INTRODUCTION

Electrical instructions and diagrams seem complicated when seen for the first time. However, they are basically simple and are easy to understand if each stage is studied in the correct sequence.

Protofour Unit Wiring has been designed to enable a modeller with no knowledge of electrical principles and no experience of wiring to plan and install a reliable model railway wiring scheme.

It is most desirable that the wiring and control diagram of a model railway layout should be drawn in conjunction with the track plan. This enables the necessary connections to be provided for in the jig construction stage. If this is not done, wiring becomes a haphazard, difficult and frustrating operation which makes excessive demands upon modelling time and patience, with a high risk of failures and damage to the appearance of the finished layout.

Protofour Unit Wiring is a standard form of electrical wiring for model railway layouts and is based on the use of Protofour Wiring Connector Strip (WCS) and Turnout Bonding Strip (TBS). The 'external' wiring connections to the track are effected through WCS, one end of which is clamped to the sleeper base by the base of the track rivet, and thus feeds the rail through the rivet head; the other end is fitted with a dropper wire leading to a terminal block below the baseboard. The 'internal' bonding of rails, for example wing and vee rails at crossings, is carried out using Turnout Bonding Strip laid along the base of the timber and held by the rivet base. Both forms of connection are invisible when track is finally laid.

Protofour Unit Wiring has five component parts:

1. Principles of Layout Wiring.
2. Wiring Diagrams.
3. Wiring Index.
4. Wiring Templates.
5. Control Diagrams.

The Principles of Layout Wiring are a summary of the basic rules for wiring a model railway.

The Wiring Diagrams are simplified, schematic wiring plans for the types of track unit found in the range of Construction Templates. Wiring Diagrams are also provided for certain combinations of standard units commonly found in the prototype.

The Wiring Index is the means by which the electrical connections shown schematically in the Wiring Diagrams may be translated into actual locations on the construction templates. Each WCS, TBS and Essential Rail Break (ERB) is indicated in terms of the crossing timber identification number on the appropriate construction template. Using the Wiring Index for the construction template concerned, the WCS, TBS and ERB positions can be marked on the template before construction commences. The necessary connections may then be provided during construction of the track unit in the jig.

The Wiring Templates are the electrical equivalent of the track planning templates, and may be used to build up an electrical equivalent of the layout in exactly the same way as the planning templates build up a diagram of the track. They are similarly printed on self-adhesive paper.

The Control Diagrams indicate the several forms of control which may be used in conjunction with Protofour Unit Wiring. ANY desired control system may be incorporated into the wiring plan produced from the wiring templates, and one form of control may be exchanged for another at any time.

1. PRINCIPLES OF LAYOUT WIRING

* All track is wired in accordance with the two-rail system in which one running rail is of opposite electrical polarity to the other, and is electrically insulated from it.
* Groups of rails in switches and crossings which have common polarity are electrically bonded by means of TBS laid along the crossing timber bases.
* The connection of electrical feeds to the track is effected through WCS attached to the base of selected rivets.
* Each formation of track is constructed as an individual electrical unit, complete with internal bonding and external connections added during construction in the jig. The precise location of these connections and bondings is determined by reference to the Wiring Index, where the appropriate crossing timber reference numbers are found under the template designation.

* When the track units are finally laid, 20swg tinned copper dropper wires are soldered to the free ends of the WCS feeds and led directly below the baseboard where they terminate in terminal blocks or tag strips.
* WCS feeds are of two types, Direct Feeds (DF) and Controlled Feeds (CF). The location of these feeds is indicated in the Wiring Diagram and the Wiring Index.
* Controlled Feeds are led to a Polarity Switch which is connected to and operated by the mechanism controlling the position of the turnout switches. The crossing thus receives a Controlled Feed of the correct polarity for the road selected through the crossing by the turnout switches.
* Connections between one track section and another are always made between the respective terminal blocks (associated with Direct Feeds) below the baseboard and never above the baseboard. This simplifies checking and alteration of the layout, and leaves the track undisturbed.
* Connections between adjacent track sections are of two types. These correspond to the connection of two Adjacent Feeds - an AF/AF connection, or to the connection of an Adjacent Feed with a Bridged Feed - an AF/BF connection. The two types of connection are clearly shown in the Wiring Diagrams, (see below).
* Connections between the control system and the track are also made through the terminal blocks containing the appropriate Direct Feeds.

Notes:

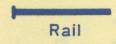
* Reverse loops, Tee junctions and Wyes require special wiring. This is given in the Protofour Manual Section 4.1.9.
* Plain Diamond Crossings cannot be made as self-contained electrical units. Their Controlled Feeds must be fed via Polarity Switches connected to the turnout switches or signals controlling running through the diamond. Common examples are shown in Wiring Diagrams 9, 12, and 13.

2. WIRING DIAGRAMS

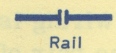
Protofour Wiring Diagrams are based on the rail patterns shown in the construction templates. Although they are not to scale, they show clearly the correct form of bonding by means of TBS, the feeds through WCS, the Polarity Switch connections, and the Essential Rail Breaks (ERB). Additionally they show the 'external' connections to adjoining sections of track.

This information is given for all track formations found in the track construction template range, and also for certain combinations of these formations commonly found in the prototype.

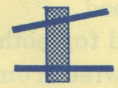
The following standard symbols are used to indicate the type of electrical connections and the form of switchgear :



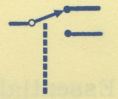
Running rail terminating at the end of a track unit.



Essential Rail Break (ERB). Irrespective of the control system employed, these breaks MUST be incorporated.

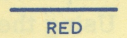


Rail bonding using TBS. This bonding is consistent with the Essential Rail Breaks indicated in the unit. (If additional rail breaks are incorporated, additional TBS bonding may be required).

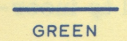


Polarity switch. These switches are linked up, and worked by, a turnout operating mechanism and are denoted by the hatched line. They automatically select the correct polarity for the Controlled Feed, and thus for the crossing, in accordance with the setting of the turnout switches.

Turnout operating device.

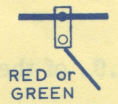


Direct Feed (DF) wiring.

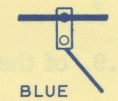


Direct Feed (DF) wiring of opposite polarity to the red DF.

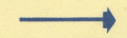
Controlled Feed (CF) wiring.



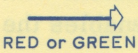
Direct Feed (DF) connection (red or green). Running rails are fed via WCS feeds from dropper wires terminating at tag boards or terminal blocks below the baseboard.



Controlled Feed (CF) connection (blue). All common crossings, and certain types of obtuse crossing, are electrically isolated from the adjoining running rails. They are fed via WCS and Controlled Feeds from polarity switches linked to the turnout operating device.



Adjacent Feed (AF) connection to the next track unit.



Bridged Feed (BF) connection to the next track unit.

Recommended Bus Bar connections.

Wiring junctions.

Notes:

* More than the necessary minimum of WCS and TBS connections are shown in the diagrams. These 'extra' connections should be incorporated to provide a 'fail-safe' operation in the event of one connection becoming defective.

* The Unit Wiring ensures that WCS and TBS connections are standard throughout, irrespective of the control system employed. However, with multiple controller operation the CF switchgear is more complicated in certain track formations. Wiring diagrams for these cases are not included in the first part of this leaflet.

Fig: 1. * WCS feeds should be installed at the third or fourth sleeper from the rail break.
* AF/AF connections only are required.
* AF/AF connections may be replaced by isolating switches if track sections are required to be rendered electrically 'dead', for example in locomotive sidings. (See also Fig: 12).

Fig: 2. * Wiring is identical for curved or 'Y' turnouts.

Figs: 3, 4, 13, & 15. * Motive power will only operate through the diamond if the second switch is set for the slip road. If possible, levers should be interlocked to prevent both switches being simultaneously set for the through roads.

Fig: 6. * The switches controlling entry to the left hand road are operated by the unit nearest to the switch toes.

Fig: 8. * The Controlled Feed polarity must be set by a polarity switch controlled by the turnout switches or a signal giving access to the crossing. (See Figs; 9, 11, 12 & 13).

Fig: 9. * For completeness, single controller wiring has been included. However, greater flexibility of operation may be obtained from the use of dual controller wiring. This wiring is detailed in Protofour Manual Section 4.1.9. As in the diamond in Fig: 3., one pair of switches must be set for the slip road to enable motive power to cross the diamond.

Fig: 10. * In the neutral position of the selector switch as shown, the polarities are selected for both straight roads, (i.e. W - X and Y - Z). Moving the selector one step clockwise from neutral will set the road W - Z. Moving the selector one step anti-clockwise from neutral will set the road Y - X.

3. WIRING INDEX

All Direct Feeds (DF/WCS), Controlled Feeds (CF/WCS), Turnout Bonding (TBS) and Essential Rail Breaks (ERB) shown in the Wiring Diagrams are incorporated into the trackwork during construction in the jig. (Protofour Manual Section 4.1.6.)

The Wiring Index lists the serial numbers of the timbers found on the construction templates against the template designations and the codes for wiring feeds from the Wiring Diagrams. Using the Index, it is a simple matter to transfer the appropriate feeds to the construction templates and to incorporate these during construction of the unit.

If substantial numbers of units are to be built, it is recommended that a set of the desired templates be marked and used as master references.

4. WIRING TEMPLATES

This aspect of the Protofour Unit Wiring System is described in detail in Section 4.1.9. of the Protofour Manual.

5. ELECTRICAL CONTROL SYSTEMS

This aspect of the Protofour Unit Wiring System is described in detail in Section 4.1.9. of the Protofour Manual.

WIRING INSTALLATION Single Controller operation.

Protofour Unit Wiring enables the installation of any form of control system in conjunction with the wiring. However, for the beginner, the initial wiring of a single controller system enables the wiring to be tested in its simplest form before a more complex system is installed.

The procedure for installing wiring for a single controller operation is as follows :

1. Select the construction templates for the track units to be built.
2. Using the Wiring Diagrams and the Wiring Index, mark all WCS, TBS and ERB positions on the templates. If two or more templates are combined to form one unit, carefully check the positions of the rail breaks. (See note below).
3. Construct the track as described in Protofour Manual Sections 4.1.3. and 4.1.6., incorporating all feeds and breaks previously marked.
4. Lay the track, and solder dropper wires to all WCS feeds.
5. Mount terminal blocks or tag strips below the baseboard and connect each dropper wire to its terminal.
6. Using the Wiring Diagrams, connect together the terminals representing AF/AF connections. Where appropriate, connect together the AF/BF terminals. (See Diagrams 1,11, & 12).
7. Check that there are rail breaks corresponding to each AF/BF connections.

8. Connect the CF terminals with the appropriate polarity switch outlet and the appropriate DF connections to the polarity switch inputs as shown in the Wiring Diagrams.
9. Check the wiring and track to ensure that all connections have been made and all loose debris removed, (to avoid possible short circuits).
10. Join the output terminals of the power pack/controller to any pair of red/green terminals. With Protofour Unit Wiring it should be possible to operate a locomotive over any part of the layout.

Notes :

* As an insurance against voltage drop along the rail (owing, for example, to several cuts in the rail head to represent rail joints) and to reduce generally the chances of electrical failure, a Bus Bar system may be employed. A Bus Bar is simply a metal connection capable of carrying the maximum current required for the layout, and thus having the same electrical potential at all points of contact. This may take the form of a copper wire, (e.g. 20swg), connecting all Direct Feeds of similar polarity, which offers a multiple path for the supply current. Bus Bar connections are shown in the Wiring Diagrams.
* Section switches (single pole/single throw type) or push buttons may be substituted for AF/AF connections or AF/BF connections between terminals. With the switch contacts open, the dependent section is cut off from the supply current, thus isolating any locomotive standing thereon. Meanwhile, another locomotive may be operated over the remaining layout. (e.g. Fig: 12; supply to track section X - Y is controlled by the section switch substituted for the AF/AF connection).
* Rail-built bufferstops must be installed as electrically isolated units, the short running rails on which they are mounted having no contact with the adjacent running rails. If contact takes place (possibly through a pair of wheels bridging the gaps between running and bufferstop rails through bad positioning of the gaps) a short circuit will occur.
* If templates are cut and combined to form special track units, great care must be taken to preserve the necessary AF and BF feeds and the appropriate AF/BF rail breaks. This is shown in the simple crossover in Fig: 11.
* Where two or more templates are combined to produce a single track unit, any AF/AF connections may be left as a continuous running rail. (Figs: 11 & 12). Section switching in this case is still possible through AF/BF connections.
* Except in certain types of control systems, ALL AF/BF connections MUST be associated with a RAIL BREAK.
* The proper testing of electrical connections during the jig building stage will virtually eliminate fault-finding after track is laid.
* Normally, polarity switches for CF operation are mounted in conjunction with and next to the switch blade operating mechanism. Alternatively, they may be mounted on the control panel itself (though this will entail extra wiring) working in unison with the switch blade mechanism selector. However, in the case of the scissors crossover, panel mounting of polarity switches may be preferable to the normal method; the required wiring is shown in Fig: 10.

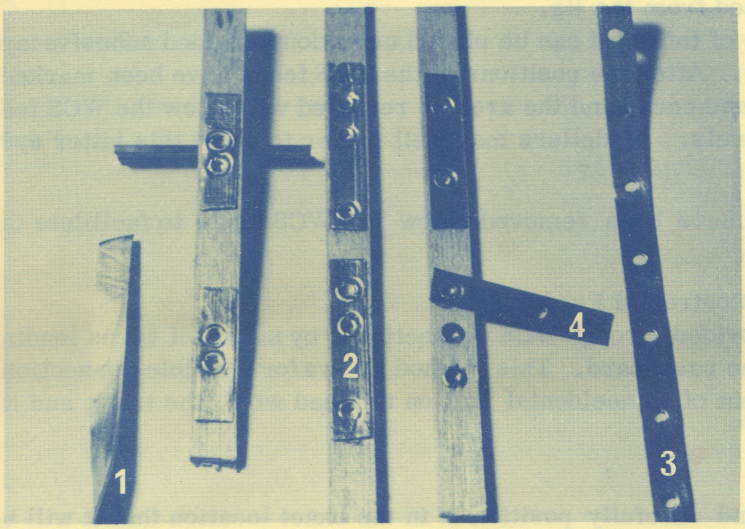
PROTOFOUR TURNOUT BONDING STRIP & WIRING CONNECTOR STRIP

INTRODUCTION

The purpose of Turnout Bonding Strip (TBS) and Wiring Connector Strip (WCS) is to provide respectively the electrical bonding of adjacent rails in certain track formations, and power feeds to the running rails, in accordance with the Protofour Unit Wiring system.

The use of these strips virtually eliminates the problems of layout wiring, as the TBS is integral with the track, thus dispensing with the use of wiring for 'internal' bonding, and the WCS provides wiring terminals for the connection of 'external' power feeds.

Protofour soldered rivet track construction allows these connections to be incorporated in the track during construction in the jig, so that the electrical and mechanical aspects of the track are covered in the same operation. This represents a very considerable saving in modelling time, and also ensures that all connections are invisible once track is laid.



1. Turnout Bonding Strip (TBS).
2. TBS fitted to underside of Crossing Timbers and rivetted.
3. Wiring Connector Strip (WCS).
4. WCS rivetted to underside of Crossing Timber for Track Feed.

TURNOUT BONDING STRIP (TBS)

This is a 1/8" wide self-adhesive copper foil strip which is applied to the base of the sleeper or crossing timber. Rivets set through and over the foil are electrically bonded by the strip, as are the rails to which the rivets are soldered. To ensure a permanent bond the foil and rivet bases may be given a coating of resin-cored solder, residual flux being removed with methylated spirit or a glass-fibre brush.

Where aluminium TBS is supplied instead of copper the procedure is the same, but the operation of coating with resin-cored solder is omitted.

This method of rail bonding is simple, neat, rapid and invisible once track is laid.

INSTALLATION

1. Use scissors to cut the desired length of TBS.
2. Select the timbers to be bonded AFTER punching but BEFORE riveting.
3. Remove the protective backing from the TBS.
4. Apply the TBS to the timber base to cover the rivet holes of the bonding group.
5. Re-run the timber through the punch tool with the foil to the base of the tool for clean punching, and re-punch the existing holes.
6. Insert rivets in the usual manner remembering that the foil will form the base of the timber.
7. Rivet the timber so that the rivet bases spread over and hold the foil.
8. Solder rivets and strip using a resin-cored solder.
9. Clean the joints using methylated spirit or a glass-fibre brush to remove all traces of flux.
10. Cut insulation gaps if necessary by slitting the foil and peeling away the unwanted strip.

WIRING CONNECTOR STRIP (WCS)

This is a 1/8" wide hard brass strip perforated at intervals to receive rivet shanks. Its greater strength enables it to be used as a free standing power feed to the rails where TBS would prove too fragile. One end of the WCS is held below the base of the track rivet and the other in a slot in the underlay where it is connected to a vertical dropper wire leading below the baseboard.

INSTALLATION

1. Insert rivets into the timbers as in normal track.
2. With the timber in the slideway of the riveting tool, hook the end WCS hole over the appropriate rivet shank, and operate the press so that the rivet base turns over and holds the WCS.
3. Leaving a tab as shown in the photograph, cut away the excess WCS using metal cutters.
4. Solder the WCS to the rivet base using resin-cored solder.
5. Clean the joint using a glass- fibre brush.

MAINTENANCE OF TRACK LEVELS IN THE JIG

The addition of WCS to the base of the sleeper or crossing timber increases the thickness. To counteract this, and preserve the rivet heads at a uniform level in the jig for soldering, the following procedures are recommended.

1. In a simple unit, the timbers carrying the WCS feeds can be omitted from the jig and soldered in place when the formation has been lifted from the jig.
2. Alternatively, in a complex unit a base of thin card can be placed using double-sided adhesive tape between the template and the jig surface. After the positions of the WCS feeds have been marked, slots can be cut through the template and card, and the area so removed will allow the WCS feed to be recessed thus preserving rail levels. Modellers may well prefer to adopt this latter system for all formations.

On the layout itself, the underlay will have been removed below the WCS feeds to facilitate the fitting of dropper wires.

ELECTRICAL TRACK FEEDS (Direct and Controlled Feeds)

Power feeds to the track are always provided through WCS connections, by means of wires leading from the free end of the WCS directly below the baseboard. This method allows for invisible connections below the ballast, and ensures that in the event of an accidental pull on the feed wire, the track and its electrical continuity remain undisturbed.

INSTALLATION

1. Place the track unit on the underlay and carefully position it in the exact location that it will be laid.
2. Carefully mark the cork underlay where the WCS feeds occur.
3. Cut slots in the underlay to accept the WCS feeds.
4. Install the track section.
5. Drill a small vertical hole in the base of the underlay slot, adjacent to the end of the WCS, to penetrate the underside of the baseboard.
6. Prepare feed wires (dropper wires) each with a small hook at the end.
7. Drop the wires through the vertical holes and solder the hook end to the WCS using resin-cored solder.
8. Fill and ballast the underlay slot.

Notes :

* In stage (2) above, check that WCS positions are not over baseboard battens.
* WCS should be led at an angle to the timber centreline and the dropper wire hole drilled between two sleepers.
* Where WCS is found awkward to fit in the jig, there is no reason why the track unit should not be made without the WCS timber, and the latter fitted when the rest of the unit is completed.

NOTES FOR USE WITH INDEX TABLES

WCS = Wiring Connector Strip.
TBS = Turnout Bonding Strip.
ERB = Essential Rail Break.

Codes in the left-hand column refer to the designations of the Construction Templates.

Figures in the Tables refer to the serial numbers of the particular timbers in the designated Templates.

OS/4.5 — Outside Slip Template. ERB points 'a' & 'h' are only necessary in the stock rail.

MPLATE	WCS									
AIN TURNOUTS	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
CS/A5L & R	2	25	20							
CS/A6L & R	2	27	22							
CS/A7L & R	2	28	23							
CS/A8L & R	2	28	23							
CS/B6L & R	2	29	24							
CS/B7L & R	2	31	26							
CS/B8L & R	2	32	27							
CS/B9L & R	2	32	27							
CS/B10L & R	2	33	28							
CS/C7L & R	2	35	29							
SLIP	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
SS/6, DS/6	8	28	6	30						
SS/7, DS/7	8	32	6	34						
OS/4.5	2	14	35	47	11	21	28	38		
DEM TURNOUT	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
/B8L-B6R	2	43	24	30	39					
/B8R-B6L	2	42	24	30	38					
/B6L-B8L	2	40	23	31	35					
/B6R-B8R										
REE-THROW TURNOUT	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
/B6L-B6R	2	30	18	25	25					
/B6L-B7L	2	33, 40	20	28	40					
/B6R-B7R										
IOND CROSSING	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
DC4	9	18	7	20						
DC5	9	22	7	24						
DC6	9	27	7	29						
DC7	9	29	8	30						
DC8	10	34	9	35						
ORS CROSSOVER	**1**	**2**	**3**	**4**	**5 + 6**		**7**	**8**	**9 + 10**	
SC/B6	2L	2L	2R	2R	20L		24L	24R	20R	
BLE JUNCTION	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
DJ/B6-L	2	55	74	83	52	24	24	35	85	
DJ/B6-R										

TBS													
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**M**	**N**	**O**
11	12	21	24										
11	12	23	26										
11	12	24	27										
11	12	24	27										
12	13	25	28										
12	13	27	30										
12	13	28	31										
12	13	28	31										
12	13	29	32										
14	15	30	33										
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**M**	**N**	**O**
4	14	15	21	22	32								
4	16	17	23	24	36								
8	13	14	17	20	23	26	27	32	35	36	40		
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**M**	**N**	**O**
11	22	25	28	30	32	36	40	42					
11	22	25	28	30	32	36	39	41					
11	22	24	26	27	29	32	36	39					
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**M**	**N**	**O**
13	14	19	22	26	29								
12	14	21	25	29	31	34	37						
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**M**	**N**	**O**
4	6	10	11	16	17	21	23						
4	6	12	13	18	19	25	27						
4	6	14	15	21	22	30	32						
4	7	15	16	22	23	31	34						
5	8	18	19	25	26	36	39						
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**M**	**N**	**O**
11L	12L	13L	21L	23L	25L	27L	27R	25R	23R	21R	13R	12R	11R
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**M**	**N**	**O**
12	13	65	66	23	25	29	31	34	79	82	86	89	

ERB							
a	**b**	**c**	**d**	**e**	**f**	**g**	**h**
19-20							
21-22							
22-23							
22-23							
23-24							
25-26							
26-27							
26-27							
27-28							
28-29							
a	**b**	**c**	**d**	**e**	**f**	**g**	**h**
6-7	29-30						
6-7	33-34						
9-10*	12-13	18-19	21-22	27-28	30-31	36-37	39-40*
(* see Notes)							
a	**b**	**c**	**d**	**e**	**f**	**g**	**h**
23-24	38-39						
23-24	37-38						
22-23	23-24	34-35					
a	**b**	**c**	**d**	**e**	**f**	**g**	**h**
17-18	24-25	24-25					
19-20	27-28	33-34					
a	**b**	**c**	**d**	**e**	**f**	**g**	**h**
8-9	18-19						
8-9	22-23						
8-9	27-28						
8-9	29-30						
9-10	34-35						
a	**b**	**c**	**d**	**e**	**f**	**g**	**h**
12-13L	13-14L	23-24L	24-25L	24-25R	23-24R	13-14R	12-13R
a	**b**	**c**	**d**	**e**	**f**	**g**	**h**
13-14	66-67	23-24	33-34	35-36	77-78	84-85	

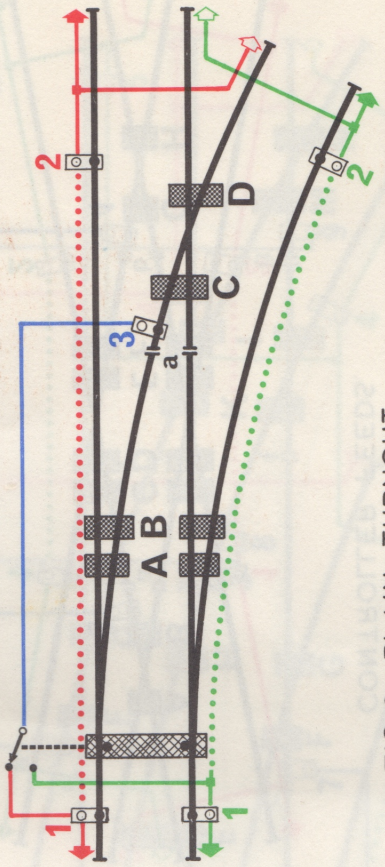


FIG. 2. PLAIN TURNOUT.

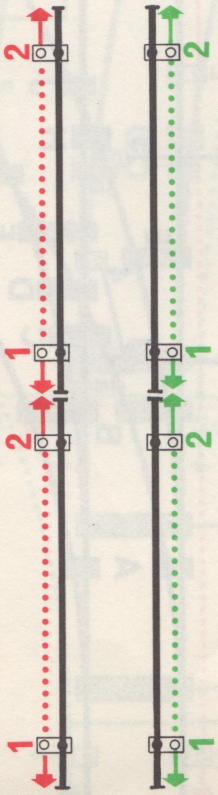


FIG. 1. PLAIN TRACK UNITS.

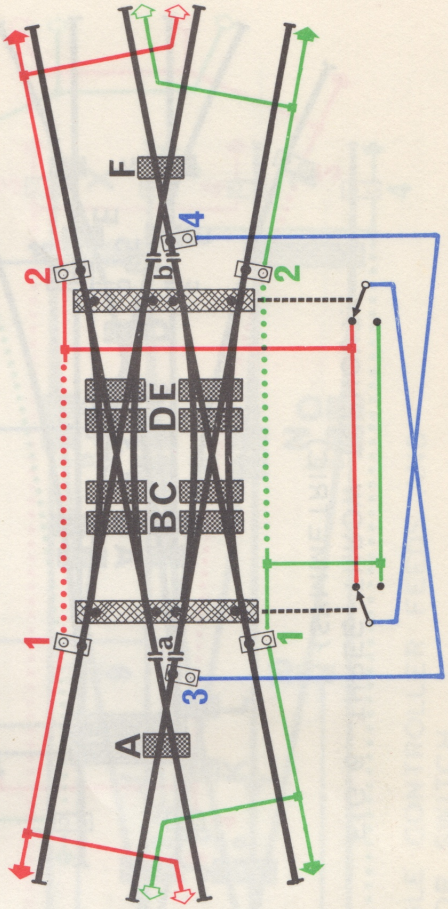


FIG. 4. DOUBLE SLIP WITH SINGLE CONTROLLER FEEDS.

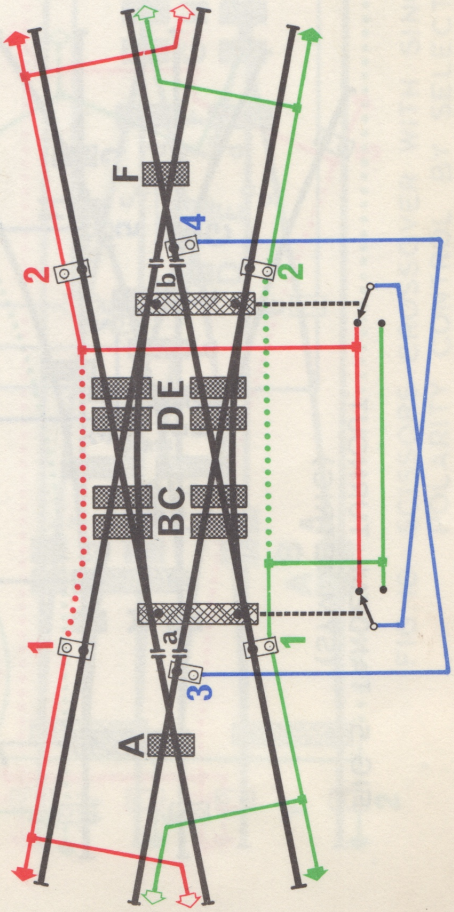


FIG. 3. SINGLE SLIP WITH SINGLE CONTROLLER FEEDS.

FIG. 5. TANDEM TURNOUT. (SYMMETRIC)

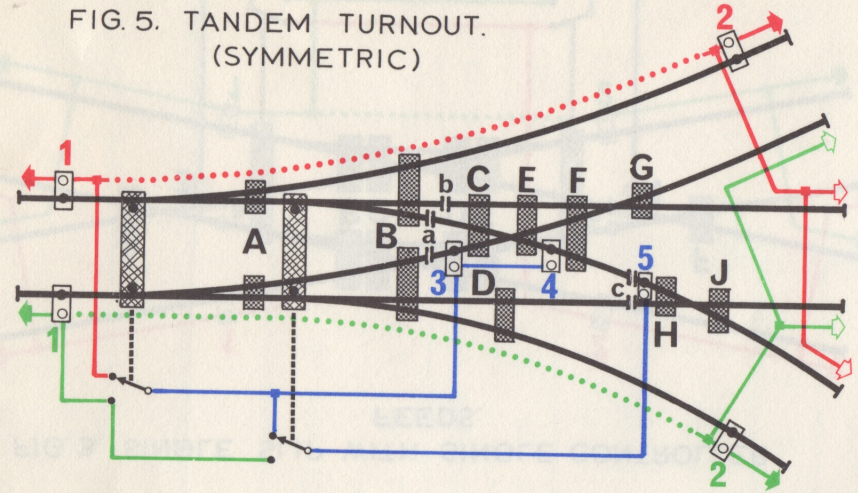
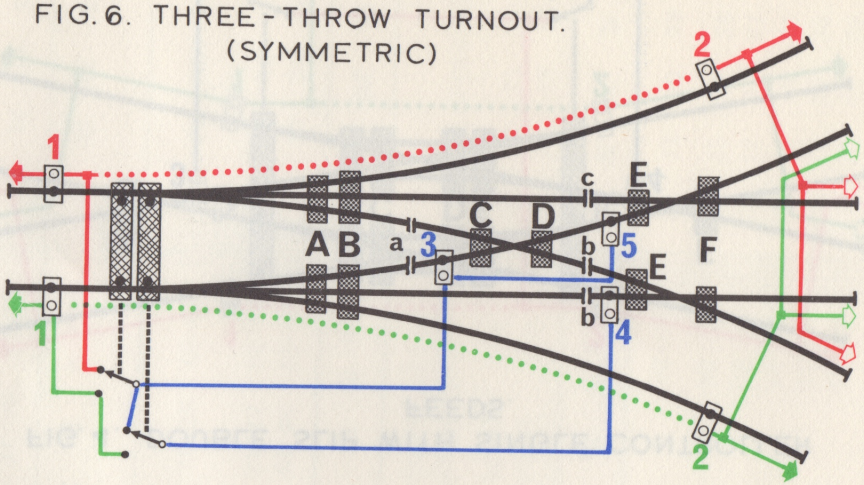


FIG. 6. THREE-THROW TURNOUT. (SYMMETRIC)



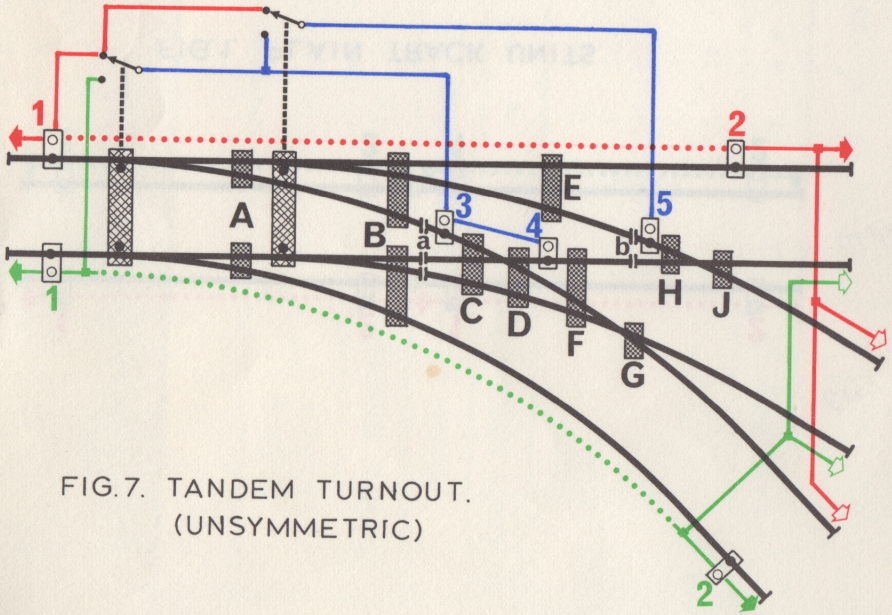
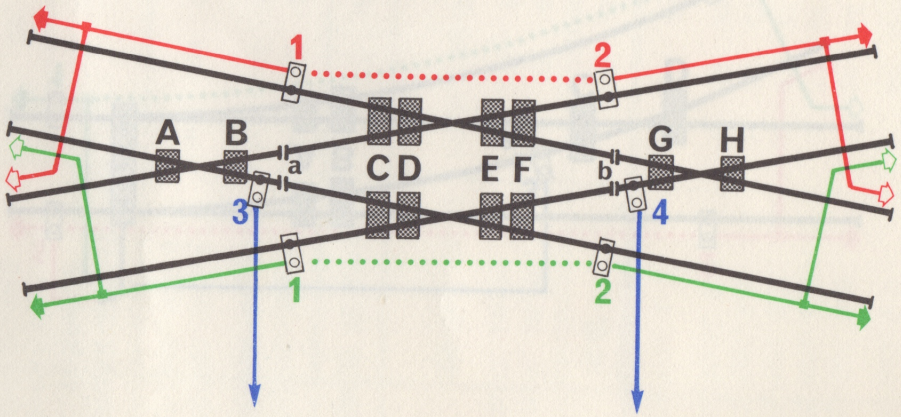


FIG. 7. TANDEM TURNOUT. (UNSYMMETRIC)

FIG. 8. DIAMOND CROSSING WITH SINGLE CONTROLLER FEEDS.



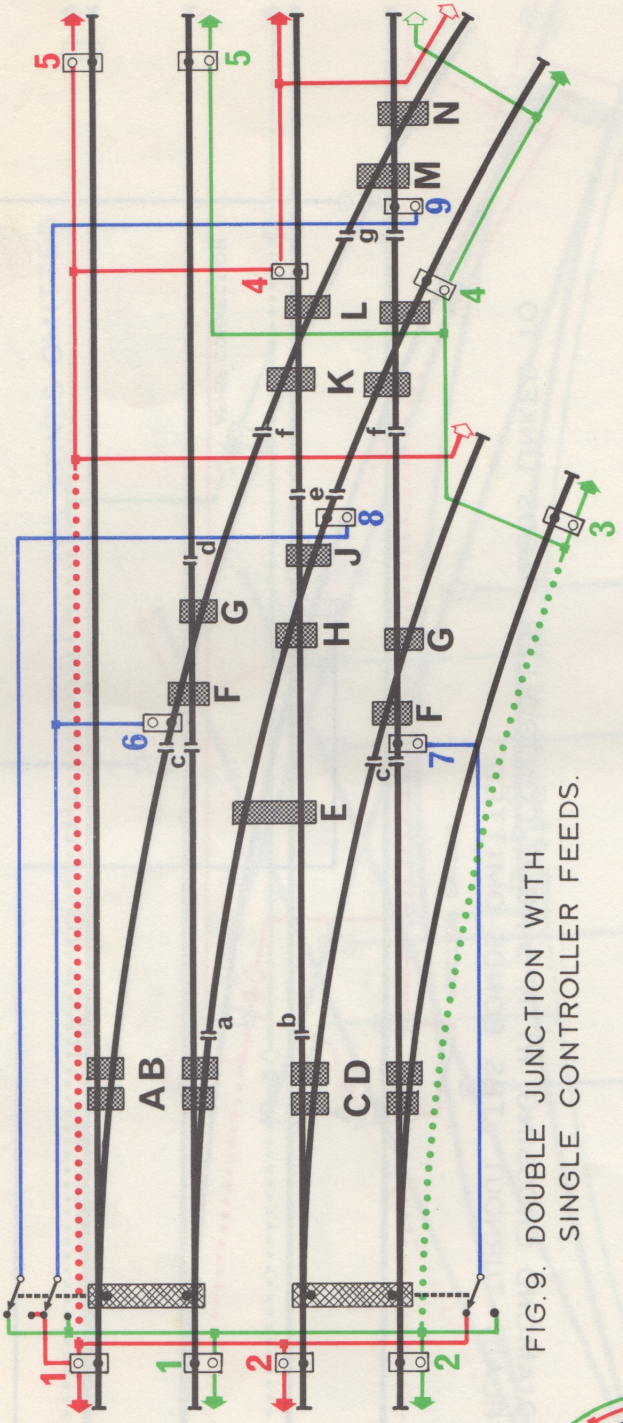


FIG. 9. DOUBLE JUNCTION WITH SINGLE CONTROLLER FEEDS.

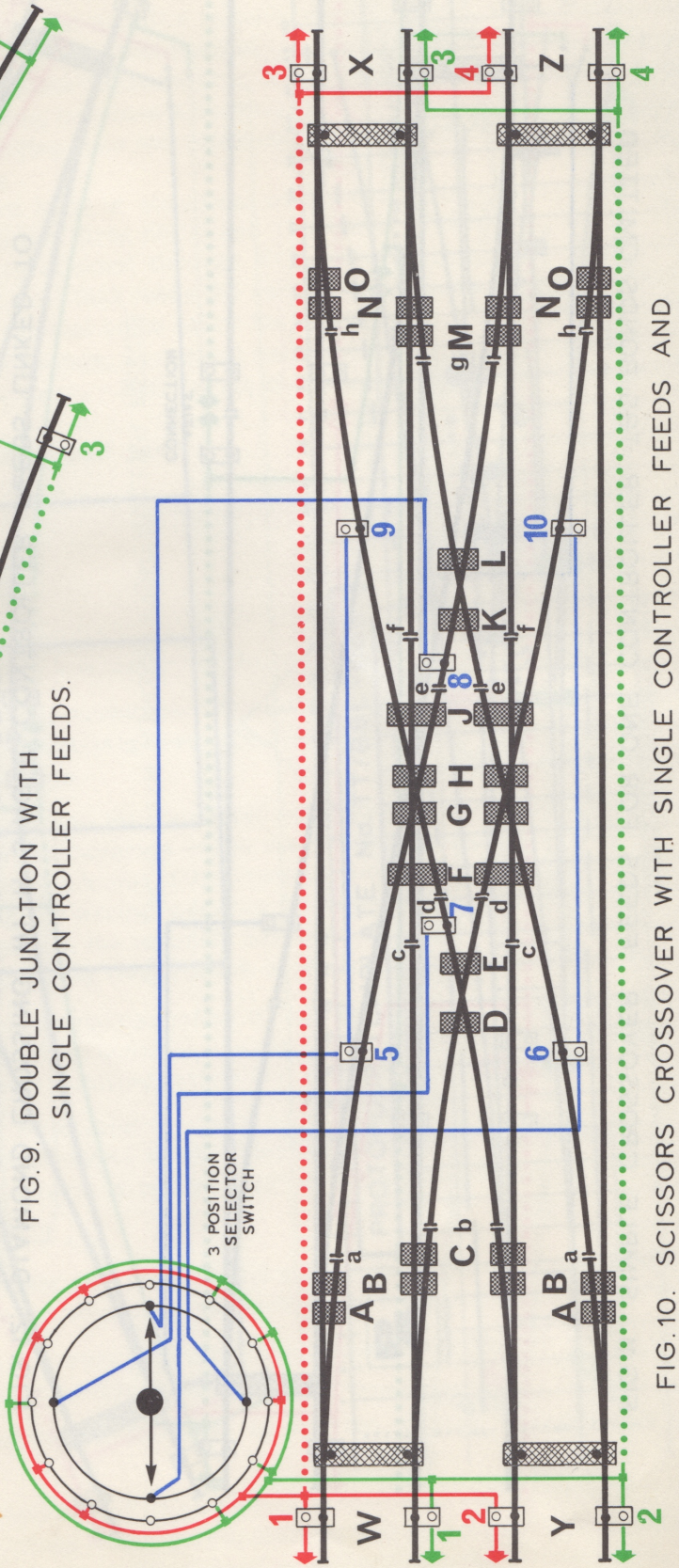


FIG. 10. SCISSORS CROSSOVER WITH SINGLE CONTROLLER FEEDS AND POLARITY CONTROL BY SELECTOR SWITCH.

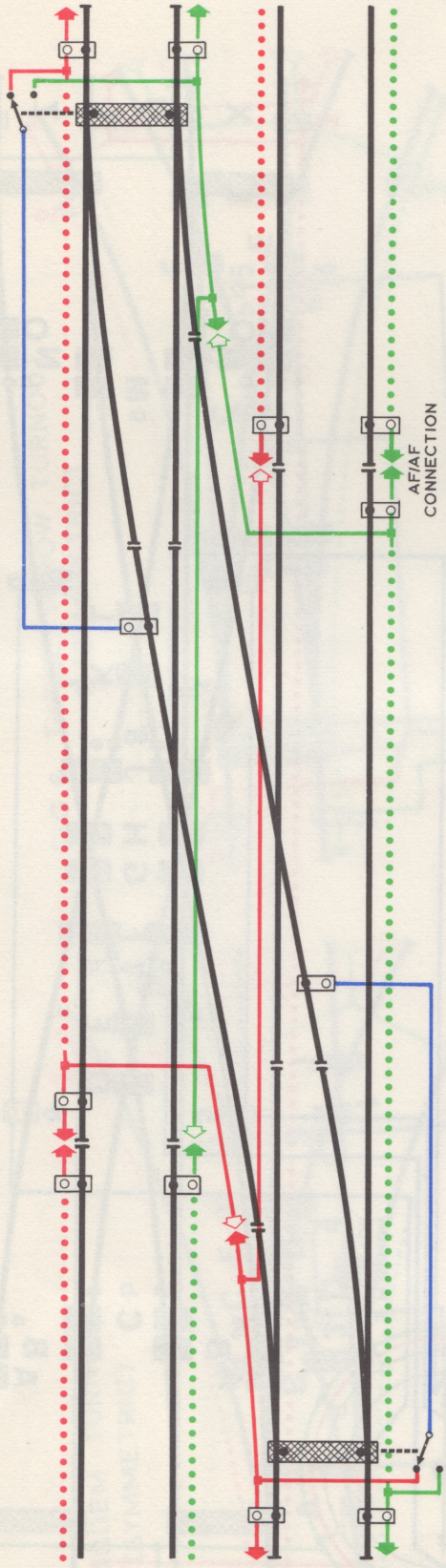


FIG. 11. SIMPLE CROSSOVER. FEEDS FOR ONE CONTROLLER. TBS BONDS OMITTED.

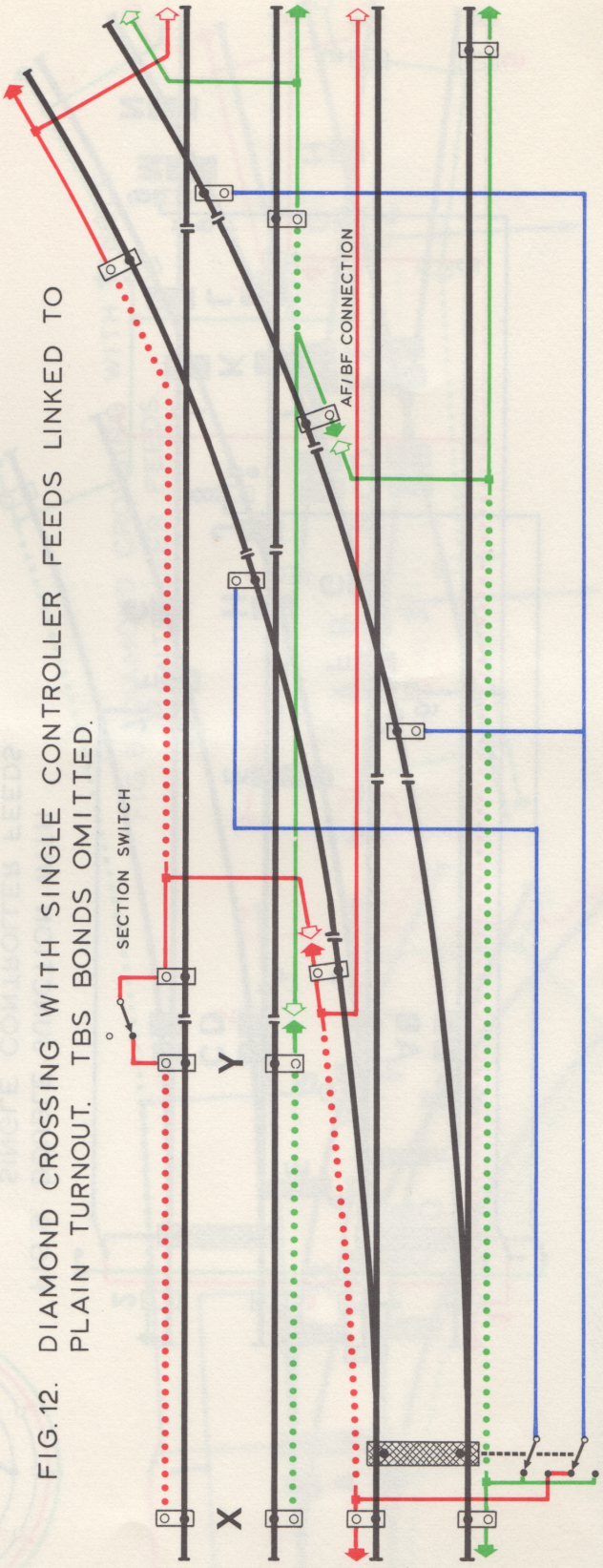


FIG. 12. DIAMOND CROSSING WITH SINGLE CONTROLLER FEEDS LINKED TO PLAIN TURNOUT. TBS BONDS OMITTED.

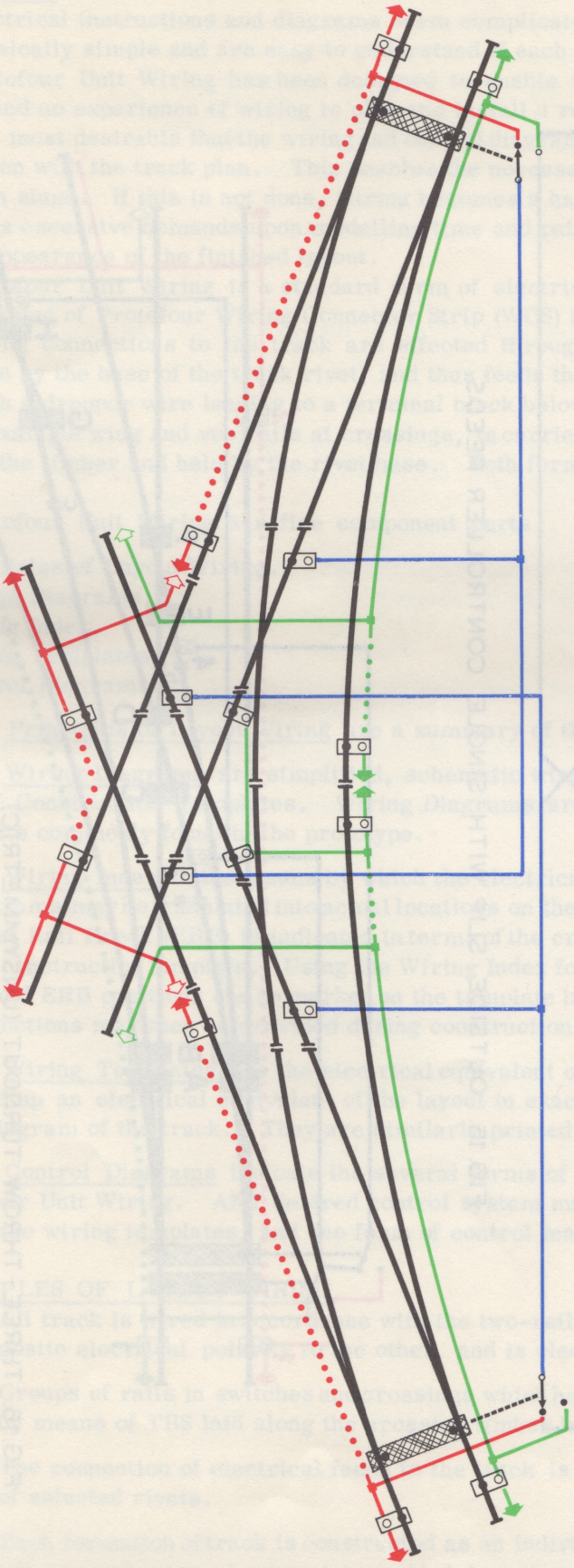


FIG.13. DIAMOND CROSSING LINKED TO PLAIN TURNOUTS. TBS BONDS OMITTED.

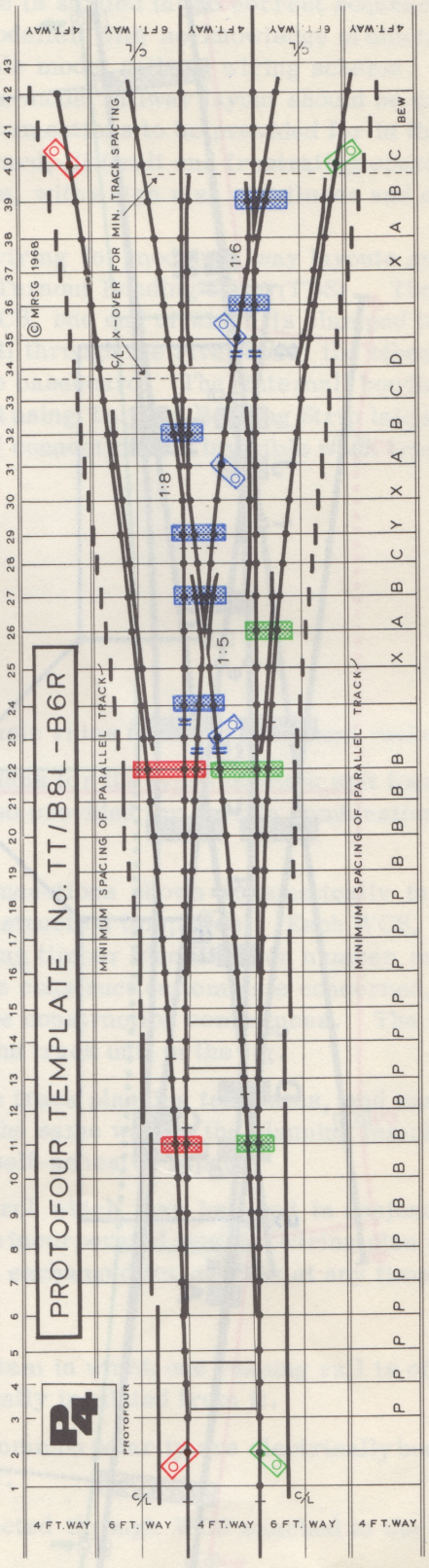


FIG.14. TANDEM TURNOUT TEMPLATE SHOWING WCS FEED AND TBS BOND LOCATIONS.

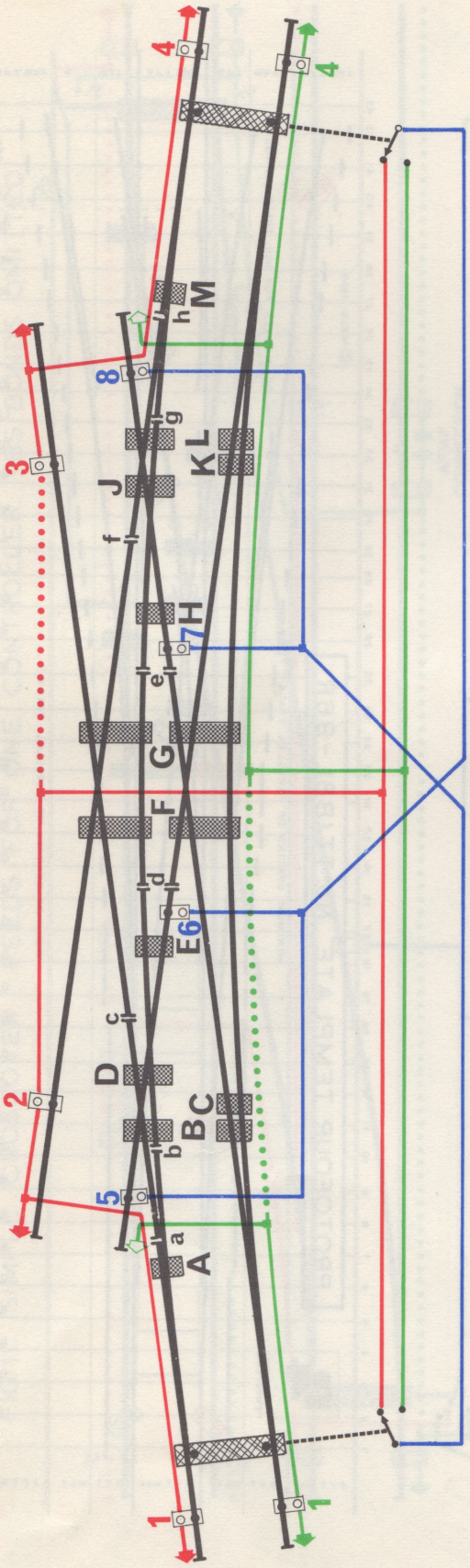


FIG.15. OUTSIDE SLIP WITH SINGLE CONTROLLER FEEDS.

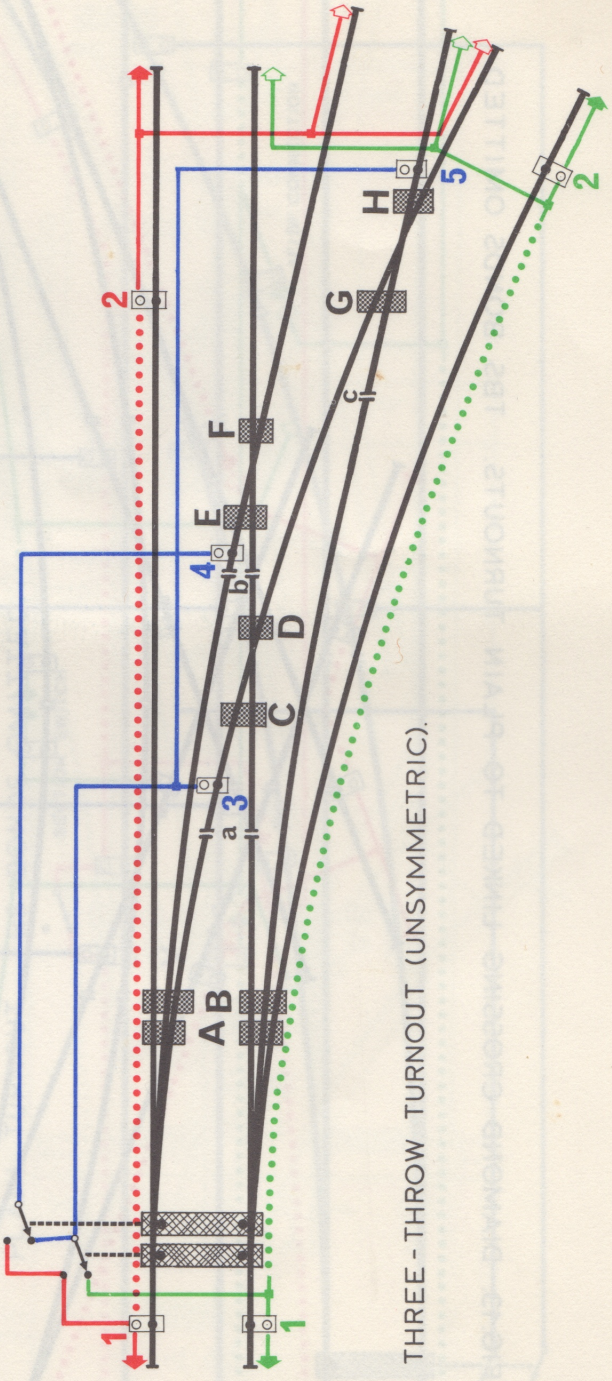


FIG.16. THREE-THROW TURNOUT (UNSYMMETRIC).