The first part of the report consists of a summarised account of the practice of the various companies and administrations, further details of which are to be found in Appendix B.

The second part deals with the various matters requiring attention in order to secure easy running at high speeds through points and crossings, including the question of crossover junctions on roads having four or more lines of way.

PART I.

The greatest load on one axle of an express engine, as returned by the companies in reply to Question II ranges from 12·89 tons on the Great Southern & Western of Ireland to 20 tons on the North Eastern. Five companies return the weight as being under 15 tons per axle, five as ranging between 16 and 16 $^{3}/_{4}$ tons, eight as between 17 and 18 tons, two 18 $^{1}/_{2}$ tons and one 20 tons.

Switch Blade and Stock Rail.

An examination of the replies shews that the section of rail adopted for making the switch blades is, with the exception of the Great Western Company, and the London & North Western Company, the same as the standard normal section in use on the main lines of the respective companies, and in Great Britain and Ireland all, with the exception of the Great Western Company and the Great Southern & Western of Ireland, use the bull-headed type varying in weight from 80 to 100·33 lb. per yard.

The Great Western Company use their normal section of rail for switches up to and including 16 feet blades, but for all switches above16 feet a special section is used (Plate 13, Fig. 3).

The London & North Western Company have in recent years increased the weight of their rails from 90 lb. to 103 lb. per yard, but their switches are still made from the 90 lb. section (Plate 19, Figs. 3, 4 and 5).

The Great Southern & Western of Ireland use the Vignoles type of rail of the same section as the main line rails (Plate 10, Figs. 2 and 3).

The New South Wales and the Canada Southern Railways both construct their switch blades from rails of normal section of the Vignoles type, the former weighs 80 lb. per yard (Plate 27, Figs. 2 to 6) and the latter 80 lb. per yard (Plate 24, Figs. 6 to l3).

It may be here noted that many of the companies have, during the past few years, increased the weight of their standard section of rail by from 8 to 10 lb. per yard, as will be seen by reference to the report to the Congress in London 1895, Section I, Question I, extract from which is shewn, for convenience of comparison with the replies to Question 5, in the Appendix herewith.

All the companies vary the length of the switch blade to meet the radius of the curve, the limits varying from a minimum of 9 feet to a maximum of 32 feet. Seven companies reply that they curve the switch blade according to the curvature of the diverging line.

The New South Wales Government Railways use a standard length of switch, curved only when the curvature of the diverging road is sharp.

The Canada Southern vary the length of the switch with the curvature of the diverging road, but, curve the blade only in special works.

The nose, or thin end of the switch is variously shaped, fourteen companies house the end of the blade under the stock rail, the extreme end being kept lower than the top of the stock rail and below the level of the flanges of the wheels; in this form the extremity or thinnest part of the tongue of the switch is not exposed to any blows from passing wheels, but eight companies state that there is a slight tendency of the fine planed edge to chip, three companies notch or crank the stock rail to receive the end of the point so that, when the point is against the stock rail, there may be no projection against which the flange of a passing wheel may strike; the London & North Western Company adopt both methods according to the length of the blades, all 20 feet in length being housed, two companies plane the blade to a fine point which rests flat against the stock rail. In each case the blade is so planed that when moved over to the stock rail it is in direct contact for a length varying with the degree of curvature of the diverging road, that is, with the length of the blade, and as a further means of support all the companies, with three exceptions, adopt short studs projecting from the stock rail at a level below the flanges of the wheels; while the North Eastern Company bolt to the stock rail a small cast iron block (Plate 23, Fig. 9).

With four exceptions, namely, the London & South Western Company, the Great Southern & Western Company of Ireland, the Canada Southern, and the New South Wales, all the companies fix their switches with the same inward inclination or cant as is given to the rails in the plain line.

The connection of the switch heel to the rail is in all cases made by means of the standard fish-plates and bolts adopted by the various companies, seven companies tighten up the heel joint to the same extent as an ordinary joint, the other companies leave the joint sufficiently slack to work freely in the slide chairs, the stock rail being secured by bolts to these latter chairs, five companies provide special chairs for the support of the heel of the switch, three of whom key up a number of these chairs dependent upon the length of the switch. The throw of the switches varies from 3 $^{1}/_{2}$ to 5 inches.

In order to prevent the tendency of the nose of the switch to lift or spring up during the passage of vehicles over it in a trailing direction, nearly all companies using the housed switch depend thereon, the other companies (except four, who do not take any special precautions) adopt special means by prolonging the point stretcher-rods so as to pass through a hole in the stock rail, by keying up the heel of the switch, while the Lancashire & Yorkshire Company use a special bracket attached to the switch passing under and bearing upon the underside of the stock rail (Plate 16, Fig. 2).

Beyond the ordinary attachment of the switch to the rail no special precautions are taken to prevent the tendency of the switch (trailing) to travel in the direction of its length, except by the Cheshire Lines Committee, who adopt a bolt passing through the heel chair and the switch; the Great Eastern Company, who provide creeping blocks at the heels of the switches; the Great Western Company, who use a connecting tie-plate bolted to the rail abutting the heel of the blade to the adjoining stock rail; the London & South Western Company, who use a bent fish-plate or round bar bolted to the stock rail and turn out rail at the heel of the switch, and the New South Wales Railways, who adopt a spacing block bolted between the stock rail and the rail abutting the heel of the switch.

The Glasgow & South Western is the only company using a special pivot for the heel of the switch, consisting of a vertical strip rounded on the face and cast on the heel chair block which bears on the web of the switch at the first bolt from the heel, this company also use, in cases where the points are situated a long distance from the signal cabin, a chair with a small roller let into its base over which the point of the switch blade travels.

With regard to the fixing of the heel of the switch blade with reference to the mathematical curve of the diverging road, there are two methods usually adopted for calculating and setting out the position of the points and crossings and the intervening curve — one method is to fix upon the length of switch to be adopted, the clearance at the heel being always a fixed quantity, and calculate for a curve tangential to the centre line of the switch — the other method is to set out the actual theoretical curve tangential to the main line and fix the heel of the switch at the standard switch heel clearance, as, however, it is practically impossible to adopt switches theoretically correct, the latter method will necessitate a re-adjustment of the curve between the heel of the blade and the nose of the crossing with the probable result that the curve would not then correctly fit in with the angle of the crossing; it appears therefore that the first method, that of calculating and setting out the curve in the first instance tangential to the switch blade, is the better method of procedure. Eight companies reply that they adopt the method of setting out the curve tangential to the switch, and twelve that they set out the curve tangential to the main line, while the Great Western Company use both methods according to the length of the switch. When the two diverging lines are of equal importance, the best result is obtained by dividing the divergence at the heel of the switch blade equally between the two lines.

The replies to Question 35 shew that none of the companies use three-throws on the main line, and, while seven of the companies use double-leads in a trailing direction, only four use them both trailing and facing, and seven of the companies do not make use of either three-throws or double leads.

Crossings.

A. — *Acute or* V *Crossings.*
B. — *Obtuse or Diamond Crossings.*

All the companies who have replied to these questions use their normal standard section of rail for the construction of their acute and obtuse crossings, excepting the Great Northern (Ireland) (Plate 9, Fig. 3; and the Great Southern & Western (Ireland) (Plate 11, Fig. 5), who use cast steel reversible blocks.

A. — ACUTE OR V CROSSINGS.

From the answers to question 38 it appears that there is a lack of uniformity in the method of describing the angle of **V** crossings.

By a 1 in 8 crossing most companies mean a crossing whose legs form the two equal sides of an isosceles triangle whose sides are 8 times the length of the base, and it appears that this is the simplest method of description.

Three companies use rivets to connect the two legs of the **V** crossing, 12 use bolts only, and 3 both rivets and bolts for this purpose.

The sharpest acute crossings used range from 1 in 8 on the North British line to 1 in 20 on the Great Northern, with a varying clearance at the knuckle of from a minimum of 1 $^{1}/_{2}$ inch on the Great Northern to a maximum of 3 $^{1}/_{4}$ inches on the London & North Western Railway. Twelve of the 22 companies replying to this Question adopt a clearance of 1 $^{3}/_{4}$ inch, four 1 $^{7}/_{8}$ inch, three 2 inches, and one 2 $^{3}/_{4}$ inches; the London & North Western Company varying from 2 to 3 $^{1}/_{4}$ inches.

The length of the legs forming the **V** of the crossing range from 10 ft. 6 in. to 24 feet, 14 companies have a fixed length for all angles, two vary the length within certain fixed limits, and four vary the length according to the angle of the crossing.

The different methods of forming and connecting the splice of the two legs to form the **V** are (in all cases where the information was sent in reply to Question 43) shewn in the plates accompanying this report, the reference numbers to the plates being given in the tabulated statement forming Appendix B.

The wing rails are generally constructed in lengths varying with the angle of the crossing.

It would appear from the replies to Question 46 that, with two exceptions, all the companies form the knuckle of the crossing by merely bending the rail to suit the angle of the crossing, the Great Western Company (Plate 14, Fig. 2) and the London & North Western Company (Plate 20, Figs. 2 and 5), curve the knuckle to certain defined curvatures varying with the angle of the crossing.

The Great Western Company and the Furness Company splay out the free end of the wing rail from the parallel clearance of 1 $^{3}/_{4}$ inch to 3 $^{1}/_{2}$ inches on a length of 3 ft. 6 in. irrespective of the angle of the crossing, the London & North Western Company adopt the same method, but the length on which the 3 $^{1}/_{2}$ inches opening is attained varies with the angle thus : for all angles up to 1 in 10 $^1/_2$ in a length of 3 ft. 6 in. for all angles between 1 in 11 and 1 in 15 in a length of 5 ft. 6 in., and for all practicable angles over 1 in 15 in a length of 7 feet, the remaining companies appear to carry the wing rail parallel with the running rail at the fixed clearance and form a curve for a short length at the free end.

In reply to Question 48, seven companies state they use stiffening blocks in their acute crossings, generally placed one at the knuckle and one on each side of the splice, fixed with through bolts to the rails.

The length of the guard rails varies from a minimum of 8 feet on the Great Southern & Western of Ireland to a maximum of 21 feet on the New South Wales Government Railways, 15 companies adopt a fixed length for all angles, while seven vary the length within certain limits according to the angle of the crossing.

The London & North Western Company use a 12 feet check rail for all angles up to 1 in 10 $^1/_2$ and 18 feet for angles from 1 in 11 to 1 in 15, in the former the rails are splayed out for a length of 4 feet, and in the latter for 6 feet from each end so as to gradually increase the clearance to 3 $^1/_2$ inches (Plate 20, Fig. 5); the Great Western (Plate 14, Fig. 1) and the Furness companies (Plate 3, Fig. 2) adopt a similar method, but the splay is obtained in a length of 3 ft. 6 in. from each end similar to the wing rails; the Great Southern & Western (Ireland) (Plate 11, Fig. 2), adopt a check rail which is curved throughout with the exception of about 2 feet of its length in the middle which is parallel to the running line with a clearance of 1 $^3/_4$ inch which is gradually increased to 5 $^1/_2$ inches; the Great Northern Company (Plate 8, Fig. 1), gradually increase the clearance between the running rail and guard rail from 1 $^1/_2$ to 1 $^7/_8$ inch; and the North Eastern (Plate 23, Fig. 1), from 1 $^1/_2$ to 2 inches; the remaining companies appear to fix the guard rail parallel to the running rail and curve or bend a short length at each end.

The Cheshire Lines, Great Southern & Western (Ireland) and the North British are the only companies who elevate the guard rail above the running rail.

With the exception of five, and the companies using the flat bottomed rails, all the remaining companies manufacture special chairs for each angle of crossing.

The Great Western Company adopt a special means, besides the ordinary chair fastenings, of fixing the nose of the crossing to the timbers; the crossing point is cut down to a depth sufficient to allow of a saddle resting on the web as cut and the bottom flange of the rail, the saddle, rail, and chair being drilled to admit of an inch bolt passing through them, the bolt which passes through the crossing timber has a large nut or washer underneath, which admits of the bolt being screwed up from the top, so that the rail, chair and sleeper are all tightly held together; the details of this special fastening are shewn (Plate 14, Fig. 4).

B. — Obtuse or Diamond Crossings.

The limit of the angle of obtuse or diamond crossings, so far as the British railways are concerned, is practically fixed by the Board of Trade who specify in the requirements " Diamond crossings as a rule not to be flatter than 1 in 8. " As in the case of the acute crossings, all the companies construct their obtuse crossings with their standard normal section of rail.

In each case the drawings shew the knuckle as being fixed in a chair which takes the place of the chock block in the acute crossings, four companies bolt the rails together with a chock block between, the London & South Western Company adopt a $^{7}/_{8}$ inch bolt, connecting the main rail and check rail, on each side of the knuckle.

The length of the check rail on each side of the knuckle varies from a minimum of 5 feet on the Great Central to a maximum of 15 feet on the Glasgow & South Western.

The Caledonian (Plate 2, Fig. 2) and the North British (Plate 22, Fig. 8) check these crossings all round, and the London & South Western also use extended check rails (Plate 21, Fig. 4).

From the replies to Question 59 in regard to the curvature of the check rails at the knuckle and splaying out of the ends, it would appear that only three companies, the Great Central, the Great Western, and the London & North Western vary the curvature with the angle of the crossing. The Great Western vary the curvature from a radius of 2 feet for crossings of 1 in 2, up to a radius of 7 feet for a crossing of 1 in 8, and splay the ends with a radius of 6 feet so as to give a clearance of 3 $^{1}/_{2}$ inches at the extreme ends of the check (Plate 14, Fig. 3).

It is to be regretted that so few companies have given definite information in regard to this very important point in the construction of these crossings.

In reply to question 60 all the companies state they do not elevate the check rail. Special chairs are cast for each angle of crossing by eleven companies, the remainder use one pattern of chair for several angles of crossings. The companies differ in the design of the crossings, the diverging branch of the obtuse and acute crossings is sometimes laid down on a continuous curve, in other cases short lengths of straight are introduced in the curve of the diverging line in order that the legs of the crossing may be laid down in a straight line, 14 companies adopt the latter method where possible, the remainder use either curved or straight as the conditions require. The North British is the only company giving super-elevation to the outer rail of the fast road through the diamond crossing.

The standard gauge is maintained through the points and crossings by all companies with the following exceptions :—

The Great Central, and the London, Brighton & South Coast lay their crossings tight to gauge, the Great Northern (Ireland), the Great Southern & Western (Ireland), and the Hull & Barnsley tighten the gauge $^{1}/_{4}$ of an inch throughout their points and crossings, the Canada Southern widen the gauge to 4 ft. 8 $^{3}/_{4}$ in. immediately in front of the switch, the North Eastern Company lay their facing points $^{1}/_{4}$ of an inch wide to gauge, and on the New South Wales Government Railway the gauge is kept $^{1}/_{4}$ of an inch tight at the point of the crossing in cases where the lead is off a straight line or the inside of a curve.