of the spring, as explained previously, is shown by the dotted lines in Fig. 1, the end being finished with a slight curve, to work freely on the firing pin. The cross-section is given in Fig. 3, showing the spring undercut in its thinner part, so that it will not rub on the trigger. It will be advisable to leave it thicker than shown, and then filed down until the requisite strength is obtained to pierce a cap.

The three parts, now constructed, are fastened together by two screws, and they should be carefully marked before drilling, to ensure accurate fitting. The position of the screws will be observed in Fig. 1, placed diagonally, and they are screwed into the bottom arm only; use Swiss bar screws, gauge 12, for the purpose. If preferable, the vertical arm may be tapped instead, and shorter screws passed through from both sides into the same hole. As the strain when the trigger is cocked is considerable, the last method would perhaps be advisable. The spring, after being drilled and polished, must be hardened in oil and then tempered to a blue colour evenly, and this can be done by laying it on a piece of brass or copper plate and holding the latter over a flame. As a spring deteriorates with successive hardenings, the reader should endeavour to obtain a good result at first. The bearing in the breech block will now require tapping, and a screw with a shoulder fitted to it, for the trigger to work on. In Fig. 5 the section of bearing, which is indicated by the dotted lines, shows one side shorter than another, this being done to clear the spring when pressed back by the firing pin. This necessitates a rather peculiar form of screw (see Fig. 3). The head is 5-16ths in. long, being continued through the right-hand side of the breech block, thus allowing the trigger to be removed without taking the block to pieces.

The right-hand side of the bearing is tapped only, the screw, after passing across the space occupied by the trigger, being continued in the form of a pin, which enters into the other side. The screw will require hardening, and the shoulder on which the trigger works polishing. Mark the centre indicated in Fig. 1 in the elbow of the upper part, and drill a hole 1-16th in., and then broach or rime it out to fit on the shoulder of the screw. The space between the trigger and the back of the breech block must not be lessened in any way, for, if it is, they will touch without releasing the firing pin. To introduce the trigger into the block, the stay across the bottom will have to be removed, and it will be as well at this stage, after oiling, to push back the firing pin, and see if the triggers cock and release the firing pin correctly. The cocking sear G (Fig. 1) forms the connecting link between the rocking lever H, and the firing pin. First shape it out of $\frac{1}{2}$ in. steel to the form given, leaving it rather thicker on the inside of the curve against which the lever H presses. File and grind the two sides, leaving it as thick as possible, and then to the side nearest the firing pin fit a round piece of steel of the diameter shown by the dotted circle in Fig. 1, and of the length in Fig. 2. In the latter figure it will be noticed it just clears the firing pin, which was filed for the purpose. This cam may be either screwed or rivetted to the sear G. The former is the better, as it allows of removal for readjustment, if necessary. Make a screw (marked G1 to prevent confusion, in Fig. 2), and adopt a similar method in fitting this screw to the one used when fitting the trigger screw; though in this case the head of the screw is close up

against the sear to keep it in position against the bearing. As the centre of the screw is almost level with the joint between the side and top of the breech block, it will fit partly into each; so, if possible, the two should be clamped together while drilling, to prevent any undue strain or forcing apart when doing so. The sear, after marking the centre, must be drilled and then opened out in a similar manner described when treating of the trigger, to fit on to the shoulder of the screw. By the way, it should be remembered to leave all the screw heads slightly beneath the surface of the block to prevent rubbing on the breech end.

I must now direct the attention of the reader to Fig. 6. Underneath the recess into which the rims of cartridges fit, will be noticed a small shaded groove; the section of this groove is shown in Fig. 1, being also shaded. It should be cut with a round file, and when done to the right depth, fix the file in the lathe, and, while revolving, place the work up against it. This gives the groove a circular appearance, much superior to the straight cut left by the file. The following is the reason for cutting the groove. As the breech descends the firing pin is only drawn back gradually, and but for the groove would catch on to the edge of the recess in the steel plate, and prevent the block from descending further. The work should now be tested by pushing the block down, or turning the rocking shaft, and if the lever H, by pressing on the cocking sear, sets the trigger, all is correct, and the sear can be polished and hardened, taking special care over the edge against which the lever presses. If it does not work properly, the slight thickness left on the sear must be reduced till the proper action is obtained. It will be as well at the present stage to make a dummy cartridge, and see that the extractor works satisfactorily with the rest.

(To be continued.)

The A.B.C. of Dynamo Design.

By ALFRED H. AVERY, A.Inst.E.E.

(Continued from page 78.)

CHAPTER VII.

IN this chapter it is proposed to design a dynamo somewhat larger than the preceding, and with some slight structural difference, in order to illustrate the various methods met with in modern practice.

We will fix the capacity of the machine we are about to construct at 500 watts—say 50 volts, 10 ampères—a good useful size, capable of running two arc lamps of 1000 c.-p., or eight to ten 16 c.-p. incandescent lamps, with an expenditure of 1 B.H.P.

The calculations for this dynamo will be somewhat simplified by the adoption of a plain drum armature; this being permissible, it will be remembered, in the case of machines having armatures over $3\frac{1}{2}$ ins. diam. On applying the rule indicated in the last chapter, it is found desirable to fix the size of the present armature at 4 ins. in diameter by 4 ins. in length. In a machine of this size a fair proportion to allow for exciting purposes is 20 per cent. of the external current—i.e., 2 ampères. Thus the armature conductors will have to carry 12 ampères in all. Referring to the general rule—4000 ampères per square inch current density for armature conductors, and 2000 ampères per square inch for field coils—we find the nearest gauge of wire for the armature to be No. 18 S.W.G. (each conductor carries but half the total amount). As shown

water, adding a pinch of unslacked lime. A strip of blotting-paper, the size of the foil, is covered with the chloride of silver paste, and rolled round the wooden cylinder, the paste being next to the foil. A piece of muslin must be wrapped twice round the blotting-paper, and secured with thread wound round several times.

A second plug (C¹) of wood or cork is now prepared to fit the tube and to support the wooden roller by boring a central hole for this purpose. A solution of weak sal ammoniac is now poured into the tube, and the top plug, together with the wooden roller, is inserted into the tube.

Previous to placing the foil in position, a small hole is pierced through the foil where it projects through the plug, and a piece of annealed silver wire is fastened to it. A copper wire is fastened to the zinc lug and the tube filled up to the top with pitch. The E.M.F. of this cell is 1.19 volt, but the current is very small owing to the cell being a small one.

How to Make a Model Quick-Firing Gun.

By A. O. WOODWARD.

(Continued from page 154.)

BEFORE commencing the stock, which, it will be observed, is similar to that of a revolver, it should be understood that this part of the model has been greatly simplified. In the original guns the trigger does not descend with the block, but is contained, along with other mechanism, inside the stock and engages with the work in the block as it ascends. It is impossible in the space to introduce all the parts, and, moreover, they would be so delicate as to render them useless for firing purposes. If wished, the lower arm of the trigger and the stock may be dispensed with, and the upper arm provided at its extremity with a hole to which a lanyard is attached, and passed over a suitable bracket on the heel plate, and pulled by the operator in that position. This method is adopted in the Hotchkiss quick-firing gun; but appears to be more liable to accidental firing than the other. In Fig. 1 J1 shows the vertical view of the stock, the dotted line being the depth to which it is cut away for the reception of the trigger, when pulled; J2 is a view of the same part from underneath. The width of the slot, slightly tapered in its length is shown, the shaded part representing the trigger.

It can be made from a solid piece of brass and have the slot milled out, provided the necessary tools are possessed for the purpose. The following method will perhaps be found the easiest one, and though made of separate pieces, will be found amply strong enough for any strain that may be imposed upon it. First file a piece of sheet brass to the shape of the shaded part in J1, and taper it towards the rear end, the taper being the same as that on the trigger, though the width, of course, must be greater to keep the pieces on each side of this centre one clear of the trigger. J2 will clearly show what is meant, the dotted lines being the continuation of the taper. Now file a piece of brass 3-16ths in. thick to the shape of the whole of the stock, and solder it on the right-hand side of the central piece, and on the opposite side solder a similarly shaped piece a full 1-16th in. thick. It will be seen in J1 that part of it is filled over the back of the steel bar D1; this will suffice to keep the stock rigid when it is fixed by a screw countersunk into the thicker side of the stock as shown in J2. The stock must then be rounded and finished similar to that of a revolver. It may be milled diagonally with a fine slitting file or left

smooth. Later, when the finishing of the gun is under consideration, a method will be described for staining this and other parts a permanent dark brown, thus affording an effective contrast to polished steel and brass.

The casting of the framework for the recoil-box (Fig. 9) must have the two surfaces accurately ground and filed to the requisite thickness, which is slightly under $\frac{1}{4}$ in., and is shown in the section under Fig. 9. Take care when filing the inner edges of the frame to have them perfectly square with the surfaces, otherwise those parts of the mechanism which are fixed to these edges will be thrown out of square. Before filing the outside edges of the frame, the back of the box should be fitted. This is made of $\frac{1}{8}$ -in. sheet brass cut to the same size as the rough exterior of the frame. File, and then grind it sufficiently to obtain a true surface and fit with the frame, and then mark it for the screws in a similar manner to the way the breech block was done, so that the screws will come in the centre of the framework; allowance, of course, must be made for that part of the frame which remains to be filed. Pillar screws, the gauge of which three dozen were ordered, are used and arranged in the following order: five across both top and bottom, three down the rear end, and two at the front, the latter being arranged to clear the two large screws which secure the box to the gun. The screws across the top and bottom are kept in a straight line, no screws being used at the curved corners of the box. As one screw will come very near to the large one holding the spring O, it will require shortening a little to clear. Those at the top and bottom must be equally spaced, so that the screws which hold the two slides in place may come equally between them, four screws being used in each of the latter. When the back has been secured, the outside of the frame can be filed, the edge of the back being done at the same time. As the box is a very prominent part of the gun, the reader should be careful to file the sides nice and square with one another and with the back, keeping the rounded edges square also; where the latter meet the straight edges a distinct line should be noticeable, and perhaps the best way to obtain this result is, after nearly reducing to size, to use a small file, holding the box in the hand meanwhile.

The slot in the back in which the rocking shaft slides to and fro is shown in Fig. 3, the centres of the two ends being at M and H1; there is a thin raised edge all round it, which keeps the pawl M free of the back. File a piece of thin sheet brass to 1-32nd in. thick to form this edge, the size being a full 1-16th in. larger all round than the slot. Drill two small holes in the back plate at the centres M and H1, and two corresponding holes in the plate made to form the edge. Two brass pins passed through these holes will suffice to keep the two in position while soldering, soft solder being used. Then drill two holes after removing the pins, a 5-16ths-in. at one centre and a $\frac{1}{4}$ -in. at the other, and file away the metal between the two. A milling cutter 5-16ths in. diam., of the same pattern as used to cut the slot in the breech block, will now be required, unless, of course, the slot can be filed accurately without using an appliance of this sort; and in this case the two holes drilled should both be 5-16ths in. diam. If the cutter be used, fix it in the lathe and introduce it into the 5-16ths-in. hole, and support either the top and bottom edge of the plate with a piece of wood parallel with the bed of the lathe, so that it will act as a guide for milling the slot, the plate being kept square with the tailstock, and pushed against the cutter by hand.

Observe that there be no strain either above or beneath the cutter which would be likely to cause it to cut away from the centre line of the slot. The section of the plate when finished is illustrated in Fig. 6. Any solder left

round the edge should be cleared away, and file the face of it true with the surface of the plate. The inner face of the back can then be finished with a hone and water, giving the former a circular motion, and thus producing the finish commonly known as "snailing." The two slides are exactly alike, and, therefore, the bottom one only has been inserted in Fig. 9, the section of both being given in Fig. 6. These are constructed of 3-16ths in. sheet, and will need little description. The two inner faces which fit into the box and keep the lid in position require filing nice and square, and when worked out roughly, lay a dead smooth file down on the bench, and then rub the work slowly over it, keeping one side pressed up against the smooth edge of the file. The edges then require bevelling, the front being rounded at the corners, and the bevel continued round these curves. The slides are not fastened to the frame until the lid has been constructed. This is made of 1-16th in. sheet brass, which after being hammered as flat as possible, should be filed until all marks are erased. The best way to hold it while filing is to cut out a piece of hard wood to a sufficient depth and size to hold the brass, and allow it to project slightly above the surface of the wood. When filed to the requisite thickness, lay the frame over it and mark the size for the lid, and file the edges which fit into the slides only at present; the edges will be better if the sharpness is just taken off them, the lid will then work smoothly. The slides can now be fixed, and while drilling the holes for the screws, keep the lid between the frame and the slide, so that the latter may be in the correct position.

The details of the lid handle are fully given in Fig. 7; it is made of steel, which should be turned first, the two ends drilled and tapped while in the lathe, and then bent to the correct shape. To do this successfully cut a piece of hard wood, 11-16ths in. by 3-16ths in., and fix it in the vice, and after making the steel red-hot, hammer it over the wood, using a small mallet. The steel piece should be long enough to fit round three sides of the wood, that is fully $1\frac{1}{4}$ in. long, and when bent to shape, finish with a piece of fine emery cloth, and then crocus powder and oil. Now file another piece to $\frac{1}{4}$ in. wide and 1-32nd in. thick, and drill two holes corresponding to those in the handle, and then profile it to the shape in the drawings. Lastly, drill another pair of holes in the lid in line and square with the box, and pass two screws (Swiss, pillar, gauge 10) through into the handle, which must be tapped to this size. The heads, of course, will require countersinking, though the thickness of the lid will not allow of very much. Any projection of the screws must then be filed off, or else they will catch on the framework.

(To be continued.)

The English military balloons are lighter and more compact than those adopted by any other Power. Other nations use oiled silk for the envelope, but our constructors use goldbeaters' skin, which is very much lighter, an envelope of 10,000 cubic feet capacity weighing only 100 lbs. In addition to being lighter than silk, the membrane is much more impermeable. The cable used to connect the balloon with the ground is of wire, and weighs but 87 lbs. for a length of 550 yards. The total weight of a balloon complete, and capable of lifting two aeronauts, is less than 2 cwt.; to which, however, must be added the weight of the cable. Hydrogen is used for inflation, and is carried compressed in steel bottles, this arrangement being much more convenient than that of generating it on the spot by means of chemicals. This store of compressed gas is the heaviest portion of the equipment, as about 2½ tons of bottles are needed to supply one charge to a balloon.—*Engineering.*

A Native Indian Turner at Work.

OUR readers will remember that a short time ago we published an article describing the primitive methods and appliances used by native turners in India. One of our readers, Mr. Henry Bailey, residing at Mozufferpore, in that country, has been kind enough to send us a photograph showing a native lathe in actual use, and this interesting picture we reproduce herewith. It will be observed that the piece of work in progress—a table leg, apparently—is supported between two fixed centres, one of which is mounted on a post driven in the



A NATIVE INDIAN TURNER.

ground, and the other on a horizontal block of wood, which is wedged up from another post driven in the ground on the outside. The work is caused to rotate backwards and forwards by means of a stick and cord which the turner works with his right hand. The tool is supported on a long block of wood, which serves as a tool-rest, and is steadied between the toes of the workman, the guiding being done by the left hand. Judging by the finished table-leg lying in front of the lathe, which appears to serve as a copy, the turner shown in this photograph is an expert user of his simple tools.

Some of our readers may be glad to hear of an exhibition at which prizes will be offered for entries of model steamers, yachts, etc. Particulars of such an exhibition will be sent by the Shildon Horticultural and Industrial Society, if a stamped addressed envelope be sent to Messrs. Tomlin & Lothian, 1, Wesley Crescent, Shildon, Durham.

a field-pole. The four having been placed in position, they are connected in series to produce north and south poles alternately, and the ending and beginning connected to the direct current brushes in the machine, thus becoming self-exciting. As the machine is not self-starting, some means must be provided for bringing it up to speed, such as a hand-wheel or electric motor. The speed, which varies with the periodicity, is found in the case of a 4-pole machine by multiplying the number of cycles per second by 30. This gives the number of revolutions per minute of the armature. Thus, in the case of a 60-cycle circuit the speed would be $60 \times 30 = 1,800$ revs. per minute.

A choking coil, which will limit the current to about to amperes, must be connected up in series with the machine on the alternating current side, and the current should not be turned on until the proper speed is reached. With a little practice, the ear will tell the right moment for closing the switch. When turned on too soon or too late, there will be considerable flashing at the direct current brushes, and, were it not for the choking coil, considerable burning of copper and most likely a fuse melted. A variable resistance should be provided in series with the field coils. The strength of the current therein will be found to affect the running of the machine considerably. After it has settled down to even running, the choking coil may be cut out by a switch provided for the purpose. The amount of current which can be rectified by this little machine will be found ample for most purposes—anything up to 50 amperes; and, if more were required, an extra pair of alternating current and direct current brushes could be added opposite the existing ones, to which they would be connected in parallel.

When rectifying a current which tends to fluctuate considerably (as it does during the day-time in the town where I reside), the machine will tend to drop out of phase, and may give a lot of trouble. The best remedy in my experience is to remove the flywheel and mount it on a separate shaft, and connect the latter to the shaft of the rectifier with a small belt running on suitable pulleys, about 2 ins. diameter. For a belt I use a porpoise leather boot lace, and find it all that can be desired. I have a small direct current motor mounted beside my rectifier for speeding up the latter. The flywheel is on the shaft of the direct current motor.

Another thing which gave me a lot of trouble until I found out the remedy accidentally, is one for which I am unable to get any explanation. It is that sometimes while doing my early experimenting the machine absolutely refused to go into phase, and for no apparent reason. Without intending to do so, I reversed the connections between the field terminals and the direct current brushes, and the machine started without the least trouble. I further found that it made no difference which way the current went round the field coils.

Apart from its use as a rectifier, it may be used as a synchronous motor up to about 1-10th h.-p., so long as it is not too suddenly or too heavily loaded. On the other hand, if driven by a belt from any source of mechanical power, it may be used as a self-exciting dynamo, giving out either an alternating current or rectified direct current up to about 100 watts.

As stated above, the winding here given is that which has given the best results on a 100-volt circuit having a periodicity of 60 cycles per second, and this winding need not be varied to any great extent for any 100-volt circuit, except that in the case of a high periodicity, such as 125 cycles, it would be better to wind the armature with No. 24 D.C.C., 100 turns to each coil.

For a 50-volt circuit the winding is the same, except that both armature and field coils are connected up two

in series and two in parallel, taking care the arrangement of the poles is the same as before. In the case of 110 volts 50 cycles, 140 turns No. 26 D.C.C. on each armature pole, and the field coils wound with 700 turns No. 31 D.C.C. to each coil, should give good results. In any case where the available circuit varies from that given in the first instance (100 volts, 60 cycles) the builder must be prepared to do some experimenting with windings and resistances in the field circuit before the best results are arrived at. The writer's machine consumes just 1 ampere, and the drop in voltage across the direct current brushes, as compared with that across the alternating current leads, varies from 1 to 2 per cent. according to circumstances. The writer will be pleased to answer any enquiries from readers through the Editor.

How to Make a Model Quick-Firing Gun.

By A. O. WOODWARD.

(Continued from page 174.)

AS the gun recoils, the rocking shaft travels with it, therefore, a slot must be cut in the lid to free it when doing so. The slot extends from the centre *HI* to the rear end of the lid, so that the latter may be pulled right off when required. The width of slot must be sufficient to allow the lever *Y* to work freely in it, as shown in Fig. 6. The end of the slot at *HI* is finished semi-circular, with that point as centre. To prevent the lid being pushed beyond its proper place, two screws are fixed in the framework, their heads only projecting. Use pillar screws, gauge 10, for the purpose, and fix them about an inch apart, and also soften them in case the heads should get knocked off. Cut two slots in the lid for their reception. You will clearly see this and other details of the recoil box in the illustration of the right-hand side of the gun.

The ends of the lid can now be finished level with the framework; while doing so, keep the lid pressed up against the two screws in the position it will occupy.

We now require the brass bracket to support the box, and the casting must be filed slightly larger in the first place, than the dimensions in Fig. 7. The cross section is also given a little below this figure. As the bracket is fixed to the recoil plate, it will be necessary to take the gun partly in pieces to enable it to be fitted. First file that side of the bracket which fits on to the plate, and see that it does so accurately; then drill a hole for and fit the screw in the position in *A* (Fig. 7), countersinking the head; drill two small holes for steady pins, which are fixed to the bracket and in a line with the screws. Before fitting steady pins, the holes drilled for their reception should always be chamfered a little to guard against any abrasion of the metal that might occur, and prevent two parts fitting closely together. After fitting the bracket mark a line on it, level with the edge of the recoil plate, and proceed to file the side which supports the box down to this line and perfectly square with the other side. If necessary, employ the method previously used to ensure correctness in this respect. The top and bottom of the bracket can then be done, and, lastly, the curved side to the section given.

Before fixing the box, the steel collet, shown on the rocking shaft (shaded in Fig. 6) must be turned to fit on the shaft and work smoothly in the slot in the back of the box. The edge should be polished and one face turned

slightly oval to prevent friction on the bearing B, but left flat sufficiently in the centre to rest against the shoulder on the rocking shaft. The other face is flat and either level with or preferably a mere shade above the level of the projection round the slot.

As it is very important to have the slot parallel with the recoil of the gun, the following way—though, perhaps, giving a little extra trouble—will give the best results.

Underneath the pawl L, Fig. 9, will be noticed the large head of a screw, which, with the two others in the frame, helps to keep the box in position. After the collet is on the shaft, place the box on the gun with the front end of the slot pressing against the collet; a small hole should have been previously drilled in the place to be occupied by this screw in the back of the box only, and also another of similar size in the place of one of the two other screws in the frame. Hold the box in a horizontal position, and, with a drill passed through the first-mentioned hole, mark on the recoil plate and drill a hole, and then pass a brass pin firmly through both. Now press back the gun until the collet on the rocking shaft is at the rear end of the slot, and pack the gun to keep it in that position, and then mark through the other hole and fix a pin in a similar manner through the frame into the bracket. The two pins will suffice to hold the box while fitting the third screw (which screws into the bracket). The pins can then be extracted, one at a time, and screws fitted in their places. The sections of the two bracket screws are given in Fig. 7; the one which secures the box to the plate T must not be very long, else it may foul the screw which secures the bracket to that part. The head can be left projecting, the pawl L being undercut sufficiently to free it.

To relieve the thrust on the pawl, a piece of steel, shaped as shown by the shaded portion in Fig. 9, and fitting up against the inner side of the frame, is made. First drill a hole of the requisite size in a piece of 3-16ths in. steel to allow the box at the end of the pawl to work in, and then profile it, leaving a full 1-32nd in. space between it and the top of the frame to receive the spring O, observing that the end is square with the frame so that the spring may fit in firmly. This part is held in position by the three screws given in the drawings. Use barscrews, gauge 12, and countersink the heads. The reader may either polish or leave the mechanism in the box dull, as he pleases; though, as it can be more easily seen than the mechanism in the breech block, it had better be polished. In either case, grinding should be resorted to to obtain a flat surface on the parts. The pawl L may be made in two ways—either filed to shape or made in a straight piece, with the round box at one end, and then bent. The last method is the best—the fibre of the metal being with the bend it is less likely to break.

Mark on $\frac{1}{4}$ in. steel, the straight part, slightly tapered and $2\frac{1}{2}$ in. long. The boss and the thick part of the pawl, as far as the first bend, must be filed at a slightly larger angle than 90° to the rest, as it is too thick to bend to shape after. Do not overlook the small catch underneath the boss, on which a spring works for the purpose of keeping the pawl down after the cam M has passed from underneath it. The end of the catch is filed at an angle to free the steel cut out to receive it, for if left square it would catch, as will be clearly understood. The boss will require drilling and countersinking for the screw, and then shaping, and while doing the latter, try it frequently into that part of the steel profiled to receive it to ensure a good fit. While bending to shape, the metal must be heated, and no attempt to bend it when cooling, or a fracture will probably result. It should then be undercut to clear the screw, as mentioned pre-

viously, and also to free it from the back of the boss. This can be done either before or after bending. It will be seen in Fig. 9 (section) that the undercut is rounded on to meet the greater width of the boss; the section of the screw is given in the same figure. It must be of such dimensions as will allow the pawl to work free; be hardened and tempered, and then have the shoulder and head nicely polished.

After the pawl has been bent it should be made the exact length given, the end filed so that it meets the cam squarely, and be slightly rounded and polished. Lastly, it will require carefully hardening and tempering to a blue colour, and should possess sufficient elasticity to give 1-16th in. when working.

As it is important to have the two projections on the cam correctly spaced and in the proper position, they must be very carefully laid out. On a piece of $\frac{1}{4}$ -in. steel scribe the horizontal line and mark the centres for the rocking shaft and the roller N. The arc shown by the dotted lines is the same as that traversed by the cam, and the two projections should be situated on the two lines drawn from the extremities of the arc, passing through the centre M. The position of the higher projection must be such that, when returning from the recoil, it will catch firmly on the pawl. When marked out, drill centre M to fit firmly on the rocking shaft, and with a small square file, cut the keyway at right angles to the line passing through the centres M and N. Profile the steel very carefully to the shape, and especially the projections, observing that these are square with the sides and leaving M 1 slightly longer to allow for adjustment.

The slot for the roller N may be either filed (which is tedious) or milled out, and must be cut to a sufficient depth to just clear the roller; the width is shown in the vertical cross-section in Fig. 6. We will suppose milling to be chosen, and then, of course, a cutter will be required, the dimensions being half the thickness of the roller and 1 in. diam. Drill a 3-16ths in. hole through a piece of $\frac{1}{8}$ in. steel, and turn a short piece of rod steel, $\frac{1}{4}$ in. diam., down to fit into it, leaving a shoulder, and rivet the two firmly together. The steel must then be turned true and to the size given, and the sides smoothed. Then cut it in a similar manner to a circular saw, straight across. Fix the cam M firmly in a small hand-vice, the handle of which must be secured in the slide-rest and regulated in such a manner that the centre of the cam is horizontal with that of the cutter. The cutter, after being hardened, the work must be brought up against it and a cut taken down the centre first and then off the two sides gradually until the slot is the required width, leaving the side, into which the head of the screw on which the roller works, slightly thicker than the other. It is necessary to gradually cut the slot to size, for were the same size of cutter to be used, the sides, being rather thin, would be forced apart and be badly cut. When this has been done, drill the cam at the centre N and countersink and enlarge the hole on the thick side for the screw head and shoulder, and tap the other one; the screw is shown shaded in Fig. 9 in line with the rocking shaft. The roller is steel, turned, drilled, hardened, and then polished to the size given. It should work freely and without shake in the cam, which can now be hardened and polished also. It will be advisable, before finally adjusting the cam, to make and fit the spring O, for, as it has a tendency to push on the cam, the working of the latter in conjunction with the pawl is slightly different to when there is no pressure applied to it.

The spring O will be made of the double shear steel obtained for the purpose, and before bending must be filed to taper exactly to the thickness given, which is slightly less than 1-16th in. at its thickest end, and must be left fully 3-16ths in. wide for the present. To hold it

while filing taper, suit it in a piece of hard wood, in a manner similar to that adopted when constructing the recoil box lid. Leave the steel 4 ins. long, or fully $\frac{1}{2}$ in. longer than is required. The peculiar bend of the spring must be observed, it being necessary. The easiest way to obtain it is to cut a piece of wood—mahogany for preference, $\frac{1}{4}$ in. thick—to the exact shape formed by the inner side of the spring, leaving the wood nearly triangular in form (the thickness will allow of it being fixed in the vice, and leave sufficient projecting to shape the spring on); the latter should then be made red-hot and bent over the wood pattern, holding it at each end with a pair of pliers, there being sufficient metal allowed for this purpose. Two or three heatings may be necessary before the correct shape is obtained. The spring must then be polished inside on the straight part, and a small portion of the bend, on which the roller N works. Now cut the ends and fit the spring in the box. The thick end, as mentioned before, must fit tightly into the space constructed for it, and then kept in position by a large screw, as shown in Figs. 6 and 9. Mark the position of the screw accurately before drilling the frame and top slide; the steel part in the box only is tapped for the screw, and the spring should be drilled separately and not with the other parts. In cutting the top slide use a countersink, not a drill, as, the slide being thin, the latter is apt to tear or raise the metal. It will be observed that the slide is cut so that the shoulder of the screw may rest on the frame of the box. The screw has a shank sufficiently long to pass through the frame and form another shoulder resting on the spring and holding that part securely to the steel one underneath. Before hardening and tempering the spring, it should be tried once to see whether it works properly, *i.e.*, the horizontal straight portion of it keeps the same position when at its lowest, or whether the spring opens at the bend. If the latter, it will not do—for the lower part of the spring is at such an angle that it precludes the roller from running up it. The easiest way to get over the difficulty is to rivet a small steel pin, with a nicely-rounded head at the end of the lower part of the spring, so that, when the roller catches against it (having previously nearly completed its traverse), the spring will be pulled in that direction, and thus keep the correct shape. The roller will not pass over the pin, the tension of the spring preventing it from doing so. It may be necessary, should the pin be required, to file a small groove with a round file underneath the cam, and in line with the roller, to clear the pin as the gun recoils. It must also be observed that the pressure on the cam must be constant, for it is this pressure that keeps the breech closed when the gun is at rest.

Now carefully harden and temper it in oil. The tempering can be done by laying the spring on a sheet of copper with an equal flame underneath it. In either case drop the spring into oil again after the colour has been obtained. The next operation is slightly tedious, for it is now necessary to grind the spring on the back edge till it possesses just sufficient power to raise the breech and keep it in that position; were the spring to be too strong, a spiral spring of proportionate strength would be necessary to pull the gun to the firing position, and again, the recoil of the gun might then prove insufficient to work the latter.

(To be continued.)

THE following plan for the tempering of tools has been recommended by a French technical paper:—The tools are heated to dull redness and are then plunged two or three times into a mixture made by dissolving 10 parts by weight of rosin in 5 parts of fish oil, and stirring in 2½ parts of melted tallow. The tools are then re-heated to dull redness and plunged into cold water.

How to Make Experimental Electrical Apparatus.

By T. G. J.

(Continued from page 201.)

Gold Leaf Electroscope.—This instrument consists of the base (Figs. 8 and 9), into which fits the bell jar, shown in Fig. 8. The top plate or table is struck from sheet brass $\frac{1}{8}$ in. thick. This can be cut to shape as near as possible with a hack saw, and, having been fitted with the $\frac{1}{2}$ -in. brass wire seen in Fig. 11, turned up in the lathe. Or it may be trued up with a file and then fitted to the brass wire by soldering. Soldering is an easy matter when done in the right way. Well clean the

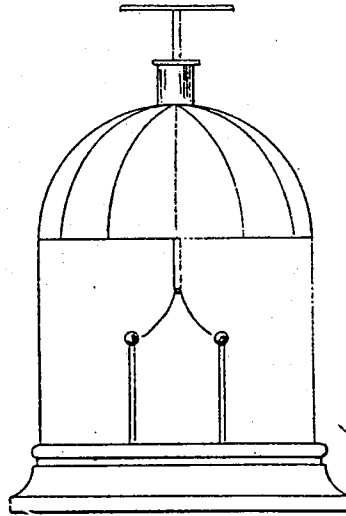


FIG. 8.

surfaces to be soldered together, by filing until quite bright; heat over the spirit lamp or Bunsen burner and use rosin as a flux; touch the centre of the brass plate with a stick of solder, and when the former is hot enough the solder will flow. Allow one or two globules to flow on to the plate, and remove the stick of solder. Take the brass rod in a pair of nippers and press it against the plate, taking care to have it quite central. Remove from

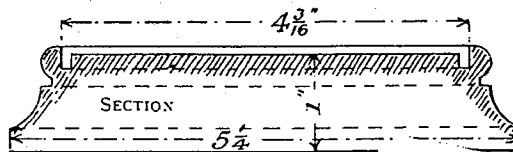


FIG. 9.

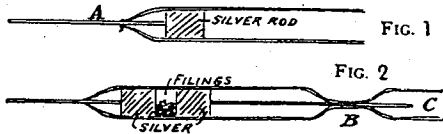
the flame and keep pressing the two pieces together until a sudden dulling of the solder shows. Polish up in the lathe and nicely round the plate. If there are any indents in cut from the sheet, these should be previous to soldering on the rod. A cork is borer (cork borers may be made

W. J.

How to Make Coherers for Wire-less Telegraphy.

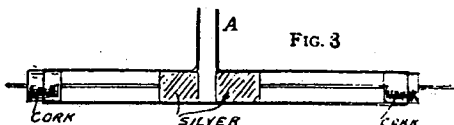
By R. V. LYNN.

FIRST take a piece of soft glass tubing about 4 to 6 millimetres thick; then take two pieces of silver rod about $\frac{1}{4}$ in. long, to fit the tube (this can be obtained from any jeweller for a few pence), and solder



on to one end of each a piece of thin copper wire—say, gauge No. 23, S.W.G. Then draw out one end of the glass tube and fit one of the pieces of silver into it, as shown in Fig. 1, and seal the tube off round the wire at the point A. Next take some fairly coarse nickel and silver filings, and mix them in the proportions, nickel 96, silver 4, and add to these a trace of mercury. This can be added in one of two ways—either by slightly amalgamating the ends of the pieces of silver rod, or by dipping the finger tip into a bead of mercury and then rubbing it on the filings. Having done this, place a small quantity of the filings in the tube and then put in the other piece of silver rod, allowing a space of about 1 millimetre between the two pieces, this being about half-filled with the prepared filings. This coherer, thus constructed, can now be used, but it will be found to work better if it is exhausted by means of an air pump. To do this the tube should be drawn out as shown in Fig. 2. By this means the filings are prevented from oxidation, and thus the coherer will last longer than one which is not vacuum. Very good results may also be obtained by substituting finely powdered carbon for the nickel silver filings, and even iron filings may be used.

Another form of coherer is the potassium coherer. This is constructed as follows:—Obtain a J-shaped glass tube of, say, 6 to 8 mm. diam., and, as before, place two pieces of silver rod having wires soldered on to them into the ends of the tube, leaving a gap of 2 mm. between them, the gap being under the vertical part of the



J-shaped tube. Then cork up the ends of the tube, bringing the wires from the pieces of silver rod out at each end, as shown in Fig. 3.

Having done this, cut up a small piece of metallic potassium very finely (this operation must be carried out under benzene), and then pour the benzene and potassium into the tube at A (Fig. 3). The coherer is then complete, and will be found to give very good results.

NOTE.—Copper rods with the ends amalgamated will be found a very good substitute for the silver rod.

ACCORDING to *The Engineer*, on the railways of Austria and Russia a common practice to prevent incrustation of the boilers of locomotives is to add a little petroleum to the feed-water. This prevents the precipitated matter adhering to the surface of the plates by coating each particle with a layer of oil.

How to Make a Model Quick-Firing Gun.

By A. O. WOODWARD.

(Continued from page 220.)

THE different parts on the rocking shaft now await the lever Y and the nut to keep them in place, and it can be made from either bar or sheet steel. If the former, the handle end should be turned first, and then the flat part filed to shape afterwards. To use sheet-steel for the construction, profile it roughly to shape, and then clamp it between two pieces of wood, leaving sufficient projecting to form the handle, and fix these in turn to the face-plate. Of course, if the reader possesses that most useful implement, a four-jaw chuck, the above process can be dispensed with and the work secured in it. Before filing the circular end, the centre for the shaft must be marked and then a hole drilled $\frac{1}{4}$ in. diam. A boss is turned from $\frac{3}{8}$ in. steel to fit tightly into the hole, with a shoulder to fit up against the lever, and then rounded off to clear the slot in the recoil box lid, as shown in the section in Fig 6, the dotted lines showing the continuation of the boss in the lever. The boss must be drilled while in the lathe and then hard-soldered to the lever and the latter rounded off at the end level with it. Cut the keyway in such a place as to ensure the lever being in horizontal position when the gun is at rest. A nicely finished nut is lastly required, and must fit on to the tapped part of the rocking shaft, and the latter rounded off level with it. The nut should be as large as the size of the lever will allow, to allow of a firm hold being obtained when tightening it. The reader had better mount the gun in a temporary wood carriage, and after the spiral spring is made, test it by firing, if he really wish to do so.

Two or three attempts may be necessary before the requisite amount of strength is obtained in the spiral spring. Naturally, it will be longer than shown in the drawings, as it is there shown compressed. The length when extended should be $3\frac{1}{2}$ ins., though it can be shorter with a stronger spring and *vice versa*. To make it, obtain some steel wire, either 16 or 18 gauge, and wind it round a steel bar fully $\frac{1}{8}$ in. diam. It will be best to do this operation in the lathe, for we can obtain the coils more even in doing so; secure one end of the wire in the chuck as well as the steel bar. When wound for a sufficient distance, say about fourteen coils, extend it to the right length and then try it in the cylinder. If it rubs, mount it on the bar again and still in the lathe, proceed to file it evenly all along, until freedom is obtained. The ends also require flattening by filing, so that they may rest squarely on the piston and cylinder end. These can be done after removing the steel bar from the spring and fixing the spring only in the lathe; it will be sufficiently rigid to allow of this being done in this manner. Harden and temper in a similar manner as the other springs were treated. If the recoil is insufficient to move the gun, the spring must be weakened by mounting on the bar and grinding in the lathe. Should the spring be too weak then the recoil of the gun will work it easily, but then, as explained before, it will not be powerful enough to work against the spring O. In the latter case, a stronger spring must be made. Should the reader not desire to make a model to fire, then the springs need not be so carefully adjusted, but the spiral spring left stronger than it need be.

The projection at the rear end of the gun is called the heel-plate, and is used both for the purpose of manipulating the gun and steadying the operator when firing.

Two bearings are fixed on the left-hand side of the gun; the front one is screwed to the recoil-plate, and the rear one on the breech end. As the heel-plate must not recoil with the gun, the shaft supporting it is screwed into the front one and locked with a nut; and the bearing fixed on the breech end so constructed that it may slide freely on the shaft, but at the same time act as a support.

The front bearing should be really fixed to the cradle, about half way between the recoil plate and the cradle pins; but as it is rather more difficult to fit it to a round surface, it has been altered. The shape and section of both were given in Fig. 1 and also in Fig. 6. They should be constructed of $\frac{1}{4}$ in. steel, and to ensure a true fit on to the gun, grind the under surfaces, and, after the bearings have been drilled, the sides also, which can be left with a matted surface. The holes and countersinks for the screws must be drilled before the shaping is done, otherwise it will be found more difficult to drill on the sloping edges. The screw heads should be rounded as shown, this being the best shape adapted to the peculiar form of the bearings. You should also strictly adhere to the position of the screws, and see that they are nice and central in the bearings. Before drilling the rear bearings select a piece of steel for the shaft and polish it, and then drill the former to the same gauge.

The length of the shaft from shoulder to shoulder is $4\frac{1}{2}$ ins., and the length of the part threaded to screw into the front bearing $\frac{3}{8}$ in.; though this need not be done till later.

The end to which the heel-plate is fixed requires a larger shoulder than the diameter of the rest of the shaft will allow. As it is a long process to construct it of a thicker bar, turn the shaft down for a distance of $\frac{3}{8}$ in. as indicated by the dotted lines, and to the diameter given. Now drill some steel $\frac{3}{8}$ in. diameter so that it will nearly fit into the part turned for its reception; then make it red-hot and hammer the shaft into it. When cold it will be found quite firm. The whole should now be turned to the shape and size given, that part of the shaft projecting beyond this added piece, being tapped to screw into the heel-plate. It will be advisable to leave this as thick as possible, and also to undercut it slightly near the shoulder to ensure a good fit. The heel-plate clutch, or holder (K1), may be constructed of either brass or steel, preferably the latter. A mild steel forging should be obtained and the three straight sides filed and ground. The width of the clutch being $5\frac{1}{16}$ ths in. Then file and groove to the depth shown by the dotted lines in the above figure. You will notice that it is left thicker at K, where the shaft is screwed into it, and the groove sloped from there towards each end. File the groove fully as deep as shown, so that the heel-plate may fit firmly into it. The width of the groove and the thickness of the sides is shown in the cross-section given, the clutch being shaded to distinguish it. Observe that the sides are of an equal thickness for their whole length, and then profile them, leaving the edges square and sharp; file the lower end very square and flat, the handle frame K2 being fitted up to it. It should now be tapped for the shaft and the latter screwed in to see that there is no projection of the screw through the other side of the clutch. Now turn and thread the front end of the shaft to the dimensions given previously. If the clutch is not quite vertical when the shaft is screwed into the front bearing, the screw which fits into the latter should have the shoulder turned slightly and the screw threaded up it. Do this very gradually until the correct position for the heel-plate is obtained, and then make a nicely finished nut to fit into the screwed end projecting beyond the bearing, and thus lock the shaft in its proper position. The part K, which is the heel-plate proper, is made of wood, and any

variety, providing it is sufficiently hard, will do for the purpose. Coco-wood gives a handsome appearance when polished, and is very suitable for the purpose. It must first be cut with a frame saw to the shape, and can then be filed. The cross-section at K is given, and from there towards the top the edges are rounded, the part above the clutch being quite oval in section. The edges from K downwards must be filed till, as it approaches the handle frame, it graduates into a square edge. The two illustrations will perhaps give a much better idea of what is meant, as it is a somewhat difficult shape to describe. The inner edge is cut to the shape indicated by the dotted lines so that it may fit tightly into the clutch, and special care should be taken to obtain a good fit at the upper end, for it is easily observed. Leave the lower end, that indicated by the dotted lines across K2, to allow for fitting to that part.

It will be seen that the handle frame is the same thickness as the wood, and also fits into the groove in the clutch; the shape and section are both given, the latter showing the way the wood is fitted into it.

It is constructed of $\frac{1}{4}$ -in. steel, and will afford the reader good filing practice. Shape it roughly first, and then file the slot for the wood tenon, using the edge of a file from which the cut on the two sides has been ground. The depth, as already stated, is shown by the dotted line across the figure. Then file the two outer surfaces parallel with one another until they fit in between the sides of the clutch and then finish to the correct shape, leaving the edges nice and square. Now make the handle of the same metal as the rest; as it is shown so clearly in the drawings, as well as the method of fixing, any description will be unnecessary. Use bar screws, gauge 12, and after the centres for these have been marked, round off the two ends of the frame, as shown in the section. The wood will require a tenon cutting on it to fit into the handle frame, and the oblique joint should be carefully marked on both sides and cut to the right depth with a fine frame saw. Six screws secure it to the frame, three on each side. They are tapped into the steel, as the thickness of the wood is not sufficient to afford a firm hold. Pillar screws, gauge 12, can be used, though they look much better with the heads rounded and then blued again. Any little inequality between the outer edges of the frame and wood can then be worked off, and lastly a screw countersunk into the centre of the clutch to secure the parts together. Though it is screwed into the wood a metal screw with a good thread will be found to hold quite firmly, especially if the hole in the wood is not drilled too large and be tapped first.

(To be continued.)

THE British Association Committee on Screw Gauges report that the system of screw threads recommended for the use of instrument makers, and known as the British Association screw threads, should be modified in the following way for all screws from No. 0 to No. 11 inclusive. For screws.—That the designating numbers, pitches, outside diameters, and the common angle of $48\frac{1}{2}$ deg. remain unchanged; but that the top and bottom of the thread shall be cylindrical, showing flats in section, and that the depth of the thread shall be increased by one-tenth of the pitch, the diameter of the solid core being in consequence diminished by one fifth of the pitch. For nuts.—That the designating numbers, the pitches, the diameter of the clear holes, and the common angle of $47\frac{1}{2}$ deg. remain unchanged; but that the top and bottom of the thread shall be cylindrical, showing flats in section, and that the depth of the thread shall be increased by one-tenth of the pitch.

How to Make a Model Quick-Firing Gun.

By A. O. WOODWARD.

(Continued from page 254.)

IN the ordinary course of things we should proceed with the sights, but as these can be adjusted more accurately when the gun is mounted on the carriage, I prefer leaving them until the latter is an accomplished fact.

Both the carriage and mountings are, to a good extent, plain, straightforward work, and as there is very little mechanism, I do not think it will be necessary to describe the process so fully as in the previous part of the article.

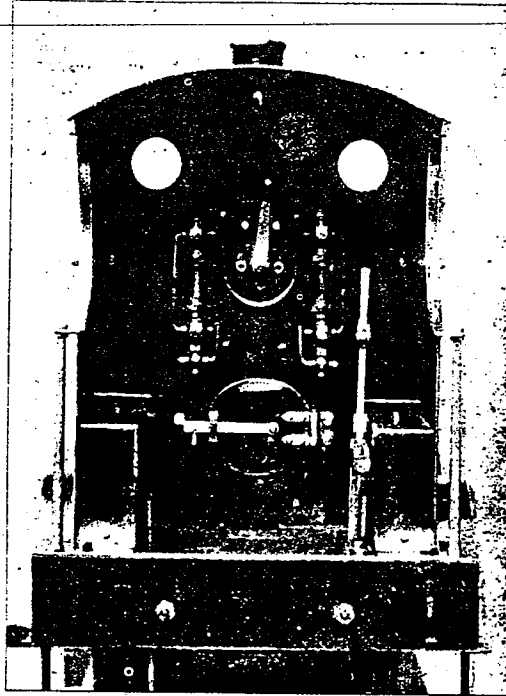
In the first place, patterns will be required, and of these there must be six: the cylindrical shaped stand, its cover, the part in which the gun swings (which we will call the cradle), two shield carriers or holders (as there are right and left, two patterns are necessary), and lastly, a pattern for covers of bearings.

Leave the base flange (Fig. 1)* rather thick in the pattern, otherwise it may warp when casting. A core of $1\frac{1}{2}$ ins. diam. must also be allowed for in this pattern. The pattern for cover should not be made to the exact outline, but as plain as possible, to ensure a clean casting. The dotted lines show the continuation of this part within A, for the purpose of holding the tapered plug of the cradle.

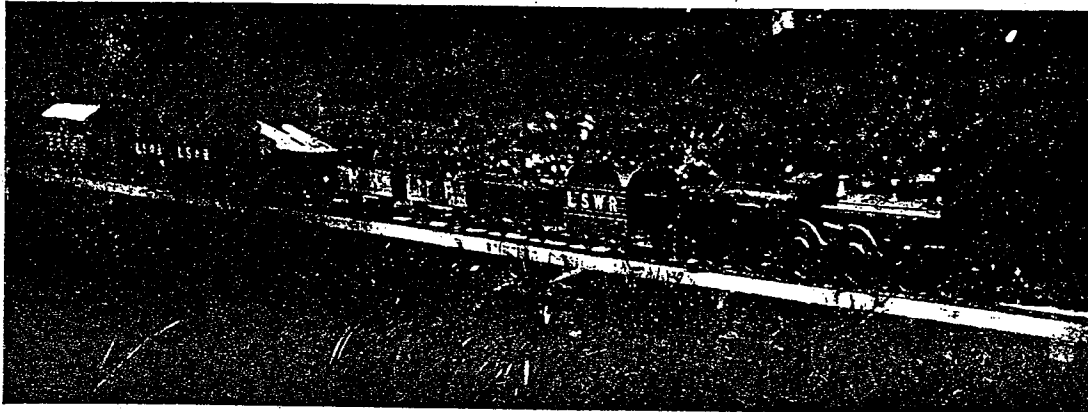
The cross section of the latter is given in Fig. 2, and needs no explanation, except that the shoulder is a steel ring, and the reason for this ring will be given later.

The shield carrier being rather a peculiar shape, three views are given in Fig. 1 and Fig. 2, these showing the side, front, and top respectively. Choice of metal for these parts is left to the reader. In the model I have by me the cylindrical stand and cover are constructed of gunmetal, and the cradle and shield carriers of brass.

certain quantity of this was mentioned as being required. It will be advisable at the present time to mark out both the shield and the stand, so that the material may be used to the best advantage. The plate is $5\frac{1}{4}$ ins. square, and



MR. WILLANS' MODEL SOUTH-WESTERN LOCOMOTIVE
(INTERIOR OF CAB)



MR. WILLANS' MODEL MIDLAND ENGINE AND GOODS TRAIN.

Whilst waiting for the castings, the plate to which the stand is bolted can be proceeded with. This is made of $\frac{1}{4}$ -in. sheet brass. In a previous part of this article a

* The drawings here referred to will be found on p. 153, July issue.

after cutting should be filed flat on both sides. If the brass is rolled true, very little filing will be needed. An application of pumice stone and water will remove all file marks, and then emery paper and oil will give the required finish. When using the latter, keep the "grain" quite straight; any wavering will give the plate an uneven

appearance. The edges are bevelled to a sharp edge, and I will mention one way by which an even and straight bevel can be obtained.

Construct a box of $\frac{3}{4}$ -in. stuff, which will allow the plate to rest in it diagonally, with one edge level with the top of one side of the box. It can then be filed, the opposite side of the box acting as a guide to keep the file level.

Treat each edge in a similar manner. After one side has been done, the plate will lie a little lower in the box, so this must be reduced correspondingly. Polish the edges at the same time with a buff, lengthways, not across the edge. The holes for the screws and bolts must be left till the stand is finished.

The bore in the stand may be either turned out or left rough. The former is to be preferred, as it allows of more accurate fixing in the lathe. No great accuracy is required, and so it can be done down from both ends to the requisite diameter.

Now turn the wood pattern of this part to fit tightly into the bore, with the centres marked on both ends. Use the wood projecting from the ends for chucking, and then proceed to turn the exterior. When turning the underside of flange, cut the metal away a little towards the centre to ensure it fitting truly to the plate. The flange is rounded off towards the straight part of the cylinder, not left square. This is shown by dotted lines, owing to the bolts obscuring it in the drawings.

The upper end has a shoulder turned on it, and is then screw-cut to receive the cover: use the same pitch of thread as in previous work. Observe that the shoulder be left square, or, preferably, undercut, so that no joint may be observable between the stand and cover. Before removing the casting from the wood, mark a circle on under side of the flange for the bolts. The holes should be in the centre of the flange, or a little towards the edge. Now lay out eight points at equal distances on the circle, and drill holes with a full $\frac{1}{2}$ -in. drill. The burrs can be taken off while in the lathe, and the whole casting polished.

Fix the lug of the cover in the lathe, and shape as much as possible while in that position. The reader must clearly observe the little vertical projecting rim, the inner side of which is shown by dotted lines. The shoulder at the top of the cover must be clearly defined from the portion which slopes up to it. The top of the shoulder must be quite flat; this will be better if left until the taper boring is done. The curves should be done by hand, not with the slide-rest, and must have a nice sweep without any ruts whatever. The small curved recess can be finished off with a small round file if the necessary sharp curve cannot be obtained with a turning tool.

On no consideration remove the work from the lathe until the boring has been done. The correct adjustment of the slide-rest for the purpose may, perhaps, not be obtained at the first cutting, though care should be taken not to set it at too great an angle at first. Use a small half-round L-shaped boring tool, one long enough to cut right through at one operation. After this has been done remove the work from the lathe, and turn a piece of hard beech to fit tightly into the bore, leaving the thinner taper end projecting a couple of inches so that it may be supported by the tailstock, and at the same time leave sufficient room between the tailstock and the work for the slide-rest.

It will be advisable to turn the wood while fixed in the 3-jaw chuck, so that it will not be necessary to remove it after it has been accurately turned. If this plan is adopted, the taper must be turned with the thin end towards the tailstock, and be of such a thickness as to allow the casting to fit tightly on it, and also allow it to touch the chuck, so that it cannot be forced further back when

cutting the thread. Further description of this part is unnecessary, as every detail and outline is given in the drawings. A set-screw passes through the cover into the cylinder and prevents any movement after the two parts are tightly screwed together. An English cock-screw, gauge 18, will do nicely for the purpose; the head is countersunk, and so placed in relation to the bolts in the bottom flange that it may face either directly forwards or backwards.

The bolts should be made next. The size is given, and care should be taken to finish them as well as possible, as they are very conspicuous.

Mark the centre of the brass base-plate, and scribe a circle the same diameter as that forming the centre line of the bolt holes, and then mark out the holes for drilling. The bolt heads are hexagonal and brightly polished; the nuts are screwed on from underneath, and can be left rough from the file. Eight more holes are needed to secure the base plate to a board (temporary at present), and before chamfering them a pattern of the brace-screw the reader intends to use should be obtained, and a chamfering tool made of such dimensions as will allow the heads (after being polished) to fit in a correct manner.

In the model illustrated the screws are placed two and two in the corner, about $1\frac{1}{2}$ ins. apart. This, of course, is a matter of taste, though it is advisable, owing to the space between the edge of the flange and those of the base-plate being rather narrow at the centre of the base-plate edges.

Whilst constructing the bolts and nuts, it will be as well to make two extra ones of similar size to secure the lower shield to the carrier. These will require polishing all over.

The side view of the cradle is given in Fig. 1, and both sides are exactly the same. The section is shown in Fig. 2.

Unless the pattern of this part is very nicely made, so that it may free the sand, a poor casting will result. Therefore, I think it will be as well to construct it so that there may be plenty of metal to allow for irregularities. The two inner faces should be sloped outwards. It will not be necessary to make any allowance for the bearings, as these are filed out. The tapered plug is turned first, and the casting is fixed to the face plate in the following manner.

Place a piece of wood until it fits tightly between the two cheeks of the casting, about 5 ins. long, and bore a hole at each end for a bolt. Then two pieces, $\frac{1}{2}$ in. thick, passing over the outer faces of the cradle, are screwed to the inner piece, and the whole bolted to the face-plate.

Adjust the casting until the plug runs fairly true, and set the slide-rest to the same angle used when boring the stand, to ensure the plug being the same taper as the hole in the latter part.

The length of the plug is 2 ins.; $3\text{-}16\text{ths}$ in. of this is turned straight for the reception of the steel ring, and the shoulder forming the under side of the cradle perfectly square with it. The slide-rest must be put square again before attempting to do this work.

Previous to this, however, turn the plug until it fits into the hole, leaving $\frac{1}{4}$ in. projecting, that is $1\text{-}16\text{th}$ in. more than we require for the steel ring.

While the cradle is still mounted in the lathe, apply some crocus powder (not emery) and oil to the tapered hole, and then run the two together, holding the stand firmly by hand. Allow them to grind till exactly $3\text{-}16\text{ths}$ in. left for the steel ring. Now for my reason for making these parts separately.

The reader will notice that the cradle is rectangular in horizontal section, and is rounded off towards the plug. Those who have had any experience at turning will know

how difficult it is to round off a casting, especially if it has to be worked up to a shoulder, and to obtain a nice clean effect.

Then, again, should the cradle have any shake or swing too easily, the thickness of the ring can be reduced, to obviate the necessity and trouble of chucking the cradle accurately in the lathe again. The rounding off can be done roughly with the slide-rest, and then will require to be finished by hand, either with a turning tool or a large smooth file. The last is by far the safer plan, though, to obtain the accurate result wanted, it will require holding very steadily. Unless this is done, the edges are not left sharp, but have, so to say, a further rounded appearance. A little practical work will soon illustrate what is meant. When this process has been done, and the work polished with emery buffs—which require holding quite as steadily as the file—we can unchuck the casting and proceed to fit the steel ring before filing the cradle to shape.

A mild steel forging or a piece of $\frac{1}{4}$ -in. steel will be required. It can be made of brass, but the steel forms a contrast, and also a better division between the cradle or stand.

It must be turned in precisely the same manner as the recoil top-ring was done, mounting it on wood after turning the interior and one side. It is held in position on the cradle plug by four screws, the longest left of the selection obtained. Countersink the heads, and then polish the work bright.

Be careful, while polishing, to keep the face quite flat, and not round the edges with the buffs used.

When the ring is applied, if the cradle swing too easily, or has any shake in the stand, a little should be taken off the ring on the under side, not that which fits up to the cradle. This should be done gradually until the cradle swings freely, not easily.

Now proceed to file the two outer flat sides of the cradle. These are $1\frac{1}{2}$ ins. apart, and must be perfectly perpendicular or parallel with the vertical outline of the cylindrical stand. This first step towards shaping the cradle will require extreme care and frequent measurement to ensure each side being parallel with the other, and at equal distance from the centre of the cradle. The distance from back to front in the narrowed portion (the parallel edges) is $1\frac{1}{2}$ ins.; these must also be perpendicular and at equal distance from the centre. Before profiling any further than described, the inner faces must be done. The section is given in Fig. 2. Before commencing, the steel strap and cradle pins must be taken off the gun to have the cradle fitted to it. It is advisable to do this, than to attempt to do the fitting while the strap is on the gun.

The shaping of the inner part is a matter of careful and steady filing, and I cannot give any hint to obtain a better result than will be forthcoming by the above process.

Mark the exact outline on back and front, and keep each face parallel with the opposite one, and also square with back and front. Use the vernier gauge frequently to guard against filing one side thinner than another, and also try the steel strap often, until a good square fit is obtained between the shoulder and the sides of the cradle. The finishing can be done by holding a stout emery buff with both hands and polishing in such a manner as to obtain a continuous "grain" from one side to the other.

As the two sides are exactly alike the profiling can be done by both at once, working straight across. Mark the outline on both sides and keep to it, never filing beyond.

The reader will clearly see from the drawings how the cradle is prepared to receive the shield holders. The surface for these is quite flat and square with the sides.

We have now arrived at a part, or rather parts, which will require most careful fitting—the bearings. In this case we have also an alternative. They may be constructed according to the drawings, or like engine bearings, with brasses.

I should advise the design given. It is certainly stronger, and will be less liable to give when boring the bearings.

First see that the tops of the two sides are most accurately filed and perfectly horizontal, so that the gun may swing without being on the "skew." It will be as well to place the cradle and carriage on a level surface, and then apply a spirit-level across the top to ascertain that everything is as it should be. If so, mark out both on the sides of and across the top the metal to be filed away. Do the work (across both sides at the same time) with a square file, leaving for the present the recesses into which the flanges of the covers fit. Then cut the recesses with a small file of the requisite thickness with both sides ground smooth, using only the edge to cut with. The reader can then—using the bottom of the recess already done as a guide—cut the slots to the necessary depth.

This file, naturally, will not finish the work quite square, but it will do what is equally important—not cut the recesses unevenly or wider than they require to be. A small square file and a thin flat one can lastly be used to finish up to the lines drawn.

In commencing the covers, file the sides of each first—not to the requisite thickness, but just sufficiently to remove any marks and allow of the outline being marked. It is not necessary to mark out the upper curved portion, as this can be done far more satisfactorily when the centres for drilling the bearings are laid out. Careful fitting and frequent testing will be essential to obtain a nice fit all over, though it is not necessary or advisable for them to fit tightly. The peculiar form of the bolts will, no doubt, have been noticed. They are threaded into the projecting flange of the cradle only, so that they may be easily removed, and continued in the form of a stout pin to hold the covers in position. This will be found amply strong enough if this pattern of cover has been adopted. The bolts are hardened and tempered, and each fitted with a loose collet to prevent abrasion of the cradle by the bolt heads. Drill holes through the cradle and cover at one operation, with a drill the same diameter as the pin continuation of the bolts, and then remove the cover and tap the holes through the cradle flanges to the correct pitch. Before replacing the cover, remove any abrasion round the holes both on the latter and the cradle. After the bolts are screwed in, the sides of the cover can be finished off level with the outer and inner faces of the cradle.

The centres for the bearings will now require most carefully and accurately working. First drill them out with a 3/32nds in. drill, and finish off with a cutter shaped like Fig. 5 (tools). It must be the exact diameter of the strap pins. Use a little oil with the cutter, and it will be found to cut a nice clean hole.

I do not know of any other shape of cutter which will do the work so satisfactorily. A twist drill is out of the question, for it will either strain or tear the covers.

The curved top of the cover, having been marked, can next be filed. This operation, after filing nearly to the line, can be better done by holding the work in the hand, and using a small smooth file. Observe that the junction between the curves and the cradle is in a nice straight line, and that the surfaces meet evenly.

Fig. 4 needs a little explanation. It is made of $\frac{1}{8}$ -in. strip steel, and should be marked out first and then a hole drilled in the position for the square.

(To be continued.)

How to Make a Model Quick-Firing Gun.

By A. O. WOODWARD.

(Continued from page 273.)

NEXT drill a number of $\frac{1}{8}$ in. holes, to form the slot, and make a cutter of this diameter similar in form to that used for slotting the breech-block.

If a screw is now passed through the first-mentioned hole to secure the work to a piece of wood, and the cutter fixed in the lathe, then by using the rest of the steel strip as a lever, the slot can be worked out quite circular, and of the same width throughout.

It should not be longer than the design given, otherwise the gun will touch the cradle when elevated or depressed to its utmost limit.

The fitting of this part to the square must be done gradually, and tried very frequently, so that a tight fit is obtained, and then further secured by a nut screwed on the part threaded for its reception.

A good fit here is essential, for if it is not so, any shake, however slight, will be magnified, to a great extent, at the muzzle of the gun.

The locking lever is made in three parts. The handle, which is fitted into the ball end of the screw, and a loose, bevelled collet, which fits on the shoulder of the latter part.

A small steel collar is also partly countersunk into the cradle, so that the link may rest against it, instead of being strained at the upper end by clamping it close up to the cradle. Mark out the position accurately on the cradle for the screw.

The hole must be exactly under the bearing, and should allow the screw free motion throughout the length of the slot.

All these parts are brightly polished, both on the outer and inner edges and flat surfaces. The polishing of the lever, of course, is done in the lathe.

The shield holders will afford good filing practice. Though they are right and left, the same measurements are observed in each.

First file and fit that face of each which is in contact with the cradle. The positions and size of the screws are given in the drawings. The inner edges of these back plates are finished flush with the inner curve of the cradle, and will be much better if done after fixing. Then file the two opposite faces to which the shield is affixed, observing, with the aid of the vernier, that they are filed parallel with the back faces to ensure the shield being upright, taking it for granted that the cradle is already so.

These two front faces can be finished more satisfactorily and level with one another after they are fixed, and also the upper and lower edges cutting straight across both holders at the same time.

The sides of the holders project slightly beyond the sides of the cradle, and are bevelled off to meet the latter. This gives a much better appearance than leaving them flush with one another.

The under face of each will be found rather difficult to file, merging as they do from a curved line (level with the under part of the cradle) to a horizontal straight one.

Do not drill the holders for the bolts until the bottom shield is ready.

The section and half front view of this and the upper one is illustrated.

The $\frac{3}{8}$ in. rolled sheet brass is used, and if the reader possesses a circular saw fitted to his lathe, it will lessen the labour in cutting them out. The upper shield is made

in two parts; the lower is one piece only. File both sides of the brace until all marks are removed. The front part of the shield is enamelled with and, therefore, will require no further treatment. The inner face must be worked with pumice-stone and water until all the file marks are removed and an uniform surface obtained.

Now profile to shape. Make the edges as square and level as possible, for these are polished—not enamelled.

Should the reader have any difficulty with these, the following hints may be found useful:—Plane up two sides of a piece of wood, $2\frac{1}{2}$ ins. by 1 in. sq., and fix this, along with a large file, in a vice, projecting the outer face of the latter from the vice jaw by a thin piece of wood. Allow $\frac{1}{2}$ in. or so of the file to project above the wood, with the latter having one of its trued surfaces towards the file and the other facing upwards in the vice.

After the work has been fairly true, it can be rubbed against the file, resting or pressing it firmly on the wood meanwhile. Curves can also be worked also with the greatest ease without in any way destroying the curvature; on the contrary, often improving them.

That part of the shield cut away to allow the gun to swing clear must all be done by hand, the above method being useless. A careful study of the plan will show how the shields overlap one another and how far the openings extend in each.

Mark the position for the bolts, and drill two $\frac{1}{8}$ in. holes. Two brass collets are then soldered to the shield, the edges being curved off to meet it.

These are soft-soldered on, and the easiest way to make them, and also to prevent them from moving whilst soldering, is to turn them with a small lug on the back to fit into the holes drilled in the shield, afterwards drilling through the shield and collet together. The front surface of these collets are polished only; the edges are enamelled when that operation is being done. This, however, is all explained later.

The holder can now be drilled and the bolts introduced, and the whole fitted together.

Now observe that the upper edge of the shield is perfectly horizontal. If this is so, and the two vertical edges square with the top, all will be satisfactory, and the upper shield can be proceeded with.

The surfaces of the two portions of the upper shield must be prepared in a similar manner, leaving the edges until the two have been joined. The joining, to be satisfactory, will be found rather difficult; for, unless the metal is bevelled to the correct angle and straight all along, a good joint is impossible. Now for a method for doing it, though the reader may, perhaps, hit on a better one. Bevel a piece of wood 1 in. square section, lay the file flat on the bench, and, holding the wood and metal to be worked firmly together, rub them lengthways on the file, testing frequently.

The two brass angle-pieces will next be made. These are bent to shape out of 3-32nds in. sheet brass. The bending, of course, leaves the metal slightly rounded, both inside and outside, at the angle. By filing to 1-16th in. these can be made quite sharp, to allow the shield to fit closely into them.

Turn the rivets up in the lathe with a round head, fairly large, and then drill the holes through the upper part of the shield and one side of the angles, chamfering the holes on the inner side of the shield. Rivet them on, and then solder the two sections of the shield together; the angle-pieces will suffice to hold them together while doing so. The holes can then be drilled through the lower shield, rivetted, and then all firmly sweated together.

Now the edges can be finished as previously; the width of the shield is the same as the lower one. All the sides are square with one another, the two upper corners being rounded only.

The clearance for the gun coincides exactly with that in the lower; and the clearance for sighting must be the exact size given, and the same distance from the centre, in case it should interfere with the sighting.

This small space can be cut out to almost the correct size with a frame saw; drill a hole at the upper end of the slot, the same diameter; this will ensure that end being nicely curved. It will be found a little difficult to polish these edges, for they must be kept quite square while doing so, and not be rounded off in all directions.

The upper shield is fixed to the lower by means of a slot arrangement; the section of one of the screws is given; it has a collar on midway, which forms a recess between it and the head, into which the lower shield fits. They are fixed to the upper shield, and the position of one is given in the drawings, about half way between the side of the shield and the opening for the gun. They are polished all over, and can be made in the form of a stud, or have the heads slit like ordinary screws.

The slots can be made by drilling holes in the exact position, and cutting down to them with a frame saw, shaping to the correct size with a small file.

When finished, the shields can be fitted together. The edges, both outer and inner (those forming the opening for the gun) should coincide, and the upper shield be perfectly upright. If it is not so, a little judicious filing of one of the slots will soon make it so.

The shield is supported by two bars, the lower ends of which rest in sockets or holes in the cradle, their upper ends passing through the shield and being secured by pins. Owing to the fact that these supports meet the shield at an acute angle, it is necessary to make a loose collar to fit on to a shoulder on each. The drawings show the supports passing through the collars (dotted lines), and also the shoulder on which they fit.

The supports are made of steel, and, provided all the parts appertaining to the shield are exactly according to the drawings, they may be of the same size. I say this advisedly, for should any part differ in this respect, the shield will not be upright. The supports are polished bright all over; do not forget to do the rounded end which projects through the shield.

Mark accurately and centrally on each side of the cradle the position for the holes, and then drill them with a 3-32nds-in. drill, and, if necessary, turn the lugs on the supports to this size after the holes are drilled to ensure a good fit. Now mark the points where the supports will penetrate the shield; this will require a little calculation to find out exactly. The space between them must correspond to that between the socket holes in the cradle. Two collars are soldered on the outer surface of the shield in a similar manner to the two through which the bolts screwing the lower shield were passed. In this instance it may be advisable to omit keeping these in position, while soldered, with the small lugs, owing to the holes having to be drilled at an acute angle. Cut these holes centrally through the collars first with a 1-16th in. drill, and then rime them out to the required size and angle, testing frequently to ensure the accuracy of the latter.

Two keys or locking-pins will now be required to secure the supports in their sockets. These are made of steel. Turn a piece down to form a pin, $\frac{1}{4}$ in. long and 1-32nd in. thick, with a ball head about 5-32nds in. diam. The heads are then filed flat on two sides, drilled and chamfered for the reception of rings, and each polished brightly all over.

I think it will be advisable to drill the holes for these pins, so that half the diameter of each hole only will be cut in the lugs of the supports instead of passing right through them as shown in the drawings, as the latter plan is apt to weaken the supports.

A small piece of steel or silver eyeglass chain must now

be obtained for attaching these pins to the supports, as well as the rings securing the ends of the chain to each part. The drawings show very clearly all the details connected with these.

The two ends of the cradle into which the supports are fixed are lastly rounded off, and this must be very carefully done, otherwise the appearance of the model will be greatly spoiled.

Mark down both faces of each side of the cradles at right angles to the top lines, level with the centre of the support holes. Also mark on the top of each side a semicircle with the hole as centre, and then file carefully to the lines drawn.

Before fixing the shield in place, the two handles for lifting it on and off must be made, though, if preferable, these can be omitted.

They each consist of a steel stud tapped into the vertical part of the shield, and a pin of straight polished bar steel passed through the sloping part, with one end slightly tapered to fit into the studs.

The studs should be made and fitted to the shield before drilling the heads. You will then ensure the holes being quite vertical for the upright bars. The holes in the sloping part of the shield, to receive these bars, will be a little difficult to drill straight away. It is better to make them with a small drill and then rime them out, using the holes in the studs as a guide, passing the rimer through both holes at the same time.

The lower ends of the upright bars are rounded off and should not project beyond the studs. All parts are polished, and lastly the upper ends of the bars filed flush with the shield. Little now remains to complete the carriage, the stop (Fig. 5)*, which is fixed to the cylindrical stand and is used to keep the gun from swinging laterally, being all that is required.

It is made entirely of steel, and fixed on the left-hand side of the carriage in the position indicated by the dotted lines in Fig. 1.

The principle of it is simple, and will be easily understood. It consists of an elliptical shaped plate, into which a lug is screwed, penetrating through the stand and also through the inner portion in which the cradle swings. The end of it is rounded off, and when screwed in by means of the lever (half a turn sufficing) it tightens up against the tapered plug of the cradle, and so keeps it in position.

Before filing the plate to its elliptical form it should be filed out hollow at the back to fit on to the stand. Use a large half round file for the purpose, and when a fairly good fit has been obtained, the stand should have a little oil smeared on it, and then the plate applied. By this means the reader will easily see where any further filing is required.

Mark out the shape of the plate while it is resting on the stand, to ensure it being quite horizontal, and then file to shape, keeping the edges square with the iron surface.

Drill a hole in the centre, and thread it with a 5-32nds-in. tap, and also drill two smaller holes, one at each end, for the screws, one for the latter being counter-sunk.

All three holes are in a line, and the two holes for the screws should be centrally drilled through the rounded ends of the plate.

The section of the plug is given in the drawings; the threaded part must be about twice the length of the hole prepared for it, to allow for screwing and unscrewing (the final adjustment is explained later). The thick end is carefully rounded to prevent abrasion of the cradle,

* The drawings here referred to will be found on p. 153, July issue.

and the opposite end is turned a little thinner for the reception of the lever. The lever is the same shape and size as that regulating the elevation of the gun, except that the present one has the handle and ball made in one piece, whereas the other is a thin end fitting into a ball head.

The ball is drilled for the plug to fit, and then a small steel pin passed through to prevent one from slipping on the other.

It will be noticed that one screw has the head elongated. This is done to prevent the lever from falling back more than a half-turn, so that its pressure can be easily applied. For this reason the reader must find the exact positions of lever and plug before keying the two together, so that when the lever is thrown back on to the screw-head, the cradle may move easily, and a half turn suffice to secure it.

(To be continued.)

For the Book-shelf.

(Any book reviewed under this heading can be obtained from THE MODEL ENGINEER Book Department, 6, Farringdon Avenue London, E.C., by remitting the published price and cost of postage.)

PRACTICAL MECHANICS. By SIDNEY H. WELLS, Wh.Sc., A.M.I.C.E., A.M.I.M.E. London: Methuen & Co., 36, Essex Street, W.C. Price 3s. 6d. Postage 3d.

There are so many text-books published dealing with the subject of mechanics that the engineering student may well feel puzzled in making a choice. We are confident, however, that he will find neither a better nor a more interesting introduction to this important branch of engineering study than the admirable little handbook prepared by Mr. Sidney H. Wells, who is well-known to our readers as the Principal of Battersea Polytechnic. Mr. Wells takes the student through a series of most instructive experiments, performed with simple and inexpensive apparatus, and shows him how to reason out for himself the principles these experiments are intended to teach. In each case the object of the experiment is stated first; then the apparatus required is clearly described; next is given the method of performing the experiment; and lastly the student is shown what deductions may be made from the results obtained. The various chapters deal with experiments on forces, levers, velocity, acceleration, elasticity, testing of wires, beams, friction, machines, mechanisms, hydraulics, and the energy of flywheels, and a number of useful exercises are included to afford additional practice to the student. As a class book for students in technical colleges this volume will undoubtedly be in considerable demand, but we think it will also be particularly valuable to engineering students living in isolated districts, where a college laboratory is not available, and who wish to study the subject experimentally at home. The apparatus is so clearly described and illustrated, and in most cases is so simple to construct, that many who are interested in this subject will feel tempted to rig up a mechanic's laboratory of their own. At any rate, those who conscientiously work out the experiments described by Mr. Wells will have a far more useful and intelligent knowledge of the subject than could possibly be obtained by any amount of working out of rules and examples on paper. The appendices, giving the cost of fitting up a class room with the various pieces of apparatus described, should prove very helpful to teachers desirous of conducting experimental classes.

THE CONSTRUCTION OF LARGE INDUCTION COILS. By A. T. HARE, M.A. London: Methuen & Co., 36, Essex Street, Strand, W.C. Price 6s. Postage 3d.

We have always felt it matter for no little surprise that so many electrical amateurs should approach the undertaking of building a large induction coil in the light-hearted spirit very often displayed. By their own avowals, they are not only not adepts at the work, but in many cases have not tried their 'prentice hand at even a medical coil. From our own experiences in the direction indicated, we have learned to regard the construction of a coil as no light undertaking, and have also every reason to endorse Mr. Hare's statements as to the lack of literature on the subject. Now he has come to the rescue of the little army of eager scientific amateurs, producing a book which, after a close investigation on our part, appears to contain every particle of information on the question one is likely to get outside the professional workshop. The method our author has followed is one which will commend itself to the scientific world all over: he first constructs his coil, and then describes its construction in an intelligent and perfectly lucid manner. Add to this the fact that before writing down his experiences, Mr. Hare exhausted all means of testing his work, and has here clearly given the results of his labours, and we have a book at once conceived on the right lines and presented in its most useful form. Every amateur coil maker who aspires to produce a thoroughly good piece of apparatus will realise, if he first peruses this work, that its cost is a trifling item compared with its invaluable contents. As a secondary matter, we may add a word of praise for the excellence of paper, binding, printing, and illustrations, which are all of the best.

THE CHEMISTRY OF THE MATERIALS OF ENGINEERING. By A. HUMBOLDT SEXTON. Manchester: The Technical Publishing Company, Limited, 31, Whitworth Street. Price 5s. nett. Postage 4d.

Whilst it is true that the most eminent metallurgists of this country and the Continent have not hesitated to make known the secrets of their science, it is also equally true that the records of their researches are to be found only in large treatises and transactions of scientific bodies, not readily accessible to the young engineer. The present volume was prepared with this fact in view, and to provide a comprehensive text-book which might serve at once as a vade-mecum for general reference and as an introduction to the larger volumes on the subject. There can be little doubt that the possession of such a book will be of great practical value to those whose daily work brings them in touch with "engineering materials." To know something of their nature, structure, and manufacture is no little help to the right use of the finished products, and this is just where Mr. Sexton's book will prove most useful. The metals—iron, steel, copper, lead, zinc, tin, and alloys—and other materials—such as wood, stone, cements, fuel, water, lubricants, &c.—are thus treated in a very sensible manner; and, as may be guessed from our remarks above, the volume can be confidently recommended.

STONE CUTTING AND POLISHING. No. 26, "Useful Arts and Handicrafts" Series. London: Dawbarn and Ward, Limited, 6, Farringdon Avenue, E.C. Price 6d. Postage 1d.

This is an excellent book for the holiday-maker who has gathered a store of pebbles and shells. The lapidary's art, so far as it is carried in the instructions of this little book, is a simple, engrossing, and comparatively inexpensive one. It should, therefore, have a considerable following amongst those who know how to use their fingers to advantage.

How to Make a Model Quick-Firing Gun.

By A. O. WOODWARD.

(Concluded from page 303.)

THE SIGHTS.—The construction of these will be found rather more difficult than the rest of the work, though, if the reader has carried the model to a successful conclusion so far, I do not see why, with the experience he has gained, he should find any great difficulty in their construction. They are not an absolute necessity, and, if wished, the rear sight can be still further simplified. I will, however, explain the construction, and leave it to the reader to decide what he may do.

In the first place, I take it for granted that the gun has been constructed exactly to every measurement given. If so, then the sights will be fairly correct when fixed, though a slight adjustment may be necessary.

The fore-sight is illustrated in Fig. 10,* which shows it mounted on the recoil ring in the exact position it must occupy. The section is shown below Fig. 10, on the gun barrel. It is constructed in two parts, the larger piece (A) being made of 3/16ths in. steel, and B, which is "knife-edge" in section, is made of 3/16ths in. bar steel, as explained later. A piece of steel larger than required must be fixed in the four-jaw chuck, or else mounted on a piece of hard wood by means of a couple of screws (the holes for these being in such a position as to be clear of the portion required for the work), and then, by means of the slide-rest, turned out to a certain extent to fit accurately on the recoil ring. Do not fix the steel centrally in the lathe, but in such a position as will allow just sufficient metal to be cut away as is required. When this has been done, the work can be marked and profiled. In the latter operation it is specially needful to keep the edges square, or else the sight will look all awry when fixed.

A 5/32nds-in. hole is drilled through the metal in its thickest part, thus giving the sight a much lighter appearance. The hole is polished, after drilling, by means of a piece of emery cloth mounted on a stick, and revolved in the lathe. Two small holes will be required for screws in the positions indicated. The smallest screws that are left can be used for the purpose, and the heads either countersunk or left projecting.

A hole, 1/32nd in. diam. and 3/16ths in. deep, is required, drilled vertically in the upper part of A for the lug of B to fit in. This will be better if drilled after the part A has been finished and fixed in position on the gun, by this means being assured of it being truly vertical. Of course, a hand drilling stock is used; and a small hole is also required on the front side of A for a screw (pillar, gauge 10, S.) to come in contact with the lug on B and keep it in position.

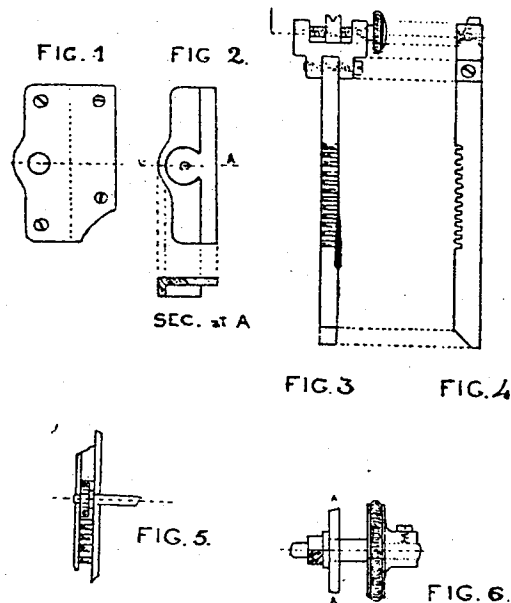
The part A can now have the edges polished carefully and true, and the two surfaces matted only. It will be observed that the position of the screws have been so arranged as to come between those securing the recoil ring to the barrel. To construct B turn a pivot on a piece of 3/16ths in. steel to fit into the hole drilled for its reception. Leave the shoulder nice and square, and then, while in the lathe, file a portion away on two opposite sides till the section given is obtained. The two sides must be

quite parallel, though inclined towards one another. It can then be cut off and profiled to the correct shape, holding it in the vice between pieces of hard wood meanwhile. Care should be taken to obtain the exact shape and section given. The back vertical edge must not be polished, though the front curved one is. The two faces are lastly polished, and then the whole blued and fixed in position by means of the setscrew.

The rear sight consists of the following parts: case, cover, rack, traverse head and screw, sight, pinion shaft, and adjusting wheel or button. By permission of the Editor I have been allowed to give below further drawings of this part, so that the details may be more seen and understood.

The fore-mentioned parts are shown respectively in Figs. 1, 2, 3, and 6 below. The case and cover may be of

REAR SIGHT. — DETAILS.



brass, and the remainder of steel, though all steel will look better.

It will be advisable, before proceeding, to call the reader's attention to one or two small details.

The cover (Fig. 1) is continued beyond the case and forms a projection by which the sight is screwed to the gun. The rack slides in the groove formed by the case and cover, and is kept in position by the breech end, as shown in the first set of drawings. The pinion is thinner than the rack. This will be explained later.

The case (Fig. 2) is the first part required, and if steel be decided on, is made of 1/8-in. strip. File the three straight sides square with one another, and then file very carefully the rebate for the rack, as shown in the section (Fig. 2), finishing to the exact dimension with a small fine file and oil. It may as well be here stated that Figs. 1, 2, and 5 are full size; the remainder are enlarged, *but not to scale*.

The centre for the pinion shaft cannot be marked until the rack and pinion are ready. The dimensions of these are given in the first drawing of the sights. The pinion

* The drawings here referred to will be found on p. 133, June issue.

can be constructed of pinion wire, obtainable from any dealer, or else a small steel wheel with eight or ten teeth and a small square hole accurately drifted in the centre can be obtained from the firm mentioned in a previous portion of this article, provided the diameter and number of teeth required is given.

The rack is much easier to cut than may appear. A piece of good steel is first filed perfectly accurate as regards thickness and width in its whole length, and then ground to correct dimensions, leaving it rather longer than required for the present. The only difficulty lies in spacing the teeth out properly, and the following method may help the reader, unless he knows a better way (of course, it is presumed that no wheel or rack cutting machine is possessed):—Secure the pinion on a piece of steel passed through it, and apply a little melted white wax to that edge of the steel strip on which the rack is to be cut. Secure the latter in the vice with the prepared face upwards, and run the pinion firmly along it for $\frac{3}{4}$ in. or so, and it will be found to leave a good impression in the wax. The marking can then be finally done by a sharp slitting file. The space between each tooth must be cut to the same depth, and to ensure this clamp a piece of brass with one edge trued, together with the rack in the vice, the edge of the brass marking the distance to which the slitting must be done. A slitting file, with a square cutting edge of the correct thickness, is used, and each slot filed carefully, observing that each tooth profiled is the same thickness as the preceding one.

The end of each tooth is rounded off. One end of the rack is filed square to fit into the traverse head, and the other bevelled. It can then have any abrasions that may have occurred ground out and polished. The polishing of this and all other small parts should be done on a piece of flat boxwood, charged with crocus or diamantine powder and mounted in the lathe. The latter powder gives a very high and beautiful polish to steel, though all scratches and cuts must be removed first.

The case can then be proceeded with. Mark the centre for the pinion shaft by placing the rack in the rebate, and the pinion in the position it must occupy, carefully noting that the teeth of rack and pinion do not engage too deeply with one another. Drill a small hole, and with a cutter, as shown in Fig. 5 (page 99), cut a recess to the same depth as the rebate (see Fig. 2), and grind the inner face of the core to receive the cover. This is made of 1-32nd in. steel, and all that is necessary at present is to file and grind one face so that a close fit is obtained between it and the case. The position occupied by the case in relation to the cover is shown by the dotted lines in Fig. 1. Mark the position for the two screws securing these parts together, and fit the screws (pillar, gauge 10, S.), the heads being left projecting. The top and bottom edges are filed level with the case, and the rear curved edge marked out and filed (case and cover in one operation). This edge is prominent and easily seen, so special care must be taken to keep the face of it square and true, especially where the straight portion emerges into the curved.

Mark the position, and drill the holes for the screws, securing the sight to the gun, using the same gauge screws as secure the case and cover together, and finish the remaining edge of the cover. One corner is cut away to clear the recoil box, and the curve should correspond to the rounded corner of the latter.

It only awaits the hole for the shaft to complete it. A small drill is passed through the hole in the case (without removing the cover) and then cut it, but do not enlarge the hole made until the small pinion shaft is ready. The reason for the pinion being thinner than the rack is explained in Fig. 6, in which the section of the shaft is given, A, A, being section of the cover.

The shaft is formed as follows:—A pivot working in the cover, the square on which the pivot is fixed, a collet (this being the largest diameter of the shaft), a straight turned portion which passes through the cover, and a thinner one on which the adjusting button is fixed. The portion which comes between the inner faces of case and cover consists of the square and collet, and it will be easily understood that, owing to the size of the collet, it will keep the pinion firmly in its place, prevent any shake—lengthways—of the shaft, and also prevent the latter from being withdrawn after the cover is screwed down. No further explanation of this is needful beyond stating that the pinion should fit tightly on the shaft, and the square and collet have no shake between case and cover, and the two ends of shaft slightly rounded off and polished.

The button has a knurled edge, and is kept in position by a small screw (one will have to be obtained for this purpose, and also one to key the traverse screws to be mentioned presently). The button is polished bright while in the lathe and before cutting off from the length of steel from which it is turned.

The hole in the cover requires opening sufficiently to receive the shaft. Fig. 5 shows the position of the shaft, pinion and rack in relation to one another when completed. The shaft for the steel frame supporting the traverse head and screw is given in Fig. 3, with side view in Fig. 4; the scale drawing is shown in the June number of the *M.E.* Use $\frac{1}{4}$ in. steel, and first file the slot to receive the squared end of the rack. Observe that it must fit tightly and without shake, as the screw only keeps the two parts together.

The remainder can then be profiled, all edges being perfectly square, especially the one on which the sight slides when traversing. The two holes had better be drilled after the screw is made. This and the adjusting button are turned in one piece; the section is given in Fig. 3. When turning it, the thinnest end and stand for threading must first be cut and then tapped to 14 gauge. Part of the stand is left smooth to work in the lug next to the button; it has a small groove cut in it to receive the locking screw. The latter is shown in Fig. 4, but not in Fig. 3, to avoid confusion. The screw, as mentioned previously, will have to be obtained, and is the smallest screw in the whole gun. The head can be countersunk, if desired, and it will be better to do so.

Before cutting the traverse screw off from the length of steel the edge of the button must be knurled; then cut the screw off, reverse the wood in the chuck, and polish the button.

The screw securing the head and rack together is a bar screw, gauge 12 (S.), and only the lug to the left hand side in Fig. 3 needed to be tapped, the rest being rimed sufficiently to clear the thread.

The section of the sight is given in Fig. 4, and it will be observed that one edge (nearest to the operator) is filed at an angle. It is optional whether this be done or the edge left square with the others. Drill and tap before filing to size, and cut the hole sufficiently wide to allow the traverse screw to work easily in it. Finish the edge which slides on the head first, gradually filing and grinding until it works smoothly and freely on the screw and head without jamming in any position, but also without any shake.

The notch is cut with a fine slitting file as deeply as the width of metal will allow. The work (sight) is then brightly polished on all sides and made a bright blue by tempering, for it is then easier to sight and train the gun. Previous to this, it should have been stated that the centres for the two bearings of traverse screw must be marked at equal distances from the face on which the sight slides;

drill the holes rather smaller than required, and open out gradually to fit the screw.

The sight is fixed to the rear end of the right-hand side of the breech block as shown in the photos in the May number. The position for the screws must be most carefully marked and drilled, and, lastly, the sights tested for accuracy. If the upper edges of the breech end have not been chamfered, this can be done. It is clearly indicated in the drawings.

The gun is now completed, and its efficiency can either be tested now or after it has been taken to pieces, cleaned, polished, and made perfect in every way. Keep all the working parts slightly oiled; the breech block when oiled, owing to its exposed condition when down, is likely to collect particles of grit, &c., so it should be frequently wiped.

Different methods of polishing have been given at various times, so little remains to be added. When polished, the gun and mountings (including steel parts) should be painted with one of the various cold lacquers sold for the purpose. If the top of the breech block has been made of brass, it should, as well as the sliding lid of the recoil box, be stained a rich dark grey colour, thus affording an effective contrast to the brass and gunmetal work. The following is the method for staining, and the mixture which colours all copper alloys indiscriminately is composed by dissolving 10 grammes arsenic in 50 grammes hydrochloric acid, and adding to the solution 7 grammes chloride of antimony and 7 grammes finely pulverised hammer scales. The parts to be coloured must be rinsed in a weak warm soda solution prior to as well as after immersion, and then by continued rinsing in water.

The shield face is enamelled white, the projecting ends of steel parts being left bright. If the reader cannot do the enamelling evenly, it had better be entrusted to the local cycle makers, who have every appliance for doing this sort of work perfectly. The model should be mounted on a polished dark mahogany slab with framed ends and moulded edges. Some of the springs may require a little further adjustment, owing to the difficulty of accurately gauging the power of the recoil without actual firing.

And now, in taking leave of the reader, may I express the hope that he will be quite successful in his work and encouraged to make further attempts in this fascinating branch of model engineering?

The Society of Model Engineers.

AMONGST the new rules of the London Society of Model Engineers, is the important one establishing a Capital Fund, to comprise all donations and entrance-fees received after November 1st, 1900. The possibilities of this fund are many, but one in particular was put forward by Mr. Herbert Sanderson, who is responsible for the new rule itself. This was that a part, at least, of the fund be devoted to the starting and equipment of a central workshop for the use of members of the Society. The idea has been well received, and a number of donations have already been handed to the treasurer, who is authorised to receive such for the benefit of the Capital Fund. One donation, from "Mr. X," amounts to £5, so that a good start has been made in this commendable direction.

Two members, who desire to remain anonymous, have presented to the Society a valuable optical lantern, which is cased in mahogany, and has oxy-hydrogen limelight jet complete. Another member has supplemented this gift by presenting a suitable screen and stand for use with the lantern.

A full report of the *Conversazione*, held on Saturday, December 1st, will appear in our next issue.

Provincial Branches.

Leeds.—Although one of the first branches of the Society of Model Engineers was formed at Leeds, local circumstances caused it to fall into abeyance. The matter has, however, been taken up, Dr. Algernon Wear, of 13, Hanover Square, Leeds, who is one of the moving spirits in the re-organisation of the branch, having expressed his willingness to receive the names of any intending member or sympathisers in the district. All such are desired to send their names at once to Dr. Wear, who will endeavour to arrange a meeting to discuss the preliminaries of the re-formation of the Leeds branch at an early date.

Bradford.—The annual meeting of the above branch took place at the Coffee Tavern, Tyrrell Street, on November 5th, 1900. Mr. A. P. Drake occupied the chair. The minutes of the last meeting were read and approved, and new members were elected. The Chairman read and commented upon the statement of accounts; and all expenses having been paid, the Society is in a good financial position for the present Session. A vote of thanks was unanimously accorded to the retiring officers. The chairman then asked for nominations for new officers for the coming Session. It was proposed, and seconded, that all should be re-elected, excepting two committee-men who were replaced by other members. No other nominations being made, these gentlemen were unanimously elected.

The following meeting was held on December 3rd, at 7 p.m., at the Tyrrell Street Coffee Tavern, Bradford, particulars of which will be forwarded for your next issue.—JAMES H. LAMB (Hon. Secretary), Holly Bank, Rushton Road, Thornbury, Bradford.

Glasgow.—Our second fortnightly meeting was held in the Grand National Halls, Main Street, South Side, Mr. David Thomson presiding in the absence of our chairman. After the usual business had been disposed of, we had a lantern lecture on Model Boilers, kindly sent by the London Society. Thanks were given to Mr. Frame for his assistance in reading the paper, and to Mr. David Thomson for supplying and manipulating the lantern. The following fixtures have been arranged to take place at the Grand National Halls, Main Street, South Side:—December 24th, a lecture will be given on Electric Models. January 11th, 1901, lectures will be given on How to Design Model Cylinders, by Messrs. Shannon, Thomson, and Frame.

In the course of his inaugural address to the Institution of Electrical Engineers, the President, Professor John Perry, M. E., D. Sc., made the following interesting observations on the subject of electrical engineering science: "Electrical engineering is in a curious position. It owes its being altogether to scientific men, to the laboratory and desk-work of a long line of experimenters and philosophers. Even now the work going on in a laboratory to-day becomes the much larger work of the engineer to-morrow. When at length the laboratory experiment is utilised in engineering, we see that there is no other kind of engineering which so lends itself to mathematical treatment and exact measurement. Most of the phenomena dealt with by the electrical engineer lend themselves to exact mathematical calculation, and after calculations are made exact measurements may be made to test the accuracy of our theory. For a completed machine or any of its parts can be submitted to the most searching electrical and magnetic tests, since these tests, unlike those applied by the mechanical engineer, do not destroy the body tested."