"The Door to Success"

VICTORIAN RAILWAYS INSTITUTE

PERMANENT WAY

CORRESPONDENCE COURSE

BOOK 2

SECTIONS 13 - 20

1947

PHOTO-LITHOGRAPHED
by
McCARRON, BIRD & CO.
479 COLLINS ST., MELBOURNE

SECTIONS

TABLE OF CONTENTS

TRACKWORK LAYOUTS.13

TURNOUTS

GENERAL

The turnout is the basis of all connecting trackwork and consists of the points, closure rails,'V' crossings and guard rails with the necessary timbers and fastenings.

In the early days of railway work the points consisted of movable rails as shown in Fig. 1, and were known as stub switches. The crossings were of light construction and were usually curved in the field to conform to the curvature of the turnout.

It was the practice to regard the turnout as a regular curve tangent to the straight track at a point called the tangent point or T.P. This curve crossed the gauge intersecting the opposite running edge at a point called the point of intersection or P. of I. This is illustrated in Fig. 2.

Many years ago stub switches were abandoned for passenger carrying railways owing to the difficulties associated with the safe locking of the movable switch rails, and they are now usually only to be found on light trolley lines.

The standard points and crossings in use today are straight and require the turnout curve to be arranged tangent to the heel of the straight switch and the wing of the straight 'V' crossing.

There are other methods of arranging the curves in the turnouts by which either or both the turnout points and the 'V' crossing turnout wing are fully or partly curved, but this type of construction is relatively expensive, and its use is confined to special cases where the limitation of space justifies the extra expenditure.

The practice in Victoria prior to 1937 was to calculate the turnout on the basis of the stub switch lead, Fig. 2, but to install the split switch or point blade and straight crossing as shown in Fig. 3. The merit in this system lay chiefly in the simplicity of the calculations necessary to determine lead lengths, curve radius and crossing angle.

In practice nothing like the calculated radius of the curve was obtainable in the standard turnouts and, owing to the different practices followed by trackmen, almost every turnout varied from the next in respect to radius and slightly in length of the curve closure or expansion spaces.

The three usual methods of laying in the turnout curve were:-

(a) By eye.
(b) By calculated offsets off the straight.
(c) By calculated offsets off a chord from the point heel to the 'V' crossing mouth.

When 'eyed in' the radius of the turnout curve was irregular, varying in radius according to the skill of the trackman, having regard to conditions of light and any wear present on the switch or the 'V' crossing being sighted.

If put in to calculated offsets off straight a pronounced kink occurred at the heel of the switch while the curve failed to join up with the straight leg of the 'V' crossing at its mouth and had to be pulled out to do so. Owing to this adjustment, curves of the so called 1000' radius turnouts, have been found to have a radius varying from approximately 1100' radius near the point heel to approximately 780' radius near the mouth of the 'V' crossing, as shown in Fig. 4.

A different condition was obtained when the curve was laid in to offsets calculated for the standard radius off a chord from the point heel to the 'V' crossing mouth. In this case the standard radius was definitely laid in, but two very noticeable kinks occurred, one at the point heel and the second at the mouth of the 'V' crossing. This usually resulted in the trackman pulling out the curve by eye about the middle portion and the final result came back to an 'eyed in' curve, but of a lesser radius than standard. Obviously adjustments made to the curve slightly altered the length of the rail required for the curve, which usually resulted in excessive expansion gaps.

The standard turnout diagrams issued in 1938 for 90 and 110 lbs. material provide for the maximum regular radius of curvature tangent to the straight switch and the standard straight 'V' crossing as shown in Fig. 5. In preparing these diagrams the old 'crossing lead' from the heels to the P. of I. was adopted to enable renewal of points in the heavier material to be effected without alteration to the timber arrangements and signal gear at the points.

As the length of the tangent behind the switch slightly exceeds the length of the tangent ahead of the crossing it was necessary to commence the turnout curve a little behind the heels. The Point of Curvature or 'P.C.' is shown on the diagram together with its position from the heels and at the mouth of the 'V' crossing.

Obviously the rails cannot be curved within the fish-plate joint and the 'P.C's'are therefore more of mathematical precision than practical importance.

With the introduction of 94 and 107 lb. rails, it became necessary to re-design the points and crossings,and advantage was taken of this opportunity to provide switches of lengths and angles more suitable to the running condition and economy of rail cutting. The sleeper spacing under the points was reduced to give extra support for the heavier axle loads and higher speeds now obtaining, and by reason of the altered switch lengths, slightly greater radii were obtained as shown on the turnout diagrams issued in 1942.

With the extended use of long rigid wheel base locomotives a further development is foreshadowed in that switches of greater length and lesser angles may become general, at least for movements off main tracks on which these locomotives are operated.

It is now the practice to denote a turnout by the number of the 'V' crossing (See 14.069), as the nominal radius previously spoken of was entirely misleading. From what has been said and from inspection of Figs. 2 and 5, it will be seen that the earlier conception of the 'T.P.' of a turnout has no relationship whatever to the modern method of designing a regular curve tangent to the heel of the straight switch and the mouth of the standard straight 'V' crossing, and that in the new standard turnouts the 'P. of I.' now refers only to the intersection of the running edges of the straight 'V' crossing.

Turnouts in which straight 'V' crossings are used are standard for trackwork in yards and sidings generally and for single turnouts off straight main track; this arrangement is described as the straight crossing turnout, Fig. 5.

For special layouts it is occasionally necessary to use a curved 'V' crossing in turnouts, the curve is laid in tangent to the straight switch and extended across the gauge through the curved 'V' crossing; this arrangement is described as the curved crossing turnout, Fig. 6.

The location pegs now put in for laying in turnouts are shown in their position in Fig. 7, and recovery pegs marked in the figure 'R.P.' are provided at suitable distances from the track to enable the replacement of centre pegs if displaced by accident.

In curved track the centre line of the track is the basis of calculations and setting out, but in track work the switch and crossing angles are the basis of calculation, and the radius of curvature in the various layouts is measured at the running edge of the outer rail.

Offsets off the straight are given on the 1938 and 1942 diagrams at 20' intervals behind the heels, and must be strictly worked to in laying in the turnout curves.

With welded closure rails the curve will usually be found to lie in regularly when pulled to the correct offsets. When short rails are required, due to the presence of insulated joints or for other reasons, curved closures are necessary if kinks are to be avoided at the joints. Short curved closure rails are issued for all heavy rail layouts of less than 15 chains or 1000' radius.

To ensure a regular curve the ganger should check the curvature by measuring equal offsets on a 20' chord as shown in Fig. 8.

The middle offsets on a 20' chord for the standard straight crossing turnouts are : -

No. of turnout ..	7.52	8.7	8.7	9.73	9.73
Length of switch ..	15'0"	16'6"	22'6"	16'6"	22'6"
Radius, outer rail ..	480'	660'	645'	842'	826'
Middle offset ..	1.1/4"	15/16"	15/16"	11/16"	3/4"

The middle offsets on a 20' chord for curved crossing turnouts are : -

No. of turnout ..	7.52	8.7	8.7	9.73	9.73
Length of switch ..	15'0"	16'6"	22'6"	16'6"	22'6"
Radius, outer rail ..	577'	773'	752'	980'	947'
Middle offset ..	1.1/16"	3/4"	13/16"	5/8"	5/8"

ABUTTING TURNOUTS

When turnouts are laid in with the stock rails abutting as in Fig. 9, the minimum distance 'D' between toes has been fixed at 18'0"; this is necessary for the free movement of 8 coupled wheel locomotives.

LOOPS

In station yards the turnout movement usually leads into parallel tracks, the simplest arrangement being the loop track shown in Fig. 10, and consisting of turnouts followed by reversing curves.

The radii of the reverse curves have not been affected by the alterations in turnouts and the middle offsets on a 20' chord for the reverse curves following standard turnouts are as follows : -

No. of turnout	7.52	..	8.7	..	9.73
Middle offset, 20' chord.	1"	..	3/4"	..	5/8"
Radius, centre line of curve following the turnout.	600'	..	800'	..	1000'

SPECIAL TURNOUTS

As previously mentioned there are different ways of arranging the curves in the turnouts.

An arrangement which is very convenient when the adjacent trackwork is laid with crossings of smaller No. than the turnout is shown in Fig. 11. In this arrangement the turnout curve commences at the heel of the straight switches and tangent thereto, and is carried across the gauge through a special curved 'V' crossing.

A turnout of this type is the special No. 9.73 turnout with a No. 9.73 curved 'V' crossing; such turnouts provide larger radii than standard and the lead is slightly longer. See 13.077.

For all special turnouts a complete drawing is issued showing particulars of points, crossings, timbering and fastenings, and the whole of the work is set out on the ground by the surveyor who must have the necessary recovery pegs placed to enable the foreman or ganger to re-establish centre pegs knocked out during the course of the work.

LADDER TURNOUTS

Where two or more parallel tracks on the same side of the main track are connected thereto, the arrangement of ladder turnouts, shown in Fig. 12, is generally used in preference to the following turnouts shown in Fig. 13. The first arrangement permits of the maximum standing room, but the points in the second and the following turnouts are special. In the case of ladder turnouts at 11'8" centres, the points are distinguished by the letter 'A' stamped with the switch length on the side of the stock rail over the heel chair. See 14.002.

The special points are necessary for two reasons : -

(1) To maintain the standard lead and curvature in all the turnouts.

(2) To enable certain wheels of locomotives to be clear of the crossing and guard rail flangeways before engaging the turnout switch.

For track centres other than 11'8", the length of stock rail varies and the distinguishing letter is likewise varied.

If a stock rail is required longer than 45'0", it is necessary to flash butt weld the extra length; this however is avoided when a closure 15'0" or longer can be used with a standard stock rail. Stock rails lengthened by welding have the letter 'W'stamped together with the distinguishing letter and switch length.

Except in emergency the stock rails must not be cut or altered in any way. Half sets of points with stock rails of the required lengths are supplied for all approved standard and special layouts, and any alterations in the field will certainly result in confusion when replacements are required. Any special points required must be ordered for the location, be specially made and classified, and recorded for replacement purposes.

THREE-THROWS

Where space is restricted the double turnout or three-throw enables three movements to be effected from a short length of track by overlapping two turnouts.

In Fig. 14 are shown three arrangements of tandem and overlapping turnouts.

The arrangement at 'A' necessitates the use of double points of different switch lengths fished at a common heel and a special 'V' crossing in the gauge of the straight track; this layout known as a three-throw is now obsolete.

At 'B' is shown the modified three-throw in which the second set of points is placed sufficiently far behind the leading set to allow for the throw of the points, and the special 'V' crossing abuts the 'V' crossing in the leading turnout. In the light rail trackwork in yards and sidings this arrangement is useful, but in heavy rail trackwork the layout is very unsatisfactory, there being insufficient room for the proper assembly and operation of point gear, and to provide suitable turnout curvature. A further undesirable feature is the use of necessary short closures in the straight track.

It is now the practice, wherever this can be done during renewals and re-arrangements, to replace the modified three-throws in main tracks with standard turnouts, but in yards and sidings where however this cannot be effected, to design the arrangement as a special layout.

The arrangement shown at 'C' is seldom met with in running tracks, but is useful in certain circumstances for a catch point turnout or car dock turnout.

SPRING 'V' CROSSING TURNOUTS

When turnouts are required for occasional slow movement off high speed track it is good practice to install a spring 'V' crossing, the object being to improve the running on the main track by eliminating the flangeway gaps. Spring 'V' crossings are either right or left-hand, a right-hand spring 'V' crossing turnout is shown in Fig. 15. See 14.071.

CLOSURES

The closures, both jointed and welded, are of sufficient length in 94 and 107 lb. turnouts to extend beyond the 'V' crossings and be clear of the guard rail assemblies. By overlapping the 'V' crossing joints, additional lateral strength is afforded to the trackwork as in Fig. 16.

The lengths of the closures in most cases correspond with those required in crossovers laid to 11'8" track centres, in consequence the number of curved closures required to be held in stock has been kept to a minimum. See 13.019.

SPECIAL JOINTS

At the heel ends of Nos. 7.52 and 9.73 'V' crossings special crossing fishplates are required, and at supported joints in 94 lb. material they replace the angle fishplates which are not suitably punched for spiking in such positions. See 10.14.

JUNCTION FISHPLATES

Very unsatisfactory trackwork results from junctioning rails of different classes within a turnout, and it is now the practice to place the junctions, if possible, one rail length clear of the turnout. In all cases one length of rail of the same class must be laid in advance of the points to avoid junctions at the ends of the stock rails. See 10.06.

TIMBERS

The length of timbers required at the toe of the points depends on the method of operation. See 16.19. To reduce the rocking effect usually associated with timbers askew to trackwork, the timbers under the 'V' crossings are set at right angles to the centre line of the crossing, and adjacent timbers in advance of the crossing are gradually slewed round without unduly upsetting the regularity of spacing. See 13.094.

PLATES

If the track is furnished with standard sleeper plates, the turnouts therein should be laid with special flat sleeper plates; these are required because the closure rails in all turnouts are laid vertical.

Different types of flat sleeper plates are provided according to the weight of rail used, and the presence of insulated joints, spring 'V' crossings, etc. See 14.113.

As the main track rails are laid with an inclination of 1 in 20° and the turnouts are laid with vertical rails, it is necessary to alter the inclination of the main track rails adjacent to the turnouts. To gradually alter the rail inclination it is now the practice to provide graduated cant plates on consecutive sleepers at the centres of the track rails abutting the turnouts. See 10.10.

At the heels of standard points the closure rails are raised above the stock rails, and to run out the difference in elevation, lug plates with steps of different heights are provided. See 14.113.

DOGSPIKES

Where flat sleeper plates are provided it is not generally necessary to double spike the outer curved closure rail, as lateral support is afforded by the inside dogspike through the medium of the flat sleeper plate.

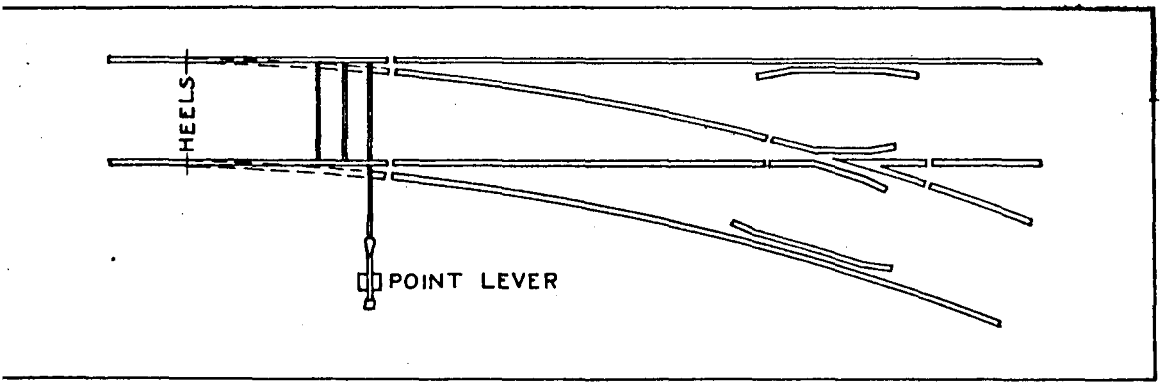


Fig.1. The Stub Switch Turnout

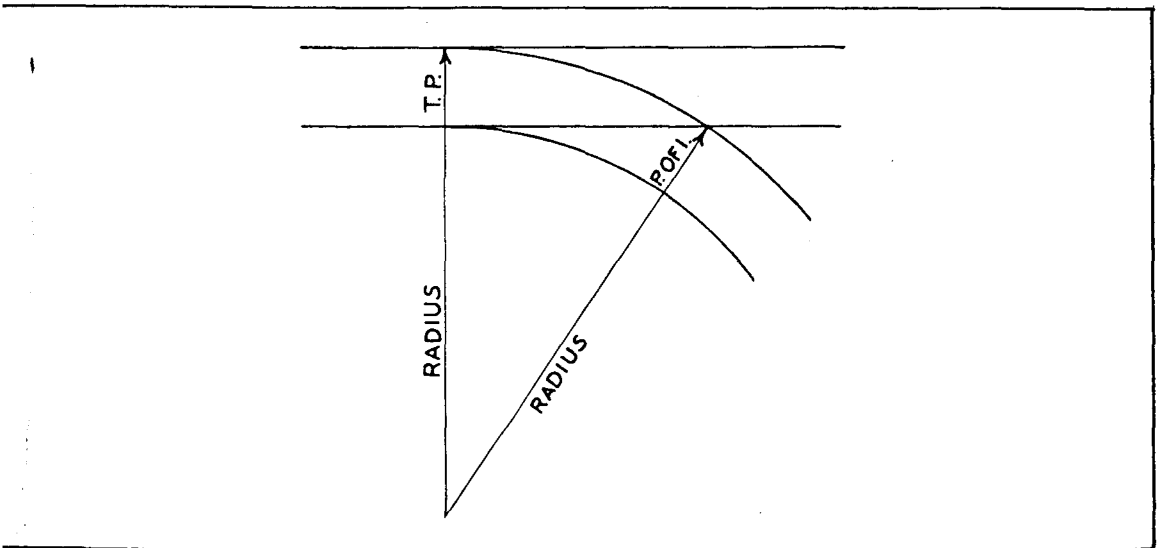


Fig.2. The Stub Switch Lead

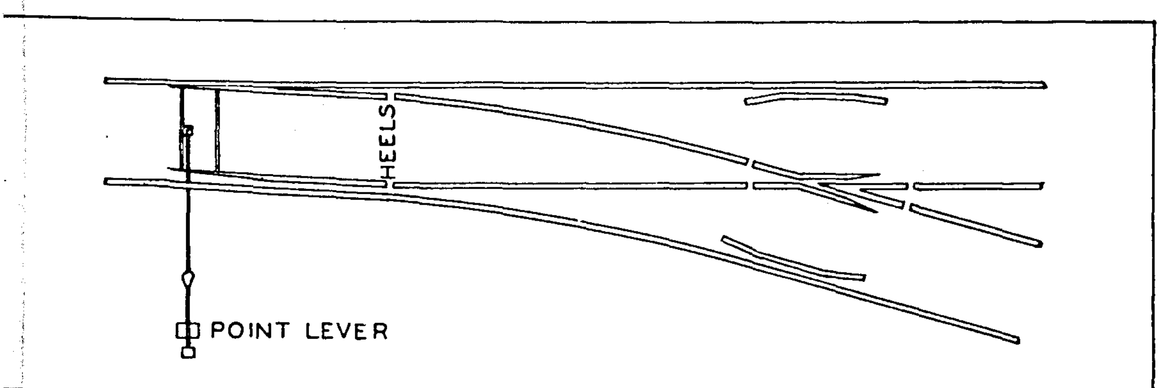


Fig.3. The Split Switch Turnout

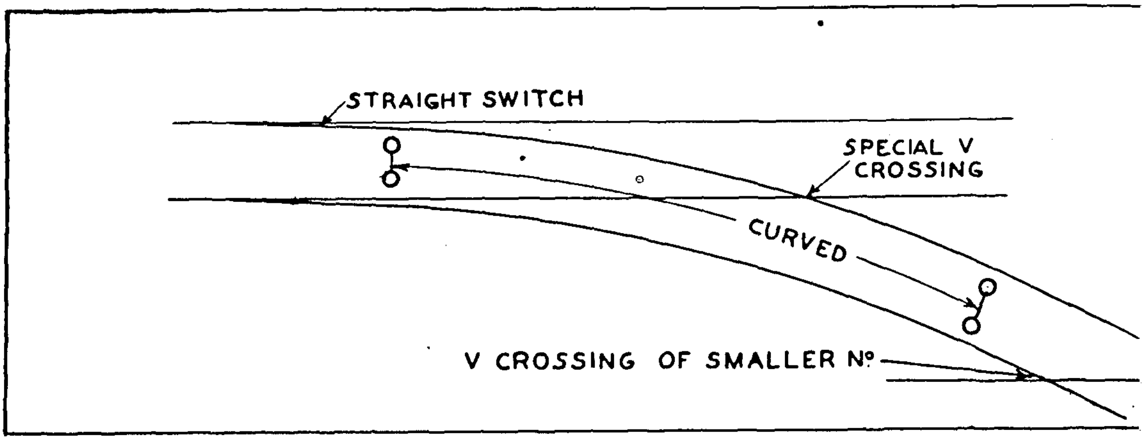


Fig.11. Special Curved Crossing Turnout

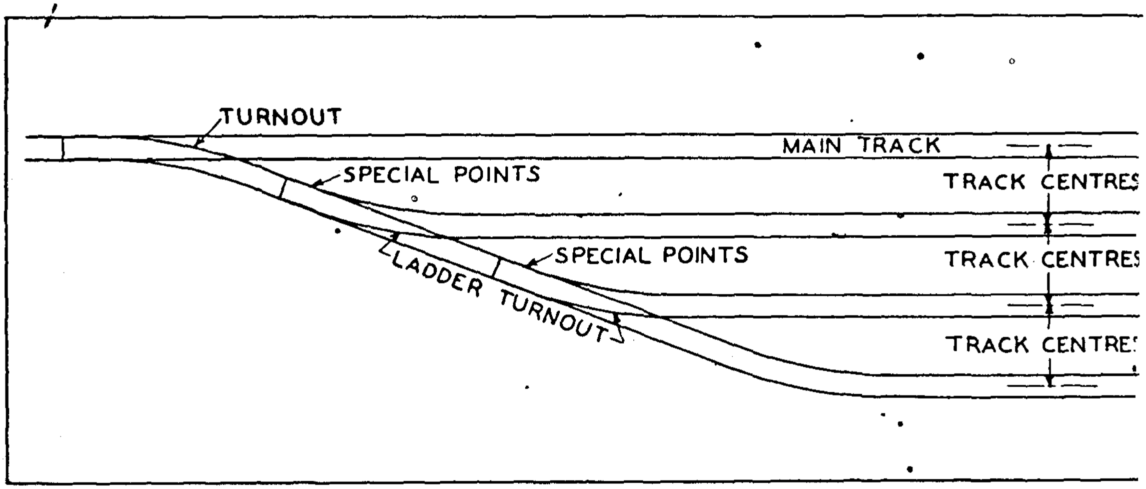


Fig.12. Ladder Turnouts

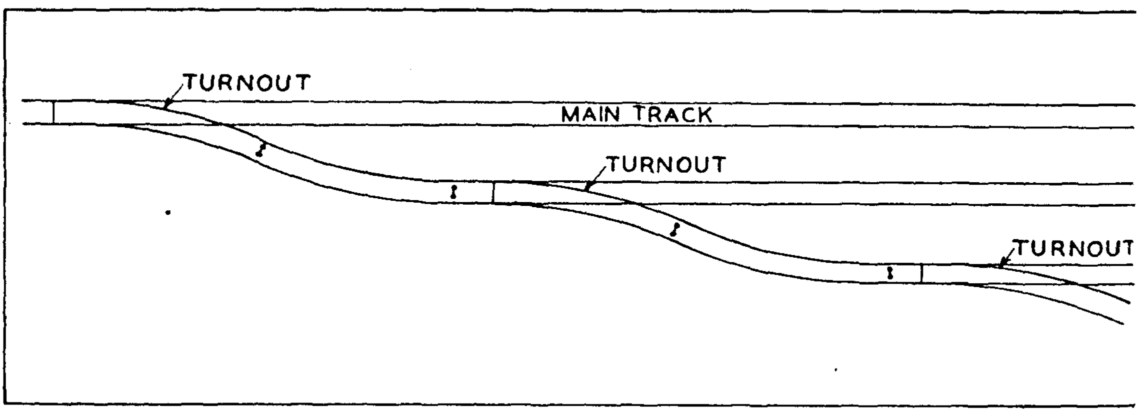


Fig.13. Following Turnouts

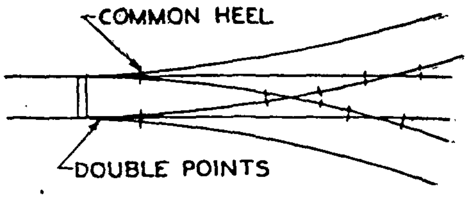


Fig. 14.A. The Three Throw.

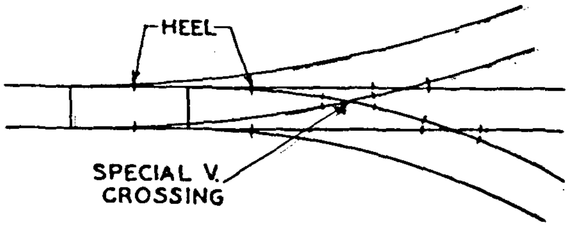


Fig. 14.B. The Modified Three Throw

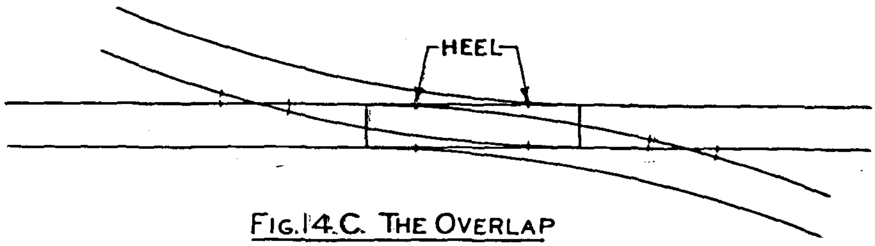


Fig. 14.C. The Overlap

Fig. 14. Overlapping Turnouts

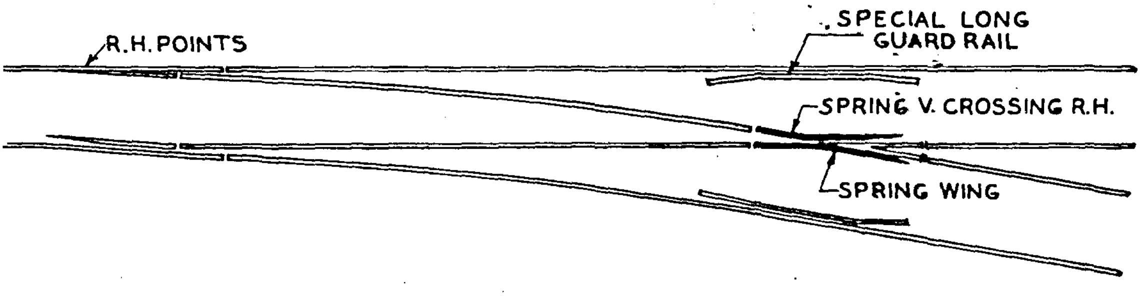


Fig. 15. Spring V. Crossing Turnout

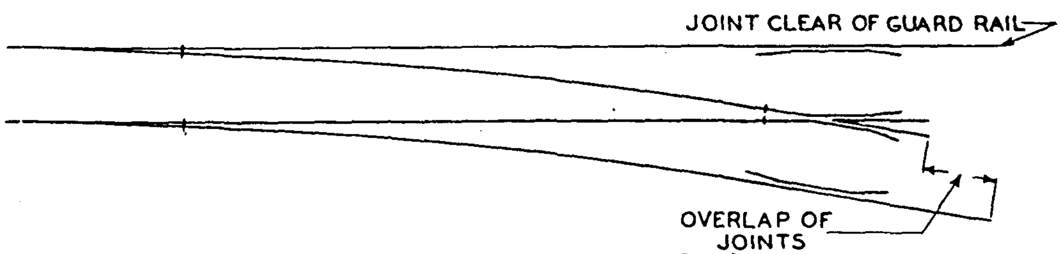


Fig. 16. Overlap of Joints in 94 & 107 Lb. Turnouts

CROSSOVERS

DEFINITION

The crossover consists of two turnouts arranged to connect two adjacent tracks.

When the adjacent tracks are straight, parallel, and closely spaced, the two turnouts are of the same No., but if the tracks are curved or inclined at an angle to each other or widely spaced, then combinations of standard turnouts and special turnouts are frequently required.

STANDARD CROSSOVERS

The simplest arrangement is the parallel track crossover shown in Figs. 17 & 18. In this case the turnouts are standard and the curves are laid in tangent to the straight switches and the straight 'V' crossings.

When the tracks are closely spaced the 'V' crossings overlap and the position and arrangements of the guard rails and their fastenings require to be carefully designed. See 13.017.

GUARD RAIL ASSEMBLY

The block positions in the standard 94 and 107 lb. 'V' crossings and the guard rails have been so arranged that the guard rail assembly can be made without fouling the 'V' crossing joint or block arrangement.

The guard rail is correctly located when the bolt hole for the guard rail end bolt is bored at the prescribed distance from the heel end of the 'V' crossings as follows:-

Crossing No.	..	7.52	..	8.7	..	9.73
Distance from heel end	..	1'10"	..	2'7"	..	2'0"

It will be obvious that these conditions obtain only when the tracks are laid to certain centres. The standards have been designed for 11'8" centres.

Clearly an alteration of as little as 1 inch in the track centres will shift the whole assembly several inches according to the No. of the 'V' crossing and, unless the track centres are so widened that the guard rail position clears the 'V' crossings altogether, there will frequently be considerable difficulty in fixing the guard rails.

To ensure the proper assembly of guard rails it is necessary that they be designed specially for any non-standard layouts, having regard to the particular crossings which are being used.

SPECIAL CROSSOVERS

Special crossovers may be considered as consisting of three general types : -

(1) Crossovers between parallel straight tracks where the track centres are wider than standard.

(2) Crossovers between inclined tracks.

(3) Crossovers between curved tracks.

Within each general type there are to be found many variations according to radii and crossing Nos., and to special circumstances such as restriction of space and the use of various standard track materials.

When crossovers are laid between parallel straight tracks with wide track centres, the overall length of the crossovers may be unduly long if standard straight 'V' crossings are used. The intersection distances can be reduced by the use of curved crossing turnouts, but although this is an advantage where space is limited such layouts are more costly to install and maintain.

In Fig. 19. is shown an arrangement in which curved crossing turnouts are used with a short length of straight between them; the standard straight crossing turnouts are shown in dotted line for comparison.

To enable the 8 coupled wheel locomotives to pass through the crossings and guard rails without binding in the flangeways and distorting the trackwork, it is necessary to provide a length of straight of not less than 11'8" between the $1\frac{3}{4}$" flangeways of the 'V' crossings and the adjacent guard rails. See 18.19, Fig. 3.

Another arrangement is shown in Fig. 20, in which turnouts of different Nos. are used. In this case the larger No. turnout is a curved crossing turnout and the turnout curve is extended sufficiently to meet the tangent of the smaller No. straight crossing turnout.

13.016

If the adjacent tracks are inclined the overall length of a crossover, laid with straight crossing turnouts, is greatly increased in comparison with a similar crossover between parallel straight tracks. One or both turnouts may be of the curved crossing type though not necessarily of the same No.

An arrangement is shown in Fig. 21, in which two curved crossing turnouts of different Nos. are used with a connecting length of straight track.

Crossovers between similar flexure curved tracks vary according to the radius of the tracks, the width of track centres and local conditions.

As a general rule crossovers between curved main tracks are avoided wherever possible as there is insufficient space between crossings to run out the cant and it is necessary to reduce the cant to suit the length of runout available; speed has therefore to be reduced by reason of the decreased cant.

Under certain circumstances the crossover may consist of two similar flexure turnouts as shown in Fig. 22, and the full cant may be applied by raising the outer track relative to the inner track, but the proximity of bridges and level crossings will often restrict the difference in level which may be permitted between the two main tracks.

The usual cases met with consist of a similar flexure turnout in the outer track and a contraflexure turnout in the inner track with a connecting length of straight between the crossings as shown in Fig. 23.

In the similar flexure turnout the crossing No. is necessarily large to enable a suitable radius to be obtained in the turnout curve, but in the contraflexure turnout a large radius is obtainable with a crossing of smaller No. See 13.052.

Curved 'V' crossings are manufactured up to No. 15, and by continuing the curve of the similar flexure turnouts through a curved crossing as at 'A' in Fig. 24, a straight 'V' crossing of a smaller No. may be used at 'B' with a consequent reduction in the overall length of the crossover.

Above No.15 the 'V' crossings are manufactured in cast manganese steel and are straight, the gap from the knee to the nose is very long and the whole of the wheel flange pressure is taken by the guard rail. Under these conditions safety and crossing life are greater with the straight 'V' crossings than with curved 'V'crossings, but the crossover is slightly longer.

When turnouts of the same No. are used to form a crossover between parallel curved tracks,special leads are required, as in junctions of similar flexure and contraflexure (See 13.081),and the intersection distances are less than for crossovers between parallel straight tracks (See 13.082); consequently conditions arise, as in Fig. 25, where the guard rails foul the guard wing rails of the 'V' crossings. In such cases the guard wing rails of 'V' crossings must be extended and suitably jointed to special guard rails as satisfactory guarding of the 'V' crossings cannot otherwise be obtained. This arrangement is shown in Fig. 26.

While trackmen are not concerned with the design of the various crossovers, it is essential that they understand the different arrangements to enable them to properly install and maintain these special layouts.

As standard points are straight it is necessary for their installation to compound the curves and re-centre the tracks when crossovers are laid between curved tracks.

Curving of stock rails, while improving the main track curvature, has the effect of increasing the switch angle, or rate of the switch,with the inevitable result that the points kick out of line.

If the crossover arrangement requires the use of curved 'V' crossings in the turnouts, it is usual to curve the main track leg of the crossing also.

For siding work however the standard straight 'V' crossings are used whenever practicable as this course facilitates renewals from stock and enables the use of standard 'V' crossings released, in serviceable condition, from main track.

There are other arrangements of crossovers connecting combinations of track centres with straight and curved track of similar flexure and contraflexure, but the principles illustrated in Figs. 18 to 24 are representative of crossovers generally.

Each layout has its own peculiarities and requires careful thought to decide the best arrangement; subsequent alterations may be difficult or impossible to effect without a major alteration of adjacent trackwork and structures.

SPRING 'V' CROSSOVERS

When crossovers are required for occasional slow movements between high speed tracks, it is good practice to install spring 'V' crossings, the object being to improve the running on the main track by eliminating the flangeway gaps.

The plated construction of spring 'V' crossings necessitates the timbers being placed in definite positions, and to do this the crossings must be placed at their correct intersection distances and track centres. Many of the older designs of spring 'V' crossings were made for turnouts, and when used in crossovers at 11'8" track centres, some of the plates did not come in line with the through timbers from the mating spring 'V' crossing.

To seat the spring 'V' crossings the timbers were slewed and the intersection distances altered. Very bad trackwork resulted from this practice, as the gauge through the crossover was appreciably affected and uneven support was provided by the slewed timbers.

The 94 and 107 lb. spring 'V' crossings have been designed for crossovers on 11'8" track centres, and the timbers and guard rails are arranged for correct assembly when laid to the proper intersection distances.

As the spring 'V' crossing is frequently associated with crossover work, the bolt hole for the guard rail end bolt is bored during manufacture. Unless the track centres are wide the same difficulties will apply in guard rail assembly as with standard 'V' crossings when the track centres are varied from 11'8".

The movable wing of the spring 'V' crossing is held in position by a powerful spring, but it is in effect a loose rail, and to properly guard these crossings special long guard rails are required.

As the guard rails are situated on the same through timbers as the plated spring 'V' crossings, special plates are required under the guard rail assemblies. See 14.120, Fig. 121.

JOINT POSITIONS

The relative positions of crossing joints are considerably altered by a change in track centres or crossing No. In many otherwise convenient trackwork arrangements it is very difficult to so place the timbers that the necessary support will be given to joints and to the trackwork generally. Unduly wide spacing of the timbers reduces the support of the trackwork and results in sags, while very close spacing has the opposite effect by causing hard spots and by making the packing difficult to perform.

It is now the practice on all layout drawings to arrange joint timbers for equal suspension of the joint on timbers at 1'8" centres or alternatively to centrally support the joint on one joint timber. Joints unevenly suspended are defin - itely unsatisfactory and are avoided wherever possible.

SPECIAL JOINTS LOCATION

Special crossing fishplates are provided for the ends of crossings where required and in guard rail flangeways. These fishplates are also required at supported joints in 94 lb. material as the angle fishplates are unsuitable for spiking in such positions. See 13.007.

JOINT EFFECTS

Batter at joints tends to cause flats on the opposite rail, the impact being carried through the wheels and axle, and when the joint is located opposite the nose in the 'V' crossing, flattening of the nose rail and guttering of the wing rail are accentuated. This condition is shown in Fig. 27.

TRACK CENTRES

Good crossover work necessitates the use of moderately wide track centres and lengths of crossings suitably arranged according to the crossing No.

In 1923 the Commissioners approved the adoption of 13'0" track centres on all new works. Standard diagrams for 13'0" track centres are now in course of preparation; the standard diagrams at present issued are for 11'8" track centres.

CLOSURES

The closures for standard crossovers have been arranged with regard to joint positions and timber spacing. Two sets of closures are in use - jointed and welded. Jointed closures are necessary in insulated layouts and are also used in layouts where it would not be economical to transport the long welded closures.

Where practicable and particularly for main trackwork, the long welded closures are always provided. The lengths of the closures have been designed to stagger the joints and thus contribute to the lateral stiffness of the trackwork.

Certain of the closures are standard for both the turnouts and the crossovers of the same Nos. As in the case of turnouts, short curved closures are issued for all heavy rail layouts of less than 15 chains or 1,000' radius. See 13.004.

In special crossovers involving difficult curve work, the layout is manufactured in the workshops, curved, and supplied complete ready for installation.

PLATING

In main trackwork the crossovers are plated on all timbers except those immediately under the 'V' crossing and guard rail assemblies. See 13.097-13.098.

TIMBERS

Owing to the increasing difficulty in obtaining long timbers of good quality, where possible alternate timbers are broken jointed, but sufficient long timbers are provided to secure the gauge, and joint timbers are always long timbers. See 13.093.

ECONOMIC CONSIDERATIONS

Generally it is preferable to incur a little more initial expense in re-arrangement and thus obtain a satisfactory job than to wrongly install expensive crossing work with the certainty that continual maintenance will be necessary and more frequent replacements be required, not to mention the unsatisfactory trackwork conditions brought about by a bad layout.

The fact that an existing layout may have served the purpose is no guide to the standard of the work which experience indicates is necessary for present day conditions.

INTERSECTION DISTANCES.

In all crossover work the accurate location of the crossing intersections is a necessity to ensure correct gauge and guard gauge, and intersection distances for standard No. crossings between parallel tracks will be found in 13. 082; these will be of use to trackmen engaged on the maintenance of crossover work.

Intersection distances are always measured along the straight track from the P. of I. of one crossing to a point square off the P. of I. of the opposite crossing, as shown in Fig. 28.

On the 1938 and 1942 standard diagrams the distances between the noses of the crossings are given instead of the intersection distances, the noses being well defined positions from which measurements can be made. It should be carefully noted, however, that in older standards the position of the noses in relation to the P. of I's. vary considerably. See 14.079.

The intersection distances given in 13.082 apply to straight 'V' crossings and do not hold true for curved 'V' crossings or combinations of curved and straight 'V' crossings; such cases are worked out according to the radius of curvature through the crossings, the No. of the crossings and the track centres, and are shown on all special layout plans.

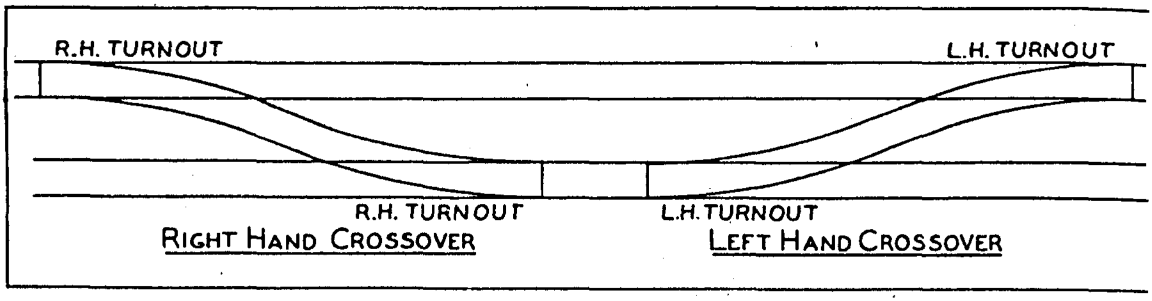


FIG.17. RIGHT & LEFT HAND PARALLEL TRACK CROSSOVERS

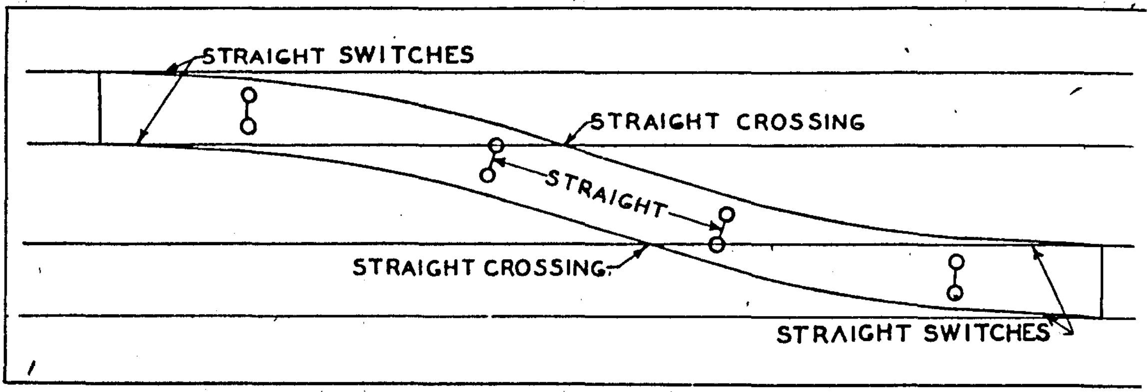


FIG.18. THE STANDARD PARALLEL TRACK CROSSOVER

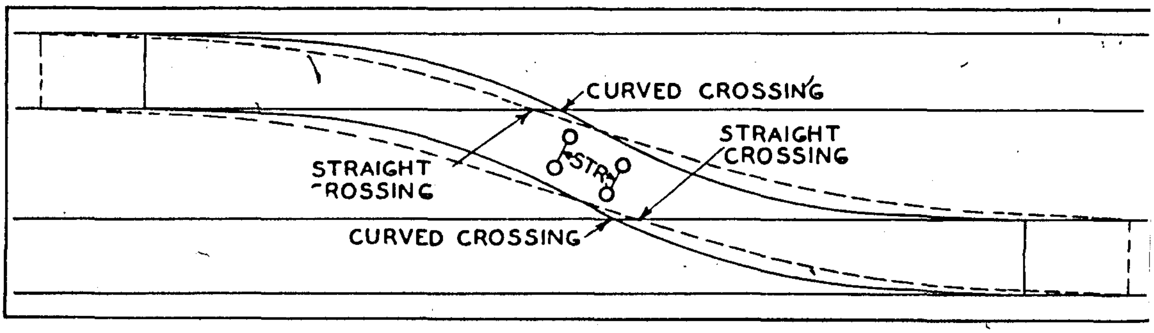


FIG.19. COMPARATIVE LENGTHS OF CROSSOVERS

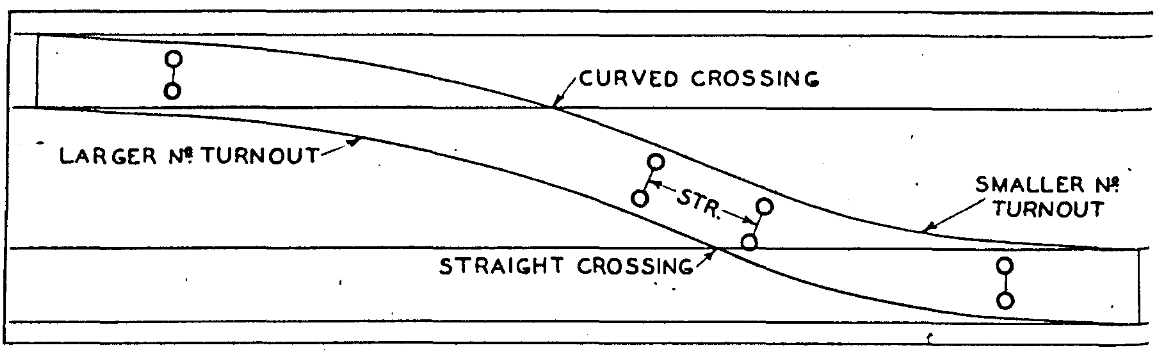


FIG.20. CROSSOVER USING TURNOUTS OF DIFFERENT NUMBER

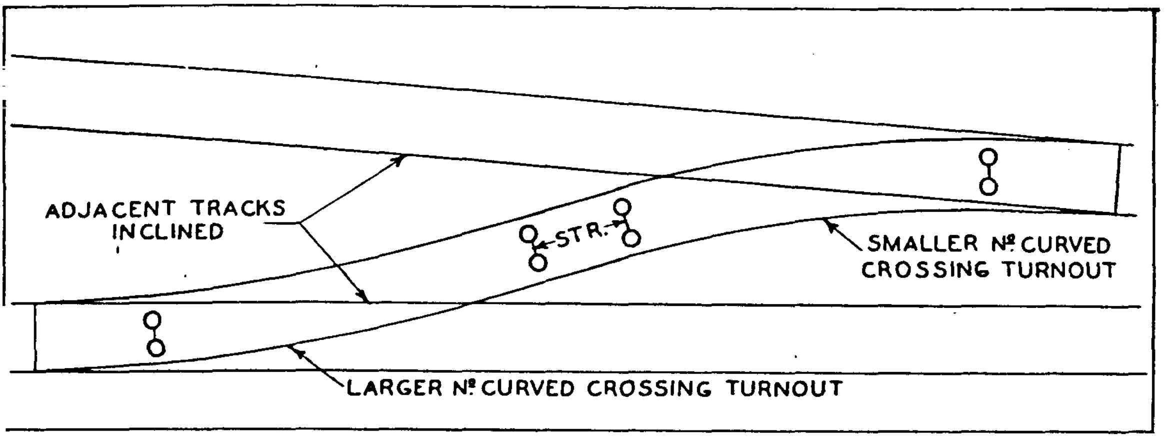


FIG. 21. CROSSOVER BETWEEN ADJACENT INCLINED TRACKS

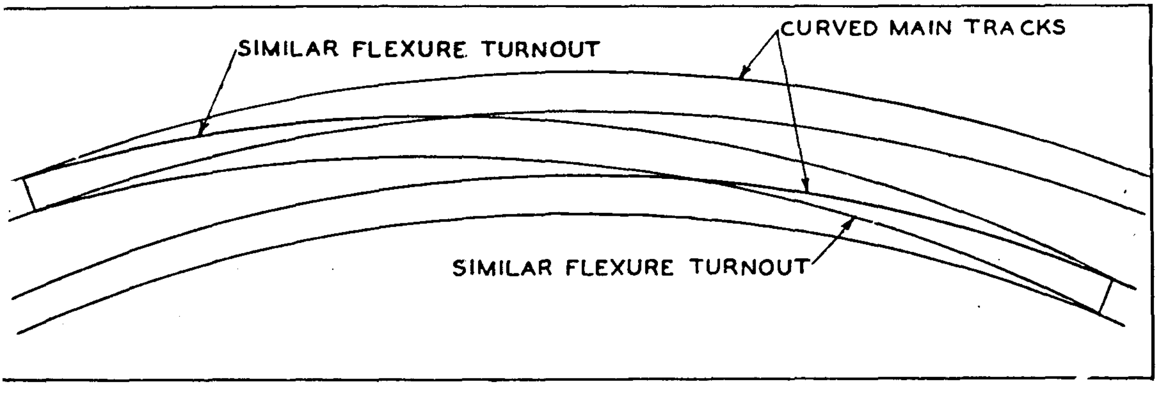


FIG. 22. CROSSOVER USING SIMILAR FLEXURE TURNOUTS

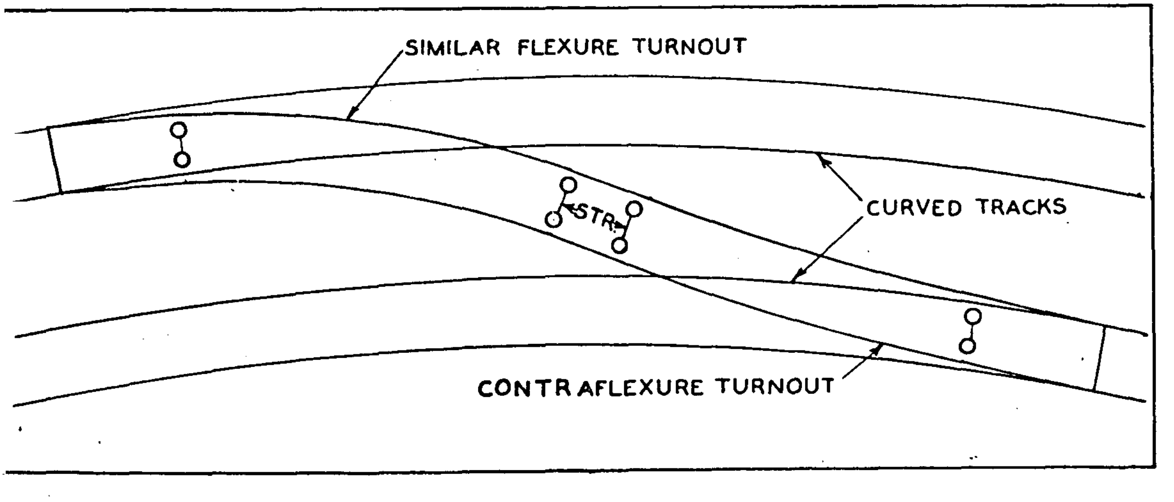


FIG. 23. CROSSOVER USING CONTRA & SIMILAR FLEXURE TURNOUTS

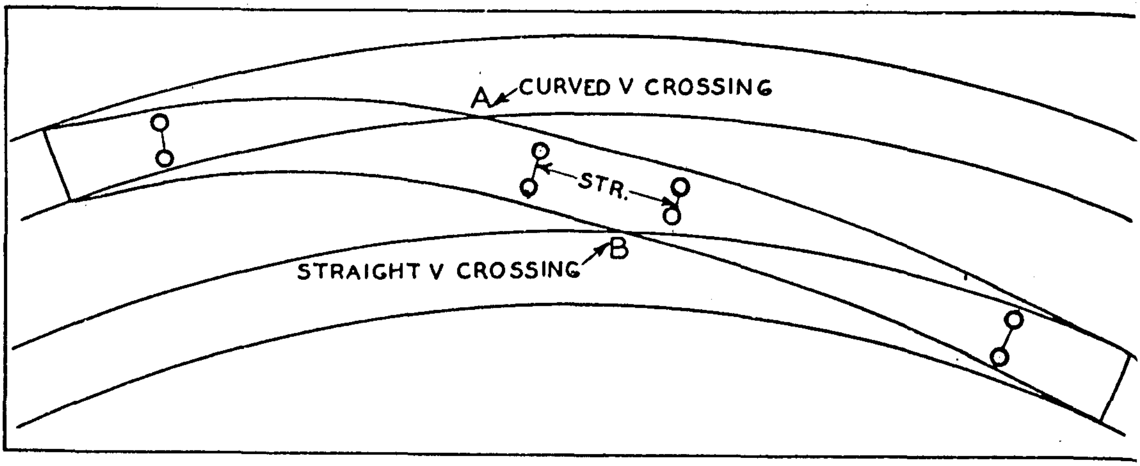


Fig. 24. Similar Flexure Crossover

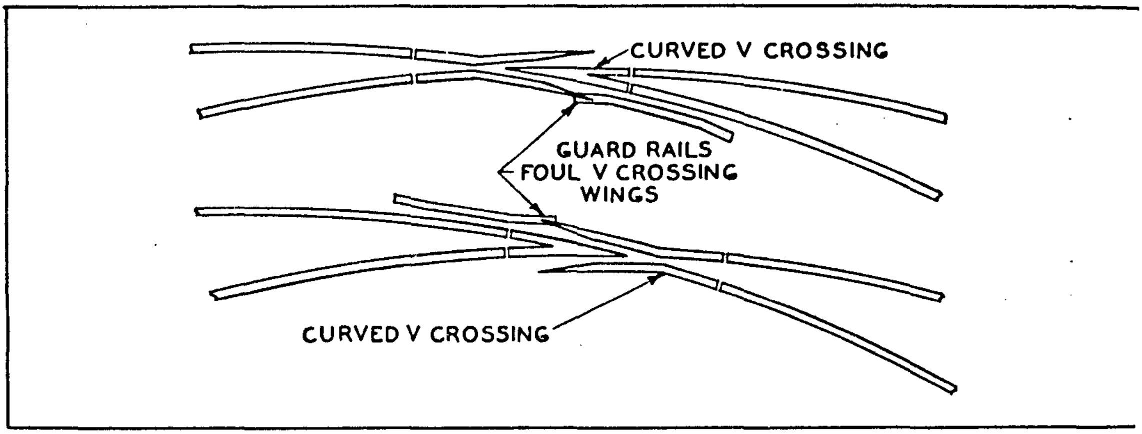


Fig. 25. Condition with Standard Guard Rails

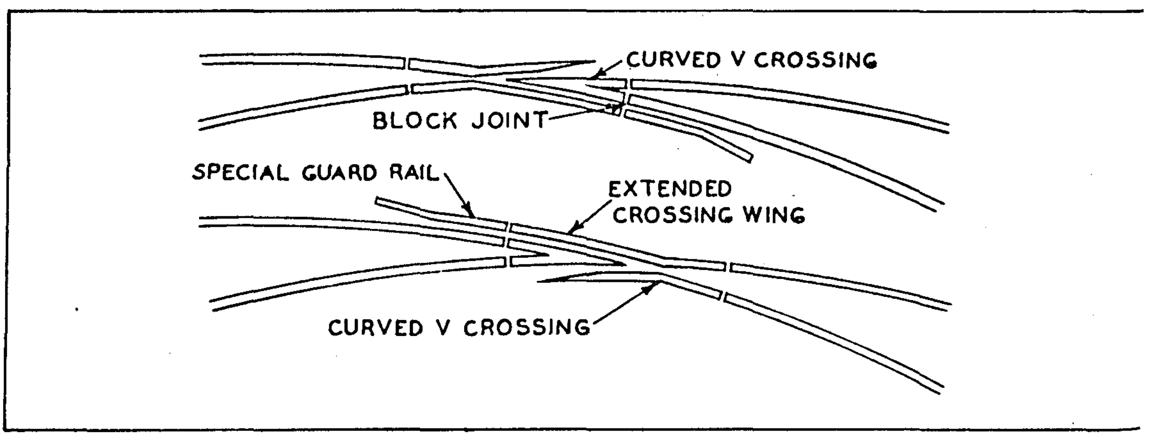


Fig. 26. Condition with Special Guard Rails

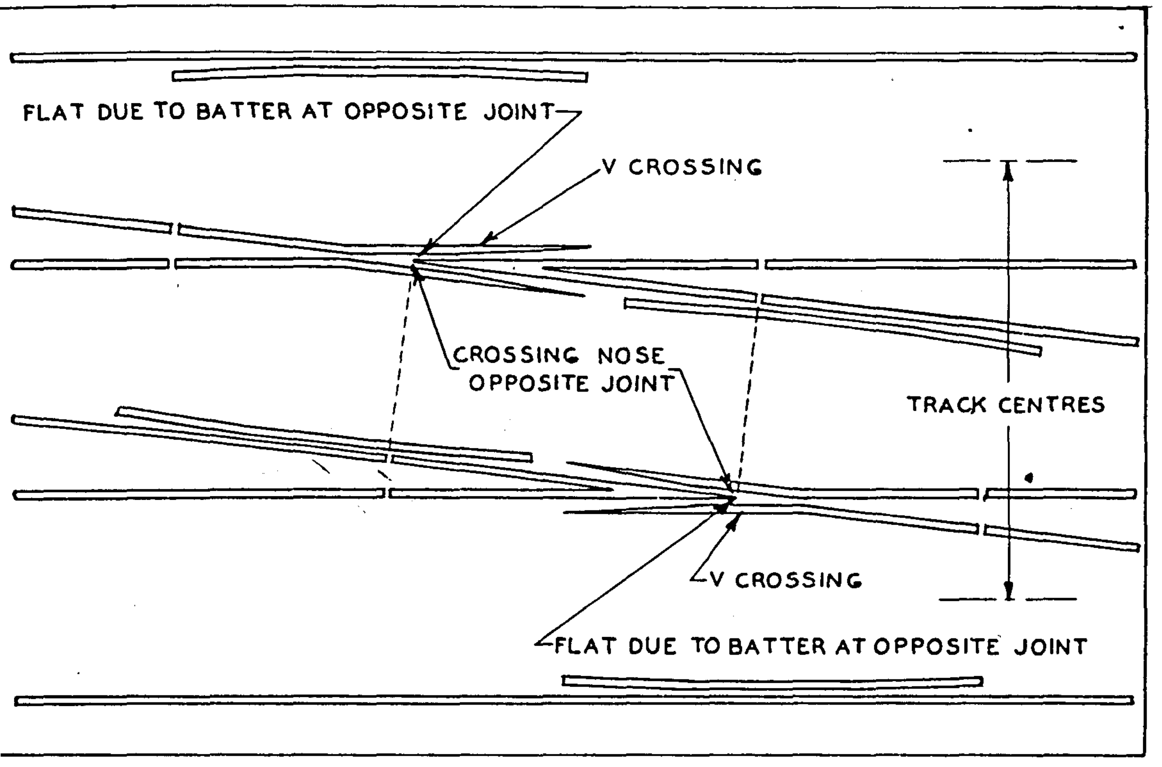


FIG. 27. JOINT EFFECT CONDITION IN A CROSSOVER

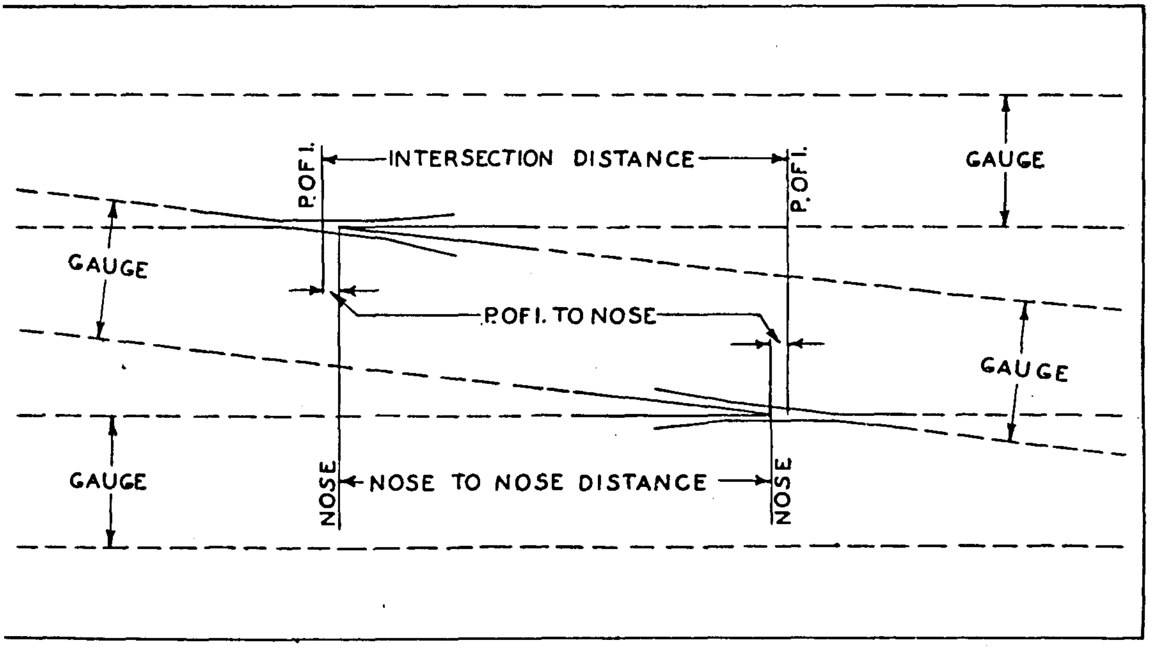


FIG. 28. DIMENSIONS GOVERNING ACCURATE CROSSING LOCATION

DIAMONDS

GENERAL

The diamond consists of four crossings, two 'V' crossings, two 'K' crossings and two pair of guard rails, with or without closure rails, arranged for cross track movements.

In diamonds of small Nos. the guard wing rails of the 'K' crossings are frequently extended to joint with special 'V' crossings and the arrangement is described as double rail construction. See Fig. 29.

Diamonds of medium Nos. require the running wings of the 'V' and 'K' crossings to be lengthened for jointing purposes, as shown in Fig. 30.

In diamonds of large Nos. the lengths of the 'V' and 'K' crossings if extended for joint purposes would be much too long for handling and transport; short closures are therefore provided to join with crossings of suitable length, as shown in Fig. 31.

Very short closures are a bad feature of trackwork and to provide a reasonable length of closure it is frequently necessary to shorten the wings of the crossings in diamonds of intermediate Nos.

There are many kinds of diamonds depending on various combinations of straight and curved tracks, examples of which are shown in Figs. 32, 33 and 34.

SYMETRICAL DIAMONDS

Symetrical diamonds in which 'K' crossings of large No. are located opposite to each other are a constant source of danger in that the gap between the knuckle and the nose exceeds the length of the wheel flange below the running surface of the crossing and a lateral slip of a wheel in this position would result in derailment.

The danger of derailment is greater with curved 'K' crossings than with straight 'K' crossings because the rolling path of the wheels on curves is at a slight angle to the crossings and the natural tendency is for the wheels to roll into the crossing gap.

As the length of the gaps increase with the No. of the crossings, safe practice requires that limits be fixed for the No. of the 'K' crossings which may be used under various conditions. See 13.028.

The hazard of derailments at 'K' crossings of medium Nos. on straight tracks is reduced by laying the 'K' crossings tight to gauge. The effect of laying 'K' crossings tight to gauge is to steady the lateral movement of wheels and give them a definite direction before they enter the gaps.

Tightening the gauge also reduces the severity of the blows from wheel backs engaging the guard side of dummy nose rails. This condition is much in evidence with 'K' crossings as used in 60, 80, 90, 100 and 110 lb. matèrials as shown in Fig. 35.

In the 94 and 107 lb. 'K' crossings the short flared guard wings are provided to gradually engage the wheel backs and reduce the severity of the blows; this arrangement is shown in Fig. 36.

The present practice is to lay 'K' crossings of standard Nos. ¼" tight to gauge. When a diamond is of small No. and the 'V' and 'K' crossings abut, it is not possible, without mechanically distorting the crossings, to lay the 'K' crossings to other than exact gauge.

The gap in 'K' crossings of small No. is short and no good purpose is achieved by laying such crossings tight to gauge. The standard guard distance of 4'11½" is lost when 'K' crossings with 1¾" flangeways are laid tight to gauge.

Diamonds of very small No. are sometimes provided with short easer rails to reduce the guttering of the wing rails where the wheel treads cross the gaps. The arrangement is shown in Fig. 37. See 14.069.

SQUARE DIAMONDS

When the tracks cross at right angles all four crossings are of the same construction and the distinction between 'V' and 'K' crossings does not exist. See Fig. 38.

Diamonds closely approaching the right angle are only possible with expensive floored crossings in which the wheel flanges roll on special hardened steel blocks in the flangeways. This construction is a necessity as the width of wheel treads is insufficient to bridge the flangeway in the vicinity of the nose. See 14.068.

Right angle or square crossings are avoided wherever possible as, owing to the flangeway gaps being opposite to each other and at right angles to the direction of traffic, the impact of the wheels is very severe unless floored crossings are provided.

Scarfed crossings cannot be constructed for crossing Nos. approaching the right angle and special knee block construction is required.

JOINT POSITIONS

The presence of insulated joints in diamond layouts and the arrangement of timbers for joint support have an important bearing on the design of diamonds, and if neglected may result in very unsatisfactory trackwork conditions.

As a general guide to the crossing arrangements required for diamonds according to Nos. the following table is appended. Modifications are necessary where the diamond forms part of a combined trackwork layout or when the diamond is curved and flangeways widened.

Type of Diamond	Suitable Crossing No. $1\frac{3}{4}$" Flangeways.
Straight track.	No. 8 and smaller
Combinations of straight and curved tracks. ..	" 6 " "
Combinations of curved tracks. ..	" 6 " "
Straight track with abutting crossings.	" 4 to No. 2
Straight track with double rail construction.	" 2 and smaller
Scarf crossing construction. ..	1.75 " larger
Easer rail construction. ..	1.75 to 3.00
Knee block construction. ..	1.74 and smaller
Special floored construction. ..	1.85 " "

UNSYMETRICAL DIAMONDS

Unsymetrical diamonds in straight trackwork occur when tracks of different gauge intersect as with 5'3" and 4'8½" gauges, and in these cases, owing to the different flangeways required, it is imperative that special crossings designed for the particular layout be laid strictly to the detailed plans provided.

Crossings with standard flangeways are frequently quite unsuitable for this work and although actual derailments may not be caused, the crossing work will be badly worn and the layout will be distorted.

All attempts to pull such crossing work to the original alignment will result in undue wear and distortion at some other part of the layout, and the only satisfactory remedy is replacement with crossings designed for the conditions obtaining.

Examples of unsymetrical diamonds in use in the Wodonga area are shown in Figs. 39 to 41.

Unsymetrical diamonds occur on similar gauge tracks where curved and straight tracks intersect and particularly at the intersection of curved and reverse curved tracks.

CURVED DIAMONDS

In reverse curved tracks it is essential for locomotive reasons to provide 11'8" of straight track between the $1\frac{3}{4}$" flangeways of guard wings and guard rails as is the case in crossovers. See 13.015.

In curved diamonds the width of flangeways, having regard to radius, adjacent trackwork and the wheel arrangement of locomotives, necessitates careful design, and frequently only special crossings will give the necessary freedom of movement to prevent distortion of track.

Excessive widening of crossing flangeways for radius reasons necessitates the use of floored construction in crossings independent of the crossing No.

Examples of unsymetrical curved and reverse curved diamonds are shown in Figs. 42, 43, & 44 and of a double reversed curve diamond in Fig. 45.

TRACK CENTRES

It is of the utmost importance that the track centres shall be definitely known before the design of any closely connected crossing work is undertaken, and that the layouts be installed strictly in accordance with the intended track centres and to the required intersection distances.

Trackmen should disabuse their minds of any impression that a shift of an inch or so in track centres does not matter; such shifts have a very real influence on intersection distances unless resort is made to gauge alterations.

The inevitable results from gauge alterations are that some crossings will be subjected to heavy wheel blows with rapid wear and distortion, crossing and guard rail bolts will be broken and the hazard of derailment be increased.

Differences in track centres likewise influence the required length of crossings and closure rails connecting with adjacent tracks, and diamond crossovers cannot be designed to abut other work unless the track centres are fixed and worked to with certainty.

INTERSECTION DISTANCES

The intersection distances for diamond crossovers in straight trackwork are always considered along the rail from P. of I. to P. of I., but for convenience in the field the dimensions in 94 and 107 lb. trackwork are given on the plans from the nose of the 'V' crossings to the centre punch mark on the knuckle of the 'K' crossings.

ALIGNMENT

Unless permanent monuments are established to fix the position of curved diamonds, considerable difficulties may arise in maintaining the trackwork to proper alignment.

Movement of the trackwork and distortion of the gauge are common occurrences and for maintenance reasons it is desirable that one track through the diamond should, wherever practicable, be straight.

GAUGE

Wear between the parts of the crossings and distortion of the crossings by traffic, or when spiking, will frequently make the gauging of diamonds in service difficult to perform. In such cases the crossings should be gauged about their centre portions as shown in Fig. 46, and the gauge between the crossings be adjusted to line with the crossings.

It is both useless and dangerous to pull and spike the legs of a diamond to exact gauge when by so doing the gauge about the central portion of the crossing work is adversely affected.

SURFACE

In curved diamonds, if cant is applied, any cant runout should not exceed 5/16" in 25', owing to the 3/16" drop at the noses of the crossings. If this precaution is neglected the danger of mounting at the noses of the crossings will be considerably increased.

EXTENDED GUARD RAILS

The tendency for leading wheels to crowd the outer rail and trailing wheels to run clear of the outer rail increases the angle of approach, and the drop across the crossing gap tends to cause oscillation.

Under these conditions it is necessary, according to crossing No., radii of curvature and direction of traffic, to provide extended guard rails to control the direction of wheels about to engage the noses of the 'K' crossings. The design of these guard rails and their location relative to the crossings are also dependent on the class of vehicles in running.

It is, therefore, of considerable importance that extended guard rails be installed and maintained in their intended positions and to the required flangeways as shown on the drawings prepared by the Mechanical Trackwork Section and issued for the information of trackmen.

LOCATION PEGS

When diamond crossings are being renewed under traffic conditions, it is not always practicable to lay out the work to intersection distances and obtain alignment with the existing trackwork.

To establish the correct position for the new crossings, pegs are placed by surveyors as shown in Figs. 47 and 48. Recovery pegs, marked R.P. in the Figs., are provided to re-establish the position of intersection pegs subject to disturbance during the course of the work.

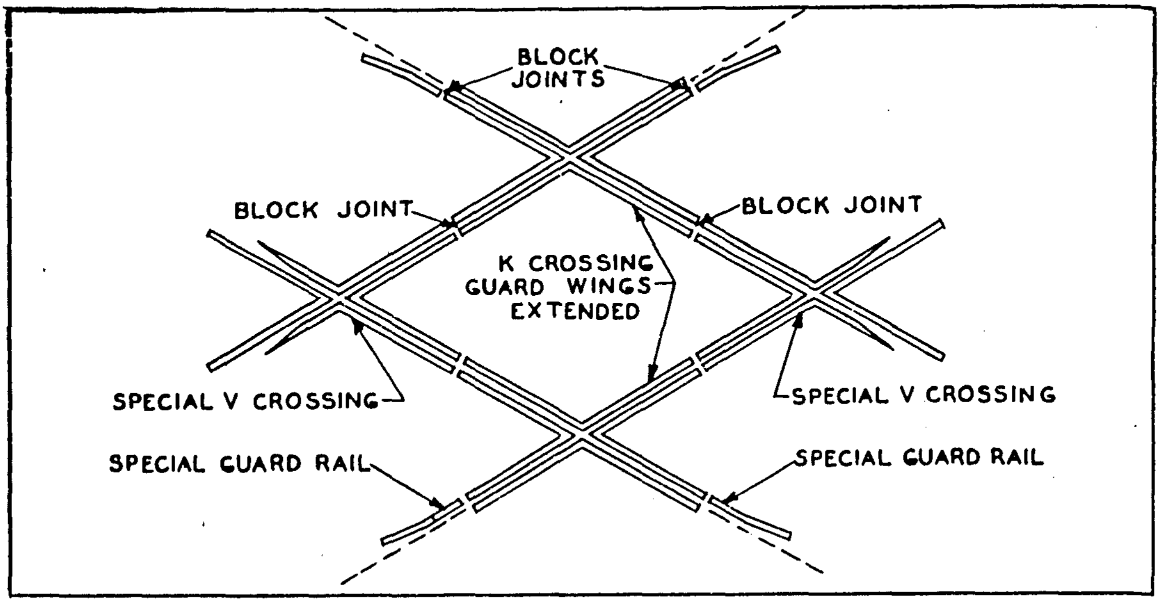


FIG. 29. THE SMALL NO. DIAMOND

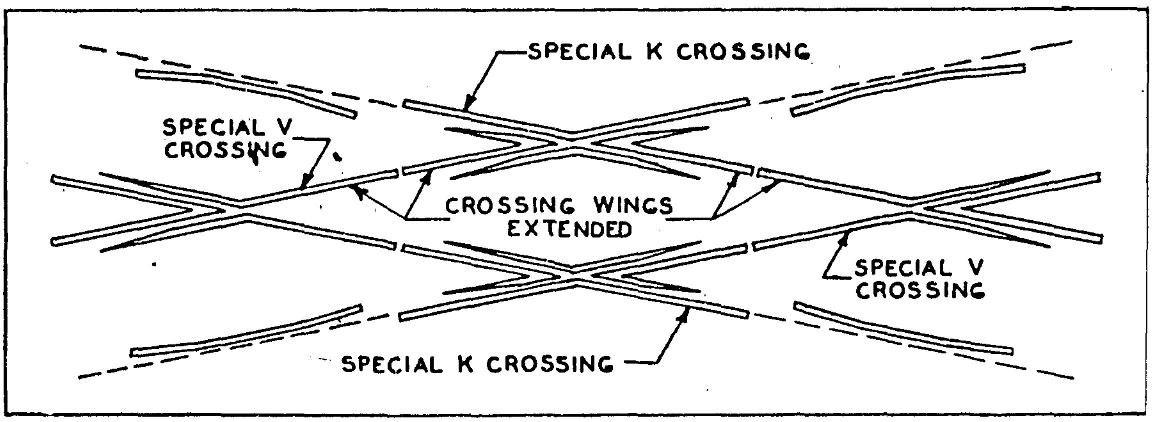


FIG. 30. THE MEDIUM NO. DIAMOND

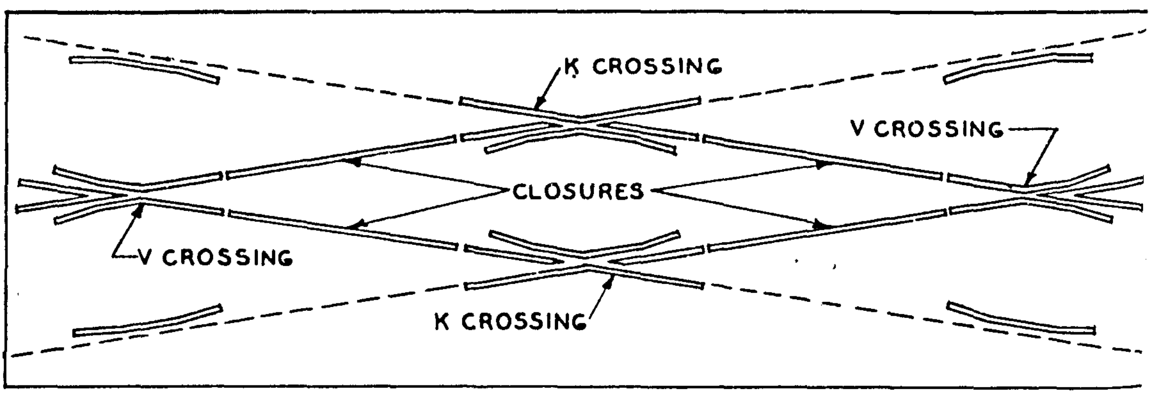


FIG. 31. THE LARGE NO. DIAMOND

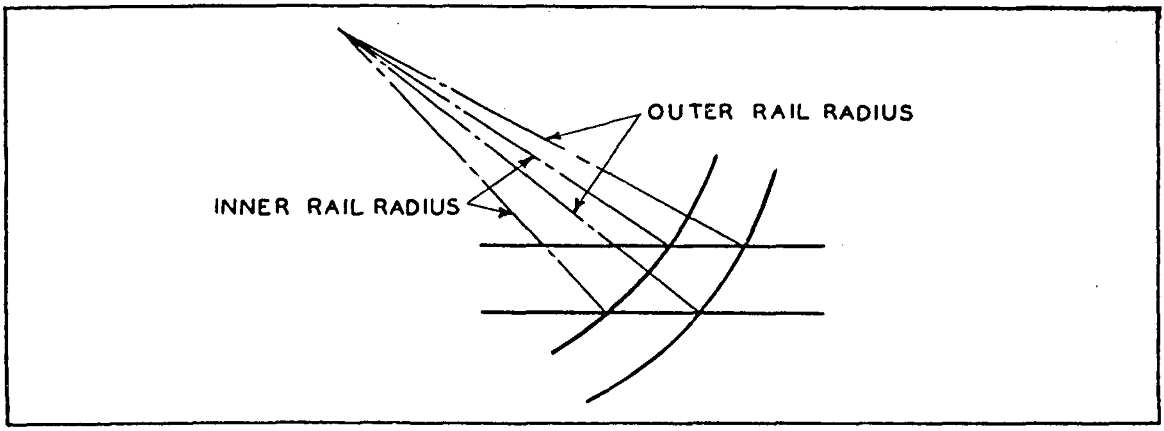


FIG. 32. DIAMOND WITH ONE TRACK CURVED

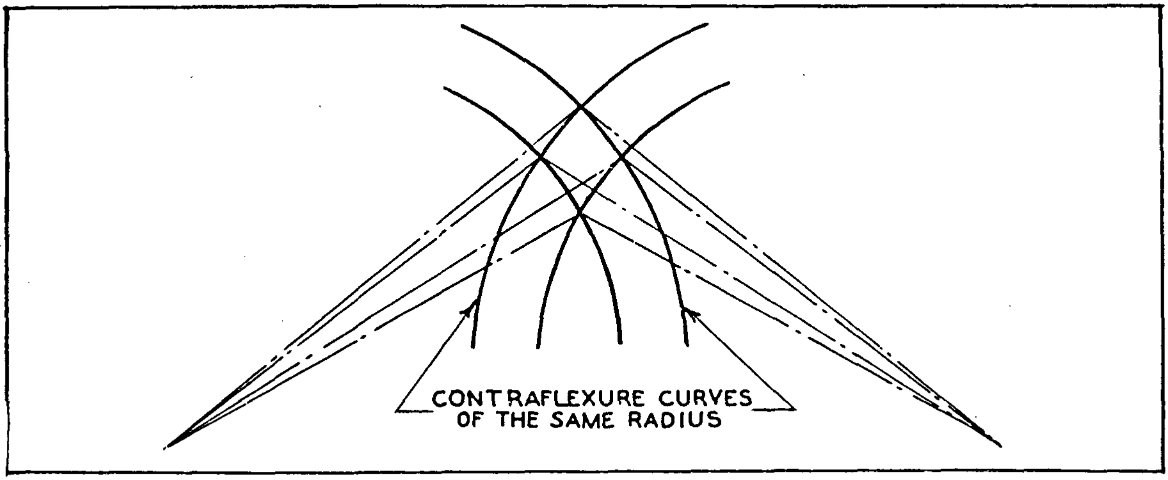


FIG. 33. THE SYMETRICAL CONTRAFLEXURE DIAMOND

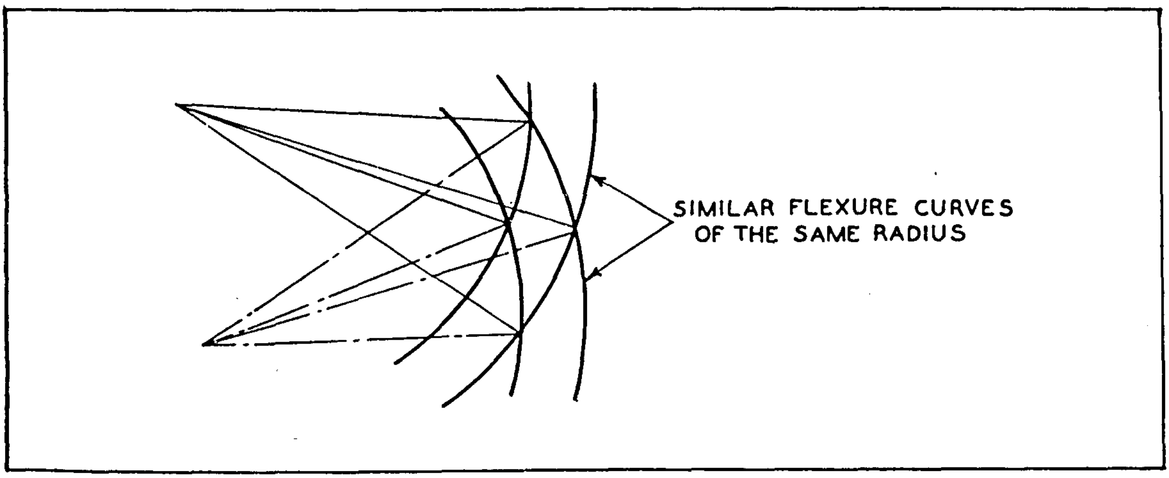


FIG. 34. THE SYMETRICAL SIMILAR FLEXURE DIAMOND

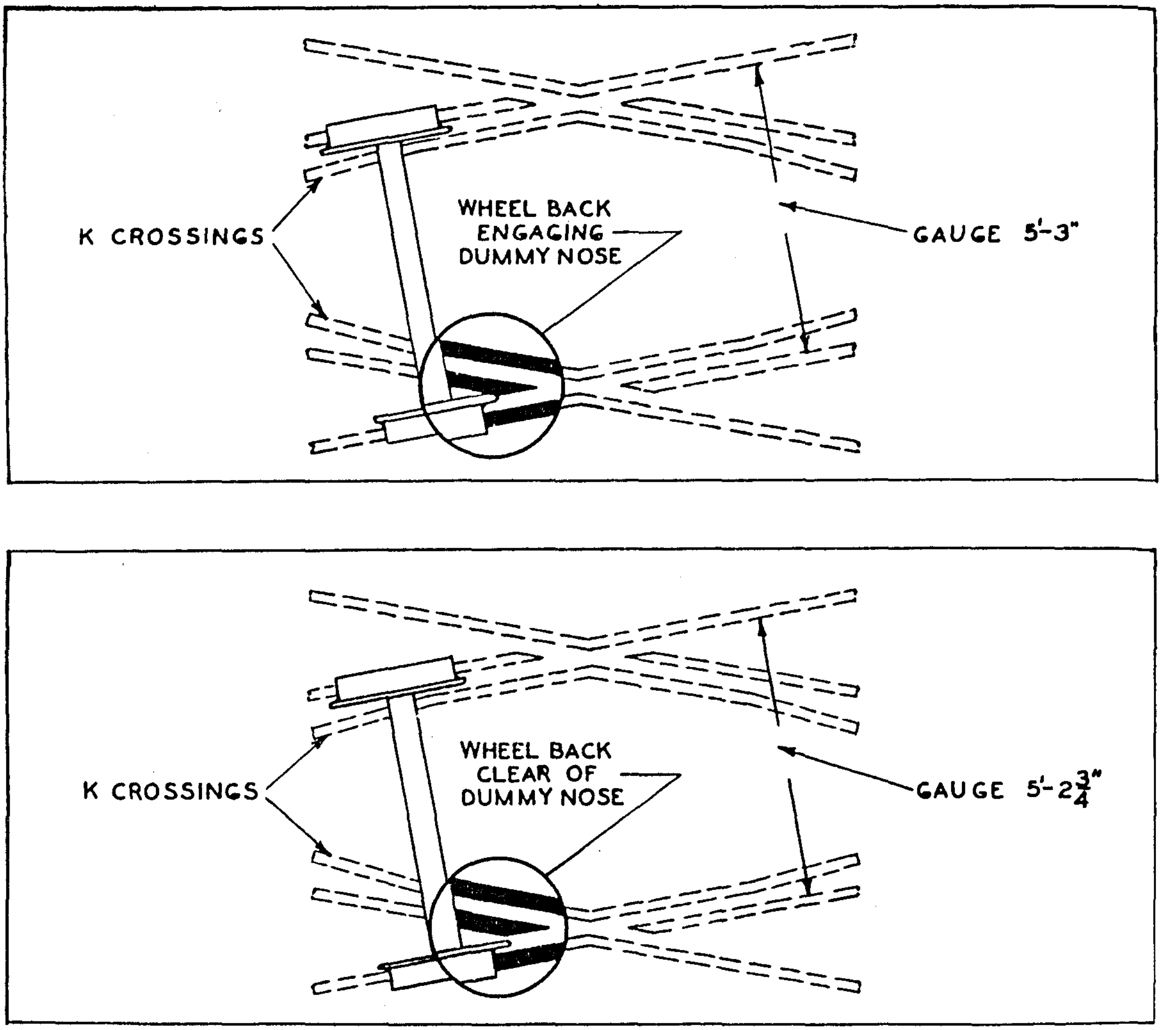


FIG. 35. WHEEL POSITION RELATIVE TO DUMMY NOSE

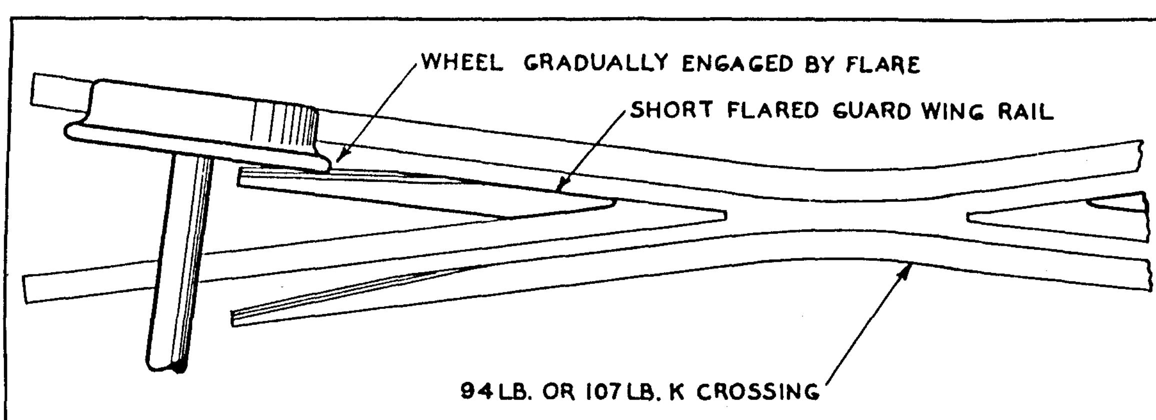


FIG. 36. WHEEL SHOWN ENGAGING FLARED GUARD WING

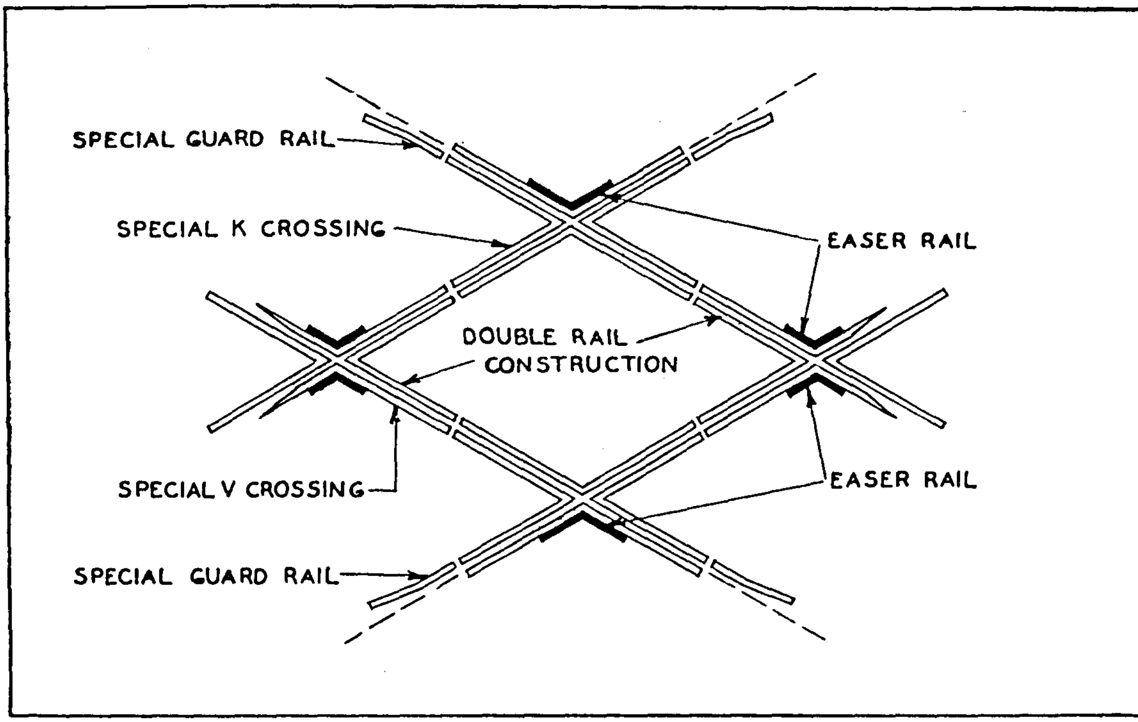


FIG. 37. POSITIONS OF EASER RAILS IN A DIAMOND

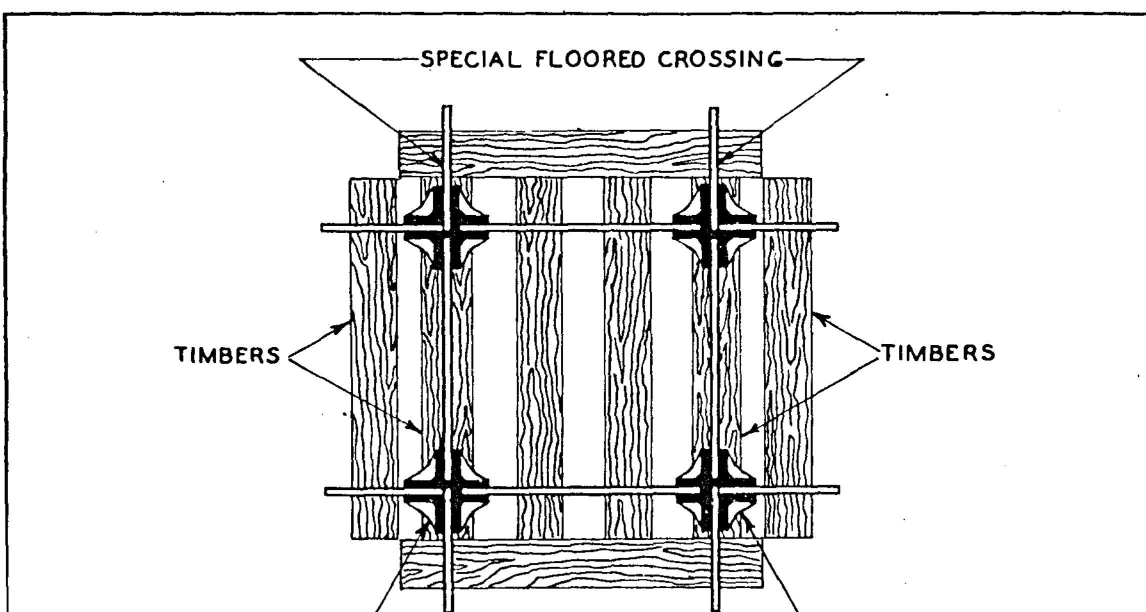


FIG. 38. THE SQUARE OR RIGHT ANGLE DIAMOND

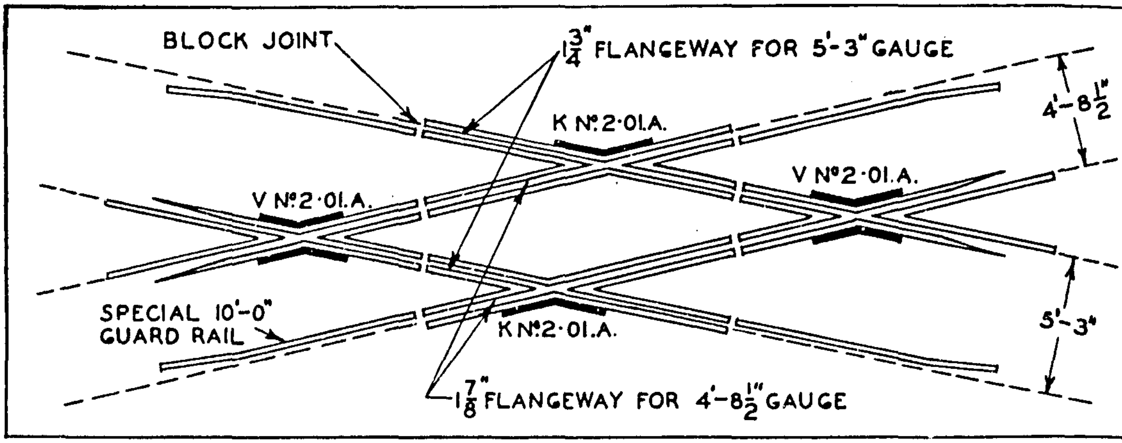


FIG. 39. NO. 2·01.A. MIXED GAUGE DIAMOND. WODONGA AREA.

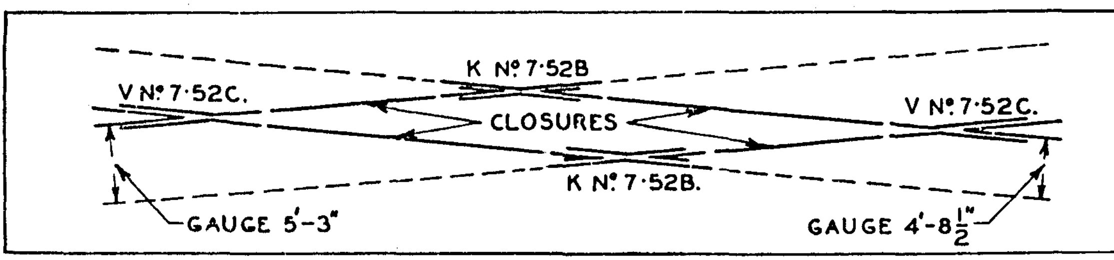


FIG. 40. NO. 7·52.B. MIXED GAUGE DIAMOND. WODONGA AREA.

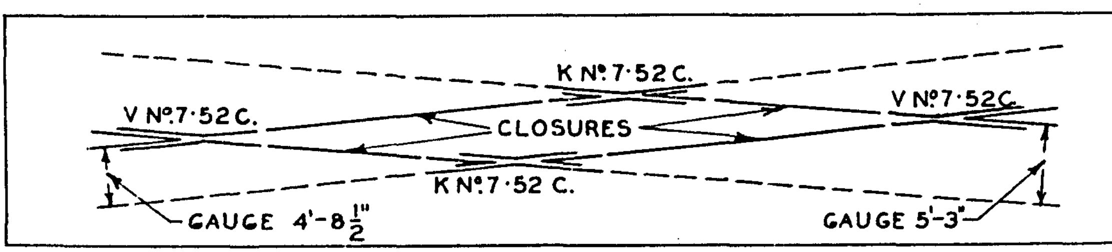


FIG. 41. NO. 7·52.C. MIXED GAUGE DIAMOND. WODONGA AREA.

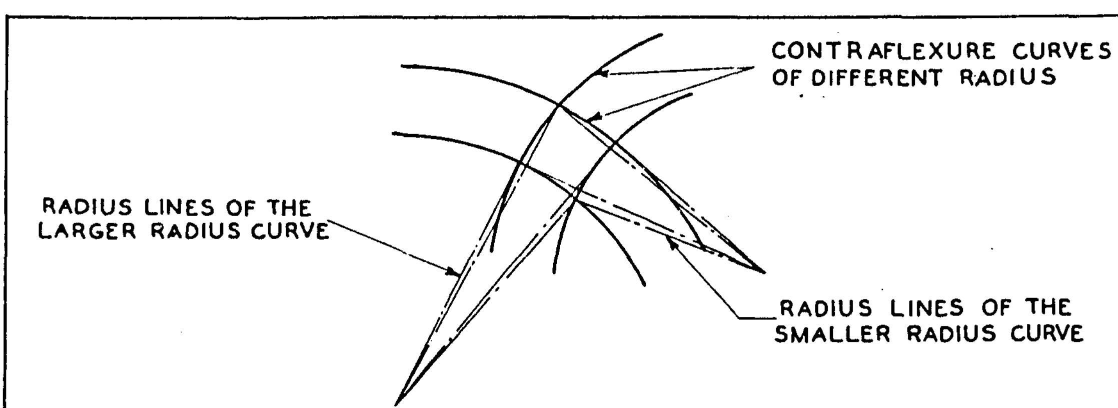


FIG. 42. THE UNSYMETRICAL CONTRAFLEXURE DIAMOND

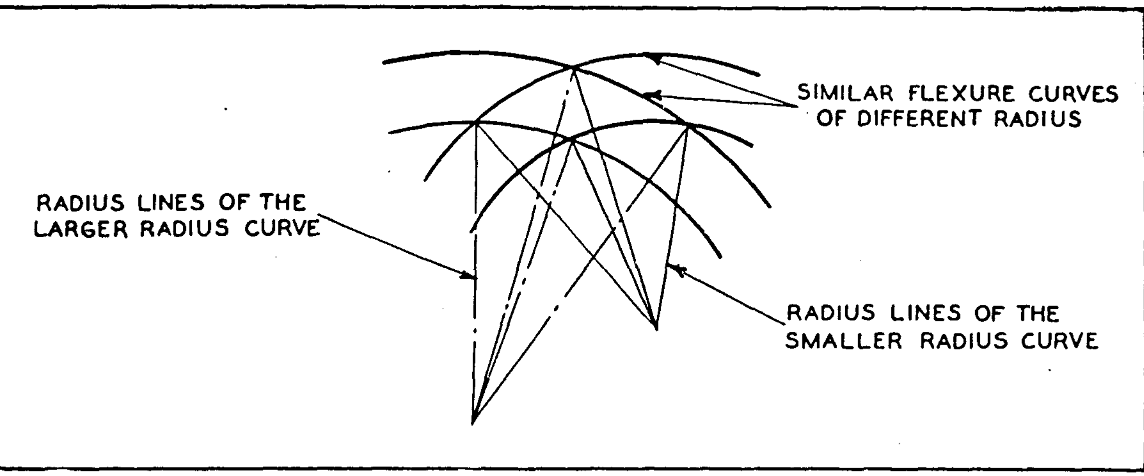


FIG. 43. THE UNSYMETRICAL SIMILAR FLEXURE DIAMOND

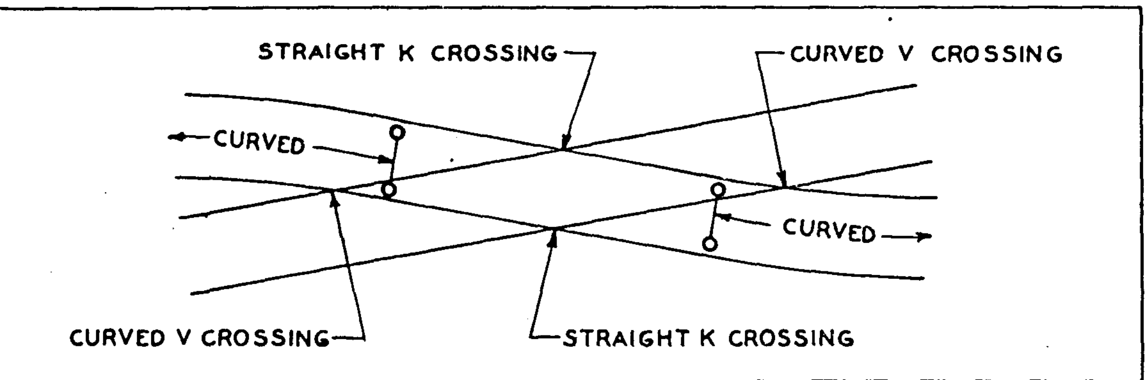


FIG. 44. THE REVERSE CURVED DIAMOND

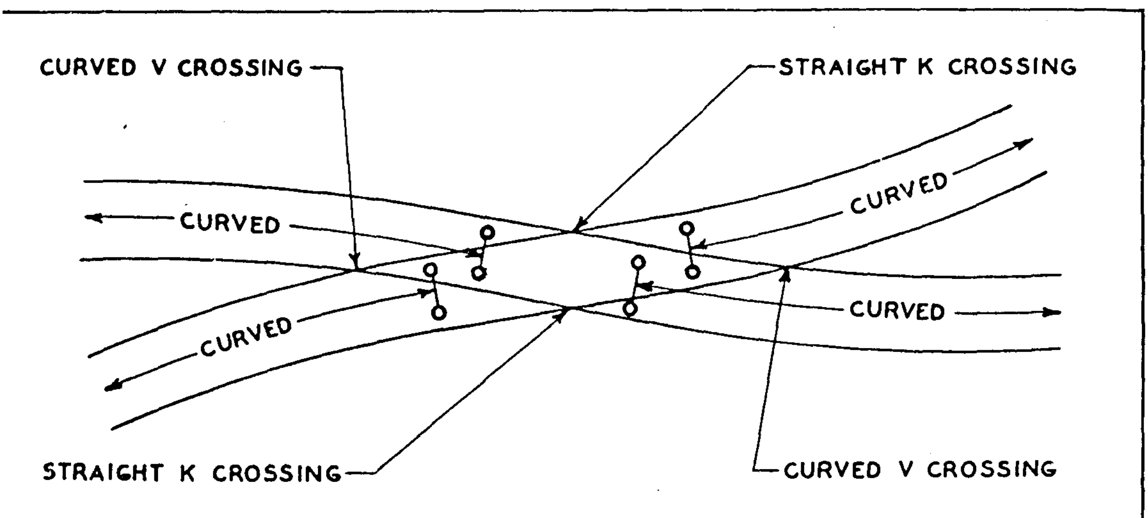


FIG. 45. THE DOUBLE REVERSE CURVED DIAMOND

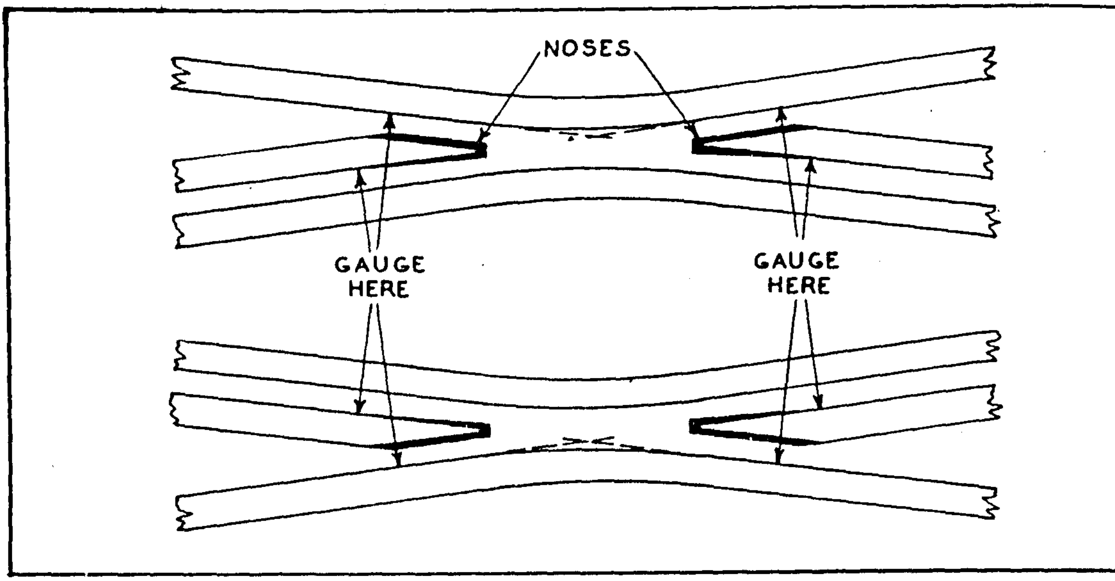


FIG. 46. K CROSSINGS SHOWING POSITIONS OF GAUGING

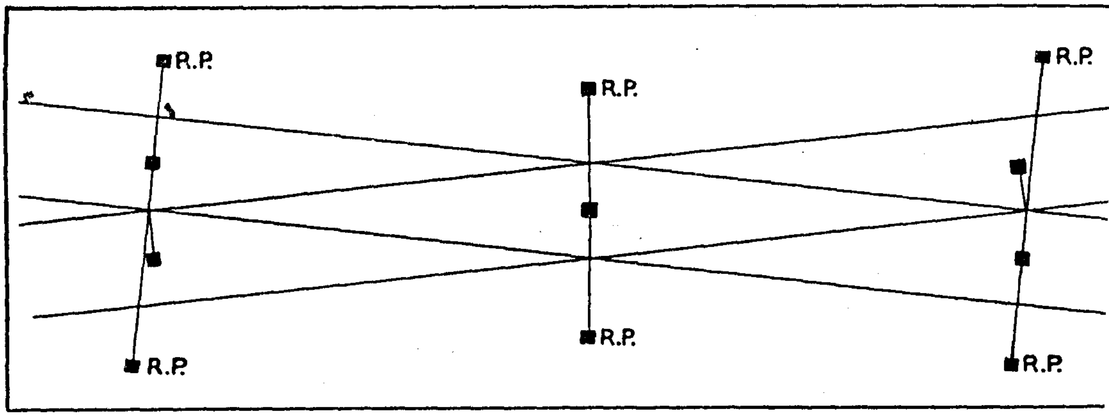


FIG. 47. LOCATION PEGS FOR LAYING IN SYMETRICAL DIAMONDS

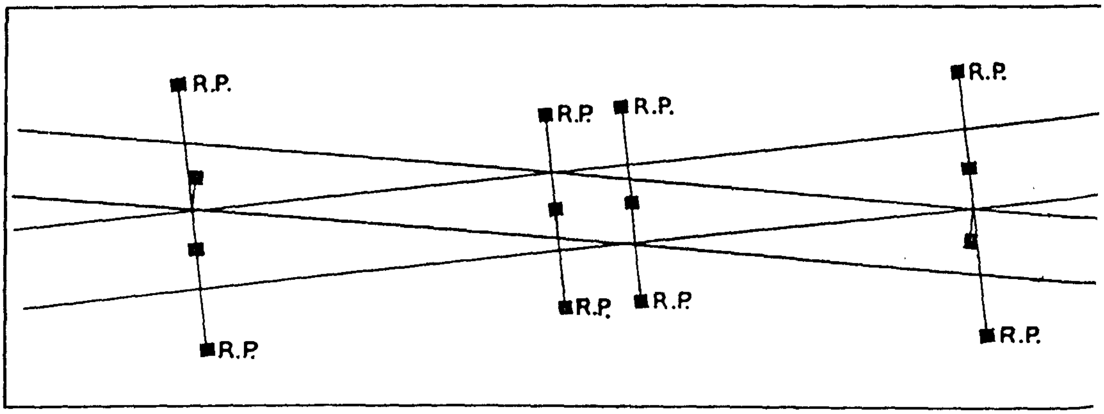


FIG. 48. LOCATION PEGS FOR LAYING IN UNSYMETRICAL DIAMONDS

COMPOUNDS

GENERAL

COMPOUNDS or SLIPS are a combination of a diamond crossover and points connecting the intersecting tracks within the intersection distances of the diamond, and may provide for one or two slip movements.

Standard compounds are arranged within diamonds of the standard Nos. 7.52, 8.7, and 9.73. A few special No. compounds have been made for difficult locations.

Double compounds require four sets of special points within the diamond, and the necessary closures. The arrangement is shown in outline in Fig. 49.

Single compounds require two sets of special points within the diamond, and the necessary closures. This arrangement is shown in outline in Fig. 50.

The compound is a convenient trackwork arrangement for use in yards and sidings where space is limited and complex traffic movements are required. It is not a desirable main track layout because radius considerations conflict with 'K' crossing requirements.

If a small No. 'K' crossing is used for safety and better riding qualities, as in diamonds, then the radius of the slips is considerably reduced.

Being a combination of points, 'V' crossings, 'K' crossings and guard rails, closely interconnected, the compound embodies all their imperfections in one compact layout without the necessary intervening trackwork to allow for gauge and running surface adjustments.

The practice now is to replace compounds in main tracks by turnouts and crossovers. In some instances this cannot be done without major alterations and No. 8.7 compounds are installed as this No. combines reasonable radius with fairly satisfactory 'K' crossing conditions.

OLD STANDARD COMPOUNDS

The 'V' crossings formerly used in compounds were common to other layouts, and in insulated compounds standard guard rails were frequently shortened to enable their installation clear of the insulated joints. Alternatively the guard rails were extended and provided with twin insulated joints. This arrangement was costly and unsatisfactory as the guard rail setting could not be adjusted for wear.

The standard 'K' crossings made prior to 1941 were very short, and to connect with the points in compounds short closures, which were difficult to maintain in line and surface, were required. The short dummy noses were frequently severely damaged and rapidly worn away by the impact of wheel backs, and the running edges of the opposite 'K' crossings were exposed to severe wear.

It was the practice prior to 1938 to regard the slip curves as regular curves tangent to the through tracks at the P. of I. of the 'V' crossings, as shown in Fig. 51.

Switches of the lengths common to turnouts of the same No. were used in the compounds, with the heels located in the position where it was calculated the slip curves diverged from the through tracks by 5¾". The slip curve was located either : -

(a) By eye, or

(b) By a middle offset of 1/4 the gauge or 1'3¾" measured at the knuckles of the 'K' crossings, and applicable to the No. 7.52, 8.7, and 9.73 compounds.

In many instances, owing to the plated construction of the early crossings, the closures had to be laid almost straight to enable the outside spikes to clear the crossing base plates.

The curves obtained by the above methods were not tangent to the switches, and in consequence there were four kinks in the short slip movement, two at the toes of the switches and two at the heels. See Fig. 52.

Owing to the length and position of the switches it was difficult to obtain the standard throw within the diamonds, particularly in heavy rail work.

The conditions of curvature were improved in the 90 and 110 lb. compounds, but as the points and crossings were required to be interchangeable with the earlier 80 and 100 lb. compounds, only minor alterations were made in the 1938 standard diagrams.

In electric signalled areas insulated joints are required at the toe end of compound stock rails according to traffic movements, and as most of the replacements in 90 and 110 lb. compounds were required in electric signalled sections, the 1938 standard diagrams were arranged with all set stock rails of the same length.

For yards and sidings not electrically signalled, long set stock rails similar to those used in 80 and 100 lb. compounds were provided to eliminate the short closure in compound crossover work laid to close track centres.

NEW STANDARD COMPOUNDS

With the introduction of 94 and 107 lb. rails, it became necessary to re-design the points and crossings, and as interchangeability of 107 lb. and 100 lb. rails was not practicable, the opportunity arose to completely re-design the compounds.

The Nos. 7.52 and 8.7 compounds shown on the 1942 standard diagrams for 94 and 107 lb. compounds, have been arranged as in Fig. 53 for double compounds, and Fig. 54 for single compounds. The following are the main features in these designs : -

(a) All set stock rails are supplied of the same length for general use in electric signalled locations, and the 1942 standard diagrams show this type of compound.

(b) Set stock rails of the required lengths to join with other trackwork layouts are specially made and stamped with the switch length and a distinguishing letter for ordering and identification purposes. See 14.002.

The length of special stock rails is usually limited to 45'0", and when practicable to use a standard stock rail with a closure of reasonable length, this is done.

Occasionally in complicated trackwork, for joints or other reasons, a stock rail is required longer than 45'0" and the required length is flash butt welded to a standard stock rail. The letter 'W' is stamped with the distinguishing letter on welded stock rails. Set stock rails which are unduly long are difficult to transport and handle without distortion.

(c) The toes of the points have been located to give the required freedom of movement for all existing and contemplated signal operating and detection gear, and to permit an increase of throw to 5" if required in connection with future locomotive wheel arrangements. See 14.007.

(d) To obtain the maximum regular radius through the slips with long switches, the points are curved from the intersection of rail heads as shown in Fig. 55. This necessitates an increase in the heel spread, which varies with the No. of the compound. See 14.008.

(e) The switches used in the slip movement are $\frac{1}{4}$" higher than their stock rails at the heels, and special $\frac{1}{4}$" sleeper plates are provided under the curved closure to maintain the track surface between the heels of the points. See Figs. 56 & 57. These switches are curved from the intersection of rail heads and their stock rails are straight.

(f) As the switches used in the through movement are fished direct to the 'K' crossings, an unsatisfactory condition exists when the switch is given $\frac{1}{4}$" heel rise, as the 'K' crossing is then lifted off the through timbers.

In the No. 7.52 compounds this condition is improved by the use of special lug plates, but this compound is used only in yards and sidings. See Fig. 57.

The 8.7 compounds are used in main tracks only where space is limited, and the switches for the through movement are level with the stock rails at the heels and in surface with the 'K' crossings. This is achieved by setting the switches down during manufacture, and special point chairs are provided to seat the switch at the required surface. A rise of $\frac{1}{4}$" is provided in the central portion of the switch to effect the transfer of guttered wheel treads. These switches are straight and their stock rails are curved. See 14.006.

(g) To gradually engage the backs of wheel flanges and direct their course through the gaps of the 'K' crossings, short flared guard wings are in-built during manufacture. The flangeways are arranged to give a cover clearance to the noses of the 'K' crossings; this is effected by reducing the flangeways of the guard wing. As the 'K' crossings are laid $\frac{1}{4}$" tight to gauge in compounds, the reduction in guard rail flangeways by $\frac{1}{8}$" has the effect of restoring the guard to guard distance to the standard 4'11$\frac{1}{2}$", at the same time providing $\frac{1}{8}$" cover to the noses of the 'K' crossing on their running edges. See 14.095, Fig. 100.

(h) The gap from the knuckle to the nose of 'K' crossings is unguarded, and if its length exceeds the length of the wheel flanges below the rail surface, there is a possibility of derailment if wheels at rest are jolted laterally by a sudden train movement. For a 3'6" dia. wheel and the ordinary form of 'K' crossing noses, the limit for absolute safety is reached with a No. 8.00 'K' crossing. To reduce the gap in the No. 8.7 'K' crossings, the nose is brought forward and is necessarily made sharper than in smaller No. 'K' crossings. See 14.068.

(i) As the radii of the curves in the slips have been reduced by the new method, the curved closures fit closely to the 'K' crossings, and the guard wings are machined to give the necessary clearance.

(j) The overall lengths of the compound 'K' crossings are arranged to fit to the heels of the compound points and the ends of the stock rails respectively. These 'K' crossings are special, and for ordering and identification purposes the letter 'A' is appended to the No. of the 'K' crossings, which is stamped accordingly on the right-hand end of the guard wing. See 14.070.

To enable accurate location of the 'K' crossings, punch marks are impressed on the running edge at the P. of I. See 14.095, Fig. 101.

(k) Special 'V' crossings slightly longer than standard 'V' crossings are required to locate insulated joints clear of the guard rails and fittings. These are distinguished by the letter 'A' appended to the 'V' crossing No. which is stamped on the right-hand wing of the 'V' crossing. See 14.070.

MOVABLE SWITCH 'K' CROSSINGS

The fixed nose rails of No. 9.73 'K' crossings cannot be extended far enough into the gaps to obviate the possibilities of derailment under adverse circumstances. If the nose rails are suitably shaped and made movable the gaps can be closed and a continuous running edge be established for either intersecting track according to the setting of the movable nose rails.

Movable nose rails operate in pairs, their form and arrangement being so similar to that of very short switches that the term movable switch 'K'has been applied to 'K' crossings of this type. See 14. 073.

Compounds in which the 'K' crossings are of the movable switch type are referred to as movable 'K' switch compounds. This arrangement is shown in Fig. 58

It is probable that for passenger movements, compounds above No. 8.7 will in future be of this type of construction, but the standard diagrams have not been issued.

COMPOUND CROSSOVERS

Compound crossovers are an arrangement of trackwork i which a crossover movement is made through one or more com pounds. The compounds may be all single, as in Fig. 59, al double, as in Fig. 60, or combinations of single and doubl compounds according to the movements desired.

As compound crossovers are usually situated in yards a sidings, the standard diagrams are arranged for 11'8" trac centres.

If the compounds are non-insulated the long stock rail connect to the 'V' crossing of the preceding compound an standard guard rail assemblies can be installed as shown i Fig. 61.

The presence of insulated joints necessitates the use o short guard rails specially prepared for the location. I 90 and 110 lb. trackwork the special guard rails are 9'0 long, but in 94 and 107 lb. trackwork, owing to the longer 'V crossings used in the compounds, the special guard rails ar 10'0" long. See 14.109, Fig. 108.

TRACK CENTRES

Mention has been made of the different lengths of stoc rails for insulated and non-insulated layouts designed fo 11'8" centres, but differences in track centres necessitat other lengths of stock rails. A difference of 1" in trac centres will alter the stock rail lengths from $7\frac{1}{2}$" to $9\frac{3}{4}$" ap proximately, according to the No. of the compounds.

Obviously the correct expansions at the joints will b entirely upset if the tracks are not laid precisely to th track centres for which the layouts have been manufactured The positions of joints and guard rail assemblies togethe with sleeper spacing are likewise affected by differences i track centres. See 13.082.

COMBINATIONS

Combinations of compounds with turnouts to form cross overs through the loops are frequently met with. The ar rangement shown in Fig. 62 has been much used in main li trackwork in the past for crossover and set back movements

It is now the practice to replace this arrangement by turnout and crossover as shown in Fig. 63 for the reaso and objections set out in respect to compounds. See 13.03

There are of course many other combinations of compounds with turnouts, three-throws and delta crossovers, some of which are illustrated in Figs. 64 to 66.

SURFACE

The surface of every compound must be on a continuous plane over the whole length of the compound, or in other words, there must be no change of grade within a compound.

If cant is applied to one straight track through a compound, due to an adjacent curve, the second straight track must follow the cant plane, and this condition is rarely possible.

Wind in the plane of a compound accentuates the inherent differences in cross levels due to switch crown and crossing gap transfer, and under these conditions the possibilities of derailment are increased.

Derailments are most likely with long wheel base rigid framed vehicles and particularly with locomotives and tenders and will, if the compound plane is irregular, occur by mounting at the nose of the 'K' crossings.

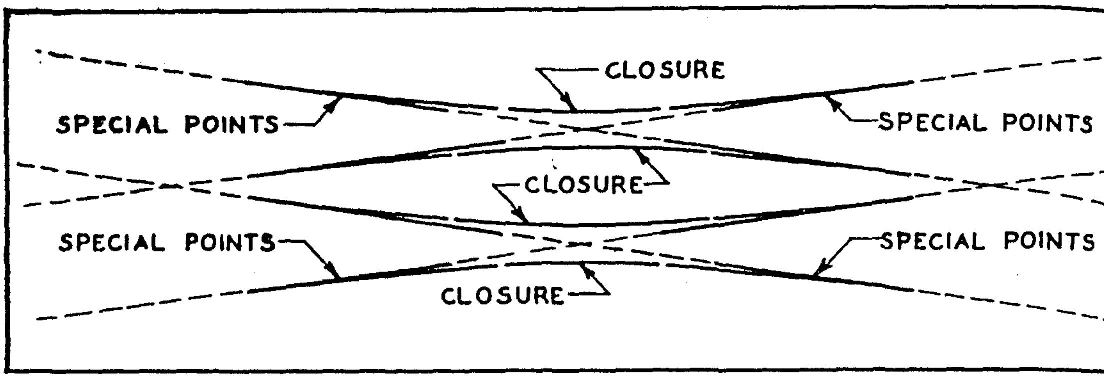


FIG. 49. DOUBLE COMPOUND. ARRANGEMENT OF POINTS AND CLOSURES

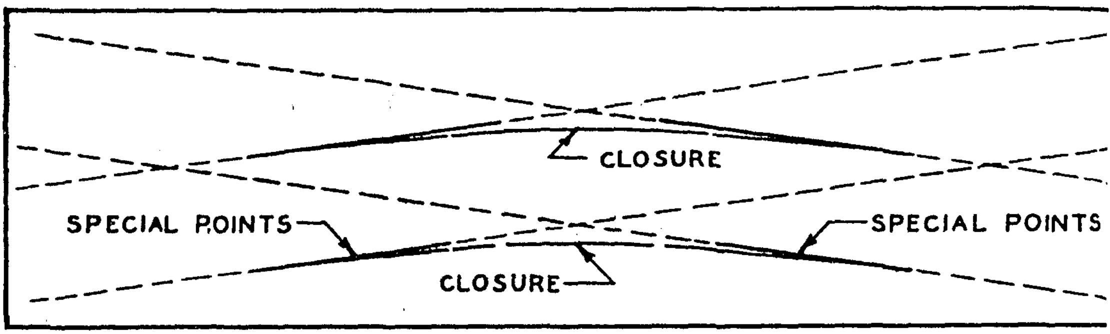


FIG. 50. SINGLE COMPOUND. ARRANGEMENT OF POINTS AND CLOSURES

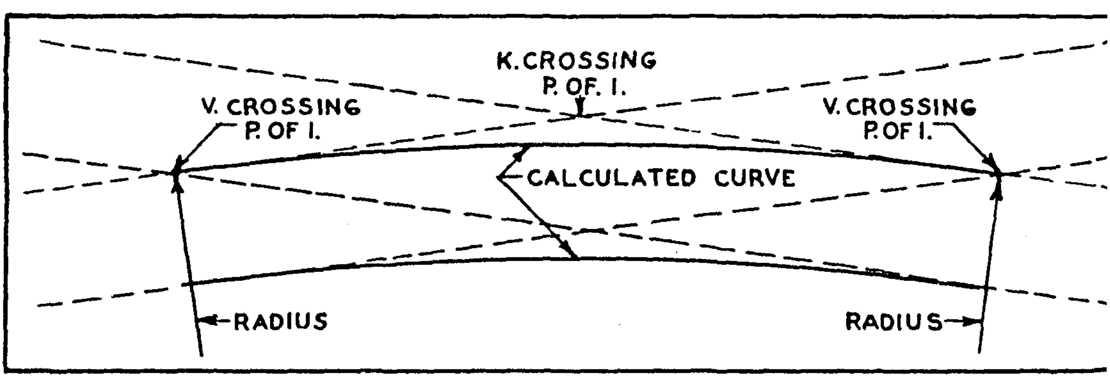


FIG. 51. OBSOLETE METHOD OF CONSIDERING SLIP CURVES

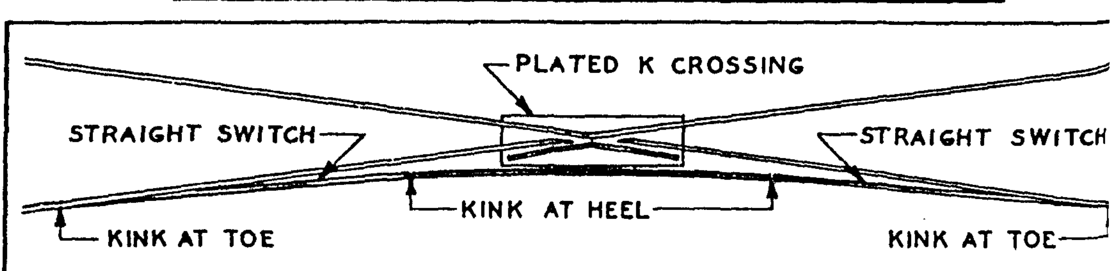


FIG. 52. EARLY COMPOUNDS. KINKS AT THE TOES AND HEELS

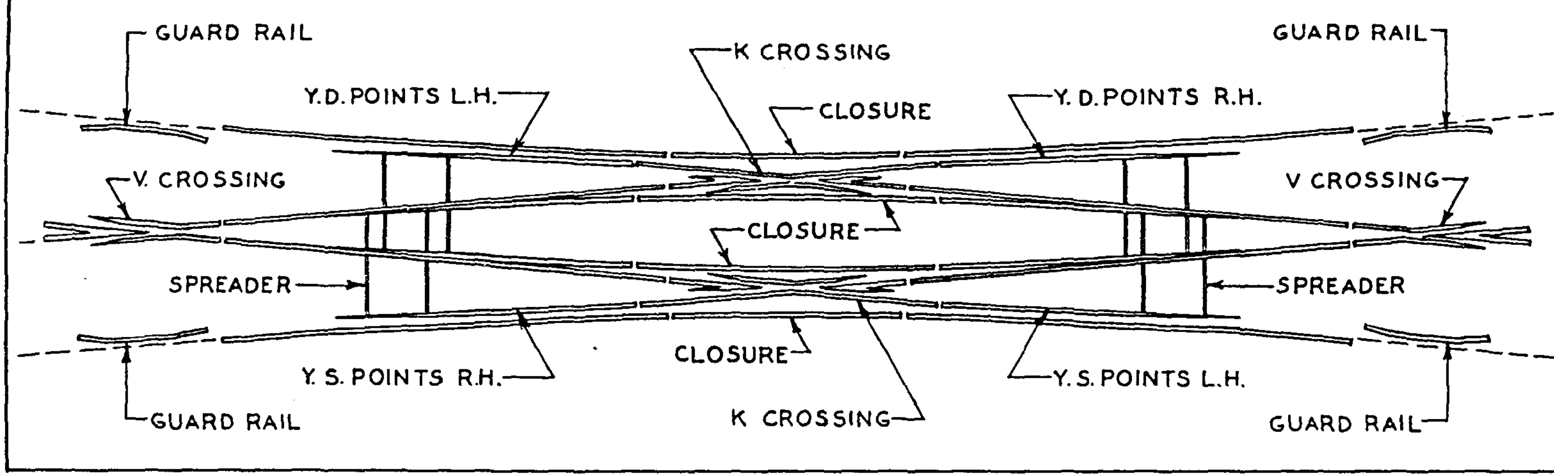


FIG. 53. THE 94 AND 107 LB. DOUBLE COMPOUND

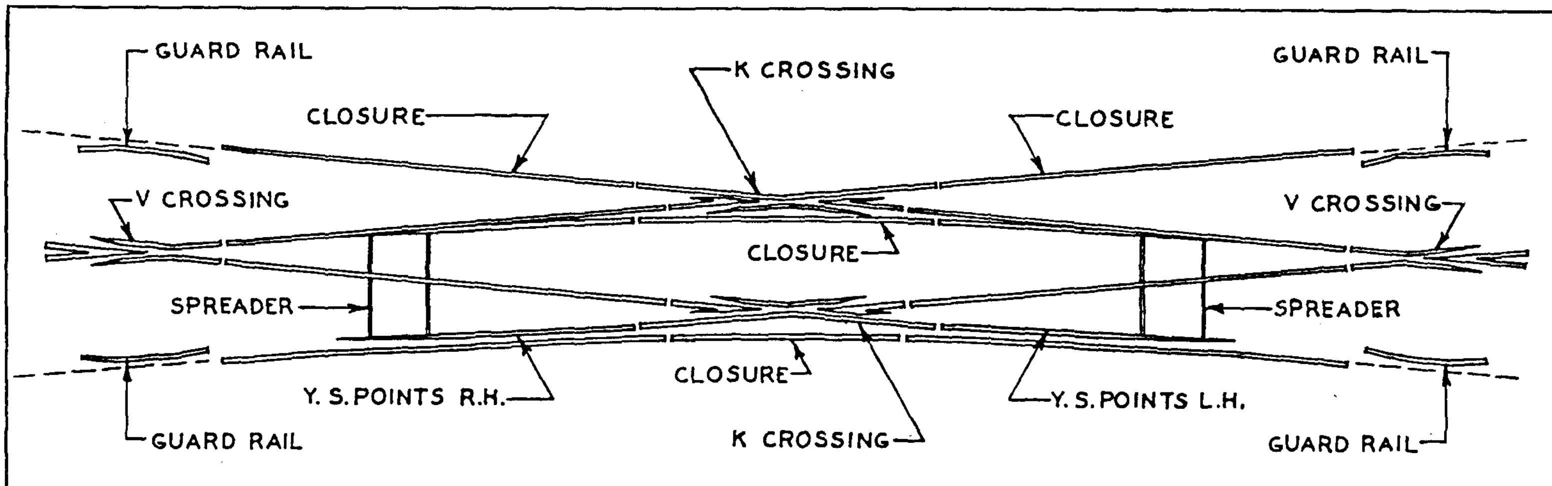


FIG. 54. THE 94 AND 107 LB. SINGLE COMPOUND

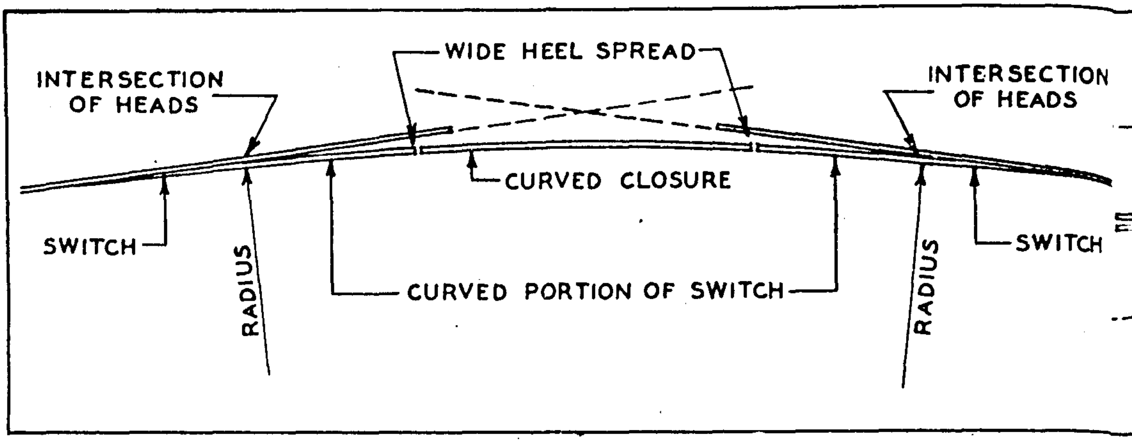


FIG. 55. CURVING OF POINTS. 94 AND 107 LB. COMPOUNDS

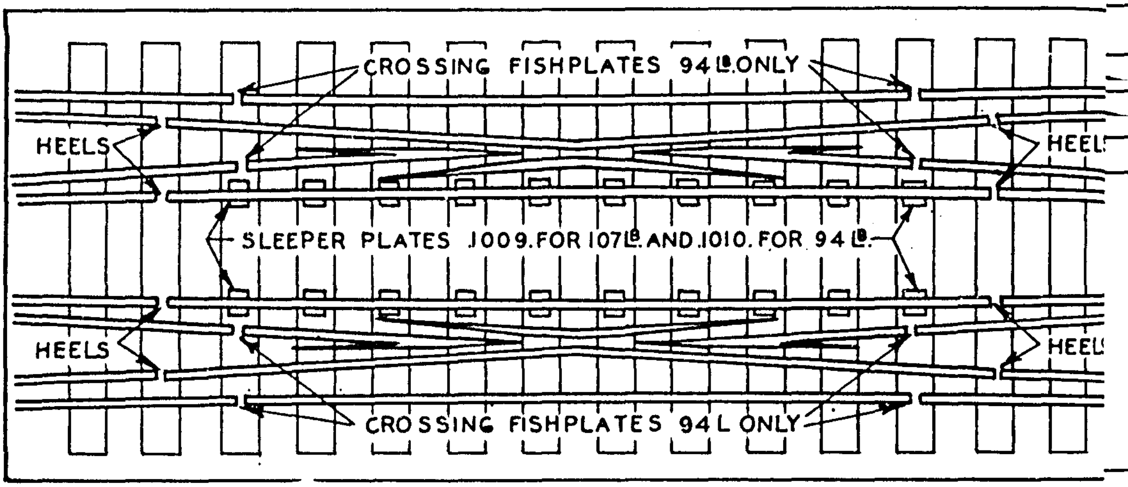


FIG. 56. No. 8·7 94 & 107 LB COMPOUNDS. DETAIL AT K CROSSINGS

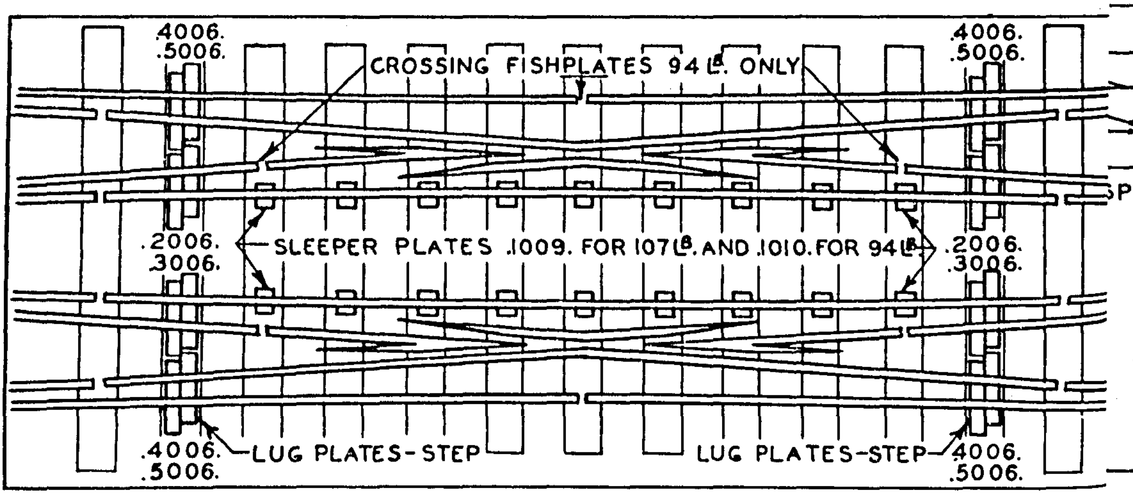


FIG. 57. No. 7·52. 94 & 107 LB. COMPOUND. DETAIL AT K CROSSINGS

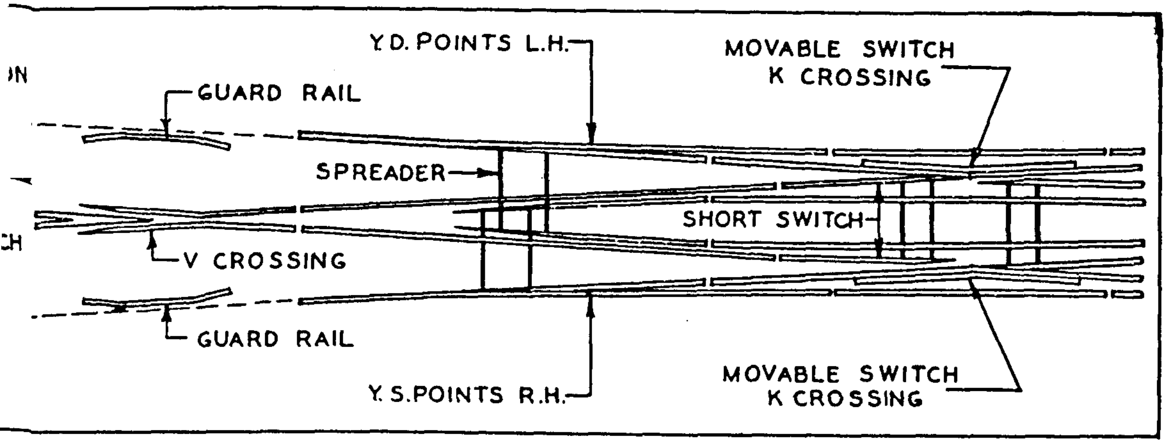


FIG. 58. THE MOVABLE K SWITCH DOUBLE COMPOUND

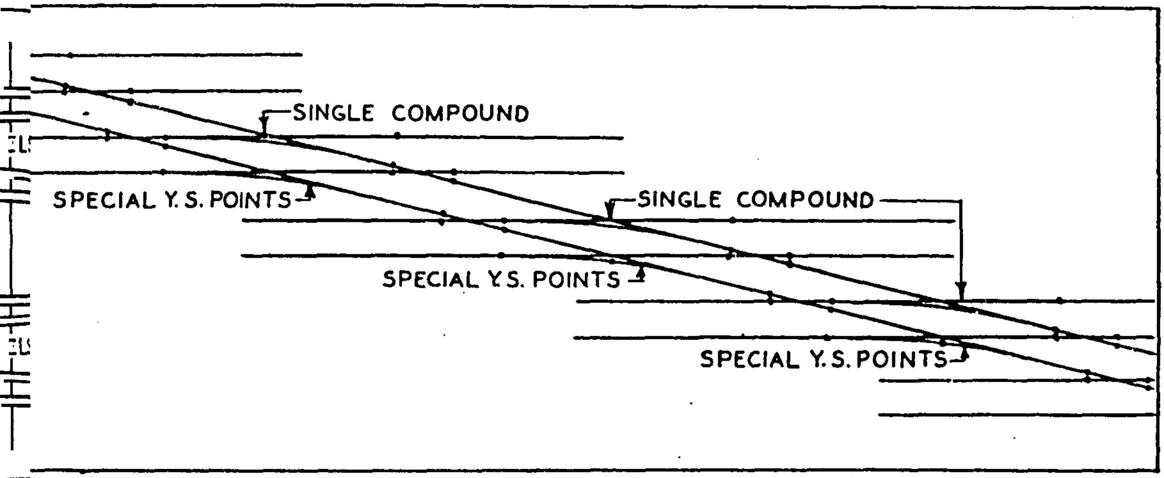


FIG. 59. COMPOUND CROSSOVER USING SINGLE COMPOUNDS

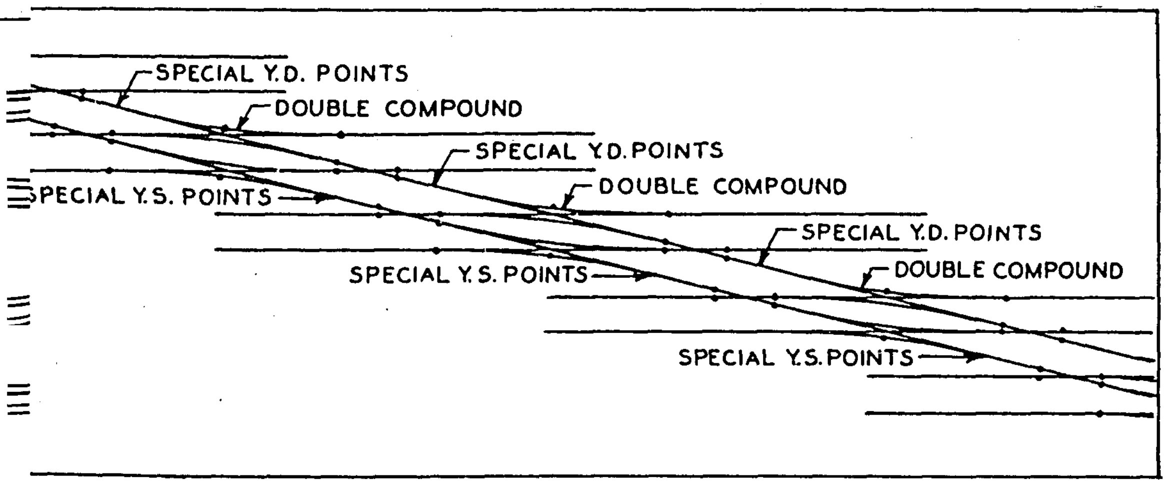


FIG. 60. COMPOUND CROSSOVER USING DOUBLE COMPOUNDS

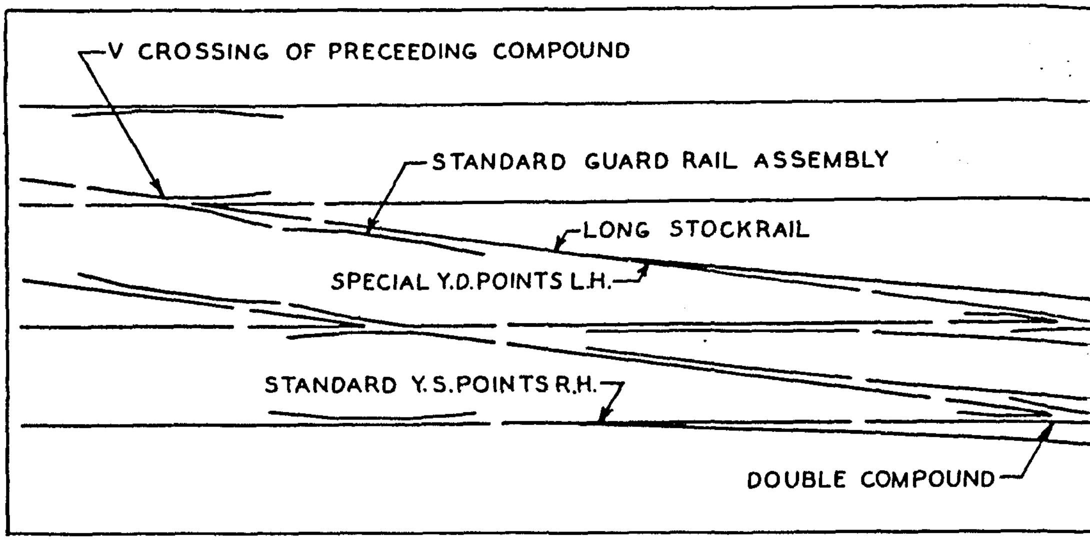


FIG. 61. NON-INSULATED LAYOUTS. THE USE OF SPECIAL POINTS

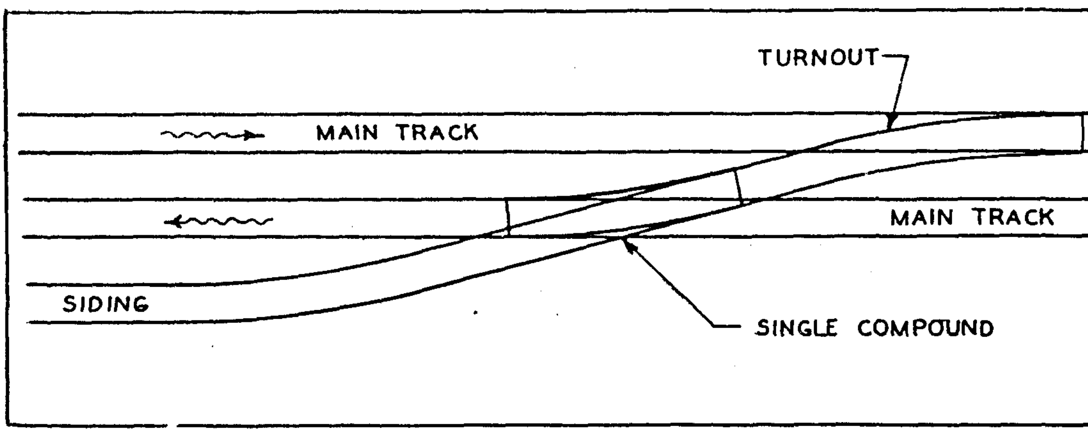


FIG. 62. OBSOLETE PRACTICE FOR MAIN TRACK CROSSOVER MOVEMENTS

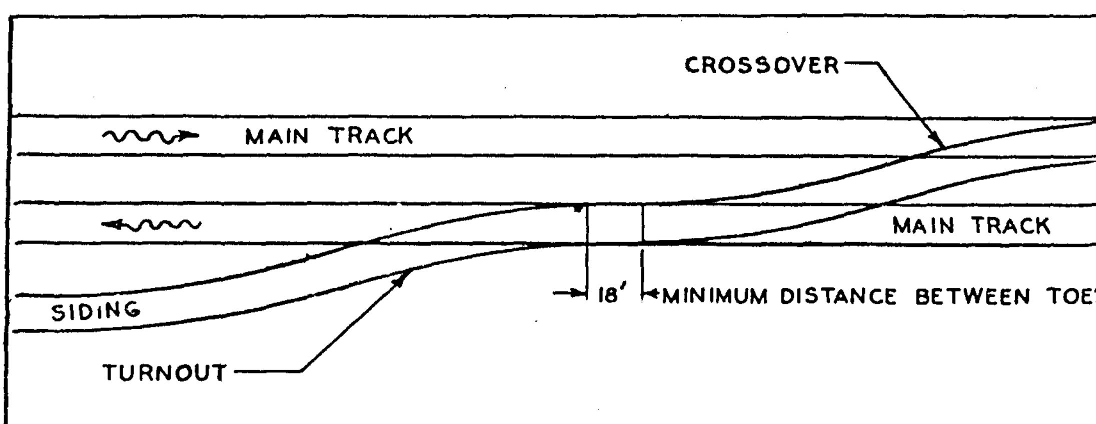


FIG. 63. NEW PRACTICE FOR MAIN TRACK CROSSOVER MOVEMENTS.

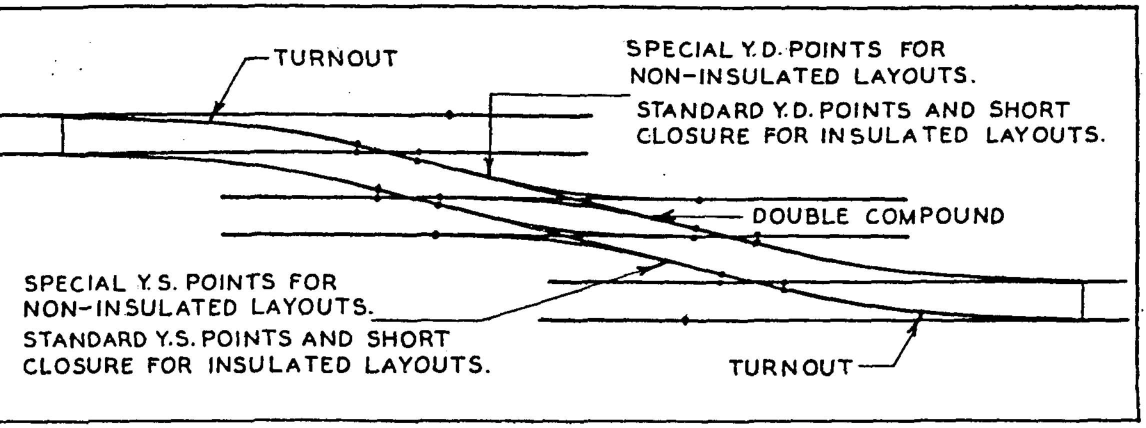


FIG. 64. THE COMPOUND ABUTTING TWO STANDARD TURNOUTS

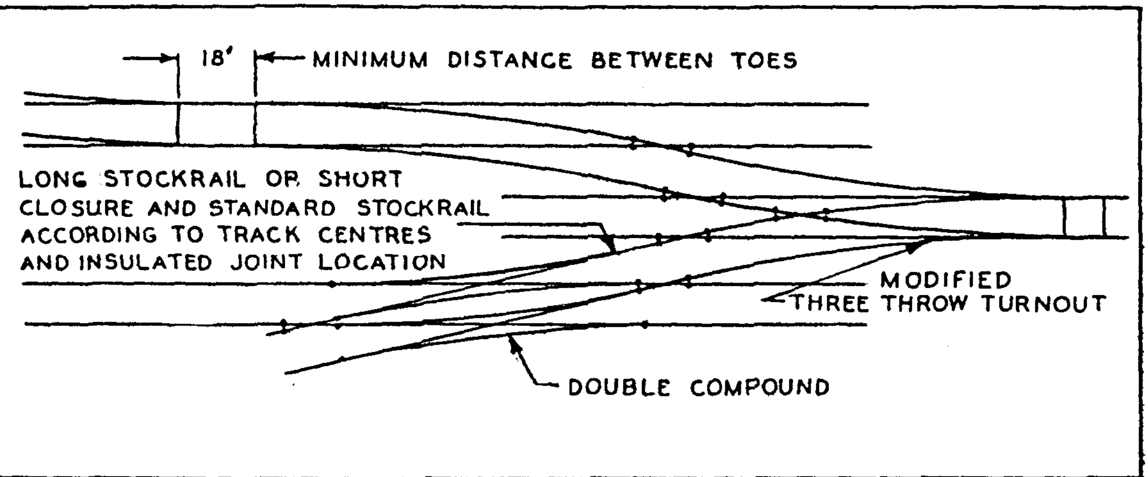


FIG. 65. THE COMPOUND ABUTTING A MODIFIED THREE THROW TURNOUT

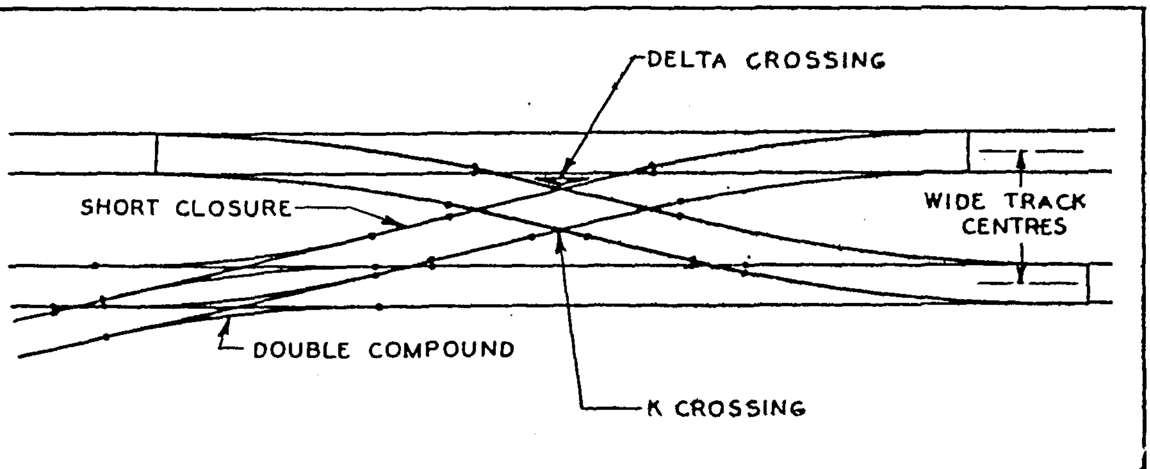


FIG. 66. THE COMPOUND ABUTTING A DELTA CROSSOVER

JUNCTIONS

DEFINITIONS

Junctions are an arrangement of trackwork at the branching point of tracks and may be single, double, or multiple.

The tracks may diverge from straight, or from curved tracks of similar flexure or contraflexure.

The term Junction is usually restricted to main tracks, but similar arrangements occur in yards and sidings.

SINGLE JUNCTIONS

A single junction off straight track is simply a turnout; for speed requirements the No. of the turnout may be larger than the standards, but will seldom exceed No.15.

Contraflexure single junctions off curved main track require 'V' crossings according to the combination of radii through the junction, but No. 12 will seldom be exceeded. See Fig. 67.

The standards for yards and sidings are No. 5 and No. 6 and in 94 and 107 lb. standards, diagrams have been prepared in which curved 'V' crossings are used.

Similar flexure single junctions require 'V' crossings of large No., and for practical purposes No. 20 is not exceeded. See Fig. 68.

In yards and sidings away from main tracks all trackwork is laid without cant; speed is limited and radii is less than in main trackwork, consequently crossing Nos. are usually smaller than for main trackwork.

For main track contraflexure junctions, as the crossing timbers are common to both tracks, any cant provided for one track will result in an equal amount of negative cant on the other track.

In these circumstances speed restrictions are usually imposed for the track with negative cant, but there is always a danger that speed may be exceeded and it is generally considered advisable to reduce the cant to a minimum and impose suitable speed restrictions on both tracks.

With similar flexure junctions the cant is in the same direction and reasonably satisfactory for the conditions, but if full cant is provided difficulties may arise in running out the cant,particularly if the junction is adjacent to bridges, level crossings or a station yard.

DOUBLE JUNCTIONS

In double junctions two tracks intersect to form a diamond, the points being slightly staggered to provide the necessary clearance between the curved tracks, as shown in Fig. 69.

Double junctions off straight tracks may be arranged with straight or curved diamonds; the former is the usual practice in yards and sidings, and the latter is more usual in main trackwork.

The straight crossing arrangement is shown in Fig.70, in which all crossings are standard and the turnouts conform to the standard diagrams.

In the curved crossing arrangement shown in Fig. 71, a bigger radius is obtainable with a curved crossing turnout in conjunction with a diamond of small No., and for main trackwork the extra cost of providing the curved crossing turnout is justified.

The crossing Nos. for the diamond formed in contraflexure junctions and the widths of flangeways required depend upon the track centres and the radii.

For safety and economy in crossing maintenance, curved 'K' crossings with $1\frac{3}{4}$" flangeways should not exceed No.6, and straight 'K' crossings should not exceed No. 8.

If the radius is the same for each branch, the arrangement is symetrical and the 'V' crossings in the diamond lie on the prolongation of the centre line between the approach track at the point of embranchment, as shown in Fig. 72.

In layouts of unequal radii as in Fig. 73, the centre line of the diamond is inclined to the side of least radius. The gaps in the 'K' crossings are not opposite and can therefore be guarded by the guard wing of the opposite 'K' crossing, but as the guard wings of 'K' crossings are built integral with the crossings, they are not adjustable for wear and satisfactory guarding conditions cannot for long be maintained.

When contraflexure double junctions occur in main trackwork, the cant for the two sets of track is in opposition and cannot be applied through the diamond owing to insufficient room in which to provide suitable runouts. In these circumstances suitable speed restrictions must be imposed.

To provide the necessary clearance between the tracks of contraflexure junctions the track centres of the approach tracks must be suitably widened before the point of embranchment, as in Figs. 72 and 73.

Diamonds in intersecting curved trackwork of different radii are unsymetrical and the 'K' crossings do not lie opposite each other; this is an advantage in that the gaps can be suitably guarded, but the arrangement of crossing and closure lengths, and the position of joints and timbers are difficult to arrange for satisfactory trackwork conditions.

Similar flexure double junctions shown in Fig. 74 are avoided if possible as crossings of large No. are required to obtain a reasonable radius for the inside curved tracks As double junctions require the use of diamond crossovers, the 'K' crossings of large No. are a constant source of danger. Even if movable switch 'K' crossings are installed, difficulties arise in maintaining the trackwork in proper alignment for the operation of the switches.

The combinations of radii and crossing No. are endless and vary further with different track centres; however, the choice of a layout will always depend upon practical trackwork considerations outlined in the sections relating to diamonds and turnouts with due regard to the required flangeways, crossing lengths, arrangement of joints and timber considerations. A combination of single and double junctions is shown in Fig. 75.

POINTS

The points used in junctions vary as in turnouts according to the radius of curvature in the layouts and the type of layout.

In contraflexure junctions the switches may be shorter than in standard turnouts of the same crossing No. Similar flexure junctions usually require longer switches than in standard turnouts of the same crossing No.

All standard points are straight between the apex (See 13.086, Fig. 98) and the heels, and the initial direction of the approach track in turnouts is in line with the straight stock rail on the right or the left side of the points according to the hand of the points. See Fig. 76.

When both tracks are curved behind the points it frequently happens that the initial direction of the approach track will not be in alignment with either stock rail between the apex and the heels. In these circumstances special points are required in which both stock rails are set or curved to meet the initial direction of the approach track as shown in Figs. 77 and 78.

If in contraflexure junctions the radius is the same in both tracks and the centre line of the approach track produced passes through the P. of I. of the 'V' crossing, then the layout is symetrical and the set in each stock rail is the same. See Fig. 79.

Stock rails which curve inwards relative to the switch, as in Fig. 80, form a nasty pocket at the toe of the points and expose the switch to severe wear. The stock rail behind the toe of the switch is soon worn on the running edge and the switch gapes at the toe thus inviting the entry of a sharp flange. Lack of support to the switch due to stock rail wear results in the toe of the switch being crushed and broken.

Binding of 8 coupled wheel locomotives with serious distortion of the points will occur if the middle offset, (M.O.), on the 18' chord in Fig. 80 exceeds $1\frac{1}{8}$".

CURVED POINTS

Curved points are used on some railway systems to overcome the difficulties met with in the foregoing examples, but they are at the best a compromise, and the difficulties of maintaining the true curvature of the points is regarded as outweighing any advantage in respect to the layout arrangement.

It will be noted that if the switches and stock rails are curved to meet the conditions in Fig. 68, for instance, then the outer switch would be curved to the radius of the inner curve and the inner switch would be curved to the radius of the outer curve.

The stock rails in Fig. 68, would be curved in the opposite order to the switches, i.e., the outer stock rail would conform to the outer curve and the inner stock rail would conform to the inner curve.

To enable the curved switches to lie snugly against curved stock rails of a different radius, special curved machining would be required. Other difficulties are met with in respect to clearance along the back of the open switches.

As a compromise some railway systems curve the stock rails to the larger radius and curve the switches to fit the stock rails. This arrangement, shown in Fig. 81, necessitates compounding the inner curve at the heel of the curved switch, and is probably the best solution to this problem, but as previously stated, difficulties immediately arise in maintaining the curvature at the points under service conditions.

Obviously, curving of the switches increases the depth of the pocket at M.O. in Fig. 80, and tends to intensify the ordinary distortion at the toe of the points.

In contraflexure junctions as shown in Fig. 67, if the switches and stock rails were curved to meet the required conditions, the switches would be curved inwards and the stock rails would be curved outwards. This arrangement would require concave machining on both sides of each switch and of different radius according to the radii of the curved tracks.

The alternative adopted by some railway systems is to curve the points for one track and reverse the curvature on the other track at the heel of the points as shown in Fig. 82. Locomotives with long rigid wheel base would bind in ordinary points arranged as in Fig. 82, and the throw of the points required to give freedom of wheel movement would be excessive.

To avoid the complications associated with the manufacture and maintenance of points in which both the switches and the stock rails are curved, it is the practice in Victoria to lay the points in straight with the following curves tangent thereto and, in re-arrangements, to compound the existing curves to join with the new layout, as for instance in the case shown in Fig. 83.

The radii of the compound curves are always somewhat less than the radius of the original curve.

SPECIAL JOINT LOCATION

For double rail construction the joints are special with outside fishplates and cast steel blocks in the flangeways. Long bolts pass through the joint assembly and the joints must be located for the convenient assembly and replacement of bolts broken in service. The observations made in respect to joints in crossovers apply also to the joint locations in diamond crossovers See 13.019.

INSULATED JOINT LOCATION

Insulated joints require central suspension on joint timbers at 1'8" centres; the standard insulated joints are designed for single rail joints and every effort should be made to avoid track circuit arrangements which require insulated joints in double rail construction. The location of insulated joints has an important bearing on the crossing and closure lengths and the timber spacing, and very bad trackwork can result from the installation of insulated joints in unintended positions.

TIMBERING

Timbering arrangements are carefully worked out for all diamond crossovers in the junctions and the plans issued must be strictly worked to as the omission or addition of timbers may seriously affect the surface of the trackwork under running conditions. See 13.095.

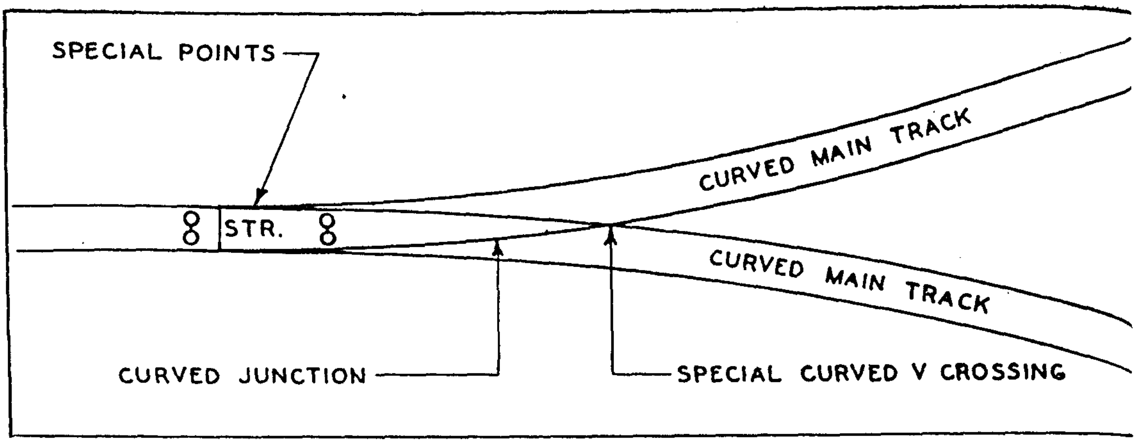


Fig. 67. The Contraflexure Single Junction

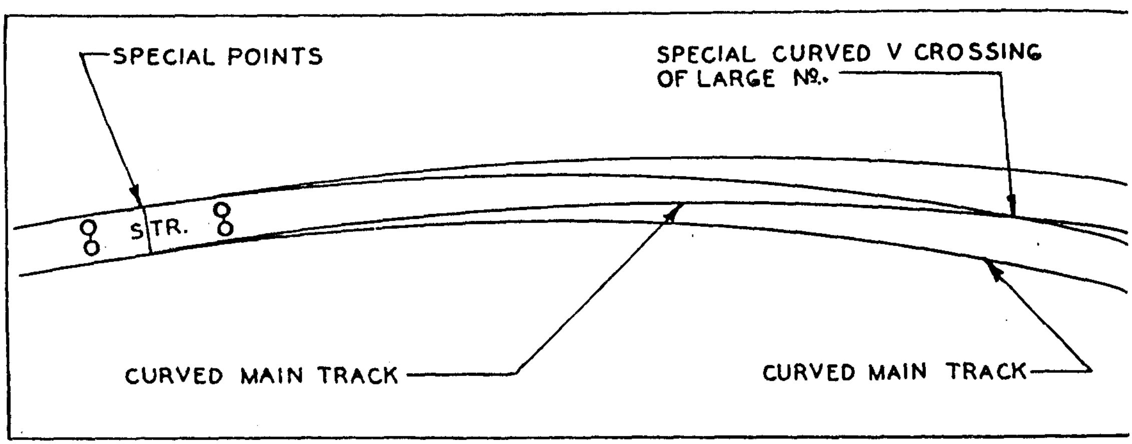


Fig. 68. The Similar Flexure Single Junction

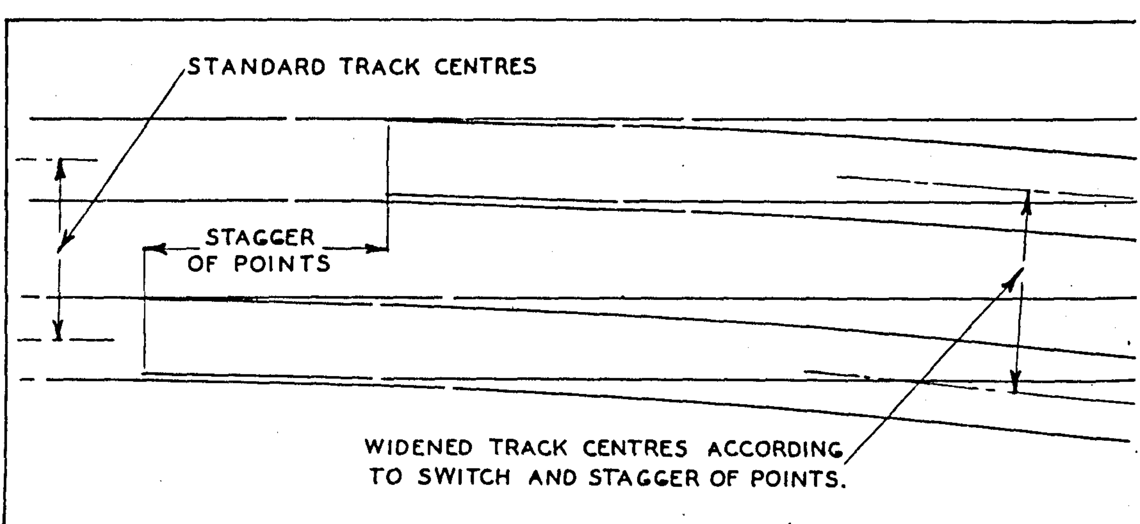


Fig. 69. Double Junctions–Staggering of Points

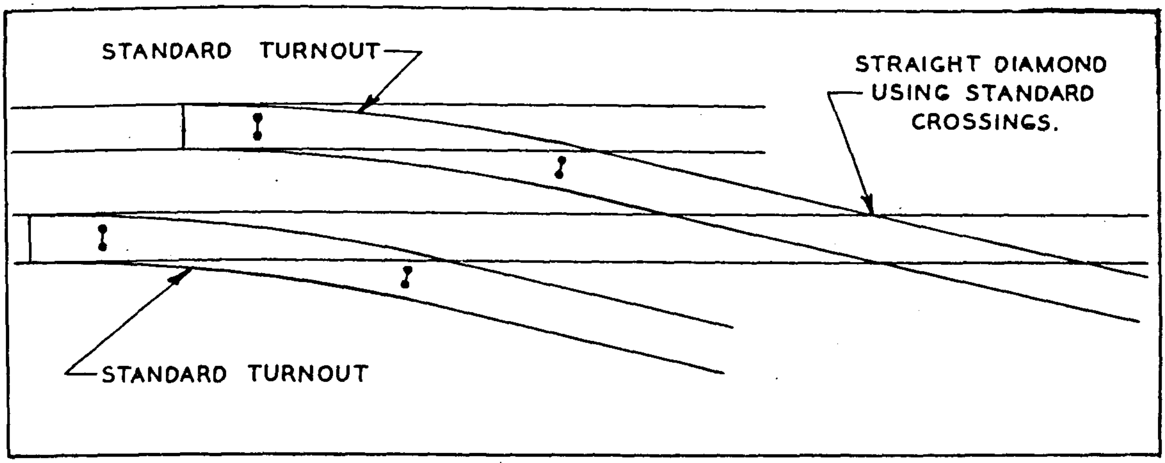


Fig. 70. Double Junction using Straight Crossings

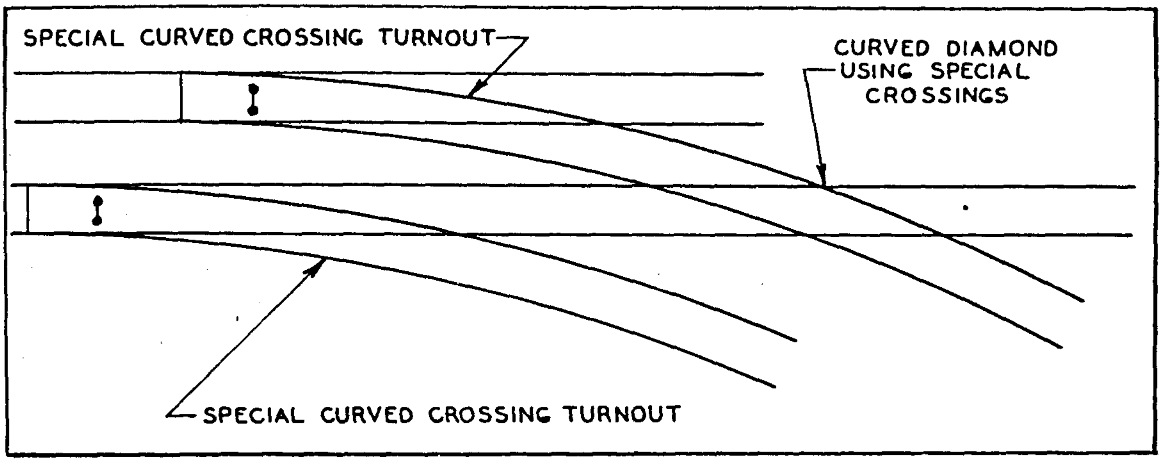


Fig. 71. Double Junction using Curved Crossings

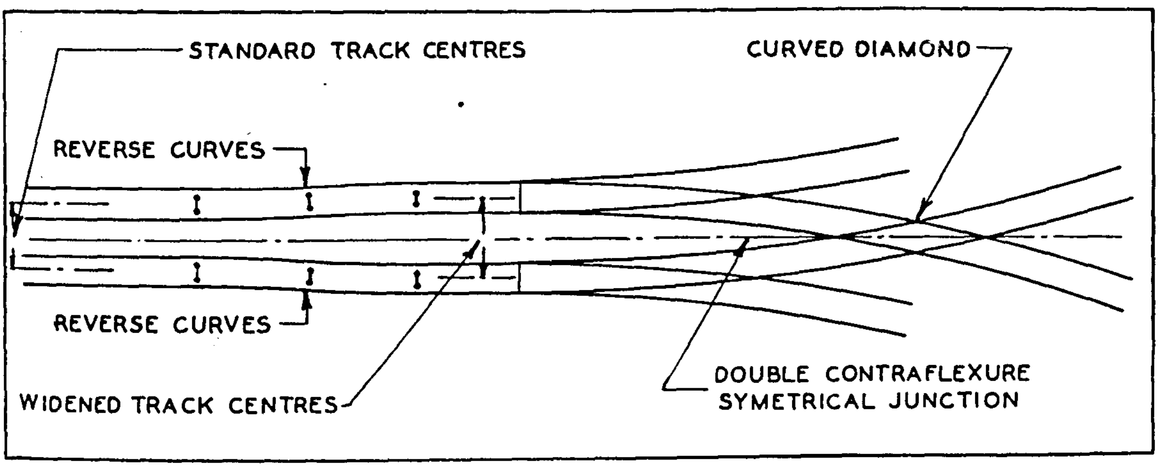


Fig. 72. The Double Contraflexure Symetrical Junction

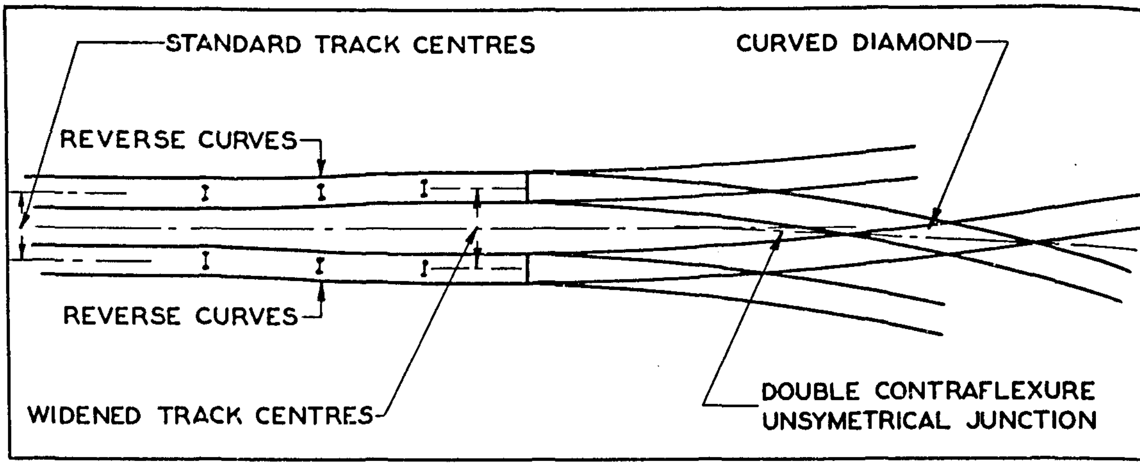


FIG. 73. THE DOUBLE CONTRAFLEXURE UNSYMETRICAL JUNCTION

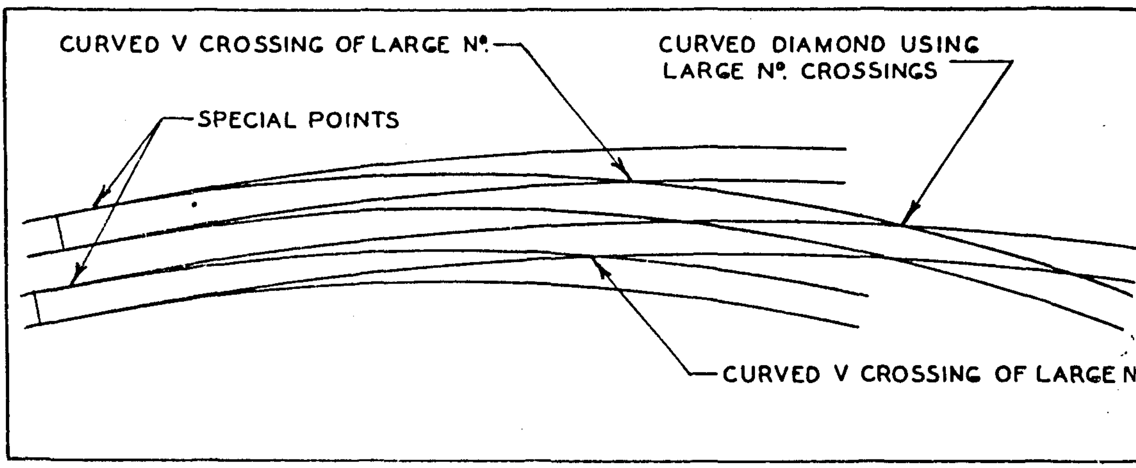


FIG. 74. THE SIMILAR FLEXURE DOUBLE JUNCTION

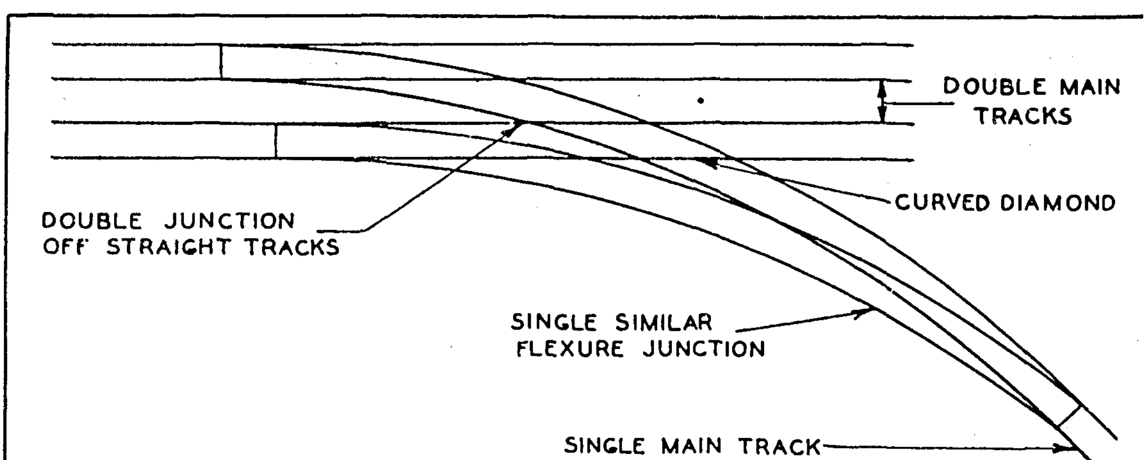


FIG. 75. DOUBLE JUNCTION ABUTTING A SINGLE JUNCTION

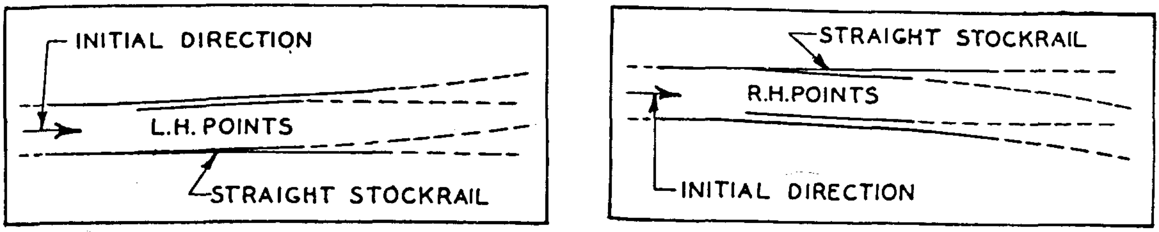


FIG. 76. RELATION OF APPROACH TRACK TO STANDARD POINTS

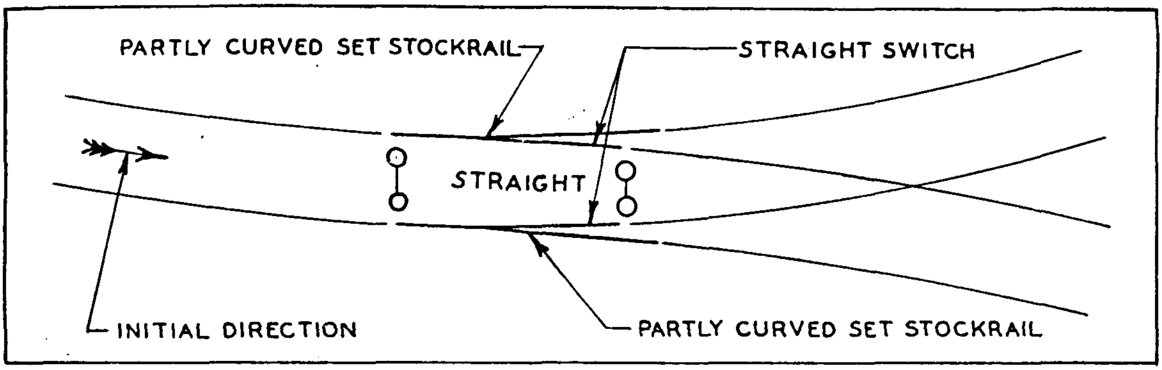


FIG. 77. CURVING OF POINTS IN UNSYMETRICAL CONTRAFLEXURE JUNCTIONS

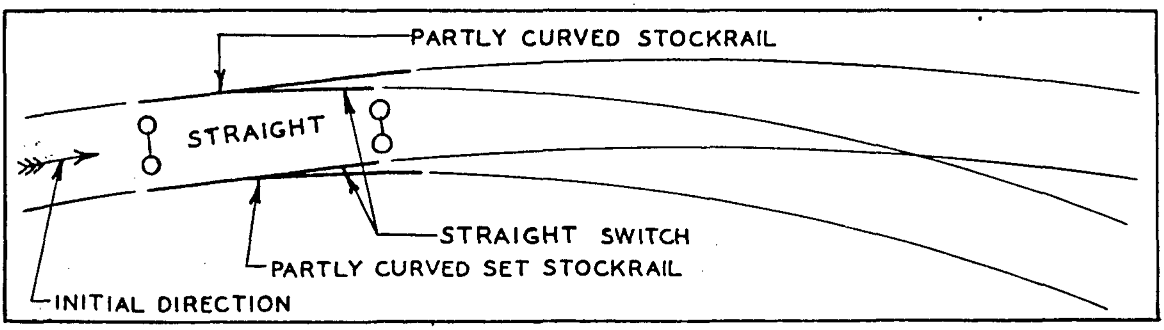


FIG. 78. CURVING OF POINTS IN SIMILAR FLEXURE JUNCTIONS

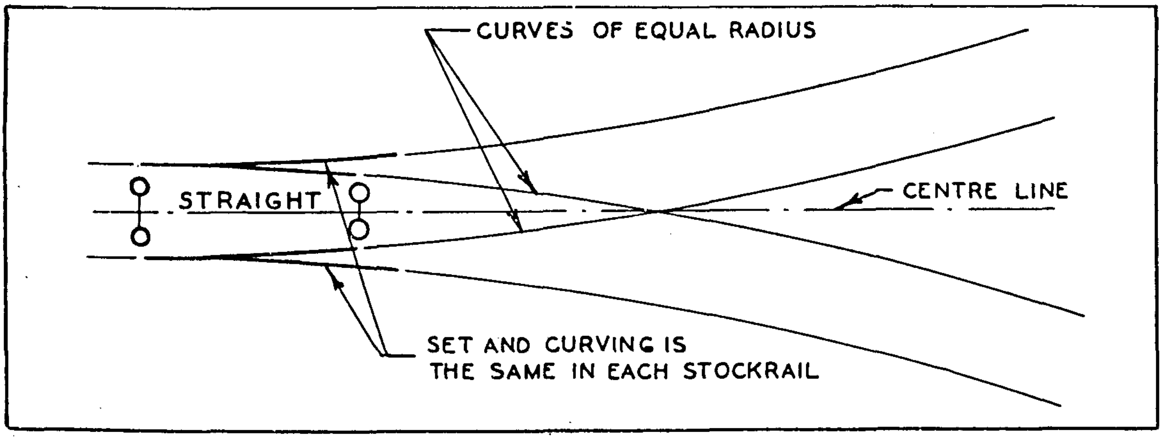


FIG. 79. CURVING OF POINTS IN SYMETRICAL CONTRAFLEXURE JUNCTIONS

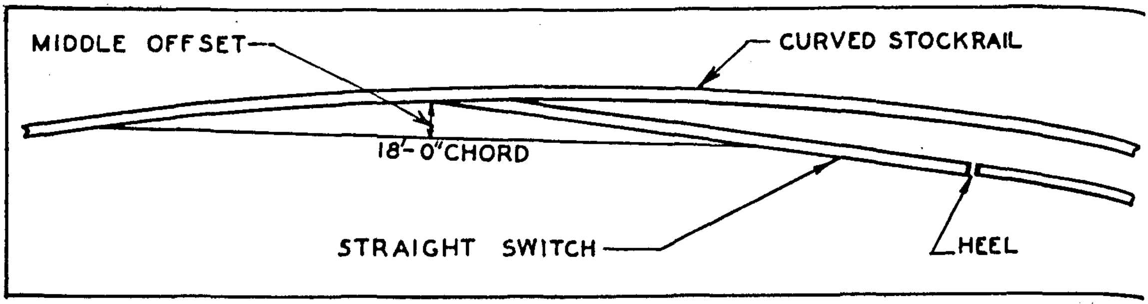


FIG. 80. CURVING OF STOCKRAIL RELATIVE TO SWITCH

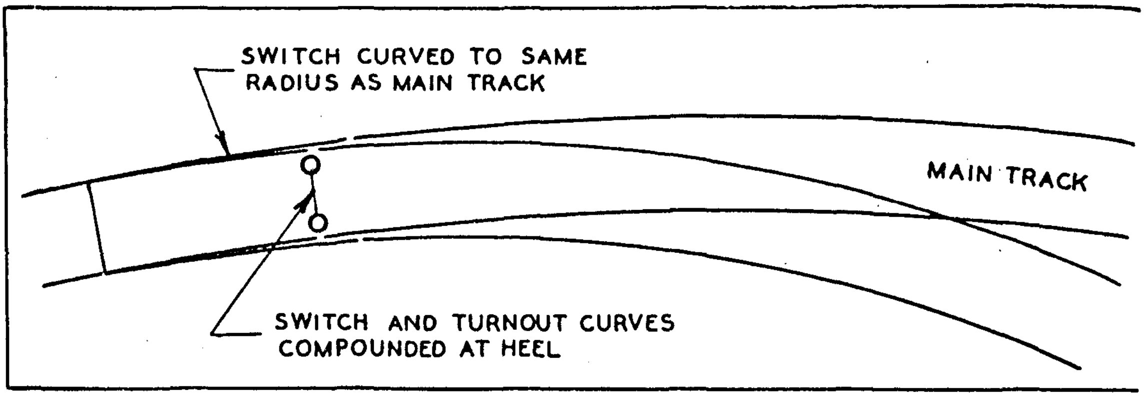


FIG. 81. COMPOUNDING OF SWITCH AND TURNOUT CURVES AT THE HEEL

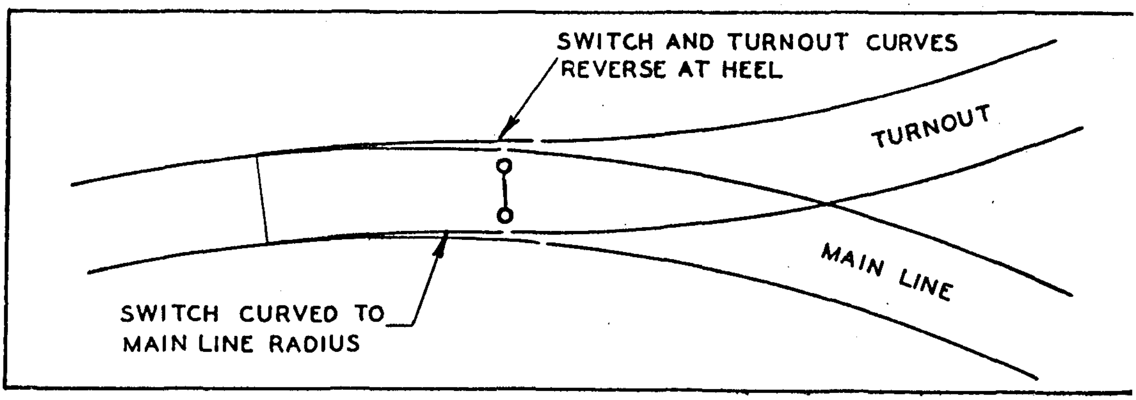


FIG. 82. ONE METHOD OF CURVING POINTS

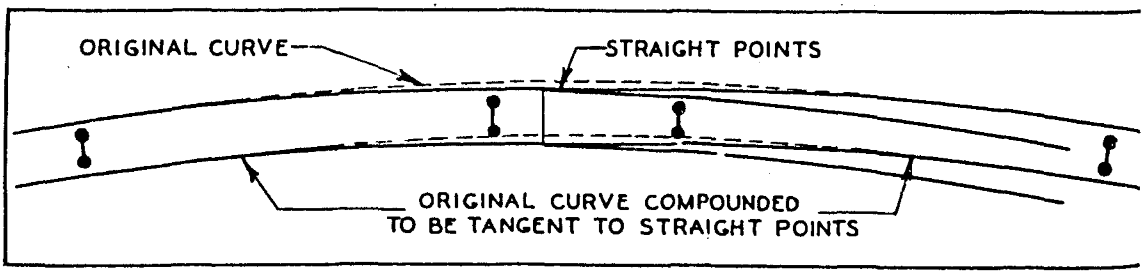


FIG. 83. THE VICTORIAN METHOD OF LAYING POINTS IN CURVED TRACK

DOUBLE & DELTA CROSSOVERS

GENERAL

Double and delta crossovers consist of two crossovers intersecting to form a diamond between the outside tracks.

When the crossovers are of the same No. and in lateral alignment, the intersecting tracks form a symetrical diamond central between the outside parallel tracks.

If the track centres are not too wide the 'V' crossings of the turnouts can be combined with the 'K' crossings of the diamond to form two delta crossings. See 14.074.

The most common arrangement is that shown in Fig. 84, which is typical of standard delta crossovers at 11'8" track centres.

Standard delta crossings are straight and the turnout curves must be laid in tangent to the straight switches and the straight 'V'portion of the delta crossings as in turnouts of the same No.

Special 'V' crossings in the diamond are curved as they are situated within the turnout curves. See Fig. 85.

TRACK CENTRES

For track centres wider than 11'8"it is usual to arrange the crossovers as shown in Fig. 86, in which the crossing intersections are bunched at a delta in one track and separate crossings are provided in the opposite track and in the diamond.

If the track centres are very wide the overall length of the crossovers may be too great for the required location and a more centrally situated diamond is used with all crossings separate as in Fig. 87.

Where the available distance in one track is limited the turnouts may overlap within the gauge of that track to form the arrangement shown in Fig. 88. The delta crossing is special in this arrangement.

COMBINATIONS

Combinations of crossing Nos., track centres and the foregoing arrangements of double and delta crossovers are endless,but some occasionally met with are illustrated in Figs.89 and 90.

STANDARD DELTAS

The delta crossings required in Fig. 84 are standard when the track centres are 11'8", and comprise two 'V' crossings and one 'K' crossing constructed as one delta crossing. See 14.074.

When standard delta crossings are laid in double or delta crossovers the delta piece of the delta crossing is a running surface for all movements and, under traffic conditions its surface is bright like other running rails.

SPECIAL DELTAS

In Figs. 88 and 91, the delta piece is not a running surface for any movement and its surface remains black under all traffic movements, the function of the running surface and guard edges are reversed, special construction is necessary and the crossing required is a 'V' delta. See 14.074.

OUTSIDE SLIPS

The arrangements shown in Figs. 90 & 91 are outside slips; the dotted slip in Fig. 91 is alternate to that in full line as there is insufficient room for the passage of rolling stock through the two loops simultaneously.

For clearance reasons the track centres in Figs. 89 & 9 should be wider than 11'8", according to the radii of the curves and the length of the rolling stock operating.

DELTA DIAMOND

This arrangement, because of the special delta construction, is introduced in this section. It is met with occasionally as at Dudley Street, North Melbourne. See Fig. 92

In the special delta at 'A' the delta piece is a running surface for the diamond tracks, but a guard edge for the through track, while in the special delta at 'B' the delta piece is a guard edge for the diamond tracks and a running surface for the through tracks. The special deltas required for this layout are 'K' deltas. See 14.074.

It will be seen from Figs. 88 & 91, that standard delta cannot be used where 'V' deltas are required, but the distinction is not quite so clear between 'K' deltas and standard deltas because constructionally they appear to be the same Actually the delta piece in the delta crossing at 'A' i smaller than that in the delta crossing at 'B', Fig. 92; thi is necessary to establish correct gauge through all tracks.

If a pair of standard deltas were laid in the delta diamond Fig. 92, the through track would be $1\frac{3}{4}$" tight to gauge when the diamond tracks were at neat gauge.

Trackwork involving the use of delta crossings is costly to construct and frequently difficult to maintain.

Heavy wear through one track may render the delta crossings quite unserviceable as the guard rails, being built in as a part of the crossings, cannot be adjusted for wear, and re-gauging the crossings for the worn conditions will adversely affect the gauge for the other two tracks with the possibility of derailment and the certainty of heavy crossing wear.

Whenever practicable in re-arrangements, double crossovers using delta crossings are being replaced by two single crossovers, as in Fig. 93.

It is probable that for 94 and 107 lb. trackwork, only one standard delta crossing will be provided for general trackwork necessitating the use of delta crossings, and that this crossing will be a No. 8.7 rail-bound manganese-insert delta crossing of 107 lb. material.

INTERSECTION DISTANCES

The intersection distances from the knuckle of the delta crossings to the P. of I. of the special 'V' crossings are measured along and at right angles to the parallel tracks. Intersection punch marks will be impressed at the running edge of all delta crossings during manufacture.

As the rails used in the construction of delta crossings have an appreciable curvature at the point of setting it will be evident that the crossings do not gauge at this point. In delta crossings of standard Nos., the loss in alignment at the P. of I. is approximately 3/16" and while the longitudinal position is correctly indicated by the punch mark the lateral position is out in space as shown in Fig. 94.

GUARD RAILS

To guard the two 'V' crossing gaps in delta crossings, a long guard rail is employed in preference to two short standard guard rails. The present standard delta guard rails are 22'6" long and provide sufficient length of $1\frac{3}{4}$" flangeway for the required guarding of the 'V' crossing gaps.

Delta guard rails must not be confused with the 22'6" speed line guard rails which do not provide a sufficient length of $1\frac{3}{4}$" flangeway to properly guard the 'V' crossing gaps of the delta crossings. See 14.098-14.099.

The delta guard rails must be placed centrally opposite the knuckle of the delta crossings.

GAUGE

As mentioned in respect to 'K' crossings in diamonds, when the No. of the 'K' crossing portion is small there is no advantage in laying such crossings tight to gauge.

A delta crossing is always stamped with the No. of the 'V' crossing portions. The No. of the 'K' crossing portion is approximately half the No. stamped on the delta crossing. Thus the No. of the 'K' crossing portion of a No. 8.7 delta crossing is No. 4.29 for which tight gauge is unnecessary.

If delta crossings are laid tight to gauge the standard guard rail gauge of 5'1¼" is reduced by the tightness to gauge and the noses of the 'V' crossing portions are exposed to heavy blows and rapid wear.

CLOSURES

Particulars of closures and joint arrangements have not as yet been fixed, but standard diagrams will be issued in due course.

In delta crossovers the turnout curves run through the special curved 'V' crossings in the 6 ft. way and the short closures between these crossings and the delta crossings are curved to turnout radius.

DOUBLE DELTA CROSSOVERS

Double delta crossovers consist of four crossovers intersecting in pairs to form four diamonds between the outside tracks. A typical arrangement is shown in outline in Fig.95 and from a traffic movement viewpoint is very convenient.

When the track centres are the minimum and clearance has to be provided for parallel movements, many difficulties arise in practical construction, and in certain combinations of crossing Nos. and track centres, the 'V' crossings lie opposite to one another and cannot be guarded.

Double delta crossovers should always be manufactured as a complete layout to carefully prepared designs, and the layout be shown to assemble to alignment and gauge before delivery for installation.

From a trackwork viewpoint such layouts are to be avoided as the joint and timber arrangements are most difficult to arrange and maintain.

It will be appreciated that while the 'K' crossing conditions in respect to the length of gaps are good, the reverse is the case with the 'V' crossings as the 'V' crossing Nos. are large and block arrangements afford little support to the crossing parts.

SURFACE

The bunching together of crossing intersections in delta crossovers considerably affects spot cross levels owing to the drop at the noses of the crossings.

Oscillation is set up as the wheel flanges engage the guard edges and throat openings of the delta crossings, and if the cross levels are not regular there is a danger of a wheel in rigid frame vehicles mounting at the nose of the 'K' crossing portions.

Vehicles with small wheels in frames under restraint from the main frame, like the pony wheels of certain locomotives, are most likely to mount. See 13.045.

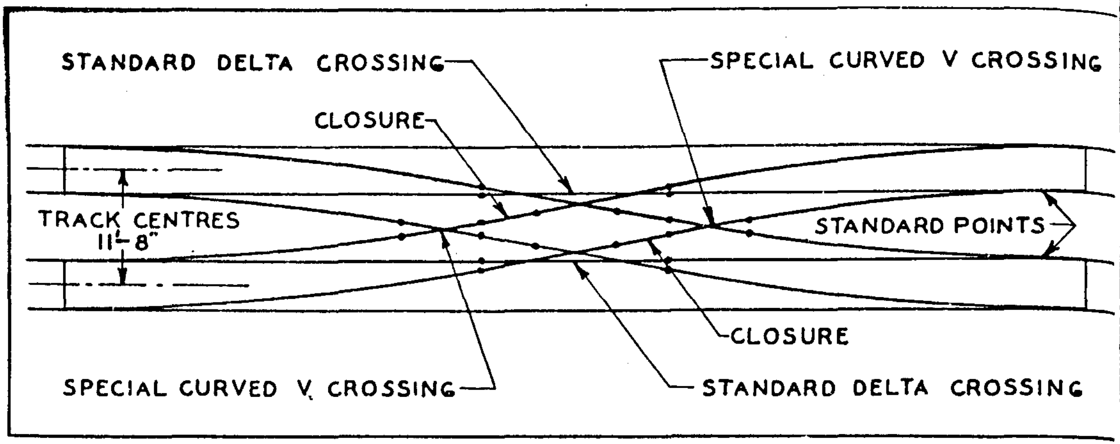


FIG. 84. THE STANDARD DELTA CROSSOVER AT 11'-8" TRACK CENTRES

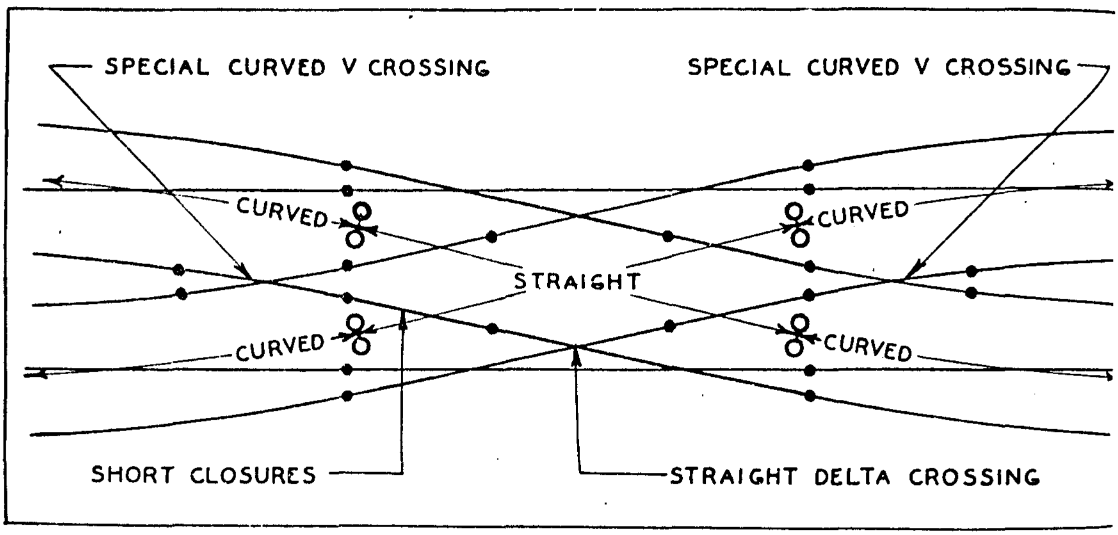


FIG. 85. THE SPECIAL V CROSSINGS IN A DELTA CROSSOVER

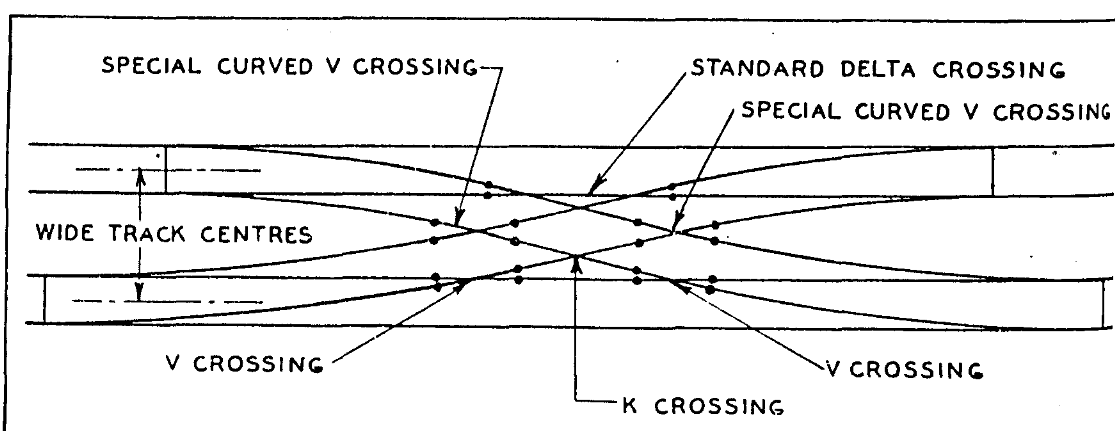


FIG. 86. THE STANDARD UNEQUAL DELTA CROSSOVER

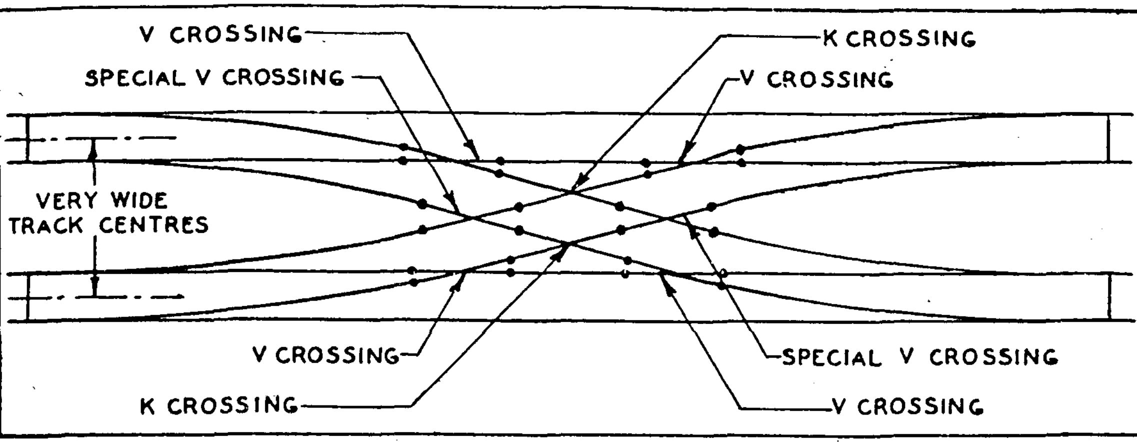


Fig. 87. The Double Crossover

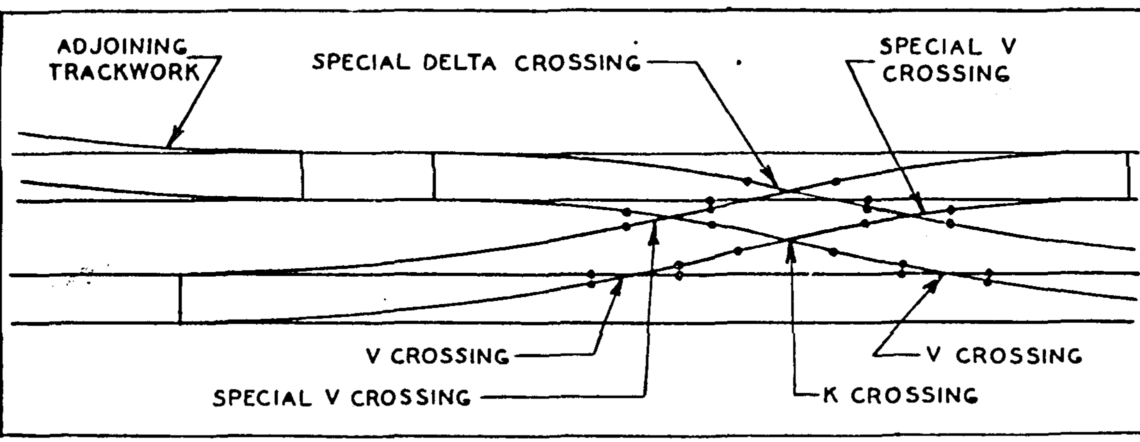


Fig. 88. The Special Unequal Delta Crossover

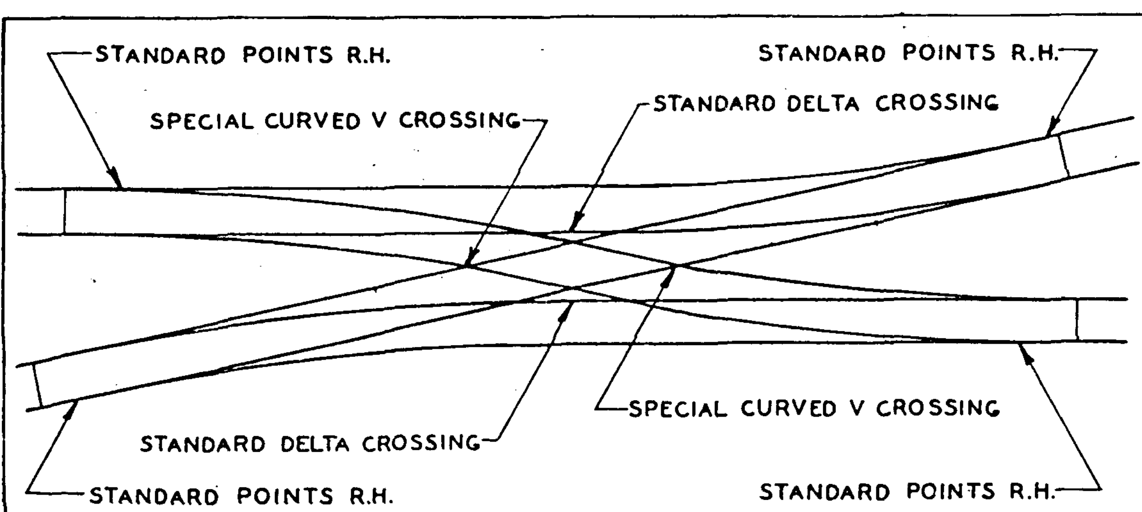


Fig. 89. A Special Delta Crossover

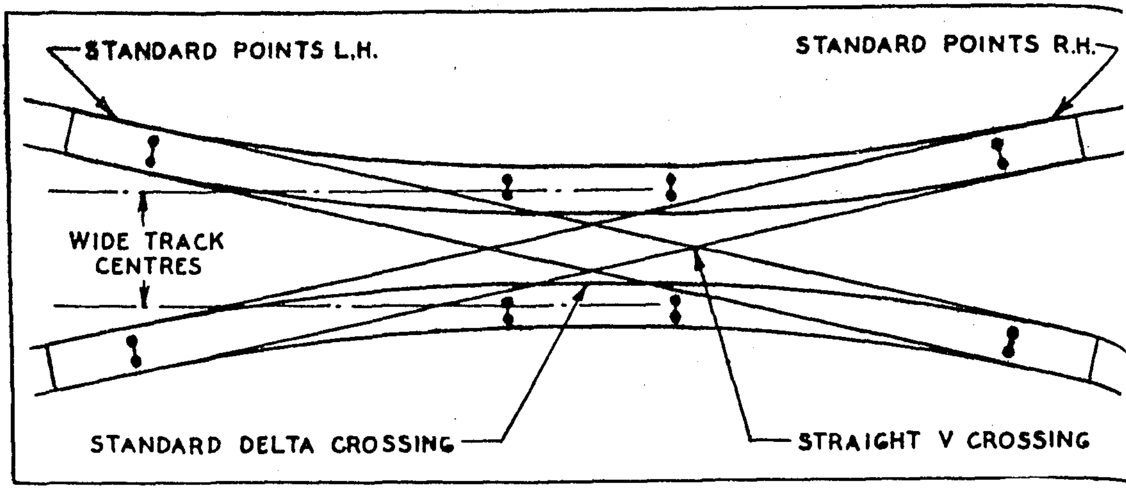


Fig. 90. The Outside Slip. using Standard Delta Crossings

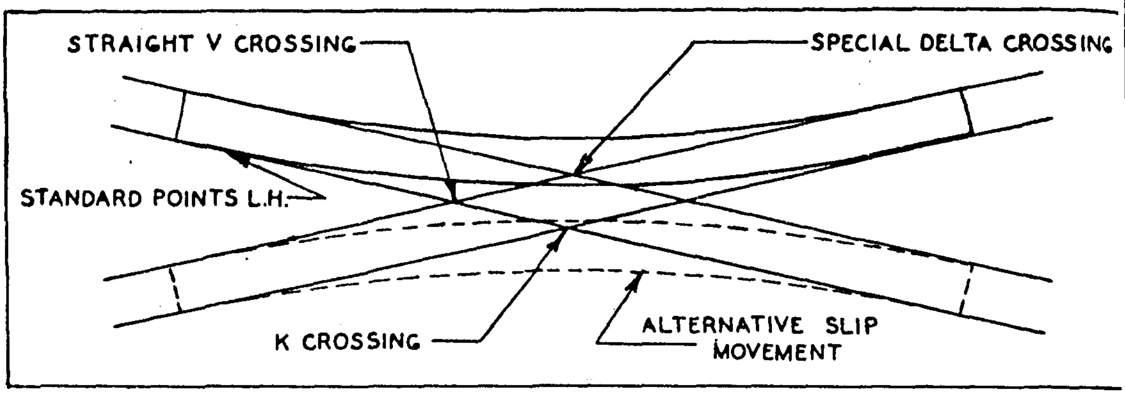


Fig. 91. The Outside Slip using a Special Delta Crossing

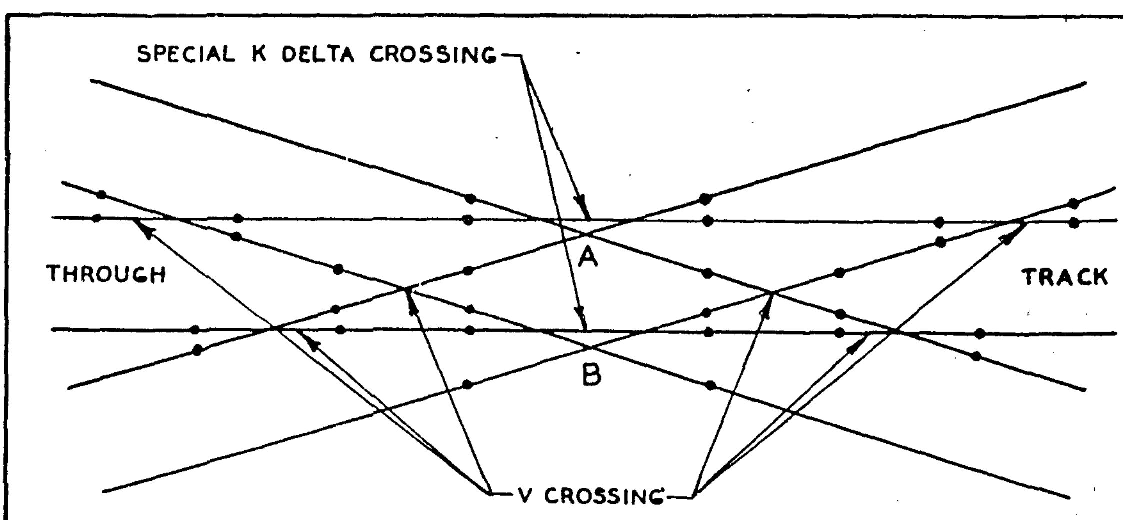


Fig. 92. The Delta Diamond

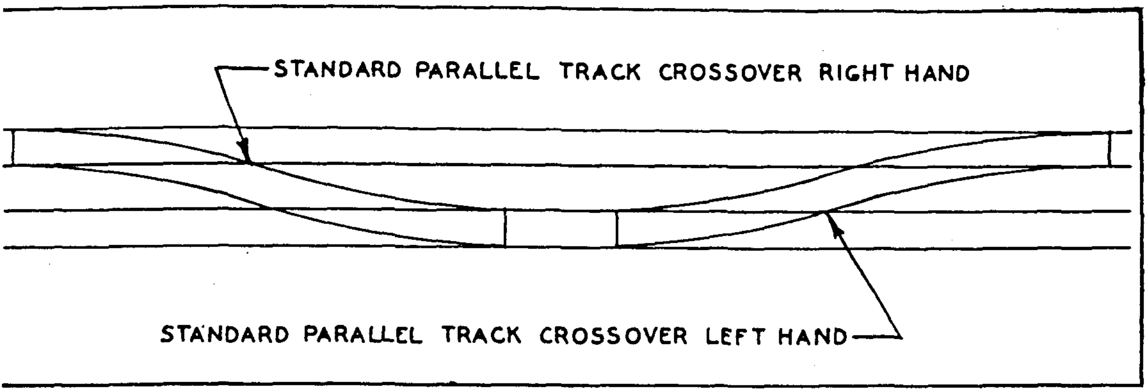


FIG. 93. THE REPLACEMENT OF A DELTA CROSSOVER BY SINGLE CROSSOVERS

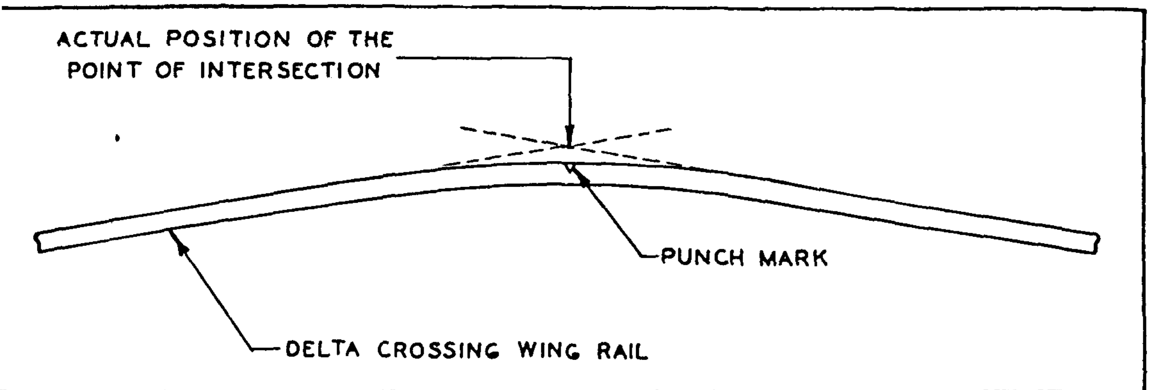


FIG. 94. THE LOSS IN ALIGNMENT AT THE POINT OF INTERSECTION

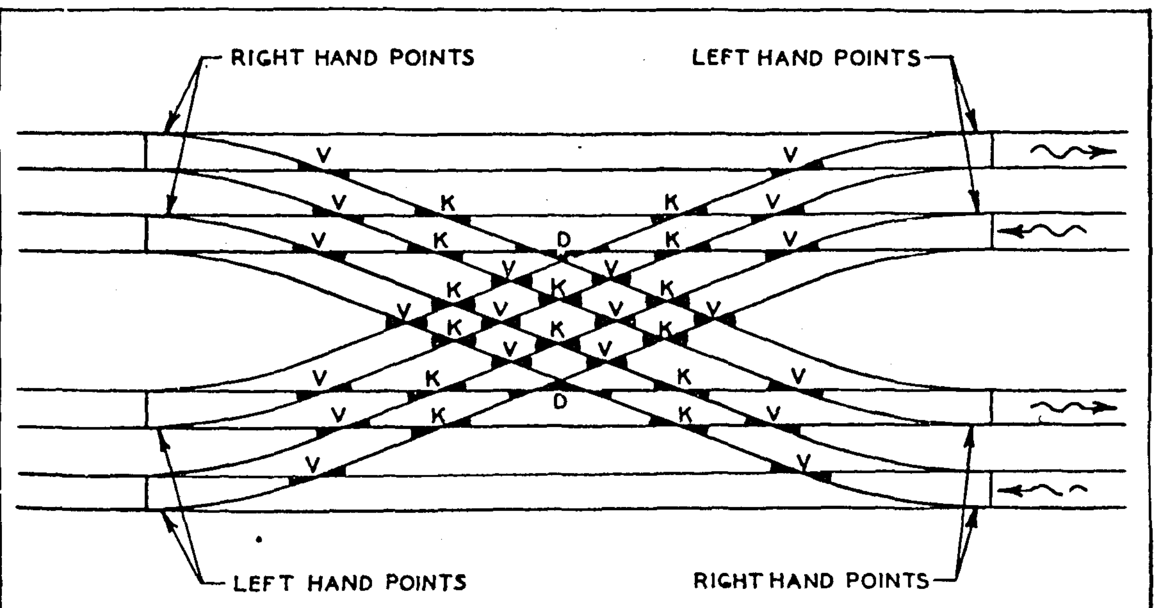


FIG. 95. THE DOUBLE DELTA CROSSOVER

LEADS & INTERSECTION DISTANCES

GENERAL

In the design, construction and installation of special trackwork, various leads and distances are used in association with different radii and crossing Nos.

Mechanical trackwork engineers are concerned with several types of leads and lead distances in design, and the manufacturers are concerned also with some of these distances and other practical lengths.

Movements engineers and surveyors are concerned with overall dimensions, intersection distances and crossing Nos. or equivalent angles, in arranging the layouts and fixing the position of pegs for the information of trackmen.

Trackmen are concerned only in the practical distances and identification of pegs to enable them to properly install the layouts and maintain them in the intended positions. An appreciation of the principles governing the arrangement of trackwork is, however, essential to avoid misunderstandings and errors in the actual work and in subsequent maintenance.

Standard layout diagrams show the position and purpose of the pegs to be driven for the information of the trackmen, but R.P's are fixed on the site by the surveyor according to local conditions, and the surveyor is responsible for indicating to the trackman-in-charge any unusual position of the R.P's. See 19.13, Figs. 12 & 13.

The following brief description covers in general the various leads and intersection distances used in trackwork.

THEORETICAL LEAD

The theoretical lead (Th.L.) is a distance from the tangent point or (T.P.) of a uniform turnout curve to the point of intersection or P. of I. of the 'V' crossing, measured along the straight main track, as shown in Fig. 96.

This lead is divided into two sections : -

1. Switch lead (S.L.) or distance from T.P. to heel of switch.

2. Crossing lead (C.L.) or distance from heel of switch to P. of I. of the 'V' crossing.

Theoretical and switch leads are only applicable to turnouts having fully curved switches and curved 'V' crossings, and do not apply to turnouts in which straight switches and straight 'V' crossings are used. See 13.001.

The crossing lead, because of its use in so much of the old trackwork, has been used, with adjustments to curvature, in the 1938 and 1942 standard Nos. 7.52, 8.7, and 9.73 turnouts off the straight track.

This lead is longer than is necessary for the arrangement of a true curve from the heel of the straight switches to the mouth of the straight 'V' crossing, and therefore short lengths of straight occur adjacent to the switch heels, as shown on the standard diagrams and indicated in Fig. 97.

The term 'lead' has been widely used to define different distances in respect to the whole or parts of a turnout and sometimes to describe the complete turnout, but there seems little doubt that the term 'lead' as originally used indicated only the position of the 'V' crossing in advance of the switches.

Although straight switches are, in general, standard in Victoria, there are special layouts in which, by necessity, partly curved switches are used, and curved crossing turnouts occur still more frequently. For these special layouts other leads and distances are in general use, but owing to constructional differences on the various railway systems, these leads and distances are differently defined.

In so far as Victorian Railway practice is concerned, the following definitions apply : -

THE LEAD

The lead is a distance from the heel of a straight switch to the P. of I. of the 'V' crossing measured along the straight track as shown in Fig. 97.

In similar flexure and contraflexure junctions the lead is measured at right angles to a line drawn through the heels of straight switches to the P. of I. of the 'V' crossing as shown in Figs. 99 & 100.

When the switches are partly curved in similar flexure and contraflexure junctions, the lead is measured at right angles to a line drawn through the switch point of curvature or S.P.C. as shown in Fig. 101. See 13.055.

It was once the practice for the trackman to range out the lead with a string line and locate the crossing, the initial setting of the timbers and the alignment of the curve from this line.

When the layouts were curved the lead was called the tangent line and was similarly used to locate the crossing, the timbers and the curve alignment. See Figs. 102 & 103.

Surveyors do not use the lead in setting out, but use instead the tangent lengths and angles at the centre line of tracks.

POSITION OF POINT OF INTERSECTION

In the old plated 'V' crossing the position of the P. of I. was indicated by a hole drilled through the foundation plate, but in standard blocked crossings the P. of I. is not marked and its location has been found to present difficulties to trackmen, particularly when worn serviceable crossings of non-standard length and special curved crossings are being installed.

To avoid mistakes in the location of the P. of I. and in the length of closures, it has been the practice since 1930 to show on standard diagrams the distance from the P. of I. to the nose of the 'V' crossings. This distance varies with the No. of the crossing and the weight and type of crossing. See 14.079.

The practical distance shown on the 1942 diagrams is from the heel of the switch to the nose of the 'V' crossing and applies only to the 94 and 107 lb. turnouts.

Particulars of distances from switch heels to noses of 'V' crossings are set out in Table 13.085.

SWITCH POINT OF CURVATURE

The switch point of curvature or S.P.C. may coincide with the heel of the switches or be situated in advance or behind the heel, depending upon the design of the turnout, as follows : -

(a) If the S.P.C. is located somewhere in the switches, the switches are partly curved and the curve is continuous or compounded with the turnout curve. See Fig. 104A.

(b) When the S.P.C. is located at the heel, the switches are straight and the turnout curve commences at the heel. See Fig. 104B.

(c) Where the S.P.C. is located beyond the heels there will be some straight behind the heels before the turnout curve commences as in the 1938 and 1942 diagrams. See Fig. 104C.

CROSSING POINT OF CURVATURE

The crossing point of curvature or C.P.C. may coincide with the mouth of the 'V' crossing or be situated before or beyond the mouth depending upon the design of the turnout as follows : -

(a) If the C.P.C. is located before the mouth of the 'V' crossing, the wing of the crossing is straight and there will be some straight between the crossing and the turnout curve. See Fig. 105A.

(b) When the C.P.C. is located at the mouth of the 'V' crossing the wing of the crossing is straight, but the turnout curve commences at the mouth of the crossing. See Fig. 105B.

(c) When the C.P.C. is located beyond the mouth of the 'V' crossing the wing is curved or partly curved and a following curve may be continuous or compounded with the turnout curve. See Fig. 105C.

TRUE LEAD

The true lead (T.L.) is a distance from the apex of the switches to the P. of I. of the 'V' crossing.

This lead is the basis of modern (straight-switch, straight-crossing) turnout design and is divided into three sections : -

1. A distance D^1 from the apex to the point of curvature of switch or switch P.C.

2. A distance D^2 between the switch P.C. and the crossing P.C.

3. A distance D^3 from the crossing P.C. to the P. of I. of the crossing.

All these distances are measured at right angles to a line drawn either through the heel of the switches or through the switch P.C. as shown in Figs. 98, 99, 100 & 101.

13.076

ADJUSTED LEADS

Leads which are varied from the true length required fo the exact arrangement of switch angle, regular curvature an crossing No. are defined as adjusted leads.

Adjusted leads occur generally in three ways : -

1. When straight switches and straight crossings are lai within a lead calculated for curved switches and curve crossings as in the case of the standard No. 7.52, 8.7 and 9.73 turnouts in which a short length of straight i inserted adjacent to the switch heel as explained in 13.073

2. When switches and crossings have been laid to join wit other trackwork without close regard to the calculate lead, as in some existing ladder turnouts leading to track at other than standard track centres.

   In some cases, to avoid the use of very short closures be tween the stock rails and the 'V' crossing in advance, i was the practice to bring the points forward to fish wit the 'V' crossing and lengthen the lead accordingly. Thi practice has now been abandoned to enable the use of stan dard welded closures, as explained in 13.007.

   Special stock rails are now provided of a length suitabl for the layout. See 14.003.

3. When switches of other than the required length have bee laid in leads designed for a given length of switch, as i cases where 15'9" switches have been used in No. 7.52 turn outs and 18'0" switches have been used in No. 8.7 turnouts

   This arrangement was used to some extent in re-laying o the North East main tracks for the purpose of reducing th distortion of the points under the action of the big loco motives.

LEAD VARIATION

Under different conditions the leads and distances D^1,I and D^3 may vary together or separately in turnouts and junc tions of the same No. as follows : -

1. Using different switch angles (the angle or rate of switch depends on the length of the switch and the hee spread).

2. Using curved or partly curved switches.

3. Using curved or partly curved crossings.

4. Combination of 1 and 3, or 2 and 3.

5. Combination of 1 or 2 with straight 'V' crossings.

STANDARD TURNOUTS OFF STRAIGHT TRACK

The leads (switch heel to P. of I.) used for the standard turnouts are as follows : -

Turnout No.	7.52	8.7	9.73
Lead	55'4.1/8"	63'11.1/16"	71'5.11/16"

The switch length and distance from the switch heel to the nose of crossings of the different weights and types in service are shown in Table 13.085.

MAIN TRACK TURNOUTS

Main track turnouts are now designed with 22'6" switches to permit the passage of 8 coupled wheel locomotives without switch distortion.

The true lead is used in the arrangement of these turnouts, and curved crossings are sometimes necessary to provide suitable curvature in the turnouts.

The distance from the switch heel to the nose of crossing measured along the straight main track is as follows for 94 & 107 lb. material.

Turnout No. Straight Crossings	Switch Length	Distance Heel to Nose	Radius of Outer Rail
8.7 9.73	22'6" 22'6"	67'3.1/4" 74'6.1/4"	644.882' 826.072'

Turnout No. Curved Crossings	Switch Length	Distance Heel to Nose	Radius of Outer Rail
8.7 9.73	22'6" 22'6"	71'5.9/16" 78'6.1/2"	752.153' 946.937'

SPECIAL TURNOUTS

The leads and radii for straight-switch straight-crossin turnouts of special No. are worked out exactly by the TRU (1 LEAD method as required; these values have been graphed t enable approximate leads and radii to be read by inspection.

DESCRIPTION OF GRAPH

This graph is shown in Fig. 106, and although not suf- ficiently accurate for the final design of trackwork layouts, this information enables a rapid comparison of lead distances and radii with crossing Nos. etc.

The lead distances shown on the graph are from the S.P. C. (at the heels, see Fig. 104B) to the C.P.C. (at the mouth of the 'V' crossing, see Fig. 105B). This is distance D shown in Fig. 98.

The graph consists of four scales which are as follows:-

(2

(1) Switch Length. This is found on both the left-hand and the right-hand sides of the graphs.

(2) Crossing No. This is found on the bottom of the graph.

(3) Turnout Outer Rail Radius. These are the lines curving from the top left-hand corner of the graph toward the lower right-hand corner.

(4) Lead Distance D^2. These are the lines curving from the top right-hand corner of the graph towards the bottom (3 left-hand corner.

USES OF GRAPH

Given Data	Data found by reading off Graph
1. Switch length and Crossing No.	Lead Distance D^2 and radius
2. Switch length and radius	Lead Distance D^2 and Crossing No.
3. Switch length and Lead Distance D^2.	Radius and Crossing No.

The use of the graph for the determination of switch length having regard to speed of trains is beyond the scope of this Course and is a matter for the Mechanical Trackwork Engineer.

TYPICAL EXAMPLES

(1) If a 22'6" switch be used with a No.15 crossing, the lead distance D^2 and the radius of the turnout can be found as follows : -

From 22'6" switch length project a line horizontally across the graph till it intersects the vertical line projected up from No. 15 crossing.

It will then be seen that the radius of the turnout lies between 2100' and 2200' and by proportion it is approximately 2175'.

The lead distance D^2 will be seen to lie between 100' and 110' and by proportion is approximately 101'4".

Therefore with a 22'6" switch used with a No.15 crossing the radius is approximately 2175' and the lead distance D^2 (Fig.98) is approximately 101'4".

(2) If a 16'6" switch be used with a radius of 700' the lead distance D^2 and the crossing No. can be found as follows:-

From 16'6" switch length project a line horizontally as before until it intersects the 700' radius line; by projecting this intersection down to the bottom scale the crossing No. will be found to be No. 8.90. Also the lead distance D^2 will be seen to lie between 50' and 60', and by proportion is approximately 59'0".

Thus a 16'6" switch used with a radius of 700' requires a No. 8.90 crossing and a lead distance D^2 of 59'0".

(3) If a 15'0" switch be used with a lead distance D^2 of 50'0" the radius and crossing No. can be found as follows : -

From a 15'0" switch length project a line horizontally as before until it intersects the 50' lead distance line; by projecting this intersection down to the bottom scale the crossing No. will be found to be No.7.64 and the radius will be seen to lie between 500' and 600'. By proportion it will be found to be approximately 510'.

Therefore, if a 15'0" switch be used with a 50'0" lead distance D^2 the crossing required is No. 7.64 and radius is 500'.

The necessary lines as described in these examples are shown on the graph Fig. 106.

JUNCTIONS

As in the case of special turnouts the leads and radii junctions are worked out as required, but graphs have been pr pared to enable approximate values to be read by inspectio

DESCRIPTION OF GRAPH

A typical graph is shown in Fig. 107 and is for 22'6 Straight Points and Straight Crossings.

The graph consists of four major scales : -

(1) Crossing No. This is found on the left-hand side of t graph.

(2) Main Line Radius, Similar Flexure Junctions. These a the lines curving from the top right-hand corner of t graph toward the lower left-hand corner.

(3) Main Line Radius, Contraflexure Junctions. These are t lines curving from the bottom left-hand corner of t graph toward the top right-hand corner.

(4) Turnout Radius. This is the sliding scale along the bo tom of the graph. The scale is shown this way so as separate the main line radius lines. The turnout rad are the figures on the right-hand end of the scale and figures on the left under scale column represent the pa ticular main line radius being used.

USES OF GRAPH

This graph can be used in two ways, namely : -

(1) Given crossing No., main line radius and type of junctio the turnout radius can be found.

(2) Given main line radius, turnout radius and type of jun tion, the crossing No. can be found.

TYPICAL EXAMPLES

(1) A set of 22'6" straight points is to be used with a No.1 straight crossing in a similar flexure junction. Th main line radius is 3000'.

To find the turnout radius proceed as follows : -

From No.12 project a line across the graph horizontally till it intersects the 3000' similar flexure main line radius line. From this intersection drop a vertical line down to the turnout radius scale till it intersects the 3000' scale column line. It will then be seen that the turnout radius lies between 800' and 1000',and by proportion is approximately 910'.

(2) A set of 22'6" straight points is to be used in a contraflexure junction. The main line radius is 2000' and the turnout radius 800'.

To find the crossing No. required proceed as follows :-

From the intersection of the 2000' scale line with the 800' turnout radius line project a line vertically upwards until it intersects the 2000' contraflexure main line radius line on the graph. From this intersection project a line horizontally across to the crossing No. scale. It will then be seen that the crossing required is a No. 8.20.

JUNCTION LEADS

The lead in a curved junction differs in length slightly from that of a turnout off the straight, but for isolated junctions this difference is of no practical importance provided that suitable closures are available. When however, the junction forms part of a layout the TRUE LEAD must be used to enable alignment and gauge to be established.

It was formerly the practice to select an exact radius for the minor junction track and in combination with the known radius of the main curved track to calculate the required crossing No. This practice necessitated the construction of many special No. crossings, which in turn required special patterns and special workshop methods and equipment, thereby adding to the cost of the crossings and slowing down the rate of production.

This practice has now been reversed and from diagrams a standard No. crossing is selected to provide a suitable radius for the minor junctions,and the turnout radius is calculated from these particulars.

The lengths of closures are calculated at the runni edge and allowances are provided for loss or gain in curvi and setting rails. Curving of the selected No. crossing i effected during manufacture, and the closure rails of 94 lt and 107 lb. main trackwork are cut, curved and bored rea for installation.

INTERSECTION DISTANCES

When one or more tracks cross through other tracks tl running edges of the rails meet within the crossings at tl Point of Intersection or P. of I. In all intersecting trac work the accurate location of the crossing intersections is necessity to ensure correct gauge and guard rail gauge.

PARALLEL STRAIGHT CROSSOVERS

The intersection distance in crossovers between paralle straight track is measured along the straight track from tl nose of one 'V' crossing to a point square off the nose c the opposite'V'crossing,as shown in 13.025,Fig.28. See 13.02

Space will not permit of tabulating the nose to nose dis tances for crossing Nos. of different weights at vario track centres,but for standard crossings reference to the fo lowing table and Table 14.079 will provide the data require

CROSSOVERS BETWEEN PARALLEL STRAIGHT TRACKS.

INTERSECTION DISTANCES

Track Centres	Crossing Nos 7.52	8.7	9.73	12	15
11'8"	8'5 3/16"	9'10 3/16"	11'1 1/16"	13'9 3/8"	17'3 7/8
12'0"	10'11 5/16"	12'9"	14'4"	17'9 3/8"	22'3 7/8
12'8"	15'11 1/2"	18'6 9/16"	20'9 13/16"	25'9 3/8"	32'3 7/8
13'0"	18'5 5/8"	21'5 3/8"	24'0 3/4"	29'9 3/8"	37'3 7/8
15'0"	33'6 1/4"	38'10 3/16"	43'6 3/8"	53'9 3/8"	67'3 7/8

Example: -

Determine nose to nose distance for a parallel straight track crossover at 12'0" track centres using No. 7.52, 60 lbs. 'D' class 'V' crossings.

From 13.082	Intersection distance	=	10'11.5/16"
From 14.079	Nose to P. of I.	=	2.3/4"

Nose to nose distance =

Intersection distance - 2 times P. of I. to nose.

Thus : -

		10'11.5/16"
- 2 x 2 3/4"	=	5.1/2"
Nose to nose	=	10' 5.13/16"

If a crossover is met with in which the track centres are non-standard, the intersection distance can be found as follows : -

1. Under the particular crossing No. take the intersection distance for the next lowest track centre.

2. Add the product of the crossing No. and the distance by which the actual track centre exceeds the next lowest track centre in the table.

Example : -

To find the intersection distance for a No. 8.7 crossover laid between parallel straight tracks at 11'10" track centres.

For No. 8.7 crossovers at 11'8" track centres, intersection distance is	9'10.3/16"
Difference 11'10" - 11'8" is 2 inches.	
Product of crossover No. and difference in track centres is 8.7 x 2 = 17.4 inches	= 1' 5.13/32"
Required intersection distance is	11' 3.19/32"

As the P. of I. cannot be located in practice to nearer than 1/16", the following decimal and fraction equivalents may be worked to : -

inches		inches	
.1	3/32 inches	.5	1/2 inches
.2	3/16 inches	.6	19/32 inches
.3	5/16 inches	.7	11/16 inches
		.8	13/16 inches
.4	13/32 inches	.9	29/32 inches

DIAMOND CROSSOVERS

When straight tracks intersect two or more paralle straight tracks to form diamond crossovers as in Fig.108, th intersection distances A, C, and D, can be found as follows:-

A or C = Gauge x Crossing No.
D = (Track Centres - Gauge) x Crossing No.

Distance B can be found approximately with sufficient accuracy for emergency installation of crossing of greater numbe than No. 4 as follows : -

B = Gauge + twice the Crossing No.

Example : -

To find the intersection distance for a No. 8.7 doubl track crossover at 12'0" track centres.

A or C = 5.25 x 8.7 = 45.675' = 45' 8.3/32

D = (12 - 5.25) x 8.7
= 6.75 x 8.7 = 58.725' = 58' 8.11/16

$$B = \frac{5.25}{2 \times 8.7} = 0.3017' = 3.\ 5/8"$$

In diamond crossovers of lesser number than No. 4, th 'V' and 'K' crossings fish together, closures are not required and data for emergency installation is therefore not included in these papers.

STANDARD TURNOUTS. HEEL TO NOSE DIMENSIONS

NO. 7.52 TURNOUTS

Weight	60D	60AS	60AS	80 O 80AS	90AS	90AS 110AS	100 P 100AS	110AS	94AS 107AS
Type		1921	1935		1928	1935		1929	1942
Switch length	15'0"	15'0"	15'0"	13'6"	13'6"	13'6"	13'6"	13'6"	15'0"
Distance heel to nose	55'6 7/8"	55'6 1/16"	55'7 7/8"	55'6 1/2"	55'6 7/8"	55'7 7/8"	55'7"	55'7 1/4"	55'9 13/16"

NO. 8.7 TURNOUTS

Weight	60D	60AS	60AS	80 O 80AS	90AS	90AS 110AS	100 P 100AS	110AS	94AS 107AS
Type		1921	1935		1928	1935		1929	1942
Switch length	15'0"	15'0"	15'0"	15'9"	15'9"	15'9"	15'9"	15'9"	16'6"
Distance heel to nose	64'2 7/16"	64'1 1/2"	64'3 7/16"	64'2 1/16"	64'2 7/16"	64'3 7/16"	64'2 9/16"	64'2 7/8"	64'5 5/8"

NO. 9.73 TURNOUTS

Weight	60D	60AS	60AS	80 O 80AS	90AS	90AS 110AS	100 P 100AS	110AS	94AS 107AS
Type		1921	1935		1928	1935		1929	1942
Switch length	15'0"	15'0"	15'0"	18'0"	18'0"	18'0"	18'0"	18'0"	16'6"
Distance heel to nose	71'9 5/8"	71'8 5/8"	71'10 9/16"	71'9 3/16"	71'9 5/8"	71'10 9/16"	71'9 13/16"	71'10 1/8"	72'1"

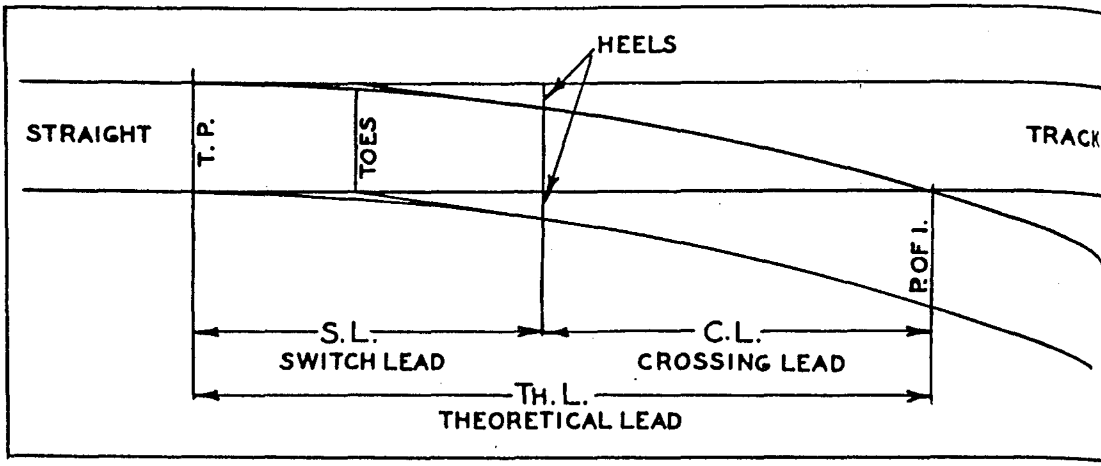


FIG. 96. THE THEORETICAL, CROSSING AND SWITCH LEADS

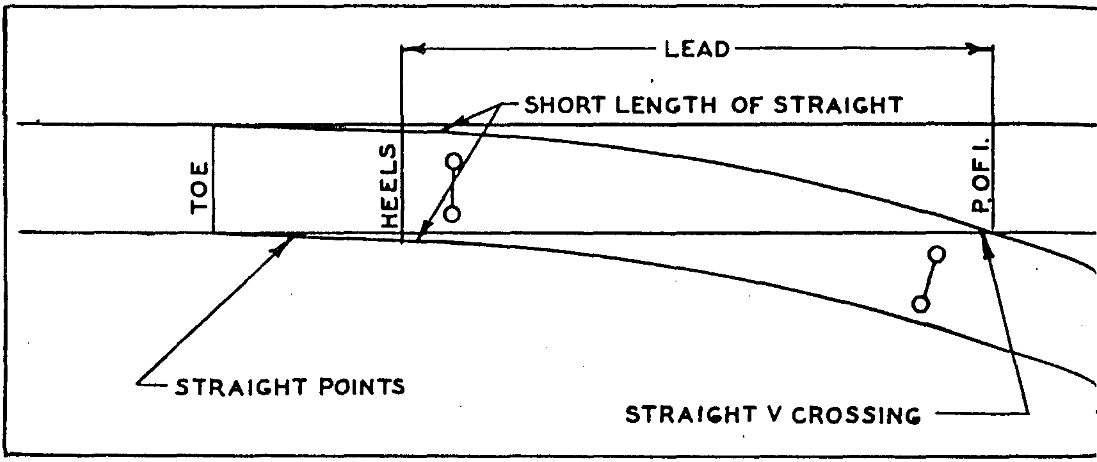


FIG. 97. THE LENGTH OF STRAIGHT ADJACENT TO THE HEEL

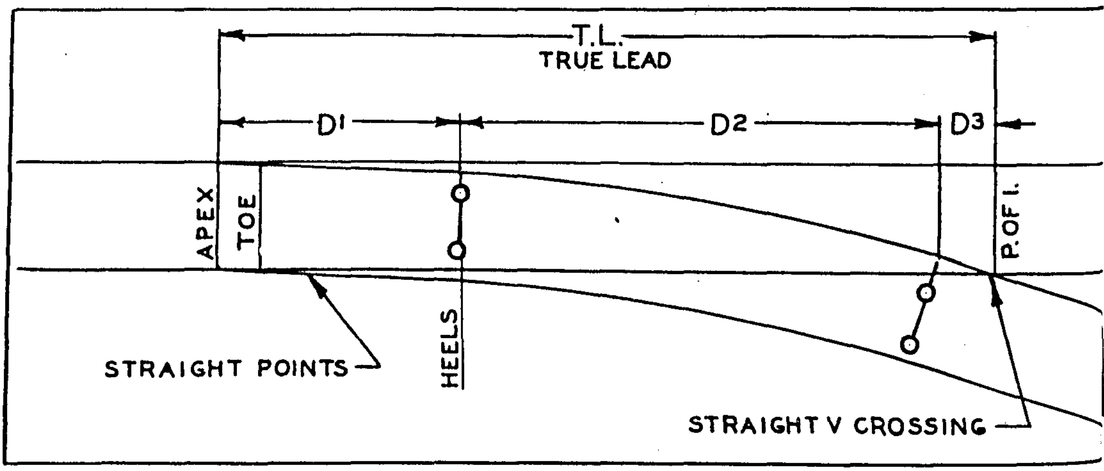


FIG. 98. THE TRUE LEAD AND THE LEAD

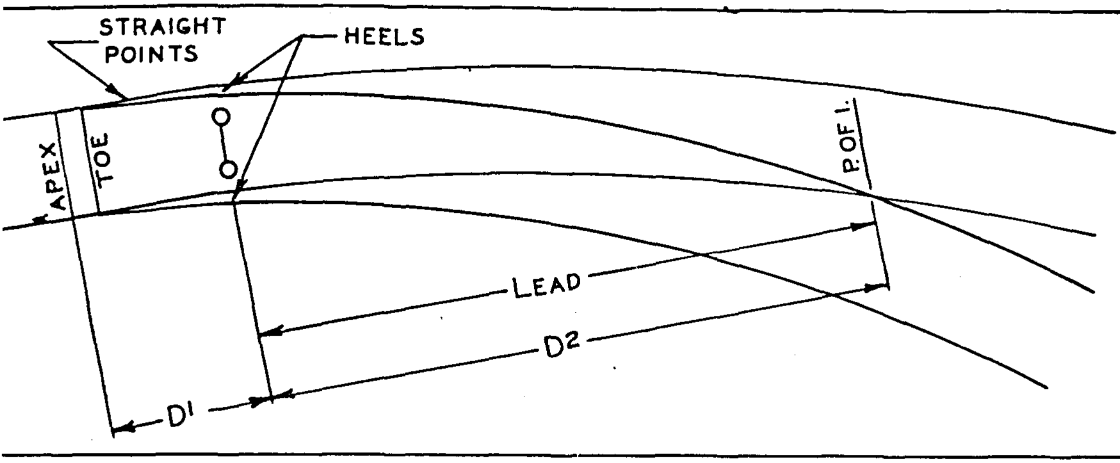


FIG. 99. THE LEAD OF A SIMILAR FLEXURE JUNCTION USING STRAIGHT POINTS

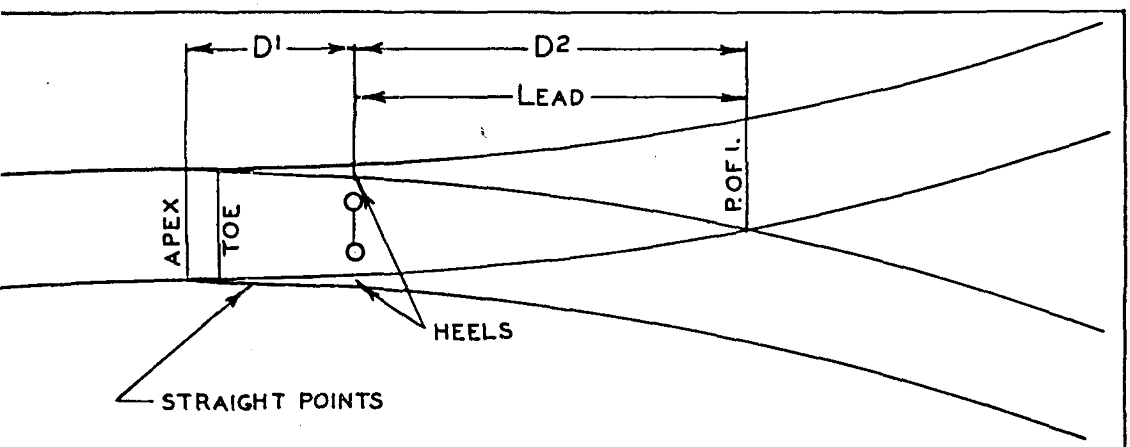


FIG. 100. THE LEAD OF A CONTRAFLEXURE JUNCTION

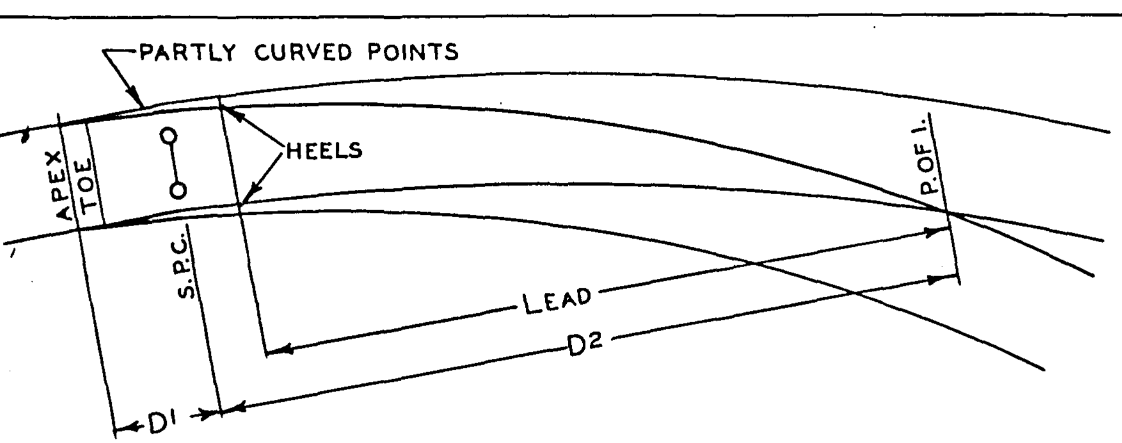


FIG. 101. THE LEAD OF A SIMILAR FLEXURE JUNCTION USING CURVED POINTS

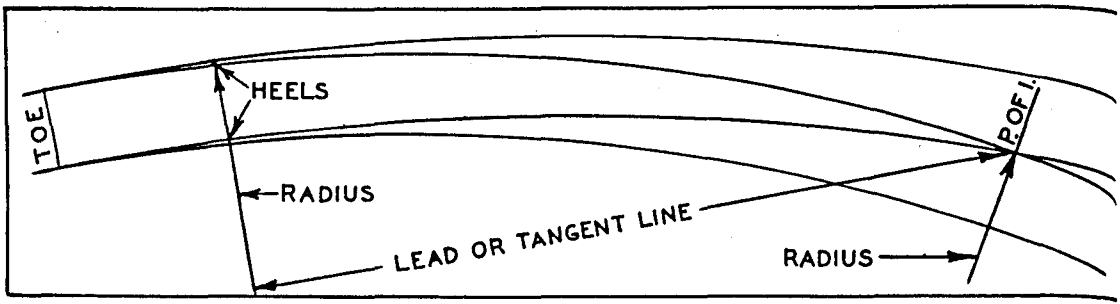


FIG. 102. THE TANGENT LINE OF A SIMILAR FLEXURE JUNCTION

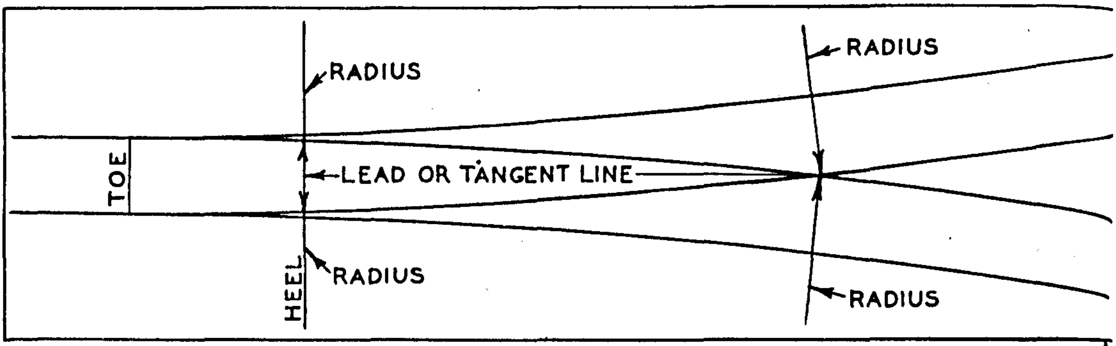


FIG. 103. THE TANGENT LINE OF A CONTRAFLEXURE JUNCTION

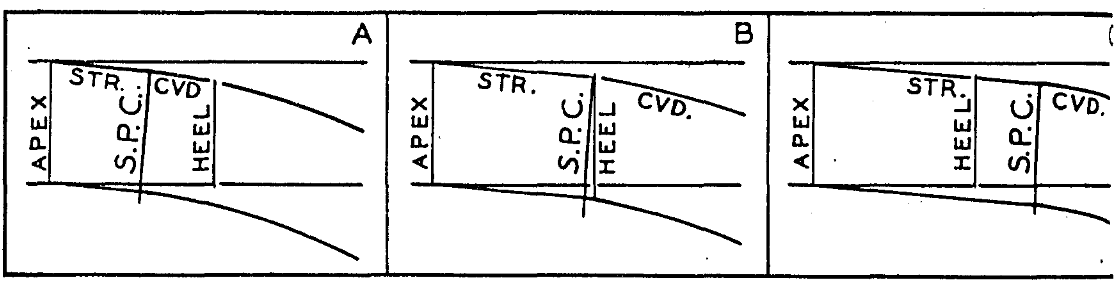


FIG. 104. THE THREE POSITIONS OF SWITCH POINT OF CURVATURE

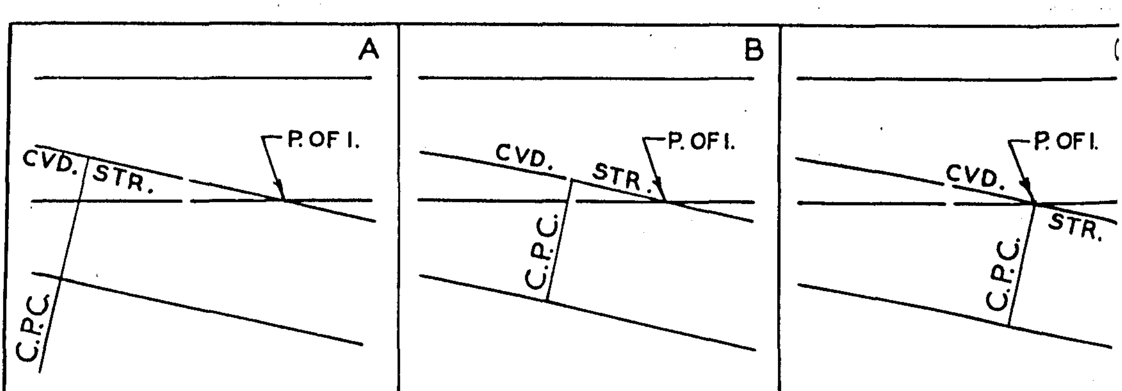


FIG. 105. THE THREE POSITIONS OF CROSSING POINT OF CURVATURE

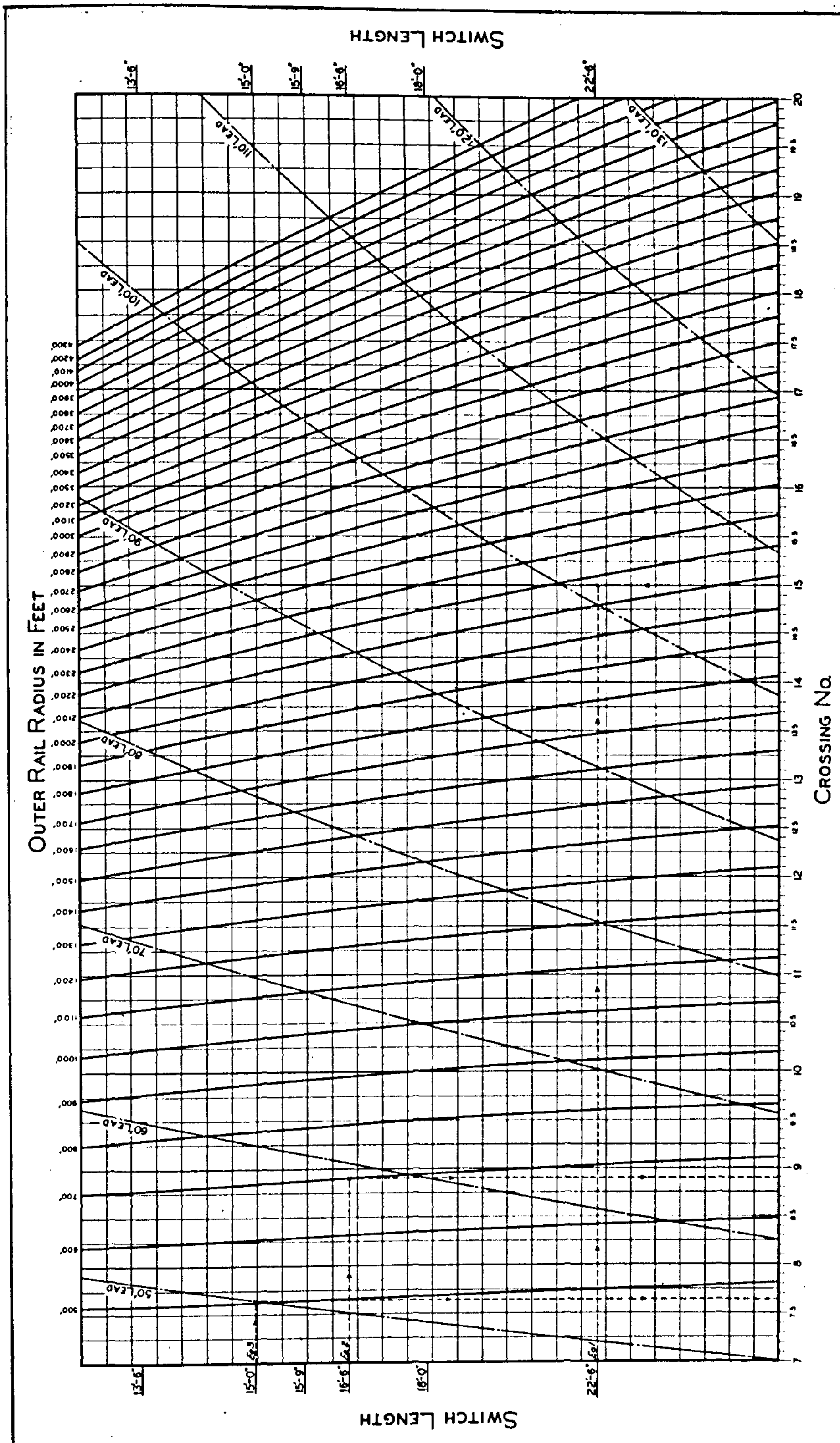
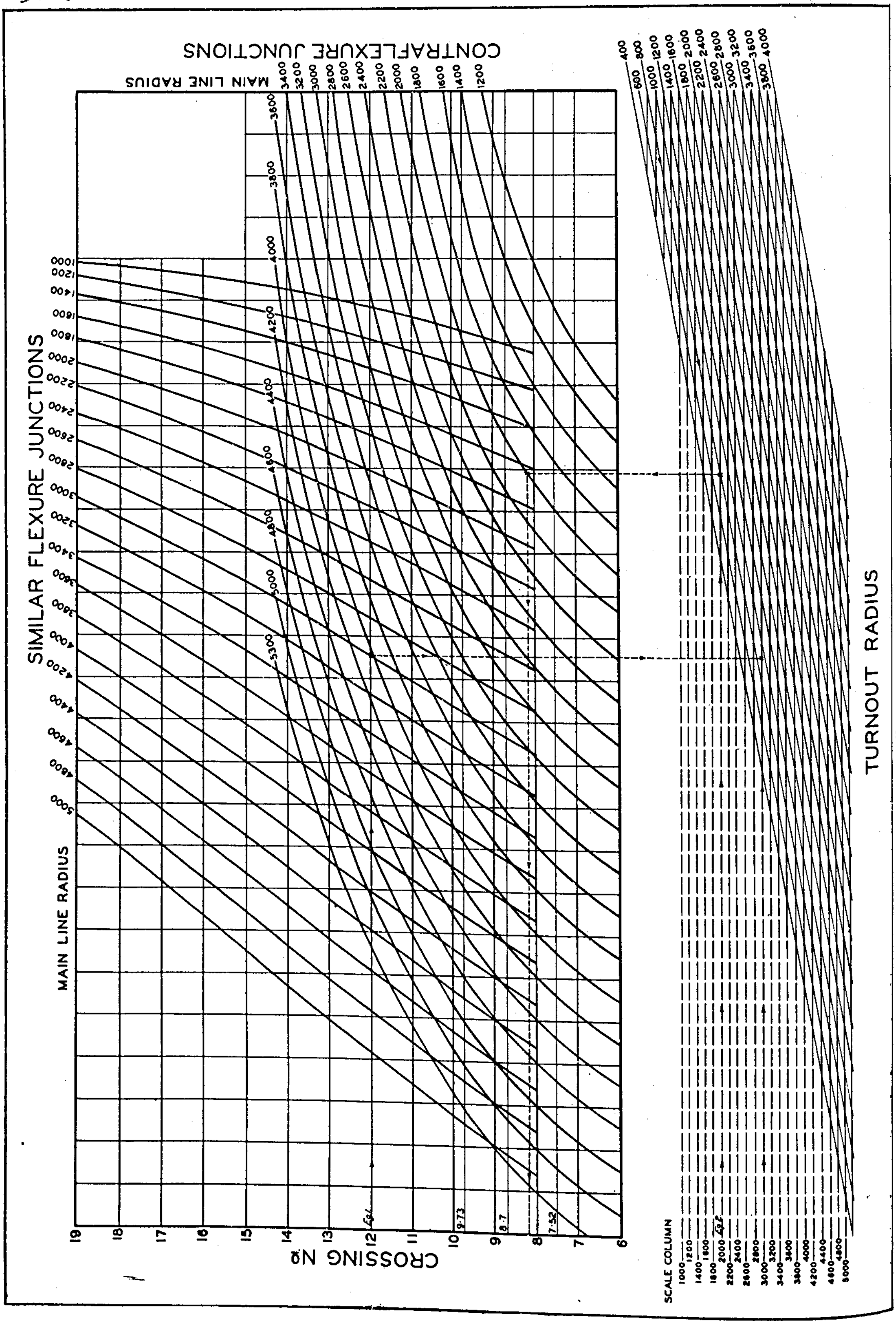


Fig. 106. Turnout Graph, Straight Switches & Crossings.


CONTRAFLEXURE JUNCTIONS
MAIN LINE RADIUS
SIMILAR FLEXURE JUNCTIONS
MAIN LINE RADIUS
TURNOUT RADIUS
CROSSING No
SCALE COLUMN

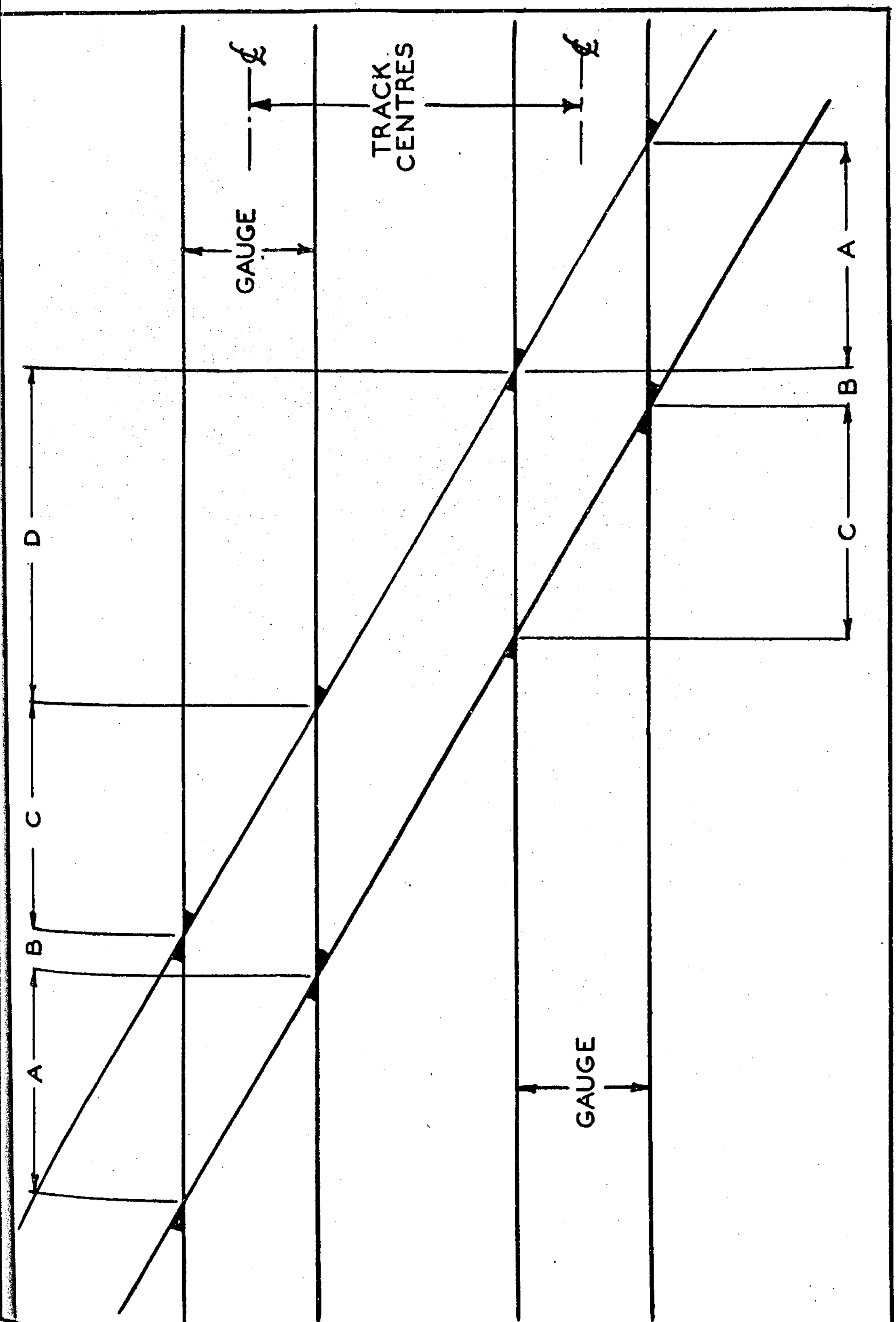


FIG.108. INTERSECTION DISTANCES DIAMOND CROSSOVERS

TIMBERING

ARRANGEMENTS

In trackwork layouts the wheel loads pass over two or more pairs of rails closely spaced, and a strong track structure is necessary to distribute the loading on the formation. For this purpose sawn timbers of heavy section and lon lengths are required, and 12" x 6" timbers are now used in al standard layouts.

It is frequently difficult to properly pack timber under crossing work, and under these conditions the crossin timbers are required to act as beams for a portion of thei length. Timbers of 12" x 6" cross section are rather springy under these conditions and 10" x 7" would be better suited t the purpose, but as this is not a regular size 10" x 8" have been considered and are at present under test at Tallarook.

The length of the timbers vary according to the layout and the proximity of other trackwork; the longest timbers generally used are 20'0". Timbers are purchased in lengths increasing by increments of 6", and it is now the practice t lay the timbers with their ends in alignment with the straight track rail in all turnout trackwork, and with the outer rail of curved trackwork.

The former practice of cutting the out ends to equal length for the inner rail of turnouts and other curved trackwork has been discontinued. With the full ballasted trackwork now installed, this work, originally done for neatness, contributes nothing to the appearance of the trackwork.

Spacing of the timbers in trackwork layouts is of considerable importance, and neglect in this regard can only result in the rapid destruction of expensive trackwork. Because of the position of the joints in trackwork it is not always possidle to arrange equal spacing, but in designing the layouts it is the practice not to exceed 2'3" centre to centre. The closest permissible spacing is 1'8" centre to centre at joints.

In selecting the timbers for the various positions in trackwork layouts it will usually be possible by a little forethought to so place the timbers that knots, gum veins and other imperfections do not lie immediately under the rail seat or where fastenings are to be secured.

In some instances it is not possible to obtain a satisfactory arrangement of timber spacing between joints, and to improve the uniformity of loading on the formation the timbers are spaced to permit an occasional joint being centrally supported on a through timber.

Uniformity of timber spacing may be of more importance than uniformity of length in the crossings, and in special crossing work this is frequently a deciding factor in fixing the lengths of the special crossings and the positions of the joints.

Under insulated joints the timbers must always be spaced 1'8" centre to centre and equi-distant from the joint centre.

Through timbers are invariably provided at the joints and, as far as possible, alternate through timbers under the crossings and guard rails to ensure an adequate tie across the gauge at the gaps of the crossings.

The former practice of placing a timber directly under the nose of crossings has been discontinued with the new undermachined crossings, but is still necessary with old standard crossings which rely largely on the support afforded by the timbers to maintain the crossing nose at the correct height relative to the crossing wing rails.

Solidly packed timbers placed directly under the nose of a crossing form an anvil upon which the crossing nose rail is bruised and flattened down, for at this position wheels are running off the crossing wing rail with more or less impact according to the condition of wear on the treads of the wheels.

POINTS

Timbers under points should be of the best quality, but if there is a choice of soundness between the ends of the timbers the better ends should be placed under the straight stock rail to afford good fastening of the point chairs which have to take the whole of the side thrust on the diverging point blade.

Timbers at the toes of points are frequently required to extend, usually on one side, for the support of point operating mechanism; the arrangements of these timbers vary according to requirements, and those commonly in use for hand worked points are shown in 16.19, Fig. 16. Other special arrangements are required for which detail drawings are supplied.

For safety and for the free movement of points the timbers under the points should be of full section, straight an without wind.

The timber spacing under the new 94 and 107 lb. point has been reduced to afford more solid track conditions and the timbers adjacent to the heel timber are closely spaced t improve the support at this important position.

The stock rails in earlier standard points are incline at 1 in 20, and to fish with the vertical closure rails in the layouts, it is necessary to run out the 1 in 20 inclination to vertical on the three timbers behind the point hee by reducing the adzing by 1/16" at each timber.

When points with 1 in 20 inclined stock rails abut crossing work with vertical rails as in Ladder Turnouts, 13.012 Fig. 12, it is necessary to run out the 1 in 20 inclination by reducing the adzing by 1/16" over the three timbers next t the joint timbers.

In 90 and 110 lb. points the former practice was t check the three timbers under the vertical stock rails behin the heels to gradually let the closure rails down to the timbers. The heels of the point blades in 90 and 110 lb. points are 3/16" higher than their stock rails and the dept of checking was decreased by 1/16" over the three timbers behind the point heels.

As lug plates with various thickness of step, See 14.113, are now standard for this purpose with 94 and 107 lb. points they should likewise be used with any 90 or 110 lb. points in future installations in preference to checking the timbers.

<u>TURNOUTS</u>

As mentioned in respect to the turnouts, timbers under the 'V' crossings are, where practicable, slewed to lie at right angles to the centre line of the 'V' crossing and thus afford more even support across the gauge for either track. In effecting this slew several timbers adjacent to the crossing timbers are gradually slewed round to meet the right angle timbers, as shown in Fig. 109.

Long timbers are continued past the 'V' crossings in turnouts to a position where two 8'0" sleepers can be laid with ends abutting.

Interlacing of timbers in trackwork layouts is not permitted in new work, though commonly in use years ago, and an example of this arrangement in the case of a turnout is shown in Fig.110. With interlaced timbers it is not possible to properly pack the timbers, and for the traffic conditions of today this arrangement is wholly unsatisfactory.

CROSSOVERS

The arrangements of timbers under the 'V' crossings in standard crossovers for 11'8" track centres are shown in Figs. 111, 112 & 113.

As long timbers are becoming increasingly difficult to procure it is now the practice to use, as far as possible, long and short timbers alternately in all layouts requiring timbers over 16'6" in length.

A method much used in the past was to join short timbers by means of the scarf joint shown in Fig. 114. This joint when properly made in sound tough timbers is very satisfactory, provided iron bolts are used and the ballast is well drained. In wet locations the steel bolts now commercially available are quickly corroded and broken, and the moisture, long retained in the scarf joint, tends to promote decay in the timber.

Scarf joints between timbers of different kinds and different conditions of seasoning are of little value as the scarf works loose and the ballast works into the joint and rapidly wears the bearing surfaces. They are not now regarded as necessary in general trackwork, but may occasionally be used with advantage in special circumstances.

DIAMONDS

The standard arrangement of timbers in diamond layouts is at right angles to the longitudinal centre line of the diamond as in Fig. 115, but in complicated layout work it is sometimes necessary to arrange the timbers for the local conditions particularly when long through timbers are necessary. In all special cases plans are supplied giving the necessary timbering particulars.

The timbering under diamonds approaching the right angle or square diamond are variously arranged according to the relative importance of the two tracks. Usually longitudinal timbers of heavy section are placed under the least important track and transverse timbers 12" x 6" are placed under the more important track with due regard to joint positions. See Fig. 116.

SPRING 'V' CROSSINGS

The earlier spring 'V' crossings had the foundation plates rivetted in position with common round or snap head rivets which protruded through the plates and it was necessary to counter bore the timbers to house the rivet heads.

All spring 'V' crossings are now made with counter-sunk rivets in the foundation plates, but the horn guide box and spring box are each secured with two 1" chair bolts with relatively flat heads, and it is necessary to counter bore the timber under the bolt heads to seat the crossing on the timbers. See 14.093, Fig. 97.

GENERAL

Long timbers, when received, should be carefully stacked and evenly supported throughout their length or they will sag and warp and may not be suitable for properly seating the trackwork when laying is commenced.

In placing timbers in position considerable damage may be done to the timbers if the points of picks and bars are driven into the timbers to assist in getting them into position.

Damage will also be effected if, in squaring the timbers to position and spacing, the light, small faced, spiking hammers are used; if a hammer is used it should be a heavy broad faced hammer. Spiking hammers will considerably damage the fibres of the timbers, whereas a heavier hammer has a less damaging effect, the blow being somewhat of a pushing action.

The use of sleeper hooks is much to be preferred for the movement of timbers to their required positions. See 8.09.

Temporary or incorrectly bored spike holes should be plugged with wooden plugs to avoid water getting into the timbers and promoting their decay.

Timber preservation commonly in use in other countries has not been used here other than for test purposes, but with the use and destruction of the better quality timbers it is probable that inferior timbers will in future be treated similarly to sleepers. See 8.05.

It is preferable that the pressure creosoting or other treatment be done after all cutting and adzing has been completed, otherwise all freshly exposed surfaces should be liberally treated with the preservative by brush, or by syringe in the case of spike, pick or bar holes.

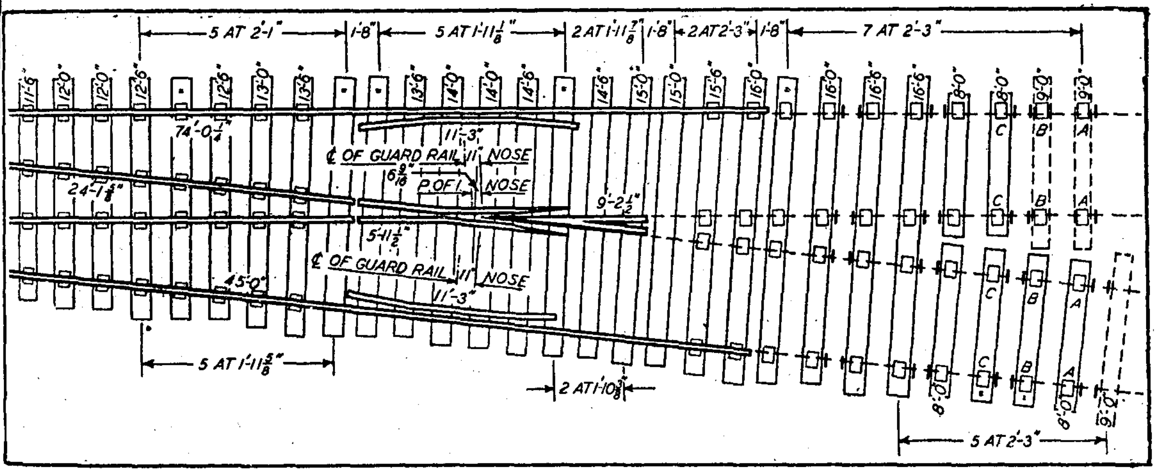


FIG. 109. SLEW OF TIMBERS

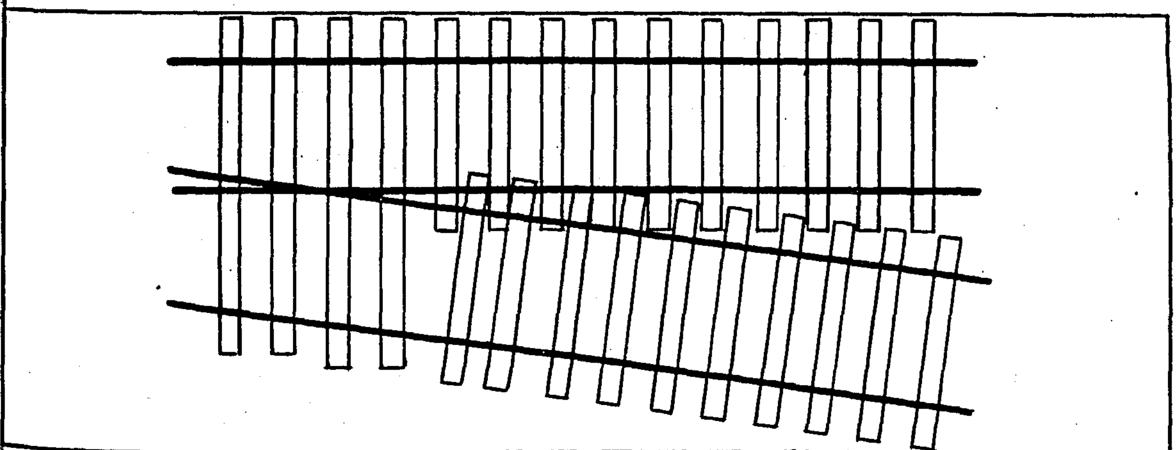


FIG. 110. INTERLACING OF CROSSING TIMBERS.

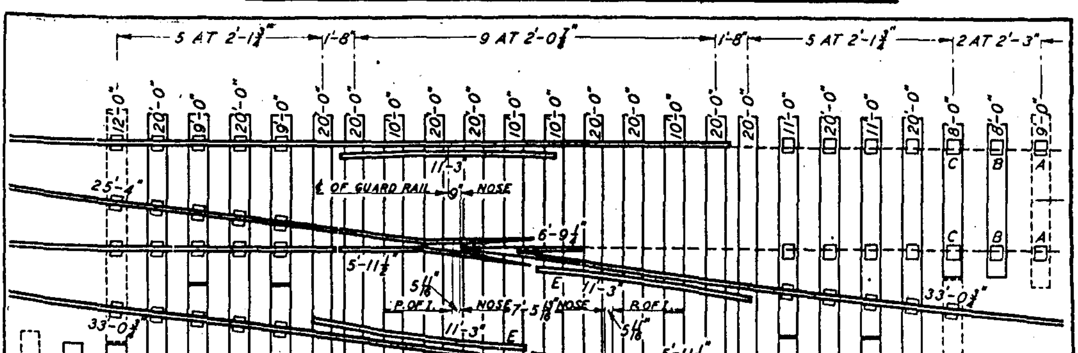


FIG. 111. TIMBERING UNDER V CROSSINGS. NO. 7·52 CROSSOVER

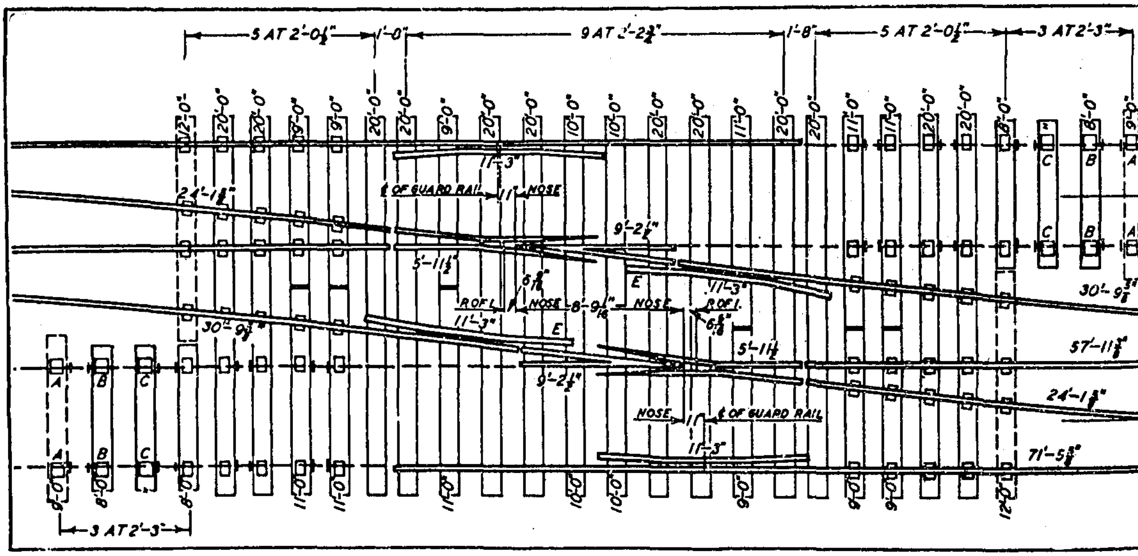


FIG. 112. TIMBERING UNDER V CROSSINGS No. 8·7 CROSSOVER

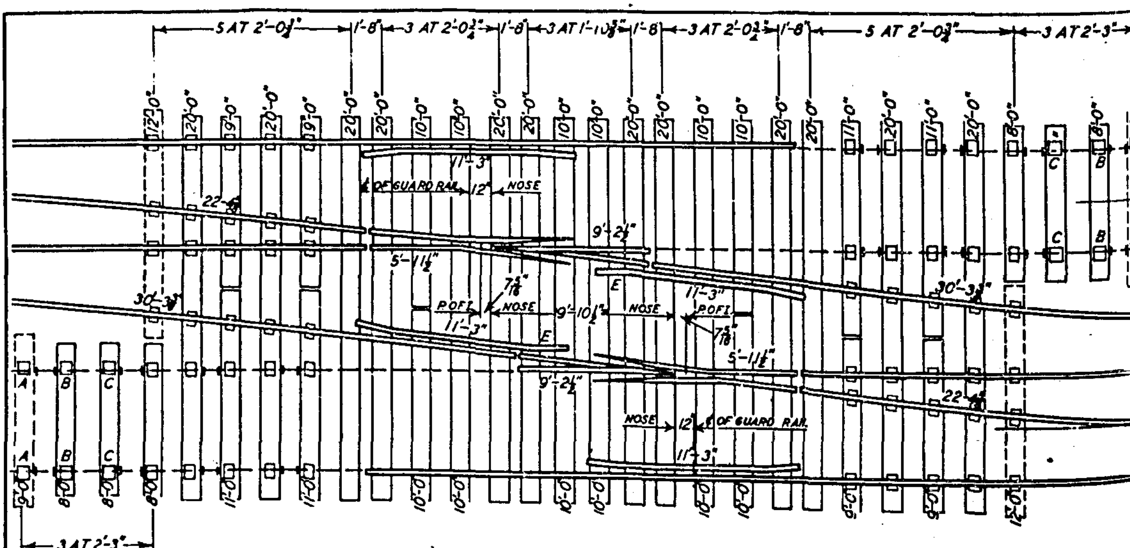


FIG. 113. TIMBERING UNDER V CROSSINGS No. 9·73 CROSSOVER

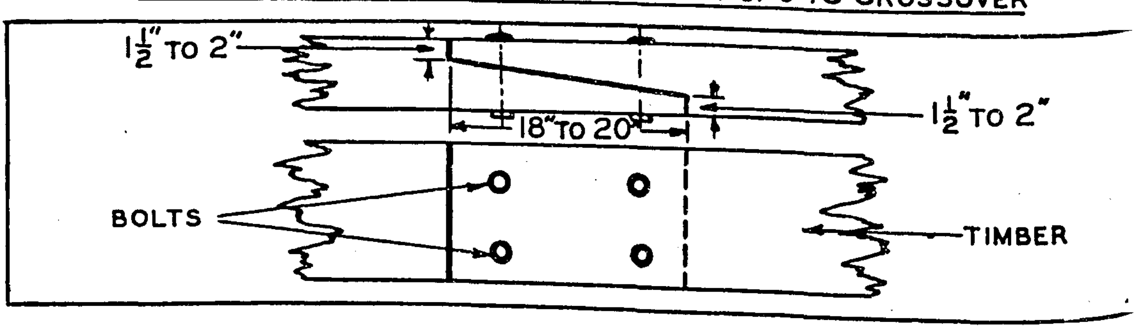


FIG. 114. THE SCARF JOINT

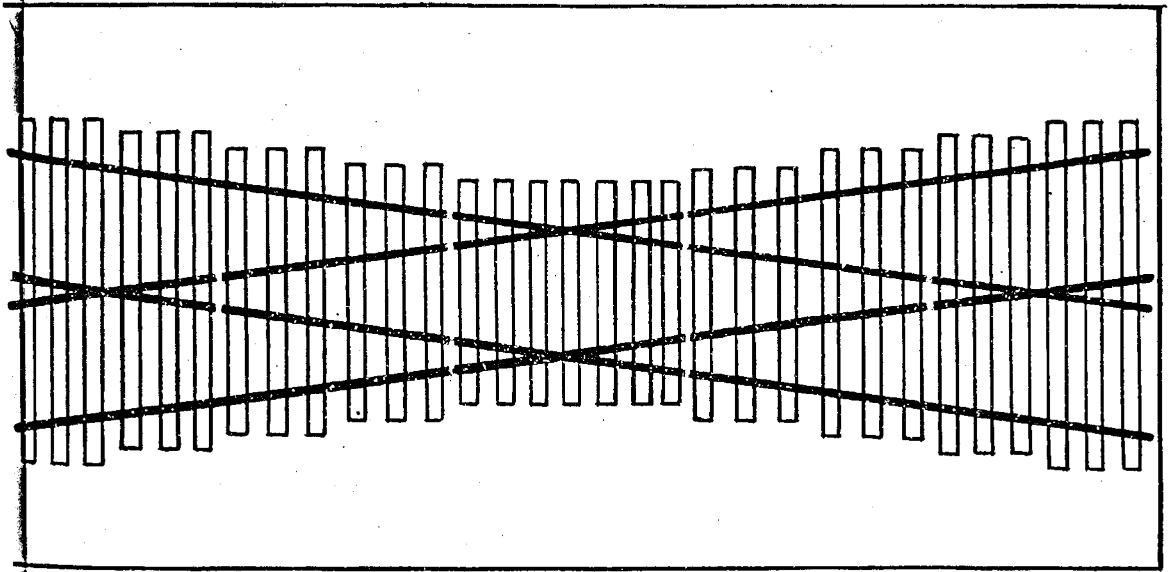


Fig. 115. Timbering of Diamond Layouts

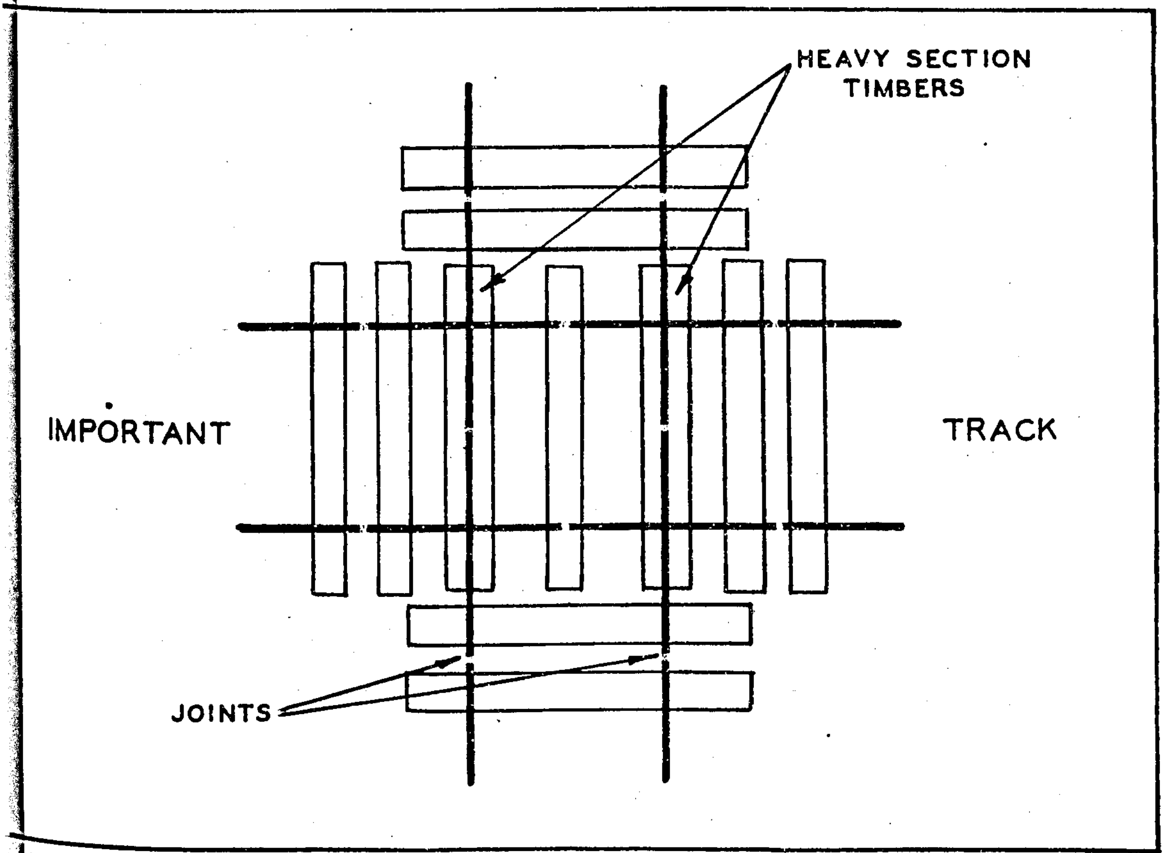


Fig. 116. Timbering of Square Diamond

LAYING TRACKWORK

METHODS

The methods of laying in points and crossings depend on the weight and class of material, the proximity of other trackwork layouts, location, traffic conditions, etc.

In passenger yards where traffic is heavy and occupation may be obtained only for limited periods and sometimes only at night, it is now usual to lay out the new trackwork adjacent to the site of ingoing.

If the layout is complex the necessary location pegs are placed for the temporary layout by surveyors to enable the work to be correctly located, as it will lie when installed in service.

Standard trackwork layouts such as turnouts off straight track, crossovers between parallel straight tracks at 11'8" track centres and standard compounds may be laid out from the measurements shown on standard plans. When, however, standard trackwork layouts are to be laid in conjunction with non-parallel tracks or curved trackwork layouts, the necessary location pegs are fixed by surveyors.

With welded closure rails the standard trackwork layouts cannot generally be assembled to other than the correct lead dimensions, but as tolerances in manufacture and adjustment of expansion spaces may slightly alter the relative positions of the trackwork units, it is of importance to check the measurements from the point heels to the noses of the crossings, and between the noses of crossings where two or more crossings are involved.

The longest straight portion of the layout should be assembled and lined before laying in the curved portions, as the curvature is generally located by offsets from the straight portions. In the case of a fully curved trackwork layout a convenient tangent is usually shown from which the positions of the points and crossings may be fixed by tape measurements and offsets.

PREPARATORY WORK

Preliminary to the commencement of laying out the trackwork adjacent to its intended position, the site must be measured, cleared of obstructions and levelled off sufficiently to enable the timbers to be laid out in position, packing to be used where required in depressions.

When the starting point and the direction for the layout have been selected, the alignment of the straight or tangent shown on the plan should be established by the aid of a strong, fine string-line and temporary stakes be driven at measured positions for the offsets.

The timbers may then be laid out to the lengths and in the approximate positions shown on the plans, and the out ends be brought to their intended alignment.

The straight stock rail half of the points and other straight rail work should next be laid and the crossings be placed in position.

When the straight portion has been brought to alignment, the positions of timbers may be marked on the rails and any correction to position be adjusted before holding the rails with gouges.

The set stock rail half of the points may next be placed, followed by the curved closure rails, and all rails be brought to gauge.

A further check of the timbering may now be made to correct slews for joint positions, butt the short timbers and adjust the out ends.

At this stage an inspection of the timbers will reveal if knots or gum veins will interfere with the security of fastenings and some changing of timbers may be necessary to avoid this condition.

Closures which it may be required to cut on the site should be at approximately the same temperature as the rails in the layout, otherwise the 1/8" expansion spaces will not be correct.

Rails measured and cut in the shade will throw a layout out of position when installed under exposure to direct solar heat, the amount of distortion depending on the length of rail and the difference in shade and sun temperature. See 9.18.

In like manner, prepared curved closures may not fit if the temperature of the rails varies considerably.

After the steel work is in alignment and to gauge, the points can be fastened down and the crossing and closure rails be skeleton spiked to correct offsets for curvature.

The whole layout should now be checked over dimensional-ly, the joints tried for correctness of fitting, and al fastenings be examined to see that they are correct and wil present no difficulties in being fully secured when the lay-out is installed in track.

If the exigencies of the work necessitate the boring o the timbers before installation, this may be done, and wil probably be more accurate than if performed in the limite time available for installation.

Arrangements should be made with the Signal Division t install and test as much of the signal gear as possible t the points and thus reduce the amount of work necessary whe the permanent installation is undertaken.

The layout should now be complete in every detail, wit the exception of the permanent spiking, and when installe should conform exactly to the temporary layout.

To ensure orderly transfer into its track position, al timbers should be numbered and matching marks made on th rails, a brush mark with white paint being very effective i the work is to be installed by night. Closures and joint should, if not match marked in manufacture, be marked with letter or number for identification.

String lines should be run along the centre lines or o convenient chords in curved trackwork, and a light saw cut b made along this alignment on each timber. See. Fig.117

If the layout is to be trucked to the site of installa-tion, consideration should be given to the order of loadin the material so that double handling will not be necessary o the job.

BREAKING OUT

The manner of breaking out the existing work must als be considered, fastenings should be worked over to see tha they can be readily removed and if any cutting out is to b performed, arrangements should be made for oxy-acetylen equipment and operators to be present for this work.

Tool equipment, lamps, flares and ambulance material should be checked over and provision be made for crane assis-tance, if required, and facilities for stacking or material train for loading the released materials should be arrange well before the work is undertaken.

If practicable the new material should be laid out on one side of the site of installation, and the stacking site or position for the materials trains for the outcoming materials be arranged on the opposite side of the work.

In station yard trackwork layouts the existing track levels may have to be maintained and the old layout will require to be stripped of ballast before breaking out. When the trackwork is weakened in this way speed restrictions must be enforced.

Temporary support may be necessary to enable under-rail work to be prepared as far as practicable before laying the new trackwork and 12" x 12" x 1'6" oregon blocks are available for this purpose.

LAYING IN

As the timbers are brought into position on the night of the job their positions can be fixed by a tape measure, their order by the numbers, and the alignment by the saw cuts and string lines; thus the minimum amount of re-spacing and end movement will be required.

If crane power is available, and there is no overhead interference, a section of the layout may be lifted into position; in this case the permanent spiking is done in the temporary layout.

In the absence of crane power the layout must be dismantled and lifted or skidded across into the permanent position piece by piece. When several tracks have to be crossed with the material, it will be found convenient to use timber and rail tongs. See 15.20, Figs. 18-20.

Some adjustment of timber spacing may be necessary owing to the position of pegs, signal rodding and drainage covers, and this can be done by the use of goose necked bars to lift the rail at adjacent timbers and sleeper hooks to draw the timbers into position. See 8.09.

The use of flogging hammers should be limited to assisting the movement where timbers tend to jamb and time is pressing.

Before the joints are tightened, the lay should be roughly surfaced, otherwise the joints may manently damaged and the steel work be seriously distor

The practice of springing the material into positio should be avoided, and a little extra time in correctly lay ing in valuable material will generally be repaid by smooth running in service and reduced maintenance. If the layou was right in the temporary set up, it must be right in the track position, and any faults are most probably in the ad- joining trackwork.

Faults in adjoining trackwork should be corrected, i practicable, before the new layout is laid in; this may nec essitate pulling the old layout out of alignment, but as re- newal is to be made it is better to concentrate the fault in this section, having regard of course to safety of traffic.

After the layout is in running, usually at reduced speed it will be necessary to re-adjust the expansion spaces, an this should be done with the Rail Joint Adjuster. See 15.18 Fig. 15.

The work is carried out by a special gang and when com- pleted is handed over to the length ganger who should satisf himself that the work is correct and running conditions sat isfactory. If the length ganger is dissatisfied with an feature of the work, that is the time to bring it unde notice.

Chalk marks should be made along the running edges o the crossings, guard edges of crossing wing rails and guar rails, to determine that running alignment is correct.

Pulling a heavy piece of trackwork for minor adjustment of alignment requires the energy of a large gang, and i should not be necessary to bring the special gang back on the job if the layout is proved to be correct on completion.

During the first few weeks in service, settlement will take place and bolts tend to slacken off; early attention t surfacing and bolt tightening should be given by the length ganger whose aim should be to consolidate the layout with a minimum of damage to the steel work and fastenings. Time spent in consolidating a new layout will be amply repaid in future trouble free service.

LAYING COMPOUNDS

Comp should be laid symetrically about a centre line pas through the points of intersection of the 'V' crossi shown in Fig. 118.

From a string line stretched along the centre line the lateral position of the timbers can be fixed, the centres of all symetrical timbers being previously marked by a light saw cut. Joint, toe and heel timbers can then be placed from the dimensions shown on standard plans using the tape along the string line. Intermediate timbers may next be laid in new work, or be dug in later when the work constitutes renewal of an existing compound.

The 'V' and 'K' crossings and straight stock rails should next be laid and the expansion keys be inserted to establish the longitudinal position of the parent diamond. As the 'K' crossings are laid 1/4" tight to gauge they should be centred about the string line as shown in Fig. 118, and gauged as shown in 13.038, Fig. 46.

The inside switches and closures should then be installed and centred about the string line to the offsets shown on 1938 and 1942 diagrams. Offsets were not given on the earlier diagrams and for re-laying 60, 80 and 100 lb. compounds, these particulars, together with the 1938 and 1942 standards, are set out hereunder. See also Fig. 119.

OFFSETS FOR COMPOUNDS			
Weight of Rail	No. of Compound	Heel Offset	Mid. Offset
60, 80 & 100	7.52	1'1.3/8"	1'3.3/4"
	8.7	"	"
	9.73	"	"
90 & 110	7.52	1'1.7/16"	1'4.1/2"
	8.7	1'1.3/8"	"
	9.73	1'1.5/16"	"
94 & 107	7.52	1'2.13/16"	1'4.9/16"
	8.7	1'4.1/8"	1'5.3/16"

Outside stock rails are installed last and laid to gauge at the mouth of the 'V' crossing and 1/8" tight to gauge at the heels of the switches.

Outside closure rails, or the extended heel ends of the set stock rails are laid to gauge off the inside closures at the centre of the compound.

Under traffic conditions it may be necessary to vary the order of laying in from that above described, but the completed compound must conform to the dimensions and offsets shown on standard plans and amplified in the foregoing for the information of trackmen.

Owing to the tightening of the gauge in the waist of the compound, it is a mistake to line one leg and adjust the gauge from this alignment, as the whole of the tightening is then effected on the opposite leg. If the compound is not accurately centred very unsatisfactory running conditions obtain, and the noses of the 'K' crossings are struck and worn on alternate running and guard edges.

As explained in COMPOUNDS, see 13.045, no change of grade or cross level is permitted within a compound.

GENERAL

It is not possible to cover in a publication of this size all of the various layouts to be met with, and to lay down hard and fast rules for laying in trackwork under all conditions, but the foregoing information and the descriptions given in Section 13 should prove helpful to trackmen engaged in laying in trackwork.

Experience and forethought necessarily play a big part in laying in of trackwork, and the assistance of the engineering staff of the Mechanical Trackwork Section is always available on application through the District Engineers.

It cannot be denied that the difference between trackwork well laid and trackwork badly laid depends largely upon the ability of the trackman in charge of this work and the men engaged on the actual work under his supervision.

This point is aptly expressed by Rench, an acknowledged American authority on trackwork, in a recent publication from which the following is quoted : - 'It is practically impossible to establish a complicated layout of switches upon the ground with the transit instrument, and whenever such a feat is attempted nice work is required on the part of the Foreman to harmonize the arrangement.'

Modern British railway practice makes considerable use of the string line and offsets for laying in trackwork as well as aligning the timbers. Frequently the whole layout is set out and the timbers bored, marked to string line, and numbered at the point of manufacture.

Some of the more complex layouts have been laid out in this way in Victoria for some years past, and an example of the alignment of the crossover at Flinders Street Viaduct is shown in Figs. 120 and 121.

It is usual in Victoria to lay out and gauge the steel work at the contractor's works before acceptance, and in the initial field layout to re-establish the position of the steel work and place the timbers in accordance with the lay-out plans.

After the layout is checked the string lines for setting the timbers are marked by a fine saw cut, as previously des - cribed. When however the timbers are separately dug in,owing to the tracks being in running, each timber has to be separ-ately spaced and positioned in respect to the steel work, and the whole layout probably be pulled several times to obtain a satisfactory alignment.

Pulling over an alignment in trackwork is seldom fruit-ful of good trackwork as the expansion spaces are lost, joints are strained and crossings distorted. When at all practicable this method of laying in trackwork should be avoided.

As in brickwork so in trackwork, the first laying in is the best if properly done; alterations and adjustments never make good work.

DETAILED OPERATIONS

New points are now supplied in half set assemblies with the switch fastened to its stock rail by heel fastenings and secured at the second chair bolt hole by a 5/8" service bolt. Owing to slight differences in the practical manufacture of materials,it is desirable that the mated material be install-ed as received, and for this reason the half set assemblies should not be dismantled prior to installation.

The heel fastenings and service bolts should be removed and the former laid down in order for correct replacement, the stock rails should then be lifted on to the chairs and be lightly bolted in position. The straight stock rail should be brought to alignment, the timbers be corrected for spacing and overhang at the out ends, and boring and fastening be completed.

In boring for the chair screws the auger must be centr by the boring ferrule, see 15.16, Fig. 11, otherwise th stock rail may be thrown out of line when the chair screw are installed.

The set stock rail should next be brought to alignmen and gauge at the points as shown in 14.061, Fig. 61.

A straight edge or fine string line should be applied t the running edges of the stock rails between the apex and th heels (or the S.P.C. in curved points) to ensure that th are perfectly straight between these points.

In the case of curved points the switches should be as sembled to the stock rails to establish the gauge and align- ment before securing the set stock rail slide chairs.

When the switches are temporarily set up, addition washers should be used under the nuts on the heel bolts otherwise the several applications of the nuts will loos the thread fitting and may distort or fracture the spri washers.

Before the slide chair screws are finally tightened dow the closure rails should be aligned and at least adequatel secured and the layout be brought to a fair surface.

The seating of the switches and bearing of stops shoul be examined and any slight adjustment of the slide chair pos ition be made after which the gauge should be checked and th screws tightened.

Before the heel bolts are finally installed and tighten the position and alignment of the holes through the clos rails should be examined by sighting through the bolt hole of the heel assembly. If the closure holes are not properl centred with the holes in the heel block and heel fishplate troubles will arise in operation of the points as expansi and contraction will interfere with the required free move- ment.

The ends of the closure rail must be square cut and i this is not the case a straight closure should be spun en for end or, if curved, a new closure be obtained.

Forcing a heel joint to position by drifts to enable in- sertion of heel bolts will result in very unsatisfactory op- eration of the points.

In a few cases where sections of the rails in the swit and the closure vary, difficulty will be found in effecting good fitting of the heel assembly, and if doubt exists as t the fitting a new closure should be obtained. If the he fitting is not correct in the first place it is unlikely th it will improve under running conditions, and the probabili is that it will become worse.

When long timbers are used, as in crossovers, every care must be taken to set the crossing to true alignment before finally fastening down. Subsequent pulling to correct the alignment of one crossing will invariably pull the mating crossing out of line and necessitate drawing and re-driving the fastenings.

As explained in 13.014 the position of guard rails is fixed by the boring for the guard rail end bolts in respect to the crossings in crossovers.

The guard rails opposite the crossings are positioned in relation to the centre line of the guard rail and the nose of the crossing, or the end of the guard rail and the adjacent rail joint as shown on the standard plans. In the older materials the guard rail is centred with the centre of the gap from the nose to the knee of the crossings. Types and adjustments of guard rails are dealt with in 14.098-14.101.

Many of the difficulties experienced in laying in trackwork arise from the use of materials designed for other conditions, and although a good trackman will usually make a passable job in many non-standard arrangements, it must be recognised that the best trackwork is only obtained by the use of the right materials.

If the trackwork units will not assemble correctly the fault may be due -

1. To design.
2. To manufacture.
3. To non-standard conditions.

Errors in respect to 1 and 2 should be reported for rectification as only by co-operation of all sections of the Service can the best results be obtained. Difficulties in respect to non-standard layouts should be referred to the District Engineer for the advice of the technical staff.

Incorrect use of materials may arise from alterations of standards in the same class of materials.

As an example affecting the expansion spaces at rail joints in some of the earlier weights and classes of material, the bolt hole sizes have been changed from the original standards (9.20-9.25) to enable the use of standard flat drills, and the position of the holes have been changed to adjust the required expansion spaces to $\frac{3}{8}$" maximum.

The drill sizes and hole spacings involved in thes changes are as follows : -

Weight & Class of Rails	Size of Drill	Hole Spacing	
		1st Hole	Other Holes
60 N, 60 A.S. 1919, 60 Sec.602, 61 S.A., 72 J, 75 L.	1.1/8"	2.3/16"	4.1/2
50 A & B, 57, 60 C & D, 66 E & F, 75 G, 70, 78	"	2.1/4"	4"
60 N.S.W.	"	2.5/16"	4.1/2
60 A.S. 1921 & 25, 80 A.S. 1921	"	2.7/16"	5"
80 K, 100 B.S.	1.1/4"	2.3/16"	4.1/2
75 H & I, 86	"	2.1/4"	4"
80 'O', 95, 80 A.S. 1915 & 25, 100 P, 115, 90, 94, 100, 107 & 110 A.S.	"	2.7/16"	5"
100 M	"	2.1/2"	4.1/2

Many other examples could be given if space permitted but it behoves the trackman to be watchful of such change and keep note of them for his future reference.

Trackwork plans of special layouts should be carefull studied before the work is put in hand, as in the course o ordinary maintenance changes in class of rail may have occurred of which records are not available in the Head Office.

Maintenance renewals contemplated in conjunction with the installation of new trackwork may involve the use o other junction fishplates, and these should be on hand before the work is commenced.

Modifications in the quantity and arrangement of the fastenings associated with the operating mechanism of points ma arise by reason of a change in the signal gear, and precaution should be taken to discuss with the Signal Supervisor th nature of the changes required.

Alterations from standards are not permitted without th authority of the Chief Civil Engineer.

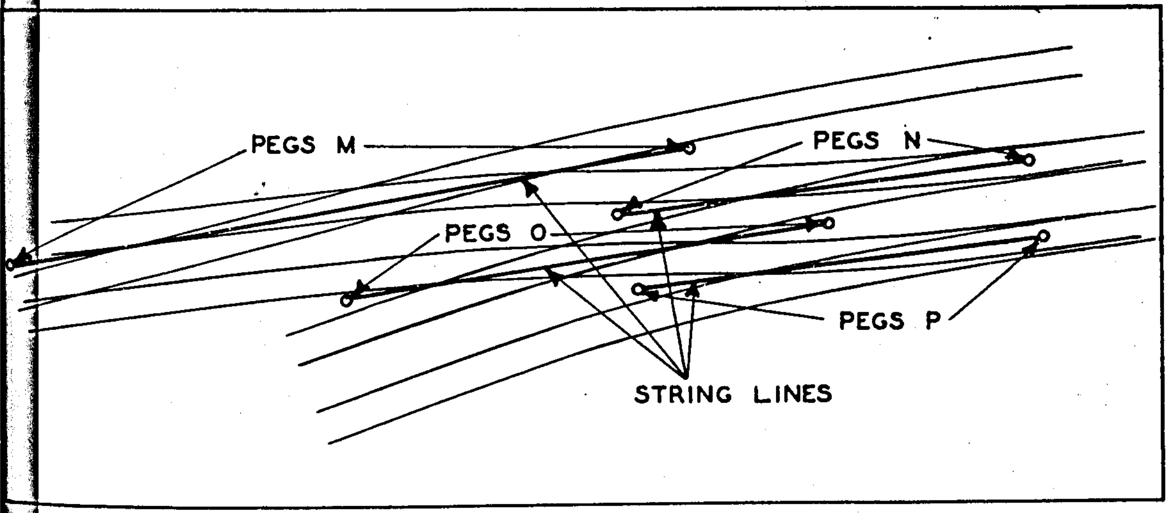


FIG. 117. STRING LINES FOR SAW CUTS ON TIMBERS. FLINDERS ST. VIADUCT CROSSOVER.

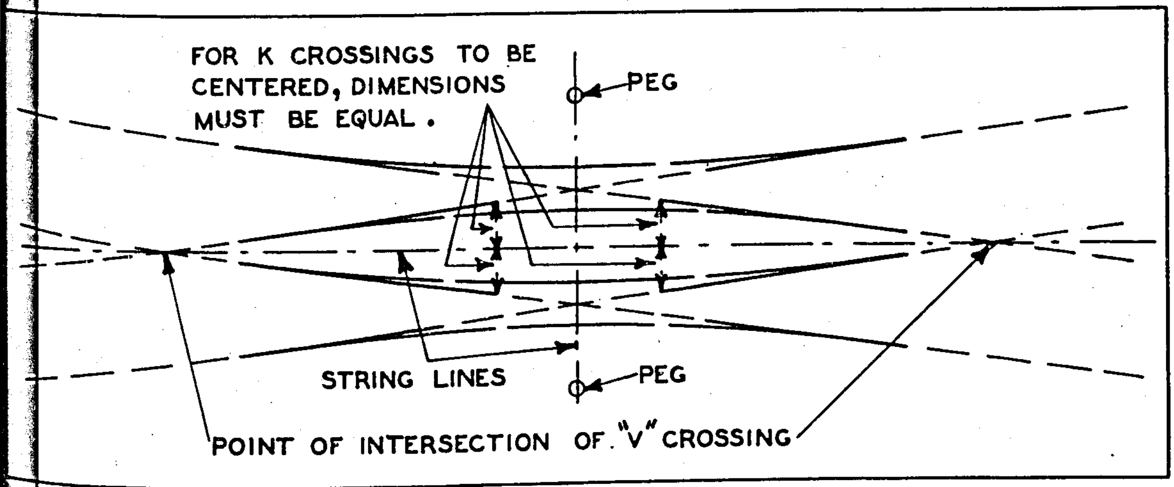


FIG. 118. LAYING COMPOUNDS.

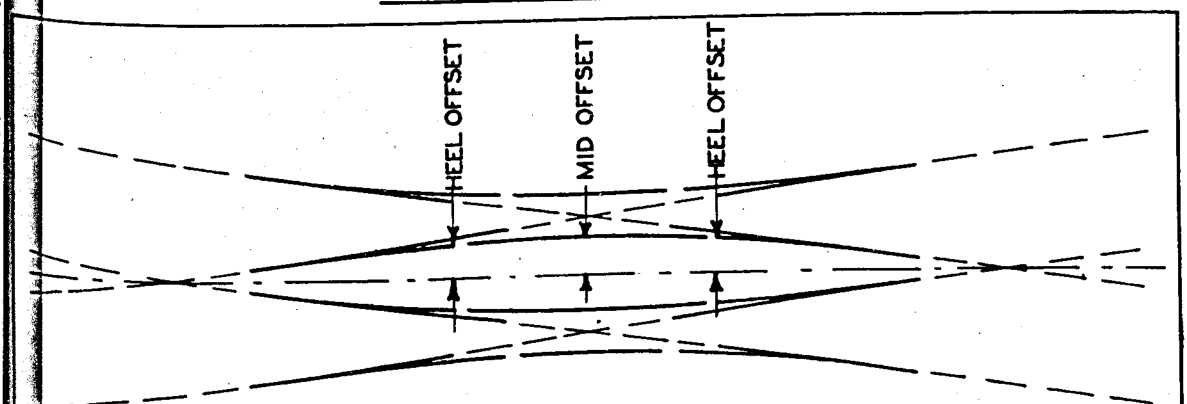


FIG. 119. OFFSETS FOR CURVED TRACKS OF COMPOUNDS.

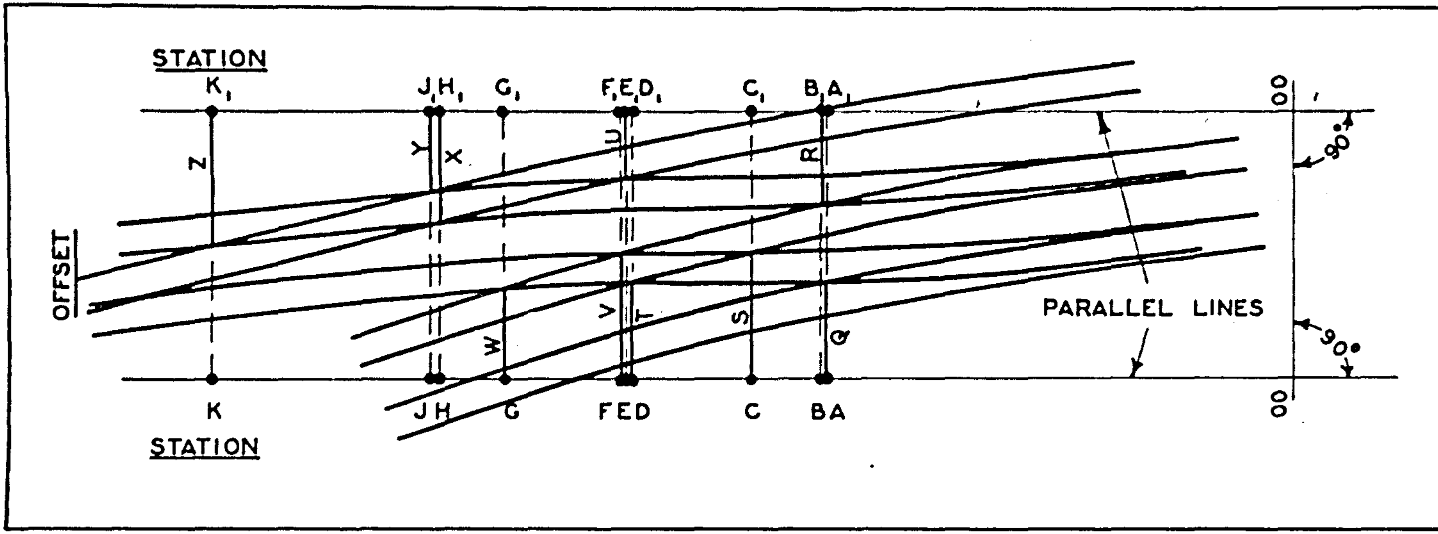
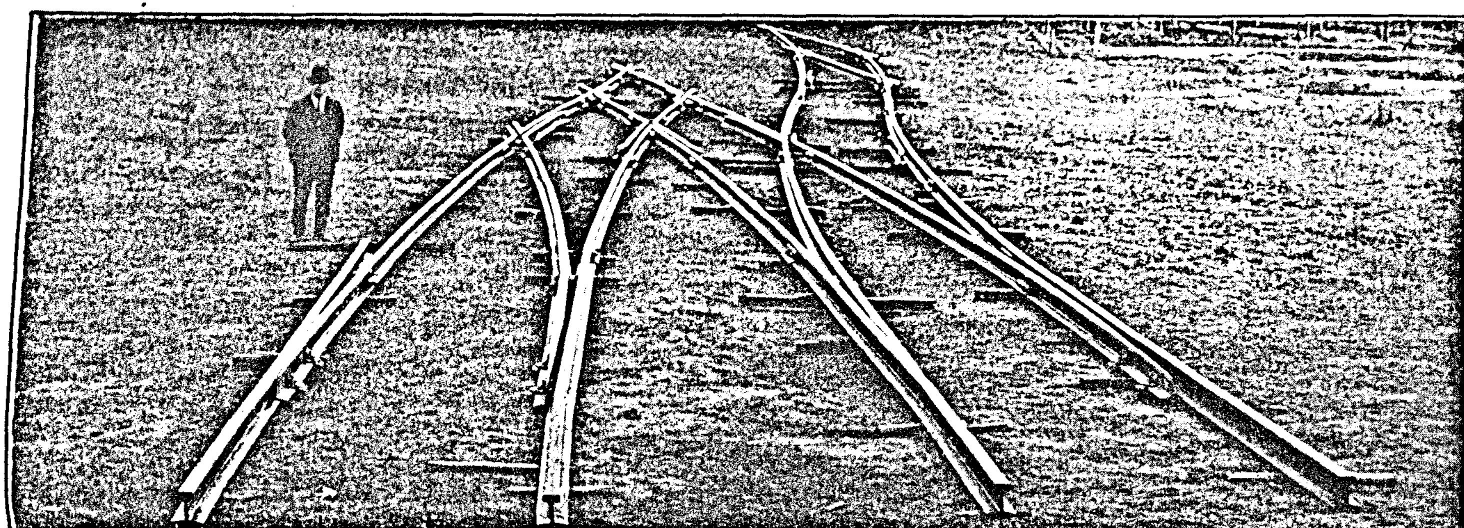


Fig. 120. Method of Laying Crossover. Flinders St. Viaduct.



TRACKWORK DETAILS. 14.

POINTS

DEFINITION

Points are an assembly of switches, stock rails, fastenings and timbers, laid to gauge, surface and alignment, connected to trackwork and provided with operating mechanism.

The purpose of the points is to divert traffic from one track to another.

A set of standard points comprises : -

a) Two stock rails, one straight and one set, right or left-hand according to requirements.

b) One pair of straight switches, one right and one left-hand.

c) Two heel blocks with heel fishplates set right or left-hand to match the switches.

d) One operating spreader bar and one back spreader bar.

e) One set of point chairs to support the stock rails and switches.

f) Chair bolts to fasten the stock rails to the chairs.

g) Heel bolts to secure the heel fastenings.

h) Chair screws to fasten the chairs to the point timbers.

i) A pull rod to connect with the operating mechanism.

A set of 16'6" points, R.H. 107 lb. rail, is shown in Fig. 1.

CLASSIFICATION

Points are classified by the weight of rail, length of switch, type, hand, special purpose and catalogue No.

TYPES

The three general types of points in use are 'X', 'Y', and 'V' nose points.

The chief distinction between 'X' and 'Y' points is that in 'X' points the toes of the switches are placed centrally on the toe slide chairs, whereas in 'Y' points the toes of the switches extend 7" beyond the centre of the toe slide chairs.

Other differences are that lugs are provided on 'X' switches to receive the ends of round spreaders, where spreader brackets are provided in 'Y' layouts with pins secure flat spreaders. The heel fishplates are a flat rol ed section in 'X' layouts, and a thicker rolled section 'Y' layouts. See 10.12-10.15.

The 'V' nose points are 'Y' points in that the toe the switch extends 7" beyond the centre of the toe slide chai but the toes of the switches are machined in shape like an in verted letter 'V'; the spreader brackets differ from th earlier type and bolts are used instead of pins to secure th flat spreaders.

Except for a limited number of replacements 'X' point have not been manufactured since 1930.

SPECIAL PURPOSE

Common points are used in standard turnouts and cross overs.

Compound points are of two varieties, XS or YS point for single compounds and XD or YD points for the mating se of points in double compounds.

In Modified Three Throws the second or following set points is described as MTT points. Double switch point used in old style Three Throws are referred to as Three Thr points.

Special points usually vary from standard in the lengt of the stock rails, but other features may be involved suc as curved switches, uneven switches, strengthened switches, manganese steel switches.

In the earlier points no convenient method of recor was established, and confusion arises in supplying replace ments unless a full description is supplied.

CATALOGUE NOS.

Catalogue Nos. are assigned to all special points manu factured in 94 and 107 lb. materials, and records are file in Head Office to enable manufacture and supply of correc duplicates.

The catalogue No. of special points is stamped on th side of the head of the stock rail immediately above the hee bolt hole. It is essential, when ordering renewals, that th catalogue No. be stated as well as the weight and class rail, and if the points are in hands, the hand must be state

The length of the switch is the basis of the catalogue No. For special points in hands, distinguishing letters are added, and for special points which are not in hands, the character + follows the distinguishing letter.

As no catalogue Nos. are in use for special points other than 94 and 107 lb. it is necessary when ordering to state the weight of rail, length of switch, type, hand, and in addition, the layout for which the points are required, the length of the stock rail and the distance from the end of the stock rail to the heel of the switches.

Whenever practicable a rough sketch should be supplied indicating any unusual features such as additional holes required in stock rails or switches for the attachment of special apparatus.

STOCK RAILS

The types and lengths of stock rails in use vary with the weight of rail, the design of the points and the trackwork layouts for which they are required.

LENGTH

In light points the lengths of stock rails for general use are 22'6" or 23'0", as these were the lengths in which the rails were purchased. Medium and heavy points have stock rails of 31'9" length for general use and special lengths according to purpose. The length of stock rails used in 94 and 107 lb. points vary according to switch length and purpose.

Particulars of lengths are given in Tables 14.021-14.032.

SETS

The set stock rails vary according to type of points; the light points, as originally manufactured, had only one set at the toe of the switch. Medium and heavy points had three sets, and the heel of the stock rail had to be curved by the platelayer to suit the radius of the layout.

In 94 and 107 lb. points the set stock rail has one set in front of the switch and the heel of the stock rail is curved during manufacture to the correct radius for the layout or to a compromise radius when the points are standard for two layouts of different radii.

Particulars of the sets are given in Fig. 2.

SLIDE CHAIR HOLES

The position of the point slide chairs is fixed by th holes punched in the stock rails for the chair bolts or chai pins.

Many years ago instructions were issued to re-space th chairs under the old points, and consequently two sets of pi holes will be found in the flanges of most of these stoc rails.

An alteration in the spacing of the chair bolt holes i medium and heavy points became necessary with the introduc- tion of electric traction and electric signalling, and ther will still be found in service stock rails having two sets o bolt holes towards the toe of the switches. The origina holes were for 'X' layouts and the later holes were for 'Y layouts.

Particulars of the spacing of chair pin holes and chai bolt holes which are now standard are shown in Figs. 3 & 4

POINT BASE SECTIONS

The sections of the points at their base vary with th type and class of rail, and affect both the switch and th stock rail. Three sections are in use, as shown in Figs. 5 6 & 7, and each section has its own particular advantages an its limitations.

The section shown in Fig. 5 was mainly used in 57, 70 78 and 86 lb. points in which the webs of the rails ar thickened to compensate for the removal of portion of th flange necessary to house the switch into the stock rail In this type a substantial portion of the flange was left o the switch, and a good bearing was secured on the slide chai to prevent, or reduce to the minimum, any tendency for th switch to roll under traffic.

For many years the base section in Fig. 6 has been i use and has enabled the manufacture of points from rails o standard sections as used in the track. Machining out th underside of the switch to over-lay the flange of the stoc rail necessarily removes the support immediately below th switch, as a working clearance must be provided, and in con sequence there is a tendency for the switches to roll unde the influence of traffic.

The section at the base of the switch and the stoc rail, shown in Fig. 7, was adopted for 94 and 107 lb. point to combine as far as possible the good features of the tw previous designs.

SWITCH TOE SECTIONS

Three sections are in use as shown in the upper portion of Figs. 5, 6, & 7.

In 57, 70, 78 and 86 lb. points, use was made of the section shown in Fig. 5, the toe of the switch being machined away like the blade of a knife, from which the term blade or point blade came to be commonly used.

The toe section shown in Fig. 6 was in general use for all weights of points manufactured from standard track rails prior to the adoption of 'V' nose points; the chief defect in this section was the crushing of the toe under heavy traffic.

In 1933 the 'V' nose section shown in Fig. 7 was adopted, but the base section shown in Fig. 6 (i.e., full flange on stock rail) continued in use until 1940. With the exception of approximately 100 sets of 90 lb. points first manufactured to base and toe section, Fig.6, all 90 and 110 lb. points conform to the base section in Fig. 6, and the toe section in Fig. 7.

All 94 and 107 lb. points conform with base and toe sections shown in Fig. 7, thus standard track rails are used in manufacture, a reasonable base is given to the switch under the weight of traffic, and extra metal is provided at the toe of the switch to avoid crushing against the stock rail.

SWITCH CROWN

The switch crown or running surface of the switch is machined to gradually rise from the toe section to the $2\frac{1}{4}$" head section, and thence to the heel section at a more gradual slope, as shown in Fig. 8. Thus the toe end of the switch carries no weight, but acts only as a wedge to deflect the wheels by means of the wheel flanges.

From the $2\frac{1}{4}$" head section the wheel treads are gradually lifted from the stock rail to enable wheels with hollow treads to cross the running surface of the stock rail without damage thereto.

In 94 & 107 lb. common points this heel rise is run out to grade over several timbers behind the heel of the switch by means of lug plates with pads of suitable thickness. See 14.113.

An exception to this arrangement occurs in the No. 8.1 compounds in which the straight switches are set downwards behind the wheel transfer position to grade at the heel. This arrangement necessitates special mounting, as set out in 13.042.

In 57, 70, 78 and 86 lb. points the switches are not crowned, but are level with the stock rails at the heel, as shown in Fig. 9, and in consequence the stock rails are severely engaged by wheels with hollow treads, as shown in Fig. 10, and in extreme cases the stock rails are liable to be ploughed out under these conditions.

SWITCH MOUNTING.

Switches other than 57, 70, 78 and 86 lb. are mounted slightly higher than the stock rails, and the top of the switches are suitably machined to gradually transfer the wheels from the switch to the stock rail and from the stock to the switch, according to the direction of motion.

At the toe the switch is ½" below the stock rail and where the width of the switch is 2¼", it is level with the stock rail, while at the heel it is higher than the stock rail according to the type of points.

It follows that rolling of the switch takes place between the position where the wheel load comes on the switch and where the switch attains sufficient width of base to resist the rolling or overturning tendency.

Sections of the three general types of switches at 2¼" head width are shown in Figs. 11, 12 & 13, from which the relative stability of the three types can be seen.

Sections at the heels corresponding to the foregoing are shown in Figs. 14, 15 & 16.

THROW, SPREAD & LENGTH OF SWITCHES

The lengths of switches in use vary with the weight and class of rail, and the layouts for which they are required, and the following lengths of switches are in use with the different weight of rails indicated.

Weight of rail	Toe Throw	Heel Spread	Length of switch
57, 70, 78 and 86	$4\frac{1}{2}$"	$4\frac{1}{2}$"	12'0", 15'0", 17'0"
60 D, 60AS	$4\frac{1}{2}$"	$5\frac{3}{4}$"	15'0"
80 O, 80AS, 90AS, 95, 100P, 100AS, 110AS, 115	$4\frac{1}{2}$"	$5\frac{3}{4}$"	13'6", 15'9", 18'0"
94AS, 107AS	5" * (see below)	$5\frac{3}{4}$" $6\frac{1}{2}$" $7\frac{5}{8}$"	15'0", 16'6", 22'6" 15'0", YS and YD 19'0", YS and YD

TOE THROW

The throw at the toe of switches governs the clearance between the open switch and the stock rail at the intersection of rail heads, as shown in Fig. 17.

In the earlier points the throw varied according to the width of rail head to maintain a clearance of $2\frac{1}{4}$" at the intersection of rail heads. This practice required different lengths of spreaders for the various weights of rails, and in 1927 the spreaders were standardized to give $4\frac{1}{2}$" toe throw for all existing points irrespective of the weight of rail.

With the wider rail heads in use today the clearance corresponding with $4\frac{1}{2}$" toe throw is insufficient to permit the passage of all wheel backs through the points without striking the back of the open switch at the intersection of rail heads, particularly if reasonable wear exists on the opposite closed switch as shown in Fig. 18.

* The 94 and 107 lb. points are designed to increase the clearances, and the throw is shown on standard plans as 5", but alteration of point levers and signal operating mechanisms requires to be made before the 5" throw can be given, and it may be some time before all points can be so adjusted.

HEEL SPREAD

The heel spread directly affects the angle or rate o slope of the switch in relation to its stock rail, and wi short switches this angle becomes too great to permit of t passage of long fixed wheel base locomotives without bindi and distortion of the points, as indicated in Fig. 19.

On the other hand the spread must be sufficient to all clearance at the heel for the backs of wheel flanges to pa through the points without binding, as shown in Fig. 2 The standard heel spread of 5¾" provides the necessary clea ance with the widest rail head in use.

In curved points the switch diverges further from t stock rail than with straight switches of the same length a in consequence a wider heel is required, as in the YS and compound points. The heel spreads for 94 & 107 lb. A. compounds are 6½" for No. 7.52, and 7⅝" for No. 8.7.

HEEL ASSEMBLY

To secure the switches in position and maintain the mounting in correct relation to the stock rail and the closu rail at the heel of the switch, it is the practice to insta heel blocks and heel fishplates with the necessary bolt As freedom of movement for the throw of the switch must be a lowed, the heel fishplates are suitably set to provide t necessary clearance.

Several arrangements of heel fastenings are in use shown in Figs. 21, 22, 23, 24, 25 & 26.

The arrangements shown in Figs. 21 and 22 are used wi 57, 70, 78 and 86 lb. points, and when renewals are conte plated it is necessary for the trackman to examine the he fastenings and determine which arrangement is in use to enab supply of the correct replacement parts.

These observations apply also to 95 and 115 lb. poin as the thick web restricts the space available for the he blocks and heel fishplates as shown in Fig. 23.

The arrangement shown in Fig. 24 is used in 60, 80 a 100 lb. 'X' points, and that in Fig. 25 is used in 'Y' poin of these weights and in some of the earlier 90 lb. 'Y' point

In 1933 the arrangement developed by the American Rai way Engineering Association was adopted as standard for ne points manufactured in medium and heavy rails; the arrang ment is shown in Fig. 26, and is typical of the heel faste ings for all 94, 107 and 110 lb. points and nearly all 90 lb points.

HEEL BLOCKS

The two and three bolt heel blocks used in earlier points are right and left hand to correspond with switches of the same hands, and were tapered to suit the length of the switch and of a section suitable to the class of rail.

When the 'Y' layouts were introduced in 1917 a common heel block for all lengths of switches of a given weight of rail was provided together with flat square washers to adjust the different tapers required with different lengths of switches.

This arrangement was unsatisfactory and the later points were provided with separate heel blocks tapered for each length of switch and marked accordingly, as shown in a typical instance in Fig. 27.

Because of the different thickness of heel fishplates in use in the 'X' and the 'Y' points, a similar difference exists in the heel blocks, and care must be taken to see that heel blocks and heel fishplates of the same type are installed to ensure the correct heel spread of the switches.

During 1924 several sets of 100 lb. A.S.'Y' layout points were manufactured for trial with vertical stock rails and the heel blocks for these points were branded with the letter 'V' in addition to the length and hand of the switch, thus 18 0 - V - L.

When in 1933 the A.R.E.A. (American Railway Engineering Association) heel arrangement was first introduced in 90 and 110 lb. points, the set stock rails were of the double set type shown in Fig. 28, and the heel blocks were made to follow the heel set in the stock rail.

This necessitated the use of 4 heel blocks for points of the same weight and length of switch but of different hands, and the heel blocks were marked according to the length of switch and hand of the points.

For 13'6", 90 lb. R.H. points, the heel blocks were marked 13 6 - 90 - R STR, and 13 6 - 90 - R SET. Heel blocks so marked cannot be used in 13'6", 90 lb. L.H. points for which the correct heel blocks are marked 13 6 - 90 - L STR, and 13 6 - 90 - L SET. A typical heel block of this type is shown in Fig. 29.

HEEL SPREAD

The heel spread directly affects the angle or rate o slope of the switch in relation to its stock rail, and wit short switches this angle becomes too great to permit of th passage of long fixed wheel base locomotives without bindi and distortion of the points, as indicated in Fig. 19.

On the other hand the spread must be sufficient to allo clearance at the heel for the backs of wheel flanges to pas through the points without binding, as shown in Fig. 20 The standard heel spread of 5¾" provides the necessary clear ance with the widest rail head in use.

In curved points the switch diverges further from th stock rail than with straight switches of the same length an in consequence a wider heel is required, as in the YS and Y compound points. The heel spreads for 94 & 107 lb. A.S compounds are 6½" for No. 7.52, and 7⅝" for No. 8.7.

HEEL ASSEMBLY

To secure the switches in position and maintain thei mounting in correct relation to the stock rail and the closu rail at the heel of the switch, it is the practice to insta heel blocks and heel fishplates with the necessary bolts As freedom of movement for the throw of the switch must be al lowed, the heel fishplates are suitably set to provide th necessary clearance.

Several arrangements of heel fastenings are in use a shown in Figs. 21, 22, 23, 24, 25 & 26.

The arrangements shown in Figs. 21 and 22 are used wit 57, 70, 78 and 86 lb. points, and when renewals are conte plated it is necessary for the trackman to examine the he fastenings and determine which arrangement is in use to enab supply of the correct replacement parts.

These observations apply also to 95 and 115 lb. poin as the thick web restricts the space available for the he blocks and heel fishplates as shown in Fig. 23.

The arrangement shown in Fig. 24 is used in 60, 80 a 100 lb. 'X' points, and that in Fig. 25 is used in 'Y' poin of these weights and in some of the earlier 90 lb. 'Y' point

In 1933 the arrangement developed by the American Rai way Engineering Association was adopted as standard for n points manufactured in medium and heavy rails; the arrang ment is shown in Fig. 26, and is typical of the heel faste ings for all 94, 107 and 110 lb. points and nearly all 90 l points.

HEEL BLOCKS

The two and three bolt heel blocks used in earlier points are right and left hand to correspond with switches of the same hands, and were tapered to suit the length of the switch and of a section suitable to the class of rail.

When the 'Y' layouts were introduced in 1917 a common heel block for all lengths of switches of a given weight of rail was provided together with flat square washers to adjust the different tapers required with different lengths of switches.

This arrangement was unsatisfactory and the later points were provided with separate heel blocks tapered for each length of switch and marked accordingly, as shown in a typical instance in Fig. 27.

Because of the different thickness of heel fishplates in use in the 'X' and the 'Y' points, a similar difference exists in the heel blocks, and care must be taken to see that heel blocks and heel fishplates of the same type are installed to ensure the correct heel spread of the switches.

During 1924 several sets of 100 lb. A.S.'Y' layout points were manufactured for trial with vertical stock rails and the heel blocks for these points were branded with the letter 'V' in addition to the length and hand of the switch, thus 18 0 - V - L.

When in 1933 the A.R.E.A. (American Railway Engineering Association) heel arrangement was first introduced in 90 and 110 lb. points, the set stock rails were of the double set type shown in Fig. 28, and the heel blocks were made to follow the heel set in the stock rail.

This necessitated the use of 4 heel blocks for points of the same weight and length of switch but of different hands, and the heel blocks were marked according to the length of switch and hand of the points.

For 13'6", 90 lb. R.H. points, the heel blocks were marked 13 6 - 90 - R STR, and 13 6 - 90 - R SET. Heel blocks so marked cannot be used in 13'6", 90 lb. L.H. points for which the correct heel blocks are marked 13 6 - 90 - L STR, and 13 6 - 90 - L SET. A typical heel block of this type is shown in Fig. 29.

In 1938 the single set and curved heel set stock rail, shown in Fig. 30, was introduced, and as the curve commences in practice behind the heel block, it was possible to make tapered heel blocks suitable for either R or L hand points.

The marks however were not altered, see Fig. 31, and to distinguish between the earlier and later blocks a straight edge must be placed against the stock rail side of the set stock rail heel block. If this face is straight the heel block is of the later type and can, in emergency, be used against the straight stock rail in points of the opposite hand, but if the face is hollow the block cannot be used without altering the spread at the heel to the extent of 1/8" or 3/16".

When the 94 and 107 lb. common points were first introduced the heel blocks were marked with the weight of the points and the letter indicating that the heel block was common to points of either hand, as shown in Fig. 32. Thus 94 R STR L SET indicated that this heel block would fit the straight stock rail of right-hand points and the set stock rail of left-hand points. Difficulties, however, arose when trackmen dismantled the half sets of points and could not distinguish between the heel blocks required for switches of different lengths.

The differences in the dimensions of the blocks are slight, and when worn the blocks may be interchangeable for the two switch lengths.

To remove these difficulties the marking was changed in 1941 and they are now marked according to length, weight and hand of the switches, see Fig. 33. These blocks are the same in R or L hand points.

For casting reasons the heel blocks now used in 94 and 107 lb. points are the same for 15'0" and 16'6" switches, but are machined according to purpose and the unwanted figures are chipped off.

In 1942 when the 94 and 107 lb. Compound Points were introduced the heel blocks for the No. 7.52 compounds were marked with the length, weight and hand of the switches and the letters CVD were added to indicate that points were curved, see Fig. 34.

For the No. 8.7 compounds however the letter 'E' or 'A' was added to indicate with which stock rail the block was to be used, see Fig. 35. The 'E' block is used with the curved stock rail and the 'A' block with the straight stock rail

In certain areas 94 lb. points with 9'3" switches are used. The blocks used with these points are branded with the length and weight of switch, hand of points, and to which stock rail the blocks are to be applied, thus 9-3 94 L STR.

During 1939 the A.R.E.A. heel assembly was introduced for reconditioned 78 and 86 lb. points and the heel blocks are branded as shown in Fig. 36.

HEEL FISHPLATES

Many different types of heel fishplates are in use, and the sections used in the older weights of rails are no longer rolled. In 10.14 and 10.15, heel fishplates in use for 'X' and 'Y' layout points are tabulated, but where doubt arises as to the required heel fishplates for old material, reference should be made to Head Office for particulars.

The heel fishplates used in the new 94 and 107 lb. points are the Australian Standard Bar type fishplates, and these are set and machined to house the distance ferrules on the 1st.heel bolt as shown in Fig. 26.

HEEL FERRULES

The heel ferrules used in 90 and 110 lb. points were of solid drawn steam pipe, but after a period of service these ferrules require replacement, as they tend to wear and become too short to properly space the set fishplates.

In 94 and 107 lb. points the heel ferrule is machined from high carbon steel and specially heat treated to withstand wear. Renewals for the 90 and 110 lb. points are of high carbon steel also.

HEEL BOLTS

Heel bolts vary according to the weight of rail and type of points; the earlier heel bolts were of iron and of mild steel with an ultimate tensile strength of 28 tons per square inch area.

Those in use in 90 and 110 lb. points are fishbolt ste[illegible] with an ultimate tensile strength of 35 tons per square [illegible] area.

The mark 'H' heel bolts used in 94 and 107 lb. poi[illegible] heat-treated, high-tensile-steel bolts of an ultimate [illegible] strength of 50 tons per square inch area.

Bolts which pass through the entire heel asse[illegible] described as heel bolts, and those which pass through th[illegible] plates and switch only are described as heel fish[illegible] See Fig. 24.

In 1938 the single set and curved heel set stock rail, shown in Fig. 30, was introduced, and as the curve commences in practice behind the heel block, it was possible to make 2 tapered heel blocks suitable for either R or L hand points.

The marks however were not altered, see Fig. 31, and to distinguish between the earlier and later blocks a straight edge must be placed against the stock rail side of the set stock rail heel block. If this face is straight the heel block is of the later type and can, in emergency, be used against the straight stock rail in points of the opposite hand, but if the face is hollow the block cannot be used without altering the spread at the heel to the extent of 1/8" or 3/16".

When the 94 and 107 lb. common points were first introduced the heel blocks were marked with the weight of the points and the letter indicating that the heel block was common to points of either hand, as shown in Fig. 32. Thus 94 R STR L SET indicated that this heel block would fit the straight stock rail of right-hand points and the set stock rail of left-hand points. Difficulties, however, arose when trackmen dismantled the half sets of points and could not distinguish between the heel blocks required for switches of different lengths.

The differences in the dimensions of the blocks are slight, and when worn the blocks may be interchangeable for the two switch lengths.

To remove these difficulties the marking was changed in 1941 and they are now marked according to length, weight and hand of the switches, see Fig. 33. These blocks are the same in R or L hand points.

For casting reasons the heel blocks now used in 94 and 107 lb. points are the same for 15'0" and 16'6" switches, but are machined according to purpose and the unwanted figures are chipped off.

In 1942 when the 94 and 107 lb. Compound Points were introduced the heel blocks for the No. 7.52 compounds were marked with the length, weight and hand of the switches and the letters CVD were added to indicate that points were curved, see Fig. 34.

For the No. 8.7 compounds however the letter 'E' or 'A' was added to indicate with which stock rail the block was to be used, see Fig. 35. The 'E' block is used with the curved stock rail and the 'A' block with the straight stock rail

In certain areas 94 lb. points with 9'3" switches are used. The blocks used with these points are branded with the length and weight of switch, hand of points, and to which stock rail the blocks are to be applied, thus 9-3 94 L STR.

During 1939 the A.R.E.A. heel assembly was introduced for reconditioned 78 and 86 lb. points and the heel blocks are branded as shown in Fig. 36.

HEEL FISHPLATES

Many different types of heel fishplates are in use, and the sections used in the older weights of rails are no longer rolled. In 10.14 and 10.15, heel fishplates in use for 'X' and 'Y' layout points are tabulated, but where doubt arises as to the required heel fishplates for old material, reference should be made to Head Office for particulars.

The heel fishplates used in the new 94 and 107 lb. points are the Australian Standard Bar type fishplates, and these are set and machined to house the distance ferrules on the 1st.heel bolt as shown in Fig. 26.

HEEL FERRULES

The heel ferrules used in 90 and 110 lb. points were of solid drawn steam pipe, but after a period of service these ferrules require replacement, as they tend to wear and become too short to properly space the set fishplates.

In 94 and 107 lb. points the heel ferrule is machined from high carbon steel and specially heat treated to withstand wear. Renewals for the 90 and 110 lb. points are of high carbon steel also.

HEEL BOLTS

Heel bolts vary according to the weight of rail and type of points; the earlier heel bolts were of iron and of mild steel with an ultimate tensile strength of 28 tons per square inch area.

Those in use in 90 and 110 lb. points are fishbolt ste with an ultimate tensile strength of 35 tons per square area.

The mark 'H' heel bolts used in 94 and 107 lb. poi heat-treated, high-tensile-steel bolts of an ultimate strength of 50 tons per square inch area.

Bolts which pass through the entire heel asse described as heel bolts, and those which pass through ths plates and switch only are described as heel fish See Fig. 24.

The heel bolts used in 'X' layout are 1" diameter and those used in 'Y' layout are 1⅛" diameter. See 10.20-10.2 and 14.134.

SWITCH STOPS

To afford lateral support to the switches between the intersection of rail heads and the heel of the switches, stops are rivetted to the web of the switches during manufacture, and when the switches are closed against the stock rails the stops should just bear against the webs of the stock rails.

The position of the stops is arranged so that they will bear against the stock rail adjacent to, but clear of, the point chairs.

The three general types of switch stops are shown in Figs. 37, 38 and 39. The type of stop used in 57, 70, 7 and 86 lb. points is shown in Fig. 37. The stop shown in Fig. 38 was used in 60, 66 and 75 lb. points, and that used in 80, 90, 94, 95, 100, 107, 110 and 115 lb. points is shown in Fig. 39.

Particulars of the lengths and types of stops in use today are shown in Table 14.033-14.035.

LUGS AND SPREADER BRACKETS

To connect the spreaders to the switches, forged steel lugs are rivetted to all 'X' layout point switches. Two types of lugs have been used, as shown in Figs. 40 and 41; those shown in Fig. 40 were used on 57, 70, 78 and 86 lb. switches, and those shown in Fig. 41 on 'X' layout switches of all other weights.

The spreader brackets used on 'Y' layout switches are of ~ree types, as shown in Figs. 42 and 43. The type shown in intr 42A differs slightly from that shown in Fig. 42B, only marke e position of the spreader pin hole, but the distinction the be noted when repairs are being effected as the boring curved ewal of the spreader will be involved.

Fo improved type of spreader bracket shown in Fig. 43 was add with 90 and 110 lb. points manufactured after 193 be use n all 94 and 107 lb. points; the spreader bracket stock es for the side entry of the flat spreaders and facilit removal and replacement.

In 90 and 110 lb. points the spreader brackets were marked R or L according to the hand of the switch to which they were rivetted, but in 94 and 107 lb. the marks R E and L E are used to indicate the side of entry, i.e., R E indicates right entry and the spreader brackets are arranged for entry according to timber spacing and the position of operating mechanism, and not in respect to the hand of the switch.

The distances from the toes of switches to the centre of the operating spreader brackets are as follows : -

Type of Points		Distance
X, XS, XMTT	...	1'1½"
XD	...	1'4¾"
Y, YS, YMTT	...	1'4¾"
YD	...	1'10¾"

SPREADERS

The spreaders used in 'X' layout points are shown in Fig. 44, and the standards are set out in Table 14.036.

In 1927 instructions were issued for the recall of all old round spreaders and for standardisation of spreaders in accordance with departmental drawings Nos. F1240 & F1268.

Non-standard spreaders must not be re-installed.

For 'Y' layouts a flat spreader is used as shown in Fig. 45 (14.055 & 14.056), and the standards are set out in Table 14.037.

The spreaders used in compounds are set to provide clearance under the stock rail of the mating set of points; this is necessary for electrical insulating reasons.

Both insulated and non-insulated spreaders are in use, the insulated type being required in electric signalled areas.

POINT CHAIRS

Point chairs are bolted or pinned at intervals to the stock rails in order to support the stock rails and switches in the required positions.

Cast iron point chairs are of two general types, the block chair and the buttress chair, as shown by typical chairs in Figs. 46-59.

BLOCK CHAIRS

Block chairs are used with 57, 70, 78 and 86 lb. points and vary slightly in length according to their positions in the assembly of the points. To distinguish the chairs raised letters are cast on the out ends as shown in Fig. 46.

BUTTRESS CHAIRS

Buttress chairs are standard for 60D, 60 A.S.,80 'O',95, 80 A.S., 90 A.S., 94 A.S., 100 P, 115, 100 A.S., 107 A.S.,and 110 A.S. points.

Typical toe, slide, and heel chairs as used in 'X' layout points are shown in Figs. 47, 48 and 49. The stock rail seats for these chairs are inclined at 1 in 20,and the slides are level.

Examples of adjustable toe, adjustable slide, adjustable dummy, slide, and heel chairs shown in Figs. 48 - 52 are used for 'Y' layout points with stock rails inclined at 1 in 20. Cast iron adjustable chairs have elongated holes to permit of adjustment on the tie plates when being installed.

Typical toe, adjustable toe, common and heel slide, adjustable slide, special dummy and adjustable dummy chairs shown in Figs. 54, 55 and 56 are used for 'Y' layout points with vertical stock rails in 90 A.S., 94 A.S., 107 A.S., and 110 A.S. material. An obsolete type of 90 lb. heel chai is shown in Fig. 53.

A number of sets of points were made in 100 A.S. material with vertical stock rails, and the slide chairs for these points are distinguished by a raised letter 'V' cast on the out ends of the chairs.

Prior to 1935, 15/16" dia. holes were provided in buttress chairs of all weights for 7/8" dia.chair pins,but chairs cast since 1935 have 1.1/16" dia. holes for 1" dia. chair screws.

DUMMY CHAIRS

The several types of dummy chairs in use are shown in Figs. 52 and 56 - 59 and comprise adjustable dummy, special dummy, common dummy, deep dummy and insulated dummy chairs.

FORGED CHAIRS

Drop forged mild steel chairs are now standard for 9? and 107 lb. points and for their description see 14.115.

SWITCH EXTENSIONS

For detection purposes in connection with signalling arrangements, switch extensions are bolted to the toes of the switches through holes provided in all 'Y' layout point switches. These attachments are made by the Signal Division and the services of a signal fitter are required for their installation and maintenance.

POINT LOCK BARS

In congested yards it is sometimes necessary for signal purposes to extend the point lock bars along the switch and beyond the heel.

The necessary attachments are made by signal fitters, but in no case must the heel fastening be interfered with or in any way altered from standard without permission of the Chief Civil Engineer. Irregularities in this regard should be immediately reported through the proper channels.

INTERCHANGEABILITY OF MATERIALS

Reference has been made in this section to the different standards of points and their fastenings; in some cases the differences are not marked, and this has led to trackmen using materials in association which were not intended for use in this way.

When points were first manufactured from A.S. rails in 1917, instructions were issued providing for the renewal of closures with A.S. rails wherever A.S. points were installed. For good trackwork this precaution is necessary, as the fishing angles of A.S. rails differ slightly from the earlier classes of rail in use.

Bad heel fitting and insufficient switch clearance under the head of the stock rails occurs when switches and stock rails of different classes in the same weight of rail are used together. The assembly of 100 lb. A.S. switches with 100 lb. 'P' stock rails is the worst case, as the switch clearance is reduced from 3/16" to 1/16" as shown in Fig.60, and there is a danger of the switch gaping if the heel is allowed any slight depression.

Wear in service has now largely provided the clearance necessary to compensate for differences in rail section, but wherever practicable switches and stock rails and the closure adjoining the heel of the points should be of the same class of rail.

GAUGE OF POINTS

Common points should be laid to exact gauge as determined by a standard track gauge. The gauge should be applied in the positions shown in Fig. 61.

Provided the straight stock rail is in true alignment and the heel spread is correct, the application of the gauge at any other positions than those indicated is unnecessary and may be misleading for the following reasons : -

1. The running side of the switches in 'X' and 'Y' points is machined at $6\frac{1}{2}^{\circ}$ to the vertical and exact gauge occurs only along a line at the top of the angle machining which extends from the toe to a little beyond the intersection of rail heads.

2. In 'V' nose points the angle of side machining is 15° and extends from the toe towards the heel of the switches for 2'0" in 90 and 110 lb. points, and 3'6" in 94 and 107 lb. points.

3. Because the heels of the points are not square with the turnout, exact gauge measured off a set stock rail or off a curved stock rail falls slightly behind the heel of the opposite switch, and unless a square is used to locate this position to apply the gauge, an incorrect reading may be made.

The gauge between stock rails at the toe of 'X' and 'Y' points measured square off the straight stock rail is 5'3¼", and at the toe of 'V' nose points is 5'3⅜" with unworn stock rails.

Compound points are laid to exact gauge at the set in front of the switch toes, and the gauges for the 94 & 107 lb. compounds at the switch heels are shown in Fig. 62.

If wear is present, allowance should be made equal to the amount of wear, as any attempt to pull the worn portions of the points to exact gauge will definitely throw the switches out of alignment and interfere with their correct seating against their stock rails.

GAUGE DISTORTION.

The condition at points is similar to that at a kink in the track; with the standard heel spread this kink is greater with short switches than with long switches.

Locomotives with long rigid wheel bases cannot pass through short switches without distortion of either or both the points and the locomotive frames. To obviate these conditions 22'6" switches are now standard for main track points where 8 coupled wheel locomotives are in running.

With short switches it will be observed that wear is in evidence on the switch and the straight stock rail as shown in Fig. 63, and that exact gauge cannot be maintained at the toe of the points.

The presence of guard rails close to the toe of the points aggravates the foregoing conditions, and in the new trackwork layouts care is taken to lay the points not closer than 17'6" from any $1\frac{3}{4}$" flangeway. For the same reasons the toes of switches should not be laid in closer than 17'6" from toe to toe, and the toe length of the new points has been fixed at 9'0" to ensure compliance with these conditions.

If the distance between toes of switches is less than the wheel base, conditions arise as shown in Fig. 64, in which the long rigid wheel base locomotives must spread the gauge to force their passage through the points.

FREEDOM OF SWITCHES

If the operating pull rod were removed from the points the switches should offer little resistance to movement by the hands of one man, and each switch should seat snugly against its stock rail and remain so after being moved into position.

Interference with the heel fastenings to produce spring in the switches is contrary to instructions and can be the cause of derailment.

Sluggish movement of switches is a common cause of derailments and may arise from uneven seating of the switches on the point chairs, incorrect spreader fitting, or tight joints at the pins in the lever and rodding.

All pin joints should be in alignment so that the pins could, if necessary, be removed readily with the fingers, and spreader ends, pins or bolts, should drop into position without distortion of the switches.

RENEWALS

With the loose fitting in use in old standard points it was necessary to interchange switches and stock rails of the same weight, class, and type, but in the new standard points the fitting is much more accurate and the best results are obtained by installing the material as received from the workshops.

For this reason it is now the practice to supply the points in half sets with the switch fitted to its stock rail and, when sufficient man power is available, the half sets of points should be installed without dismantling other than the heel bolts to permit insertion of the closure rails.

LUBRICATION

Chair slides should be cleaned and lubricated frequently. In districts where sand is troublesome graphite is the most suitable lubricant for this purpose, otherwise point oil is provided, but its use should be confined to the slide surface of the point chairs.

Excessive use of oil causes the point fastenings to work loose. A little oil applied to the pins, rod ends, cranks and spreader bolts greatly reduces the friction and improves the operation of the switches.

CATCH POINT DERAILS

Sidings which connect with the main tracks are 'trapped' to prevent vehicles in the sidings being moved foul of the running tracks. The trackwork arrangement provided for this purpose is the catch point derail. Deflecting rails are provided where necessary to ensure that a runaway vehicle will be thrown clear of the main track.

The usual position of derail catch points is shown in 19.07,Fig.1, and the arrangement of deflecting rails and deflecting switch for 60 and 80 lb. tracks is shown in Fig. 65.

Catch point derails in the older rail sections were assembled from standard materials, and the deflecting switch from a selected worn switch. The necessity for selecting a worn deflecting switch will be clear from Fig. 66, showing that the crown of the switch must not stand above the track rail or there will be a danger of derailment by mounting or spreading the gauge in a trailing movement.

While the safety purpose of the catch point derail is the first consideration, it is also necessary to consider the convenience of re-railing vehicles and the extent of damage to the trackwork during derailing and re-railing movements.

CATCH POINT DERAIL SINGLE SWITCH

The 94 and 107 lb. single catch point derail is shown in Fig. 67, and several features of design should be noted to ensure correct installation.

To prevent derailing and re-railing wheels from dropping between the stock rail and the track rail behind the heel and overturning or ploughing out one or other of the rails, the stock rail divergency is limited to 4¼" measured between the rail heads.

Lug plates step are used to ensure the correct height of stock rail mounting, and the end of the special stock rail is ramped to lessen obstruction as with guard rails and wing rails of crossings, and also to assist in re-railing operations.

The point slide chairs are of the drop forged mild steel type and the track rail opposite the derail switch is supported by rail chairs of similar type.

It will be seen that all under rail fastenings are of 1" thickness which simplifies the work of installation, and the lateral support afforded by the rail chairs reduces the danger of spreading the gauge during re-railing movements.

A slotted flat spreader sliding through a spreader bracket on the track rail opposite the derail switch limits the switch movement and thus enables the switch to more definitely control the movement of the derailing vehicle.

Heel fastenings are standard, but the new Mark 'C' short chair-bolts are required with the mild steel slide and rail chairs.

The correct position for installing a catch point derail is on the straight track, and when the heel of the catch point derail is at the fouling point the maximum standing room is given clear of the switch toe.

In congested yards instances have arisen where catch point derails are required in the curved closure rails of trackwork layouts, such arrangements are definitely bad trackwork and should be avoided.

The 'V' nose point section is unsuitable for switches on curves and in 94 and 107 lb. trackwork a switch section has been adopted for catch point derails as shown in Fig. 67.

This section includes the standard switch-to-stock rai fitting and employs standard fastenings, but the running sid of the switch is machined to $6\frac{1}{2}^{\circ}$ which is more suitable fo fully curved switches and equally suitable for catch point de rails on the straight since no movement of divergency ther takes place.

DERAIL TURNOUT

Where it is important to guide runaway vehicles clear c running lines or structures as well as to reduce damage t track, a derail turnout is installed, as shown in Fig. 68

In this arrangement the 'V' crossing is replaced by flange lift block assembly and pad block. These are s placed to enable the wheels to cross over the track rail with out damage thereto.

The points in use in derail turnouts are of a standar type, but on some railways special points are in use as show in Fig. 69.

It is claimed for these special points that maintenanc is greatly reduced, as the switches are not part of the run ning track and only come into operation when it is necessary t derail vehicles making an irregular movement.

CATCH SIDING

When it is desirable to trap a runaway vehicle withou derailment, a catch siding is installed.

Derails and chock blocks are track appliances serving th same purpose as catch point derails. See 16.10.

94 & 107 lb. A.S. STOCK RAIL DETAILS

LAYOUT	No. of LAYOUT	STOCK RAIL LENGTH	CATALOGUE No.	SET, STRAIGHT or CURVED	HEEL LENGTH	SWITCH	TOE LENGTH
TURNOUT PARALLEL TRACK CROSSOVER	7.52	30'0"	—	Str. Set.	6'0"	15'0"	9'0"
	8.7	33'9"	—	" "	8'3"	16'6"	"
		40'0"	—	" "	8'6"	22'6"	"
	9.73	33'9"	—	" "	8'3"	16'6"	"
		40'0"	—	" "	8'6"	22'6"	"
LADDER TURNOUT 11'8" Centres	7.52	33'9"	15'0" A	" "	7'3½"	15'0"	11'5½"
	8.7	36'0"	16'6" A	" "	6'11½"	16'6"	12'6½"
	9.73	41'8½"	16'6" AW	Set	8'3"	"	16'11½"
		33'9"	"	Str.	"	"	9'0"
COMPOUNDS DOUBLE AND SINGLE	7.52	23'9"	—	"	4'1"	15'0"	4'8"
		32'6¾"	—	Cvd	12'10¾"	"	"
	8.7	29'6¾"	—	Str. Cvd.	2'1"	19'0"	8'5¾"

94 & 107 lb. A.S. STOCK RAIL DETAILS

LAYOUT	No. of LAYOUT	STOCK RAIL LENGTH	CATALOGUE No.	SET, STRAIGHT or CURVED	HEEL LENGTH	SWITCH	TOE LENGTH
COMPOUND CROSSOVER 11'8" CENTRES NON INSULATED LAYOUT	7.52	23'9"	–	Str.	4'1"	15'0"	4'8"
		32'6¾"	–	Cvd.	12'10¾"	"	"
		41'10½"	15'0" H	"	"	"	13'11¾"
	8.7	29'6¾"	–	Str. Cvd.	2'1"	19'0"	8'5¾"
		37'9 9/16"	19'0" A	Cvd.	"	"	16'8 9/16"
JUNCTION SYMMETRICAL CONTRAFLEXURE	6.0A	30'0"	15'0" D+	Set	6'0"	15'0"	9'0"
	5.0A	"	15'0" F+	"	"	"	"

80, 90, 100 & 110 lb. STOCK RAIL DETAILS

LAYOUT	NOMINAL RADIUS	STOCK RAIL LENGTH	SET or STRAIGHT	HEEL LENGTH	SWITCH	TOE LENGTH
TURNOUT	600'	31'9"	Set. Str.	5'6½"	13'6"	12'8½"
	800'	31'9"	" "	6'3¾"	15'9"	9'8¼"
	1000'	31'9"	" "	7'0½"	18'0"	6'8½"
SINGLE COMPOUND	600'	23'11½"	Set	4'9"	13'6"	5'8½"
		27'7⅜"	Str.	9'3½"	"	4'9⅞"
		31'11⅜"	Set	5'9"	"	12'8⅜"
	800'	28'4½"	"	6'5¼"	15'9"	6'2¼"
		33'8¾"	Str.	11'9½"	"	"
		35'4 3/16"	Set	6'5½"	"	13'1 11/16"
	1000'	27'9"	"	6'6¾"	18'0"	3'2¼"
		31'9"	Set. Str.	"	"	7'2¼"
DOUBLE COMPOUND	600'	27'7⅜"	Str.	9'4½"	13'6"	4'8⅞"
		31'11⅜"	Set	5'9"	"	12'8⅜"
		36'3¾"	"	"	"	17'0¾"

80, 90, 100 & 110 lb. STOCK RAIL DETAILS						
LAYOUT	NOMINAL RADIUS	STOCK RAIL LENGTH	SET or STRAIGHT	HEEL LENGTH	SWITCH	TOE LENGTH
DOUBLE COMPOUND	800'	28'4$\frac{1}{2}$"	Set	6'5$\frac{1}{4}$"	15'9"	6'2$\frac{1}{4}$"
		33'8$\frac{3}{4}$"	Str.	11'9$\frac{1}{2}$"	15'9"	"
		35'4$\frac{3}{16}$"	Set	6'5$\frac{1}{2}$"	"	13'1$\frac{11}{16}$"
	1000'	27'9"	"	6'6$\frac{3}{4}$"	18'0"	3'2$\frac{1}{4}$"
		31'9"	Set.Str.	"	"	7'2$\frac{1}{4}$"
MODIFIED THREE THROWS	600'x600'	31'9"	" "	5'6$\frac{1}{2}$"	13'6"	12'8$\frac{1}{2}$"
		31'9"	Set	8'6$\frac{1}{2}$"	"	9'8$\frac{1}{2}$"
		37'3"	Str.	8'6"	"	15'3"
	600 x 800	31'9"	Set.Str.	5'6$\frac{1}{2}$"	"	12'8$\frac{1}{2}$"
		31'9"	Set	7'2$\frac{1}{8}$"	15'9"	8'9$\frac{7}{8}$"
		37'3"	Str	7'1$\frac{5}{8}$"	"	14'4$\frac{3}{8}$"
	600x1000	31'9"	Set.Str.	5'6$\frac{1}{2}$"	13'6"	12'8$\frac{1}{2}$"
		31'9"	Set	6'5$\frac{5}{16}$"	18'0"	7'3$\frac{11}{16}$"
		37'3"	Str.	6'4$\frac{13}{16}$"	"	12'10$\frac{3}{16}$"

		37'3"	Str.	6'4 13/16"	"	12'10 3/16"

80,90, 100 & 110 lb. STOCK RAIL DETAILS						
LAYOUT	NOMINAL RADIUS	STOCK RAIL LENGTH	SET or STRAIGHT	HEEL LENGTH	SWITCH	TOE LENGTH
MODIFIED THREE THROWS	800 x 600	31'9"	Set.Str.	6'3¾"	15'9"	9'8¼"
		34'0½"	" "	5'6½"	13'6"	15'0"
	800 x 800	31'9"	" "	6'3¾"	15'9"	9'8¼"
		31'9"	Str.	12'10 7/16"	"	3'1 9/16"
		31'9"	Set	5'9½"	"	10'2½"
	800 x 1000	31'9"	Set.Str.	6'3¾"	"	9'8¼"
		31'9"	Set	5'4"	18'0"	8'5"
		37'3"	Str.	4'6½"	"	14'8¾"
	1000 x 600	31'9"	Set.Str.	7'0½"	"	6'8½"
		31'9"	" "	5'6½"	13'6"	12'8½"
	1000 x 800	31'9"	" "	7'0½"	18'0"	6'8½"
		31'9"	" "	6'3¾"	15'9"	9'8¼"
	1000 x1000	31'9"	" "	7'0½"	18'0"	6'8½"

90 & 110 lb. A.S. STOCK RAIL DETAILS						
LAYOUT	NOMINAL RADIUS	STOCK RAIL LENGTH	SET or STRAIGHT	HEEL LENGTH	SWITCH	TOE LENGTH
TURNOUT	600'	31'9"	Str.Set.	5'6½"	13'6"	12'8½"
	800'	31'9"	" "	6'3¾"	15'9"	9'8¼"
	1000'	31'9"	" "	7'0½"	18'0"	6'8½"
COMPOUNDS DOUBLE AND SINGLE INSULATED LAYOUTS	600'	27'7⅜"	Str.	9'5"	13'6"	4'8⅜"
		33'9"	Set	15'7¼"	"	4'7¾"
	800'	33'9"	Str.	11'10¼"	15'9"	6'1¾"
		29'3"	Set	7'4¼"	"	"
	1000'	29'3"	Str	4'2⅞"	18'0"	7'0⅛"
		31'6"	Set	7'0½"	"	6'5½"
MODIFIED THREE THROWS	600 x 600	27'7⅜"	Str.	9'5"	13'6"	4'8⅜"
		32'7⅞"	Set	"	"	9'8⅞"
		31'9"	Str.Set.	5'6½"	"	12'8½"
	600 x 800	33'9"	Str.	11'10¼"	15'9"	6'1¾"
		31'11½"	Set	7'4¼"	"	8'10¼"
		31'9"	Str.Set.	5'6½"	13'6"	12'8½"

90 & 110 lb. A.S. STOCK RAIL DETAILS

		31'9"	Str.Set.	5'6½"	13'6"	12'8½"

90 & 110 lb. A.S. STOCK RAIL DETAILS

LAYOUT	NOMINAL RADIUS	STOCK RAIL LENGTH	SET or STRAIGHT	HEEL LENGTH	SWITCH	TOE LENGTH
MODIFIED THREE THROWS	600'x1000'	29'3"	Str.	4'2⅞"	18'0"	7'0⅛"
		29'7"	Set	"	"	7'4⅛"
		31'9"	Str.Set.	5'6½"	13'6"	12'8½"
	800'x 600'	27'7⅜"	Str.	9'5"	"	4'8⅜"
		33'9"	Set	15'7¼"	"	4'7¾"
		31'9"	Str.Set.	6'3¾"	15'9"	9'8¼"
	800'x 800'	33'9"	Str.	11'10¼"	"	6'1¾"
		37'10½"	Set	"	"	10'3¼"
		31'9"	Str.Set.	6'3¾"	"	9'8¼"
	800'x1000'	29'3"	Str.	4'2⅞"	18'0"	7'0⅛"
		30'8¼"	Set.	4'2⅞"	"	8'5⅜"
		31'9"	Str.Set.	6'3¾"	15'9"	9'8¼"
	1000'x600'	31'9"	" "	5'6½"	13'6"	12'8½"
		31'9"	" "	7'0½"	18'0"	6'8½"

90 & 110 lb. A.S. STOCK RAIL DETAILS						
LAYOUT	NOMINAL RADIUS	STOCK RAIL LENGTH	SET or STRAIGHT	HEEL LENGTH	SWITCH	TOE LENGTH
MODIFIED THREE THROWS	1000'x800'	31'9"	Str.Set.	6'3¾"	15'9"	9'8¼"
		31'9"	" "	7'0½"	18'0"	6'8½"
	1000'x1000'	31'9"	" "	"	"	"
COMPOUND CROSSOVER 11'8" CENTRES NON-INSULATED LAYOUT	600'	27'7⅜"	Str.	9'5"	13'6"	4'8⅜"
		33'9"	Set	15'7¼"	"	4'7¾"
		41'10¼"	"	"	"	12'9"
	800'	33'9"	Str.	11'10¼"	15'9"	6'1¾"
		29'3"	Set	7'4¼"	"	"
		36'2¾"	"	"	"	13'1½"
	1000'	29'3"	Str.	4'2⅞"	18'0"	7'0⅛"
		31'6"	Set	7'0½"	"	6'5½"
		40'2⅞"	"	"	"	15'2⅞"

60 lb. A.S. STOCK RAIL DETAILS

	40'2$\frac{7}{8}$"	"	"	"	15'2$\frac{3}{8}$"

60 lb. A.S. STOCK RAIL DETAILS

LAYOUT	NOMINAL RADIUS	STOCK RAIL LENGTH	SET or STRAIGHT	HEEL LENGTH	SWITCH	TOE LENGTH
TURNOUT PARALLEL TRACK CROSSOVER	600'	22'6"	Set.Str.	4'0"	15'0"	3'6"
	800'	22'6"	" "	"	"	"
	1000'	22'6"	" "	"	"	"
TURNOUT WELDED LEADS	7.52 15'0"E	31'6"	" "	7'6"	"	9'0"
	8.7 " "	31'6"	" "	"	"	"
COMPOUNDS DOUBLE AND SINGLE	600'	22'6"	" "	4'2"	"	3'4"
	800'	20'1$\frac{1}{8}$"	Str.	4'1$\frac{3}{4}$"	"	11$\frac{3}{8}$"
		20'1$\frac{1}{4}$"	Set	"	"	11$\frac{1}{2}$"
	1000'	20'0$\frac{15}{16}$"	Str.	4'1$\frac{1}{2}$"	"	11$\frac{7}{16}$"
		20'1$\frac{1}{16}$"	Set	"	"	11$\frac{9}{16}$"
MODIFIED THREE THROWS	600' x 600'	22'6"	Set.Str.	4'0"	"	3'6"
		22'6"	" "	6'3$\frac{1}{4}$"	"	1'2$\frac{3}{4}$"
	600' x 800'	22'6"	" "	4'0"	"	3'6"
		22'6"	" "	6'7$\frac{5}{8}$"	"	10$\frac{3}{8}$"

60 lb. A.S. STOCK RAIL DETAILS

LAYOUT	NOMINAL RADIUS	STOCK RAIL LENGTH	SET or STRAIGHT	HEEL LENGTH	SWITCH	TOE LENGTH
MODIFIED THREE THROWS	600'x1000'	22' 6" 22' 6"	Set.Str. Set.Str.	4'0" 7'2$\frac{3}{4}$"	15' 0" 15' 0"	3'6" 3$\frac{1}{4}$"
	800'x 600' 800'x 800' 800'x1000'	22' 6"	Set.Str	4'0"	15' 0"	3'6"
	1000'x 600' 1000'x 800' 1000'x1000'	22' 6"	Set.Str	4'0"	15'0"	3'6"

60 lb. D STOCK RAIL DETAILS

60 lb. D STOCK RAIL DETAILS

LAYOUT	NOMINAL RADIUS	STOCK RAIL LENGTH	SET or STRAIGHT	HEEL LENGTH	SWITCH	TOE LENGTH
TURNOUT	600'	20'0"	Set.Str.	4'0"	* 12'0"	4'0"
PARALLEL TRACK CROSSOVER	800'	23'0"	" "	"	15'0"	"
DELTA CROSSOVER	1000'	"	" "	"	"	"
SINGLE AND DOUBLE COMPOUNDS	600'	22'6"	" "	4'2"	* 12'0"	6'4"
	800'	20'1$\frac{1}{8}$"	Str.	4'1$\frac{3}{4}$"	15'0"	11$\frac{3}{8}$"
		20'1$\frac{1}{4}$"	Set	"	"	11$\frac{1}{2}$"
	1000'	20'0$\frac{15}{16}$"	Str.	4'1$\frac{1}{2}$"	"	11$\frac{7}{16}$"
		20'0$\frac{1}{16}$"	Set	4'1$\frac{1}{2}$"	"	10$\frac{9}{16}$"
MODIFIED THREE THROWS	600 x 600	22'6"	Set.Str.	6'3$\frac{1}{4}$"	* 12'0"	4'2$\frac{3}{4}$"
		"	" "	4'0"	"	6'6"
	600 x 800	22'6"	" "	6'7$\frac{5}{8}$"	"	3'10$\frac{3}{8}$"
		22'6"	" "	4'0"	15'0"	3'6"
	600 x 1000	22'6"	" "	7'2$\frac{3}{4}$"	* 12'0"	3'3$\frac{1}{4}$"
		22'6"	" "	4'0"	15'0"	3'6"

* Note: - 12'0" switches shown discontinued June, 1923, to be replaced by 15'0" switches by the direction of the Commissioners.

60 lb. D STOCK RAIL DETAILS

LAYOUT	NOMINAL RADIUS	STOCKRAIL LENGTH	SET or STRAIGHT	HEEL LENGTH	SWITCH	TOE LENGTH
MODIFIED THREE THROWS	800 x 600	22'6"	Set.Str.	4'0"	15'0"	3'6"
		20'0"	" "	"	* 12'0"	4'0"
	800 x 800	22'6"	" "	"	15'0"	3'6"
		22'6"	" "	"	"	"
	800 x 1000	22'6"	" "	"	"	"
		22'6"	" "	"	"	"
	1000 x 600	22'6"	" "	"	"	"
		20'0"	" "	"	* 12'0"	4'0"
	1000 x 800	22'6"	" "	"	15'0"	3'6"
		22'6"	" "	"	"	"
	1000 x 1000	22'6"	" "	"	"	"
		22'6"	" "	"	"	"

* Note: - 12'0" switches shown discontinued June, 1923, to be replaced by 15'0" switches by the direction of the Commissioners.

WEIGHT	SWITCH	STOCK	HEEL	LENGTH OF STOPS (web to web)	POSITION OF STOPS FROM HEEL OF SWITCH	BOLTS RQRD PER STOP	Fig.

REPLACEMENT SWITCH STOPS

WEIGHT and CLASS	SWITCH LENGTH	STOCK RAIL	HEEL SPREAD	LENGTH OF STOPS (web to web) Heel	Inter	Front	POSITION OF STOPS FROM HEEL OF SWITCH Heel	Inter	Front	BOLTS PER Dia.	RQRD STOP Len.	No	Fig. No
§60 lb D	12'0"	1 in 20	5 3/4"	4 1/8"	3 3/16"	2 1/4"	2' 6"	2' 0"	2' 0"	5/8"	2 1/4"	2	38
" "	15'0"	"	"	4 1/4"	3 3/8"	2 9/16"	2' 8"	2' 2"	2' 2"	"	"	"	"
" "	8'0"	"	"	3 9/16"	-	-	2' 6"	-	-	"	"	"	"
§ " AS	12'0"	"	"	4 1/4"	3 5/16"	2 13/32"	"	2' 0"	2' 0"	"	"	"	"
" "	15'0"	"	"	4 3/8"	3 9/16"	2 13/16"	2' 8"	2' 2"	2' 2"	"	"	"	"
" "	8'0"	"	"	3 5/8"	-	-	2' 6"	-	-	"	"	"	"
" "	15'0"	Vert	"	4 5/16"	3 1/2"	2 11/16"	2' 8"	2' 2"	2' 2"	"	"	"	"
* " "	"	1 in 20	"	4 13/32"	"	2 17/32"	"	2' 6"	2' 7"	"	"	"	"
§66 lb E	12'0"	"	"	4 3/16"	3 1/4"	2 5/16"	2' 6"	2' 0"	2' 0"	"	"	"	"
" "	15'0"	"	"	4 11/32"	3 17/32"	2 3/4"	2' 8"	2' 2"	2' 2"	"	"	"	"
70 lb Stock	14'8"	"	4 1/2"	2 15/16"	2 11/32"	1 25/32"	2' 0"	2' 0"	2' 0"	-	-	-	37
75 lb H	15'0"	"	"	3 7/16"	2 15/16"	2 7/16"	2' 8"	2' 2"	2' 2"	5/8"	2 1/4"	2	38
" "	"	"	5 3/4"	4 11/32"	3 17/32"	2 3/4"	"	"	"	"	"	"	"
§78 lb Stock	12'0"	"	4 1/2"	2 31/32"	2 3/8"	1 13/16"	1' 10 1/2"	1' 10 1/2"	1' 10 1/2"	-	-	-	37
" "	15'0"	"	"	"	"	"	"	"	"	-	-	-	"

Continued on 14.034

REPLACEMENT SWITCH STOPS

WEIGHT and CLASS	SWITCH LENGTH	STOCK RAIL	HEEL SPREAD	LENGTH OF STOPS (web to web)			POSITION OF STOPS FROM HEEL OF SWITCH			BOLTS RQRD PER STOP			Fig. No
				Heel	Inter	Front	Heel	Inter	Front	Dia.	Len.	No	
§78 lb Stock	12'0"	1 in 20	$5\frac{3}{4}$"	$2\frac{31}{32}$"	$2\ \frac{3}{8}$"	$1\frac{13}{16}$"	$1'10\frac{1}{2}$"	$1'10\frac{1}{2}$"	$1'10\frac{1}{2}$"	-	-	-	37
" "	15'0"	"	"	"	"	"	"	"	"	-	-	-	"
80 lb O& AS	13'6"	"	"	$4\ \frac{1}{2}$"	-	$3\frac{9}{16}$"	2' 0"	-	2' 3"	$\frac{3}{4}$"	$2\frac{1}{4}$"	2	39
" "	15'9"	"	"	"	$3\ \frac{3}{4}$"	$2\ \frac{7}{8}$"	2' 0"	2' 3"	"	"	"	"	"
" "	18'0"	"	"	$4\ \frac{5}{8}$"	$3\ \frac{7}{8}$"	$3\frac{3}{16}$"	"	"	"	"	"	"	"
86 lb Stock	15'0"	"	$4\frac{1}{2}$"	$2\frac{13}{16}$"	$2\frac{5}{16}$"	$1\frac{25}{32}$"	"	$2'\ 1\frac{1}{2}$"	$1'\ 7\frac{1}{2}$"	-	-	-	37
90 lb AS	13'6"	Vert	$5\frac{3}{4}$"	$4\frac{13}{32}$"	-	$3\frac{19}{32}$"	"	-	2' 3"	$\frac{3}{4}$"	$2\frac{1}{4}$"	2	39
" "	15'9"	"	"	$4\ \frac{1}{2}$"	$3\ \frac{3}{4}$"	$3\frac{1}{16}$"	"	2' 3"	"	"	"	"	"
" "	18'0"	"	"	$4\frac{19}{32}$"	$3\frac{29}{32}$"	$3\ \frac{1}{4}$"	"	"	"	"	"	"	"
94 lb AS	Stops for these Points are not replaced in the field												"
95 lb Stock	13'6"	1 in 20	$5\frac{3}{4}$"	$3\ \frac{7}{8}$"	$2\frac{15}{16}$"	$1\frac{31}{32}$"	2' 0"	2' 3"	2' 3"	$\frac{3}{4}$"	$2\frac{3}{4}$"	2	"
" "	15'9"	"	"	$4\frac{1}{32}$"	$3\frac{3}{16}$"	$2\ \frac{3}{8}$"	"	"	"	"	"	"	"
" "	18'0"	"	"	$4\ \frac{1}{8}$"	$3\frac{7}{16}$"	$2\frac{11}{16}$"	"	"	"	"	"	"	"
100 lb P&AS	13'6"	"	"	$4\ \frac{1}{2}$"	-	$3\frac{7}{16}$"	"	-	"	"	$2\frac{1}{4}$"	"	"
" "	15'9"	"	"	"	$3\ \frac{3}{4}$"	$2\ \frac{7}{8}$"	"	2' 3"	"	"	"	"	"
" "	18'0"	"	"	$4\frac{9}{16}$"	$3\ \frac{7}{8}$"	$3\ \frac{1}{8}$"	"	"	"	"	"	"	"

Continued on 14.035

Continued on 14.035

REPLACEMENT SWITCH STOPS

WEIGHT and CLASS	SWITCH LENGTH	STOCK RAIL	HEEL SPREAD	LENGTH OF STOPS (web to web) Heel	Inter	Front	POSITION OF STOPS FROM HEEL OF SWITCH Heel	Inter	Front	BOLTS PER Dia.	Len.	RQRD STOP No	Fig. No
107 lb AS	Stops for these Points are not replaced in the field.												39
110 " "	13'6"	Vert	$5\frac{3}{4}$"	$4\frac{11}{32}$"	-	$3\frac{9}{16}$"	2'0"	-	2'0"	$\frac{3}{4}$"	$2\frac{1}{4}$"	2	"
" " "	15'9"	"	"	$4\frac{7}{16}$"	$3\frac{21}{32}$"	$2\frac{15}{16}$"	"	2'3"	"	"	"	"	"
" " "	18'0"	"	"	$4\frac{9}{16}$"	$3\frac{7}{8}$"	$3\frac{7}{32}$"	"	"	2'3"	"	"	"	"
115 lb Stock	13'6"	1 in 20	"	$3\frac{29}{32}$"	-	$2\frac{31}{32}$"	"	-	"	"	$2\frac{3}{4}$"	"	"
" "	15'9"	"	"	$4\frac{1}{32}$"	$3\frac{7}{32}$"	$2\frac{13}{32}$"	"	2'3"	"	"	"	"	"
" "	18'0"	"	"	$4\frac{5}{32}$"	$3\frac{7}{16}$"	$2\frac{23}{32}$"	"	"	"	"	"	"	"

N o t e s : -

* To be used when replacing 12'0" 60 lb. A. S. Switches.

§ 12'0" Switches were discontinued in June 1923, to be replaced by 15'0" Switches by the direction of the Commissioners.

Each Point Stop will be supplied complete with bolts and nuts, and shims or washers according to the type of Stop required.

The number of the shims or washers which may be used between any Stop and the Switch shall not exceed 3 No.

The existing rivet holes in the Switches must be utilised when bolting on the replacement Stops and no additional holes are to be drilled. Should any of the existing holes in the Switches be smaller than the bolt diameters they must be enlarged to suit.

All nuts must be kept tightly screwed up to properly maintain the Stops in position, and the ends of the bolts are to be slightly rivetted over.

Before the No. of shims or washers to be used with the Stops are determined, it should be seen that the Stock Rails are properly lined up straight between the Heels and Toes of the Switches so that the Switches will lay snugly against the Stock Rails.

'X' LAYOUT SPREADERS

	TYPE OF LAYOUT		SPREADER No. 1	No off	SPREADER No. 2	No off	Operating Spreader Bracket	No off
INTERLOCKED	Single Pair	Insulated Non-insul	1F1268 3F1268	1 1	4F1268 8F1268	1 1	– 4B43	– 1
INTERLOCKED	Single Compound	Insulated Non-insul	2F1268 7F1268	2 2	4F1268 8F1268	2 2	– 4B43	– 2
INTERLOCKED	Double Compound	Insulated Non-insul	2F1268D 7F1268D	4 4	4F1268 8F1268	4 4	– 4B43	– 4
INTERLOCKED	Double Compound operated by 2 rods	Insulated Non-insul	2F1268 7F1268	4 4	4F1268 8F1268	4 4	– 4B43	– 4
HAND WORKED	Single Pair	Insulated Non-insul	5F1268 3F1268	1 1	4F1268 8F1268	1 1	– 11B43	– 1
HAND WORKED	Single Compound	Insulated Non-insul	6F1268 9F1268	2 2	4F1268 8F1268	2 2	– 11B43	– 2
HAND WORKED	Double Compound operated by 1 rod	Insulated Non-insul	6F1268D 9F1268D	4 4	4F1268 8F1268	4 4	– 11B43	– 4
HAND WORKED	Double Compound operated by 2 rods	Insulated Non-insul	6F1268 9F1268	4 4	4F1268 8F1268	4 4	– 11B43	– 4

PART	100 & 115 lb.	80, 86 & 95 lb.	60, 66 & 75 lb.
No. 1 Spreader	A = 4'4¼"	A = 4'5"	A = 4'5⅜"
No. 2 Spreader	A = 4'5⅜"	A = 4'6¼"	A = 4'6⅜"

Note: – Previous to 1945 Operating Spreader Bracket 104B3 was in use and for its application see 16.05.

Note: - Previous to 1945 Operating Spreader Bracket 104B3
was in use and for its application see 16.05.

'Y' LAYOUT SPREADERS

TYPE OF LAYOUT			Spreader No.1	No. off	Spreader No.2	No off	Spreader No.3	No off	Operating Spreader Bracket	Operating Spreader No off
INTERLOCKED	Single Pair	Insulated Non-insul	1B43 1B159	1 1	2B43 2B159	1 1	3B43 3B159	1 1	- 4B43	- 1
INTERLOCKED	Single Compound	Insulated Non-insul	1B50 4B159	2 2	2B50 5B159	2 2	3B50 6B159	2 2	- 4B43	- 2
INTERLOCKED	Double Compound operated by 1 rod	Insulated Non-insul	1B50 4B159	4 4	2B50 5B159	4 4	3B50 6B159	4 4	- 4B43	- 4
INTERLOCKED	Double Compound operated by 2 rods	Insulated Non-insul	15B50 4B159	4 4	2B50 5B159	4 4	3B50 6B159	4 4	- 4B43	- 4
INTERLOCKED	Movable 'K' Switch Compounds	Insulated Non-insul	6B50 20B159	4 4	12B50 21B159	4 4	- -	- -	- 4B43	- 4
HAND WORKED	Single Pair	Insulated Non-Insul	2F1769 1B159	1 1	2B43 2B159	1 1	3B43 3B159	1 1	- 11B43	- 1
HAND WORKED	Single Compound	Insulated Non-insul	4F1769 4B159	2 2	2B50 5B159	2 2	3B50 6B159	2 2	- 11B43	- 2
HAND WORKED	Double Compound operated by 1 rod	Insulated Non-insul	4F1769 4B159	4 4	2B50 5B159	4 4	3B50 6B159	4 4	- 11B43	- 4
HAND WORKED	Double Compound operated by 2 rods	Insulated Non-insul	6F1769 4B159	4 4	2B50 5B159	4 4	3B50 6B159	4 4	- 11B43	- 4

Note: - Previous to 1945 Operating Spreader Bracket 10B43
was in use and for its application See 16.05.

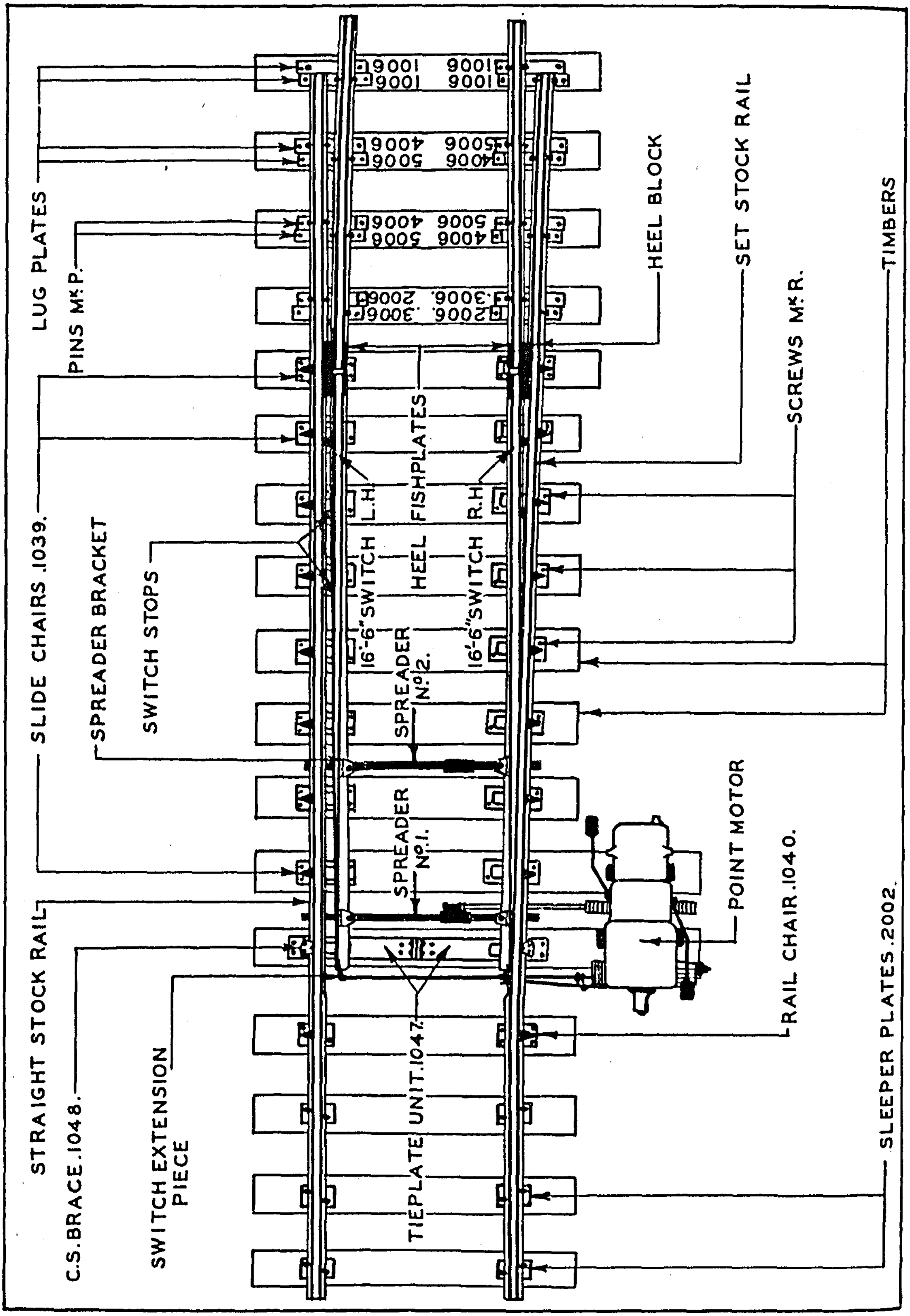


Fig. 1. Typical Set of 16'-6" R.H. 107 Lb. Points

Fig. 1. Typical Set of 16'-6" R.H. 107 Lb. Points

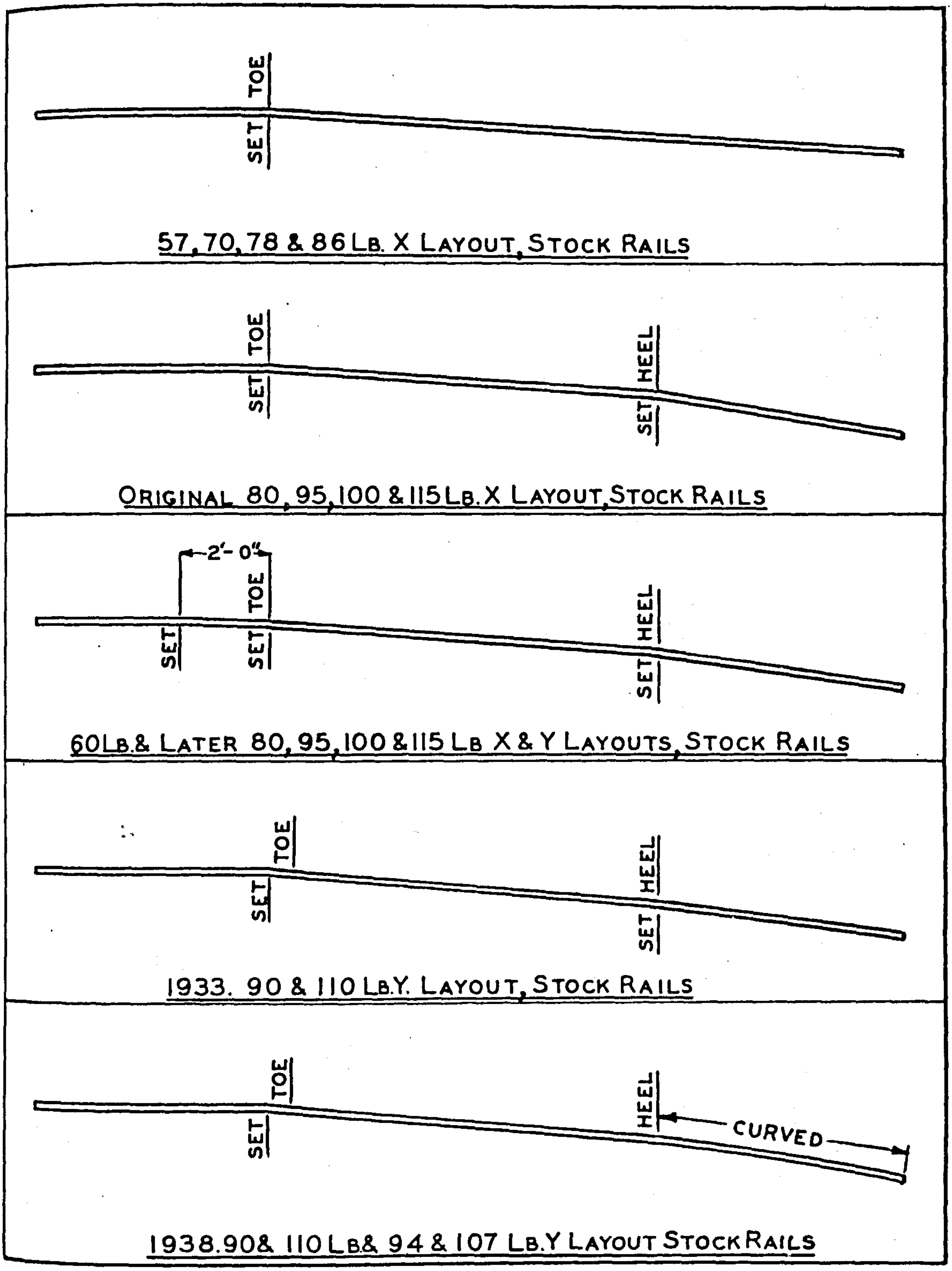


Fig. 2. Particulars of Stock Rail Sets

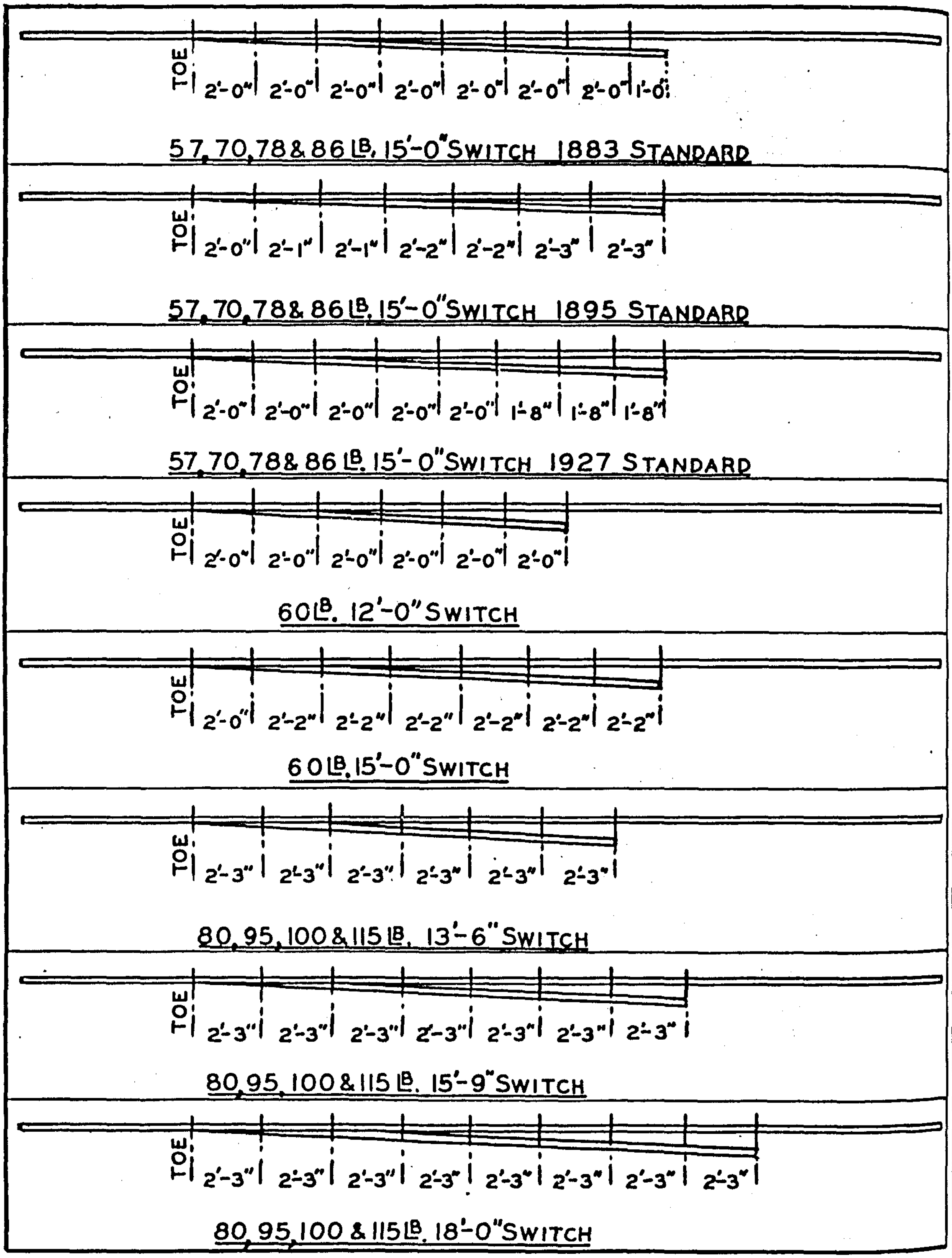


FIG. 3. SPACING OF CHAIR PINS & BOLTS, X LAYOUT, STOCK RAILS.

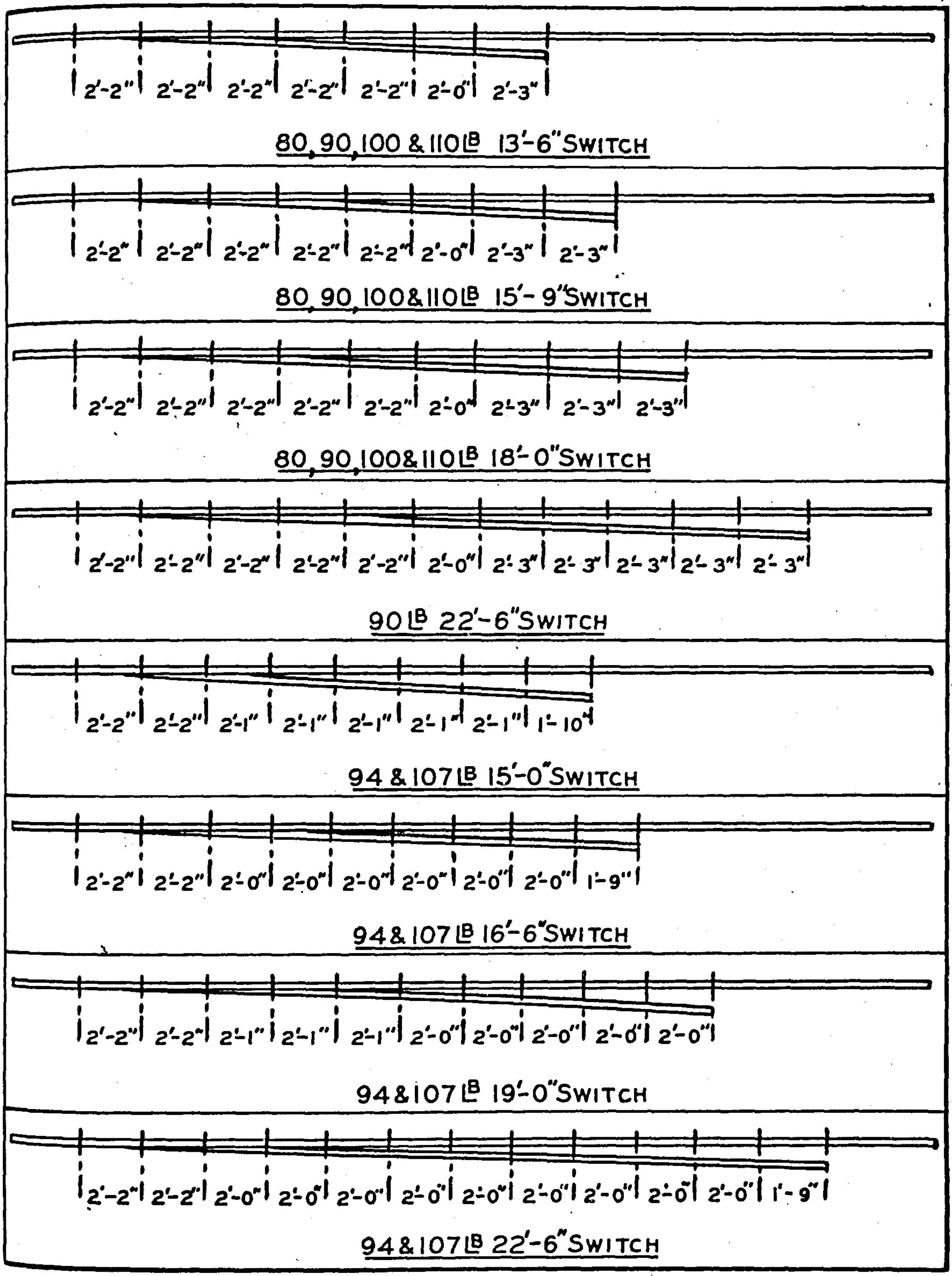


FIG. 4. SPACING OF CHAIR BOLTS, Y LAYOUT, STOCK RAILS

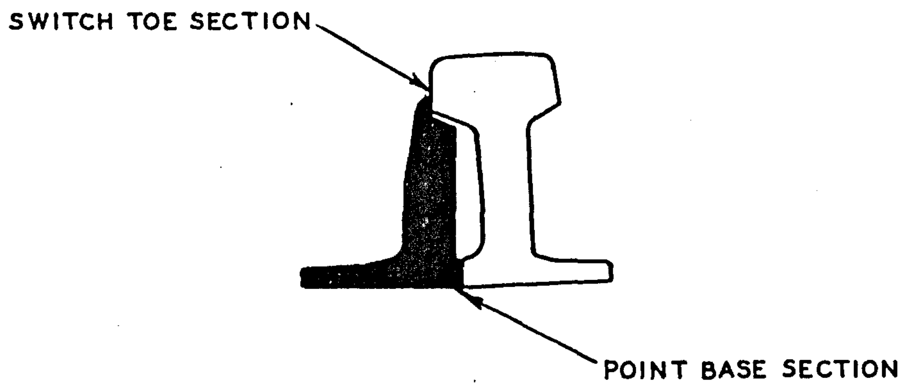


FIG. 5. POINT BASE & SWITCH TOE SECTIONS

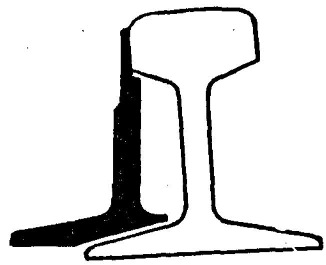


FIG. 6. POINT BASE & SWITCH TOE SECTIONS

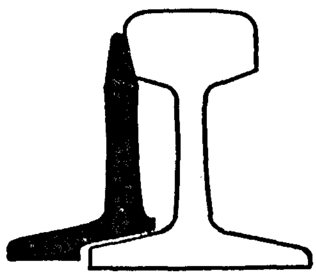


FIG. 7. POINT BASE & SWITCH TOE SECTIONS

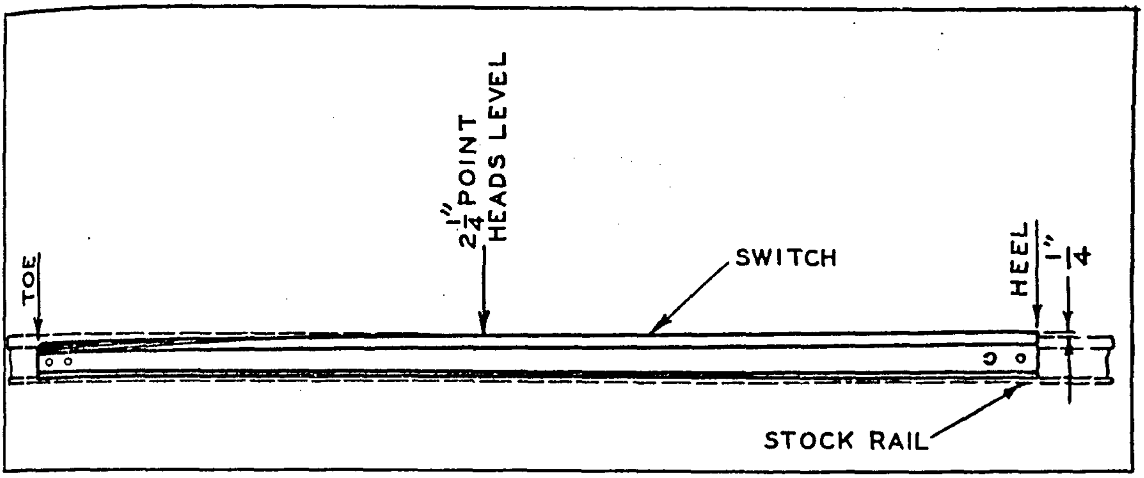


Fig. 8: Switch Crown

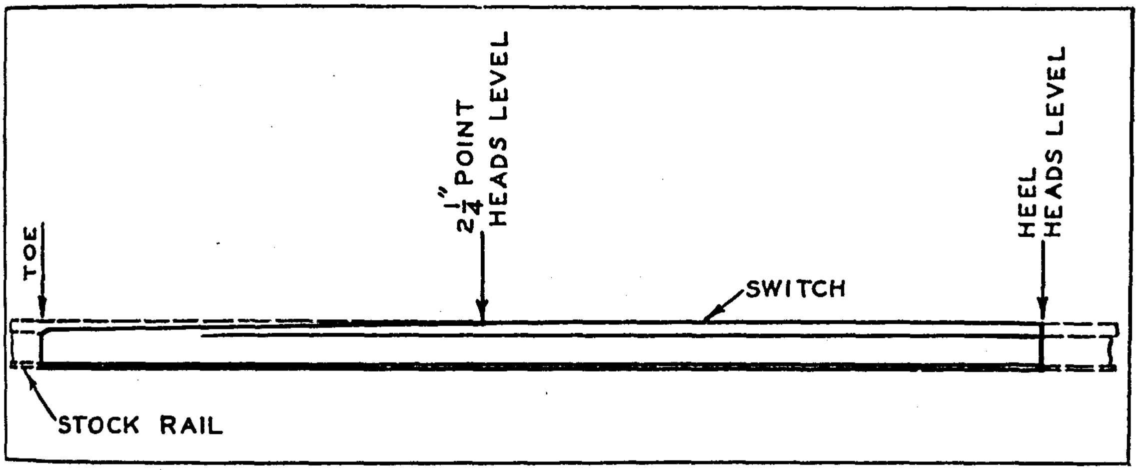


Fig. 9. Switch without Crown

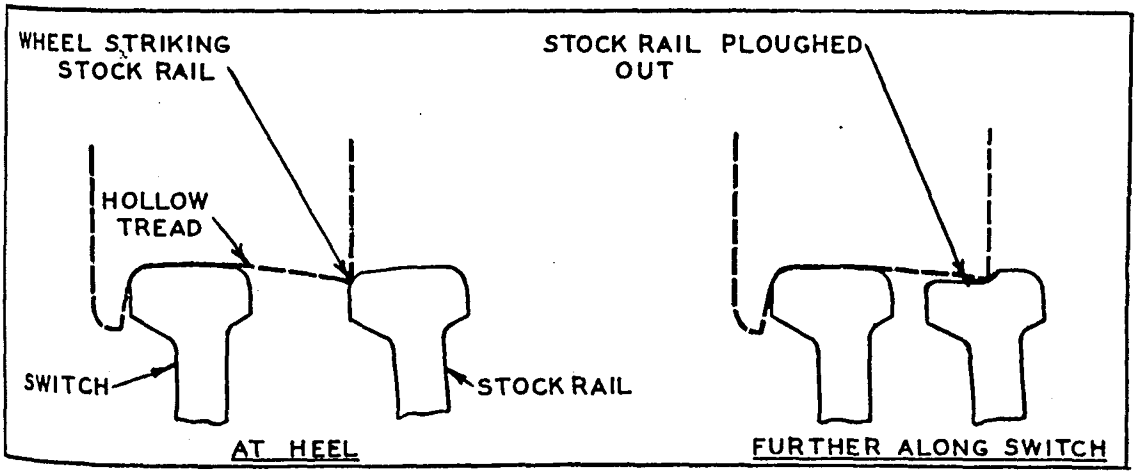


Fig. 10. Effect of Lack of Switch Crown on Stock Rail

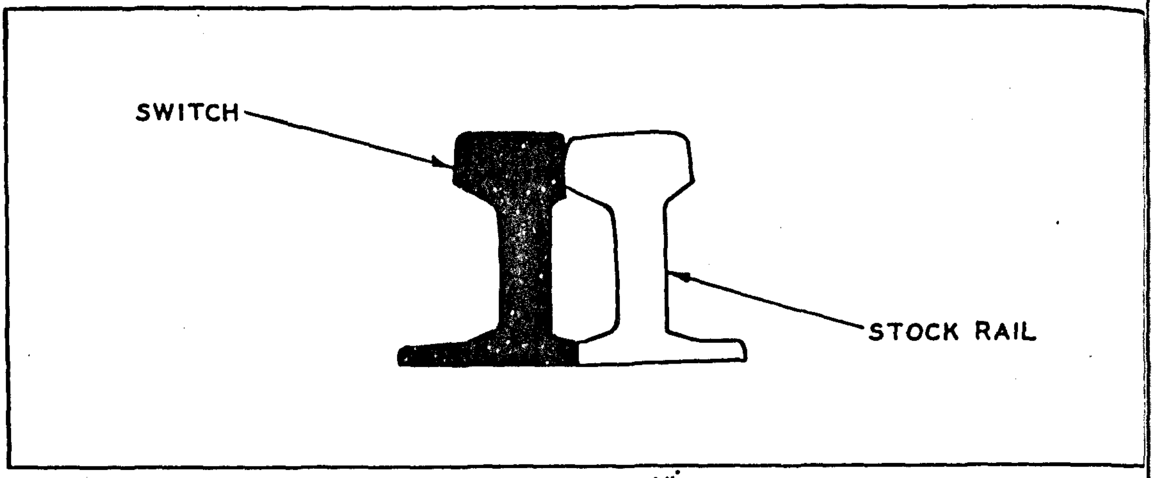


FIG. 11. SECTION AT $2\frac{1}{4}''$ HEAD WIDTH

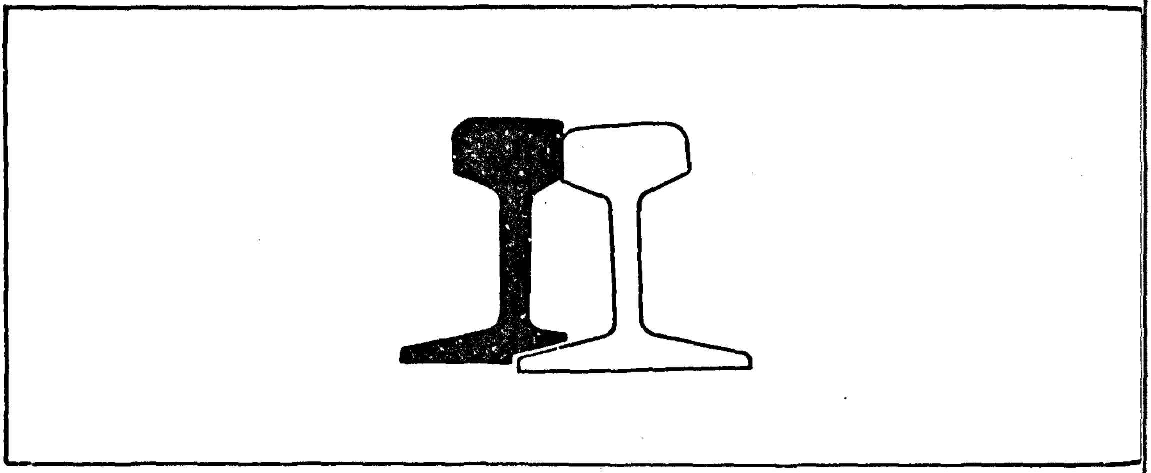


FIG .12 .SECTION AT $2\frac{1}{4}''$ HEAD WIDTH

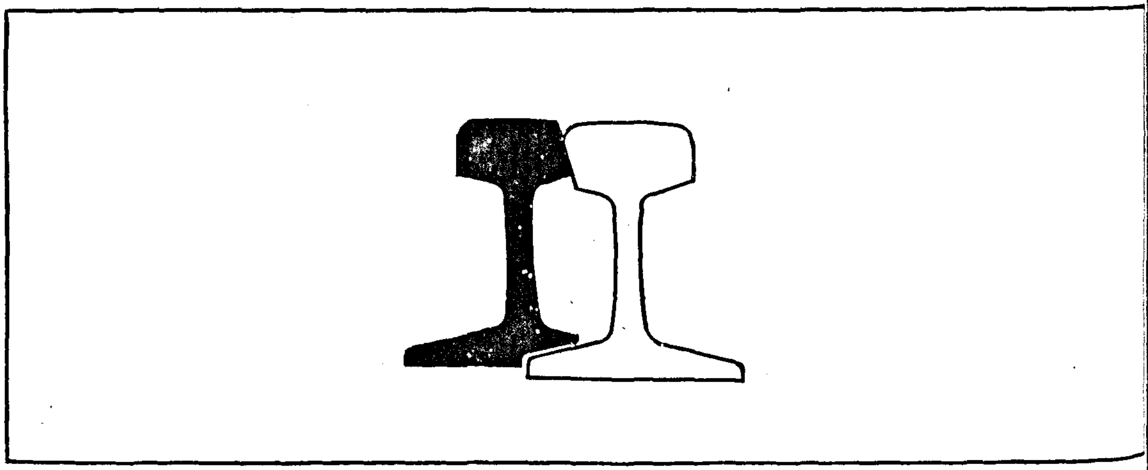


FIG. 13. SECTION AT $2\frac{1}{4}''$ HEAD WIDTH

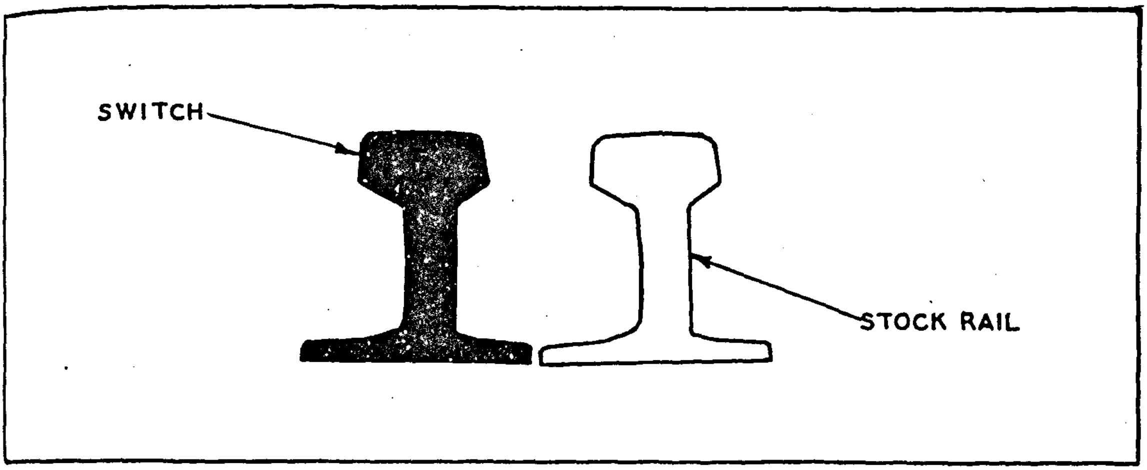


FIG. 14. SECTION AT HEEL

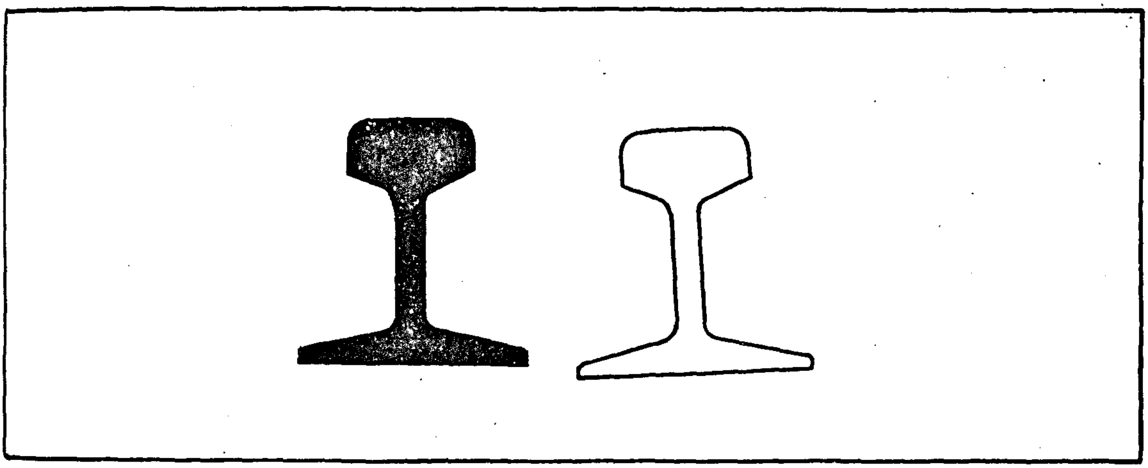


FIG. 15. SECTION AT HEEL

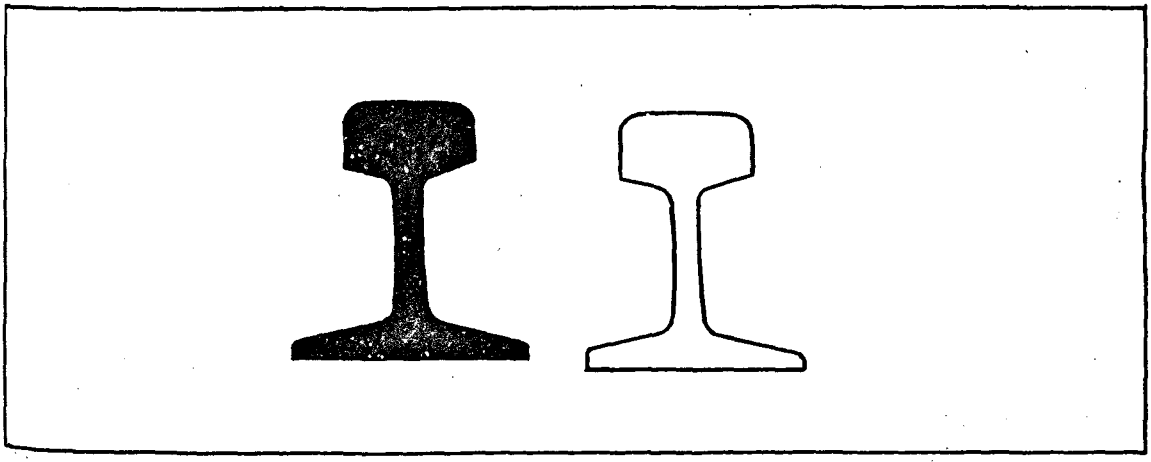


FIG. 16. SECTION AT HEEL

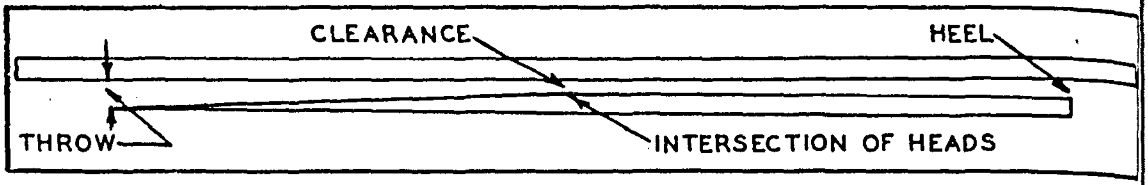


Fig. 17. Clearance at Intersection of Heads

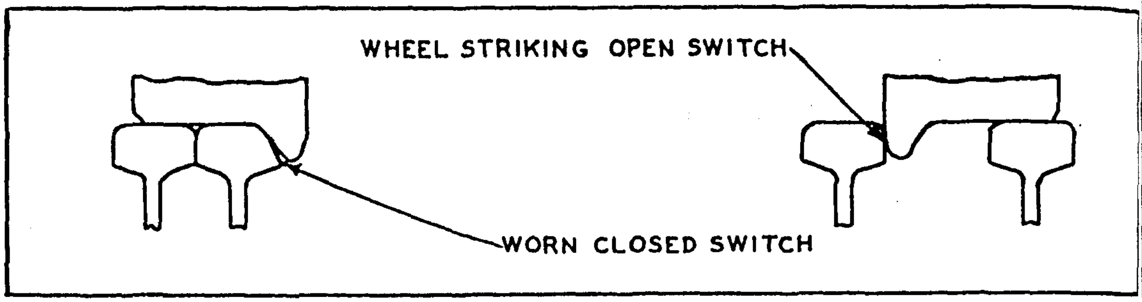


Fig. 18. Insufficient Clearance at Intersection of Heads

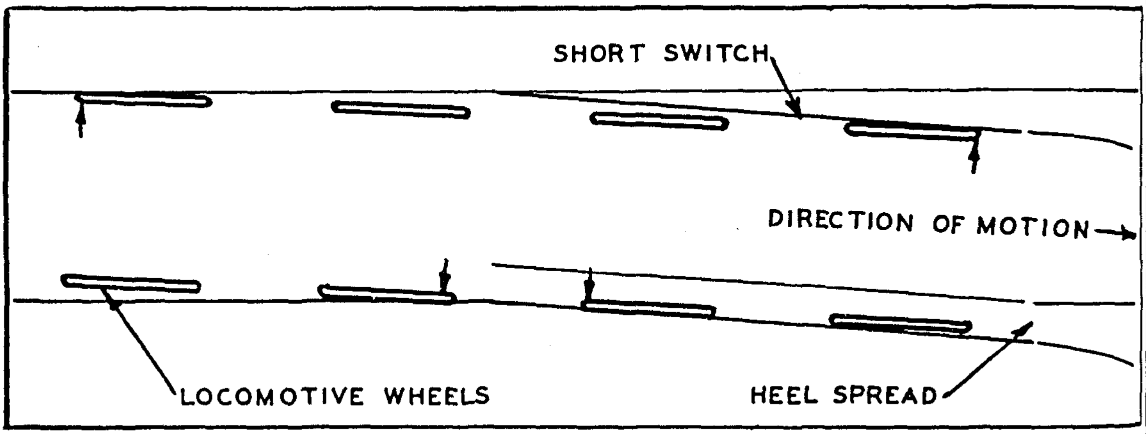


Fig. 19. Effect of Heel Spread on Short Switches

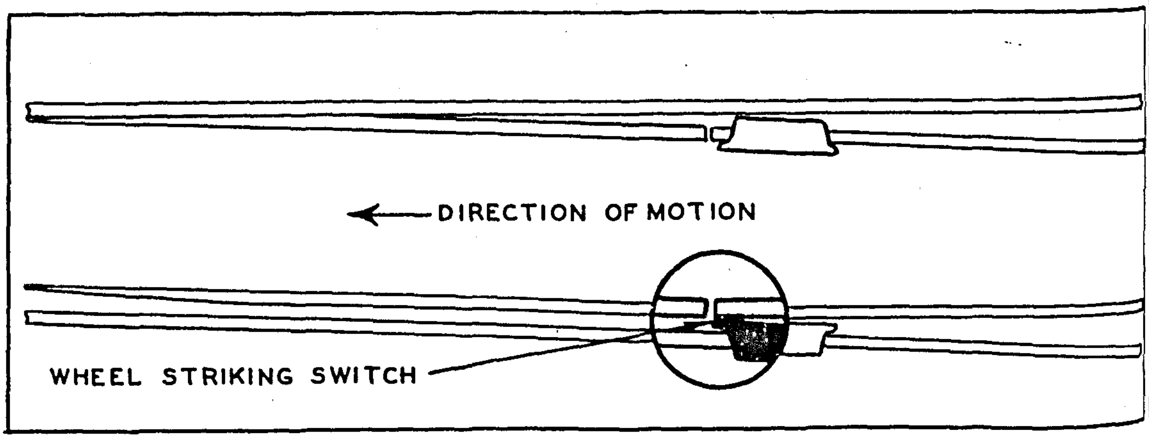


Fig. 20. Effect of Insufficient Heel Spread

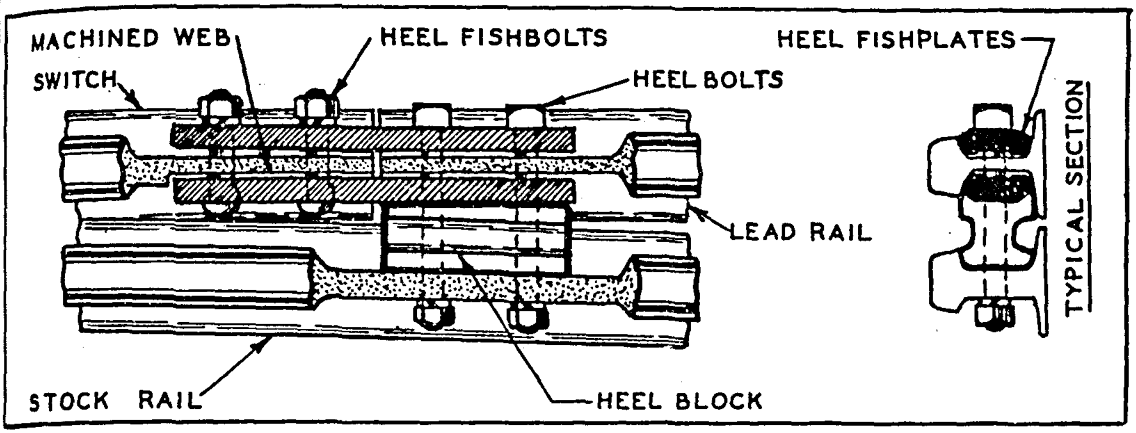


FIG. 21. TYPICAL 57, 70, 78 & 86 LB HEEL 1890

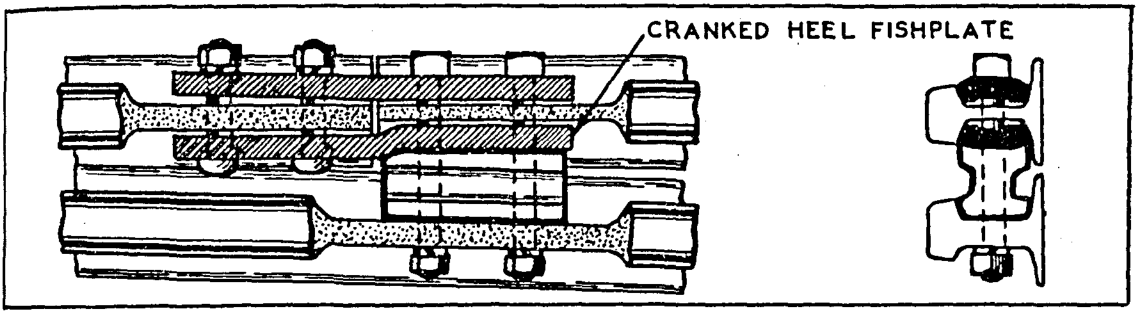


FIG. 22. TYPICAL 57, 70, 78 & 86 LB. HEEL. 1887.

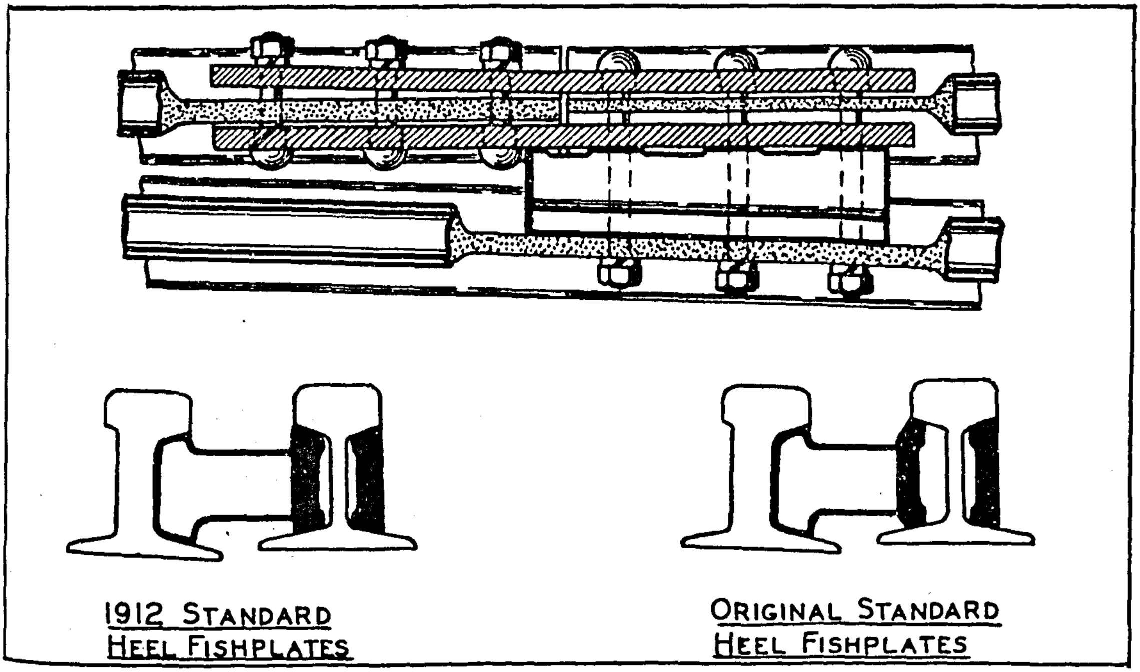


FIG. 23. TYPICAL 95 & 115 LB HEEL

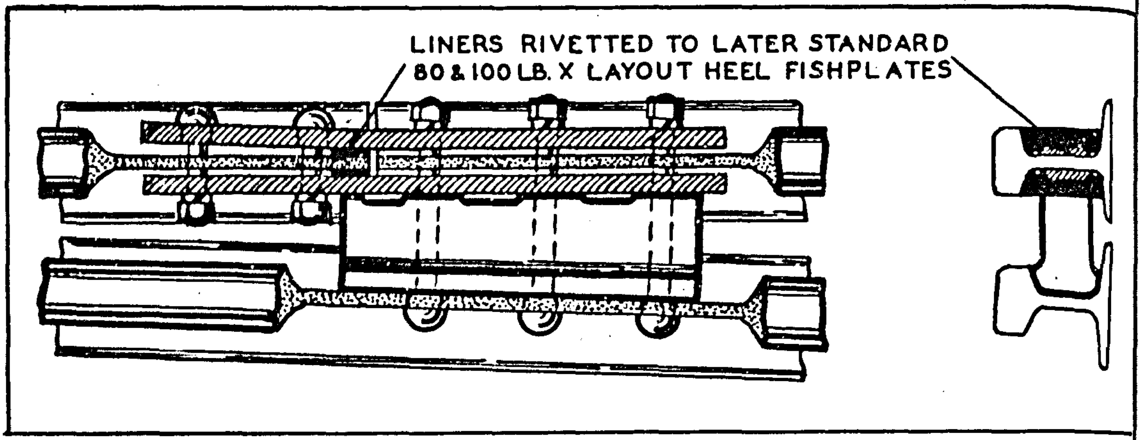


Fig. 24. Typical 60, 80 & 100 lb. X Layout Heel

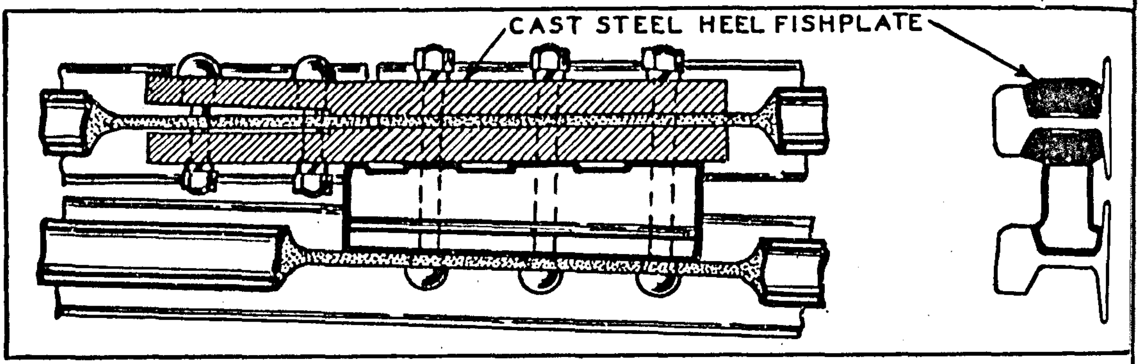


Fig. 25. Typical 80 & 100 lb. Y Layout Heel

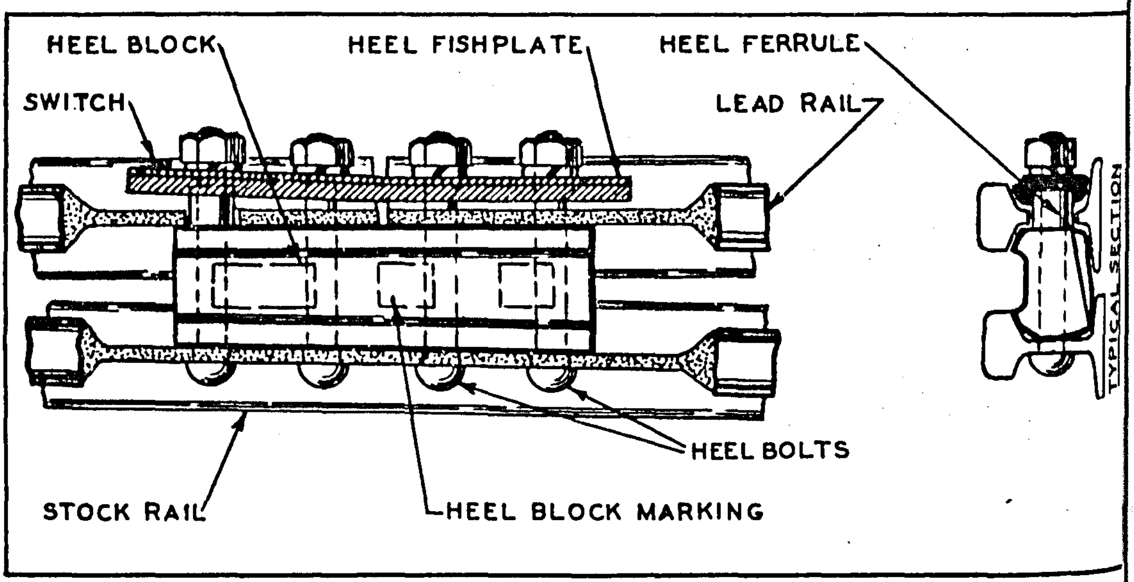


Fig. 26. The A.R.E.A. Heel

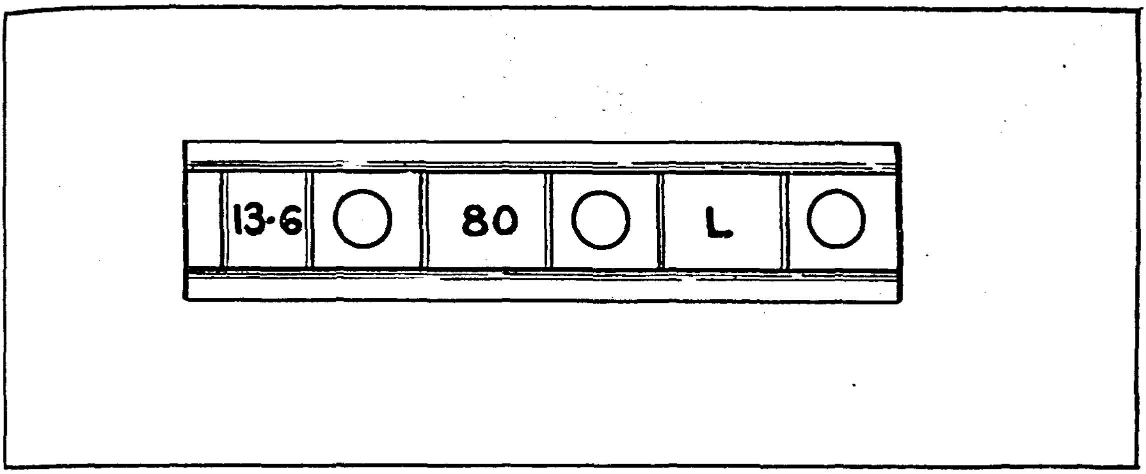


FIG. 27. TYPICAL 80& 100LB. Y LAYOUT HEEL BLOCK

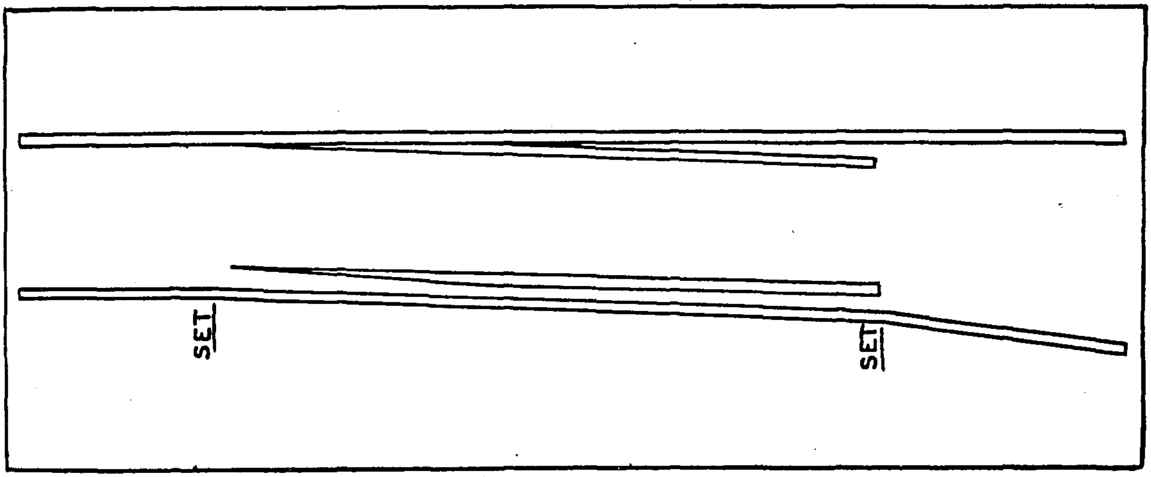


FIG. 28. 1933 STANDARD 90& 110LB. POINTS

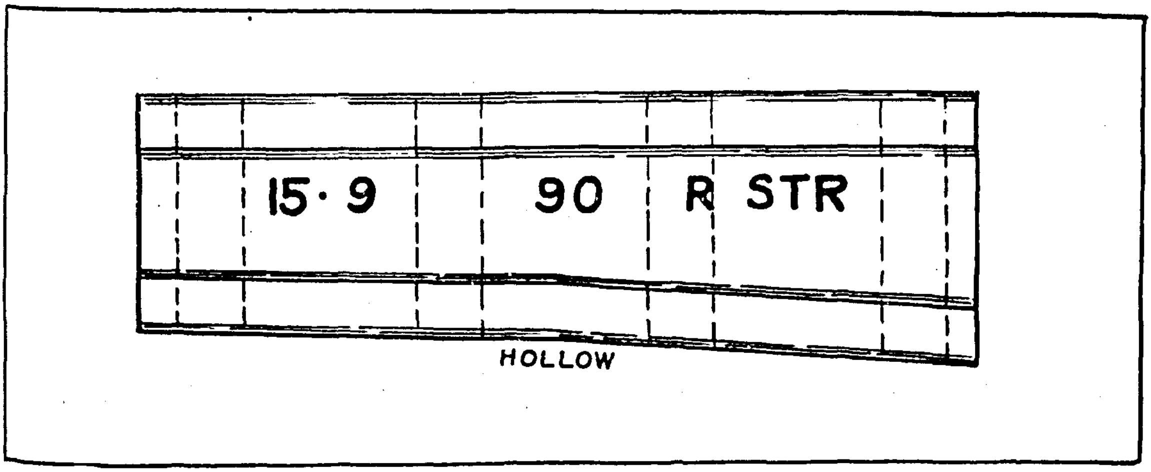


FIG. 29. 1933 STANDARD HEEL BLOCK 90& 110LB.

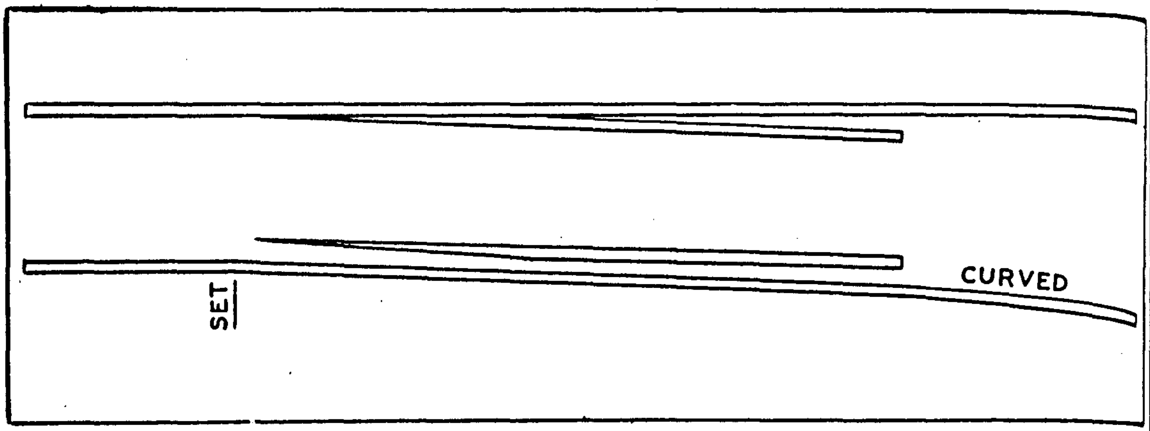


Fig. 30. 1938 Standard 90&110 lb. Points

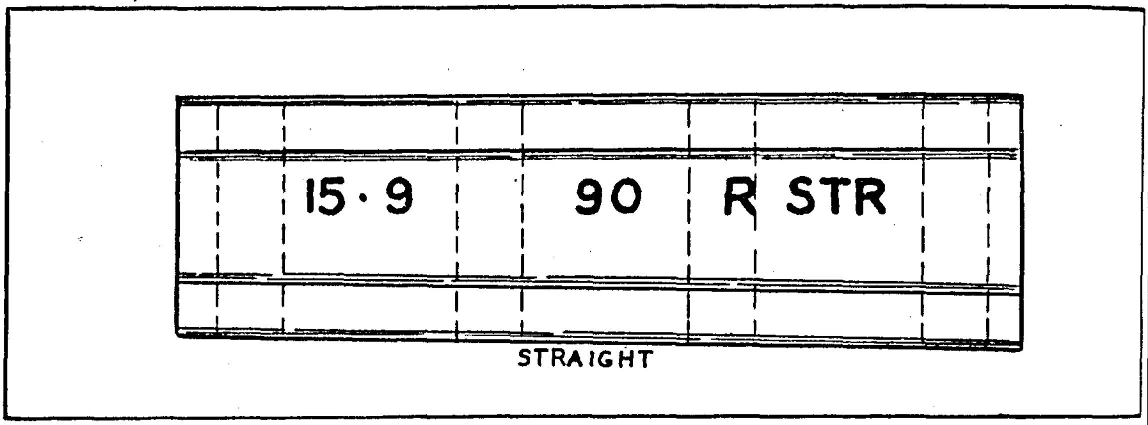


Fig. 31. 1938 Standard Heel Block 90&110 lb.

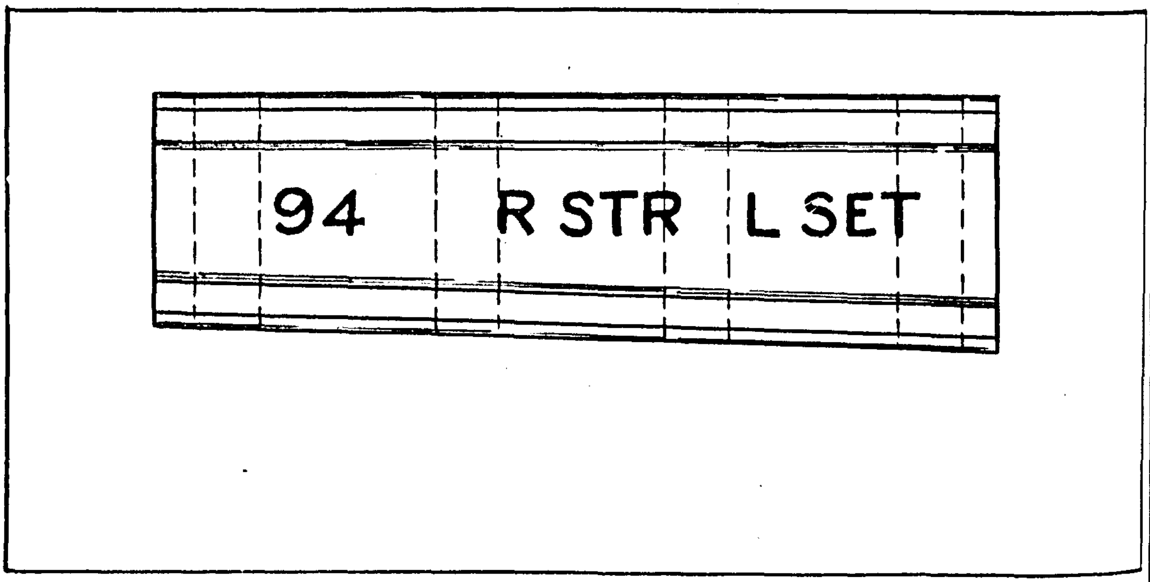


Fig. 32. Original 94&107 lb. Heel Block for Common Points

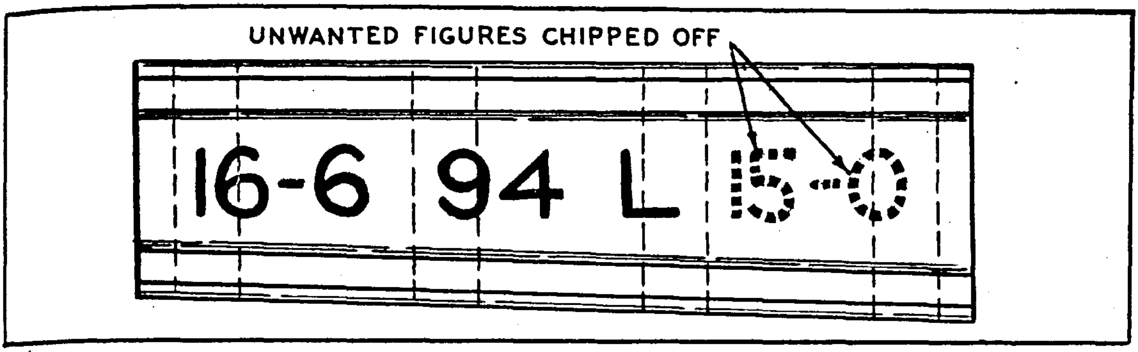


FIG. 33. 1941. STANDARD 94 & 107 LB. HEEL BLOCK FOR COMMON POINTS

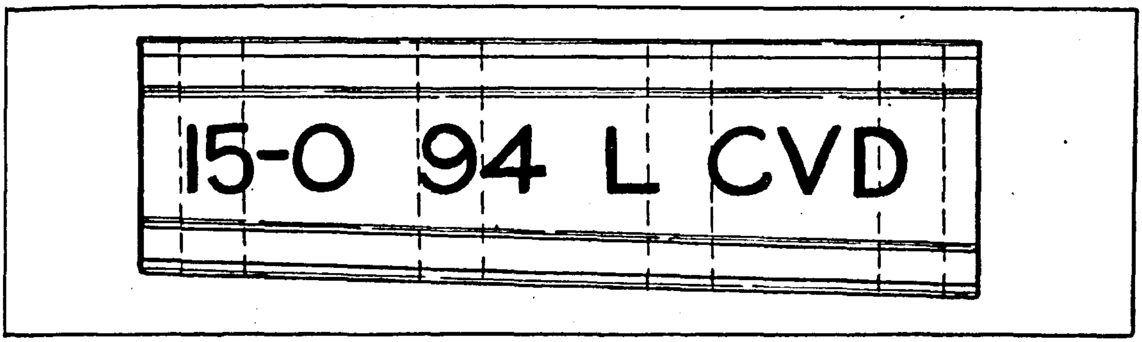


FIG. 34. HEEL BLOCK FOR 15'-0" POINTS No. 7·52 COMPOUNDS 94 & 107 LB.

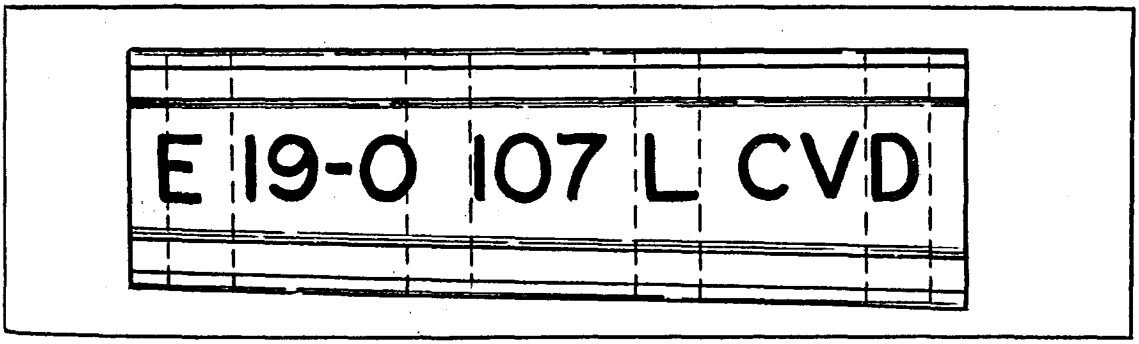


FIG. 35. HEEL BLOCK FOR 19'-0" POINTS No. 8·7 COMPOUNDS 94 & 107 LB.

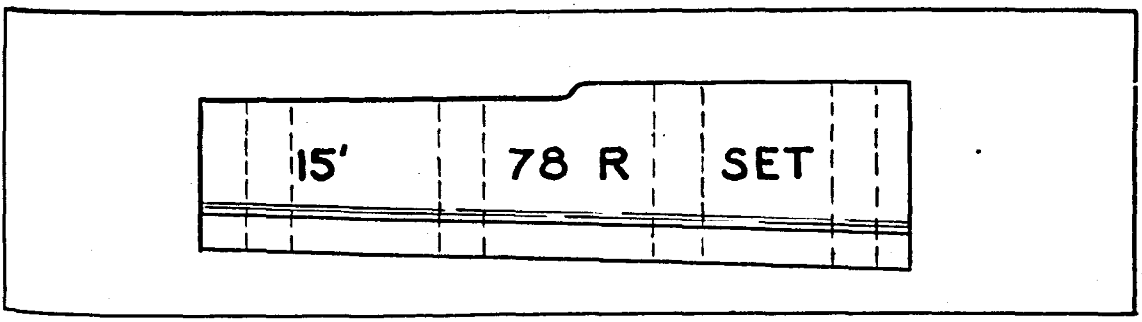


FIG. 36. 1939 STANDARD HEEL BLOCK FOR 78 & 86 LB. POINTS

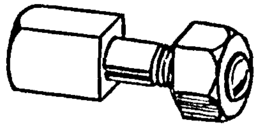


FIG.37. 57, 70, 78 & 86 LB. SWITCH STOP

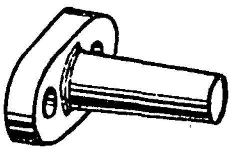


FIG.38. 60, 66 & 75 LB. SWITCH STOP

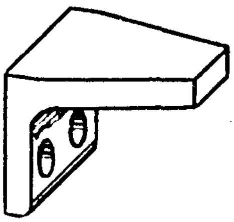


FIG. 39. 80, 90, 94, 95, 100, 107, 110 & 115 LB. SWITCH STOP

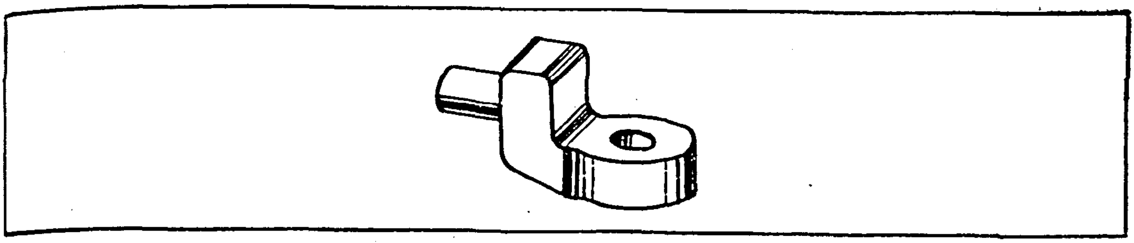


Fig. 40. 57, 70, 78 & 86 LB. Lug

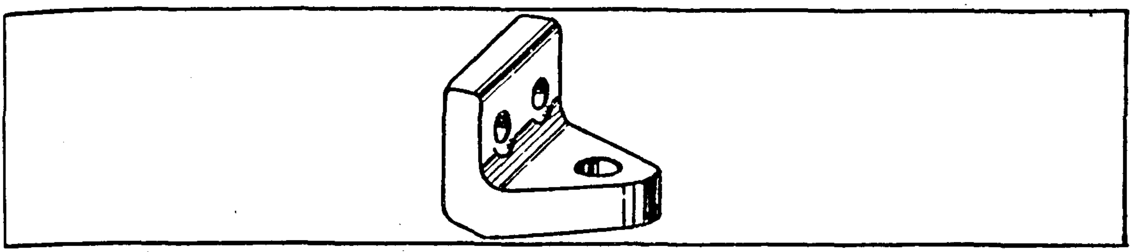
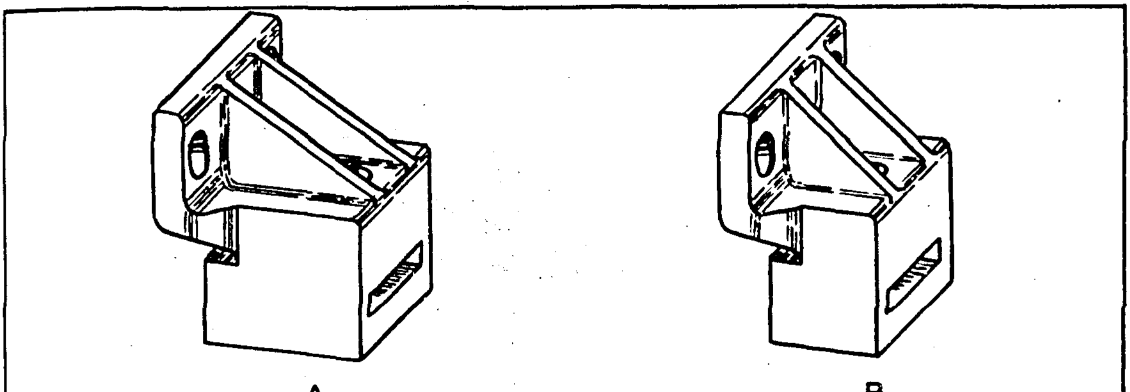


Fig. 41. 60, 80, 95, 100 & 115 LB. Lug X Layout



A B

Fig. 42. Spreader Brackets Y Layout

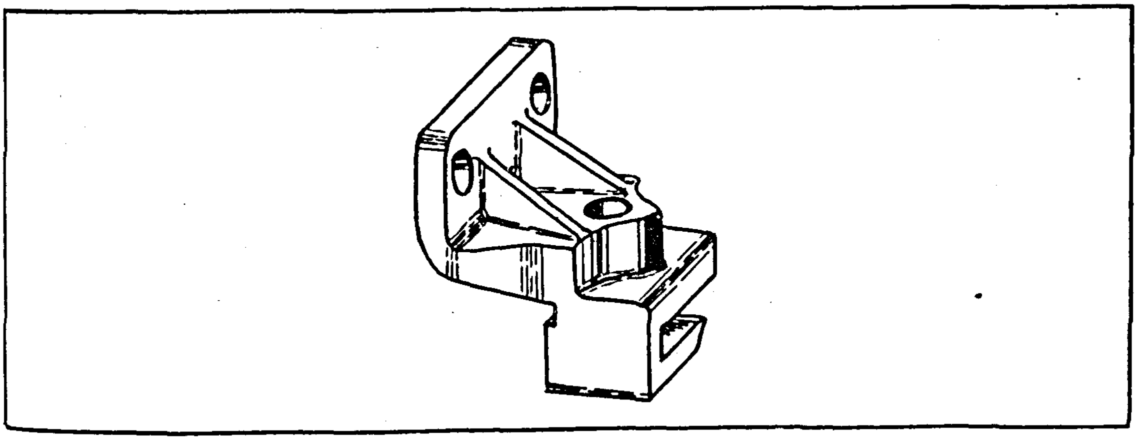


Fig. 43. Improved Y Layout Spreader Bracket

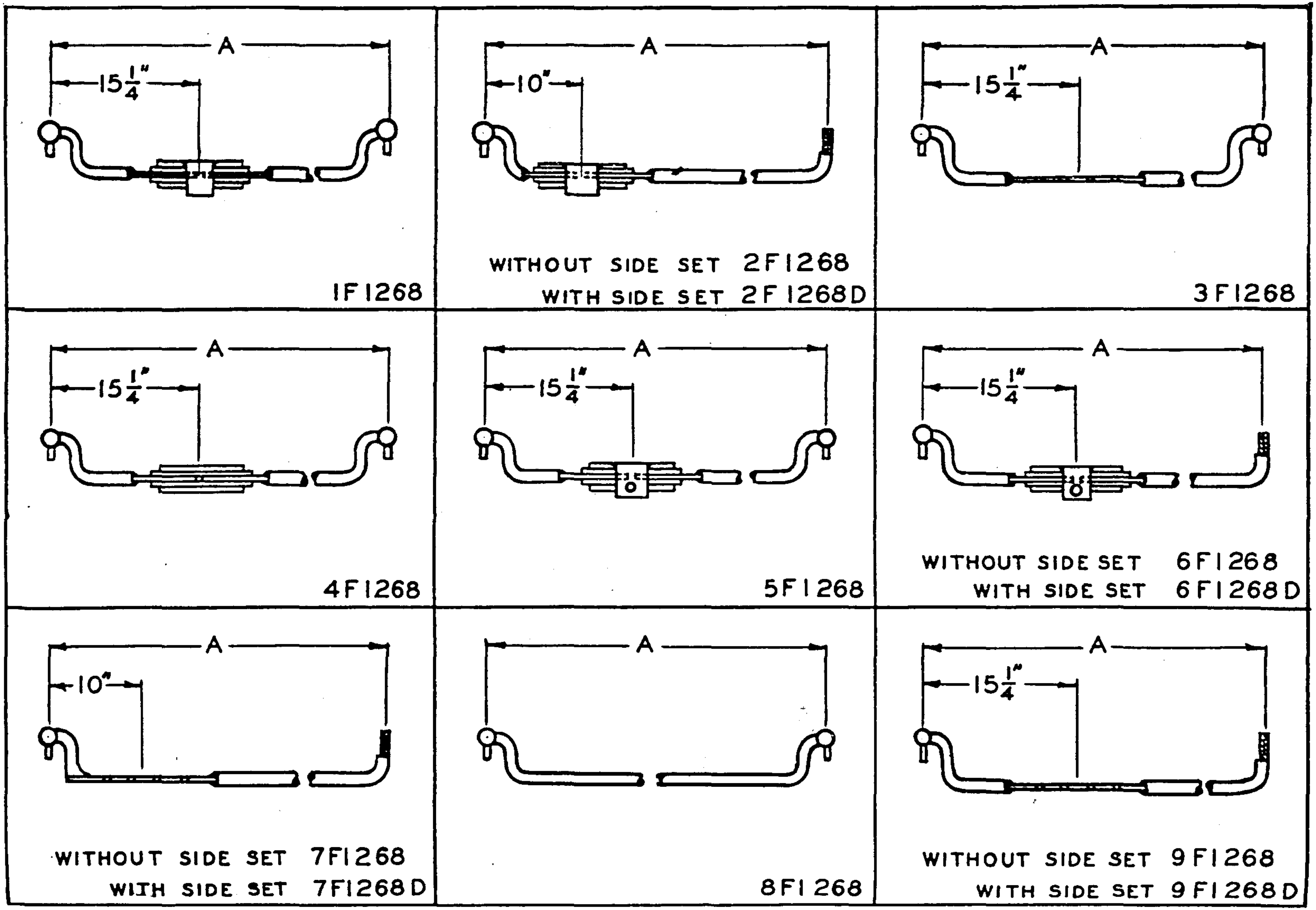
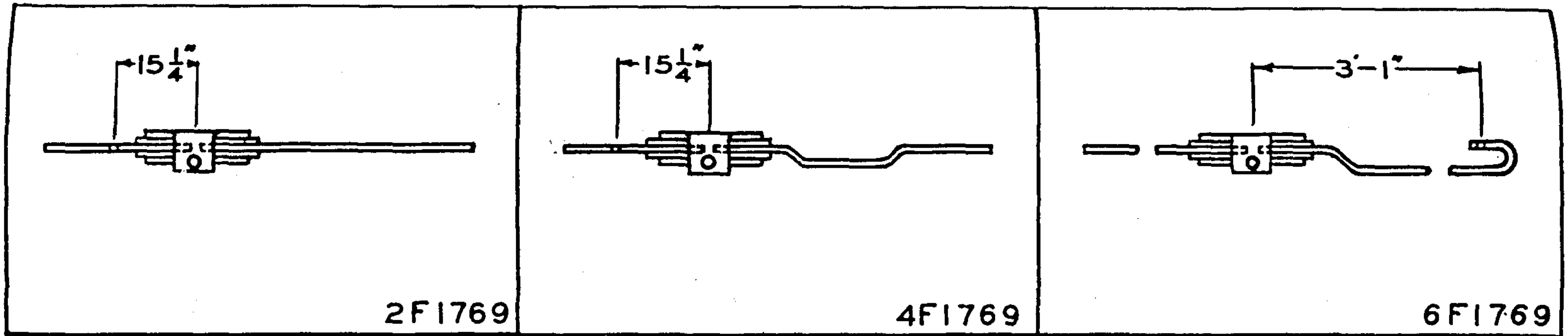
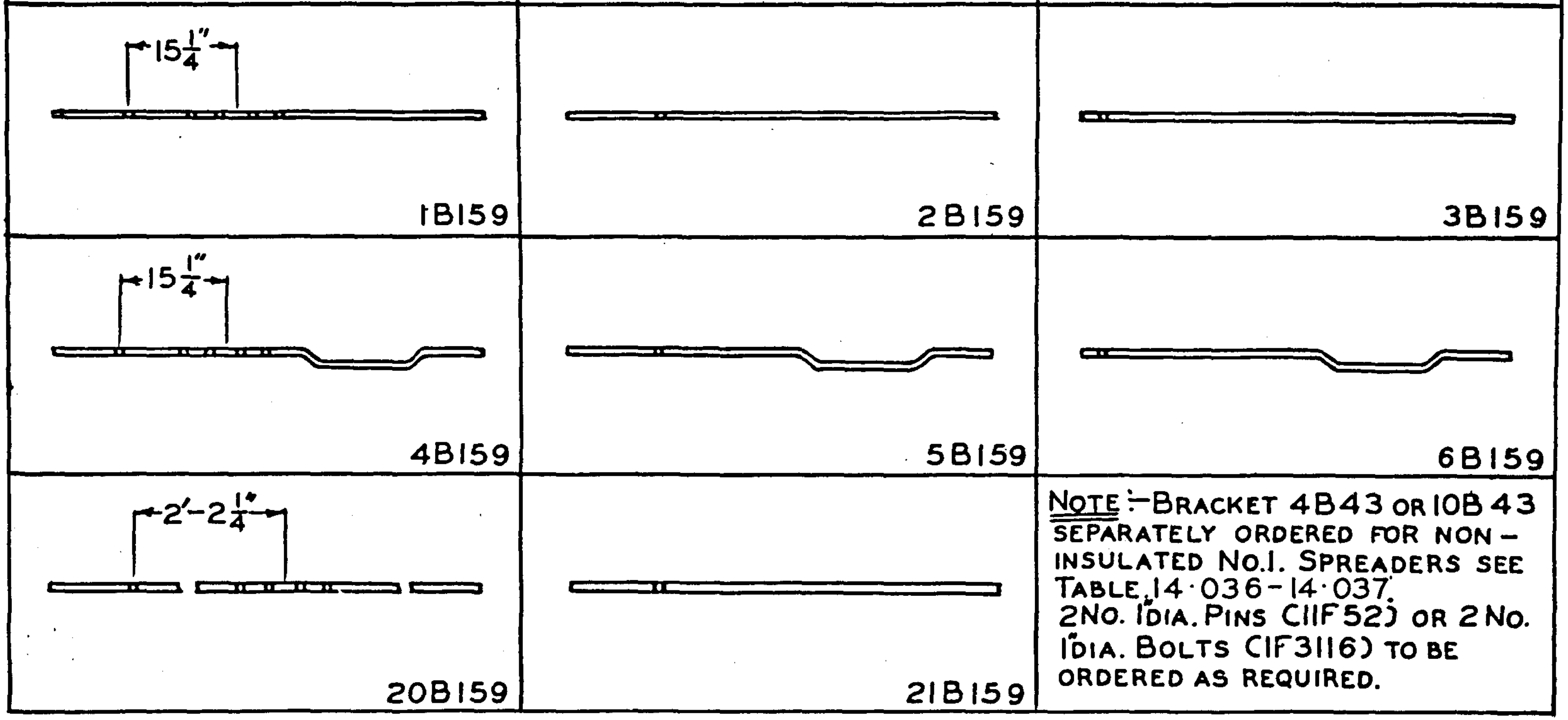


FIG. 44. X LAYOUT SPREADERS

FIG. 44. X LAYOUT SPREADERS





NOTE:- BRACKET 4B43 OR 10B43 SEPARATELY ORDERED FOR NON-INSULATED No.1. SPREADERS SEE TABLE, 14·036-14·037. 2 No. 1" DIA. PINS (11F52) OR 2 No. 1" DIA. BOLTS (1F3116) TO BE ORDERED AS REQUIRED.

FIG. 45. Y LAYOUT SPREADERS

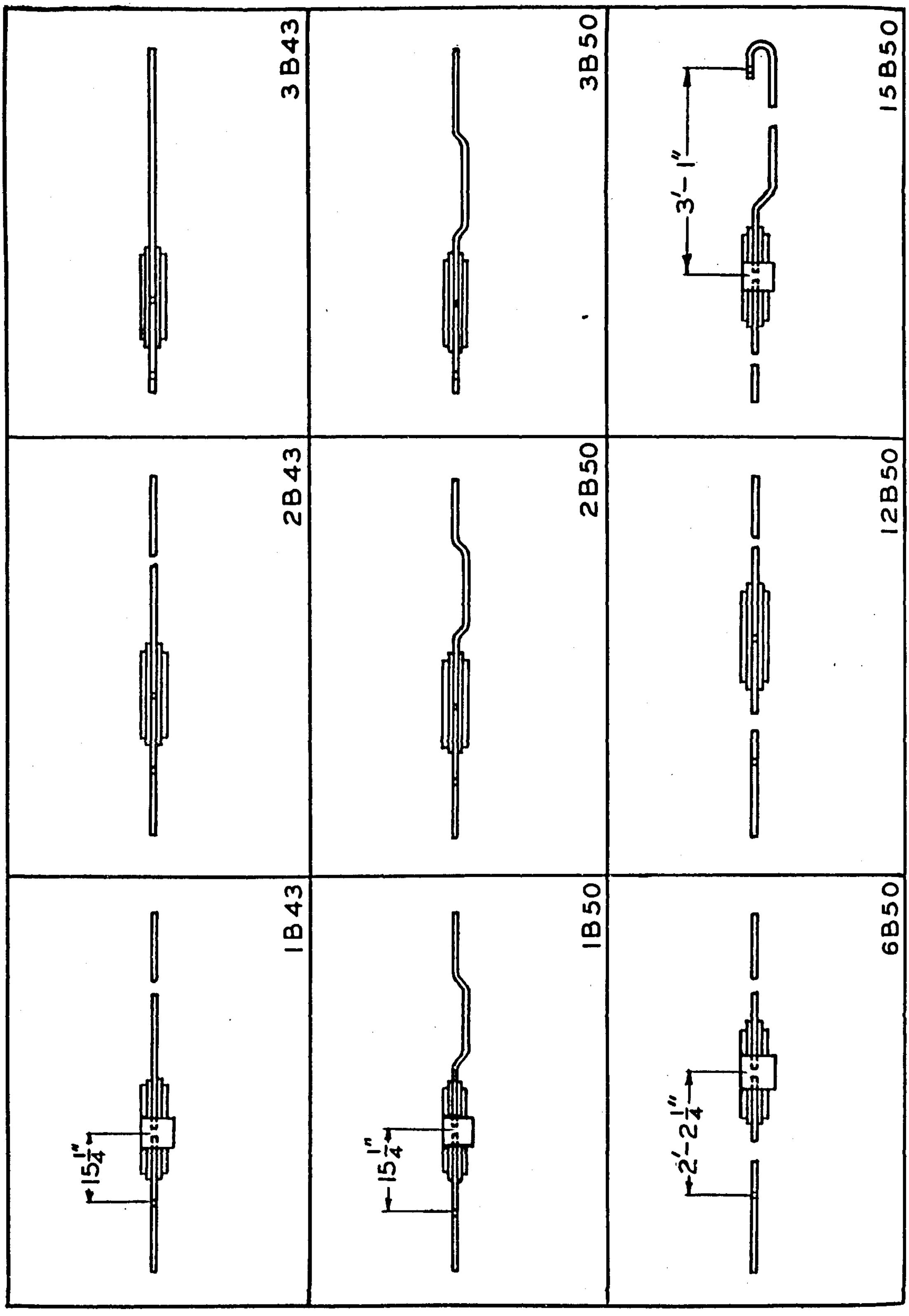


Fig. 45. Y Layout Spreaders

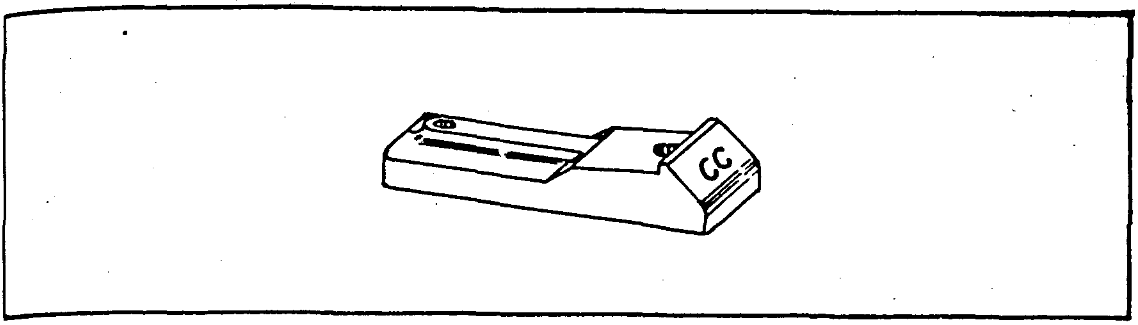


FIG. 46. TYPICAL BLOCK CHAIR

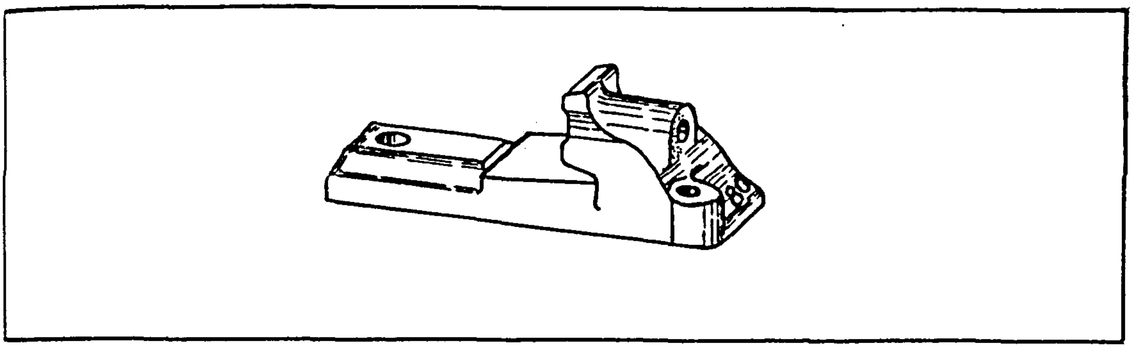


FIG. 47. TYPICAL 60, 80 & 100 LB. COMMON TOE CHAIR X LAYOUT

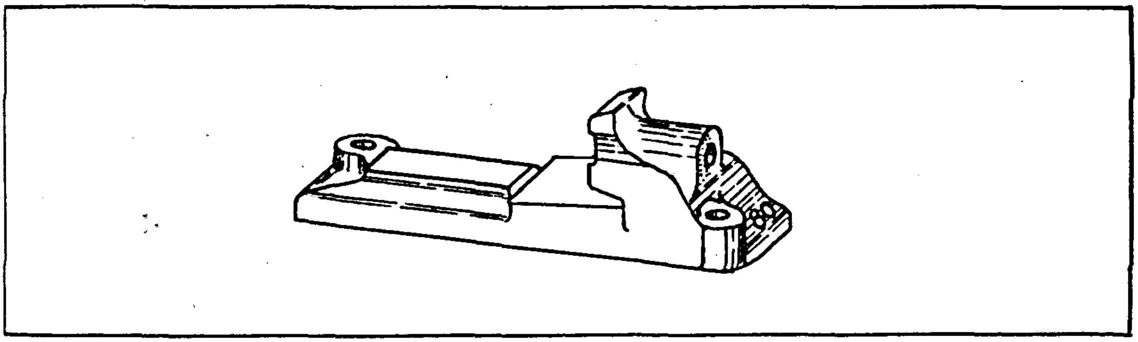


FIG. 48. TYPICAL 60, 80 & 100 LB. COMMON SLIDE CHAIR X & Y LAYOUT

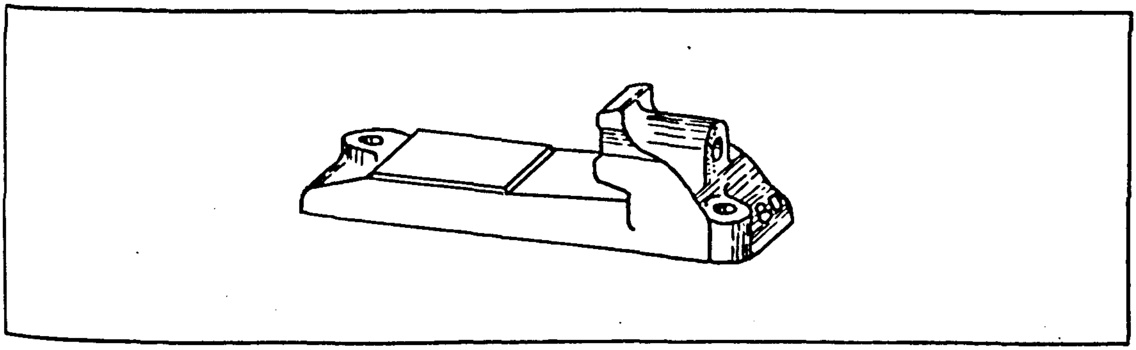


FIG. 49. TYPICAL 60, 80 & 100 LB. COMMON HEEL CHAIR X & Y LAYOUT

FIG. 45. Y LAYOUT SPREADERS

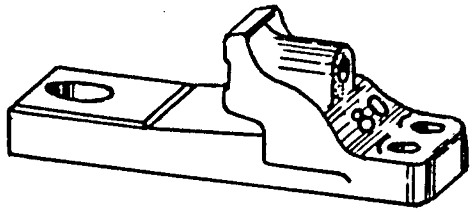


Fig.50. Typical Adjustable Toe Chair 80&100lb Y Layout

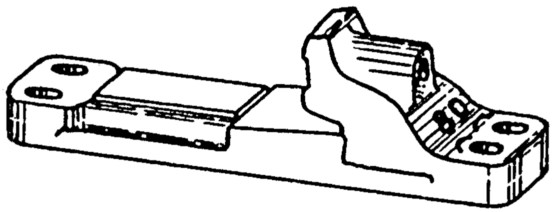


Fig. 51. Typical Adjustable Slide Chair 80&100lb. Y Layout

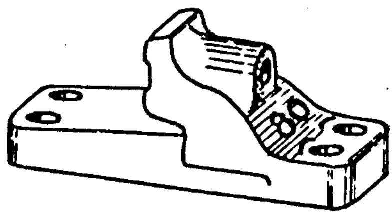


Fig.52. Typical Adjustable Dummy Chair 80&100lb. Y Layout

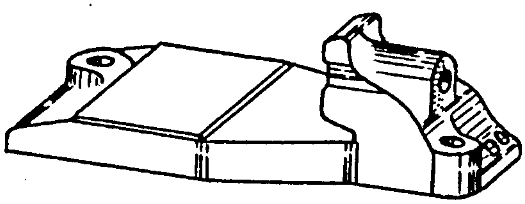
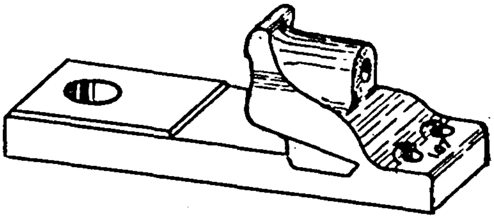
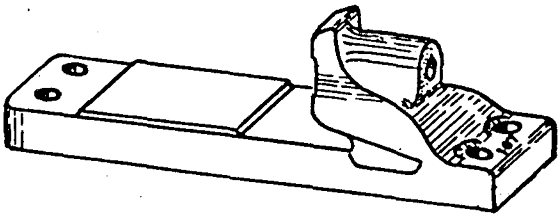


Fig. 53. Early 90lb. Heel Chair



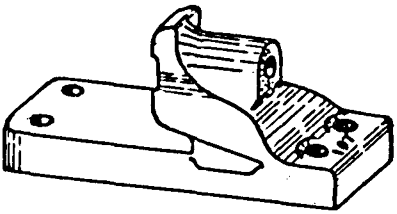
COMMON TOE CHAIR — ROUND HOLES
ADJUSTABLE TOE CHAIR — SLOTTED HOLES

Fig. 54. 90, 94, 107 & 110 LB. Toe Chairs



COMMON & HEEL SLIDE CHAIR — ROUND HOLES
ADJUSTABLE SLIDE CHAIR — SLOTTED HOLES

Fig. 55. 90, 94, 107 & 110 LB. Slide Chairs



SPECIAL DUMMY CHAIR — ROUND HOLES
90 & 110 LB. ADJUSTABLE DUMMY CHAIR — SLOTTED HOLES

Fig. 56. 90, 94, 107 & 110 LB. Special Dummy Chairs

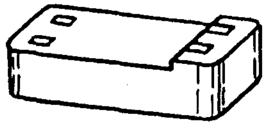


Fig.57. Typical Common Dummy Chair

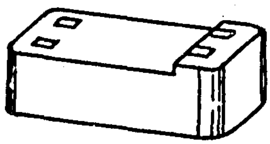


Fig.58. Typical Deep Dummy Chair

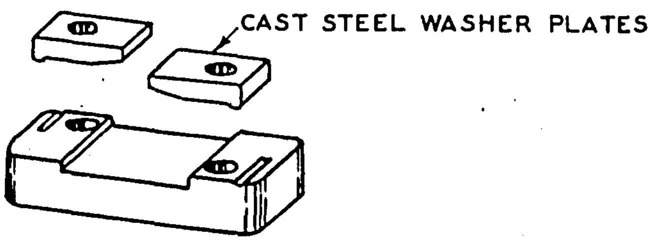


Fig.59. Typical Insulated Dummy Chair

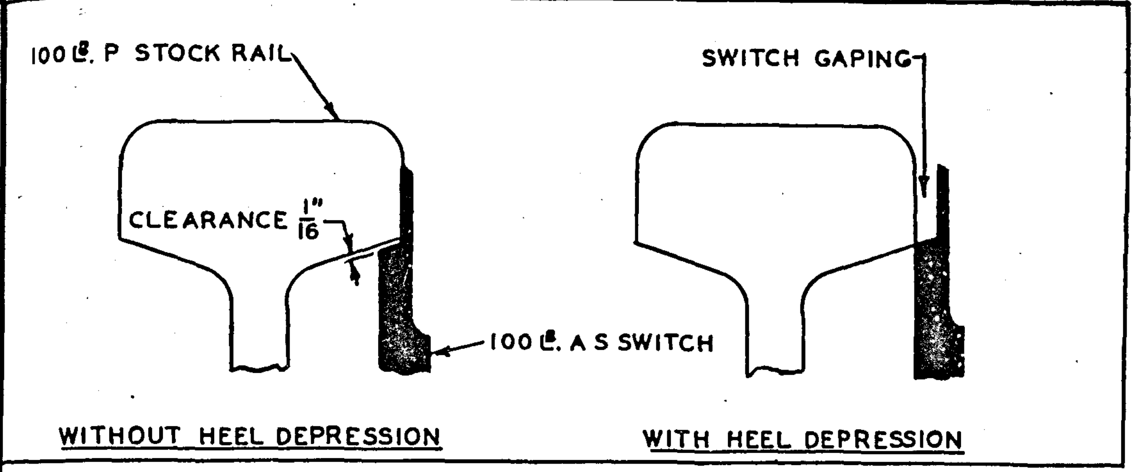


FIG. 60. EFFECT OF THE ASSEMBLY OF DIFFERENT CLASS MATERIAL

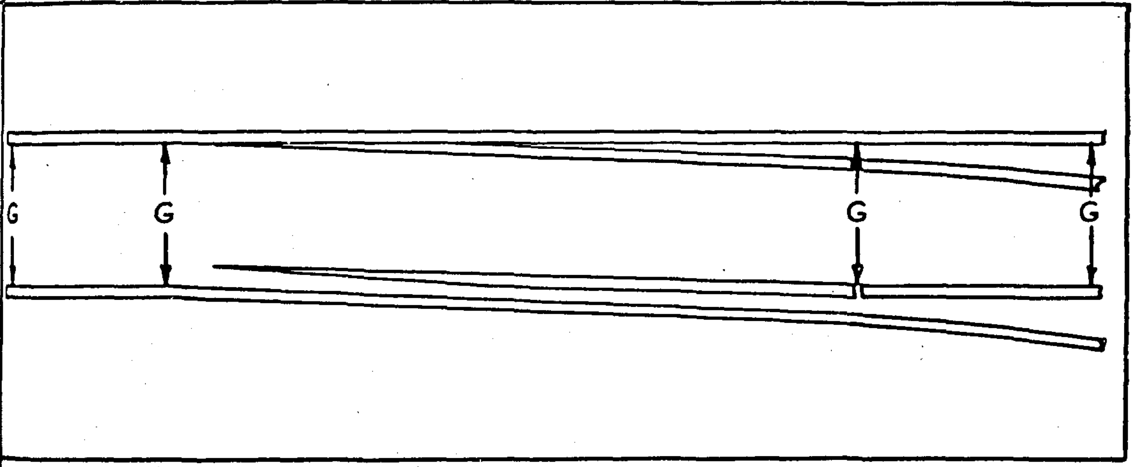
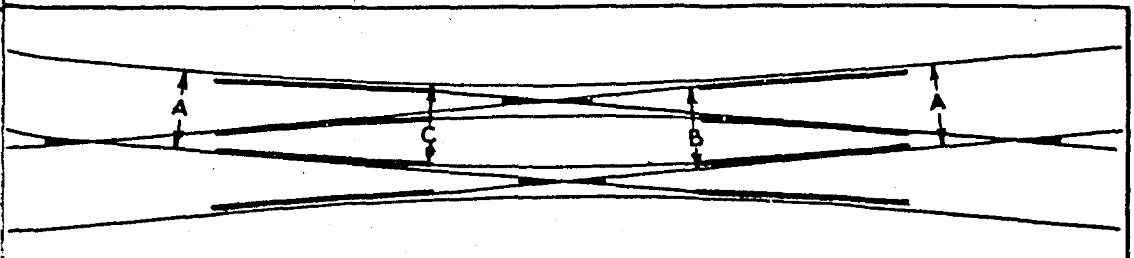


FIG. 61. POSITIONS AT WHICH POINTS ARE TO BE GAUGED



	A	B	C
7·52	5'-3"	5'-2 7/8"	5'-3"
8·7	5'-3"	5'-2 7/8"	5'-2 15/16"

FIG. 62. GAUGES FOR 94 & 107 LB. COMPOUNDS

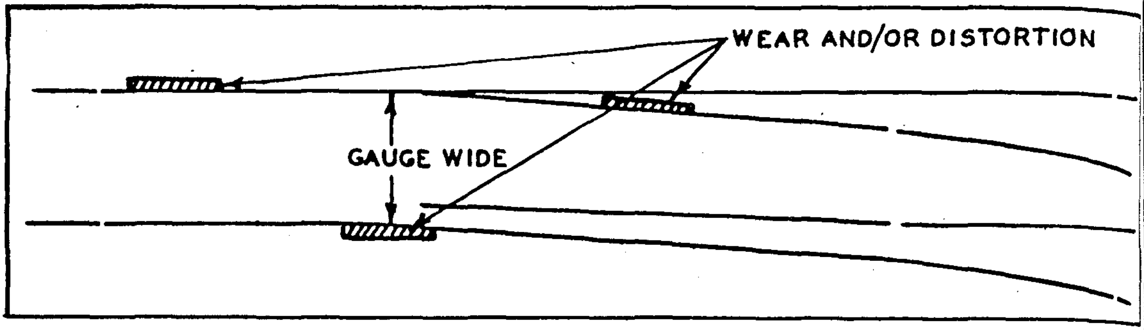


FIG. 63. GAUGE DISTORTION

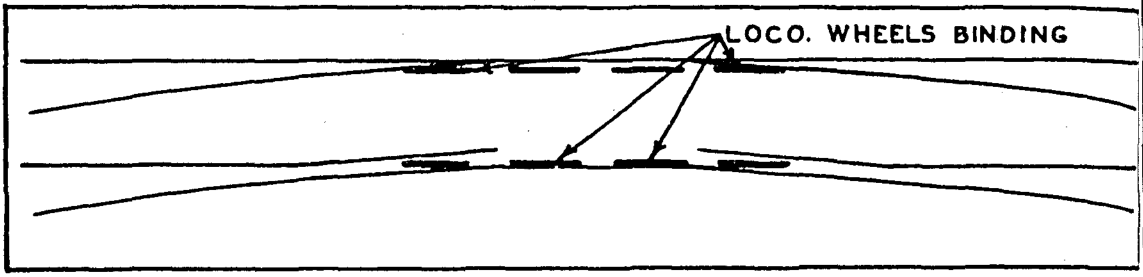


FIG. 64. TOES OF SWITCHES LAID TOO CLOSE

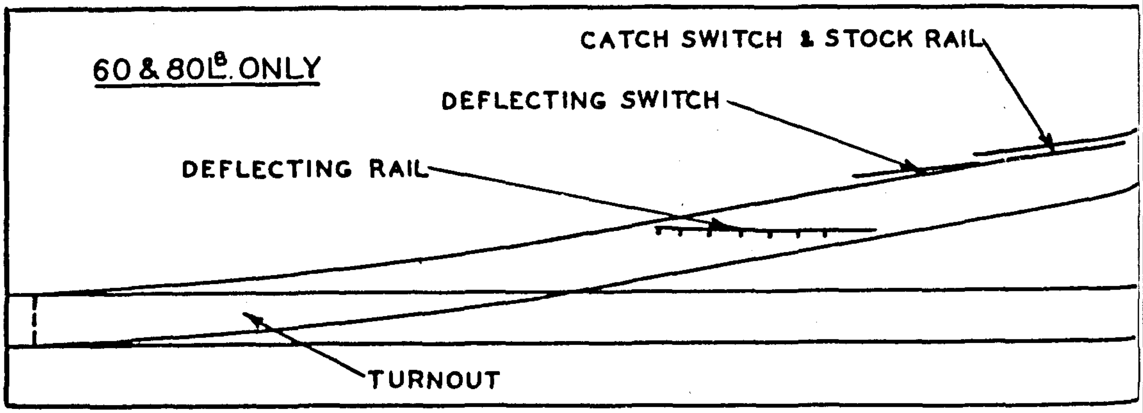


FIG. 65. ARRANGEMENT OF DEFLECTING RAIL & SWITCH

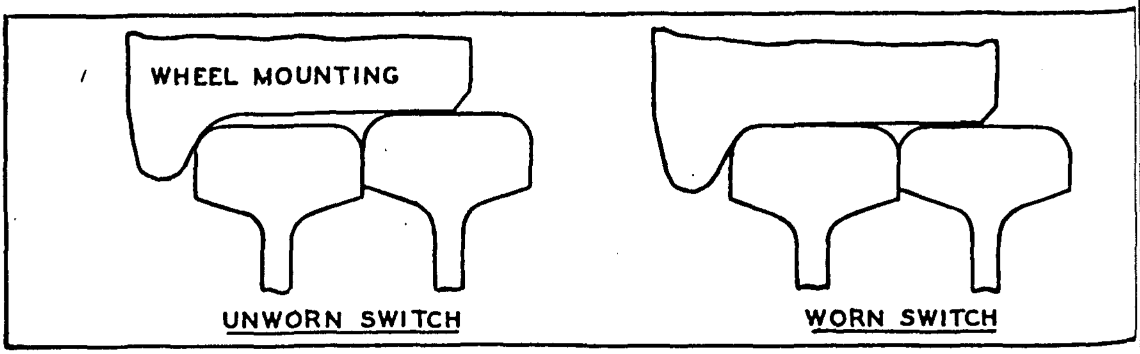


FIG. 66. NECESSITY FOR SELECTING WORN DEFLECTING SWITCH

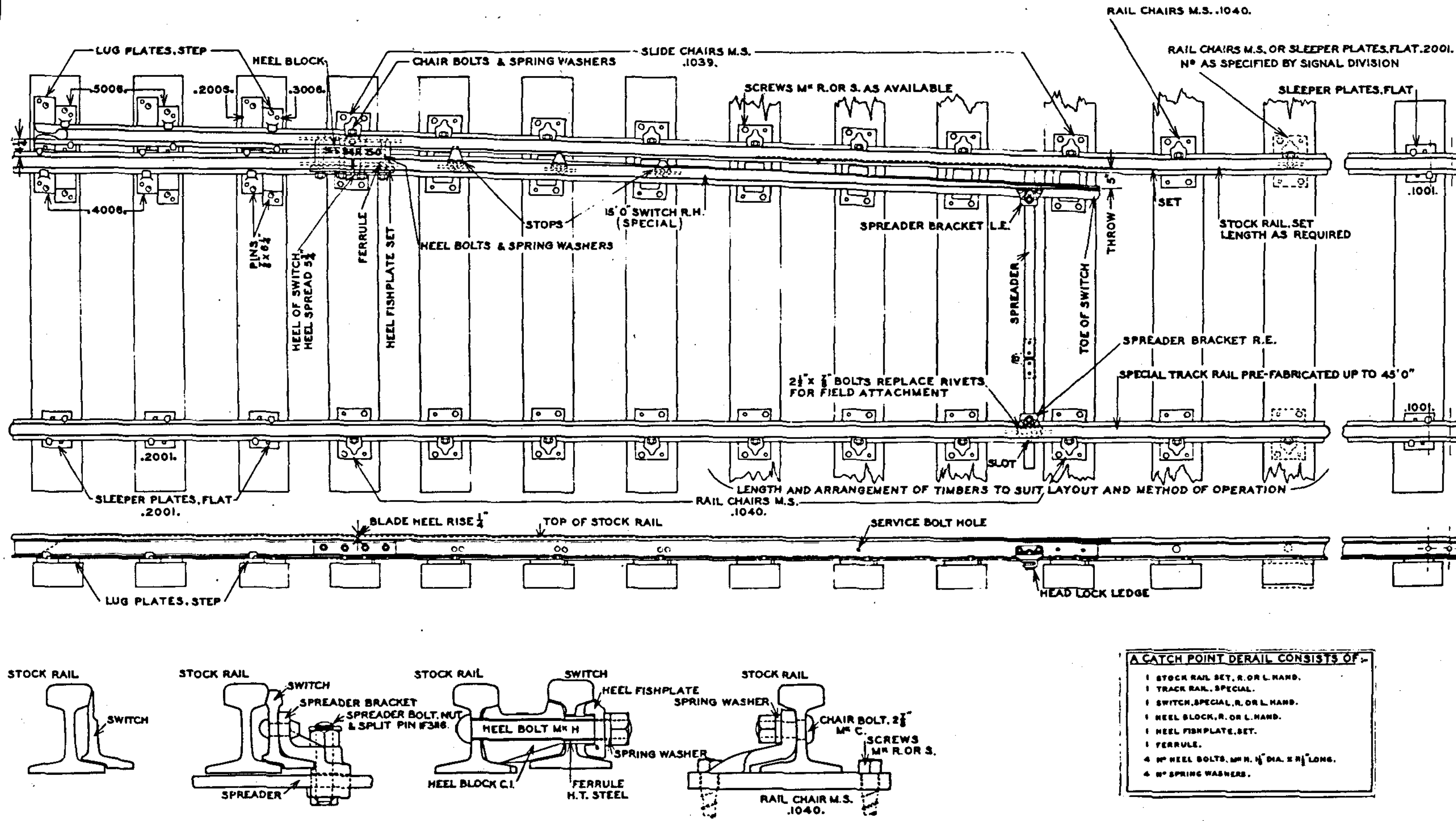


FIG. 67. CATCH POINT DERAIL SINGLE SWITCH

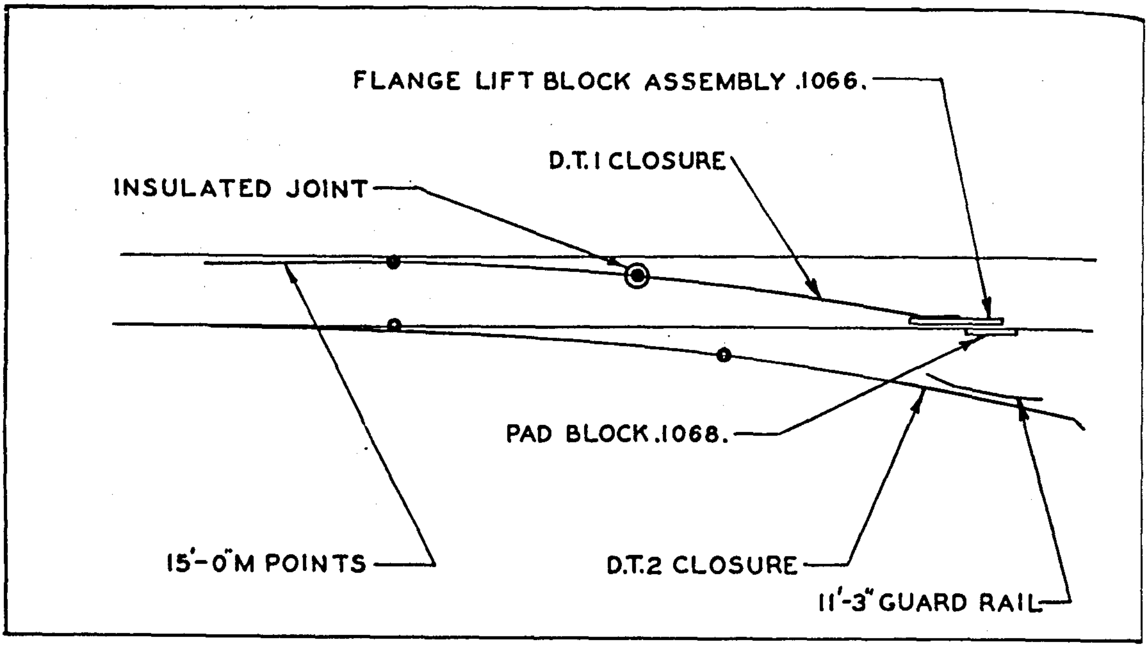


FIG. 68. THE DERAIL TURNOUT

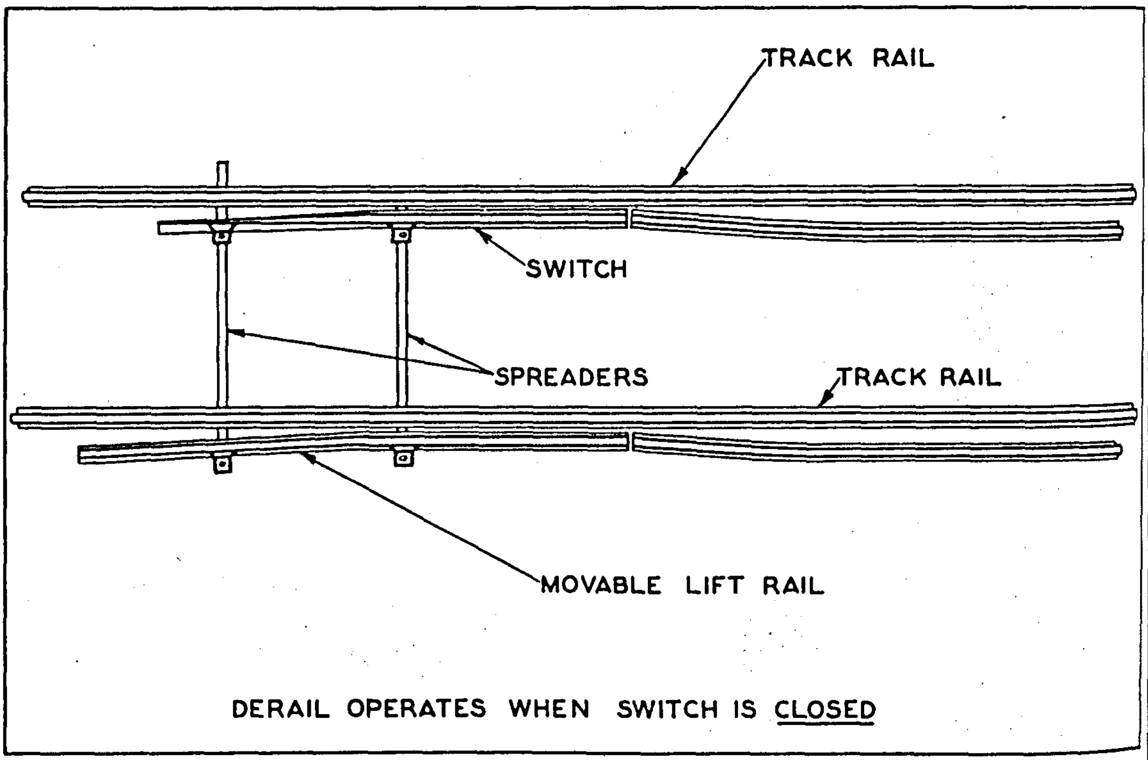


FIG. 69. A TYPE OF SPECIAL DERAIL POINTS.

CROSSINGS

GENERAL

Crossings are trackwork structures arranged to provide the necessary flangeways to enable the wheel flanges to pass across the running rails at the intersections of rails.

The three types of crossings commonly met with are the 'V', 'K', and Delta crossings, as shown in Figs. 70, 71 and 72.

All crossings are now manufactured from standard section track rails selected in respect to quality, section and rail series. The earlier crossings obtained from overseas were manufactured from the double headed rails and the rail parts were held in position in cast iron chairs; few of these crossings now remain in service.

Crossings manufactured from the flat bottom or 'T' rails are either rivetted to a foundation plate or bolted together with cast iron spacer blocks. For many years the blocked crossing has been the standard design, but at one time special heavy section rails were used and some of these crossings are still in service. Crossings of special rail sections require special fishplates to make the joint with track rails.

FLANGEWAYS

The standard flangeways in crossings are $1\frac{3}{4}$" wide at the nose, but widen to $3\frac{1}{2}$" at the ends of the wings, and to suitable width at the throat according to the crossing No. This increase in widening is necessary to gradually engage the wheel backs and draw them over into position to allow the wheel treads to cross from the wing rails to the nose of the crossing.

When the crossings are required to be laid on curves of sharp radius, the flangeways at the nose must be increased to permit the passage of locomotive wheels as with check rails on curves. See 3.17. The opening at the end of the wing rails and at the throat of the crossing must also be widened.

Flangeways are an important aspect of crossing design and maintenance as they affect both the running clearance for the flanges and the running surface for wheel tread transfer.

14.066

In the older crossings the flangeways were arranged as follows : -

At the throat	..	2¼"	between	the	rails.
" " nose	..	1¾"	"	"	"
" " flare opening		2¼"	"	"	"
" " wing end opening		3½"	"	"	"

'V' crossings of this design, shown in Fig. 73, provide a gradual engagement for the backs of wheel flanges, but reduce the area of the running surface for wheel tread transfer and are therefore prone to heavy wear on the wings.

In 90, 94, 107 and 110 lb. 'V' crossings shown in Fig. 74, the flangeways are as follows : -

At the throat	..	1¾"	between gauge lines.	
" " nose	..	1¾"	"	the rails.
" " flare opening		3½"	"	" "

The throat is widened by curving instead of setting the wing rails and the width varies with the crossing No. but is never less than 2⅛" between the rails.

Wing rails are machined at 25° slope and converge from 3½" opening to 1¾" a little behind the nose.

This arrangement has a three-fold effect in that the curved backs of the new A.N.Z.R., wheel flanges smoothly engage the 25° machined flares (see 13.034, Fig. 36), and the 1¾" flangeway behind the nose draws the wheels over to provide additional tread bearing on the nose and wing rails in the area of wheel tread transfer, as shown in Fig. 75, while the curved wing rails provide a gradual engagement for the backs of wheel flanges engaging the wing rails at the throat in a facing movement.

The design is necessarily a compromise as flangeway clearance and wheel tread transfer are opposing considerations.

When renewals are being made with serviceable crossings, care should be taken to select a crossing with the least worn flangeway for the main line movement, as by so doing a larger tread bearing area will be provided for the faster trains.

The flangeways in old crossings tend to close as the spacer blocks become worn, and such crossings should not be used for a movement on a curve when a full flangeway clearance is required.

By the careful selection ofserviceable crossings for the service required of them, better running is made possible and longer life may be obtained from the crossing.

Crossings with widened flangeways are special and are stamped according to catalogue No. See 14.070.

SPACER BLOCKS

The cast iron spacer blocks now used have a full bearing on the fishing faces of the rail parts in the crossings and provide a small clearance from the webs of the rail parts to enable an initial tightening of the crossing bolts to be made after the crossing has had a few days service in track. See Fig. 76.

At the mouth of 90,94, 107 and 110 lb. crossings a pipe ferrule and bolt are installed to prevent distortion of the crossing.

CROSSING BOLTS

Crossing bolts installed in new crossings manufactured since 1934 are of high tensile steel specially heat treated for the service. These bolts are standard in 90, 94, 107 and 110 lb. crossings, and the nuts should be kept pulled up as tight as possible with the standard track spanners.

Crossing bolts installed in crossings manufactured prior to 1934 were of mild steel and will not withstand excessive tightening as the bolts simply stretch in these circumstances and protrude through the nuts leaving no thread on the bolt shank for future tightening.

The 1935 type crossings shown in Fig. 74 have the crossing bolts spaced at 5" centres to enable the application of standard fishplates in the event of rail fracture adjacent to the spacer blocks. In earlier crossings the bolts were spaced at 4" centres.

HEAD LOCKS

Head lock washers are provided on the new crossings to grip the oval neck of the crossing bolts and prevent turning when tightening the nuts. The head locks are tapered or parallel according to their position on the crossings, and are marked with the letter 'T' to indicate the top for assembly, as shown in Fig. 77.

SPRING WASHERS

Various types of spring washers have been used during manufacture of crossings, but those in use on new crossings are of a heavy section designed to maintain the required tension with the high tensile steel crossing bolts in use.

NOSE SECTIONS

The nose sections of crossings vary in shape, size and position according to the weight of rail and the design of the crossings. Position, shape and height of the nose relative to the wing rails have an important bearing on the life and safety of the crossings under traffic.

Ideal conditions obtain when new wheels pass over a new crossing without vertical or lateral impact, and these conditions are met, as shown in Fig. 78, by machining the nose below the level of the wing rails to allow for the conicity of the wheel treads, and to gauge at $\frac{5}{8}$" below rail surface.

The nose section in standard crossings when new is 3/16" below the rail surfaces of the wing rails, and rises to the same level as the wing rails about 12" behind the nose. This rise or run on is less with crossings of small No. and greater with crossings of large No; it has the effect of transferring the wheel loads from the wing rail to the nose at a position where the nose is wide enough to take the weight without damage.

Obviously, conditions arise with worn wheel treads when new crossings can be damaged, and likewise new wheels will not pass over a worn crossing without impact. These conditions are shown in Figs. 79, 80 and 81.

With worn wheels, as in Fig. 79, the wheels drop off the wing rail on to the nose causing the nose to flatten down as shown in Fig. 81; this occurs with facing movements. Worn wheels, trailing through the crossing, strike and mount the running edge of the wing rail ahead of the nose causing guttering of the wing rails. The area subject to wear under these conditions is shown shaded in Fig. 82.

FLANGE RISER BLOCKS

In crossings of small No. and particularly those crossings requiring wide flangeways, the wear at the area of wheel transfer is very severe, and conditions arise in which a satisfactory transfer cannot be effected with the usual open flangeway construction.

To reduce the wear under these conditions, steel flange riser blocks are fitted, as shown in Fig. 83, and the wheels roll on the flanges across the crossing gaps. Crossings of this type are referred to as Floored Crossings.

TREAD EASER RAILS

Guttering of wing rails in crossings of small No. also occurs with worn wheels on the outside edges of the wing rail, as shown in Fig. 84, and to avoid undue wear, crossings intended for heavy traffic locations are manufactured with tread easer rails, as shown in 13.035, Fig. 37.

The easer rail lifts the worn wheel on to the outside of the wing rail without shock, and also provides additional support to the wing rails at the knee or knuckle of the crossing.

CROSSING NUMBER

Crossings of different angles are required according to the trackwork layouts in which they are used, and for calculation and setting out purposes, the angle is expressed in degrees, minutes and seconds.

For convenience in construction and identification the crossing angle is expressed as a rate of slope such as 1 in 8.7, or more shortly as No. 8.7.

Three methods are in use to describe the slope of crossings, as shown in Figs. 85, 86 and 87; that shown in Fig. 85 is the method used in Victoria for railway crossings, and that in Fig. 86 is used for tramway crossings.

The angles corresponding to No. 7.52, vary with the method of measurement as shown in Figs. 85, 86 and 87.

Occasionally old crossings may be met with having no identification No. and it will be necessary to line and measure the crossing to ascertain the No. An approximate method is to mark the position on either side of the nose where the distance between running edges is 6", and measure the length between the marks in feet and decimals of a foot, as shown in Fig. 88.

When making such measurements care should be taken to allow for any wear on the crossing, and to observe if the crossing is straight or curved.

The extent of curvature can be approximately determined by extending the alignment of the crossing to the heel and mouth by means of a fine line and measuring the offsets, as shown in Fig. 89. Measurements of this kind require some experience in practical crossing construction and are better left to an engineer experienced in this class of work.

CATALOGUE NOS.

The former practice of describing a crossing by its rate of slope or numerical number such as 1 in 8.7, though sufficient identification for a standard crossing of a given weight of rail, was inadequate for identification of crossings varying in constructional details, such as overall length, special wings, or curvature.

To provide an absolute record of such crossings and thus enable ordering, manufacturing and replacement of crossings correctly, the system of catalogue numbers was introduced in 1940. The catalogue number system makes use of the crossing number followed by a letter, and is stamped on the head of the right-hand wing rail towards the guard entry end as shown in Fig. 90.

Standard straight crossings are stamped with the number of the crossing only such as No. 8.7, but crossings varying in any way from standard have an identification letter or letters following the crossing No. Examples of crossings from the catalogue are shown in Fig. 91.

Special crossings manufactured prior to the introduction of catalogue numbers require to be measured up before renewals can be undertaken, but replacements of catalogued crossings can be made with the certainty that the replacement crossing will be an exact duplicate of the original crossing.

As the differences may not always be apparent, care should be taken to thoroughly clean the wing rail, and with the aid of a knife or other pointed instrument to clean out the No. and ascertain if any letters are also stamped with the number.

STANDARD 'V' CROSSINGS

The standard 'V' crossing consists of four pieces of rail curved, set and machined for accurate assembly, with the rail parts secured in position by crossing bolts passing through the rails and cast iron spacer blocks, as shown in Fig. 76.

The point of intersection of a 'V' crossing is that position in advance of the nose of the crossing where the running edges produced intersect or cross over, as in Fig. 92. This position is always in the gap of the crossing between the nose and the knee. Nose to P. of I. dimensions are shown in Table 14.079.

LENGTHS

The intersection and overall lengths of 'V' crossings vary with the crossing No. and the rail section from which they were manufactured, and particulars are as set out in Table 14.080.

NOMENCLATURE

The terms used in the description of 'V' crossings and their applications are shown in Figs. 73 and 74.

SPECIAL 'V' CROSSINGS

Special 'V' crossings vary from standard in many ways. The crossing number or rate of slope, the length, openings, flangeways, curvature and type of construction are the chief differences.

MANGANESE STEEL 'V' CROSSINGS

These crossings are of two general types, viz: - completely cast, as shown in Fig. 93, and rail bound as shown in Fig. 94.

'V' crossings have also been made from rolled manganese steel rail both in standard and special Nos. and these are distinguished by the rolling brands on the rail parts.

The rail bound manganese steel crossing shown in Fig. 94 is standard for the No. 20 'V' crossings used in high speed tracks.

^{K}V AND ^{V}V CONSTRUCTION

In special trackwork layouts it is sometimes necessary to commence a guard rail within the 'V' crossing. This is known as '^{K}V' construction, as shown in Fig. 95. The nose rail is designed to provide the necessary width of flangeways to pass the backs of locomotive wheels, and its position differs from that of the 'V' crossing nose because of its function as a guard rail.

If two converging guard rails commence within the 'V' crossing, the construction is known as '^{V}V' construction, as shown in Fig. 96.

SPRING 'V' CROSSINGS

The purpose of the spring 'V' crossing is to provide, as nearly as practicable, a continuous rail for one movement through the crossing, and its use is confined to locations where trains run at high speed on the main track and only slow movements are made through the turnout.

14.072

As shown in Fig. 97, one wing rail is hinged at the mouth of the crossing and is held in contact with the 'V' of the crossing by a powerful spring adjusted to the correct compression for the operation of the crossing under traffic conditions.

When vehicles make the turnout movement, the path of the wheels is controlled by the long guard rail in the turnout opposite the crossing, and the spring wing rail is drawn open by the pressure of the wheel backs into the open position shown in Fig. 98. As the spring wing rail is movable and forms part of the running rail of the main track, it also requires a long guard rail for protection of the main track movement.

Provided the speed through the turnout is always slow, the spring 'V' crossing has a long life, and its use greatly improves the running conditions on the main track.

Spring 'V' crossings are made right and left-hand for use in right and left-hand turnouts and crossovers. The spring wing rail of a right-hand spring 'V' crossing is on the right side looking from the mouth of the crossing, as shown in Fig. 97.

'K' CROSSINGS

The standard 'K' crossing consists of four or six pieces of rail curved, set and machined for accurate assembly, with the rail parts secured in position by crossing bolts passing through the rails and cast iron spacer blocks, as shown in Figs. 99 and 100.

The point of intersection of a 'K' crossing is that position in advance of the dummy noses of the crossing where the running edges produced intersect with the running edges of the running wing rail, as in Figs. 99, 100 & 101. This position is always at the theoretical knuckle of the crossing half-way between the two dummy noses.

To reduce the strike at the knuckle, and for practical constructional reasons, the running wing rail is curved at this position, and the theoretical knuckle is slightly displaced from the actual running edge of the running wing rail, as shown in Fig. 101. See 13.038, Fig. 46.

The arrangement shown in Fig. 100 is standard for the new 94 and 107 lb. 'K' crossings, and that shown in Fig. 99 applies to 'K' crossings of all the earlier weights of rail.

LENGTHS

The intersection and overall lengths of 'K' crossings vary with the crossing No. and the rail section from which they were manufactured, and particulars are set out in Table 14.081.

NOMENCLATURE

The terms used in the description of 'K' crossings and their applications are shown in Figs. 99 & 100.

SPECIAL 'K' CROSSINGS

Special 'K' crossings vary from standard in many ways. The crossing No. the length, openings, flangeways, curvature and type of construction are the chief differences.

MANGANESE STEEL 'K' CROSSINGS

Manganese steel rail has been used for the construction of 100 lb. 'K' crossings at several places in the suburban area, and are identified by the rolling brands on the rail parts.

'VK' CONSTRUCTION

This type of construction occurs singly or in duplicate in double rail layouts where guard rails commence within the 'K' crossing, examples of which are shown in 13.032, Fig. 29; 13.035, Fig. 37; and 13.036, Fig. 39.

The new standard 'K' crossings used in 94 and 107 lb. layouts are of the 'VK' type with short flared guard wings placed to gradually engage the backs of wheel flanges and guide them into the most favorable position to run through the crossing gaps.

MATCHING 'K' CROSSINGS

In Diamonds and Compounds 'K' crossings are used in pairs as shown in 13.032, Fig. 29-31; and 13.047, Figs. 53 & 54, and because of the difference in position of the dummy noses and their constructional differences, departmental instructions provide that 'K' crossings of the same type must always be used together.

MOVABLE SWITCH 'K' CROSSINGS

With 'K' crossings of large No. the length of the unguarded gaps from the nose to the knuckle of the crossings is greater than the arc of the wheel flanges below the surface of the rails, and as stated in 13.026, there is an ever present danger of derailment due to the wheel flanges striking and taking the wrong side of the dummy noses.

The length of the gap also reduces the bearing area of the rails available for wheel tread transfer, and wear is consequently heavy.

To provide an unbroken surface for the wheels, and also eliminate the crossing gaps, the type of construction shown in Fig. 102 is in use opposite "A" Box, Flinders Street, and has been proposed for all new 'K' crossings of Nos. larger than 8.7.

The new No. 9.73 compounds will probably be of this type of construction, as shown in 13.049, Fig. 58.

DELTA CROSSINGS

A delta crossing is a composite crossing usually combining two 'V' crossings and one 'K' crossing in the one trackwork structure, as shown in Fig. 103.

LENGTHS

The intersection and overall lengths of standard delta crossings vary with the crossing No. and rail section from which they are manufactured, and particulars are set out in Table 14.082.

NOMENCLATURE

The terms used in the description of standard delta crossings and their applications are shown in Fig. 103.

TYPES

Standard delta crossings are designed for traffic over the delta centre, and the rail parts are machined and arranged accordingly.

Delta crossings used in special arrangements, see 13.064, have rail parts machined and arranged to properly support the running rails. While it is possible to interchange some of these delta crossings, it should be appreciated that a limited life only can be expected from rail parts designed for guard rail service when subjected to running rail conditions.

'K' DELTA CROSSINGS

Apart from constructional differences 'K' Delta crossings are used in pairs, having different intersection lengths to enable gauge to be established, as shown in 13.070, Fig. 92.

'V' DELTA CROSSINGS

This combination when made in standard Nos. is too long for convenient handling as one trackwork structure and articulated construction is adopted, as shown in Fig. 104. In this arrangement some flexibility is obtained at the joints between the crossing parts and renewals of worn portions are facilitated.

INHERENT DEFECTS

Delta crossings are inherently defective compared with 'Y' and 'K' crossings owing to the multiplicity of rail parts and spacer blocks necessary in their construction, and the necessity to machine away so much of the rail sections to assemble the individual rail parts.

A further undesirable feature is the excessive length of the crossing bolts required to unite the many parts. The elongation of steel is directly proportional to the elasticity of the steel and the length of the bar; thus for the same initial bolt tightness the stretch in the long bolts is greater, and as the loading conditions are more severe, it is practically impossible to keep the many rail parts rigidly united.

Movement between rail parts and spacer blocks is excessive, and the rate of internal wear is rapid with the result that the flangeways are reduced. Reduction of the flangeways results in the delta crossings pulling out of alignment, and making it practically impossible to maintain the correct running and guard gauges through all the tracks. Excessive wear and heavy strikes occur at the nose and guard edges of delta crossings as the result of incorrect alignment and gauge

For the above reasons delta crossings are to be avoided wherever practicable and renewals should be made as soon as internal wear becomes excessive rather than by reason of head wear of the rail parts.

CROSSING MAINTENANCE

Two factors are involved in crossing maintenance : -

1 Running conditions.
2. Mechanical repair.

RUNNING CONDITIONS

The necessity for proper drainage of the formation, adequate ballast of good quality, in good condition, and properly packed sound timbers, applies to crossing maintenance in the same way as to track maintenance. Joint conditions, alignment, and surface are likewise of equal importance.

Flange wear of the running and guard edges of crossings is dependent mainly on the maintenance of correct gauge and correct guard rail gauge. The stability of the guard rail under traffic conditions is vital to the protection of the crossings, both in respect to safety and in reduction of flange wear on the crossing.

14.076

Guard rails are provided to protect the crossing and of necessity are subject to heavy wear, particularly for the turnout movement. It should therefore be clear that no good purpose is being served by permitting heavy flange wear on the crossing in an endeavor to economise in guard rail replacements.

The correct position of a crossing guard rail is 5'1$\frac{1}{4}$" from the running edge of the crossing it is guarding, and this distance should be maintained at all times. See 14.100.

MECHANICAL REPAIRS

Mechanical repairs may be sub-divided for convenience, into : -

1. Adjustments.
2. Minor renewals.
3. Field repairs.
4. Workshop repairs.

ADJUSTMENTS

Internal wear is directly related to bolt tightness and trackmen should at all times keep the crossing bolts properly tightened for the service required of them.

The crossing should be properly secured to the timbers with good spikes to ensure that movement of the crossing does not take place under traffic. It is useless to properly secure the guard rail if the crossing is not likewise secured.

With 'K' and Delta crossings there is a tendency for the crossings to get out of line and allow of heavy flange blows at guard edges and at the noses and throats of the crossings. Observations should usually indicate in which direction the crossings should be pulled to restore smooth running conditions, and the earliest opportunity should be taken to restore the crossings to this condition.

When the displacement of the crossings is due to creep of adjacent rails, sufficient rail anchors should be applied to control this creep, bearing in mind that creep may be due to unstable track conditions which should likewise receive early attention.

It is probably true that many crossings are severely damaged by neglect in respect to the foregoing adjustments, and consequently earlier renewals are necessitated.

MINOR RENEWALS

These generally concern the replacement of broken or over-stretched bolts with new or serviceable bolts of proper length and suitable spring washers with bevel washers to properly seat the bolt heads and spring washers.

Joint renewals likewise assist in prolongation of the life of the crossings by preventing shatter cracks at the ends of the crossings.

FIELD REPAIRS

Occasionally in emergency it may be necessary to replace a broken rail part with a sound part from an old crossing. This practice is not to be recommended, as the proper fitting of crossing parts cannot be expected in these circumstances, and the repair at the best can only be a makeshift.

Field repairs of any consequence should be undertaken by Points and Crossings gangs which are properly equipped for this work.

Sound crossings with a minimum of internal wear are built up to section at the nose and on the wing rails by the oxy-acetylene welding process. The welding is carried out in the track and trains are allowed to pass over the crossing during the process. This work is done by the welders attached to the Points and Crossings gangs and requires specialised skill for successful results.

The rail is first prepared by removal of all unsound metal, then uniformly heated before deposition of the weld metal. Areas of deposited metal are hammered while hot to the required shape and surface, and excess metal is cut away with hot sates. The building up is carried out in small sections to prevent overheating of the rail, and a special wear resisting steel is used for the purpose.

WORKSHOP REPAIRS

Crossings in which the rail parts are sound, but the block fitting has been lost owing to internal wear and lack of bolt maintenance, may be completely rebuilt.

Rebuilding is a workshop job involving complete dismantling; each rail part is inspected and corrected for setting and curvature as with new rail parts. Usually the nose blocks, scarf blocks, wedge blocks and knee blocks are scrapped, and new full fishing-angle fitting blocks are installed.

The nose rail is raised to correct height and high tensile steel bolts are installed in the central part of the crossing. When necessary the wing rails are built up by oxy-acetylene welding and the surface is ground or machined as required.

Crossings which have previously been welded in track are not generally suitable for rebuilding, and all crossings are therefore examined by an engineer before undertaking this work.

The life of a rebuilt crossing is practically equal to that of a new crossing under ordinary conditions.

Departmental instructions require that crossings suitable for rebuilding be reported to Head Office to enable inspection and arrangements to be made for release of the crossing for rebuilding.

Crossings of rails under 80 lb. section are not rebuilt.

94 A.S 107 A.S | 90 A.S 110 A.S | 110 A.S 1929 | 90 A.S 1928 | 100 P 100 A.S | 80 O 80 A.S | 60 A.S 1935 | 50 A.S 1921 | 60 D | CROSSING NUMBER

P. OF I. TO NOSE 'V' CROSSINGS

CROSSING NUMBER	60 D	50 A.S 1921	60 A.S 1935	80 O 80 A.S	100 P 100 A.S	90 A.S 1928	110 A.S 1929	90 A.S 110 A.S 1935	94 A.S 107 A.S
3.0	-	-	-	-	-	-	-	-	$2\frac{11}{32}$"
3.3	-	-	$1\frac{5}{8}$"	-	-	-	-	$1\frac{11}{16}$"	-
5.0	-	-	-	-	-	-	-	-	$3\frac{13}{16}$"
5.5	$1\frac{19}{32}$"	1"	$2\frac{25}{32}$"	$1\frac{5}{16}$"	$1\frac{11}{16}$"	-	-	$2\frac{3}{4}$"	-
7.52	$2\frac{3}{4}$"	$1\frac{29}{32}$"	$3\frac{3}{4}$"	$2\frac{3}{8}$"	$2\frac{7}{8}$"	$2\frac{3}{4}$"	$3\frac{3}{32}$"	$3\frac{25}{32}$"	$5\frac{11}{16}$"
8.7	$3\frac{3}{8}$"	$2\frac{7}{16}$"	$4\frac{3}{8}$"	3"	$3\frac{1}{2}$"	$3\frac{13}{32}$"	$3\frac{13}{16}$"	$4\frac{3}{8}$"	$6\frac{9}{16}$"
9.73	$3\frac{31}{32}$"	$2\frac{29}{32}$"	$4\frac{7}{8}$"	$3\frac{1}{2}$"	$4\frac{1}{8}$"	$3\frac{31}{32}$"	$4\frac{7}{16}$"	$4\frac{7}{8}$"	$7\frac{5}{16}$"
12.0	-	-	-	-	-	-	-	-	$9\frac{1}{32}$"
12.3	$5\frac{13}{32}$"	$4\frac{5}{32}$"	$6\frac{1}{8}$"	$4\frac{13}{16}$"	$5\frac{5}{8}$"	-	-	$6\frac{1}{8}$"	-
15.0	-	-	-	-	-	-	-	-	$11\frac{1}{4}$"
15.1	7"	$5\frac{11}{32}$"	-	$6\frac{5}{16}$"	$7\frac{1}{4}$"	-	-	-	-

60 A.S. 1935 — 2'0" wing flare length. Set.
60 A.S. 1921, 90 A.S. 1928 } 1'1" wing end splay. Set.
110 A.S. 1929
90 & 110 A.S. 1935 — 2'6" wing flare length. Machined.

INTERSECTION LENGTHS 'V' CROSSINGS

WEIGHT OF RAIL	CROSSING NUMBERS	WING INTERSECTION LENGTH	VEE INTERSECTION LENGTH	OVERALL LENGTH
60 lb D & A.S	Up to 6.51	6'0$\frac{3}{4}$"	7'5$\frac{1}{4}$"	13'6"
	6.52 " 8.11	5'10"	7'8"	"
	8.12 " 9.215	5'9"	7'9"	"
	9.216 to 11.015	5'8"	7'10"	"
	11.016 " 13.7	"	9'10"	15'6"
	13.8 Upwards	5'5$\frac{1}{4}$"	10'0$\frac{3}{4}$"	"
80 lb O & A.S	Up to 8.11	5'11$\frac{1}{2}$"	6'9$\frac{1}{4}$"	12'8$\frac{3}{4}$"
100 lb P & A.S	8.12 " 11.015	"	9'2$\frac{1}{2}$"	15'2"
90 & 110 lb A.S	11.016 Upwards	"	13'6$\frac{1}{2}$"	19'6"
94 & 107 lb A.S	Up to 7.52	5'11$\frac{1}{2}$"	6'9$\frac{1}{4}$"	12'8$\frac{3}{4}$"
	7.53 " 10.54	"	9'2$\frac{1}{2}$"	15'2"
	10.55 Upwards	"	13'6$\frac{1}{2}$"	19'6"

INTERSECTION LENGTHS 'K' CROSSINGS

WEIGHT OF RAIL	CROSSING NUMBERS	'K' INTERSECTION LENGTH	OVERALL LENGTH	APPROXIMATE LENGTH FOR LOADING
60 80 90 100 & 110 lb	All Standard angles	6'3"	12'6"	12'6"
94 & 107 lb	7.52	10'1⅜"	20'2¾"	20'2¼"
	* 7.52-A	{ 8'10⅜" 12'11⅜" }	21'9¾"	25'10"
	8.7	11'3"	22'6"	22'5½"
	* 8.7-A	{ 9'2" 11'3" }	20'5"	22'5½"

* No. 7.52-A & 8.7-A 'K' Crossings are used in compounds and have odd 'K' intersection lengths.

INTERSECTION LENGTHS DELTA CROSSINGS

WEIGHT AND YEAR	CROSSING NO	INTERSECTION LENGTHS			OVERALL LENGTHS	
		DELTA K	DELTA V	DELTA	STRAIGHT	DIAGONAL
60D & A.S. 80 O & A.S. 90 A.S.1929	7.52	8'10½"	4'7½"	8'5½"	17'8½"	17'9"
	8.7	10'1¼"	5'1¾"	9'10 9/16"	20'2 1/16"	20'2½"
	9.73	11'1¾"	5'6 11/16"	11'1 13/16"	22'3 3/16"	22'3½"
100 P & A.S. 90 A.S. 1930,1935 110 A.S. 1930,1935	7.52	9'4½"	5'1½"	8'5½"	18'8½"	18'9"
	8.7	10'9"	5'9½"	9'10 9/16"	21'5 9/16"	21'6"
	9.73	11'10½"	6'3 7/16"	11'1 13/16"	23'8 11/16"	23'9"
90 A.S. 1938 110 A.S. 1938	7.52	10'4⅛"	5'11½"	8'7⅛"	20'6⅛"	20'7⅝"
	8.7	11'0 17/32"	5'11½"	10'0⅜"	21'11⅜"	22'0⅝"
	9.73	11'7 31/32"	5'11½"	11'3½"	23'2½"	23'3 9/16"

Type 1929, 30 Guard Wing Rail flare - Set.
Type 1935, 38 " " " " - Machined.

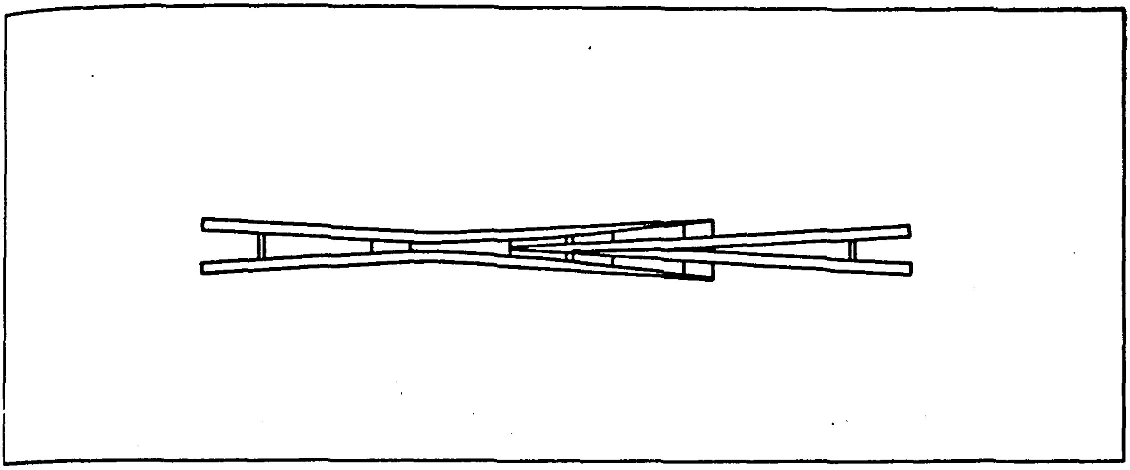


FIG. 70. V CROSSING.

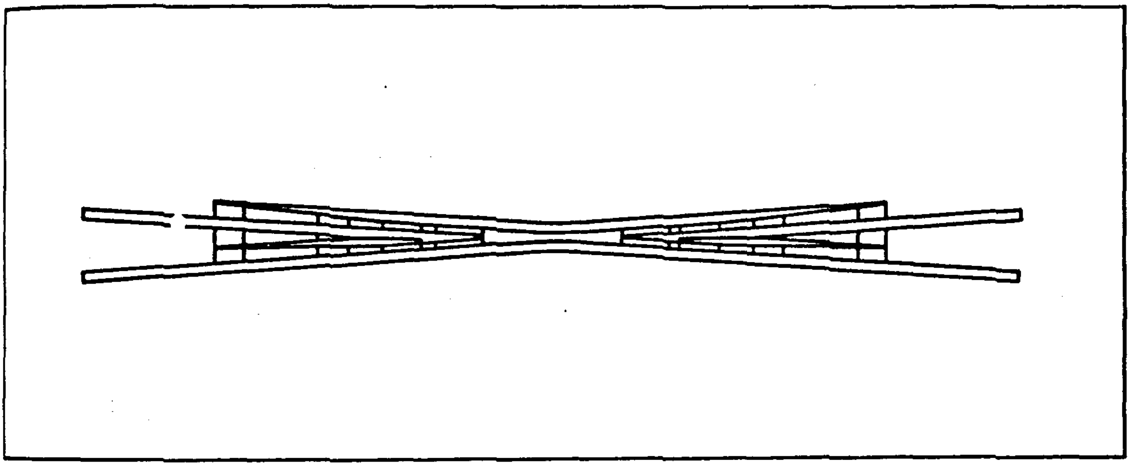


FIG. 71. K CROSSING

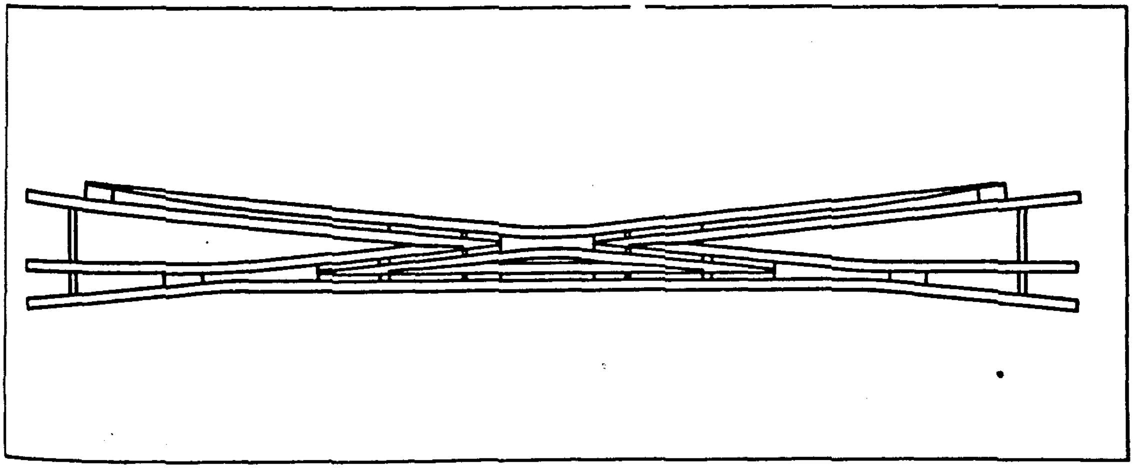


FIG. 72. DELTA CROSSING.

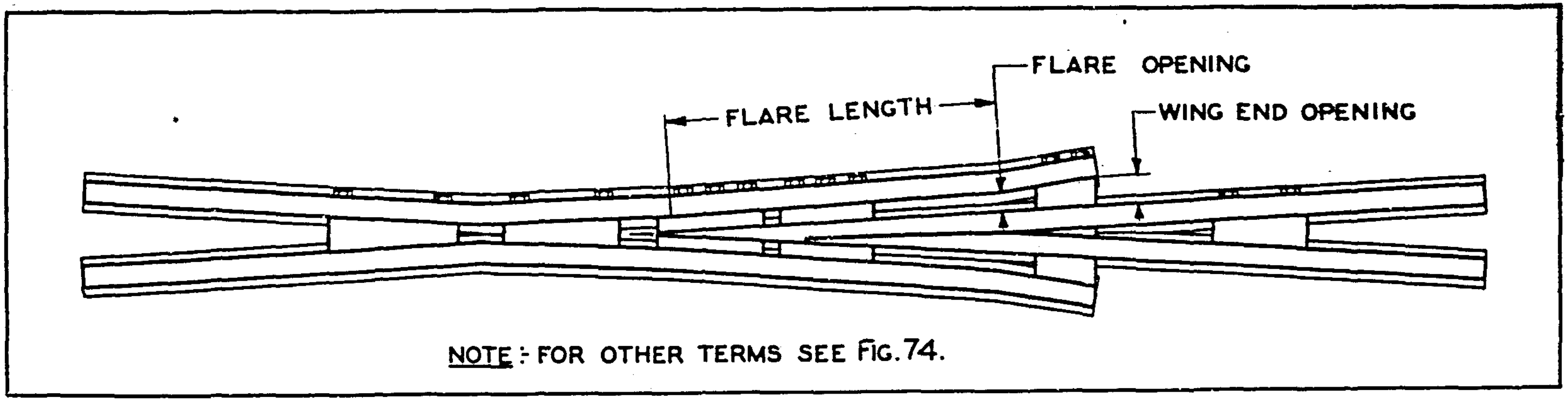


FIG. 73. V CROSSING. OLD TYPE.

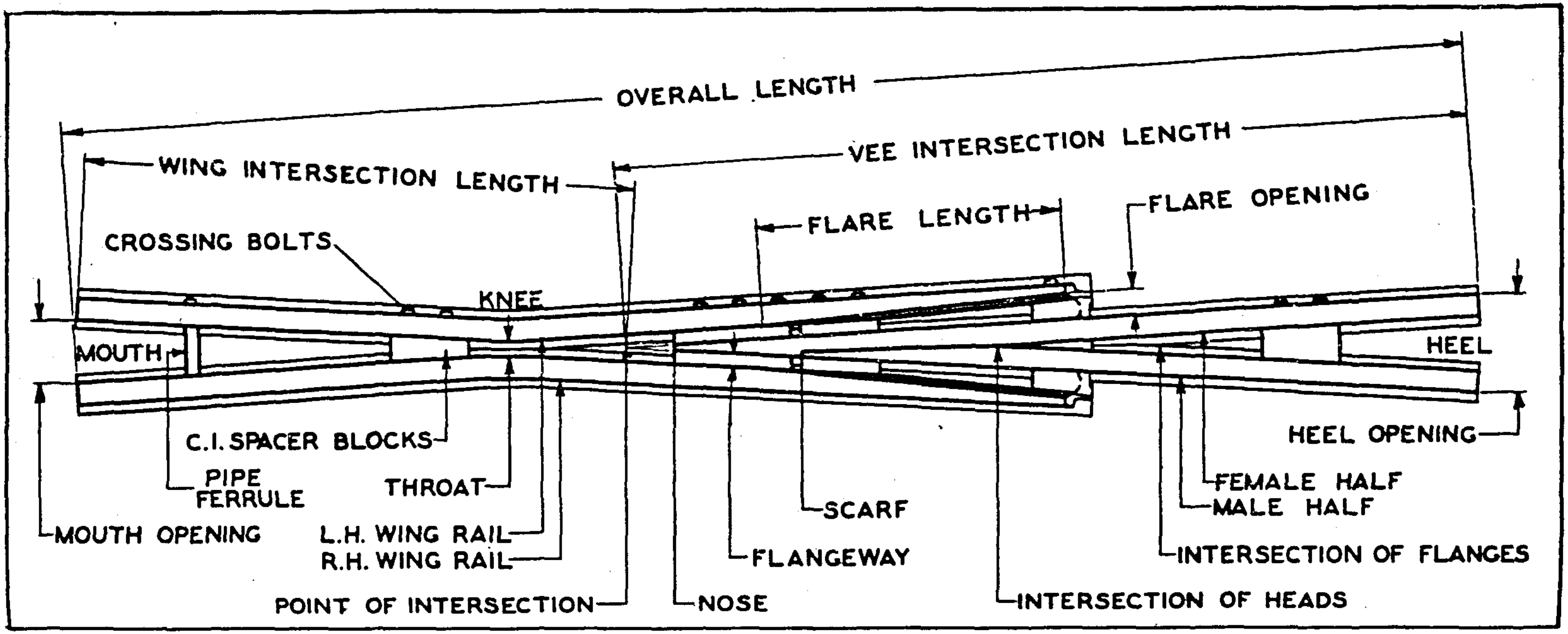


FIG. 74. V CROSSING. TYPE 1935.

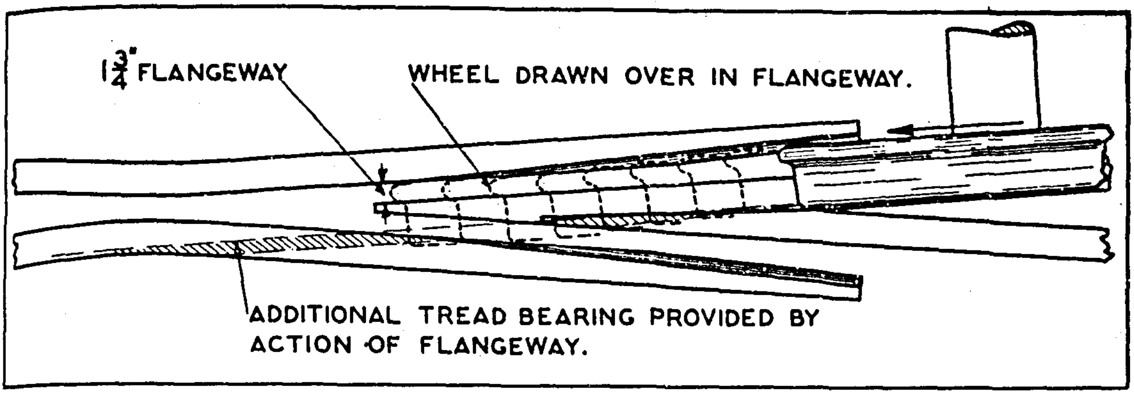


FIG. 75. WHEEL DRAWN OVER BY FLARED GUARD WING.

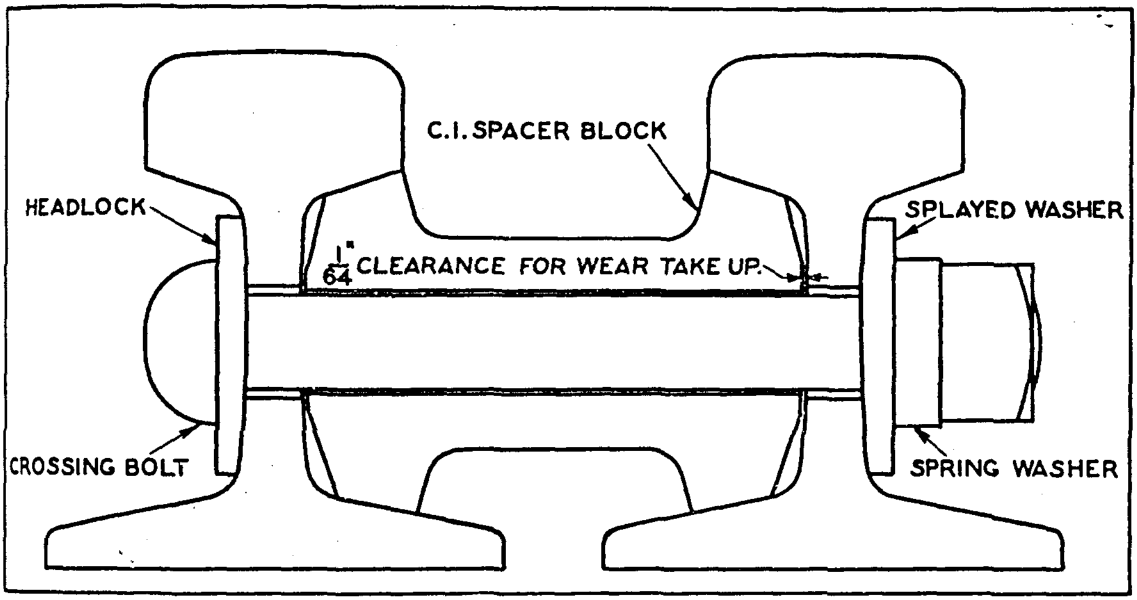


FIG. 76. TYPICAL CAST IRON SPACER BLOCK FITTING.

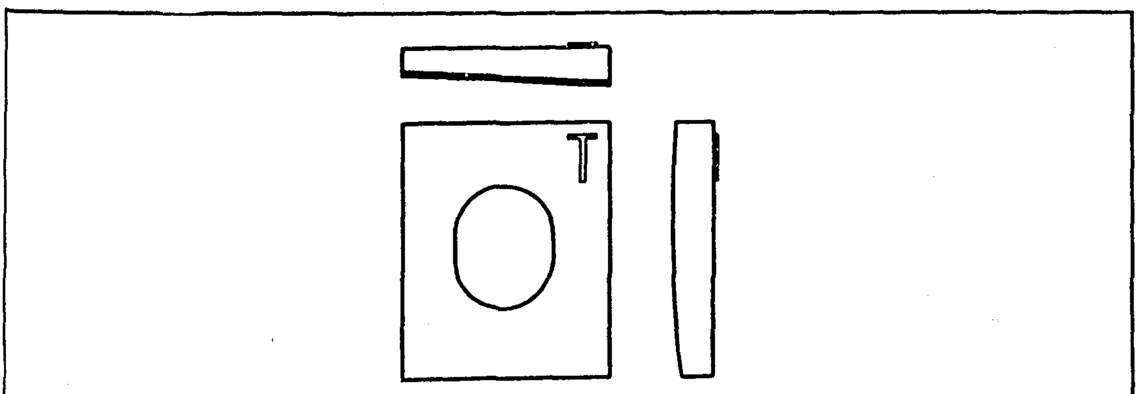


FIG. 77. HEADLOCK.

FIG. 74. V CROSSING. TYPE 1935.

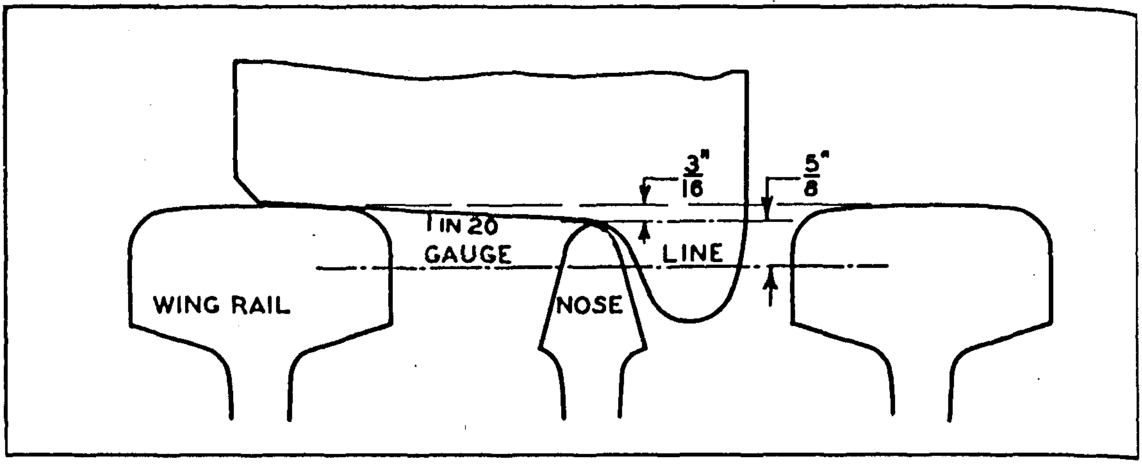


Fig. 78. Ideal Nose Conditions. New Wheel on New Crossing.

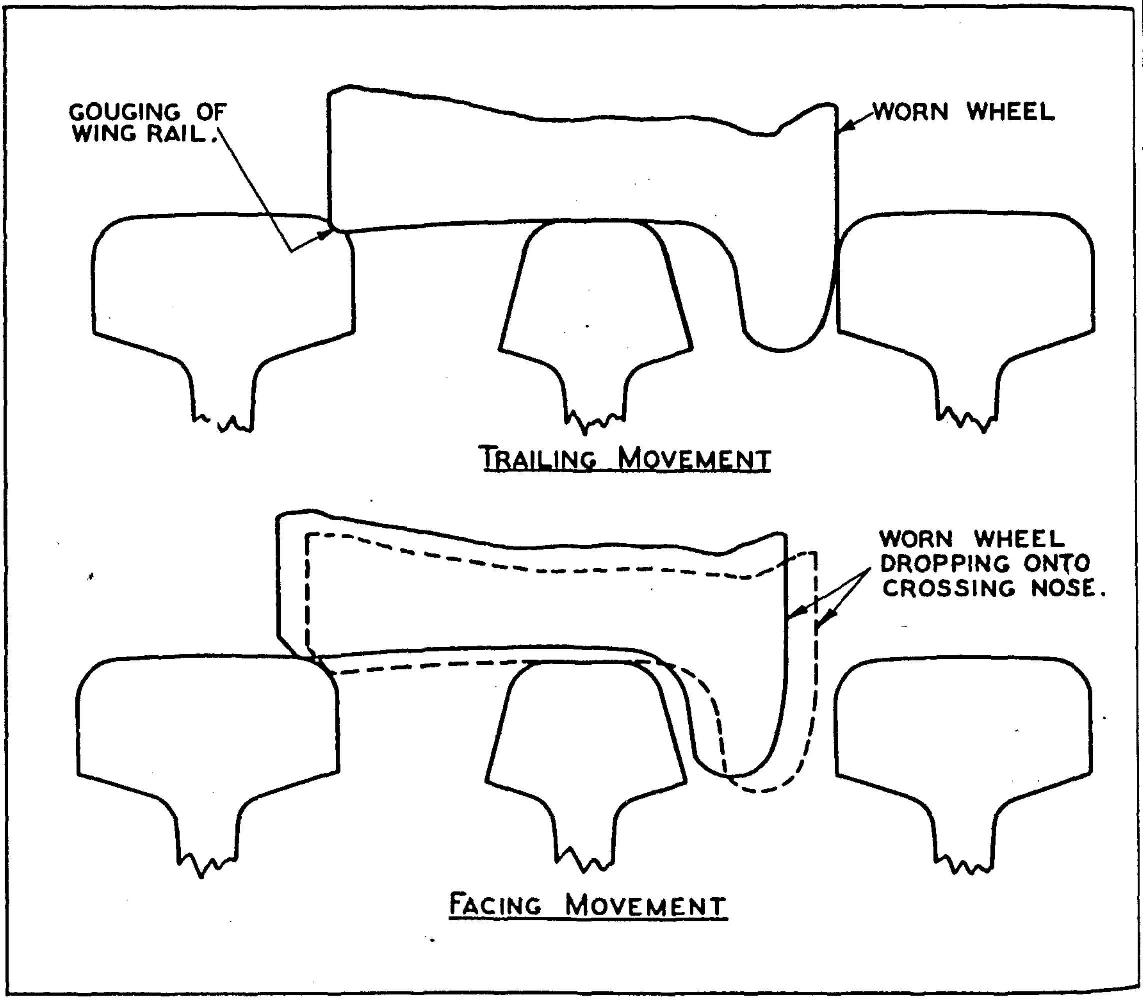


Fig. 79. Damage to New Crossing by Worn Wheel.

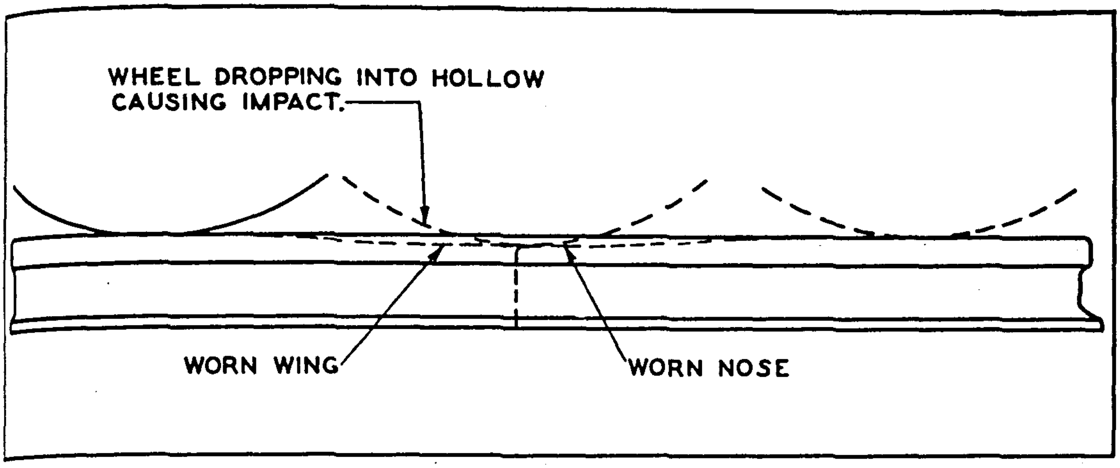


FIG. 80. WHEEL IMPACT ON WORN CROSSING.

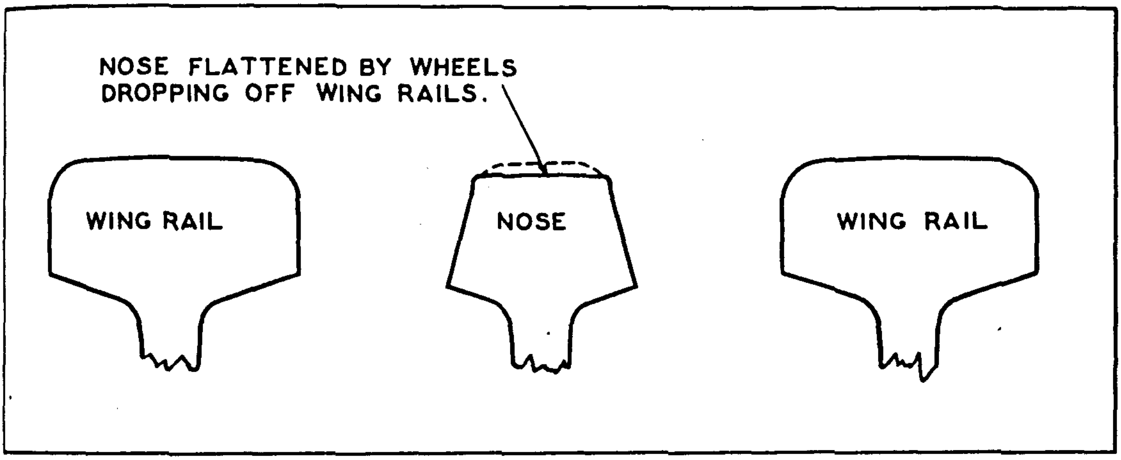


FIG. 81. FLATTENING OF NOSE.

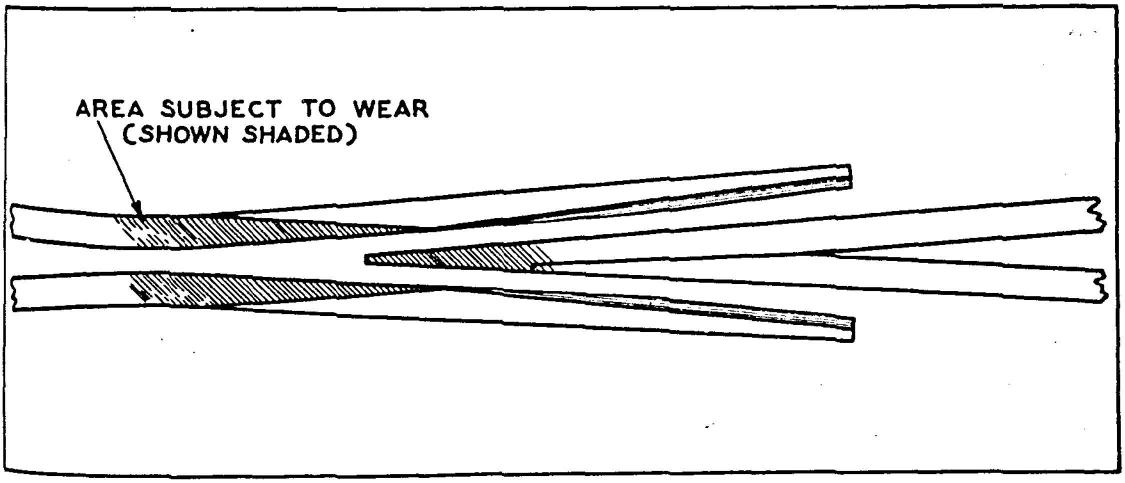


FIG. 82. AREA SUBJECT TO WEAR. V CROSSING.

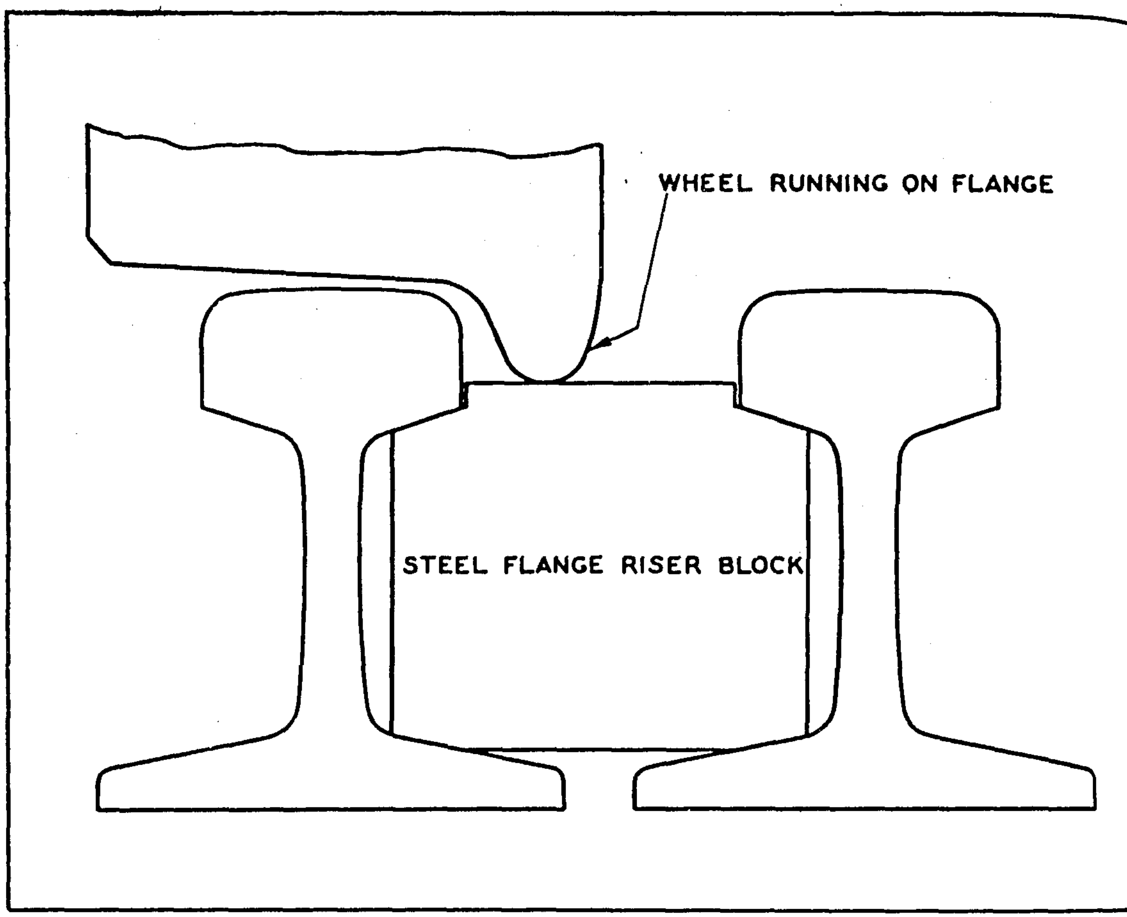


FIG. 83. FLANGE RISER BLOCK.

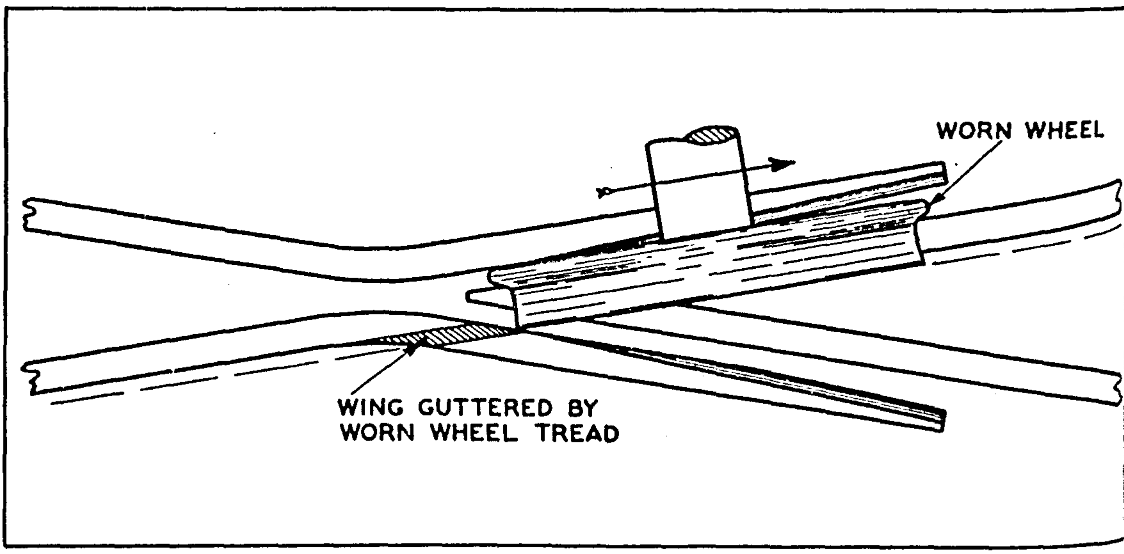


FIG. 84. GUTTERING OF WING RAIL. WIDE ANGLE CROSSING.

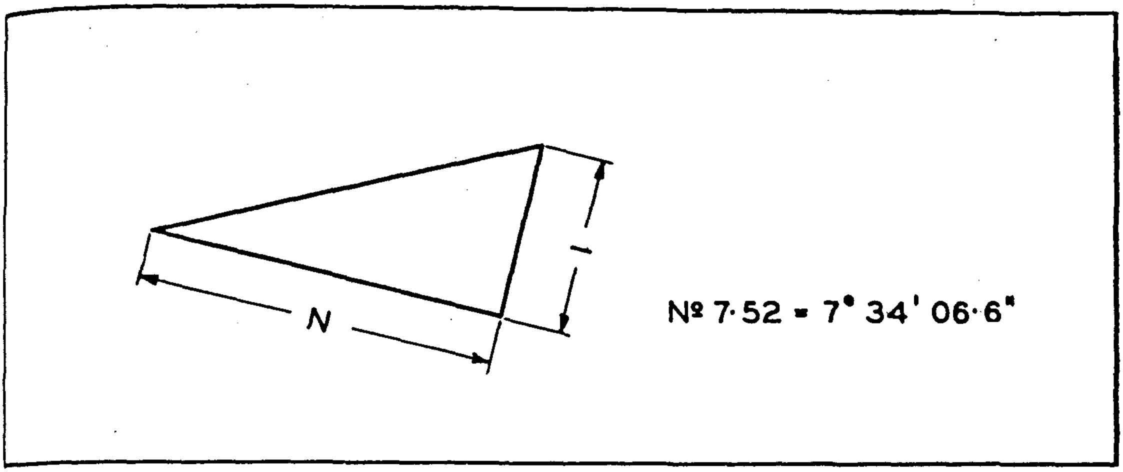


FIG. 85. SLOPE OF CROSSING. METHOD I.

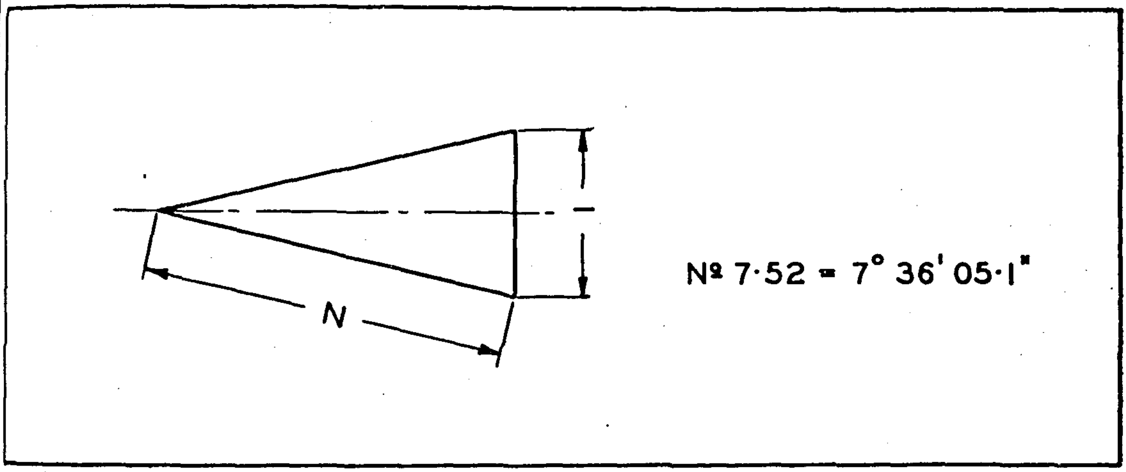


FIG. 86. SLOPE OF CROSSING. METHOD 2.

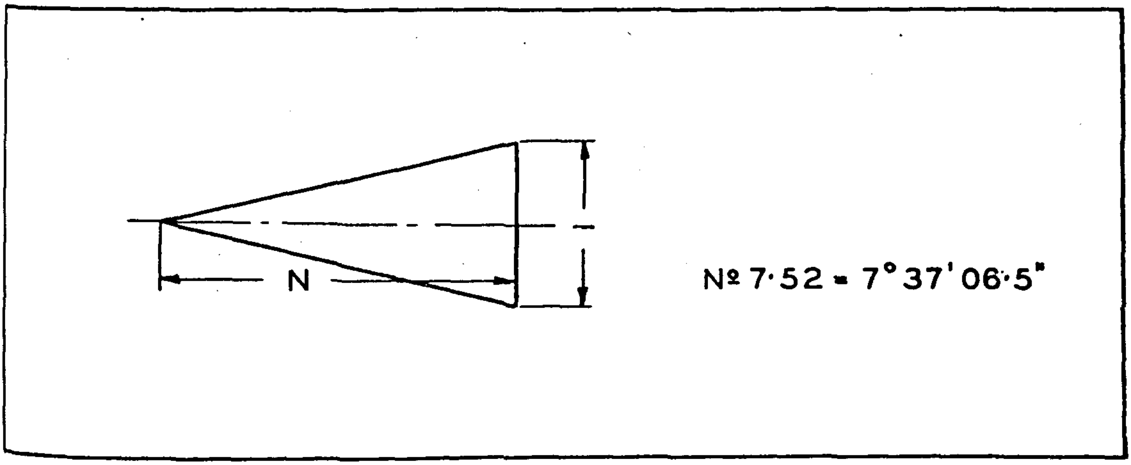


FIG. 87. SLOPE OF CROSSING. METHOD 3.

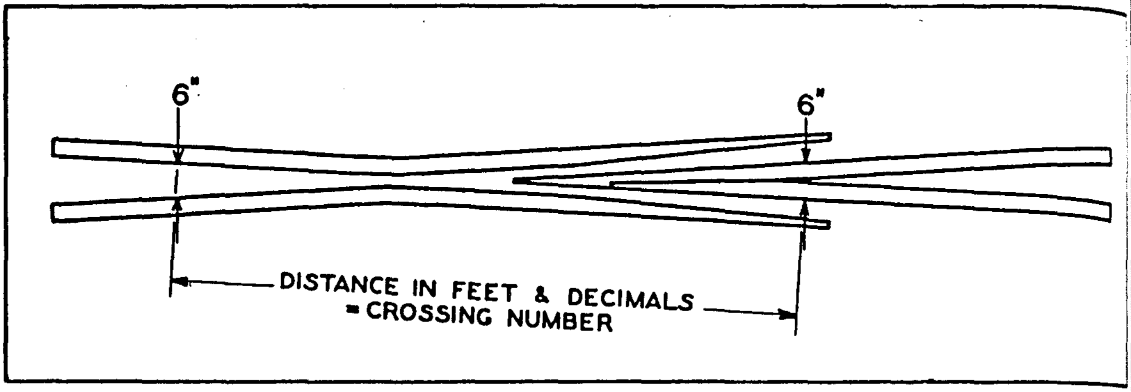


FIG. 88. METHOD OF DETERMINING CROSSING NUMBER. STRAIGHT CROSSING.

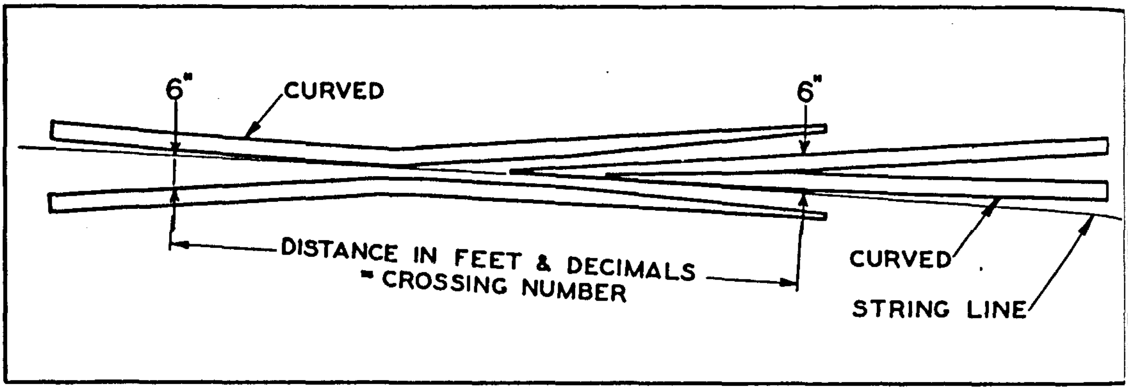


FIG. 89. METHOD OF DETERMINING CROSSING NUMBER. CURVED CROSSING.

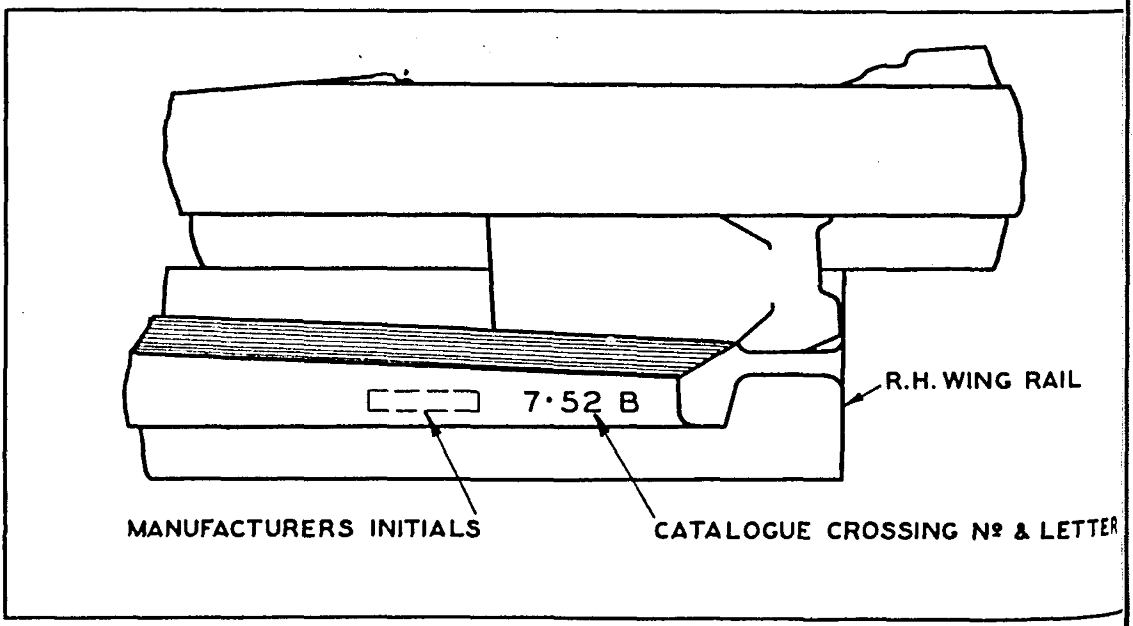


FIG. 90. CROSSING CATALOGUE NUMBER STAMPING.

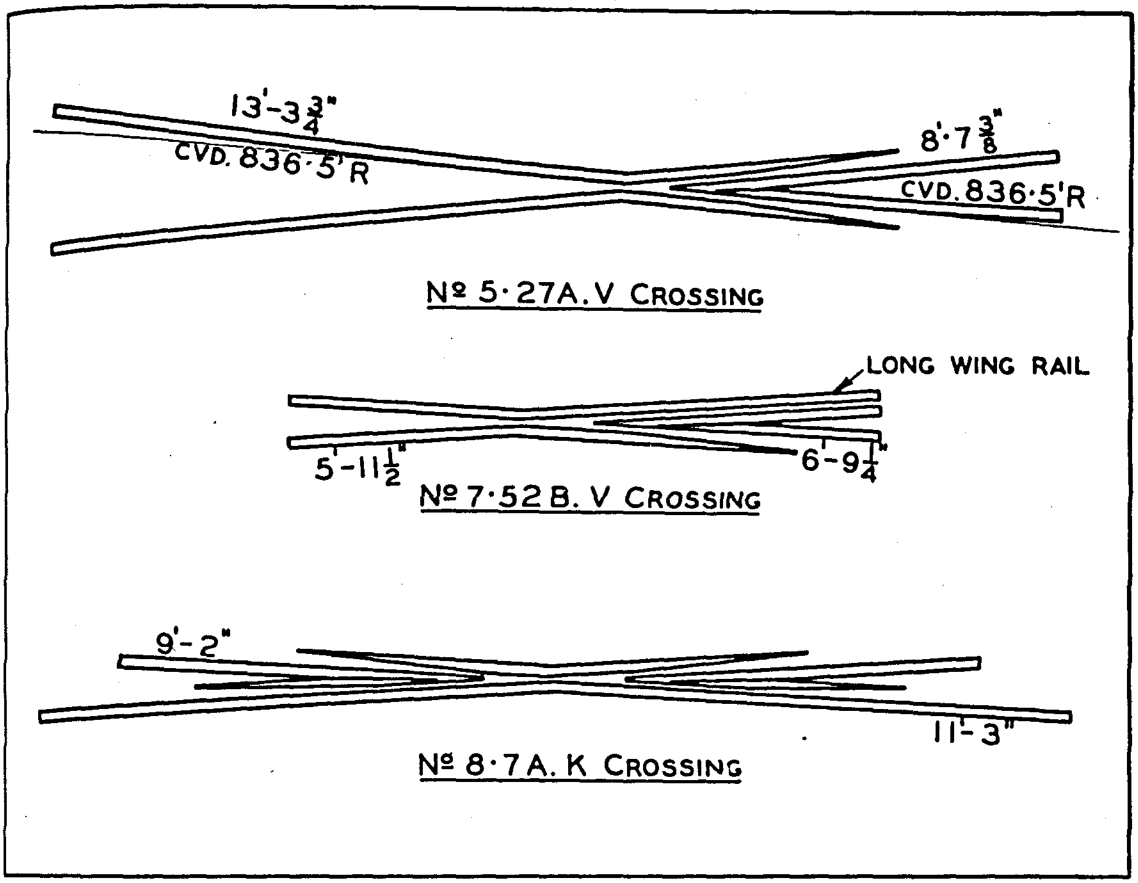


FIG. 91. EXAMPLES OF CATALOGUE CROSSINGS.

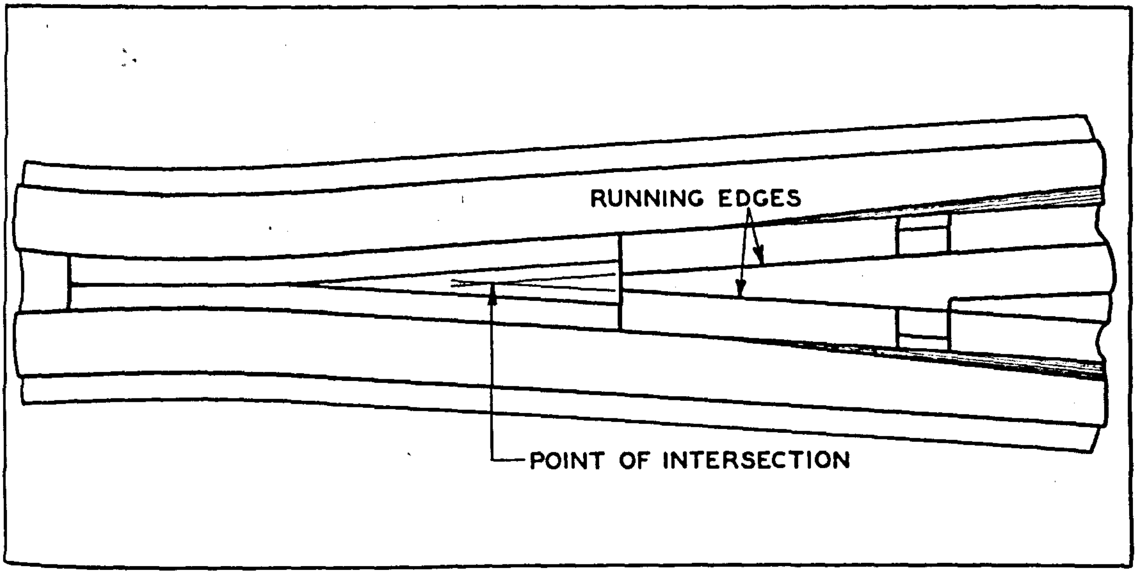


FIG. 92. POINT OF INTERSECTION. V CROSSING.

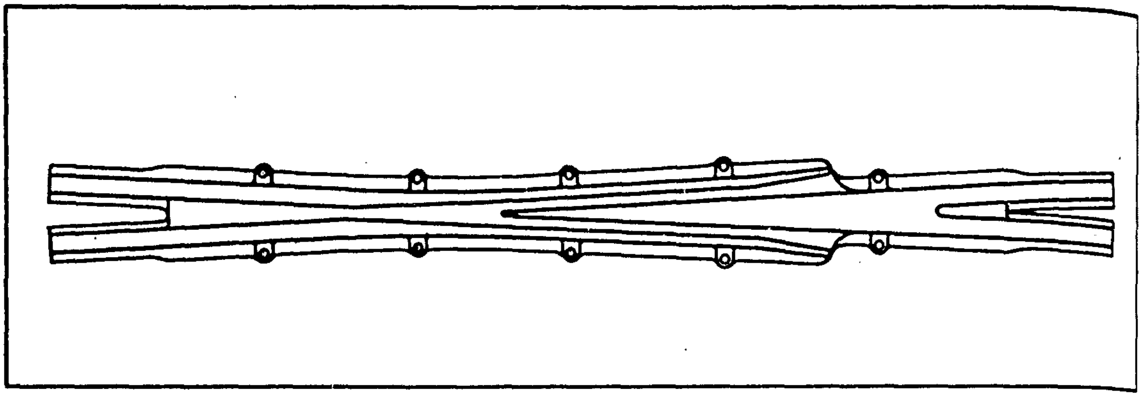


FIG. 93. CAST MANGANESE CROSSING.

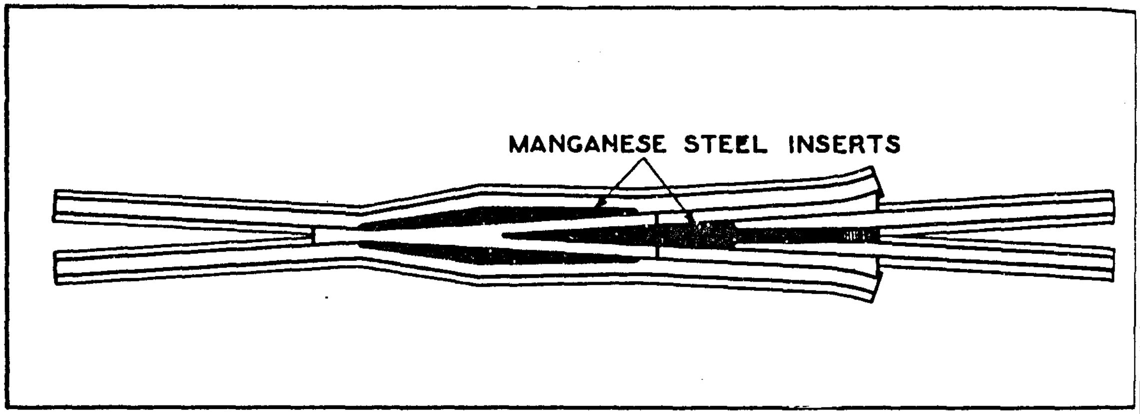


FIG. 94. RAIL BOUND MANGANESE CROSSING.

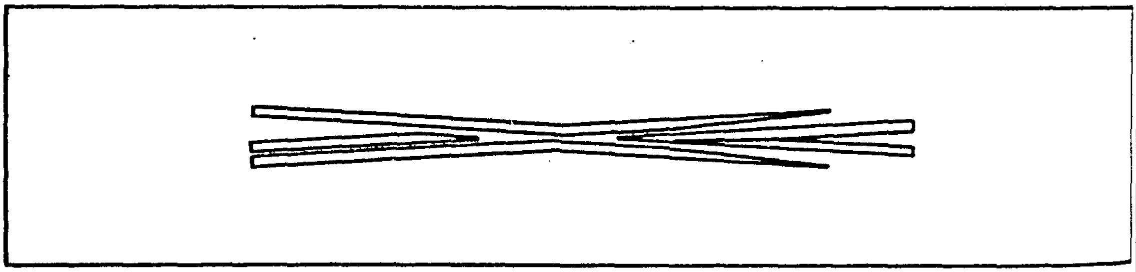


FIG. 95. SPECIAL V CROSSING, KV CONSTRUCTION.

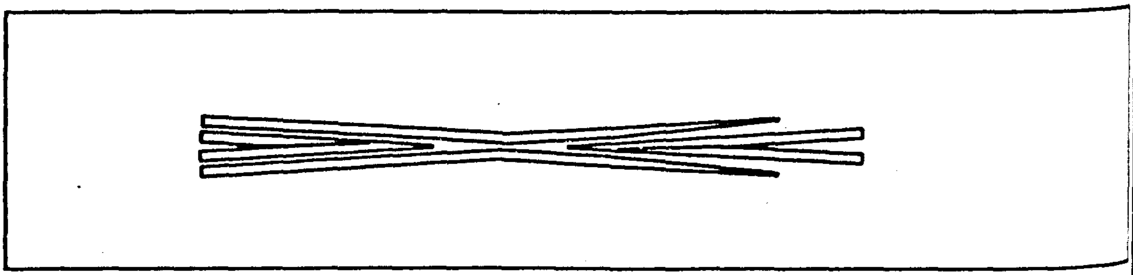


FIG. 96. SPECIAL V CROSSING, VV CONSTRUCTION.

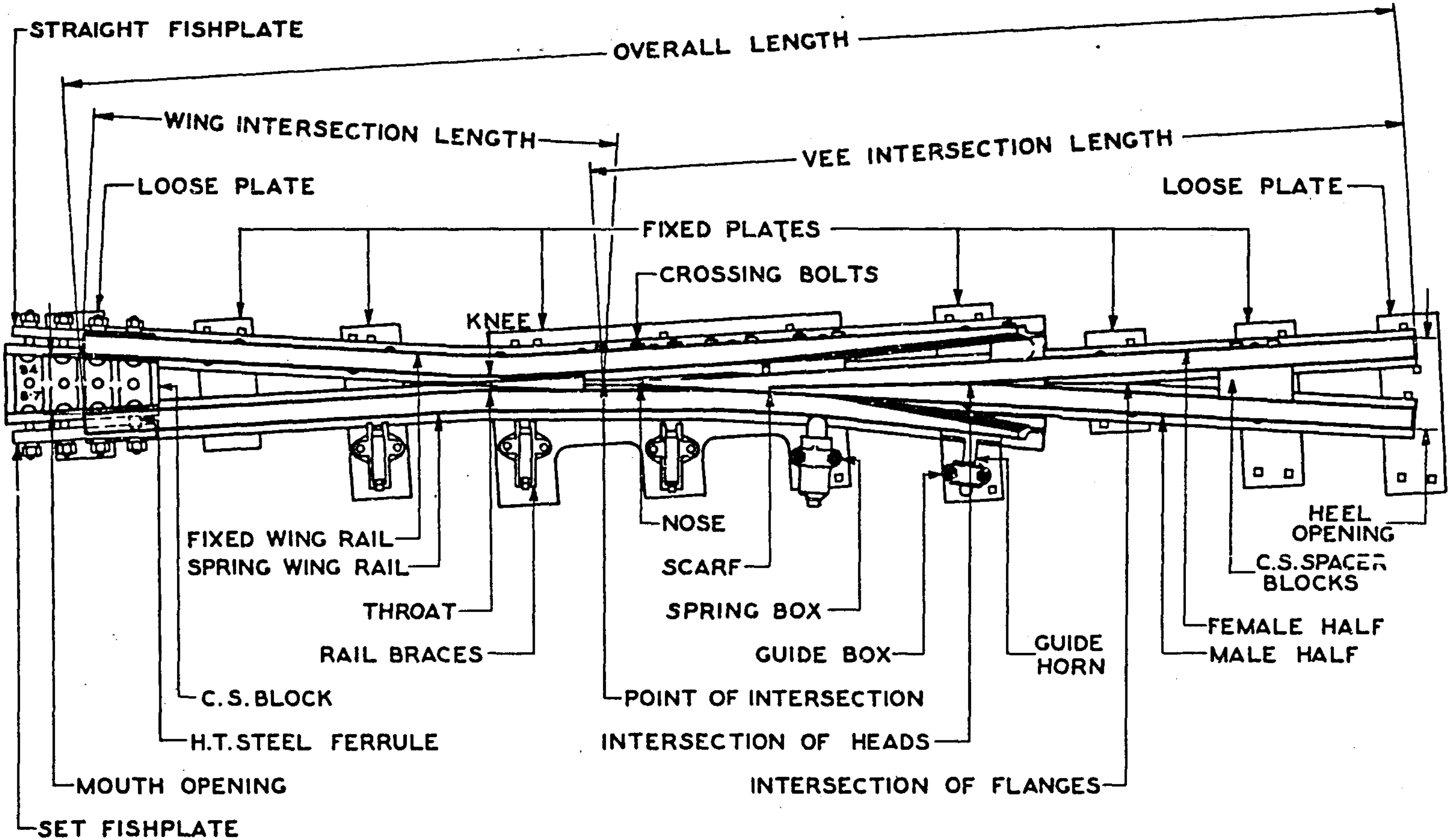


FIG. 97. SPRING V CROSSING. Nº 8·7, R.H., 94 B.A.S.

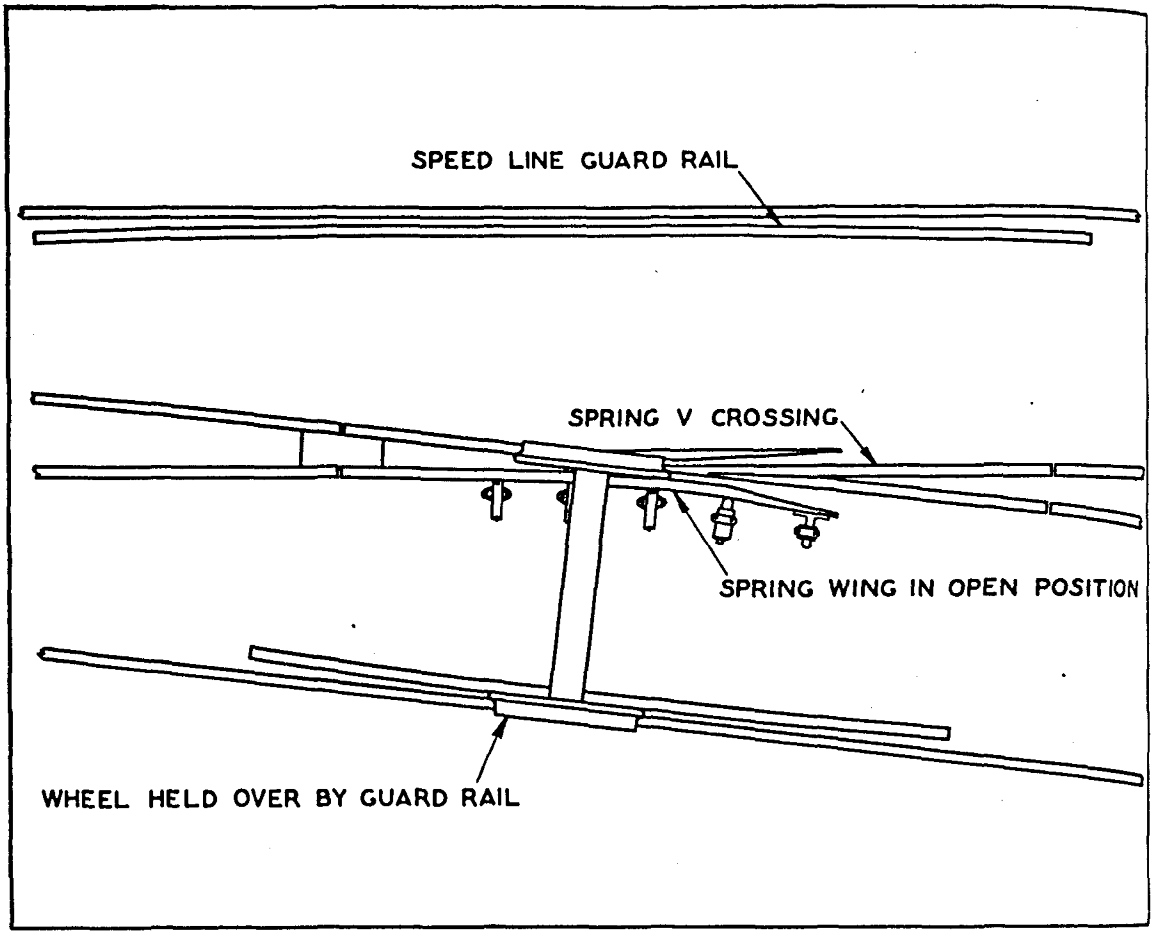


Fig. 98. Spring V Crossing. Spring Wing in Open Position.

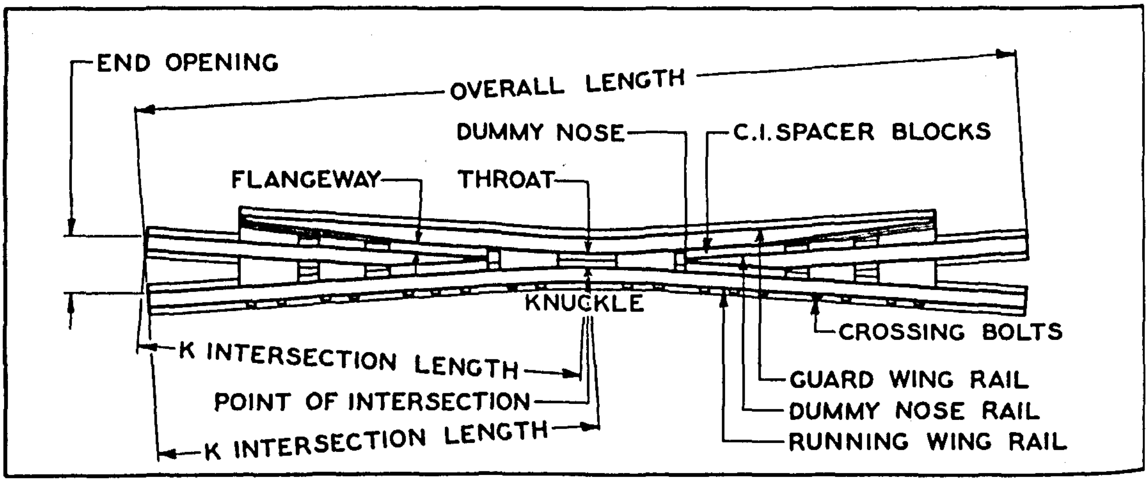


Fig. 99. K Crossing, Old Type.

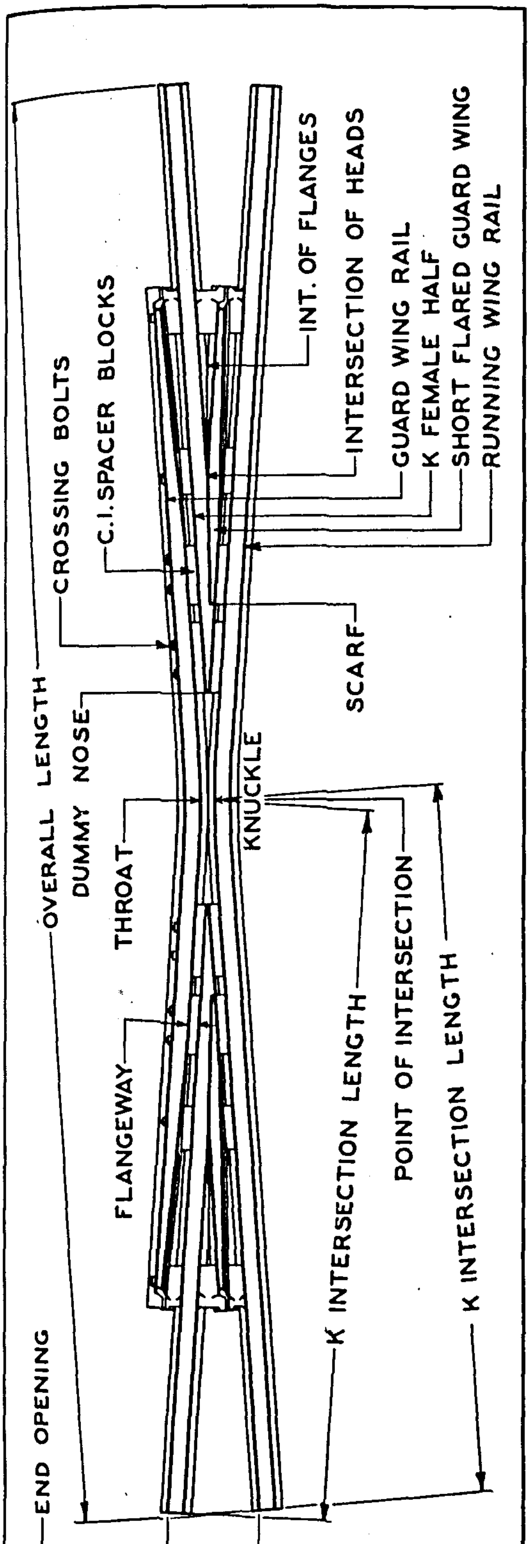


Fig. 100. K Crossing, Type 1940.

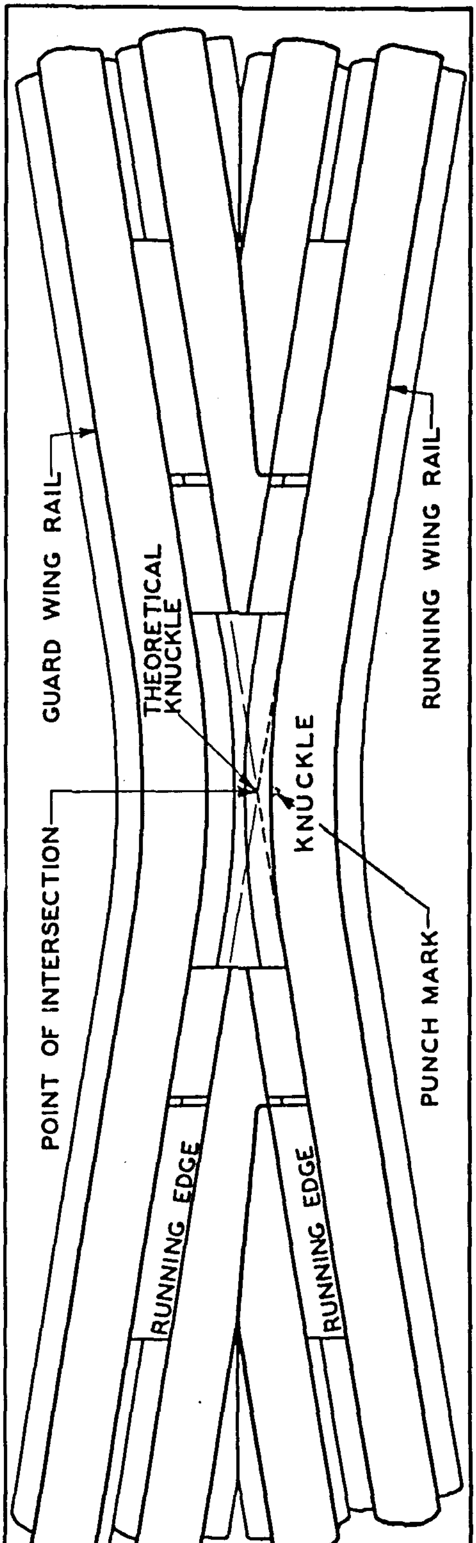


Fig. 101. Theoretical Knuckle, K Crossing.

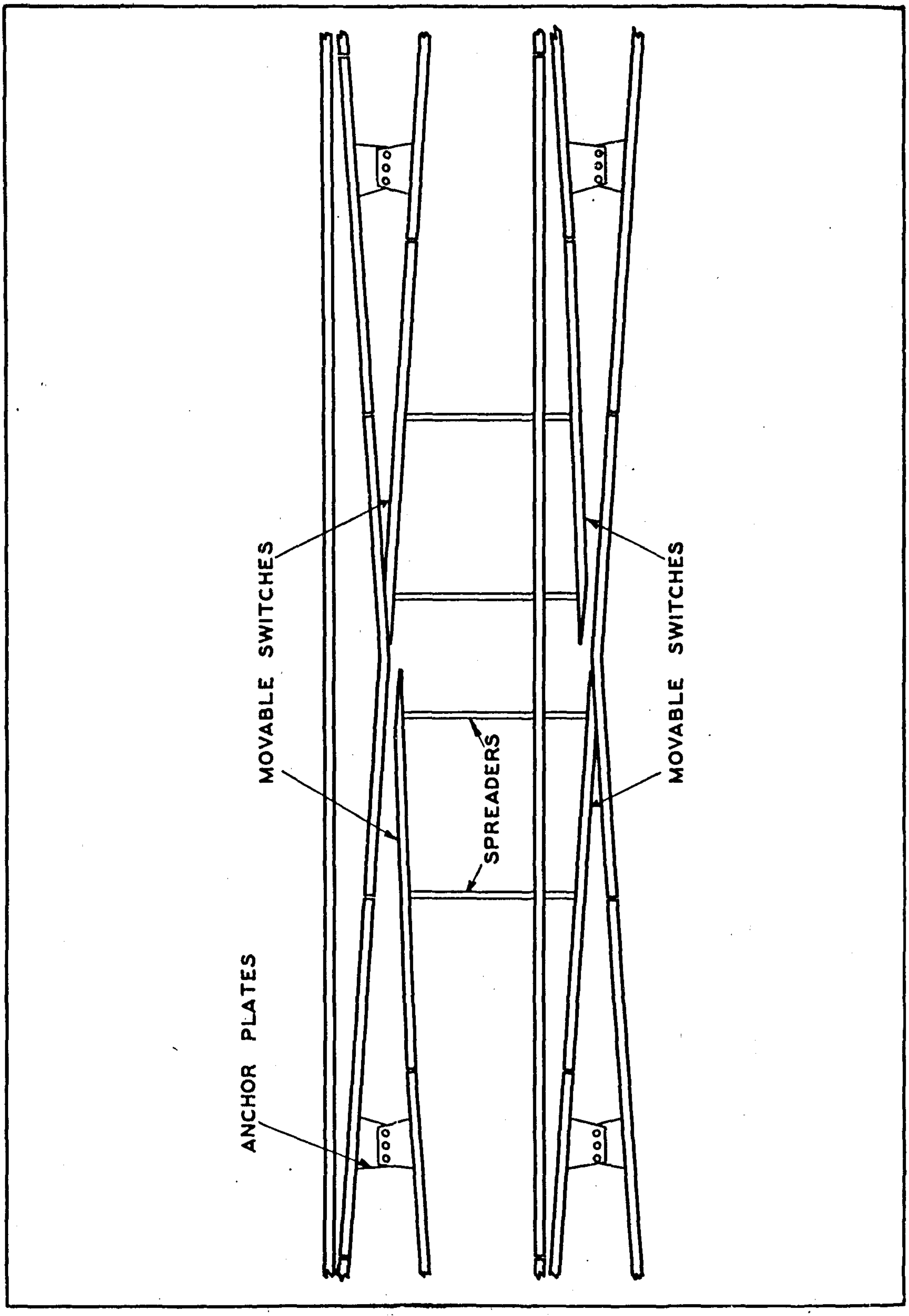


FIG. 102. MOVABLE SWITCH K CROSSING (IN USE AT 'A' BOX, FLINDERS STREET.)

Fig. 102. Movable Switch K Crossing (In Use at 'A' Box, Flinders Street.)

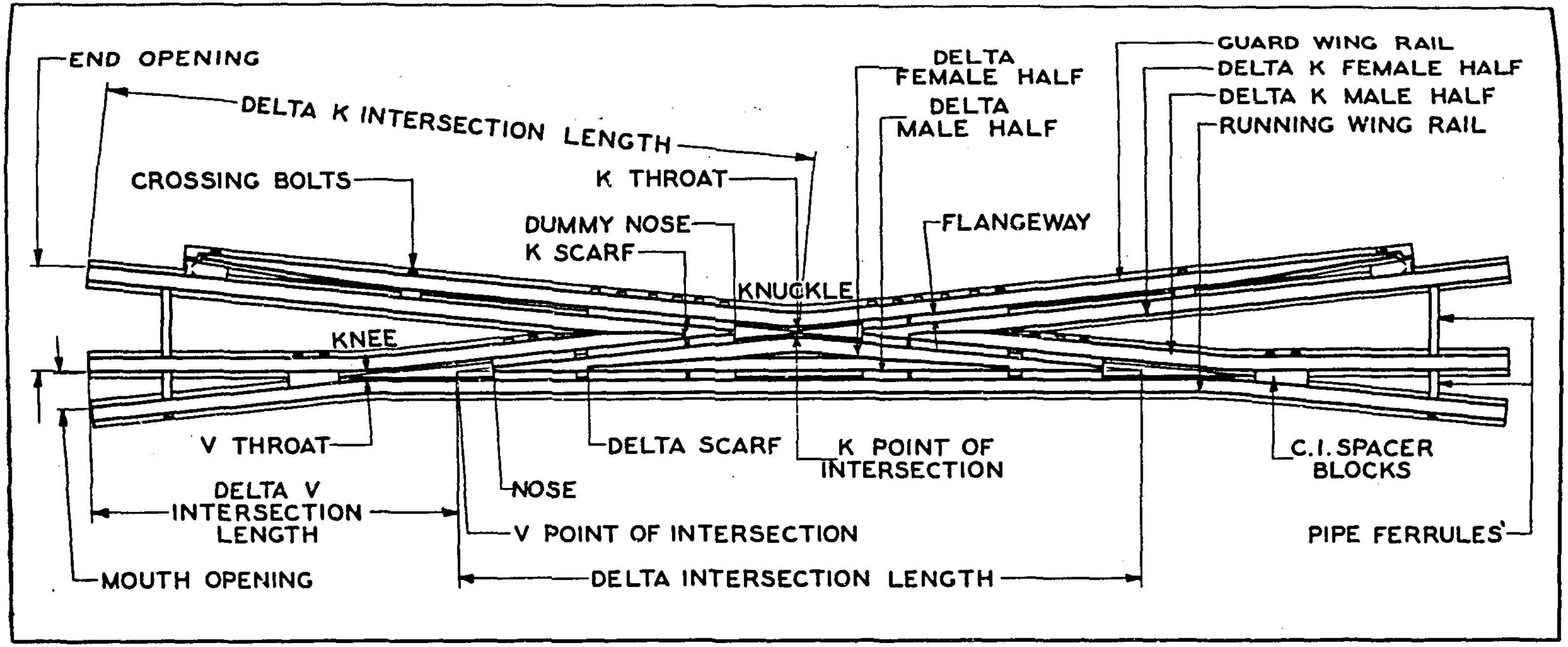


Fig. 103. Delta Crossing

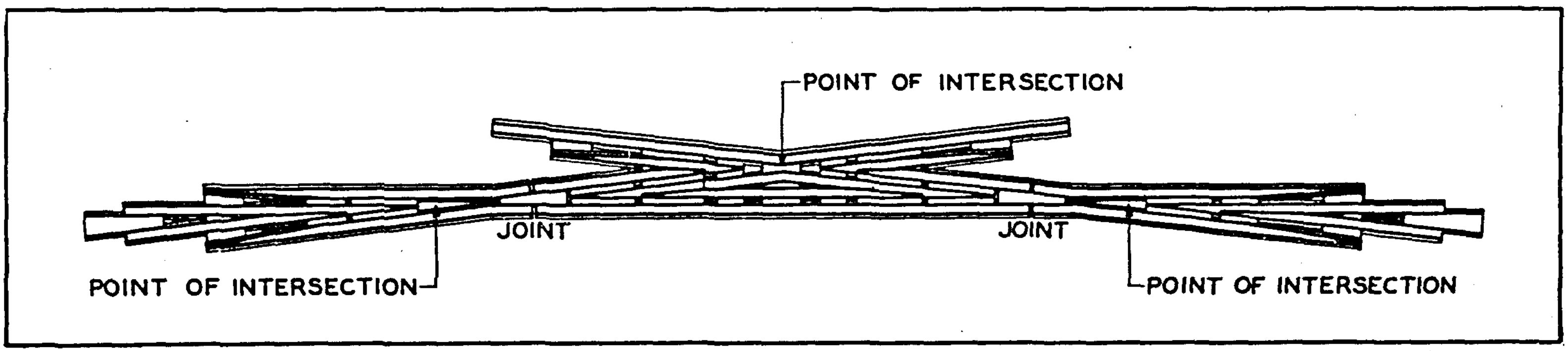


Fig. 104. Articulated V Delta Crossing.

GUARD RAILS

TYPES

Guard rails are of two general types : -

1. Continuous guard rails used on curves, on bridges and through tunnels.

2. Crossing guard rails used to cover the gaps at the crossings and to reduce the side wear through the crossings.

CONTINUOUS GUARD RAILS

These are safety rails laid within the gauge to control the passage of derailed wheels and prevent serious accidents.

Continuous guard rails are laid adjacent to the inner rail on curves where derailments could result in considerable damage. At bridges on curves it is necessary to provide a guard rail on the inner rail to ensure safety in the event of derailment.

It is now usual to so place the guard rail that in the event of a wheel mounting the rail it will run on the flange along the top of its rail to a position clear of any obstruction, and then engage a short flared guard rail to draw the wheel back to gauge.

The arrangement of the guard rail used on Flinders Street Viaduct is shown in Fig. 105, and is typical of continuous guard rails installed of recent years. See 3.41, Fig. 40.

CROSSING GUARD RAILS

Various types of crossing guard rails are in use according to weight of rail, purpose and year type, particulars of which are set out in Table 14.106, and Fig. 106.

To fulfil its purpose the crossing guard rail must engage the backs of approaching wheel flanges no matter what running position they occupy, and gradually draw the wheels over to a position 5'1¼" from the running edge of the crossing it guards.

For low speed traffic the shock on engaging the guard rail is of little importance, but with high speed traffic dangerous conditions are set up if a sudden lateral displacement of the wheels is attempted. It is therefore necessary to provide a long flared entry to all guard rails used on high speed tracks to enable a gradual lateral displacement of the wheels before entering the 1¾" flangeways.

To guard the wheels from entering the gaps of the crossings and becoming derailed it is necessary that the parallel length of straight guard rail shall be longer than the gap of the crossing it is guarding.

The overall length of the guard rail when laid on crossover work is limited by the proximity of the adjacent crossing as shown in Fig. 107.

With 11'8" track centres, 5'3" gauge and crossings of standard Nos., the length of the guard rail is a minimum and the 10'0" guard rail is provided to meet this case when insulated joints are installed, as in compound crossovers. See Fig. 108.

The length of crossing guard rail in general use for 'V' crossings up to No. 9.73 is 11'3", which length provides a suitable rate of entry flare and sufficient length of straight to guard standard No. 'V' crossings.

For 'V' crossings over No. 9.73 a 15'0" guard rail is now provided and this has an easier rate of flare more suitable to maintain speed line conditions.

Two types of 22'6" crossing guard rails are now made, one being intended for Spring 'V' Crossings which are usually associated with speed line conditions and require an easy flared guard rail.

The other type of 22'6" guard rail is used with Delta Crossings and has a long straight portion in the centre to cover guard the two crossing gaps in the Delta Crossing. Delta crossings are not suitable speed line trackwork structures, and the necessity for easy flared guard rails with Delta crossings does not therefore arise.

As the guard rail forms an obstruction within the gauge and may catch the ends of lashings, tow lines, etc., it is now the practice to bevel the ends as shown in Fig. 109. This practice is also adopted at the ends of crossing guard wings on the new crossings.

In some of the earlier trackwork layouts the closure rails were laid at 1 in 20 rail inclination, and the bases of the guard rails were not sheared, but overlaid the flange of the track rail. Guard rails of this type are unsuitable for modern trackwork layouts. See Fig. 110.

For many years the rails through trackwork layouts have been laid vertical and the flanges of guard rails are sheared to allow for adjustment.

GUARD RAIL ADJUSTMENT

The position of a guard rail in respect to its crossing is 5'1¼" from the running edge of the crossing for 5'3" gauge and 2'4¼" for 2'6" gauge no matter what the gauge of the track may be owing to widening on curves or lack of maintenance.

To enable the correct guard rail gauge to be maintained within practicable limits, adjustments are provided by ferrules or blocks in conjunction with guard rail bolts and respiking of the guard rails. Details of guard rail ferrules and blocks are shown in Table 14.104-14.105.

In the older guard rails 4 No. ⅛" flat washers were provided with the ferrules and adjustments were made by removing washers. The new standard guard rails used in 94 and 107 lb. trackwork are provided with adjustable blocks which enable several adjustments of ⅛" to be made by slackening off the guard rail bolts and moving the blocks to the next serration; this type of adjustable block is shown in Fig. 111.

With new rails 1¾" flangeway is established when the print marks are brought to alignment as in Fig. 111.

The guard rail end blocks in use in 90, 94, 107 and 110 lb. trackwork are of the type shown in Fig. 112, and are non-adjustable, consequently the guard rail has to be sprung towards the track rail when making adjustments.

To reduce the tendency to pull the track rail out of alignment when adjusting the guard rail, an excess of set is given to the new guard rails and when first installed it is necessary to pull the ends of the guard rails up to contact with the end blocks by means of the guard rail end bolts. When the guard rail is first installed the track rail is pushed over against the outside dogspikes and subsequent adjustments reduce this pressure until the limit of adjustment has been reached.

The adjustment of the 22'6" guard rails at spring 'V' crossings is made in the same way, but guard rail gauge plates, Detail No. 1003, are installed to raise the track rails to the same surface as the spring 'V' crossings. Screw spikes and adjustable take-up buttons are provided in lieu of dog-spikes for the purpose of securing the guard rail to the crossing timbers, as shown in Fig. 113. See 14.131.

With standard guard rails the necessity for re-driving the dogspikes to follow up the guard rail adjustment considerably weakens the crossing timbers, and where frequent guard rail adjustments are necessary use is made of the screw spike and take-up button adjustment, but the guard rail gauge plates are not used at other than spring 'V' crossing locations.

MANUFACTURE

All standard guard rails are manufactured at workshops ready for installation in track and alterations from the standard are not permitted.

CHECK RAILS

Check rails are laid at 5'1$\frac{1}{4}$" from the outer rail of curved track to reduce the wear on the outer rail. In this position the backs of locomotive wheels come in contact with the check rail when the running face of the opposite wheel flange is just making contact with the running edge of the outer rail, as shown in Fig. 114.

At the ends of check rails the entry flare must be the same as at the ends of all guard rails, and this is accomplished by using a half guard rail as shown in Fig. 115. Half guard rails are readily cut from standard guard rails, or may be obtained on requisition ready for installation.

The practice of oxy-acetylene cutting the ends of standard rails for this purpose is not now permitted.

FLANGEWAYS

To permit of the free passage of long wheel base locomotive wheel flanges through flangeways on curves, it is necessary to widen the flangeways according to radii of the curves.

As the check rail gauge of 5'1$\frac{1}{4}$" must be maintained it is necessary to make the widening in the track gauge on the inner rail. If this precaution is omitted there will be binding of the locomotive wheels in the check rail flangeway with the tendency to mount or to plough out and overturn the inner rail of the curve.

FLANGEWAY COMBINATIONS

In curved trackwork the flangeways must be carefully arranged to provide the necessary freedom of movement of long wheel base locomotives while affording the intended protection to the trackwork.

Combinations of crossing and guard rail flangeways have the same effect as double check rails on curved track. See 18.19, Fig. 3. Curvature of track adjacent to the flangeways may also cause binding of locomotive wheels. These factors are taken into account in the design of new layouts, but trackmen should study the conditions with a view to subsequent maintenance.

Insufficient widening of the gauge of track combined with incorrect adjustment of the guard rails and check rails will result in undue wear of rail parts, therefore the effect of intended adjustments should be carefully considered before the adjustments are made.

For locomotive reasons continuous flangeways on the outer rail require to be wider than flangeways on the inner rail as shown in Fig. 116. See 3.18.

Summarised the conditions to be maintained are : -

1. 5'1¼" between a crossing guard rail and the running edge of its crossing on 5'3" gauge track.

2. 2'4¼" between a crossing guard rail and the running edge of its crossing on 2'6" gauge track.

3. 4'11½" between the flared end of a guard rail and the running edge of the opposite rail on 5'3" gauge track.

4. 2'2½" between the flared end of a guard rail and the running edge of the opposite rail on 2'6" gauge track.

5. 4'11½" between the guard edges of crossing wing rails or guard rails when these occur opposite each other in curved trackwork on 5'3" gauge track.

6. 2'2½" between the guard edges of crossing wing rails or guard rails when these occur opposite each other in curved trackwork on 2'6" gauge track.

And because of these requirements crossings must be provided with suitable wider flangeways according to radii of curved trackwork. When however the widening of crossing flangeways is such that for the given No. of the crossing the lateral position of the wheel tread is too far over for proper wheel tread transfer special floored crossings are required. See 14.088, Fig. 83.

EXTENT OF GAUGE WIDENING

Widening of gauge is applied to curves of 10 chains radius and under, and since check rails and continuous guard rails are usually associated with such curves, the widening of gauge table is set out below.

Lines of 5'3" Gauge		
Radius in Chains	Extra width of Gauge	Gauge of track
6 and under	½"	5'3½"
Over 6 to 7	⅜"	5'3⅜"
" 7 to 8	¼"	5'3¼"
" 8 to 10	⅛"	5'3⅛"
" 10	Nil	5'3"

Lines of 2'6" Gauge		
Radius in Chains	Extra width of Gauge	Gauge of track
6 and under	¼"	2'6¼"
Over 6	Nil	2'6"

The above table conforms with present practice, but future developments in locomotive design may modify these particulars.

GUARD RAIL FERRULES AND BLOCKS

WEIGHT and CLASS	TYPE	LENGTHS OF FERRULES: SHORT	LENGTHS OF FERRULES: INTER-MEDIATE	LENGTHS OF FERRULES: LONG	FLAT WASHERS SUPPLIED
60 lb. C.	1880	$3\frac{1}{4}''$	-	-	Nil
50 lb. A.	1885	$3\frac{1}{8}''$	-	-	"
50 lb. B.	"	$3\frac{1}{2}''$	-	-	"
66 lb. E.	"	$3\frac{1}{2}''$	-	-	"
66 lb. F.	"	$3\frac{5}{8}''$	-	-	"
75 lb. H.	"	$3\frac{3}{4}''$	-	-	"
75 lb. I.	"	4"	-	-	"
60 lb. D.	1910	$2\frac{15}{16}''$	-	$3\frac{1}{2}''$	4 No. per Ferrule
60 lb. A.S.	1921	$3\frac{3}{8}''$	-	$4\frac{3}{8}''$	" " "
	1922	"	-	"	" " "
	1924	"	-	"	" " "
	1935	$3\frac{5}{16}''$	-	* $5\frac{19}{32}''$	" " short Ferrule
80 lb. O.	1899	$4\frac{9}{32}''$	-	-	Nil
	1910	$3\frac{1}{2}''$	-	$4\frac{1}{16}''$	4 No. per Ferrule
100 lb. P.	1899	$4\frac{9}{32}''$	-	-	Nil
	1910	$3\frac{11}{16}''$	-	$4\frac{1}{4}''$	4 No. per Ferrule
80 lb. A.S.	1910	$3\frac{1}{2}''$	-	$4\frac{1}{16}''$	" " "
	1923	"	-	$5\frac{7}{16}''$	" " short Ferrule
	1924	"	-	$4\frac{17}{32}''$	" " Ferrule

Continued on 14.105

1924	"	–	$4\frac{17}{32}$"	" " Ferrule

Continued on 14.105

GUARD RAIL FERRULES AND BLOCKS. (cont).

WEIGHT and CLASS	TYPE	LENGTHS OF FERRULES SHORT	INTER-MEDIATE	LONG	FLAT WASHERS SUPPLIED
100 lb.A.S	1910	$3\frac{11}{16}$"	–	$4\frac{1}{4}$"	4 No. per Ferrule
	1923	"	–	$5\frac{5}{8}$"	" " " short Ferrule
	1924	"	–	$4\frac{23}{32}$"	" " " Ferrule
90 lb.A.S	1924	$3\frac{7}{16}$"	–	$4\frac{15}{32}$"	" " " "
	1930 (9'0") (11'3")	"	$3\frac{17}{32}$"	$4\frac{23}{32}$"	" " " "
	1930 (22'6")	"	–	$4\frac{5}{8}$"	" " " "
	1935	"	–	* $5\frac{23}{32}$"	" " " short Ferrule
110 lb.A.S	1924	$3\frac{5}{8}$"	–	$4\frac{21}{32}$"	" " " Ferrule
	1930 (9'0") (11'3")	"	$3\frac{3}{4}$"	$4\frac{15}{16}$"	" " " "
	1930 (22'6")	"	–	$4\frac{27}{32}$"	" " " "
	1935	"	–	* $5\frac{29}{32}$"	" " " short Ferrule
§ (94 lb.A.S) (107 lb.A.S)	1940	Adjusting block	Splayed block	End block	Nil

* Splayed end blocks (Not branded with weight of rail)
§ All 94 & 107 lb. A.S. Blocks are branded 94 or 107 for identification.
Note: - Lengths of Ferrules shown are measured at top of Ferrule and over the centre line of the bolt hole.

DETAILS OF GUARD RAILS						
TYPE	WEIGHT & CLASS	LENGTHS	No. of FERRULES or BLOCKS	END OPENING	FLARE OPENING	INCLINATION of RUNNING RAIL
1880	60 lb. C	10'0" 11'6"	2 2	- -	$2\frac{1}{4}$" "	1 in 20* " " *
1885	50 lb. A&B 66 lb. E&F 75 lb. H&I	10'0" 11'6"	2 2	- -	" "	" " " "
1899	80 lb. O 100 lb. P	11'0" 21'0"	3 5	- -	" "	" " " "
1910	60 lb. D 80 lb. O & A.S. 100 lb. P&A.S.	11'0" 21'0"	5 8	$3\frac{1}{2}$" "	$2\frac{1}{2}$" "	" " " "
1921	60 lb. A.S.	11'0" 21'0"	5 8	$4\frac{1}{2}$" "	$3\frac{1}{8}$" "	" " " "
1922	60 lb. A.S.	11'0" 21'0"	5 8	- -	$3\frac{1}{8}$" "	" " " "
1923	80&100 lb. A.S.	11'0" 21'0"	5 8	- -	$3\frac{1}{2}$" "	" " " "
1924	60,80,90,100 & 110 lb. A.S.	12'0" 22'0"	5 8	" "	$3\frac{1}{8}$" "	" " " "
1930	90&110 lb A.S.	11'3" 22'6"	5 8	" "	" "	Vertical "
1935	60, 90 & 110 lb. A.S.	11'3" 22'6"	5 8	- -	$3\frac{3}{4}$" "	" "
1940	94&107 lb. A.S. (Delta)	10'0" 11'3" 15'0" 22'6" 22'6"	4 4 6 7 8	- - $3\frac{1}{2}$" " -	$3\frac{1}{2}$" " $2\frac{3}{8}$" " $3\frac{1}{2}$"	" " " " "

* Type 1880. Guard Rails are also inclined at 1 in 20.

See Fig. 106.

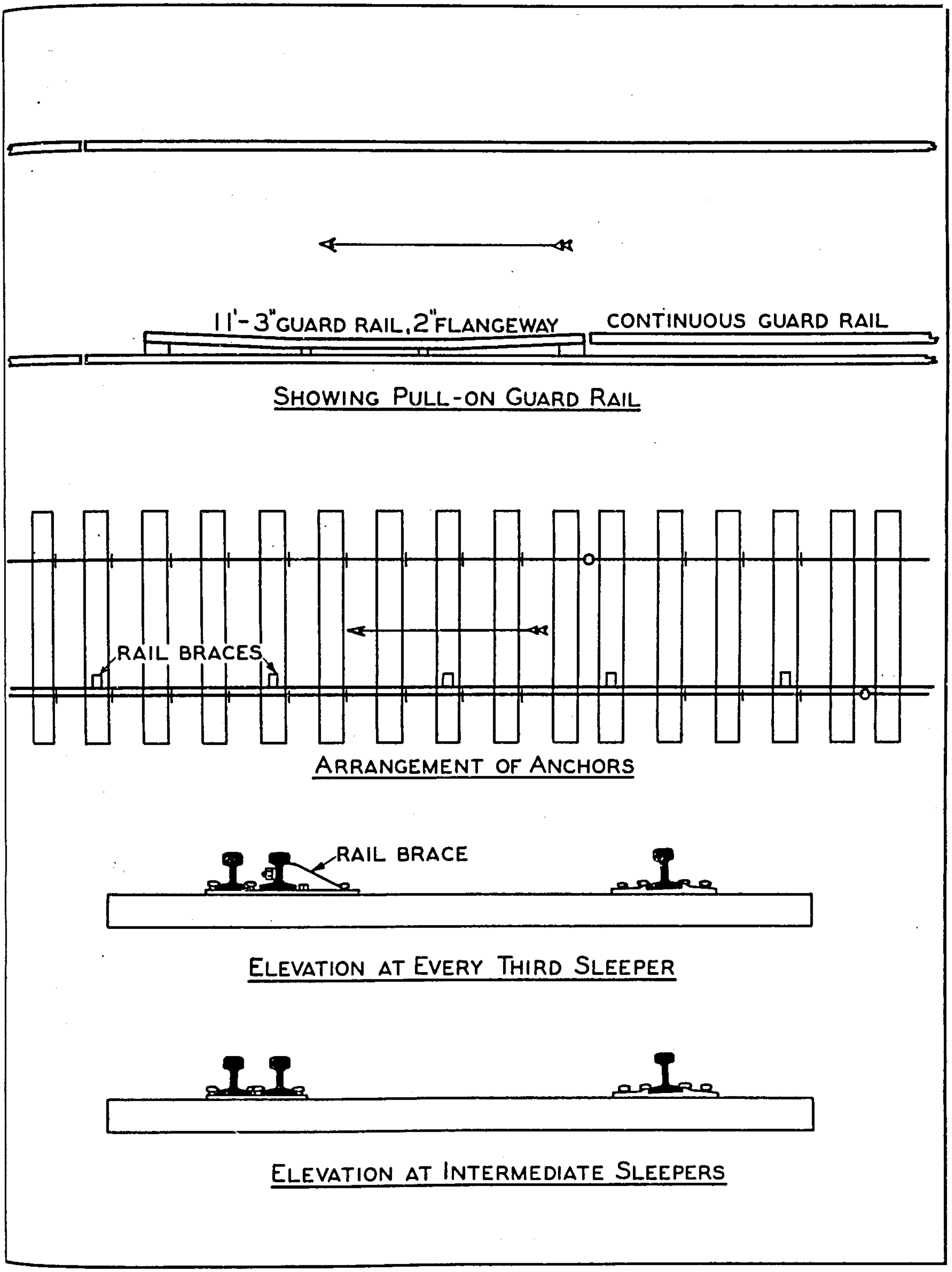


FIG. 105. CONTINUOUS GUARD RAIL ARRANGEMENT. FLINDERS ST. VIADUCT.

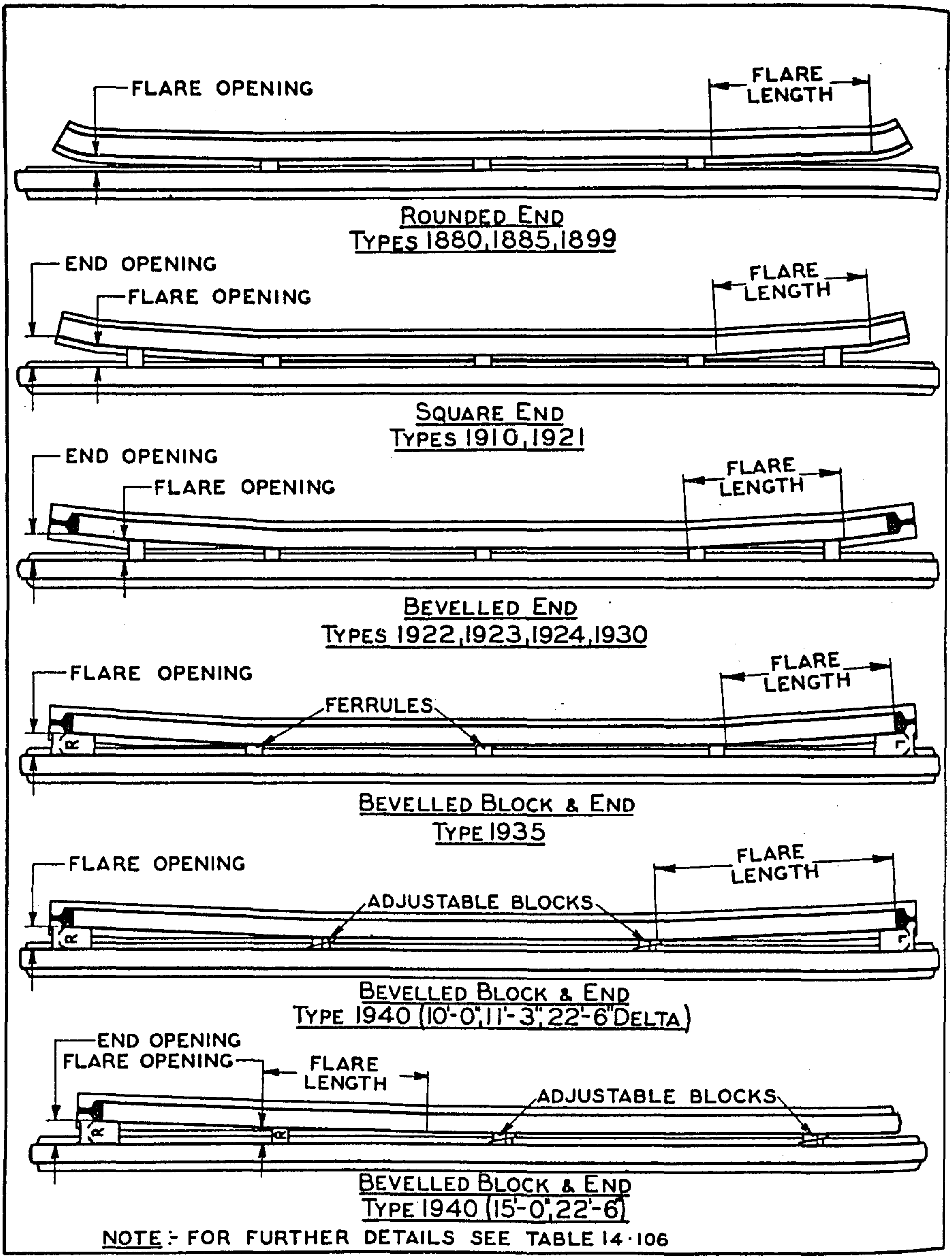


FIG. 106. STANDARD GUARD RAILS.

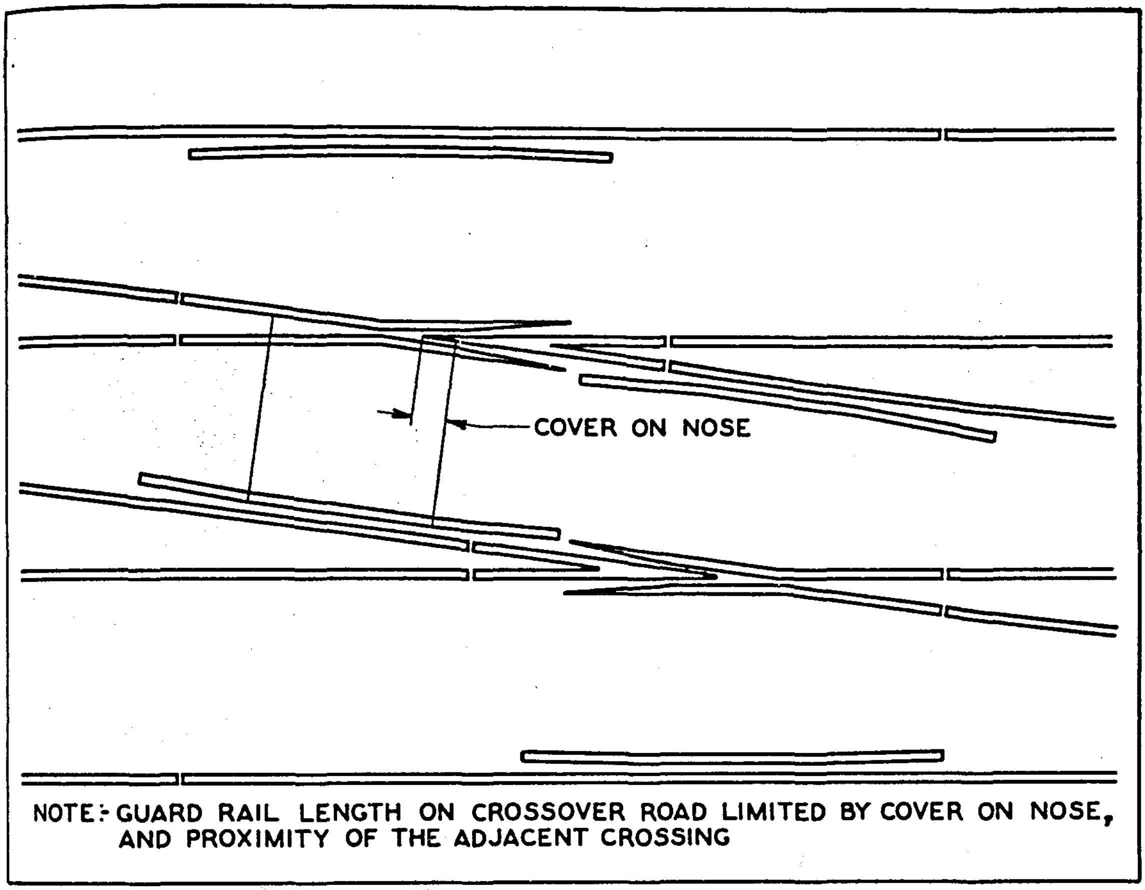


FIG. 107. OVERALL LENGTH OF GUARD RAIL LIMITED IN CROSSOVERS.

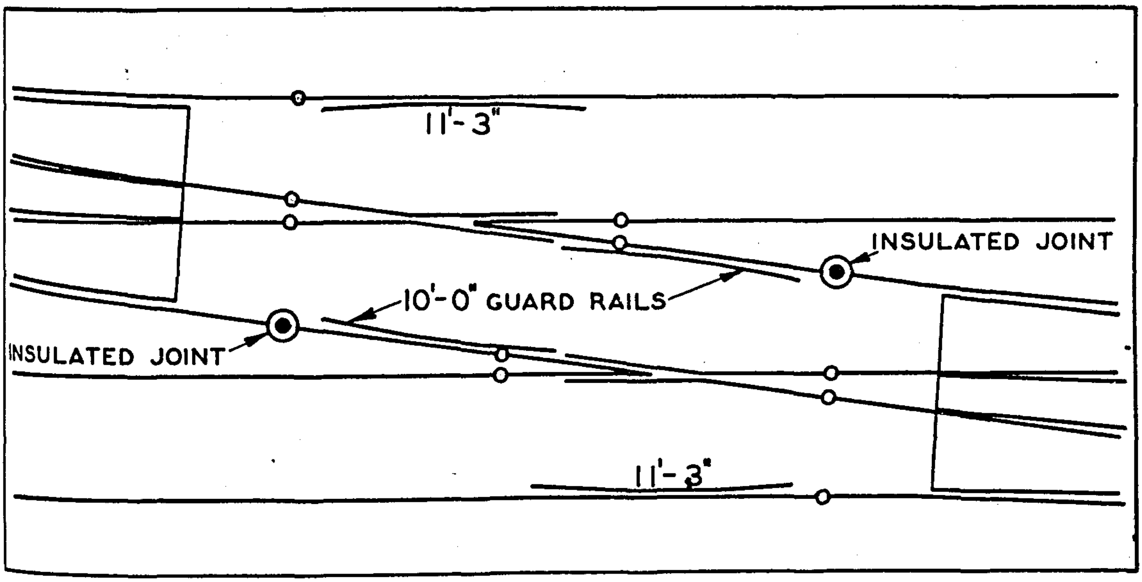


FIG. 108. USE OF 10'-0" GUARD RAILS, COMPOUND CROSSOVER.

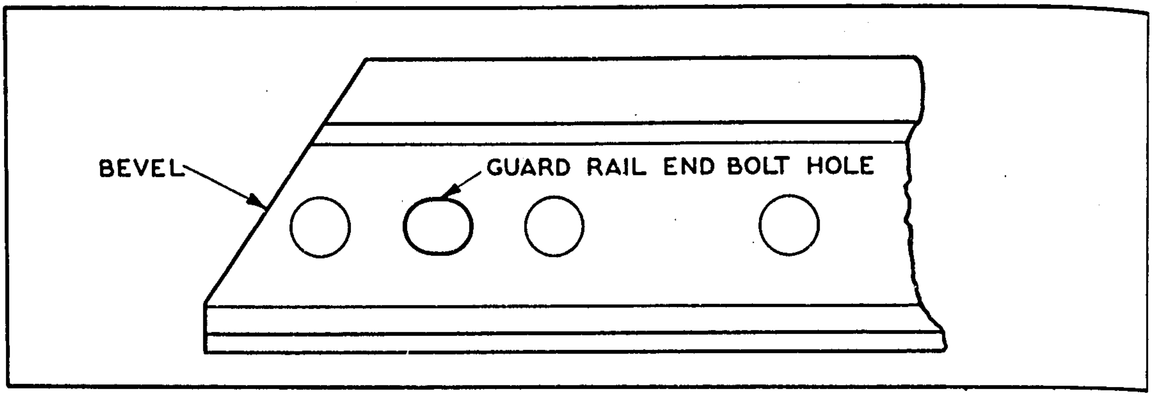


Fig. 109. Bevelled End of Guard Rail.

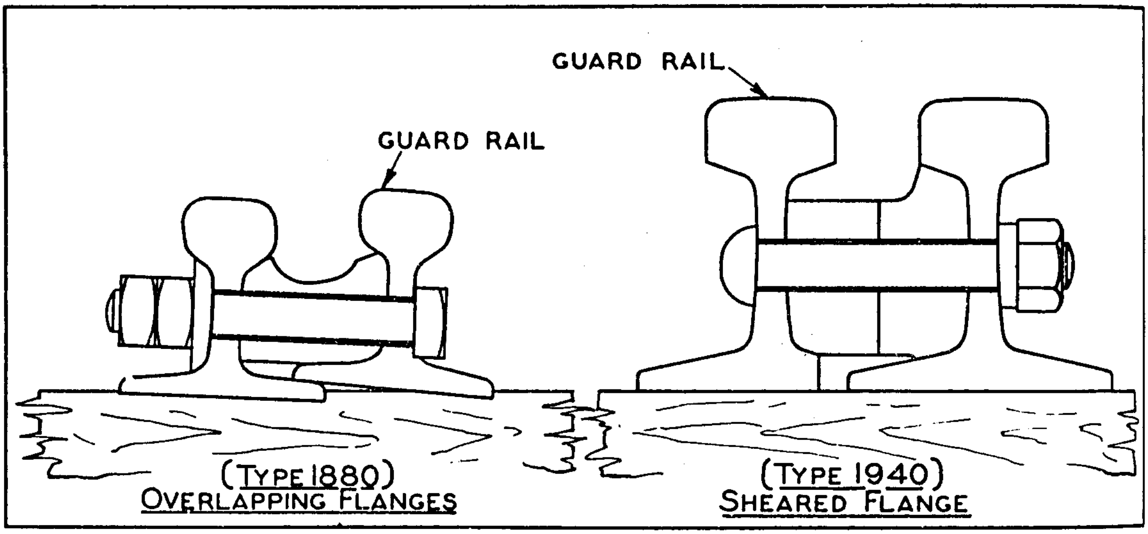


Fig. 110. Arrangement of Guard Rail Flanges.

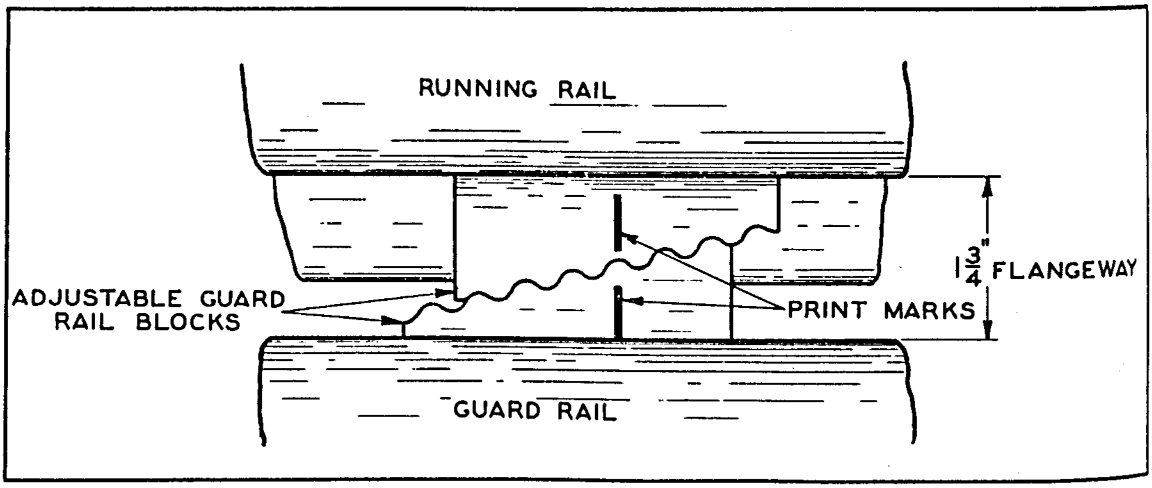


Fig. 111. Adjustable Guard Rail Blocks.

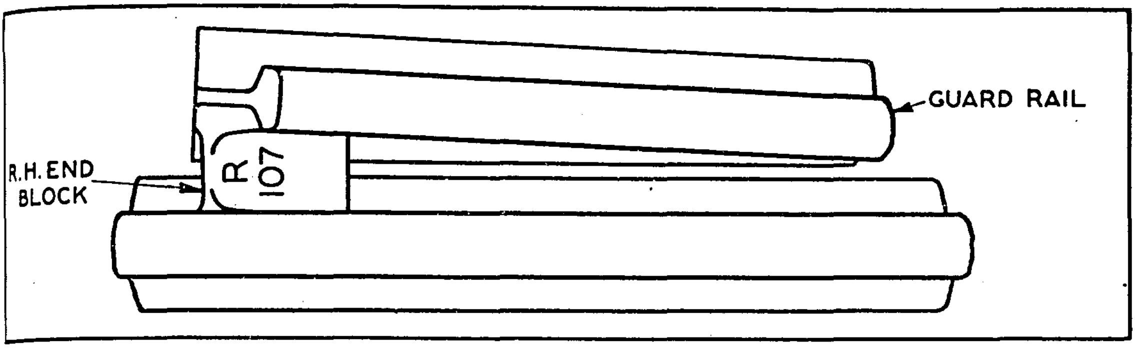


FIG. 112. GUARD RAIL END BLOCK.

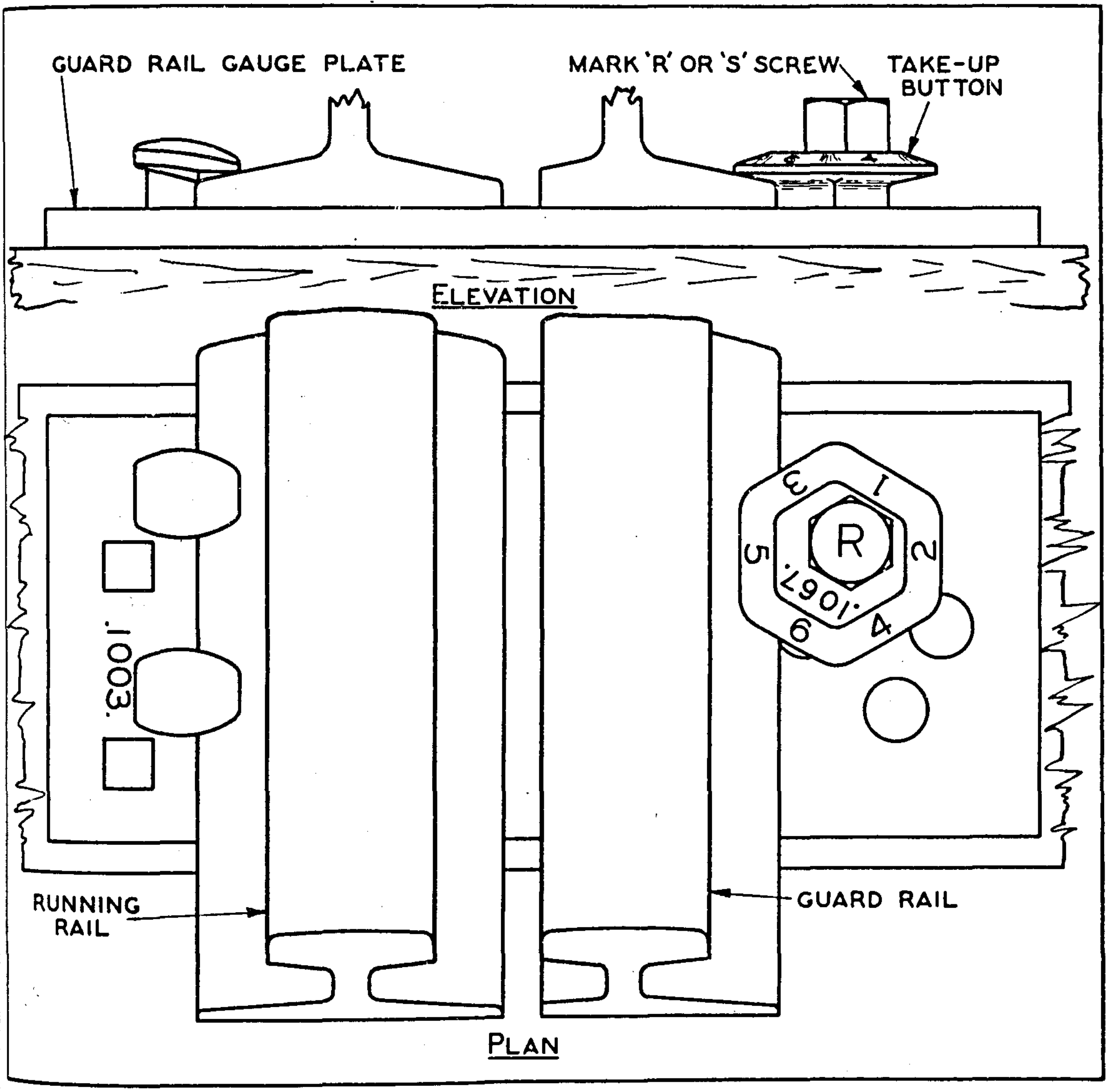


FIG. 113. APPLICATION OF TAKE-UP BUTTON, OPPOSITE SPRING CROSSING.

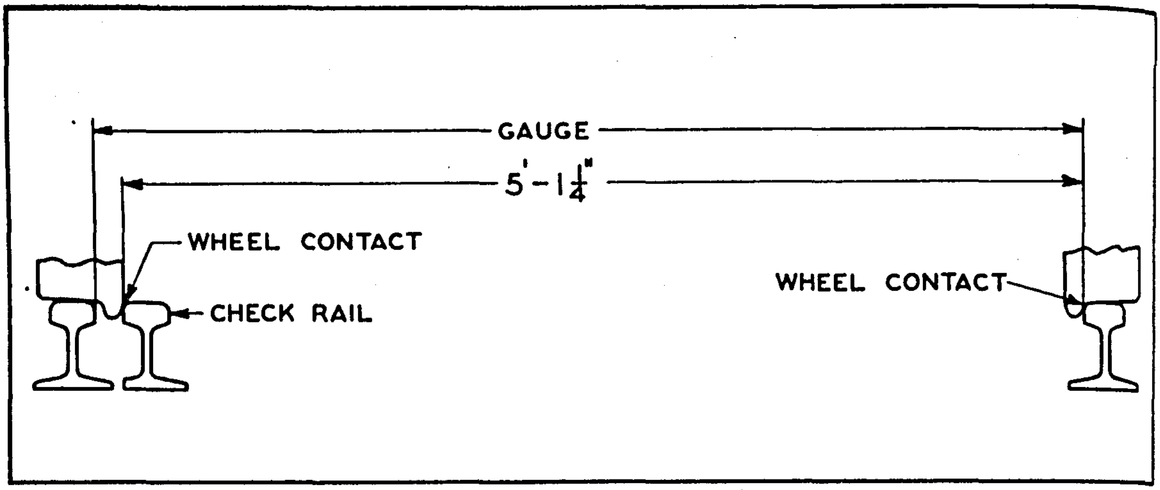


FIG. 114. CORRECT RELATIONSHIP OF WHEELS TO OUTER RAIL ON CURVES.

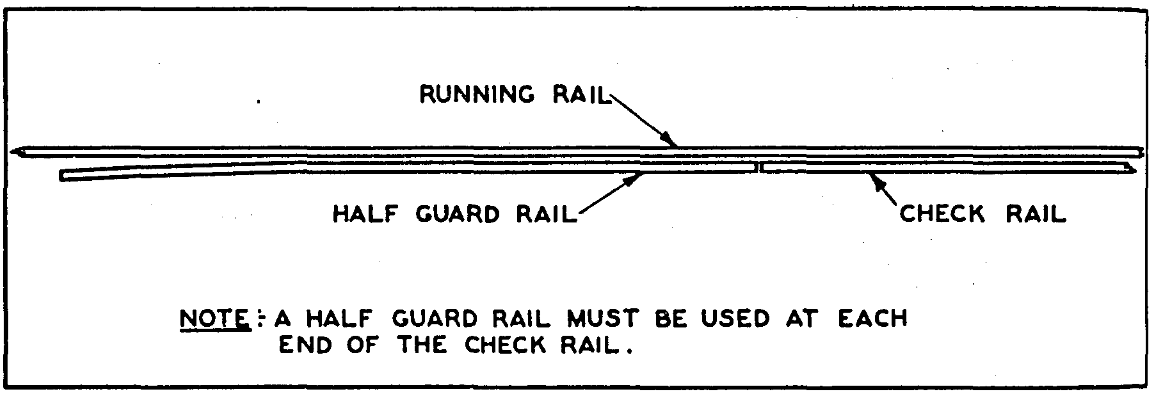


FIG. 115. HALF GUARD RAIL AT END OF CHECK RAIL.

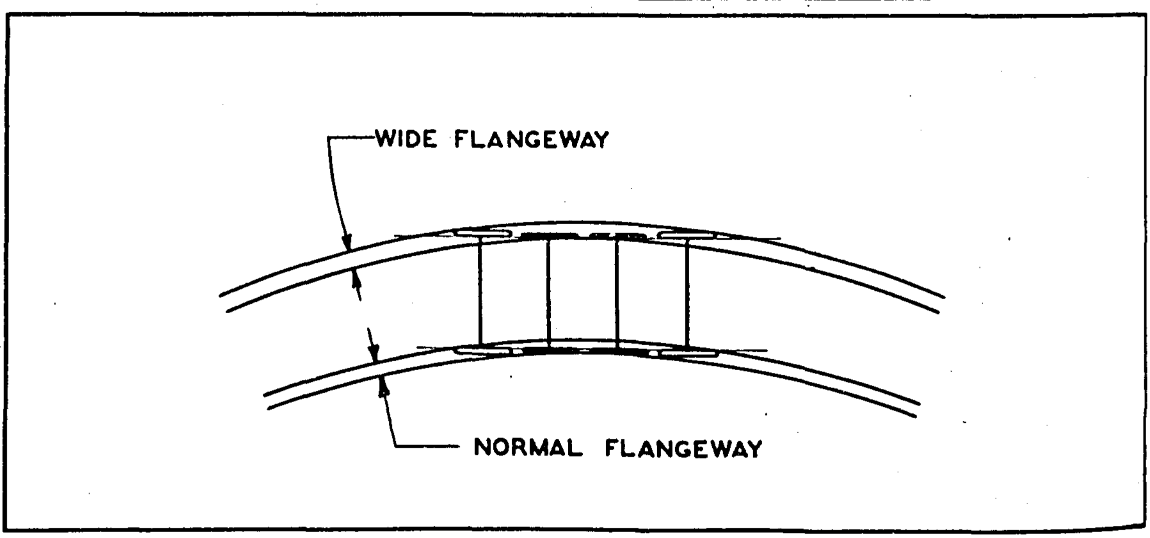


FIG. 116. WIDENING OF FLANGEWAY ON OUTER RAIL.

PLATE DETAILS

DETAIL NO. SYSTEM

When a large number of different types of fastenings are dealt with, some of which have more than one use, it is confusing if names are used for description. To enable absolute identification and a ready means of showing on small scale plans the type and position of fastenings to be used, a detail No. system was introduced in 1940. The basis of the detail No. system is a three figure numeral commencing with No. 001.

As additional fastenings are standardised the next number in sequence is allotted, thus 002, 003, and so on up to 999. The system therefore provides in the first place for the identification of 999 distinctly different fastenings.

It is however frequently necessary in plate work to provide some plate of the form of an existing standard, but of special thickness. To distinguish between plates of different thickness but of the same form, an additional numeral is prefixed to the series, thus 1001, 2001, 3001, etc.

The application of this system will be clear from Table 14.116. Additional types of sleeper plates are constantly being developed to meet trackwork requirements,but those listed are at present standardised.

SLEEPER PLATES FLAT

Various flat sleeper plates are required in the different layouts according to purpose and weight of rail; those in use at present are itemised in Table 14.116, and illustrated in Figs. 117, 120, 121, 122, 123, 124 & 125.

CROSSING PLATES

Where insulated joints cannot be avoided at the ends of crossings it is not always possible to install the standard flat sleeper plates in these positions owing to the different crossing Nos. and rail sections. In these cases crossing plates are provided and stamped with a detail No. for identification. See Fig. 117.

LUG PLATES

In locations where two rails closely approach at the heels of points and the heels of crossings etc., insufficient room exists for the installation of separate sleeper plates. For these locations lug plates are provided as shown in Figs. 118 and 119.

When the rails are at different elevations as in the case of the stock rail and closure rail at the heel of points, it is necessary to provide a step on the lug plates to properly support the closure rail. Lug plates step are shown in Fig. 118. The flat lug plates and lug plates for check rails are shown in Fig. 119. All are stamped with detail Nos. for identification.

The use of lug plates enables a wide range of conditions to be plated with one common forging, and the addition of the step thereby greatly reduces the work of manufacture and the quantity of plates required to be held in stock. A width of 5" has been adopted for lug plates in anticipation of a possible future use of 10" width timbers in trackwork layouts.

To avoid pinning too close to the edge of the timbers, two sets of pin holes are provided, and for use with both 94 and 107 lb. rails two spike holes in the suitable positions are also provided. The arrangement of the lug plates differs for the two weights of rail as shown in Figs. 118 & 119.

<u>CRANK STAND BASE PLATES</u>

Crank Stand Base Plates, Fig. 126, are used to mount the cranks and stands in suitable positions in relation to point timbers and at the required height in relation to the pull rods and lever rods when arranged as shown in 16.19, Fig. 16.

<u>TIE PLATES</u>

Maintenance of correct gauge at the toes of points is vital in the case of interlocked, motor operated and detected point layouts. To provide a means of permanently holding the points to correct gauge, tie plates are installed at the toes of the switches.

Tie plates were first installed in connection with the electrification of the suburban railways, and it was then the practice to use three tie plates as shown in Figs. 127 & 128.

Since 1926 only the toe tie plate or No. 2 tie plate has been used in new installations, and when No. 1 and No.3 tie plates are released in the course of maintenance renewals, they are altered at workshops to provide additional No.2 tie plates.

As originally made all tie plates were right or left-hand according to the hand of the points. Since 1933 the holes for the chair screws have been elongated which enables the tie plates to be used for either hand of the points.

At the ends of tie plates, screw adjustments are provided for the correct initial setting of the gauge. Exceptions occur in compounds and some modified three-throw layouts where insufficient room exists for the adjusting screws.

FORGED TIE PLATES

The new tie plates and rail braces are common to 94 and 107 lb. points. The radial back brace enables use with all lengths of switches and all stock rail settings from full right-hand to full left-hand. See Figs. 129 & 130.

The turnout tie plate assembly consists of two similar units insulated and bolted at the centre of the gauge with adjusting shims for initial gauge adjustment. Insulations are provided and installed by the Signal Division.

A raised slide surface is forged on the tie plate during manufacture, and the switch and stock rail are seated directly on the tie plate without the use of toe slide chairs.

Special tie plates of similar design, but of different lengths are provided for Nos. 7.52 and 8.7 compounds; see Figs. 129 & 130. Tie plates for No. 9.73 compounds and other special layouts will be designed at a future date.

FORGED SLIDE CHAIRS

Slide chairs drop-forged from mild steel plate are now standard for 94 and 107 lb. points. These chairs, detail No. 1039 & 2039, shown in Figs. 131 & 132 are being used with all 22'6" switches, and will become general when the existing stock of cast iron chairs is exhausted. Special forged slide chairs, used with compounds, are itemised in Table 14.116.

FORGED RAIL CHAIRS

The forged rail chair, detail No. 1040, shown in Fig. 133, replaces dummy chairs in the new layouts equipped with forged slide chairs and tie plates, and at other locations where dummy chairs were formerly used.

HEADLOCKS

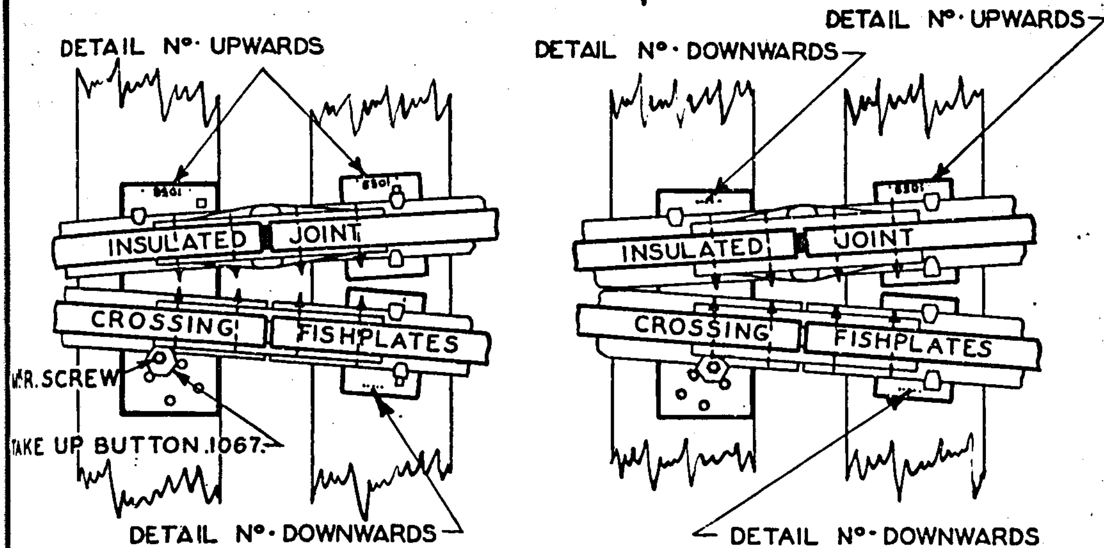
Headlocks are small plates punched with oval holes to take oval neck bolts and prevent them from turning; the plates fit between the rail fishing angles and obviate the filing out of field drilled holes. See Fig. 134.

GENERAL

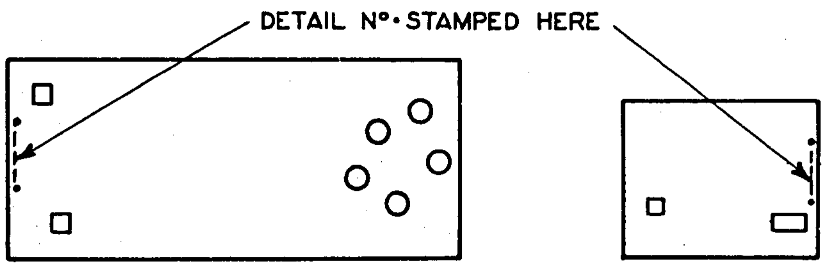
All new under rail plate details are being brought to 1" thickness as standard to enable rail seating to be maintained uniform without the use of special thickness plates or checking of timbers in layouts.

SLEEPER PLATES				
DETAIL NO. 94 lb 5" Flange	DETAIL NO. 107 lb $5\frac{3}{4}$" Flange	THICKNESS OF PLATE	USES	Fig Ref No.
1001 2001 3001	1002 2002 3002	$\frac{5}{8}$" 1" $\frac{3}{4}$"	Sleeper Plates, Flat " " " " " "	120 " "
1003	1003	$\frac{5}{8}$"	Guard Rail Gauge Plate	121
1004 2004	1005 2005	$\frac{5}{8}$" 1"	Sleeper Plate, Flat for Type 1939 Insulated Joint. " " " " "	122 "
1007	1008	$\frac{5}{8}$"	Check Rail Gauge Plate for Type 1939 Insulated Joint.	123
1010 2010 3010	1009 2009 3009	$\frac{1}{4}$" $\frac{3}{8}$" $\frac{1}{2}$"	Sleeper Plates (Packing) " " " " " "	124 " "
1058 1059 2058 2059	1058 1059 2058 2059	$\frac{5}{8}$" " 1" "	" " Flat, for Type 1939 Insulated Joints, Crossing Application.	117
1062 2062	1063 2063	$\frac{5}{8}$" 1"	Check Rail Gauge Plate " " "	125 "
1006 2006 3006 4006 5006 1057	1006 2006 3006 4006 5006 1057	1" " " " " "	Lug Plate, Flat " " Step (3/16") " " " " " " " (1/8") " " " " " " Flat, for Check Rails.	119 118 " " " 119

NOTE :- INSERT BOLTS THUS :- ↓



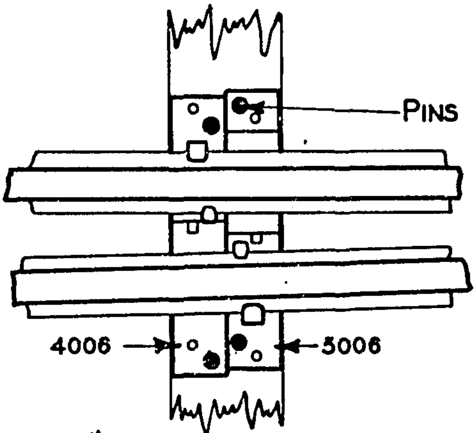
TYPICAL 80, 90, 94 LB. APPLICATION. TYPICAL 100, 107, 110 LB. APPLICATION.



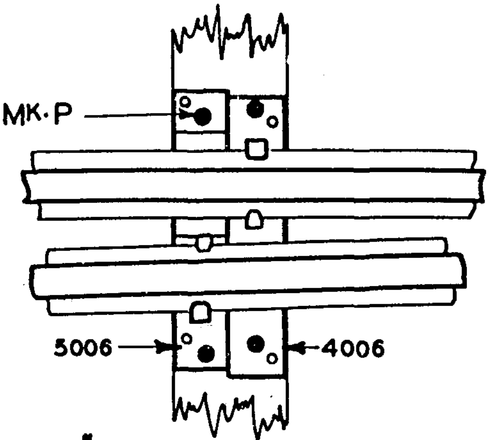
LONG PLATE SHORT PLATE.

THICKNESS OF PLATE.	DETAIL Nº·	
	LONG	SHORT
5/8"	.1058.	.1059.
1"	.2058.	.2059.

Fig. 117. SLEEPER PLATES FLAT FOR TYPE 1939 INSULATED JOINTS. CROSSING APPLICATION.

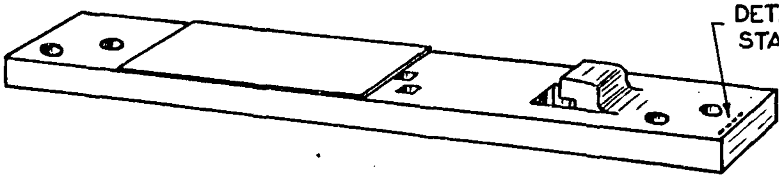


$\frac{1}{8}$" STEP ARRANGEMENT
94 LB.A.S.

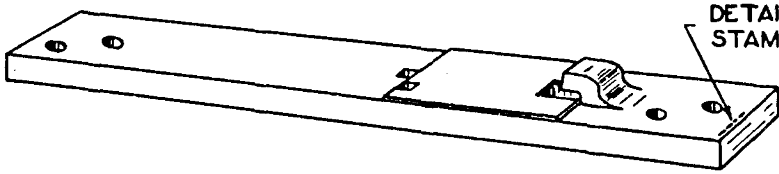


$\frac{1}{8}$" STEP ARRANGEMENT
107 LB.A.S.

FOR $\frac{3}{16}$" STEP ARRANGEMENTS USE DETAILS .2006. & .3006.



SIZE OF STEP PLATE.	BASE PLATE DETAIL No.	DETAIL No. OF WELDED ASSEMBLY
$8\frac{7}{8}$" x 5" x $\frac{3}{16}$"	.1006.	.3006.
$8\frac{7}{8}$" x 5" x $\frac{1}{8}$"	.1006.	.5006.



SIZE OF STEP PLATE	BASE PLATE DETAIL No.	DETAIL No. OF WELDED ASSEMBLY
$5\frac{3}{4}$" x 5" x $\frac{3}{16}$"	.1006.	2006.
$5\frac{3}{4}$" x 5" x $\frac{1}{8}$"	.1006.	.4006.

FIG. 118. LUG PLATES STEP.

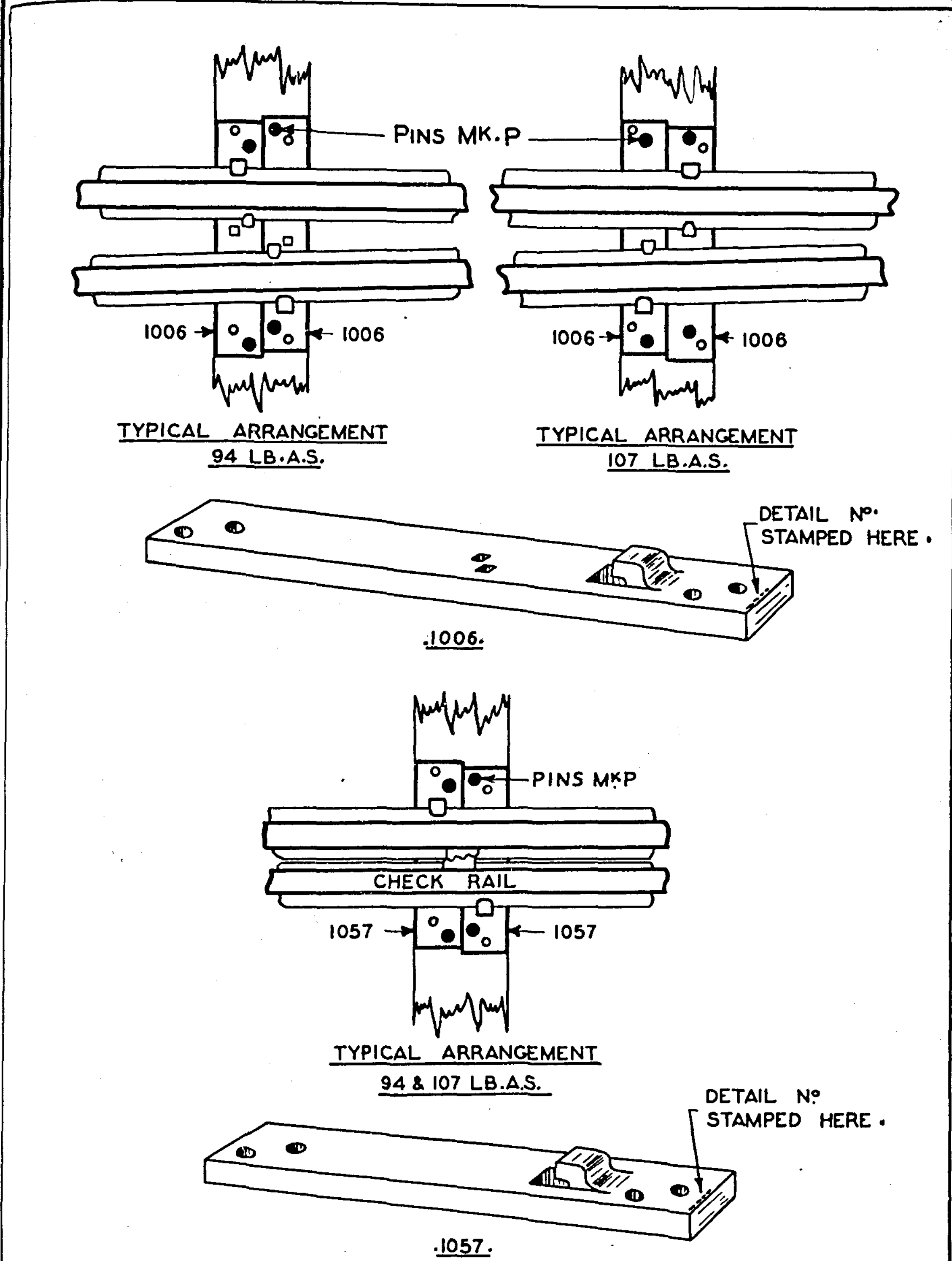
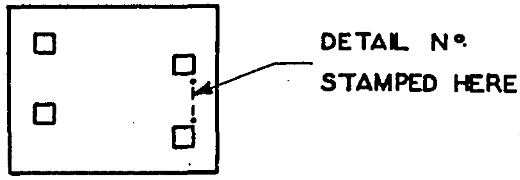


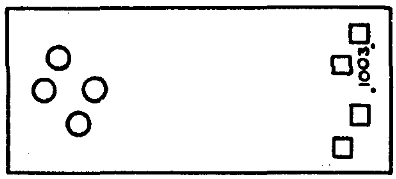
FIG.119. LUG PLATE FLAT AND LUG PLATE FOR CHECK RAILS.



FOR APPLICATION SEE .8·13. FIG. Nº 11.

SEE TABLE 14·116

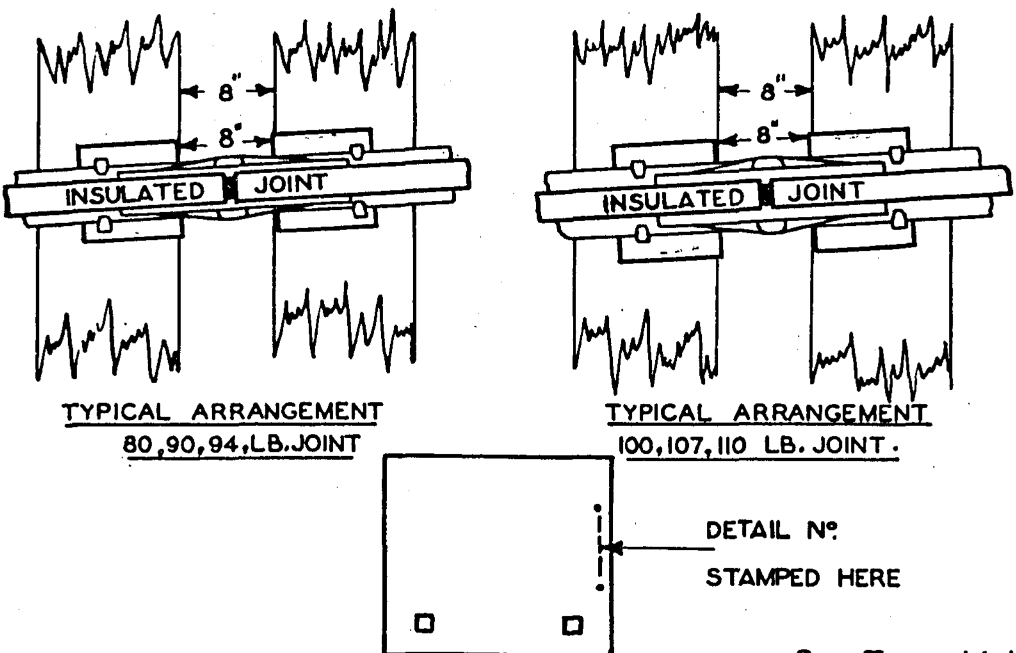
FIG. 120. SLEEPER PLATES. 001. AND 002. SERIES.



FOR APPLICATION SEE 14·111. FIG. Nº 113.

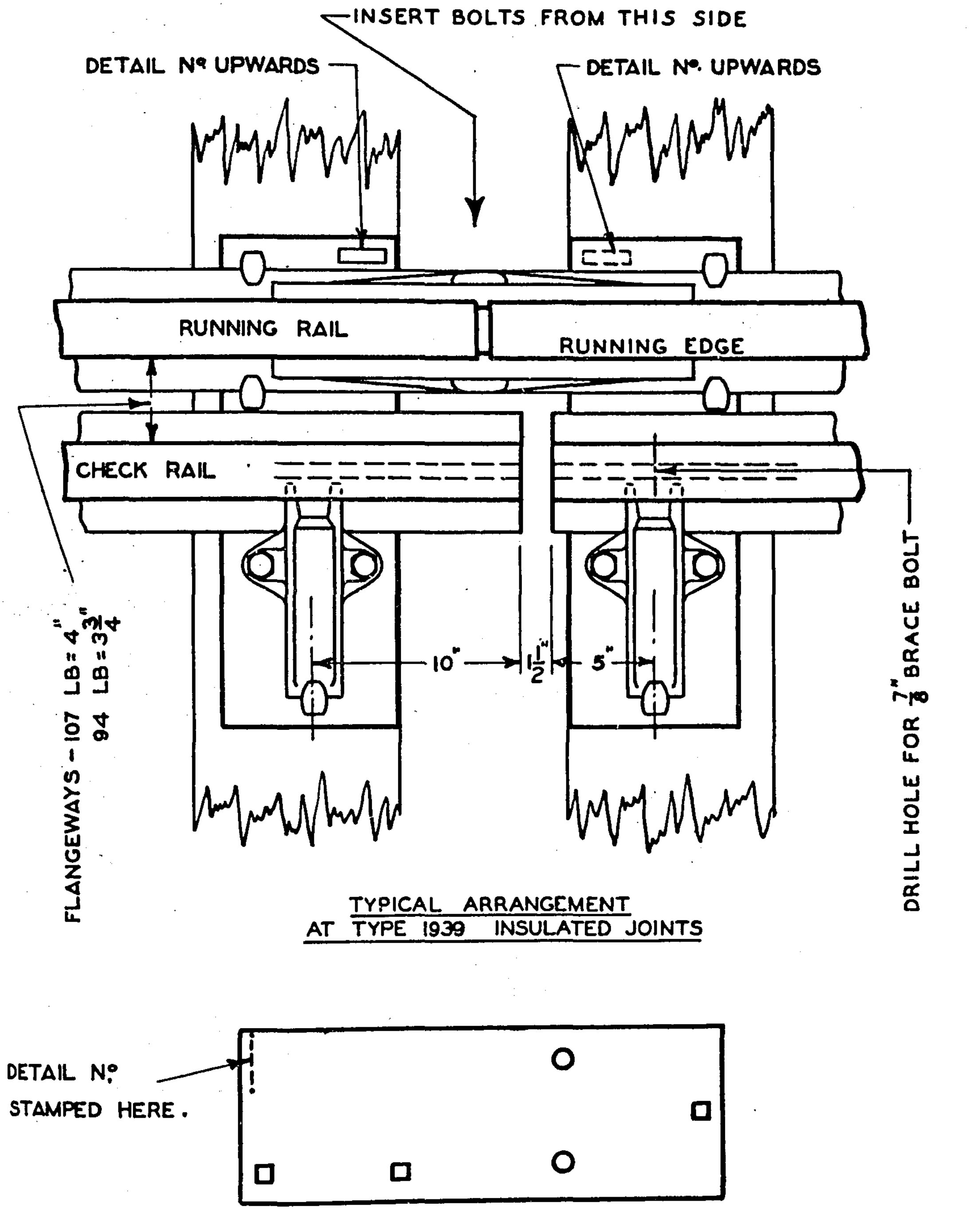
SEE TABLE 14·116

FIG. 121. GUARD RAIL GAUGE PLATE . 1003.



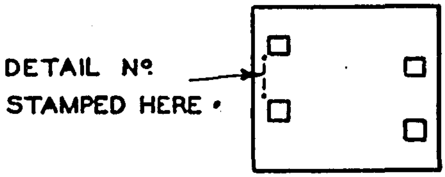
SEE TABLE 14·116

FIG. 122. SLEEPER PLATES FOR TYPE 1939 INSULATED JOINTS. 004. AND 005. SERIES.



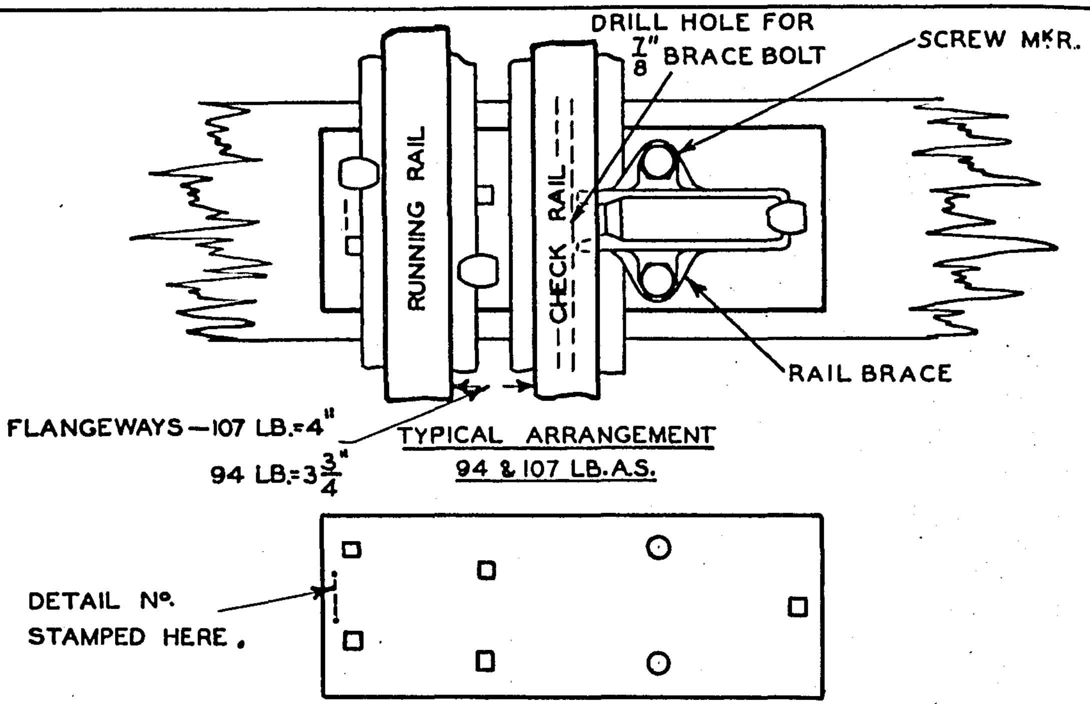
SEE TABLE 14·116

FIG. 123. CHECK RAIL GAUGE PLATES FOR TYPE 1939 INSULATED JOINTS. 1007. AND. 1008.



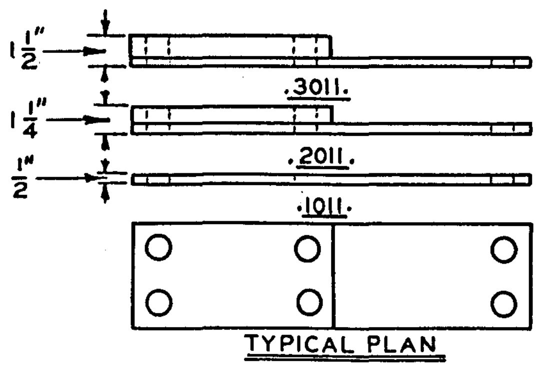
SEE TABLE 14·116

FIG.124. SLEEPER PACKING PLATES. 009. AND 010. SERIES.



SEE TABLE 14·116

FIG.125. CHECK RAIL GAUGE PLATE. 062.AND 063. SERIES.



FOR APPLICATION SEE 16·19. FIG Nº16.

FIG.126. CRANK STAND BASE PLATES.

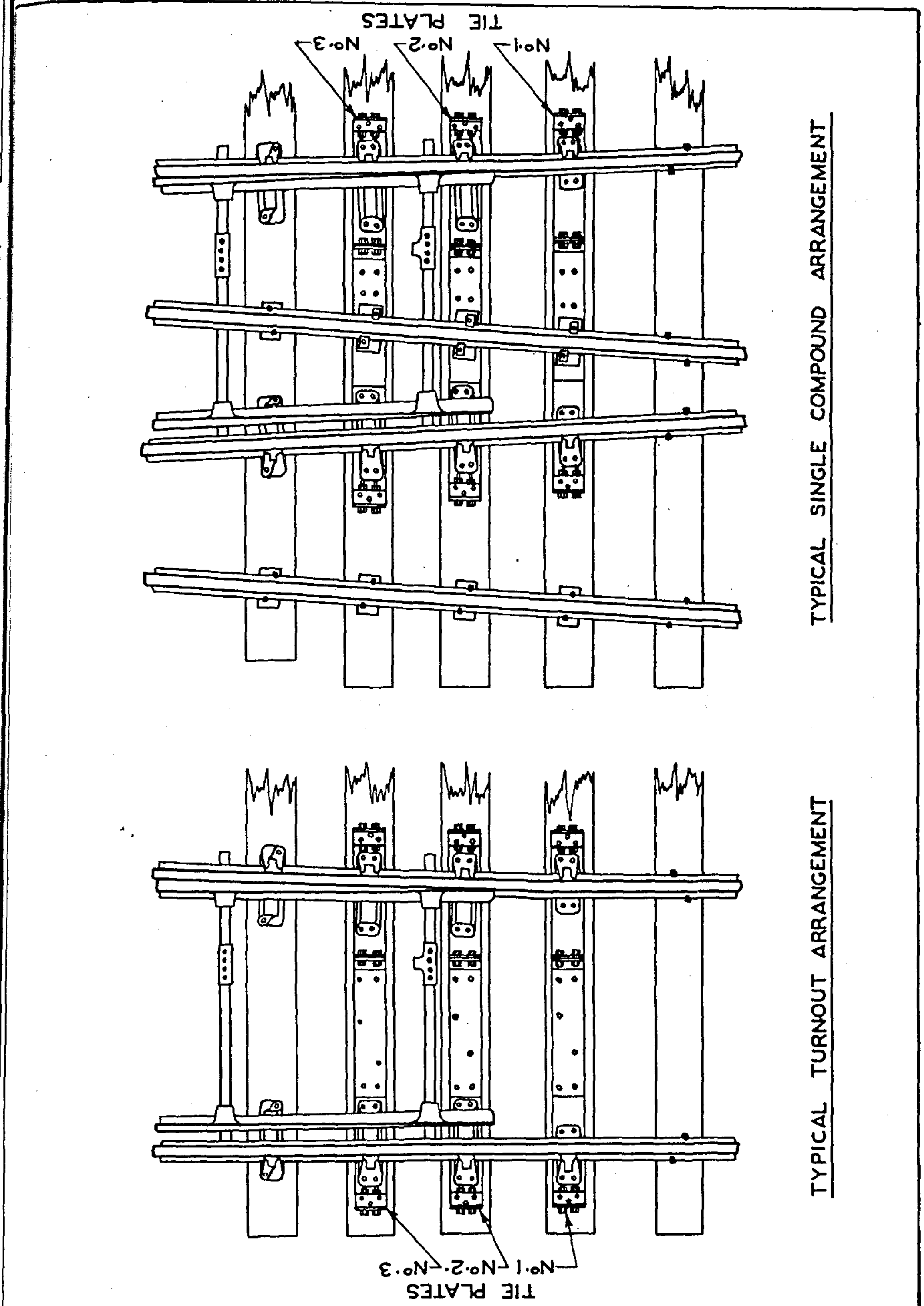


FIG. 127. OLD STANDARD TIE PLATES.

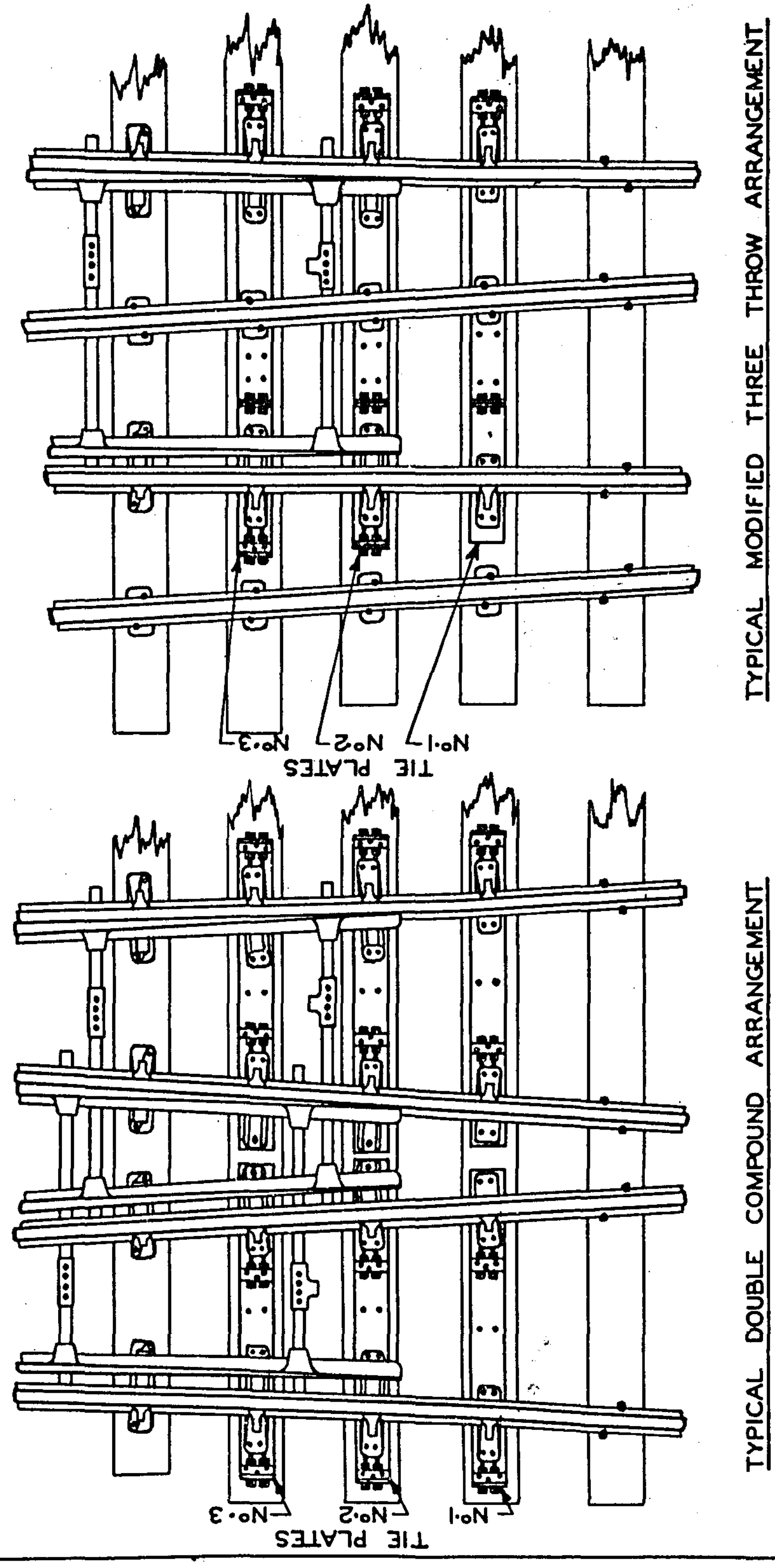


Fig. 128. Old Standard Tie Plates.

Fig. 128. Old Standard Tie Plates.

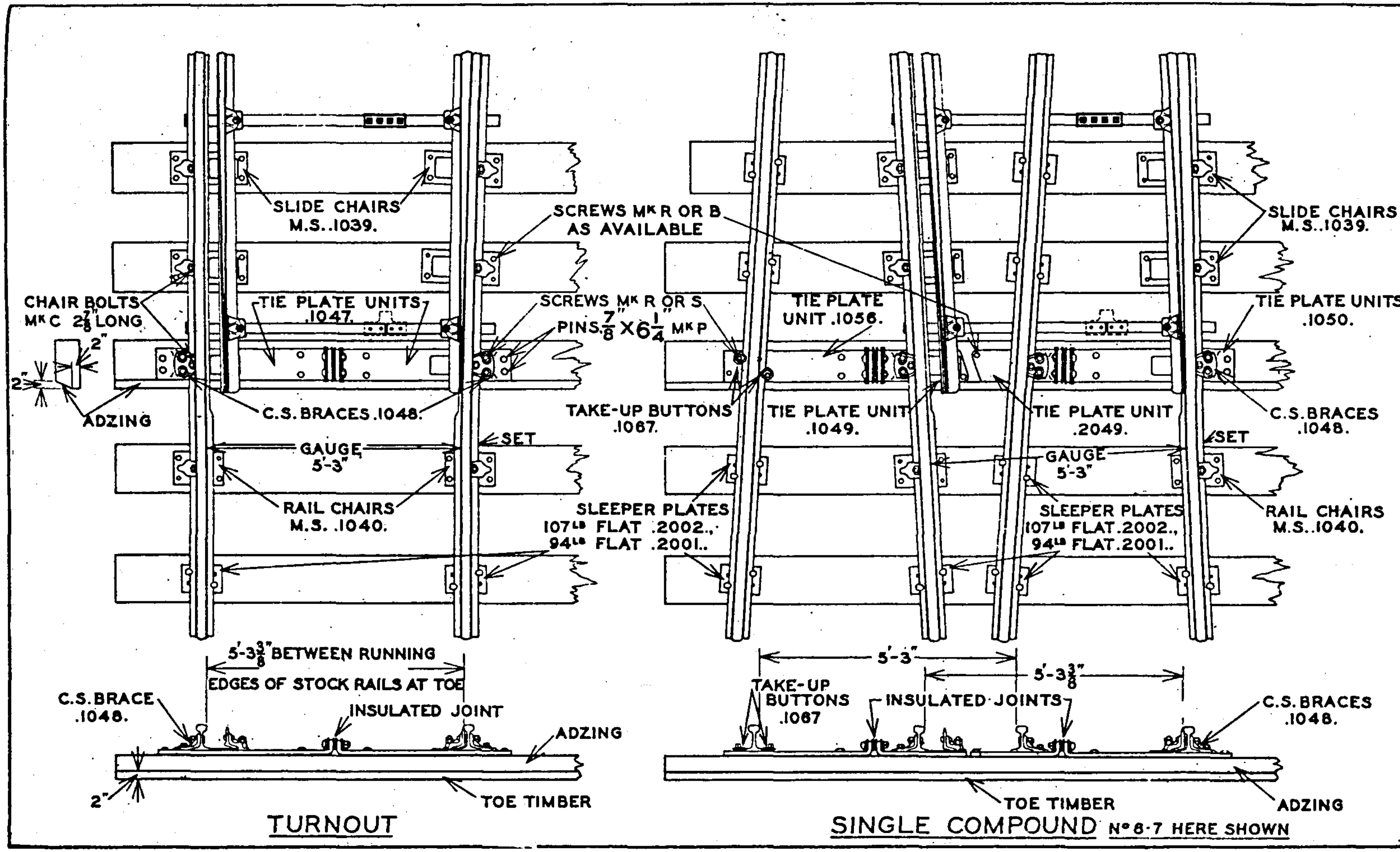
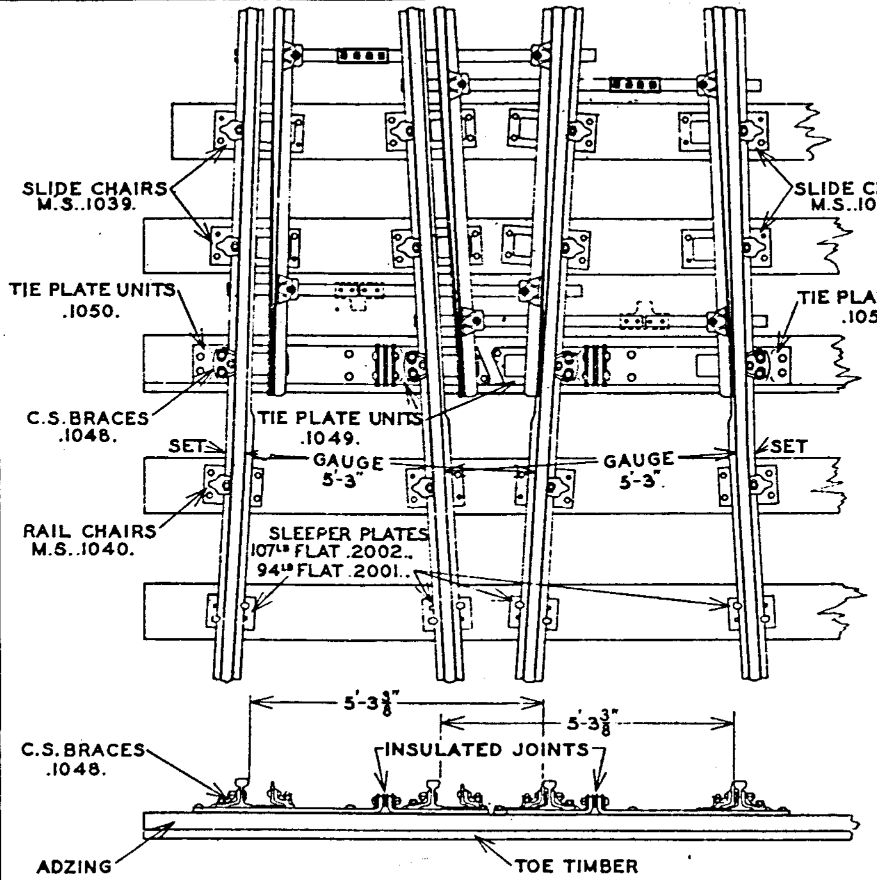


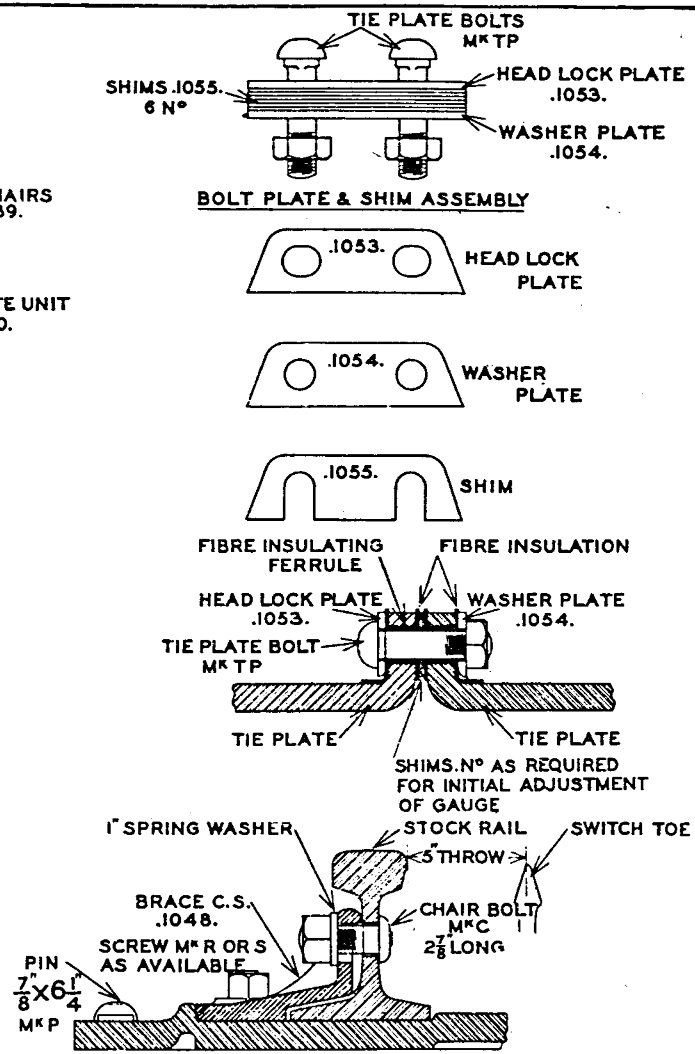
Fig. 129. Present Standard Tie Plates.



DOUBLE COMPOUND N° 8·7 HERE SHOWN

UNITS REQUIRED FOR EACH TIE PLATE ASSEMBLY				
TURNOUT	SINGLE COMPOUND		DOUBLE COMPOUND	
.1047. 2N° FOR ALL LENGTHS OF SWITCHES.	N° 7·52	.1047..1049..1056..2049.	N° 7·52	.1047. 2N°..1049.2N°
	N° 8·7	.1050..1049..1056..2049.	N° 8·7	.1050. 2N°..1049.2N°

UNITS LISTED UNDER SINGLE AND DOUBLE COMPOUNDS REFER ONLY TO ONE END OF THE COMPOUND.



BOLT PLATE AND SHIM ASSEMBLIES SUPPLIED SEPARATELY.

INSULATIONS SUPPLIED BY SIGNAL DIVISION. ONE SET (5F130) PER JOINT.

FIG. 130. PRESENT STANDARD TIE PLATES.

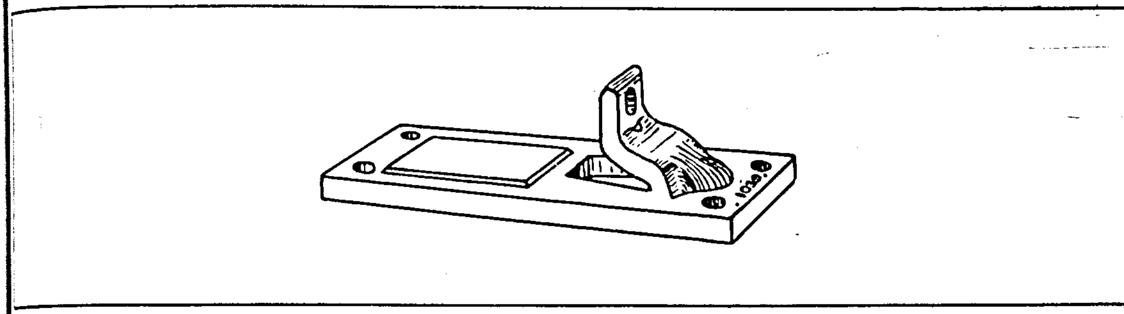


Fig. 131. Slide Chair. 1039.

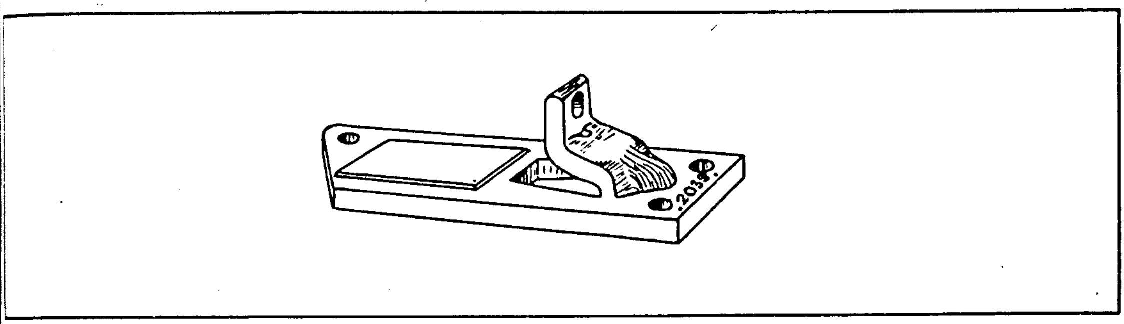


Fig. 132. Slide Chair. 2039.

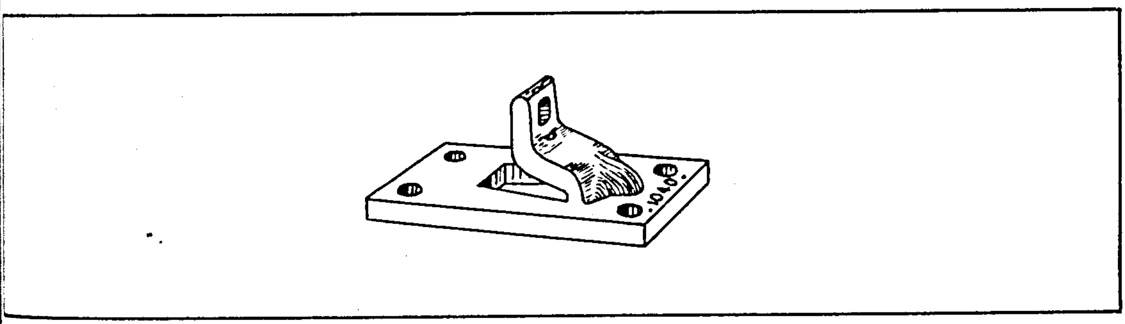


Fig. 133. Rail Chair. 1040.

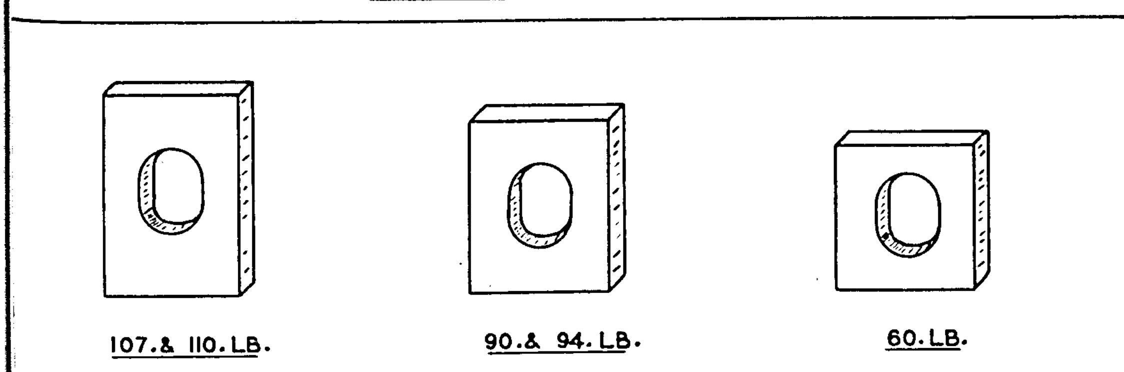


Fig. 134. Headlocks.

TRACKWORK FASTENINGS

SCREWS

To secure some of the trackwork details to the timbers in trackwork layouts, use is made of special screws. The type of screw in general use is shown in Fig. 135, and is supplied in 1 inch diameter and various lengths according to purpose. The head is hexagonal and of small size to fit in confined spaces and allow of box spanner clearance.

Letter marks are formed in raised characters on the heads of the screws to distinguish them in the driven position and indicate the manner of driving as well as for ordering purposes.

The following particulars indicate the mark and purpose of the screws.

Mark of Screw	Purpose.
'R' or 'S'	C.I. Common and Heel Slide Chairs, 90, 94, 107 and 110 lb. layouts.
"	Tie Plate Unit, Detail 1056.
'R' or 'B'	" " " " 1049.
"	" " " " 2049.
"	M.S. Slide Chairs, Detail 1039 and 2039.
"	" " " " 1069 to 6069.
"	" Rail " " 1049.
"	C.I. Toe Slide Chairs in double compounds.
"	Rail Braces for check rails.
"	Take-Up Button, Detail 1067
"	Point Levers.
"	Spring 'V' Crossings.
"	Base Plate (for crank stands), Detail 1011 to 3011
"	Crank Stand, Detail 1012, (with base plate, Detail 1011.
'I' or 'S'	Crank Stand, Detail 1012, (with base plate, Detail 2011 or 3011).
'I'	C.I. Special Dummy Chairs.
"	C.I. Adjustable Toe Chairs and Adjustable Slide Chairs in tie plated points, 80-110 lb. layouts.
'L'	C.I. Insulated Dummy Chairs for tie plated, insulated single compounds, 80-110 lb. layouts.
"	Timber Guards at some level crossings.

The Mark 'R' screw has a hot-rolled thread and is interchangeable with Mark 'B' and Mark 'S' screws as indicated in the above table.

PINS

The types of pins in use are shown in Fig. 136, and 10.25 Figs. 2A & 2B, and particulars of size and purpose are as follows : -

Dia.	Length	Type	
$\frac{3}{4}$"	6"	Cup head	78 & 86 lb. point slide chairs.
"	7"	" "	" " " " "
* $\frac{7}{8}$"	$6\frac{1}{4}$"	" " }	60,80 & 100 lb. point slide chairs.
"	"	Mark 'P' }	Lug plates and tie plates.
*"	$6\frac{1}{2}$"	Counter-sunk	60, 80 & 100 lb. compound slide chairs.

* These pins were used in some of the earlier 90 & 110 lb., point slide chairs. The Mk'P'pin was standardised in 1945.

The Mark 'P' pin is recessed underneath the head to provide a means for gripping the pin to enable easy removal.

BOLTS

Trackwork bolts comprise heel bolts, heel fishbolts, guard rail bolts, chair bolts, crossing bolts and miscellaneous bolts, particulars of which are given below.

When bolts are required for renewals, first identify the weight and year standard of the material for which they are required, as shown in the various tables. From the tables of present standard bolts find the correct bolt and specify it completely, stating length, diameter and shape. The correct spring washer for each bolt is shown in the tables.

HEEL BOLTS AND HEEL FISHBOLTS

Heel bolts and heel fishbolts are used to secure the heel fastenings of points and details are given in Table 14.133 and 14.134. The types of bolts used are shown in Figs. 137 & 138.

The shouldered heel fishbolts, shown in Fig. 138, are used for the early type 'Y' layout point heels. The heel fishbolts in 'X' layout points are standard fishbolts. See tables of fishbolts 10.20-10.21, and 14.047 to 14.048, Figs. 21 to 25.

GUARD RAIL BOLTS

Guard rail bolts, Fig. 139, are used to secure the guard rails to the track rails and are of suitable length according to the weight, class and type of guard rail. Owing to the widening of the flangeway at the ends two lengths of bolts are required and details are given in Table 14.135 and 14.136.

CHAIR BOLTS

Chair bolts are used to secure the stock rails of points to point chairs of the buttress type. The types of chair bolts in use are shown in Fig. 140. Particulars are as follows : -

LENGTH	DIAMETER	WASHER	USE (TYPE OF CHAIR)
* $6\frac{3}{4}$" 'C'	1"	$\frac{1}{4}$"(1944)	80 lb. 'O' & A.S. Cast Iron Chairs 100 " P & A.S. " " " 90 & 110 lb. " " " " 94 & 107 lb. " " " "
$2\frac{7}{8}$" 'C'	"	"	94 & 107 lb. A.S. Mild Steel Chairs
$5\frac{7}{8}$"	$\frac{7}{8}$"	$\frac{1}{4}$"	60 lb. D & A.S. Cast Iron Chairs

* The present standard bolt carries the head brand 'C'. The original standard bolt carries no head brand.

CROSSING BOLTS

Crossing bolts, Fig. 141, secure the individual parts of crossings to provide rigid track structures.

Crossing bolts must be ordered to <u>length required</u>.

Square and hexagonal head crossing bolts are of <u>Mild Steel</u>. Cup head crossing bolts are of <u>High Tensile Steel</u>. Particulars are as follows : -

DIA-METER	SHAPE HEAD	SHAPE NECK	SHAPE NUT	SPRING WASHER	USE (TYPE OF CROSSING)
1"	Square	Round	Hex.	1"	80 Lb. 'O' & A.S. 100 lb. P & A.S. and 90 & 110 lb. A.S. with no machined flare on wings.
* "	Hex.	"	"	$\frac{1}{4}$"(1944)	
$\frac{7}{8}$"	Square	"	"	1"	60 lb. D & 60 lb. A.S. 1921
* "	Hex	"	"	$\frac{1}{4}$"(1944)	
1"	Cup	Oval	"	$\frac{1}{2}$"	90 & 110 lb. A.S. with machined flare on wings. 94 & 107 lb. A.S.
$\frac{7}{8}$"	"	"	"	"	60 lb. A.S. 1935.

* Indicates bolts used for replacements.

MISCELLANEOUS BOLTS

A number of bolts for miscellaneous uses are detailed in Table 14.137.

SPRING WASHERS

To compensate for wear in bolted assemblies and maintain tension in the bolts between periods of adjustment, use is made of high resistance spring washers. The types of spring washers in use in trackwork layouts are shown in Fig. 142. Particulars of size and purpose are shown in Table 14.138. See 10.38, Fig. 53.

FLAT WASHERS

Flat washers are used in guard rail assemblies of the older standards to provide a means of adjusting the guard rail flangeways. The standard flat washer, Fig. 143, is $\frac{1}{8}$" thick x $2\frac{1}{2}$" outside diameter.

Flat washers are used under the spring washers of chair bolts in C.I. chairs having oval holes for the chair bolts, and in tie plated points under the screw heads on the C.I. adjustable slide and adjustable toe chairs, and when M.S. chairs are in use, under the screws on the C.S. braces, 1048. The washers form bridges over the oval holes provided for vertical and lateral adjustment of the chairs and for radial adjustment of the braces.

SPREADER BOLTS

In 90 and 110 lb. points manufactured since 1933 and in all 94 and 107 lb. points the spreaders are connected to the spreader brackets by means of a spreader bolt, IF3116, shown in Fig. 144.

SPREADER PINS

In 80 lb. and 100 lb. A.S. 'Y' layout points and in 90 and 110 lb. points manufactured prior to 1933 a spreader pin, 11F52, is used for the above purpose. See Fig. 145.

MISCELLANEOUS PINS

Pins used in spring crossing anchor straps and point lever connections are shown in Table 14.139, and Fig.146.

TAKE-UP BUTTONS

Take-up buttons shown in 14.111, Fig. 113, are used to provide a means of adjustment at guard rails. By using consecutive faces on the take-up buttons, i.e.,1, 2, 3, 4, etc., adjustments of $\frac{1}{8}$" up to $\frac{5}{8}$" are obtained.

Take-up buttons are used also in new level crossing work, on tie plates for compounds with M.S. chairs, on insulated joint plates at ends of 'V' crossings and on steel sleepers at ash dump locations.

RAIL BRACES

Rail braces are of many types to suit the various weights and classes of rails and according to purpose. The chief use is in bracing continuous check rails, but they have also been used to give additional support to the outer rail on sharp curves particularly with light weight rails. In 90, 94, 107 and 110 lb. spring 'V' crossings they are used as stops for the movable wing of the crossing. See 14.093 & 14.094, Figs. 97 & 98.

The present standard rail braces, Fig. 147, are designed for multiple use on the various weights and classes of rails. Three present standard rail braces are available, 60 lb, 80-90-94 lb., and 100-107-110 lb.

Many of the earlier rail braces were fixed by pins or dog-spikes, but the present standard are secured with the mark 'R' or 'B' screw and bolted where necessary to the rails. No bolts are used with the braces when fitted to spring 'V' crossings.

DISTANCE FERRULES

To maintain the necessary freedom for movement at the heel of switches and the mouth of spring 'V' crossings where set fishplates secure the movable rails, tubular ferrules are inserted between the heel or mouth blocks and the set fish-plates.

In 90 and 110 lb. 'V' nosed points the ferrules first used were of black iron pipe $1\frac{3}{4}$" long and fitted with angle fishplates suitably counterbored to receive the ferrule. After 1933 flat fishplates were used with ferrules of red steam pipe $1\frac{1}{8}$" long.

The ferrules now supplied for replacements are of heat treated steel $1\frac{7}{8}$" and 1. 3/16" long to allow for wear on the block faces.

All 94 and 107 lb. points and spring 'V' crossings are fitted with heat treated ferrules 1.13/16" long. See Fig.148.

ORIGINAL HEEL BOLTS & HEEL FISHBOLTS						
LENGTH	DIA-METER	SHAPE			WASHER	USE: (TYPE OF HEEL)
		HEAD	NECK	NUT		
$11\frac{1}{2}$"H"	$1\frac{1}{8}$"	Cup	Oval	Hex	$\frac{3}{8}$"	94 & 107 lb.A.S.No.8.7 Compounds
$10\frac{3}{8}$"	"	"	"	"	"	94 & 107 lb.A.S.No.7.52 Compounds
$9\frac{5}{8}$"H"	"	"	"	"	"	94 & 107 lb.A.S.Y.L.O.
$10\frac{1}{8}$", $9\frac{7}{8}$", $9\frac{5}{8}$"	"	"	"	"	"	80 & 100 lb. Y.L.O. (prior to 1923).
10"	"	"	"	"	"	80 & 100 lb.A.S.Y.L.O. (after 1923).
$10\frac{1}{8}$"	"	"	"	"	"	90 & 110 lb.A.S.Y.L.O. (Angle fishplate).
$9\frac{3}{8}$"	"	"	"	"	"	90 & 110 lb.A.S.Y.L.O. (Flat fishplate).
a. $5\frac{3}{8}$"	"	"	"	$\frac{7}{8}$" Hex	"	80 lb.O & A.S.Y.L.O. 100 lb.P. & A.S.Y.L.O.
a. 5"	"	"	"	"	"	100 lb.P. & A.S.Y.L.O.
a. $4\frac{5}{8}$"	"	"	"	"	"	80 lb.O & A.S.Y.L.O.
$9\frac{1}{2}$"	1"	"	"	Hex	"	80 lb.O & A.S.X.L.O. 100 lb.P. & A.S.X.L.O. 95 & 115 lb. X.L.O.
b. $9\frac{1}{4}$"	"	Square	Round	Square	"	86 lb. X.L.O.
b. $8\frac{5}{8}$"	$\frac{7}{8}$"	"	"	"	"	57, 70 & 78. lb.X.L.O.
$8\frac{7}{8}$"	"	Cup	Oval	Hex	$\frac{1}{4}$"	60 lb. D. X.L.O. 60 lb. A.S. X & Y.L.O.

a. Heel fishbolts. See Fig. 138.
b. Supplied with 2 square nuts and a $\frac{3}{8}$" bevelled washer.

Note: "H" denotes head mark.
Y.L.O = Y Layout; X.L.O. = X Layout.

PRESENT STANDARD HEEL BOLTS & HEEL FISHBOLTS

LENGTH	DIAMETER	SHAPE: HEAD	SHAPE: NECK	SHAPE: NUT	WASHER	USE: (TYPE OF HEEL)
$11\frac{1}{2}$"H"	$1\frac{1}{8}$"	Cup	Oval	Hex	$\frac{3}{8}$"	94 & 107 lb. A.S. No. 8.7 Compounds.
$10\frac{3}{8}$"H"	"	"	"	"	"	94 & 107 lb. A.S. No. 7.52 Compounds 80 lb. O & A.S. Y.L.O 100 lb. P & A.S. Y.L.O 90 & 110 lb. A.S. Y.L.O (Angle fishplates)
$9\frac{5}{8}$"H"	"	"	"	"	"	94 & 107 lb. A.S. Y.L.O 90 & 110 lb. A.S. Y.L.O (Flat fishplates)
a. 5"	"	"	"	$\frac{7}{8}$" Hex	"	100 lb. P. & A.S. Y.L.O
a. $4\frac{5}{8}$"	"	"	"	"	"	80 lb. O & A.S. Y.L.O
$9\frac{1}{2}$"	1"	"	"	Hex	$\frac{1}{4}$"(1944)	80 lb. O & A.S. X.L.O 100 lb. P. & A.S. X.L.O 95 & 115 lb. X.L.O
b. 8"	"	Square	Round	"	"	86 lb. X.L.O
b. 8"	$\frac{7}{8}$"	"	"	"	$\frac{1}{4}$"	57, 70 & 78 lb. X.L.O
$8\frac{7}{8}$"	"	Cup	Oval	"	"	60 lb. D. X.L.O 60 lb. A.S. X & Y.L.O

a. Heel fishbolts. See Fig. 138. b. Crossing bolts supplied.

Note: "H" denotes head mark.
Y.L.O = Y Layout; X.L.O. = X Layout.

ORIGINAL GUARD RAIL BOLTS						
LENGTH	DIAMETER	SHAPE			WASHER	USE: (TYPE OF GUARD RAIL)
		HEAD	NECK	NUT		
7¾" 8¼"	1" "	Cup "	Oval "	Hex "	1" "	80 lb O & A.S. 1910 100 " P. " " "
7¾" 8¾"	" "	" "	" "	" "	" "	80&100 lb A.S. 1923, 24. 90&110 " " 1924, 30.
6¾" 8⅝"	" "	" "	" "	" "	⅜" "	" " " " 1935
6¾"	"	"	"	"	¼" Grovers	80 lb O & 100 P. 1899.
6⅞" 'G' 8¼" 'G'	" "	" "	" "	" "	⅜" "	94 & 107 lb A.S. 1940.
a. 6⅜"	⅞"	Square	Round	Square	"	60 lb C. 1880 50 " A. & B. 1885 66 " E. & F. " 75 " H. & I. "
6¼" 7"	" "	" "	" "	Hex "	½" "	60 lb D. 1910
6¾" 7¾"	" "	" "	" "	" "	" "	60 lb A.S. 1921, 22, 24
6¼" 8"	" "	" "	" "	" "	" "	60 lb A.S. 1935

a. Supplied with 2 square nuts and a ⅜" bevelled washer

Note: - 'G' denotes head mark.

PRESENT STANDARD GUARD RAIL BOLTS

LENGTH	DIA-METER	SHAPE: HEAD	SHAPE: NECK	SHAPE: NUT	WASHER	USE
$6\frac{1}{4}$"	$\frac{7}{8}$"	Square	Round	Hex.	$\frac{1}{4}$"	Common bolt for 50 lb. A. & B, 60 lb. C. & D, 66 lb. E. & F, 75 lb. H. & I. guard rails. Short bolt for 60 lb.A.S.guard rails.
7"	"	"	"	"	"	Long bolt for 60 lb. A.S.guard rails prior to 1935.
$6\frac{7}{8}$" 'G'	1"	Cup	Oval	"	$\frac{1}{4}$" (1944)	Short bolt for all weights and classes of guard rails 80 - 110 lbs.
$8\frac{1}{4}$" 'G'	"	"	"	"	"	Long bolt for all weights and classes of guard rails 80 - 110 lbs. Bolt for steel sleepers for ash dumps.
$8\frac{5}{8}$" 'G'	"	"	"	"	"	Long bolt for 94 & 107 lb. Derail Turnout guard rail with D.T.3 end blocks.

Note: - 'G' denotes head mark.

MISCELLANEOUS BOLTS

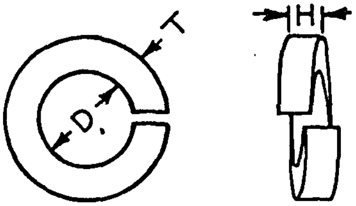
LENGTH	DIAMETER	SHAPE HEAD	SHAPE NECK	SHAPE NUT	WASHER	USE
3"	$\frac{7}{8}$"	Hex	Round	Hex	$\frac{1}{8}$"M.S. $\frac{1}{8}$"Spg.	80&100 lb A.S.Tieplate 90&110 " " " 94&107 " " " with C.I. Chairs
$\frac{1}{8}$" 'T.P'	1"	Cup	Oval	"	$\frac{1}{4}$"(1944)	94&107 lb A.S.Tieplate with M.S. Chairs
0" 'T'	"	"	"	"	"	Tramway Crossing Joint
$4\frac{1}{4}$"	$\frac{7}{8}$"	"	"	"	$\frac{1}{4}$"	100-107-110 lb Rail Brace 80-90-94 " " " 60 " " "
* $6\frac{3}{4}$" 'C'	1"	Chair Bolt			$\frac{1}{4}$"(1944)	90,94,107&110 lb A.S. Spring Crossings, (Spring & Guide Boxes).
2"	$\frac{3}{4}$"	Square	Round	Hex	-	80 & 100 lb Spring Crossings, (Spring Box)
5" 'H'	$1\frac{1}{8}$"	Cup	Oval	"	$\frac{3}{8}$"	94 & 107 lb A.S.Spring Crossings, (Toe Block)
$4\frac{3}{4}$" $5\frac{3}{4}$"	$\frac{5}{8}$" "	Hex "	Round "	" "	- -	Quadrant Lever Weights
2" 7" $7\frac{1}{2}$" 6"	$\frac{3}{4}$" " " "	" " " Square	" " " "	" " " "	- - - -	Spur Lever, (Frame) " " (Weight) " " " " " "

* Bolt with head mark 'C' is the present standard. The original bolt carried no head brand.

Note: - 'TP'., 'T', 'C' and 'H' denote head marks.

Note: - 'G' denotes head mark.

SPRING WASHERS



D = Diameter

T = Thickness

H = Height

D	H	T	U S E
1 3/16"	3/8"	3/8"	1 1/8"d Heel Bolts and Heel Fishbolts
1 1/16" Type 1944 * 1 1/16"	1/4" 3/8"	3/8" 3/8"	1" d Guard Rail Bolts " " Heel Bolts " " Chair Bolts " " Fishbolts " " Junction Fishbolts
15/16"	1/4"	"	7/8" " Guard Rail Bolts " " Heel Bolts " " Chair Bolts " " Fishbolts " " Junction Fishbolts
* 1 1/8"	1"	1/4"	1" " Guard Rail Bolts
* 1"	1/2"	"	7/8" " " " "
13/16"	1/4"	3/8"	3/4" " Fishbolts
1 1/16"	1/2"	"	1" " Crossing Bolts
* 1 1/8"	1"	5/16"	" " Mild Steel Crossing Bolts (square heads).
15/16"	1/2"	3/8"	7/8" " Crossing Bolts
* 15/16"	1"	1/4"	" " Mild Steel Crossing Bolts (square heads).

* Original Standard, now obsolete.

MISCELLANEOUS PINS			
LENGTH	DIAMETER	TYPE	USE
3"	1"		80 & 100 lb. Spring Crossing Anchor. (single strap)
2¼"	1"		80 & 100 lb. Spring Crossing Anchor. (double strap)
2⅞"	"		90 & 110 lb. A.S. Spring Crossing Anchor.
4⅞" 5½"	" "	11F52 "	C.C.W. Point Lever.
2⅜" 5½"	" "	" "	W.S^A Point Lever.
6⅜"	"	"	Quadrant Lever.
4⅝" or 4⅛"	1¼" "	 Sq.Head	Spur Lever.
2"	⅞"	10F52	Lever Rod End, 1H186. (Quadrant).
2 7/16"	"	"	Lever Rod and Pull Rod End 2B38, and Link, Detail No. 1060.
3⅜"	1"	11F52	Lever Rod End, 6H186. (Spur).
4⅝"	1"	1F1437	Crank Stands. 1H227 and Detail No.1012

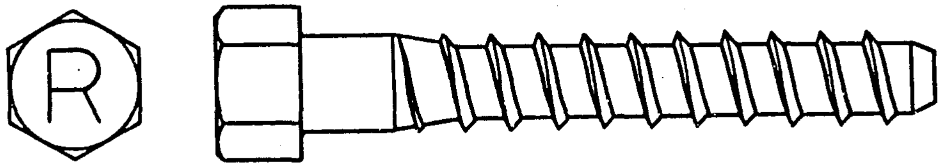


FIG. 135. SCREW. (MARK 'R' SHOWN)

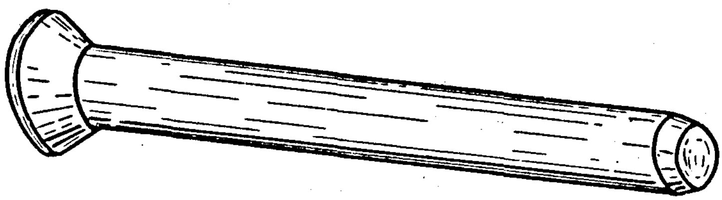


FIG. 136. COUNTERSUNK CHAIR PIN.

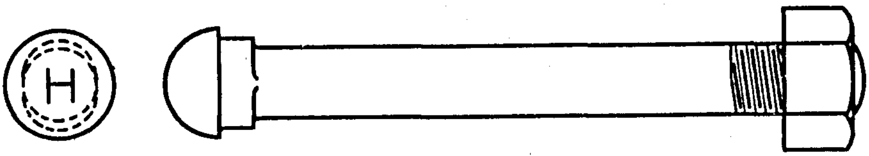


FIG. 137. TYPICAL HEEL BOLT. (MARK 'H' SHOWN.)

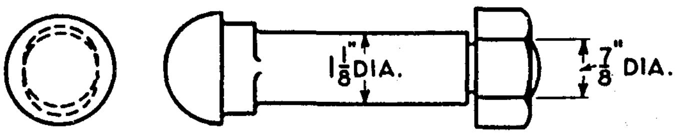


FIG. 138. HEEL FISHBOLT.

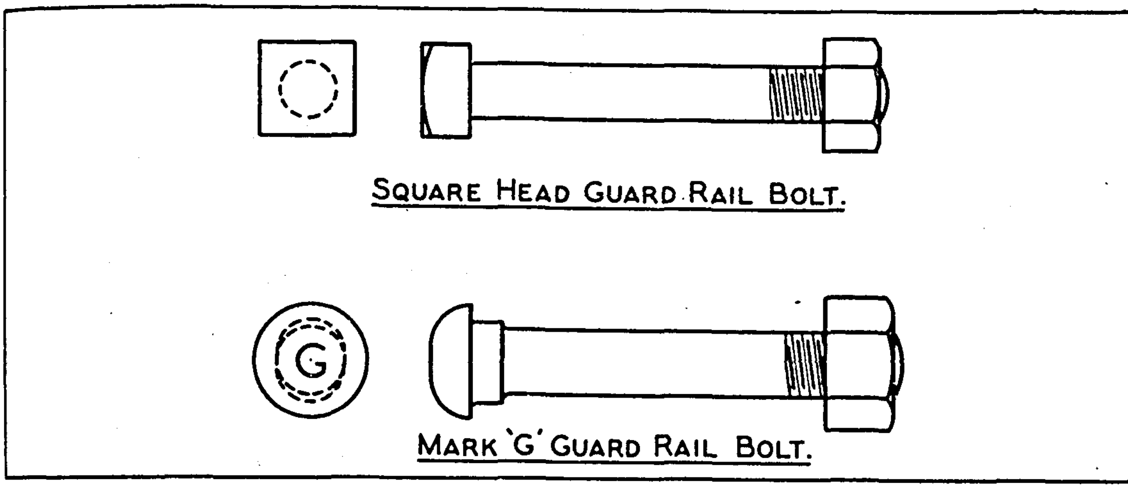


FIG. 139. TYPICAL GUARD RAIL BOLTS.

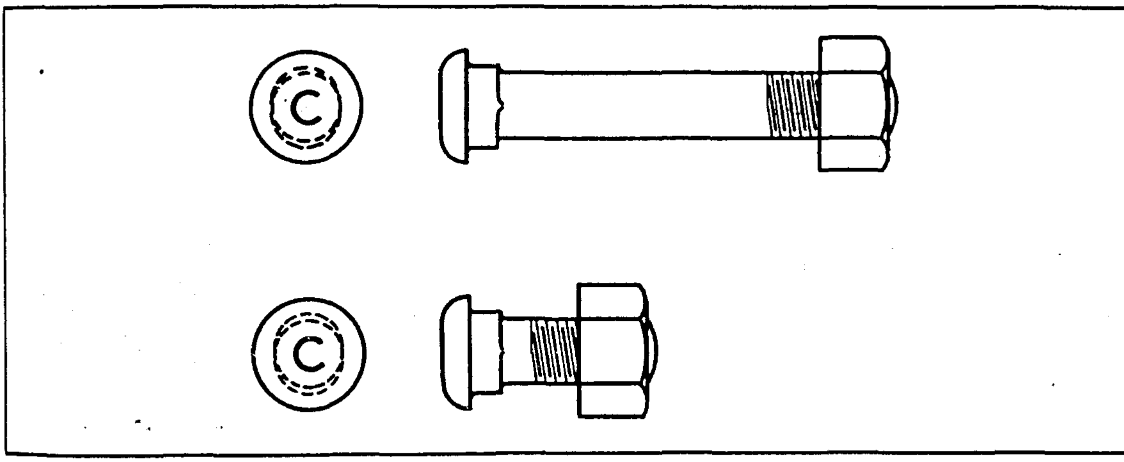


FIG. 140. CHAIR BOLTS. (MARK 'C' SHOWN.)

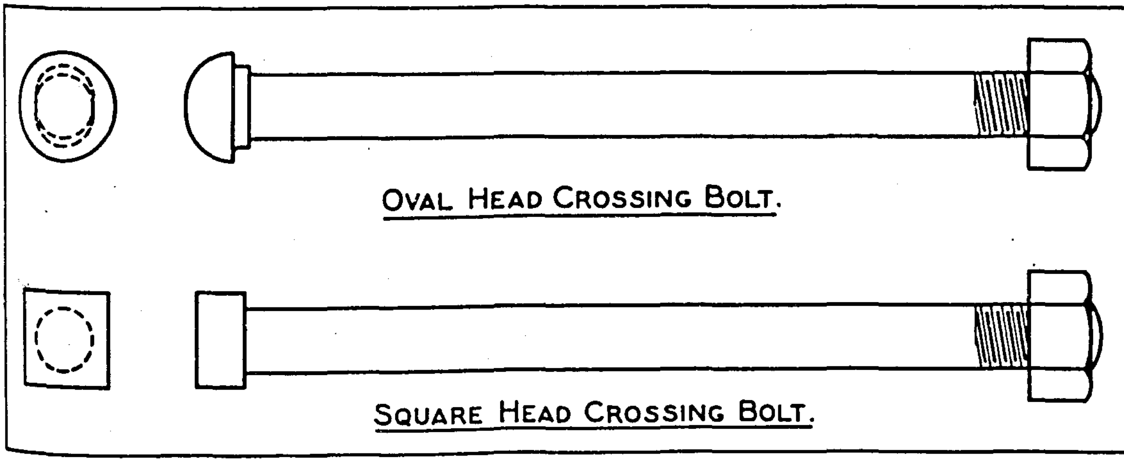


FIG. 141. TYPICAL CROSSING BOLTS.

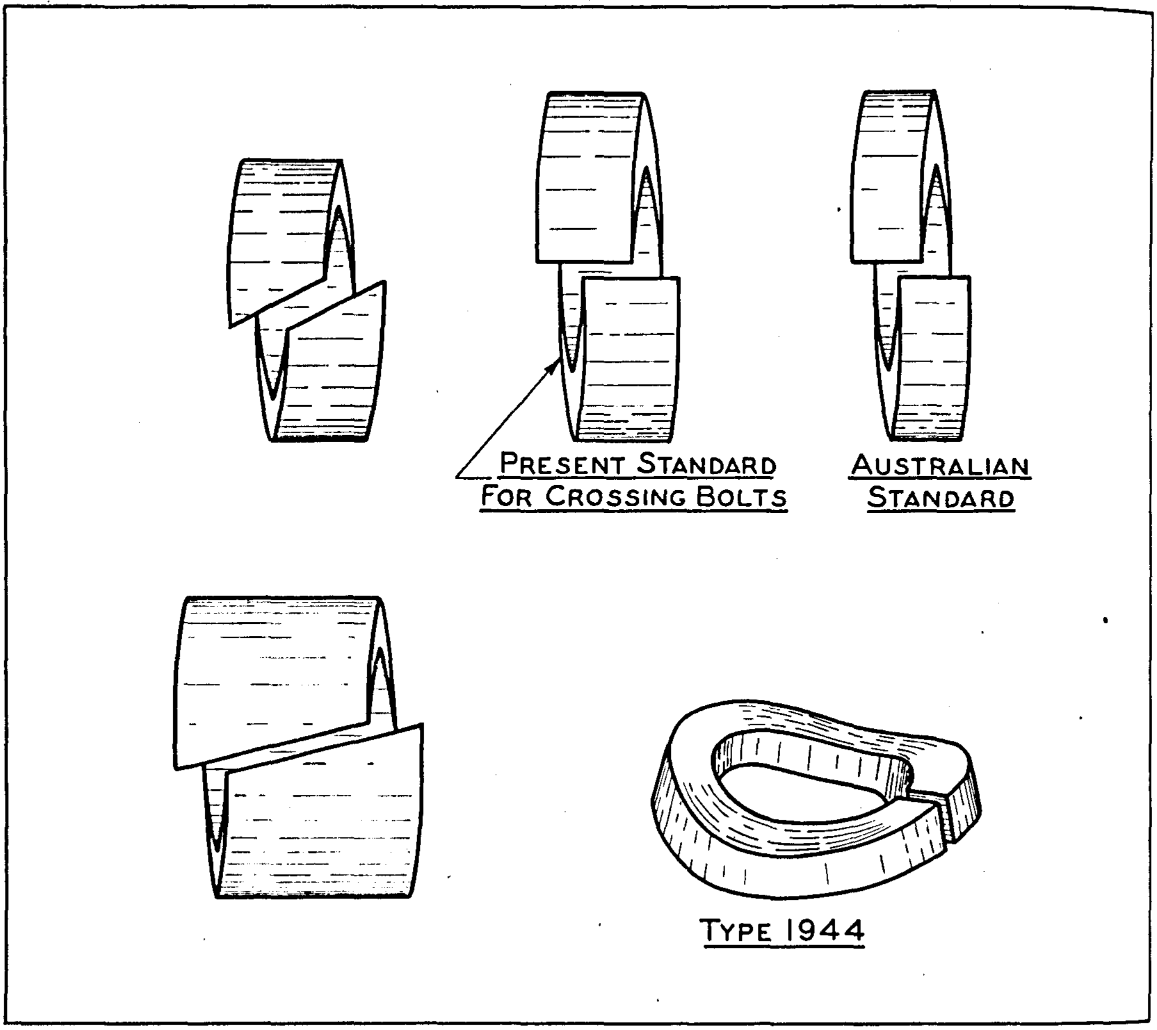


FIG. 142. TYPICAL SPRING WASHERS.

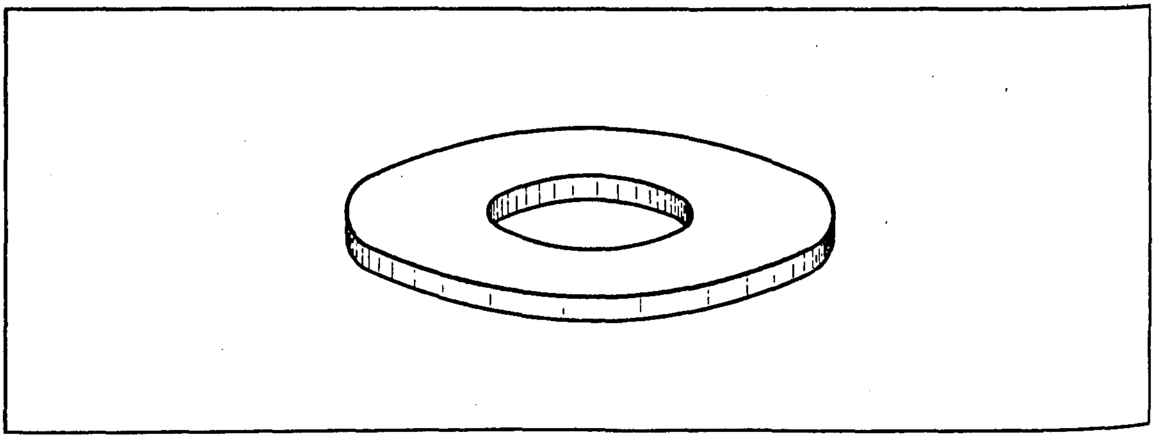


FIG. 143. FLAT WASHER.

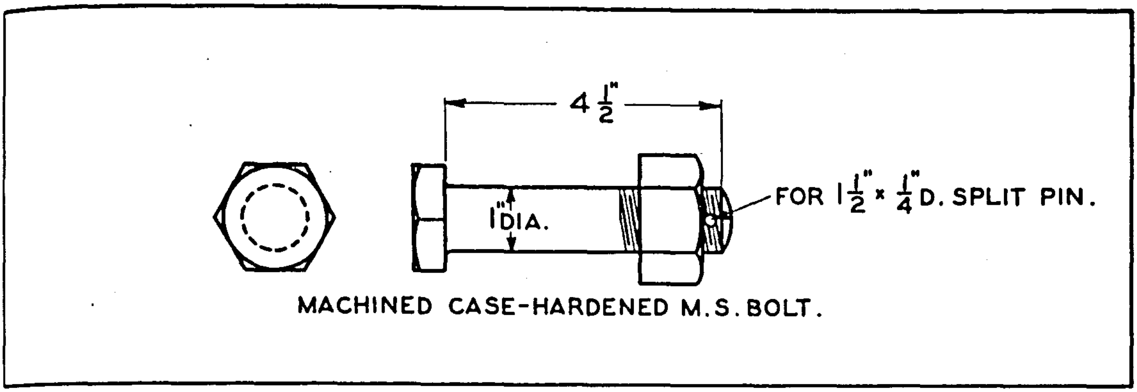


FIG. 144. SPREADER BOLT. 1F3116.

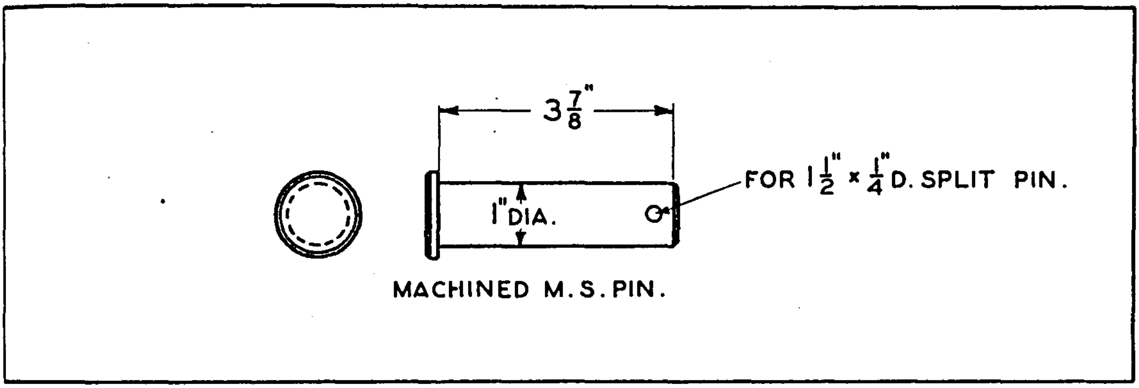


FIG. 145. SPREADER PIN. 11F52.

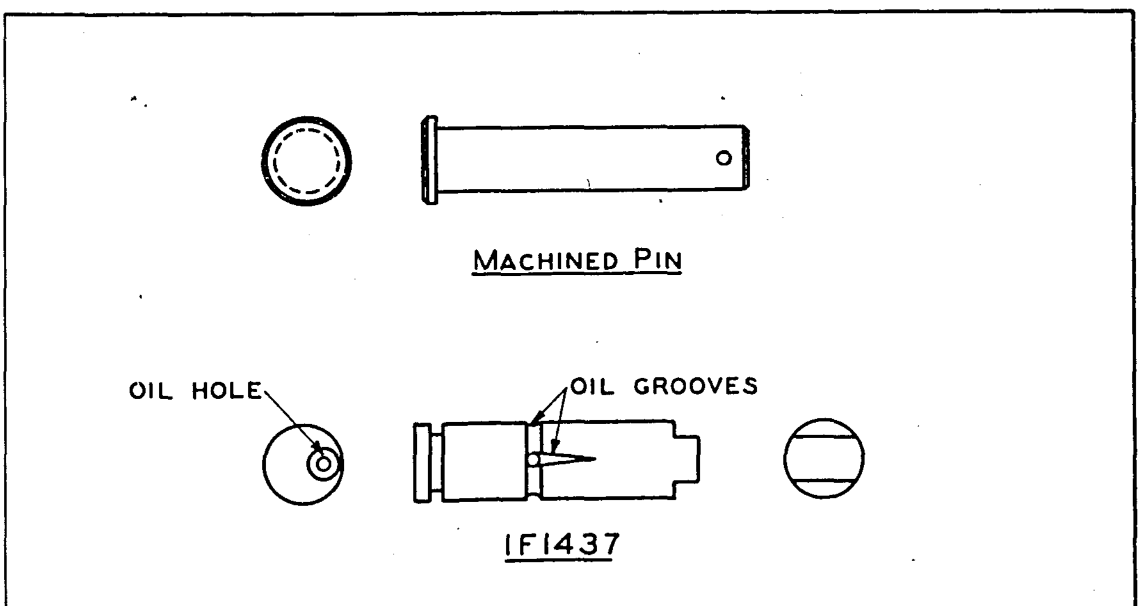
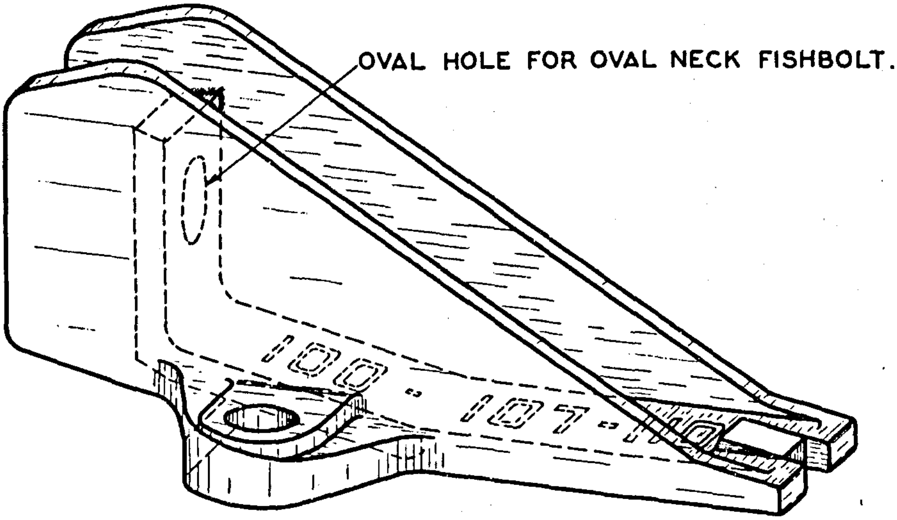


FIG. 146. MISCELLANEOUS PINS.



$\frac{7}{8}$" DIA. X $4\frac{1}{4}$" OVAL NECK FISHBOLT FOR ALL RAIL BRACES.

FIG. 147. RAIL BRACE. 100-107-110 LB.

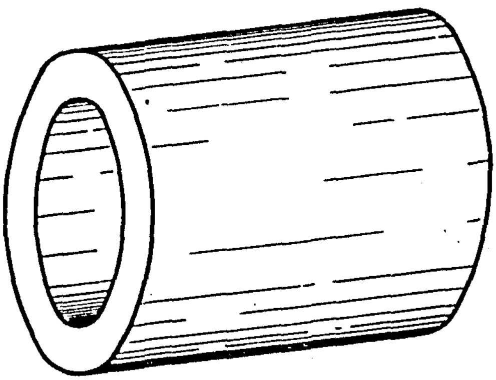


FIG. 148. HEAT TREATED STEEL FERRULE.

TRACK TOOLS. 15.

GENERAL

The tools and appliances used in the construction and maintenance of track and trackwork constitute a heavy expenditure, and a careful check should be kept on the issue and proper use of this equipment. Each gang is supplied with a complete outfit of small tools and spares for use while tools are away for repairs.

Broken and worn out tools should be returned for repair or replacement as the quantity and quality of the work are adversely affected by the use of blunt cutting tools and damaged hand tools. Tools which have outlived their usefulness should be returned for reclamation and replacement by later standard equipment.

Tool sheds and tool boxes are provided for the orderly storing of tools when not in active use, and the condition and orderliness of the tool storage very largely reflects the calibre of the trackman in responsible charge.

The class of tools supplied depends upon the nature of the track, the gang strength and local conditions. Lists of tools required are set out in the Way & Works Instruction Book and C.C.E. circulars. Special tools which are not ordinarily required are obtainable from the Road Foreman's Depot or the Workshops Manager, Spotswood, and must be returned on completion of the work for which they are required.

CARE OF TOOLS

The ordinary track tools are usually single purpose tools designed for a certain definite use, and they should not be used for other purposes as damage may result to the tools and the possibility of accidents be thereby increased.

Tools which are not being used should be placed clear of the track and piled vertically about a bar or against a post to avoid men tripping over them in the course of their work.

The edges of cutting tools should be protected both from the point of view of preserving the tools in good condition and to avoid the possibility of injury to the men. Augers, adzes and axes can be protected by a piece of old hose or even a block of light wood. Wooden handles should be examined for splits and shakes, and be smoothed to remove splinters and avoid injury to the hands.

Bars and levers should be frequently examined for signs of fracture, particularly if they have been subjected to rough use or inadvertently strained in service.

In wet weather every effort should be made to keep the finer tools dry and to see that they are dry before storing away.

Tools with moving parts such as rail drilling machines, rail saws, jim crows, etc., should be kept clear of dirt and be regularly oiled in the working parts.

Chisels, punches and figures for branding rails will be damaged if not held firmly and square with the direction of the hammer blow.

Broken heads of hammers or punches etc., will not admit of good work, and may cause the blow to glance and cause injury. Tools in this condition should be returned for reconditioning.

Nicking lines should be dried out in loose folds before coiling for storage, otherwise the line will decay.

Sharpening stones should be wrapped in old bagging or otherwise protected and kept clean; if allowed to become dirty they soon lose their cutting or grinding qualities.

Steel tapes should be dried and oiled before coiling. Cleaning should be done by passing the tape to and fro between a cloth held between the thumb and one finger; if passed between the thumb and two fingers the tape will tend to buckle and will not lay flat when required for use.

Fabric tapes must be cleaned and dried before coiling to prevent deterioration.

Track jacks should be used according to their purpose; the light Trewella jacks provided for lifting track are unsuitable for lifting heavy crossing work for which the heavier Simplex or Golightly jacks should be used.

Pneumatic tyred barrows, where used, should be protected as far as possible from the effects of weather; when not in use an old bag should be thrown over the tyre. The life of the tyre will be increased if it is kept properly inflated.

When a rail is drilled with a blunt pointed drill bit the work will be made easier if the centre punch is used occasionally to indent the centre of the hole and enable the drill but to get a bite in the metal.

Drilling is easier if the rate of feed or pressure is maintained evenly on the drill during the operation, otherwise the base of the hole tends to become polished and the drill bit loses its bite.

The locking collar on the drill chuck should be tightened only by hand. Its function is to centre the drill bit in the drill spindle by means of the clamping jaws which engage in driving slots in the drilling spindle.

To adjust the drill length the locking collar and clamping jaws are removed and the drill end re-engaged in the slotted adjusting nut; rotating the drill by hand causes the adjusting nut to travel in the threaded drill spindle, thus controlling the length of the drill protruding from the chuck. See Fig. 1.

A spot of turpentine at the point of the drill bit will improve its cutting action.

CHECKING

'T' squares should be checked for accuracy before use, and a convenient method is to reverse the square across the gauge of straight track marking each rail with the position of the square. If the square is reasonably true the two marks made with the square on one rail should exactly overlay the two marks made with the square on the opposite rail. See Fig. 2.

Spirit levels should be checked for accuracy before use; the following procedure will suffice to establish if the level is true.

1. Place the level on a straight edge and mark its position thereon.

2. Elevate the lower end of the straight edge by packing until the bubble shows centre.

3. Without disturbing the straight edge, reverse the level within the marked position (end for end).

If the level is true the bubble will again register centre as shown in Fig. 3.

HAND TOOLS

The rail turning bar shown in Fig. 4 should always be used for turning rails, and not the points of lining bars or picks.

In the re-spacing of sleepers the goose-neck bar shown in Fig. 5 is more convenient and expeditious than the use of the track jack.

To prevent square headed fishbolts from turning when the nuts are tightened, use should be made of the bridle shown in Fig. 6 in preference to using two spanners; dogspikes or other packing should not be used to wedge the bolt head, as injury may be caused in the event of the wedge slipping.

Spanners which are worn or strained to a condition where the grip on the nuts is uncertain are useless to retain in any gang kit and should be returned to depot for repair or replacement. Pipe extensions must not be used on spanner handles.

The standard track spanners are shown in Figs. 7 & 8. Clyburn and other shifting spanners are suitable and convenient for odd size nut fastenings; they should not be used on fishbolts or crossing bolts as they will be strained and rendered useless.

Track gauges and adzing gauges lose their accuracy if subjected to unintended uses; they can only be considered as a gauge when they are known to be correct and should therefore be subject to regular checking.

To accurately test an adzing gauge the distance 'A' should be checked from Table 15.11, and the inclination of the plates be checked as shown in Fig. 9.

Though not strictly accurate a useful test may be made by reversing the adzing gauge (end for end) in a well adzed sleeper and observing if the gauge accurately fits the adzing in either position.

Adzing gauges are stamped on the end plate with particulars of the weight and class of rail and the application, i.e., intermediate, square joint and broken joint. Care must be taken to select the correct adzing gauge according to the type of fishplates in use, i.e., angle or flat fishplates.

Boring templates are used to locate the dogspike holes for the application of sleeper plates and to prove the surface of the sleeper for flatness. The positionsof the dogspike holes are marked through the 7/32" diameter holes in the template by means of a suitable punch.

Boring templates are stamped on the connecting bar with the weight and class of rail to which they apply, and separate templates are provided for single and double shoulder sleeper plates. A typical boring template is shown in Fig. 10.

Boring ferrules, see Fig. 11, are used to centre the auger when boring through the chair holes and rail brace holes for chair or brace screws.

Sighting boards, blocks, and straight edges should be handled with care to prevent damage to the edges. The standard sighting board is shown in Fig.12, and the method of using this equipment is shown in 11.46, Figs. 2-4.

Lining and claw bars are of two types, heavy and light, as shown in Fig. 13; the light type is the later standard.

Pinch bars are shown in Fig.14, and are of two types; the light bar is the present standard.

The rail joint adjuster, shown in Fig.15, is a powerful tool arranged to pull or push rails for correction of the expansion spaces.

The type of rail joint adjuster illustrated will pull up to 20 chains of rail if the fastenings are free and the effort of the jack is assisted by pinching the rail off the sleepers at intervals along its length. When pulling back a long stretch of rail two or more rail joint adjusters may be used, at intervals, linked to push or pull, as required.

The rail hanger, Fig. 16, is used to suspend welded rail under a trolley axle when it is necessary to move the rail into positions such as station pits or under bridges. A rail lifting lever, Fig. 17, is also in use for transporting welded rail by the aid of trolley axles.

Rail tongs are convenient devices for lifting and carrying loose rails into position, particularly where existing tracks have to be crossed.

The two types of rail tongs in use are shown in Figs. 18 & 19; the type with the timber cross bar is the later and more convenient device and may be obtained on application from the plant store at Spotswood Workshops.

Timber tongs are much used on overseas railways and have been used to a limited extent in Victoria, the type in use is shown in Fig. 20.

Sleeper nippers are a convenient device to hold the sleeper to the rail for spiking before packing, although this is usually done with a bar and heel. A type of nipper in use overseas is shown in 11.50, Fig. 14, and several of these devices have been obtained for trial in Victoria.

Track aligners are an arrangement of compound levers hinged to a sole plate. They are powerful tools designed to throw the track with a minimum of effort and without damage to the formation. Types of track aligners in use are shown in Figs. 21 and 22.

Ratchet spanners, shown in Fig. 23, are in use among special gangs, and are convenient tools for bolting operations in laying in trackwork layouts. As the ratchet spanner is heavier than the standard track spanner it is not so suitable for general track maintenance work.

Jiggers used with augers for sleeper boring are of several types, as shown in Figs. 24, 25 & 26. The latest pattern shown in Fig. 26 is now standard and its improved features will be evident from the illustration.

Screw wrenches in use are of two types, as shown in Figs. 27 and 28; the tubular wrench is lighter and stronger and is the present standard. Geared screw wrenches are in use overseas, and some of these tools have been obtained of a type shown in Fig. 29.

Rail benders of the Jim Crow pattern are shown in Figs. 30 & 31.

The Emmersion rail bender shown in Fig. 32 is in use by special gangs; although a powerful tool it is inconvenient to use in confined spaces.

Pin holes in point spreader connections are subject to considerable wear in the suburban area and hole size is restored by the application of Walters split bushes shown in Fig. 33.

Walters split bushes are held in position by the wedge as shown in Fig. 34. New bushes are readily applied by driving out the wedge to release the old bush and driving a new wedge with a new bush in position.

A piloted reamering tool, shown in Fig. 35, is employed to enlarge the pin hole about its original centre line. The installation of Walters split bushes is usually carried out by the Signal Division.

Hand operated rail drilling machines, shown in Fig. 36, should be set up with the contact points of the rail yoke in exact alignment with the axis of the drill, otherwise the drill will tend to run up or down to meet this alignment.

Hand operated rail saws, shown in Fig. 37, are arranged to grip the rails with unworn sides and will not grip a rail with a worn side, but the insertion of a block of hardwood between the movable jaws and the rail web, as shown in Fig. 38, will enable the saw frame to be rigidly clamped for operation.

POWER TOOLS

Tools operated by power are being increasingly used ; many such tools are adapted to several uses thus enabling one power unit to perform different operations. The power units in use are generally Pneumatic, Hydraulic, Electric or Internal Combustion units.

PNEUMATIC TOOLS

Pneumatic or compressed air operated tools comprise percussion units with suitable tool ends for breaking up the ballast beds, packing sleepers, general excavation work, spike driving and spikepulling. Rotary impact units are in use for screwing up and removing nuts, chair screws, etc. Rotary units are used for sleeper boring, rail grinding, etc.

TIE TAMPERS

A tie tamper is a percussion hammer arranged with two handles and provided with a tampering bar shaped at the packing end similarly to an ordinary beater. See Fig. 39. The tamping tool is held in the machine by a chuck to retain the tool from dropping out during operation. To control the tamping position, handles are provided, arranged to balance the machine in the hands of the operator and thereby reduce fatigue.

In its action the machine differs from the ordinary method of tamping in that the tamping bar remains in contact with the ballast while in operation instead of being lifted up and down to strike a blow.

The machine is held in a vertical position at the start with the tamping tool resting on the ballast parallel to the sleeper as shown in Fig. 40. Owing to the rapid percussion blows of the piston on the shank end of the tool, it is driven down through the ballast to the bottom of the sleeper.

If the ballast is loose there is no need to clear it away for packing as required with the hand beater, but if the ballast is compacted, it should be loosened with a pick before commencing to tamp.

When the tool reaches the bottom of the sleeper the tamper is inclined to an angle sufficient to pack the ballast to the centre of the sleeper, as shown in Fig. 41.

As the tool is in constant contact with the ballast and the blows are struck on the tool, the packing action has the effect of shoving the ballast into position without crushing it.

It is a mistake to throw weight on to the tamper with a view to increasing the tamping action, the reverse occurs in such a case as the stroke of the percussion hammer is reduced and the speed of packing is slowed down.

The tie tamper is designed for easy operation and should be held in a comfortably balanced position in the hands; there is sufficient weight in the tool to feed itself into the ballast and consolidate the packing.

Over tamping is a mistake as the track will be forced up beyond the jack lift or the ballast be driven into the formation to form water pockets.

Tamping should be commenced under the rail with an operator on either side of the sleeper, working first to the out end and then within the gauge to 15 inches from the running edge. The time required for tamping should not exceed two minutes, i.e., one minute outside the rail and one minute inside the rail.

When tamping is done between rails at the heels of points or at crossings, the tamping tool is entered between the rails and then turned into the correct tamping position.

To operate the machine to best advantage an air pressure of about 70 lb. per sq. in. is required, but from 75 to 80 lb. per sq. in. is necessary when using the tool pick for breaking out concrete or consolidated road materials.

PNEUMATIC WRENCHES

Pneumatic rotary impact wrenches consist of an air driven unit coupled to an impact unit and spanner head. The impact unit converts the rotary movement into a series of 'rotary impacts' which produce a powerful turning effect upon the nuts.

This tool is very suitable for the removal of tight, rust-bound nuts which under ordinary circumstances would need to be broken off by the hammer.

Reaction of the tool in the operator's hands is the same when removing a tight nut or running down a loose nut.

For tightening bolts to a pre-determined tension a special attachment is provided.

HYDRAULIC TOOLS

Hydraulic or water operated tools are powerful slow-motion tools and their use in track maintenance is limited to heavy lifting, rail bending and creep adjustment.

A convenient type of hydraulic rail bender is shown in Fig. 42, and two of these appliances are in use in the metropolitan area. The hydraulic rail bender is provided with jaws shaped to grip the rail section and evenly bend the rail head web and flange simultaneously.

ELECTRIC TOOLS

Electric tools at present in use consist of grinders used by the Points and Crossings Gangs in connection with welding and surfacing of the rail parts.

When these tools are in use trackmen must take care not to damage the cables carrying the electric current, as the effects of electric shock may be fatal.

INTERNAL COMBUSTION TOOLS

Internal combustion tools comprise petrol driven percussion units with suitable tool ends for breaking up ballast beds, packing sleepers, spike driving, ramming and consolidating materials. Rotary impact units are also made for screwing up and removing nuts, chair screws, etc.

The internal combustion percussion tools are self-contained units, but the rotary machines usually consist of a separate power unit driving the tool ends by suitable connections.

The tampers of the type shown in Figs. 43 & 44 are used by the Points & Crossings repair gangs. The rammer shown in Fig. 45, has been used to a limited extent, being hired when required.

Rail saws, rail drills and track wrenches powered by internal combustion engines are in use on bigger jobs where the amount of work warrants the use of such plant; the types of machines are shown in Figs. 46, 47 and 48. The power track wrench, Fig. 48, has a drilling attachment as shown in Fig.49.

POWER PLANTS

The power plants required to supply compressed air for the operation of pneumatic tools and the generation of electric current for welding and grinding are obtained from the Laurens Street Depot complete with tools, spares, etc.

With each plant complete instructions are provided for the care and operation of the equipment, the fuel and lubricating oil required, the list of tools provided and other particulars as shown on the 'Field Record of Plant' card of which a typical example is shown on 15.12 & 15.13.

On receipt of the plant all items must be checked with the particulars shown on the field card and any discrepancies noted and reported.

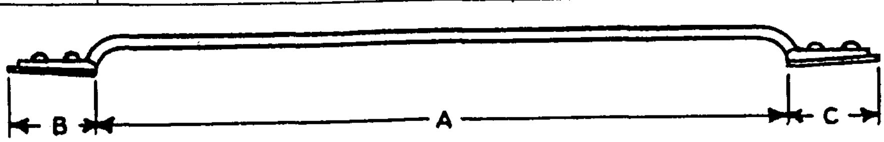
During the operation of the plant any minor defects in operation must be noted and recorded on the field card for the information of the maintenance fitters.

When the plant is to be returned the list of tools must be checked over and any losses reported as shown for example on typical card 15.13.

To enable correct identification of the grades of fuels and lubricants required for portable mechanical plant without reference to manufacturers symbols, the Department has established a system of V.R. code symbols.

In no circumstances should fuel or lubricating oil other than that shown on the field card be used, otherwise damage may be done to the plant and costly repairs be involved with delays to the work in hand.

ADZING GAUGES					
WEIGHT OF RAIL	APPLICATION	DIMENSIONS			REMARKS
		A	B	C	
60N & 60AS	Intermediates	5'1$\frac{5}{8}$"	4$\frac{1}{4}$"	4$\frac{1}{4}$"	
" "	Square Joints	4'11"	5$\frac{9}{16}$"	5$\frac{9}{16}$"	Angle Fishplates
60 D.	All Sleepers	5'1$\frac{1}{4}$"	4$\frac{3}{8}$"	4$\frac{3}{8}$"	Flat "
60 C.	" "	5'1"	"	"	" "
66 E.	" "	5'0$\frac{11}{16}$"	5"	5"	" "
66 F.	" "	5'1$\frac{5}{16}$"	4$\frac{1}{2}$"	4$\frac{1}{2}$"	" "
75 H.	" "	5'1$\frac{1}{4}$"	4$\frac{3}{4}$"	4$\frac{3}{4}$"	" "
"	Square Joints	4'11$\frac{1}{8}$"	5$\frac{3}{4}$"	5$\frac{3}{4}$"	Angle Fishplates
"	Broken Joints	5'0$\frac{3}{16}$"	"	4$\frac{3}{4}$"	" "
80 O & 80 AS	Intermediates	5'1$\frac{1}{4}$"	5"	5"	
" "	Square Joints	4'10$\frac{1}{4}$"	6$\frac{1}{2}$"	6$\frac{1}{2}$"	" "
" "	Broken Joints	4'11$\frac{3}{4}$"	6$\frac{1}{2}$"	5"	" "
90AS & 94 AS	Intermediates	5'1$\frac{1}{4}$"	5"	"	
" "	Square Joints	4'11$\frac{1}{8}$"	6"	6"	" "
" "	Broken Joints	5'0$\frac{3}{16}$"	6"	5"	" "
100P & 100 AS	Intermediates	5'0$\frac{3}{4}$"	5$\frac{3}{4}$"	5$\frac{3}{4}$"	
" "	Square Joints	4'9$\frac{1}{2}$"	7$\frac{3}{8}$"	7$\frac{3}{8}$"	" "
" "	Broken Joints	4'11$\frac{1}{8}$"	"	5$\frac{3}{4}$"	" "



TYPICAL FIELD RECORD OF PLANT

Machine. AIR COMPRESSOR No. 46. Capacity. 75 C.F. at 100 lbs. Weight 2250 lbs.

Power Units. WAUKESHA X.A.H. Type. PETROL H.P. 25 R.P.M. 1100

(Main mechanical details of machine are shown in this space)

Fuel, Oil and Greases

Part	Purposes	Name or S.A.E. Rating	V.R. Code	Consumption
ENGINE	FUEL	MOTOR SPIRIT	V.R-S	10 GLS. PER DAY
ENGINE	LUBRICATION	MOBILOIL A.F. SAE 40	V.R-F	$1\frac{1}{2}$ PTS. " "
COMPRESSOR	"	DTE HEAVY MEDIUM	V.R-A	1 " " "
GENERAL	GREASE	NO. 3 CUP	V.R-2 (5 lb.Tins)	1 lb. PER. WK
AIR FILTER	LUBRICATION	MOBILOIL A.F. SAE 40	V.R-F	$\frac{1}{2}$ PT. " "

Attention Machine Requires while in Service in the Field :-

Twice Daily .. .. Replenish radiator water. Drain inter-cooler and receiver.

Daily .. .. .. Check oil level in engine and compressor crankcases and air filter. Grease with gun and oil rods, etc. Screw down grease cups on pump and clutch 1 turn.

Every 50 hours .. Change and clean air filter

Every 100 hours .. Change crankcase oil.

Hand of engine oil gauge should stand approximately vertical. To take off wheels, remove nuts from wheel hub, do not touch outer circle of bolts. Always pull up on crank handle. Do not crank a very hot engine. Wash compressor air filter only in hot soapy water. Keep machine clean and tools locked in tool box. Cover radiator in frosty locations.

TYPICAL FIELD RECORD OF PLANT

Date arrived	Date despatched	Consigned to
(A)pproximate No. of hours in use	124 hrs.	METRO D. E. DEPOT Laurens Street, North Melbourne.

List of Tools, Spare Parts and Equipment.		Details of Repairs effected in the field or necessary before further use.
Despatched with Machine	**Returned**	
Grease Gun	Returned	Air Cock on Main Receiver leaking.
8" Screw Driver	"	Clutch will not disengage properly, requires adjustment.
9" Shifting Wrench	"	
$\frac{1}{2}$"-$\frac{5}{8}$" Spanner	"	
$\frac{7}{8}$"-1" "	"	
1 Spark Plug Box Spanner	"	
1 No. $\frac{7}{8}$" S.A.E. Spark Plug	Used	
2 No. 4 D. Padlocks	Returned	Dist. Engr. _ _ _ _ _ _ _
1 Tool Box. Medium	"	
Foreman		Foreman _ _ _ _ _
The Machine Tools, etc., are to be checked on arrival and before despatch by the Foreman.		

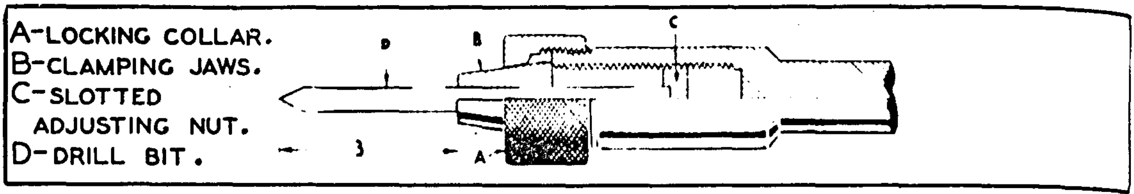


FIG. 1. DRILL CHUCK.

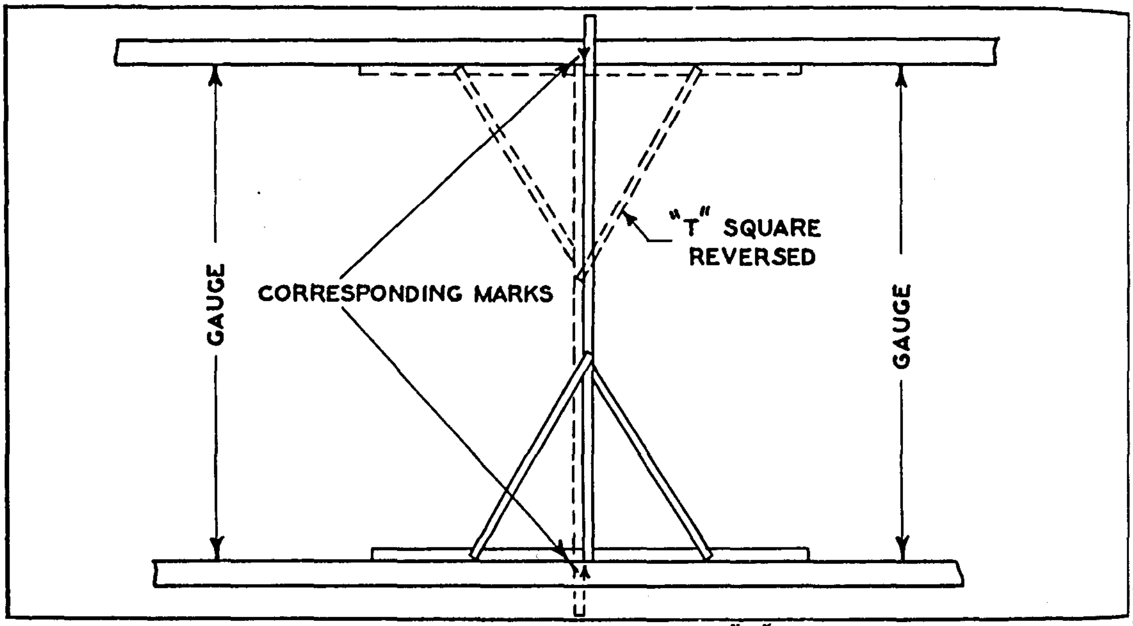


FIG. 2. A METHOD OF CHECKING "T" SQUARES.

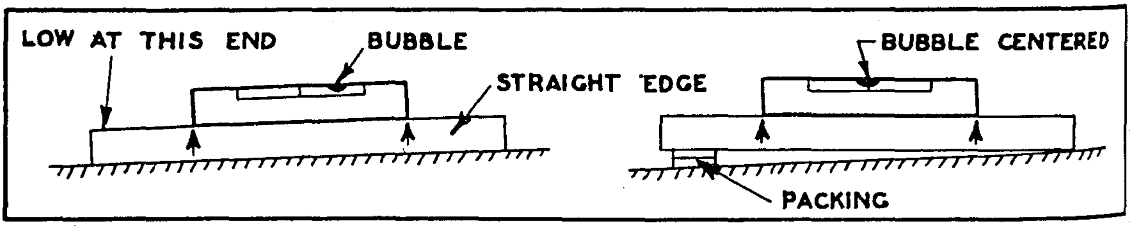


FIG. 3. A METHOD OF CHECKING SPIRIT LEVELS.

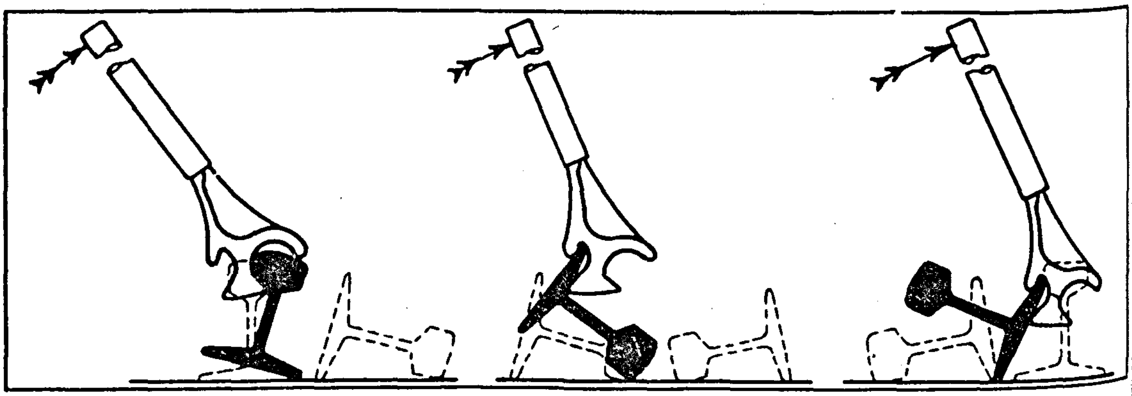


FIG. 4. USE OF THE RAIL TURNING BAR.

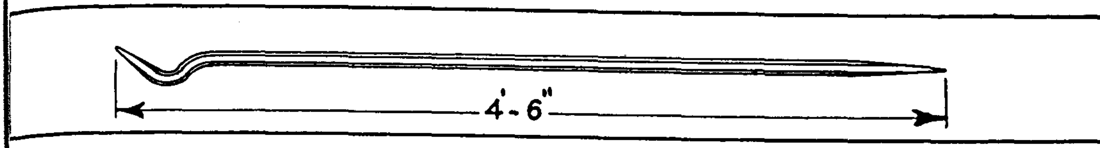


Fig. 5. Goose-neck Bar.

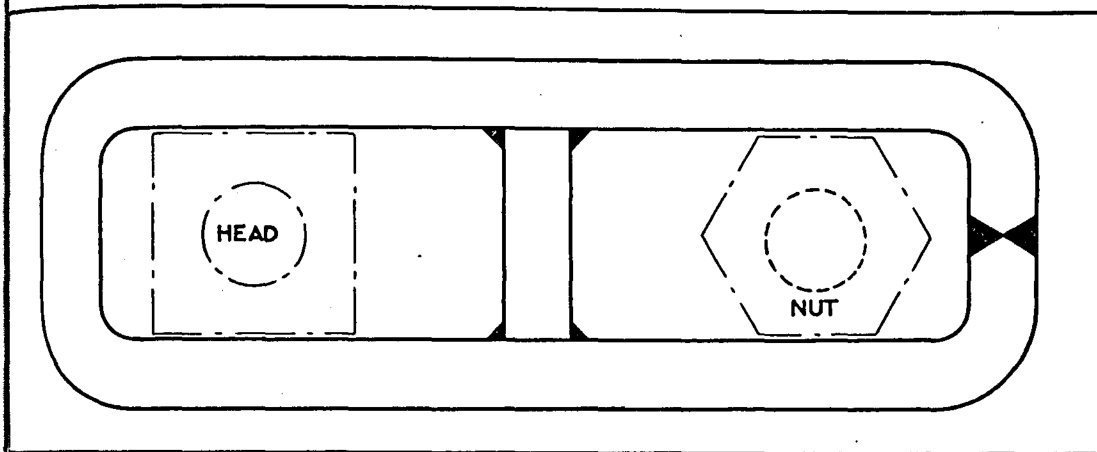


Fig. 6. The Nut Bridle.

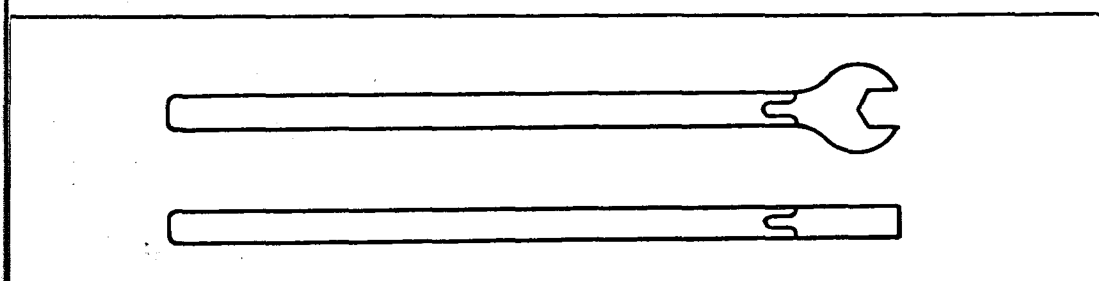


Fig 7. Standard Track Spanner.

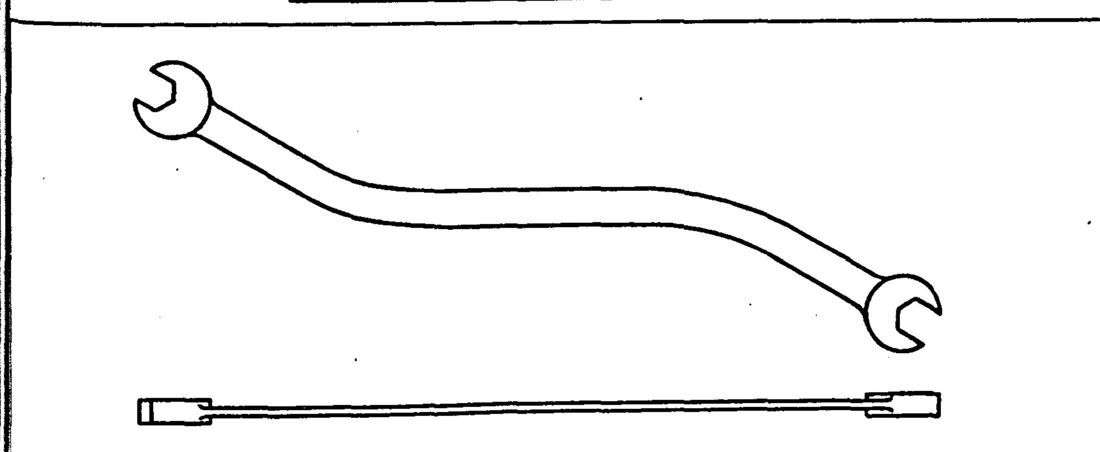


Fig. 8. Double ended Track Spanner.

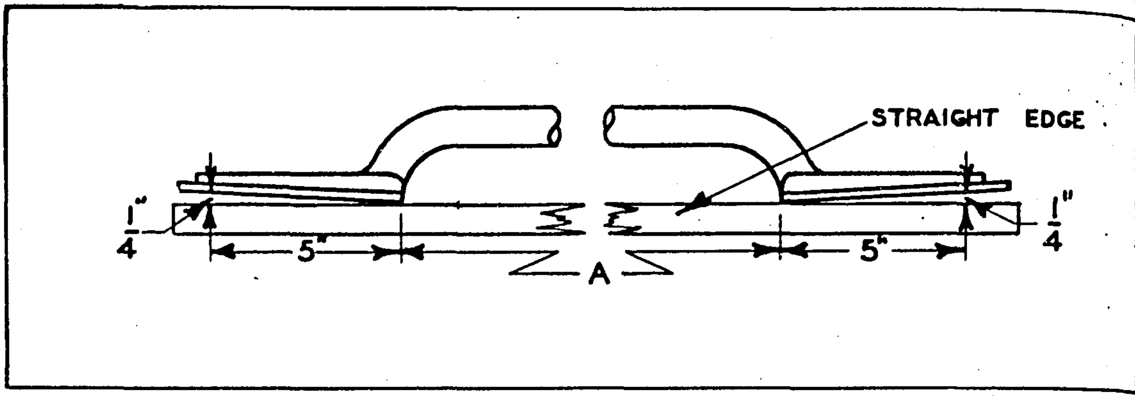


FIG. 9. METHOD OF CHECKING AN ADZING GAUGE.

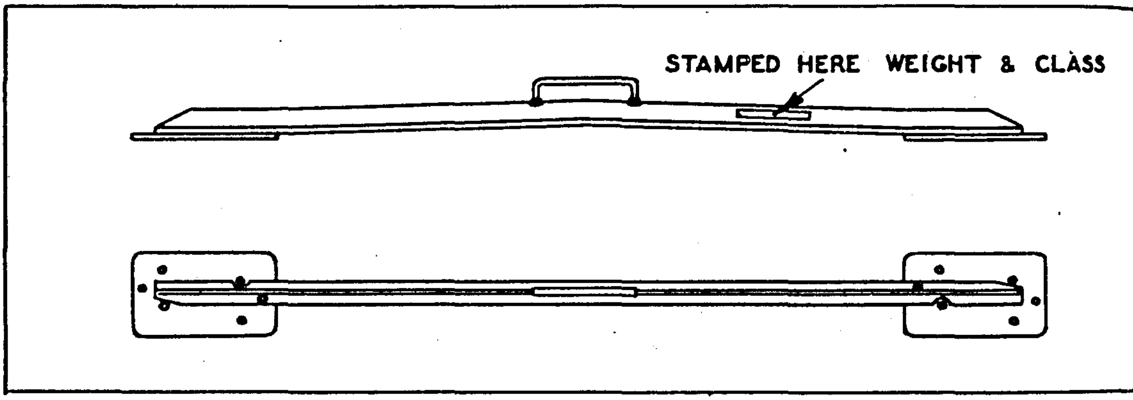


FIG. 10. TYPICAL BORING TEMPLATE.

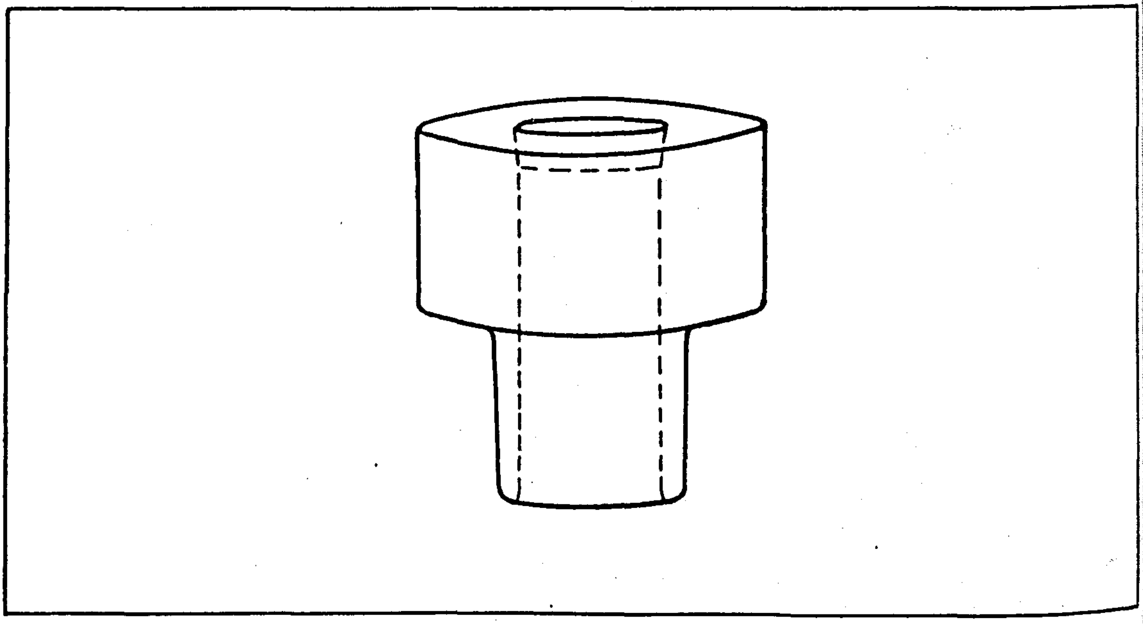


FIG. 11. BORING FERRULE.

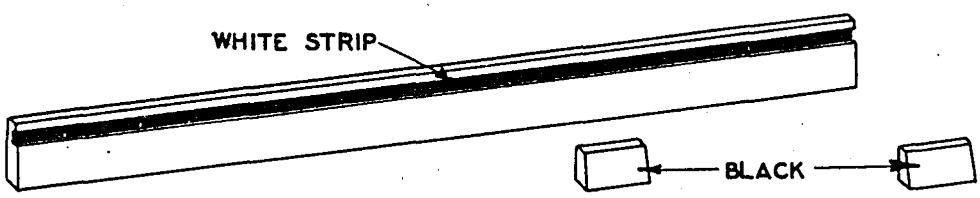


Fig. 12. Standard Sighting Board and Blocks.

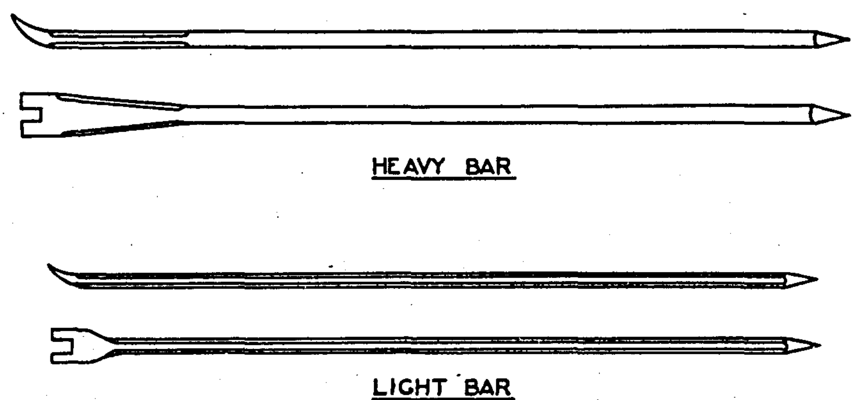


Fig. 13. Lining and Claw Bars.

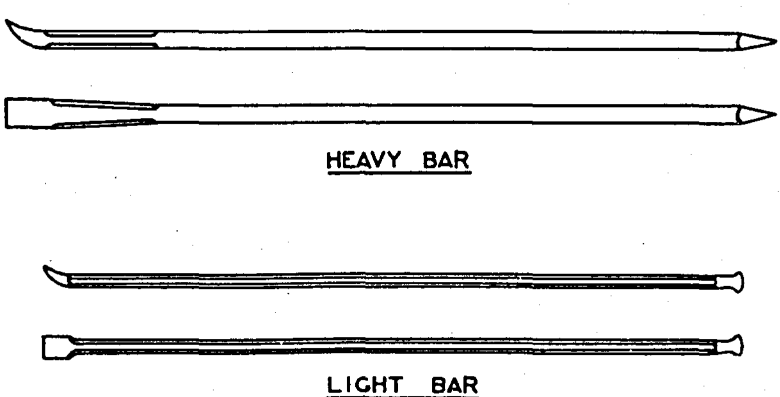
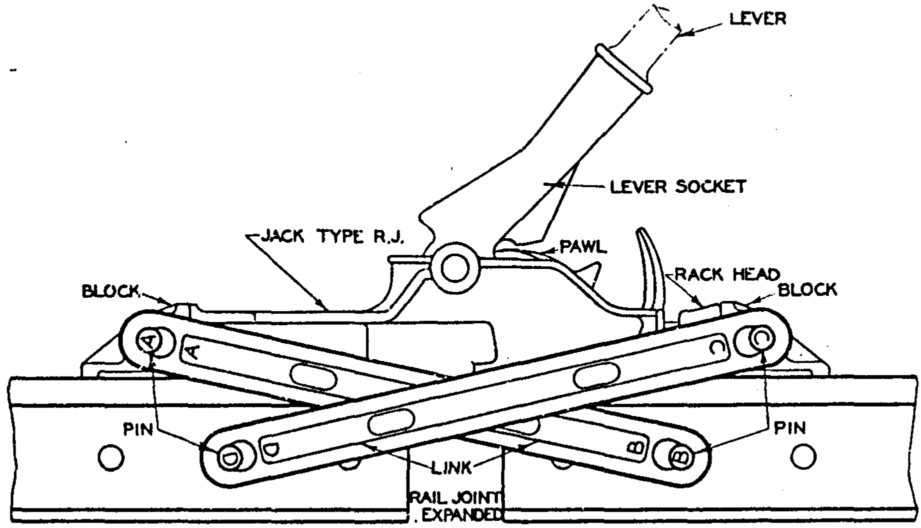
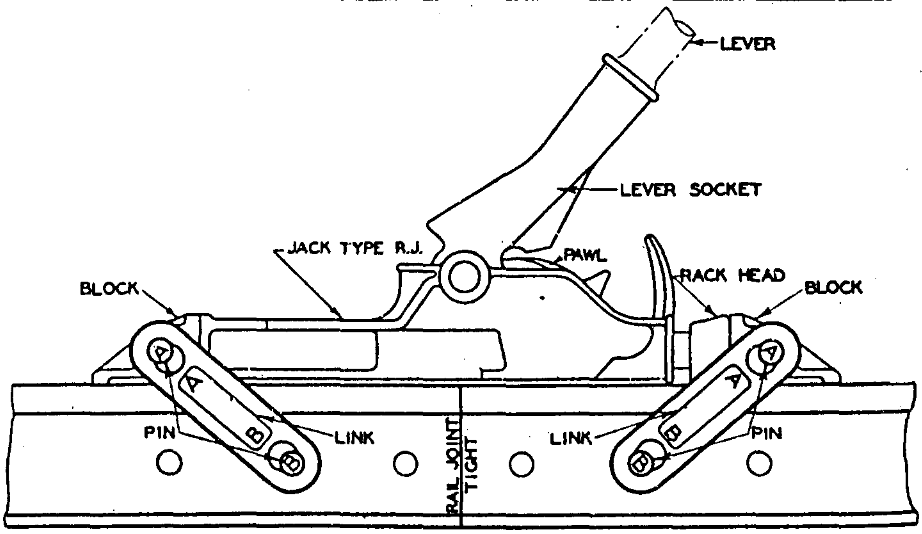


Fig. 14. Pinch Bars.



GENERAL ARRANGEMENT
ASSEMBLY WITH LONG LINKS FOR CLOSING JOINTS
FISHPLATES REMOVED



GENERAL ARRANGEMENT
ASSEMBLY WITH SHORT LINKS FOR EXPANDING JOINTS
FISHPLATES REMOVED

FIG. 15. RAIL JOINT ADJUSTER

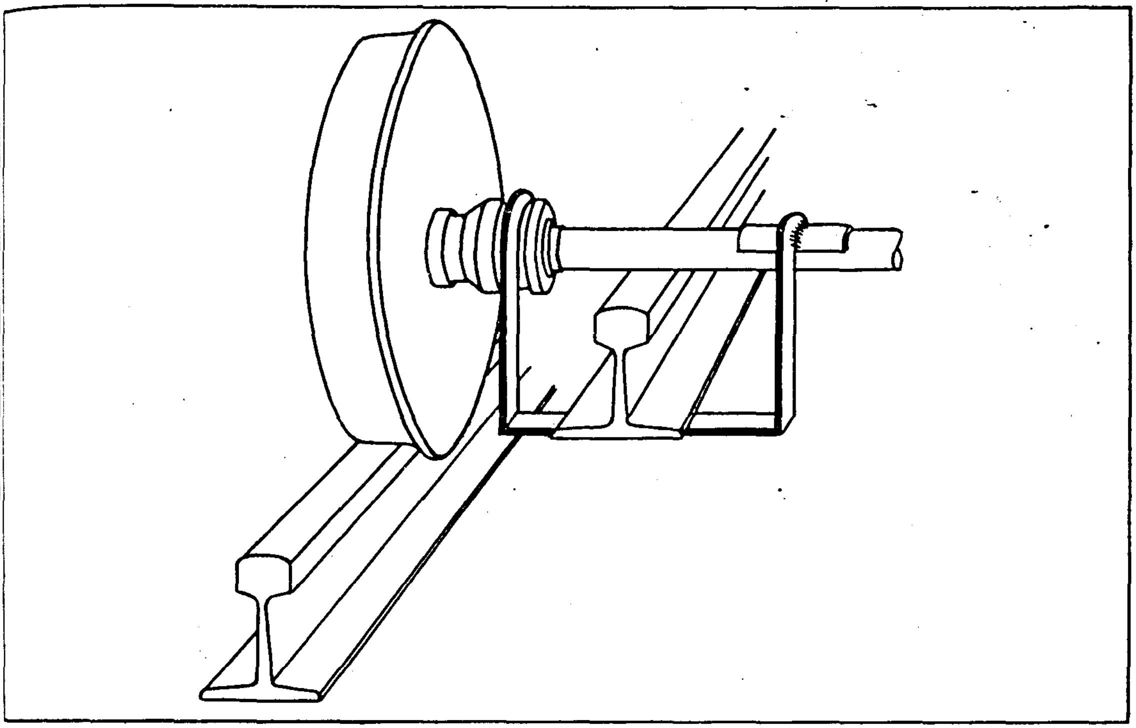


FIG. 16. RAIL HANGER.

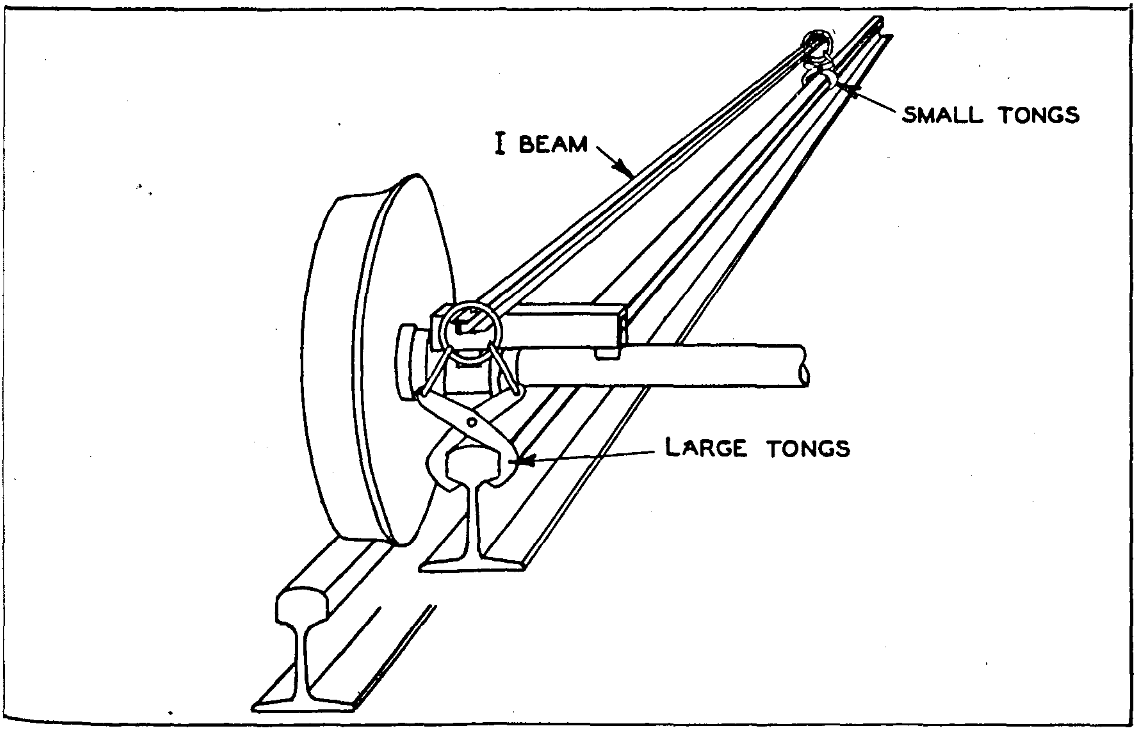


FIG. 17. RAIL LIFTING LEVER.

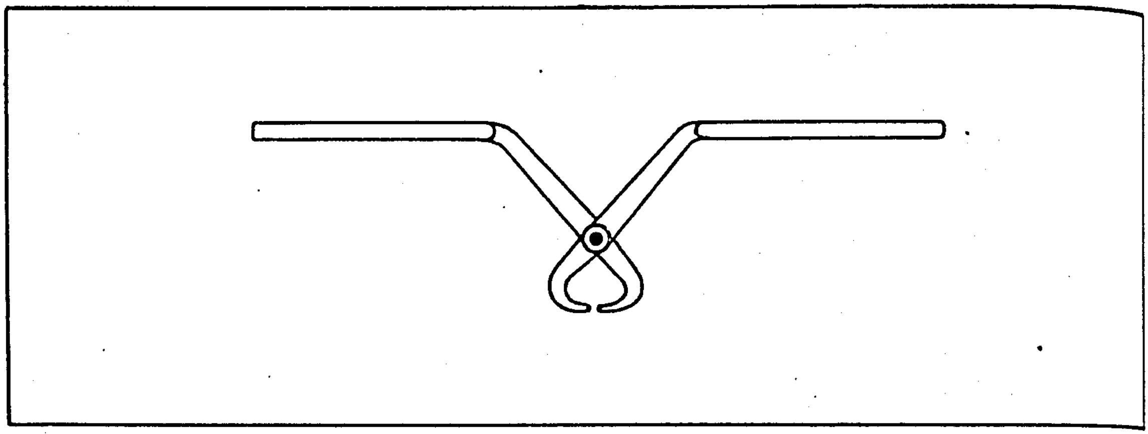


FIG. 18. RAIL TONGS. OLD STANDARD.

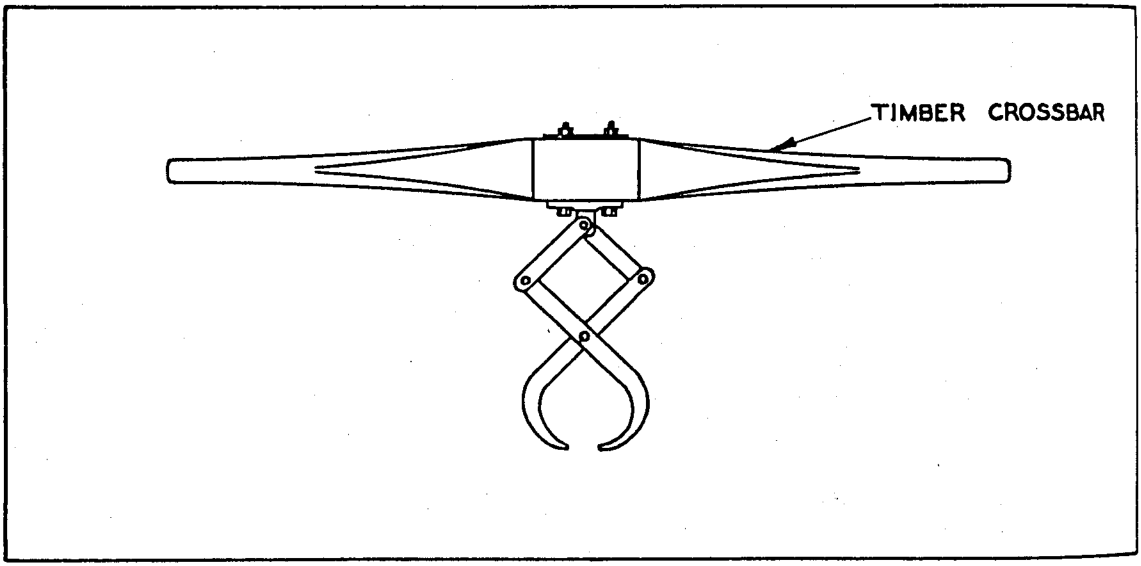


FIG. 19. RAIL TONGS. NEW STANDARD.

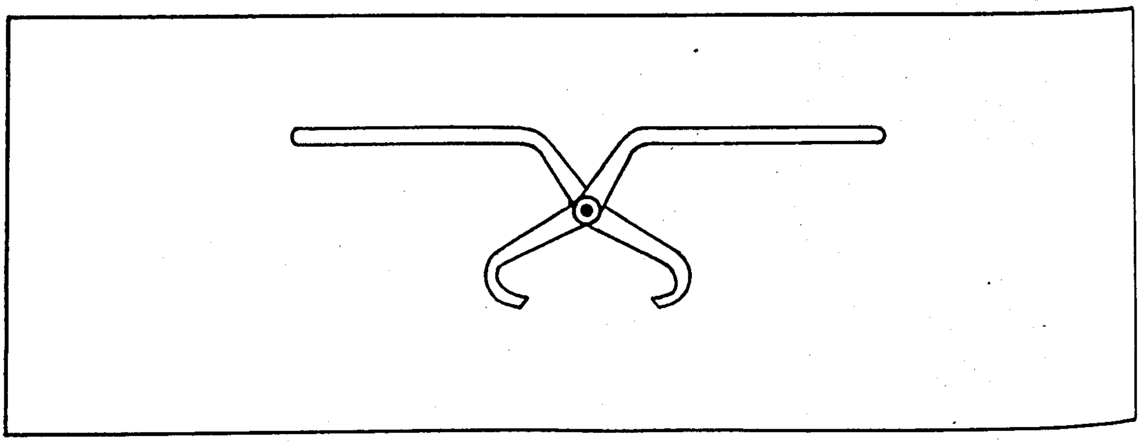


FIG. 20. TIMBER TONGS.

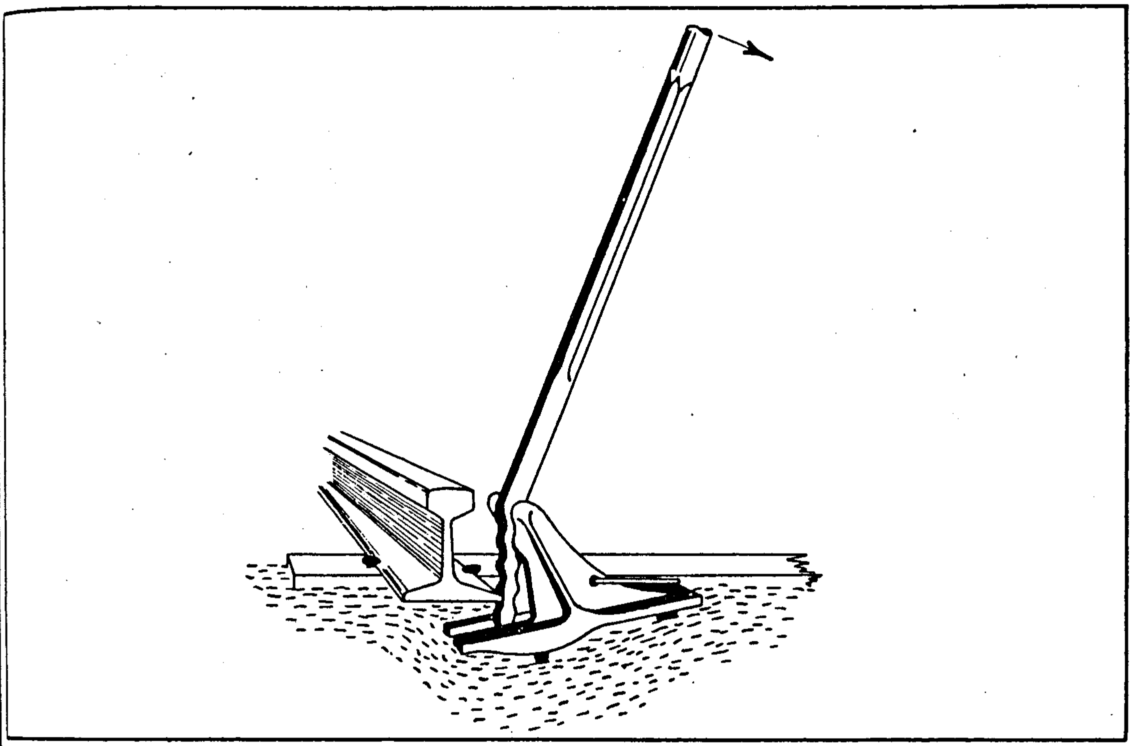


FIG. 21 . TRACK ALIGNER . TYPE "A".

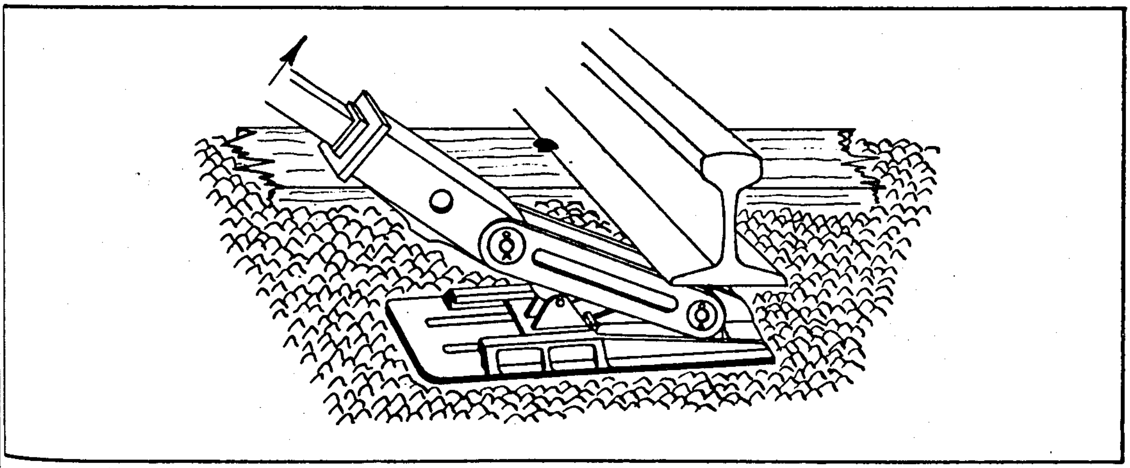


FIG. 22. TRACK ALIGNER. TYPE "B".

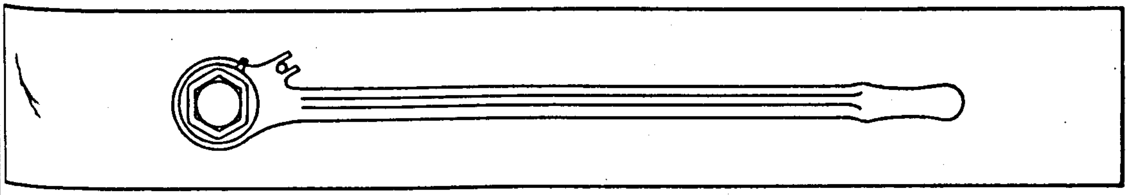


FIG. 23 . RATCHET SPANNER .

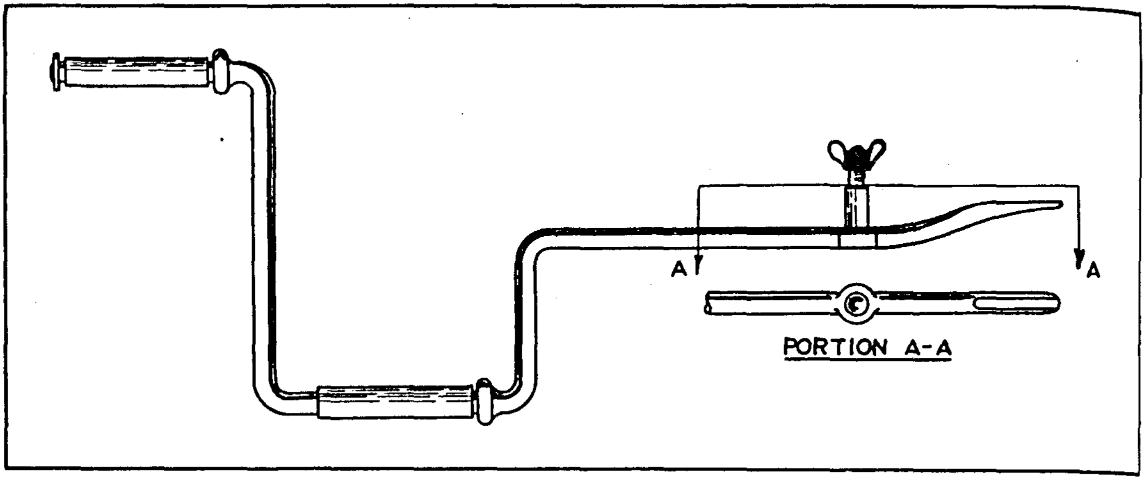


FIG. 24. JIGGER. OLD STANDARD.

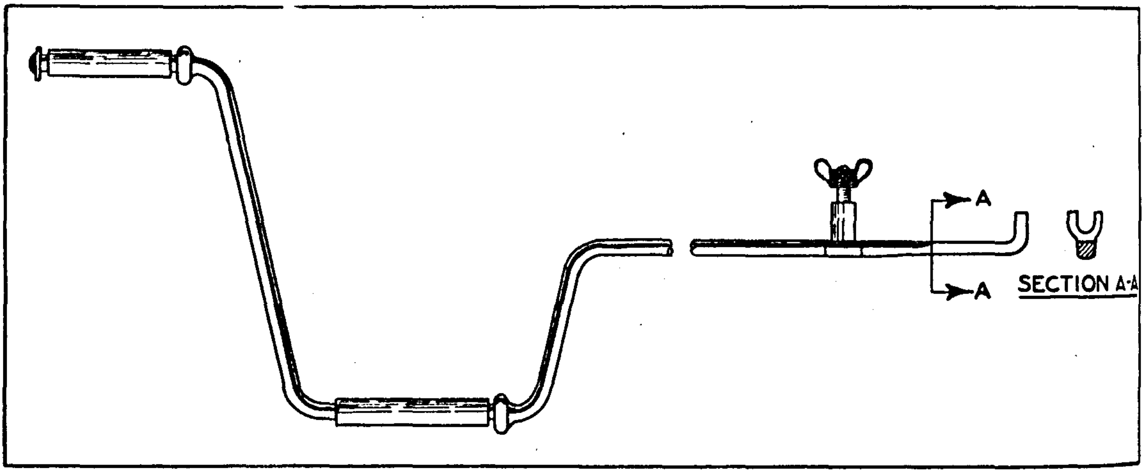


FIG. 25. JIGGER. IMPROVED STANDARD.

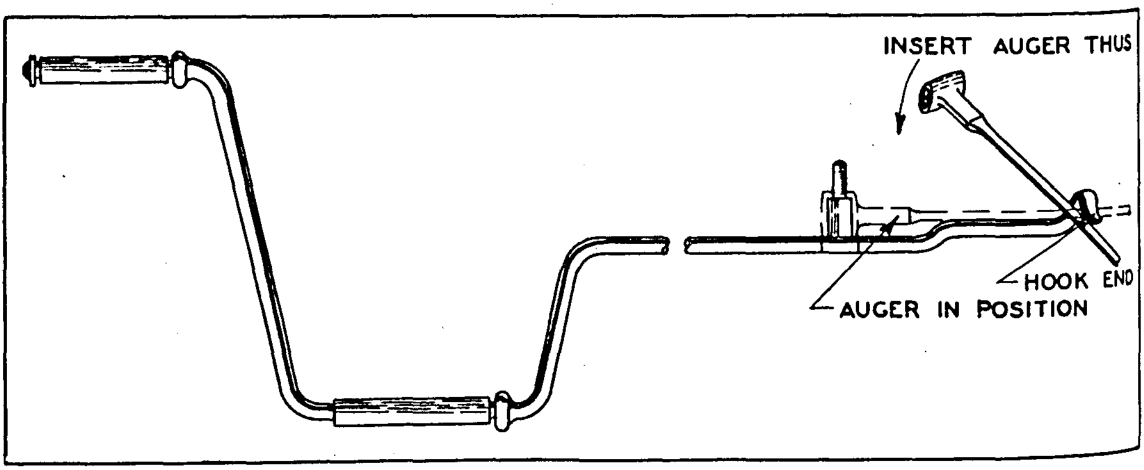


FIG. 26. JIGGER. NEW STANDARD.

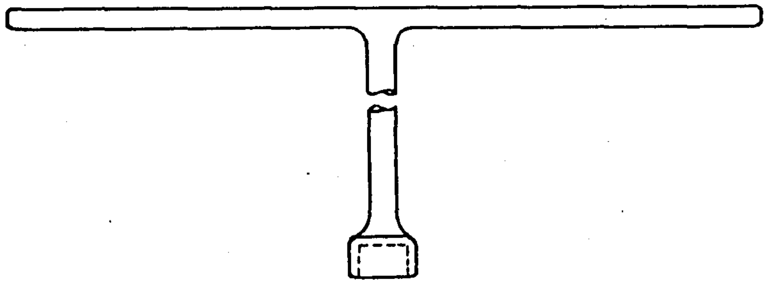


FIG. 27. SCREW WRENCH. OLD STANDARD.

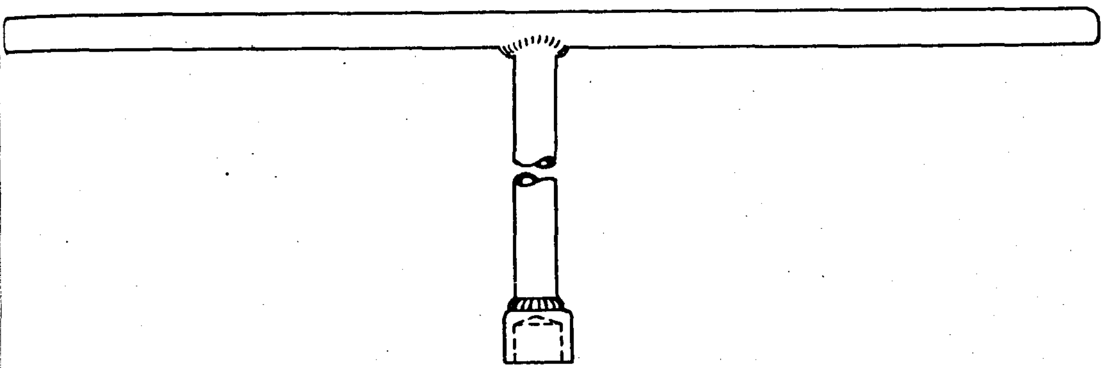


FIG. 28. SCREW WRENCH. NEW STANDARD.

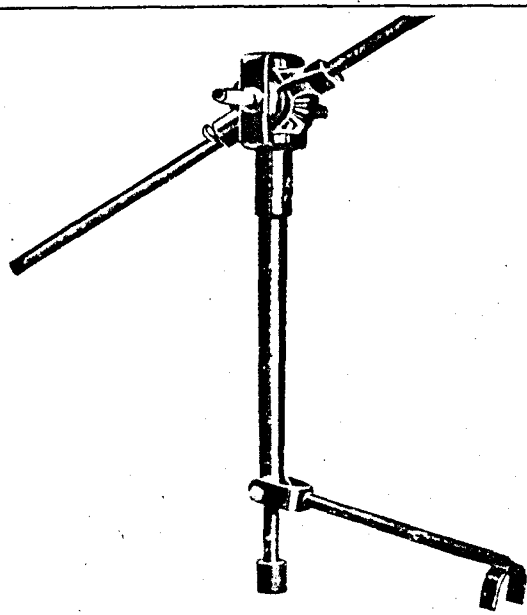


FIG. 29. GEARED SCREW WRENCH.

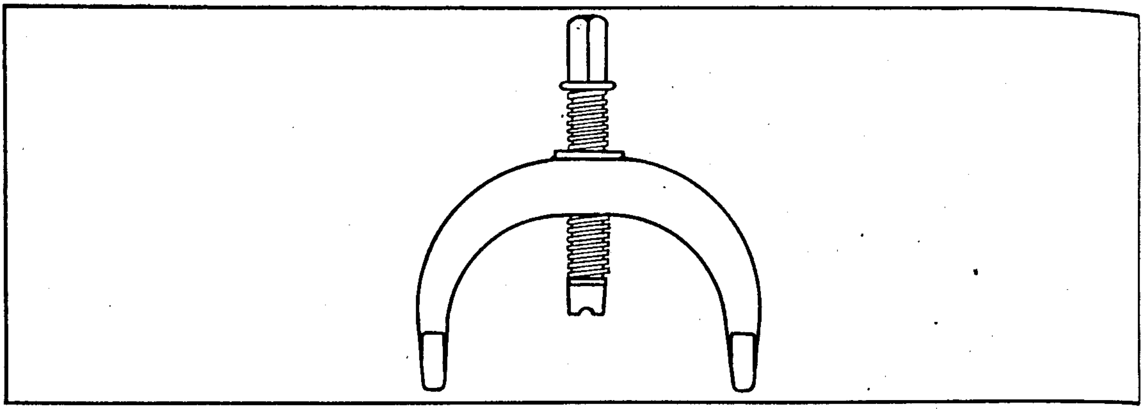


FIG. 30. LIGHT RAIL BENDER.

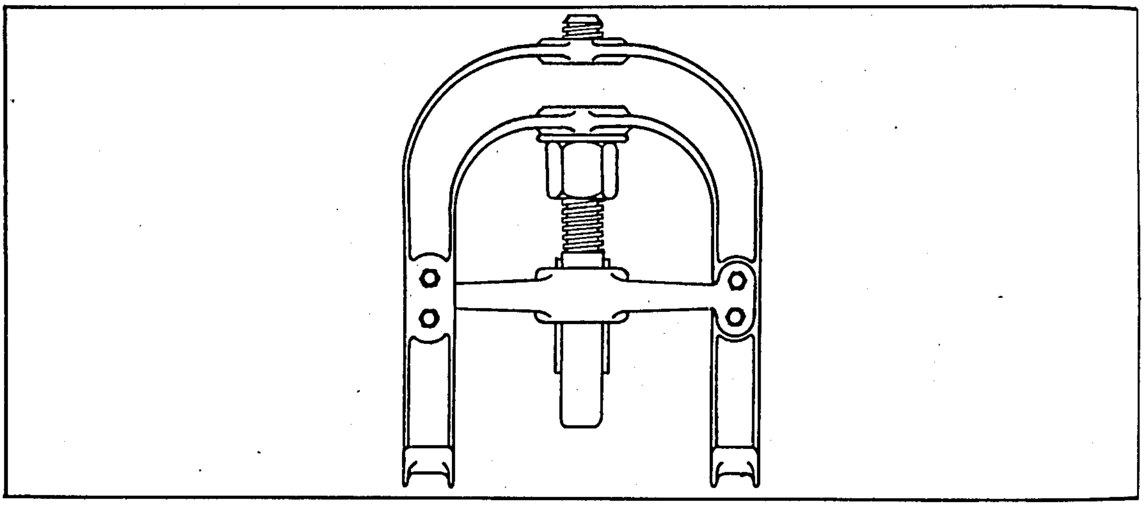


FIG. 31. HEAVY RAIL BENDER.

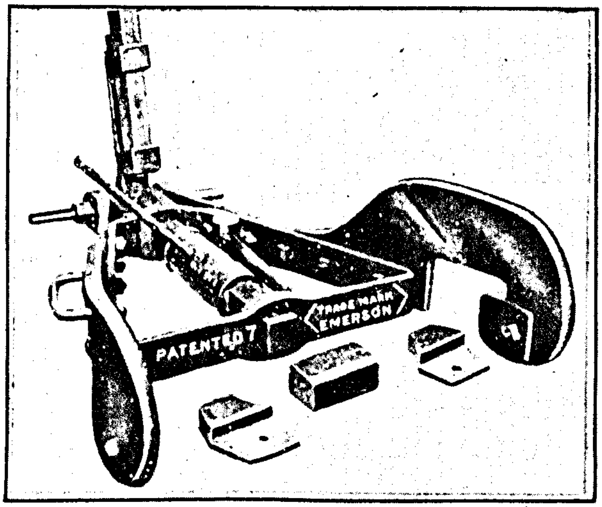


FIG. 32. EMMERSON RAIL BENDER.

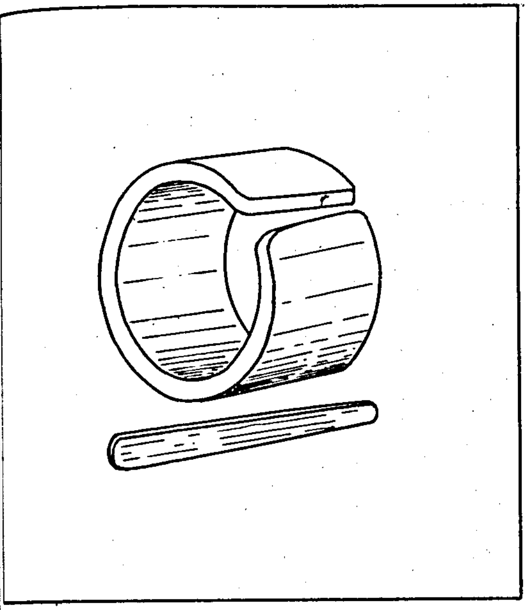


FIG. 33. WALTERS SPLIT BUSH.

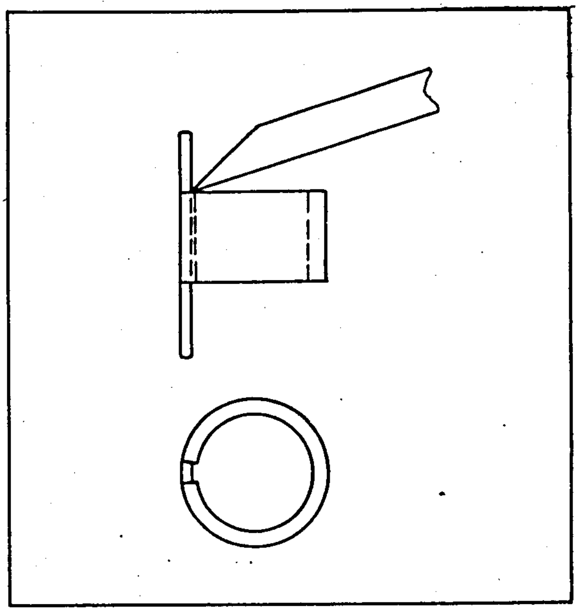


FIG. 34. WEDGING OF BUSH.

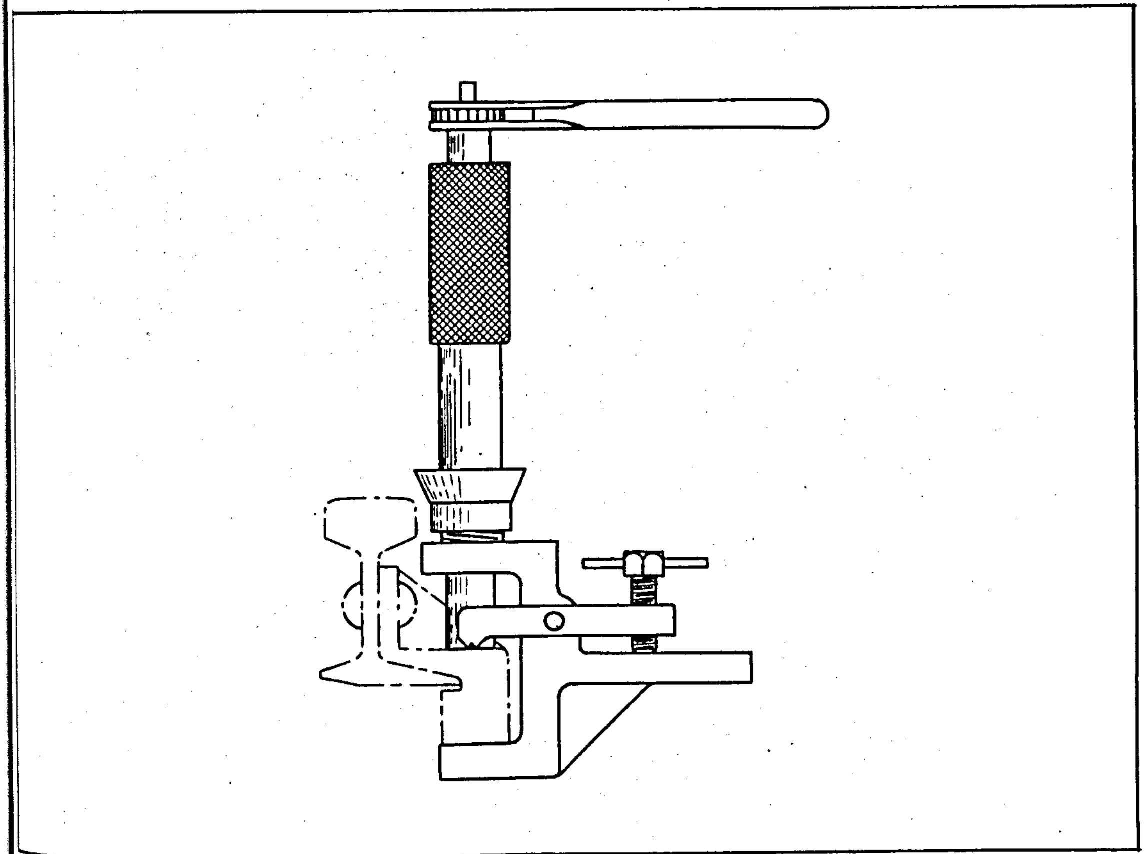


FIG. 35. PILOTED REAMERING TOOL AND JIG FOR SPREADER BRACKETS.

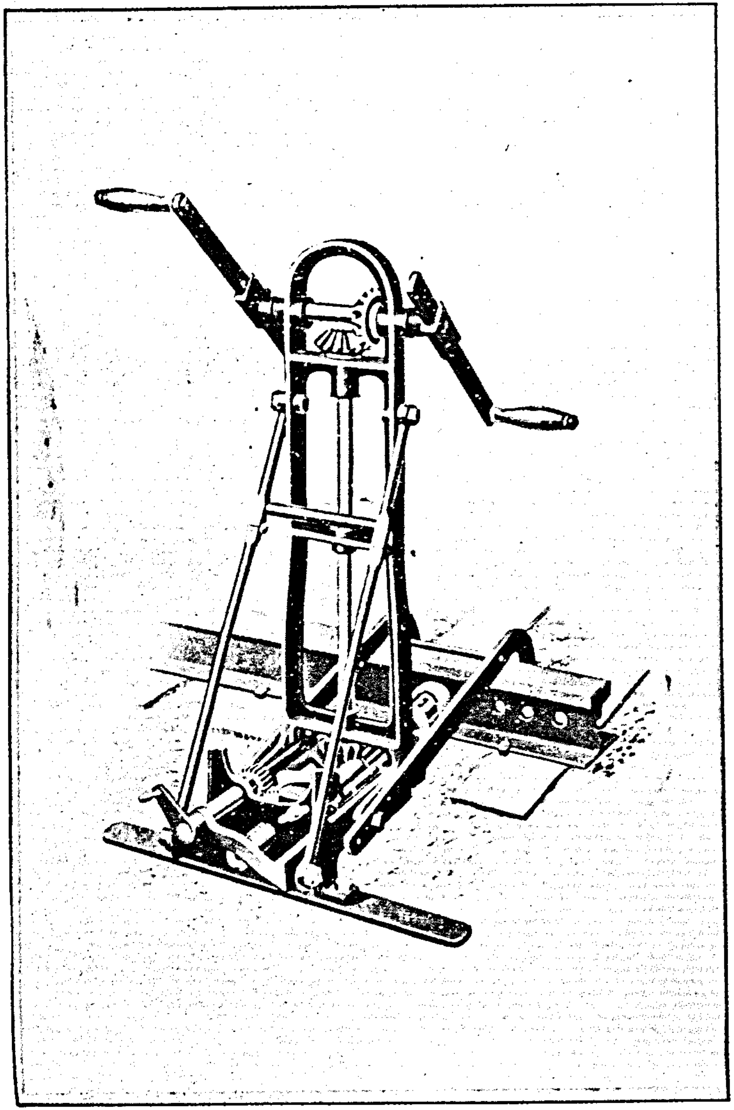


Fig. 36. Hand Operated Rail Drill.

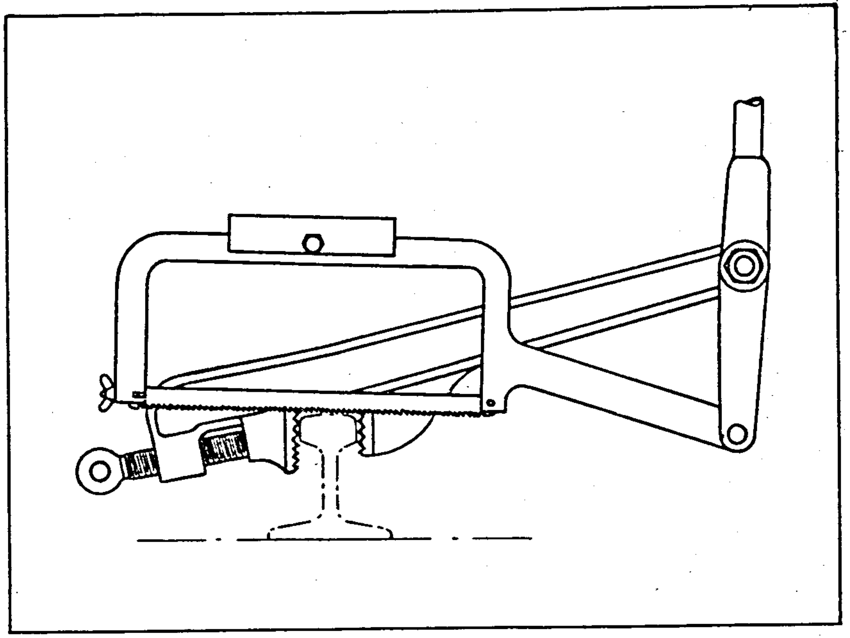


Fig. 37. Hand Operated Rail Saw.

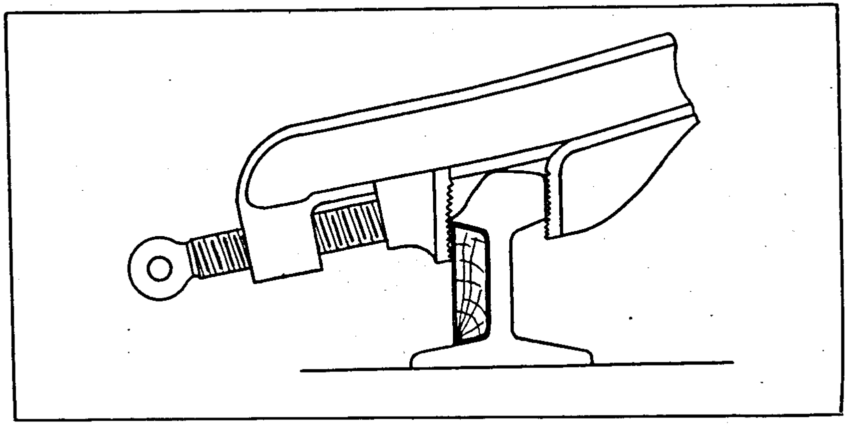


Fig. 38. Clamping of Jaws on Worn Rail.

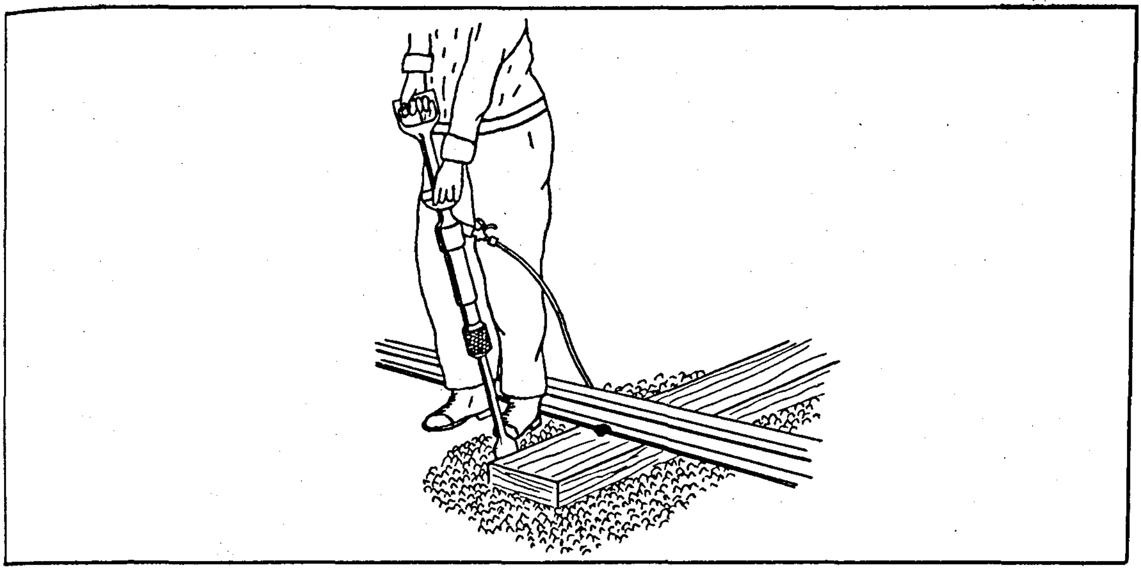


Fig. 39. Pneumatic Tie Tamper.

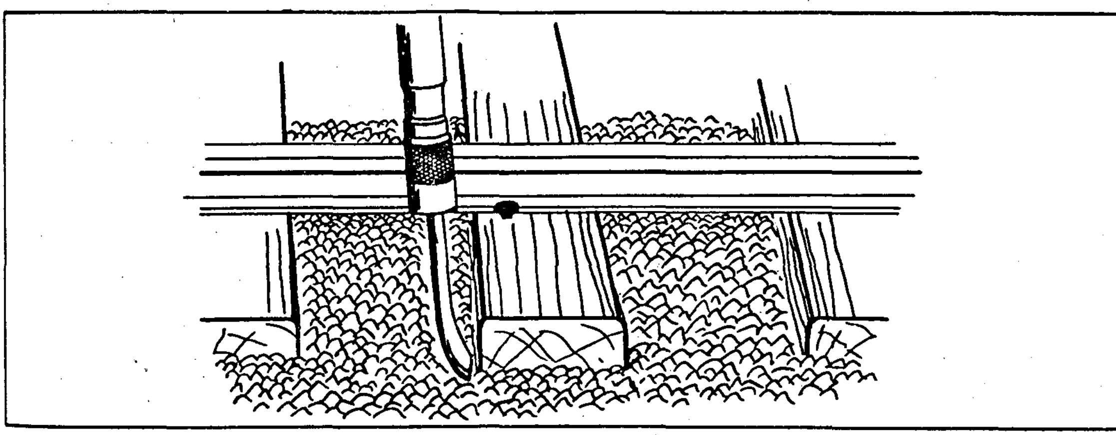


Fig. 40. Position of Tamper when Starting to Tamp.

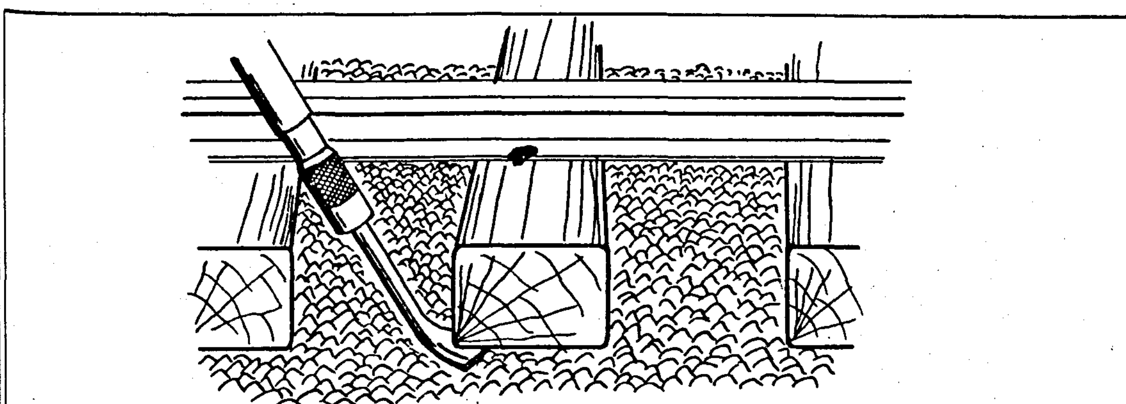


Fig. 41. Position of Tamper when Tamping Ballast under Sleepers.

Fig. 38. Clamping of Jaws on Worn Rail.

Fig. 36. Hand Operated Rail Drill.

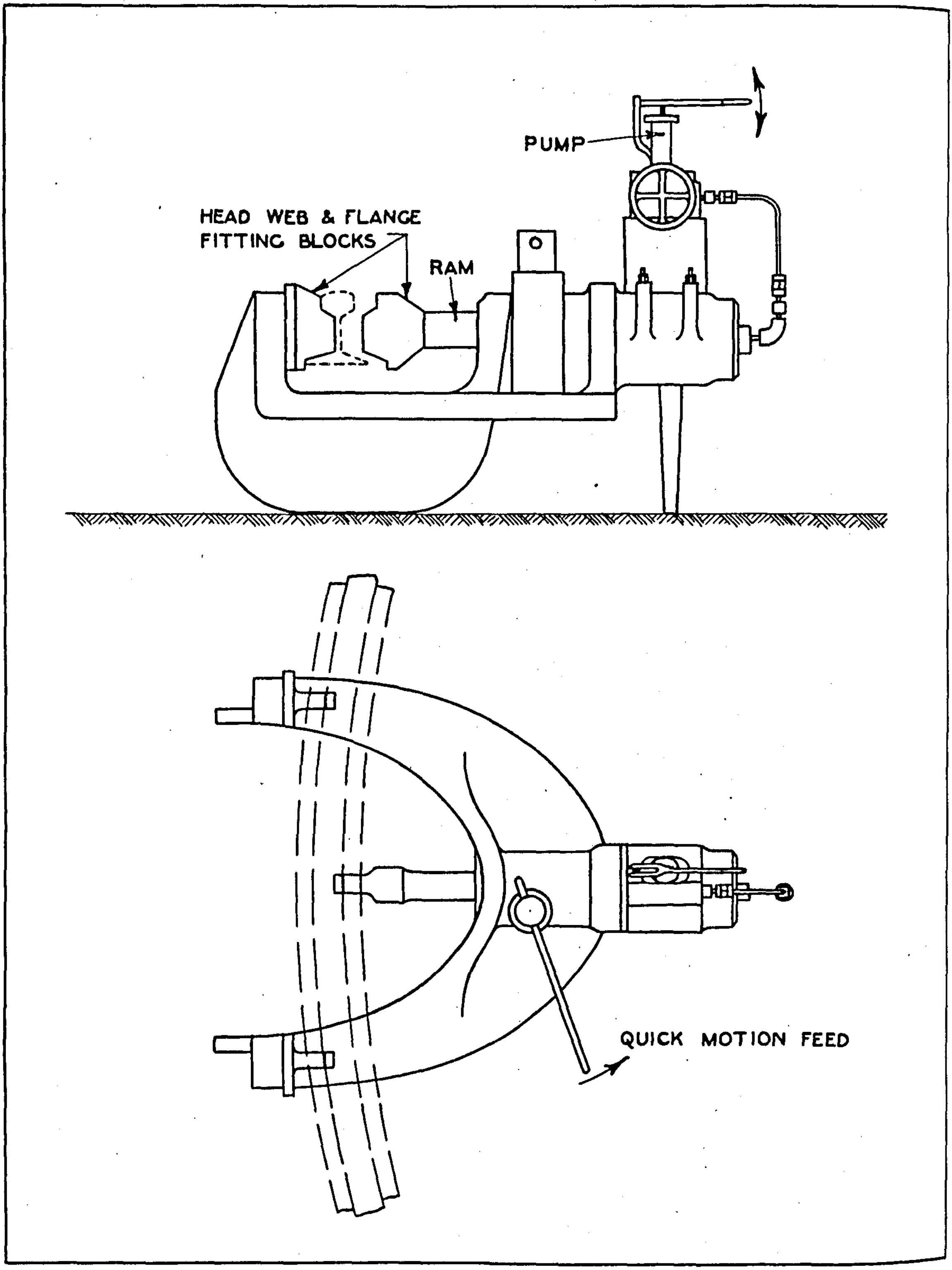


FIG. 42. HYDRAULIC RAIL BENDER.

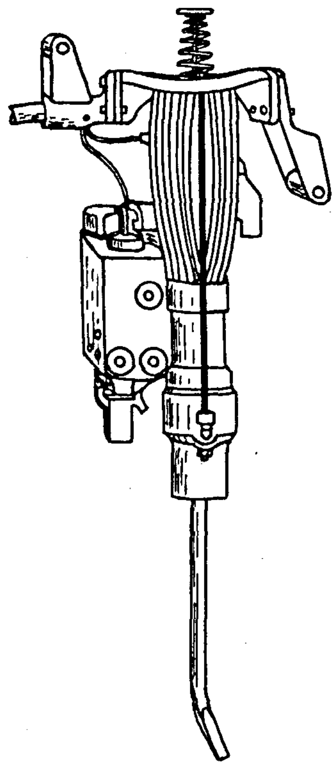


Fig. 43. Barco Tie Tamper.

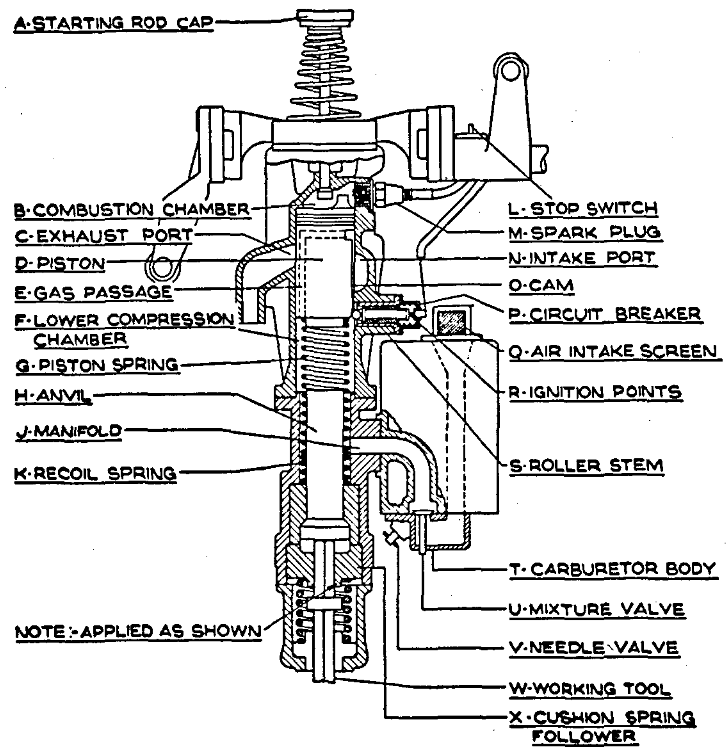


Fig. 44. Tie Tamper Operation Diagram.

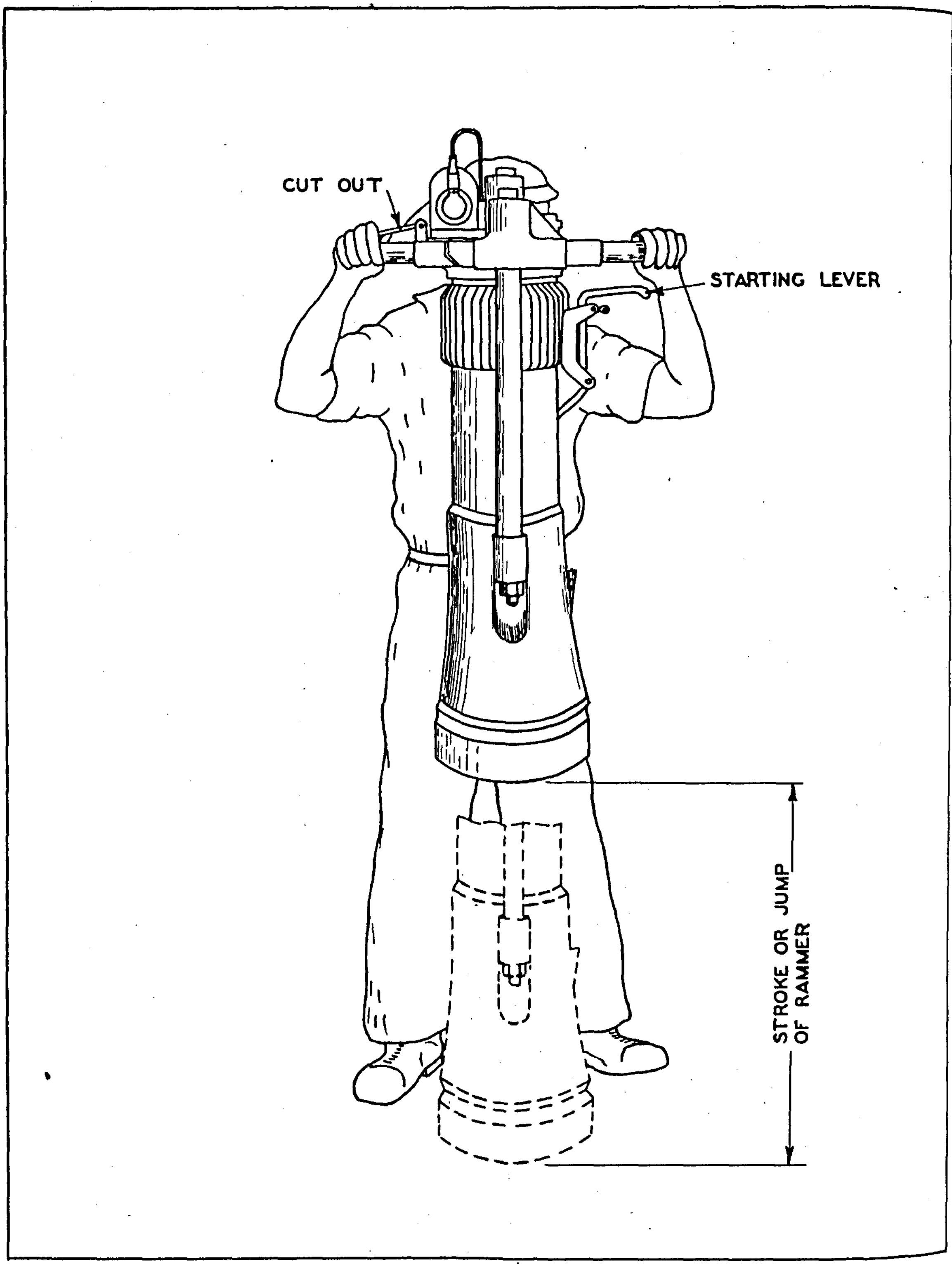


Fig. 45. Rammer.

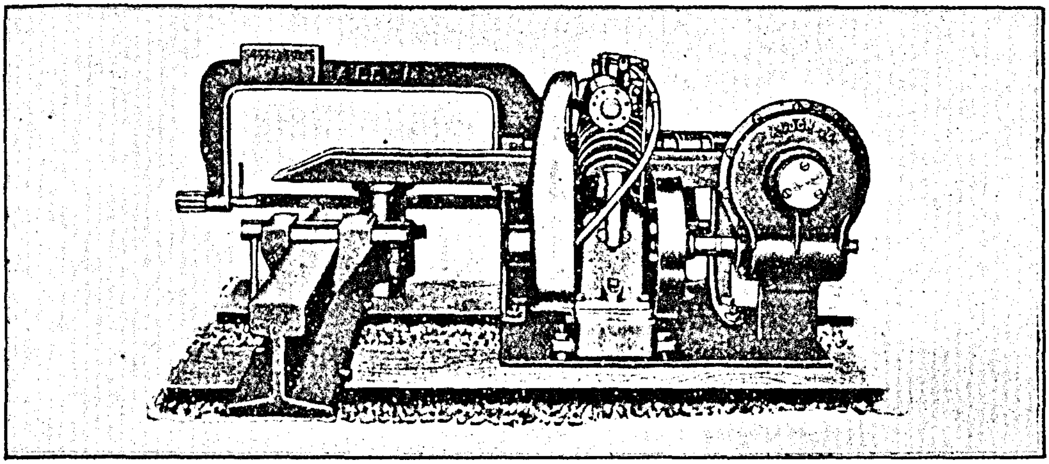


FIG. 46. POWER RAIL SAW.

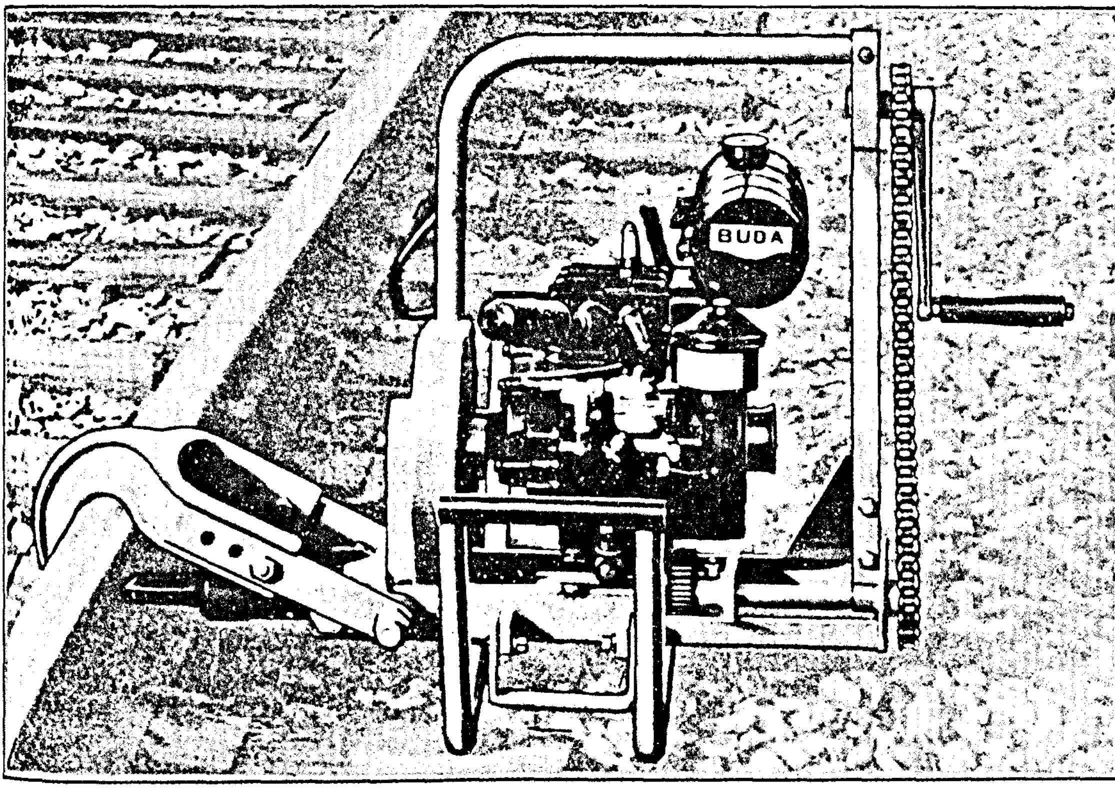


FIG. 47. POWER RAIL DRILL.

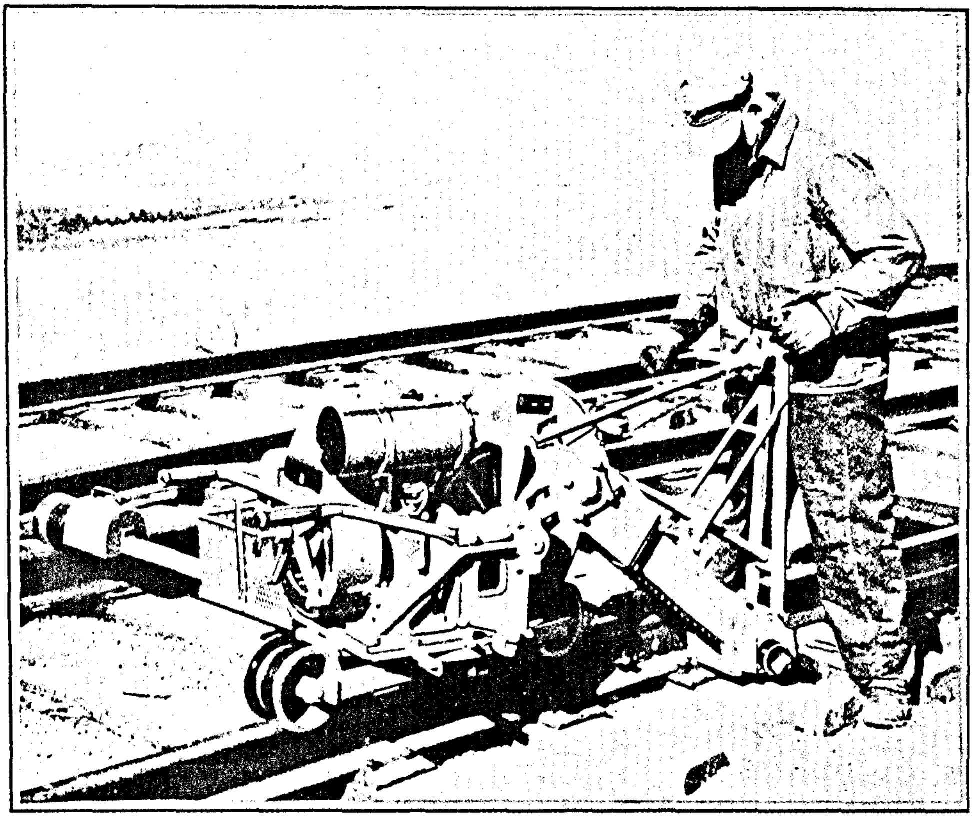


FIG. 48. POWER TRACK WRENCH.

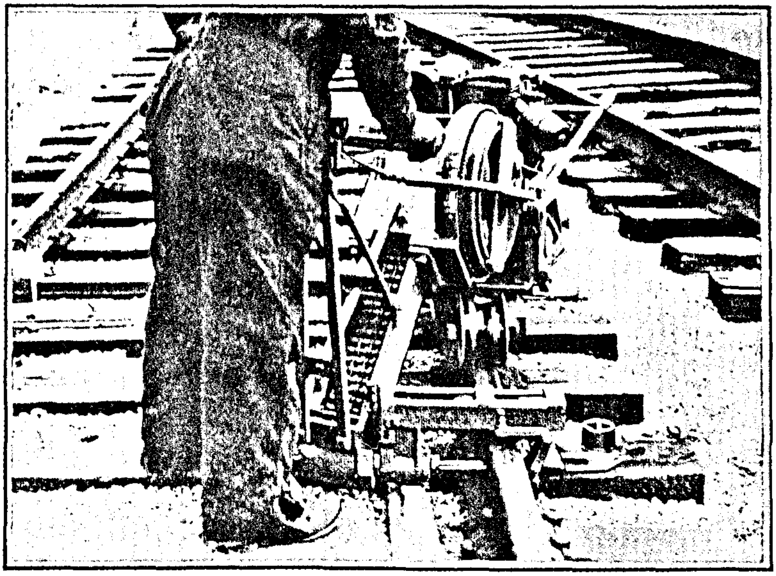


FIG. 49. DRILLING ATTACHMENT TO TRACK WRENCH.

TRACK APPLIANCES. 16.

PURPOSE

In conjunction with the track and trackwork layouts numerous appliances are provided to serve certain special purposes. Those appliances with which the trackmen have mostly to deal are described in this section.

POINT LEVERS

Point levers are installed at hand worked points to control the 'lay' of the switches and hold them securely in position for the safe movement of trains.

The types of point levers now manufactured are the C.C.W. Improved Spur Lever, Q.45 Quadrant Lever, W.S^A. Spring Point Lever, and the Pier and Wharf Spring Point Lever. For maintenance purposes the spur lever is reconditioned, but for new work the C.C.W. improved spur lever is standard.

Other types of levers which are still in service but are not now manufactured are the Column Box, Converted Ford Lever, W.S. Lever, Taylor's Lever, Thompson's Lever, and Bruce's Lever. See Figs. 1, 2, 3, 4, 5 & 6.

SPUR LEVER

The spur lever shown in Fig. 7 is a weighted lever arranged to hold the switches in one position. To alter the 'lay' of the switches the lever must be pulled over by hand and be held in the reverse position during the movement of vehicles through the points.

Owing to the different weights and lengths of switches in use the energy required for operation varies, and to meet these conditions, three sizes of spur weights are provided :-

For light switches	use	6"	dia.	weight	=	44	lbs
" medium	"	"	6½"	"	" =	56	"
" heavy	"	"	7"	"	" =	70	"

The energy required to rapidly move the weight and to bring it to rest is considerable and increases as the square of the velocity of motion. If a heavy weight is used unnecessarily, as with the short 60 lb. switches, the excess energy in the weight will tend to force the stock rails out of line, damage the rods, cranks and spreaders, and unduly wear and loosen the pins, screws and fastenings.

C.C.W. LEVER

The C.C.W. Lever, as shown in Fig.8, is an improved type of spur lever in which the energy of the weight is cushioned by coil springs within the weight, thereby enabling a general application to all weights of points without undue damage to rods and connections.

FORD QUADRANT LEVER

The Ford Quadrant Lever, shown in Fig. 9, is a weighted lever provided with a lost motion device in the form of a notched quadrant and a spring loaded trigger attached to a loose lever.

When the trigger is engaged in one or other of the notches in the quadrant the lever operates in the same way as the spur lever. If the trigger is released and the lever moves through the arc of free motion to the other notch the 'fall' of the lever is reversed and the points are held over for the opposite 'lay'. The points may be operated by hand without alteration of the trigger position.

Ford Quadrant levers exist in three sizes and are generally distinguished by the dimension 'D' in Fig. 9, being $10\frac{1}{2}$", $11\frac{1}{2}$" or $12\frac{1}{2}$". The three sizes were employed with the three different switch throws in use prior to 1927, but the $12\frac{1}{2}$" quadrant has been the only size manufactured for many years.

Ford levers, by the nature of the design, are prone to rebound and, under unfavorable conditions, if the rate of rebound corresponds with the lateral impulses of passing wheels, the lever may pull the switches open and cause mounting or splitting of the switches.

To guard against this contingency the design was modified in 1920 to provide a spring loading in lieu of the ball weight; this type of lever, of which many are in use, is shown in Fig. 2, and when introduced was described as a W.S. lever, but is now known as the Converted Ford lever.

Q.45 LEVER

The Q.45 Quadrant Lever shown in Fig. 10 is an improved quadrant lever furnished with either of two weights; Mark 'L' for points under 80 lb. weight, and Mark 'H' for points of 80 lb. weight and over.

W.S. LEVER

The W.S. lever shown in Fig.3, was introduced in 1933 and many of this type are in use.

A defect common to the Converted Ford and W.S. levers is the tendency for the spring sleeve to jump out of engagement with the adjusting screw. This usually occurs when the levers are not correctly centred for even throw of the switches or when the throw exceeds $4\frac{1}{2}$ inches.

W.S.A LEVER

The W.S.A Lever shown in Fig. 11 is the standard spring point lever now made for hand worked points other than points on piers and wharfs.

Steel castings are employed for the lever, lever frame, spring sleeve and toggle. The toggle slides in guides in the lever frame to prevent it slipping out of position.

On the upper surface of the spring sleeve the word 'Top' is cast in raised letters and the sleeve should always be assembled in this way. The operating spring is completely enclosed within the spring sleeve which has an opening in the bottom to drain water and emit wind-borne materials in sandy districts.

PIER SPRING LEVERS

These are in use on Melbourne Harbour Trust piers and in floored locations such as Goods Sheds.

This type of lever, shown in Fig.12, is similar in operation to the W.S.A point lever, but incorporates a loose handle and dog clutch engagement. Adjustments are similar to the W.S.A spring point lever.

INSTALLATION

The C.C.W., Q.45 and W.S.A point levers are suitable for the 5" switch throw in 94 and 107 lb. points when rodded and arranged as shown in Fig. 16.

With the older arrangements of rodding and timbers the throw of all switches is limited to $4\frac{1}{2}$".

POINT LEVER ADJUSTMENTS

Faulty operation may result from incorrect adjustment of point levers.

In the case of spur levers the weight acts through the short spur lever to provide the energy to move the switches as well as to hold them against the stock rail, and the angular position of the weight directly affects the energy of the lever. See Table 16.11.

Spring point levers are provided with adjusting screws to vary the compression of the spring to meet requirements. Long and heavy switches require more spring compression for operation than is necessary or desirable with short light weight switches. When the adjustment of the spring compression has been made, the lock nut on the adjusting screw must be tightened to maintain the adjustment.

The location of the lever frame on the timbers directly affects the operation of the lever and the instructions for installation provide as follows : -

1. Totally release the spring adjusting screw.
2. Connect up the rodding.
3. Place the switches half open.
4. Place the point lever handle in a vertical position.
5. Set lever base in position, mark off base for set screws and turn in the screws.
6. Adjust the spring compression to exert sufficient pressure to hold the switches to the stock rails.
7. Tighten the lock nut on the adjusting screw.

Excessive compression of the spring greatly increases the effort required to operate the lever. See Table 16.11.

ALIGNMENT

Alignment of the levers, cranks, lever rods, pull rods, operating spreader brackets and the pins in the linkage must be correct otherwise binding at the joints and bending of the rods will greatly reduce the available energy of the lever to control the movement of switches.

The rod jaws must be in the same plane and suitable operating spreader brackets are provided for this purpose. See 16.05.

PULL RODS

Pull rods connect the operating spreader (see 14.013.) either direct with the point lever or through the medium of a crank and lever rod.

The old standard pull rods shown in Figs. 13 & 14 must not be re-installed when renewals are being effected, but many of these are still in use.

The present standard pull rods are shown in Fig.15, but special length rods are provided to meet non-standard conditions. Wherever practicable the standard pull rods should be used in conjunction with the crank and lever rod as shown on the standard diagrams and illustrated in Fig. 16.

LEVER RODS

Old standard lever rods are shown in Figs. 17 & 18, and the present standard in Fig. 19. Ford and Converted Ford levers have a special lever rod eye to connect with these types of point levers, as shown in the figures.

The two lengths of lever rods 1'10" and 2'10" are necessary to provide a working clearance between point levers attached to double compounds and similar arrangements, as room must be provided for the operator to stand between the point levers without fouling the operation of the second point lever.

Lever rods used with C.C.W., Q.45 and W.S^{A}. levers for 5" switch throw are each 2'3" long.

CRANKS AND CRANK STANDS

Cranks and crank stands are issued as an assembly; the type formerly standard is shown in Fig. 20 and the present standard in Fig. 21.

The former standard is secured to the timbers by three No. $\frac{7}{8}$" dia. pins, and the latter by four No. 1" dia. mark 'B' or 'R' screws.

OPERATING SPREADER BRACKETS

Operating spreader brackets are of various types and are bolted to the No. 1 or operating spreader; their purpose is to provide a connection between the pull rod and the operating spreader.

The type of operating spreader bracket now standard for hand worked points is No. 11 B 43 for pins in the vertical plane, and No. 10 B 43 for pins in the horizontal plane. See Fig. 22.

RESILIENT SUSPENSIONS

The increase in length and weight of switches necessitates the application of greater effort to operate the switches, and when these are at some distance from the signal box further energy is absorbed in movement of rods, cranks, etc.

To reduce the pull required to throw the switches a means of suspension is provided, where necessary, in the form of a resilient suspension. The type of resilient suspensions in present use and their installation at points are shown in Fig. 23.

Installation and maintenance is carried out by fitters, but trackmen should observe whether the device is operating or not and report any defects noticed.

Ballast must be kept clear of the sway beam to allow movement provided by the spring suspension.

When correctly adjusted as shown in Fig. 23, the switch should not bear on any chairs other than the heel chairs and the operation may be observed, in the absence of a passing train, by standing on the operating spreader and noting the vertical movement of the switches.

The vertical movement is controlled by the pipe distance ferrule and inserted washers, and must not exceed 1/16". An excessive rise of the switch may cause the switch to gape at the toe and thus cause mounting of wheels or damage to the switch.

TRACK LUBRICATORS

Track lubricators in use are of two types, the Meco and the P. and M.

Both machines are operated by the action of passing wheel treads actuating pumps which force the lubricant to the wiping bars. The wiping bars fit closely to the running edge of the rail and exude the lubricant at intervals along the feathered edge of the bars in the position to make contact with the fillet and upper running face of the wheel flanges.

Meco track lubricators are in use on the main suburban tracks and P. and M. track lubricators on less busy suburban and country tracks. The Meco track lubricator is shown in Fig. 24, and the P. and M. in Fig. 25.

LUBRICANT

For satisfactory operation of the lubricators and effective lubrication of the track, a specially prepared graphitic grease must be used.

The grease is charged into containers and fed under pressure to the pumps and great care must be taken to avoid ingress of foreign materials when charging is being done, otherwise blockages and possible damage to the lubricators may occur.

CAPACITY

Meco Track lubricators have a grease storage capacity of 57 lbs. and the P. and M. of $12\frac{1}{2}$ lbs; one inch of piston movement in grease container represents a grease consumption of approximately $4\frac{1}{2}$ lbs. in Meco track lubricators, and 2 lbs. in P. and M. track lubricators.

WHEEL CONTACT

Not all the wheel flanges make contact with the wiping bars, although all wheel treads actuate the pumps, and it is therefore necessary to carefully select a location in the track where light flange contact occurs.

Good maintenance of track at lubricating stations is essential as undue oscillation of vehicles causes the wheel flanges to heavily engage and damage the wiping bars.

The quantity of grease applied to each flange making contact with the wiping bars is very small, being on the average 1/2000 part of a lb.

RATE OF FEED

Regular and careful adjustment of pump settings is essential to ensure that the necessary quantity of grease is applied to wheel flanges for protection of the rail sides, but an excess of grease must not be permitted.

If the rate of feed is excessive grease will be forced up under the tread of the wheels and on to the running surface of the rails. When grease reaches the running surface of the rails the operation of trains will be adversely affected by the slipping of wheels under traction or during the application of brakes.

INSTALLATION

The installation of track lubricators is done under engineering supervision; maintenance and servicing of the track lubricators in the metropolitan area are attended to by fitters.

SERVICING

In country districts where trackmen may be required to service P. & M. lubricators, the following procedure must be followed.

1. Insert the withdrawing screw through the container cover and screw into piston.

2. Take up the slack in withdrawing screw by rotating the handle nut and slightly withdrawing the piston.

3. Remove filling hole plug and attach funnel.

4. Fill funnel with lubricant taking care not to enclose pockets of air in the lubricant.

5. Draw the piston right back to fully compress the spring.

6. As the piston is withdrawn, lubricant will be sucked into the container.

7. It may be necessary to make more than one filling of the funnel before the container is completely filled.

TROUBLES

Failure to deliver grease may be due to any of four causes : -

(a) Air lock in the lubricant container.

(b) Fine dust or metal in the guide holes in the pump castings through which the plungers operate.

(c) Worn or defective washers in the brass pump interior at the foot of the plungers.

(d) Dirt or grit in the brass pump interior.

To disperse an air lock : -

1. Insert withdrawing screw in piston head and tighten up handle nut to hold the piston.

2. Detach pump assemblies at bolts marked 'A' in Fig. 26.

3. Slacken off handle nut until grease is continuously emitted at the ports leading to pump chambers.

4. Replace the pump assemblies and operate the pump by foot to ascertain if grease is coming through.

Troubles due to (b), (c) and (d) should be attended to by a fitter.

CONDITIONS

As the condition of track is constantly changing according to running conditions, seasons and degree of maintenance, it is necessary to occasionally relocate the track lubricators to maintain good wiping conditions.

Trackmen can assist in this regard by daily observing the operation of the track lubricators and reporting when either of the following conditions is evident.

1. Absence of grease on the running sides of the outer rail of curves usually lubricated by the lubricator.

2. Unusually heavy wear commencing to take place at the feathered edges of the wiping bars.

It should be noted also that in wet weather grease will not be applied to the rail sides; this is due to the inability of lubricants to adhere to the wet wheel flanges. After rain has fallen it usually requires the passage of several trains under dry conditions to re-apply the lubricant to the rail.

The effective range of the lubricant under continued dry weather conditions and frequent train service may be as much as 10 miles.

Lubrication is effective when the rail side presents a dull faint bluish appearance on a smooth surface of the rail side, as shown in Fig. 28. The unlubricated condition is shown in Fig. 27.

The condition of the rail side is the best evidence of the effectiveness of the lubrication, and not the presence of a noticeable film of grease.

Track lubrication may not be effective on badly aligned curves where the rail at the joints is straight and the centres excessively curved. Under these conditions the unlubricated lower radius of some wheel flanges will make contact with the rail side and not the lubricated fillet and upper surface of the flange. Re-alignment of such curves to regular radius is necessary to enable track lubrication to function effectively.

Unduly wide gauge and incorrect cant for the average speed will induce heavy wear and greatly reduce the effectiveness of lubrication.

LOCKING BARS

Locking bars are provided at non-interlocked points on or leading to the main track; the type commonly in use is shown in Fig. 29, and when set over to lock the points the end of the hinged bar should closely contact the web of the closed switch. A padlock is provided to lock the bar in position as shown.

Another type of locking device occasionally used in compounds where space is restricted is shown in Fig. 30. This device is secured in position by a shear pin and padlock, and in the event of the points being trailed through, the pin is designed to shear and permit the switches to move without damage thereto. Replacement shear pins are provided for relocking the points.

CHOCK BLOCKS

Types of Chock Blocks in use are shown in Figs. 31 & 32. The pivot type is no longer installed, but many are still in use. The hinged types are now standard and are manufactured for either right-hand or left-hand operation. When in use the chock block is padlocked in the position shown in full line, and when out of use is padlocked in the position shown in dotted line.

Ballast must be kept clear of the space required for housing the chock blocks in both positions.

When chock blocks are ordered, the hand required, and the weight and class of rail for which they are required must be stated.

DERAILS

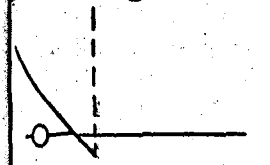
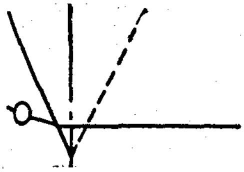
Derails are of two types, as shown in Figs. 33 and 34. That in Fig. 33 is a safety device installed and maintained by the Signal section, but the portable device shown in Fig. 34 is provided to afford protection to temporary obstructions such as workmen's sleeping cars and cars under repair in sidings which cannot be protected by the points leading into the sidings being locked for another road.

SIGNAL APPLIANCES

These appliances comprise the operating, interlocking and detecting mechanisms at points, and the train trips at sections in electric signalled track.

Installation and maintenance of these appliances is carried out by the Signal Division. Due notice must be given to the Signal Supervisor before repairs and renewals of track and trackwork are undertaken at the site of these appliances to enable the signal staff to be in attendance.

POINT LEVERS. OPERATING FORCES

TYPE OF POINT LEVER	THROW OF SWITCH	SIZE OF WEIGHT INS.	SIZE OF WEIGHT LBS.	FORCES IN PULL RODS LBS. SWITCH Closed	FORCES IN PULL RODS LBS. SWITCH Open	PULL REQRD TO OPERATE POINT LEVER LBS. To Open	PULL REQRD TO OPERATE POINT LEVER LBS. To hold Open
ur arranged thus. 	4½"	6 x 6	44	270	80	25	12
	"	6½x6½	56	320	101	30	16
	"	7 x 7	70	360	125	36	19
ur arranged thus. 	4½"	6 x 6	44	140	20	20	2
	"	6½x6½	56	172	28	24	4
	"	7 x 7	70	210	36	30	5
adrant, Q 45.	4"	7 x 5	48	367	220	47	28
	4½"	"	"	378	207	"	26
	5"	"	"	390	192	"	23
	4"	7 x 4	38	308	183	39	23
	4½"	"	"	316	172	"	21
.C.W. Improved pur. Movement qual over centre ine.	5"	-	83	194	135	32	22
alance Box	4½"	8 x 8	103	103	103	12	12
.S.A. Spring	4½"	-	-	570	-	71	-
	5"	-	-	540	-	66	-
	These forces obtain when maximum spring compression, with square section springs, is applied.						

ote: - Figures are calculated on forces necessary to overcome dead weight or spring load only, and do not take into account the forces necessary to move the points.

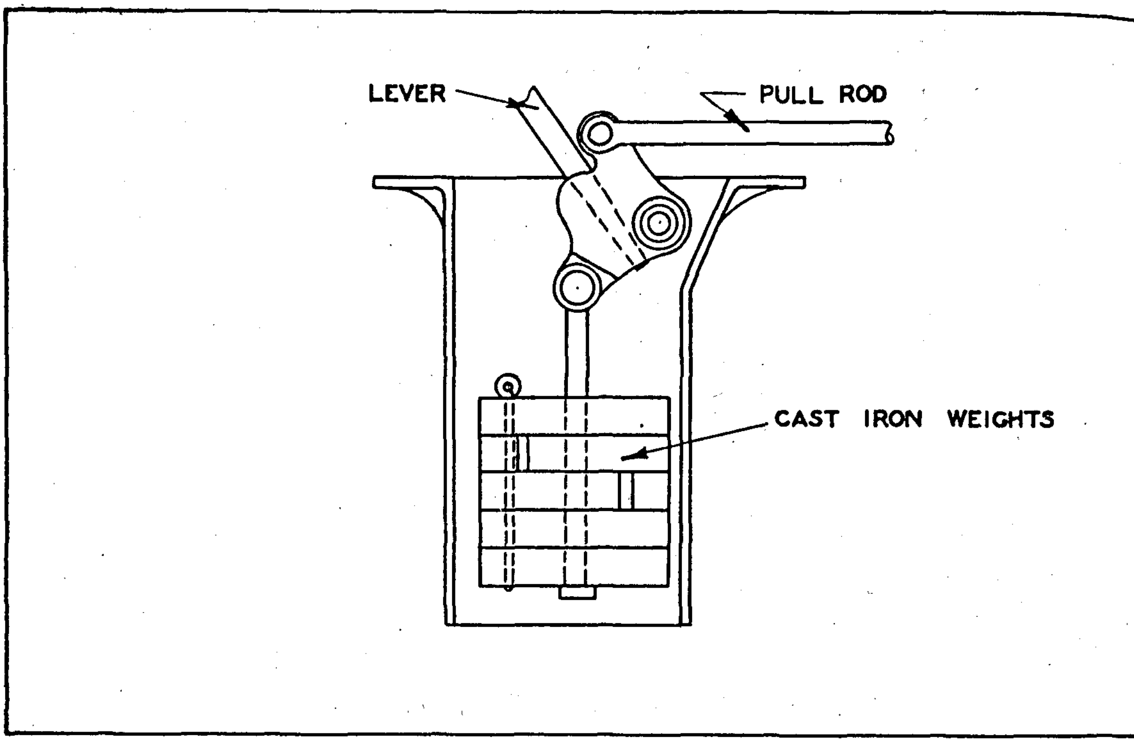


FIG.1.COLUMN BOX LEVER.

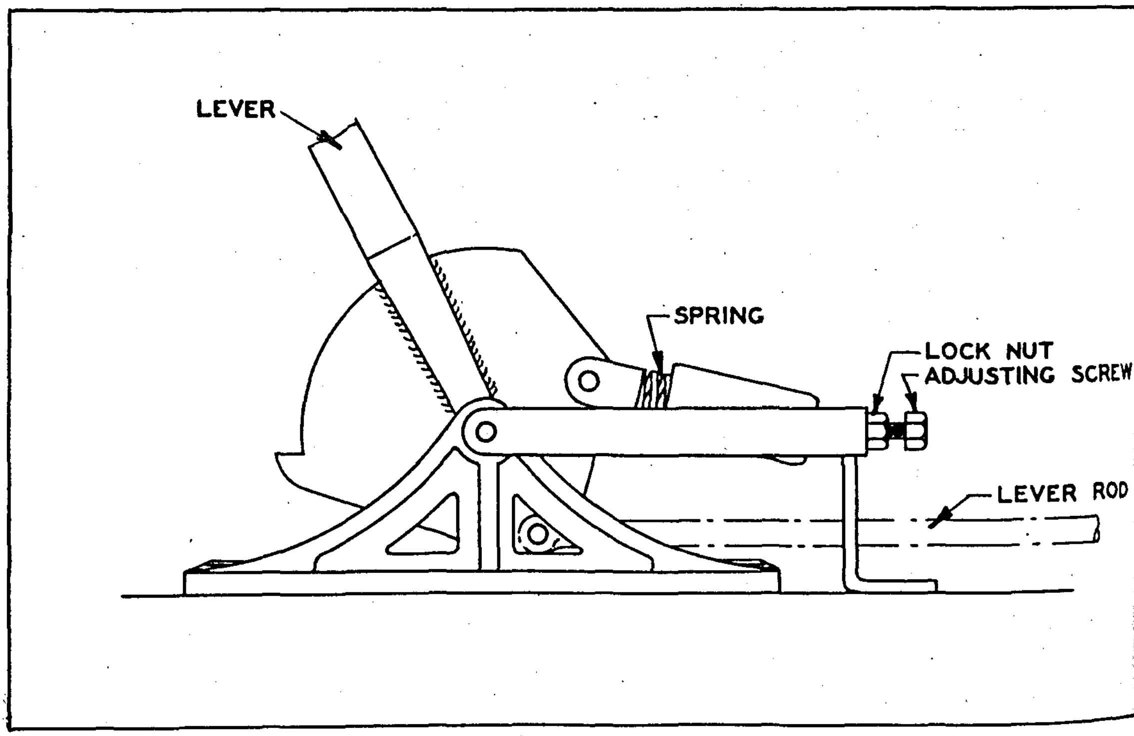


FIG.2.CONVERTED FORD LEVER.

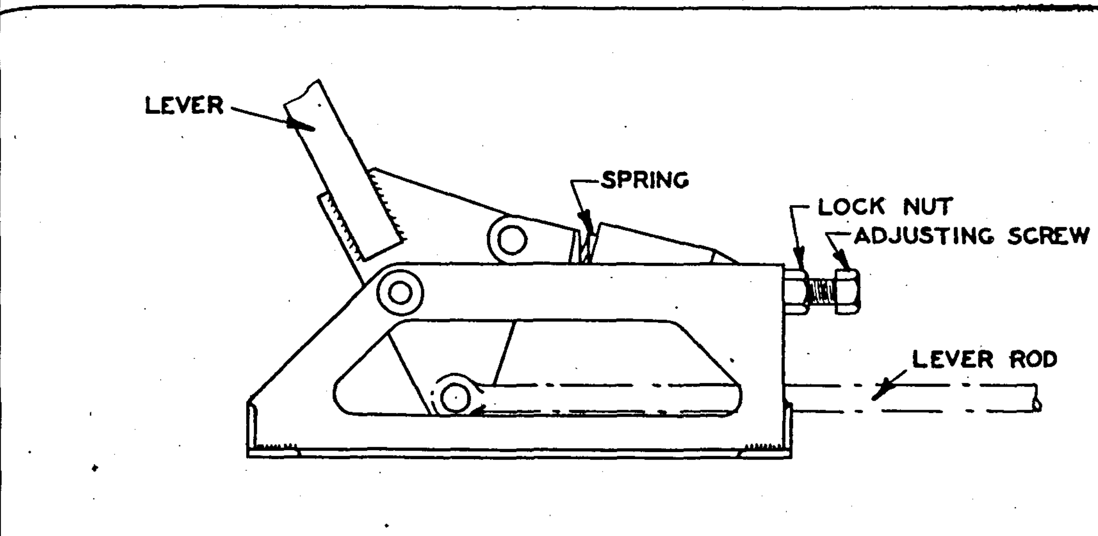


FIG.3. W.S. LEVER.

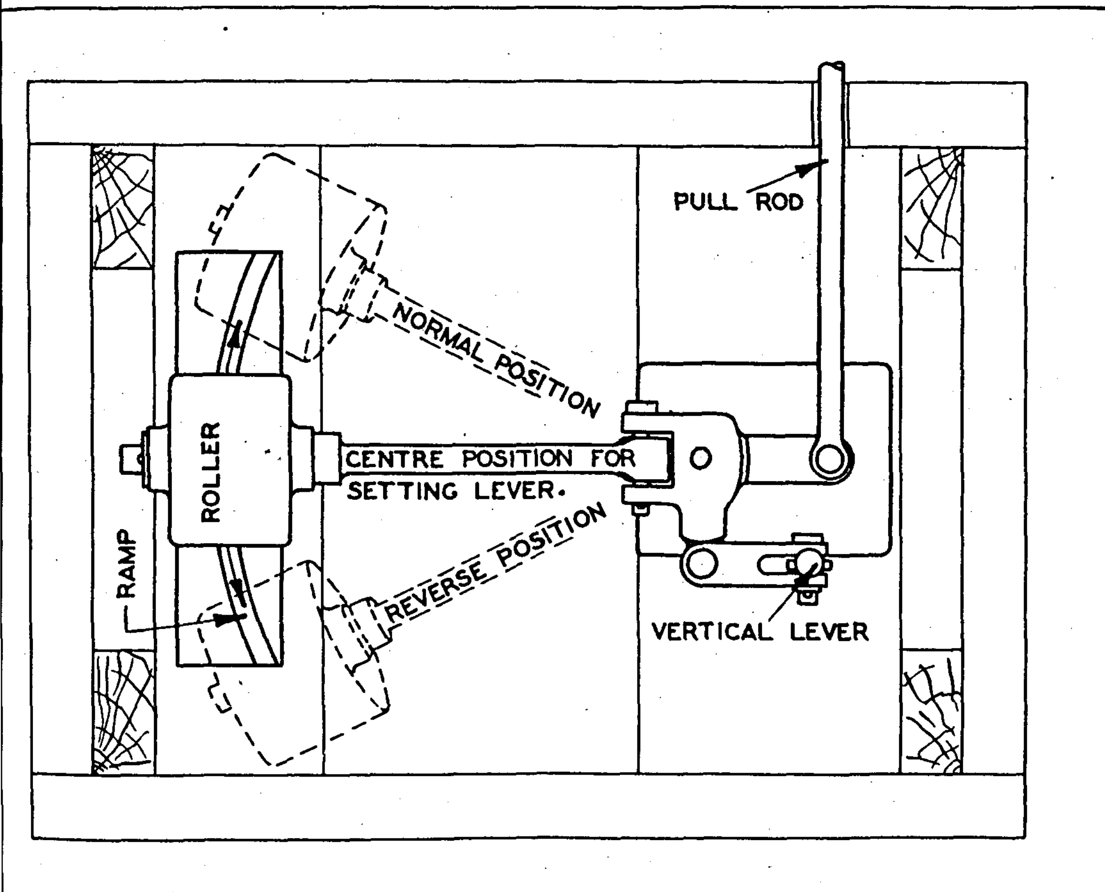


FIG.4. TAYLOR'S LEVER.

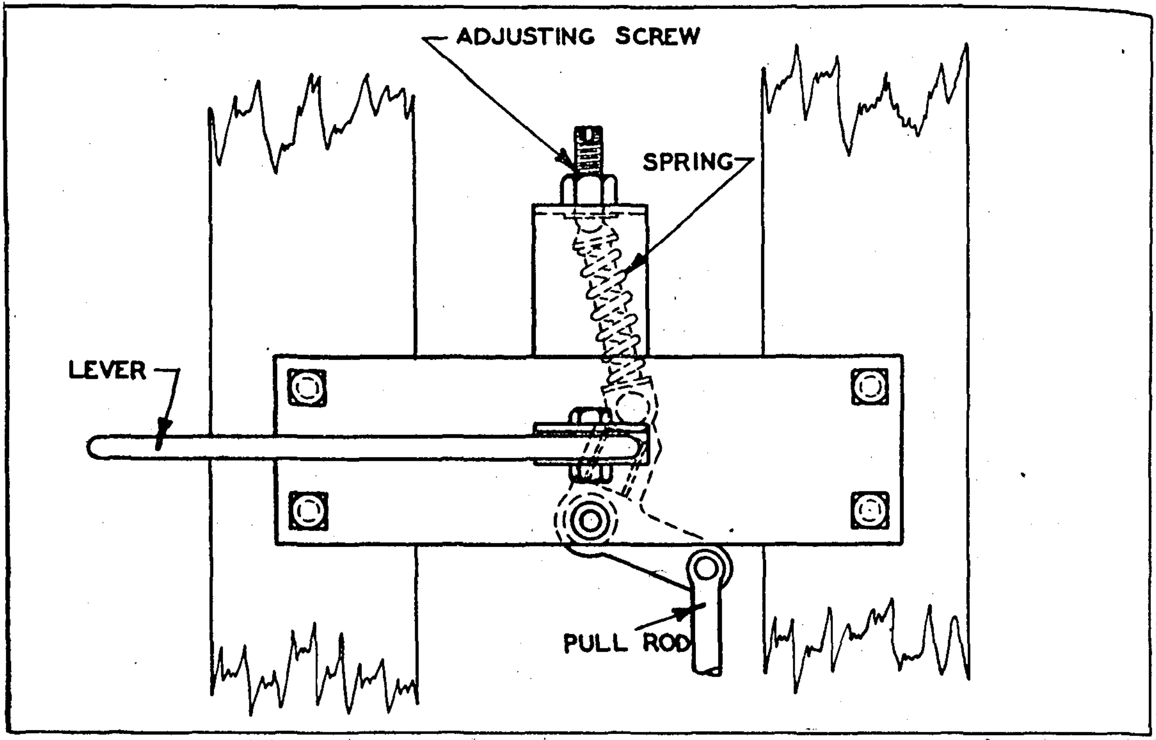


FIG. 5. THOMPSON'S LEVER. TYPE 2/A.S.

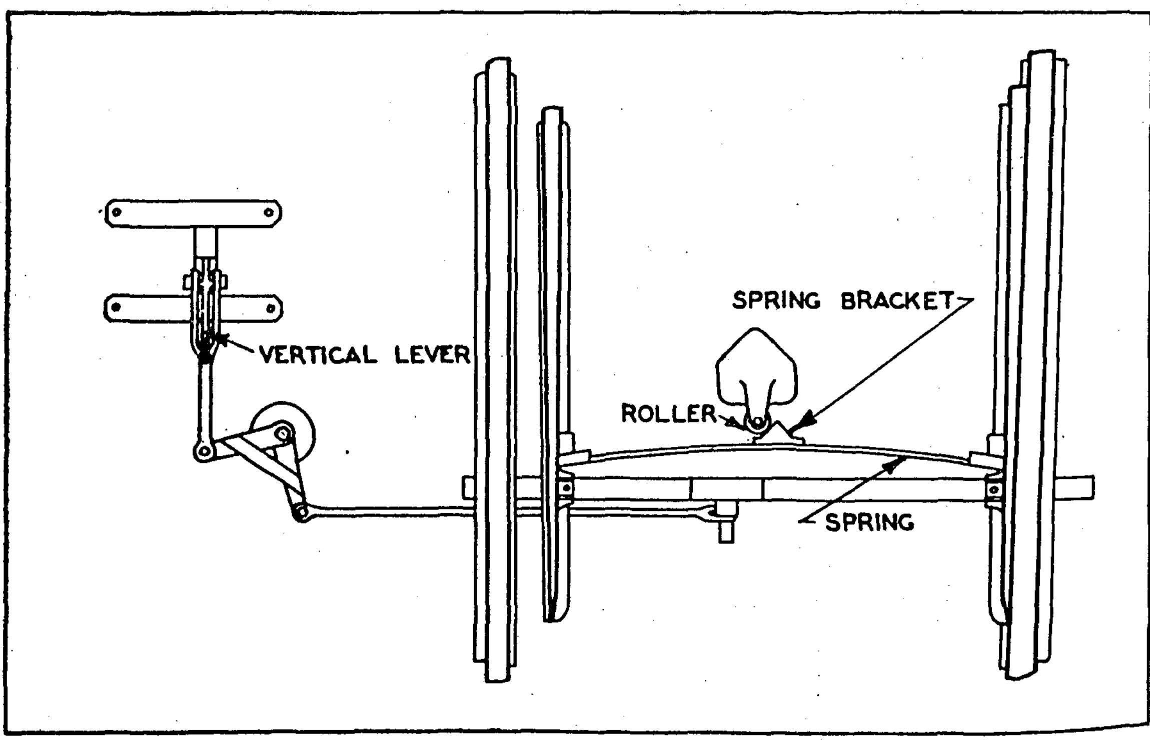


FIG. 6. BRUCE'S LEVER.

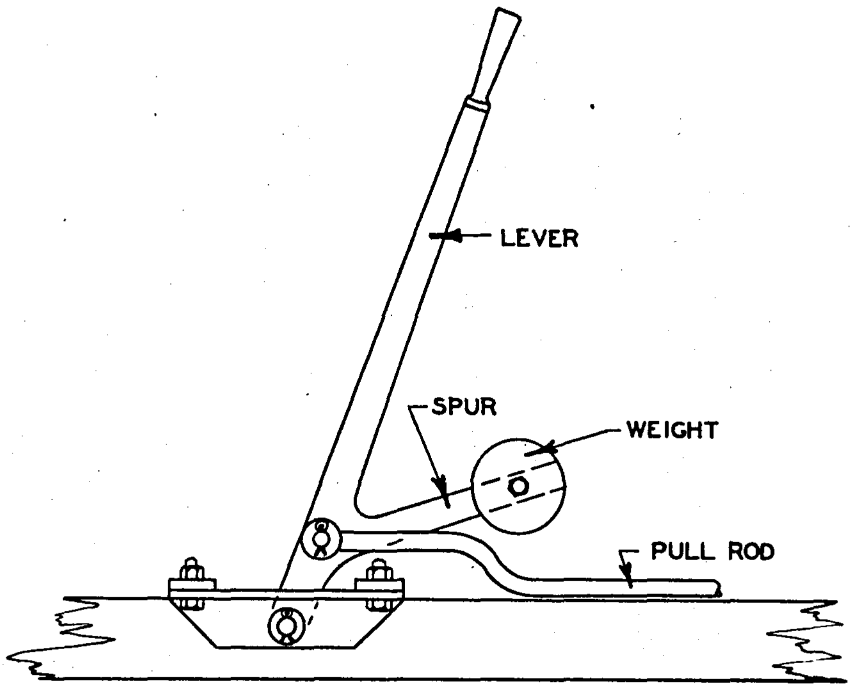


FIG. 7. SPUR LEVER.

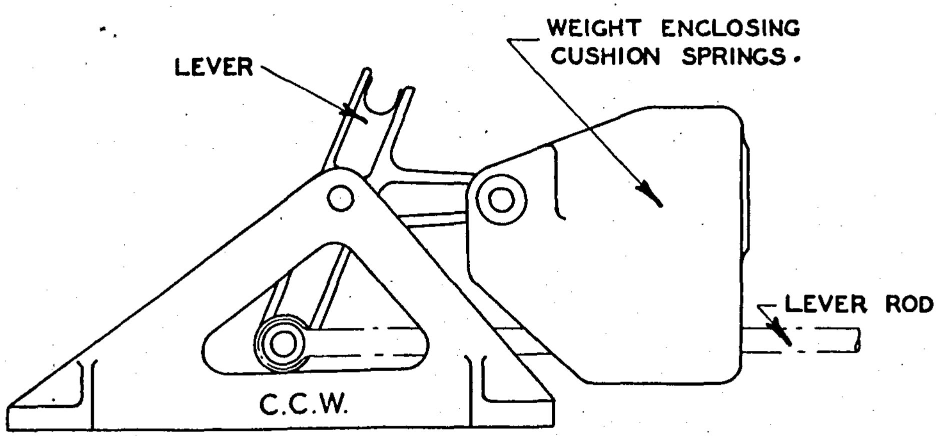


FIG. 8. C.C.W. LEVER.

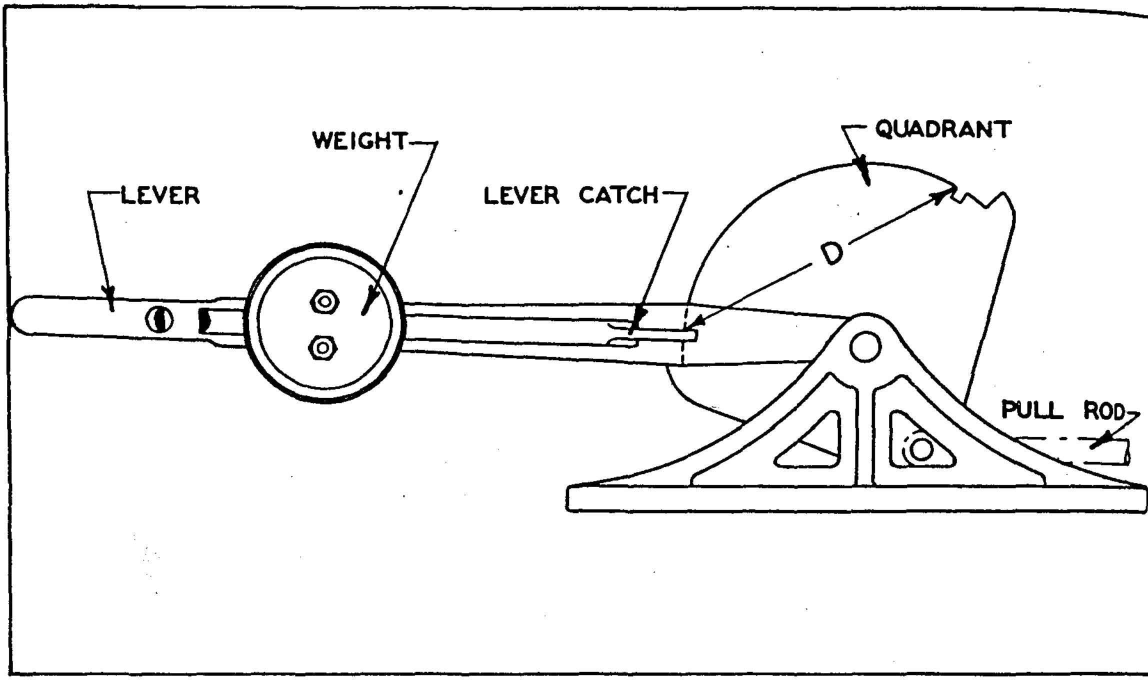


FIG. 9. FORD QUADRANT LEVER.

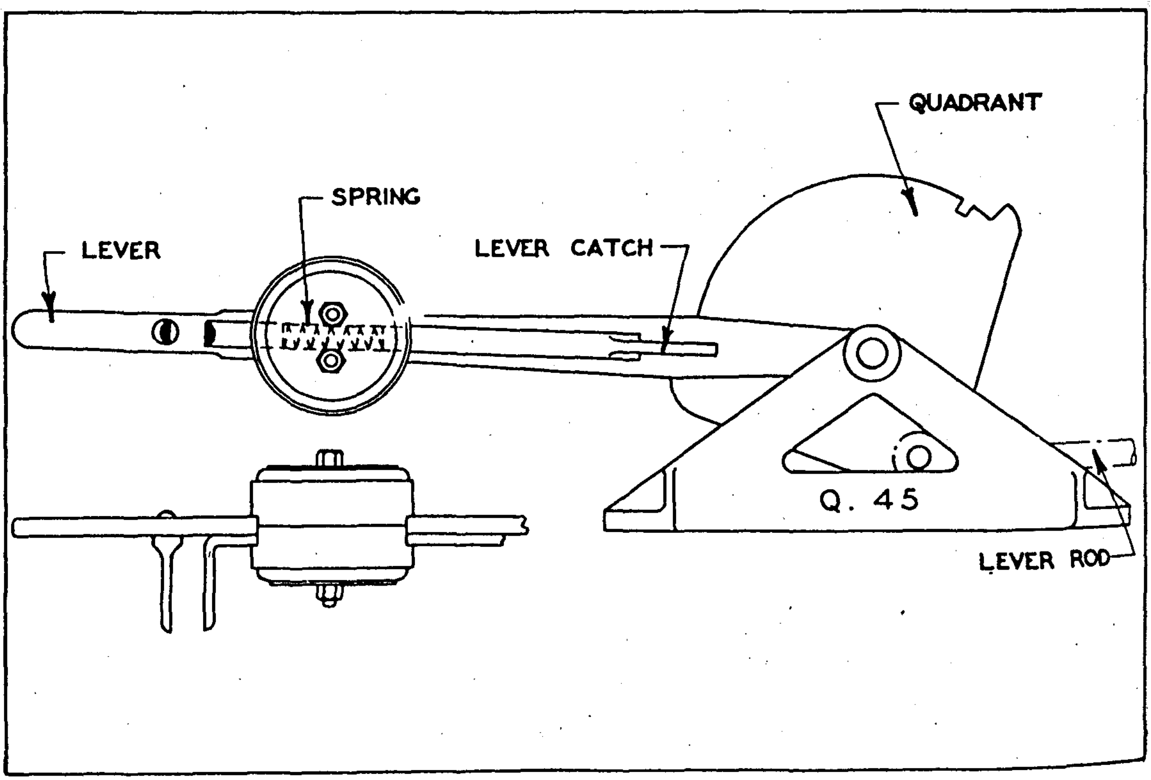


FIG. 10. Q.45 LEVER.

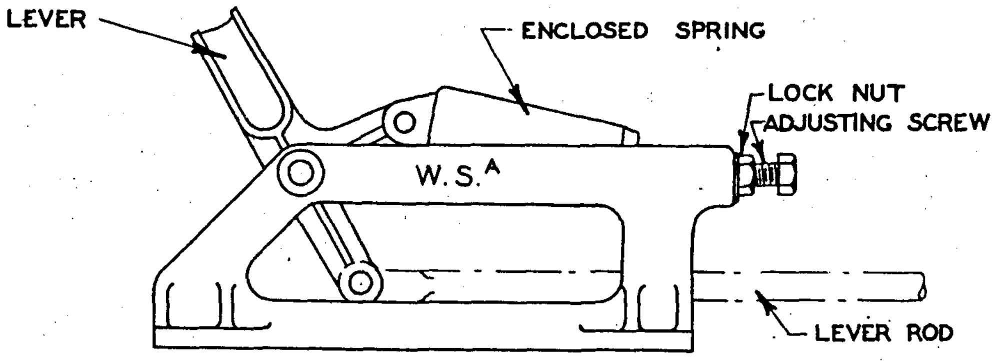


FIG. 11. W.S.A. LEVER.

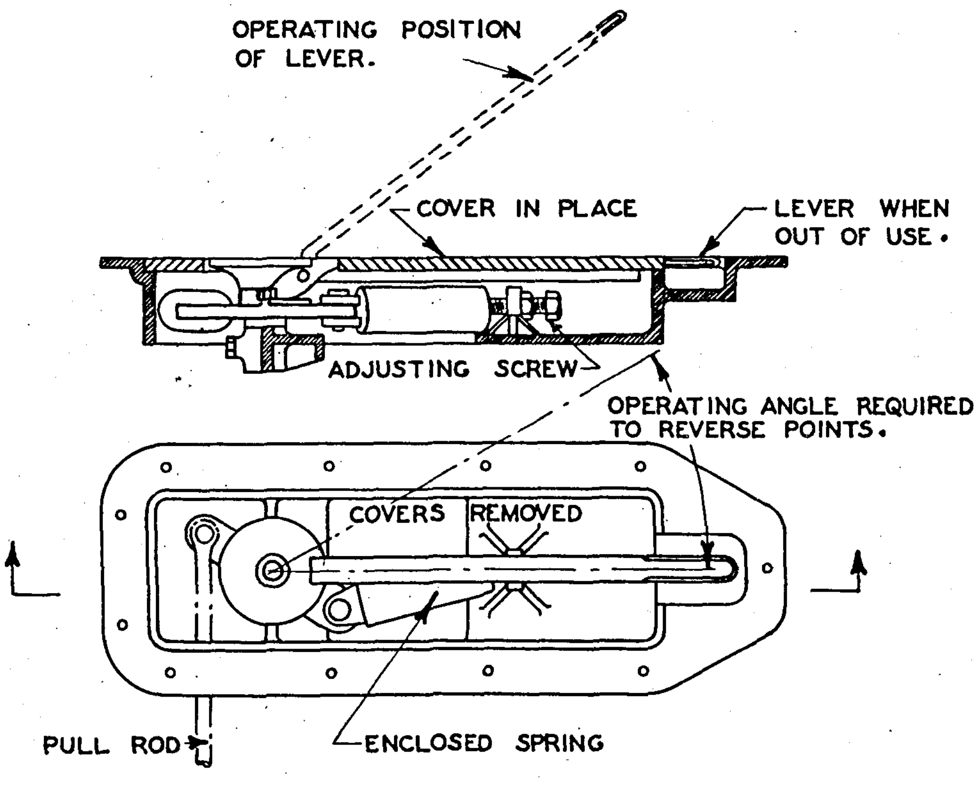


FIG. 12. PIER SPRING LEVER.

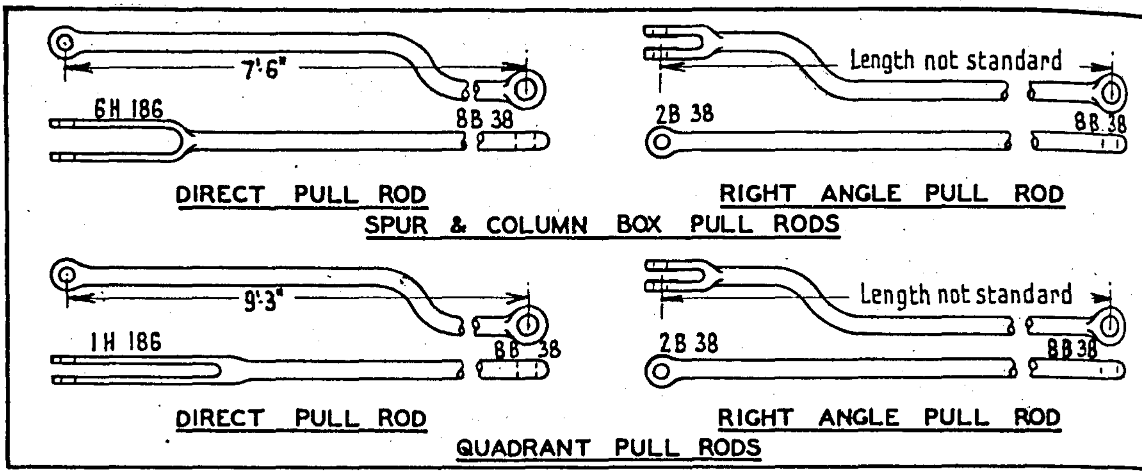


FIG. 13. OLD STANDARD PULL RODS.

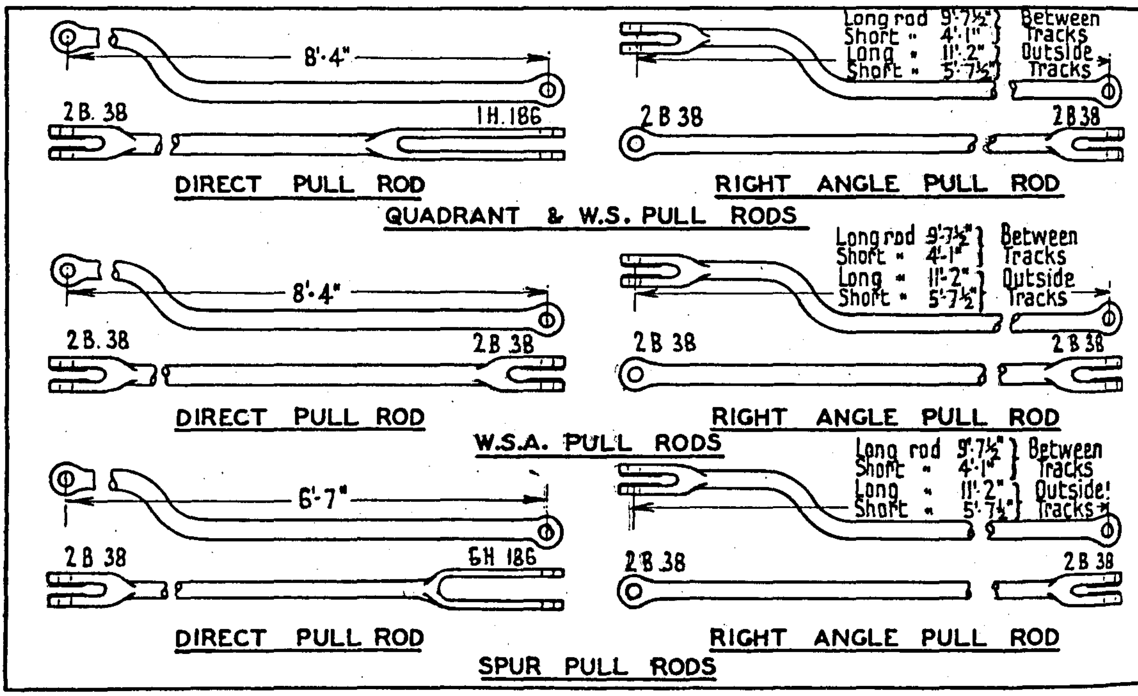


FIG. 14. 1927 STANDARD PULL RODS.

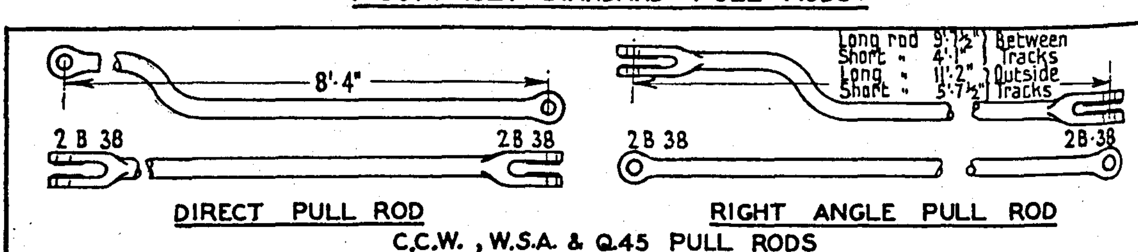


FIG. 15. PRESENT STANDARD PULL RODS.

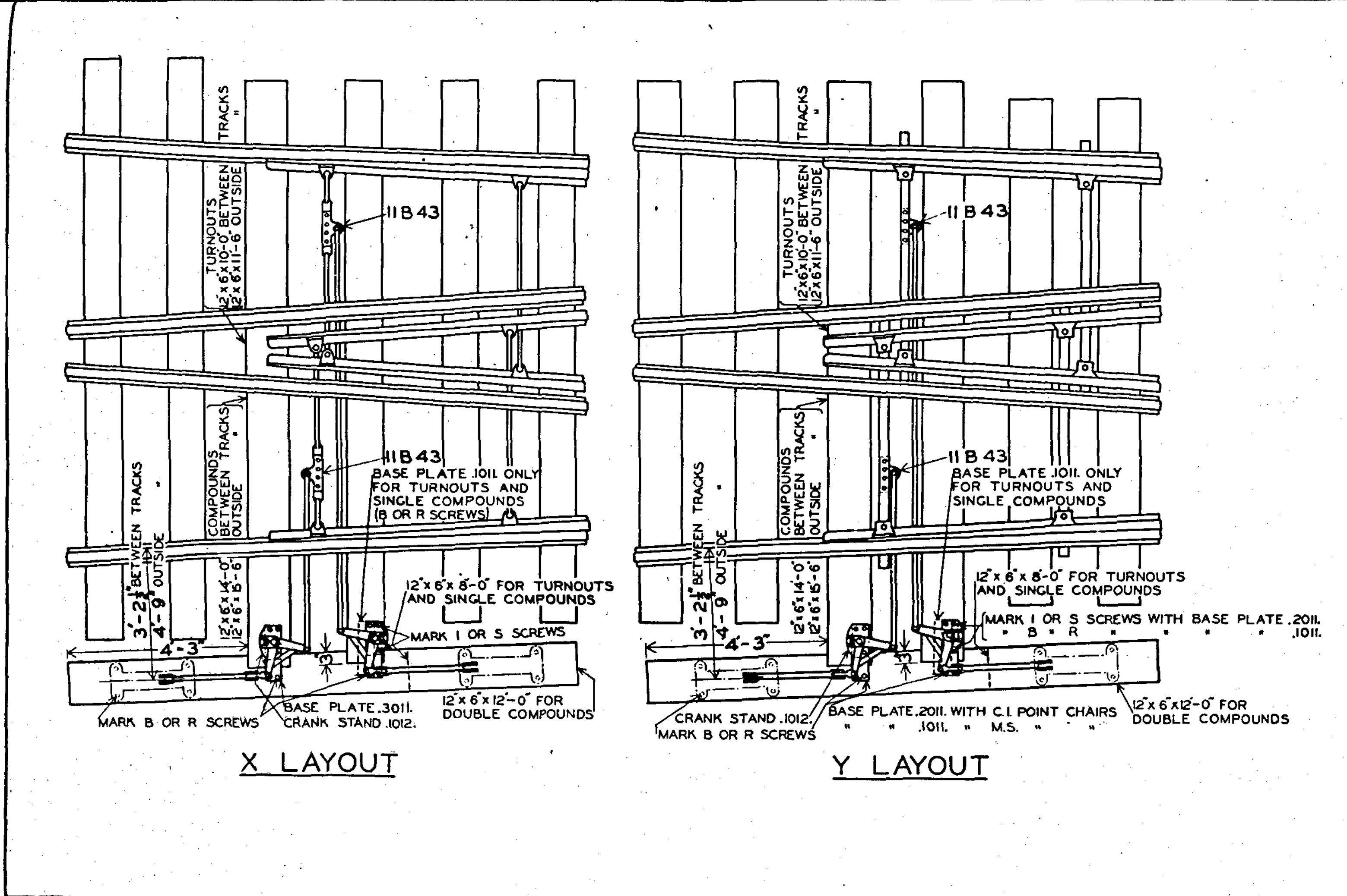


FIG. 16. STANDARD ARRANGEMENT OF POINT LEVERS, PULL & LEVER RODS.

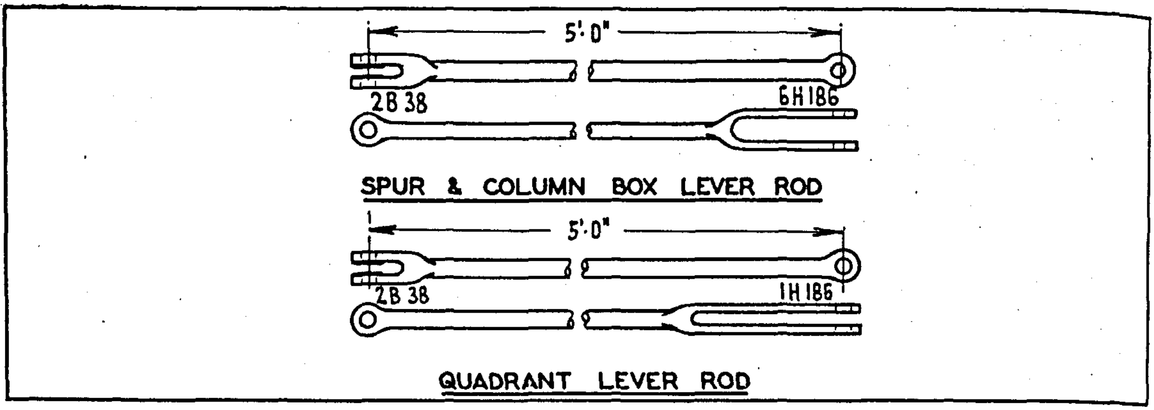


FIG. 17. OLD STANDARD LEVER RODS.

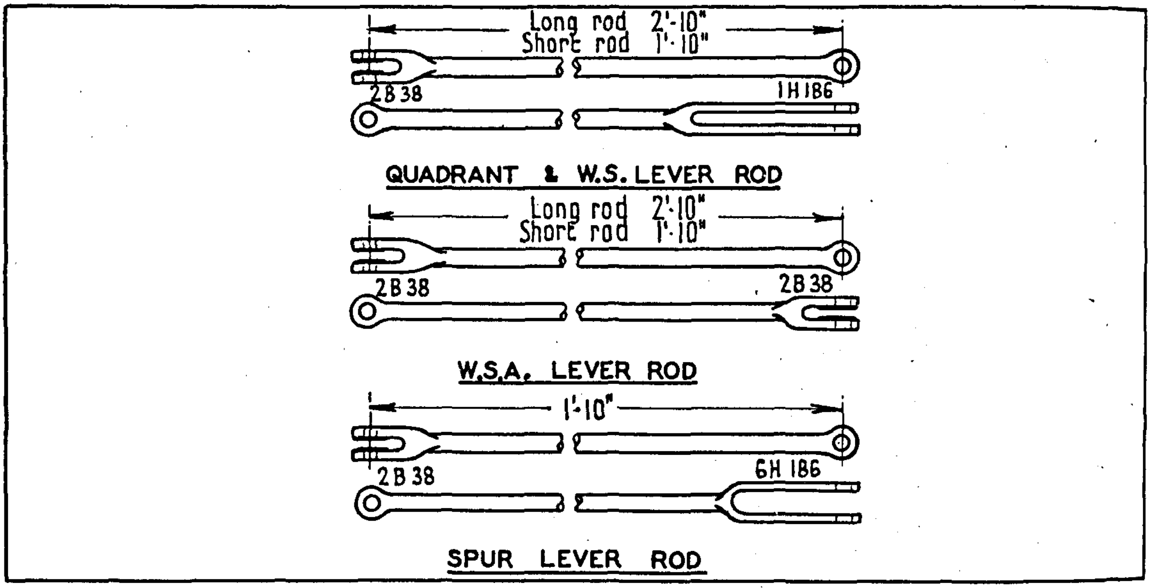


FIG. 18. 1927 STANDARD LEVER RODS.

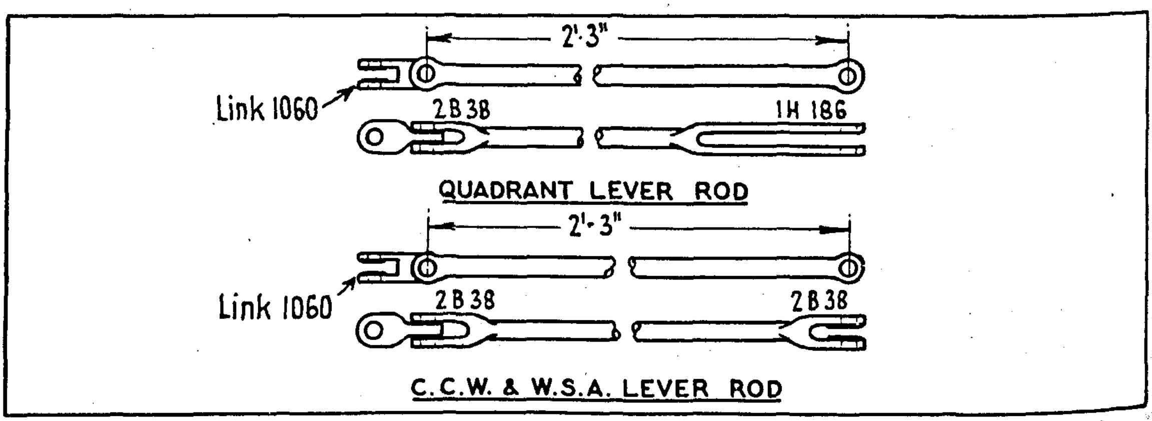


FIG. 19. PRESENT STANDARD LEVER RODS.

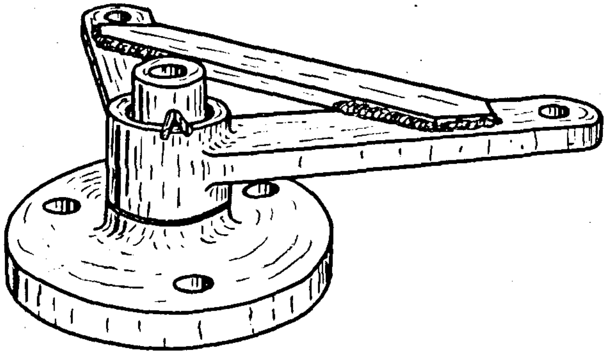


FIG. 20. OLD STANDARD CRANK & CRANK STAND ASSEMBLY.

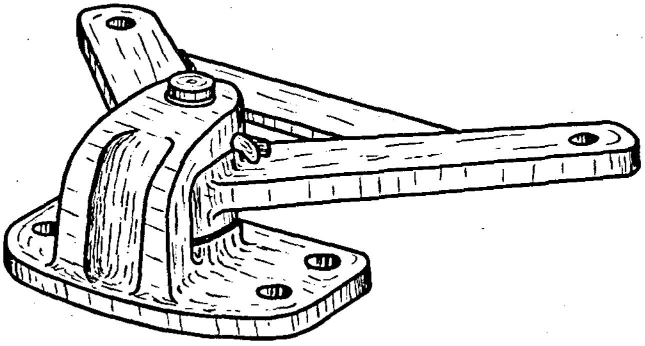


FIG. 21. PRESENT STANDARD CRANK & CRANK STAND ASSEMBLY.

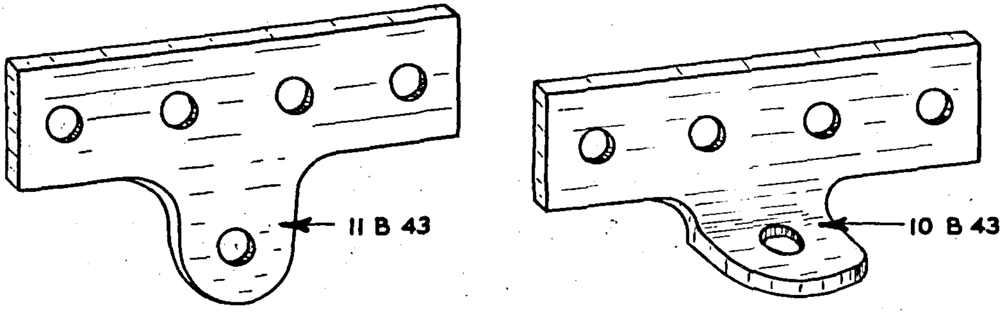
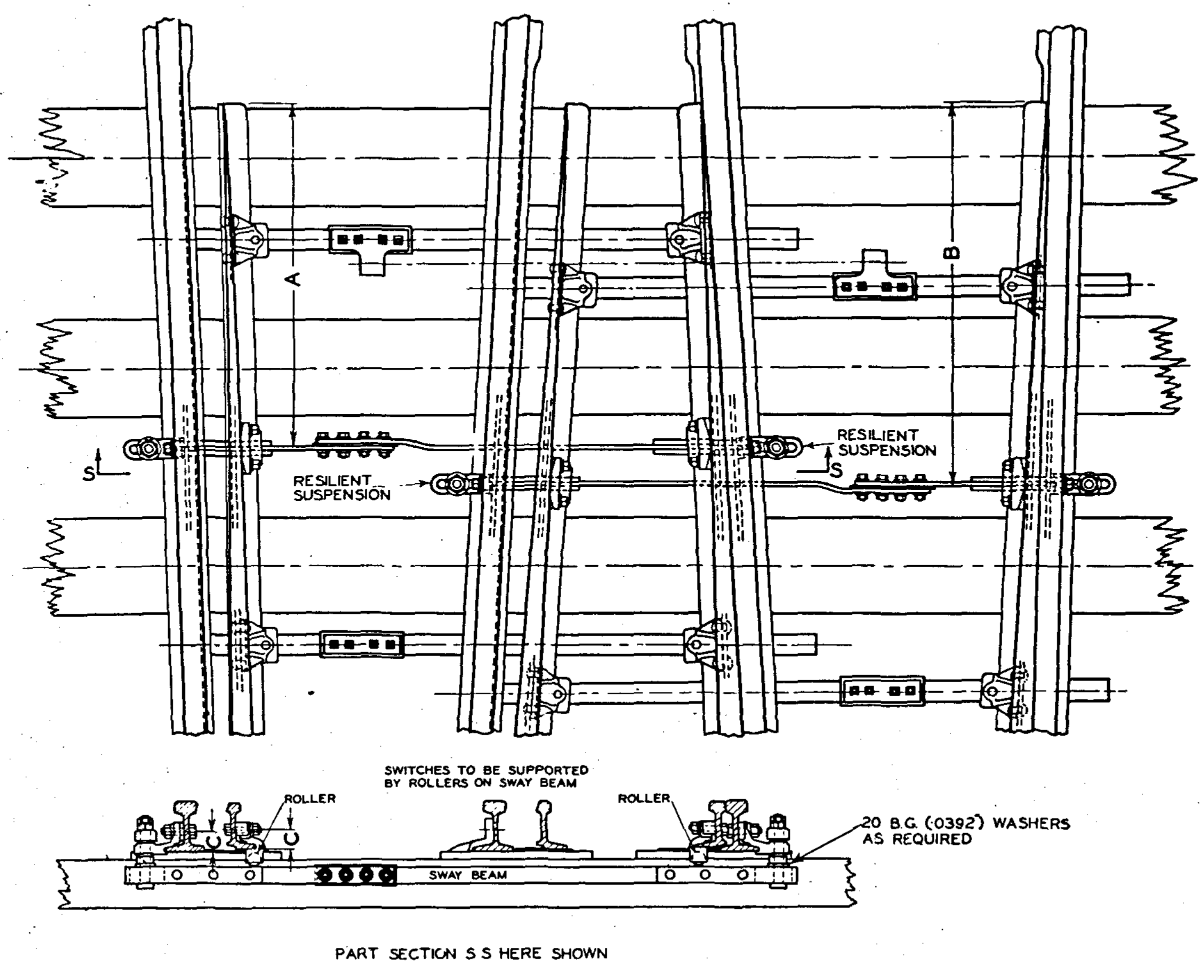


FIG. 22. OPERATING SPREADER BRACKETS.



DRILLING PARTICULARS		
TYPE OF POINTS	DIMENSION	
	A	B
Y, YS, YM, VY, VYS & VYM	3'-6"	—
YD & VYD	3'-6"	3'-9"
X, XS & XM	3'-0"	—
XD	3'-0"	3'-3"

WEIGHT & CLASS OF RAIL	DIMENSION C
80 LB. O.	2 5/16"
80 " A.S.	2 3/8"
90 " A.S.	2 7/16"
94 " A.S.	2 7/16"
100 " P.	2 11/16"
100 " A.S.	2 5/8"
107 " A.S.	2 11/16"
110 " A.S.	2 11/16"

ADJUSTMENTS

CLEARANCE IS TO BE ADJUSTED BY THE USE OF 20 B.G. (·0392") WASHERS.
THE SPRING LOAD MUST BE ADJUSTED TO JUST BIND THE WASHERS

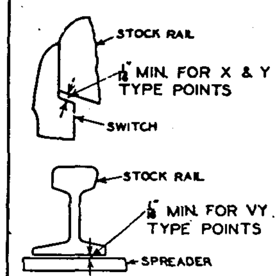


FIG. 23. RESILIENT SUSPENSION.

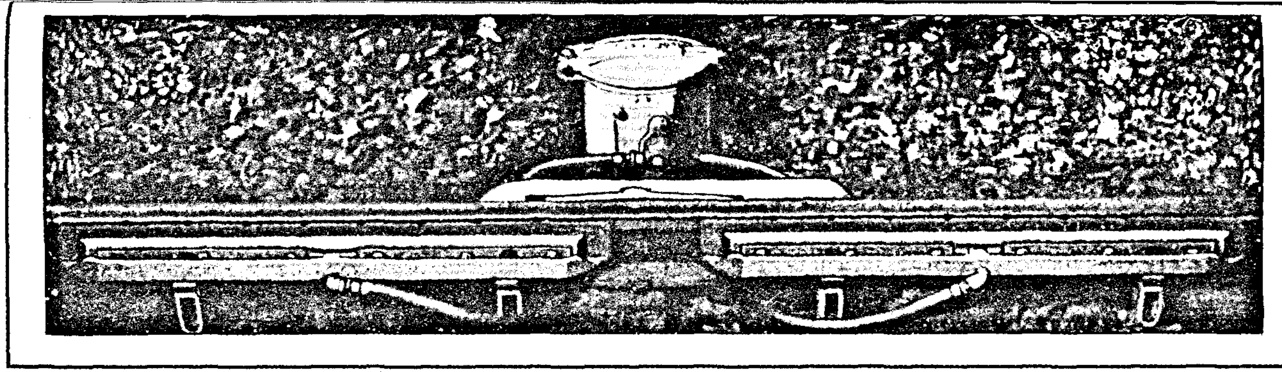


Fig. 24. Meco Track Lubricator.

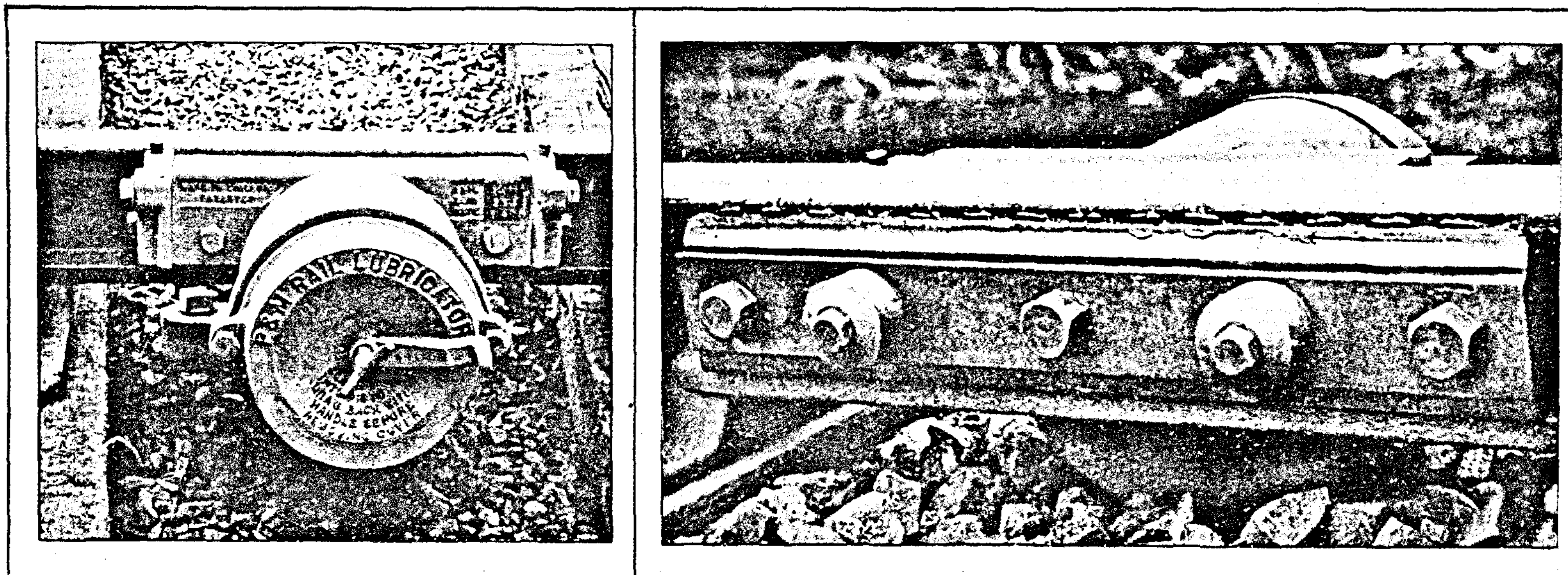


Fig. 25. P. & M. Track Lubricator.

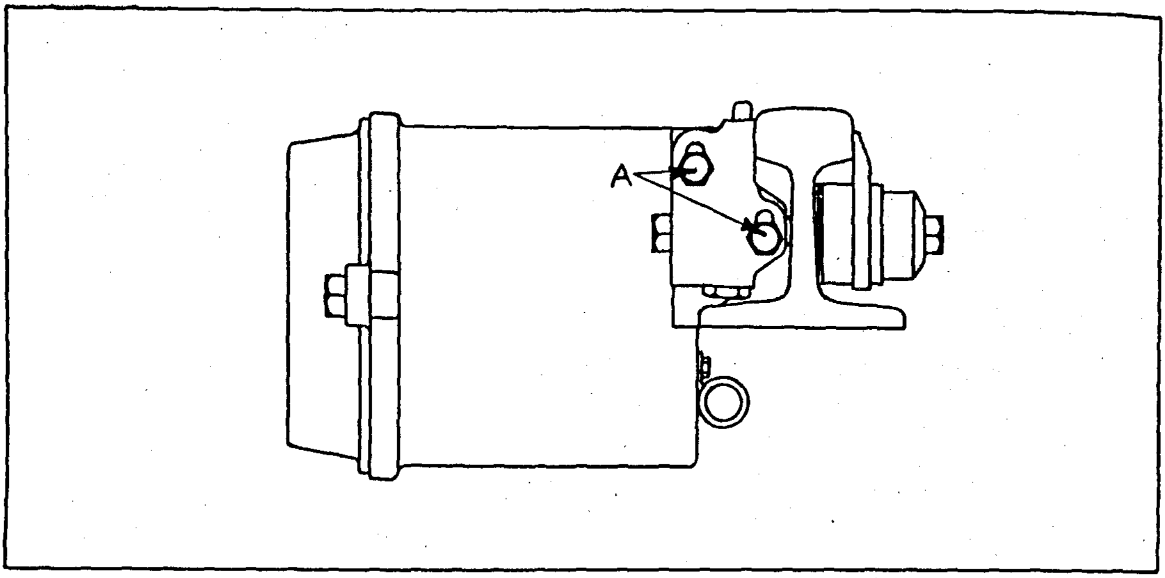


FIG. 26. P&M. TRACK LUBRICATOR SHOWING PUMP ASSEMBLY.

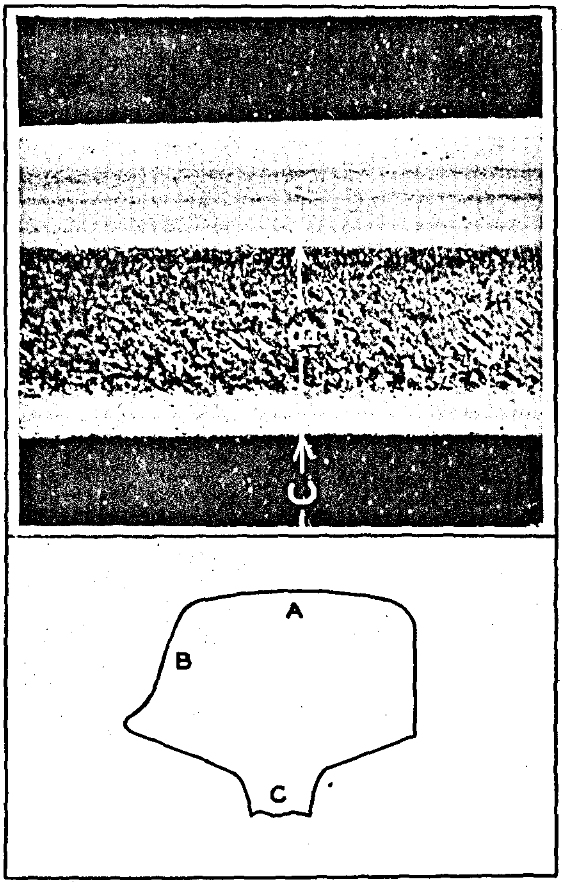


FIG. 27. UNLUBRICATED RAIL.

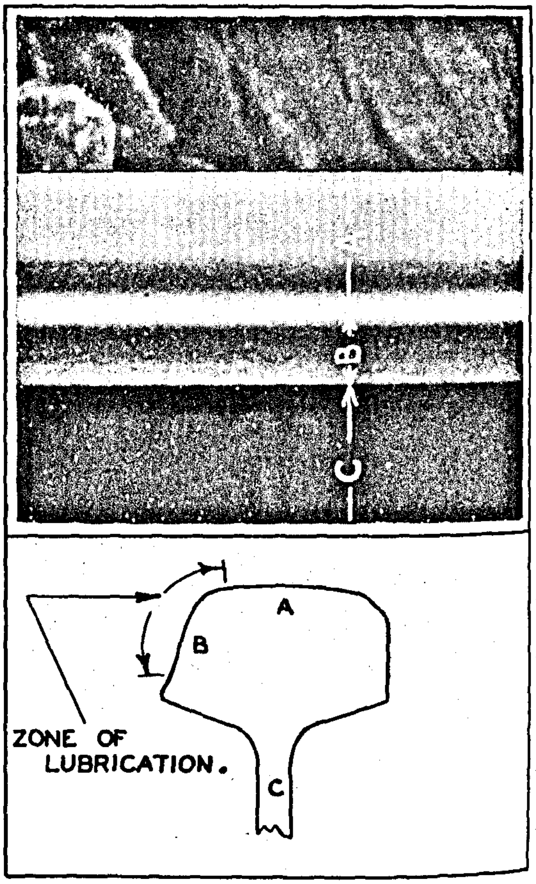


FIG. 28. EFFECTIVE LUBRICATION.

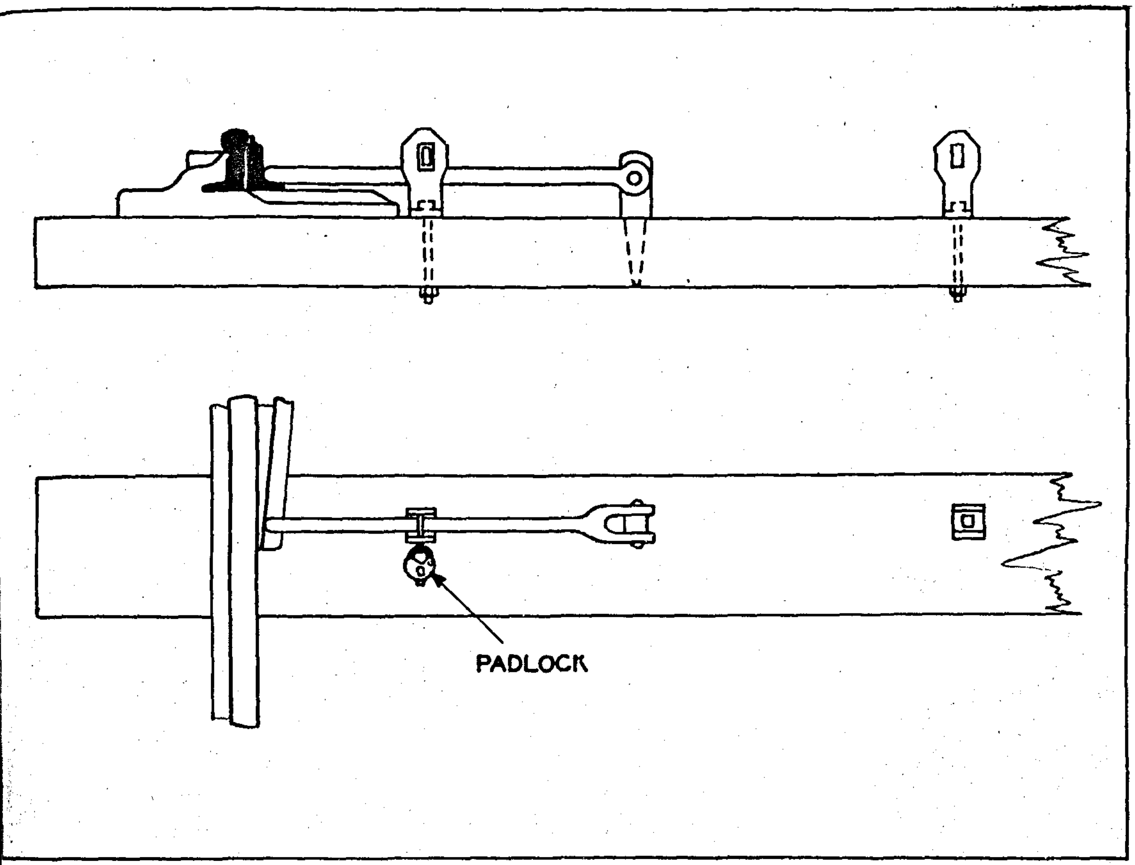


FIG.29. LOCKING BAR.

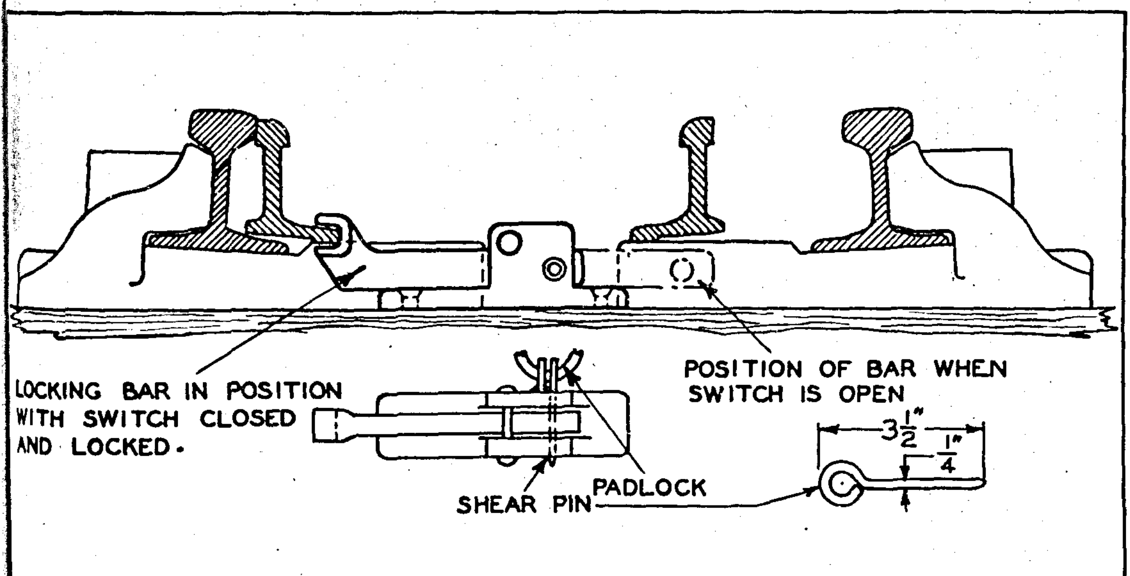


FIG.30. BROWN'S LOCKING DEVICE FOR 60 LB. COMPOUND POINTS.

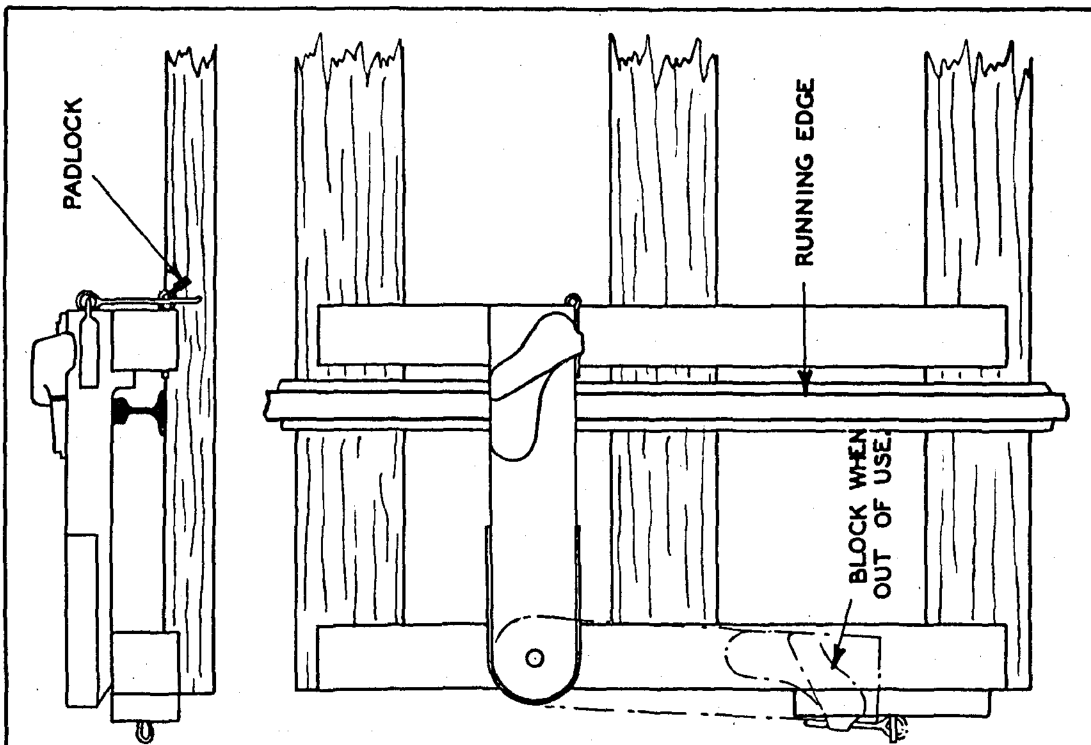


FIG.31.PIVOT TYPE CHOCK BLOCK.

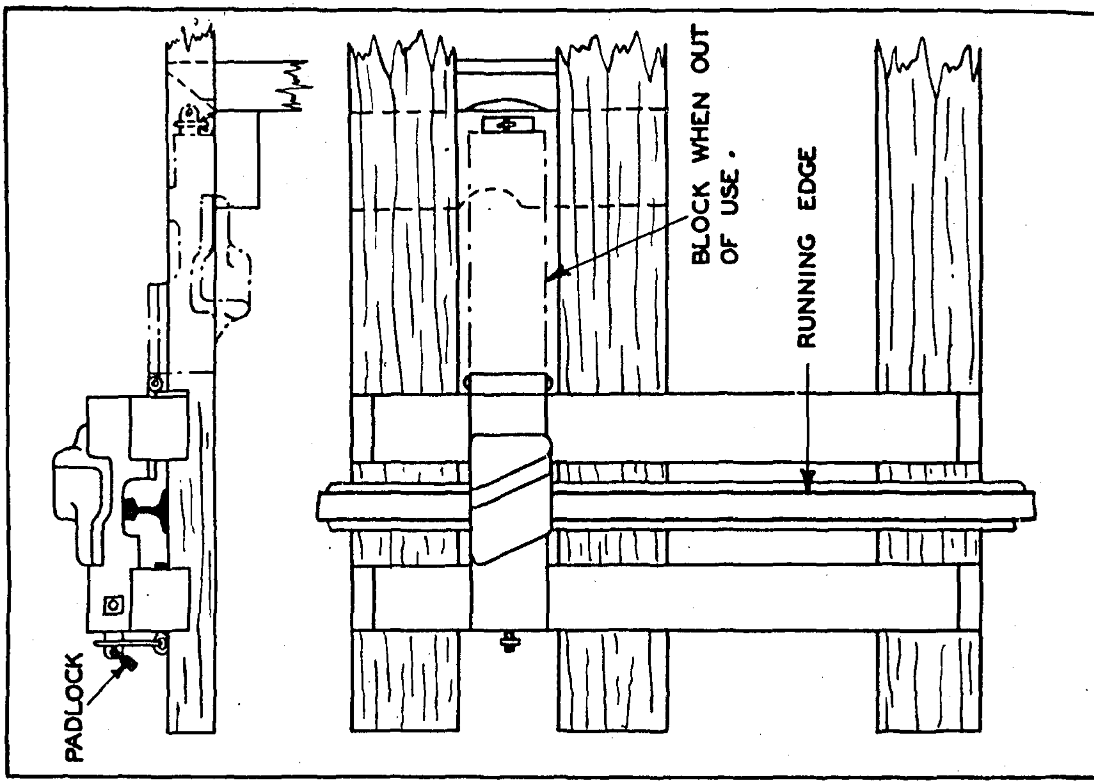


FIG.32.HINGED TYPE CHOCK BLOCK.

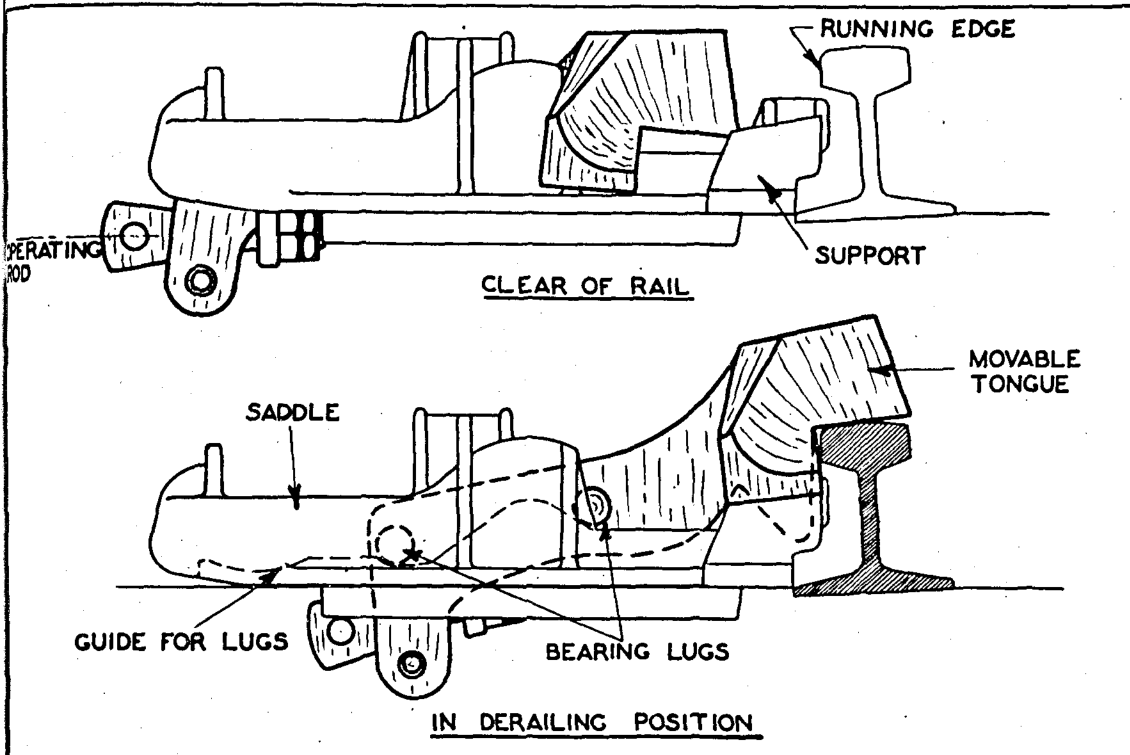


FIG. 33. DERAIL. TYPE E.

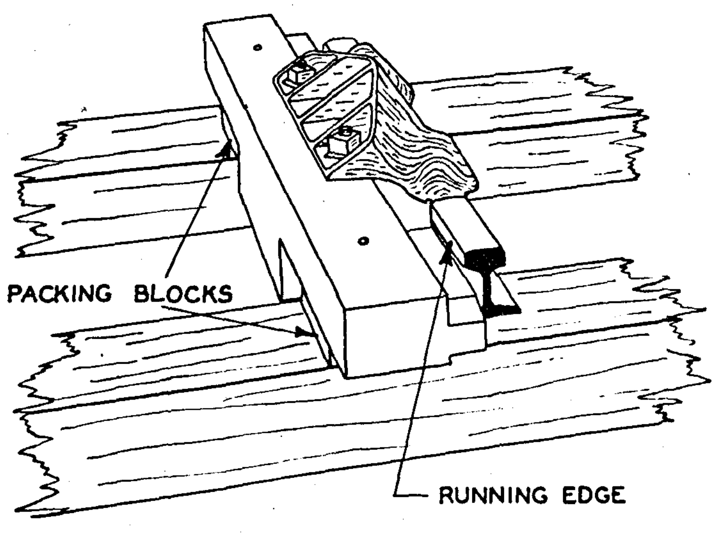


FIG. 34. DERAIL.

17. MIXED GAUGE TRACKWORK.

GENERAL

At the common terminal station for two railways of different gauge, some overlapping of trackwork is necessary to permit of suitable traffic movements.

When the track gauges vary appreciably the necessary trackwork layouts can be arranged with a minimum of special material, but when the difference in the gauges is small, special material is required and the choice of layouts is necessarily limited by practical considerations.

THIRD RAIL

The most usual arrangement of mixed gauge trackwork is that employing the third rail system in which, as the name implies, one rail is common to both tracks.

In third rail work the Mechanical Trackwork Engineer has to provide for combinations of conditions peculiar to each track gauge separately and in conjunction.

All that has been said in previous papers in respect to track gauge at crossing work, guard rail gauge and flangeways, curvature, divergency, etc., applies with even greater importance to third rail trackwork.

When also the elements of trackwork in each gauge are different, such as in flangeways, limiting curvature, divergency etc., it should be appreciated that an attitude of near enough may not be good enough if accidents and derailments are to be avoided on both gauges.

Many curious arrangements of trackwork have been proposed to enable the majority of the usual traffic movements to be made through third rail trackwork, but fortunately for everybody, few of these arrangements have materialised.

Several practical arrangements are in use for 5'3" and 4'8½" mixed gauge combinations, and these are shown in Figs.1, 2, 3 and 4.

In all cases the turnout movement is away from the third rail and never across it; this simplifies the trackwork but necessitates changing the third rail from one side of the gauge to the other side when turnouts from each gauge diverge successively. Changing over of the third rail is effected by fixed transfers shown in Fig. 5.

The way in which the transfers are arranged for turnouts from either gauge, and the direction of the turnouts whether right or left-hand, vary according to the layouts, but one arrangement in use is shown in Fig. 6.

At the junction of mixed gauge tracks a fixed point enables the traffic on both gauges to enter or leave the third rail track as shown in Fig. 4.

Safety precautions are of course provided to control the movement of the trains on the separate and combined gauges.

It is desirable that any 'V' crossing be on the single rail as separate adjustments can then be made to the covering guard rails. See Fig. 7.

A double 'V' crossing is necessary when the third rail is crossed and the single guard rail cannot be satisfactorily adjusted for the protection of both gauges. See Fig.8.

To guard crossings in third rail trackwork of the 5'3" and 4'8½" combination special guard rail assemblies are required as shown in Fig. 9.

As the third rail overlaps only for a short distance at the junction station and buffer stops cannot be used at the ends of the overlaps, it is necessary to install sand stops as a means of bringing vehicles to a stop should they overrun the gauges.

A plan of the type of sand stop in use and their positions in relation to the overlaps are shown in Fig. 10.

Third rail diamonds are avoided by isolating each gauge prior to crossing; this enables a mixed gauge diamond to be installed as described in 13.028. An arrangement of third rail trackwork in use showing the isolation and re-grouping of third rail trackwork to effect the diamond crossover is shown in Fig. 11.

The trackwork units in third rail work do not all lend themselves to description and easy identification by reference to hand, consequently a system of marking is in use in which the letters 'T R' are followed by numerals to distinguish each layout

T.R. marks and numbers are stamped on each trackwork unit and reference must be made to these markings when dealing with this material.

It will be seen from Fig. 11 that all T.R. units have been carefully designed to fit into certain trackwork arrangements, having regard to the engines and vehicles intended to pass through the gauges, flangeways, curvatures and divergencies.

All T.R. layouts are gauged throughout during and after manufacture as units and as a layout, and for the purpose of final gauging at inspection the T.R. gauge shown in Fig. 12 is applied to all running and guard gauge dimensions.

Trackmen concerned with the installation of new T.R. layouts are therefore able to work to running gauges only, but for renewals and maintenance adjustments, the T.R. gauge must be used.

The gauges in third rail trackwork layouts are $\frac{1}{4}$" tight in parts of the layouts to provide the necessary clearance for wheel flanges, and in using the T.R. gauge trackmen must refer to the mechanical trackwork layout drawings to ascertain the gauge variations required.

In the 4'8$\frac{1}{2}$" trackwork branching from third rail and which at present occurs only at the N.S.W. border, the trackwork layouts have been built to N.S.W. standards and any 4'8$\frac{1}{2}$" trackwork under Victorian Railways control must be so maintained.

The N.S.W. standards for guard rail adjustments are set out hereunder : -

1. Dimension P. Fig. 13 must not exceed 4'5" under any condition and should not be allowed to become less than 4'4$\frac{7}{8}$".

2. Dimension Q. Fig. 13 must not exceed 4'6$\frac{3}{4}$" and should not be allowed to become less than 4'6$\frac{5}{8}$".

3. Dimension R. Fig. 13 must not be less than 1$\frac{5}{8}$" and should be maintained as near as possible to 1$\frac{3}{4}$" on straight or widened by the same amount as the gauge is widened on curves.

Note. The flangeways in 'V' crossings for N.S.W. gauge are 1$\frac{7}{8}$" wide.

<u>GAUNTLET TRACKS</u>

A gauntlet track is an arrangement whereby two tracks interlace so that the four rails lie within a space of less than twice the gauge of the tracks as shown in Fig. 14.

The arrangement is convenient at bridges and tunnels during repairs to the parallel track, as complete occupation can be given during the repairs.

Special signalling arrangements must of course be provided for traffic movements through gauntlets.

WEIGHBRIDGE TRACKS

As truck weighbridges are unsuitable for the passage of heavy locomotives, it is necessary to provide four rails at these locations, two of which are supported clear of the weighing table and carry the locomotive while the trucks travel on the other pair of rails attached to the weighbridge.

The locomotive should take the straight track and the trucks the loop; if the arrangement is reversed the locomotive will bind in and spread the gauge through the points.

The ends of the rails on the weighing track are not fished to the adjoining track rail because the operation of weighing requires a slight vertical movement. A space must be maintained of not less than $\frac{1}{4}$" or more than $\frac{1}{2}$" between the track rails and the weighbridge rails in the weighing road.

As the locomotive track crosses the weighbridge pit on fixed supports the track rails are fished at the joints and the joints should be spaced equally distant from the weighbridge abutments as shown in Fig. 15.

FOUR RAIL THREE TRACK LAYOUTS

An arrangement of trackwork occasionally met with on wharves and docks in order to spot trucks to best advantage for dumping coal and ore is shown in Fig. 16. In this arrangement the three tracks comprise four rails with a special three throw enabling any one track to be used as required.

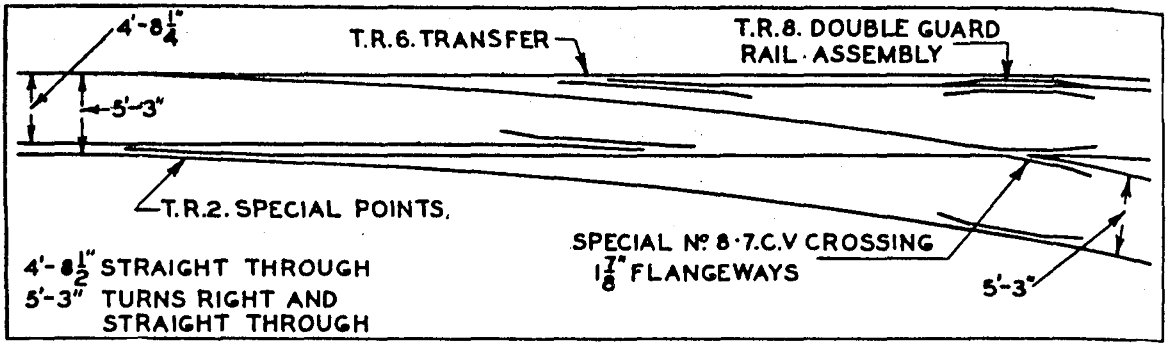


FIG.1. THE T.R.2 THIRD RAIL TURNOUT

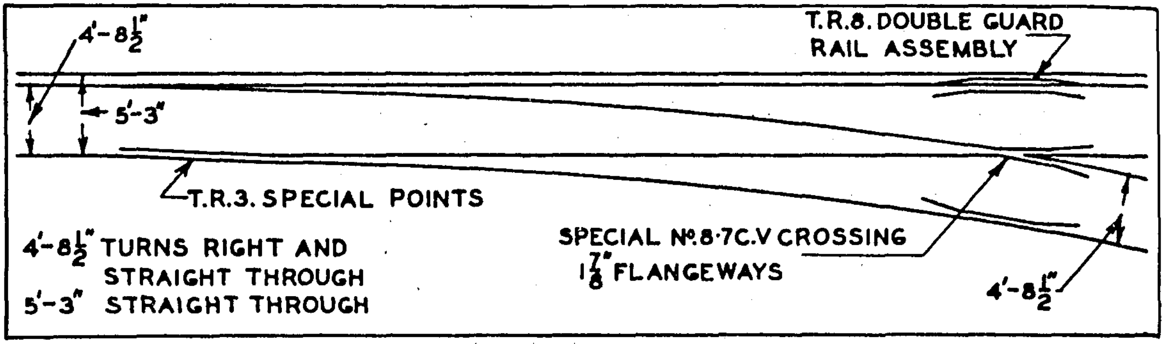


FIG.2. THE T.R.3. THIRD RAIL TURNOUT

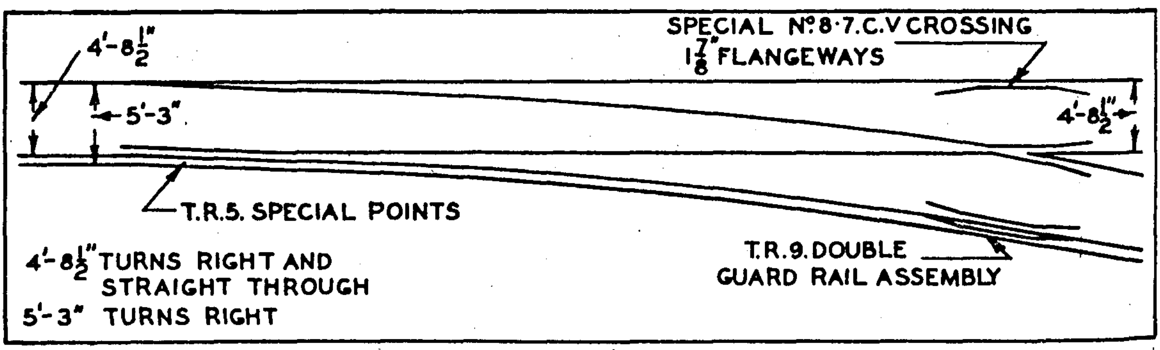


FIG.3. THE T.R.5. THIRD RAIL TURNOUT

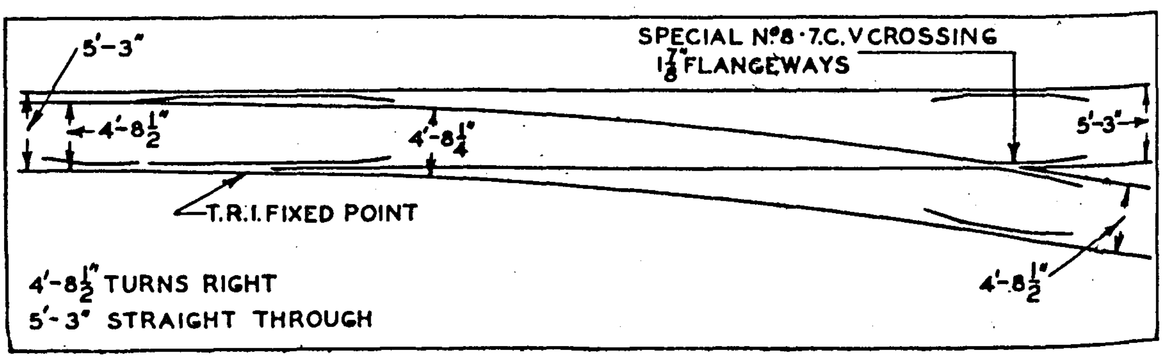


FIG.4. THE T.R.1. FIXED POINT THIRD RAIL TURNOUT

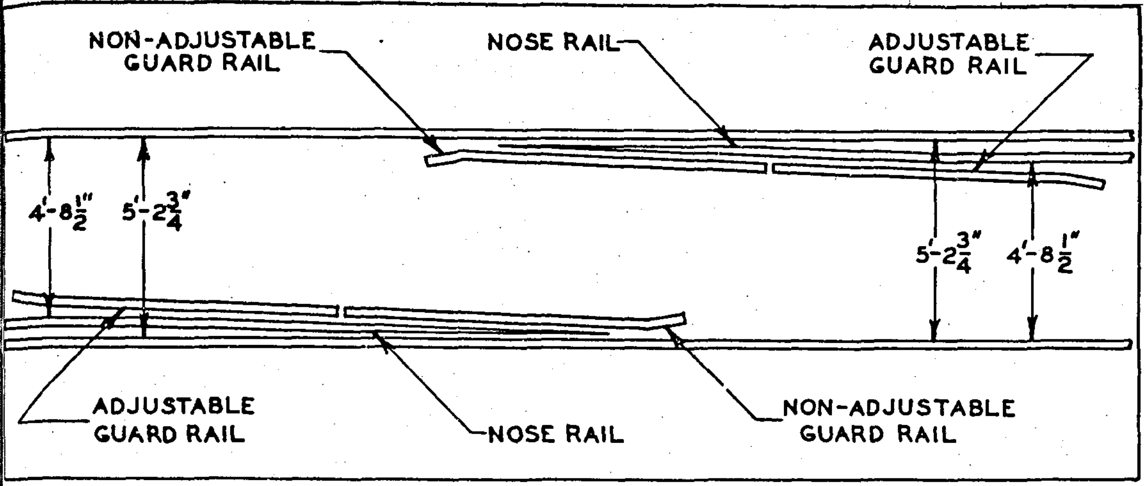


FIG. 5. THE T.R.6. THIRD RAIL TRANSFER

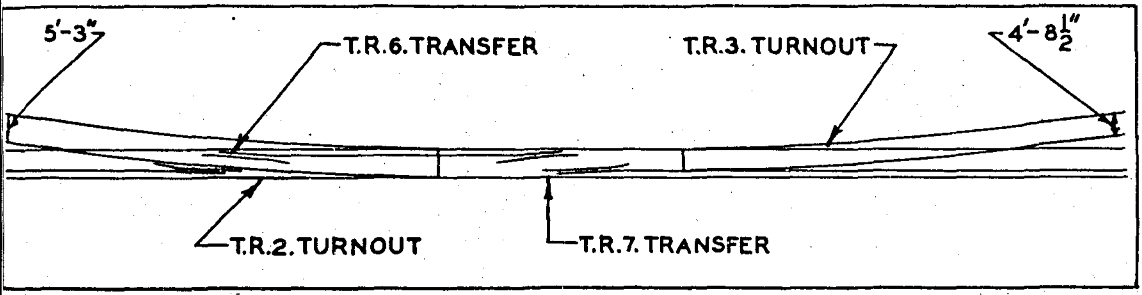


FIG. 6. ARRANGEMENT OF THIRD RAIL TRANSFERS

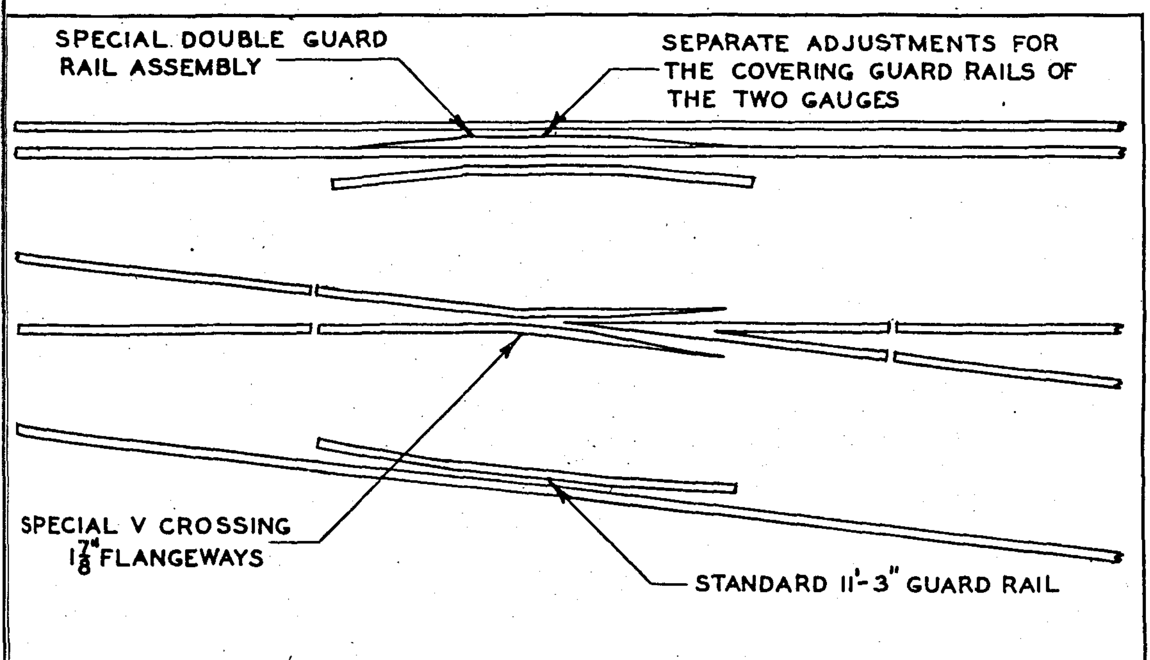


FIG. 7. GUARD RAIL CONDITIONS WITH THE V CROSSING ON THE SINGLE RAIL

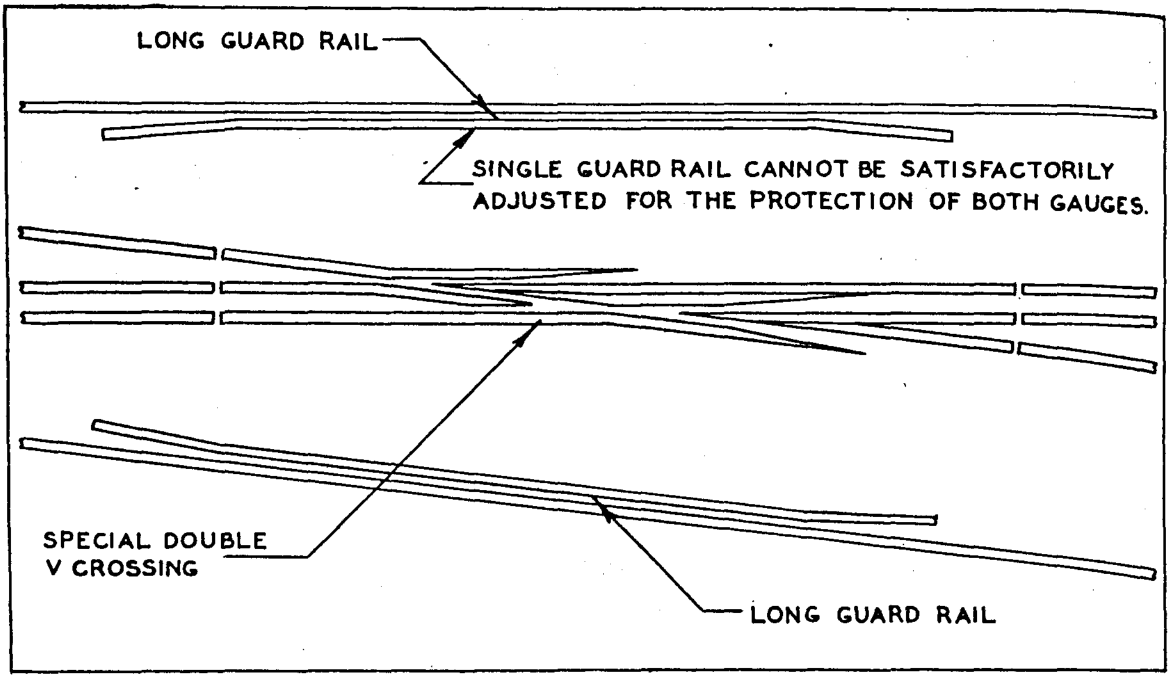


FIG. 8. GUARD RAIL CONDITIONS WHEN THE THIRD RAIL IS CROSSED

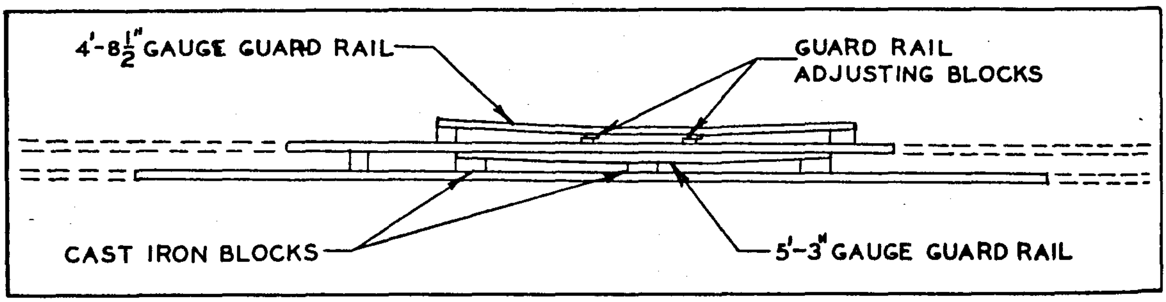


FIG. 9. THE SPECIAL DOUBLE GUARD RAIL ASSEMBLY

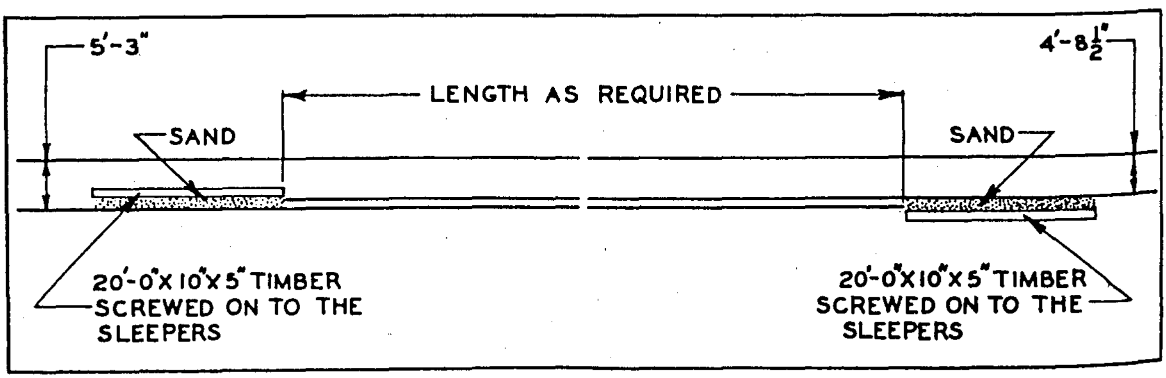


FIG. 10. THE THIRD RAIL SAND STOPS

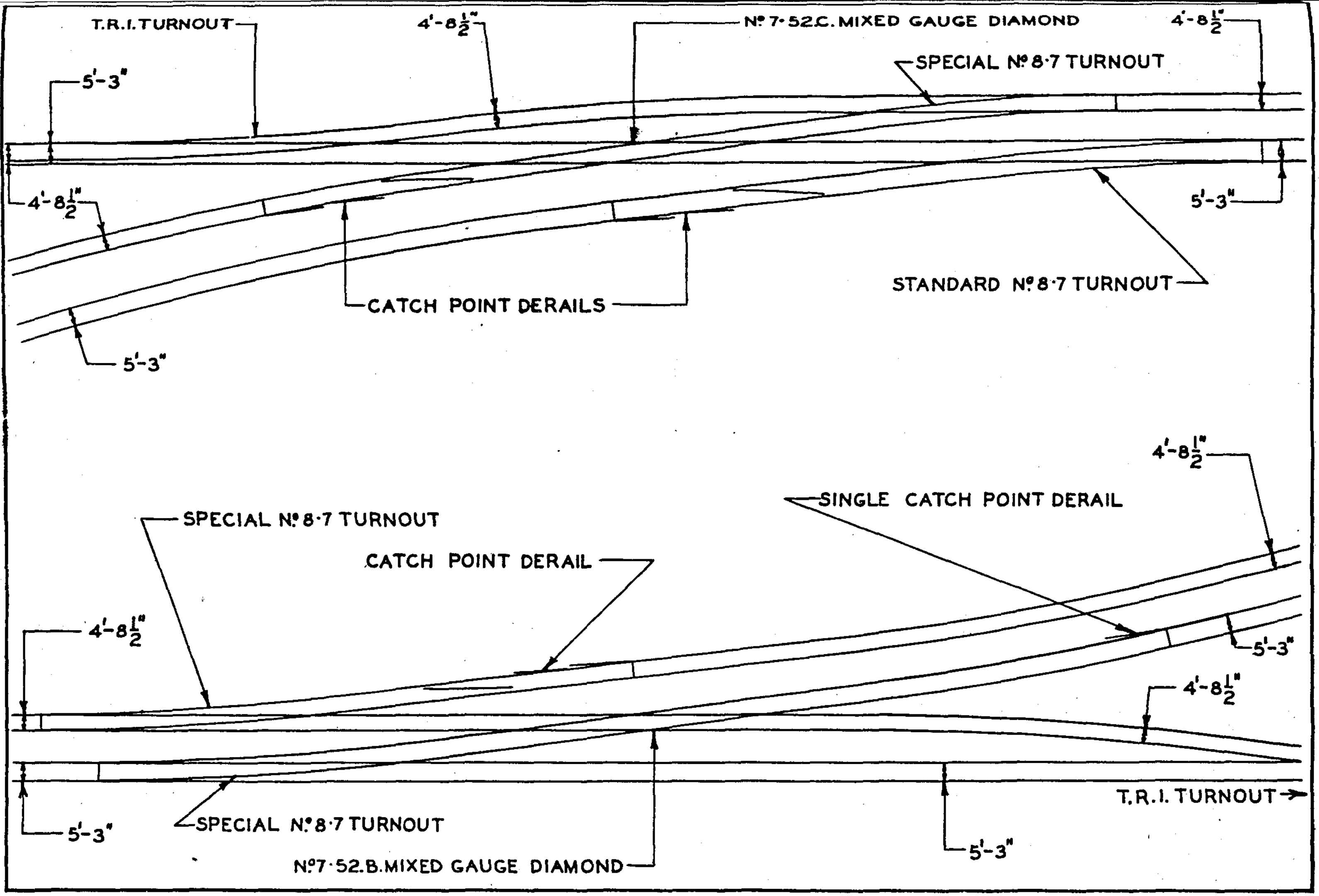


FIG. 11. THE ARRANGEMENT FOR THE ISOLATION AND RE-GROUPING OF THIRD RAIL TRACKWORK

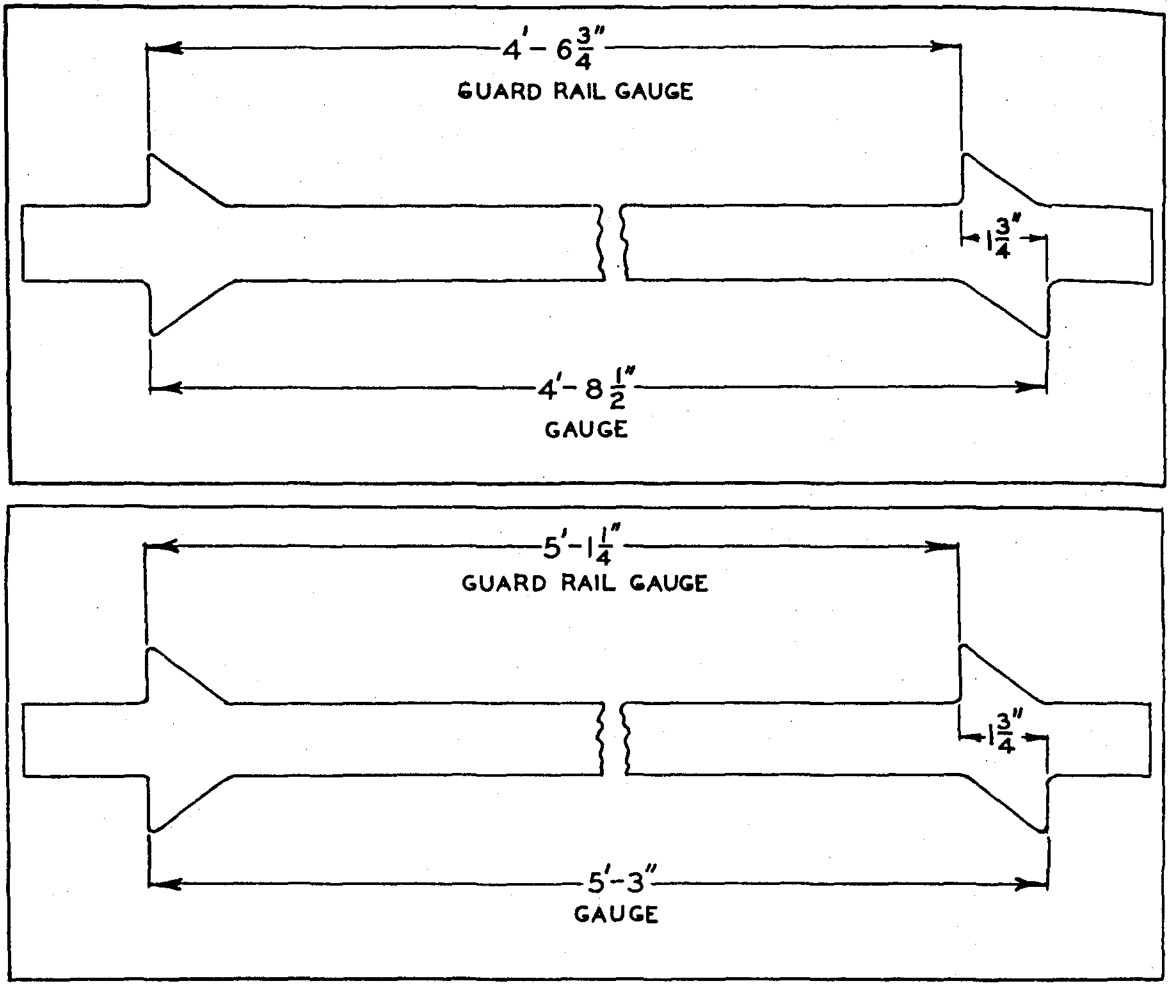


FIG. 12. THE THIRD RAIL GAUGES

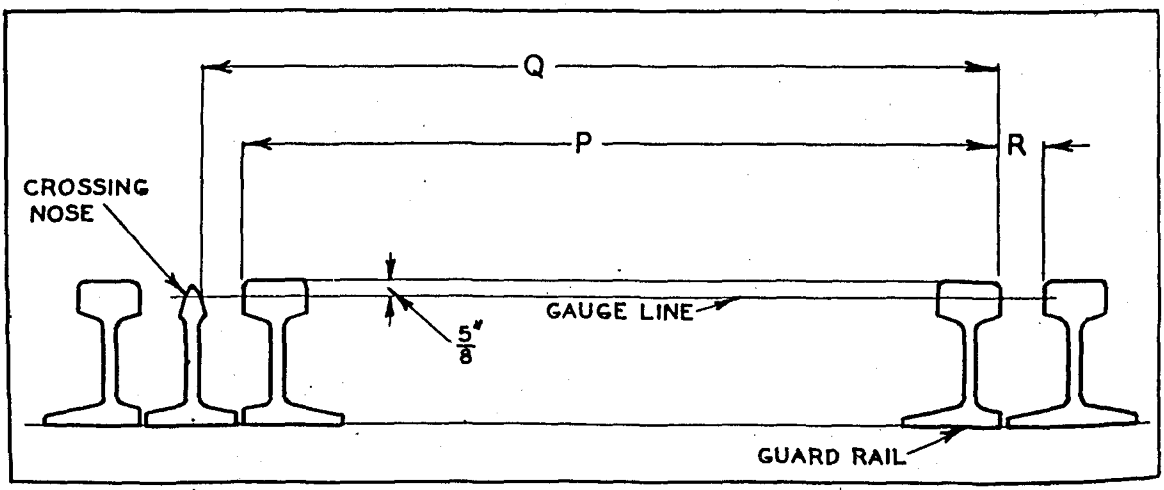


FIG. 13. THE N.S.W. STANDARDS FOR GUARD RAIL ADJUSTMENTS

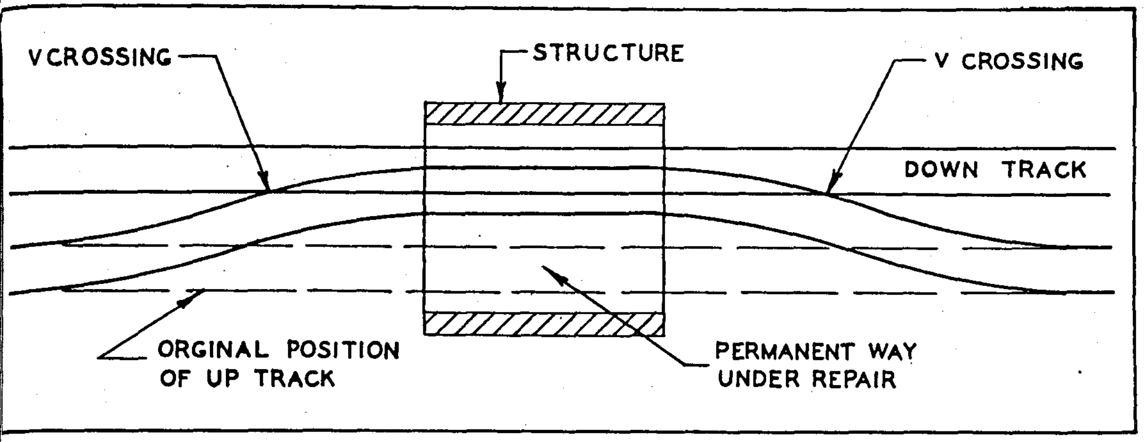


FIG.14. THE GAUNTLET TRACK

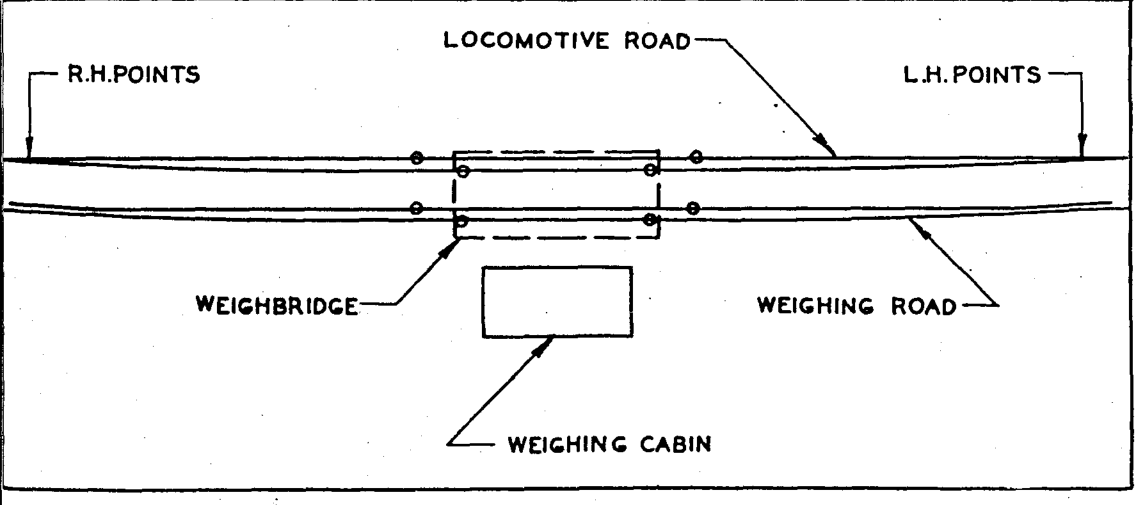


FIG.15. THE WEIGHBRIDGE TRACK

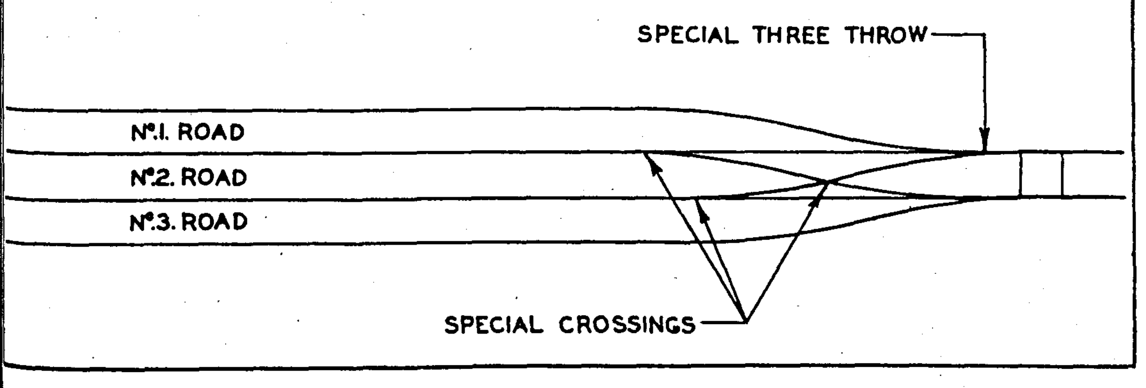


FIG.16. THE FOUR RAIL THREE TRACK LAYOUT

18. ACCIDENTS & DAMAGE.

CAUSES

Accidents are usually attributable to one of three causes, viz: human errors, defective equipment, and forces of nature.

HUMAN ERRORS

Human errors probably constitute the greatest danger in the operation of railways as in other forms of transport. Experience has shown that many accidents are the direct outcome of similar errors repeated by different individuals, and it is therefore possible to classify these causes and lay down working principles to prevent repetition.

These principles are the basis of the Rules and Regulations issued by the Department, and their intention is to guard against known causes of accident. It is the duty of trackmen as well as operating personnel to familiarise themselves with the Rules and Regulations for the safety of traffic as well as their personal safety.

Errors arising from neglect to observe the Rules and Regulations amount to carelessness and some of the more common acts of carelessness causing accidents are listed hereunder :-

(a) Facing points not held hard over or released before the last wheel has passed over the switches.

(b) Neglect to observe that the switches have returned to normal position after a trailing movement through them.

(c) Neglect to observe if the switches are properly set for an intended movement.

(d) Giving a signal to set back without completing the trailing movement through the points.

(e) Interfering with the position of the switches during the passage of vehicles through the points.

(f) Faulty brake application and rough shunting.

(g) Standing vehicles within the fouling point.

(h) Neglect to properly clean and lubricate the slide surface of the point chairs resulting in sluggish operation of the switches.

(i) Failure to observe and remove obstructions between the switches and stock rails.

DEFECTIVE EQUIPMENT

Equipment may be defective in material or adjustment; aterial defects are primarily the responsibility of the manuacturing and inspectional sections, but adjustments are under he care of the maintenance staff.

Defective maintenance of track or rolling stock may cause ccidents and damage as great as that caused by operational rrors, and the following maintenance defects are those which re most commonly met.

STRAIGHT TRACK DEFECTS

a) Foul joints causing a wheel flange to strike and mount the rail, especially with a worn wheel flange.

b) Tight gauge in conjunction with defective joints causing a wheel to mount at a joint.

c) Wide gauge insecurely spiked which, under unfavorable circumstances, will permit of a wheel dropping within the gauge.

The maximum allowable excess in gauge is 1" and cases are on record of derailment occurring with $1\frac{1}{4}$" excess gauge with loose spikes.

d) Decayed sleepers in a group failing to hold the track to gauge.

e) Irregular surface, or cross nips in track, which cause vehicles to rock sufficiently to allow a wheel flange to mount the rail; 'T', 'H', 'L', 'M' and 'U' vans, particularly iced 'T' vans without other loading, are critical vehicles under these conditions. Many of the new welded type of trucks such as the 'GZ' and 'GY' are likewise critical to irregular surface,particularly if loaded heavily towards one end.

CURVED TRACK DEFECTS

In addition to the defects common to straight track the nfluence of curvature accentuates the tendency to derailment ue to the pressure between the inside buffers when traversing he curve.

a) A severe bump at the same instant that the rear inner wheel drops into a depression may cause the leading outer wheel to mount.

The mounting position occurs ahead of the nip, a distance approximately equal to the wheel base of the vehicle. A nip of 3/4" in a length of 6' at a joint is sufficient to cause derailment.

In this connection it must be clearly understood that the surface condition of track under load is altogether different from that obtaining in the unloaded condition, from which the necessity for observing the condition of track under traffic should be apparent. See Voidmeters,11.05.

(b) When wear occurs at the running edge of the outer rail causing the gauge to be widened beyond the increase allowed on account of curvature, and if re-gauging be left unattended, derailments may occur from spreading of the gauge or by a worn flange mounting the worn side of the outer rail.

(c) Irregular curvature tends to develop variations in gauge, and this condition permits of wheel flanges making a critical angle of contact at the running edge of the outer rail with the danger of mounting.

(d) Sudden changes of cant cause high-sided four-wheel vehicles to rock and may cause a wheel to lift sufficiently to mount the outer rail.

(e) Excessive cant may cause wheels of locomotives steaming slowly under heavy load to mount the outer rail.

(f) Any of the foregoing defects may not be in themselves a cause of derailment, but in combination the effect may be sufficient to be so.

<u>OVERHEAD CONTACT WIRE</u>

Apart from derailment, accidents may be caused in the electrified area by excessive movement of the pantograph relative to the overhead contact wire.

To distribute the wear on the surface of the pantograph the contact wire is staggered in alignment relative to the track. The amount of displacement relative to the centre line of track is 1 foot on either side, and the contact portion of the pantograph extends 2'3" on either side of the centre line of the vehicles.

There is therefore 2'3" - 1'0" or 1'3" of safety margin to low for swaying of the vehicles, and if further relative movent takes place there is a danger of the pantograph tearing wn the dropper wires and breaking the contact wire at the nnection with the overhead mast.

Because of the spring mounting of electric motor vehicles e pantograph can swing over a maximum distance of 11 inches. us reducing the safety margin from 1'3" to 4".

The effect of altering the cant by 1" is to move the pantgraph by 3" so that the danger point is almost reached. See g. 1. When the contact wire is erected its position is fix- with regard to the cant on the curve, and cant should not be tered without suitable alterations being made in respect to e contact wire.

Under service conditions goods trains traversing electried lines at slow speeds tend to throw additional weight on e inner rails and depression of the inner rail may take place us increasing the cant. It is therefore necessary in the ectrified area to correct the cant when the variation from e intended cant reaches an amount of 3/4" so that a variation 1" may not be exceeded at any time.

TRACKWORK DEFECTS

These defects are associated with installation and maintence conditions through points, crossings, guard rails and layt curves, and are possible causes of derailments since they versely affect operating conditions. These defects are as llows :-

POINT HEEL FASTENINGS

Switches binding at the heels because of badly fitting closure rails, or free movement prevented by insufficient clearance in set heel fishplates.

Stops not bearing against web of stock rail, thus allowing the switch to whip and open at the toe when lateral flange pressure is exerted toward the heel.

Stops bearing against web of stock rail before the toe of the switch is home against the running side of its stock rail.

Defective heel chair interfering with the vertical mounting of the stock rail, switch and closure rail, and thus binding the heel.

Heel fishbolts over-tightened in 'X' layout points.

6. Heel fishplates of opposite hand applied in 'Y' layout points.

7. Omission of distance ferrules in A.R.E.A. heel assemblies.

POINT SLIDE CHAIRS

1. Stock rail vertical mounting incorrect due to the tightening of the chair bolts before the point timbers are packed.

2. Stock rail lateral mounting incorrect due to drift of the point chairs when the chair pins are driven or the chair screws inserted.

3. Chair seating uneven due to warped timbers or neglect to skim off unevenness before the chairs are seated.

4. Boring chips making uneven seating between the timber and the chair.

SPREADER AND OPERATING CONNECTIONS

1. Forcing spreader ends, pins or bolts into position thus springing or twisting the switches out of alignment; this causes the switches to move under traffic and stick in operation.

2. Bending or twisting of spreaders, pull rods, lever rods, cranks or lever parts results in stiff and uncertain operation of the switches.

CLOSURES

1. Sawcut out of square, size and position of holes for heel bolts incorrect, closure out of alignment with point heel assembly.

2. Irregular curvature; this varies the rate of turning of vehicles traversing the layout curves and likewise varies the pressure between the wheel flanges and the outer rail. This results in uneven wear and may cause a sharp flange to mount the rail.

3. Condition (2) is aggravated by irregular surface and gauge and in combination are possible causes of derailment.

CROSSINGS AND GUARD RAILS

1. As explained in 14.075, 14.076, 14.100 & 14.102 the combination of gauge and guard rail gauge must be correctly maintained to reduce the dangers of derailments at the crossings.

In this connection it is useless to apply the gauges to oose guard rails and improperly secured track rails as later- l movement of traffic may sufficiently distort the gauge and ard rail gauge to cause derailment.

It is likewise futile to gauge crossings in curved cross- g work without regard to the necessary flangeways as well as e gauge and guard rail gauge.

In crossovers at close track centres the guard rails and ard wing rails of the crossings provide an almost continuous langeway through the crossing work, and if the required con- itions are standard gauge, then the gauge from guard rail to ard rail is $4'11\frac{1}{2}"$. See Fig. 2.

Tightening up crossing bolts to compensate for internal ear may increase this distance to $4'11\frac{3}{4}"$, and a latitude of " wide gauge further increases this distance to 5'0", which s the distance between the backs of locomotive wheels.

Under these conditions locomotives are restrained in dir- tion by the guard edges, and if curves adjoin the crossing rk, there will be a strong tendency for leading and trailing heels to mount the curved rails. See Fig. 3.

<u>WHEEL-TO-RAIL CONTACT</u>

To safely deflect the wheels of a train from one track to nother it is essential that the points alone shall influence he movement of the vehicles. To the extent that the move- nt imparted to vehicles by other trackwork opposes the move- nt directed by the points, there will be greater wear and ore likelihood of derailment than where the points alone con- rol the movement.

The influence of adjacent guard rails and crossing work n the movement of vehicles and running position of the wheels aries with the type of vehicle and the direction of movement.

Incorrect and irregular gauge at or leading to the points y be factors in causing derailment.

It is not possible to list the many wheel-to-rail condi- ions contributing to derailments because the circumstances resent in each instance must be taken into account.

Two instances of derailments of which the causes were not pparent at first sight are quoted with the view to interest tudents and impress upon them the importance of closely ob- erving all the conditions at the time of derailment.

Case 1. Electric locomotive derailed on steep down grade with heavy train, trailing wheel of trailing bogie mounted at the closed switch. Brakes had been heavily applied.
Mark of wheel flange on top of stock rail commenced 8 inches before toe of switch, no mark visible on switch.

In Fig. 4, the position of the trailing bogie relative to the switch is shown and the contact point between the wheel flange and the rail is clearly a trailing contact. The direction of motion of the train is at an angle to that of the electric locomotive and the resultant force is in the direction of mounting as shown by the marks on the stock rail.

It is probable that the trailing wheel slipped up the rail radius by contact with the rear flange radius as shown in Fig. 5. Reference to subsequent damage is unnecessary here and has been omitted.

Case 2. 'Q' truck derailed at facing points on a curve, leading wheel of leading bogie mounted the closed switch. Marks on the side of switch indicated mounting behind the toe.
A guard rail had been fixed ahead of these points, and the gauge was 5/8" wide 6' ahead of the points.

In Fig. 6, the position and direction of the leading wheels are shown as influenced by the guard rail, and the position of the trailing wheels is so restrained as to greatly increase the angle of approach between the leading wheel and the switch.

The condition of wear on the wheel flange is shown in Fig. 7, and it is probable that mounting took place by reason of the wide angle of approach assisted by the sharp wheel flange.

It should always be remembered that the radius on the side of the rail head and the radius at the bottom of a wheel flange are put there for the purpose of preventing derailments due to the wheel mounting the rail, and the further these profiles are departed from by the action of wear so will the hazard of derailment increase.

It should also be remembered that while the angle of approach between the wheel flange and the rail is a minimum, the tendency to mount is a minimum; and when wear and angle of approach are considerable, the danger of mounting is also considerable.

WORN MATERIALS

The running surface, running edges and guard edges of rackwork components are all subject to wear and a stage is eached in the service life of materials when any further wear ight result in failure and possible derailments. Actual ailure of a worn part or series of parts in service may be ue to breakage or to the inability of the worn parts to conrol the position of wheel flanges.

RAIL WEAR

The extent of wear permitted on rails has been fixed by ail wear gauges, and the manner of applying these gauges is hown in Fig. 8.

Because rails wear differently according to the service hey perform - as on curves where the rail side is usually orn most or in station pits where the running surface is subected to heavy abrasion - it follows that several gauges are equired to check the various conditions of rail wear.

In Fig. 9, the five standard gauges are shown as if they ere all assembled simultaneously in the gauge holder. No.1 auge shows the maximum running surface or top wear. Nos. 2, , and 4 are intermediate conditions of wear of both the running surface and the running edge. No.5 shows the maximum llowable side wear, and it will be observed that very little unning surface wear is permitted in this case.

The rail wear gauges and holders are applicable to several similar rail sections and particulars are stamped on the auges.

SWITCH WEAR

The diverging switch in a set of points is subject to eavy side wear in facing movements.

Trailing movements over the diverging switch cause heavy ide wear of the stock rail in front of the switch toe.

Facing movements on the straight further extend the stock ail side wear behind the switch and leave the switch exposed o crushing by the wheel flanges. See Fig. 10.

A crushed switch toe soon breaks away from the switch eaving a ramp-like section which may cause a sharp flange heel to mount and become derailed. See Fig. 11.

Switches crushed in this way should be dressed with a oarse file to form a new toe; badly crushed switches are reachined to form a new toe some inches further back, as shown n Fig.12.

'V' nosed points were introduced to reduce the rate of destruction by crushing at the toe of the switches.

Heavy wear on the stock rail face behind the switch toe is a dangerous condition with any points, and the worn stock rail should be replaced at the earliest opportunity.

Welding is not permitted on the toes of switches; it has been used with some success on the sides of worn stock rails in yards and sidings, but when used on heavy service points it usually results in fracture of the stock rail within the zone of welding.

Excessive wear on the running surface or crown of the switches, such that the level of the switch falls below the stock rail, will allow of worn wheels nipping the stock rails and, in bad cases, bursting the gauge and overturning the stock rails.

Progressive wear of the slide surfaces of point slide chairs and the underside of the switches will cause the switches to ride the base of the stock rails and roll outwards under traffic.

An action similar to the sliding together of scissor blades occurs at the edges of switch and stock rail flanges if the switch is improperly supported by the slide chairs and the resistance thus offered to movement may result in the switch standing partly open.

<u>CROSSING WEAR</u>

Wear on the running surface of crossings is usually greatest across the gaps of the crossings as the wheel treads are only partly supported in crossing over the flangeways.

When this wear reaches the limit, as determined by the crossing wear gauge shown in Fig. 13, a dangerous condition is being approached as a trailing wheel of a vehicle running into the depression may cause the leading opposite side wheel to lift and mount the rail.

Crossings of 90, 94, 107 and 110 lb. rails should be welded when the wear reaches 1/4"; the condemning gauge is 1/2".

Side wear through the flangeways reduces the surface area across the crossing gaps and accelerates the top wear; it is therefore necessary to restore the flangeways in some cases, but if the side wear is due to faulty alignment of the crossings it is both useless and dangerous to reduce the flangeways by side welding.

The permissible side wear at the knuckle of 'K' crossings s 1/4", as shown in Fig. 14, and the equivalent side wear on he nose is such that the crossing becomes dangerous when the ide wear has removed the radius of the rail head and exposed sharp edge to contact wheel flanges.

VEHICLE DEFECTS

The following defects may cause derailments : -

- Wheel flanges worn sharp.
- Incorrect distance between wheels on the axle.
- Wheels out of line.
- Axles out of square.
- Bent axles.
- Defective draw gear or couplings.
- Broken buffers.
- Badly cross-balanced trucks.

LOADING DEFECTS

If the loading is very unevenly distributed conditions ill be favorable to derailment, as follows : -

- Heavy load at rear of truck tends to allow front wheels to lift when rear wheels drop into a slight depression of track.

- Heavy loading on one side of truck tends to allow wheels on light side to mount on curves, and the effect is increased when track conditions are favourable to derailment.

ROUGH SHUNTING

The effects of rough shunting may be the immediate cause f derailment or may contribute to subsequent derailments owng to vehicle damage.

- Immediate derailments can result from the buffer locking of side buffer trucks,the breaking of couplings and draw gear, the breaking of buffer-stops and bumping vehicles off the track.

- Subsequent derailments arise from the damage done to vehicles such as, strained couplings and draw gear breaking away, bent axles and 'W' guards, fractured axle boxes and pads shifted causing wheels to track out of line and become derailed.

COMBINED EFFECTS

Operational errors, vehicle and track defects, which alone would not cause derailment may in combination do so and the only safe condition is that in which all the separate elements are maintained at all times within the limits of allowable departure from first class standards.

FORCES OF NATURE

Though less frequent in occurrence the consequences of accidents caused by the forces of nature can be tragic. Storms and gales may lead to obstructions of the track and these must be looked for and be promptly cleared.

Fires burning out adjacent sleepers, and fires in bridge decking, even if extinguished before extensive damage is done, may so weaken the track as to cause derailment.

Failure of earthworks, if extensive, will lead to considerable delay in restoration work even if accidents have been averted. The primary cause of slips in earthworks is nearly always due to the action of water, either surface or subsoil.

SLIPS IN CUTTINGS

Slips affecting cuttings may be divided into four classes:-

1. Surface slips due to surface erosion or to the slopes of the cutting not having been taken back to the angle of repose of material excavated. See Fig. 15.

2. Slips due to crushing or erosion of horizontal beds of permeable soil underlying sounder material. See Fig. 16.

3. Slips due to sliding of overburden or inclined beds of a greasy nature. See Fig. 17.

4. Local or general movement of the hillside above or below the formation when the dip of the strata is unfavourable. See Fig. 18.

Slips in class (1) are caused by weathering away of the softer portions of the slopes thus leaving masses of material without adequate support. Vibration set up by the movement of trains further loosens these masses of material until the material collapses.

To avoid obstruction of the track it is necessary to clean down the unstable materials from the slopes of the cuttings.

Small slips may vary from a mass of material sufficient to obstruct the cess drains and one rail to larger masses completely obstructing traffic.

With a small slip it will usually be possible to clear the rails by spreading the material and, if necessary, temporarily throwing any excess into the opposite cess.

At the earliest opportunity the slopes from which the slip has occurred should be examined and the upper portion be trimmed back to avoid further movement of unsupported material.

If the cutting is deep it may not be possible to dress the slopes above the slip and some form of surface treatment may be necessary, such as pitching or sleepering the broken portion of the slope to shed surface water and afford support to the material above the slip.

Slips in classes (2), (3) and (4) usually involve special works under engineering supervision.

SLIPS ON EMBANKMENTS

Slips affecting embankments may be divided into three classes : -

1. Surface slips on slope of embankment owing to surface erosion, local saturation, or faulty construction.
2. Sliding of embankment at the surface of side-long ground owing to absence of benching or ingress of water.
3. Movement of subsoil under embankment owing to water logged condition of ground.

In class (1) undue surface erosion is usually an indication of insufficient slope for the class of material and the remedy is therefore to add sufficient material to provide a stable condition, or to protect the existing slopes by vegetation or stone pitching.

Slips in classes (2) and (3) are difficult to deal with and may ultimately make re-location of the track on firmer ground necessary.

If the cause has been the ingress of water it should be apparent that a little care in prevention of water saturation might save a tremendous amount of work in curing the damage done.

FLOODS

During floods the drainage systems provided for the disposal of normal surface water may be entirely submerged and earthworks be exposed to serious saturation. It is therefore of considerable importance that all precautions be taken to remove obstructions which might interfere with the disposal of the water.

The highest water levels reached should be marked on both the up and down stream sides of bridges and waterways, either on the structures, or if these are inaccessible, then by pegs driven in the embankment to mark the position reached by the flood waters.

The marking of the water levels on both sides of flood openings and the comparison of the levels gives an indication as to whether the waterway is of sufficient area to dispose of its catchment water or whether the outlets are effective.

The damming back of water on the down stream side of bridges and waterways indicates a blockage lower down the watercourse.

Fences to which wire-netting is attached may be so fouled by grass and floating debris as to considerably interfere with the movement of flood waters. Wire-netting must not be attached to fences on the line of the waterway to a bridge or culvert.

If the flood waters rise appreciably the fences will collapse, thus suddenly releasing a large body of water which may cause scours and overtop drains and culverts ordinarily of sufficient area to deal with surface waters.

A wise precaution with wire-netting in depressions subject to floodings is to fasten the top of the netting to the fence wire by means of bent wire hooks. Pressure of water against the wire-netting will cause the hooks to open and the netting to fall flat on the ground before much water has accumulated.

Much useful information in respect to the velocity and direction of currents can be obtained by inspection of flooded areas during unusually severe floods.

An engineer should be present if possible to observe a severe flood at its maximum.

WASHAWAYS

Washing out of ballast and surface formation may occur der abnormal conditions of flooding or result from the ockage of shallow culverts under the track.

In some cases the water may rise above the formation level d pass across the track through the ballast without causing tual scouring of materials, but the formation may be so akened by saturation that a dangerous condition of track will ist until the formation has dried out.

At bridges, culverts and flood openings where flood wat-s are concentrated to pass under the track, the water may be owing at a high velocity and capable of rapidly scouring ose materials.

With unusually high flood levels there is a danger of the ter flowing in behind the abutments of the bridges and open-gs or around the sides of the culverts and washing out the jacent embankment. Damage of this nature may be averted if served at an early stage by strengthening the embankment on e up-stream face with spalls or sandbags.

If the water has piped through before strengthening is mmenced there will be every likelihood of the embankment ving in, and men placing materials to reduce the washaway ould appreciate this danger and confine their activities to e solid portion of the embankment.

Once the water has broken through, scouring may cut away ch of an embankment and action should be taken to reduce is scouring as much as possible by protecting the up-stream ge of the washaway with brushwood and stones.

By application of a little thought a great deal can be ne to reduce the extent of a washaway and every yard of terial retained in place will save a lot of work and time in construction.

TEMPORARY REPAIRS

After the floods have subsided it will generally be nec-sary to first effect temporary repairs to restore the track r traffic, and later to undertake the permanent repairs.

The methods of effecting temporary repairs depend on the ture and extent of the washout, and the materials, equipment d gang strength available. Usually quantities of old eepers and bridge timbers are available, and these should be olleyed to the site to avoid delays.

Scouring out of gravel ballast without damage to formatio can be treated in several ways according to the nature of th scouring.

When the flood waters overtop a long stretch of track th erosion of ballast commences at the down stream end of th sleepers and may, before the flood subsides, wash out the ballast only under one rail. In such a case the remaining ballast can be distributed to re-surface the track temporarily, o if the formation is sound, old sleepers may be placed lengthwise under the track sleepers to give a firm bed until mor ballast can be obtained, or the track can be lowered to th level of the scoured ballast.

If the washaway is at a culvert and not wider than 2 feet, the track could be supported on bridge beams or rail placed under the rails and carried well back into the soli formation, as shown in Fig. 19.

A bed of old sleepers should be laid and the bridge beam or rails be slipped in under the track to a position vertically below the rails. To bring the track to surface wooden wedges should be driven between the track sleepers and the supporting timbers or rails.

Washaways in shallow banks up to 6 feet deep and of mor than 20 feet width will require a number of central support under the bridge beams or rails and these may be built up o old sleepers in pig-sty form, as shown in Fig. 20.

The pig-sty supports should be placed to give a span o not more than 10 feet and the bridge beams or rails should b sufficiently long to span the gap and extend across adjacen pig-sty supports.

When the washaway is through a deep embankment the trac must be supported by temporary framed trestles and this wor will usually be carried out under engineering supervision.

BOARDS OF ENQUIRY

Boards of Enquiry are constituted to investigate and report on : -

(a) The cause of accidents, derailments, etc.
(b) Nature and extent of damage.
(c) Action necessary to prevent a recurrence.

As the evidence of cause may be obliterated by weather nditions and the impressions of eye witnesses be dulled by piry of time, it is important that preliminary investigaons be made by responsible officers on the site at the time the accident.

Departmental reports on the prescribed forms must be cometed and forwarded through supervising officers. The Branch ports are before the Enquiry Boards during the enquiry and rm a valuable part of the evidence on which the Boards may se their conclusions.

In some cases of operational errors the evidence in anch reports and that disclosed by examination of the condiions at the site of the accident may be conclusive and a findg be possible without taking formal evidence. When the ard is not satisfied with the evidence thus disclosed, an quiry will be held and the staff concerned in any way with e accident or with circumstances likely to have caused or ntributed to the accident will be called to give evidence.

Trackmen called to give evidence before a Board of Eniry should have all the facts known to them well in mind; tes made at the time of the accident, derailment, etc., ould be at hand for reference, and the evidence should be ven frankly and clearly.

The members of the Boards are officers with experience, d the questions they will put are intended to bring out some pects of the cause of accident which may not have occurred the witness.

In these circumstances some witnesses are apt to become nfused and make statements influenced by the trend of quesoning at the enquiry rather than on the actual facts they obrved at the time of the mishap. Such statements make the rk of the Boards more difficult and may constitute an unhappy perience for the witness, particularly if he is of a nervous sensitive disposition.

Witnesses should confine their evidence to the actual cts observed by them; if they have failed to observe some cts it is better to openly say so than to make evasive ansrs.

Questions likely to be asked of trackmen are, the date and time of mishap, the location, direction of movement, speed and regularity of movement, condition of the track or trackwork, the gauge and cross levels at the point of derailment and at intervals of 6 feet for 30 feet of track preceding the point of derailment, and date and nature of repairs effected prior to and after the mishap.

If the mishap was on a curve, the radius, cant and regularity of curvature will be questioned.

In addition the weight and class of material, sleeper spacing, depth of ballast and drainage conditions are required.

All marks on rails indicating the point of mounting and course taken by wheels and position of wheels when derailed vehicles came to rest are likewise required.

A statement of damage to the track showing what repairs and replacements were necessary to restore the track for traffic will also be required.

With these particulars in mind no trackman should doubt his ability to satisfactorily tender evidence before a Board of Enquiry.

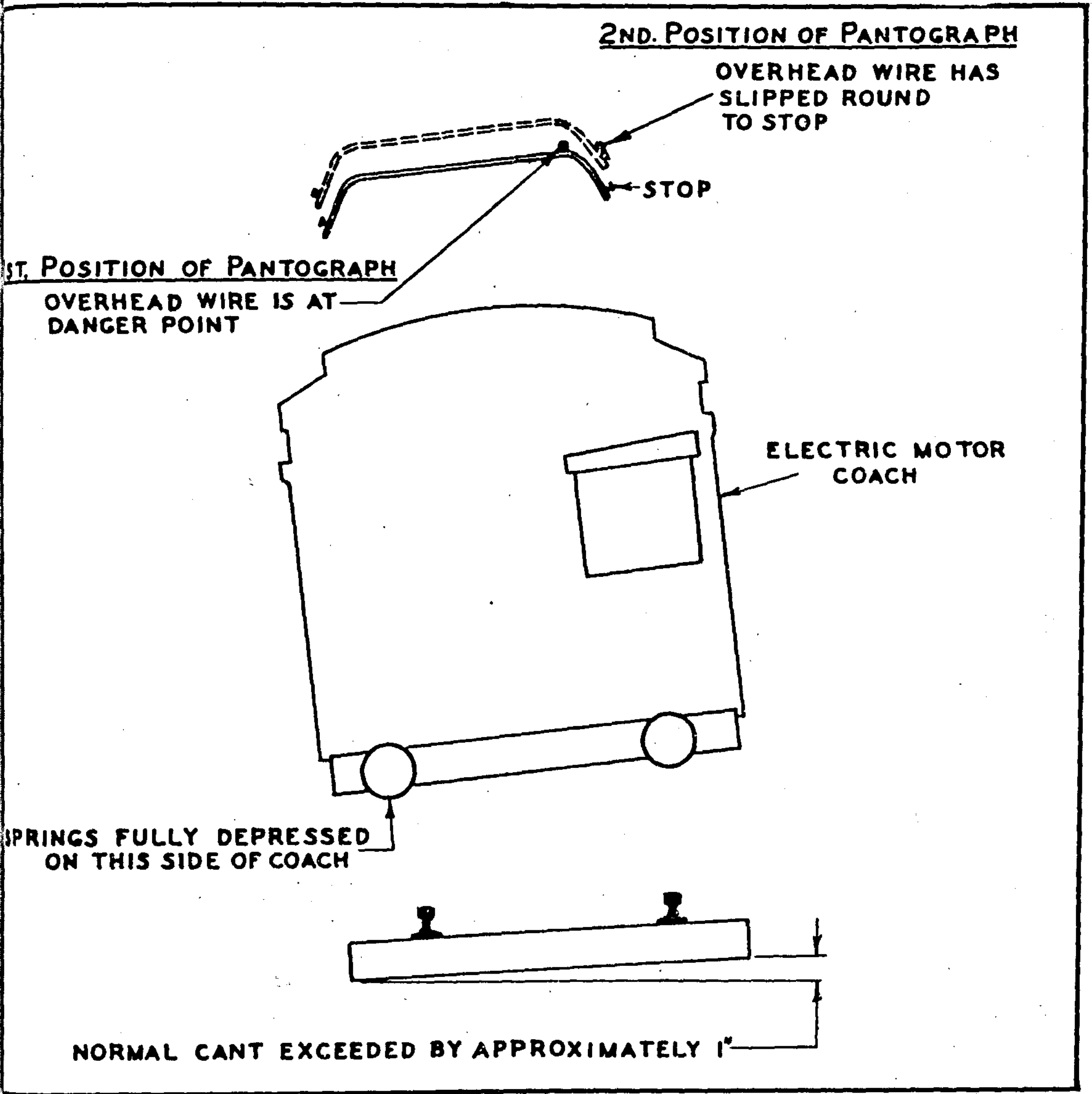


FIG.1. THE EFFECT OF CANT ON THE PANTOGRAPH, ELECTRIC STOCK

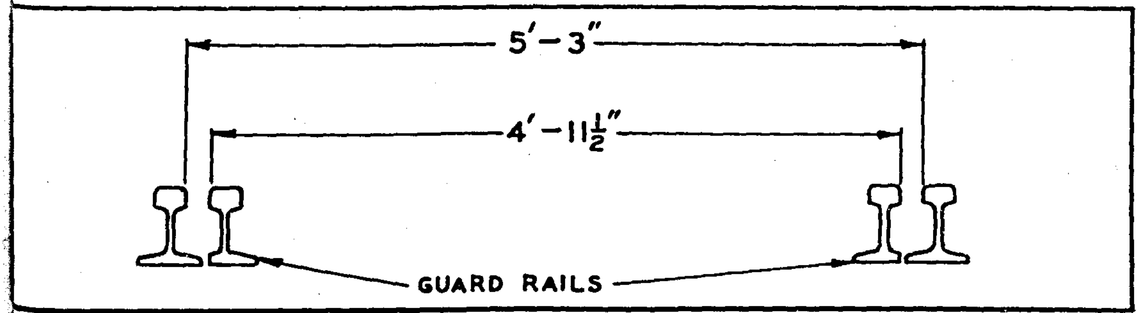


FIG.2. GUARD RAIL TO GUARD RAIL GAUGE

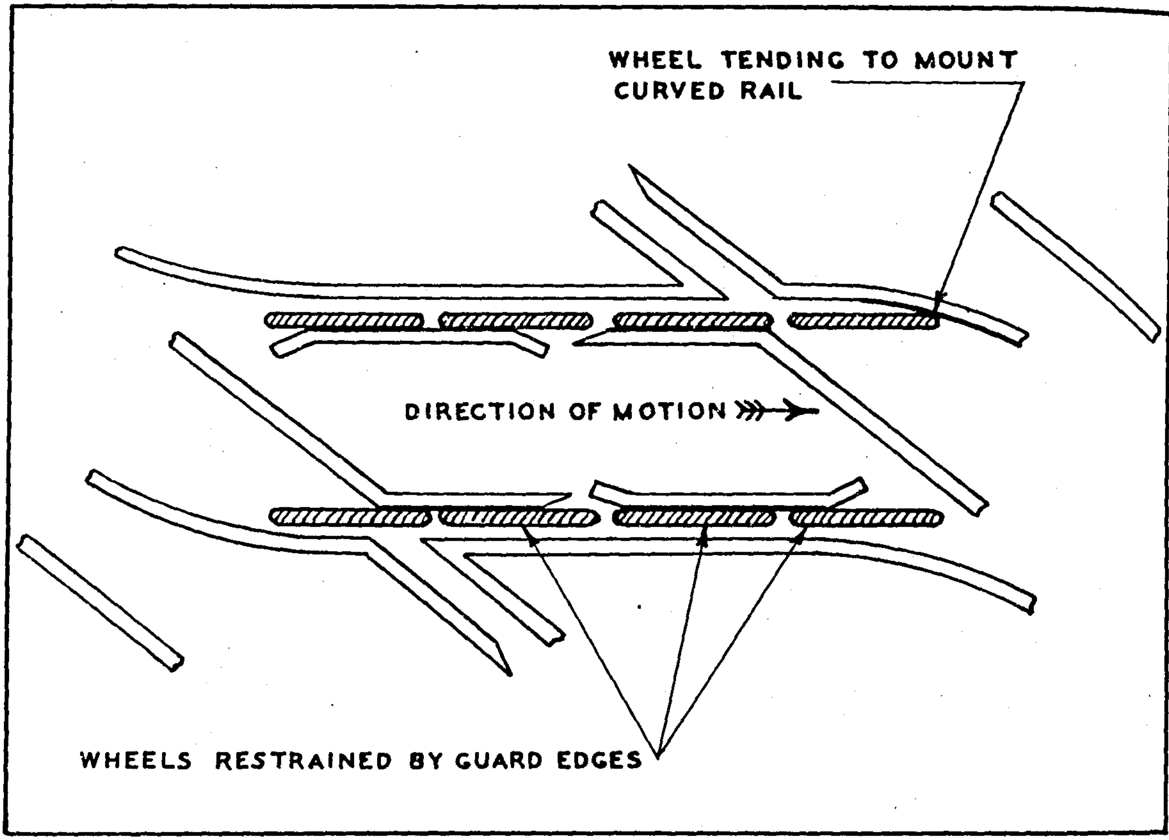


Fig. 3. Locomotive Wheels restrained by Guard Edges

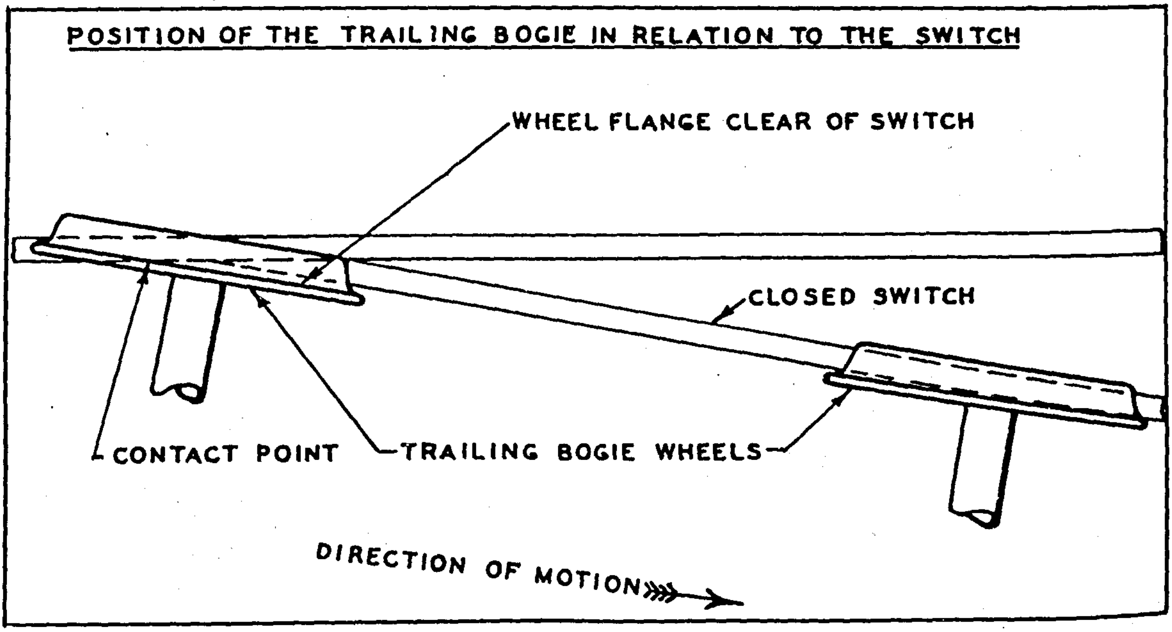


Fig. 4. Derailment of Electric Locomotive

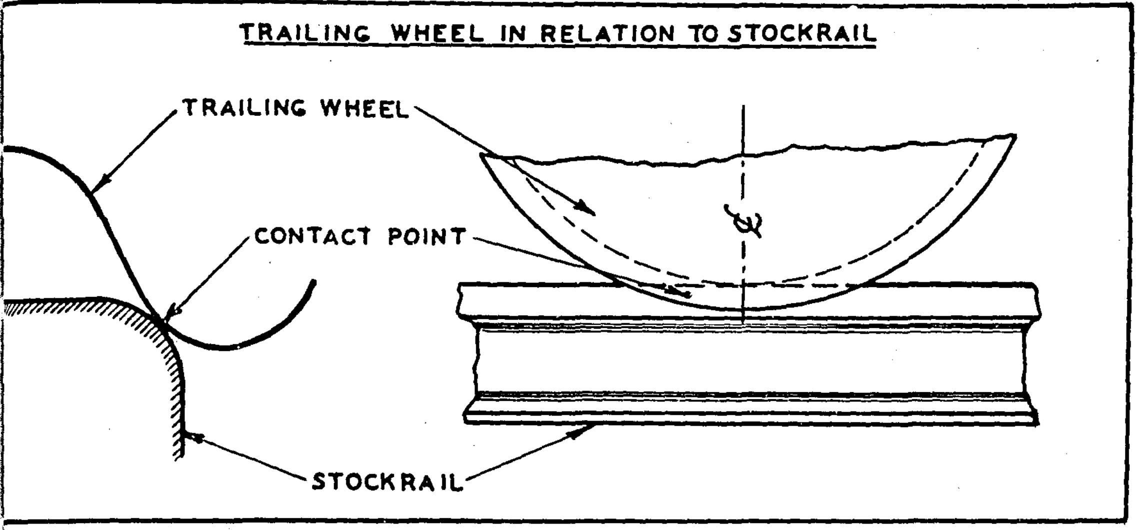


FIG. 5. DERAILMENT OF ELECTRIC LOCOMOTIVE

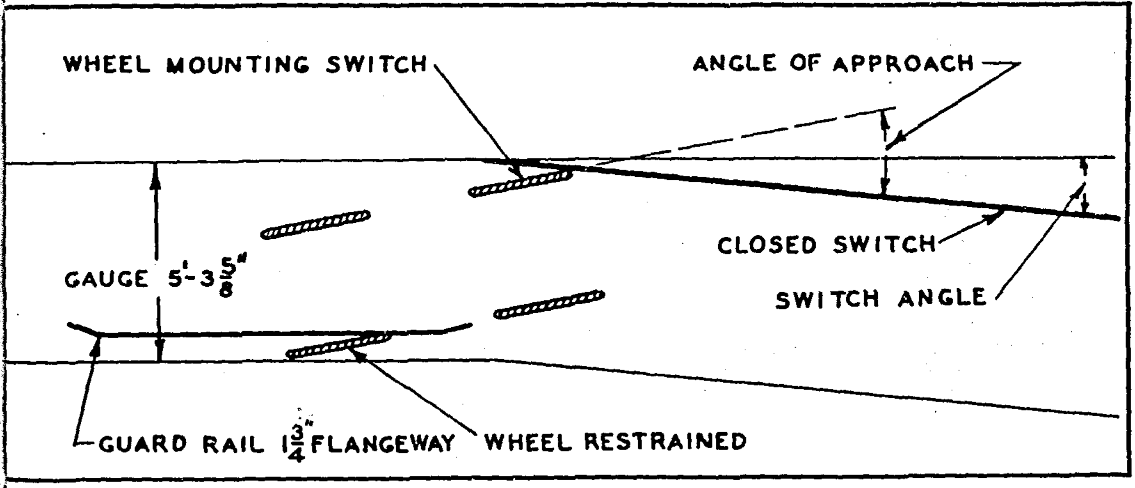


FIG. 6. DERAILMENT OF Q TRUCK

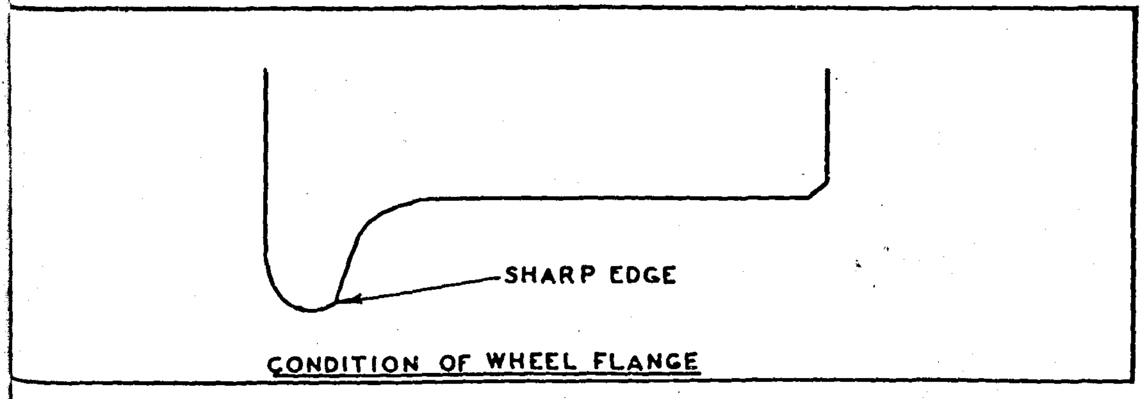


FIG. 7. DERAILMENT OF Q TRUCK

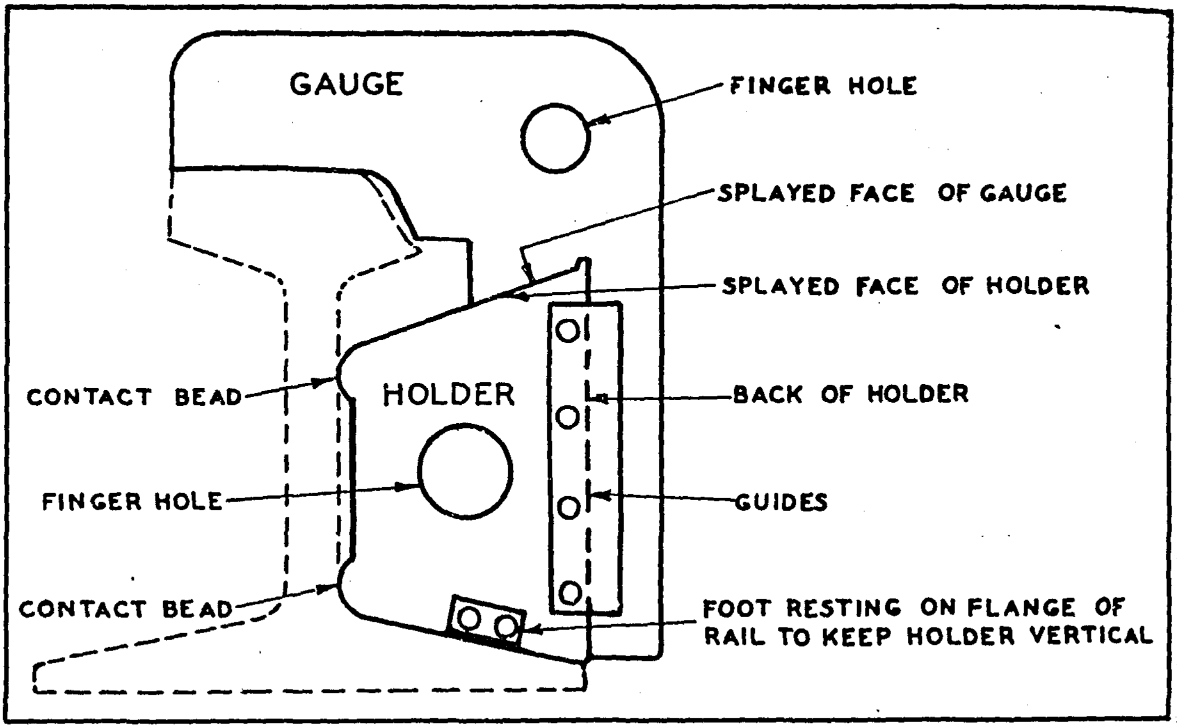


FIG. 8. METHOD OF APPLYING RAIL WEAR GAUGES

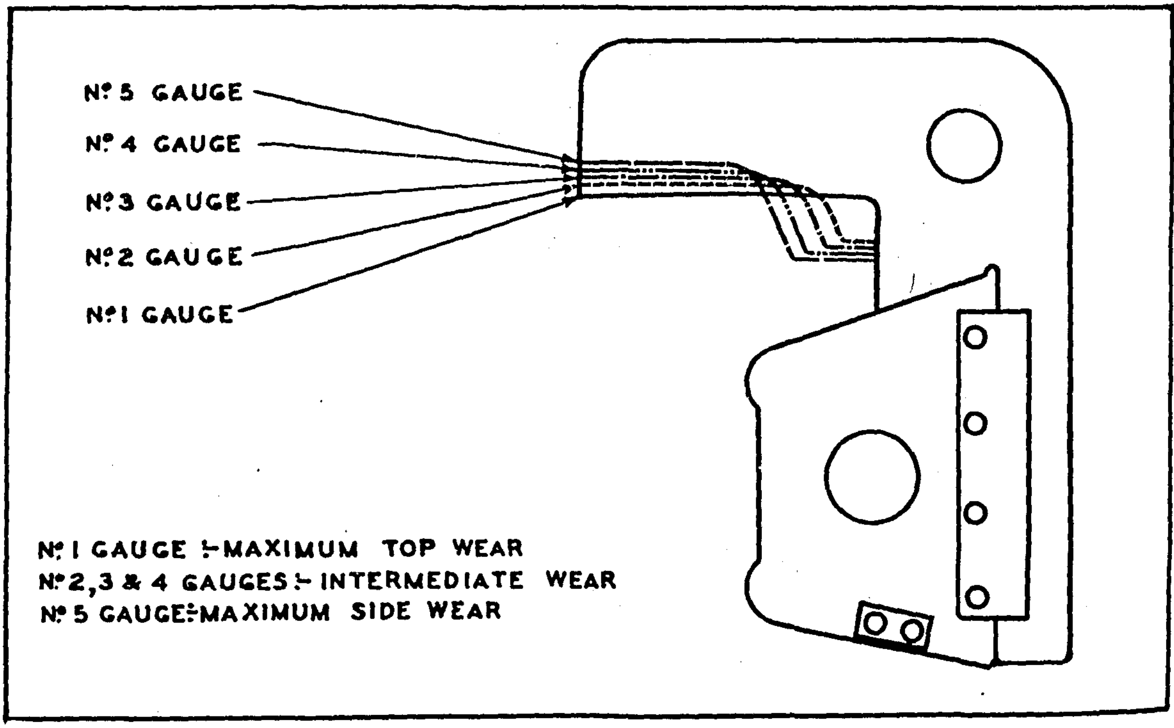


FIG. 9. COMPARISON OF THE RAIL WEAR GAUGES

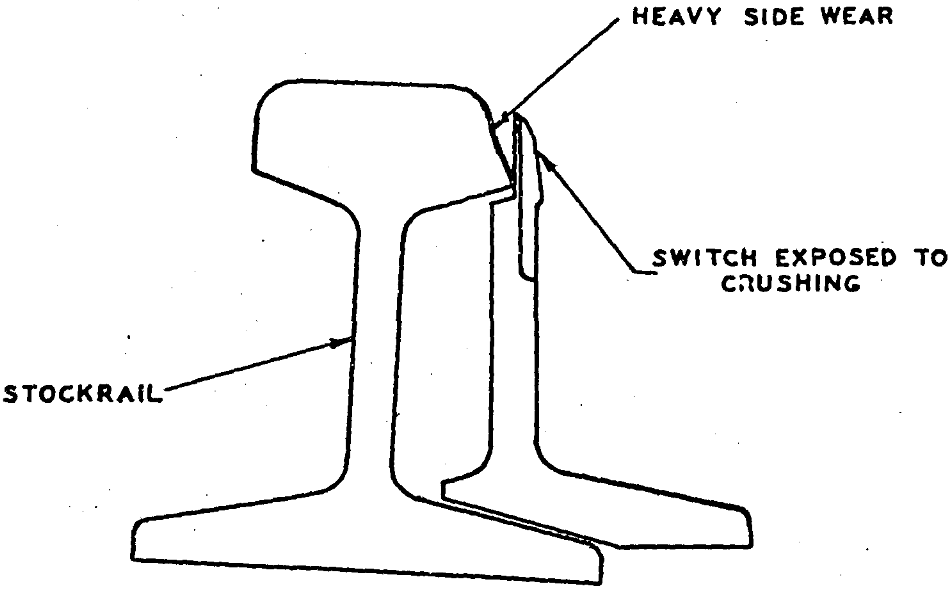


FIG. 10. SWITCH EXPOSED BY WORN STOCKRAIL

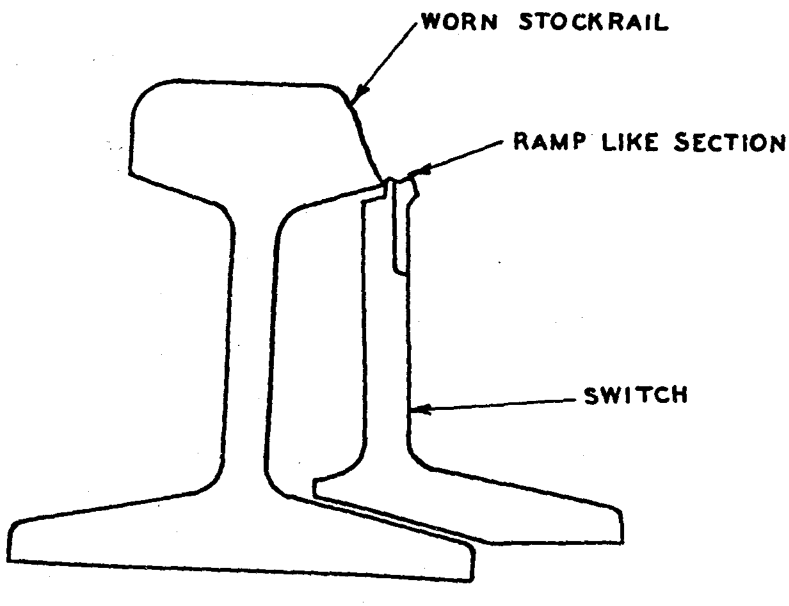


FIG. 11. CRUSHED SWITCH TOE BROKEN AWAY

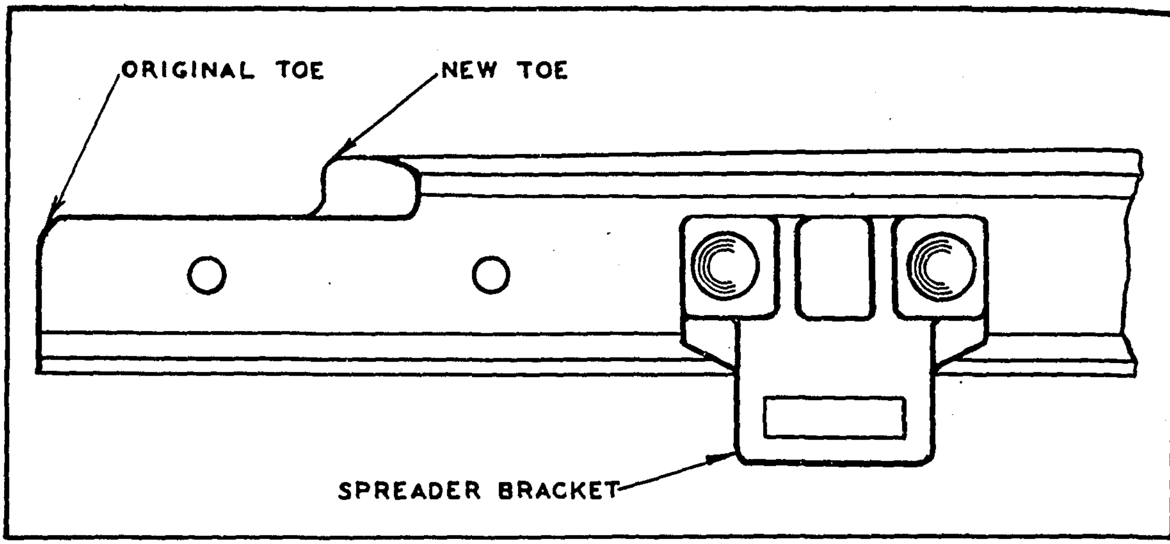


FIG. 12. REMACHINING A CRUSHED SWITCH TO GIVE A NEW TOE

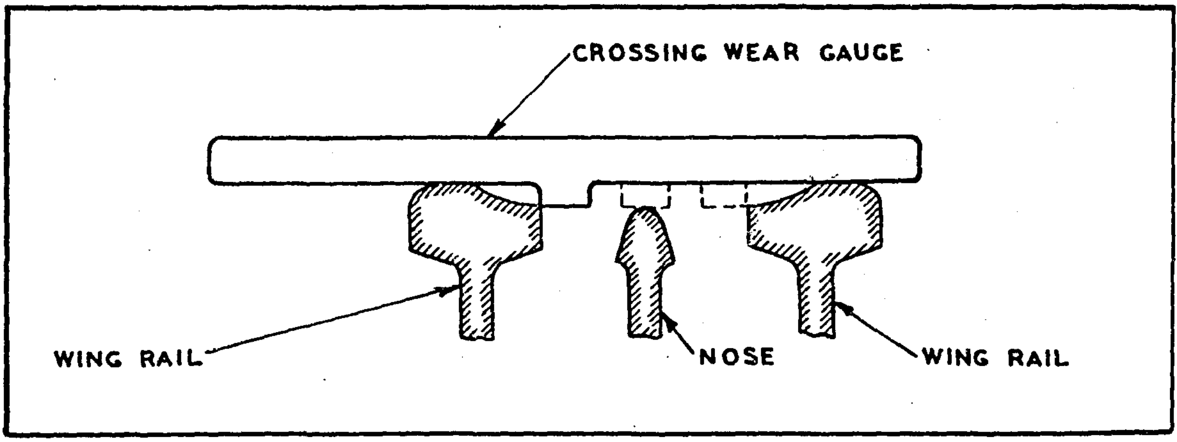


FIG. 13. APPLICATION OF THE CROSSING WEAR GAUGE

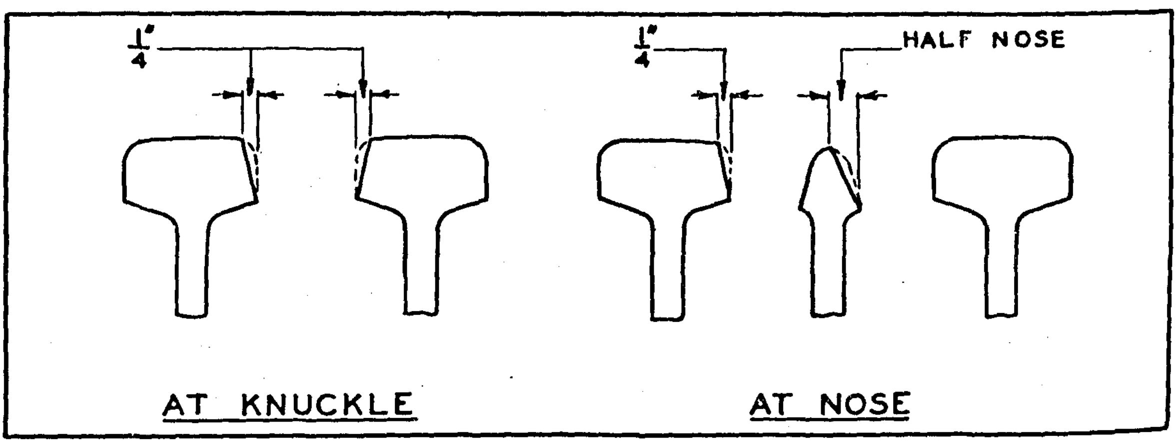


FIG. 14. PERMISSIBLE WEAR ON K CROSSINGS

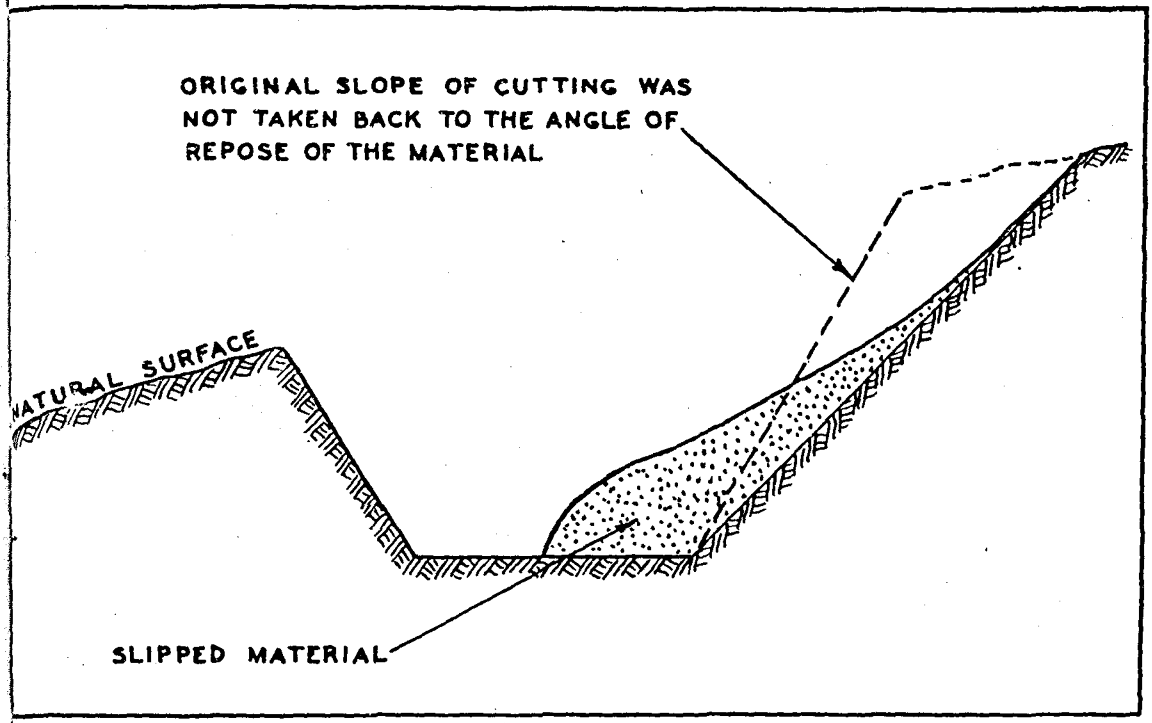


FIG. 15. A SURFACE SLIP IN A CUTTING

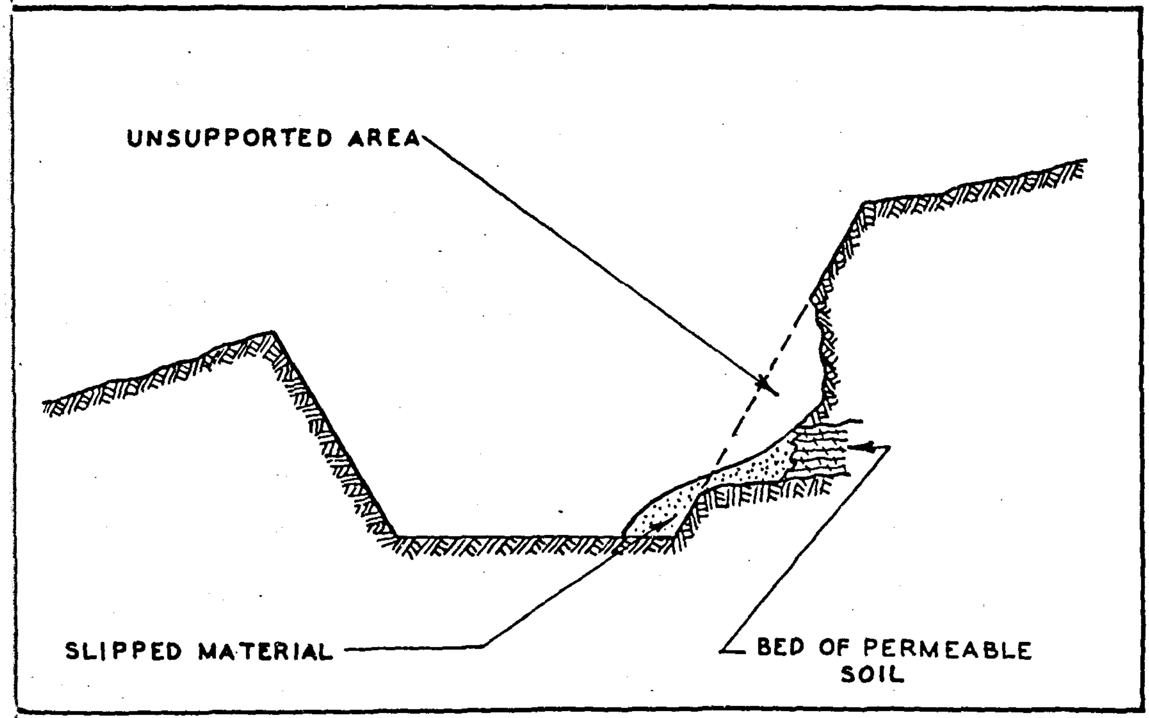


FIG. 16. A SLIP DUE TO EROSION OF PERMEABLE BED OF SOIL

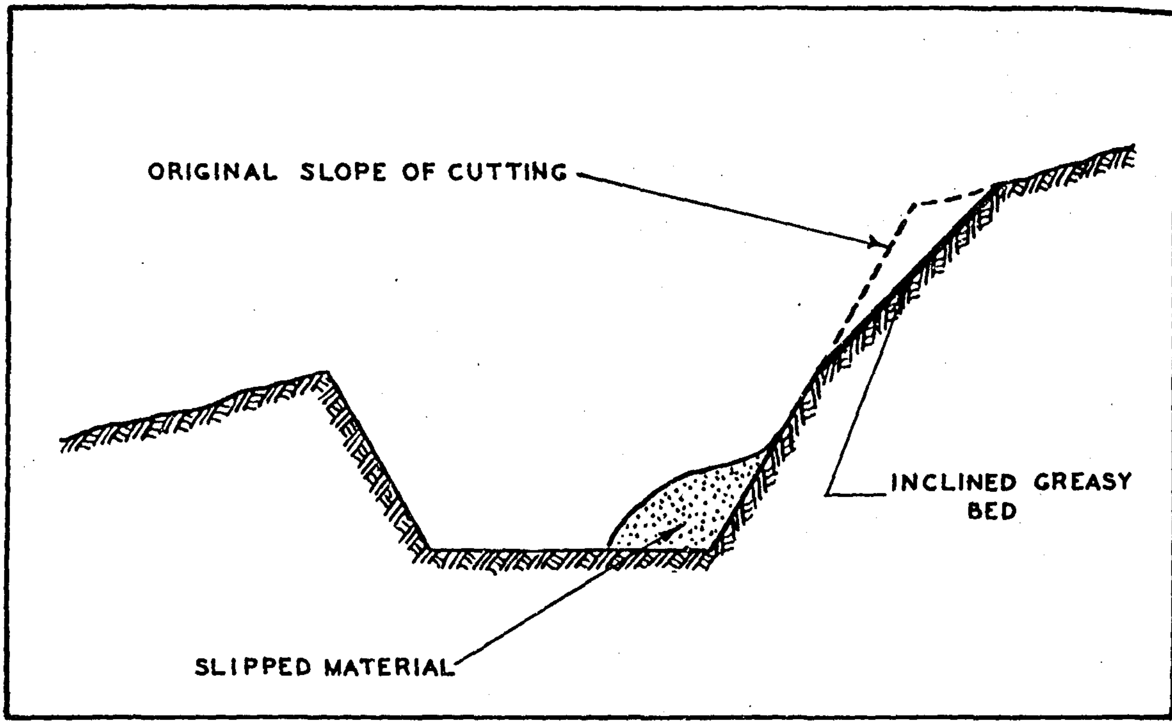


Fig. 17. A Slip due to Inclined Greasy Beds

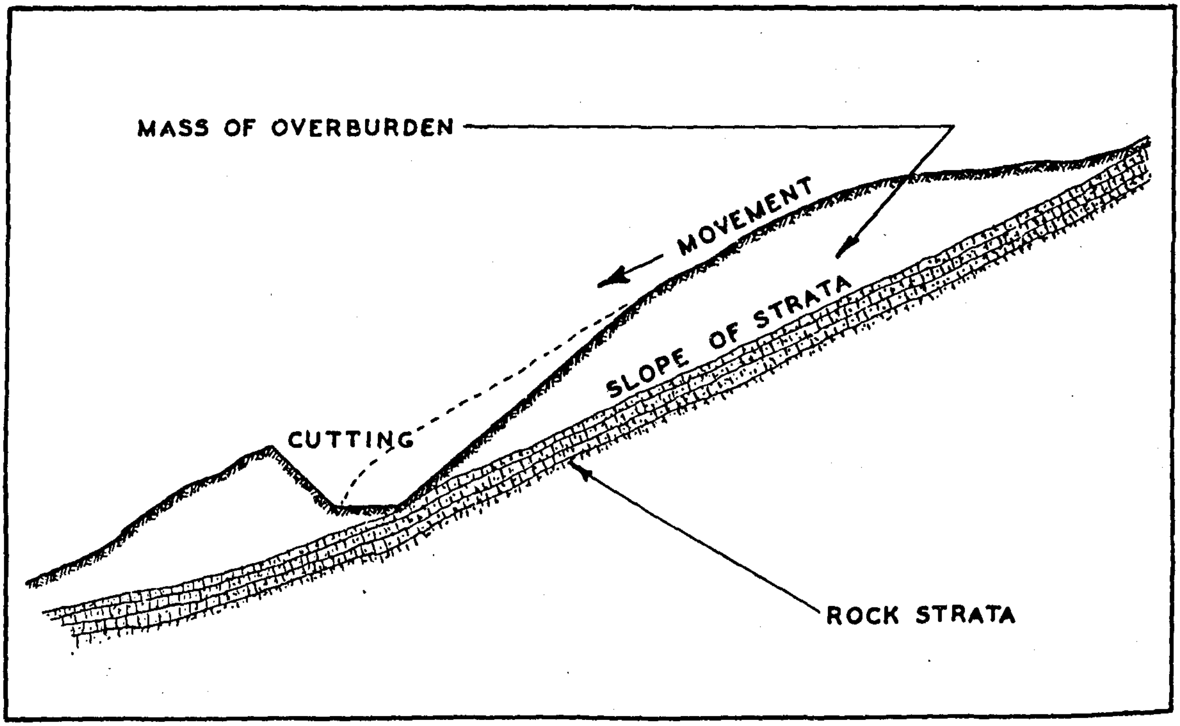
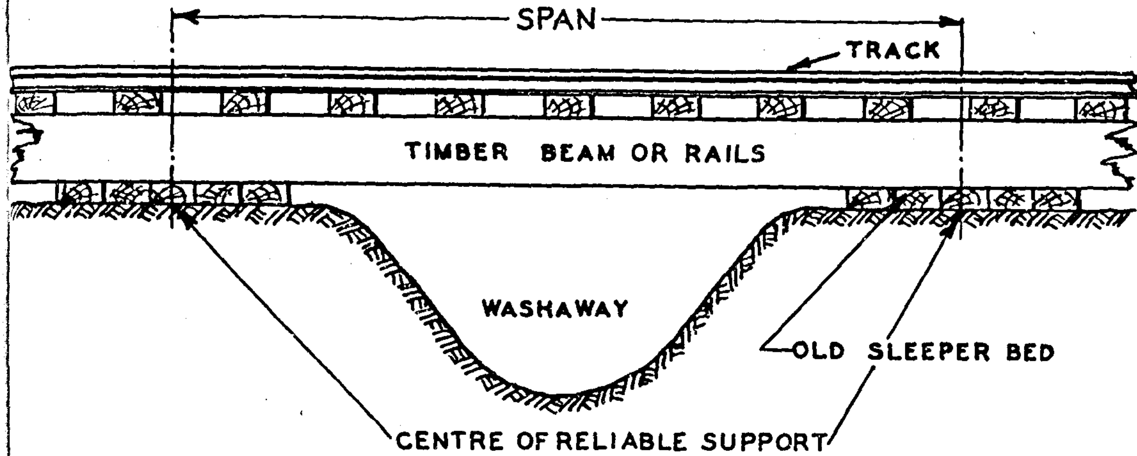


Fig. 18. Slip due to a Local or General Movement of Hillside

NOTE:-

SPANS 17′ TO 20′:- 4 No. 21″ x 9″ TIMBER BEAMS.
SPANS 16′ & UNDER:- 4 No. 18″ x 7½″ TIMBER BEAMS
MAX. SPEED:- 10 M.P.H. ALL CLASSES OF ENGINES



BEAMS ARE TO BE CARRIED BACK INTO SOLID FORMATION

FIG. 19. TEMPORARY REPAIRS AT A WASHAWAY OF A CULVERT

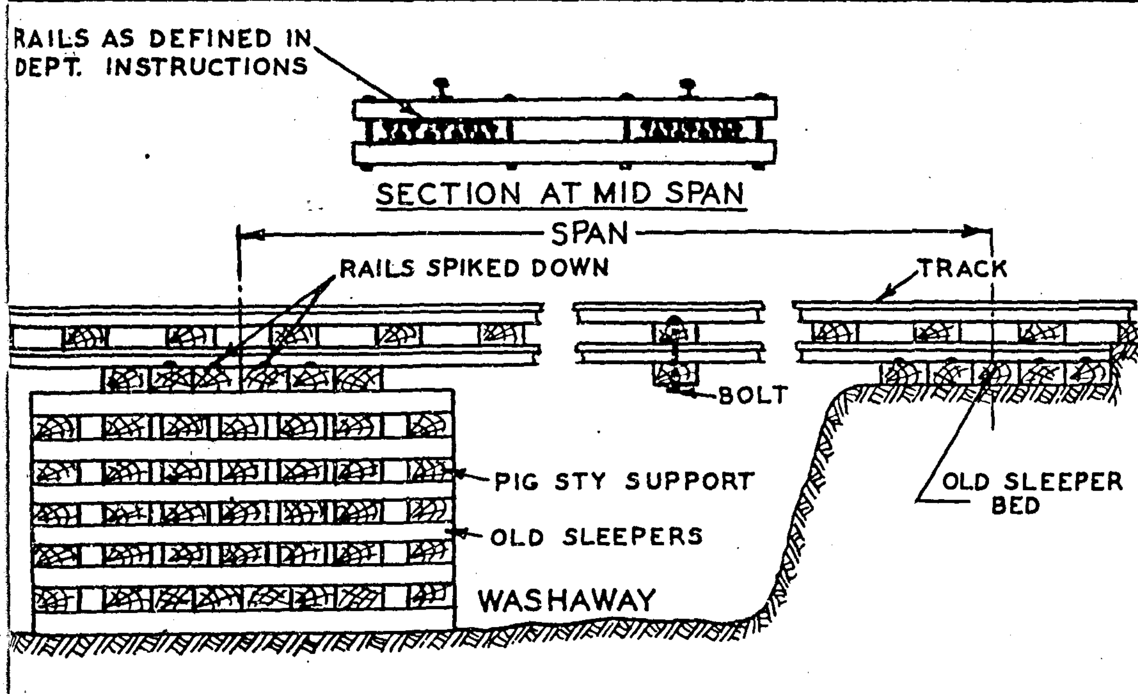


FIG. 20. TEMPORARY REPAIRS AT A WASHAWAY IN A SHALLOW BANK

19. PLANS, PEGS & RECORDS.

PLANS

Written or verbal descriptions of work to be carried out are convenient only in a general way, since they convey to the mind an incomplete picture of the work and provide no convenient permanent record. Plans are therefore drawn to represent a miniature picture of the work showing the entire arrangement of tracks, adjacent structures, boundaries and positions of survey lines necessary for correct location of the work.

To enable each small part to be accurately described for the purpose of manufacture, detail drawings are made of each part showing the dimensions, materials, and methods of manufacture. Arrangement drawings are required to show how individual parts are used in association with other parts. In the case of small parts it is usually necessary to draw them to full size and sometimes to larger size to make clear exactly what is required.

It is, therefore, necessary to adopt different scales for plans and drawings according to their purpose. Descriptive drawings are occasionally made to distorted scales, their purpose being to show some part as an object, whereas working drawings really show the shadow or shape of the part when looked at from one direction.

Trackmen are generally concerned with the plans and some arrangement drawings as provided in the Department's Trackwork Plans Catalogue.

The scale used in preparing station ground plans is 40 feet to 1 inch, so that a distance of 400 feet is represented on the plans by a length of 10 inches.

To show the lengths and positions of sleepers and timbers, rails lengths and positions of joints, a larger plan is required, and the scale generally adopted for this purpose is 8 feet to 1 inch.

Plans prepared to this scale are too large for insertion in the Trackwork Plans Catalogue, and in the case of the standard layouts the plans have been reduced by a photographic process from a scale of 5 feet to 1 inch to a convenient size and in so doing the accuracy of the scale is lost, although the plan remains a true miniature picture of the layout.

In Fig. 1 is shown a plan of a small station ground drawn to a reduced scale to fit the size of this book.

Portion of a timber arrangement plan drawn accurately to 8 feet to 1 inch is shown in Fig. 2.

A turnout drawn accurately to 40 feet to 1 inch is shown in Fig. 3, while in Fig. 4 is a reproduction of the timbering arrangement at a crossover as it appears in the Trackwork Plans Catalogue.

A better understanding of the extent of the work is obtainable from a knowledge of the scales to which the plans are drawn, but it should never be necessary to obtain working dimensions from plans by scale, although approximate distance may be so determined for such purposes as the stacking and shifting of materials, etc.

Plans pertaining to a particular location are always drawn with Melbourne on the left-hand side and when viewed in this way the top of the plan is the down side and the bottom the up side of the tracks.

As mileages are measured from Melbourne, the mileages on plans are read from left to right, consequently when reading a plan such as that shown in Fig. 1, the observer should regard himself as looking down on the station yard from the position marked 'A' on the plan. In this position the station ground would appear in outline as shown on the plan with all tracks, buildings, boundary fences, etc., in the exact positions as shown on the plan.

Diagrams are special plans drawn to show particular features of an arrangement or a set of conditions, and are not necessarily scale drawings.

The diagrams of standard trackwork layouts are prepared for general use without reference to the position of Melbourne and are shown for right-hand layouts only. Trackmen should therefore understand that the arrangements for left-hand layouts or turnouts in the opposite direction are varied.

This can be best exemplified by the holding of Fig. 3, - a right-hand turnout - to a large mirror, in which it is found that a left-hand turnout is reflected, although the worded portion will be seen back to front.

After a little practice it will be possible to understand the actual plans no matter in what way they are viewed, and to transpose right and left-hand layouts in a mental picture.

The chief distinction between a plan and a drawing is that a plan shows only one view of the object whereas a detailed drawing generally shows three views and may show sections as though the object were cut through and then viewed.

Fig. 5 is a full size plan of a match box seen from above, but the match box would probably not be recognised from this plan.

In Fig. 6 a drawing of the same match box is shown and its form may be identified by covering each view in turn with the appropriate face of an ordinary match box.

A descriptive drawing of the same match box is shown in Fig. 7, from which the object is clearly identified. There are various methods of projecting descriptive drawings, but these are of no importance to trackmen, although much used in architectual work.

It is usually necessary to show on plans the existing arrangements, the intended work, and sometimes the possible future work. To distinguish between the outlines which frequently overlap, it is necessary to use a different system of lines such as full lines of different thickness, broken, dotted and chain lines.

Plans prepared in this way are frequently difficult to follow when viewed out on the track under all conditions of wind and weather, and to facilitate the reading of such plans it is the practice to colour the tracks according to the nature of the work. New trackwork is coloured RED, existing main tracks BLUE, existing sidings SIENNA, trackwork to be removed YELLOW, and possible future trackwork GREEN. See Fig.8.

<u>SYMBOLS</u>

Many small details cannot be illustrated on plans of a convenient size, and to indicate their position and description, use is made of symbols.

Symbols are alphabetical, numerical or descriptive characters and may be particular in respect to a certain plan or general in respect to all plans.

An instance of alphabetical symbols is shown in 11.49, Fig. 12, in which the positions of points on a curve are indicated by letters for the purpose of identification with the notes describing how to string a curve at a sharp kink.

In the same way numerical symbols are frequently used on trackwork layout plans to aid in identifying the position of special closures each of which is numbered at the ends and the corresponding numbers shown on the plans.

Descriptive symbols are confined to a definite reference o some object or relative position and it is very necessary hat the descriptive symbol should always have the same meaning, consequently codes of symbols are adopted according to urpose.

Many codes of symbols are in use, but those with which he trackman has usually to deal are Trackwork Plan Symbols nd, occasionally, Fire Protection and Water Supply Symbols, nd these are illustrated in Fig. 9.

PEGS

In other sections of these papers the positions of pegs n relation to the various portions of the layouts and curves ave been indicated. When however various layouts are laid n conjunction, and in addition, survey pegs and earthwork pegs re provided, confusion may arise in identification of individual pegs.

In Fig. 10 is shown a trackwork arrangement involving he work of bank construction and cutting excavation, as well s the laying of tracks, the erection of fences, and the provision of culverts and drains.

The pegs which would be placed by the surveyors setting ut the work are shown by small squares, and the lines ranged ut by the surveyors in fixing the pegs are shown like a spider web in Fig. 11. It will be appreciated that only the pegs ill appear on the ground as the lines of sight have no material existence.

The problem of the trackman is to carry out the work hown in Fig. 10, to exactly line up with the surveyor's pegs hown in Fig. 11, to correctly locate banks, cuttings, fences nd drains in position and to grade, and to arrange the trackork layouts in their correct positions and the tracks and rackwork to correct alignment.

When the earthwork, fencing and drainage have been completed and pegs disturbed during this work have been re-established, the plan would appear as in Fig. 12.

On completion of the work the permanent pegs remaining re shown in relation to the work in Fig. 13.

The pegs driven on the job may vary according to circumstances, but in general the following description applies.

. Centre line pegs (construction) 3" x 2" x 12" long driven to within $2\frac{1}{2}$" of surface.

2. Centre line pegs (permanent) 3" x 3" x 3'0" long driven to within $\frac{1}{2}$" of sleeper level. See 3.36, Figs. 22A & 22D.

3. Indicator pegs (temporary) 2" x 2" x 1'6" long driven to sleeper level at 6" on the up side of a concealed centre line peg to indicate its position.

4. Batter pegs (temporary) 2" x 2" x 1'3" long or longer depending on the nature of the ground. See Figs. 11 & 14.

5. Fence pegs (temporary) 2" x 2" x 12" long driven to within 2" of surface and painted white above ground level.

6. At the angle of fence lines 'V' trenches 6 feet long are cut to indicate the change in direction. See Fig. 15.

7. Tangent intersection pegs (permanent) 3" x 3" x 3'0"driven as required, top painted blue. See 3.36, Fig. 23.

8. Tangent pegs (permanent) 3" x 3" x 3'0" driven to within $\frac{1}{2}$" of sleeper level, top painted blue. See 3.36,Figs.22B and 22C.

The point to which measurements are taken is indicated by a nail driven in the pegs.

All distances are measured horizontally and where pegs are at appreciably different levels as in bank work, cuttings and drainage, a plum bob is required to drop the measurement from a tape held horizontally as shown in Fig. 16.

RECORDS

Permanent records of the work carried out are of lasting importance from the point of view of operation, maintenance and alterations.

The records vary according to their purpose. The accurate location of the fences on the record plans indicates the boundary of railway property. The position, size and grade of the drains are required in connection with floods and drainage matters. Particulars of the weight and class of rail and the catalogue number of the points and crossings, etc., are necessary for maintenance purposes, and the methods of point operation, signal arrangements, etc., are required to enable safe operation of traffic.

Authorized departures from the plans must be properly recorded and the plans accordingly amended. Much of this work is not the direct concern of the trackman, but it is clear that renewals and alterations made necessary in the course of maintenance must be duly advised if the Head Office records are to be kept up to date.

For this purpose various forms are in use, as set out in the Way and Works Instruction Book and amended from time to time by circulars, instructions, etc., but as these are necessarily amended according to changing conditions they are not defined in this Course.

Certain permanent records are marked on the track materials themselves and have been defined in the various sections of this Course; these are the rail brands and heat numbers, the points and crossings catalogue numbers, the trackwork parts numbers, dates when rails, points and crossings are laid in track, mileages, cant and flood levels, all of which the trackman is directly concerned with in his daily work and must be able to identify.

<u>REFERENCE DRAWINGS</u>

The purpose of reference drawings is to provide additional or alternative information to that shown on the standard plans.

It will be appreciated that standard plans could not be issued in a usable size catalogue to separately show each standard trackwork layout with isolated differences.

It should be equally clear that the different arrangements cannot be superimposed on the same plans. Wherever it has been possible to note alternatives on standard trackwork layout plans this has been done.

Typical instances of alternative standards shown on standard trackwork layout plans are the alternative welded closures, and installation of graduated cant plates. Obviously graduated cant plates are not required if the adjacent track rails are laid vertically, but they are required when these rails are laid with the standard 1 in 20 rail inclination.

The under rail fastenings are not shown at the points, but this does not infer they are not required.

It should be clear, therefore, that a careful study of the reference drawings referred to on the standard trackwork layout or other plans must be made to enable the track man to fully understand the detailed arrangements of the fastenings required.

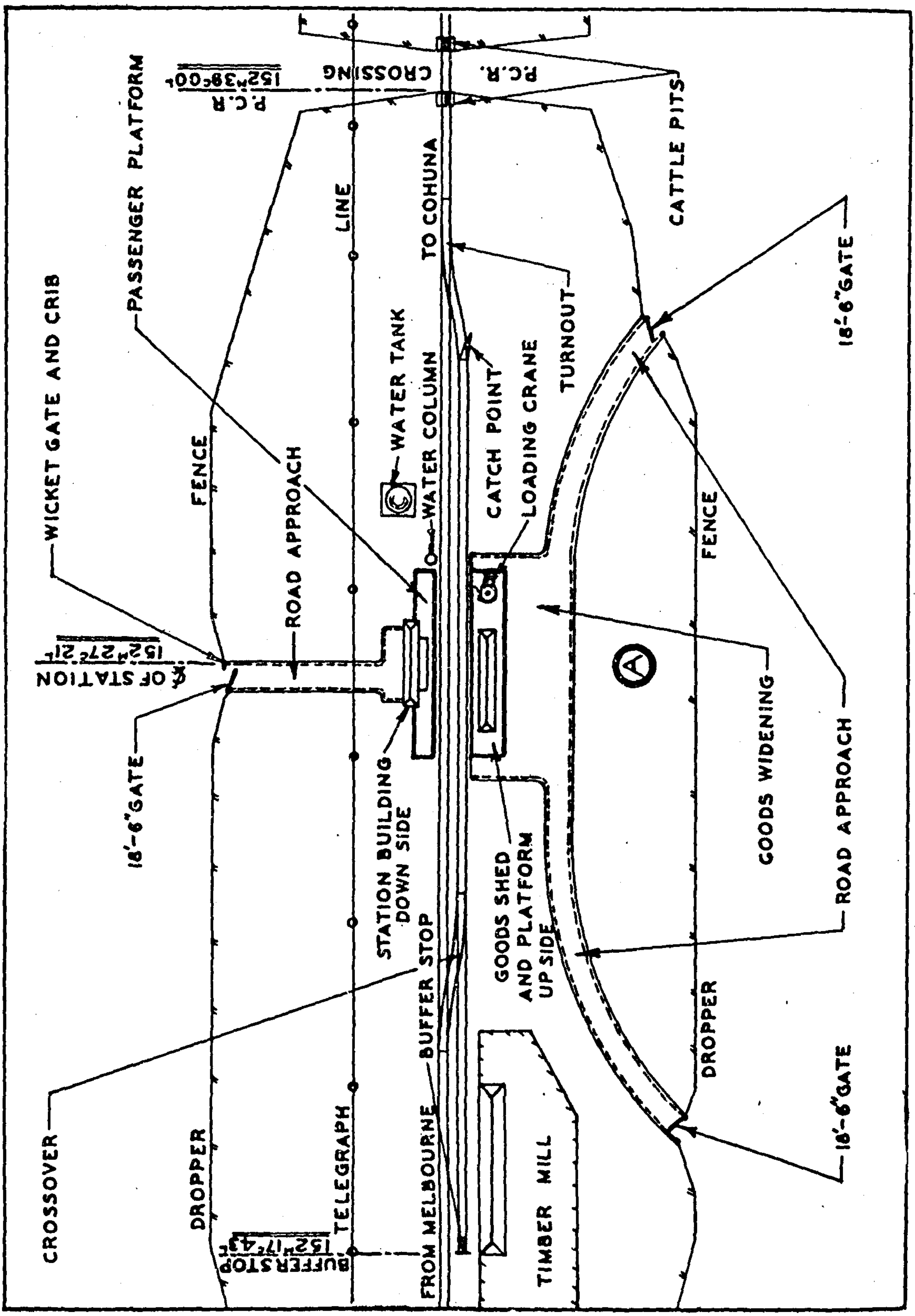


Fig. 1. Typical Plan of a Small Station Ground

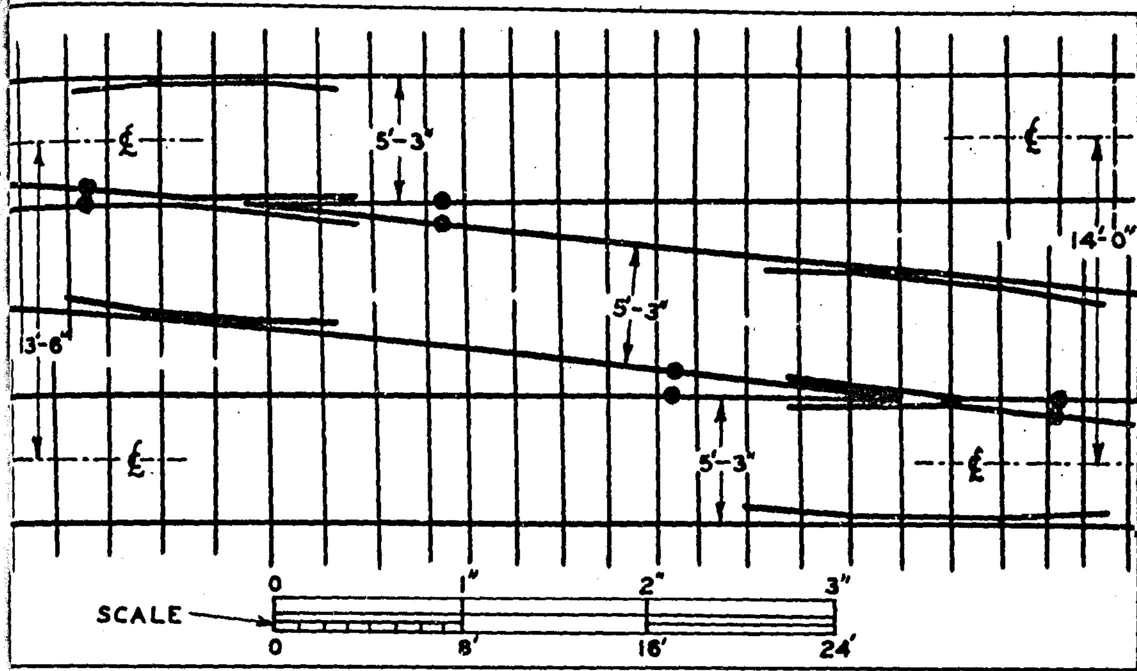


Fig. 2. Portion of Timber Plan — Scale:- 8'-0" to 1"

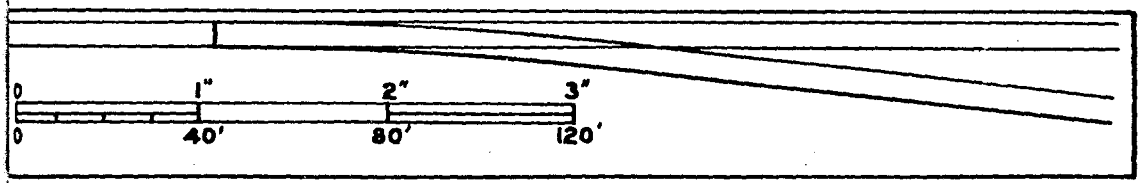
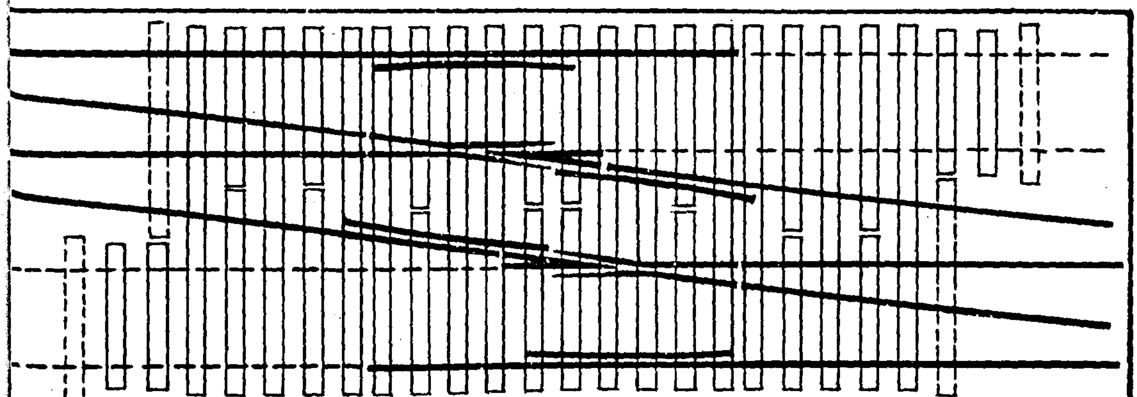


Fig. 3. Turnout R.H. — Scale:- 40'-0" to 1"



Portion of the Timbering Arrangement of the No. 7·52 Parallel Track Crossover 11'-8" Centres as shown on Standard Trackwork Plan No. F.398.A

Fig. 4. Timbering Arrangement — Standard Trackwork Plans

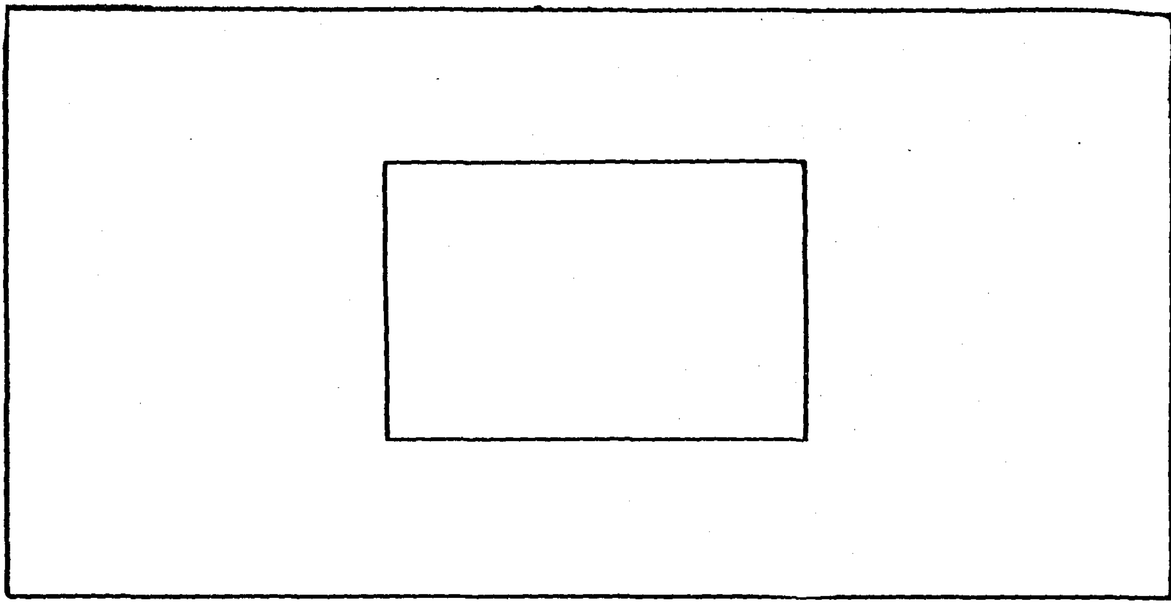


FIG. 5. FULL SIZE PLAN OF A MATCH BOX

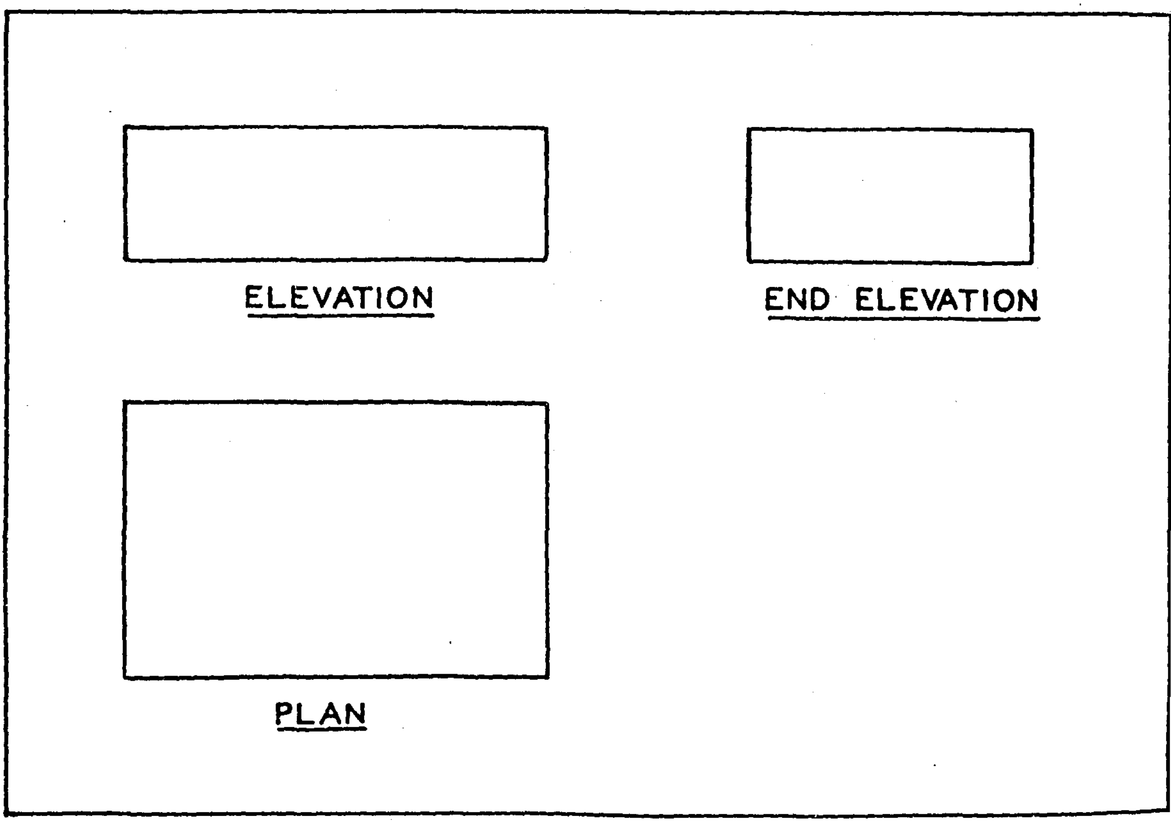


FIG. 6. FULL SIZE DRAWING OF A MATCH BOX

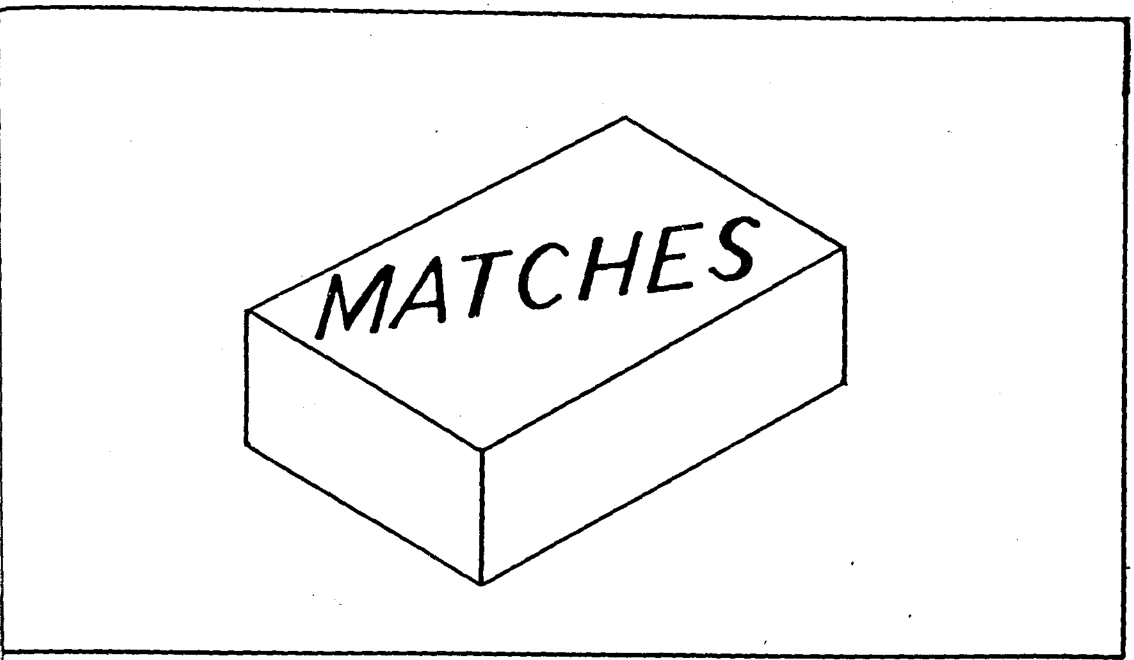


Fig.7. Descriptive Drawing of a Match Box

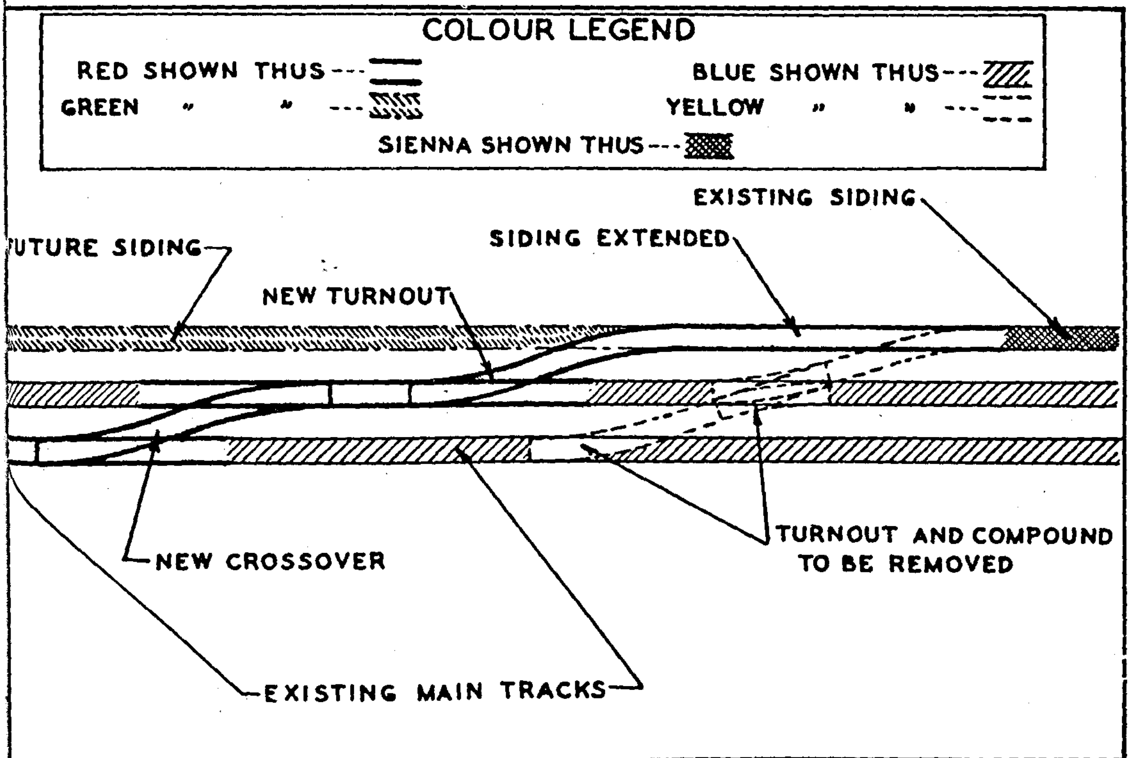


Fig. 8. The System of Colouring Plans

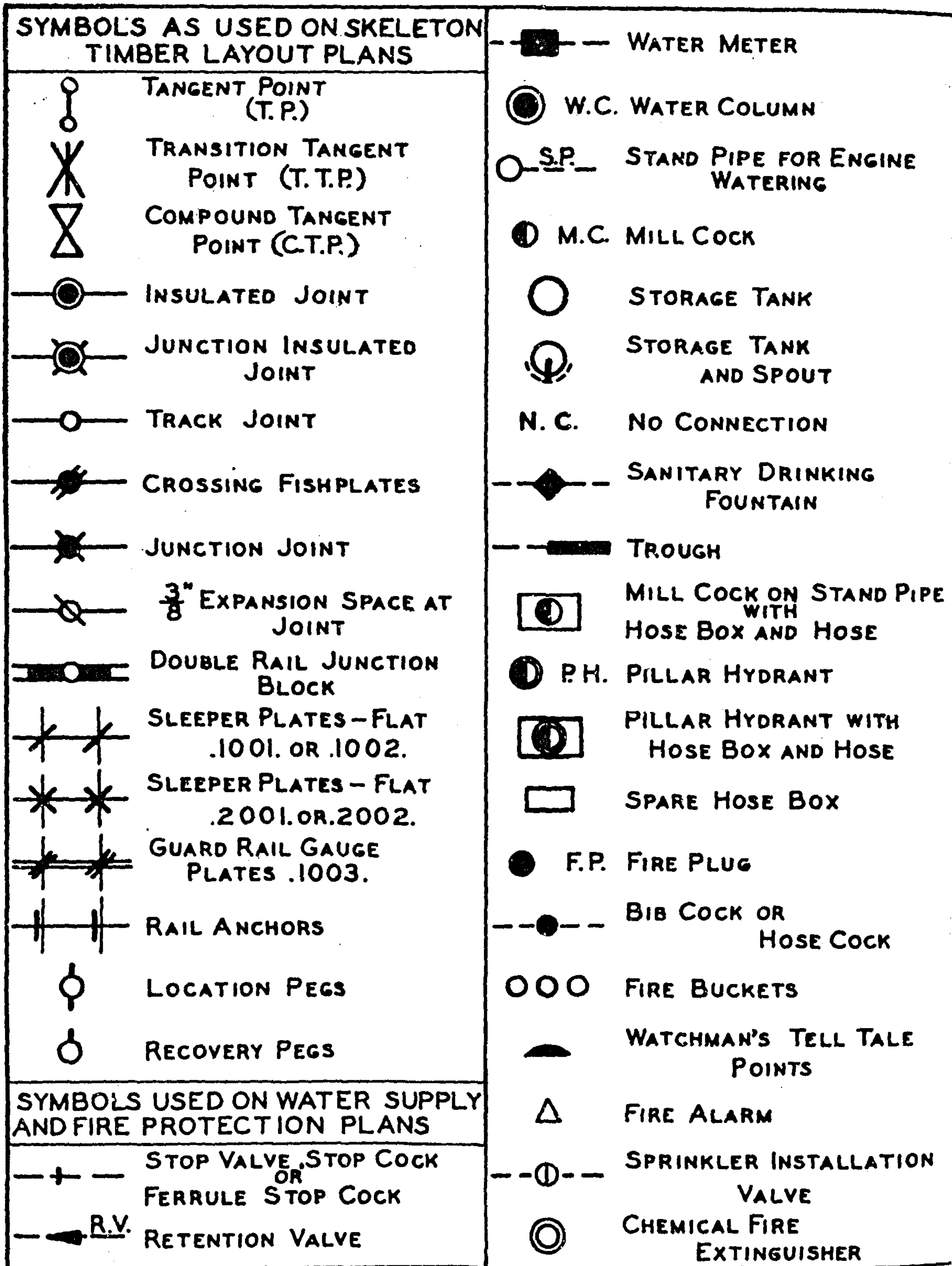


FIG. 9. DESCRIPTIVE SYMBOLS

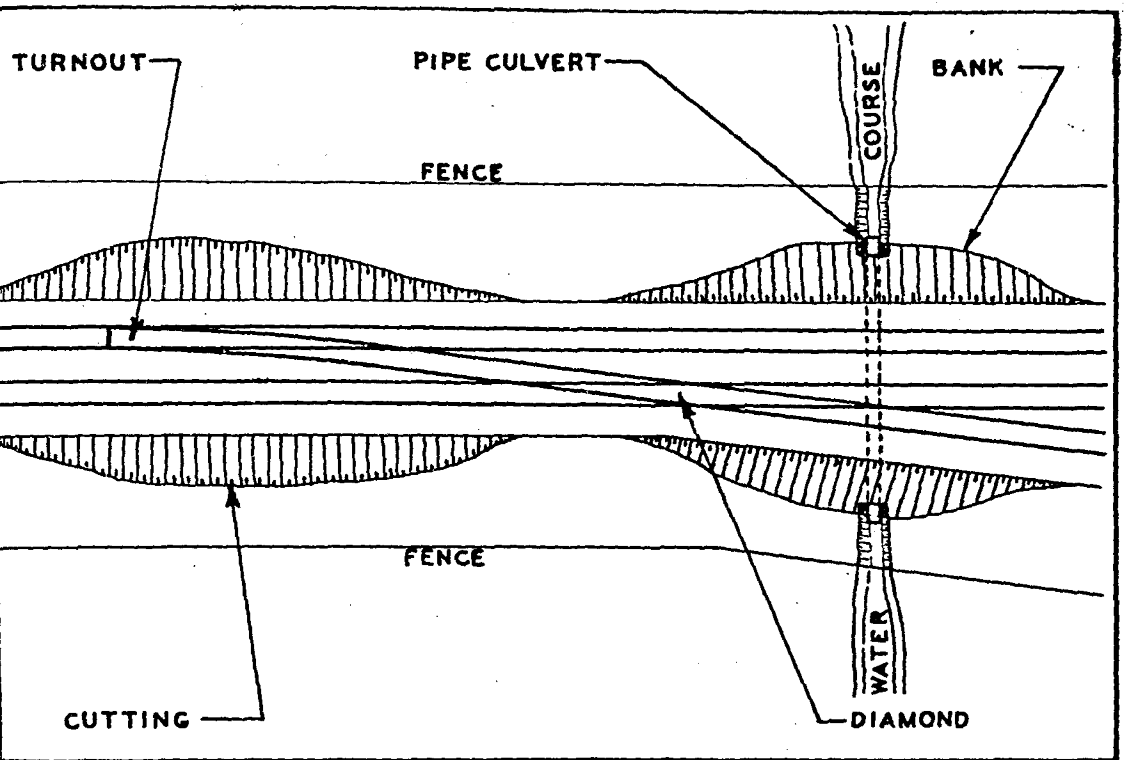


FIG.10. PLAN SHOWING WORK TO BE CARRIED OUT

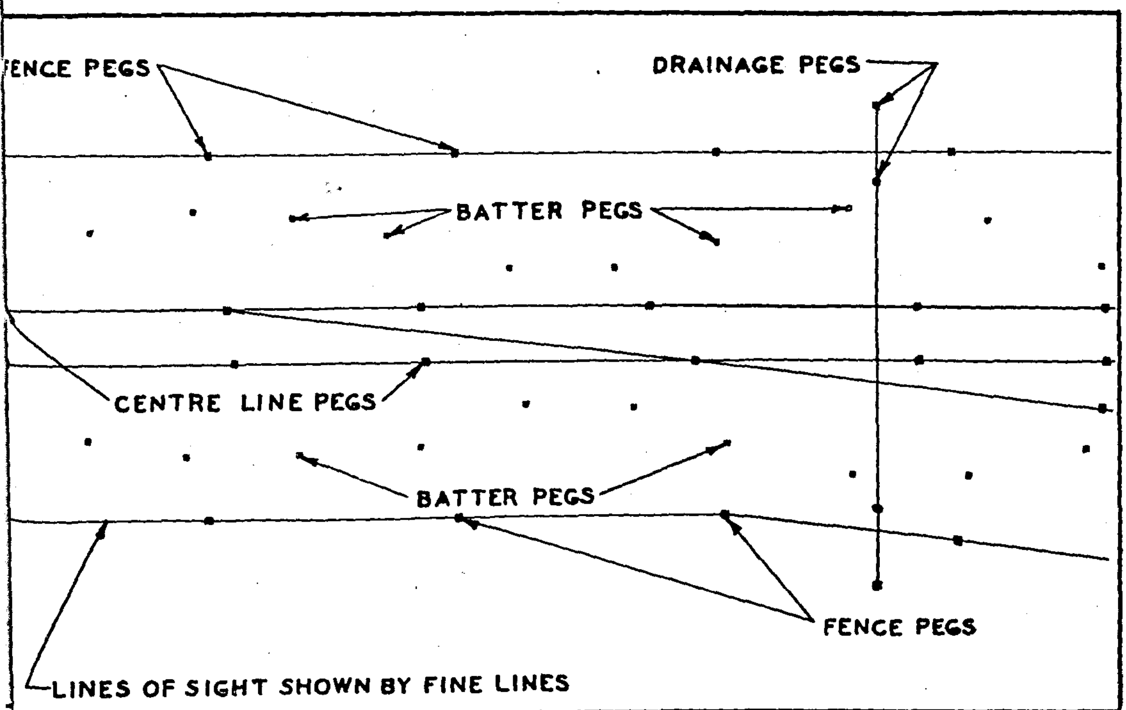


FIG.11. PEGS PLACED BY THE SURVEYOR IN SETTING OUT

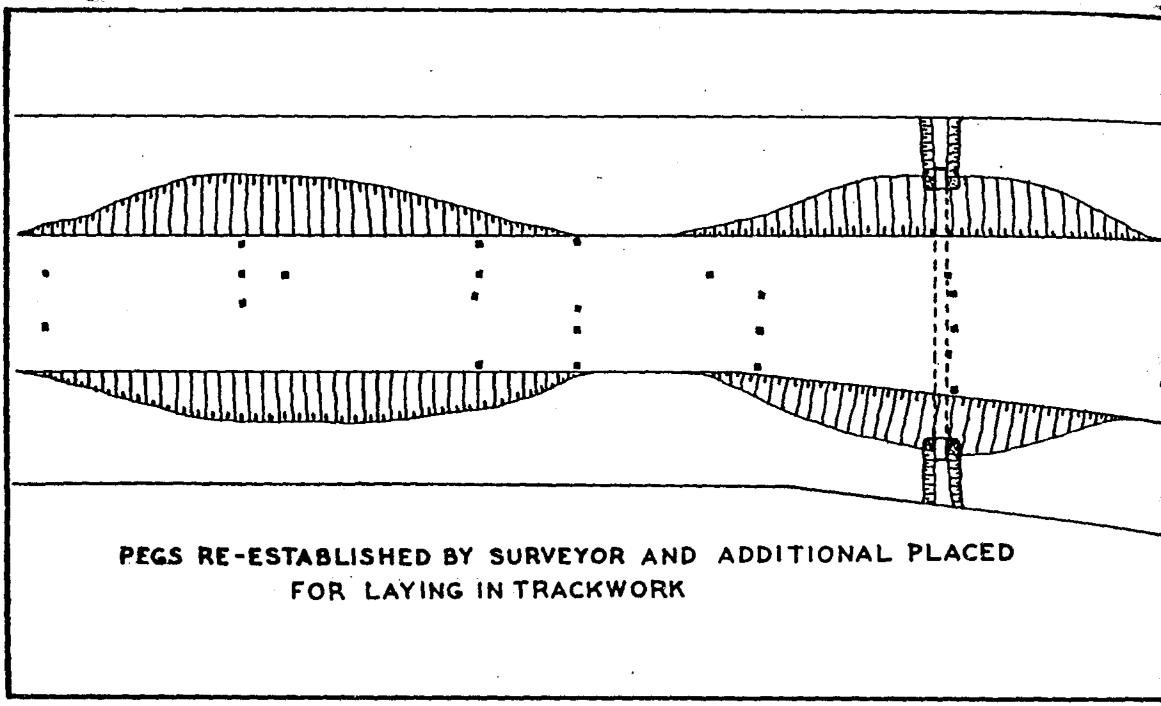


FIG. 12. EARTHWORK, DRAINAGE, ETC. COMPLETED

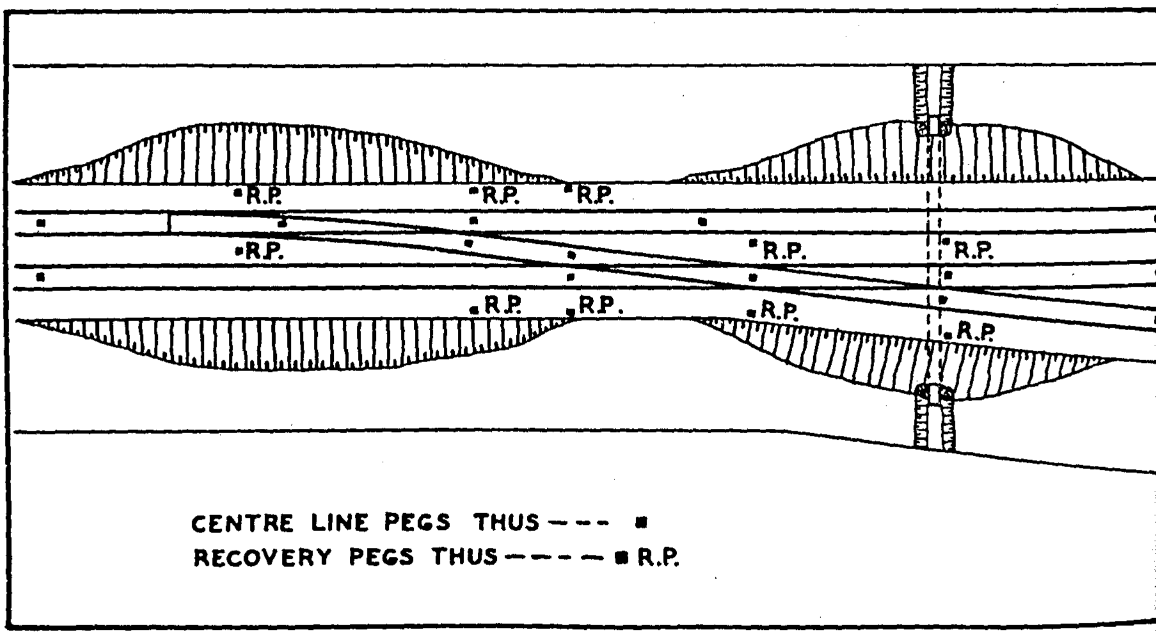


FIG. 13. WORK COMPLETED – PERMANENT PEGS IN POSITION

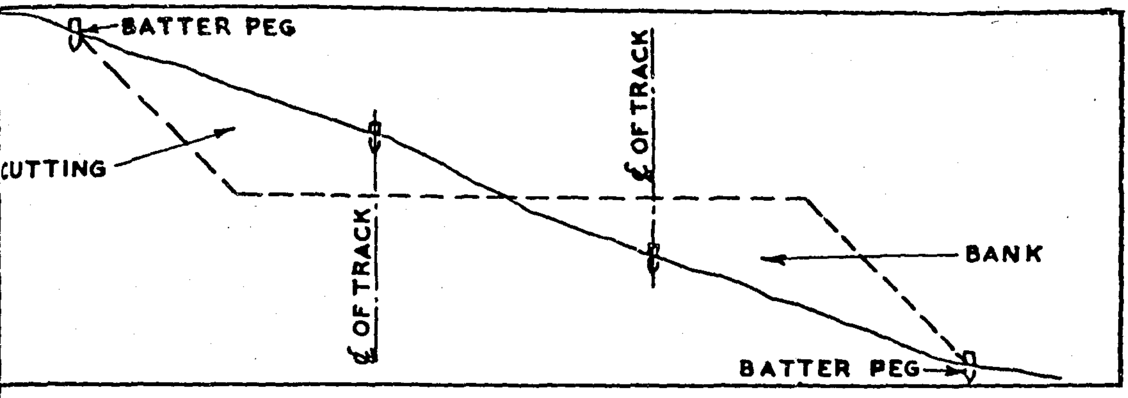


Fig.14. Batter Pegs

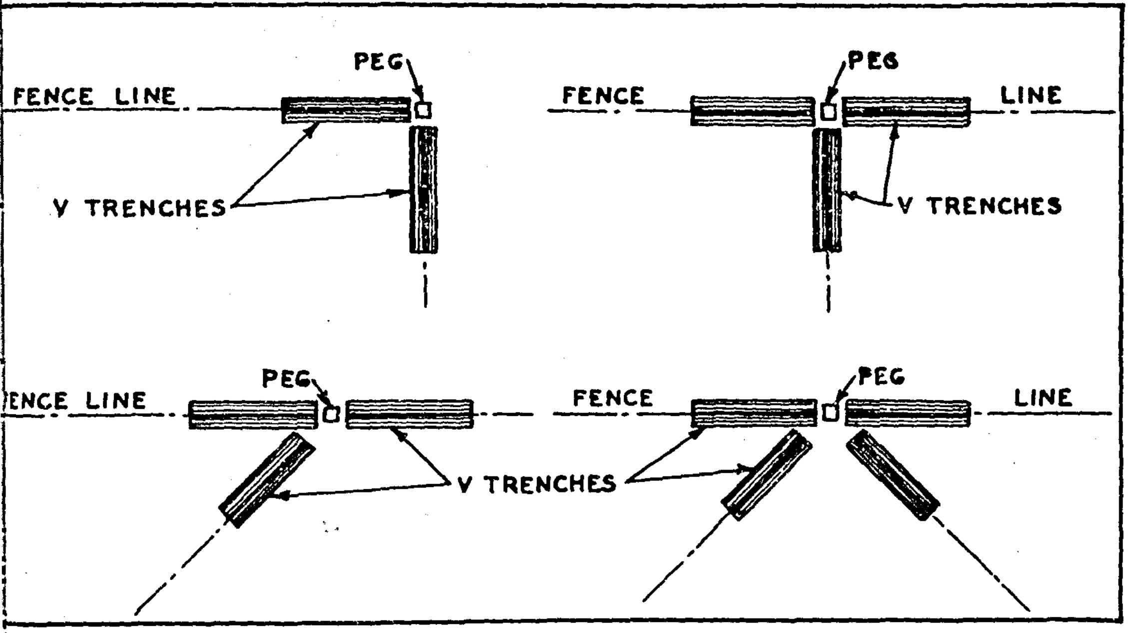


Fig.15. V Trenches at the Angle of Fence Lines

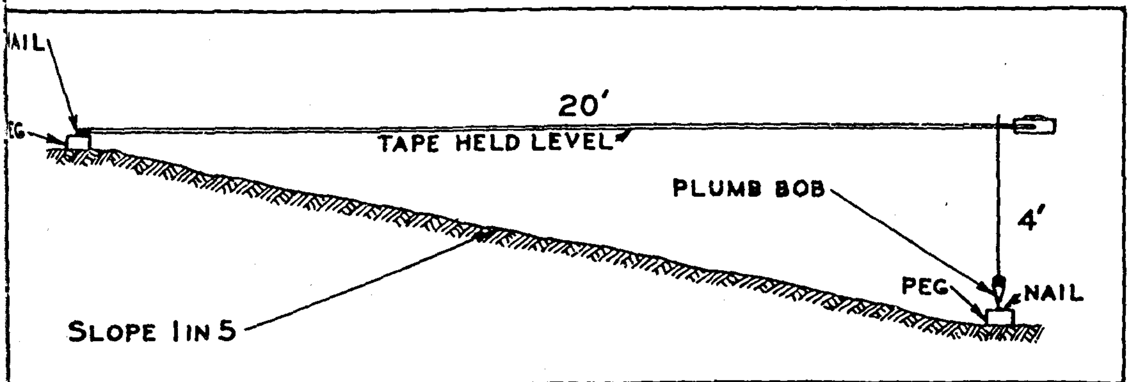


Fig.16. Method of measuring from Pegs

20. QUANTITIES.

GENERAL

A knowledge of weights and measures is necessary for the trackman dealing with earthworks, ballast and track materials. The elementary principles of arithmetic and mensuration are required for the estimation of quantities and weights in the course of the work and for loading and distributing materials.

British standard weights and measures are set out in Tables 20.22 & 20.23, and the weights of track and track-work materials in Tables 20.44-20.48.

ARITHMETIC

The number of things of the same kind may be expressed in units and parts of a unit. Two systems are in use to express the parts of a unit as follows : -

1. The Fraction.
2. The Decimal.

FRACTIONS

For those students who may have lost touch with arithmetical operations a few examples are included.

Example : - Add together $\frac{1}{2}$, $\frac{1}{3}$ and $\frac{1}{4}$

First bring all fractions to a common bottom value, in this case twelfths, then -

$$\frac{6}{12} + \frac{4}{12} + \frac{3}{12} = \frac{13}{12} \text{ or } 1\frac{1}{12} \quad \text{Answer}$$

Example : - Multiply together $\frac{5}{8}$, $3\frac{1}{5}$ and $\frac{3}{4}$

First reduce the whole number to the equivalent fraction.

$3\frac{1}{5}$ may be expressed as $\frac{16}{5}$

$$\text{then} \quad \frac{\not 5}{\not 8} \times \frac{\overset{2}{\not 16}}{\not 5} \times \frac{3}{\underset{2}{\not 4}} = \frac{3}{2} \text{ or } 1\frac{1}{2} \quad \text{Answer}$$

Cancelling, i.e., dividing one or more figures of the numerator (top figures) into the denominator (bottom figures) and vice versa, is employed in order to simplify the operation.

mple : - Divide $\frac{5}{8}$ by ($3\frac{1}{5}$ multiplied by $\frac{3}{4}$)

Instead of multiplying $3\frac{1}{5}$ by $\frac{3}{4}$ and dividing the result o $\frac{5}{8}$, the operation may be done in one step by inversion of last two fractions and multiplying all three together, s : -

$$\frac{5}{\not{8}_2} \times \frac{5}{16} \times \frac{\not{4}}{3} = \frac{25}{96} \quad .. \text{ Answer}$$

DECIMALS

The decimal part of a unit is the number of tenths of the t or multiples of tenths, i.e., hundredths, thousandths, . To distinguish between the whole number and the decimal t, a dot or point is inserted, as for example : -

Six and three tenths is written	..	6.3
Seven and eightyfive hundredths "	..	7.85
Twentyfour and three thousandths "	..	24.003
The addition of these quantities equals		38.153

Multiplication and division are performed as shown in the llowing examples.

mple : - Multiply 16.426 by 4.34

Two methods may be used, according to personal choice.

```
      16.426                2.     16.426
       4.34                         4.34
      65704                        65 704
    4 9278                          4 9278
   65 704                            65704
   71.28884  .  Answer             71.28884  .. Answer
```

To fix the position of the decimal point, count the number figures on its right in the two numbers to be multiplied this case 5) and have the same number on its right in the wer.

Example : - Divide 2.16 by 4.764 to 3 places of decimals.

First make both numbers whole numbers by moving the decimal point to the 'right' the same number of places in each case.

The numbers are then 2160 and 4764

```
4764 )  21600  (   .453   ..  Answer
        19056
         25440
         23820
          16200
          14292
           1908
```

4764 will not divide into 2160 therefore add 0 to the latter and place the decimal point in the answer.

4764 will now divide into 21600, 4 times. After multiplication and subtraction a remainder of 2544 is obtained and to this 0 is appended and the process repeated.

CONVERSION

To convert fractions into decimals the denominator is divided into the numerator.

Example : - Express $\frac{3}{8}$ as a decimal.

```
8 )  30  (  .375   ..   Answer
     24
      60
      56
       40
       40
```

To convert decimals into fractions the decimal becomes the numerator, and the denominator is obtained by placing 1 for the decimal point and an 0 for every figure to the right of it.

Example : - Express .625 as a fraction.

$$.625 = \frac{625}{1000}$$

This should be simplified if possible by cancellation -

$$\frac{625}{1000} = \frac{25}{40} = \frac{5}{8} \quad .. \text{ Answer}$$

REDUCTION

When it is desired to express a part of a large unit in rms of lesser units, the arithmetical process is described reduction.

ample : - Express $\frac{1}{24}$ tons in cwts, qrs, lbs.

$$\frac{1}{\cancel{24}_6} \times \frac{\cancel{20}^5}{1} = 0\frac{5}{6} \text{ cwts.}$$

$$\frac{5}{\cancel{6}_3} \times \frac{\cancel{4}^2}{1} = \frac{10}{3} = 3\frac{1}{3} \text{ qrs.}$$

$$\frac{1}{3} \times \frac{28}{1} = \frac{28}{3} = 9\frac{1}{3} \text{ lbs.}$$

$= 0$ cwts 3 qrs $9\frac{1}{3}$ lbs. Answer

conversion $\frac{1}{24} = .0416$

ample : - Express $.041\dot{6}$ tons in cwts, qrs, lbs.

$$.041\dot{6} \times 20 = .8\dot{3} \text{ cwts.}$$

$$.8\dot{3} \times 4 = 3.\dot{3} \text{ qrs.}$$

$$.\dot{3} \times 28 = 9.\dot{3} \text{ lbs.}$$

$= 0$ cwts. 3 qrs. $9.\dot{3}$ lbs. Answer

$.\dot{3}$ means .3 repeating as far as you care to calculate, d closely approaches the value of $\frac{1}{3}$ so that the answers are agreement.

Lesser units may also be expressed in terms of larger its.

ample : - Express 22,284.19 lbs in tons, cwts, qrs, lbs.

```
 )22284.19( 795 qrs.    4 )795( 198 cwts.     20 )198(  9 tons
  196                      4                       180
   268                     39                       18 cwt.
   252                     36
    164                     35
    140                     32
     24.19 lbs.              3 qrs.
```

9 tons 18 cwt 3 qrs 24.19 lbs. Answer

PRACTICAL GEOMETRY

It can be shown by geometry that a triangle having sides in the ratio of 3, 4, and 5 is a right angle triangle. This fact is very useful to trackmen in squaring off the joints in tracks when a square is not at hand.

If the gauge of the track is taken as the side of a triangle of ratio 3 and the running edge of the rail as the side of the triangle represented by the ratio 4, the diagonal will equal the ratio 5, see Fig. 1.

When the diagonal is calculated, the base may be marked off along the rail from a joint and the square off position of the opposite rail joint may be established by measuring the diagonal back from this mark as shown in Fig. 2.

Example : -
Determine the base and diagonal for a right angle triangle when the side of this triangle is the gauge of the track.

Gauge	=	5'3"	=	63 inches
Base measures	$\frac{4}{3} \times 63$	= 84	=	7'0"
Diagonal "	$\frac{5}{3} \times 63$	= 105	=	8'9"

This solution can be easily remembered by the sequence of the figures 7, 8, and 9, i.e., base = 7'0", diagonal = 8'9".

For 2'6" gauge, base = 3'4". Diagonal = 4'2"

This can be remembered by sight as 3, 4, 4, 2.

Because the diagonals of a rectangular parallelogram are equal, this fact can be used to check the relative positions of the 'K' crossings in diamonds and compounds, and the position of rails in square jointed 'straight' track, see Figs. 3 & 4.

In the application of this principle calculations are unnecessary, as it should be self evident that if the diagonals are different, the shift to make the diagonals equal will equal approximately half the measured difference.

Example : -
Diagonals differ by 6 inches, shift = 3 inches to make diagonals equal.

SQUARE ROOT

Many problems in which right angle triangles occur re-ire a calculation of one side when the other two sides are own.

In any right angle triangle the square described on the potenuse is equal to the sum of the squares described on the her two sides, as shown in Fig. 5 in which the length of the des are 3, 4, and 5, but these values vary according to the ape of the right angle triangle, as shown in Fig. 6.

The usual manner of indicating the square of a number is write the figure 2 above and to the right of the number us 5 x 5 = 5 squared = 5^2 = 25.

The number which multiplied by itself equals some value defined as the square root of this value and is usually in-cated by the sign $\sqrt{\quad}$ meaning that the square root of this lue is required, thus $\sqrt{25} = 5$.

When the values are small the square root may often be termined by inspection, thus $\sqrt{49} = 7$; $\sqrt{81} = 9$; $\sqrt{400} = 20$, c., but when several figures are involved a method of deter-ning the square root by trial and error is used as shown in e following examples.

amples : -

(a) Find $\sqrt{155236}$ (b) Find $\sqrt{1481.4801}$ (c) Find $\sqrt{.9216}$

```
(a)                    (b)                          (c)
     |15 52 36(394          |14 81.48 01(38.49          |.92 16(.96
   3 | 9                  3 | 9                       9 | 81
  69 | 652               68 | 581                   186 | 1116
     | 621                  | 544                       | 1116
 784 |  3136            764 |  3748                     | ....
     |  3136                |  3056
     | ....            7689 |   69201
                            |   69201
                            | .....
```

Ans. 394 Ans. 38.49 Ans. .96

The method is to divide the number into periods of two gures on either side of the decimal point.

Find by trial the largest number which multiplied by it-lf is less than the first period, place this number in the acket to the right and also at the left of the vertical line.

Place the product of this number multiplied by itself der the first period and subtract to obtain a remainder.

Annex to this remainder the two figures in the next period.

Double the number in the bracket at the right and place this value to the left of the vertical line.

Now find by trial the largest number which when placed with the number at the left of the vertical line and multiplied by itself is less than the previous remainder with the annexed period.

Deduct this product to find the next remainder and proceed in similar manner as far as required.

In many cases it will be found that there is no end to the process, or in other words the quantity has no exact square root; in such cases two to three decimal places will usually suffice.

It will be seen that there are as many figures in the root of a number as there are periods in the number.

Conversely if the answer is required to two or three decimal places there must be two or three periods to the right of the decimal point in the number.

When the number does not contain sufficient decimal periods these are provided by adding ciphers for the required periods.

To obtain an answer correct to two decimal places the square root must be taken out to three decimal places for which purpose there must be three decimal periods.

When the third decimal figure in the answer is 5 or more than 5, the second decimal figure in the answer must be increased by 1 to be correct to two decimal places.

.5 is equal to $\frac{1}{2}$, .6 is greater than $\frac{1}{2}$, 1.6 is nearer to 2 than 1; .4 is less than $\frac{1}{2}$, 1.4 is therefore nearer to 1 than to 2.

Two further points arise -

When the number of figures to the left of the decimal point do not form complete periods, as in 907.61 which could be written 0907.61 without changing its value. In practice the cipher is omitted.

When the number formed by adding 1 to the left of the vertical line is greater than the remainder with the annexed period. Annex the next period also to the remainder, place a cipher in the answer and a cipher to the left of the vertical line and proceed as here shown.

```
√907.61 =
          |09 07. 61 00( 30.12
        3 | 9                Ans.
      601 |..0761
          |   601
     6022 |  16000
          |  12044
          |   3956 etc.
```

ample : -
What length of fencing would be required to enclose an area land shown in Fig. 7. Full working to be shown and the swer is required correct to 2 places of decimals.

Drop a perpendicular line'DB'shown dotted in Fig. 7, and divide the area into two right angle triangles 'X' and 'Y'.

the right angle triangle 'X'

Length AD = $\sqrt{AB^2 + DB^2}$

```
²  =  10.5          DB² =  6.5         B² + BD² =  110.25
      10.5                 6.5                  +   42.25
      ----                 ---                     ------
      5 25                3 25                     152.50
    105 0                39 0
    ------               -----
    110.25               42.25
```

```
B² + DB² = √152.500000  = |1 52.  50  00  00(    12.349
                         1 |1
                        22 | 52
                           | 44
                       243 |  850
                           |  729
                      2464 | 12100
                           |  9856
                     24689 |  224400
                           |  222201
```

AD = 12.35 correct to 2 decimal places.

In the right angle triangle 'Y'

$$\text{Length } BC = \sqrt{DC^2 - DB^2}$$

$DC^2 = 9.25 \times 9.25$:

```
   9.25
   9.25
   ----
   4625
 1 850
83 25
-------
85.5625
```

$DB^2 = 6.5 \times 6.5$:

```
  6.5
  6.5
  ---
  3 25
 39 0
 -----
 42.25
```

$DC^2 - DB^2 = 85.5625 - 42.25 = 43.3125$

```
  85.5625
- 42.25
  -------
  43.3125
```

$\sqrt{DC^2 - DB^2} = \sqrt{43.312500} =$

```
      | 43. 31  25  00( 6.581
    6 | 36
  125 |  731
      |  625
      |  ------
 1308 |  10625
      |  10464
      |  ------
13161 |    16100
      |    13161
      |    ------
```

BC = 6.58 correct to 2 decimal places.

Length of fencing required = AB + BC + CD + DA

AB	=	10.5
BC	=	6.58
CD	=	9.25
DA	=	12.35
Answer	..	38.68 Chains

MENSURATION

To calculate the volume of a mass it is necessary to determine the area of its cross section at one or more position and its length.

$$\text{Volume of cubic contents} = \text{Average cross section area} \times \text{Length}$$

AREA OF SURFACES

The areas of surfaces commonly met with may be calculated from the following particulars : -

1. The PARALLELOGRAM, see Fig. 8, is a four sided figure having opposite sides parallel.

   (a) Parallelograms on the same base and of the same height are of equal area.

   (b) Area of a parallelogram = base x height.

2. The TRIANGLE, see Fig. 9, is a three sided figure.

(a) Triangles on the same base and of the same height are of equal area.
(b) Area of a triangle $= \dfrac{\text{Base} \times \text{height}}{2}$

3. The TRAPEZOID, see Fig. 10, is a four sided figure having two of its opposite sides parallel.

(a) Trapezoids of the same height, when the sums of their parallel sides are the same, are of equal area.
(b) Area of a trapezoid $= \dfrac{\text{Sum of parallel sides}}{2} \times \text{Height}$

4. IRREGULAR SHAPES, see Fig. 11.

(a) Bounded by straight lines the figure may be broken up into the elements shown by dotted lines, and each area be separately calculated by methods 1, 2, or 3.
(b) Area of irregular shape = sum of separate areas.

5. IRREGULAR SHAPES, see Fig. 12.

(a) Bounded by curved lines the figure may be divided into strips as shown by dotted lines and each area be separately calculated by method 1.
(b) Area of irregular shape = sum of separate areas.

6. The CIRCLE, see Fig. 13, is an area bounded by a continuous outline of regular curvature or circumference.

(a) Area of a circle = Area of enclosing square x .7854
(b) " " " = Area of enclosing square x $\frac{11}{14}$ approx.
(c) Circumference of circle = Diameter x 3.1416
(d) " " " = Diameter x $\frac{22}{7}$ approx.

VOLUME OR CUBIC CONTENTS

In calculating the volume or cubic contents of a mass various methods are employed according to the shape.

1. The PARALLELEPIPED, see Fig. 14, is a mass of constant cross section of the shape of the parallelogram.

Volume = (a) Area of base x height.
(b) Length x breadth x height.

When the length, breadth and height are all equal and the angles are square the body is a cube.

2. The PRISM, see Fig. 15, is a mass of constant cross section formed by one or more triangles.

Volume = Area of end x length.

3. The WEDGE, see Fig. 16, is a mass of triangular cross section.

$$\text{Volume} = \frac{\text{Area of base x height}}{2}$$

4. The PRISMOID, see Fig. 17, is a mass bounded by three or more surfaces, two of which are parallel.

Volume=(Sum of the areas of parallel surfaces+4 times the sectional area half-way between the parallel surfaces) x distance between the parallel surfaces ÷ 6.

5. The PYRAMID, see Fig. 18, is a mass contained within triangular faces resting on a common base.

$$\text{Volume} = \text{(a)} \ \frac{\text{Volume of enclosing cube}}{6}$$

$$\text{(b)} \ \frac{\text{Area of base x height}}{3}$$

6. The CYLINDER, see Fig. 19, is a mass contained within the outline of a revolving rectangle.

Volume = (a) Volume of enclosing parallelepiped x .7854
(b) Diameter x Diameter x height x .7854
(c) Diameter x Diameter x height x $\frac{11}{14}$ Approx.

7. The CONE, see Fig. 20, is a mass contained within the outline of a revolving right angle triangle about a perpendicular side.

$$\text{Volume} = \text{(a)} \ \frac{\text{Volume of enclosing cylinder}}{3}$$

$$\text{(b)} \ \frac{\text{Area of base x height}}{3}$$

8. The SPHERE, see Fig. 21, is a mass contained within the outline of a revolving circle about a diameter.

Volume = (a) Volume of enclosing cube x .5236

(b) Diameter x diameter x diameter x .5236

Methods of applying the principles of mensuration tc ractical problems are given in the following examples.

PROBLEMS

Among the problems the trackman may occasionally require o solve are those dealing with the quantity of ballast in a ruck, earth to be removed from a trench, etc; these problems nvolve consideration of cubic measurement.

Cubic measurement = Length x Breadth x Depth

xample No. 1.

88 cubic yards of gravel are available to surface a pathway 6 chains long and 24 feet wide. What will be the average epth at which the gravel must be spread?

88 cubic yards = 88 x 27 cubic feet
36 chains = 36 x 66 feet

Length x Breadth x Depth = Cubic measurement

36 x 66 x 24 x Depth = 88 x 27 Cub. feet

$$\text{Therefore depth} = \frac{88 \times 27}{36 \times 66 \times 24}$$

$$\text{Cancelling} \quad \frac{\overset{1}{\cancel{\overset{4}{\cancel{88}}}} \times \overset{1}{\cancel{\overset{3}{\cancel{27}}}}}{\underset{1}{\cancel{\underset{4}{\cancel{36}}}} \times \underset{1}{\cancel{\underset{3}{\cancel{66}}}} \times 24} = \frac{1}{24} \text{ feet}$$

$$\frac{1}{\underset{2}{\cancel{24}}} \times \frac{\overset{1}{\cancel{12}}}{1} = \frac{1}{2} \text{ inch}$$

Answer .. $\frac{1}{2}$ inch.

xample No. 2.

What quantity of ridge gravel could be excavated from the rea shown in Fig. 22. The depth of gravel in feet having een established by trial shafts as indicated in circles thus (2) etc.

Cubic contents = Area of each triangle x average depth.

Triangle	Areas Sq.ft	Average depths Feet	Cubic contents Cub.ft.
A	$\frac{30 \times 20}{2} = 300$	$\frac{1+2+3}{3} = 2$	$300 \times 2 = 600$
B	$\frac{40 \times 30}{2} = 600$	$\frac{2+3+4}{3} = 3$	$600 \times 3 = 1800$
C	$\frac{50 \times 40}{2} = 1000$	$\frac{2+3+4}{3} = 3$	$1000 \times 3 = 3000$
D	$\frac{50 \times 50}{2} = 1250$	$\frac{3+4+5}{3} = 4$	$1250 \times 4 = 5000$
E	$\frac{50 \times 50}{2} = 1250$	$\frac{1+3+5}{3} = 3$	$1250 \times 3 = 3750$
F	$\frac{40 \times 50}{2} = 1000$	$\frac{1+3+5}{3} = 3$	$1000 \times 3 = 3000$
G	$\frac{40 \times 30}{2} = 600$	$\frac{1+2+3}{3} = 2$	$600 \times 2 = 1200$
			18350

Answer .. 18,350 cubic feet.

Example No. 3.

How many cubic yards of gravel are contained in the heap shown in Fig. 23?

AVERAGE CROSS SECTION METHOD

$$\text{Cross Section area (approx. Triangular)} = \frac{\text{Base} \times \text{Height}}{2}$$

$$X = \frac{6 \times 2}{2} = 6 \text{ sq. ft.}$$

$$Y = \frac{18 \times 4}{2} = 36 \text{ sq. ft.}$$

$$Z = \frac{11 \times 3}{2} = 16\tfrac{1}{2} \text{ sq. ft.}$$

$$\text{Sum of cross section areas} = 58\tfrac{1}{2} \text{ sq. ft.}$$

$$\text{Volume} = 58\tfrac{1}{2} \times 20 = 1170 \text{ cub.ft.}$$

$$\frac{1170}{27} = 43\tfrac{1}{3} \text{ cub.yds.}$$

Answer .. $43\frac{1}{3}$ cubic yards.

Example No. 4

An excavation is to be taken out across ground of uneven surface in Fig. 24. Approximately how many cubic yards of material must be excavated?

Top width of A	=	2' + 3' + 3'	=	8'
B	=	2' + 1' + 1'	=	4'
C	=	2' + 4' + 4'	=	10'
D	=	2' + 2' + 2'	=	6'

Cross section areas at ends $= \dfrac{\text{Sum of parallel sides}}{2} \times \text{depth}$

$$A = \frac{2+8}{2} \times 3 = 15 \text{ sq.ft.}$$

$$B = \frac{2+4}{2} \times 1 = 3 \text{ sq.ft.}$$

$$C = \frac{2+10}{2} \times 4 = 24 \text{ sq.ft.}$$

$$D = \frac{2+6}{2} \times 2 = 8 \text{ sq.ft.}$$

Cub. contents of portion $X = \dfrac{A+B}{2} \times 20 = \dfrac{15+3}{2} \times 20 = 180$ cub. ft.

" " " $Y = \dfrac{B+C}{2} \times 30 = \dfrac{3+24}{2} \times 30 = 405$ cub. ft.

" " " $Z = \dfrac{C+D}{2} \times 10 = \dfrac{24+8}{2} \times 10 = 160$ cub. ft.

" " $X + Y + Z = 745$ cub. ft.

Converting to cubic yards -

$$\frac{745}{27} = 27.592 \text{ cub. yards.}$$

Answer .. 27.592 cubic yards. Approx.

.. ..

A slightly more difficult problem arises when the shape of a heap of ballast or an excavation has sloping sides and ends, as shown in Fig. 25.

The method used to work out a problem of this nature is as follows : -

PRISMOIDAL FORMULA

Multiply the sum of the top and bottom areas plus 4 times the middle area by the depth and divide the result by 6.

Expressed as a formula : -

$$\text{Cubic contents} = \frac{(\text{Top area} + \text{Bottom area} + 4 \text{ times Mid. Area})}{6} \times \text{depth}$$

Example No. 5.

A ballast heap measures 40' x 12' at the base and the slope of the sides and ends is 1 to 1. If the height is 4' how many cubic feet of ballast does the heap contain?

Top length - Because of the 1 to 1 slopes the top will be 4' shorter at each end than the bottom length : -

Top length	=	$40 - 4 - 4$	=	32 ft.
Top width	=	$12 - 4 - 4$	=	4 "
Middle length	=	$\frac{40 + 32}{2}$	=	36 "
Middle width	=	$\frac{12 + 4}{2}$	=	8 "

Top area	=	32 x 4	=	128 sq.ft.
Middle area	=	36 x 8	=	288 " "
4 times Middle area	=	288 x 4	=	1152 " "
Bottom area	=	40 x 12	=	480 " "

substituting these values in the formula : -

$$\text{Cubic contents} = \frac{(128 + 480 + 1152)}{6} \times 4$$

$$= \frac{1760 \times 4}{6}$$

$$= 1173.3 \text{ cubic feet.}$$

Answer .. 1173.3 cubic feet.

The formula used in example No. 5, is an exact method of determining the volume of a prismoid, whereas the method of average end section used in example No. 4, is an approximation.

To show the difference between the results obtained by he two methods, example No. 4 is repeated using the Prismoi-dal formula.

xample No. 6

Middle areas are first determined.
Cross sections are trapezoids.

$$\text{Areas} = \frac{\text{Sum of parallel sides}}{2} \times \text{depth}$$

Depths at middle areas are the average depths at end cross sections.

Portion	X	Y	Z
verage depth =	$\frac{3+1}{2} = 2$ ft.	$\frac{1+4}{2} = \frac{5}{2}'$	$\frac{4+2}{2} = 3$ ft.
op widths =	$2+2+2 = 6$ ft.	$2+\frac{5}{2}+\frac{5}{2} = 7$ ft.	$2+3+3 = 8$ ft.
um par'l. sides =	$\frac{6+2}{2} = 4$ ft.	$\frac{2+7}{2} = \frac{9}{2}'$	$\frac{2+8}{2} = 5$ ft.
iddle area =	$4 \times 2 = 8$ sq.ft.	$\frac{9}{2} \times \frac{5}{2} = \frac{45}{4}$ sq.ft.	$5 \times 3 = 15$ sq.ft.

ubic contents of each portion

$$X.\ Y.\ \&\ Z = \frac{\text{End Area} + \text{End Area} + 4 \text{ times Mid. Area}}{6} \times \text{depth}$$

ubic contents portion $X = \frac{15+3+(8 \times 4)}{6} \times 20 = 166.\dot{6}$

" " " $Y = \frac{3+24+(\frac{45}{4} \times 4) \times 30}{6} = 360$

" " " $Z = \frac{24+8+(15 \times 4)}{6} \times 10 = 153.\dot{3}$

ubic contents X + Y + Z = $679.\dot{9}$ cub.ft

$.\dot{9}$ means .9 repeating as far as you care to calculate and losely approaches the value of 1, so that the volume should e taken as 680 cubic feet.

onverting to cubic yards $= \frac{680}{27} = 25.185$ cub. yds.

Answer .. 25.185 cubic yards.

omparing this answer with the answer obtained by the average ross section method used in example No. 4, the error is 7.592 - 25.185 = 2.4 cubic yards.

xpressed as a percentage error $= \frac{2.4}{25.185} \times 100 = 9\frac{1}{2}\%$ error.

It is frequently convenient to calculate the volume by the average cross section method and subtract the 'prismoidal correction' from this volume.

PRISMOIDAL CORRECTION

Prismoidal correction $= \frac{L}{12}\ (d-d_1)\ \ (w-w_1)$, See Fig. 26.

Example No. 7.

Referring to portion X, Fig. 24.

$d=3'\quad d_1=1'\quad w=8'\quad w_1=4'\quad L=20'$

Prismoidal correction $= \frac{20}{12} \times 2 \times 4 = 13.\dot{3}$ c.ft.

Referring to portion Y, Fig. 24.

$d=4'\quad d_1=1'\quad w=10'\quad w_1=4'\quad L=30'$

Prismoidal correction $= \frac{30}{12} \times 3 \times 6 = 45$ c.ft.

Referring to portion Z, Fig. 24.

$d=4'\quad d_1=2'\quad w=10'\quad w_1=6'\quad L=10'$

Prismoidal correction $= \frac{10}{12} \times 2 \times 4 = 6.\dot{6}$ c.ft.

Sum of the Prismoidal corrections $64.\dot{9}$ c.ft.

Volume found by Average Cross Section method = 745 cub. ft.
Less Prismoidal correction $64.\dot{9}$, say 65 = 65 " "
Corrected Volume = 680 " "

The corrected volume is in agreement with the volume found by the Prismoidal formula in example No. 6.

Example No. 8

What volume is contained in the embankment shown in Fig.27?

End area $\frac{20+50}{2} \times 10 = 350$ sq. ft.

" " $\frac{20+65}{2} \times 15 = 637.5$ " "

Sum of end areas $= 987.5$ " "

Average of end areas $\frac{987.5}{2} = 493.75$ sq. ft.

Volume $= 493.75 \times 500 = 246875$ cub.ft.

Prismoidal correction $= \frac{L}{12}\ (d-d_1)\ \ (w-w_1)$
(to be subtracted)

$= \frac{500}{12} \times 5 \times 15 = 3125$ c.ft $= 1\frac{1}{3}\%$

Corrected volume = 243750 c.ft

Volume in cubic yards $= 9027.\dot{7}$ cub. yards.

The Prismoidal formula may be applied to find the volume of the cone, pyramid and sphere.

In the case of the cone and the pyramid an imaginary plane is considered to exist at the apex, the area of which is zero.

With the sphere two imaginary planes are considered to exist, one above and one below the sphere, the area of each being zero. These planes are parallel and separated by the diameter of the sphere.

Example No. 9

A well sunk in solid rock and surmounted by a hemispherical brick top, shown in Fig. 28, is filled to overflowing. Approximately how many gallons of water will be contained?

Volume A = Half the volume of a sphere

$$= \frac{1}{2} \times \frac{\text{Top area} + \text{Bottom area} + 4(\text{middle area})}{6} \times \text{height}$$

Top area = 0

Bottom " = 0

Middle " $= 14 \times 14 \times \frac{11}{14} = 154$ sq. ft.

" " $\times\ 4 = 4 \times 154 = 616$ " "

$$\text{Volume of A} = \frac{(0 + 0 + 616) \times 14}{2 \times 6} = \frac{154 \times 14}{3} = \frac{2156}{3} \text{ c.ft.}$$

Volume of B

Top area $= 14 \times 14 \times \frac{11}{14} = \frac{1078}{7}$ sq. ft.

Bottom area $= 10 \times 10 \times \frac{11}{14} = \frac{550}{7}$ " "

Middle area $= 12 \times 12 \times \frac{11}{14} = \frac{792}{7}$ " "

" " $\times\ 4 = 4 \times \frac{792}{7} = \frac{3168}{7}$ " "

$$\text{Volume of B} = \left(\frac{1078}{7} + \frac{550}{7} + \frac{3168}{7}\right) \times \frac{10}{6} = \frac{4796}{7} \times \frac{10}{6} = \frac{23980}{21} \text{ c.ft.}$$

Volume of C

Top area $= 10 \times 10 \times \frac{11}{14} = \frac{550}{7}$ sq. ft.

Bottom area = 0

Middle area $= 5 \times 5 \times \frac{11}{14} = \frac{275}{14}$ " "

Middle area $\times\ 4 = 4 \times \frac{275}{14} = \frac{550}{7}$ " "

Volume of C $= \left(\frac{550}{7} + 0 + \frac{550}{7}\right) \times \frac{2}{6} = \frac{1100}{7} \times \frac{2}{6} = \frac{1100}{21}$ c.ft

Volume A+B+C$= \frac{2156}{3} + \frac{23980}{21} + \frac{1100}{21} = \frac{15092 + 23980 + 1100}{21}$

$= \frac{40172}{21}$ Converted to gallons -

$$\frac{40172}{21} \times \frac{25}{4} = 11955.95 \text{ gallons.}$$

Example No. 10

A circular tank 4' dia. and 6' high contains 2' of water. How many gallons does it contain?

Area of a circle = Diameter x Diameter x $\frac{11}{14}$

Cubic contents = Area x depth

1 cubic foot of water = $6\frac{1}{4}$ gallons = $\frac{25}{4}$ gallons

Area of tank = $4 \times \cancel{4}^{2} \times \frac{11}{\cancel{14}_{7}} = \frac{88}{7}$ sq. ft.

Cubic contents = $\frac{88}{7} \times 2 = \frac{176}{7}$ c. ft.

Gallons contents = $\frac{\cancel{176}^{44}}{7} \times \frac{25}{\cancel{4}} = \frac{1100}{7}$ gallons

Answer .. 157.14 gallons

If the tank is full it contains -

$\frac{6}{2} \times 157.14$ galls. = 471.42 gallons

WEIGHTS

Example No. 11

Referring to the tables, find the total weight of the following track materials.

6 No. 90 lb. A.S. rails 45' long

12 pairs 90 lb. A.S. fishplates.

48 No. fishbolts (1" x $5\frac{3}{8}$") with nuts and $1\frac{1}{16}$" x $\frac{3}{8}$" x $\frac{3}{8}$" spring washers.

Rails $\frac{6 \times 91.2 \times 45}{3}$ = 8208 lbs.

Fishplates 12 x 67.89 = 814.68 lbs.

Fishbolts & Nuts 55 per cwt = $\frac{112}{55}$ lbs. each

48 No = $\frac{48 \times 112}{55}$ = 97.74 lbs.

Spring washers 685 per cwt = $\frac{112}{685}$ lbs. each

48 No. = $\frac{48 \times 112}{685}$ = 7.85 lbs.

Total weight -

Rails	=	8208.00	lbs.
Fishplates	=	814.68	lbs.
Fishbolts & Nuts	=	97.74	lbs.
Spring washers	=	7.85	lbs.
		9128.27	lbs.

1. Weight in tons.

```
2240)9128.27( 4.0751
     8960
      16827
      15680
       11470
       11200
          2700
          2240
           460
```

2. Weight in tons, cwts, qrs, lbs.

```
28)9128.27( 326 qrs
   84
    72
    56
    168
    168
      0.27 lbs

4)326( 81 cwts
  32
   06
    4
    2 qrs

20) 81( 4 tons
    80
     1 cwt
```

Answer 4.0751 tons. ... 4 tons 1 cwt. 2 qrs. 27 lbs.

Example No. 12.

A siding has to be extended 15 chains using 75 lb. H. rails, 23 feet long, with 11 sleepers to the rail length, 4 hole fishplates, and 4 dogspikes to each sleeper. Metal ballast to be boxed up to full main track ballast profile 5'3" track.

With the following information calculate the quantity and weight in tons of each class of material and the total weight in tons of all the material required.

Sleepers 10 to the ton. Fishplates 81 pairs to the ton.
Fishbolts 1240 " " " Washers 13660 No. " " ".
Dogspikes 2240 " " " Ballast 1 c.yd. equivalent to 1.1 tons.

Cubic contents of track per mile including sleepers and ballast - 2902.7 cubic yards.
Cubic contents 9'0" x 10" x 5" sleeper = .11574 c.yds

(For the number and volume of sleepers per mile of track for various rail lengths and sleeper spacings, see Table 20. 49).

Rails required	=	$\frac{15 \times 66 \times 2}{23}$	=	86.086, say 86 No.
Sleepers "	=	43 x 11	=	473 No.
Dogspikes "	=	473 x 4	=	1892 No.
Fishplates "				86 pair.
Fishbolts "	=	86 x 4	=	344 No.
Washers "	=	86 x 4	=	344 No.

15 chains of sleepers & ballast

$$= \frac{15}{80} \times 2902.7 = 544.27083 \text{ c. yds}$$

Cubic contents of sleepers

=	473 x .11574	=	54.74502	" "
	Ballast	=	489.52581	" "

Weights : -

Ballast	489.52581 x 1.1	=	538.4784	tons
Sleepers	$\frac{473}{10}$	=	47.3	
Rails	$\frac{86 \times 23 \times 75}{2240 \times 3}$	=	22.0759	
Fishbolts	$\frac{344}{1240}$	=	.2774	
Washers	$\frac{344}{13660}$	=	.0252	
Dogspikes	$\frac{1892}{2240}$	=	.8446	
Fishplates	$\frac{86}{81}$	=	1.0617	
	T o t a l	=	610.0632	tons

Note : - The nominal weight of 75 lb. rails has been used because with old rails the actual weight varies with the amount of wear of the rails.

WEIGHTS AND MEASURES

AVOIRDUPOIS WEIGHT

		1 ounce ..	oz.
16 ounces	=	1 pound ..	lb.
28 pounds	=	1 quarter ..	qr.
4 quarters	=	1 hundredweight ..	cwt.
20 hundredweights	=	1 Ton ..	T.

1 Ton	=	2240 lbs. = 35,840 ozs.
1 cwt.	=	112 lbs. = 1792 ozs.
1 cental	=	100 lbs. = 1600 ozs.

8 stone	=	1 cwt.
1 stone	=	14 lbs.

All ordinary articles are weighed by this table which is known as the imperial standard.

LINEAL MEASURE or MEASURE OF LENGTH

		1 inch	in.
12 inches	=	1 foot	ft.
3 feet	=	1 yard	yd.
$5\frac{1}{2}$ yards	=	1 rod, pole or perch ..	per.
40 poles	=	1 furlong	fur.
8 furlongs	=	1 mile	M.
3 miles	=	1 league	L.

1 M = 320 rods = 1760 yds. = 5280 ft. = 63,360 ins.

For smaller lengths than an inch, eighths, tenths, sixteenths, thirtyseconds, sixtyfourths, hundredths, thousandths, etc., are used.

SURVEYOR'S LINEAL MEASURE

		1 inch	in.
7.92 inches	=	1 link	li.
100 links	=	1 chain	ch.
80 chains	=	1 mile	M.

1 ch. = 4 rods = 22 yds. = 66 ft. = 792 ins.

Surveyor's lineal measure is used in measuring land.

WEIGHTS AND MEASURES

SQUARE OR SUPERFICIAL MEASURE

144 square inches	=	1 square foot	..	Sq.ft.
9 square feet	=	1 square yard	..	sq.yd.
30¼ square yards	=	(1 square rod	..	sq.rd.
		(1 square pole	..	sq.po.
		(1 square perch	..	sq.per.
40 square rods) square poles) square perches)	=	1 rood	..	r.
4 roods	=	1 acre	..	ac.
640 acres	=	1 square mile	..	sq.ml.
100,000 square links	=	4,840 square yards	=	1 acre
10 square chains	=	4,840 square yards	=	1 acre

Sq. in.	Sq. ft.	Sq. yd.	Sq.rd.	r.	Ac.	Sq.M
144	1					
1,296	9	1				
39,204	272¼	30¼	1			
1,568,160	10,890	1,210	40	1		
6,272,640	43,560	4,840	160	4	1	
4,014,489,600	27,878,400	3,097,600	102,400	2,560	640	1

A square having an area of 1 acre has sides which measure 69.57 yards or 208.71 feet.

A square having an area of 1/2 acre has sides which measure 49.19 yards or 147.58 feet.

A square having an area of 1/4 acre has sides which measure 34.79 yards or 104.36 feet.

CUBIC OR SOLID MEASURE

1728 cubic inches	=	1 cubic foot	..	cu.ft
27 cubic feet	=	1 cubic yard	..	cu.yd
40 cubic feet	=	1 ton (shipping)	..	T. sh

1 cu. yd. = 27 cu. ft. = 46,656 cu. ins.

FASTENINGS FOR ALL 60 LB. A.S. LAYOUTS 15'0" 'X' SWITCHES

FASTENINGS	TURN-OUTS	SINGLE CMPNDS.	DOUBLE CMPNDS.	MODFD. THREE THROWS	STND. DELTAS
CHAIRS, Common Toe	-	-	8	-	-
" " Slide	14	28	48	28	56
" " Heel	2	4	8	4	8
" " Dummy	-	40	12	16	-
PINS, Chair, Common	32	64	120	64	128
" " Countersunk	-	-	8	-	-
BOLTS, Heel Block	6	12	24	12	24
" " Fishbolt	4	8	16	8	16
" Chair	16	32	64	32	64
" Guard Rail, long	4	8	8	12	8
" " " short	6	12	12	18	12
WASHERS, Spring, Chairbolt	16	32	64	32	64
" " Heel bolt	6	12	24	12	24
" " Guard Rail "	10	20	20	30	20
" Flat	40	80	80	120	80
SPREADERS	2	4	8	4	8
FISHPLATES, Heel (pairs)	2	4	8	4	8
" Crossing (pairs)	-	12	12	11	8
FERRULES, long	4	8	8	12	8
" short	6	12	12	18	12
DOGSPIKES, 7" for Dummy Chairs.	-	80	24	32	-

Notes:- For details of Spreaders see Table 14.036.

Except for maintenance purposes, the manufacture of 60 lb. materials has been discontinued.

The 12'0" switch is unsuitable for 6 coupled wheel locomotives and is no longer supplied.

FASTENINGS FOR 80 & 100 lb. 'Y' LAYOUTS WITHOUT TIE PLATES

Note:- Lists for these layouts with tie plates are not included as future installations will be confined to layouts without tie plates.

FASTENINGS	TURNOUTS			S.COMPNDS			D.COMPNDS		
	600	800	1000	600	800	1000	600	800	1000
CHAIRS, Common Toe	-	-	-	-	-	-	8	8	8
" " Slide	12	14	16	24	28	32	40	48	56
" " Heel	2	2	2	4	4	4	8	8	8
" " Dummy	-	-	-	40	46	52	12	14	16
PINS, Chair, Common	28	32	36	56	64	72	104	120	136
" "Countersunk	-	-	-	-	-	-	8	8	8
BOLTS, Heel Block	6	6	6	12	12	12	24	24	24
" " Fishbolt	4	4	4	8	8	8	16	16	16
" Chair	14	16	18	28	32	36	56	64	72
" Guard Rail,long	4	4	4	8	8	8	8	8	8
" " " short	6	6	6	12	12	12	12	12	12
WASHERS,Spring,Chairbolt	14	16	18	28	32	36	56	64	72
" " Heel bolt	6	6	6	12	12	12	24	24	24
" "Guard Rail "	10	10	10	20	20	20	20	20	20
" Flat	40	40	40	80	80	80	80	80	80
SPREADERS	2	2	3	4	4	6	8	8	12
FISHPLATES,Heel (pairs)	2	2	2	4	4	4	8	8	8
" Crossing (pairs)	-	-	-	12	12	12	12	12	12
FERRULES, long	4	4	4	8	8	8	8	8	8
" short	6	6	6	12	12	12	12	12	12
DOGSPIKES, 7" for Dummy Chairs	-	-	-	80	92	104	24	28	32

Notes : - For details of Spreaders see Table 14.036

Except for maintenance purposes, the manufacture of 80 & 100 lb. material has been discontinued.

The radii shown are nominal only.

For extra fastenings see Table 20.31.

FASTENINGS FOR 80 & 100 lb. 'Y' LAYOUTS WITHOUT TIE PLATES

Note: - Lists for these layouts with tie plates are not ıcluded as future installations will be confined to lay-ıts without tie plates.

DETAIL OF FASTENINGS	MODIFIED THREE THROWS									DELTAS		
	600 Foll. By			800 Foll. By			1000 Foll. By			STANDARD		
	600	800	1000	600	800	1000	600	800	1000	600	800	1000
AIRS, Common Slide	24	26	28	26	28	30	28	30	32	48	56	64
" " Heel	4	4	4	4	4	4	4	4	4	8	8	8
" " Dummy	14	16	18	14	16	18	14	16	18	-	-	-
INS, Chair, Common	56	60	64	60	64	68	64	68	72	112	128	144
LTS, Heel Block	12	12	12	12	12	12	12	12	12	24	24	24
" " Fishbolt	8	8	8	8	8	8	8	8	8	16	16	16
" Chair	28	30	32	30	32	34	32	34	36	56	64	72
" Guard Rail, long	12	10	10	12	12	12	12	12	12	12	12	12
" " " short	18	18	18	18	18	18	18	18	18	24	24	24
SHERS, Spring, Chairbolt	28	30	32	30	32	34	32	34	36	56	64	72
" " Heel bolt	12	12	12	12	12	12	12	12	12	24	24	24
" " Guard Rail "	30	28	28	30	30	30	30	30	30	36	36	36
" Flat	120	112	112	120	120	120	120	120	120	144	144	144
READERS	4	4	5	4	4	5	5	5	6	8	8	12
SHPLATES, Heel (pairs)	4	4	4	4	4	4	4	4	4	8	8	8
" Crossing (pairs)	11	11	11	11	11	11	11	11	11	8	8	8
RRULES, long	12	10	10	12	12	12	12	12	12	12	12	12
" short	18	18	18	18	18	18	18	18	18	24	24	24
GSPIKES, 7" for Dummy Chairs	28	32	36	28	32	36	28	32	36	-	-	-

tes : - For details of Spreaders see Table 14.036.

Except for maintenance purposes, the manufacture of 80 & 100 lb. material has been discontinued.

The radii shown are nominal only.

For extra fastenings see Table 20.31.

FASTENINGS FOR 90 & 110 Lb. LAYOUTS, 'V' NOSED SWITCHES WITH TIE PLATES

DETAIL OF FASTENINGS.	TURNOUTS						COMPOUNDS					
	'V' Crossing			Spring Crossing			Single			Double		
	600	800	1000	600	800	1000	600	800	1000	600	800	1000
CHAIRS, Adjustable Slide	2	2	2	2	2	2	4	4	4	4	4	4
" " Toe	-	-	-	-	-	-	-	-	-	4	4	4
" Common Toe	-	-	-	-	-	-	-	-	-	4	4	4
" Common & Heel Slide	12	14	16	12	14	16	24	28	32	44	52	60
" Deep Dummy	-	-	-	-	-	-	2	2	2	-	-	-
" Common Dummy	-	-	-	-	-	-	24	28	32	-	-	-
" Insulated Dummy	-	-	-	-	-	-	2	2	2			
RAIL BRACES	-	-	-	3	3	3	-	-	-	-	-	-
BOLTS, Chair	14	16	18	14	16	18	28	32	36	56	64	72
" Guard Rail, long	4	4	4	4	4	4	8	8	8	8	8	8
" " " short	6	6	6	12	12	12	12	12	12	12	12	12
WASHERS, Spring	24	26	28	30	32	34	48	52	56	76	84	92
" Flat	32	32	32	56	56	56	64	64	64	72	72	72
PINS, Chair	6	6	6	6	6	6	-	-	-	-	-	-
SCREWS, Chair	42	46	50	42	46	50	88	96	104	160	176	192
" Rail Brace	-	-	-	6	6	6	-	-	-	-	-	-
FERRULES, Guard Rail, long	4	4	4	4	4	4	8	8	8	8	8	8
" " " short	6	6	6	12	12	12	12	12	12	12	12	12
PLATES " " Gauge	-	-	-	14	16	16	-	-	-	-	-	-
DOGSPIKES, 7" for Dummy Chairs	-	-	-	-	-	-	48	56	64	-	-	-
DOGSPIKES, 9" for Deep Dummy Chairs	-	-	-	-	-	-	8	8	8	-	-	-
SPREADERS, No. 1	1	1	1	1	1	1	2	2	2	4	4	4
" No. 2	1	1	1	1	1	1	2	2	2	4	4	4
" No. 3	-	-	1	-	-	1			2	-	-	4
TIE PLATES	1	1	1	1	1	1	2	2	2	4	4	4
TIMBER COVERS for Tie Plates	1	1	1	1	1	1	-	-	-	-	-	-
FISHPLATES, Crossing, Pair	2	-	2	3	1	3	4	8	12	4	8	12
INSULATED JOINTS, Tracklocked Areas	2	2	2	2	2	2	4	4	4	4	4	4

Notes :- For details of Spreaders see Table 14.037

The radii shown are nominal only.

For extra fastenings see Table 20.32

FASTENINGS FOR 90 & 110 lb. LAYOUTS, 'V' NOSED SWITCHES WITH TIE PLATES

ETAIL OF FASTENINGS	MODIFIED THREE THROWS									DELTAS STANDARD		
	600 Foll. By			800 Foll. By			1000 Foll. By					
	600	800	1000	600	800	1000	600	800	1000	600	800	1000
AIRS, Adjustable Slide	3	3	3	4	3	3	4	4	4	8	8	8
" " Toe	1	1	1	-	1	1	-	-	-	-	-	-
" Common Toe	-	-	1	-	-	1	-	-	-	-	-	-
" Common & Heel Slide	24	26	27	26	28	29	28	30	32	48	56	64
" Deep Dummy	1	1	1	1	1	1	1	1	1	-	-	-
" Common Dummy	13	15	17	13	15	17	13	15	17	-	-	-
LTS, Chair	28	30	32	30	32	34	32	34	36	56	64	72
" Guard Rail, long	10	10	10	10	10	10	10	10	10	12	12	12
" " " short	18	18	18	18	18	18	18	18	18	24	24	24
SHERS, Spring	56	58	60	58	60	62	60	62	64	92	100	108
" Flat	88	88	88	88	88	88	88	88	88	128	128	128
INS, Chair	-	-	-	-	-	-	-	-	-	24	24	24
REWS, Chair	83	87	90	88	91	94	92	96	100	168	184	200
RRULES, Guard Rail, long	10	10	10	10	10	10	10	10	10	12	12	12
" " " short	18	18	18	18	18	18	18	18	18	24	24	24
GSPIKES, 7" for Dummy Chairs	26	30	34	26	30	34	26	30	34	-	-	-
GSPIKES, 9" for Deep Dummy Chairs	4	4	4	4	4	4	4	4	4	-	-	-
PREADERS, No. 1	2	2	2	2	2	2	2	2	2	4	4	4
" No. 2	2	2	2	2	2	2	2	2	2	4	4	4
" No. 3	-	-	1	-	-	1	1	1	2	-	-	4
IE PLATES	2	2	2	2	2	2	2	2	2	4	4	4
IMBER COVERS for Tie Plates	-	-	-	-	-	-	-	-	-	4	4	4
ISHPLATES, Crossing, Pair	4	4	6	2	-	2	4	2	4	-	-	-
NSULATED JOINTS, racklocked Areas	4	4	4	4	4	4	4	4	4	8	8	8

tes : - For details of Spreaders see Table 14.037.

The radii shown are nominal only.

For extra fastenings see Table 20.32.

FASTENINGS FOR 90 & 110 lb. LAYOUTS, 'V' NOSED SWITCHES WITHOUT TIE PLATES

DETAIL OF FASTENINGS.	TURNOUTS						COMPOUNDS					
	'V' Crossing			Spring Crossing			Single			Double		
	600	800	1000	600	800	1000	600	800	1000	600	800	1000
CHAIRS, Common Toe	-	-	-	-	-	-	-	-	-	8	8	8
" Common & Heel Slide	14	16	18	14	16	18	28	32	36	48	56	64
" Common Dummy	-	-	-	-	-	-	28	32	36	-	-	-
RAIL BRACES	-	-	-	3	3	3	-	-	-	-	-	-
BOLTS, Chair	14	16	18	14	16	18	28	32	36	56	64	72
" Guard Rail, long	4	4	4	4	4	4	8	8	8	8	8	8
" " " short	6	6	6	12	12	12	12	12	12	12	12	12
WASHERS, Spring	24	26	28	30	32	34	48	52	56	76	84	92
" Flat	24	24	24	48	48	48	48	48	48	48	48	48
SCREWS, Chair	42	46	50	42	46	50	88	96	104	160	176	192
" Rail Brace	-	-	-	6	6	6	-	-	-	-	-	-
FERRULES, Guard Rail, long	4	4	4	4	4	4	8	8	8	8	8	8
" " " short	6	6	6	12	12	12	12	12	12	12	12	12
PLATES " " Gauge	-	-	-	14	16	16	-	-	-	-	-	-
DOGSPIKES, 7" for Dummy Chairs	-	-	-	-	-	-	56	64	72	-	-	-
SPREADERS, No. 1	1	1	1	1	1	1	2	2	2	4	4	4
" No. 2	1	1	1	1	1	1	2	2	2	4	4	4
" No. 3	-	-	1	-	-	1	-	-	2	-	-	4
FISHPLATES, Crossing, Pair	2	-	2	3	1	3	4	8	12	4	8	12
INSULATED JOINTS, Tracklocked Areas	2	2	2	2	2	2	4	4	4	4	4	4

Notes : - For details of Spreaders see Table 14.037.

The radii shown are nominal only

For extra fastenings see Table 20.32.

FASTENINGS FOR 90 & 110 lb. LAYOUTS, 'V' NOSED SWITCHES WITHOUT TIE PLATES

DETAIL OF FASTENINGS	MODIFIED THREE THROWS									DELTAS STANDARD		
	600 Foll. By			800 Foll. By			1000 Foll. By					
	600	800	1000	600	800	1000	600	800	1000	600	800	1000
AIRS, Common Toe	1	1	2	-	1	2	-	-	-	-	-	-
" Common & Heel Slide	27	29	30	30	31	32	32	34	36	56	64	72
" Common Dummy	14	16	18	14	16	18	14	16	18	-	-	-
LTS, Chair	28	30	32	30	32	34	32	34	36	56	64	72
" Guard Rail, long	10	10	10	10	10	10	10	10	10	12	12	12
" " " short	18	18	18	18	18	18	18	18	18	24	24	24
SHERS, Spring	56	58	60	58	60	62	60	62	64	92	100	108
" Flat	72	72	72	72	72	72	72	72	72	96	96	96
REWS, Chair	83	87	90	88	91	94	92	96	100	168	184	200
RRULES, Guard Rail, long	10	10	10	10	10	10	10	10	10	12	12	12
" " " short	18	18	18	18	18	18	18	18	18	24	24	24
GSPIKES, 7" for Dummy Chairs	28	32	36	28	32	36	28	32	36	-	-	-
READERS, No. 1	2	2	2	2	2	2	2	2	2	4	4	4
" No. 2	2	2	2	2	2	2	2	2	2	4	4	4
" No. 3	-	-	1	-	-	1	1	1	2	-	-	4
SHPLATES, Crossing, Pair	4	4	6	2	-	2	4	2	4	-	-	-
SULATED JOINTS, acklocked Areas	4	4	4	4	4	4	4	4	4	8	8	8

tes : - For details of Spreaders see Table 14.037

The radii shown are nominal only.

For extra fastenings see Table 20.32

EXTRA FASTENINGS

Extra fastenings as shown below are used for trackwork layouts when depressed timbers are required by the Signal Division.

Quantities shown are for each depressed timber ahead of a set of points

80 AND 100 lb.

DETAIL OF FASTENINGS	TURNOUTS						COMPOUNDS					
	'V' Crossing			Spring Crossg			Single			Double		
	600	800	1000	600	800	1000	600	800	1000	600	800	1000
CHAIRS Common Dummy	2	2	2	2	2	2	8	8	8	8	8	8
DOGSPIKES 7"	4	4	4	4	4	4	16	16	16	16	16	16

80 AND 100 lb.

DETAIL OF FASTENINGS	MODIFIED THREE THROWS									DELTAS STANDARD		
	600 foll. By			800 Foll. By			1000 Foll. By					
	600	800	1000	600	800	1000	600	800	1000	600	800	1000
CHAIRS Common Dummy	6	6	6	6	6	6	6	6	6	8	8	8
DOGSPIKES 7"	12	12	12	12	12	12	12	12	12	16	16	16

Extra fastenings as shown below are used for trackwork layouts when depressed timbers are required by the Signal Division.

CHAIRS Common Dummy	6	5	6	6	6	6	6	6	6	8	8	8
DOGSPIKES 7"	12	12	12	12	12	12	12	12	12	16	16	16

EXTRA FASTENINGS

Extra fastenings as shown below are used for trackwork layouts when depressed timbers are required by the Signal Division.

Quantities shown are for each depressed timber ahead of a set of points.

90 AND 110 lb.

DETAIL OF FASTENINGS	TURNOUTS						COMPOUNDS					
	'V'Crossing			Spring Crossg			Single			Double		
	600	800	1000	600	800	1000	600	800	1000	600	800	1000
CHAIRS, Special Dummy	2	2	2	2	2	2	4	4	4	8	8	8
" Deep "	-	-	-	-	-	-	4	4	4	-	-	-
BOLTS, Chair	2	2	2	2	2	2	4	4	4	8	8	8
WASHERS, Spring	2	2	2	2	2	2	4	4	4	8	8	8
HEADLOCKS for Chair Bolts	2	2	2	2	2	2	4	4	4	8	8	8
DOGSPIKES, 9"for Deep Dummy Chairs	-	-	-	-	-	-	8	8	8	-	-	-
SCREWS, Chair	4	4	4	4	4	4	8	8	8	16	16	16

90 AND 110 lb.

DETAIL OF FASTENINGS	MODIFIED THREE THROWS									DELTAS		
	600 Foll.By			800 Foll.By			1000 Foll.By			STANDARD		
	600	800	1000	600	800	1000	600	800	1000	600	800	1000
CHAIRS, Special Dummy	4	4	3	4	4	3	4	4	4	8	8	8
" Deep	2	2	3	2	2	3	2	2	2	-	-	-
BOLTS, Chair	4	4	3	4	4	3	4	4	4	8	8	8
WASHERS, Spring	4	4	3	4	4	3	4	4	4	8	8	8
HEADLOCKS for Chair Bolts	4	4	3	4	4	3	4	4	4	8	8	8
DOGSPIKES, 9"for Deep Dummy Chairs	4	4	6	4	4	6	4	4	4	-	-	-
SCREWS, Chair	8	8	6	8	8	6	8	8	8	16	16	16

MATERIAL FOR 94 & 107 LB. LAYOUTS WITH C. I. CHAIRS WITH TIE PLATES

MATERIAL REQUIRED	STANDARD TURNOUTS			COMPOUNDS Single		COMPOUNDS Double	
	7.52	8.7	9.73	7.52	8.7	7.52	8.7
POINTS and CROSSINGS	See additional Table 20.43						
GUARD RAILS, 11' 3", with Blocks Pairs	1	1	1	2	2	2	2
CHAIRS, Common & Heel Slide	14	16	16	22	20	44	40
" Adjustable Slide	2	2	2	4	4	4	4
" " Toe	-	-	-	-	-	4	4
" Special, Mark 'A'	-	-	-	6	4	12	8
" " " 'B'	-	-	-	-	2	-	4
" " " 'C'	-	-	-	-	2	-	4
" " " 'D'	-	-	-	-	2	-	4
" " " 'E'	-	-	-	-	2	-	4
" " " 'F'	-	-	-	-	4	-	8
" Common Dummy	-	-	-	28	36	-	-
" Deep "	-	-	-	2	2	-	-
" Insulated "	-	-	-	2	2	-	-
" Special "	2	2	2	8	8	8	8
* HEADLOCKS for Chair Bolts	2	2	2	8	8	8	8
RAIL ANCHORS	70	80	82	-	-	-	-
BOLTS, Chair, 6¾" Mark 'C'	18	20	20	40	48	72	88
" Guard Rail 6⅞" " 'G'	4	4	4	8	8	8	8
" " " 8¼" " "	4	4	4	8	8	8	8
WASHERS, Spring, 1" dia. Type 1944	66	68	68	116	128	144	168
" Flat	8	8	8	16	16	28	28
PINS, Mark 'P'	46	46	58	24	8	40	8
DOGSPIKES, 7" for Dummy Chairs	-	-	-	56	72	-	-
" 9" for Deep Dummy Chairs	-	-	-	8	8	-	-
" 6" for Plates	330	340	400	120	140	140	160
" 5"	90	120	90	310	360	330	390
SPREADERS 1 & 2, with Bolts 1F3116	1 each	1 each	1 each	2 each	2 each	4 each	4 each
TIE PLATES	1	1	1	2 No.YS	2 No.YS	4 No.YD	4 No.YD
INSULATED JOINTS, Type 1939	2	2	2	4	4	4	4
SLEEPER PLATES, Flat for Insltd. Jnts. (1004 or 1005-T'outs) (2004 or 2005-Compds)	4	4	4	8	8	8	8
SLEEPER PLATES, Flat ⅝" (1001 or 1002)	116	128	144	8	24	8	24
" " 1" (2001 or 2002)	4	-	6	4	-	-	-
" " Packing ¼" (1009 or 1010)	-	-	-	9	10	18	20

* This item is required only when the hole for Special Dummy Chair Bolt is field drilled.

Note: - For details of Spreaders, see Table 14.037

" " Packing ¼"(1009 or 1010) | - | - | - | 9 | 10 | 18 | 20

* This item is required only when the hole for Special Dummy Chair Bolt is field drilled.

Note: - For details of Spreaders see Table 14.037

MATERIAL FOR 94 & 107 lb. LAYOUTS WITH C. I. CHAIRS WITH TIE PLATES

MATERIAL REQUIRED				Single		Double	
	7.52	8.7	9.73	7.52	8.7	7.52	8.7
LUG PLATES for Leads, Flat 1006	8	8	14	-	-	-	-
" " " " Step 2006	2	2	2	2	-	4	-
" " " " " 3006	2	2	2	2	-	4	-
" " " " " 4006	4	4	4	2	-	4	-
" " " " " 5006	4	4	4	2	-	4	-
GRADUATED CANT PLATES 'A'	6	6	6	8	8	8	8
" " " 'B'	6	6	6	8	8	8	8
" " " 'C'	6	6	6	8	8	8	8
SCREWS, Mark 'I'	14	14	14	36	36	48	48
" " 'R' or 'S'	38	42	42	76	92	152	184
" " 'L'	-	-	-	4	4	-	-
" " 'B'	-	-	-	-	-	4	4
FISHPLATES, Track, Pairs							
for 107 lb. Layouts	8	10	8	11	16	10	16
for 94 lb. Layouts	6	8	6	4	8	4	8
FISHBOLTS, for Track Plates							
1"x5" for 107 lb. Layouts	32	40	32	44	64	40	64
1"x5⅝" for 94 lb. Layouts	24	32	24	16	32	16	32
FISHPLATES, Crossing, Pairs							
for 107 lb. Layouts	2	-	2	4	-	4	-
for 94 lb. Layouts	4	2	4	11	8	10	8
FISHBOLTS for Crossing Plates							
1"x5" for 107 lb. Layouts	8	-	8	16	-	16	-
1"x5" for 94 lb. Layouts	16	8	16	44	32	40	32
Where depressed timbers are required by the Signal Division the following quantities are extra, and are for each extra depressed timber ahead of each set of points.							
CHAIRS, Special Dummy	2	2	2	8	8	8	8
BOLTS, Chair, 6¾" Mark 'C'	2	2	2	8	8	8	8
WASHERS, Spring, 1" dia. Type 1944	2	2	2	8	8	8	8
HEADLOCKS for Chair Bolts	2	2	2	8	8	8	8
SCREWS, Mark 'I'	4	4	4	16	16	16	16
For each extra depressed timber delete following from above Schedule.							
SLEEPER PLATES, Flat ⅝"(1001 or 1002)	2	2	2	8	8	8	8

MATERIAL FOR 94 & 107 LB. LAYOUTS WITH C. I. CHAIRS WITHOUT TIE PLATES

MATERIAL REQUIRED	STANDARD TURNOUTS			COMPOUNDS			
				Single		Double	
	7.52	8.7	9.73	7.52	8.7	7.52	8.7
POINTS and CROSSINGS		See additional Table 20.43					
GUARD RAILS, 11'3", with Blocks, Pairs	1	1	1	2	2	2	2
CHAIRS, Common & Heel Slide	16	18	18	26	24	48	44
" " Toe	-	-	-	-	-	4	4
" Special Mark 'A'	-	-	-	6	4	12	8
" " " 'B'	-	-	-	-	2	-	4
" " " 'C'	-	-	-	-	2	-	4
" " " 'D'	-	-	-	-	2	-	4
" " " 'E'	-	-	-	-	2	-	4
" " " 'F'	-	-	-	-	4	-	8
" Common Dummy	-	-	-	32	40	-	-
" Special "	2	2	2	8	8	8	8
✳ HEADLOCKS for Chair Bolts	2	2	2	8	8	8	8
RAIL ANCHORS	70	80	82	-	-	-	-
BOLTS, Chair, 6¾" Mark 'C'	18	20	20	40	48	72	88
" Guard Rail 6⅞" " 'G'	4	4	4	8	8	8	8
" " " 8¼" " "	4	4	4	8	8	8	8
WASHERS, Spring, 1" dia. Type 1944	66	68	68	116	128	144	168
PINS, Mark 'P'	32	40	40	16	-	32	-
DOGSPIKES, 7" for Dummy Chairs	-	-	-	64	80	-	-
" 6" for Plates	60	60	60	120	140	140	160
" 5"	360	400	430	310	360	330	390
SPREADERS 1 & 2, with Bolts 1F3116	1 each	1 each	1 each	2 each	2 each	4 each	4 each
INSULATED JOINTS, Type 1939	2	2	2	4	4	4	4
SLEEPER PLATES, Flat for Insltd. Jnts. (1004 or 1005-T'outs) (2004 or 2005-Compds)	4	4	4	8	8	8	8
SLEEPER PLATES, Flat ⅝" (1001 or 1002)	4	4	4	8	24	8	24
" " " 1" (2001 or 2002)	-	-	-	4	-	-	-
" " Packing ¼" (1009 or 1010)	-	-	-	9	10	18	20

✳ This item is required only when the hole for Special Dummy Chair Bolt is field drilled.

Note: - For details of Spreaders see Table 14.037.

Continued on 20.36

RS

MATERIAL FOR 94 & 107 lb. LAYOUTS WITH C. I. CHAIRS WITHOUT TIE PLATES

MATERIAL REQUIRED	STANDARD TURNOUTS 7.52	8.7	9.73	Single 7.52	Single 8.7	Double 7.52	Double 8.7
LUG PLATES for Leads, Flat 1006	4	8	8	-	-	-	-
" " " Step 2006	2	2	2	2	-	4	-
" " " " 3006	2	2	2	2	-	4	-
" " " " 4006	4	4	4	2	-	4	-
" " " " 5006	4	4	4	2	-	4	-
GRADUATED CANT PLATES 'A'	6	6	6	8	8	8	8
" " " 'B'	6	6	6	8	8	8	8
" " " 'C'	6	6	6	8	8	8	8
SCREWS, Mark 'I'	6	6	6	20	20	24	24
" " 'R' or 'S'	46	50	50	92	108	176	208
" " 'B'	-	-	-	-	-	4	4
FISHPLATES, Track, Pairs							
for 107 lb. Layouts	8	10	8	11	16	10	16
for 94 lb. Layouts	6	8	6	4	8	4	8
FISHBOLTS for Track Plates							
1"x 5" for 107 lb. Layouts	32	40	32	44	64	40	64
1"x 5⅜" for 94 lb. Layouts	24	32	24	16	32	16	32
FISHPLATES, Crossing, Pairs							
for 107 lb. Layouts	2	-	2	4	-	4	-
for 94 lb. Layouts	4	2	4	11	8	10	8
FISHBOLTS for Crossing Plates							
1"x 5" for 107 lb. Layouts	8	-	8	16	-	16	-
1"x 5" for 94 lb. Layouts	16	8	16	44	32	40	32
Where depressed timbers are required by the Signal Division the following quantities are extra, and are for each extra depressed timber ahead of each set of points.							
CHAIRS, Special Dummy	2	2	2	8	8	8	8
BOLTS, Chair, 6¾" Mark 'C'	2	2	2	8	8	8	8
WASHERS, Spring, 1" dia. Type 1944	2	2	2	8	8	8	8
HEADLOCKS for Chair Bolts	2	2	2	8	8	8	8
SCREWS, Mark 'I'	4	4	4	16	16	16	16

Special Dummy Chair Bolt is field drilled.

Note: - For details of Spreaders see Table 14.037.

Continued on 20.36

MATERIAL FOR 94 & 107 LB. LAYOUTS WITH M.S. CHAIRS WITH TIE PLATES

MATERIAL REQUIRED	STANDARD TURNOUTS			COMPOUNDS Single		COMPOUNDS Double	
	7.52	8.7	9.73	7.52	8.7	7.52	8.7
POINTS and CROSSINGS		See	additional		Table	20.43	
GUARD RAILS, 11'3", with Blocks, Pairs	1	1	1	2	2	2	2
CHAIRS M. S. 1039	14	16	16	20	20	40	40
" " 1040	2	2	2	4	4	8	8
" " 1069	-	-	-	6	4	12	8
" " 2069	-	-	-	-	2	-	4
" " 3069	-	-	-	-	2	-	4
" " 4069	-	-	-	-	2	-	4
" " 5069	-	-	-	-	2	-	4
" " 6069	-	-	-	2	4	4	8
RAIL ANCHORS	70	80	82	-	-	-	-
BOLTS, Chair, $2\frac{7}{8}$" Mark 'C'	18	20	20	38	46	72	88
" Guard Rail $6\frac{7}{8}$" Mark 'G'	4	4	4	8	8	8	8
" " " $8\frac{1}{4}$" " "	4	4	4	8	8	8	8
WASHERS, Spring, 1" dia. Type 1944	66	68	68	114	126	144	168
" Flat 1" dia.	4	4	4	12	12	16	16
PINS, Mark 'P'	48	48	60	28	12	48	16
DOGSPIKES, 6" for Plates	330	340	400	120	140	140	160
" 5"	90	120	90	380	440	330	390
SPREADERS 1 & 2, with Bolts 1F3116	1 each	1 each	1 each	2 each	2 each	4 each	4 each
C. S. BRACE 1048	2	2	2	6	6	8	8
TIE PLATE UNIT 1047	2	2	2	2	-	4	-
" " " 1049	-	-	-	2	2	4	4
" " " 1050	-	-	-	-	2	-	4
" " " 1056	-	-	-	2	2	-	-
" " " 2049	-	-	-	2	2	-	-
BOLT, PLATE & SHIM Assembly	1	1	1	4	4	4	4
TAKE-UP BUTTON 1067	-	-	-	4	4	-	-

Note: - For details of Spreaders see Table 14.037

Continued on 20.38

MATERIAL FOR 94 & 107 lb. LAYOUTS WITH M. S. CHAIRS WITH TIE PLATES

Note: - For details of Spreaders see Table 14.037

Continued on 20.38

MATERIAL REQUIRED	STANDARD TURNOUTS			Single		Double	
	7.52	8.7	9.73	7.52	8.7	7.52	8.7
INSULATED JOINTS, Type 1939	2	2	2	4	4	4	4
SLEEPER PLATES, Flat, for Insltd. Jnts. (1004 or 1005 - T'outs) (2004 or 2005 - Compds)	4	4	4	8	8	8	8
SLEEPER PLATES, Flat $\frac{5}{8}$" (1001 or 1002)	116	128	144	-	-	-	-
" " " 1" (2001 or 2002)	4	-	6	44	64	8	24
" " Packing $\frac{1}{4}$" (1009 or 1010)	-	-	-	9	10	18	20
LUG PLATES for Leads, Flat 1006	8	8	14	-	-	-	-
" " Step 2006	2	2	2	2	-	4	-
" " " 3006	2	2	2	2	-	4	-
" " " 4006	4	4	4	2	-	4	-
" " " 5006	4	4	4	2	-	4	-
GRADUATED CANT PLATES 'A'	6	6	6	8	8	8	8
" " " 'B'	6	6	6	8	8	8	8
" " " 'C'	6	6	6	8	8	8	8
SCREWS, Mark 'R'	48	52	52	108	120	196	220
FISHPLATES, Track Pairs							
for 107 lb. Layouts	8	10	8	11	16	10	16
for 94 lb. Layouts	6	8	6	4	8	4	8
FISHBOLTS, for Track Plates							
1"x5" for 107 lb. Layouts	32	40	32	44	64	40	64
1"x5$\frac{3}{8}$" for 94 lb. Layouts	24	32	24	16	32	16	32
FISHPLATES, Crossing, Pairs							
for 107 lb. Layouts	2	-	2	4	-	4	-
for 94 lb. Layouts	4	2	4	11	8	10	8
FISHBOLTS for Crossing Plates							
1"x5" for 107 lb. Layouts	8	-	8	16	-	16	-
1"x5" for 94 lb. Layouts	16	8	16	44	32	40	32
Where depressed timbers are required by the Signal Division, the following additions and deletions should be made.							
Additional Plates							
SLEEPER PLATES, Flat 1" (2001 or 2002)	4	4	4	-	-	-	-
Delete following from above Schedule.							
SLEEPER PLATES, Flat $\frac{5}{8}$" (1001 or 1002)	4	4	4	-	-	-	-

MATERIAL FOR 94 & 107 LB. LAYOUTS WITH M. S. CHAIRS WITHOUT TIE PLATES.

MATERIAL REQUIRED	STANDARD TURNOUTS			COMPOUNDS Single		COMPOUNDS Double	
	7.52	8.7	9.73	7.52	8.7	7.52	8.7
POINTS and CROSSINGS		See additional Table 20.43					
GUARD RAILS, 11'3", with blocks, Pairs	1	1	1	2	2	2	2
CHAIRS M.S. 1039	16	18	18	24	24	44	48
" " 2039	-	-	-	-	-	4	-
" " 1040	2	2	2	4	4	8	8
" " 1069	-	-	-	6	4	12	8
" " 2069	-	-	-	-	2	-	4
" " 3069	-	-	-	-	2	-	4
" " 4069	-	-	-	-	2	-	4
" " 5069	-	-	-	-	2	-	4
" " 6069	-	-	-	2	4	4	8
RAIL ANCHORS	70	80	82	-	-	-	-
BOLTS, Chair, $2\frac{7}{8}$" Mark 'C'	18	20	20	36	44	72	88
" Guard Rail, $6\frac{7}{8}$" Mark 'G'	4	4	4	8	8	8	8
" " " $8\frac{1}{4}$" " "	4	4	4	8	8	8	8
WASHERS, Spring, 1" dia. Type 1944	66	68	68	112	124	144	168
PINS, Mark 'P'	32	40	40	16	-	32	-
DOGSPIKES, 6" for Plates	60	60	60	500	580	470	550
" 5"	360	400	430	-	-	-	-
SPREADERS 1 & 2, with Bolts 1F3116	1 each	1 each	1 each	2 each	2 each	4 each	4 each
INSULATED JOINTS, Type 1939	2	2	2	4	4	4	4
SLEEPER PLATES, Flat, for Insltd. Jnts (1004 or 1005-T'outs) (2004 or 2005-Compds)	4	4	4	8	8	8	8
SLEEPER PLATES $\frac{5}{8}$" (1001 or 1002)	4	4	4	-	-	-	-
" " 1" (2001 or 2002)	-	-	-	48	68	8	24
" " Packing $\frac{1}{4}$" (1009 or 1010)	-	-	-	9	10	18	20

Note: - For details of Spreaders see Table 14.037

Continued on 20.40

" " Packing ¼"(1009 or 1010) | - | - | - | 9 | 10 | 18 | 20

Note: - For details of Spreaders see Table 14.037

Continued on 20.40

MATERIAL FOR 94 & 107 lb. LAYOUTS WITH M. S. CHAIRS WITHOUT TIE PLATES

MATERIAL REQUIRED				Single		Double	
	7.52	8.7	9.73	7.52	8.7	7.52	8.7
LUG PLATES for Leads, Flat 1006	4	8	8	-	-	-	-
" " Step 2006	2	2	2	2	-	4	-
" " " 3006	2	2	2	2	-	4	-
" " " 4006	4	4	4	2	-	4	-
" " " 5006	4	4	4	2	-	4	-
GRADUATED CANT PLATES, 'A'	6	6	6	8	8	8	8
" " " 'B'	6	6	6	8	8	8	8
" " " 'C'	6	6	6	8	8	8	8
SCREWS, Mark 'R'	52	56	56	104	116	204	232
FISHPLATES, Track, Pairs							
for 107 lb. Layouts	8	10	8	11	16	10	16
for 94 lb. Layouts	6	8	6	4	8	4	8
FISHBOLTS for Track Plates							
1"x5" for 107 lb. Layouts	32	40	32	44	64	40	64
1"x5⅜" for 94 lb. Layouts	24	32	24	16	32	16	32
FISHPLATES, Crossing, Pairs							
for 107 lb. Layouts	2	-	2	4	-	4	-
for 94 lb. Layouts	4	2	4	11	8	10	8
FISHBOLTS for Crossing Plates							
1"x5" for 107 lb. Layouts	8	-	8	16	-	16	-
1"x5" for 94 lb. Layouts	16	8	16	44	32	40	32
Where depressed timbers are required by the Signal Division, the following additions and deletions should be made.							
Additional Plates - SLEEPER PLATES, Flat, 1" (2001 or 2002)	4	4	4	-	-	-	-

MATERIAL FOR 94 & 107 LB. TURNOUTS WITH 22'6" SWITCHES M.S. CHAIRS. WITH AND WITHOUT TIE PLATES

MATERIAL REQUIRED	TURNOUTS WITH 22'6" SWITCHES			
	WITH TIE PLATES		WITHOUT TIE PLATES	
	8.7	9.73	8.7	9.73
POINTS and CROSSINGS	See additional Table 20.43			
GUARD RAILS, 11'3", with Blocks, Pairs	1	1	1	1
CHAIRS M. S. 1039	22	22	24	24
" 1040	2	2	2	2
RAIL ANCHORS	80	82	80	82
BOLTS, Chair, Mark 'C', $2\frac{7}{8}$"	26	26	26	26
" Guard Rail, Mark 'G', $6\frac{7}{8}$"	4	4	4	4
" " " " $8\frac{1}{4}$"	4	4	4	4
WASHERS, Spring, 1" dia. Type 1944	74	74	74	74
" Flat 1" dia.	4	4	-	-
PINS, Mark 'P'	56	68	48	48
DOGSPIKES, 6", for Plates	360	430	70	70
" 5"	120	90	410	450
SPREADERS 1, 2, & 3, with Bolts 1F3116	1 each	1 each	1 each	1 each
C. S. BRACE 1048	2	2	-	-
TIE PLATE UNIT 1047	2	2	-	-
BOLT, PLATE & SHIM Assembly	1	1	-	-
INSULATED JOINTS, Type 1939	2	2	2	2
SLEEPER PLATES, Flat, for Insulated Jnts $\frac{5}{8}$" (1004 or 1005)	4	4	4	4
" " " $\frac{5}{8}$" (1001 or 1002)	132	152	4	12
" " " 1" (2001 or 2002)	-	6	-	-
LUG PLATES for Leads, Flat 1006	8	14	8	8
" " " Step 2006	4	4	4	4
" " " " 3006	4	4	4	4
" " " " 4006	4	4	4	4
" " " " 5006	4	4	4	4

Note: - For details of Spreaders see Table 14.037

Continued on 20.42.

MATERIAL. REQUIRED	TURNOUTS WITH 22'6" SWITCHES	
	WITH TIE PLATES	WITHOUT TIE PLATES

MATERIAL FOR 94 & 107 lb. TURNOUTS WITH 22'6" SWITCHES, M. S. CHAIRS. WITH AND WITHOUT TIE PLATES

Note: - For details of Spreaders see Table 14.037

Continued on 20.42.

MATERIAL. REQUIRED	TURNOUTS WITH 22'6" SWITCHES			
	WITH TIE PLATES		WITHOUT TIE PLATES	
	8.7	9.73	8.7	9.73
GRADUATED CANT PLATES 'A'	6	6	6	6
" " " 'B'	6	6	6	6
" " " 'C'	6	6	6	6
SCREWS, Mark 'R'	66	66	70	70
FISHPLATES, Track Pairs				
for 107 lb. Turnouts	10	8	10	8
for 94 lb. Turnouts	8	6	8	6
FISHBOLTS, for Track Plates				
1"x5" for 107 lb. Turnouts	40	32	40	32
1"x5$\frac{3}{8}$" for 94 lb. Turnouts	32	24	32	24
FISHPLATES, Crossing, Pairs				
for 107 lb. Turnouts	-	2	-	2
for 94 lb. Turnouts	2	4	2	4
FISHBOLTS, for Crossing Plates				
1"x5" for 107 lb. Turnouts	-	8	-	8
1"x5" for 94 lb. Turnouts	8	16	8	16
Where depressed timbers are required by the Signal Division, the following additions and deletions should be made.				
Additional Plates				
SLEEPER PLATES, Flat, 1" (2001 or 2002)	4	4	4	4
Delete following from above Schedule				
SLEEPER PLATES, Flat, $\frac{5}{8}$" (1001 or 1002)	4	4	-	-

POINTS AND CROSSINGS FOR 94 & 107 lb. LAYOUTS

STANDARD TURNOUTS

MATERIAL	NO. 7.52	NO. 8.7	NO. 9.73
POINTS, L or R.H	1 set 15'0"	1 set 16'6"	1 set 16'6"
'V' CROSSINGS	1 No. 7.52	1 No. 8.7	1 No. 9.73

STANDARD TURNOUTS WITH 22'6" SWITCHES

MATERIAL	NO. 8.7	NO. 9.73
POINTS, L. or R.H	1 set 22'6"	1 set 22'6"
'V' CROSSINGS	1 No. 8.7	1 No. 9.73

COMPOUNDS

MATERIAL	Single		Double	
	No. 7.52	No. 8.7	No. 7.52	No. 8.7
POINTS				
15'0" Y.S., L.H.	1	-	1	-
" " R.H.	1	-	1	-
" Y.D., L.H.	-	-	1	-
" " R.H.	-	-	1	-
19'0" Y.S., L.H.	-	1	-	1
" " R.H.	-	1	-	1
" Y.D., L.H.	-	-	-	1
" " R.H.	-	-	-	1
'V' CROSSINGS	2 No. 7.52A	2 No. 8.7A	2 No. 7.52A	2 No. 8.7A
'K' CROSSINGS	2 No. 7.52A	2 No. 8.7A	2 No. 7.52A	2 No. 8.7A

WEIGHTS OF PERMANENT WAY MATERIALS

RAILS

NOMINAL WEIGHT PER YARD LBS	TYPE	ACTUAL WEIGHT PER YARD LBS	WEIGHT PER MILE OF SINGLE TRACK TONS
50	B	50.12	78.760
60	C	60.19	94.584
60	D.1889,1881	60.53	95.119
60	D.1893	60.20	94.600
60	N	60.06	94.380
60	A. S.	60.22	94.631
60	N.S.W.	59.67	93.767
66	E	66.91	105.144
66	F	65.48	102.897
72	J	73.73	115.861
75	G	76.55	120.293
75	H.1885	75.12	118.046
75	H.1888	75.58	118.769
75	L	74.62	117.260
75	I	74.87	117.653
80	K.1879,1882	81.95	128.779
80	O	80.28	126.154
80	A.S.	80.30	126.186
90	A.S.	91.20	143.314
94	A.S.	93.74	147.306
100	P	100.38	157.740
100	A.S.	100.48	157.897
100	B.S.	99.95	157.064
100	M	97.61	153.387
107	A.S.	106.72	167.703
110	A.S.	110.29	173.313
90	B.S. Tram	90.57	142.324
92	Tram	92.38	145.169
96	B.S. Tram	96.40	151.486
102	B.S. Tram	102.06	160.380

Note: - For identification of Rails see 9.20-9.25.

Tons of rail per mile of single track =

$$\text{actual weight of rail per yard} \times \frac{11}{7}$$

An allowance should be made for loss of weight resulting from wear in old rails.

WEIGHTS OF PERMANENT WAY MATERIALS

FISHPLATES

TYPE & YEAR OF FISHPLATE	WEIGHT PER PAIR LBS	NO OF PAIRS PER TON	TYPE & YEAR OF FISHPLATE	WEIGHT PER PAIR LBS	NO OF PAIRS PER TON
50 A	14.83	151	80 A.S-NSW 1919	62.98	36
50 B 1873	14.88	151	80 A.S. 1915	77.13	29
57 Stock "	"	"	" 1921	76.10	"
60 C 1879	14.54	154	80/90 A.S.		
70 Stock "	"	"	1925,28,35	67.89	33
60 D 1881	20.93	107	94 A.S. 1937	"	"
" 1889	23.33	96	" 1939	39.45	57
" 1893	25.58	88	* 100 P 1897	107.65	21
* 60 N 1901	58.22	38	* " "	96.80	23
* " "	53.34	42	115 Stock "	57.07	39
60 A.S. 1919	53.76	42	100 A.S. 1915	99.92	22
" 1921	59.75	37	" 1921	96.90	23
" 1925	60.94	37	" 1923	125.50	18
60 Sec.602 1919	39.90	56	" B.S. 1924	83.02	27
61 S.A. 1879	28.32	79	" M. 1889	46.32	48
66 E.1879 Light	20.99	107	107 A.S. 1937	52.59	43
" " Heavy	23.33	96	100/110 A.S.		
78 Stock "	"	"	1925,28	78.79	28
66 F 1886	23.33	"	60 A.S.Flat 4 hole	23.32	96
72 J	21.44	104	60 " " 6 "	34.98	64
75 H 1885	32.62	69	80 O Flat	43.14	52
" 1886	27.82	81	80 A.S. "	43.62	51
86 Stock 1885	24.89	90	90 A.S. "	36.25	62
75 H & I 1929	52.34	43	100 P "	57.0	39
75 I 1881	21.44	104	100 A.S. "	57.45	39
75 G	21.09	106	110 A.S. "	40.85	55
75 L 1879	18.28	123	90 B.S. Tram	50.0	45
80 K "	23.96	93	92 "	70.04	32
* 80 O 1897	83.68	27	96 "	50.0	45
* " "	75.69	30			
95 Stock "	43.08	52	102 "	58.72	38

Note: - For identification of fishplates see 10.12 - 10.15.
* For alternative sections see 10.28.Fig.27

WEIGHTS OF PERMANENT WAY MATERIALS

STANDARD FISHBOLTS

LENGTH	DIA.	HEAD	NECK	NUT	LB/EA.	NO PER.CWT	NO PER.TON
6¾"	1"	Hex.	Round	Hex.	2.69	42	835
6"	1"	"	"	"	2.52	44	890
5⅜"	1"	Cup	Oval	"	2.04	55	1100
5"	1"	"	"	"	1.92	58	1170
4½"	1"	"	"	"	1.81	62	1240
4¾"	1"	Square	Round	"	2.30	49	975
4½"	1"	Cup	Nib	"	1.80	62	1240
4¼"	1"	Square	Round	"	2.26	50	990
4⅛"	1"	Cup	Square	"	1.83	61	1220
3¾"	1"	"	Oval	"	1.64	68	1370
4¼"	⅞"	"	"	"	1.36	82	1650
4⅛"	⅞"	"	Nib	"	1.14	98	1960
4"	⅞"	"	Square	Square	1.35	83	1660
3¾"	⅞"	Square	Round	"	1.52	74	1470
3¾"	⅞"	Cup	Oval	Hex.	1.27	88	1760
3⅝"	⅞"	Square	Round	Square	1.50	75	1490
4"	¾"	Cup	Oval	Hex.	.96	117	2330
3¾"	¾"	"	Nib	Square	.93	120	2410
3⅝"	¾"	"	Oval	Hex.	.90	124	2490

WEIGHTS OF PERMANENT WAY MATERIALS

DOGSPIKES

TYPE	LBS. EACH	NO.PER.CWT	NO.PER.TON
$4\frac{1}{2}$" x $\frac{5}{8}$"	.58	193	3860
5" x $\frac{3}{4}$"	1.00	112	2240
6" x $\frac{3}{4}$"	1.16	97	1930
7" x $\frac{3}{4}$"	1.33	84	1680
9" x $\frac{3}{4}$"	1.58	71	1420

SPRING WASHERS

TYPE	LBS. EACH	NO.PER.CWT	NO.PER. TON
13/16"x$\frac{3}{8}$"x$\frac{1}{4}$"for $\frac{3}{4}$" fishbolts	.093	1205	24090
15/16"x$\frac{3}{8}$"x$\frac{1}{4}$"for $\frac{7}{8}$" fishbolts	.103	1090	21750
1.1/16"x$\frac{3}{8}$"x$\frac{3}{8}$"for 1" fishbolts	.164	685	13660
Type 1944	.120	935	18670

SLEEPER PLATES AUSTRALIAN STANDARD

TYPE	LBS. EACH	NO.PER.CWT	NO.PER.TON
Single Shoulder 80,90,94lb	8.75	13	256
" " 100,107,110lb	10.5	11	213
Double Shoulder 80,90,94lb	12	9	187
" " 100,107,110lb	13	9	172

'FAIR' RAIL ANCHORS

TYPE	LBS. EACH	NO.PER.CWT	NO.PER.TON
75 lb. (reconditioned 80 lb)	2.54	44	880
80 lb.	2.54	44	880
90 lb.	2.50	45	900
94 lb.	2.58	43	870
100 lb.	2.74	41	820
107 lb.	2.80	40	800
110 lb.	2.75	41	815

WEIGHTS OF PERMANENT WAY MATERIALS.

S L E E P E R S

Type of Timber	9'0" x 9" x $4\frac{1}{2}$"		9'0" x 10" x 5"	
	Approx. Weight Each. Lbs.	No. Per Ton	Approx. Weight Each. lbs.	No. Per Ton
Grey Box ..	177	13	219	10
Coast Grey Box ..	175	"	216	"
Mountain Grey Gum .	167	"	206	11
Red Ironbark ..	"	"	"	"
Yellow Box ..	165	14	203	"
Red Box ..	162	"	200	"
Yellow Gum ..	"	"	"	"
Red Gum ..	154	15	191	12
Yertchuck ..	149	"	184	"
Mahogany ..	144	16	178	13
Blue Gum ..	142	"	175	"
River Red Gum ..	"	"	"	"
Brown Stringybark..	"	"	"	"
Red Stringybark ..	139	"	172	"
Yellow Stringybark	"	"	"	"
Silver Top Ash ..	134	17	166	14
White Stringybark..	132	"	163	"
Manna Gum ..	129	"	159	"
Messmate ..	119	19	147	15

BALLAST

CLASS OF BALLAST	TONS PER CUBIC YARD	CUBIC YARDS PER TON
Gravel ..	1.3	.77
Sand ..	1.08	.93
Metal $1\frac{1}{2}$", $2\frac{1}{2}$" & Screenings.	1.1	.91
Earth ..	1.0	1.0
Spalls ..	1.06	.94
Scoria ..	.7	1.43
Ashes ..	.6	1.67

SLEEPERS PER MILE OF SINGLE TRACK				
RAIL LENGTH	NO. OF SLEEPERS PER RAIL LENGTH	NO. OF SLEEPERS PER MILE OF SGLE. TRACK.	CUBIC YARDS PER MILE OF TRACK	
			9'0"x10"x5"	9'0"x 9"x4½"
45'0"	18	2112	244.4	198
"	20	2347	271.6	220
"	21	2464	285.2	231
"	22	2581	298.7	242
"	23	2699	312.4	253
40'0"	16	2112	244.4	198
"	18	2376	275.0	222.8
"	19	2508	290.3	235.1
"	20	2640	305.6	247.5
31'9"	12	1996	231.0	187.1
"	14	2328	269.4	218.3
"	15	2494	288.7	233.8
"	16	2661	308.0	249.5
31'6"	12	2011	232.8	188.5
"	14	2347	271.6	220.0
"	15	2514	291.0	235.7
28'6"	13	2408	278.7	225.8
"	14	2594	300.2	243.2
23'0"	9	2066	239.1	193.7
"	10	2296	265.7	215.3
"	11	2525	292.2	236.7
22'6"	8	1877	217.2	176.0
"	9	2112	244.4	198.0
"	10	2347	271.6	220.0
"	11	2581	298.7	242.0

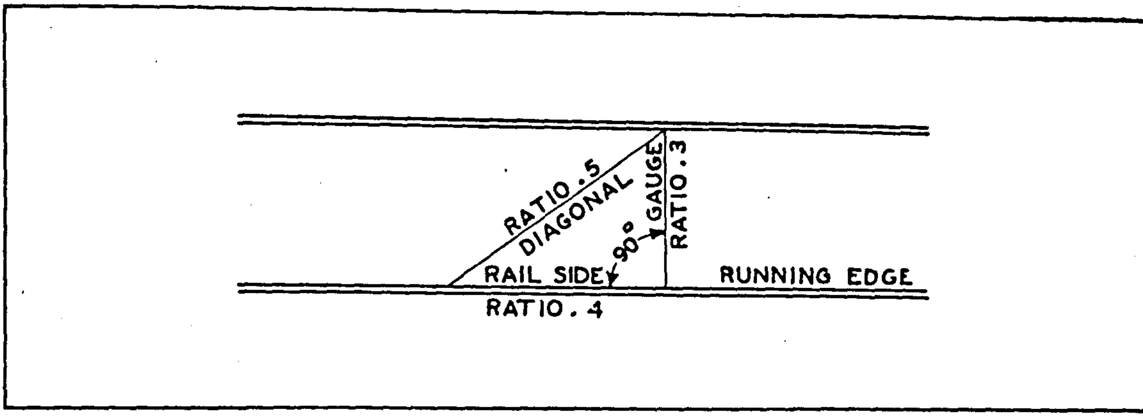


FIG. 1. RATIO OF DIAGONALS TO GAUGE.

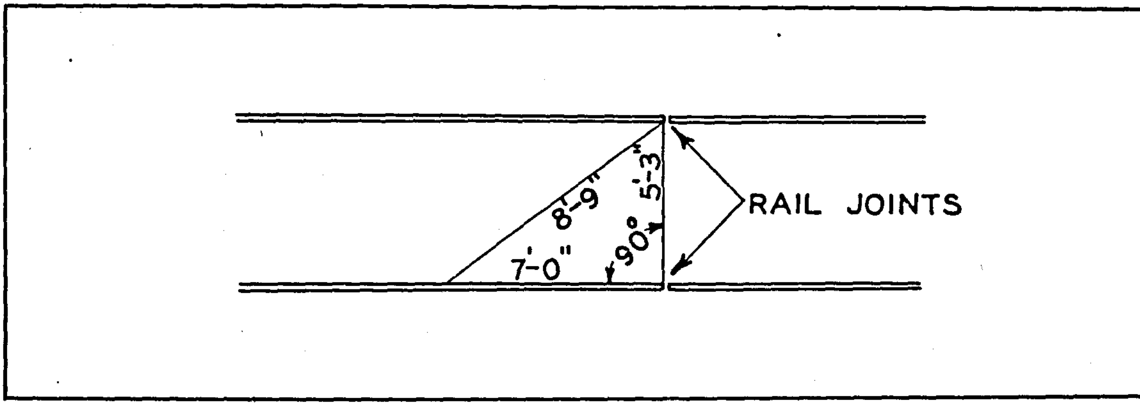


FIG. 2. LOCATING JOINT POSITIONS BY THE RIGHT ANGLE TRIANGLE METHOD.

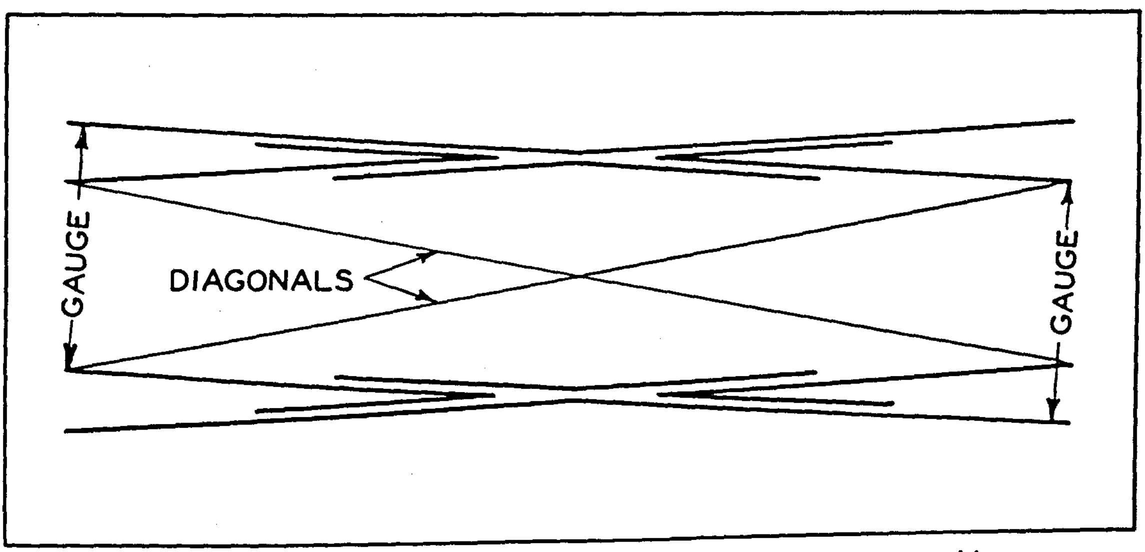


FIG. 3. LOCATING POSITION OF 'K' CROSSINGS BY DIAGONAL METHOD.

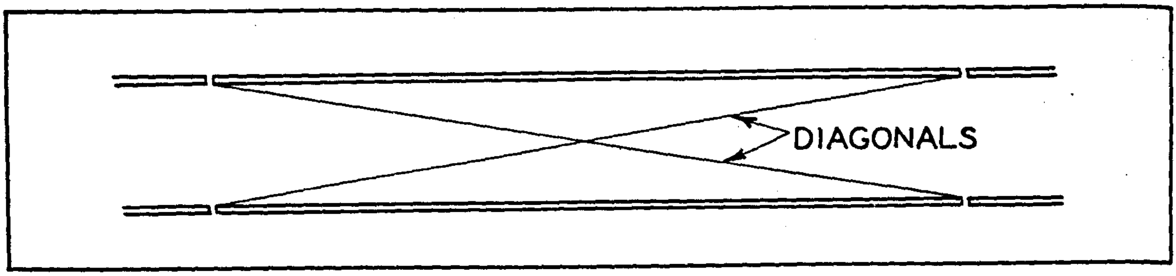


FIG. 4. LOCATING JOINT POSITIONS BY DIAGONAL METHOD.

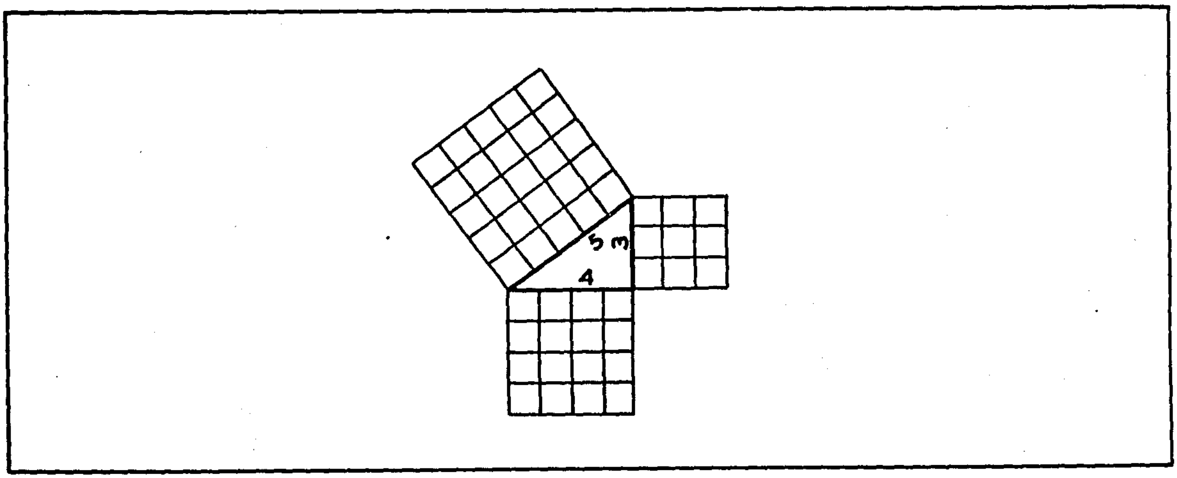


FIG. 5. ILLUSTRATING THE PROPERTIES OF THE RIGHT ANGLE TRIANGLE.

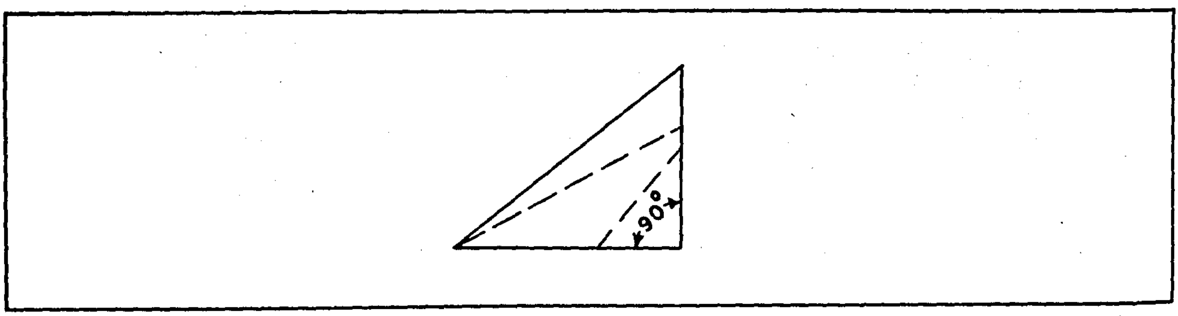


FIG. 6. ILLUSTRATING VARIOUS RIGHT ANGLE TRIANGLES.

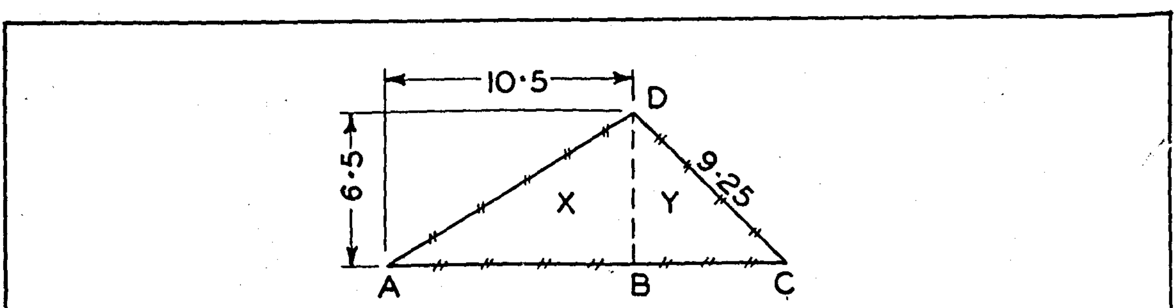


FIG. 7. FINDING THE UNKNOWN SIDES OF A TRIANGLE.

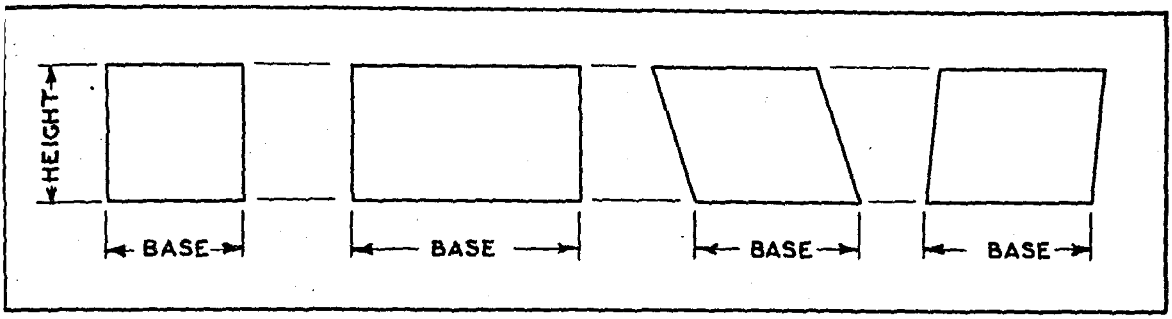


Fig. 8. Parallelograms.

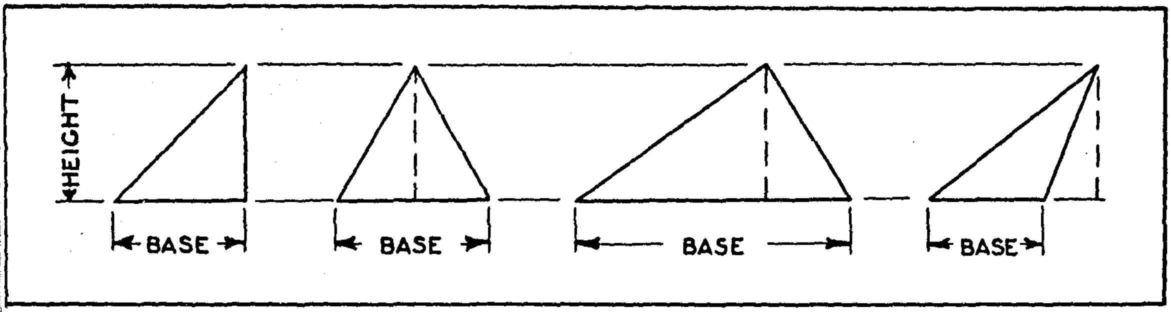


Fig. 9. Triangles.

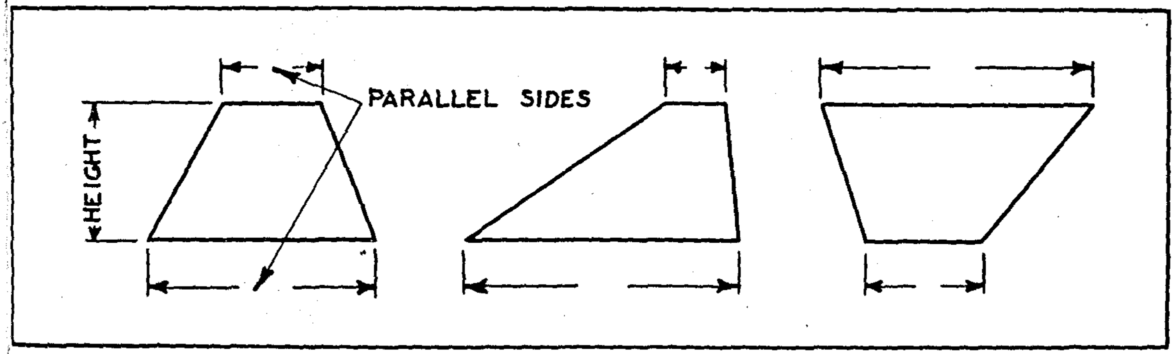


Fig. 10. Trapezoids.

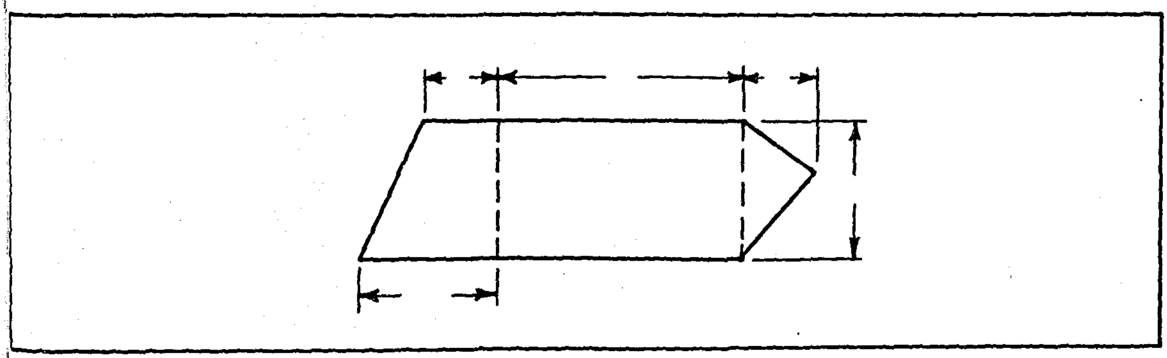


Fig. 11. Irregular Shapes Bounded by Straight Lines.

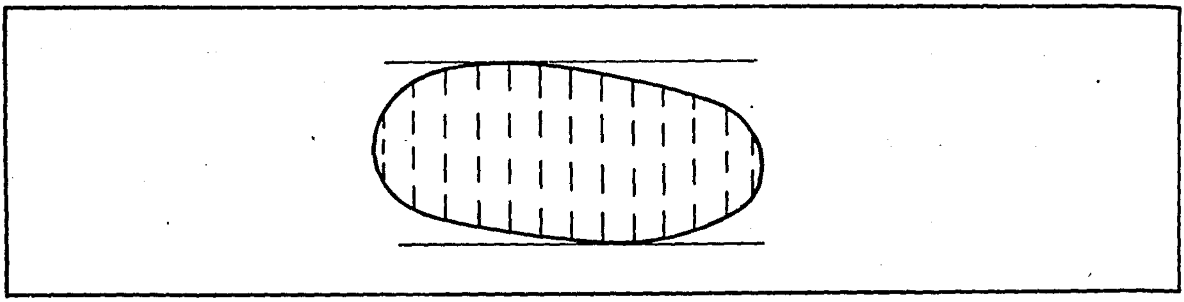


FIG. 12. IRREGULAR SHAPES BOUNDED BY CURVED LINES.

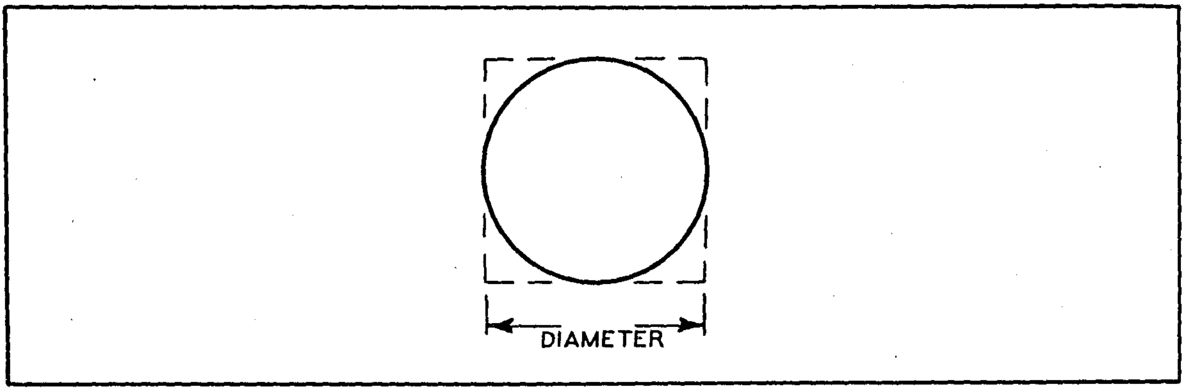


FIG. 13. THE CIRCLE.

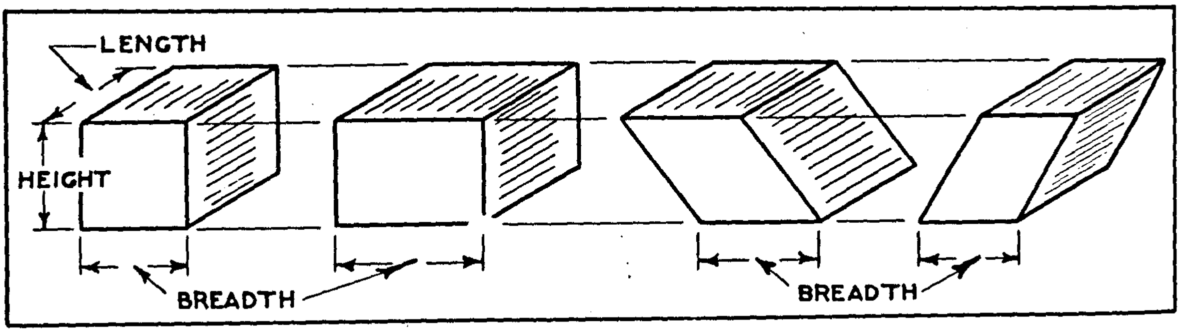


FIG. 14. PARALLELEPIPEDS.

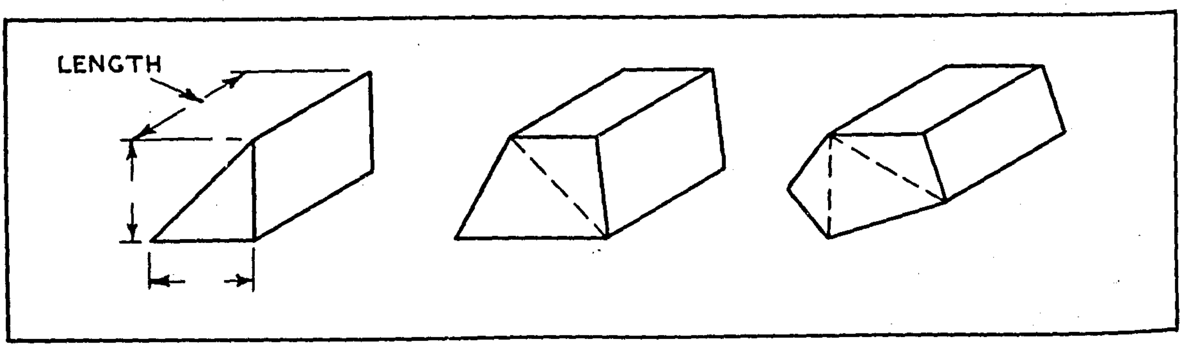


FIG. 15. PRISMS.

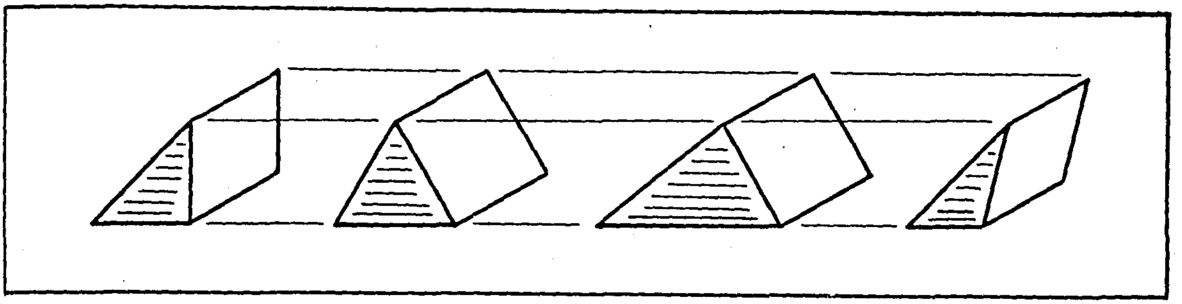


Fig. 16. Wedges.

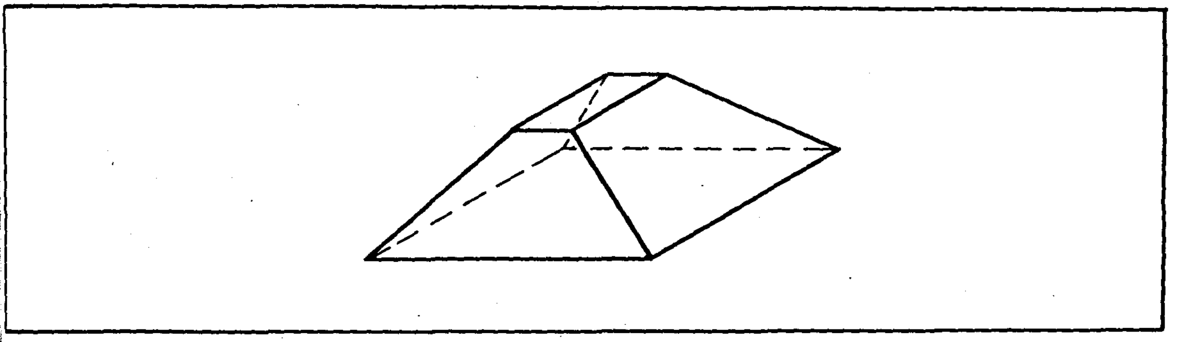


Fig. 17. The Prismoid.

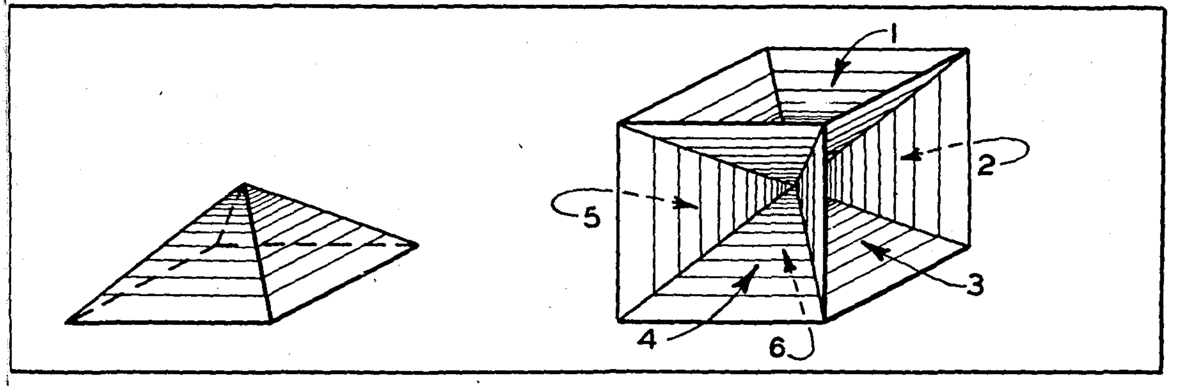


Fig. 18. The Pyramid.

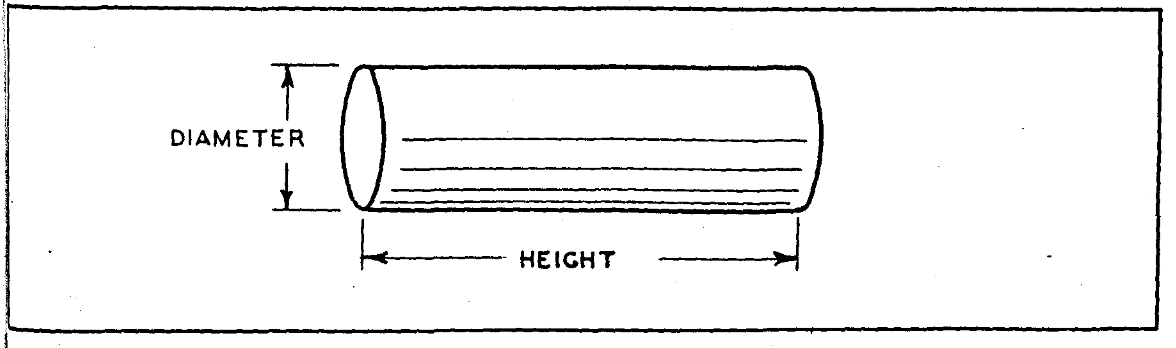


Fig. 19. The Cylinder.

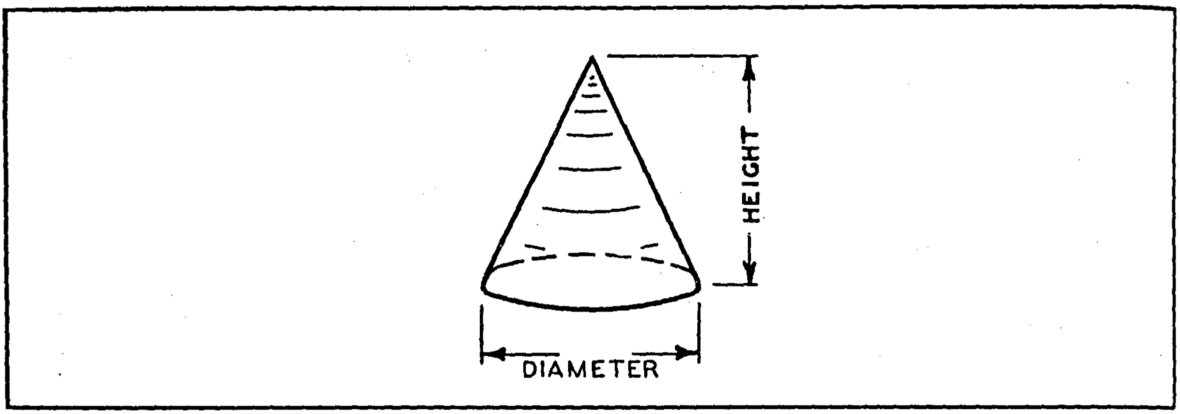


FIG. 20. THE CONE.

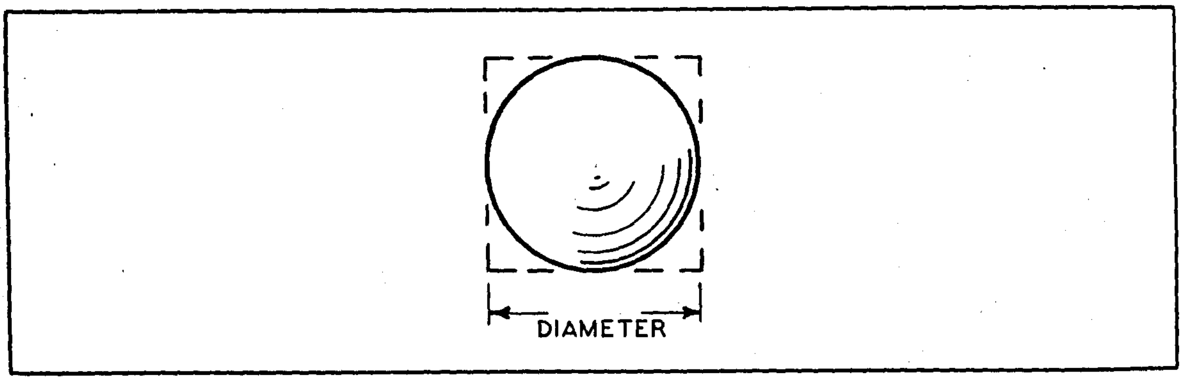


FIG. 21 . THE SPHERE

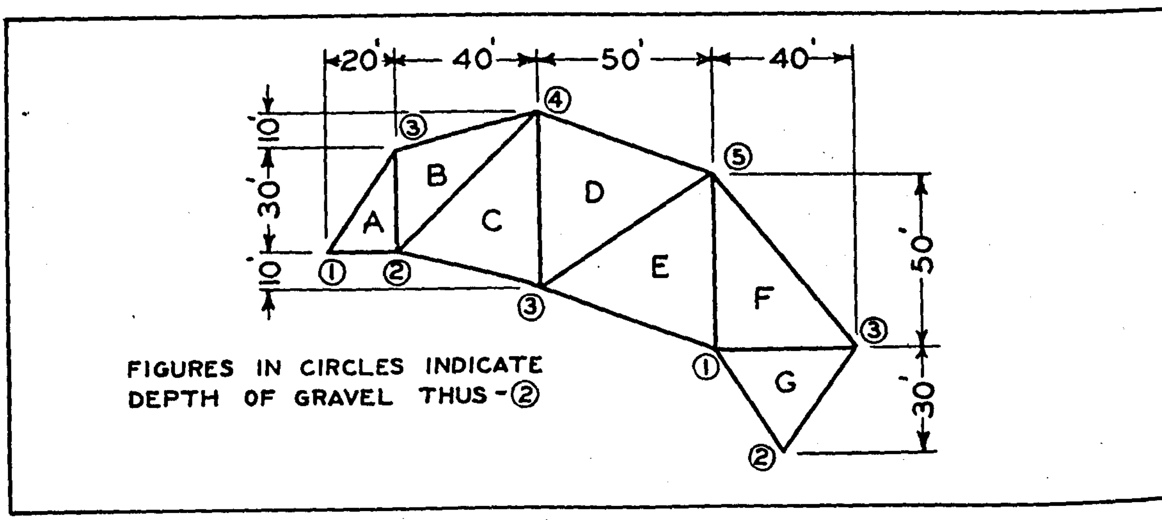


FIG. 22. EXAMPLE No. 2.

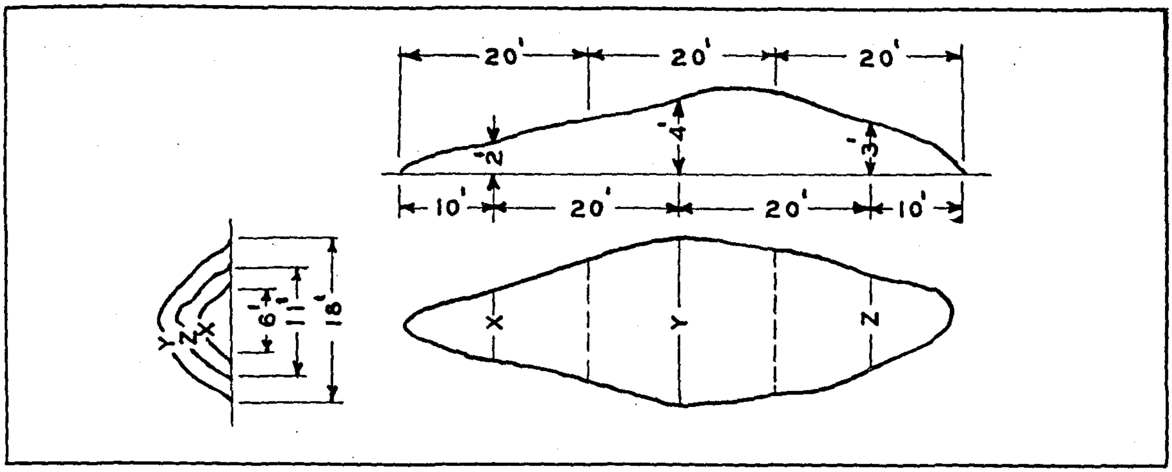


FIG. 23. EXAMPLE No. 3.

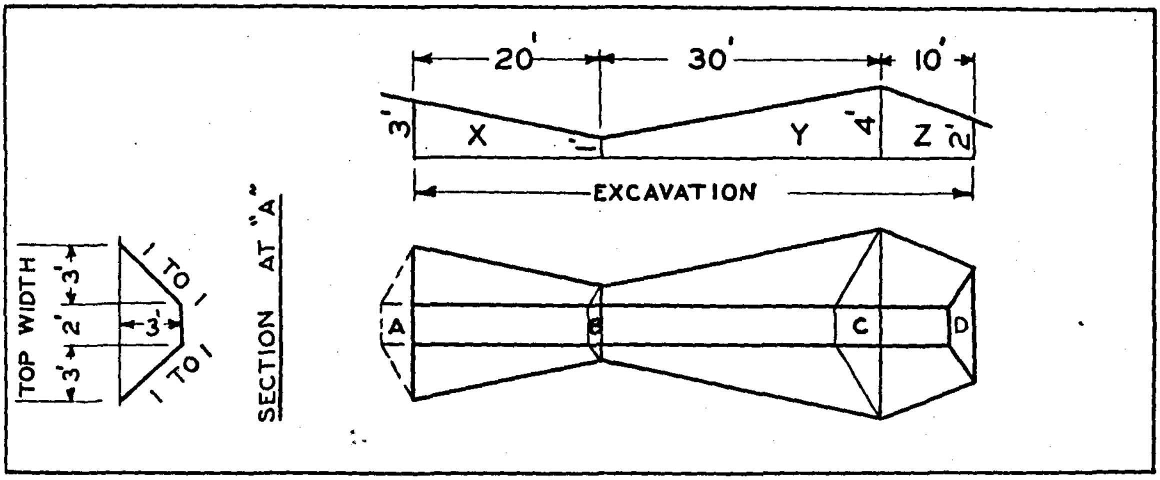


FIG. 24. EXAMPLE No. 4.

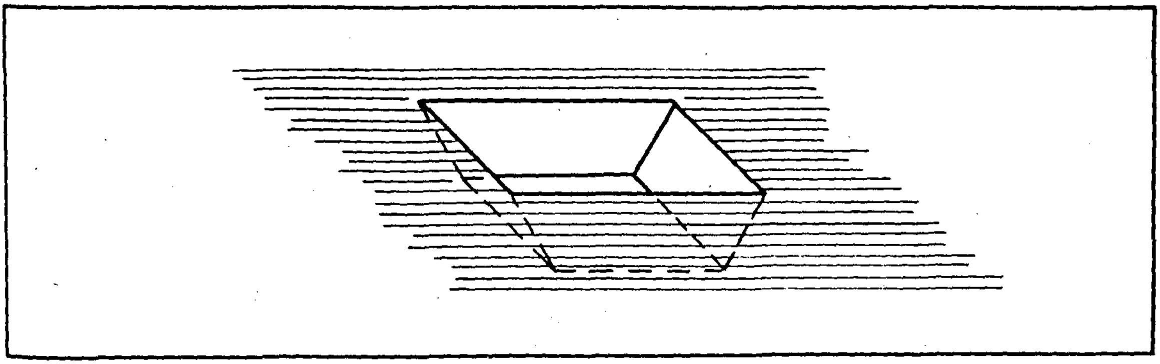


FIG. 25. EXCAVATION WITH SLOPING SIDES AND ENDS.

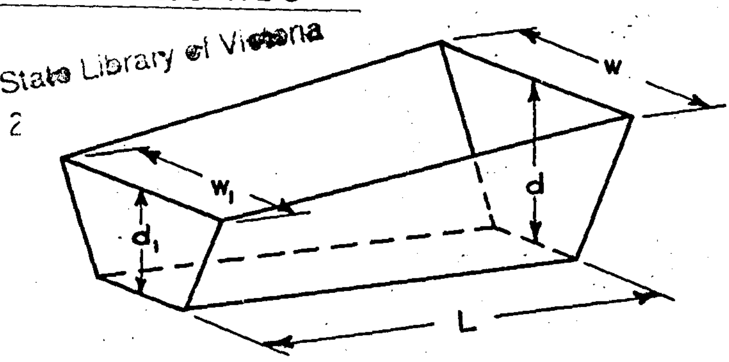


FIG. 26. ILLUSTRATING TERMS IN THE PRISMOIDAL CORRECTION.

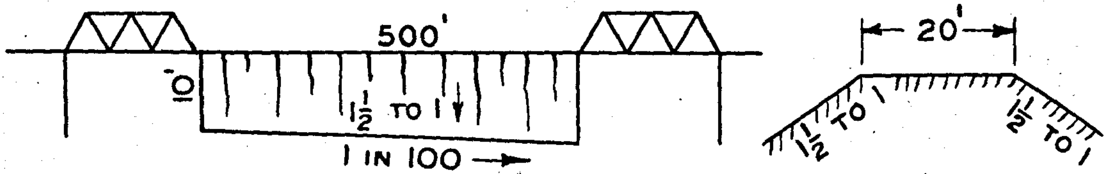


FIG. 27. EXAMPLE N° 8.

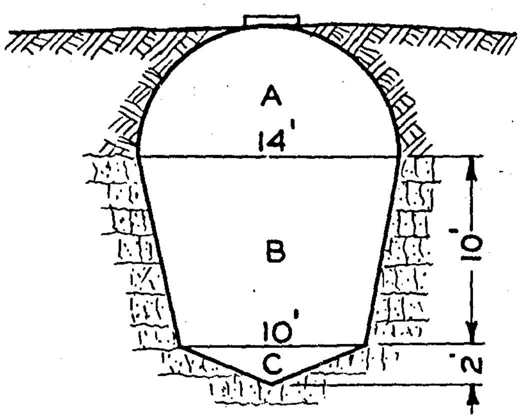


FIG. 28. EXAMPLE N° 9.