

Transportation Engineering

Course Code –CE-422

Contact Hours -3+3

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Turnout

- Combination of **points and crossings** by manipulation of which a train may be transferred from **one track to another track** is called a turnout.
- **A turnout may be let hand turnout or right hand turnout.**

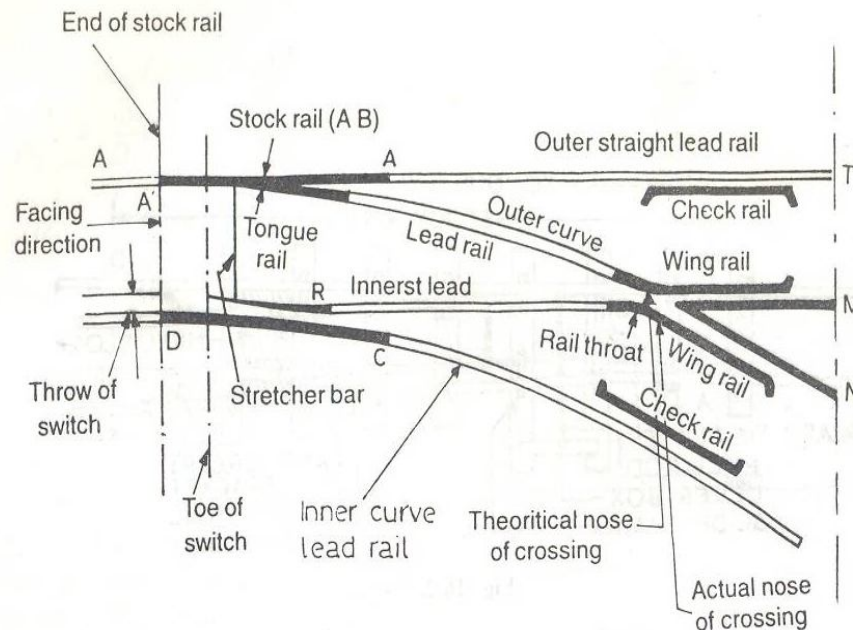


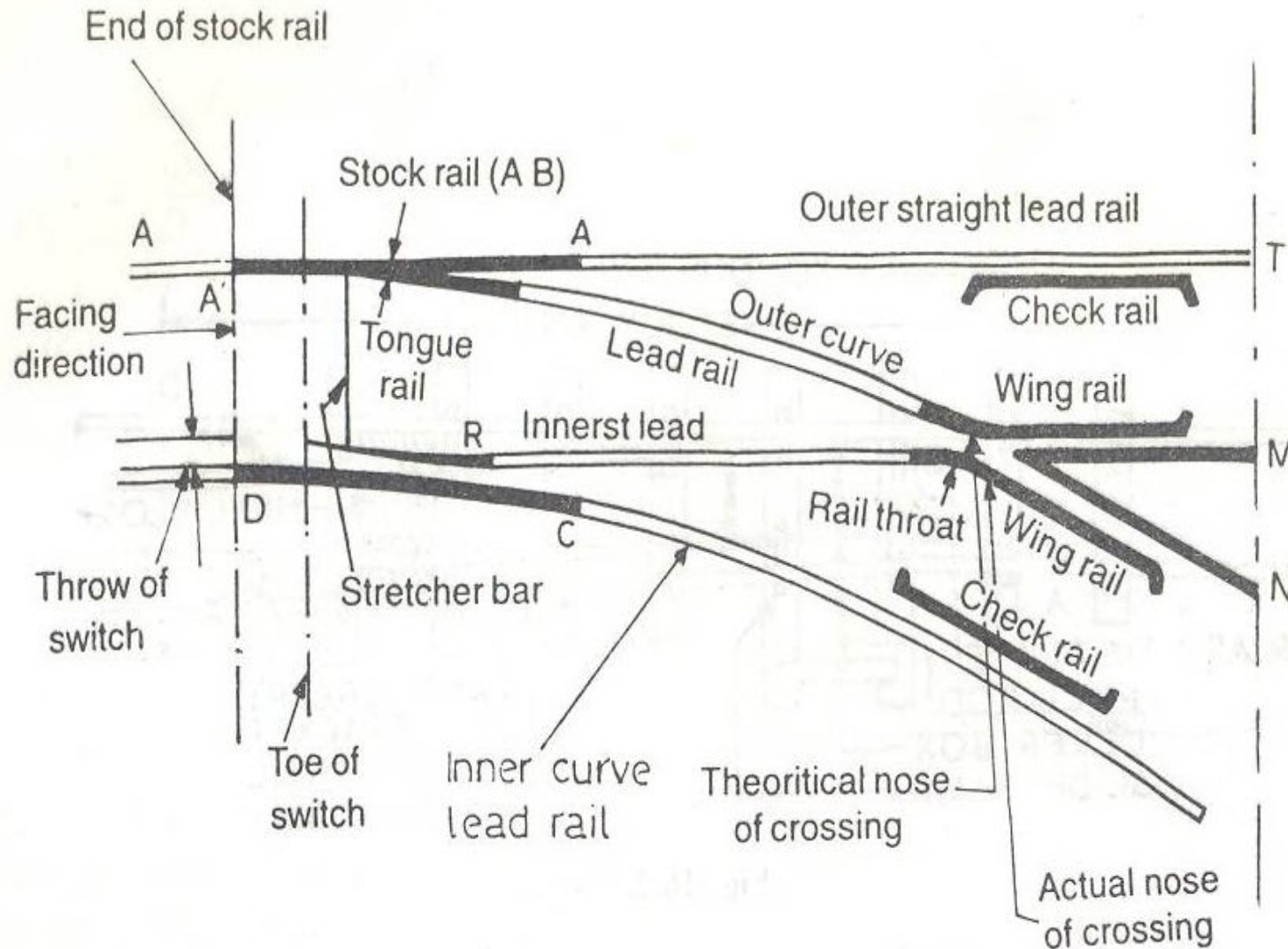
Fig. 16.1. (a) Right hand turnout

Components of a Turnout

Following are the components of turnout

- A pair of stock rails
- A pair of tongue rails
- A Vee crossing
- Two check rails
- Switch tie plate and crossing tie plate
- Rods, crank lever for operating the point
- Studs
- Bearing plates, stretcher bars
- Plunger bar

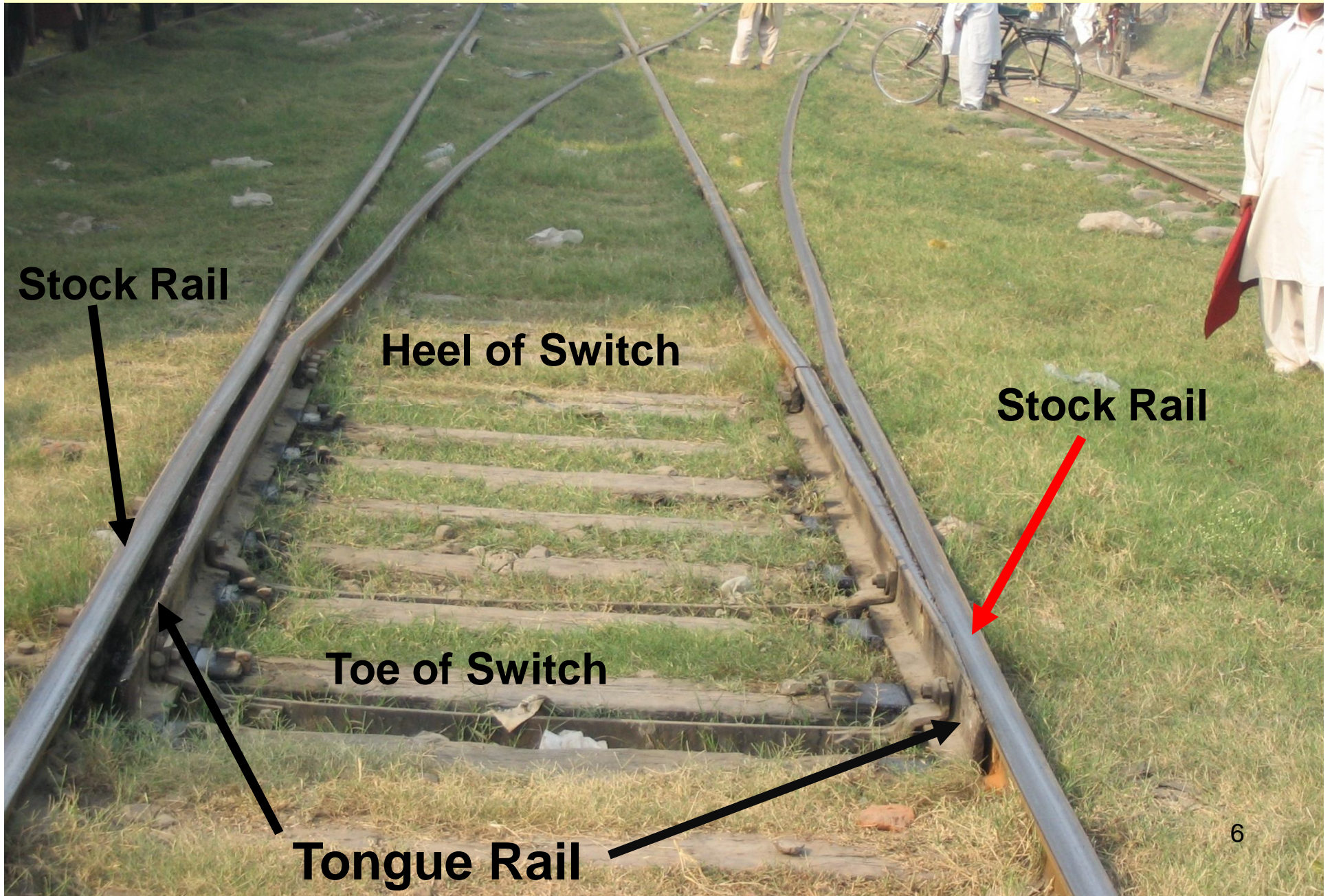
Right Hand Turnout



Point

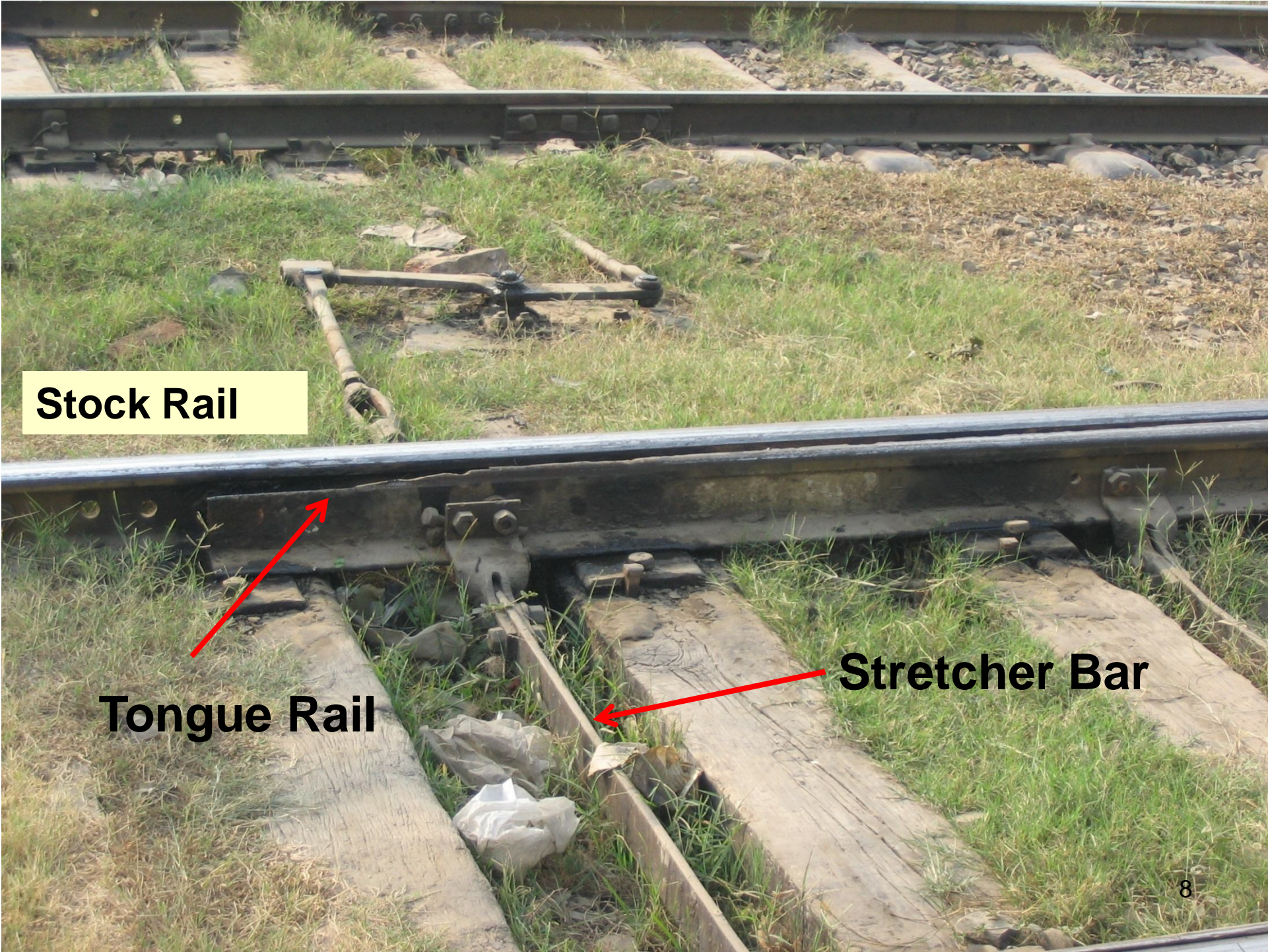
- A **set of switches** is termed as a point.
- Switches
 - **All switches consists of four rails**
 - Two rails are known as **stock rails** & two rails as **tongue rails**
 - Combination of **one stock rail and tongue rail** is called **switch**.
 - The **tongue rail** may be **straight or curved**.

Point



Point

- Tongue Rail has a **very thin cross section** at the **toe of the switch** to make a **snug fit section** with stock rail.
- **The tongue is connected to the stock rail at the heel of switch with the help of** heel blocks and fish plates.
- The **tongue rails** are supported on **sliding plates and each pair of tongue rail** is connected at the toe with the help of **stretcher bars**.



Stock Rail

Tongue Rail

Stretcher Bar

Point

- Tongue rails are laid at slightly lower elevation than the stock rail to avoid wear.
- Facing Point- if the train travels from the toe to heel of the switch, the point is known as facing point.
- Trailing Point- if the train passes over the heel first and afterwards toe it is called trailing point.

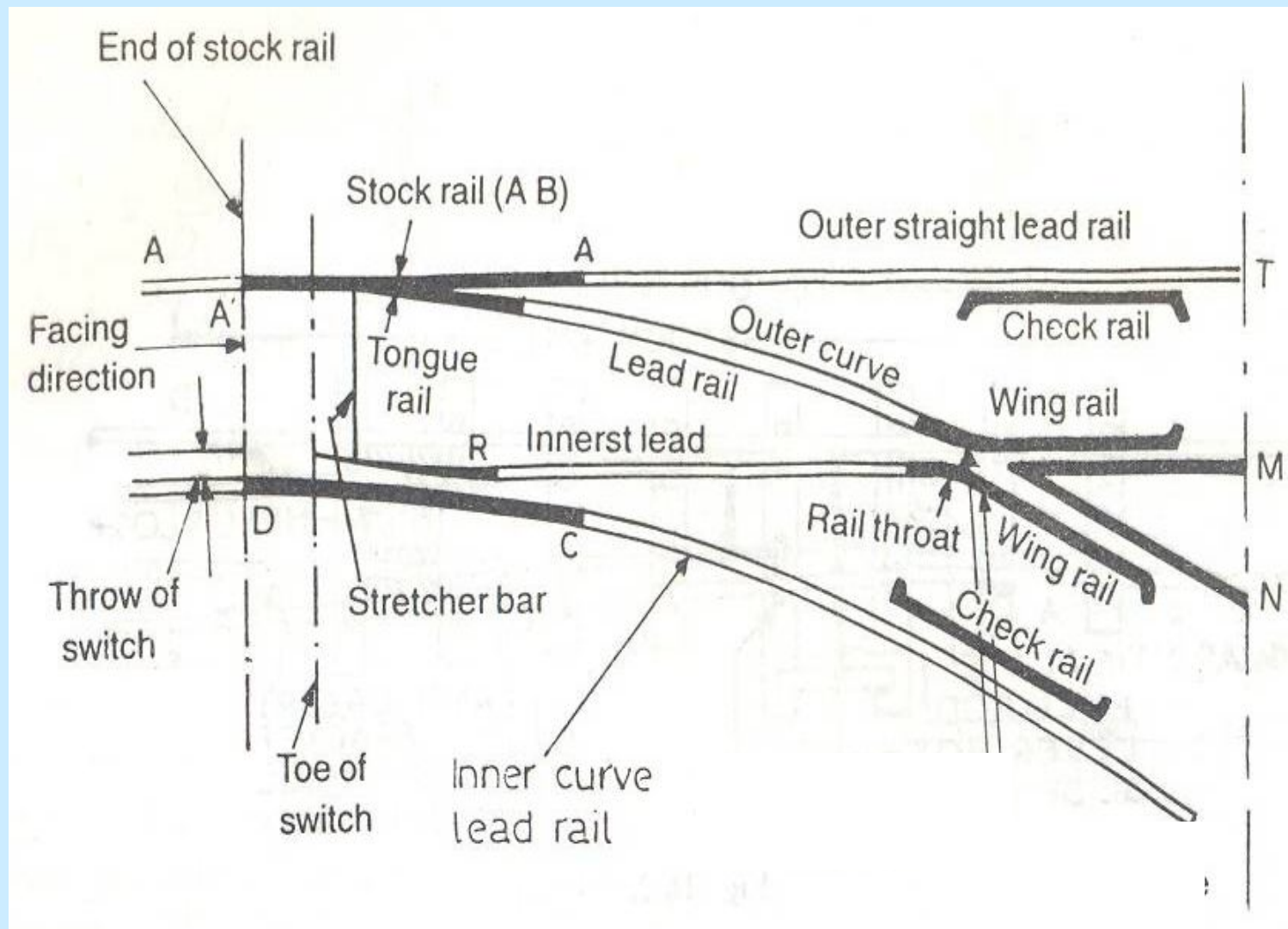
Point

- The same set of points can act as facing as well as trailing points.
- When the train passes over the point first and afterwards the crossing, the turnout is called facing turnout.
- If the train passes the crossing first and afterwards the point then it is called trailing turnout.
- If we stand facing the point, the switch to the right is the right hand switch and to the left is the left hand switch.

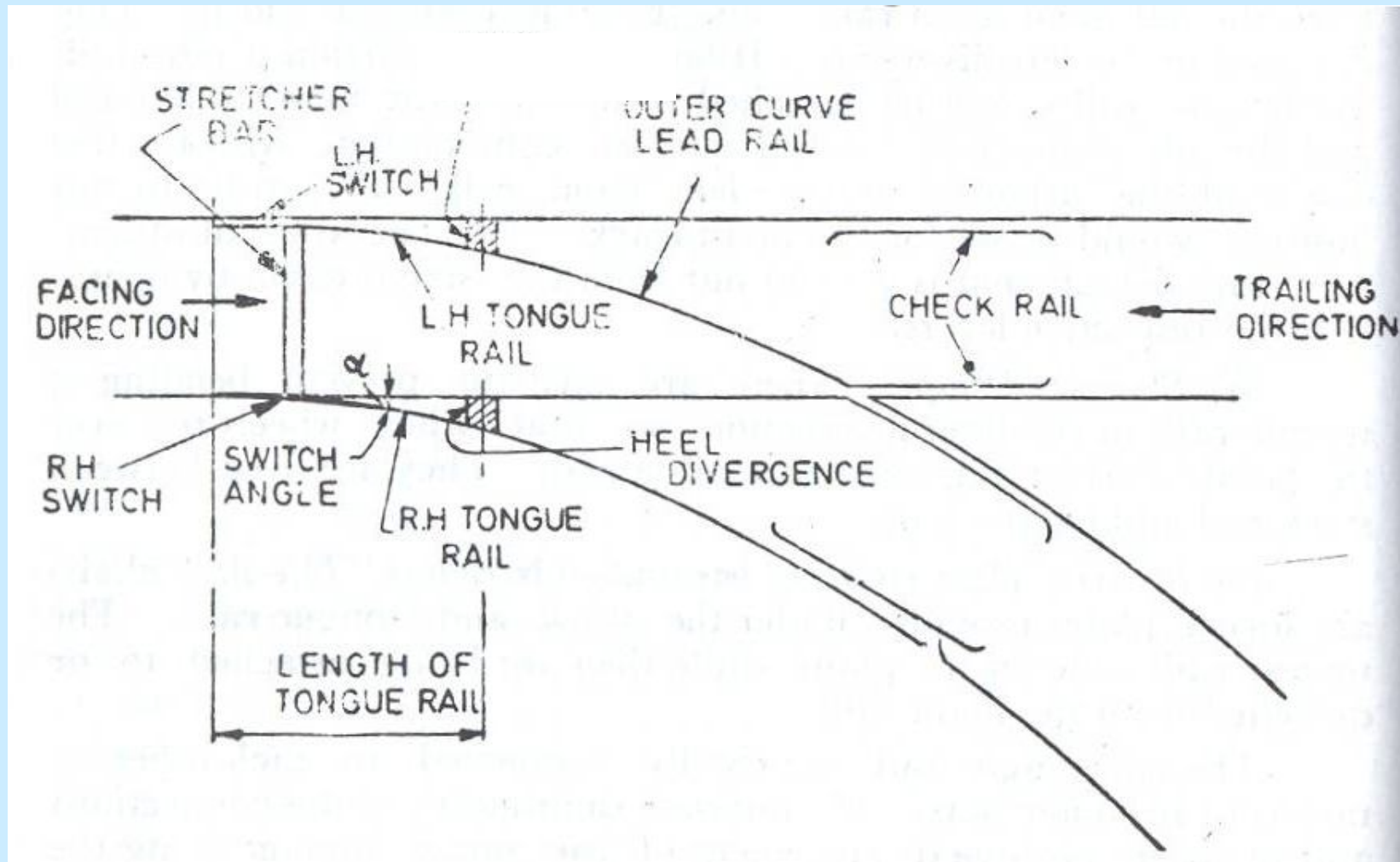
Point

- Throw of Switch- the distance by which the **toe of the tongue** is moved from its **contact position**
- Heel Divergence- **distance between** the stock rail and the tongue rail at the heel of switch **is called heel divergence.**
- Switch Angle- angle subtended between the **gauge faces** of the stock rail and tongue rail. Its value depends upon **heel divergence** and **length of the tongue rail.** The smaller the switch angle, the **smoother is the running** over the turnout.

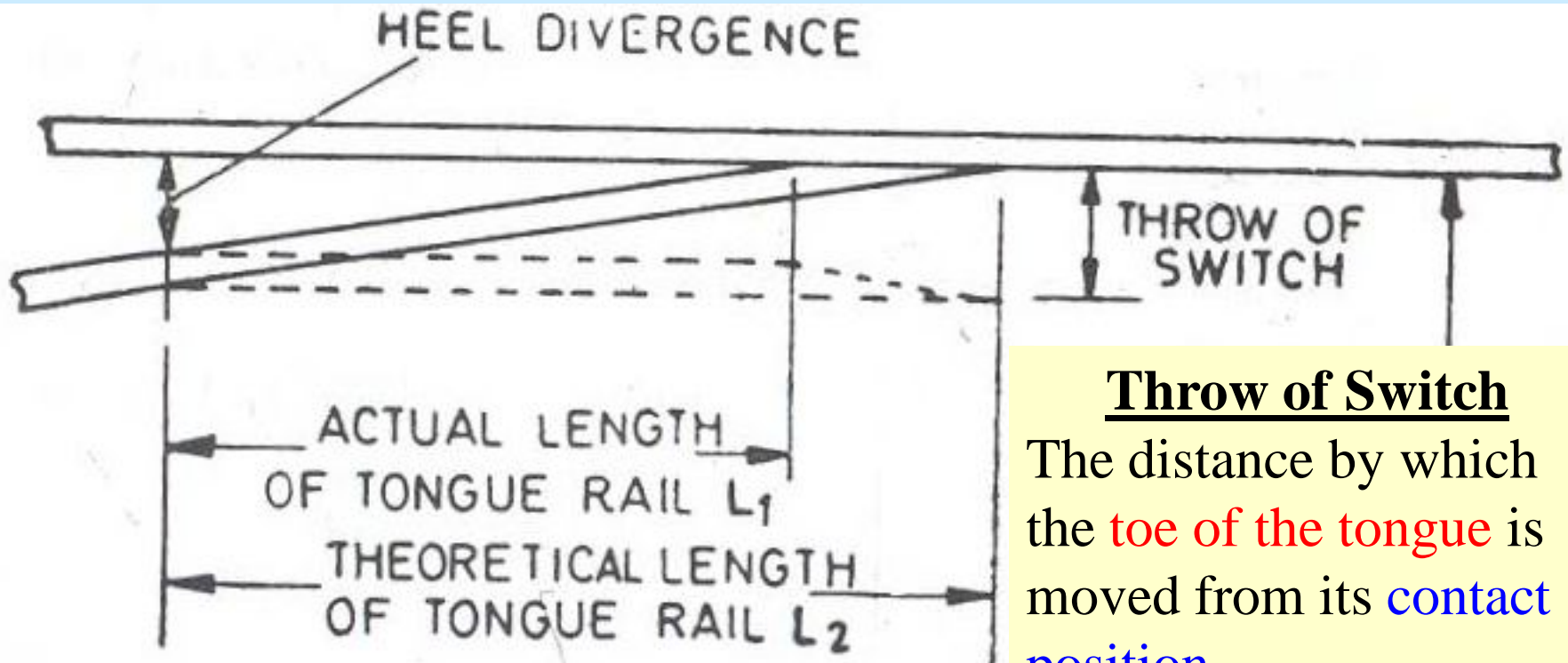
Right Hand Turnout



Right Hand Turnout



Switch Angle and Heel Divergence



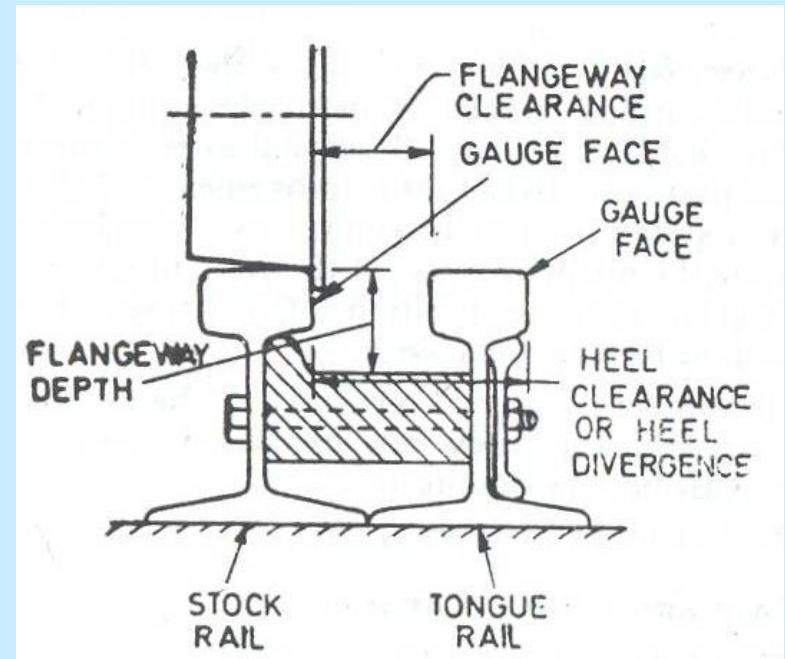
Throw of Switch

The distance by which the **toe of the tongue** is moved from its **contact position**.

Heel Divergence- **distance between** the stock rail and the tongue rail at the heel of switch is **called heel divergence**.

Point

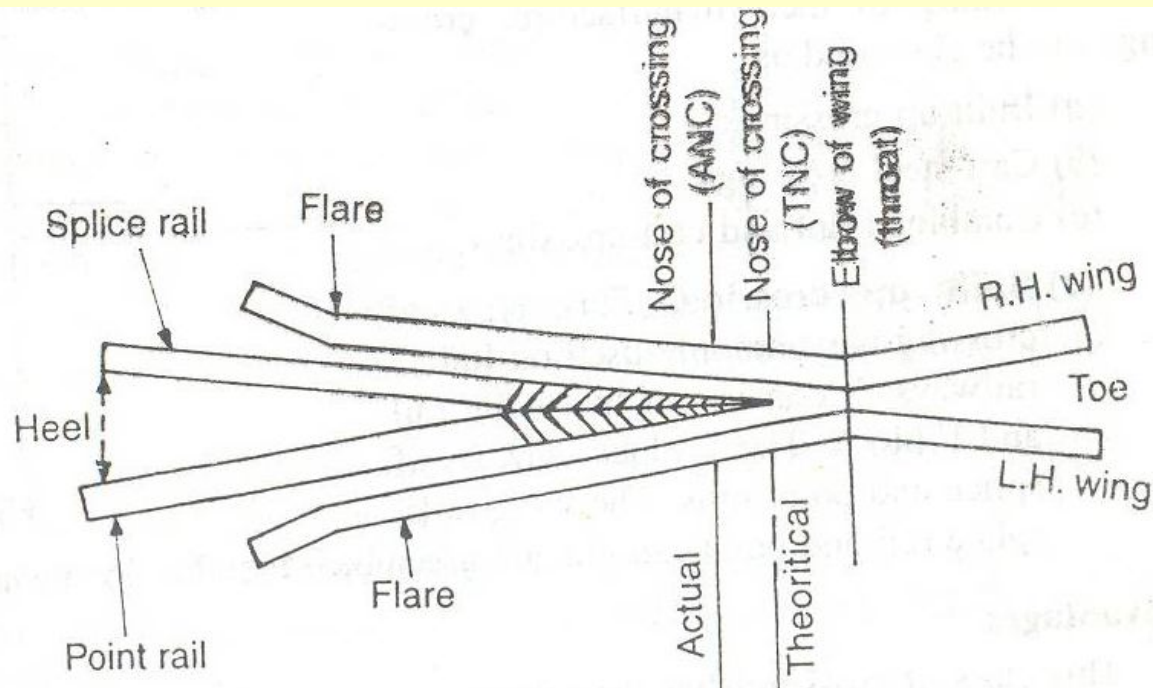
- Flange Way Clearance - is provided as clearance for the movement of wheel flanges and for this reason it is known as **flange way clearance**.
- Flange Way Depth - is the vertical distance between the top of the heel block and top of the head of stock rail.



Heel Divergence- distance between the stock rail and the tongue rail at the heel of switch is called heel divergence.

Crossing

- The function of crossing is to enable the flanges of wheels to cross the rails.
- Components of crossing are VEE piece and wing rails
- Vee piece consists of point rail and splice rail



Crossing

- Point rail and Splice Rails are connected together.
- Point rail ending at nose and splice rail little behind the nose.
- Actual nose is a bit less than theoretical nose.
- Theoretical nose is the point where the gauge face of point and splice rails cross and is a little ahead of actual nose otherwise nose would be too slender if brought to a fine point.

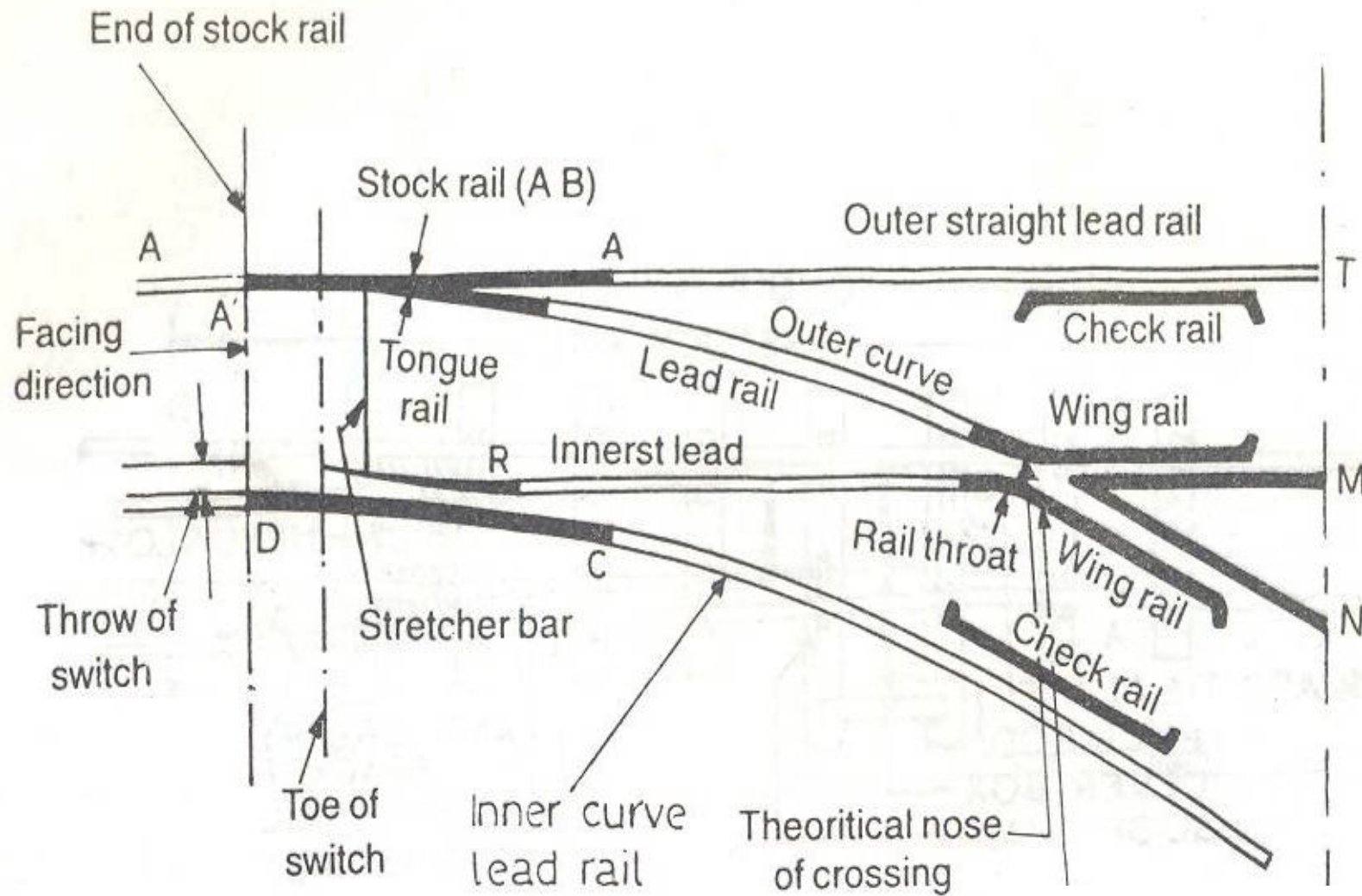


Fig. 16.1. (a) Right hand turnout

Stretcher bar

Crossing

- The nose is kept $\frac{3}{4}$ in in particular.
- Toe of crossing
- Heel of Crossing
- Angle of Crossing- angle between the gauge faces of point rail and splice rail.
- Gauge faces are the faces with which wheel flanges comes in contact.
- The size of the crossing is measured by its angle

Crossing

- Throat is the narrowest space between the two wing rails where they are bent.
- Check rails are provided for guiding the flange of the wheel when the opposite wheel is negotiating the gap at the crossing.
- Wing rails guide the flange of the wheel when it moves over the throat.
- The rails which connect point with the crossing are called lead rails.

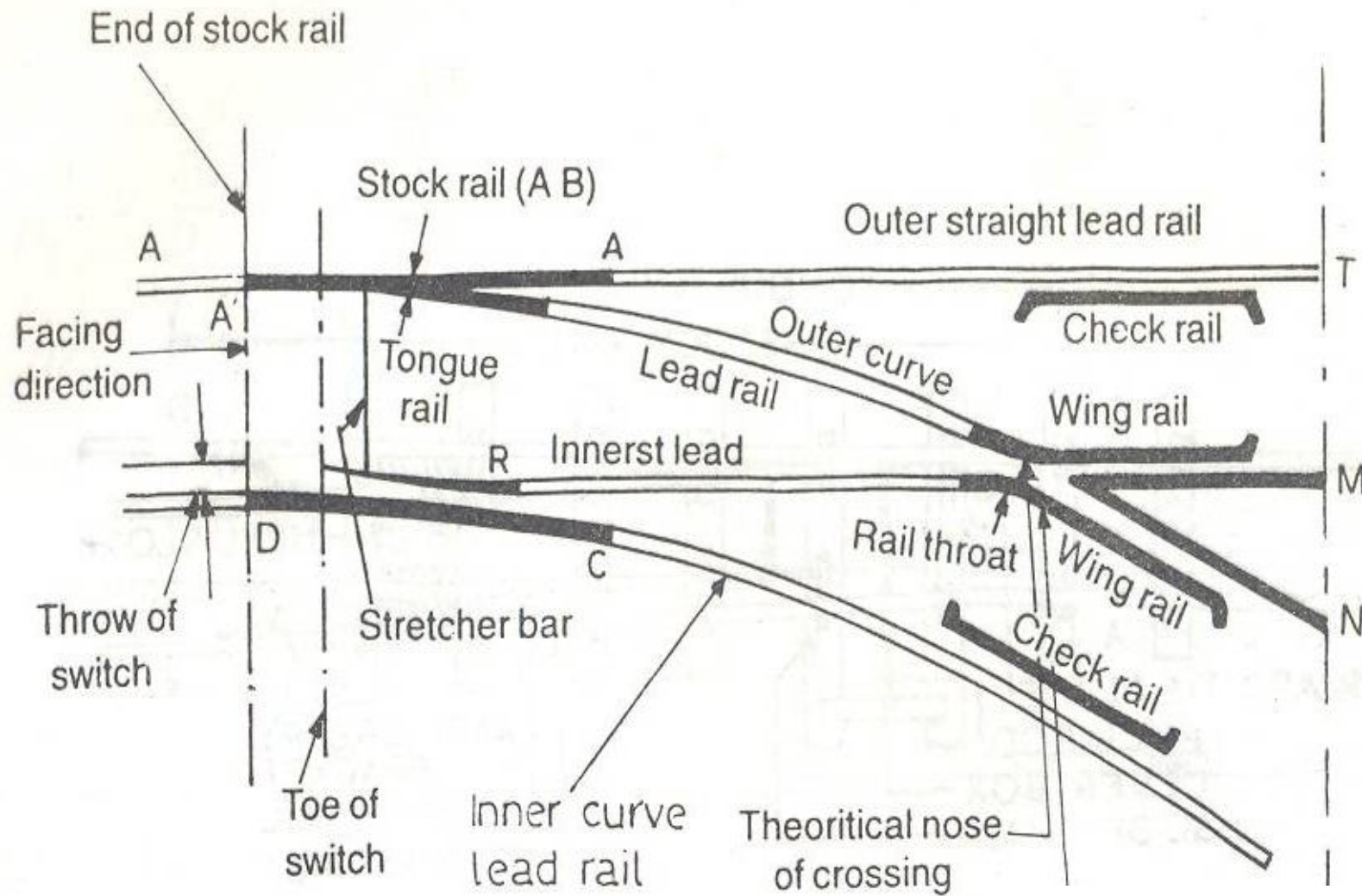


Fig. 16.1. (a) Right hand turnout

Stretcher bar

CROSSING

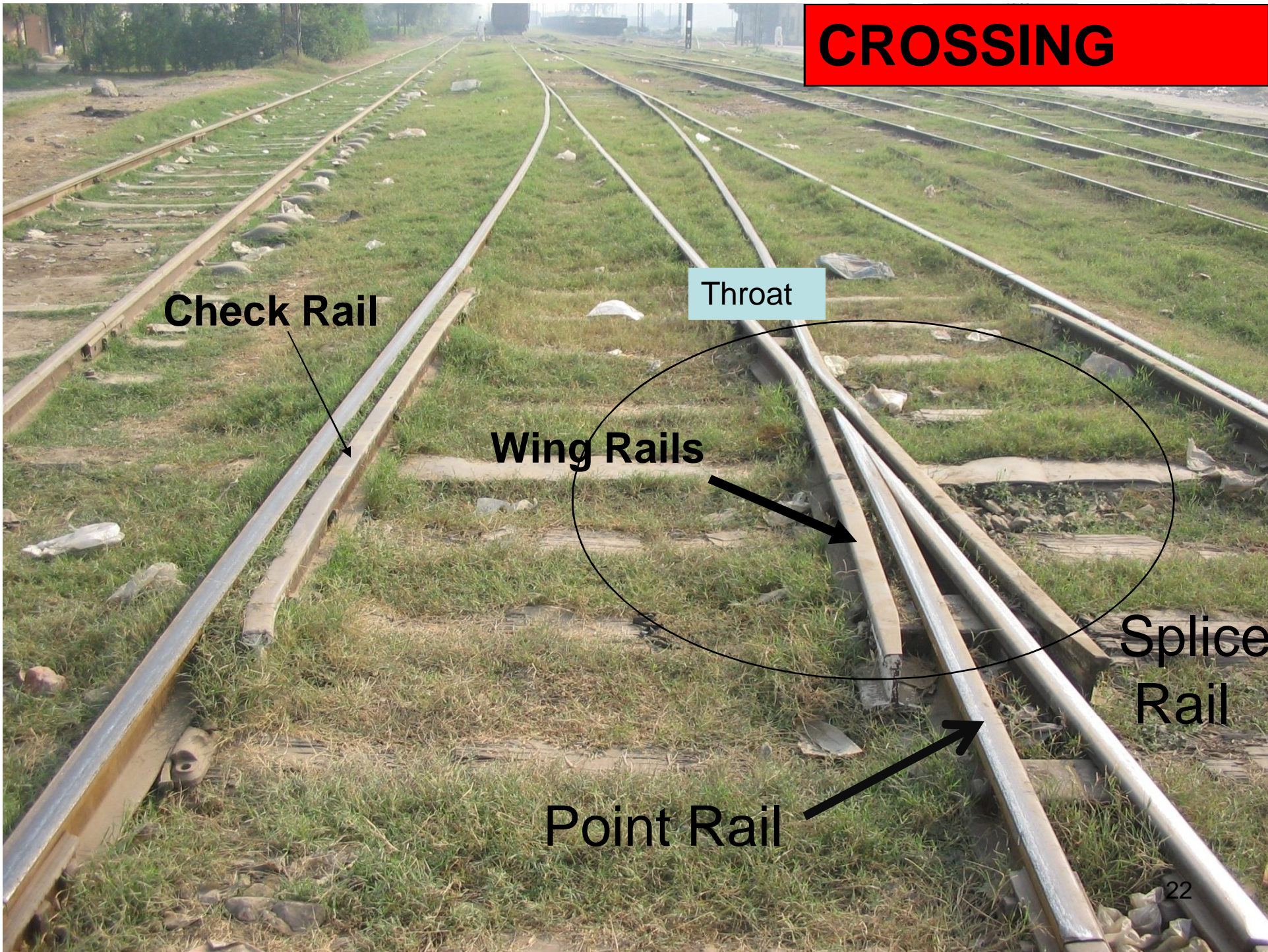
Check Rail

Throat

Wing Rails

Splice Rail

Point Rail



Left Hand Turnout

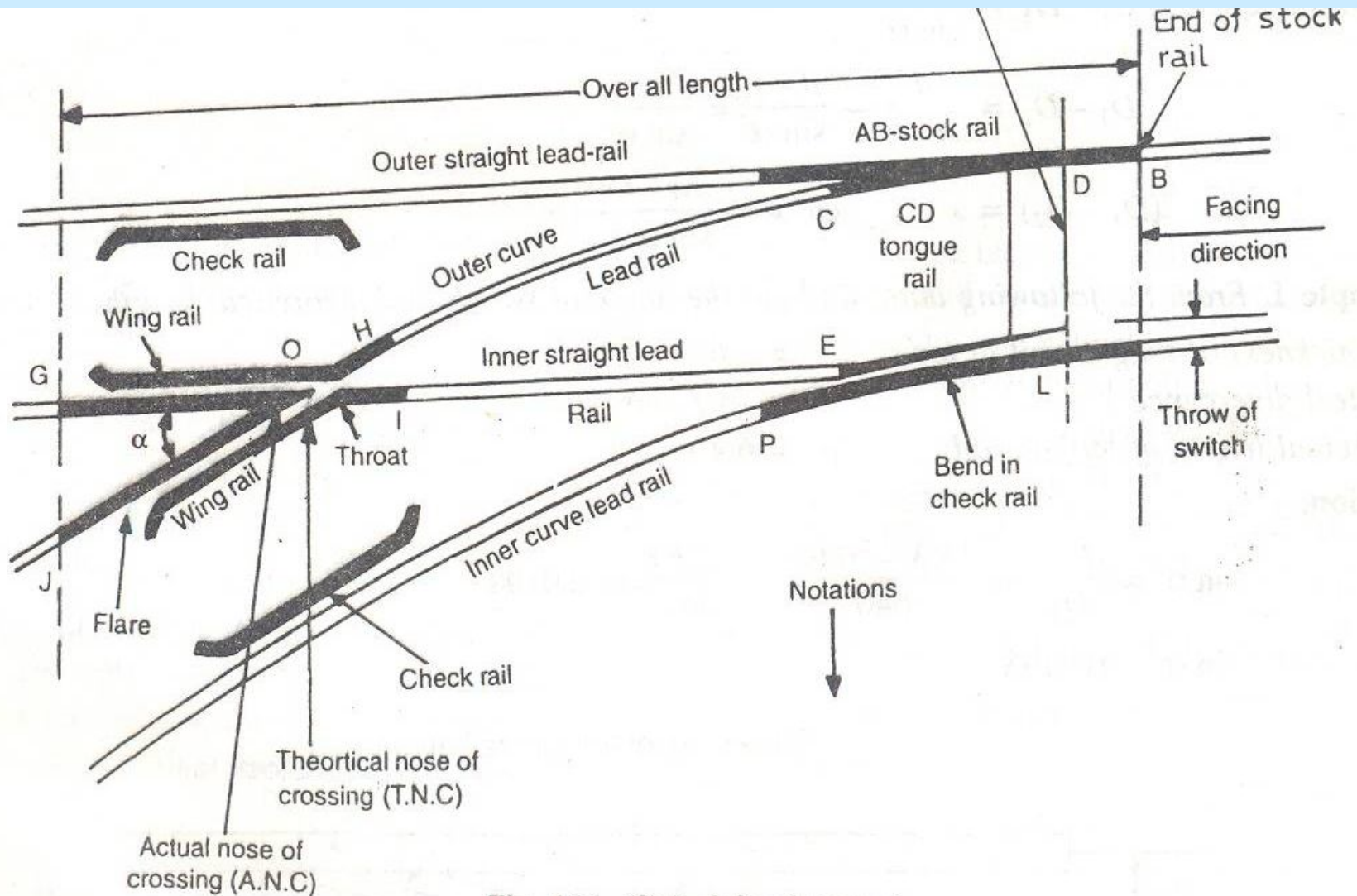


Fig 16.1 (b) Left hand turnout

Left Hand and Right Hand Turnout

- Combination of **points and crossings** by manipulation of which a train may be transferred from one track to another track is called **a turnout**.
- **A turnout may be left hand turnout or right hand turnout.**
- The distance from the **toe of the switch to the heel of crossing** is called **overall length of turnout**

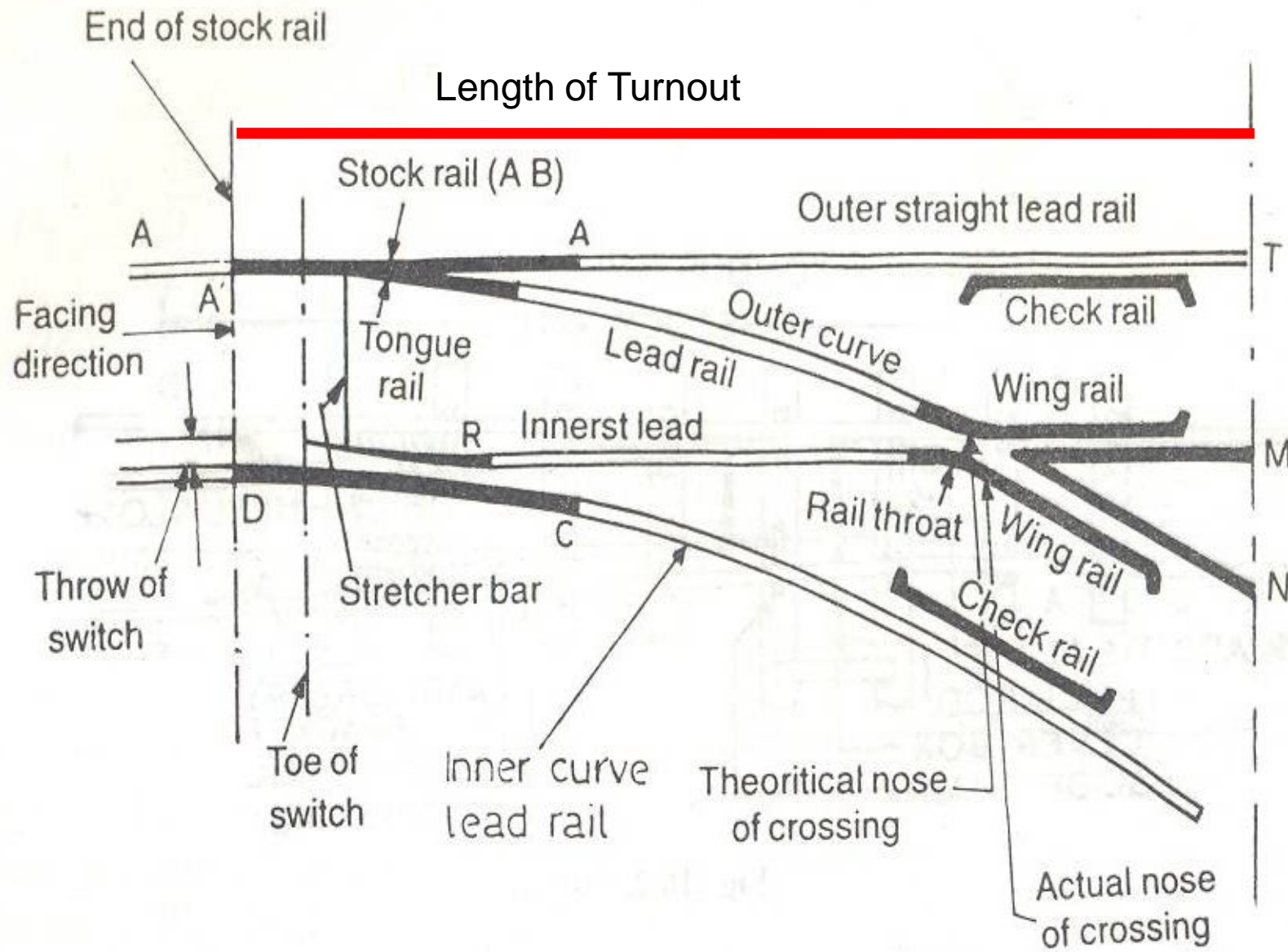


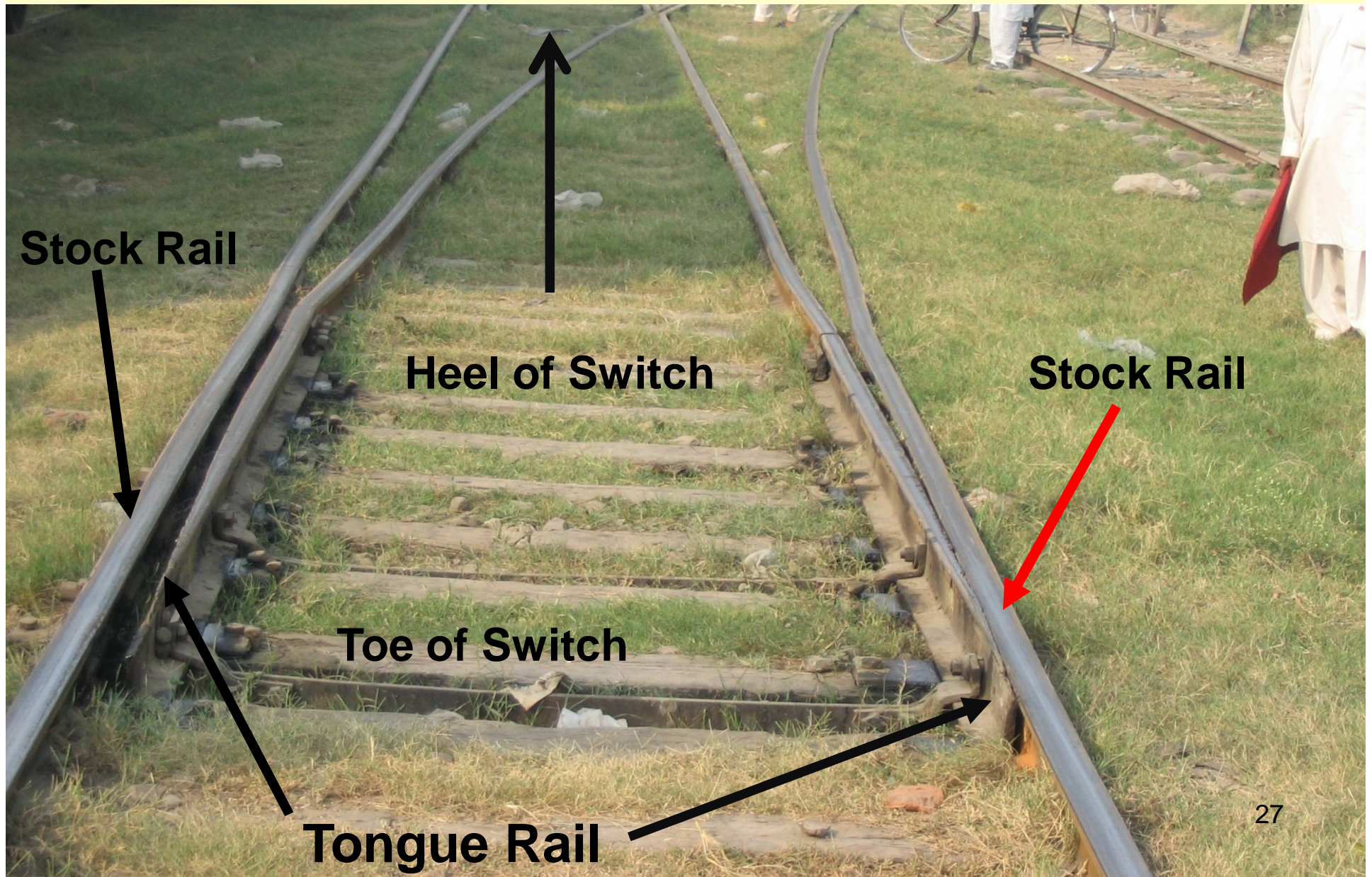
Fig. 16.1. (a) Right hand turnout

Stretcher bar

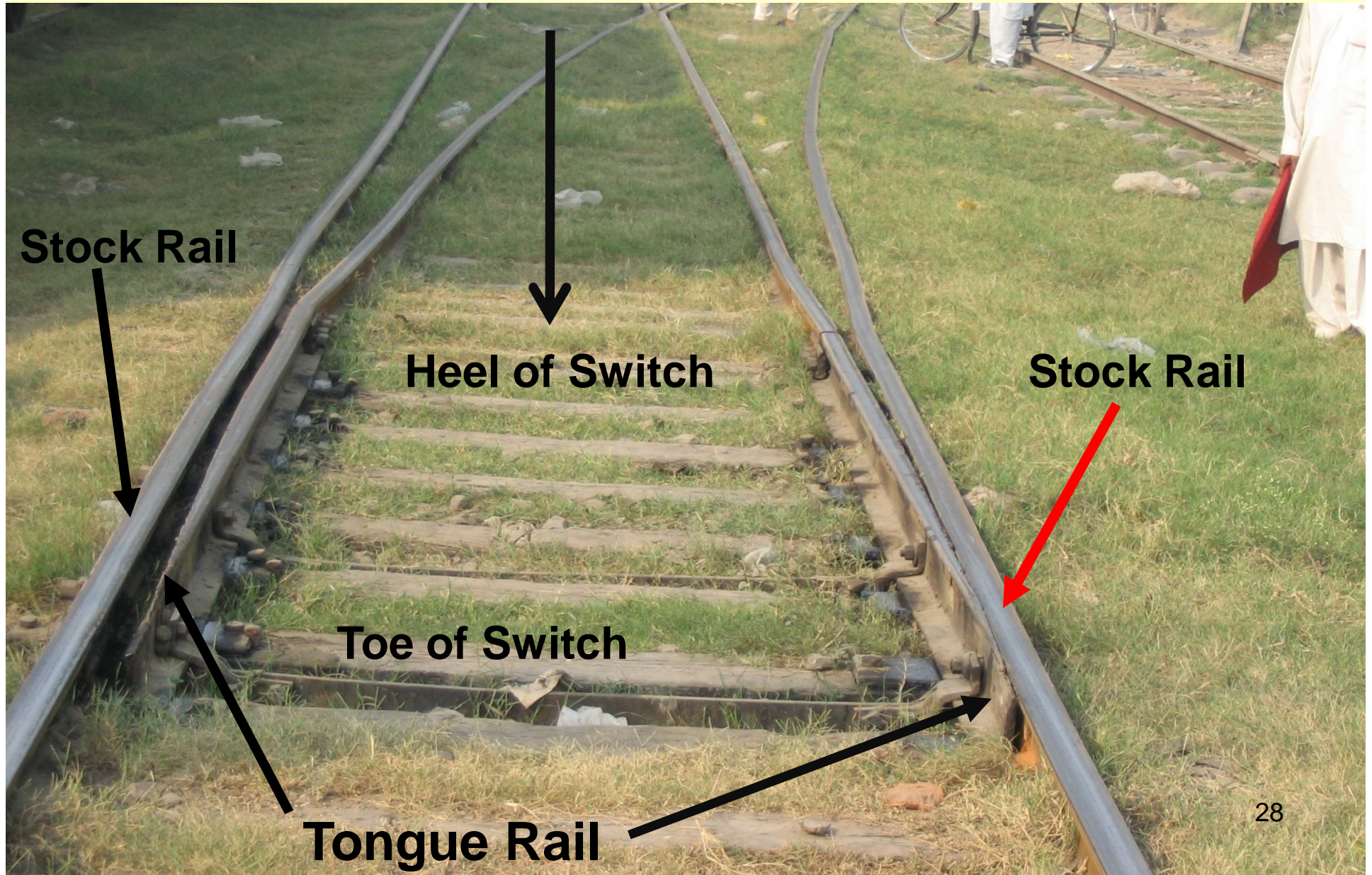
Point and Crossings

- Point
 - Two Switches
- Switch
 - Stock Rail (more in x-section)
 - Tongue Rail
- Crossing
 - Wing Rails
 - Vee Piece
- Vee Piece
 - Point Rail (more in length than Splice Rail)
 - Splice Rail

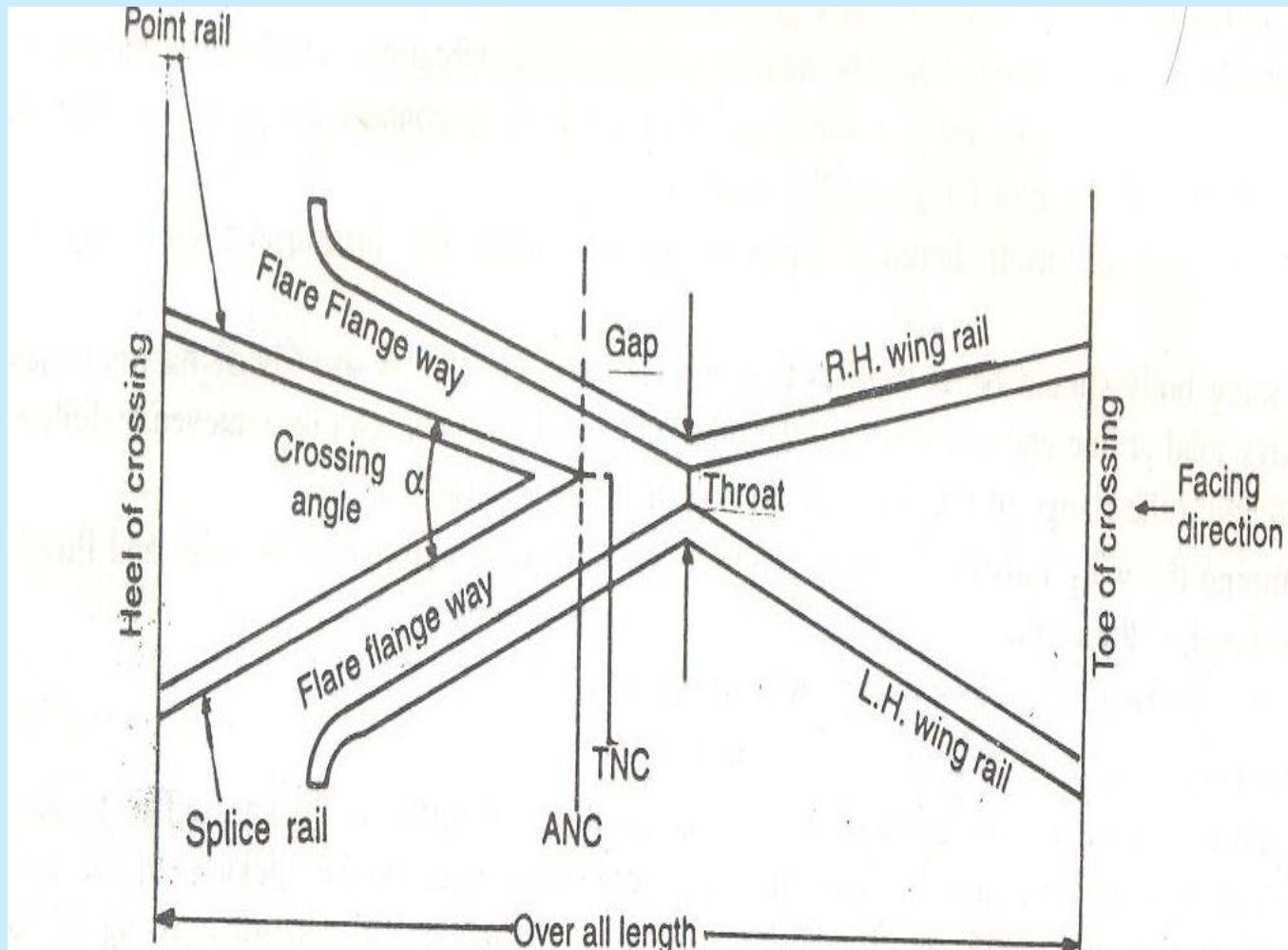
Facing Point- if the train travels from the toe to heel of the switch, the point is known as facing point.



Trailing Point- if the train travels from the heel to toe of the switch, the point is known as trailing point.



Actual and Theoretical Nose of Crossing



Size of Crossing

- Size of a crossing is expressed in terms of distance required in spreading **point and splice rail** by **one foot**.
- **The spread is measured between** gauge faces of the rails.
- If the spread between the **point rail and splice rail** at a distance of **x ft** from the nose of crossing is **1 ft**, the size of crossing is **1 in x**.
- **Generally size is 1:8.5, 1:12 & 1:16.**
- Crossing with sharp angles are used over the track where high speed prevails.

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Size and Angle of Crossing

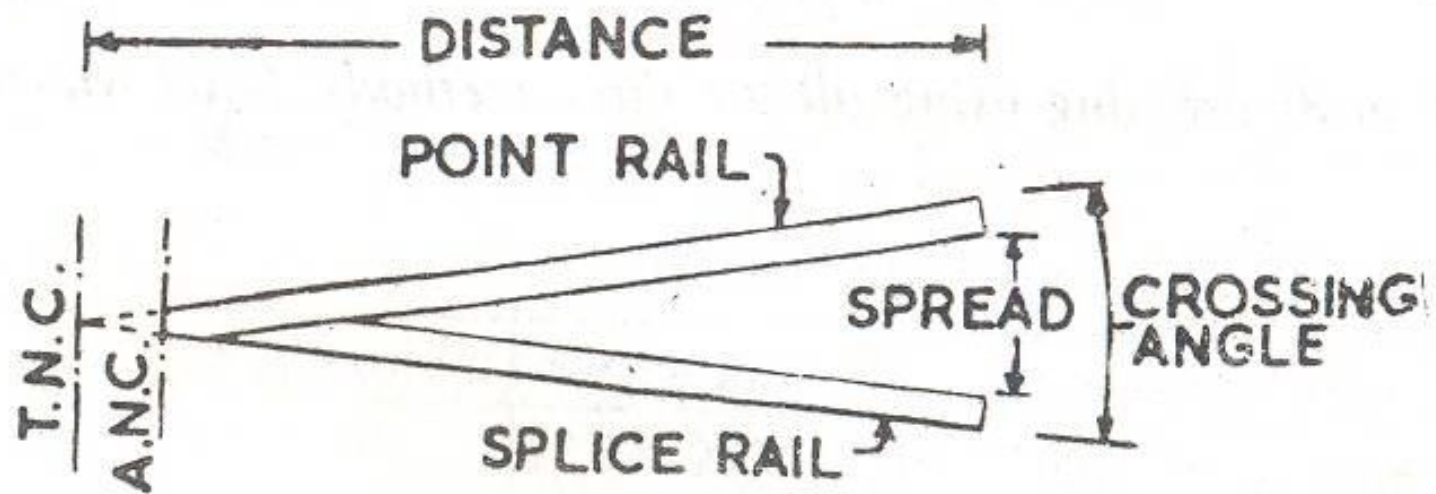
- As a rough rule, permissible speed in **miles per hour** is kept less than **twice the number of crossing**
- Speed over **1 : 10 crossing** should be kept below **20 mph**.
- The angle between **gauge faces of point rail and splice rail** is **angle of crossing**.

There are three method to set crossing angle

- **Right angle method (Cole's Method)**
- Centerline method
- **Isosceles Method**

Size and Angle of Crossing

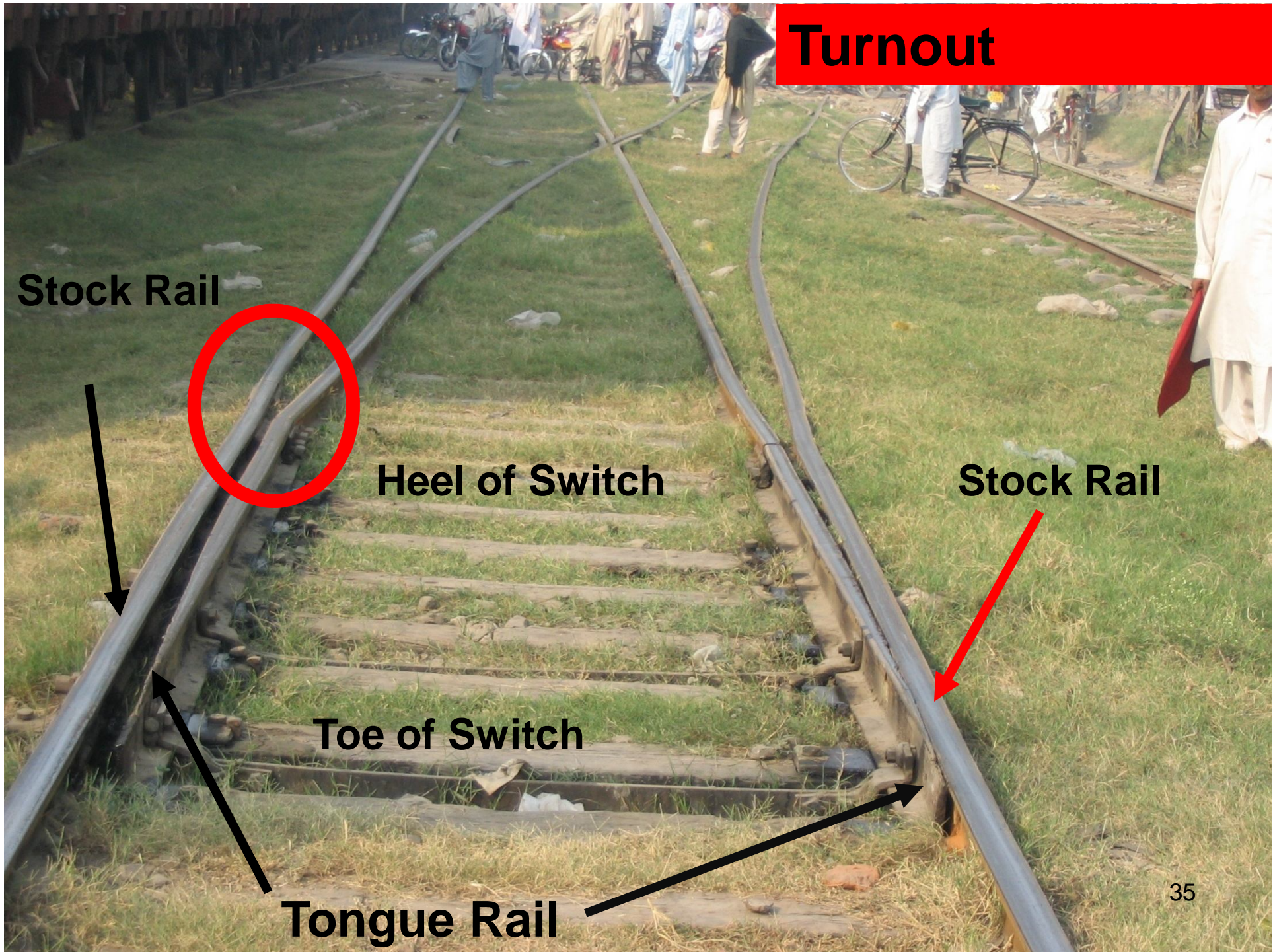
- Find out the values of crossing angles for 1 : 12 and 1 : 8.5 by three methods.



Switch

- Switch is the combination of stock rail and tongue rail.
- The distance between stock rail and tongue rail at the heel of switch is heel divergence.
- Heel divergence value depends upon flange clearance and width of rail head.
- The value of switch angle depends on heel divergence and length of tongue.
- For BG heel divergence varies from $5\frac{1}{4}$ " to $5\frac{3}{8}$ "

Turnout



Length of Switch

- Crossing Size

– 1 :16

– 1:12

– 1 in 8.5

- Length of Switch

– 32 ft

– 21 ft

– 15.5 ft

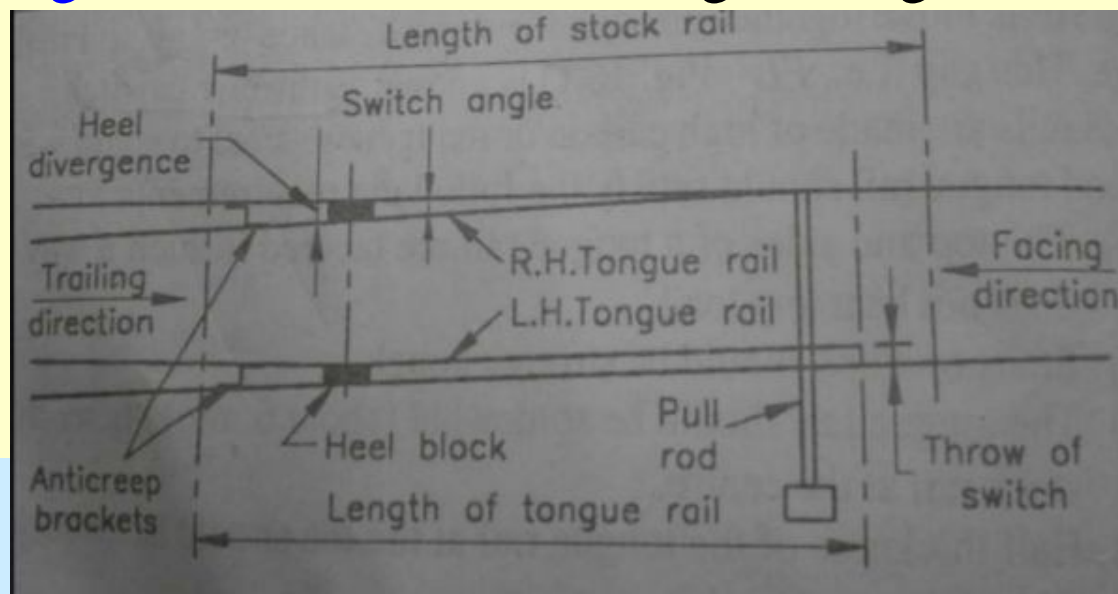
Types of Switch

- Stub Switch (obsolete)
 - It is old design
 - They do not have separate tongue rails rather than stock rails move inward
- Split Switch
 - Loose heel type
 - Fixed Heel Type

Switch

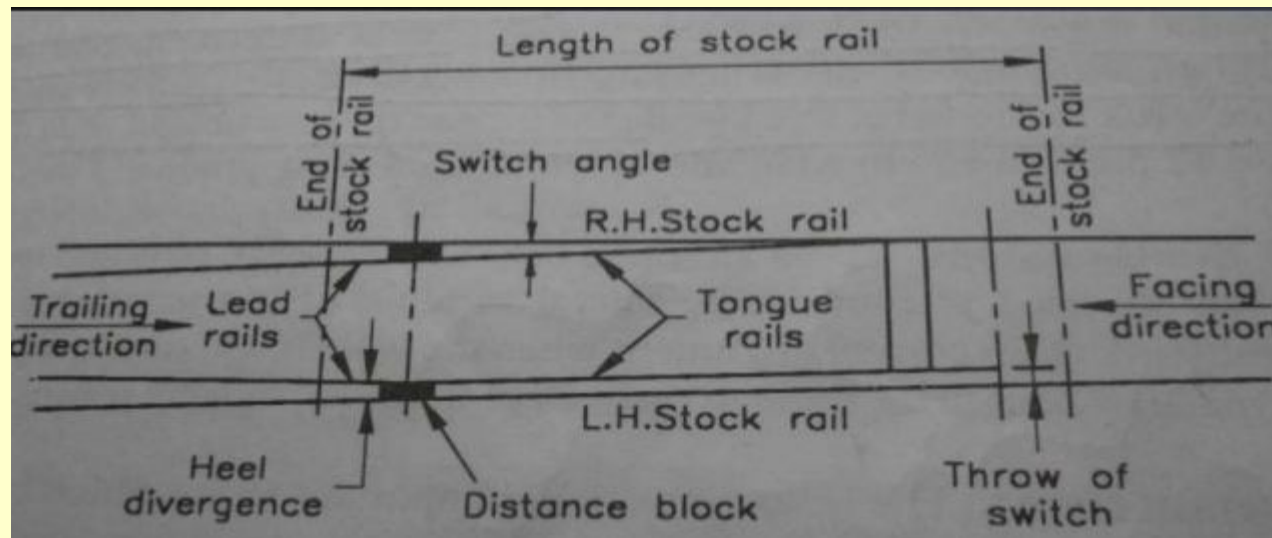
- Loose Heel Type

- In this type, the rail pivots about the **heel joints** held by **blocks and fish plates**.
- The tongue rail **finishes at the heel of the switch**
- **The fish plates holding the switch rail is slightly bent.**
- The disadvantage of this type of switch is that due to **abrupt change of curvature**, the rolling stock get a knocking.



Switch

- Fixed Heel type
 - The tongue rail does not end at the heel of switch rather it is extended beyond it.
 - The movement at the toe of switch is made possible by the flexibility of the tongue rail.

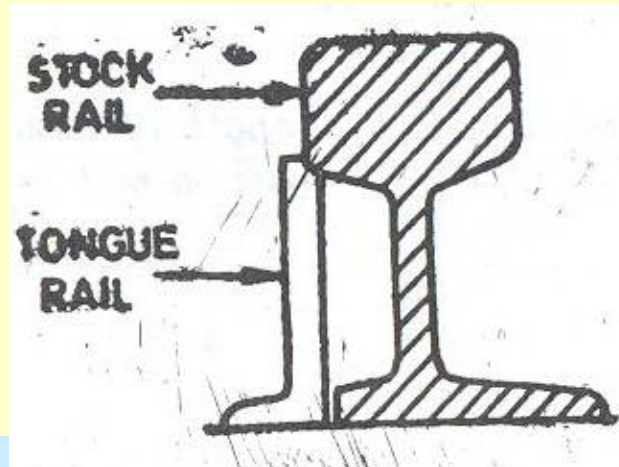


Types of Switch Based on Shape

- Undercut Switch
- Striahtcut Switches
- Over-riding Switch

Undercut Switch

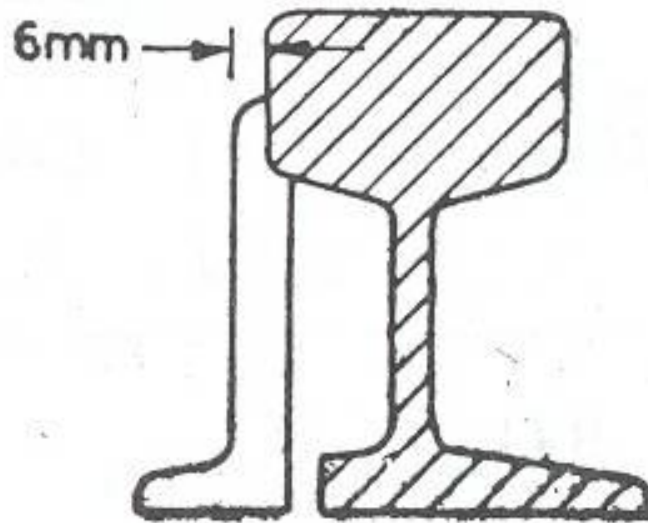
- The tongue rail at the toe of the switch is planed so that the **toe is accommodated under the head of the stock rail**



Types of Switch Based on Shape

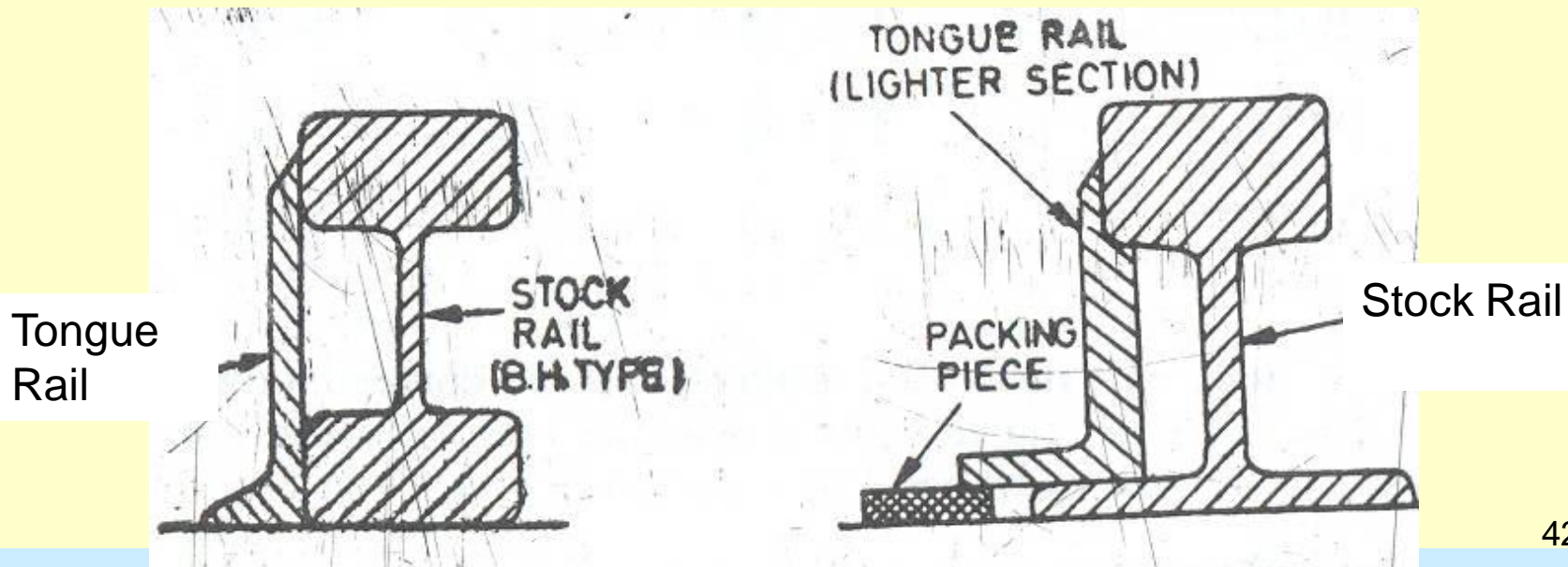
Undercut Switch

- In modified section, half web of the tongue rail is below the head of the stock rail and the width of top of tongue rail is increased. This modification reduces the splitting tendency of tongue.



Types of Switch Based on Shape

- Straight Cut Switch
 - The tongue rail is kept **slightly in line with the stock rail**. This is usually provided for **Bull headed rails**
- Overriding Switch
 - The **tongue rail** slides over the foot of the **stock rail**.



Types of Turnout

- Double Turnout
- Diamond Crossing
- Symmetrical split
- Crossover
- Gathering Lines
- Gauntlet Track
- Temporary Diversion

Double Turnout

- This is also known as **tandem turnout**. Two turnout takes off from the main track.

Diamond Crossing

When **two track of same gauge** or **different gauge** cross each other at an angle less than 90 deg. **Two angles are acute** and **two angles are obtuse**

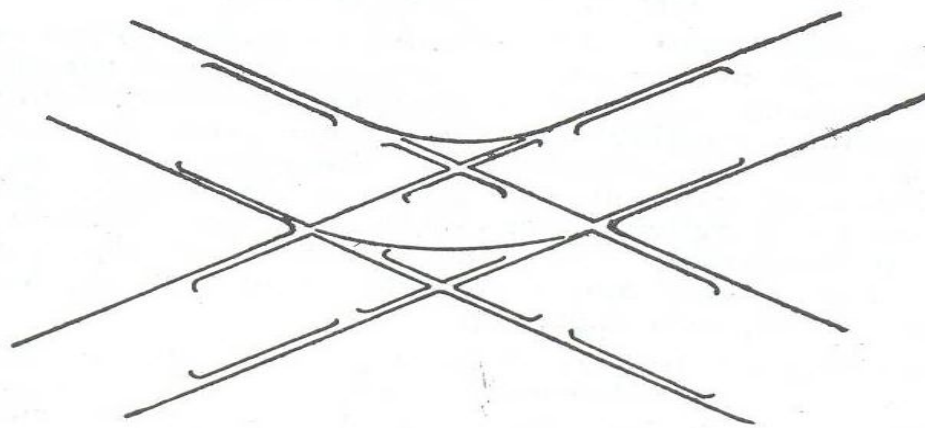
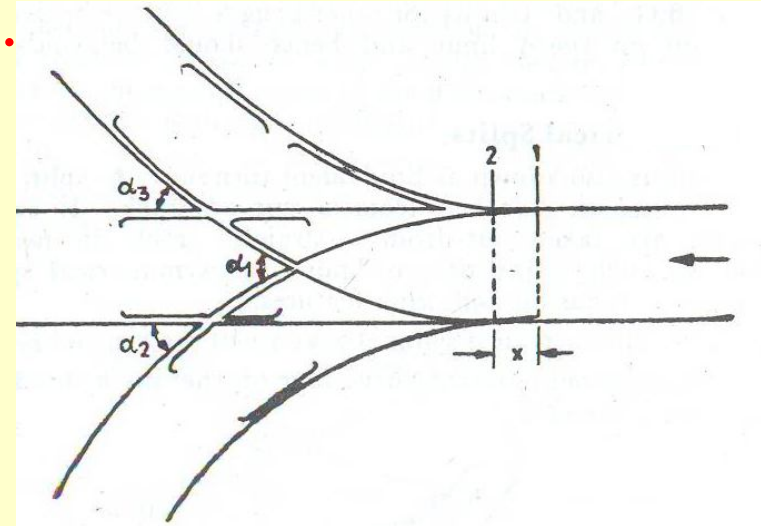


Fig. 5·10 (c). Diamond crossing.

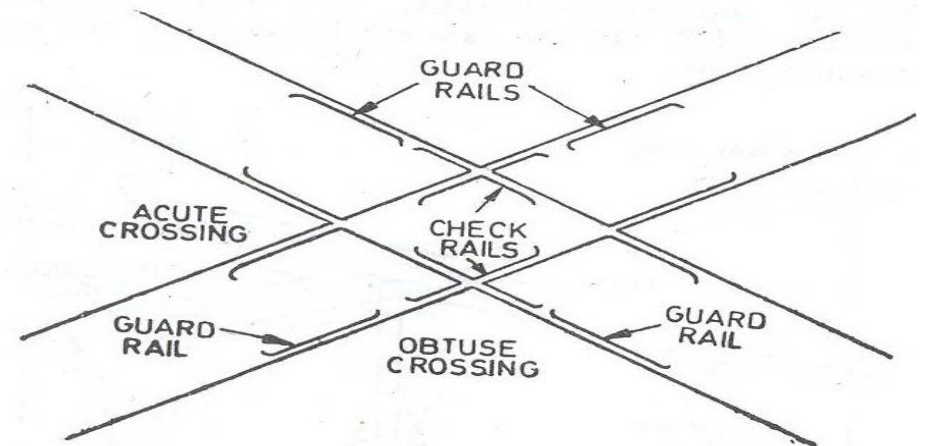


Fig. 5·10 (b). Obtuse angle crossing.

Double Turnout

- This is also known as **tandem turnout**. Two turnout takes off from the main track.

Diamond Crossing

When **two track of same gauge** or **different gauge** cross each other at an angle less than 90 deg. **Two angles are acute and two angles are obtuse**

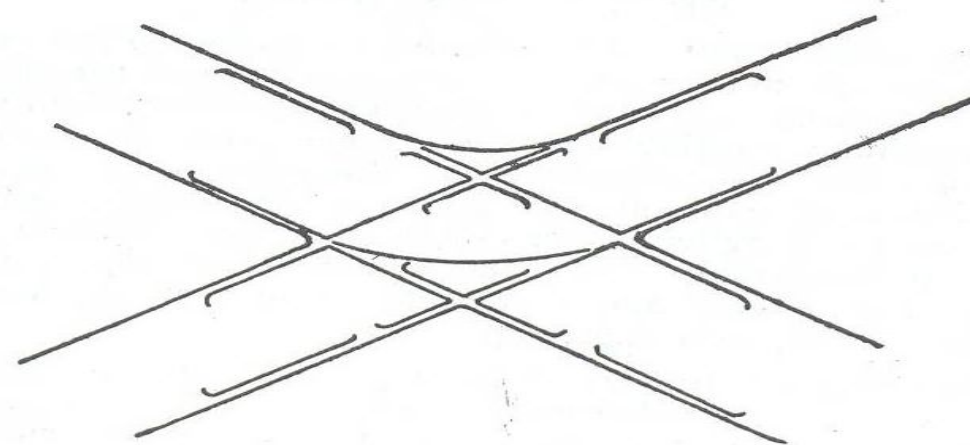
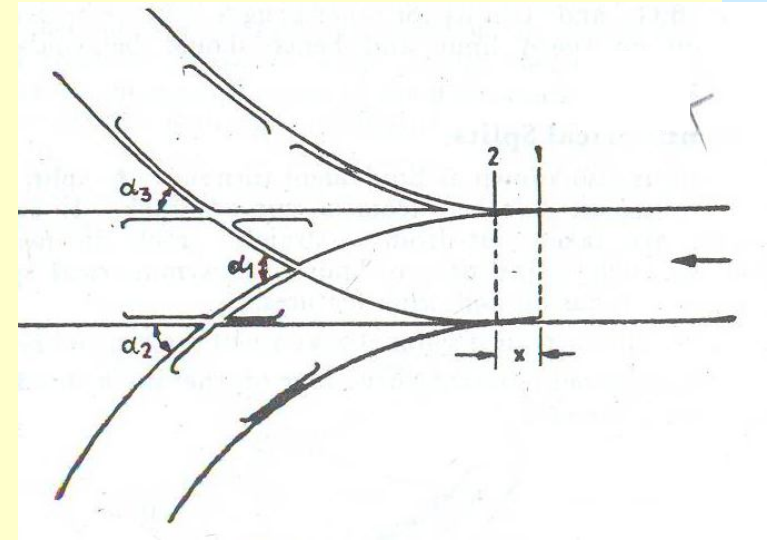
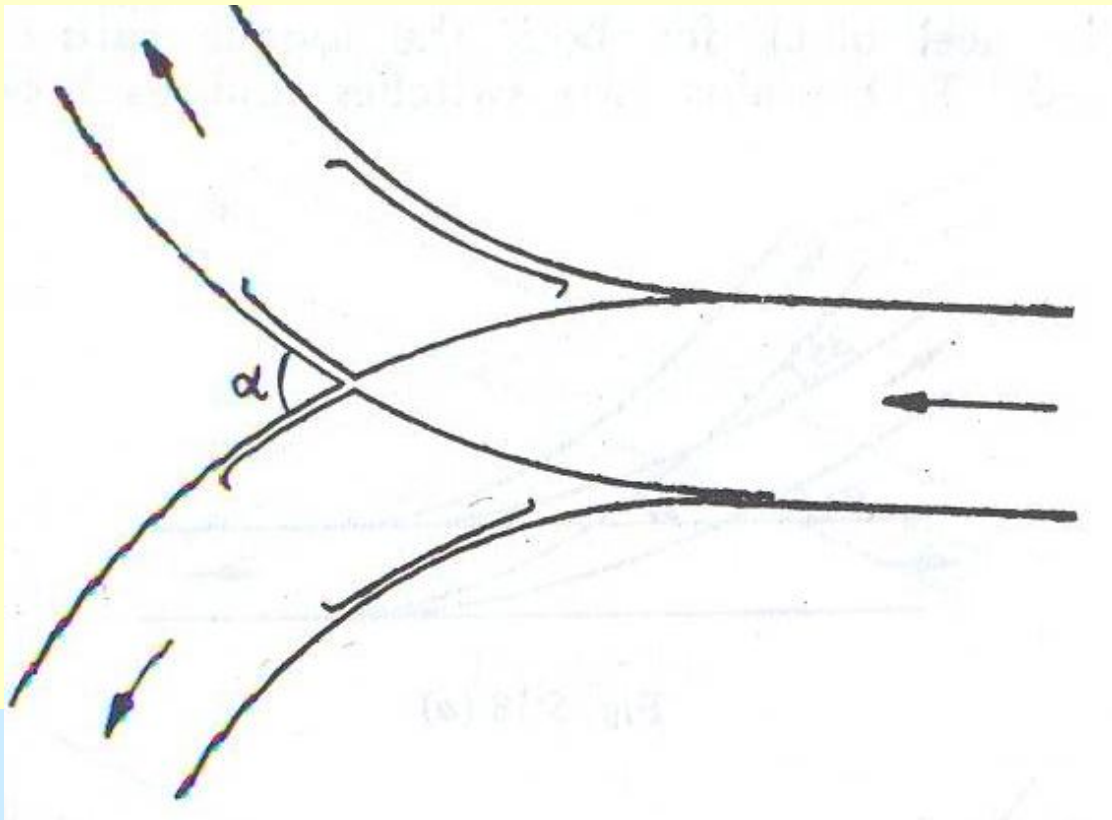


Fig. 5.10 (c). Diamond crossing.

Symmetrical Split

- This is also known as **equivalent turnout**. If two similar turnouts are taken out from the **straight track** in **two different directions** such a junction is known as **symmetrical split**.



Cross Over

- Transfer of a train from one continuous track to another continuous track. The track may be or may not be parallel to each other. Crossover consists of two sets of point and crossings.

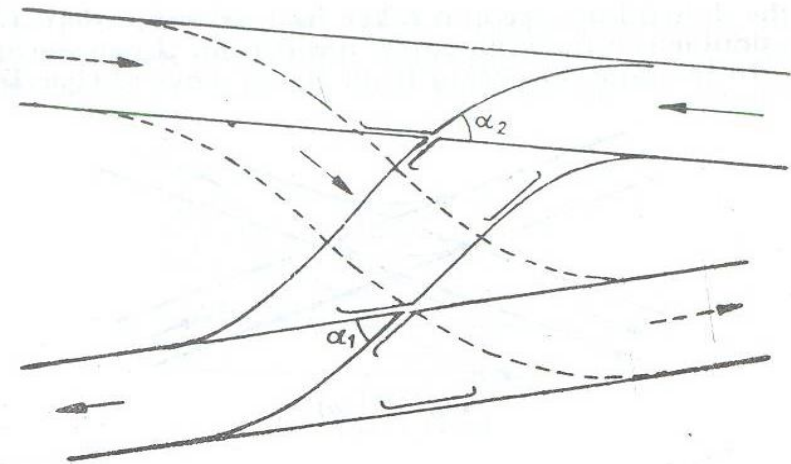


Fig. 5·20 (b). Cross-over (Diverging) track

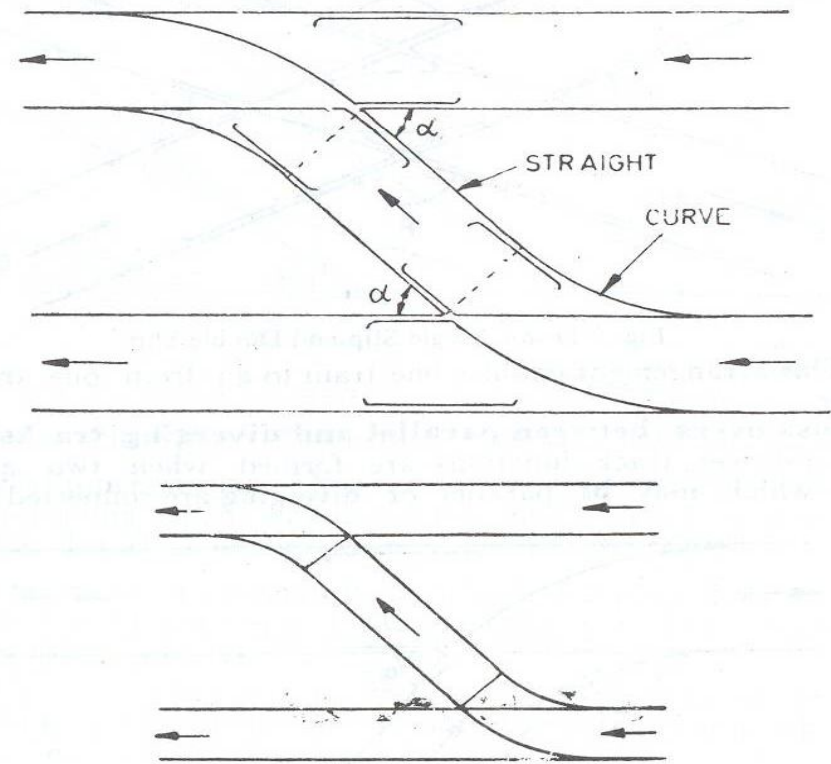
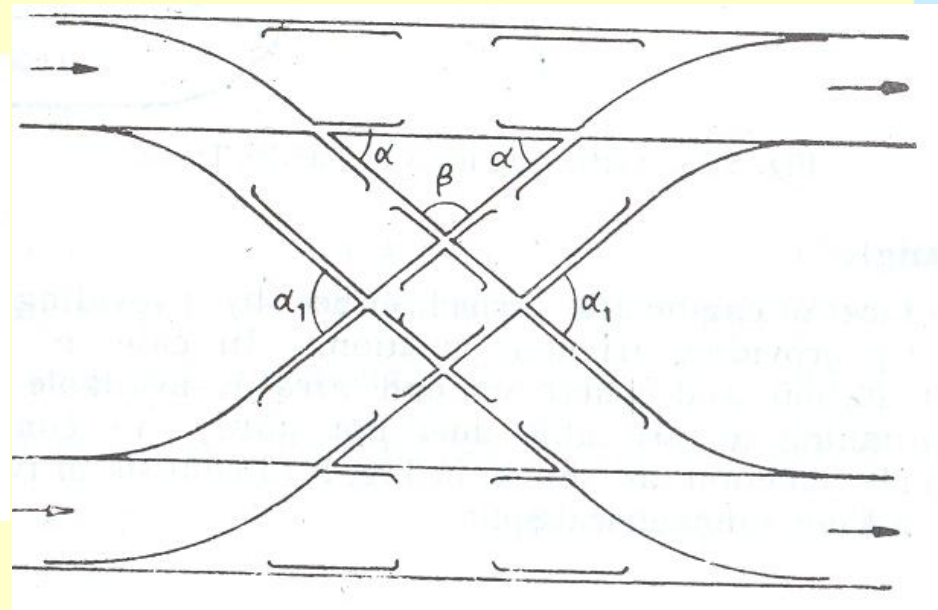
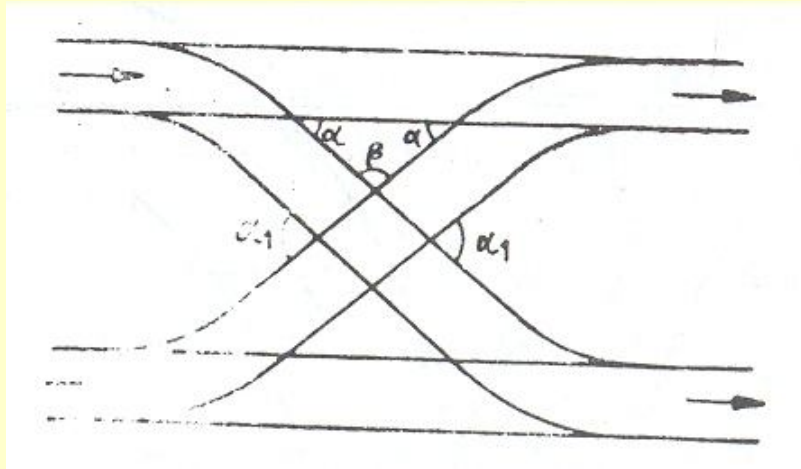


Fig. 5·20 (c). Cross-over with straight length and curve.

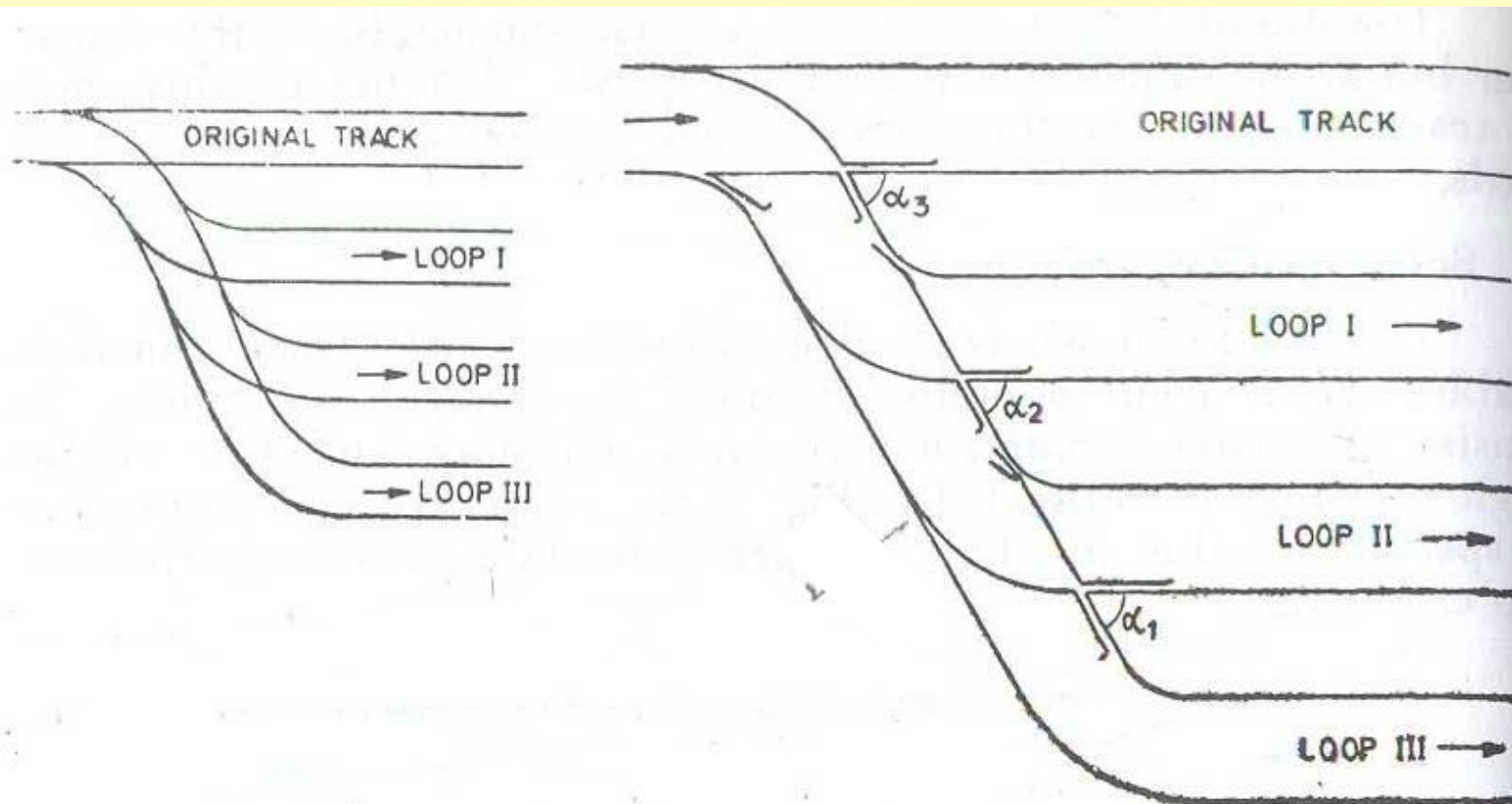
Scissors Cross-over

- This is also known as **double cross-over**. **This track junction enables trains from opposite direction to change the track.** If the space is insufficient, scissors cross-over is provided.



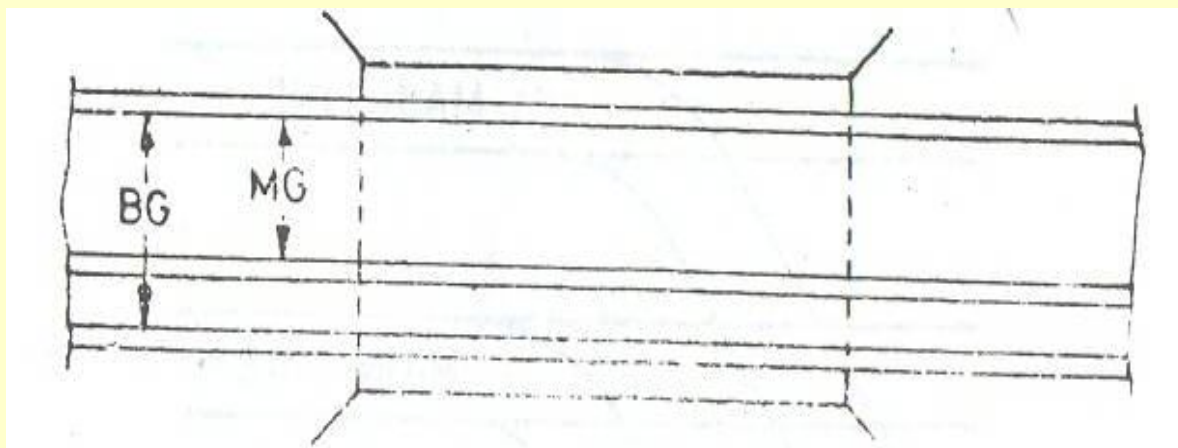
Gathering Lines

- When a number of parallel lines are connected together with the main track, the connecting line is called gathering lines (ladder lines).



Gauntlet Track

- The track which essentially is super-imposition of one track over another. When two lines of different gauges are required to cross a common bridge. In this case three rails laid for two tracks, one rail common to both of them. This arrangement saves the cost of an extra bridge.



Temporary Diversion

- Whenever certain stretch of the track has to be closed for one reason or the other, the traffic is diverted by providing a temporary diversion.

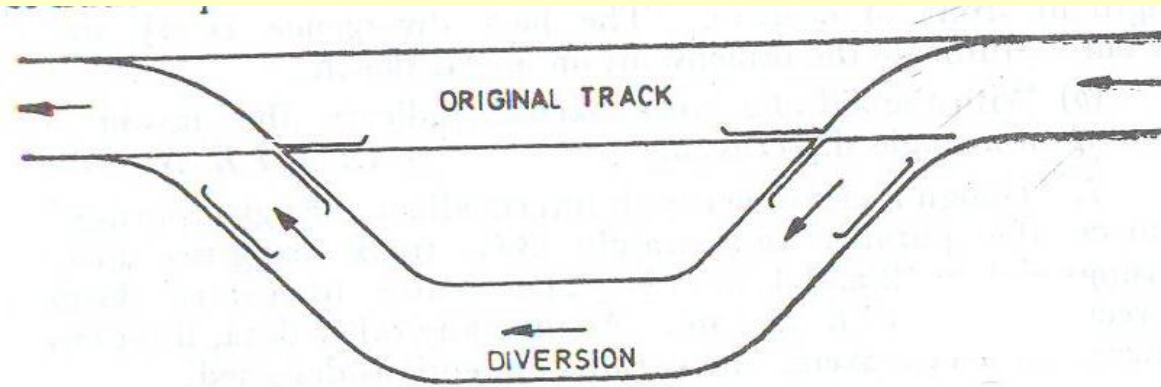


Fig. 5·27 (a)

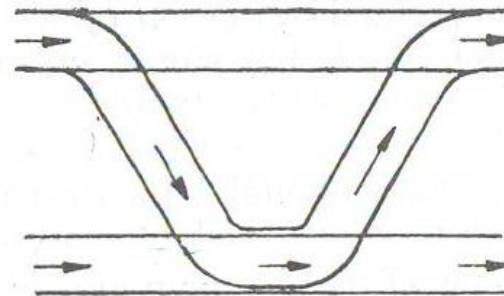


Fig. 5·27 (b). Temporary Diversions.

Station and Yards

Station means any place on a railway line, where

- Traffic is dealt.
- Authority to proceed is given to trains.
- Movement of the train is controlled to avoid accidents.

Requirement of Railway Station

The general features for a railway station can be classified into following categories

- General
- Public
- Traffic
- Locomotive

Requirement for Railway Station

General

- Suitable approach roads to station, offices for the staff

Public

- Waiting room, Mosque, booking office, platform, Sanitary arrangement, Water supply, Restaurants, Telephone, parking

Traffic

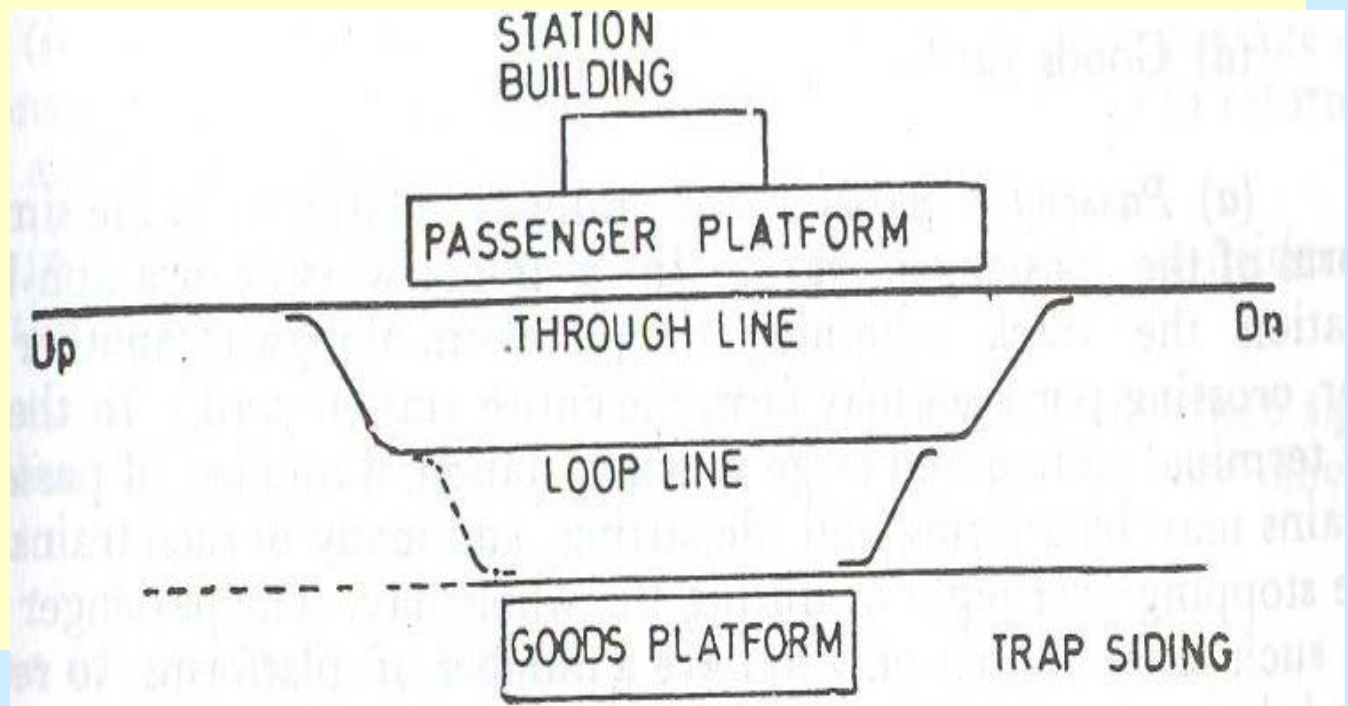
- Signals, sidings / side loops

Locomotives

- Watering, fueling, inspection and repair, arrangement to change the direction of locomotive

Layout of Single Line Station

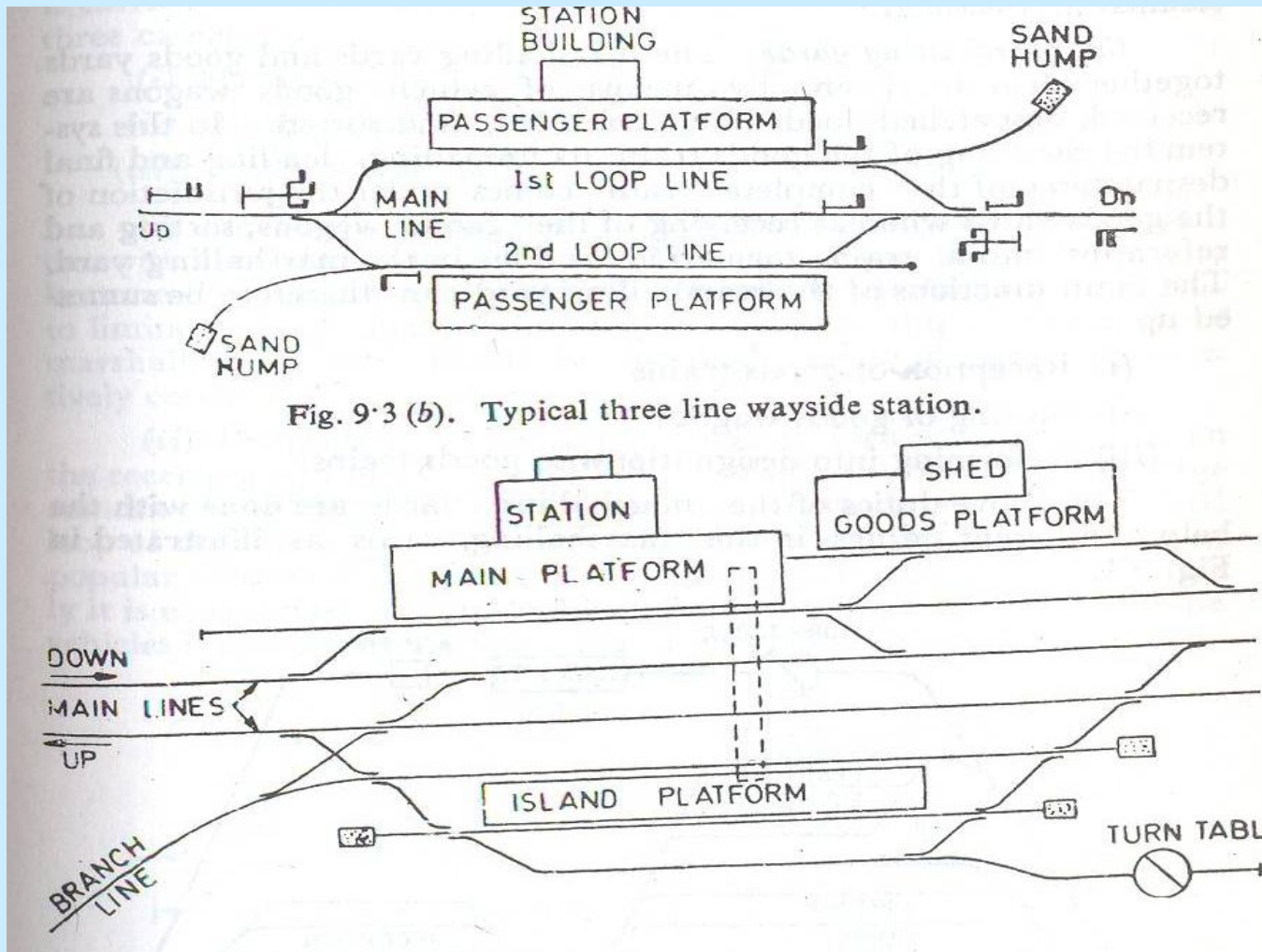
- By single line we mean running track is one but **additional loops or siding** are provided for the crossing of trains or for the **parking of goods trains**. **Turnout** are used to divert the train from main line to branch line.



Layout of Double Line Station

- Double line station is one in which **two running tracks** are there. **Crossovers** are provided between the **two main tracks**. **Advantage of double line station that if the two trains are running in the same direction, then we have the facility, that the fast moving train can pass the slow moving train without any disturbance.**

Layout of Double Line Station



Junction

- Junction is a station where a **branch line track meets with the main line track** or any other combination. **Special arrangement are made for interchange of traffic between branch line and main line.**
- Terminal is a station at which a **railway line or one of its branches terminates or ends.**

Dead End / Buffer Stop

- **It is provided where the track ends.** **Buffer is a spring loaded device which absorbs the shock** in case the train touches it.

Terminal

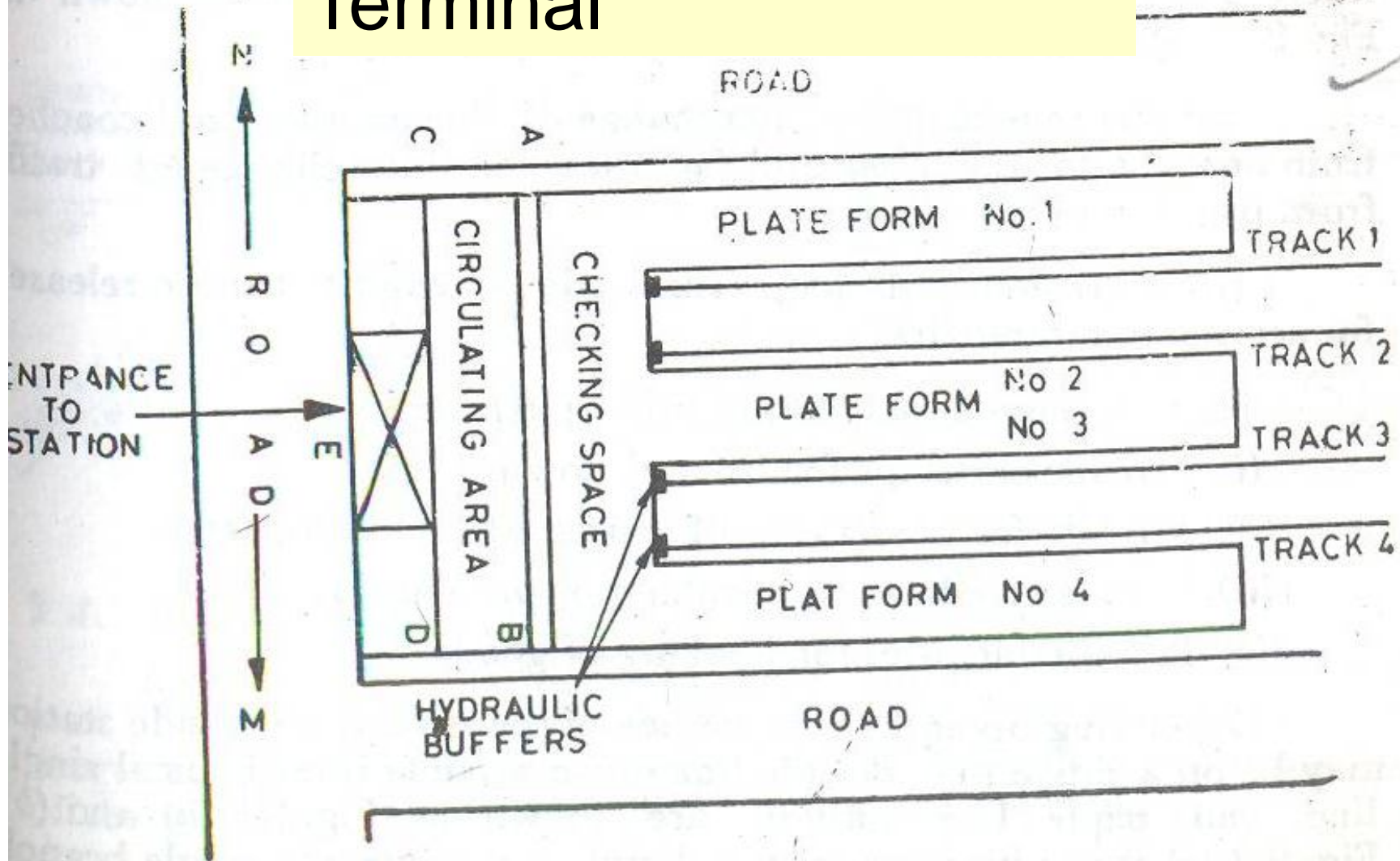


Fig. 9.1. Typical Terminal Junction.

Buffer Stop



Platform

- Passenger Platform
- Goods Platform

Passenger Platform

- Minimum width = 12 ft (The width varies but min is 12 ft beyond which buildings are constructed)
- Length= The length should not be less than longest passenger train
- In Pakistan, length is 600 – 1000 ft.
- Minimum height above the rail level is 2.5' to 2.75'.

Good Platform

- Height of the good platform is more than the height of the passenger platform.
- Normally, the top of the good platform must be flush with the floor level of the good wagon so that bulky articles can easily be loaded in the wagons.

Yards

- Yard is the **network of tracks** laid within definite limits **for sorting of vehicles and making up of trains.**
- **Yards are usually laid on level ground** as gradient in case of yards is not desirable. Normally 1 : 1000 is recommended and in difficult situation 1 in 400.
- Layout of the yard depends upon **passenger traffic**, **goods traffic** and the type of traffic.

Railway Yard can be divided into

- Passenger Yards
- **Goods Yard**
- **Marshalling yard**
- **Loco yard**

Railway Yard



Passenger Yards

- The function of the **passenger yard** is to provide facility for the **movement of passengers and vehicles for passengers.**

Goods Yards

- A goods yard has to cater for the **receipt, loading, unloading and delivery of goods and movement of goods vehicles.**
- **This portion includes facility for goods traffic, loop lines, goods shed and machinery for loading and unloading of bulky vehicles.**

Locomotive Yards

- It is the space where facilities have to be provided for **service and inspection** of locomotives.
- **The loco yard contains a number of tracks leading engine to shed, inspection pits, repair pits, turntable, repair shed, water columns for filling water etc.**

Marshalling Yards

- Marshalling yards are used for the **sorting of the goods vehicles and to arrange the wagons**, in order of their destination. Marshalling yards are the **distributing centers**.
- Empty wagons are also kept in **marshalling yard and dispatched to different stations** as and when required.

Design Requirement of Marshalling Yards

- Marshalling yards should be designed in such a manner that shunting operation does not disturb the schedule of the regular trains.
- It should be located parallel to the main line.
- Marshalling yard should be designed in such a way that maximum number of wagons, are dispatched to their destination in short time.
- Movement of vehicle should be preferably in one direction so that process will be easier and conflicts are the minimum.
- Necessary repair facilities should be provided in marshalling yard.

Layout of Marshalling Yards

It consist of

- Reception Siding
- **Sorting Siding**
- Departure Siding

Reception Siding

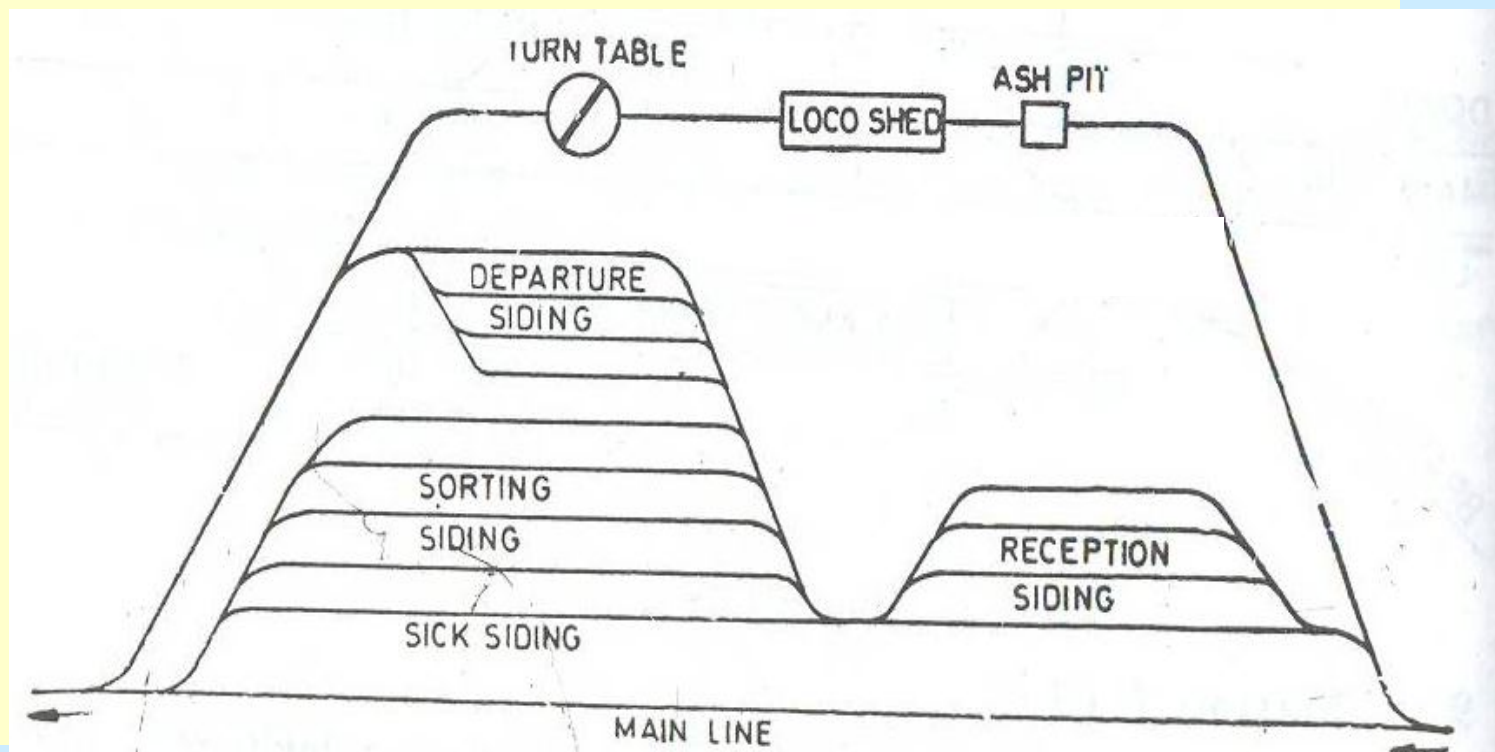
- These are sidings where the **incoming good vehicles are received and wait** for their turn for **shunting operation**.
- The shape of reception siding are in the **form of a grid** and **their lengths are kept equal**.

Sorting Siding

- These are the sidings where **shunting operation** is carried out.
- Each **track of the siding** is allotted to wagons **bound for one particular destination**.
- From **reception sidings** train go to the **sorting sidings**.
- Their number depends upon on the **number of destinations or group of stations** to which **wagons have to be dispatched**.

Departure Siding

- Departure sidings are optional, these would depend upon the intensity on the main track.
- If the main track is busy then we have **departure siding**. It is also in the form of grids as the reception siding



Yards based on Topography

Depending upon the topography marshalling yards are

- Flat Yard
- Gravitation Yard
- Hump Yard

Flat Yard

- In flat yard, **all movements of the wagon** is carried out **with the help of engines**. Such yards are wasteful in the **use of engines** and are only justified where **space is limited**.

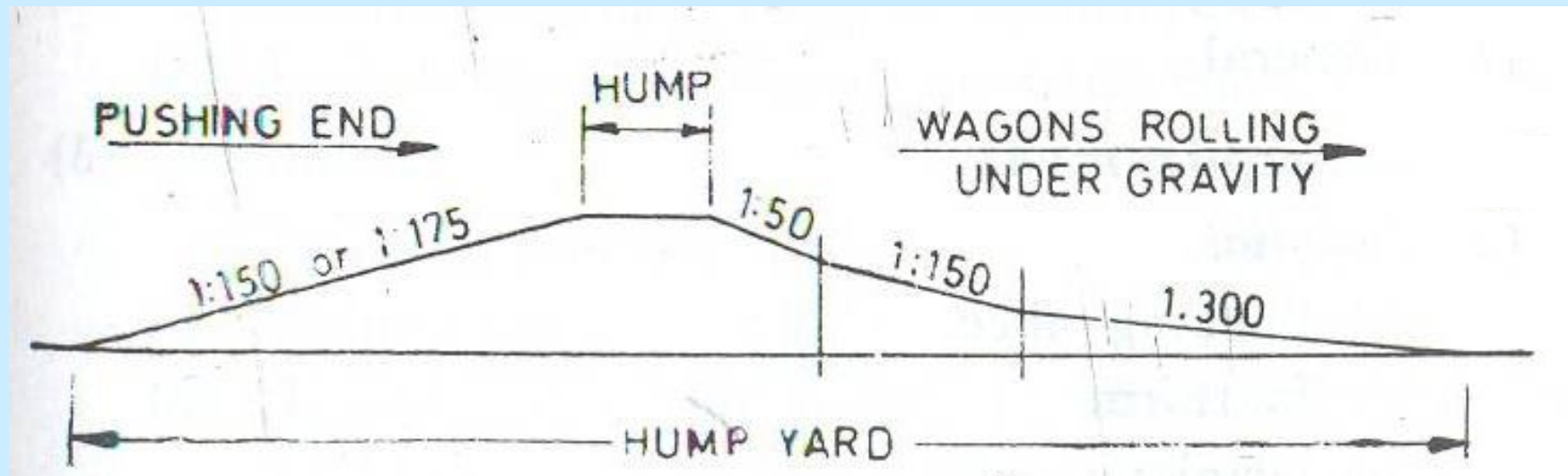
Gravitation Yards

- In gravitation yards, the track are laid at **suitable gradient** and the **wagons are moved under gravity force**. The movement is controlled by the **wagon brakes**. This is ideal type of **marshalling yard** but is handicapped due to topography of the area.

Hump Yard

- A hump yard is one in which the wagons are pushed up a summit by an engine and **gravitate down the opposite slope** into various sidings.

Hump Yard



Site selection for railway Station

- The proposed site should be on a **fairly level ground** with **good drainage facilities**.
- It should be near **town or city**.
- **Sufficient area for** future development
- **It should be able to serve the needs for civil and military authorities.**
- The site should be such that **permissible gradient should be easily attained**.

Construction of Permanent Way

- Land Acquisition (temporary and permanent)
- Earthwork (formation, ballast, sleepers, rails)
- Construction of Bridges
- Construction of Station Building and Staff Quarters
- Plate Laying
- Ballast Laying

Plate Laying

- The operation of laying out **rails and sleepers** over the compacted formation is known as **plate laying**.
- The **packing of ballast** is not covered under **plate laying** since the formation is allowed to **consolidate under the traffic** carried out by the railway line.
- In plate laying **the point up to which the track has already been laid** is known as **rail head**.
- The point from which **laying of track** is to start is known as **base**.

Methods for Track Construction

- Side Method/ Tramline Method
- Telescopic Method
- American Method

Tramline Method

- This method is used when a track already exist such as doubling of track.
- The material required for track construction are carried to the site in material trains.
- The assembly of the track component is started from one end by the manual labor.

Tramline Method

- This method can be employed for laying of new track.
- In this case construction material is carried out on trucks or temporary track
- The temporary track is placed at a lower level as compared to main track.
- The work of linking of track can be started at more than one point.

Telescopic Method

- This method can be employed for laying of new track.
- In this case construction material is carried out on trucks or temporary track. The temporary track is placed at a lower level as compared to main track.
- The work of linking of track can be started at more than one point.
- In this method rails, sleepers and fittings are unloaded from the material train as close to the rail head as possible.
- The sleepers are carried either by carts or by the men along the adjoining service roads and spread on the ballast.
- Rails are carried by rail carrier or by men.

Telescopic Method

- Labour working on the **laying of track** may be divided into three groups
 - **Material Gang**
 - **Linking- in- gang**
 - **Packing-in-gang**

Material Gang

- Their responsibility is to **unload the material** from the train and **To arrange the material item wise**
- **To transport it to site.**
- The transportation of the rail **is a specialized job** and this party is **specially trained** for this job.

Telescopic Method

- Linking- in- gang
 - their responsibility is to **fix the rails to the sleepers** and link the rail together **to the fish plates**.
- Following sequence is adopted for linking
 - Marking the centre line of track
 - **Laying of sleepers**
 - **Placing of bearing plate above the sleepers**
 - **Fixing of rails to sleepers**
 - Provision of expansion joints
 - **Joining by fish plate**

Telescopic Method

- Packing-in-gang
 - The function of this gang is to **pack the earth below and round the sleepers** and bring the track to level
 - **To bring the track to correct alignment and level.**

American Method

- This is a mechanical method. In this method **special track laying machines are used.**
- Preassembled panels of track, **each panel** consisting of rails with appropriate number of sleepers **are taken to the rail head with machinery and is linked.**





Material Depot

- In any method of linking the progress depends upon very much on correct and regular supply of material at the rail head.
- To ensure this supply, one or more material depots are established.
- The main depot is usually laid out at a convenient site near the point of junction of the new track with an existing railway.
- Materials required for the construction of new railway line are received from the material train at the main depot and are arranged at the main depot.

Material Depot

- The layout should be such that the wagons can be unloaded and removed quickly. Mechanical devices e.g cranes for unloading heavy material may also be employed.
- Minimum two sets of wagons are necessary. If one wagon is at the rail head, the other is loaded at the depot. If the distance between the rail head and depot is large, subsidiary depot near the rail head may be established.
- The stock of the material is so arranged that the correct number of each item is available for loading without any loss of time.
- The material train should be marshalled in correct order.







