RAILWAYS
Pavement elements

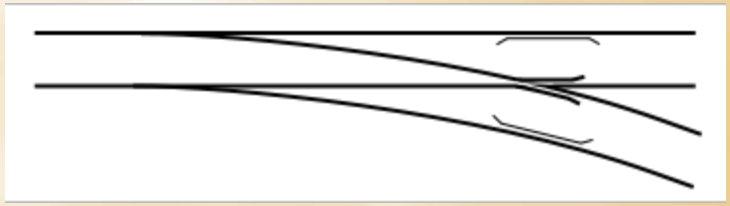
1. Turnouts
2. Ladder tracks
3. Derailers
4. Trap (run-off) points and bump stops
5. Turning tables and rail shifting machines
6. Gauntlet track

Jarosław Zwolski, PhD CE

Turnouts - types

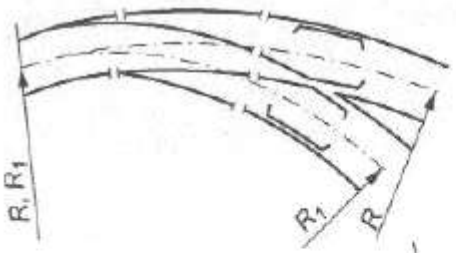
Turnout – a device enabling passage of a train from one track on another one.
Crossing – a device enabling passage of a train running on one track across another one without any possibility of interchange.
Standard turnout – a turnout enabling passage of a train from the main track (straight) on the diverging track (a). Can be right or left hand.
In case of the junction is located in curve a curved turnout is used:
(b) unsymmetric curved turnout,
(c) unsymmetric Y-turnout,
(d) symmetric Y-turnout.

a)

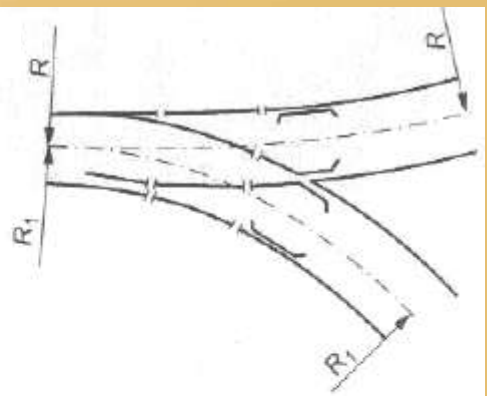


German BWG/WBG
French COGIFER (VOSSLOH)
Austrian VAE GmbH
are the most important turnouts producers in Europe.

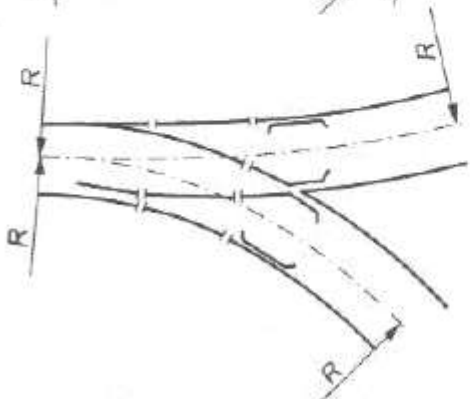
b)



c)



d)



Gallery of turnouts

Standard left hand turnout



Standard right hand turnout



Unsymmetric curved right hand turnout



Symmetric Y (wye) turnout



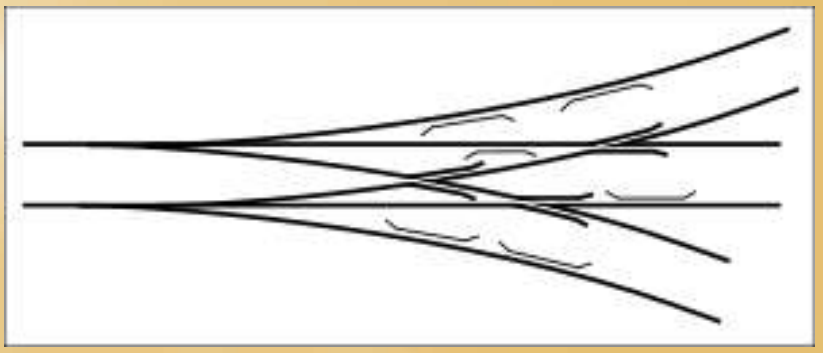
Turnouts - types

Interlaced turnout – a turnout enabling passage of a train from one straight track on two diverging tracks. Can be 1-sided (left or right hand) or 2-sided (symmetric or unsymmetric).

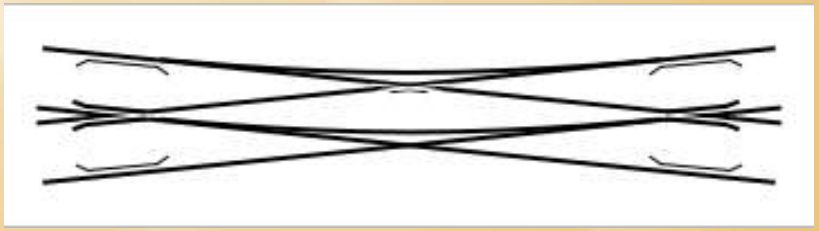
Slip – a structure enabling passage of a train moving on one track across another track with possiblity of interchange of one direction (single slip) or two directions (double).



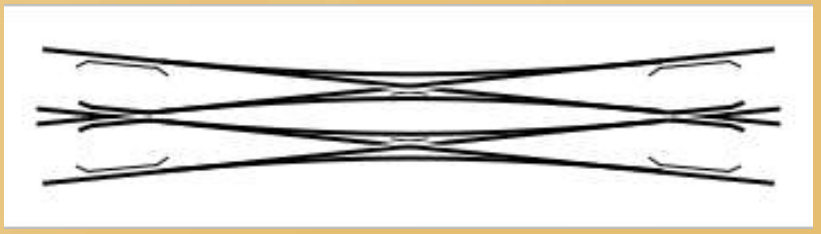
3-way turnout (interlaced, 1-sided right hand)



3-way turnout (interlaced, 2-sided unsymmetric)



Single slip



Double slip

Gallery of turnouts



3-way turnout (interlaced,
2-sided unsymmetric)



3-way turnout (interlaced,
2-sided symmetric) for narrow gauge



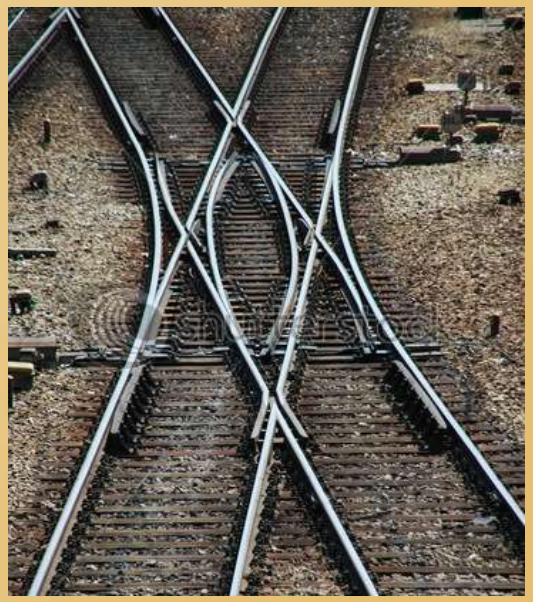
3-way turnout (interlaced,
2-sided symmetric) for tramway

Gallery of turnouts



Double outside slip (Beasler type) – obsolete

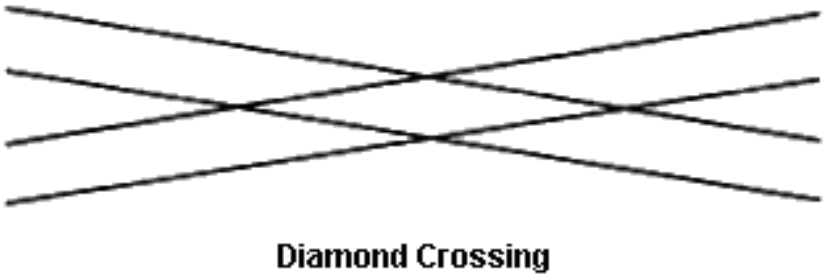
Double slip



Single slip



Crossing



Diamond Crossing



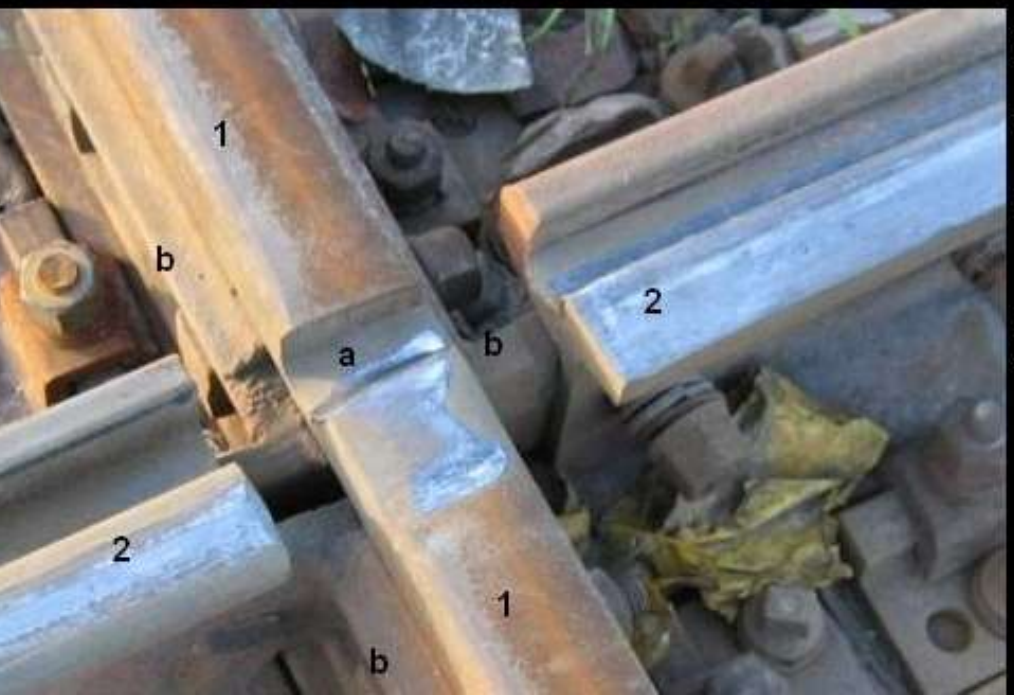
Tracks crossing at the right angle



Tracks crossing in the central part of the double crossover (scissors crossover)



Crossing of railway and tramway track



1 – railway rail S49
2 – tramway rail Ri60
a – a cut across of the head of the railway rail enabling passage of the tram wheel
b – angle frogs keeping the geometry of the crossing rails

A big noise is emmited during passage of a railway train.

Tramway turnouts



This type of double slip is called either outside slip or Baeseler double switch. The main difference between this type and former ones is that here the sets of points are moved outside the rhombus of the switch.



Usually the layout of the tram tracks in a crossroad is complex so it is designed individually.

Structure

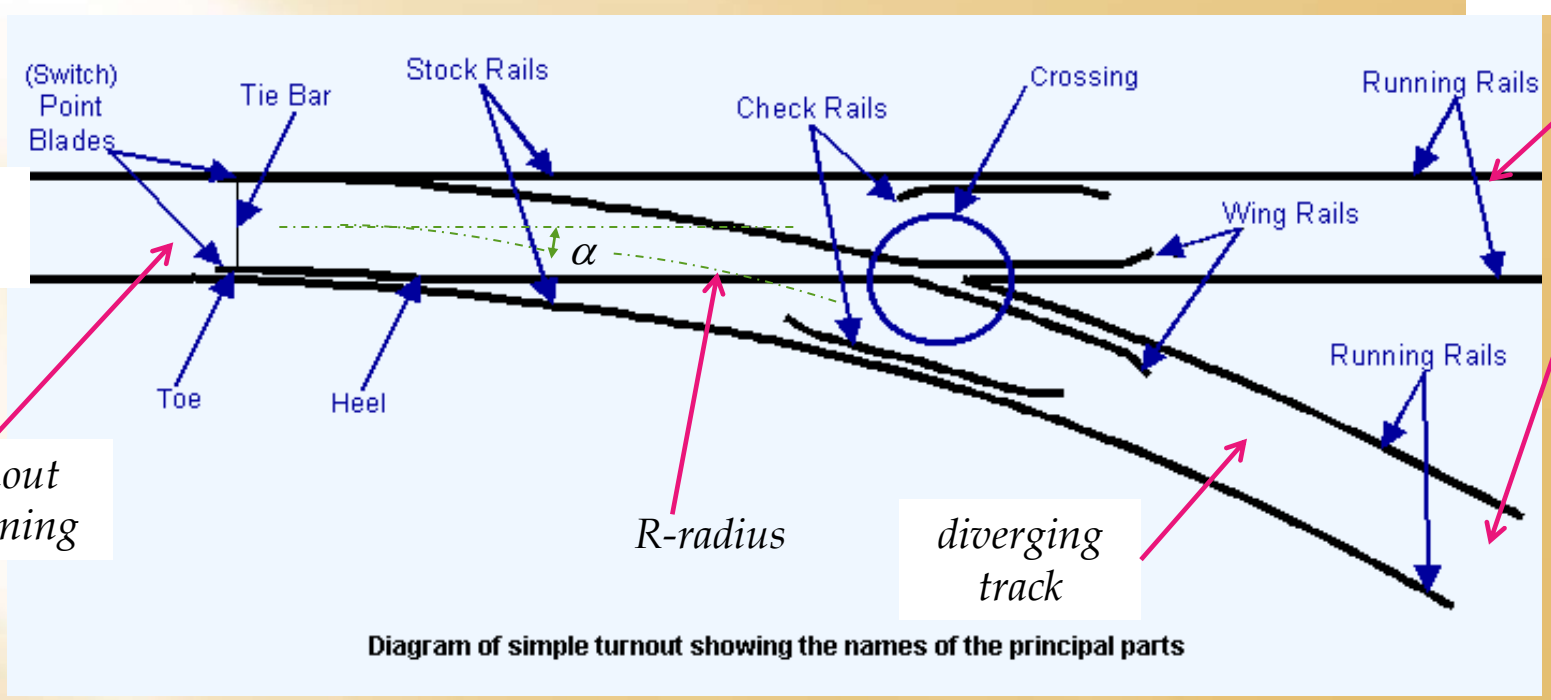


Diagram of simple turnout showing the names of the principal parts

Right hand standard turnout

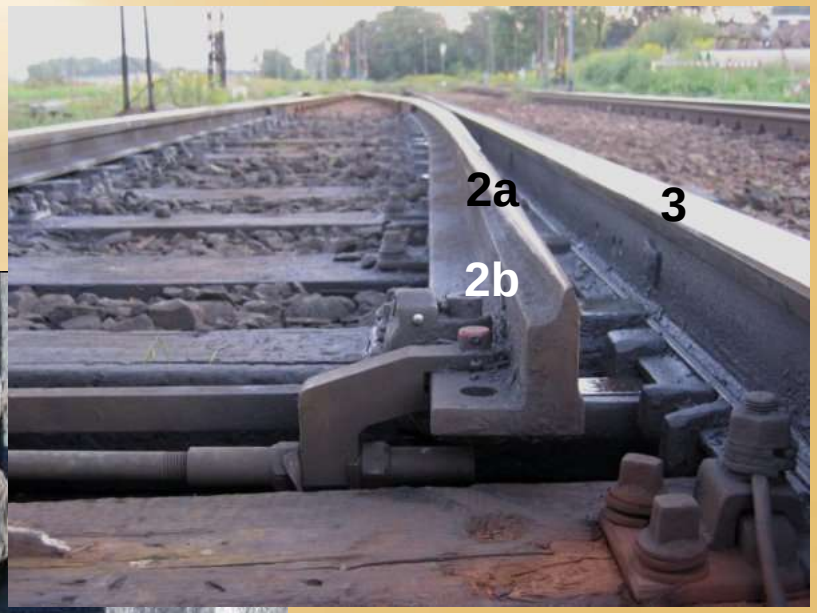


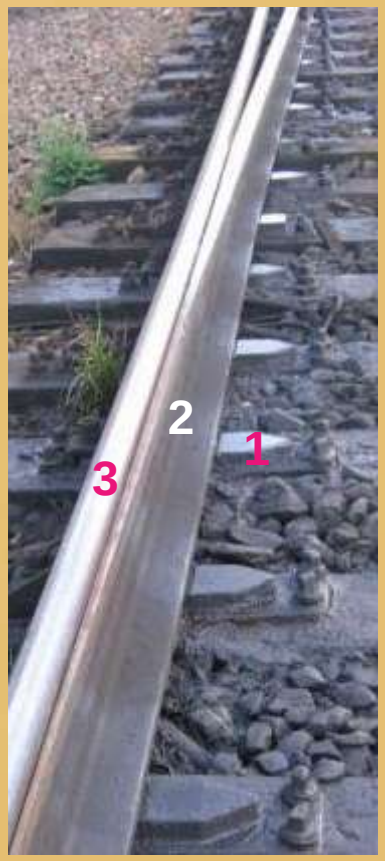
The points

The standard turnout consists of 4 parts: the switch, the linking rails, the crossing mounted in between the running rails of the adjacent tracks and the switch motor.

The switch is for directing the wheelsets on the proper track. It consists of 2 rails of a special profile moving transversally (points) and 2 fixed rails (the stock rails).

The curved point sticks to the straight stock rail and the straight point sticks to the curved stock rail.

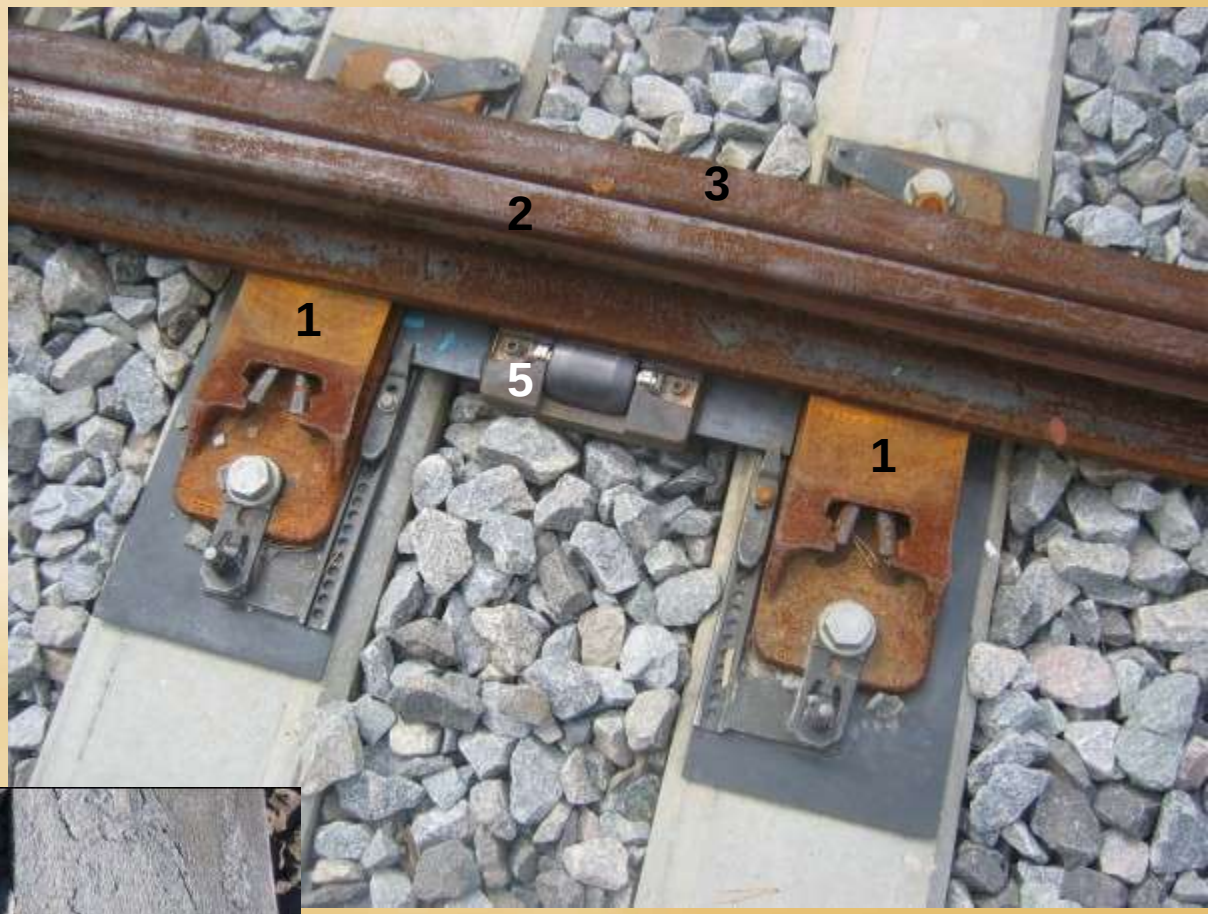






1. Sliding surface of the stool
2a. The point foot
2b. The point blade
3. The stock rail
4. The side stiffener
5. Tie bar (stretcher)

The points sliding

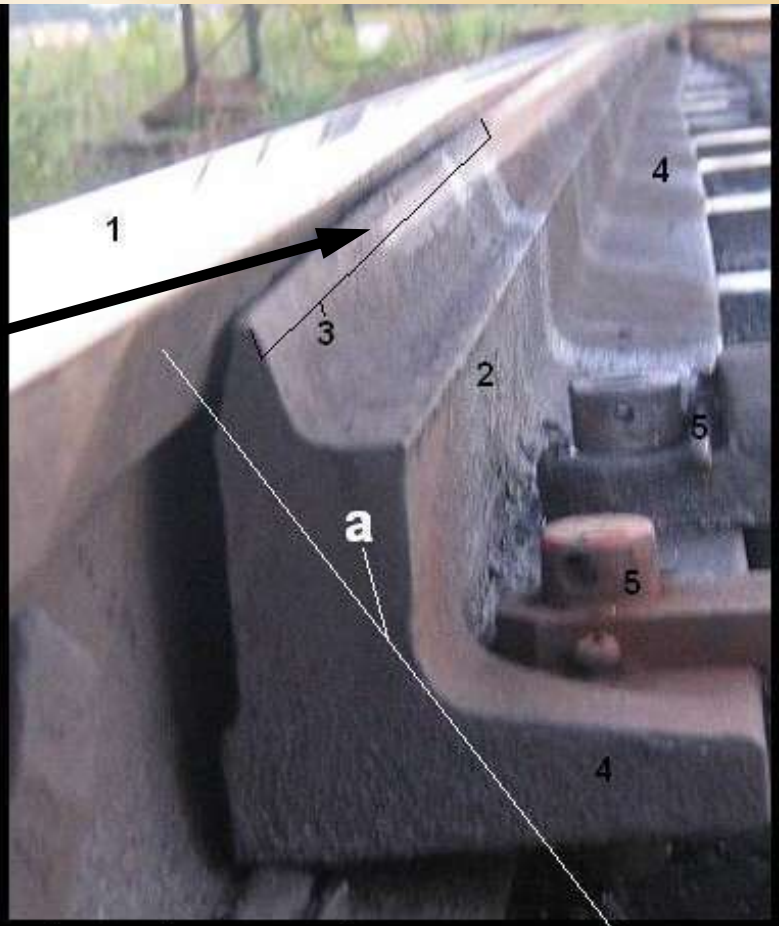


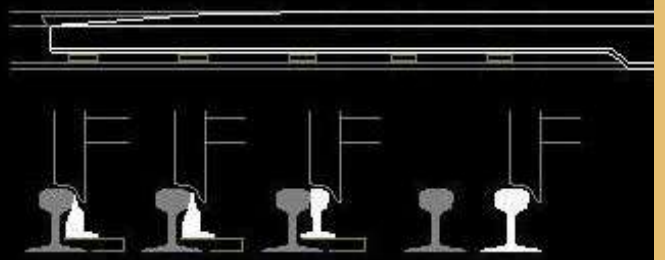


1. Sliding surface of the stool
2a. The point foot
2b. The point blade
3. The stock rail
4. The side stiffener
5. The roll

Details of the point

the point of the contact between wheel and the blade





1) the stock rail
2) the point (toe)
3) lowering of the toe
4) the foot of the point
5) bolts of the tie bar



Crossings (frogs)

The crossing is placed in the region where the rails cross each other and together with the check rails it enables the passage of the wheelset through the crucial point of the turnout.
The wing rails enable guiding the wheels and ease passing through the free space between the wing rails and the crossing nose and ensure fitting of the wheel into the proper groove of the crossing.



A cast manganese crossing in a standard UK turnout. Special base plates have to be provided at turnouts for switch blades, check rails and crossing work.



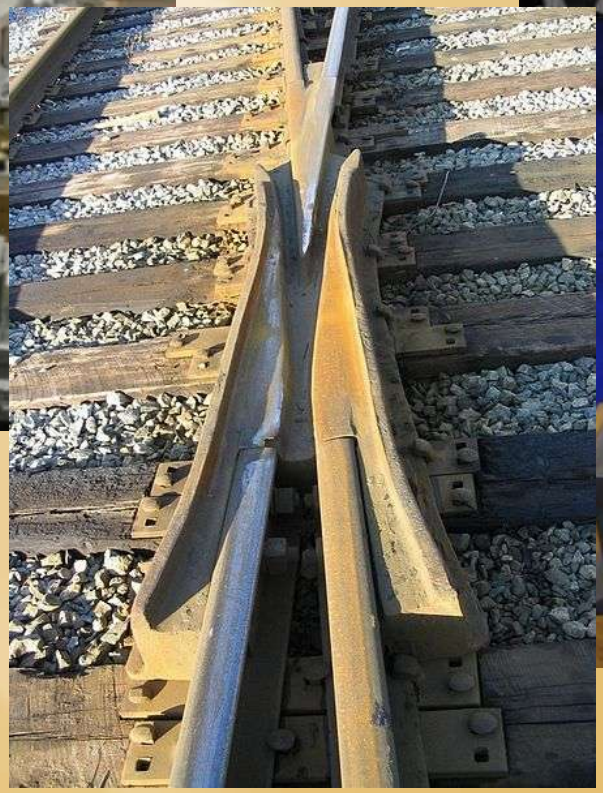
Crossings (frogs)

Two different types of crossing are used:
a) made of whittled rails put together



b) cast as one piece of manganese steel

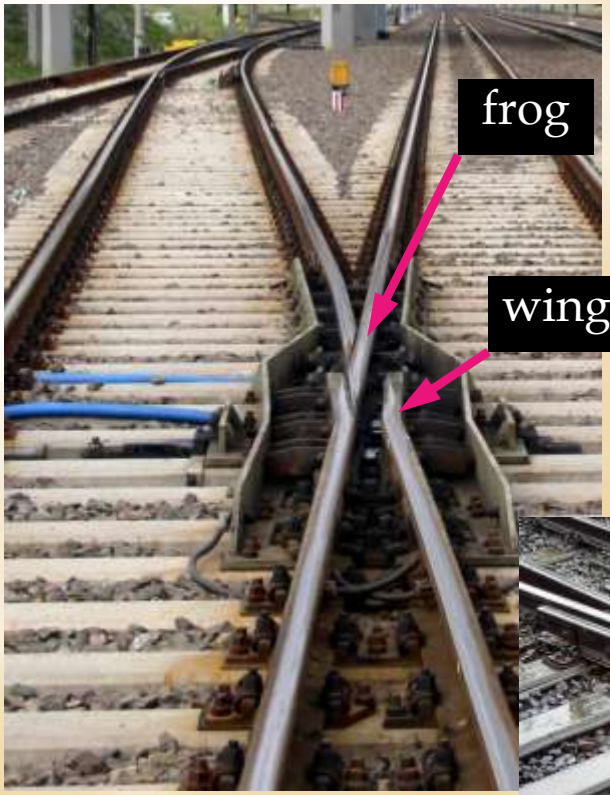




Self guarding
manganese frog

Movable crossings

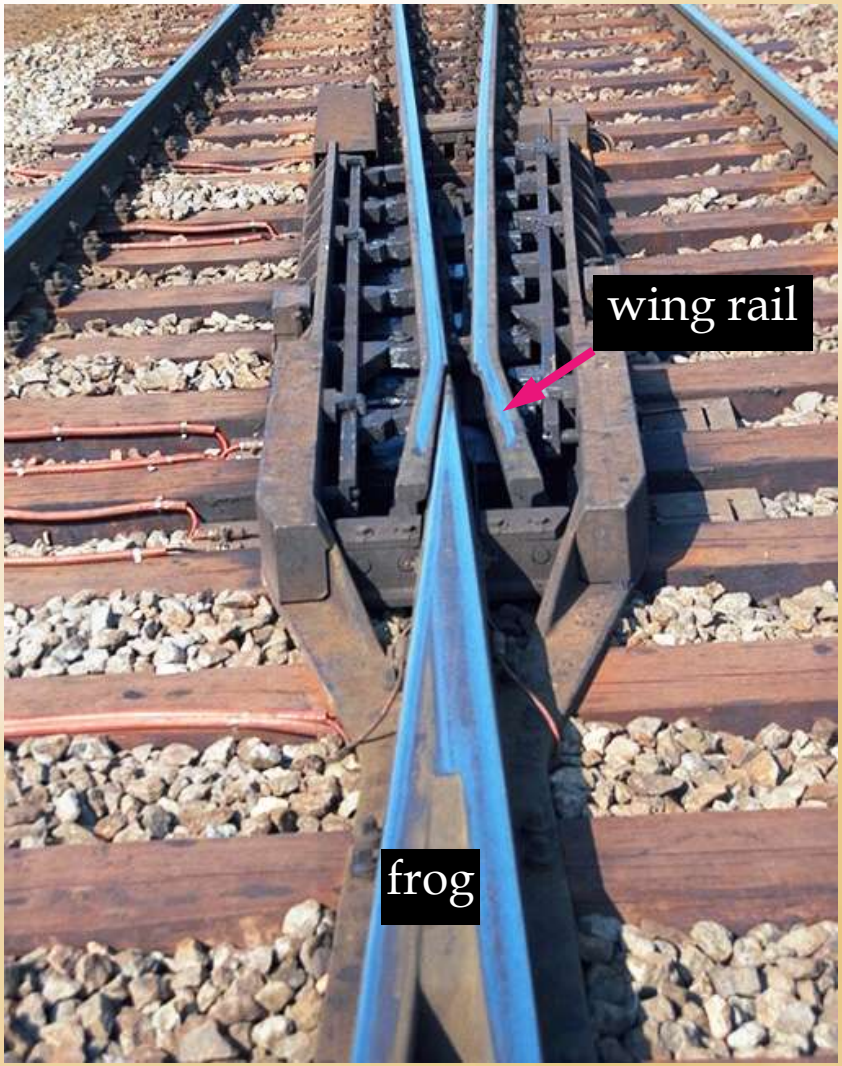
The tip of the frog can be movable in turnouts dedicated to High Speed Lines.
The allowable velocity on the diverging direction is over 100 km/h.

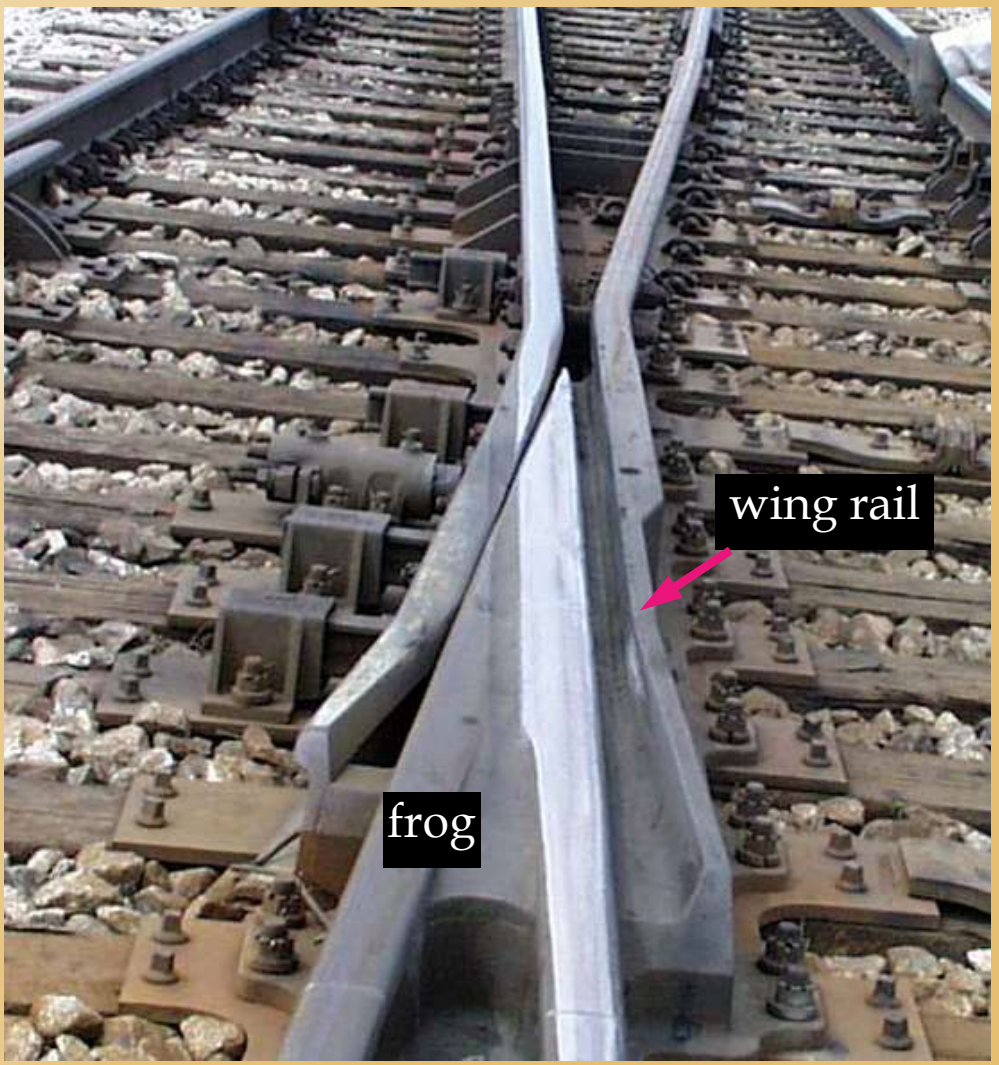




Movable wing rails

The tips of the wing rails can be movable in turnouts dedicated to High Speed Lines. In these solutions the frog is fixed.





The switch motor

The switch motor, an electromagnetic, pneumatic or hydraulic device which enables to *throw the switch*, it means to change direction of traffic. The switch motor pushes and pulls the tie bar linking the points an they stick to one or to the another stock rail. The tie bar is locked in the final position to ensure stable location of points during a train passage.



Modern switch motor with the tie bar

The switch motor



The switch motor can be used also to move the swingnose of the crossing or the wing rails in case they are movable.



Points are propelled by 3 switch motors working together. The longer the blades are, the more motors are involved to ensure the straight and simultaneous movement (1 – 7 pieces).

Mechanic control

Mechanic, local control the switch is performed by a lever with counterweight pushing the tie bar and locking the points. Over the lever the direction indicator is visible. In modern turnouts the facing points lock is used to fix the position of points.





Mechanic remote control is performed from the control tower by means of special system of levers assigned to the switches. The mechanic force is transmitted by steel ropes laid on pulleys to the switch mechanism. Turning the lever causes pulling the taut rope by around 500 mm and enables throwing the switch.

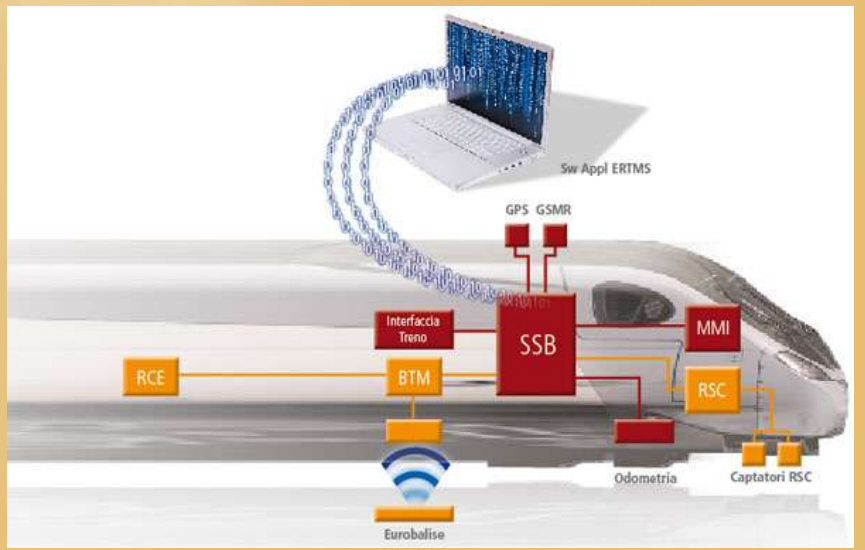
Automatic controlling the switches

On the main lines the existing control system are replaced by automatic remote control systems based on advanced electronic and computer systems.
The ERTMS system cooperates with the computer on the train.





Basel
(Switzerland)
control tower



Other elements



Layout of special sleepers supporting the turnout structure and the transition to the standard sleepers

The turnout equipped in heating device preventing from freezing of the points in winter.



Characteristic of turnout

Typical parameters are usually coded in symbols (different for national railways). For Polish designation:

Turnout type:

- standard turnout (Rz),
- 1-sided curved turnout (Rlj),
- symmetric Y-turnout (Rls),
- single slip (Rkp),
- double slip (Rkpd),
- 3-way interlaced 1-sided turnout (Rpj),
- 3-way interlaced 2-sided turnout (Rpd),
- diamond crossing (St).

Example designation:
Rz S60-300-1:9 Lssd

Configuration: right (P), left (L), right/left (P-L), left/right (L-P) - for the 3-way turnouts.

Rail type installed (S60, UIC60, 60E1, S49, 49E1).

Radius: 70, 140, 150, 190, 300, 500, 760, 1200.

Angle: for turnouts 1:4.8, 1:5, 1:6.6, 1:7, 1:7.5, 1:9, 1:12, 1:14, 1:18.5,
for crossings 1:2, 1:2.4, 1:2.9008, 1:3224, 1:343, 1:444, 1:5, 1:6.6, 1:9, 1:18.5.

Points type: spring (s), semi-spring (ss), hinged (c).

Sleeper type: wooden (d), concrete (b).

Turnouts for High Speed

For High Speed Tracks special construction of turnouts are used:

- R = 4800/2450 – 1:24.26 (v = 130 km/h),
- R = 2500 – 1:26.5 (v = 130 km/h),
- R = 10000/4000 – 1:32.5 (v = 160 km/h),
- R = 16000/6100 – 1:40.15 (v = 200 km/h),
- R = 10000/4000/∞ (v = 160 km/h) with clotoid curve,
- R = 25000/8000/∞ (v = 200 km/h) with clotoid curve.



High speed turnout as used on Japanese Shinkansen "Bullet Train" lines. There are seven point machines to move the blade rails. The turnout is designed for 160 km/h running.

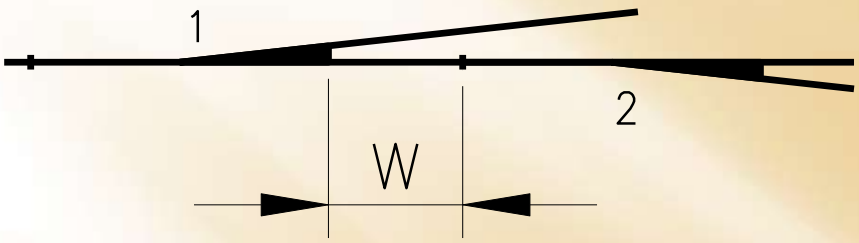
Which turnout where?

1. Standard turnout with angle 1:9 and less are allowed to use on main line, with bigger angle – only on side tracks.
2. 3-way turnouts are used exceptionally for shortening ladder tracks on side tracks and sidings.
3. Curved turnouts are used (exceptionally) when the track is laid in a curve.
4. Single and double slips are used only when necessary on side tracks (fort main tracks they are forbidden). The speed on the straight track may not exceed 100 km/h.
5. Turnouts can be located on concave inclination changes (R=2000 m) and convex inclination changes (R=5000 m).
6. Selection of the turnout radius (R) for the speed on the diverging track (v_{dop}):
7. Respectively the angle is chosen which goes with the radius:
   - → 190-1:9, 300-1:9
   - → 500-1:12
   - → 760-1:14
   - → 1200-1:18.5.

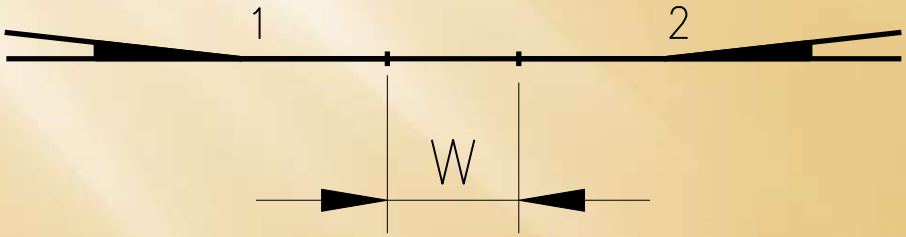
R [m]	v_{dop} [km/h]
190	40
300	40
500	60
760	80
1200	100

$$v_{dop} = 3{,}6\sqrt{0{,}65R}$$

Turnouts in track

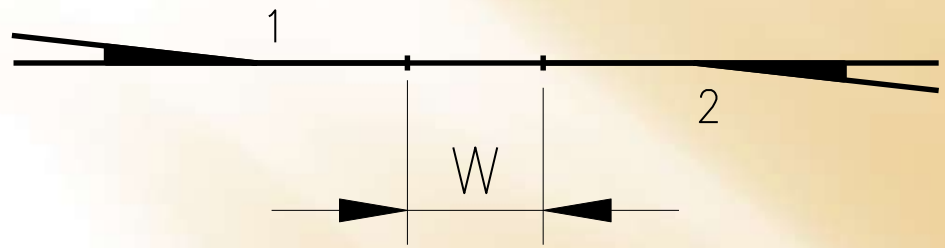


On main line track.	w=15 m
On subsidiary track, in case of widening in the turnout No 2.	w=6 m
On side tracks or in case the turnout No 2 has no widening.	w=0 m

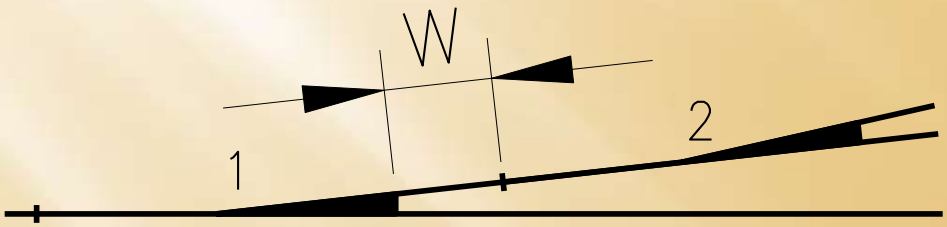


For turnouts in which the points are tangent to the stock rails (all turnouts with S49)	w=0 m
For other turnouts:	
- on main line tracks	w=15 m
- on other tracks, but the condition w>V/6 [m] should be obeyed	w=6 m

Turnouts in track

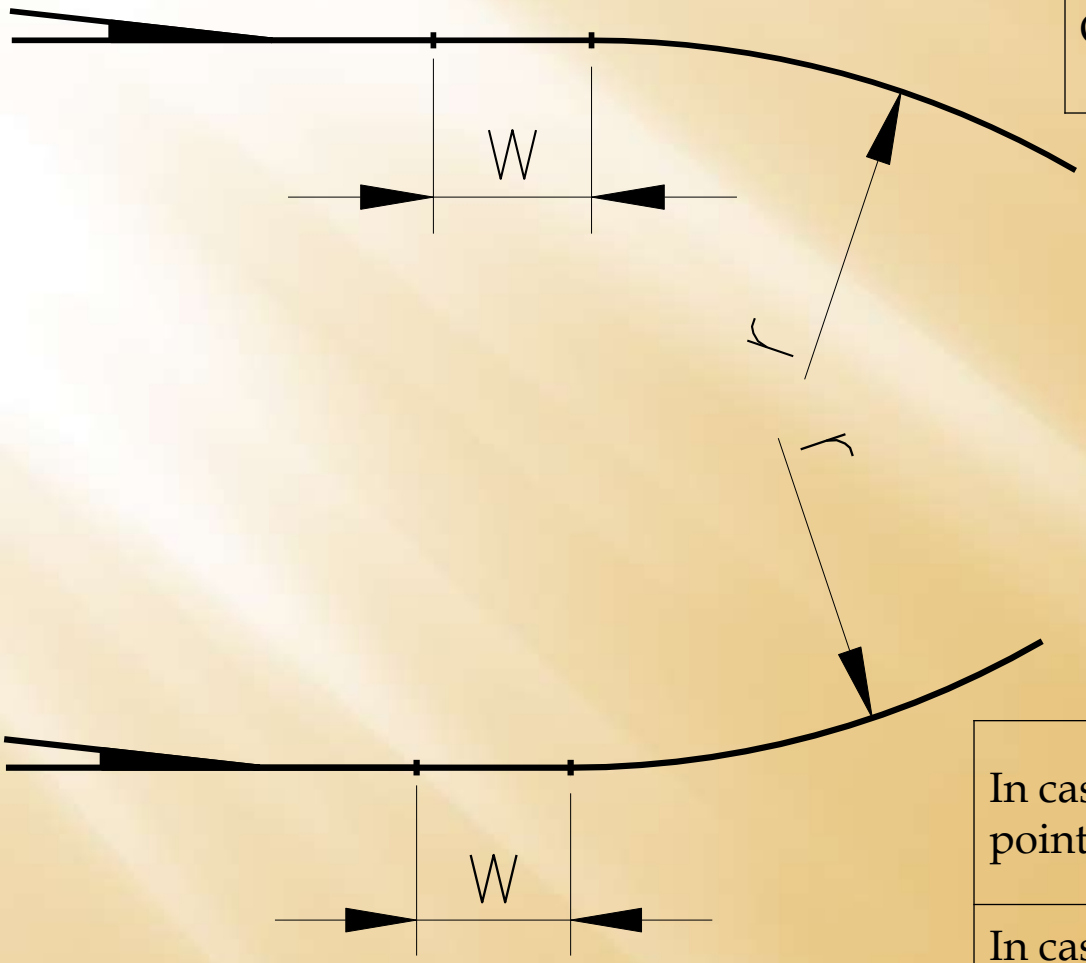


On main line tracks.	w=15 m	condition w=V/6 [m]
On other tracks.	w=6 m	



In case the both turnouts have the points tangent to the stock rails and curved crossings (one curve along the diverging track) or the turnout No 2 has no widening	w=0 m
On side tracks, regardless the turnouts types.	w=0 m
On subsidiary tracks, if the turnout No 1 has the straight crossing and the turnout No 2 has widening.	w=6 m

Turnouts in track

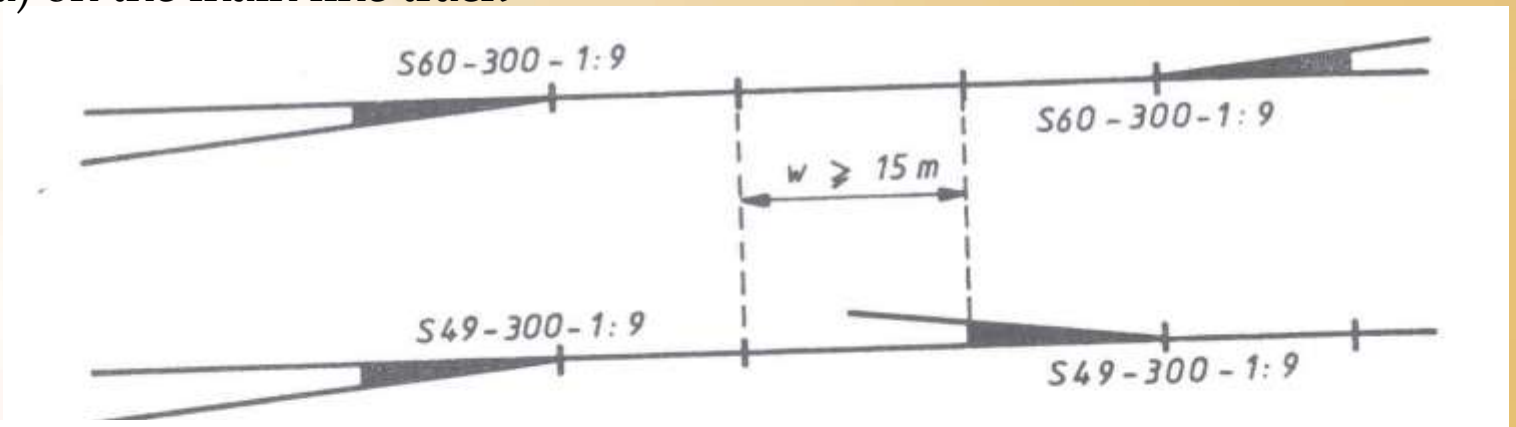


On all tracks	w=V/6 [m] and not less than 6 m

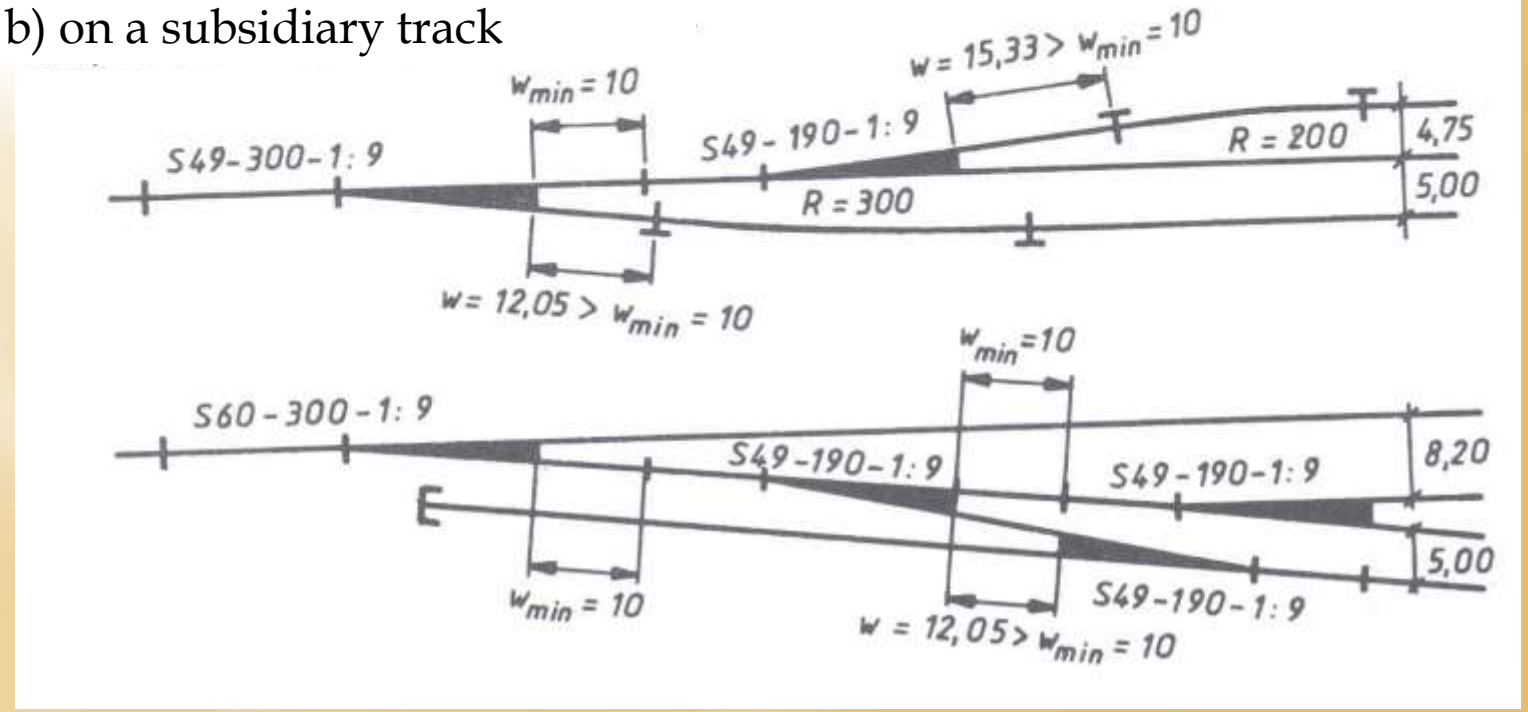
In case the turnout has not the points tangent to the stock rails	w=V/6 [m] and not less than 6 m
In case the turnout has the points tangent to the stock rails and the radius r is not shorter than the turnout radius R	w=0 m

Examples

a) on the main line track



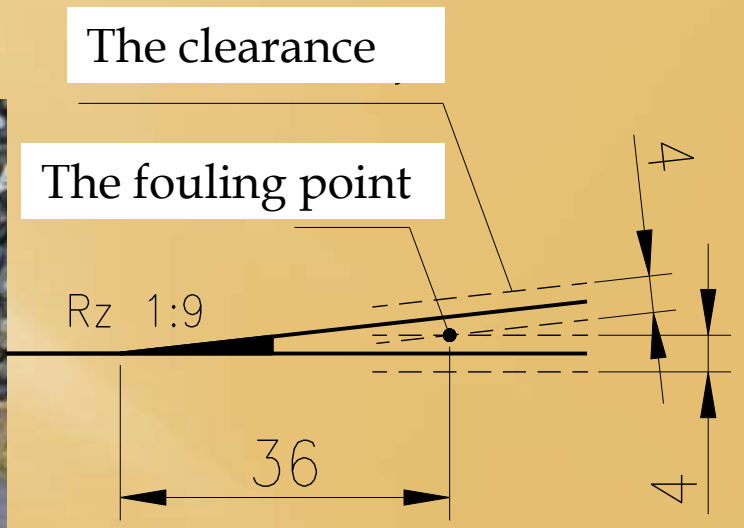
b) on a subsidiary track



The fouling point

The fouling point: the point between tracks where the clearance spaces of two joining tracks meet each another (at a turnout or crossing). The track before the fouling point could be taken by carriages without collision.



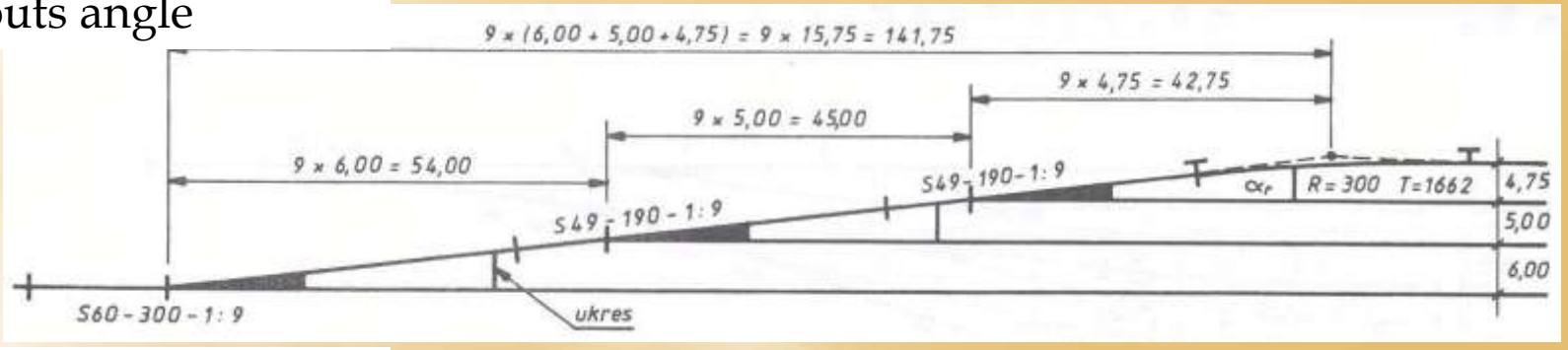




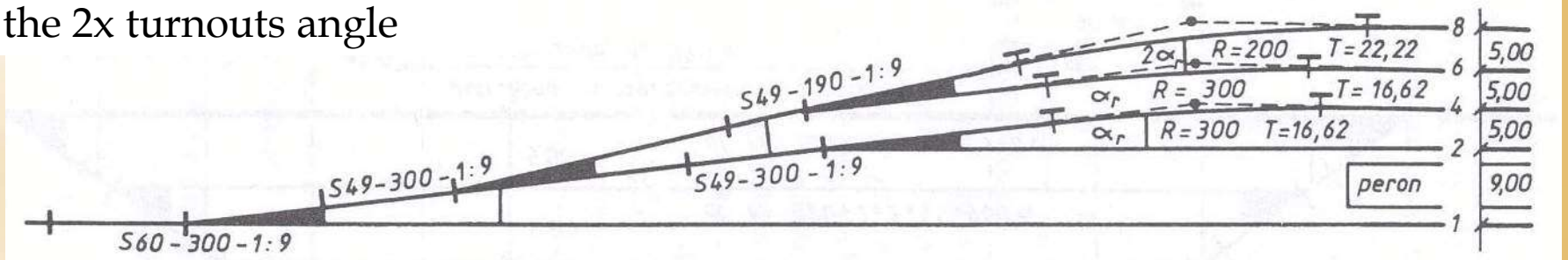
Ladder track

Ladder track: connection of a few tracks by turnouts . The most simple but the longest solution is the ladder track at the turnout's angle. A group ladder tracks at the end of station are called station head.

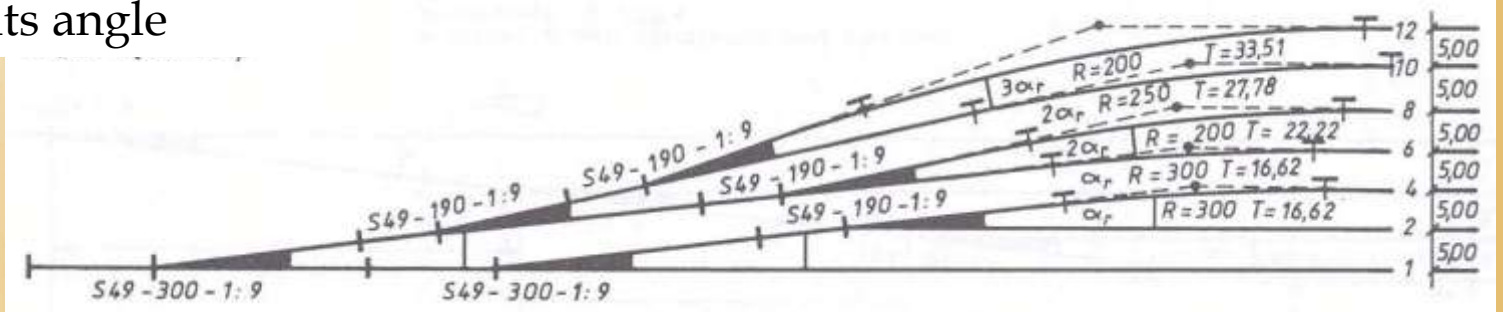
a) at the turnouts angle



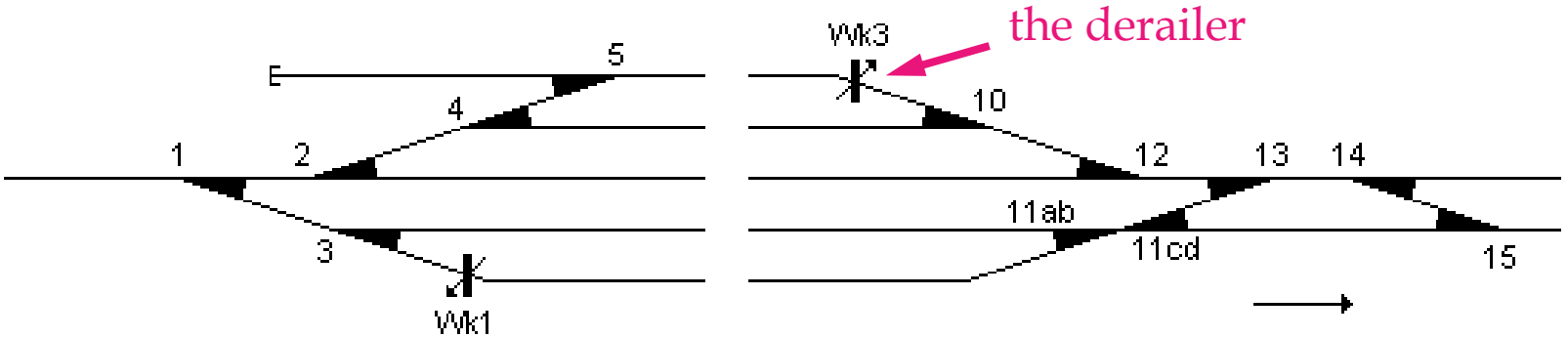
b) at the 2x turnouts angle

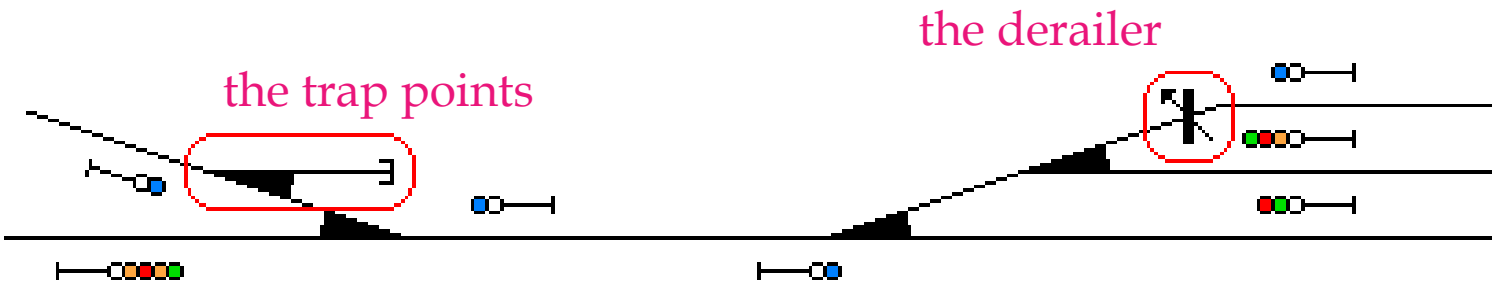


c) at the 3x turnouts angle



Shunting safety





The derailer

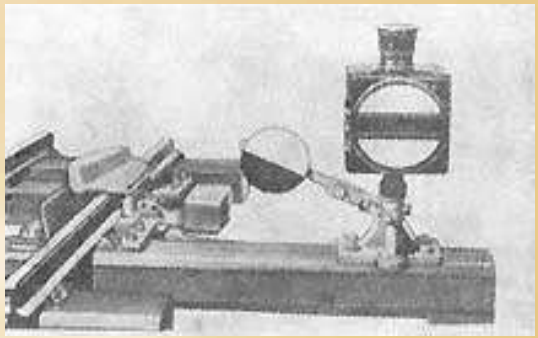


motor

derail beam

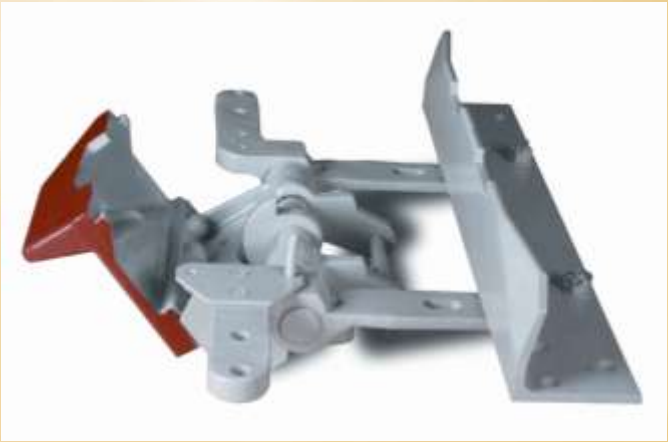
The derailer – how it works?

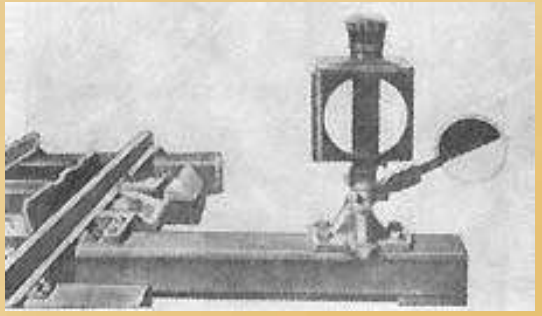




The derailer closed

Movie

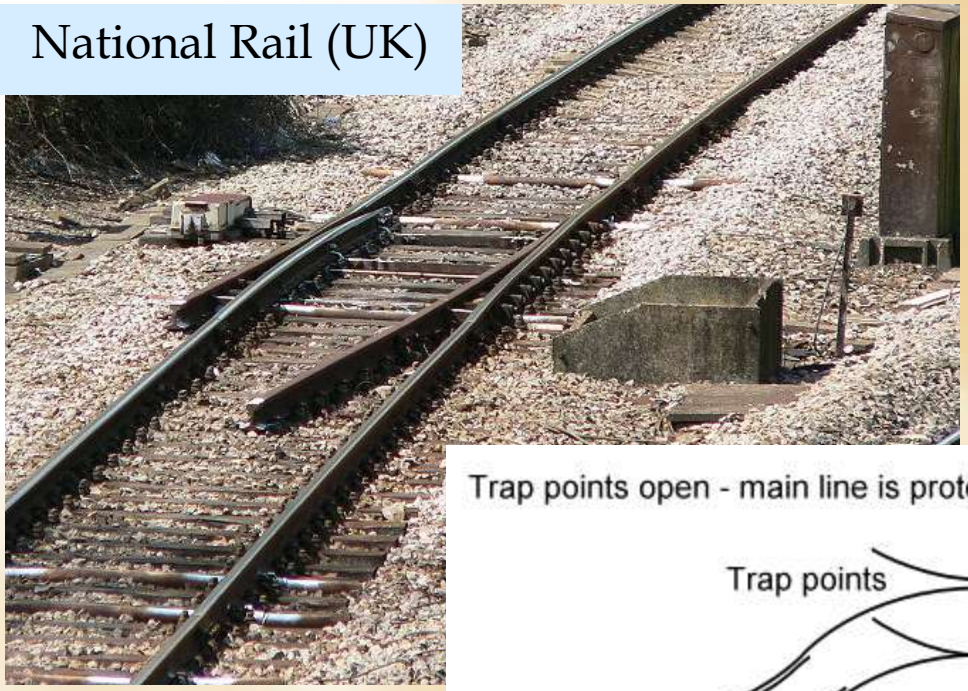




The derailer open

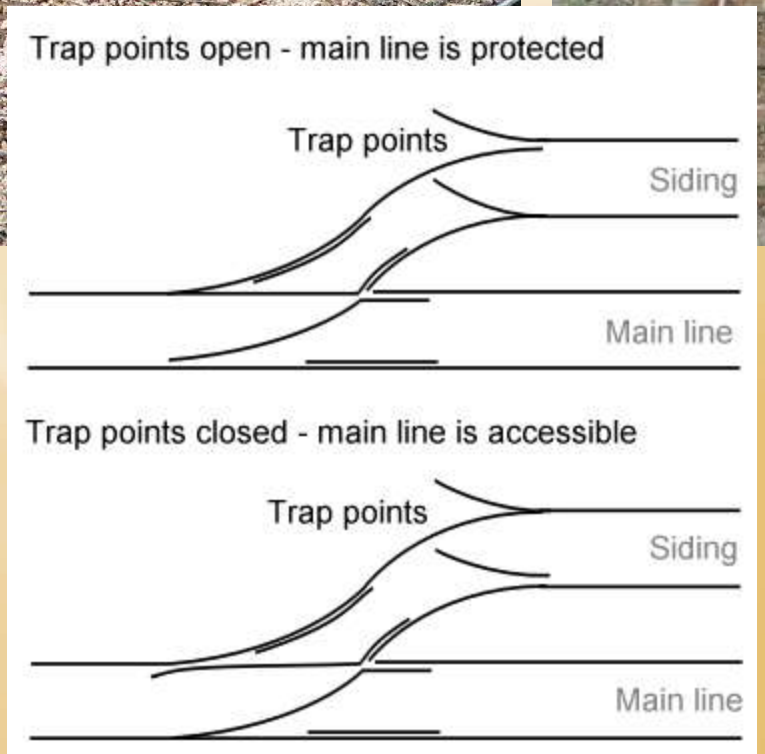
Other derailers

National Rail (UK)



National Rail (UK)





The run-off points

The run-off point is a track ended with a bump stop, serving as a safety device protecting the main line from unauthorized intrusion of rolling stock from side track.



With a curved turnout leading on the run-off point



With a standard turnout leading on the run-off point

The bump stop

The bump stop is an equipment of the run-off point. Its function is to stop a running carriage in a safe way. Sometimes the track before the bump stop is covered by sand which helps to decrease the energy of the running carriage.
Various designs of the bump stop can be used:

1) steel, made of user rails or rolled shapes,
2) massive concrete,
3) energy-absorbing.



Steel

Concrete





Steel with a hydraulic energy absorber



Steel with a friction energy absorber

Steel with rolled shapes





Steel with a zig-zac energy absorber



Steel with used rails





Concrete with a hydraulic energy absorber



Steel with
used rails



Steel with a friction
energy absorber



Massive concrete



Steel with a friction energy absorber



Steel with a zig-zac energy absorber

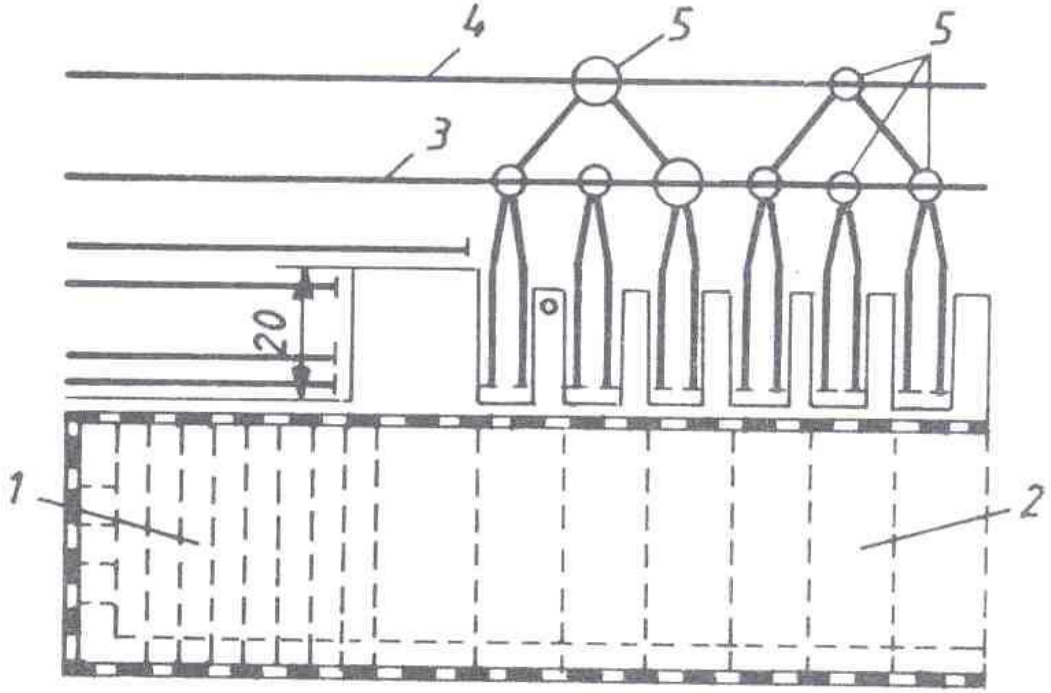
Turning table

The turning table – a machine serving for direction change of a carriage by a turn of the platform on which the carriage is standing.
Radius of the track for turning round is quite large so turning a locomotive about 180° would require large space for a loop track.
The platform of the turning table has built-in section of a track and it has a length enabling fitting one carriage or locomotive. It is often used in front of a locomotive shed to direct the locomotive to the proper workstate located radially.





The turning table – example



Layout of turning tables at a warehouse: 1 – expedition warehouse, 2 – receiving warehouse, 3 – approaching track, 4 – exit track, 5 – turning table

Rail shifting machine

The rail shifting machine - a machine serving for direction change of a carriage by a shift of the platform on which the carriage is standing. The platform of the shifting machine has built-in section of a track and it has a length enabling fitting one carriage or locomotive. It is often used in front of a workstate or a locomotive shed to direct the vehicle to the proper workstate located paralelly.





The gauntlet track

The gauntlet track - an arrangement in which railway tracks run parallel on a single trackway and are interlaced such that only one pair of rails may be used at a time. Since this requires only slightly more width than a single track, all 3 or 4 rails can be carried on the same sleepers. Trains run on the discrete pair of rails appropriate to their direction or loading gauge.

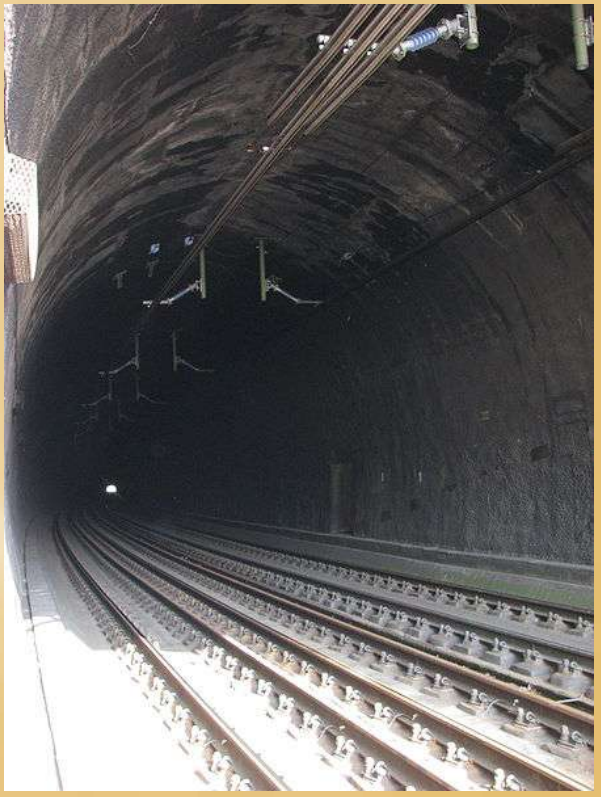




The gauntlet track-examples



Triple track line with six rails on the "Lossetalbahn" near Kassel, accomodate standard gauge freight trains on the center track and narrow body (2.65 m) tram-trains on the outer tracks nearer to the platform edges.



The Gemmenich Tunnel has a special track layout to enable the passage of wide military loads. The double-track tunnel has a third set of rails interlaced with one of the normal tracks. Active points (switches) at each end of the tunnel allow a train to divert along the central track, whilst other trains are blocked by signalling.

The gauntlet track-tramway





The gauntlet track in tramway allows to shift the switch out of the road to prevent the switch from being driven over by cars and trucks.