

Sustainable Circular Track Line Network

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of International Patent Application No. PCT/CN2012/075257 with an international filing date of May 9, 2012, designating the United States, now pending, and further claims priority benefits to Chinese Patent Application No. 201110128735.9 filed on May 10, 2011. The contents of all of the aforementioned applications, including any intervening amendments thereto, are incorporated herein by reference. Inquiries from the public to applicants or assignees concerning this document or the related applications should be directed to Matthias Scholl P.C., Attn.: Dr. Matthias Scholl Esq., 14781 Memorial Drive, Suite 1319, Houston, TX 77079.

BACKGROUND OF THE INVENTION

[0002] Field of the Invention

[0003] The invention relates to a railway route-system and line/network planning, and more particularly to the structure of multi-track turnouts, junctions and stations, and inside which switch-compages.

[0004] Description of the Related Art

[0005] A railway network is the foundation of vehicles' operation. However, Metro and Regional lines (RER) mainly adopt Back-and-Forth (BF) routing, disconnecting each other, allowing no vehicles' transfer but only passengers'

interchange on-foot. Traditional fork-lines cored by 从-shaped (FIG.11-YX) turnouts or similar, remain compound BF routing, causing traffic flows in both branches cut by half, and therefore fail in continuous branching. Although connected by complex junctions, the Inter-City railway (IC) is bond to too many switches and crosses (i.e. red-lights), to dispatch continuous train-shifts local and express.

[0006] Moreover, both IC and Metro rely mainly on general traffics for feeder- ship. Stations become larger when bus/taxi stations and car parking gather all around, resorting crowds and causing disorder or even jams.

[0007] In summary, based on the traditional full-return routing, lines can hardly connect each other by existing turnouts or junctions, while keeping traffic flow saturate and balanced, let alone reorganizing multi-way trains; and rail-transit in general can hardly expand its service layover to replace general traffics.

SUMMARY OF THE INVENTION

[0008] In view of the above described problems, it is one objective of the invention to break through the full-return routing in disconnected or stiffly connected lines/networks; and instead, to employ circulating route-system in the properly connected sustainable lines/networks, including the poly-rails feeder-lines/nets derived; and in this way, improving rail-transit service layover, safety and efficiency in general.

[0009] To achieve the above objective, and in accordance with one embodiment

of the invention, provided is fundamentally a sustainable railway network, which comprises circular-turnouts covered by multi-way stations, as cores and/or key nodes of the circulating lines/networks and of the feeder-lines/nets derived; which employs the circulating route-system to minimize red-lights, enhance and balance multi-way traffic flow; which facilitates vehicles' interchange and reorganizing, and passengers' on-board and/or easy transfer; and which improves service layover, safety and efficiency in general, and effectively reduces the building and operating cost of the railway network.

[0010] A circular-turnout comprises at least three multi-connected BF ports, and at least one set of at least three-way circular V-ramps or tracks, facilitating at least tri-directional vehicles turning from the Back-track of each BF port into the Forth-track of the same (right or left) side nearby BF port, completing a circulation.

[0011] In a class of this embodiment, the V-ramp is compound of multiple ramps, assembling a crescent shaped junction; the flat bottom V-track with two ramps comprises a serial of two Crescent Junctions (VCJ).

[0012] The Crescent Junction(VCJ) is one-way-through, restricting all ramps inside unidirectional and non-crossing each other, comprising an Overtaking Track (OT) by its shorter and less-curved side, Platform-Tracks (PT) by its longer and more-curved side, and a Train-Yard (TY) in between.

[0013] In a class of this embodiment, the circular-turnout is a poly-rails turnout, comprising at least three multi-connected Bf or bF or BF or bf ports, and at least one set of at least three-way V or v-ramps of at least two rail-types in circulation.

[0014] In a class of this embodiment, the circular-turnout is a hollow-star

turnout, comprising at least one set of at least four-way V-ramps/tracks in circulation, connecting at least four BF=trunks.

[0015] In a class of this embodiment, the circular-turnout is a switchable turnout, cored by at least one set of T-link, connecting at least two BF=trunks. The T-link comprises at least one d-m ramp across T-shoulders in horns' shape, connecting one BF port at T-foot. The d-m ramp is one-way, starting from a diverging-switch and ending by a merging-switch, both d/m switches irreversible with fork-angles outpointing.

[0016] In a class of this embodiment, the circular-turnout is a circular-switchable turnout, comprising at least one set of at least three-way V-ramps/tracks totally inserted by the d-m ramps or D-M tracks; connecting at least three totally BF=trunks.

[0017] In a class of this embodiment, the d-m ramp or D-M track is restricted within the turnout range, and by its ship lock structure, employs four ways of switching: d/m both-on, d-on/m-off, d-off/m-on, d/m both-off. As a result, the switchable turnout or circular-switchable turnout enjoys at least one switch-frozen model, during which period at least one d-m both-off ramp/track is modified into a parking lot or shuttle-line, without interfering rest of the traffic inside the turnout.

[0018] The multi-way station is a station or a group of sub-stations covering a circular-turnout, including a station or sub-station covering a poly-rails turnout or poly-rails hub. The poly-rails hub comprises at least one circular-turnout made of at least one rail-type.

[0019] In a class of this embodiment, a multi-way station comprises at least one multi-lateral platform with at least three boarding sides, for trains of at

least one rail-type; and which is monolayer or split-leveled or connected by split-level passages.

[0020] In a class of this embodiment, the multi-way station facilitates passengers' circular-transfer, when at least three trains of at least one rail-type synchronously stop by the multi-lateral platform in a heads-by-ends manner, and one-step-transfer between the parallel coaches heads-by-ends.

[0021] The circulating-lines/networks comprise semi-return circulating-lines and non-return circulating-networks. The circulating-line/lines or existing BF line/lines or both together, may be modified or merge into one circulating-network, when their peripheral terminals further connected by additional circular-turnouts into an outer circle.

[0022] In a class of this embodiment, the circulating line including a tree line, or a hollow star line, or a polygonal interchange line, or a circle-radial line, comprises at least one circular-turnout, connecting at least three BF=sections, among which at least two BF=trunks; at least part of vehicles semi-return from and circulate among at least three terminals.

[0023] In a class of this embodiment, the circulating network is a circles-combination, comprising at least one inner-rings-combination of monolayer or grade-separated. The monolayer inner-rings-combination comprises at least two rings of same rotation, which is split-able internally or attachable externally. The grade-separated inner-rings-combination is duplicable in two or four or six directions, comprising at least one self-cross-loop, or at least one self-cross-loop plus at least one ring of same rotation. The self-cross-loop comprises at least three open-end rings of same rotation.

[0024] In a class of this embodiment, the circulating line/network is a feeder-line or feeder-net of a miner rail-type; the feeder-line covers or braids at least

one major rail-type, resulting in poly-rails hub/hubs and poly-rails section/sections; the feeder-net inserts or threads the circular-turnout/turnouts of at least one major rail-type, resulting in poly-rails turnouts or poly-rails hubs and poly-rails sections. The feeder-net is an inner-ring or inner-rings-combination, including a polygonal inner-rings-combination; which comprises at least two inner-rings of same rotation connected in alternate angles, and the inside ring is still replace-able by an inner-rings-combination.

[0025] In a class of this embodiment, the poly-rails hub comprises at least two rail-types, and at least one set of V or v-ramps of at least one rail-type; including a Candlestick-hub or Kite-hub or Star-hub, or a 个/大/木-hub.

[0026] In a class of this embodiment, the poly-rails section comprises at least two rail-types of different capacity, shifts and stops, and at least parallel and bidirectional double tracks, including Bf=bF anti-way feeding section and b-BF-f same-way feeding section.

[0027] In a class of this embodiment, the feeder-net is a Circular-Shuttles (CnS) line in an ever closed inner-ring of flexible rotation, comprising at least three trains dividable and reorganize-able. When inserted between the nV or nYX turnout of a rapid-rail and nc inner-rings-combination of a light-rail, the CnS line employs same-way feeding or circular-transfer with the outside rapid-rail or the inside light-rail, or keep off from the both side rails' circular-transfer.

[0028] A sustainable railway network of a second embodiment of the invention, comprising circular-turnouts and/or plate-turnouts, covered by multi-way stations, as cores and/or key nodes of circulating lines/networks, including feeder-lines/nets derived, employs circulating route-system to minimize red-lights, enhance and balance traffic flows; and facilitates vehicles' interchange and reorganizing, and passengers' on-board and/or easy transfer.

[0029] In a class of this embodiment, the plate-turnout comprises at least one circular-plate; the circular-plate is a double-track plate or a triple-track plate, facilitating bidirectional or tri-directional vehicles to pass through or circular-switch.

[0030] In a class of this embodiment, the circular-plate is a suspended plate of a pot-cover shape, comprising double or triple track-slots fixed underneath the plate, facilitating bidirectional or tri-directional suspended vehicles to pass through or circular-switch.

[0031] In a class of this embodiment, the circulating line/network employs at least one plate-frozen model, during which period the both ends plate-off BF= section is modified into a double-shuttles line, and the at least three ends plate-off sections are modified into an at least triple-shuttles line, without interfering rest of the traffic in the circulating line/network.

[0032] Advantages of the invention comprise:

[0033] 1) The circular-turnouts serving as cores and/or key nodes of the circulating lines/networks, employ circulating route-system to minimize red lights, enhance and balance multi-way traffic flows, facilitate vehicles' interchange and reorganizing, and sustainable branching and expanding of the multi-track lines/networks,.

[0034] 2) The multi-way station or sub-stations, directly covering the circular-turnouts, spreading out to balance the crowd, facilitate passengers' on-board and/or easy transfer, with more choices of routing.

[0035] 3) Based on the circulating route-system, the circulating lines/networks including the poly-rails feeder-lines/nets derived, improve the

rail-transit service layover, safety and efficiency in general; and in this way, replace the general traffics to reduce their pollution and jams.

[0036] 4) Since all double-track sections remain in use, all stations within two layers of space, all dispatching and scheduling optimized by simplified and concentrated junctions; the circulating lines/networks is sustainable to reduce the building and operating cost.

BRIEF DESCRIPTION OF THE DRAWINGS

[0037] FIG.1 is a schematic view of the circulating lines/networks, locations of turnouts and hubs, modification and poly-rails feeder-ship.

[0038] FIG.2 shows the structure of a 4VX, or 4V+, or 8V hollow-star-turnout.

[0039] FIG.3 magnifies the Yv/T2v turnout and Bf=bF section of FIG.1.

[0040] FIG.4 shows the structure of 2YT and I-shaped turnout in a 4V tree-line.

[0041] FIG.5 shows the structure of a YT station, platforms and VCJs.

[0042] FIG.6 shows vehicles' interchange and re-organizing and passengers' transfer in the TZ-turnout/station.

[0043] FIG.7 shows vehicles' interchange and re-organizing and passengers' transfer in the T-turnout/station.

[0044] FIG.8 shows vehicles' interchange and re-organizing in the Y3T turnout/station.

[0045] FIG.9 shows a 4YT tree-line and its further modification into an A/4C circles-combination.

[0046] FIG.10 magnifies FIG.1- T8/T16, showing the structure of a poly-rails Candlestick-hub.

[0047] FIG.11 is the sketch map of a triangle or hexagonal cross-interchange turnout.

[0048] FIG.12 shows the square or octagonal cross-interchange turnout, structure of c1 feeder-net and 4YXv turnouts/sub-stations.

[0049] FIG.13 magnifies FIG.12-Xv, showing the structure of a YXv turnout/sub-station.

[0050] FIG.14 shows the 4T and 4VCJ structure and 4P multi-lateral platforms, in a kite-hub and covering station.

[0051] FIG.15 shows the structure of a hexagonal through-interchange hub.

[0052] FIG.16 shows the c1/4/5 inner-rings threading a compound 4V and a kite-turnout, and their modification into a polygonal inner-rings combination.

[0053] FIG.17 magnifies FIG.15-Mu, showing the structure of 个/大/木-hub.

[0054] FIG.18 is a sketch map of the Cable-Cars' circles-combination.

[0055] FIG.19 is a sketch map of a Monorail's circles-combination, and the central part shows a six-way star-hub.

[0056] FIG.20 shows vehicles' interchange and reorganizing in a triple-track plate-turnout.

[0057] FIG.21 shows vehicles' interchange and reorganizing in a double-track plate-turnout.

[0058] FIG. 22 shows the suspended turn-plate of a pot-cover shape, carrying bidirectional suspended vehicles.

[0059] FIG. 23 shows the C'1/C2 inner-rings-combination duplicable in two directions.

[0060] FIG. 24 modifies some turnouts of FIG. 23 into the plate-turnouts.

[0061] FIG. 25 shows locations of the $4v+M(2BF+)$ poly-rails kite-hubs, and monorail's inner-rings-combination duplicable in four directions.

[0062] FIG. 26 modifies some turnouts of FIG. 25 into the plate-turnouts.

[0063] FIG. 27 magnifies FIG.25- $4v+M$, showing structure of the poly-rails kite-hub.

[0064] FIG. 28 shows structure of the poly-rails eight-way star-hub.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0065] Detailed description will be given below in conjunction with drawings and embodiments accompanying.

[0066] Metro or RER lines can hardly pass through a square city in the

X-ways; while FIG.1-T2/T6/T10/T14 shows a four-terminal line connected by a hollow-X-shaped turnout 4Yv, taking advantage of four sides' streets to avoid central district. In this way, all trains online circulate among T2-T14-T10-T6-T2 and four double-track sections through the central 4Yv turnout.

[0067] As shown by FIG.2/4-8/11-12/14-15, and always from central point of view, a circular-turnout comprises at least three multi-connected Back-and-Forth (BF) ports, and at least one set of at least three-way V-turn ramps or tracks, facilitating vehicles turning from the Back-track of each BF port into the Forth- track of the same(right or left) side nearby BF port, completing an at least three-way circulation, such as B1-F3/ B3-F2/B2-F1 in FIG.5.

[0068] In Fig.12 and magnified as Fig.13-FB3, the 4YX turnout comprises 4BF ports and two sets of 4V-tracks, outside 4Y turning left and inside 4X turning right. Although crossing each other, the 4X still structure a hollow-X 4V-tracks in circulation. The rapid-rail track in FIG.3-T2v is straight, and the outside corner V-ramp in Fig.18 even turns left; but still either track/ramp runs into the first **bf** or **bf** port on its right side, structuring a T2v or V2v circular-turnout.

[0069] FIG.4 shows an I-shaped 4V turnout, deriving two Y3V turnouts; the V1-4 or V3-2 ramp has a short and curved V-bottom; and the V4-3 or V2-1 track has a long and flat V-bottom, deriving a serial of two V-ramps.

[0070] In a class of this embodiment, as show by FIG. 5 and FIG. 12, a V-ramp is compound of parallel ramps non-crossing each other, assembling a

junction in crescent shape, namely a Crescent Junction (VCJ). FIG.10 and FIG.14 show that, a flat bottom V-track comprises a serial of two VCJs.

[0071] Shown by FIG. 5, the VCJ is one-way-through, comprising an Overtaking Ramp (OR) by its shorter and less curved side, Platform Tracks (PT) by its longer and more curved side, and a Train Yard (TY) in between.

[0072] In this way, multi-directional trains can be re-organized or replaced inside their own junctions, without interfering each other. Since at least two VCJs concentrated within one station range, they save land, equipments and manpower for management and maintenance.

[0073] In a class of this embodiment, as shown by FIG.1-2, four V-tracks T2-14- 10-6-2, or V-ramps V1-7-5-3-1 structure a 4VX hollow-X turnout, four V-ramps (V8-6-4-2-8) assemble a 4V+(X/+ mean bearings of 4BF) hollow-cross turnout; each connecting four BF=trunks (= means parallel/bidirectional connected) with equating traffic flows and free of switch or cross, i.e. free of red lights.

[0074] Accordingly, 3-n V-ramps make a 3-nV hollow-star turnout, such as the 8V (V8-7-6-5-4-3-2-1-8) in FIG.2, connecting 3-n BF=trunks with equating traffic flows. We classify above 4-nV as hollow-star turnouts, which are single- layer to saves space, avoid central obstacle and red-lights, therefore fitting a mass centre or transit-hub.

[0075] In a class of this embodiment, FIG.3-Yv shows a poly-rails turnout comprising at least three-way V- ramps/tracks of two rail-types, with at least three BF or Bf or bF or bf ports in circulation.

[0076] In a class of this embodiment, the circular-turnout is a switchable turnout or a circular-switchable turnout. The switchable turnout comprises at least one T-link cored by one d-m ramp in horns-shape as FIG.4/d4-m1 and magnified as d3-m1 in FIG.6-T. The circular-switchable turnout comprises at least one set of at least three way V-ramps/tracks totally inserted by d-m ramps as FIG.8 or by D-M tracks as FIG.11. The d-m ramp is one way through, starting from a diverge-switch and ending by a merge-switch, both switches irreversible with a pair of forking- angles out-pointing, and both restricted within the turnout range.

[0077] In a class of this embodiment, the d-m ramp is irreversible as shown by FIG.6; inside which all switches are marked **d** or **m**, except the one under Z-track, which is reversible as a merging-switch when a train enters Z-track, and as a diverging-switch when it exits.

[0078] In a class of this embodiment, owing to its ship-lock structure, the d-m ramp employs four switching ways: d/m both-on, d-on/m-off, d-off/m-on and d/m both-off. FIG.4 shows, a switchable turnout employs at least one switch-frozen model; during 2Y period the d/m both-off ramps d4-m1/d2-m3 are modified into parking lots, or during 2BF+2S period the d/m both-off tracks d4-m3/d2-m1 are modified into one double-shuttles (2S) line, without interfering rest of the traffic inside the turnout.

[0079] Shown by FIG.8-Y3T during the Y3V switch-frozen period, d/m both-off ramps d3-m1, d1-m2 and d2-m3 modified into parking lots for stand-by

trains 3R with both-side doors open, serving as walking bridges on the track-pitches. When all YT in FIG.1 frozen in Y3V model, there will be no switching or crossing in the network at all; then traffic flows may be enhanced by 180% in a balanced way (up to 72" per shift instead of present limit 2').

[0080] In a class of this embodiment, FIG.3-T2v shows a poly-rails turnout, with a light-rails' T-link connecting 2v and bf=branch, leaving the rapid-rails' track F-B not only free of switch, but also free of rail-type.

[0081] In a class of this embodiment, the circular-switchable turnout comprises at least one set of at least three V-ramps/tracks totally inserted by d-m ramps as FIG.8, or by D-M tracks as FIG.11. FIG.8-13 show a collection of the circular-switchable turnouts, each comprising at least one set of at least three-way V-ramps or tracks totally inserted by d-m ramps or D-M tracks, connecting at least three totally BF=trunks with equating traffic flows.

[0082] As shown by FIG.8/upper layer, when T-link d3-m1 tripled by two more T-links d1-m2 and d2-m3 with 120 deflection angle, structured is a Y3T-turnout; deriving d1-m3, d3-m2 and d2-m1 three d-m ramps totally inserting Y3V-ramps in circulation; connecting three BF=trunks with equating traffic flows. Besides the outside Y3V-ramps turning right in circulation, the 3T-ramps circular-turn left and cross each other, forming inside reverses circulation.

[0083] In a class of this embodiment, we classify T/TZ/Y3T shown by FIG. 6-8 as a YT turnout in general, which comprises at least one T-link cored by a

d-m ramp across T-shoulders, employs at least one switch-frozen model Y3V, connects at least two BF=trunks with traffic flows enhanced and balanced, and facilitates continuous branching by keeping at least one BF=trunk sustainable, as shown in FIG.9-4YT and FIG.1-8YT.

[0084] In a T turnout as FIG.6, the train approaching d3 separates into two parts, the Front part turns to branch through F2, the Rare part turns into d3-m1 ramp and after changing passengers, apical grafting BF2=Branch Returned part BR after m1 and before the post-T station, restoring full length to move on.

[0085] In this way, the T-foot BF=branch enjoys same train-shifts as in the BF=trunk across T-Shoulders, except coaches cut by half. Since passengers normally get less in a branch than a trunk, the branch stations and platforms can be half length as well; saving land and the building cost.

[0086] Nevertheless, the branch traffic flow can be balanced by supplementing a returning track Z (FIG.7), deriving d3- m2/d2-m1 ramps besides d3-m1; and in this way, the T turnout is modified into a TZ turnout.

[0087] Inside a TZ turnout (FIG.7), the branch-train breaks into two parts as well, its F part merges into the trunk at m1, its R part switches at d2 into Z-track, after changing passengers, returns at m2, waiting for the next F part from d3.

[0088] As shown by FIG.8, the Y3T turnout facilitates tri-directional trains'

circular-interchange by alternate switching 3d-on/3m-off before 3R trains' stop and 3d-off/3m-on afterwards; so that red-lights minimized. Moreover, a Y3T turnout connects totally three BF=trunks with equating traffic flows.

[0089] When three trains synchronously approach the Y3T turnout/station, each breaking into two parts, the 3F parts turn nearer sides non-stop, apical grafting the last-shift 3R' parts at three post-Y3T stations; the 3R parts turn further sides into d3-m1, d1-m2 and d2-m3 ramps, after changing passengers, forward to three post-Y3T stops, waiting for next-shift 3F parts. In this way, tri-directional trains are reorganized by circular-exchanging 3R parts.

[0090] Obviously, a switch-frozen model is free of red-lights, offering denser shifts and longer trains, especially during the rush-hours; in this way, enhancing and balancing multi-way traffic flows at least in continuous trunks.

[0091] Comparatively, present fork-lines cored by YX turnouts (FIG.13) are compound BF lines, connecting only one BF=trunk, causing train-shifts in 2BF=branches cut by half; and therefore, fail in continuous branching. Although it may facilitate F/R separating and restoring as in Spain and Japan, but never reorganization in circulation.

[0092] Taking Nanjing Metro Line1 for example, and supposing all 30 stops of equal time-distance; trains fully return between N=S or N=W by jumping shifts but never mix; 11 stops in N=YX trunk at 2'/shift, 15 stops in S=YX and 4 stops in W=YX, both branches at 4'/shift; N=S/N=W 2/3 trips express, but S=W BF

trips transit up and down at pre-YX station; since $11/30+1/2$ ($15/30+4/30$) $=20.5/30$, so the saturation of train-shifts in Line1 is about 68%.

[0093] If we change above YX into T turnout and take $N=T=S$ as a continuous BF=trunk across T-shoulders and $T=W$ at T-foot as branch, with train-length cut by half, then $11/30+15/30+1/2 \times 4/30=28/30$, so the saturation raised up to 93%. If half-trains in $T=W$ not enough, we can still modify T into TZ turnout with 100% saturation. Both T/TZ turnouts keep 2/3 trips express, except N-S/ W-N door-to-door or just one-step transit at T/TZ station.

[0094] When the above T/TZ-foot BF=branch extending, we may further change T/TZ into Y3T turnout, connecting 3/3 BF=trunks to N/S/W with not only 100% saturation, but also total trips express by on-board transfer.

[0095] Moreover, the YT turnouts facilitate continuous branching with traffic flows enhanced and balanced, by keeping at least $N=S$ trunk sustainable; and in this way, improving Line1's service layover, safety and efficiency.

[0096] In a class of this embodiment, the circular-switchable turnouts for IC or RER are much larger. FIG.8-Y3T magnified by FIG.11-upper layer appears a 3YX triangle cross-interchange turnout, cored by D1-M3/D3-M5/ D5-M1 3T-links inside, and 3V- tracks totally inserted by D1-M5/D5-M3/D3-M1 outside. Double layers of 3YX in alternate angles connected by additional six d-m ramps: d-m4/d2-m5/d3- m6/d4-m1/d5-m2/d6-m3, assemble a 6YX hexagram turnout, balancing traffic flows in 6BF=trunks towards six terminals.

[0097] Accordingly, FIG.12 upper-layer shows a 4YX square cross-interchange turnout. Double layers of 4YX in alternate angles, and connected by eight additional d-m ramps:d8-m5/d7-m4/d6-m3/d5-m2/d4-m1/d3-m8/d2-m7/ d1-m6, framing an 8YX octagonal turnout and connecting 8FB=trunks.

[0098] In above 6/8-way turnouts, 6-8 trains may each break into 3-4 parts, stopping along 3-4 sub-stations; once all parts follow the nD-nd...nm-nM order in circulation, same time at different points, or same points in different time, they cross-interchange and reorganize into 6-8 new trains synchronously.

[0099] Shown by FIG.14 and magnified by FIG.16-BF2/4/6/8, a kite-shaped turnout comprises one set of 4V-ramps or tracks totally inserted by d4-m3/ d3-m2/d2-m1/d1-m4 ramps/tracks, and cored by 4T-links: d3-m1/d2-m4/ d1-m3/d4-m2, connecting 4BF=trunks; namely a 4V4T through-interchange turnout, and in short, a kite-turnout.

[00100]FIG.15 shows a hexagram through-interchange turnout, comprising two sets of circular 3V-ramps totally inserted by d-m ramps: B1-d1-m5/B5-d5-m3/B3-d3-m1 and d2-m6-F6/d6-m4-F4/d4-m2-F2, connecting 6 BF=trunks with equating traffic flows.

[00101]When 4/6 trains synchronously approaching the kite/hexagram turnout, each breaking into 2-3 parts, the 4F/6F parts strait forward, apical grafting 4R'/6R' parts at or before the post-kite/hexagram stations; 4M/6M parts stop

at central or second cross; 4R/6R parts switch to the right-side sub-stations; after changing passengers 4MR/6MR parts merge at the post- kite/hexagram stations, waiting for the next 4F/6F parts.

[00102]As shown by FIG.1, a multi-way station is a station (YT) or a group of sub-stations (4Yv) covering a circular-turnout; including a station covering a polybasic turnout (Yv/T2v), or a polybasic hub (T8/T16).

[00103]Shown by FIG.11-12,FIG.15-16, the large scale polygonal IC/RER turnouts can be each covered by a group of 3-16 sub-stations spreading all around; and in this way, improving their service layover and efficiency.

[00104]In a class of this embodiment, as shown by P or p in FIG.2-3, FIG.5, FIG. 13-14 and FIG.27-28, a multi-way station comprises at least one multi-lateral platform, which further comprises at least three boarding sides, for at least one rail-type; and which is monolayer or split-leveled (FIG.27-p1/p3/p5/p7) or connected by split-level passages(FIG.14/P1-4).

[00105]As shown by hollow arrows in FIG.2-3 and FIG.5, the multi-way station or sub-stations with its/their multi-lateral platform/platforms facilitate passengers' circular-transfer, when at least three trains stop by synchronously, in a manner of heads-by-ends; and facilitate passengers' one-step transfer between parallel coaches heads-by-ends.

[00106]In FIG.1, 8 (parts of) trains synchronously stop by 4Yv sub-stations in a heads-by-ends manner, performing 4-lateral circular-transit in 4Yv-P (FIG.3).

Meanwhile, light-rail 4 trains stop by the third sides of Yv-P, in heads-by-ends manners with 8 Metro trains, performing 3-lateral circular-transfer in four independent polybasic turnouts/stations (Yv).

[00107]When a YT turnout/station frozen in the Y3V model as FIG.5, 3 trains stop by the 3-lateral P in a heads-by-ends manner; passengers getting on and off gather in central P and mid-coaches closer to central stares; passengers turning left move to head-coaches and by one-step transit to end-coaches at left side; in this way, passengers from B1-F3/B3-F2/B2-F1 trains transfer to B3-F2/B2-F1/B1-F3 trains synchronously, in good order of circulation.

[00108]The circulating-lines/networks comprise semi-return circulating- lines and non-return circulating-networks. FIG.9 shows a 4YT tree line, when its six peripheral terminals E1/E2/S and W1/W2/N all connected by two additional YT turnouts at E2/W2 into an outer ring, there appear one anti- clockwise A-ring, hooping four clockwise inner-rings C1/C2/ C3/C4; in this way the circulating line is modified into an A/4C circulating network.

[00109]FIG.1 shows, when their peripheral terminals totally connected by YT turnouts at T1-16, the 4V (T2-14-10-6-2) hollow-star line, the 8YT (T15/13/11/9/7/5/3/1) circle-radial line, and two crossing BF lines (T4-12/T8-16) totally merge into one A/C2-5 circulating-network.

[00110]In a class of this embodiment, the circulating line is a tree-line (FIG.4, FIG.8-9), or a circle-radial line (FIG.1-8YT), or a hollow-star line (FIG.1-4V,

FIG.2- 4VX/4V+/8V), or a polygonal line (FIG.11-12,FIG.14-16), comprising at least one circular-turnout, connecting at least three BF=sections, at least part of vehicles semi-return from and circulate among at least three terminals.

[00111]In a compound BF tree-line as Nanjing Line1, trains fully return between N=S and N=W by jumping shifts but never mix. While in a YT tree-line, half trains return only half way to YT, then forward to the third terminals; when YT frozen in Y3V model, all trains semi-return and circulate among E/S/W(FIG.8).

[00112]The existing suspended monorail or cable-car line is a single ring pressed flat from both sides or pulled flat by two terminals; vehicles' circulation between two points is normally recognized as BF2U. FIG.17 upper-layer shows a Y3V3U circulating line, with its single ring pressed flat from triple sides; all vehicles semi-return at, and circulate among (at least) three terminals.

[00113]In a class of this embodiment, a non-return circulating network comprises at least one inner-rings combination (FIG.1 centre). The inner-rings- combination is duplicable in two (FIG.23) or four (FIG.25) or six (FIG.16-17) ways, comprising at least two inner-rings of same rotation (FIG.9 A/4C), or at least one self-cross- loop (FIG.25 C'), or at least one self-cross-loop plus at least one inner-ring of same rotation(FIG.23 C'1/C2). The self-cross- loop comprises at least three open-end-rings of same rotation(FIG.18 C'1 or C'2, FIG.25 C'-1/2/3/4).

[00114]The existing circle line adopts an A/C or C/A routing, comprising only

one inner-ring C or A, in full BF with its outer-ring A or C. While shown by FIG.9, the circulating network A/4C comprises 4C as an inner-rings-combination, each inner-ring C1-C4 in 1/4 BF section along the same outer-ring A, and the rest in BF sections with each other.

[00115]FIG. 22 shows a butterfly-shaped inner-rings combination, comprising only one self-cross-loop, but including four open-end rings C'-1/-2/-3/-4, of same rotation; and which is duplicable in four ways.

[00116]FIG.19 shows an orange-peels inner-rings-combination, with only one self-cross-loop, which comprises six open-end rings C'-1/2/3/4/5/6 of same rotation. FIG.18 shows two self-cross-loops C'1/C'2, each in a triple-leaf shape, and comprising three open-end rings of same rotation.

[00117] In a class of this embodiment, the circulating line/network is a feeder-line or feeder-net of a miner rail-type, covering or braiding or inserting or threading at least one major rail-type, resulting in poly-rails turnouts(FIG.3) or poly-rails hub/hubs (FIG.27-28) and poly-rails sections. The feeder-net is an inner-ring (FIG.12-c1)or inner-rings-combination(FIG.1 centre) or a polygonal inner-rings-combination(FIG.16 c1/c4/c5); which comprises at least two rings of same rotation and connected by alternate angles, the inside ring is replaceable by an inner-rings-combination.

[00118]In a class of embodiment 0090, the poly-rails hub comprises at least two rail-types and at least one set of circular V-ramps of at least one rail-type; including a candlestick-hub(FIG.1-T8/16 magnified by FIG.10), or a star-hub (FIG.19/FIG.28) or a kite-hub(FIG.27), or a 个/大/木-hub(FIG.17).

[00119]According to Graph Theory, a **n**-way node in connected graph possesses vertex **n**. In case of mass transit, a **n**-way station handles **n(n-1)** trips, passing through or transit, except departure and arrival; i.e. 6 trips by a 3-way station, 12 trips by a 4-way station, 20 trips by a 5-way hub station, 30 trips by a 6-way hub station and 56 trips by an 8-way hub station...

[00120]In FIG.19 centre, double layers of Y3V frame a 6-way Star-hub. When a Metro **Y3T** turnout covered by a Monorail **y3t** line in same bearings, appears a poly-rail Star-hub; handling 30 trips (2.5 times than Cross-hub's 12), including 12 express (3 times than Cross-hub's 4) in the same two-layer space.

[00121]FIG.28 shows, when a Cross-hub of Metro or RER or both together bladed by a Monorail 4vX Hollow-star turnout/line, structured is a poly-rails 8-way Star-hub; handling 8 trips express, 4 trips circular transfer at bf1/3/5/7 and 8 trips b-BF-f follow-way feeding... totally 56 trips; nearly 5 times than the original Cross-hub and still in the same two-layer space.

[00122] Shown by FIG.25-4v+M and magnified as FIG.27, when four Cross-hubs and lines of Metro overlapping or overlapped by four Monorail 4v+ turnouts and inner- rings-combinations, there come four poly-rail Kite-hubs and more b/BF/f follow-way feeding sections in same tunnels, horizontally bf turn up and vertically bf down. In this way, Metro trains only stop at Cross-hubs, being fed by Monorail trains, stopping every local stations.

[00123] Shown by FIG.16-Ge/Da/Mu and magnified as FIG.17, when rapid rails' 个/大/木 sub-stations threaded by c1/c4/c5, they are modified into poly-rails hubs. FIG.17-BF8/Bf2/BF4/bF6 form a poly-rails 4-way 个-hub, BF8/Bf2/bF6 make a Yv set and the v-ramp over-crossing BF4=8 fulfills third side circulation; it handles 5 express trips among total 12. BF8/ Bf1/Bf2/bF6/bF7 form a poly- rails 5-way 大-hub, with a same Yv set; handling 7 express trips among total 20.

The whole FIG.17 appears a poly-rails 6-way 木-hub, handling 9 express among total 30 trips.

[00124] Both 大/木-hubs comprise a light-rail's K-link, which is cored by d6-m2 ramp in horns-shape. When c4/c5 trains synchronously approaching the hub, each breaks into two parts; 2F parts non-stop and keep in their home rings till the post-K stops; 2R parts switch into the K-link, after changing passengers, cross-interchange to the post-K stops, waiting for the next shift 2F.

[00125]In FIG.1-center shaft, the **BF** line of IC railway is covered by Metro A/C2-5 network, deriving two candle-stick hubs(FIG.1-T8/T16 magnified by FIG.10), facilitating b-BF-f feeding in T8/T16 hubs and central station as well. It's better for IC trains to break into F/M/R parts, too, to same time and length of platforms. Comparatively, B-BF-F or B-B/F-F transfer is quite popular in NY or HK Metro, but those are between two lines of same rail-type.

[00126]In FIG.1 or FIG.12 square center, the 4Yv or 4Xv turnout is inserted by an 3c inner-rings-combination or a c1 inner-ring. In FIG.16, the 4Ge/4Da compound 4VX turnout and the 4Mu kite-turnout are totally inserted by a polygonal inner- rings-combination c1/c4/c5. Obviously, both c1 above can be further modified into **nc** inner-rings-combination to improve service layover.

[00127] Shown by half dots along c1/c4/c5 in FIG.16, the light trains stop one-side, in Bf=bF anti-way feeding the heavy trains (IC or RER or both together) stopping at hubs only. After c1 replaced by FIG.1-3c, framed is a 5c inner-rings-combination, facilitating trains' interchange and passengers' on-board transfer among c1-5.

[00128] A sustainable railway network of a second embodiment of the invention, comprising circular-turnouts and/or plate-turnouts, covered by multi-way stations, as cores and/or key nodes of circulating lines/networks and of feeder-lines/nets derived; employs circulating route-system to minimize red-lights,

enhance and balance traffic flows; facilitates vehicles' interchange and reorganization and passengers' on-board and/or easy transfer.

[00129] In a class of this embodiment, the plate-turnout is cored by at least one circular-plate, including a double-track plate (FIG.21) or a triple-track plate (FIG.20), facilitating bidirectional or tri-directional vehicles to pass through or switch by synchronously.

[00130] A monorail's Y3V turnout (FIG.19 upper-layer) can be modified into a plate-turnout by installing a triple-track plate. When tri-directional trains passing by synchronously, they break into 3F/3R parts and drop 3R inside the plate; 3F apical graft last shift 3R at post-Y stops; 3R switch 120°A by the plate, then forward to left side post-Y stops, waiting for next 3F parts. In this way, the Y3V line is improved same as a Y3T line, facilitating coaches' interchange and passengers' on-board transfer.

[00131] By installing one circular-plate, the double-layer 6-way star-hub (FIG.19) can be modified into a monolayer plate-turnout; inside which, 3R from B1/5/3 switch 60°A (3Z), forwarding to F4/2/6 and post-star stops, waiting for next 3F from B2/4/6; alternate angles 60°A rotation facilitate six-way coaches' circular-passing and switching repeatedly. Therefore the plate-turnout saves land and space as well, even if adopted by normal rails.

[00132] In a class of this embodiment, the circulating line/network employs at least one plate-frozen model; during which period, the both ends plate-off double-track section is modified into a double-shuttles line, the at least three ends plate-off section is modified into an at least triple-shuttles line, without interfering rest of the traffics in the network.

[00133] FIG.21 show a double-track plate at a monolayer cross, facilitating alternative 2V-turn of 90°C to nearer-side (2VN) or 90°A to further- side (2VF),

and a plate-frozen model on horizontal BF, while vertical BF=section modified into a double-shuttle line (FIG.24-2S).

[00134] As shown by FIG.24-3S and FIG.26-4S, when 3-4 ends plate-off , the 3V-4V section is modified into a triple-shuttle 3S or quadruple-shuttle 4S line; without interfering rest of the traffics. Moreover, the 3S or 4S turnout remains a circular-turnout and facilitates passengers' circular-transit, when 3/4 trains synchronically stop by the 3/4-lateral platform heads-by-ends, but all keeping right or left in alternation.

[00135] In a class of this embodiment, as shown by FIG.22, the circular-plate is a suspended plate in a pot-cover shape, fixed by double track-slots(TS) or triple track-slots underneath the plate, facilitating bidirectional or tri-directional suspended vehicles to pass through or switch by synchronously. The suspended plates, as cores and/or key nodes, enable the suspended monorail to branch or network sustainably; utilizing the reverse side of bridges or tunnels (FIG.26) to save space and building cost of both rail-types.

[00136] Both double-track or triple-track plates facilitate continuous U-turns (FIG.20-3U) at the terminals, replacing U-rings (FIG.19-U) to save land. Moreover, the plate terminal may further branch by the same plate coring a new circular-plate-turnout, in the sustainable line/network.

Claims:

1. A sustainable circulating railway line/network, comprising circular-turnouts, covered by multi-way stations, as cores and/or key nodes of circulating-line and/or network; employs circulating route-system to minimize red-lights, enhance and balance traffic flows, deriving poly-rails feeder-ship to improve service layover; facilitates vehicles' interchange and reorganizing during their operation, and passengers' on-board and/or easy transfer; improves service layover, efficiency and safety; and effectively reduces the building and operating cost of the railway network.

2. The sustainable circulating railway network of claim 1, wherein said circular-turnout is an at least three-way turnout for bidirectional double-tracks, comprising at least three multi-connected Back-and-Forth ports, and at least one set of at least three-way V-ramps/tracks; said V-ramps/tracks turn from the Back-tracks of each BF port into the Forth-tracks of the nearer-side BF port, completing a circulation.

3. The sustainable circulating railway network of claim 1 or 2, wherein said multi-way station is a station or a group of sub-stations covering a circular-turnout, including a station or sub-station covering a bibasic turnout or hub; said bibasic hub comprises at least two rail-types, and at least one set of at least three way V/v-ramps of at least one rail-type.

4. The sustainable circulating railway network of claim 1, wherein

said circulating lines/networks comprise semi-return circulating lines and non-return circulating networks; said circulating line/lines may branch or merge sustainably by said circular-turnouts into said circulating network; said circulating line comprises at least one circular-turnout, connecting at least three BF sections, at least part of vehicles semi-return and circulate among at least three terminals; said circulating network comprises at least one inner-rings-combination; said inner-rings-combination is duplicable in two or four or six directions, comprising at least two inner-rings of same rotation, or at least one self-cross-loop, or at least one self-cross-loop plus at least one inner-ring of same rotation; said self-cross-loop comprises at least three open-end inner-rings of same rotation.

5. The sustainable circulating railway network of claim 2, wherein

Said circular-turnout includes bibasic turnout, comprising at least three multi-connected BF or Bf or bF or bf ports, and at least three-way V/v-ramps of two rail-types in circulation; said V-ramp may be compound of parallel ramps in a crescent shape, assembling a Crescent Junction; said V-turn track comprises a serial of two Crescent Junctions; said Crescent Junction is one-way-through, comprising an Overtaking Ramp by its shorter and less-curved side, Platform Tracks by its longer and more-curved side, and a Train-Yard in between.

6. The sustainable circulating railway network of claim 2, wherein

said circular-turnout includes a switchable turnout or circular-switchable turnout; said switchable turnout comprises at least one d-m ramp; said

circular-switchable turnout comprises at least one set of at least three way V-ramps/tracks totally inserted by said d-m ramps/tracks; said d-m ramp/track is one-way, starting from a diverge-switch at the B-track of one BF port, and ends by a merge-switch at the F- track of another BF port, both diverge and merge switches irreversible with forking angles outpointing.

7. The sustainable circulating railway network of claim 2, wherein said circular-turnout includes a plate-turnout; said plate-turnout comprises at least one turn-plate, and employs at least one plate-frozen model; said turn-plate is a ground plate or a suspended plate in pot-cover shape; said turn-plate is a double-track plate or triple-track plate, with all tracks on face or track-slots underneath longer than a single coach; during fixed plate-frozen model, the at least two ends plate-off section or at least three way sections is/are modified into at least double-shuttles line, without interfering rest of the traffic inside the network.

8. The sustainable circulating railway network of claim 10, wherein said multi-way station comprises at least one multi-lateral platform; said multi-lateral platform is monolayer or split-leveled or connected by split-level passages, comprising at least three boarding sides for at least one rail-type; said multi-lateral platform or platforms in a group of sub-stations facilitates passengers' door-to-door circular-transit, when at least three trains stop by in a heads-by-ends manner.

9. The sustainable circulating railway network of claim 11, wherein said circulating line/network includes feeder-line and feeder-net; said feeder-line covers or braids at least one major rail-type, resulting in a bibasic hub; said feeder-net is an inner-ring or inner-rings-combination, inserting or threading the major rail-type, resulting in bibasic turnouts or hubs and bibasic sections; said bibasic hub comprises at least one set of V/v-ramps of at least one rail-type; said bibasic section comprises at least two rail-types and at least double tracks parallel and bidirectional.

10. The sustainable circulating railway network of claim 6, wherein said d-m ramp/track is restricted within the turnout range, and owing to its ship lock structure, employs four ways of switching: d/m both-on, d-on/m-off, d-off/m-on, d/m both-off; said switchable or circular-switchable turnout employs at least one switch-frozen model, during which period a d/m both-off ramp/track is modified as a parking lot or shuttle line, without interfering rest of the traffics.