INTRODUCTION

These instructions have been written as a result of considerable practical experience and they represent a completely reliable method of track production. The modeller using the Protofour system for the first time is therefore recommended to follow the instructions step by step, and to resist the temptation to take short cuts until he is completely familiar with the technique.

THE PROTOFOUR TRACK SYSTEM

Protofour track components consist of scale section nickel silver rail, precision-cut and pre-punched ply sleepers, crossing timbers in strip form, specially designed rivets, wiring connector and bonding strips, and non-functional components such as ballast, chairs, fishplates and stretcher bars.

The track is jig-assembled on construction templates which indicate the position of all components and act as a direct building plan and construction surface. Ruler measurements are eliminated; track settings are determined by Gauges. (See Sections 4.1.3. & 4.1.5.).

GENERAL TRACK CONSTRUCTION PROCEDURE

* The holes provided in the sleepers, or punched in the crossing timbers at positions indicated by the construction templates, are charged with rivets. Selected timbers, as indicated on the Wiring Diagram are fitted with self-contained Turnout Bonding Strip (TBS).
* The charged sleepers are passed through a press tool, and the rivets are set permanently into them. (Section 4.1.4.). Wiring Connector Strip (WCS) is incorporated where electrical feeds are marked on the Wiring Diagram. Rivets at WCS and TBS positions are soldered using a rosin-cored solder.
* The prepared sleepers are placed in their appropriate positions on the template jig where they are held by double-sided adhesive tape previously applied to the template surface.
* The rails are added and soldered to the appropriate rivets, using Gauges to hold the rails upright and at the correct spacings.
* The completed track unit is detached from the jig, artificially 'weathered' and laid in position on the baseboard, preferably on a cork underlay.
* Slots are cut into the cork underlay to accept WCS. Dropper wires are soldered to the WCS and holes drilled in the baseboard for the dropper wires.
* The baseboard is drilled to accept the control wires of the Turnout Operating Units.
* Track sections are attached to the underlay by a coating of PVA adhesive which also retains the ballast granules.
* Turnout Operating Units and stretcher bars are installed. Chairs, fishplates, and other
* decorations are fitted and the final 'weathering' applied.

The successful performance of track depends upon the observance of five basic dimensional rules (Section 4.1.5.) and the additional requirements of a level rail top and correct alignments which have to be maintained during construction and laying. It is therefore essential to construct track on a completely level surface, and also to lay it on a completely flat base. To achieve this, chipboard with a laminate (Formica) surface is desirable for use as a construction jig. Chipboard, e.g., Weyroc, with a cork sheet surface is recommended for the baseboard.

The laminate-surfaced chipboard is converted into a construction jig simply by attaching a construction template. The Protofour templates completely eliminate the difficult and time-consuming measurement, draughting and preparation previously inseparable from scale track construction.

The process of soldering the rail to the rivet heads is similarly facilitated by storing solder paint in a plastic 'throwaway' syringe without needle. This syringe is used to apply exact quantities of solder paint to the rivet heads, which a touch with a hot soldering iron converts to a firm solder joint with the minimum of solder flow. It is emphasised that the size of the syringe orifice is critical, and the correct Protofour syringe should be used, as other types may deposit excess paint on the sleepers or be difficult to operate. A thin solder coating only is needed for a close fitting of the decorative chairs to the rivet joints.

TOOLS AND EQUIPMENT

The following are the only tools and equipment required to build the entire range of scale trackwork:

Materials: Rail; Sleepers; Crossing Timbers; Rivets; Wiring Connector Strip; Turnout Bonding Strip; Chairs; Fishplates; Ballast; Stretcher Bars (for switches).

Gauges: Protofour Track Gauge; Check Gauge; Crossing Flangeway Gauge; Switch Blade Gauge set.

Tools: Protofour Press; Punch Tool; Riveting Tool; Soldering Iron, 25w minimum capacity; Fryolux Solder Paint, Standard Grade; Plastic Syringe; File; Scraper; Glass Fibre Brush; Square Nosed and End Cutting Pliers; Coping Saw and Blades.

Equipment: Laminate-faced Chipboard Jig; Construction Templates; Double-sided Adhesive Tape; Steel Straight Edge; Ballpoint or Nylon Tipped Pen.

CONSTRUCTION OF PLAIN LINE

1. Select Plain Line Template ST 1 and cut out the desired section. Lay double-sided adhesive tapes along the laminate surface of the chipboard and lay the template carefully over them, so that both tapes and template are wrinkle-free and completely flat.
2. Lay further double-sided adhesive tapes immediately outboard of the template rail lines and add a crossing timber or card strip over the appropriate sleeper edge lines to act as limiters. (Check the settings with a standard sleeper). The limiters ensure an even sleeper edge line in the finished track and prevent rivet joints from straying out of alignment, thus causing difficulty in fitting the chairs.

3. Charge the sleepers by scattering the rivets over a flat surface and hooking the sleeper holes over those rivets lying shank upward. Feed the charged sleepers through the riveting tool and set the rivets by operating the press. Where required, add wiring connector strips for electrical feeds before riveting, as described in Section 4.1.8.
4. Lay sleepers in position on the template, rivet heads uppermost, and press them onto the tapes so that they are held firmly. The sleepers with wiring connector strips for feeds should be laid at the third or fourth position from the end of the section; those with direct bonding strips should form the pair of sleepers at the rail joint positions. Solder the rivet/WCS joints to ensure a low resistance electrical joint.
5. Mix the solder paint thoroughly and fill the syringe by retracting the plunger. Wipe the nozzle and charge the rivets of one sleeper near each end of the section with solder paint.

5. Mix the solder paint thoroughly and fill the syringe by retracting the plunger. The solder paint should be of the right consistency to flow easily with slight pressure on the plunger; if it is too viscous add a little water and stir well. Wipe the nozzle and, holding the syringe almost vertical and in contact with the rivet, charge the rivets of one sleeper near each end of the section with solder paint.
6. Position one rail upright over the rail line and rivets and solder the rail at the charged rivets. Set the second rail in position over the rail line and rivets, using TG to hold the rail upright and to gauge. Solder the rail at the charged rivets and remove the rails complete with sleepers from the jig.
7. Charge the remaining rivets with solder paint, and replace the rail and sleepers from Stage 6 in the jig.
8. Use the steel rule and the template guide lines to align one rail while soldering at every rivet; the rail should be lightly pressed down to ensure proper contact with the rivet head. First solder the pair of rivets at the middle of the line followed by those pairs between the centre and the end of the line. During soldering the iron can be slid along the base of the rail, followed by the Track Gauge.
9. Solder the second rail using TG to maintain rail gauge (Section 4.1.5.). The tapes absorb the temperature expansion of the rail and rivets may be soldered in any order.
10. Insert a flat knife under the sleepers and gently prise the track section from the jig.
11. Clean the residual flux and paint from the track using methylated spirit or the glass fibre brush.

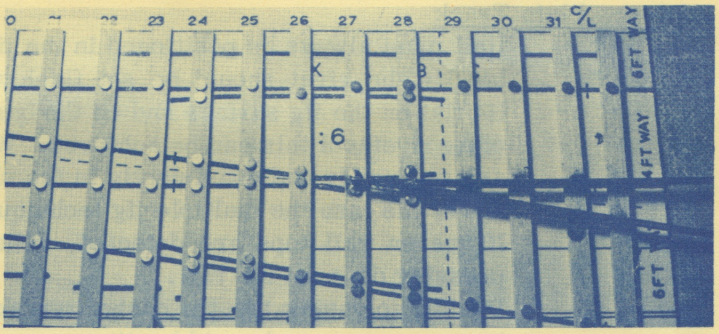
Notes: Plain Track

* Rail must always be positioned in the jig with the LARGER head uppermost.
* Ideally the rivet should be set flush with the bottom of the sleeper enabling the latter to lie flat on the jig surface and on the baseboard underlay, and with care in the adjustment of the rivet tool this can be achieved. Where this is not possible, then provided the rivets are set evenly and consistently in the sleepers, a slightly raised rivet base is acceptable and in this case the multiple jig technique should be employed for all track. (See later).
* If uneven rail tops are detected, reheat the offending joints to melt the solder, while pressing down on the rail.
* During soldering the tip of the iron should contact both the rivet and the base of the rail to ensure even and rapid heating.
* In extreme cases the solder paint may not flow satisfactorily during soldering. This may result from failure to mix the paint thoroughly before use, too little paint for the job, too cool an iron, or perhaps greasy rivet heads. The application of a little extra flux from a second syringe may cure the trouble in some cases.
* Before soldering operations begin, always clean the base of the rail with the glass fibre brush and wipe the rail with a facial tissue. If the rivet heads are dull or discoloured, brush them with the glass fibre brush also. Soldering cannot take place between dirty or greasy surfaces; clean bright metal is essential.
* Make curved track by using the appropriate section of template ST 1, but soldering only one rail in the jig. The track should then be removed, and pinned lightly on the baseboard to the desired curvature, placing the soldered rail on the inside of the curve. The second rail is then added and soldered in place using the TG with the wider claw to the outside of the curve to provide gauge widening.

CONSTRUCTION OF TURNOUTS

1. Select the appropriate template and fix to the laminate-surfaced chipboard as for plain track. The tapes on the laminate should, wherever possible, have the same positioning as those on the template surface.
2. Lay double-sided adhesive tape outboard of the running rails and additionally on either side of the crossing, clear of the rivet positions. This gives added grip to the crossing timbers near the vee.
3. Lay additional acetate strips and double-sided adhesive tapes to form a multiple run jig if necessary. (See later).

4. Use an identical template for marking out timbers, as this avoids unnecessary use of the tapes. Lay a crossing timber strip against the timber centreline marked on the template; mark the rivet positions on the timber opposite the marks on the template, using a pencil or ballpoint dot. Add an additional ring to indicate those rivet positions to which WCS strip will be added. Attach TBS strip to cover the groups of rivets shown on the wiring diagrams and mark the rivet positions on the strips after attachment. Indicate the ends of individual timbers by a transverse line. Add the timber serial number for later identification, DO NOT separate the timbers at this stage. Continue marking until all timbers are completed, working along the timber strips until each is full. This gives the greatest economy of materials and the easiest method of handling.
5. Run the strips through the punch tool, removing each rivet dot as it appears below the punch.
6. Charge the timbers with rivets as with plain track, keeping the marked side of the timber uppermost. Run the charged strips through the riveting tool, setting each rivet. Attach WCS strips as described in Section 4.1.8.
7. Separate the individual timbers using end cutters, sharp scissors, tin snips, a modelling knife or a single-edged razor blade, cutting squarely at the transverse lines. Solder all rivets attached to WCS or TBS.
8. Lay the timbers in position on the jig, rivet heads uppermost, according to the serial numbers. The markings and bondings are now on the underside of the turnout. Press the timbers into the tapes for a firm grip. Check that the rivet heads are correctly in line with the rail marks, as there are now no end limiters as in plain track construction.
9. Prepare point and splice rails and form these into the vee as in the instructions detailed later.



10. Apply freshly mixed solder paint to the crossing rivets as in plain track construction.
11. Carefully position the vee so that the nose is over the 'A' timber, and exactly in line with the rail marks. The point rail should lie in the main road of the turnout. Solder the point and splice rails at the outermost rivets only, as a temporary positioning.
12. Confirm and if necessary adjust the position of the vee nose in good lighting, as this is the most important single setting in the construction of the turnout. Lightly solder the nose of the vee, then solder the remaining rivets normally and finally solder the nose of the vee firmly. Remove any solder residue from the running rails by means of a scraper, which should be kept well sharpened.
13. The running rails at timbers (1) and (2) continue through the turnout as stock rails, and these are next positioned. The position of the 'set' in the curved stock rail, just ahead of the switch toe, is marked and applied using the square-nosed pliers. A slight joggle can be applied to the straight stock rail when building a 'facing' turnout. Apply solder paint to the rivets on timbers (1) and (2) and to a pair of stock rail rivets near the crossing. Position and solder the stock rails to these rivets, using the TG ahead of the switches to maintain gauge.
14. Prepare the switch, closure and wing rails in one or two pieces, as in the instructions detailed later. For one-piece assembly proceed as follows. The straight switch rail is positioned first, and the rivets for this and the appropriate wing rail are charged with solder paint. Position the toe of the switch over the first 'P' chair and place the TG over the closure and stock rails to hold the switch rail upright. Use the CF to maintain the crossing flangeway and the straight edge to align the vee and the closure rail. Lightly solder the wing rail at the 'X' timber.
15. Recheck all alignments, and with the CF gauge in position, and lightly pressing the wing rail towards the vee, solder the remaining rivets at the wing rail as far as the 'Y' timber.
16. Repeat steps 14 and 15 for the curved switch rail, using the rail guide lines for positioning, but continuing the use of the CF for the flangeways.

17. Using the straight edge as a guide, solder the straight switch rail so that it forms a completely straight line from the vee to the stock rail at timber (1). Note: If wing rails and switch/closure rails are made in two parts, the procedure is similar to that described above for one piece assembly. In this case however the wing rail and switch/closure rail units should be made slightly oversize and filed to ensure an exact fit.
18. Apply solder paint to the stock rail rivets, if necessary releasing the single joints opposite the vee. With the straight edge as a backstop to the straight switch rail, press the curved stock rail inwards so that the straight switch nestles against it along the planing, and lightly solder the stock rail opposite the switch heel. Next, using the TG and the straight edge, solder the straight stock rail throughout. Lightly press the curved switch rail against the straight stock rail so that it also nestles along the planing, and solder at the heel. Using the template curved switch rail line as a guide, solder the curved closure rail to the rivets. Finally solder the curved stock rail to gauge using the TG with the wider claw to the outside of the curve, i.e. over the curved closure rail. This procedure ensures that the straight road remains straight, and that the diverging road deflects through the switches according to the angle of the switch planing.
19. Prepare the check rails as described later, and position them according to the template guide lines, using the CG to determine the spacing from the vee. The screw slot end of the CG should be over the check rail, and the threaded end with the flat section over the vee.
20. Check that all the rivets have been soldered, and insert a flat knife below sleepers (1) and (2). Prise the turnout unit gently from the jig working toward the crossing.
21. Clean the residual flux and paint from the turnout using methylated spirit or the glass fibre brush.
22. If one piece assembly of wing, closure and switch rails has been adopted, cut the mandatory wing/closure rail gaps with a fine piercing saw, as indicated on the wiring diagrams.

Notes: Turnouts

* Ensure that the use of the various gauges is fully understood before commencing construction. (Section 4.1.5.).
* All rails must be positioned with the LARGER head uppermost.
* A 'set', or angle, occurs in the curved stock rail 1-2mm ahead of the toe of the switch. The angle is the same as that of the switch blade planing. Facing turnouts often have a slight joggle in both stock rails as shown in the sketch.
* The bases of the rivets should be soldered to the TBS to provide permanent electrical connection. Excess flux should be cleaned away after the operation.
* Switches, closure and wing rails made in one piece ensure accurate alignment and levels during assembly, but if this procedure is adopted great care must be taken when gaps are cut in the closure/wing rails after removal from the jig.
* It is essential to ensure that switch rails are upright with no twists. When the switch blades are secured to the Turnout Operating Unit and are correctly mated with the stock rails, trouble-free operation over the blades is guaranteed.
* The above instructions refer to a simple turnout. The more complex formations are built up in exactly the same way. IT IS ESSENTIAL TO POSITION ALL THE VEES FIRST IN ORDER TO ENSURE CORRECT ALIGNMENTS. Once these are located, position the obtuse crossings of diamonds or slips, and then align the connecting rails. Always check alignments of rails at crossings by looking along the rail from one end of the unit. If any disparity is noted between vees, obtuse crossings and the complementary rails, the alignment should be reworked.

CROSSING VEES

The vee is formed from two rails, the point rail which lies in the main road of the turnout, and the splice rail which is attached to it in the curved road, as in the sketch. For model purposes, both rails have the same angle of planing, which is the same as the angle of crossing. It is therefore sound technique to file the final angle on both rails together, so that they are identical but of opposite 'hand'.

To assemble the vee, some form of locating device is necessary, and this should take the form of a miniature jig of the same materials and construction as the main jig. To produce all vees to the same angle, a crossing template of the correct value is taped to the jig, and holes drilled for pegs as shown in the sketch. The pegs locate the rails, and ensure that they remain upright while being soldered. Another form of jig that is equally effective can be made from two pieces of straight card or ply (2mm thick) glued at the desired angle.

Templates, (sheets CC/4; CC/6; CC/8 & CC/12), for the construction of vees in jigs are available for crossing angles from 1:4 to 1:16.

For faithful reproduction of the prototype, the splice rail should be inset into the point rail.

Preparation of the Rails:

1. File the rail to an angle as in the sketch.
2. Bend the rail so that the angle lies flush with the running face and gently file true.
3. Reverse the rail and file the crossing angle. File point and splice rails together.
4. Trim ends of angle square with the end cutters, and remove the rail head burrs with a scraper.
5. Insert the rails in the jig, LARGER head uppermost, and wedge in place with a circular wedge. Solder the rails together using plentiful flux for easy solder flow. As an alternative to soft solder the use of a silver-based solder such as 'Wescolite' will give a stronger joint.
6. Clean off all residue with methylated spirit and scrape away any excess solder.

SWITCH BLADES, CLOSURE RAILS AND WING RAILS

The filing of switch blades follows the same procedure as with point and splice rails, except that the angles are flatter. Additionally, the lower web of the running face of the switch rail should be left intact to retain stability. The simplest procedure is therefore to file the planing at the back of the switch first. This should be carried out on a flexible surface, such as Formica, overhanging the edge of the bench by the same amount as the length of the planing. This allows more material to be removed from the middle of the planing than from the ends, due to the flexing of the Formica. This slightly concave planing ensures that the switch blade will always fit snugly to the stock rail and that the toe will not stand proud, where it might derail passing vehicles. If circular stretcher bars are to be fitted, the holes for these should be drilled at this stage. The switch should then be placed, planing downwards, on a plate which has a hole drilled and tapped for a 6BA (or M2) screw. The cheesehead screw is then used to hold down the rail and to prevent the file from working on the lower web of the rail as in the sketch. The running face of the switch is then filed to the same angle as the planing, and the switch bent slightly with the square-nosed pliers to realign the running face. The scraper is used to clean off and smooth the faces of the switch blades.

Wing and Closure rails connect the switches to the crossing. The point at which the closure rail bends to become the wing rail is termed the knuckle, and its position must be marked accurately. The rail is bent to the same angle as the crossing, and cut slightly over length with the end cutters. The end is then trimmed square with the file. Care must be taken to form the knuckle as a sharp bend, and the pliers must be held at right-angles or the rail will not stand upright on both sides of the bend.

Check rails are made in a similar way to the wing rails, by cutting slightly over length and trimming flat with a file. The slight flare is applied to both check and wing rails by means of the square-nosed pliers.

For information concerning the use of the Wire Bending Tool in the production of wing and check rails, see Section 4.1.11.

GENERAL NOTES

Double sleepers

Protofour sleepers are approximately half scale thickness, which allows increased accuracy of manufacture and, owing to the general method of ballasting in the prototype, a considerable saving in the use of materials without any loss of visual quality. However, in sidings and other locations it is sometimes desirable to indicate the full depth of the sleeper. This may be carried out for plain line by riveting two sleepers together. The procedure is not recommended for use with turnouts. A centre punch should be used to expand the rivet, instead of the press tool which is designed to spread the rivet. The sleepers are placed in the jig and the track assembled in the ordinary way. The thickness of the underlay should be reduced by 1/16" where double sleepers are laid, and several plain sleepers should be added to each end of the rail section to carry the rail over the boundary between the two types of underlay.

Multiple Run Jigs

The use of these is strongly recommended where more than one unit of its kind is to be constructed. The use of thin acetate strips over the jig tapes offers clearance for rivet bases and WCS, and by enabling the replacement of used tapes the system offers the maximum economy of material. Alternatively the acetate strips may be replaced by an overall sheet of plastic.

When the template has served its purpose, the entire assembly may be removed from the jig surface by peeling it away. The jig is then ready for the application of the next template.

Track Repair

In the event of accidental breakage of the sleepers, the damaged parts may be removed by releasing the solder joints with a hot soldering iron. New sleepers are then made as in initial construction, and placed on the jig. The unit is then reset in the jig and soldered. The new sleeper will be exactly dimensioned whether it is made from the original template or from a new one of the same type.

Track Laying

Track Detailing, Weathering and Laying is described in Section 4.1.7.

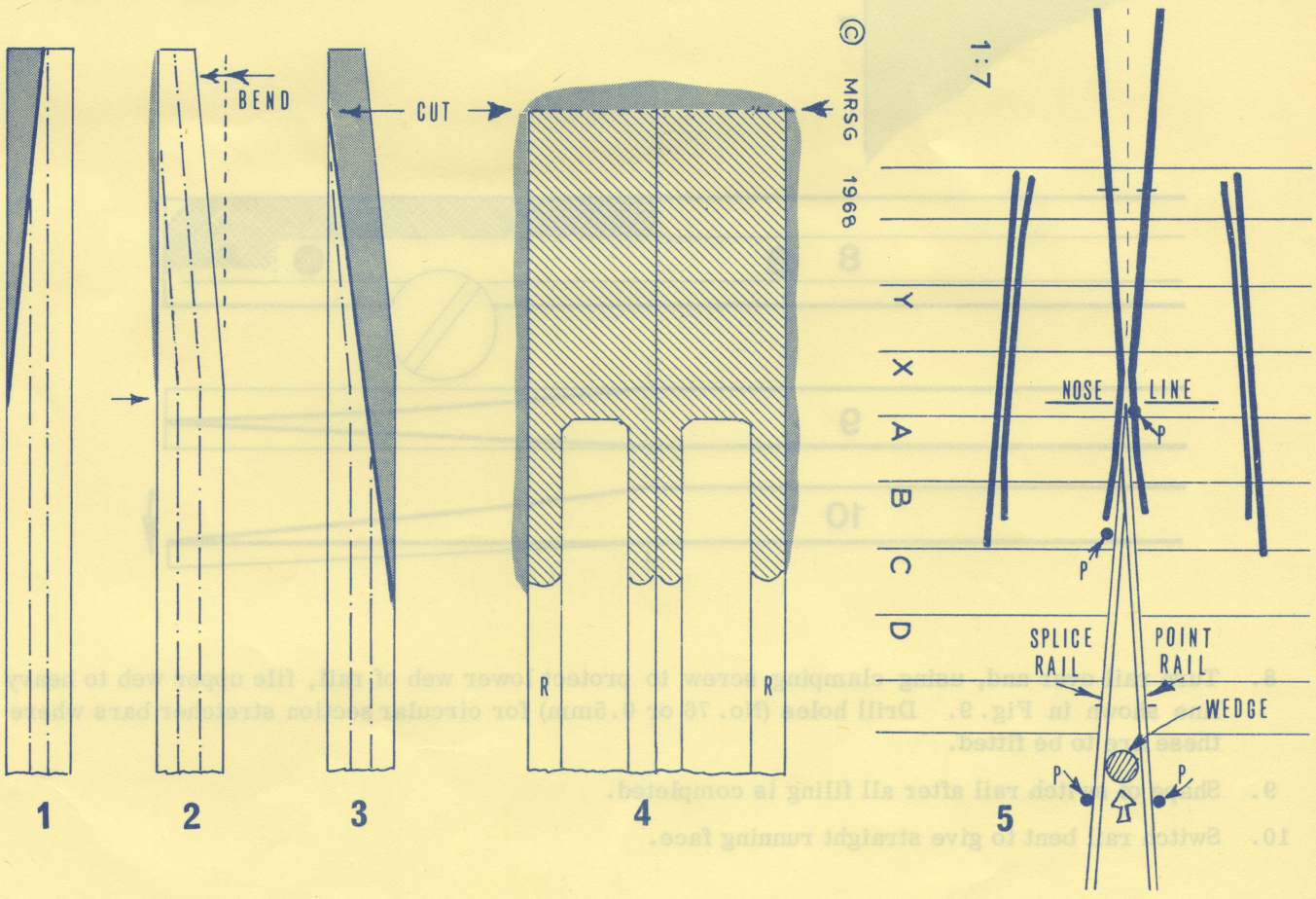
BIBLIOGRAPHY

The instructions in this leaflet are intended to be complete. However, modellers may wish to refer to the following sources of information concerning prototype trackwork —

1. 'Protofour' series of articles by the Model Railway Study Group appearing in the 'Model Railway Constructor' from January 1967 onwards.
2. 'British Permanent Way' by W.P.Alexander. The 'Model Railway Constructor', Oct.-Dec. 1960.
3. 'British Railway Track' by the Permanent Way Institution.
4. 'Finer Points' by L.E.Carroll. The 'Model Railway News', January 1955.

CONSTRUCTION OF POINT, SPLICE & SWITCH RAILS

Point and Splice Rails

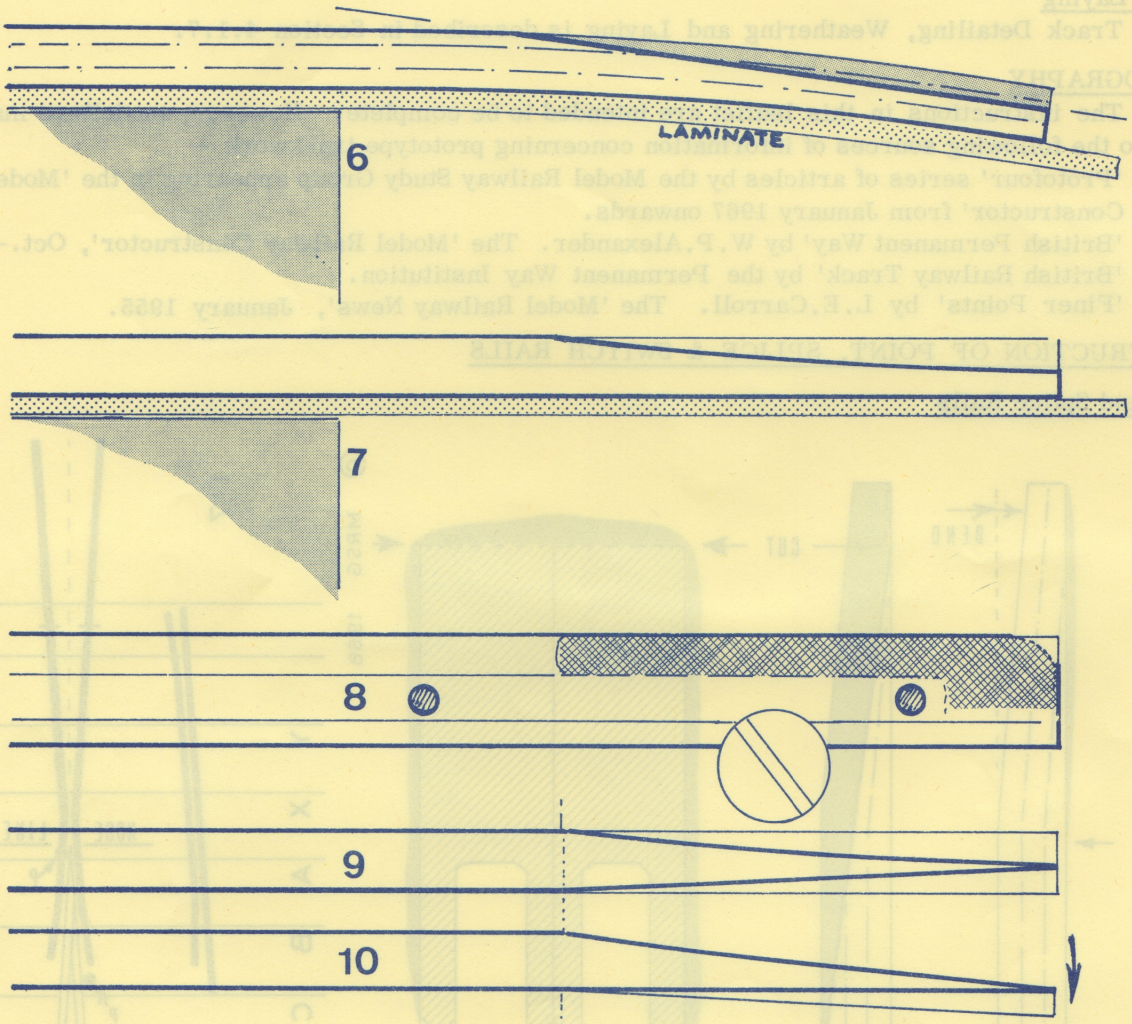


1. File shaded area to the shape indicated by the heavy lines.
2. Bend rail until the filed area lies in line with the running edge of the rail, and trim flush.
3. File shaded area to the heavy line to form the angle of the crossing.
4. Remove filing burrs with end cutters and the scraper.
5. Miniature jig made from Crossing Template. Insertion of pegs allows the rail to be held by a wedge while soldering, and also ensures that rails are held upright.

Switch Rails

6. File shaded area to heavy line. The laminate bends under pressure of work and thus forms a concave planing.

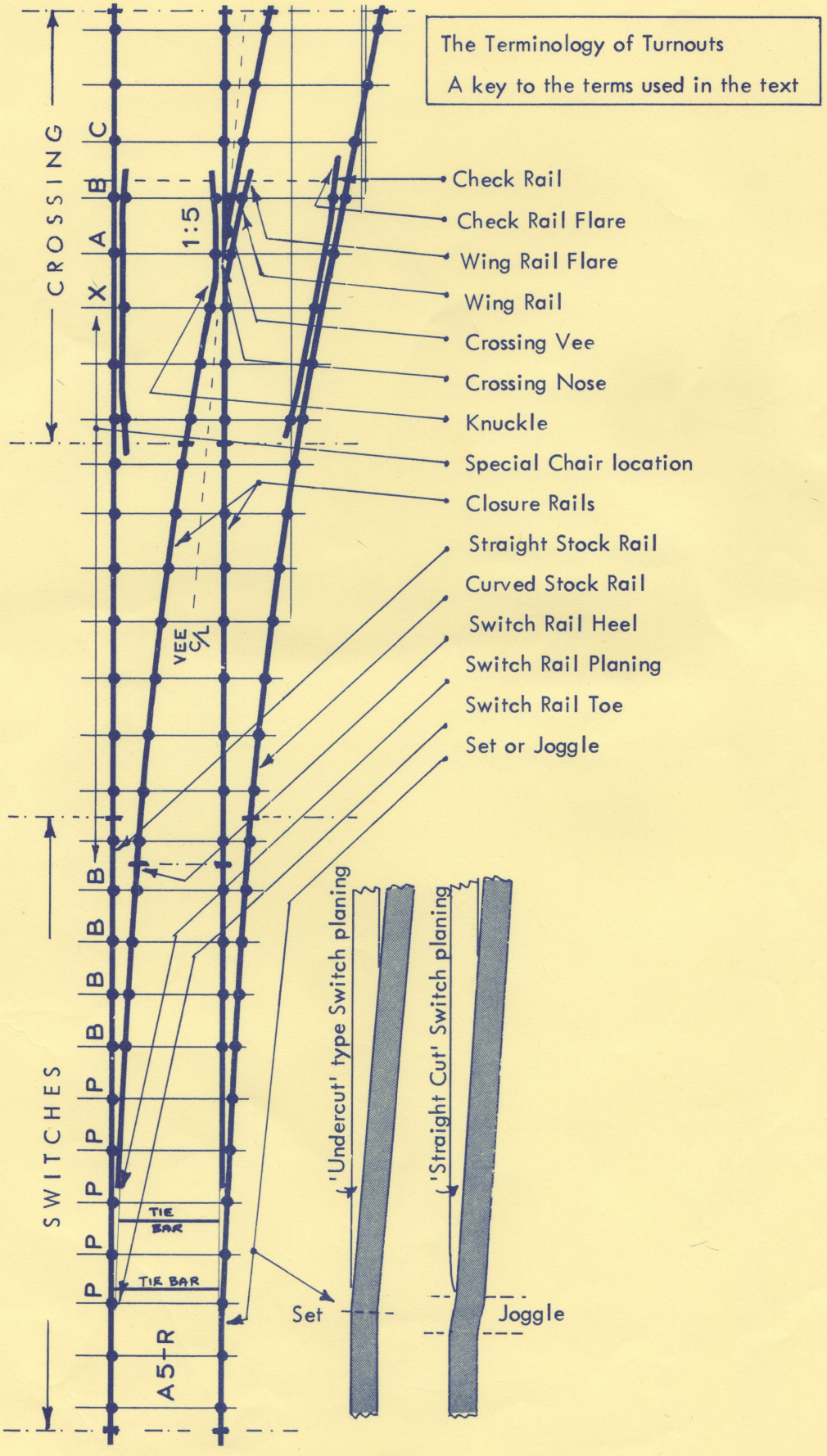
7. Concave planing with rail and laminate in normal position over bench.



8. Turn rail over and, using clamping screw to protect lower web of rail, file upper web to heavy line shown in Fig. 9. Drill holes (No. 76 or 0.5mm) for circular section stretcher bars where these are to be fitted.

9. Shape of switch rail after all filing is completed.

10. Switch rail bent to give straight running face.


The Terminology of Turnouts
A key to the terms used in the text
CROSSING
C
B
A
X
1:5
VEE
℄
B
B
B
B
P
P
P
P
P
SWITCHES
TIE BAR
TIE BAR
A5-R
Check Rail
Check Rail Flare
Wing Rail Flare
Wing Rail
Crossing Vee
Crossing Nose
Knuckle
Special Chair location
Closure Rails
Straight Stock Rail
Curved Stock Rail
Switch Rail Heel
Switch Rail Planing
Switch Rail Toe
Set or Joggle
'Undercut' type Switch planing
'Straight Cut' Switch planing
Set
Joggle