

(51) International Patent Classification:
E01C 1/04 (2006.01) *E01C 1/00* (2006.01)(21) International Application Number:
PCT/CA2011/001233(22) International Filing Date:
14 November 2011 (14.11.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/413,432 13 November 2010 (13.11.2010) US
2736686 5 April 2011 (05.04.2011) CA

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Montreal, Quebec H2T 1C1 (CA).(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ,
CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO,
DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP,KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD,
ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI,
NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU,
RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ,
TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA,
ZM, ZW.(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD,
RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ,
DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT,
LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS,
SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM,
GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).**Published:**

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the
claims and to be republished in the event of receipt of
amendments (Rule 48.2(h))

(54) Title: WEAVING-FREE INTERCHANGE WITH FEW BRIDGES AND EXTERIOR EXITS AND ENTRANCES ONLY

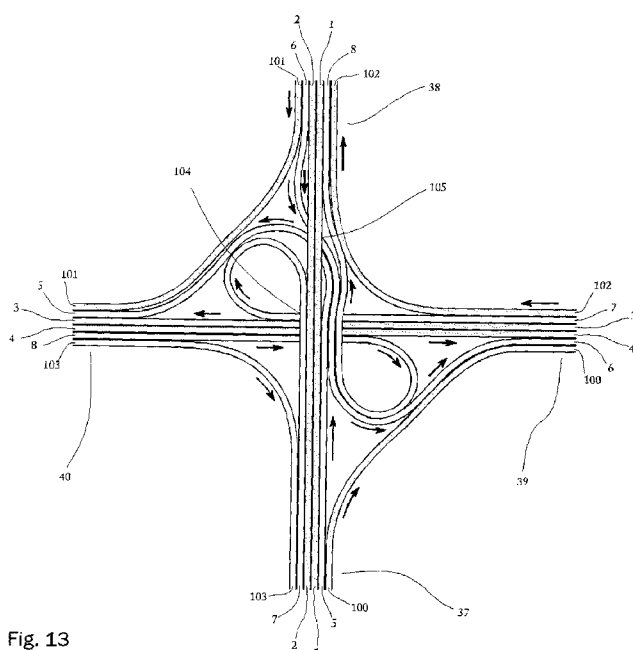


Fig. 13

(57) Abstract: The present invention is a traffic-weaving-free grade-separated road junction that provides for continuous flow of traffic and provides exterior exits and entrances only (i.e., it provides right-side exits and entrances only where the convention is for traffic to keep to the right, but provides left-side exits and entrances only where the convention is for traffic to keep to the left). Two of the embodiments have two loop ramps and require as few as two bridges. Two other embodiments have no loop ramps and require as few as three bridges. In addition, four other embodiments have one loop ramp and require as few as three bridges; two other embodiments have no loop ramps and require as few as four bridges; and two embodiments provide U-turn ramps, have no loop ramps, and require as few as three bridges. Compared to prior art junctions that also provide for continuous flow of traffic, avoid weaving, and provide exterior exits and entrances only, the present invention can be constructed with fewer bridges and/or fewer loop ramps. Therefore, the present invention provides reduced structure-related costs and/or increased safety and speed for drivers. In addition, because it can be constructed with fewer bridges than said prior art junctions, the present invention provides lower aesthetic impacts and other environmental costs. Finally, the embodiments of the present invention provide an additional set of design options for road engineers to choose from when designing within particular constraints of right-of-way, topography, and other factors.

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TITLE OF INVENTION:

Weaving-Free Interchange With Few Bridges and Exterior Exits and Entrances Only

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CROSS REFERENCE TO RELATED APPLICATIONS

This application claims priority of US Provisional Application No. 61413432, filed 13 November 2010, which is hereby incorporated by reference in its entirety.

BACKGROUND OF THE INVENTION

10 This invention relates to grade-separated junctions for intersecting roads, and more particularly, to grade-separated junctions that provide for the continuous and weaving-free flow of traffic on intersecting roads, and that provide exterior exits and entrances only. For the purposes of this patent, the term ‘exterior exit’ refers to a right-side exit where the convention is for traffic to keep to the right, but refers to a left-side exit where the convention is for traffic to keep to the left, while the term
15 ‘exterior entrance’ refers to a right-side entrance where the convention is for traffic to keep to the right, but refers to a left-side entrance where the convention is for traffic to keep to the left.

Grade-separated junctions are more commonly known as interchanges. There are many interchange configurations that permit free flow of traffic for traffic traveling directly through the interchange or turning left or right onto the intersecting road or roads. However, these existing
20 configurations have disadvantages in one or more of the following aspects: safety, traffic capacity, construction costs, maintenance costs, modification costs, right-of-way costs, or environmental costs.

The ‘cloverleaf’ configuration (US Pat. No. 1,173,505), because it requires as few as one bridge, has relatively low structure-related costs, but as is well-known, the weaving of traffic exiting from and entering onto the mainlines reduces the safety and capacity of the interchange. A common treatment
25 of interchanges is the addition of separate collector-distributor roads. This removes weaving-related problems from the mainlines, but weaving still exists on the collector-distributor roads. In addition, the addition of collector-distributor roads increases structure-related costs and right-of-way requirements. Another disadvantage of the cloverleaf configuration is that the loop ramps of the cloverleaf result in large right-of-way requirements and/or low design speeds.

30 Several weaving-free interchange configurations have since been developed. The ‘four-level directional’ or ‘stack’ configuration (see Exhibit 10-33 B and C from A Policy on the Geometric Design of Highways and Streets, Fourth Edition, by the American Association of State Highway and Transportation Officials) provides improved capacity and safety, but has high structure-related costs

due to the length and height of structures required. In addition, because of the height of some of the structures, there can be problems with icing in cold conditions. Another problem is that the height of the structures can be problematic from an urban design and aesthetic perspective. Finally, future modifications of the configuration are expensive.

The semi-directional (see Exhibit 10-33 A of A Policy on the Geometric Design of Highways and Streets, Fourth Edition, by the American Association of State Highway and Transportation Officials) or 'turbine' configuration can have somewhat lower structure-related costs than the four-level directional. An uncommon modification of the 'turbine' (see Fig. VB6.11 from VicRoads Supplement to the Austroads Guide to Road Design Part 4C – Interchanges, Rev. 1.1), sometimes called the 'windmill', can have still lower structure-related costs, as it can be constructed using as few as five bridges.

Two lower-cost weaving-free modifications of the cloverleaf configuration also exist, each with two loop ramps. One, a 'semidirect' interchange (see Exhibit 10-33 of A Policy on the Geometric Design of Highways and Streets, Fourth Edition, by the American Association of State Highway and Transportation Officials), sometimes called a 'clover-stack', still has relatively high structure-related costs due to the height and length of two of the structures required. Another type of semidirect interchange (see Fig. 10 of "A model for calculating optimal vertical alignments of interchanges" by Lee and Cheng, Transportation Research Part B, Vol. 5, Issue 5, pp. 423-445), sometimes called a 'clover-turbine', can have somewhat lower structure-related costs.

Nevertheless, the 'turbine', 'windmill', 'clover-stack', and 'clover-turbine' configurations are inappropriate for many applications because of excessively high structure-related costs.

Five other prior weaving-free modifications of the cloverleaf configuration exist. A rare such configuration, which has four loop ramps and requires as few as five bridges, is sometimes called a 'braided' cloverleaf. A built example of this configuration exists near Frankfurt, Germany, at the junction of the bundesautobahnen 3 and 5. Another configuration is shown in Figs. 3h and 3i of International Patent Application Publication No. WO 2004/104301. This configuration has four loop ramps, requires as few as five bridges, and requires a very large right-of-way. The remaining three prior weaving-free modifications of the cloverleaf configuration each have two loop ramps and require as few as three bridges. The first is the 'continuous flow cloverleaf-type interchange', described in US Pat. No. 4,861,184. The second is sometimes called the 'partially-unrolled cloverleaf'. A built example of this configuration exists near Reading, UK, at the junction of the M4 and A329 motorways. The third, more common configuration is sometimes called the 'clovermill', because it uses two left-turn ramps with a form similar to those of the 'windmill'. A built example of this configuration exists at the junction of Interstate 395 and King St. in Alexandria, Virginia, USA.

There are numerous existing interchange configurations where some or all of the exits or entrances are interior rather than exterior (i.e., where some exits or entrances are located at the left side of the road where the convention is for traffic to keep to the right, or where some exits or entrances are located at the right side of the road where the convention is for traffic to keep to the left). Some examples are found in French Pat. No. 2,442,915, and US Pat. No. 1,689,161, No. 2,941,454, No. 3,107,590, No. 7,425,104, and some embodiments of No. 4,630,961. These configurations are generally deprecated for system interchange applications because interior exits, as defined here, have been recognized as causing safety and operational problems.

All prior existing weaving-free interchange configurations that provide for continuous flow of traffic and that provide exterior exits and entrances only require three or more bridges. All prior existing weaving-free interchange configurations that provide for continuous flow of traffic, have no loop ramps, and provide exterior exits and entrances only require five or more bridges. Because reducing the number of structures in an interchange tends to reduce structure-related costs – that is, construction, maintenance, and modification costs – as well as aesthetic impacts and other environmental costs, there is a need for a weaving-free interchange configuration that provides for continuous flow of traffic, provides exterior exits and entrances only, and can be constructed with fewer than three bridges. In addition, because loop ramps provide lower capacity and safety for a given amount of right-of-way, there is also a need for a weaving-free interchange configuration that provides for continuous flow of traffic, has no loop ramps, provides exterior exits and entrances only, and can be constructed with fewer than five bridges. Finally, because prior interchange configurations may not be appropriate for some sites with particular constraints of right-of-way, topography, and other factors, there is a general need for new interchange configurations to provide more design options to transportation planners and engineers.

BRIEF SUMMARY OF THE INVENTION

The present invention is a traffic-weaving-free grade-separated road junction that provides for continuous flow of traffic and provides exterior exits and entrances only. Two of the embodiments have two loop ramps and require as few as two bridges. Two other embodiments have no loop ramps and require as few as three bridges. In addition, four other embodiments have one loop ramp and require as few as three bridges; two other embodiments have no loop ramps and require as few as four bridges; and two embodiments provide U-turn ramps, have no loop ramps, and require as few as three bridges. Compared to prior art junctions that also provide for continuous flow of traffic, avoid weaving, and provide exterior exits and entrances only, the present invention can be constructed with fewer bridges and/or fewer loop ramps. Therefore, the present invention provides reduced structure-related costs and/or increased safety and speed for drivers. In addition, because it can be constructed with fewer bridges than said prior art junctions, the present invention provides lower aesthetic impacts

and other environmental costs. Finally, the embodiments of the present invention provide an additional set of design options for road engineers to choose from when designing within particular constraints of right-of-way, topography, and other factors.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF DRAWINGS

Figs. 1 through 30 are plan view schematics of the various embodiments of the invention. Note that the drawings of **Figs. 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, and 30** are based on horizontal reflections of the drawings of **Figs. 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, and 29**, respectively.

Fig. 1 shows the arrangement of road surfaces in a first embodiment, which has two loop ramps and requires as few as two bridges; **Fig. 2** shows a second embodiment, which has two loop ramps and requires as few as two bridges. **Fig. 3** shows the arrangement of road surfaces in a third embodiment, which has no loop ramps and requires as few as three bridges; **Fig. 4** shows a fourth embodiment, which has no loop ramps and requires as few as three bridges. **Fig. 5** shows the arrangement of road surfaces in a fifth embodiment, which has no loop ramps and requires as few as three bridges. U-turn ramps are also provided for each leg of the interchange; **Fig. 6** shows a sixth embodiment of the invention, which has no loop ramps and requires as few as two bridges. U-turn ramps are also provided for each leg of the interchange. **Fig. 7** shows the arrangement of road surfaces in a seventh embodiment, which has one loop ramp and requires as few as three bridges; **Fig. 8** shows an eighth embodiment, which has one loop ramp and requires as few as three bridges. **Fig. 9** shows the arrangement of road surfaces in a ninth embodiment, which has one loop ramp and requires as few as three bridges; **Fig. 10** shows a tenth embodiment of the invention, which has one loop ramp and requires as few as three bridges. **Fig. 11** is a plan view schematic of the arrangement of road surfaces in an eleventh embodiment, which has no loop ramps and requires as few as four bridges; **Fig. 12** shows a twelfth embodiment of the invention, which has no loop ramps and requires as few as four bridges.

Fig. 13 is a plan view schematic showing a possible arrangement of overpasses and underpasses for the first embodiment of the invention; **Fig. 14** is a plan view schematic showing a possible arrangement of overpasses and underpasses for the second embodiment of the invention. **Fig. 15** is a plan view schematic showing a possible arrangement of overpasses and underpasses for the third embodiment of the invention; **Fig. 16** is a plan view schematic showing a possible arrangement of overpasses and underpasses for the fourth embodiment of the invention. **Fig. 17** is a plan view schematic showing a possible arrangement of overpasses and underpasses for the fifth embodiment of the invention; **Fig. 18** is a plan view schematic showing a possible arrangement of overpasses and underpasses for the sixth embodiment of the invention. **Fig. 19** is a plan view schematic showing a possible arrangement of overpasses and underpasses for the seventh embodiment of the invention;

Fig. 20 is a plan view schematic showing a possible arrangement of overpasses and underpasses for the eighth embodiment of the invention. **Fig. 21** is a plan view schematic showing a possible arrangement of overpasses and underpasses for the ninth embodiment of the invention; **Fig. 22** is a plan view schematic showing a possible arrangement of overpasses and underpasses for the tenth embodiment of the invention. **Fig. 23** is a plan view schematic showing a possible arrangement of overpasses and underpasses for the eleventh embodiment of the invention; **Fig. 24** is a plan view schematic showing a possible arrangement of overpasses and underpasses for the twelfth embodiment of the invention. **Fig. 25** is a plan view schematic showing another possible arrangement of overpasses and underpasses for the first embodiment of the invention; **Fig. 26** is a plan view schematic showing another possible arrangement of overpasses and underpasses for the second embodiment of the invention. **Fig. 27** is a plan view schematic showing another possible arrangement of overpasses and underpasses for the third embodiment of the invention; **Fig. 28** is a plan view schematic showing another possible arrangement of overpasses and underpasses for the fourth embodiment of the invention. **Fig. 29** is a plan view schematic showing another possible arrangement of overpasses, underpasses, and right-turn ramps for the third embodiment of the invention; **Fig. 30** is a plan view schematic showing another possible arrangement of overpasses, underpasses, and right-turn ramps for the fourth embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

The inventive matter of the present invention is the arrangement of road surfaces relative to one another. Specific geometric features such as the horizontal and vertical alignments are not claimed as the inventive matter in this invention. As with any interchange configuration, a practitioner with ordinary skill in the art of geometric design of roadways will determine the most appropriate geometry to apply to the various embodiments of this invention by considering relevant design standards and design criteria particular to a given site of interest.

It will be obvious to the practitioner of ordinary skill in the art of geometric design of roadways that, in any of the embodiments of this invention, one or more road surfaces may be omitted as desired by the practitioner utilizing the current invention; in addition, it will be obvious that one or more road surfaces may be added as desired by the practitioner utilizing the current invention. Such modifications are commonly made to standard interchange configurations, such as those mentioned in the accounting of prior art above.

Note that in the descriptions that follow, it is assumed that the invention is to be applied to roads where the convention is for traffic to keep to the right. It will be obvious to a person of ordinary skill in the art how to modify the description when the invention is to be applied instead to roads where the convention is for traffic to keep to the left.

No right-turn ramps are drawn in the schematics of **Figs. 1 to 12**. It will be obvious to a practitioner with ordinary skill in the art of geometric design of roadways how best to add right-turn ramps to any embodiment of the present invention. Of the numerous interchange configurations with right-side exits and entrances only that have been developed, there is a wide variety of different arrangements of mainlines and left-turn ramps relative to one another, and the diversity of configurations practitioners have devised, and continue to devise, is an indication that devising such arrangements is not obvious; however, there is a much smaller variety of feasible arrangements of right-turn ramps relative to the mainlines and left-turn ramps in interchanges with right-side exits and entrances only. Thus, it is obvious to the practitioner of ordinary skill how to devise such arrangements. Where the exits for the right-turn and left-turn ramps are located along substantially the same length of road, a right-side exit to a right-turn ramp can either be located to the right or the left of the exit for the adjacent left-turn ramp, and where the entrances for the right-turn and left-turn ramps are located along substantially the same length of road, a right-side entrance from a right-turn ramp can either be located to the right or the left of the entrance for the adjacent left-turn ramp. Clearly, there are very few possible arrangements. Because it is obvious to a practitioner of ordinary skill how to best arrange right-turn ramps in interchanges with right-side exits and entrances, and because there are numerous existing constructed precedents of the already scarce number of different arrangements or right-turn ramps in various interchanges with right-side exits and entrances, right-turn ramps have not been included in **Figs. 1 to 12**.

Figs. 13 through 30 show several embodiments of the present invention with possible arrangements of right-turn ramps. The arrangements of right-turn ramps in **Figs. 13 through 28** are the most common arrangements; **Figs. 29 and 30** show possible alternative arrangements where the exits to and entrances from two right-turn ramps are located to the left of the adjacent left-turn exits and entrances, from the perspective of a driver traveling to, along, and exiting from the right-turn ramp. A similar arrangement of right turn ramps is seen in the turbine interchange of Belgian Pat. No. 638,746 and No. 641,129. However, all of the embodiments illustrated in **Figs. 13 through 30** may be constructed with a variety of arrangements of right-turn ramps other than those illustrated. As described above, an exit to a given right-turn ramp can either be located to the right or the left of the exit for the adjacent left-turn ramp, and an entrance from a right-turn ramp can either be located to the right or the left of the entrance for the adjacent left-turn ramp.

In the following descriptions, three abbreviations are used: 'RS' stands for 'road surface', 'RSs' stands for 'road surfaces', while 'GSC' stands for 'grade-separated crossing'.

Fig. 1 is a plan view schematic of the arrangement of roadways in a first embodiment of the invention. This embodiment has two loop ramps and requires as few as two bridges. RSs **1, 2, 3, and 4** are commonly called mainlines. RS **1** is provided for through traffic traveling from the extremity of

the junction 37 to extremity of the junction 38. RS 2 is provided for through traffic traveling from the extremity of the junction 38 to extremity of the junction 37. RS 3 is provided for through traffic traveling from the extremity of the junction 39 to extremity of the junction 40. RS 4 is provided for through traffic traveling from the extremity of the junction 40 to extremity of the junction 39.

RSs 5, 6, 7, and 8 are commonly called left-turn ramps. RS 5 is provided for through traffic traveling from the extremity of the junction 37 to extremity of the junction 40. RS 6 is provided for through traffic traveling from the extremity of the junction 38 to extremity of the junction 39. RS 7 is provided for through traffic traveling from the extremity of the junction 39 to extremity of the junction 37. RS 8 is provided for through traffic traveling from the extremity of the junction 40 to extremity of the junction 38.

At the extremity of the junction 37, RS 1 is disposed laterally between RS 2 and RS 5, and RS 2 is disposed laterally between RS 7 and RS 1. At the extremity of the junction 38, RS 1 is disposed laterally between RS 2 and RS 8, and RS 2 is disposed laterally between RS 6 and RS 1. At the extremity of the junction 39, RS 4 is disposed laterally between RS 6 and RS 3, and RS 3 is disposed laterally between RS 4 and RS 7. At the extremity of the junction 40, RS 3 is disposed laterally between RS 5 and RS 4, and RS 4 is disposed laterally between RS 3 and RS 8.

The above description of RSs 1 through 8 also applies to Figs. 2 through 30.

Note again that specific geometric features such as horizontal and vertical alignments are not claimed as the inventive matter in this invention. The arrangements of road surfaces are defined by their positions relative to one another – for example, in the embodiment of Fig. 1, RS 1, at the extremity of the junction 37, is disposed laterally between RS 2 and RS 5, and at the extremity of the junction 38, it is disposed laterally between RS 2 and RS 8, and between the extremities of the junction 37 and 38, it has grade-separated crossing with RSs 8, 4, 3, 7, 5, and 6, and these grade-separated crossings occur in a particular order relative to one another. Note also that the phrase “disposed laterally between” in this patent does not imply an identical vertical elevation. For example, in the embodiment of Fig. 1, at the extremity of the junction 37, RS 1 may be at a vertical elevation distinct from that of RS 2 and RS 5. In most cases, a practitioner constructing the embodiment will place RS 1 at a vertical elevation substantially similar to that of RS 2 and RS 5; however, there may be cases where it is preferred not to do so. This kind of practice is also well-known to practitioners of the art of geometric design of roadways, and numerous interchanges of various configurations have been thus constructed.

RS 1 intersects with RS 4 at GSC 9; RS 1 intersects with RS 3 at GSC 10; RS 2 intersects with RS 3 at GSC 11; RS 2 intersects with RS 4 at GSC 12; RS 5 intersects with RS 4 at GSC 13; RS 5 intersects with RS 3 at GSC 14; RS 6 intersects with RS 3 at GSC 15; RS 6 intersects with RS 4 at

GSC 16; RS 1 intersects with RS 5 at GSC 17; RS 1 intersects with RS 6 at GSC 18; RS 2 intersects with RS 6 at GSC 19; and RS 2 intersects with RS 5 at GSC 20.

The above description of GSCs 9 through 20 also applies to Figs. 2 through 12. Note that RSs 1 through 6 are arranged, relative to each other, in the same arrangement in all embodiments of the present invention. The various embodiments of the present invention are formed by providing different arrangements of other RSs, such as 7, 8, and others described below, relative to RSs 1 through 6.

RS 1 intersects with RS 8 at GSC 21; RS 1 intersects with RS 7 at GSC 22; RS 2 intersects with RS 7 at GSC 23; RS 2 intersects with RS 8 GSC 24; RS 5 intersects with RS 8 at GSC 25; RS 5 intersects with RS 7 at GSC 26; RS 6 intersects with RS 7 at GSC 27; RS 6 intersects with RS 8 at GSC 28; RS 8 intersects with RS 8 at GSC 29; RS 8 intersects with RS 4 at GSC 30; RS 8 intersects with RS 3 at GSC 31; RS 8 intersects with RS 7 at GSC 32. RS 7 intersects with RS 7 at GSC 33; RS 7 intersects with RS 3 at GSC 34; RS 7 intersects with RS 4 at GSC 35; and RS 7 intersects with RS 8 at GSC 36.

In the following descriptions, the phrase 'is disposed along' stands for 'is disposed intermediately along the length of'. For example, the sentence that follows means 'GSC 21 is disposed intermediately along the length of RS 1 between the extremity of the junction 37 and GSC 9'.

GSC 21 is disposed along RS 1 between the extremity of the junction 37 and GSC 9. GSC 9 is disposed along RS 1 between GSC 21 and GSC 10; GSC 10 is disposed along RS 1 between GSC 9 and GSC 22; GSC 22 is disposed along RS 1 between GSC 10 and GSC 17; and GSC 17 is disposed along RS 1 between GSC 17 and GSC 18. SC 19 is disposed along RS 2 between the extremity of the junction 38 and GSC 20; GSC 20 is disposed along RS 2 between GSC 19 and GSC 23; GSC 23 is disposed along RS 2 between GSC 11 and GSC 23; GSC 11 is disposed along RS 2 between GSC 23 and GSC 12; and GSC 12 is disposed along RS 2 between GSC 11 and GSC 24. GSC 25 is disposed along RS 5 between the extremity of the junction 37 and GSC 13; GSC 13 is disposed along RS 5 between GSC 25 and GSC 14; GSC 14 is disposed along RS 5 between GSC 13 and GSC 26; GSC 26 is disposed along RS 5 between GSC 14 and GSC 17; and GSC 17 is disposed along RS 5 between GSC 26 and GSC 20. GSC 19 is disposed along RS 6 between the extremity of the junction 38 and GSC 18; GSC 17 is disposed along RS 6 between GSC 19 and GSC 27; GSC 27 is disposed along RS 6 between GSC 17 and GSC 15; GSC 15 is disposed along RS 6 between GSC 27 and GSC 16; and GSC 16 is disposed along RS 6 between GSC 15 and GSC 28. GSC 32 is disposed along RS 7 between the extremity of the junction 39 and GSC 27; GSC 27 is disposed along RS 7 between GSC 32 and GSC 26; GSC 26 is disposed along RS 7 between GSC 27 and GSC 22; GSC 22 is disposed along RS 7 between GSC 26 and GSC 23; GSC 23 is disposed along RS 7 between GSC 22 and GSC 33; GSC 33 is disposed along RS 7 between GSC 23 and GSC 34; GSC 34 is disposed along RS 7

between GSC 33 and GSC 35; and GSC 35 is disposed along RS 7 between GSC 34 and GSC 36. GSC 36 is disposed along RS 8 between extremity of the junction 40 and GSC 24; GSC 24 is disposed along RS 8 between GSC 36 and GSC 21; GSC 21 is disposed along RS 8 between GSC 24 and GSC 25; GSC 25 is disposed along RS 8 between GSC 21 and GSC 28; GSC 28 is disposed along
 280 RS 8 between GSC 25 and GSC 29; GSC 29 is disposed along RS 8 between GSC 28 and GSC 30; GSC 30 is disposed along RS 8 between GSC 29 and GSC 31; and GSC 31 is disposed along RS 8 between GSC 30 and GSC 32.

The above description of Fig. 1 applies also to Fig. 2. Fig. 2 is a plan view schematic of the arrangement of roadways in a second embodiment of the invention. This embodiment has two loop
 285 ramps and requires as few as two bridges. This embodiment is based on a horizontal reflection of the drawing of Fig. 1.

Fig. 3 is a plan view schematic of the arrangement of roadways in a third embodiment of the invention. This embodiment has no loop ramps and requires as few as three bridges.

RS 7 intersects with RS 6 at GSC 41; RS 7 intersects with RS 5 at GSC 42; RS 7 intersects with
 290 RS 1 at GSC 43; RS 7 intersects with RS 2 at GSC 44; RS 7 intersects with RS 3 at GSC 45; and RS 7 intersects with RS 4 at GSC 46. RS 8 intersects with RS 4 at GSC 47; RS 8 intersects with RS 3 at GSC 48; RS 8 intersects with RS 2 at GSC 49; RS 8 intersects with RS 1 at GSC 50; RS 8 intersects with RS 5 at GSC 51; and RS 8 intersects with RS 6 at GSC 52.

GSC 9 is disposed along RS 1 between extremity of the junction 37 and GSC 10; GSC 10 is
 295 disposed along RS 1 between GSC 9 and GSC 43; GSC 43 is disposed along RS 1 between GSC 10 and GSC 50; GSC 50 is disposed along RS 1 between GSC 43 and GSC 17; and GSC 17 is disposed along RS 1 between GSC 50 and GSC 18. GSC 19 is disposed along RS 2 between extremity of the junction 38 and GSC 20; GSC 20 is disposed along RS 2 between GSC 19 and GSC 49; GSC 49 is disposed along RS 2 between GSC 20 and GSC 44; GSC 44 is disposed along RS 2 between GSC 44
 300 and GSC 11; and GSC 11 is disposed along RS 2 between GSC 44 and GSC 12. GSC 13 is disposed along RS 5 between extremity of the junction 37 and GSC 14; GSC 14 is disposed along RS 5 between GSC 13 and GSC 42; GSC 42 is disposed along RS 5 between GSC 14 and GSC 51; GSC 51 is disposed along RS 5 between GSC 42 and GSC 17; and GSC 17 is disposed along RS 5 between GSC 51 and GSC 20. GSC 19 is disposed along RS 6 between extremity of the junction 38 and GSC
 305 18; GSC 18 is disposed along RS 6 between GSC 19 and GSC 52; GSC 52 is disposed along RS 6 between GSC 18 and GSC 41; GSC 41 is disposed along RS 6 between GSC 52 and GSC 15; and GSC 15 is disposed along RS 6 between GSC 41 and GSC 16. GSC 41 is disposed along RS 7 between extremity of the junction 39 and GSC 42; GSC 42 is disposed along RS 7 between GSC 41 and GSC 43; GSC 43 is disposed along RS 7 between GSC 42 and GSC 44; GSC 44 is disposed along
 310 RS 7 between GSC 43 and GSC 45; and GSC 45 is disposed along RS 7 between GSC 44 and GSC

46. GSC 47 is disposed along RS 8 between extremity of the junction 40 and GSC 48; GSC 48 is disposed along RS 8 between GSC 47 and GSC 49; GSC 49 is disposed along RS 8 between GSC 48 and GSC 50; GSC 50 is disposed along RS 8 between GSC 49 and GSC 51; and GSC 51 is disposed along RS 8 between GSC 50 and GSC 52.

315 The above description of Fig. 3 applies also to Fig. 4. Fig. 4 is a plan view schematic of the arrangement of roadways in a fourth embodiment of the invention. This embodiment has no loop ramps and requires as few as three bridges. This embodiment is based on a horizontal reflection of the drawing of Fig. 3.

Fig. 5 is a plan view schematic of the arrangement of roadways in a fifth embodiment of the invention. This embodiment has no loop ramps and requires as few as three bridges. U-turn ramps are also provided for each leg of the interchange.

RS 7 intersects with RS 6 at GSC 41; RS 7 intersects with RS 5 at GSC 42; RS 7 intersects with RS 1 at GSC 43; RS 7 intersects with RS 2 at GSC 44; RS 7 intersects with RS 3 at GSC 45; and RS 7 intersects with RS 4 at GSC 46. RS 8 intersects with RS 4 at GSC 47; RS 8 intersects with RS 3 at GSC 48; RS 8 intersects with RS 2 at GSC 49; RS 8 intersects with RS 1 at GSC 50; RS 8 intersects with RS 5 at GSC 51; and RS 8 intersects with RS 6 at GSC 52.

RSs 53, 54, 55, and 56 are commonly called U-turn ramps. RS 53 is provided for U-turn traffic traveling from the extremity of the junction 37 and returning to the extremity of the junction 37. RS 54 is provided for U-turn traffic traveling from the extremity of the junction 38 and returning to the extremity of the junction 38. RS 55 is provided for U-turn traffic traveling from the extremity of the junction 39 and returning to the extremity of the junction 39. RS 56 is provided for U-turn traffic traveling from the extremity of the junction 40 and returning to the extremity of the junction 40.

RS 53 intersects with RS 55 at GSC 57; RS 53 intersects with RS 4 at GSC 58; RS 53 intersects with RS 3 at GSC 59; RS 53 intersects with RS 55 at GSC 60; RS 53 intersects with RS 7 at GSC 61; RS 53 intersects with RS 8 at GSC 62; RS 53 intersects with RS 1 at GSC 63; RS 53 intersects with RS 2 at GSC 64; RS 53 intersects with RS 8 at GSC 65; RS 53 intersects with RS 7 at GSC 66; RS 53 intersects with RS 55 at GSC 67; RS 53 intersects with RS 3 at GSC 68; RS 53 intersects with RS 4 at GSC 69; and RS 53 intersects with RS 55 at GSC 70. RS 54 intersects with RS 2 at GSC 71; and RS 54 intersects with RS 1 at GSC 72. RS 55 intersects with RS 6 at GSC 73; RS 55 intersects with RS 5 at GSC 74; RS 55 intersects with RS 1 at GSC 75; RS 55 intersects with RS 2 at GSC 76; RS 55 intersects with RS 3 at GSC 77; RS 55 intersects with RS 4 at GSC 78; RS 55 intersects with RS 2 at GSC 79; RS 55 intersects with RS 1 at GSC 80; RS 55 intersects with RS 5 at GSC 81; and RS 55 intersects with RS 6 at GSC 82. RS 56 intersects with RS 4 at GSC 83; and RS 56 intersects with RS 3 at GSC 84.

345 GSC 80 is disposed along RS 1 between extremity of the junction 37 and GSC 9; GSC 9 is
 disposed along RS 1 between GSC 80 and GSC 10; GSC 10 is disposed along RS 1 between GSC 9
 and GSC 75; GSC 75 is disposed along RS 1 between GSC 10 and GSC 62; GSC 62 is disposed along
 RS 1 between GSC 75 and GSC 50; GSC 50 is disposed along RS 1 between GSC 62 and GSC 63;
 GSC 63 is disposed along RS 1 between GSC 50 and GSC 17; and GSC 17 is disposed along RS 1
 350 between GSC 63 and GSC 18. GSC 71 is disposed along RS 2 between extremity of the junction 38
 and GSC 19; GSC 19 is disposed along RS 2 between GSC 71 and GSC 20; GSC 20 is disposed along
 RS 2 between GSC 19 and GSC 64; GSC 64 is disposed along RS 2 between GSC 20 and GSC 49;
 GSC 49 is disposed along RS 2 between GSC 64 and GSC 44; GSC 44 is disposed along RS 2
 between GSC 49 and GSC 76; GSC 76 is disposed along RS 2 between GSC 44 and GSC 11; GSC 11
 355 is disposed along RS 2 between GSC 76 and GSC 12; and GSC 12 is disposed along RS 2 between
 GSC 11 and GSC 79. GSC 15 is disposed along RS 3 between extremity of the junction 39 and GSC
 14; GSC 14 is disposed along RS 3 between GSC 15 and GSC 59; GSC 59 is disposed along RS 3
 between GSC 14 and GSC 10; GSC 10 is disposed along RS 3 between GSC 59 and GSC 11; GSC 11
 is disposed along RS 3 between GSC 10 and GSC 68; GSC 68 is disposed along RS 3 between GSC
 360 11 and GSC 77; GSC 77 is disposed along RS 3 between GSC 68 and GSC 45; GSC 45 is disposed
 along RS 3 between GSC 77 and GSC 48; and GSC 48 is disposed along RS 3 between GSC 45 and
 GSC 84. GSC 83 is disposed along RS 4 between extremity of the junction 40 and GSC 47; GSC 47 is
 disposed along RS 4 between GSC 83 and GSC 46; GSC 46 is disposed along RS 4 between GSC 47
 and GSC 78; GSC 78 is disposed along RS 4 between GSC 46 and GSC 69; GSC 69 is disposed along
 365 RS 4 between GSC 78 and GSC 12; GSC 12 is disposed along RS 4 between GSC 69 and GSC 9;
 GSC 9 is disposed along RS 4 between GSC 12 and GSC 58; GSC 58 is disposed along RS 4 between
 GSC 9 and GSC 13; and GSC 13 is disposed along RS 4 between GSC 58 and GSC 16. GSC 41 is
 disposed along RS 7 between extremity of the junction 39 and GSC 42; GSC 42 is disposed along RS
 7 between GSC 41 and GSC 61; GSC 61 is disposed along RS 7 between GSC 42 and GSC 43; GSC
 370 43 is disposed along RS 7 between GSC 61 and GSC 44; GSC 44 is disposed along RS 7 between
 GSC 43 and GSC 66; GSC 66 is disposed along RS 7 between GSC 44 and GSC 45; and GSC 45 is
 disposed along RS 7 between GSC 66 and GSC 46. GSC 47 is disposed along RS 8 between
 extremity of the junction 40 and GSC 48; GSC 48 is disposed along RS 8 between GSC 47 and GSC
 65; GSC 65 is disposed along RS 8 between GSC 48 and GSC 49; GSC 49 is disposed along RS 8
 375 between GSC 65 and GSC 50; GSC 50 is disposed along between GSC 49 and GSC 62; GSC 62 is
 disposed along RS 8 between GSC 50 and GSC 51; and GSC 51 is disposed along RS 8 between GSC
 62 and GSC 52.

The above description of Fig. 5 applies also to Fig. 6. Fig. 6 is a plan view schematic of the
 arrangement of roadways in a sixth embodiment of the invention. This embodiment has no loop ramps

and requires as few as three bridges. U-turn ramps are also provided for each leg of the interchange. This embodiment is based on a horizontal reflection of the drawing of Fig. 5.

Fig. 7 is a plan view schematic of the arrangement of roadways in a seventh embodiment of the invention. This embodiment has one loop ramp and requires as few as three bridges.

RS 1 intersects with RS 8 at GSC 21; RS 1 intersects with RS 7 at GSC 22; RS 2 intersects with RS 7 at GSC 23; RS 2 intersects with RS 8 GSC 24; RS 5 intersects with RS 8 at GSC 25; RS 5 intersects with RS 7 at GSC 26; RS 6 intersects with RS 7 at GSC 27; RS 6 intersects with RS 8 at GSC 28; RS 8 intersects with RS 8 at GSC 29; RS 8 intersects with RS 4 at GSC 30; RS 8 intersects with RS 3 at GSC 31; RS 8 intersects with RS 7 at GSC 32; RS 7 intersects with RS 3 at GSC 94; RS 7 intersects with RS 4 at GSC 95; and RS 7 intersects with RS 8 at GSC 96.

GSC 21 is disposed along RS 1 between the extremity of the junction 37 and GSC 9; GSC 9 is disposed along RS 1 between GSC 21 and GSC 10; GSC 10 is disposed along RS 1 between GSC 9 and GSC 22; GSC 22 is disposed along RS 1 between GSC 10 and GSC 17; and GSC 17 is disposed along RS 1 between GSC 22 and GSC 18. GSC 19 is disposed along RS 2 between the extremity of the junction 38 and GSC 20; GSC 20 is disposed along RS 2 between GSC 19 and GSC 23; GSC 23 is disposed along RS 2 between GSC 11 and GSC 20; GSC 11 is disposed along RS 2 between GSC 23 and GSC 12; and GSC 12 is disposed along RS 2 between GSC 11 and GSC 24. GSC 25 is disposed along RS 5 between the extremity of the junction 37 and GSC 13; GSC 13 is disposed along RS 5 between GSC 25 and GSC 14; GSC 14 is disposed along RS 5 between GSC 13 and GSC 26; GSC 26 is disposed along RS 5 between GSC 14 and GSC 17; and GSC 17 is disposed along RS 5 between GSC 26 and GSC 20. GSC 19 is disposed along RS 6 between the extremity of the junction 38 and GSC 18; GSC 17 is disposed along RS 6 between GSC 19 and GSC 27; GSC 27 is disposed along RS 6 between GSC 17 and GSC 15; GSC 15 is disposed along RS 6 between GSC 27 and GSC 16; and GSC 16 is disposed along RS 6 between GSC 15 and GSC 28. GSC 32 is disposed along RS 7 between the extremity of the junction 39 and GSC 27; GSC 27 is disposed along RS 7 between GSC 32 and GSC 26; GSC 26 is disposed along RS 7 between GSC 27 and GSC 22; GSC 22 is disposed along RS 7 between GSC 26 and GSC 23; GSC 23 is disposed along RS 7 between GSC 22 and GSC 85; GSC 85 is disposed along RS 7 between GSC 23 and GSC 86; and GSC 86 is disposed along RS 7 between GSC 85 and GSC 87. GSC 87 is disposed along RS 8 between extremity of the junction 40 and GSC 24; GSC 24 is disposed along RS 8 between GSC 87 and GSC 21; GSC 21 is disposed along RS 8 between GSC 24 and GSC 25; GSC 25 is disposed along RS 8 between GSC 21 and GSC 28; GSC 28 is disposed along RS 8 between GSC 25 and GSC 29; GSC 29 is disposed along RS 8 between GSC 28 and GSC 30; GSC 30 is disposed along RS 8 between GSC 29 and GSC 31; and GSC 31 is disposed along RS 8 between GSC 30 and GSC 32.

The above description of **Fig. 7** applies also to **Fig. 8**. **Fig. 8** is a plan view schematic of the arrangement of roadways in an eighth embodiment of the invention. This embodiment has one loop ramp and requires as few as three bridges. This embodiment is based on a horizontal reflection of the drawing of **Fig. 7**.

Fig. 9 is a plan view schematic of the arrangement of roadways in a ninth embodiment of the invention. This embodiment has one loop ramp and requires as few as three bridges.

RS 1 intersects with RS 8 at GSC 21; RS 1 intersects with RS 7 at GSC 92; RS 2 intersects with RS 7 at GSC 92; RS 2 intersects with RS 8 GSC 24; RS 5 intersects with RS 8 at GSC 25; RS 5 intersects with RS 7 at GSC 90; RS 6 intersects with RS 7 at GSC 89; RS 6 intersects with RS 8 at GSC 97; RS 8 intersects with RS 4 at GSC 98; RS 8 intersects with RS 3 at GSC 99; RS 8 intersects with RS 7 at GSC 88; RS 7 intersects with RS 3 at GSC 94; RS 7 intersects with RS 4 at GSC 95; and RS 7 intersects with RS 8 at GSC 96.

GSC 21 is disposed along RS 1 between the extremity of the junction 37 and GSC 9; GSC 9 is disposed along RS 1 between GSC 21 and GSC 10; GSC 10 is disposed along RS 1 between GSC 9 and GSC 91; GSC 91 is disposed along RS 1 between GSC 10 and GSC 17; and GSC 17 is disposed along RS 1 between GSC 91 and GSC 18. GSC 19 is disposed along RS 2 between the extremity of the junction 38 and GSC 20; GSC 20 is disposed along RS 2 between GSC 19 and GSC 92; GSC 92 is disposed along RS 2 between GSC 11 and GSC 20; GSC 11 is disposed along RS 2 between GSC 92 and GSC 12; and GSC 12 is disposed along RS 2 between GSC 11 and GSC 24. GSC 25 is disposed along RS 5 between the extremity of the junction 37 and GSC 13; GSC 13 is disposed along RS 5 between GSC 25 and GSC 14; GSC 14 is disposed along RS 5 between GSC 13 and GSC 90; GSC 90 is disposed along RS 5 between GSC 14 and GSC 17; and GSC 17 is disposed along RS 5 between GSC 26 and GSC 20. GSC 19 is disposed along RS 6 between the extremity of the junction 38 and GSC 18; GSC 17 is disposed along RS 6 between GSC 19 and GSC 89; GSC 89 is disposed along RS 6 between GSC 17 and GSC 15; GSC 15 is disposed along RS 6 between GSC 89 and GSC 16; and GSC 16 is disposed along RS 6 between GSC 15 and GSC 97. GSC 88 is disposed along RS 7 between the extremity of the junction 39 and GSC 89; GSC 89 is disposed along RS 7 between GSC 90 and GSC 89; GSC 90 is disposed along RS 7 between GSC 89 and GSC 91; GSC 91 is disposed along RS 7 between GSC 90 and GSC 92; GSC 92 is disposed along RS 7 between GSC 91 and GSC 93; GSC 93 is disposed along RS 7 between GSC 92 and GSC 94; GSC 94 is disposed along RS 7 between GSC 93 and GSC 95; and GSC 95 is disposed along RS 7 between GSC 94 and GSC 96. GSC 96 is disposed along RS 8 between extremity of the junction 40 and GSC 24; GSC 24 is disposed along RS 8 between GSC 87 and GSC 21; GSC 21 is disposed along RS 8 between GSC 24 and GSC 25; GSC 25 is disposed along RS 8 between GSC 21 and GSC 97; GSC 97 is disposed along

RS 8 between GSC 25 and GSC 98; GSC 98 is disposed along RS 8 between GSC 97 and GSC 99; and GSC 99 is disposed along RS 8 between GSC 98 and GSC 88.

450 The above description of Fig. 9 applies also to Fig. 10. Fig. 10 is a plan view schematic of the arrangement of roadways in a tenth embodiment of the invention. This embodiment has one loop ramp and requires as few as three bridges. This embodiment is based on a horizontal reflection of the drawing of Fig. 9.

455 Fig. 11 is a plan view schematic of the arrangement of roadways in an eleventh embodiment of the invention. This embodiment has no loop ramps and requires as few as four bridges.

RS 7 intersects with RS 6 at GSC 41; RS 7 intersects with RS 5 at GSC 42; RS 7 intersects with RS 1 at GSC 43; RS 7 intersects with RS 2 at GSC 44; RS 7 intersects with RS 3 at GSC 85; and RS 7 intersects with RS 4 at GSC 86; and RS 7 intersects with RS 8 at GSC 87. RS 8 intersects with RS 6 at GSC 97; RS 8 intersects with RS 2 at GSC 24; RS 8 intersects with RS 1 at GSC 21; RS 8 intersects with RS 5 at GSC 25; RS 8 intersects with RS 6 at GSC 97; RS 8 intersects with RS 4 at GSC 98; RS 8 intersects with RS 3 at GSC 99; and RS 8 intersects with RS 7 at GSC 88.

GSC 21 is disposed along RS 1 between extremity of the junction 37 and GSC 9; GSC 9 is disposed along RS 1 between GSC 21 and GSC 10; GSC 10 is disposed along RS 1 between GSC 9 and GSC 43; GSC 43 is disposed along RS 1 between GSC 10 and GSC 17; and GSC 17 is disposed along RS 1 between GSC 50 and GSC 18. GSC 19 is disposed along RS 2 between extremity of the junction 38 and GSC 20; GSC 20 is disposed along RS 2 between GSC 19 and GSC 49; GSC 49 is disposed along RS 2 between GSC 20 and GSC 44; GSC 44 is disposed along RS 2 between GSC 44 and GSC 11; GSC 11 is disposed along RS 2 between GSC 44 and GSC 12; and GSC 12 is disposed along RS 2 between GSC 11 and GSC 24. GSC 25 is disposed along RS 5 between extremity of the junction 37 and GSC 13; GSC 13 is disposed along RS 5 between GSC 25 and GSC 14; GSC 14 is disposed along RS 5 between GSC 13 and GSC 42; GSC 42 is disposed along RS 5 between GSC 14 and GSC 17; and GSC 17 is disposed along RS 5 between GSC 42 and GSC 20. GSC 19 is disposed along RS 6 between extremity of the junction 38 and GSC 18; GSC 18 is disposed along RS 6 between GSC 19 and GSC 41; GSC 41 is disposed along RS 6 between GSC 52 and GSC 15; GSC 15 is disposed along RS 6 between GSC 41 and GSC 16; and GSC 16 is disposed along RS 6 between GSC 15 and GSC 97. GSC 88 is disposed along RS 7 between extremity of the junction 39 and GSC 41; GSC 41 is disposed along RS 7 between GSC 88 and GSC 42; GSC 42 is disposed along RS 7 between GSC 41 and GSC 43; GSC 43 is disposed along RS 7 between GSC 42 and GSC 44; GSC 44 is disposed along RS 7 between GSC 43 and GSC 85; GSC 85 is disposed along RS 7 between GSC 44 and GSC 86; and GSC 86 is disposed along RS 7 between GSC 85 and GSC 87. GSC 87 is disposed along RS 8 between extremity of the junction 40 and GSC 24; GSC 24 is disposed along RS 8 between GSC 87 and GSC 21; GSC 21 is disposed along RS 8 between GSC 24 and GSC 25; GSC

25 is disposed along RS 8 between GSC 21 and GSC 97; GSC 97 is disposed along RS 8 between
GSC 21 and GSC 98; GSC 98 is disposed along RS 8 between GSC 97 and GSC 99; and GSC 99 is
485 disposed along RS 8 between GSC 98 and GSC 88.

The above description of Fig. 11 applies also to Fig. 12. Fig. 12 is a plan view schematic of the
arrangement of roadways in a twelfth embodiment of the invention. This embodiment has no loop
ramps and requires as few as four bridges. This embodiment is based on a horizontal reflection of the
drawing of Fig. 11.

490 Regarding all of the embodiments shown in Figs. 13 to 30, it will be obvious to a practitioner with
ordinary skill in the art of geometric design of roadways how to design an appropriate geometry
which uses additional bridges if the particular requirements of a given site require such a geometry.
For example, where a freeway has a very wide median, it may be more appropriate to place the
freeway on at least two bridges rather than one very wide bridge. It will also be obvious to such a
495 practitioner how to modify the arrangements of overpasses and underpasses so a particular group of
RSs is placed on an overpass rather than an underpass, for example. It will also be obvious to a person
of ordinary skill that each of the embodiments may be constructed with arrangements of overpasses
and underpasses different from those shown in the drawings. For example, where a first RS is shown
as extending underneath other RSs, it is also possible to instead extend the first RS over the other RSs.
500 In addition, it will be obvious to a person of ordinary skill that adjacent RSs in the embodiments may
be connected to each other, or may be separated, and may have any vertical alignment, horizontal
alignment, or cross-sectional characteristics desired. For example, RS 3 may adjoin RS 4, and the
boundary between the two RSs may simply be marked with painted lines, or alternatively, RS 3 may
be separated from RS 4 by a wide grassy median; and RS 3 may have a curving horizontal or vertical
505 alignment if required; and RS 3 may have one travel lane or several travel lanes.

It will also be obvious to a practitioner with ordinary skill in the art of geometric design of
roadways how to interpret Figs. 13 to 30. In order to minimize clutter in these drawings, so-called
'hidden lines' have not been drawn. A practitioner with ordinary skill will nevertheless understand,
for example, that in the embodiment of Fig. 13, RS 3 extends continuously from the extremity of the
510 junction 39 to the extremity of the junction 40. Though the drawn lines representing the outer edges of
RS 3 do not intersect the drawn lines representing the edges of RSs 8, 6, 5, 1, 2, and 7, it will be
obvious to a person of ordinary skill that RS 3 continues underneath RSs 8, 6, 5, 1, 2, and 7.

Fig. 13 shows a possible arrangement of overpasses and underpasses for the first embodiment of
the invention. Arrows show the direction of traffic flow along the different RSs in the interchange
515 (assuming right-hand traffic). In this figure, right-turn ramps are shown. These are RSs 100 through
103. RS 100 is provided for traffic moving from the extremity of the junction 37 to the extremity of
the junction 39. RS 101 is provided for traffic moving from the extremity of the junction 38 to the

extremity of the junction 40. RS 102 is provided for traffic moving from the extremity of the junction 39 to the extremity of the junction 38. RS 103 is provided for traffic moving from the extremity of the junction 40 to the extremity of the junction 37. The foregoing description of RSs 100 through 103 also applies to Figs. 14 through 30. In the version of the embodiment shown, two bridges are required, a first bridge 104 and a second bridge 105. Other arrangements of overpasses and underpasses are also possible; for example, RSs 8 (where it is laterally adjacent to RS 1), 1, 2, 5, 6, and 7 (where it is laterally adjacent to RS 2) can pass underneath RSs 8 (where it is laterally adjacent to RS 4), 4, 3, and 7 (where it is laterally adjacent to RS 3). In addition, if the particular constraints of a real-world site require it, the embodiment can be constructed with more than two bridges. (See Fig. 25 for one such example.) The above description of Fig. 13 applies also to Fig. 14, except that Fig. 14 shows a possible arrangement of overpasses and underpasses for the second embodiment of the invention.

Fig. 15 shows a possible arrangement of overpasses and underpasses for the third embodiment of the invention. Arrows show the direction of traffic flow along the different RSs in the interchange (assuming right-hand traffic). In the version of the embodiment shown, three bridges are required, a first bridge 104, a second bridge 106, and a third bridge 107. Other arrangements of overpasses and underpasses are also possible. In addition, if the particular constraints of a real-world site require it, the embodiment can be constructed with more than three bridges. (See Fig. 27 for one such example.)

The above description of Fig. 15 applies also to Fig. 16, except that Fig. 15 shows a possible arrangement of overpasses and underpasses for the fourth embodiment of the invention. Fig. 17 shows a possible arrangement of overpasses and underpasses for the fifth embodiment of the invention.

Arrows show the direction of traffic flow along the different RSs in the interchange (assuming right-hand traffic). In the version of the embodiment shown, three bridges are required, a first bridge 104, a second bridge 106, and a third bridge 107. Other arrangements of overpasses and underpasses are also possible. In addition, if the particular constraints of a real-world site require it, the embodiment can be constructed with more than three bridges. As mentioned previously, one or more roadways may be omitted from any of the embodiments of this invention. In particular, when constructing the fifth embodiment, it may be preferred to omit one or more of the U-turn ramps. The above description of Fig. 17 applies also to Fig. 18, except that Fig. 18 shows a possible arrangement of overpasses and underpasses for the sixth embodiment of the invention.

Fig. 19 shows a possible arrangement of overpasses and underpasses for the seventh embodiment of the invention. In the version of the embodiment shown, three bridges are required, a first bridge 104, a second bridge 105, and a third bridge 107. Other arrangements of overpasses and underpasses are also possible. In addition, if the particular constraints of a real-world site require it, the embodiment can be constructed with more than three bridges. The above description of Fig. 19 applies also to Fig. 20, except that Fig. 20 shows a possible arrangement of overpasses and underpasses for the eighth embodiment of the invention.

Fig. 21 shows a possible arrangement of overpasses and underpasses for the ninth embodiment of the invention. In the version of the embodiment shown, three bridges are required, a first bridge **104**, a second bridge **105**, and a third bridge **108**. Other arrangements of overpasses and underpasses are also possible. In addition, if the particular constraints of a real-world site require it, the embodiment can be constructed with more than three bridges. The above description of **Fig. 21** applies also to **Fig. 22**, except that **Fig. 22** shows a possible arrangement of overpasses and underpasses for the tenth embodiment of the invention.

Fig. 23 shows a possible arrangement of overpasses and underpasses for the eleventh embodiment of the invention. In the version of the embodiment shown, four bridges are required, a first bridge **104**, a second bridge **106**, a third bridge **107**, and a fourth bridge **108**. Other arrangements of overpasses and underpasses are also possible. In addition, if the particular constraints of a real-world site require it, the embodiment can be constructed with more than three bridges. The above description of **Fig. 23** applies also to **Fig. 24**, except that **Fig. 24** shows a possible arrangement of overpasses and underpasses for the twelfth embodiment of the invention.

Fig. 25 shows another possible arrangement of overpasses and underpasses for the first embodiment of the invention. In the version of the embodiment shown, three bridges are required, a first bridge **104**, a second bridge **105**, and a third bridge **110**. Other arrangements of overpasses and underpasses are also possible. In addition, if the particular constraints of a real-world site require it, the embodiment can be constructed with more than three bridges. The above description of **Fig. 25** applies also to **Fig. 26**, except that **Fig. 26** shows a possible arrangement of overpasses and underpasses for the second embodiment of the invention.

Fig. 27 shows another possible arrangement of overpasses and underpasses for the third embodiment of the invention. **Fig. 27** shows an exceptional example of how the third embodiment can be constructed using more than three bridges if desired. In the version of the embodiment shown, eleven bridges are required: a first bridge **104**, a second bridge **106**, a third bridge **107**, a fourth bridge **110**, a fifth bridge **111**, a sixth bridge **112**, a seventh bridge **113**, an eighth bridge **114**, a ninth bridge **115**, a tenth bridge **116**, and an eleventh bridge **117**. Other arrangements of overpasses and underpasses are also possible. In addition, if the particular constraints of a real-world site require it, the embodiment can be constructed with more bridges. The above description of **Fig. 27** applies also to **Fig. 28**, except that **Fig. 28** shows a possible arrangement of overpasses and underpasses for the fourth embodiment of the invention.

Fig. 29 shows another possible arrangement of overpasses, underpasses, and right-turn ramps for the third embodiment of the invention. This embodiment is similar to that shown in **Fig. 15**; however, the right-turn ramps **101** and **103** are arranged differently in **Fig. 29**. The exit for right-turn ramp **101** is located on the left-hand side (from the point of view of traffic approaching the exit) of the exit for

left-turn ramp 6; similarly, the exit for right-turn ramp 103 is located on the left-hand side (from the point of view of traffic approaching the exit) of the exit for left-turn ramp 8. The entrance to the freeway from right-turn ramp 101 is located on the left-hand side (from the point of view of traffic entering the freeway) of the entrance for left-turn ramp 5; similarly, the entrance to the freeway from right-turn ramp 103 is located on the left-hand side (from the point of view of traffic entering the freeway) of the entrance for left-turn ramp 7. As noted above, it will be obvious to a practitioner with ordinary skill in the art of geometric design of roadways how best to add right-turn ramps to any embodiment of the present invention. Figs. 29 and 30 are provided simply to show possible arrangements where the right-turn exits on two approaches to the junction are located to the left of the left-turn exits, from the perspective of a driver approaching the exits. A similar arrangement of right turn ramps is seen in the turbine interchange of Belgian Pat. No. 638,746 and No. 641,129. The above description of Fig. 29 applies also to Fig. 30, except that Fig. 30 shows a possible arrangement of overpasses and underpasses for the fourth embodiment of the invention.

It will be obvious to those skilled in the art of geometric design of roadways how to modify the embodiments of this invention by replacing one or more of the left-turn ramps with one or more left-turn ramps of different arrangements. Such ramps are often called flyover ramps, and are often given forms similar to the left-turn ramps of the 'turbine' or four-level directional interchange configurations mentioned above. Such modifications are commonly made when it becomes necessary to increase the capacity of an interchange.

It will be obvious to those skilled in the art of transportation engineering that the configurations of road surfaces in the embodiments of this invention may also be applied to various kinds of traveled ways or lines of transportation. For example, the road surfaces of the embodiments described herein may be railroads, bicycle paths, footpaths, and so forth.

Those of ordinary skill will understand and appreciate the existence of other variations, combinations, and equivalents of the specific embodiments and examples herein. The invention should therefore not be limited by the above described embodiments and examples, but by all embodiments and methods within the scope and spirit of the invention.

CLAIMS

What is claimed is:

1. A road junction comprising:

a first road surface for traffic traveling in a first direction; a second road surface for traffic
5 traveling in a direction substantially opposite to said first direction; a third road surface for traffic
traveling in a direction intersecting said first and second road surfaces; a fourth road surface for traffic
traveling in a direction substantially opposite to said traffic traveling on said third road surface;

a first, a second, a third, and a fourth extremity of the junction;

said first road surface extending from said first extremity of the junction to said second extremity
10 of the junction; said second road surface extending from said second extremity of the junction to said
first extremity of the junction; said third road surface extending from said third extremity of the
junction to said fourth extremity of the junction; said fourth road surface extending from said fourth
extremity of the junction to said third extremity of the junction; a fifth road surface extending from
said first extremity of the junction to said fourth extremity of the junction; a sixth road surface
15 extending from said second extremity of the junction to said third extremity of the junction; at said
first extremity of the junction, said first road surface being disposed laterally between said second and
fifth road surfaces;

at said second extremity of the junction, said second road surface being disposed laterally between
said first and sixth road surfaces; at said third extremity of the junction, said fourth road surface being
20 disposed laterally between said sixth and third road surfaces; at said fourth extremity of the junction,
said third road surface being disposed laterally between said fifth and fourth road surfaces;

said first road surface intersecting said fourth road surface at a first grade-separated crossing; said
first road surface intersecting said third road surface at a second grade-separated crossing; said second
road surface intersecting said third road surface at a third grade-separated crossing; said second road
25 surface intersecting said fourth road surface at a fourth grade-separated crossing; said fifth road
surface intersecting said fourth road surface at a fifth grade-separated crossing; said fifth road surface
intersecting said third road surface at a sixth grade-separated crossing; said sixth road surface
intersecting said third road surface at a seventh grade-separated crossing; said sixth road surface
intersecting said fourth road surface at an eighth grade-separated crossing; said fifth road surface
30 intersecting said first road surface at a ninth grade-separated crossing; said fifth road surface
intersecting said second road surface at a twelfth grade-separated crossing; said sixth road surface
intersecting said second road surface at an eleventh grade-separated crossing; said sixth road surface
intersecting said first road surface at a tenth grade-separated crossing;

said first grade-separated crossing being disposed intermediately along the traveled length of said first road surface between said first extremity of the junction and said second grade-separated crossing; said second grade-separated crossing being disposed intermediately along the traveled length of said first road surface between said first grade-separated crossing and said ninth grade-separated crossing; said ninth grade-separated crossing being disposed intermediately along the traveled length of said first road surface between said second grade-separated crossing and said tenth grade-separated crossing; said eleventh grade-separated crossing being disposed intermediately along the traveled length of said second road surface between said second extremity of the junction and said twelfth grade-separated crossing; said twelfth grade-separated crossing being disposed intermediately along the traveled length of said second road surface between said eleventh grade-separated crossing and said third grade-separated crossing; said third grade-separated crossing being disposed intermediately along the traveled length of said second road surface between said twelfth grade-separated crossing and said fourth grade-separated crossing; said fifth grade-separated crossing being disposed intermediately along the traveled length of said fifth road surface between said first extremity of the junction and said sixth grade-separated crossing; said sixth grade-separated crossing being disposed intermediately along the traveled length of said fifth road surface between said fifth grade-separated crossing and said ninth grade-separated crossing; said ninth grade-separated crossing being disposed intermediately along the traveled length of said fifth road surface between said sixth grade-separated crossing and said twelfth grade-separated crossing; said eleventh grade-separated crossing being disposed intermediately along the traveled length of said sixth road surface between said second extremity of the junction and said tenth grade-separated crossing; said tenth grade-separated crossing being disposed intermediately along the traveled length of said sixth road surface between said eleventh grade-separated crossing and said seventh grade-separated crossing; and said seventh grade-separated crossing being disposed intermediately along the traveled length of said sixth road surface between said tenth grade-separated crossing and said eighth grade-separated crossing.

2. The road junction of claim 1, further comprising:

a seventh road surface extending from said third extremity of the junction to said first extremity of the junction; an eighth road surface extending from said fourth extremity of the junction to said second extremity of the junction;

at said first extremity of the junction, said second road surface being disposed laterally between said seventh and first road surfaces; at said third extremity of the junction, said third road surface being disposed laterally between said fourth and seventh road surfaces; at said fourth extremity of the junction, said fourth road surface being disposed laterally between said third and eighth road surfaces; at said second extremity of the junction, said first road surface being disposed laterally between said second and eighth road surfaces;

said first road surface intersecting said eighth road surface at a thirteenth grade-separated crossing; said first road surface intersecting said seventh road surface at a fourteenth grade-separated crossing; said second road surface intersecting said seventh road surface at a fifteenth grade-separated crossing; said second road surface intersecting said eighth road surface at a sixteenth grade-separated crossing; said fifth road surface intersecting said eighth road surface at a seventeenth grade-separated crossing; said fifth road surface intersecting said seventh road surface at an eighteenth grade-separated crossing; said sixth road surface intersecting said seventh road surface at a nineteenth grade-separated crossing; said sixth road surface intersecting said eighth road surface at a twentieth grade-separated crossing; said eighth road surface intersecting said eighth road surface at a twenty-first grade-separated crossing; said eighth road surface intersecting said fourth road surface at a twenty-second grade-separated crossing; said eighth road surface intersecting said third road surface at a twenty-third grade-separated crossing; said eighth road surface intersecting said seventh road surface at a twenty-fourth grade-separated crossing; said seventh road surface intersecting said seventh road surface at a twenty-fifth grade-separated crossing; said seventh road surface intersecting said third road surface at a twenty-sixth grade-separated crossing; said seventh road surface intersecting said fourth road surface at a twenty-seventh grade-separated crossing; said seventh road surface intersecting said eighth road surface at a twenty-eighth grade-separated crossing;

said thirteenth grade-separated crossing being disposed intermediately along the traveled length of said first road surface between said first extremity of the junction and said first grade-separated crossing; said fourteenth grade-separated crossing being disposed intermediately along the traveled length of said first road surface between said second grade-separated crossing and said ninth grade-separated crossing; said fifteenth grade-separated crossing being disposed intermediately along the traveled length of said second road surface between said twelfth grade-separated crossing and said third grade-separated crossing; said sixteenth grade-separated crossing being disposed intermediately along the traveled length of said second road surface between said fourth grade-separated crossing and said first extremity of the junction; said seventeenth grade-separated crossing being disposed intermediately along the traveled length of said fifth road surface between said first extremity of the junction and said fifth grade-separated crossing; said eighteenth grade-separated crossing being disposed intermediately along the traveled length of said fifth road surface between said sixth grade-separated crossing and said ninth grade-separated crossing; said nineteenth grade-separated crossing being disposed intermediately along the traveled length of said sixth road surface between said tenth grade-separated crossing and said seventh grade-separated crossing; said eighth grade-separated crossing being disposed intermediately along the traveled length of said sixth road surface between said seventh grade-separated crossing and said twentieth grade-separated crossing; said twenty-first grade-separated crossing being disposed intermediately along the traveled length of said eighth road surface between said twentieth grade-separated crossing and said twenty-second grade-separated crossing; said twenty-second grade-separated crossing being disposed intermediately along the

traveled length of said eighth road surface between said twenty-first grade-separated crossing and said twenty-third grade-separated crossing; said twenty-third grade-separated crossing being disposed intermediately along the traveled length of said eighth road surface between said twenty-second grade-separated crossing and said twenty-fourth grade-separated crossing; said twenty-fifth grade-separated crossing being disposed intermediately along the traveled length of said seventh road surface between said fifteenth grade-separated crossing and said twenty-sixth grade-separated crossing; said twenty-sixth grade-separated crossing being disposed intermediately along the traveled length of said seventh road surface between said twenty-fifth grade-separated crossing and said twenty-seventh grade-separated crossing; and said twenty-seventh grade-separated crossing being disposed intermediately along the traveled length of said seventh road surface between said twenty-sixth grade-separated crossing and said twenty-eighth grade-separated crossing.

3. The road junction of claim 1, further comprising:

a seventh road surface extending from said third extremity of the junction to said first extremity of the junction; an eighth road surface extending from said fourth extremity of the junction to said second extremity of the junction;

at said first extremity of the junction, said second road surface being disposed laterally between said seventh and first road surfaces; at said third extremity of the junction, said third road surface being disposed laterally between said fourth and seventh road surfaces; at said fourth extremity of the junction, said fourth road surface being disposed laterally between said third and eighth road surfaces; at said second extremity of the junction, said first road surface being disposed laterally between said second and eighth road surfaces;

said first road surface intersecting said seventh road surface at a thirteenth grade-separated crossing; said first road surface intersecting said eighth road surface at a fourteenth grade-separated crossing; said second road surface intersecting said eighth road surface at a fifteenth grade-separated crossing; said second road surface intersecting said seventh road surface at a sixteenth grade-separated crossing; said fifth road surface intersecting said seventh road surface at a seventeenth grade-separated crossing; said fifth road surface intersecting said eighth road surface at an eighteenth grade-separated crossing; said sixth road surface intersecting said eighth road surface at a nineteenth grade-separated crossing; said sixth road surface intersecting said seventh road surface at a twentieth grade-separated crossing; said seventh road surface intersecting said third road surface at a twenty-first grade-separated crossing; said seventh road surface intersecting said fourth road surface at a twenty-second grade-separated crossing; said eighth road surface intersecting said fourth road surface at a twenty-third grade-separated crossing; said eighth road surface intersecting said third road surface at a twenty-fourth grade-separated crossing;

140 said thirteenth grade-separated crossing being disposed intermediately along the traveled length of
 said first road surface between said second grade-separated crossing and said fourteenth grade-
 separated crossing; said fourteenth grade-separated crossing being disposed intermediately along the
 traveled length of said first road surface between said thirteenth grade-separated crossing and said
 ninth grade-separated crossing; said fifteenth grade-separated crossing being disposed intermediately
 145 along the traveled length of said second road surface between said twelfth grade-separated crossing
 and said sixteenth grade-separated crossing; said sixteenth grade-separated crossing being disposed
 intermediately along the traveled length of said second road surface between said fifteenth grade-
 separated crossing and said third grade-separated crossing; said seventeenth grade-separated crossing
 being disposed intermediately along the traveled length of said fifth road surface between said sixth
 150 grade-separated crossing and said eighteenth grade-separated crossing; said eighteenth grade-
 separated crossing being disposed intermediately along the traveled length of said fifth road surface
 between said seventeenth grade-separated crossing and said ninth grade-separated crossing; said
 nineteenth grade-separated crossing being disposed intermediately along the traveled length of said
 sixth road surface between said tenth grade-separated crossing and said twentieth grade-separated
 155 crossing; said twentieth grade-separated crossing being disposed intermediately along the traveled
 length of said sixth road surface between said nineteenth grade-separated crossing and said seventh
 grade-separated crossing; said twenty-first grade-separated crossing being disposed intermediately
 along the traveled length of said seventh road surface between said sixteenth grade-separated crossing
 and said twenty-second grade-separated crossing; and said twenty-fourth grade-separated crossing
 160 being disposed intermediately along the traveled length of said eighth road surface between said
 twenty-third grade-separated crossing and said fifteenth grade-separated crossing.

4. The road junction of claim 1, further comprising:

a seventh road surface extending from said third extremity of the junction to said first extremity of
 the junction; an eighth road surface extending from said fourth extremity of the junction to said
 165 second extremity of the junction;

at said first extremity of the junction, said second road surface being disposed laterally between
 said seventh and first road surfaces; at said third extremity of the junction, said third road surface
 being disposed laterally between said fourth and seventh road surfaces; at said fourth extremity of the
 junction, said fourth road surface being disposed laterally between said third and eighth road surfaces;
 170 at said second extremity of the junction, said first road surface being disposed laterally between said
 second and eighth road surfaces;

said first road surface intersecting said eighth road surface at a thirteenth grade-separated
 crossing; said first road surface intersecting said seventh road surface at a fourteenth grade-separated
 crossing; said second road surface intersecting said seventh road surface at a fifteenth grade-separated
 175 crossing; said second road surface intersecting said eighth road surface at a sixteenth grade-separated

crossing; said fifth road surface intersecting said eighth road surface at a seventeenth grade-separated crossing; said fifth road surface intersecting said seventh road surface at an eighteenth grade-separated crossing; said sixth road surface intersecting said seventh road surface at a nineteenth grade-separated crossing; said sixth road surface intersecting said eighth road surface at a twentieth grade-separated crossing; said seventh road surface intersecting said third road surface at a twenty-first grade-separated crossing; said seventh road surface intersecting said fourth road surface at a twenty-second grade-separated crossing; said seventh road surface intersecting said eighth road surface at a twenty-third grade-separated crossing; said eighth road surface intersecting said fourth road surface at a twenty-fourth grade-separated crossing; said eighth road surface intersecting said third road surface at a twenty-fifth grade-separated crossing; said eighth road surface intersecting said seventh road surface at a twenty-sixth grade-separated crossing;

said thirteenth grade-separated crossing being disposed intermediately along the traveled length of said first road surface between said first extremity of the junction and said first grade-separated crossing; said fourteenth grade-separated crossing being disposed intermediately along the traveled length of said first road surface between said second grade-separated crossing and said ninth grade-separated crossing; said fifteenth grade-separated crossing being disposed intermediately along the traveled length of said second road surface between said twelfth grade-separated crossing and said third grade-separated crossing; said sixteenth grade-separated crossing being disposed intermediately along the traveled length of said second road surface between said fourth grade-separated crossing and said first extremity of the junction; said seventeenth grade-separated crossing being disposed intermediately along the traveled length of said fifth road surface between said first extremity of the junction and said fifth grade-separated crossing; said eighteenth grade-separated crossing being disposed intermediately along the traveled length of said fifth road surface between said sixth grade-separated crossing and said ninth grade-separated crossing; said nineteenth grade-separated crossing being disposed intermediately along the traveled length of said sixth road surface between said tenth grade-separated crossing and said seventh grade-separated crossing; said eighth grade-separated crossing being disposed intermediately along the traveled length of said sixth road surface between said seventh grade-separated crossing and said twentieth grade-separated crossing; said nineteenth grade-separated crossing being disposed intermediately along the traveled length of said seventh road surface between said twenty-sixth grade-separated crossing and said eighteenth grade-separated crossing; said twenty-first grade-separated crossing being disposed intermediately along the traveled length of said seventh road surface between said fifteenth grade-separated crossing and said twenty-second grade-separated crossing; said twenty-second grade-separated crossing being disposed intermediately along the traveled length of said seventh road surface between said twenty-first grade-separated crossing and said twenty-third grade-separated crossing; said sixteenth grade-separated crossing being disposed intermediately along the traveled length of said eighth road surface between said twenty-third grade-separated crossing and said thirteenth grade-separated crossing; said twenty-

fourth grade-separated crossing being disposed intermediately along the traveled length of said eighth road surface between said twentieth grade-separated crossing and said twenty-fifth grade-separated crossing; and said twenty-fifth grade-separated crossing being disposed intermediately along the traveled length of said eighth road surface between said twenty-fourth grade-separated crossing and said twenty-sixth grade-separated crossing.

5. The road junction of claim 1, further comprising:

a seventh road surface extending from said third extremity of the junction to said first extremity of the junction; an eighth road surface extending from said fourth extremity of the junction to said second extremity of the junction;

at said first extremity of the junction, said second road surface being disposed laterally between said seventh and first road surfaces; at said third extremity of the junction, said third road surface being disposed laterally between said fourth and seventh road surfaces; at said fourth extremity of the junction, said fourth road surface being disposed laterally between said third and eighth road surfaces; at said second extremity of the junction, said first road surface being disposed laterally between said second and eighth road surfaces;

said first road surface intersecting said eighth road surface at a thirteenth grade-separated crossing; said first road surface intersecting said seventh road surface at a fourteenth grade-separated crossing; said second road surface intersecting said seventh road surface at a fifteenth grade-separated crossing; said second road surface intersecting said eighth road surface at a sixteenth grade-separated crossing; said fifth road surface intersecting said eighth road surface at a seventeenth grade-separated crossing; said fifth road surface intersecting said seventh road surface at an eighteenth grade-separated crossing; said sixth road surface intersecting said seventh road surface at a nineteenth grade-separated crossing; said sixth road surface intersecting said eighth road surface at a twentieth grade-separated crossing; said eighth road surface intersecting said eighth road surface at a twenty-first grade-separated crossing; said eighth road surface intersecting said fourth road surface at a twenty-second grade-separated crossing; said eighth road surface intersecting said third road surface at a twenty-third grade-separated crossing; said eighth road surface intersecting said seventh road surface at a twenty-fourth grade-separated crossing; said seventh road surface intersecting said third road surface at a twenty-fifth grade-separated crossing; said seventh road surface intersecting said fourth road surface at a twenty-sixth grade-separated crossing; said seventh road surface intersecting said eighth road surface at a twenty-seventh grade-separated crossing;

said thirteenth grade-separated crossing being disposed intermediately along the traveled length of said first road surface between said first extremity of the junction and said first grade-separated crossing; said fourteenth grade-separated crossing being disposed intermediately along the traveled length of said first road surface between said second grade-separated crossing and said ninth grade-

separated crossing; said fifteenth grade-separated crossing being disposed intermediately along the traveled length of said second road surface between said twelfth grade-separated crossing and said third grade-separated crossing; said sixteenth grade-separated crossing being disposed intermediately along the traveled length of said second road surface between said fourth grade-separated crossing and said first extremity of the junction; said seventeenth grade-separated crossing being disposed intermediately along the traveled length of said fifth road surface between said first extremity of the junction and said fifth grade-separated crossing; said eighteenth grade-separated crossing being disposed intermediately along the traveled length of said fifth road surface between said sixth grade-separated crossing and said ninth grade-separated crossing; said nineteenth grade-separated crossing being disposed intermediately along the traveled length of said sixth road surface between said tenth grade-separated crossing and said seventh grade-separated crossing; said eighth grade-separated crossing being disposed intermediately along the traveled length of said sixth road surface between said seventh grade-separated crossing and said twentieth grade-separated crossing; said nineteenth grade-separated crossing being disposed intermediately along the traveled length of said seventh road surface between said twenty-fourth grade-separated crossing and said eighteenth grade-separated crossing; said twenty-fifth grade-separated crossing being disposed intermediately along the traveled length of said seventh road surface between said fifteenth grade-separated crossing and said twenty-sixth grade-separated crossing; said twenty-sixth grade-separated crossing being disposed intermediately along the traveled length of said seventh road surface between said twenty-fifth grade-separated crossing and said twenty-seventh grade-separated crossing; said twenty-first grade-separated crossing being disposed intermediately along the traveled length of said eighth road surface between said twentieth grade-separated crossing and said twenty-second grade-separated crossing; said twenty-second grade-separated crossing being disposed intermediately along the traveled length of said eighth road surface between said twenty-first grade-separated crossing and said twenty-third grade-separated crossing; and said twenty-third grade-separated crossing being disposed intermediately along the traveled length of said eighth road surface between said twenty-second grade-separated crossing and said twenty-fourth grade-separated crossing.

6. The road junction of claim 1, further comprising:

a seventh road surface extending from said third extremity of the junction to said first extremity of the junction; an eighth road surface extending from said fourth extremity of the junction to said second extremity of the junction;

at said first extremity of the junction, said second road surface being disposed laterally between said seventh and first road surfaces; at said third extremity of the junction, said third road surface being disposed laterally between said fourth and seventh road surfaces; at said fourth extremity of the junction, said fourth road surface being disposed laterally between said third and eighth road surfaces;

at said second extremity of the junction, said first road surface being disposed laterally between said second and eighth road surfaces;

285 said first road surface intersecting said eighth road surface at a thirteenth grade-separated crossing; said first road surface intersecting said seventh road surface at a fourteenth grade-separated crossing; said second road surface intersecting said seventh road surface at a fifteenth grade-separated crossing; said second road surface intersecting said eighth road surface at a sixteenth grade-separated crossing; said fifth road surface intersecting said eighth road surface at a seventeenth grade-separated crossing; said fifth road surface intersecting said seventh road surface at an eighteenth grade-separated crossing; said sixth road surface intersecting said seventh road surface at a nineteenth grade-separated crossing; said sixth road surface intersecting said eighth road surface at a twentieth grade-separated crossing; said seventh road surface intersecting said seventh road surface at a twenty-first grade-separated crossing; said seventh road surface intersecting said third road surface at a twenty-second grade-separated crossing; said seventh road surface intersecting said fourth road surface at a twenty-third grade-separated crossing; said eighth road surface intersecting said seventh road surface at a twenty-fourth grade-separated crossing; said eighth road surface intersecting said fourth road surface at a twenty-fifth grade-separated crossing; said eighth road surface intersecting said third road surface at a twenty-sixth grade-separated crossing; said eighth road surface intersecting said seventh road surface at a twenty-seventh grade-separated crossing;

 said thirteenth grade-separated crossing being disposed intermediately along the traveled length of said first road surface between said first extremity of the junction and said first grade-separated crossing; said fourteenth grade-separated crossing being disposed intermediately along the traveled length of said first road surface between said second grade-separated crossing and said ninth grade-separated crossing; said fifteenth grade-separated crossing being disposed intermediately along the traveled length of said second road surface between said twelfth grade-separated crossing and said third grade-separated crossing; said sixteenth grade-separated crossing being disposed intermediately along the traveled length of said second road surface between said fourth grade-separated crossing and said first extremity of the junction; said seventeenth grade-separated crossing being disposed intermediately along the traveled length of said fifth road surface between said first extremity of the junction and said fifth grade-separated crossing; said eighteenth grade-separated crossing being disposed intermediately along the traveled length of said fifth road surface between said sixth grade-separated crossing and said ninth grade-separated crossing; said nineteenth grade-separated crossing being disposed intermediately along the traveled length of said sixth road surface between said tenth grade-separated crossing and said seventh grade-separated crossing; said eighth grade-separated crossing being disposed intermediately along the traveled length of said sixth road surface between said seventh grade-separated crossing and said twentieth grade-separated crossing; said nineteenth grade-separated crossing being disposed intermediately along the traveled length of said seventh road surface between said eighth grade-separated crossing and said twenty-first grade-separated crossing;

surface between said twenty-seventh grade-separated crossing and said eighteenth grade-separated crossing; said twenty-first grade-separated crossing being disposed intermediately along the traveled length of said seventh road surface between said fifteenth grade-separated crossing and said twenty-second grade-separated crossing; said twenty-second grade-separated crossing being disposed intermediately along the traveled length of said seventh road surface between said twenty-first grade-separated crossing and said twenty-third grade-separated crossing; said twenty-third grade-separated crossing being disposed intermediately along the traveled length of said seventh road surface between said twenty-second grade-separated crossing and said twenty-fourth grade-separated crossing; said sixteenth grade-separated crossing being disposed intermediately along the traveled length of said eighth road surface between said twenty-fourth grade-separated crossing and said thirteenth grade-separated crossing; said twenty-fifth grade-separated crossing being disposed intermediately along the traveled length of said eighth road surface between said twentieth grade-separated crossing and said twenty-sixth grade-separated crossing; and said twenty-sixth grade-separated crossing being disposed intermediately along the traveled length of said eighth road surface between said twenty-fifth grade-separated crossing and said twenty-seventh grade-separated crossing.

7. The road junction of claim 3, further comprising:

a ninth road surface extending from said first extremity of the junction and returning to said first extremity of the junction; a tenth road surface extending from said second extremity of the junction and returning to said second extremity of the junction; an eleventh road surface extending from said third extremity of the junction and returning to said third extremity of the junction; a twelfth road surface extending from said fourth extremity of the junction and returning to said fourth extremity of the junction;

at said first extremity of the junction, said ninth road surface being disposed laterally between said first and fifth road surfaces; and at said first extremity of the junction, said ninth road surface being disposed laterally between said seventh and second road surfaces; at said second extremity of the junction, said tenth road surface being disposed laterally between said second and sixth road surfaces; and at said second extremity of the junction, said tenth road surface being disposed laterally between said eighth and first road surfaces; at said third extremity of the junction, said eleventh road surface being disposed laterally between said third and seventh road surfaces; and at said third extremity of the junction, said eleventh road surface being disposed laterally between said sixth and fourth road surfaces; at said fourth extremity of the junction, said twelfth road surface being disposed laterally between said fourth and eighth road surfaces; and at said fourth extremity of the junction, said twelfth road surface being disposed laterally between said fifth and third road surfaces;

said first road surface intersecting said eleventh road surface at a twenty-fifth grade-separated crossing; said first road surface intersecting said eleventh road surface at a twenty-sixth grade-separated crossing; said first road surface intersecting said ninth road surface at a twenty-seventh

355 grade-separated crossing; said first road surface intersecting said tenth road surface at a twenty-eighth
 grade-separated crossing; said second road surface intersecting said tenth road surface at a twenty-
 ninth grade-separated crossing; said second road surface intersecting said ninth road surface at a
 thirtieth grade-separated crossing; said second road surface intersecting said eleventh road surface at a
 thirty-first grade-separated crossing; and said second road surface intersecting said eleventh road
 360 surface at a thirty-second grade-separated crossing; said fifth road surface intersecting said eleventh
 road surface at a thirty-third grade-separated crossing; and said fifth road surface intersecting said
 eleventh road surface at a thirty-fourth grade-separated crossing; said sixth road surface intersecting
 said eleventh road surface at a thirty-fifth grade-separated crossing; and said sixth road surface
 intersecting said eleventh road surface at a thirty-sixth grade-separated crossing; said seventh road
 365 surface intersecting said ninth road surface at a thirty-seventh grade-separated crossing; and said
 seventh road surface intersecting said ninth road surface at a thirty-eighth grade-separated crossing;
 said eighth road surface intersecting said ninth road surface at a thirty-ninth grade-separated crossing;
 and said eighth road surface intersecting said ninth road surface at a fortieth grade-separated crossing;
 said ninth road surface intersecting said eleventh road surface at a forty-first grade-separated crossing;
 370 and said ninth road surface intersecting said eleventh road surface at a forty-second grade-separated
 crossing; and said ninth road surface intersecting said eleventh road surface at a forty-third grade-
 separated crossing; and said ninth road surface intersecting said eleventh road surface at a forty-fourth
 grade-separated crossing; said third road surface intersecting said eleventh road surface at a forty-fifth
 grade-separated crossing; said fourth road surface intersecting said eleventh road surface at a forty-
 375 sixth grade-separated crossing; said fourth road surface intersecting said twelfth road surface at a
 forty-seventh grade-separated crossing; said third road surface intersecting said twelfth road surface at
 a forty-eighth grade-separated crossing; said fourth road surface intersecting said ninth road surface at
 a forty-ninth grade-separated crossing; said third road surface intersecting said ninth road surface at a
 fiftieth grade-separated crossing; and said third road surface intersecting said ninth road surface at a
 380 fifty-first grade-separated crossing; said fourth road surface intersecting said ninth road surface at a
 fifty-second grade-separated crossing;

said first grade-separated crossing being disposed intermediately along the traveled length of said
 first road surface between said twenty-fifth grade-separated crossing and said second grade-separated
 crossing; said twenty-sixth grade-separated crossing being disposed intermediately along the traveled
 385 length of said first road surface between said second grade-separated crossing and said thirteenth
 grade-separated crossing; said twenty-seventh grade-separated crossing being disposed intermediately
 along the traveled length of said first road surface between said fourteenth grade-separated crossing
 and said ninth grade-separated crossing; said tenth grade-separated crossing being disposed
 intermediately along the traveled length of said first road surface between said ninth grade-separated
 390 crossing and said twenty-eighth grade-separated crossing; said eleventh grade-separated crossing
 being disposed intermediately along the traveled length of said second road surface between said

twenty-ninth grade-separated crossing and said twelfth grade-separated crossing; said thirtieth sixth grade-separated crossing being disposed intermediately along the traveled length of said second road surface between said twelfth grade-separated crossing and said fifteenth grade-separated crossing;

395 said thirty-first grade-separated crossing being disposed intermediately along the traveled length of said second road surface between said sixteenth grade-separated crossing and said third grade-separated crossing; said fourth grade-separated crossing being disposed intermediately along the traveled length of said second road surface between said third grade-separated crossing and said

400 thirty-second grade-separated crossing; said fiftieth grade-separated crossing being disposed intermediately along the traveled length of said third road surface between said sixth grade-separated crossing and said second grade-separated crossing; said fifty-first grade-separated crossing being disposed intermediately along the traveled length of said third road surface between said third grade-separated crossing and said forty-fifth grade-separated crossing; said forty-fifth grade-separated crossing being disposed intermediately along the traveled length of said third road surface between

405 said fifty-first grade-separated crossing and said twenty-first grade-separated crossing; said twenty-fourth grade-separated crossing being disposed intermediately along the traveled length of said third road surface between said twenty-first grade-separated crossing and said forty-eighth grade-separated crossing; said twenty-third grade-separated crossing being disposed intermediately along the traveled length of said fourth road surface between said forty-seventh grade-separated crossing and said

410 twenty-second grade-separated crossing; said forty-sixth grade-separated crossing being disposed intermediately along the traveled length of said fourth road surface between said twenty-second grade-separated crossing and said fifty-second grade-separated crossing; said fifty-second grade-separated crossing being disposed intermediately along the traveled length of said fourth road surface between said forty-sixth grade-separated crossing and said fourth grade-separated crossing; said forty-

415 ninth grade-separated crossing being disposed intermediately along the traveled length of said fourth road surface between said first grade-separated crossing and said fifth grade-separated crossing; said fifth grade-separated crossing being disposed intermediately along the traveled length of said fifth road surface between said thirty-third grade-separated crossing and said sixth grade-separated crossing; said thirty-fourth grade-separated crossing being disposed intermediately along the traveled

420 length of said fifth road surface between said sixth grade-separated crossing and said seventeenth grade-separated crossing; said thirty-fifth grade-separated crossing being disposed intermediately along the traveled length of said sixth road surface between said twentieth grade-separated crossing and said seventh grade-separated crossing; said eighth grade-separated crossing being disposed intermediately along the traveled length of said sixth road surface between said seventh grade-

425 separated crossing and said thirty-sixth grade-separated crossing; said thirty-seventh grade-separated crossing being disposed intermediately along the traveled length of said seventh road surface between said seventeenth grade-separated crossing and said thirteenth grade-separated crossing; said thirty-eighth grade-separated crossing being disposed intermediately along the traveled length of said

seventh road surface between said sixteenth grade-separated crossing and said twenty-first grade-separated crossing; said thirty-ninth grade-separated crossing being disposed intermediately along the traveled length of said eighth road surface between said twenty-fourth grade-separated crossing and said fifteenth grade-separated crossing; said fortieth grade-separated crossing being disposed intermediately along the traveled length of said eighth road surface between said fourteenth grade-separated crossing and said eighteenth grade-separated crossing; said forty-ninth grade-separated crossing being disposed intermediately along the traveled length of said ninth road surface between said forty-first grade-separated crossing and said fiftieth grade-separated crossing; said fiftieth grade-separated crossing being disposed intermediately along the traveled length of said ninth road surface between said forty-ninth grade-separated crossing and said forty-second grade-separated crossing; said forty-second grade-separated crossing being disposed intermediately along the traveled length of said ninth road surface between said fiftieth grade-separated crossing and said thirty-seventh grade-separated crossing; said thirty-seventh grade-separated crossing being disposed intermediately along the traveled length of said ninth road surface between said forty-second grade-separated crossing and said fortieth grade-separated crossing; said fortieth grade-separated crossing being disposed intermediately along the traveled length of said ninth road surface between said thirty-seventh grade-separated crossing and said twenty-seventh grade-separated crossing; said twenty-seventh grade-separated crossing being disposed intermediately along the traveled length of said ninth road surface between said fortieth grade-separated crossing and said thirtieth grade-separated crossing; said thirtieth grade-separated crossing being disposed intermediately along the traveled length of said ninth road surface between said twenty-seventh grade-separated crossing and said thirty-ninth grade-separated crossing; said thirty-ninth grade-separated crossing being disposed intermediately along the traveled length of said ninth road surface between said thirtieth grade-separated crossing and said thirty-eighth grade-separated crossing; said thirty-eighth grade-separated crossing being disposed intermediately along the traveled length of said ninth road surface between said thirty-ninth grade-separated crossing and said forty-third grade-separated crossing; said forty-third grade-separated crossing being disposed intermediately along the traveled length of said ninth road surface between said thirty-eighth grade-separated crossing and said fifty-first grade-separated crossing; said fifty-first grade-separated crossing being disposed intermediately along the traveled length of said ninth road surface between said forty-third grade-separated crossing and said fifty-second grade-separated crossing; said fifty-second grade-separated crossing being disposed intermediately along the traveled length of said ninth road surface between said fifty-first grade-separated crossing and said forty-fourth grade-separated crossing; said thirty-fourth grade-separated crossing being disposed intermediately along the traveled length of said eleventh road surface between said thirty-fifth grade-separated crossing and said forty-second grade-separated crossing; and said thirty-third grade-separated crossing being disposed intermediately along the traveled length of said eleventh road surface between said forty-first grade-separated crossing and said thirty-sixth grade-separated crossing.

8. The road junction of claim 1, wherein said first, or second, or third, or fourth road surfaces is omitted, or first and third, or first and fourth, or second and third, or second and fourth road surfaces are omitted.

470 9. The road junction of claim 2, wherein said first, or second, or third, or fourth, or seventh, or eighth road surfaces is omitted, or first and third, or first and fourth, or first and seventh, or first and eighth, or second and third, or second and fourth, or second and seventh, or second and eighth, third and seventh, or third and eighth, or fourth and seventh, or fourth and eighth, or first and seventh and third, or first and seventh and fourth, or first and eighth and third, or first and eighth and fourth, or second and seventh and third, or second and seventh and fourth, or second and eighth and third, or second and
475 eight and fourth road surfaces are omitted.

10. The road junction of claim 3, wherein said first, or second, or third, or fourth, or seventh, or eighth road surfaces is omitted, or first and third, or first and fourth, or first and seventh, or first and eighth, or second and third, or second and fourth, or second and seventh, or second and eighth, third and seventh, or third and eighth, or fourth and seventh, or fourth and eighth, or first and seventh and third, or first and seventh and fourth, or first and eighth and third, or first and eighth and fourth, or second and seventh and third, or second and seventh and fourth, or second and eighth and third, or second and
480 eight and fourth road surfaces are omitted.

11. The road junction of claim 4, wherein said first, or second, or third, or fourth, or seventh, or eighth road surfaces is omitted, or first and third, or first and fourth, or first and seventh, or first and eighth, or second and third, or second and fourth, or second and seventh, or second and eighth, third and seventh, or third and eighth, or fourth and seventh, or fourth and eighth, or first and seventh and third, or first and seventh and fourth, or first and eighth and third, or first and eighth and fourth, or second and seventh and third, or second and seventh and fourth, or second and eighth and third, or second and
485 eight and fourth road surfaces are omitted.

490 12. The road junction of claim 5, wherein said first, or second, or third, or fourth, or seventh, or eighth road surfaces is omitted, or first and third, or first and fourth, or first and seventh, or first and eighth, or second and third, or second and fourth, or second and seventh, or second and eighth, third and seventh, or third and eighth, or fourth and seventh, or fourth and eighth, or first and seventh and third, or first and seventh and fourth, or first and eighth and third, or first and eighth and fourth, or second and seventh and third, or second and seventh and fourth, or second and eighth and third, or second and
495 eight and fourth road surfaces are omitted.

13. The road junction of claim 6, wherein said first, or second, or third, or fourth, or seventh, or eighth road surfaces is omitted, or first and third, or first and fourth, or first and seventh, or first and eighth, or second and third, or second and fourth, or second and seventh, or second and eighth, third and seventh, or third and eighth, or fourth and seventh, or fourth and eighth, or first and seventh and third,
500

or first and seventh and fourth, or first and eighth and third, or first and eighth and fourth, or second and seventh and third, or second and seventh and fourth, or second and eighth and third, or second and eight and fourth road surfaces are omitted.

505 14. The road junction of claim 7, wherein one or more of said first, third, seventh, eighth, ninth, tenth, eleventh, or twelfth road surfaces, or one or more of said first, fourth, seventh, eighth, ninth, tenth, eleventh, or twelfth road surfaces, or one or more of said second, third, seventh, eighth, ninth, tenth, eleventh, or twelfth road surfaces, or one or more of said second, fourth, seventh, eighth, ninth, tenth, eleventh, or twelfth road surfaces are omitted.

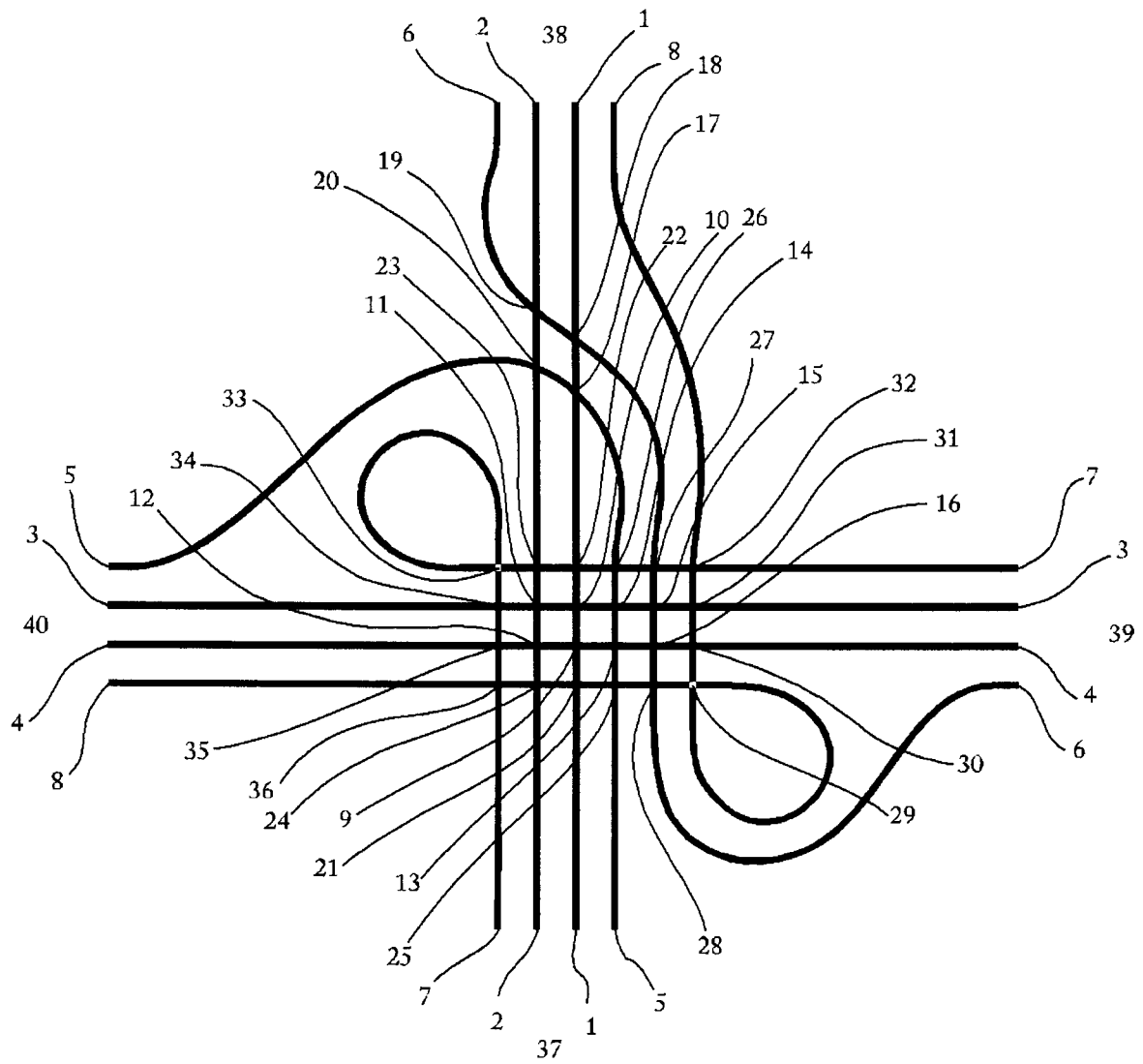


Fig. 1

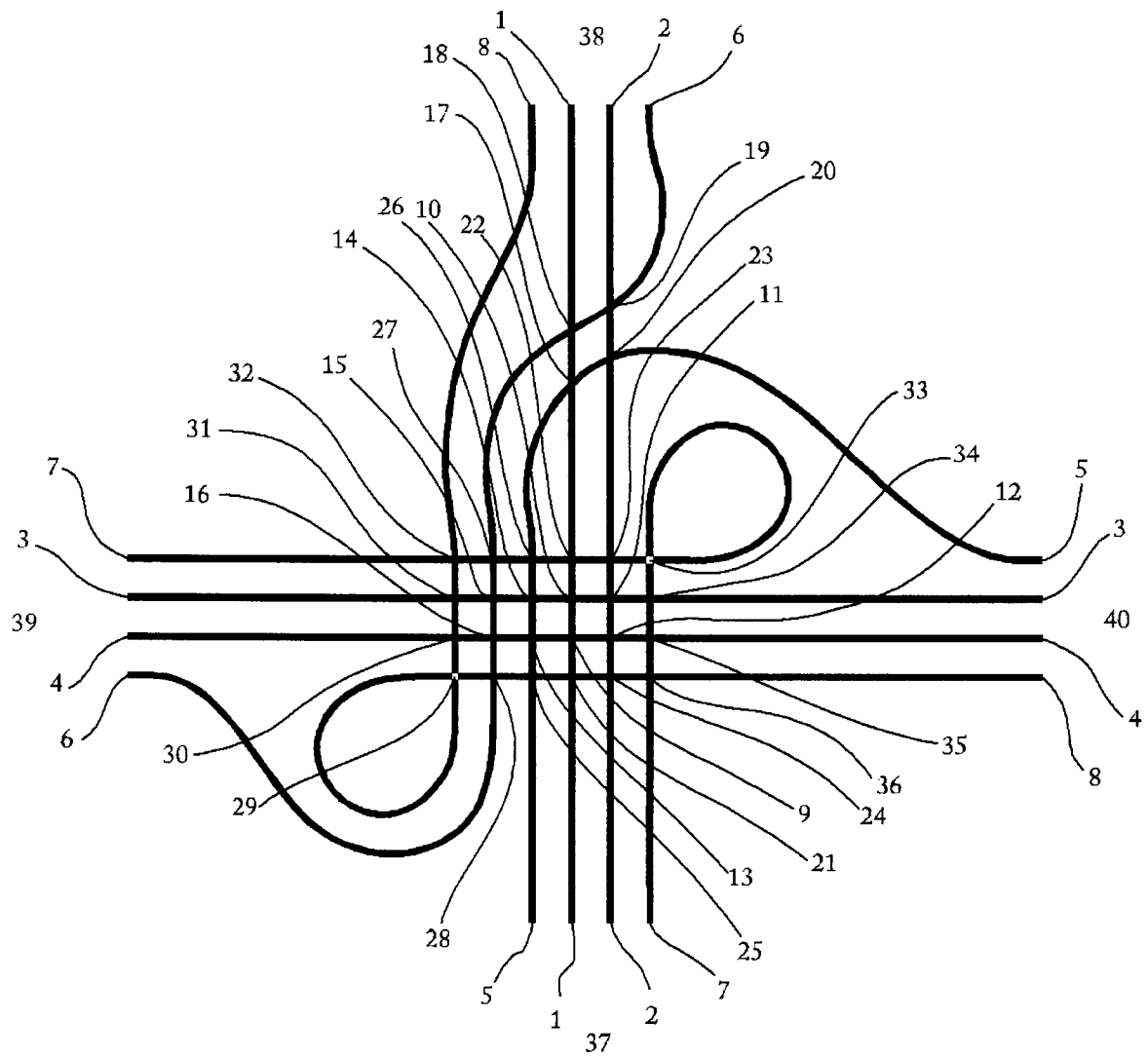


Fig. 2

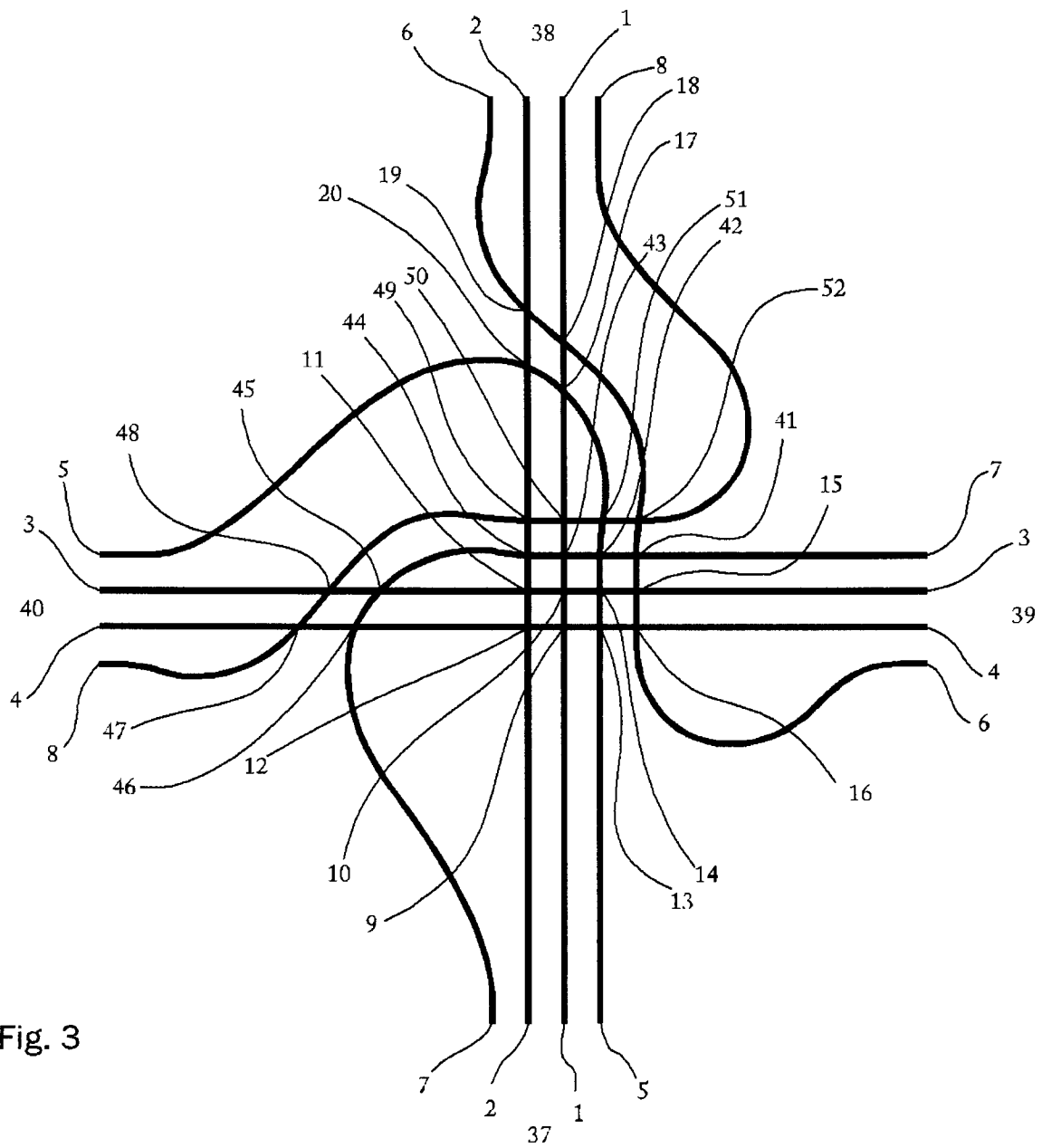


Fig. 3

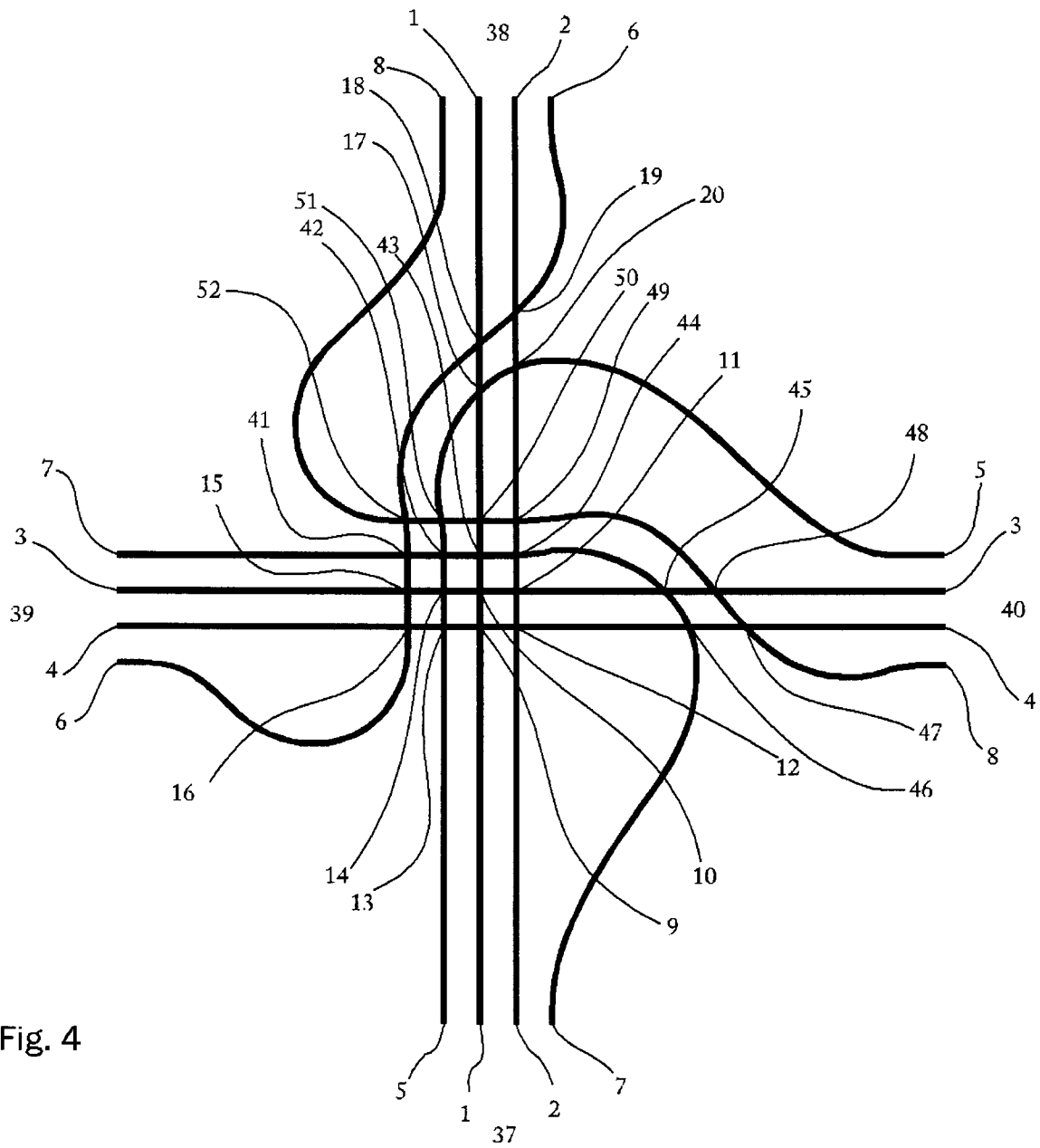


Fig. 4

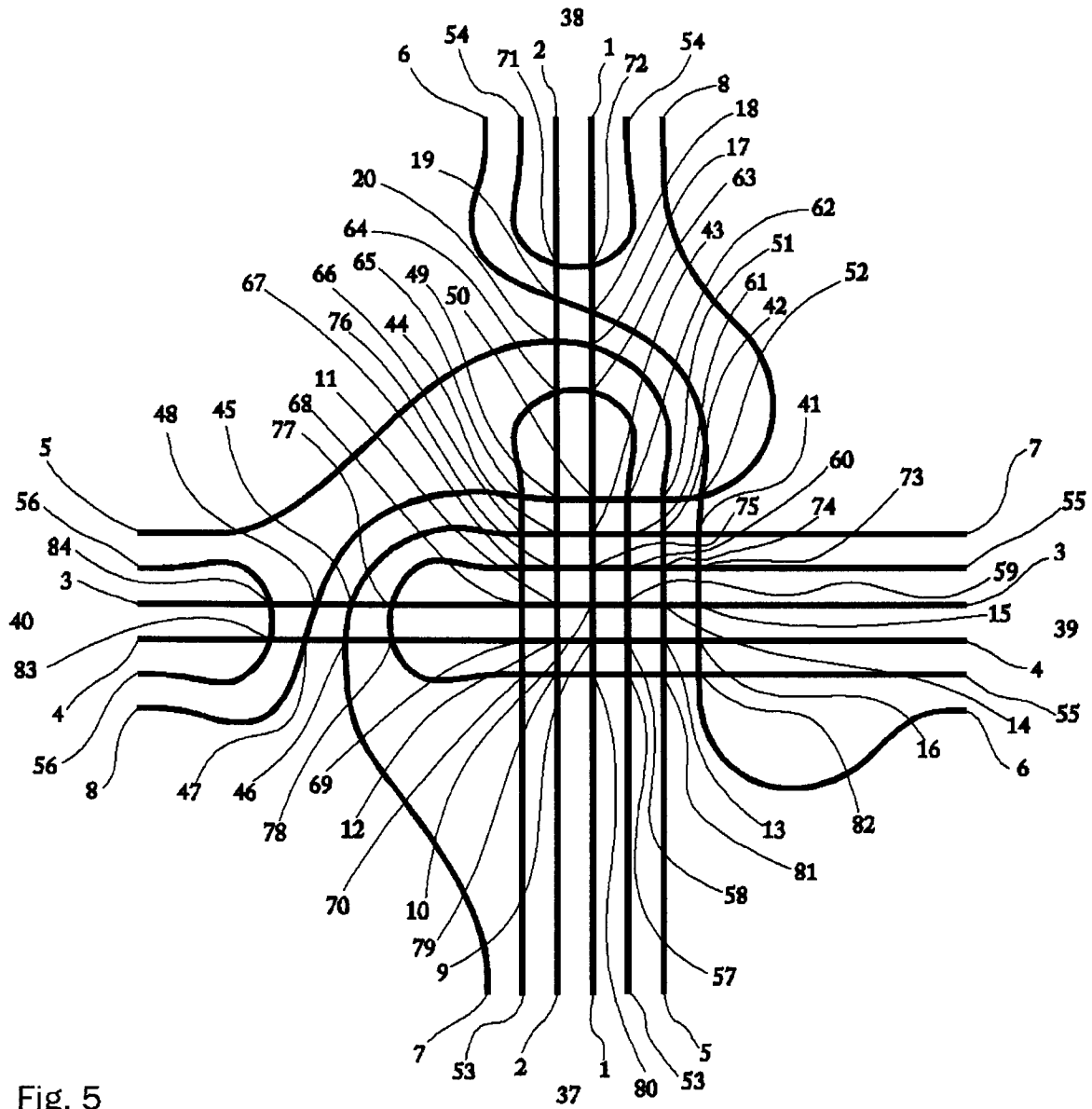


Fig. 5

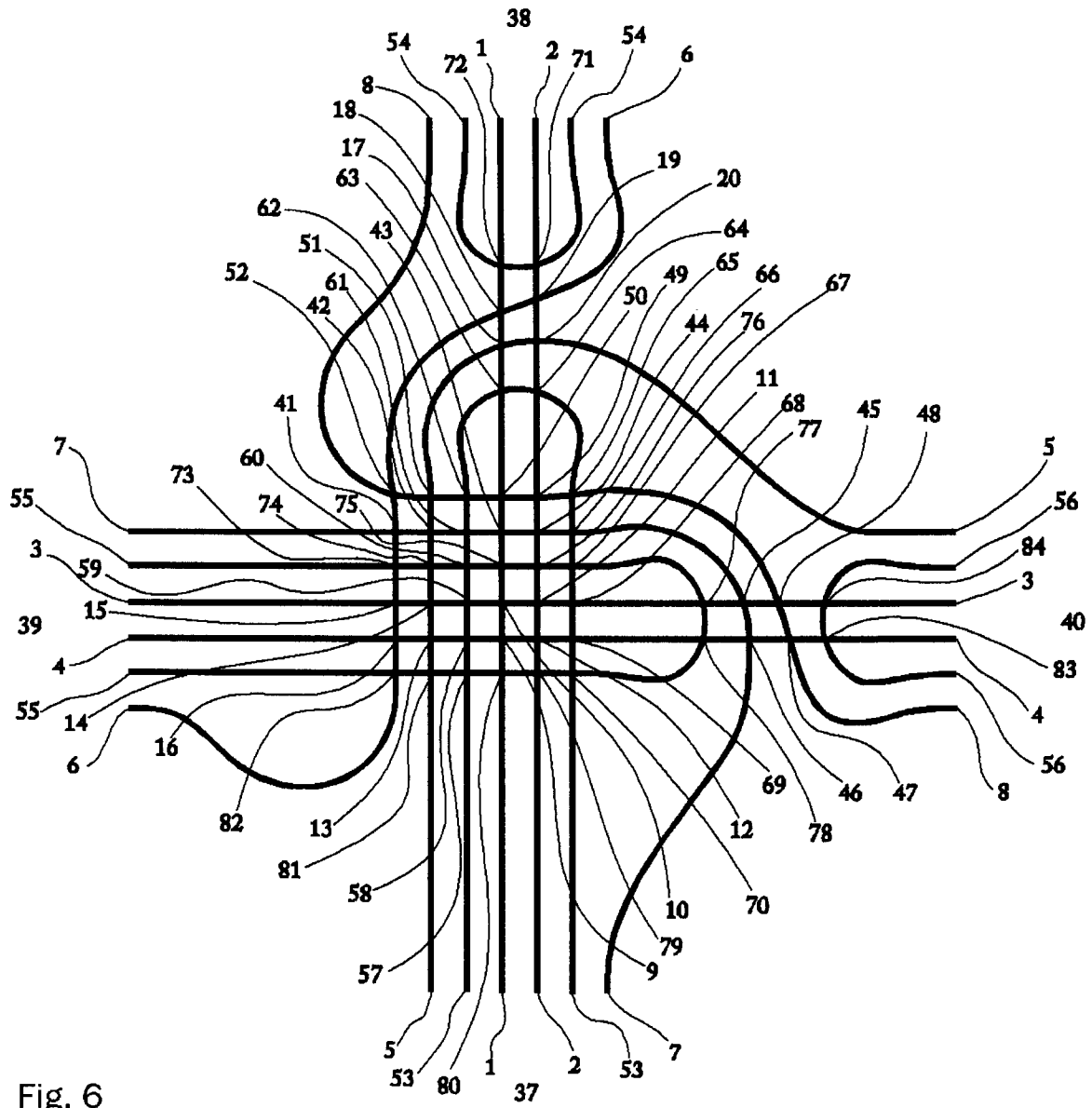


Fig. 6

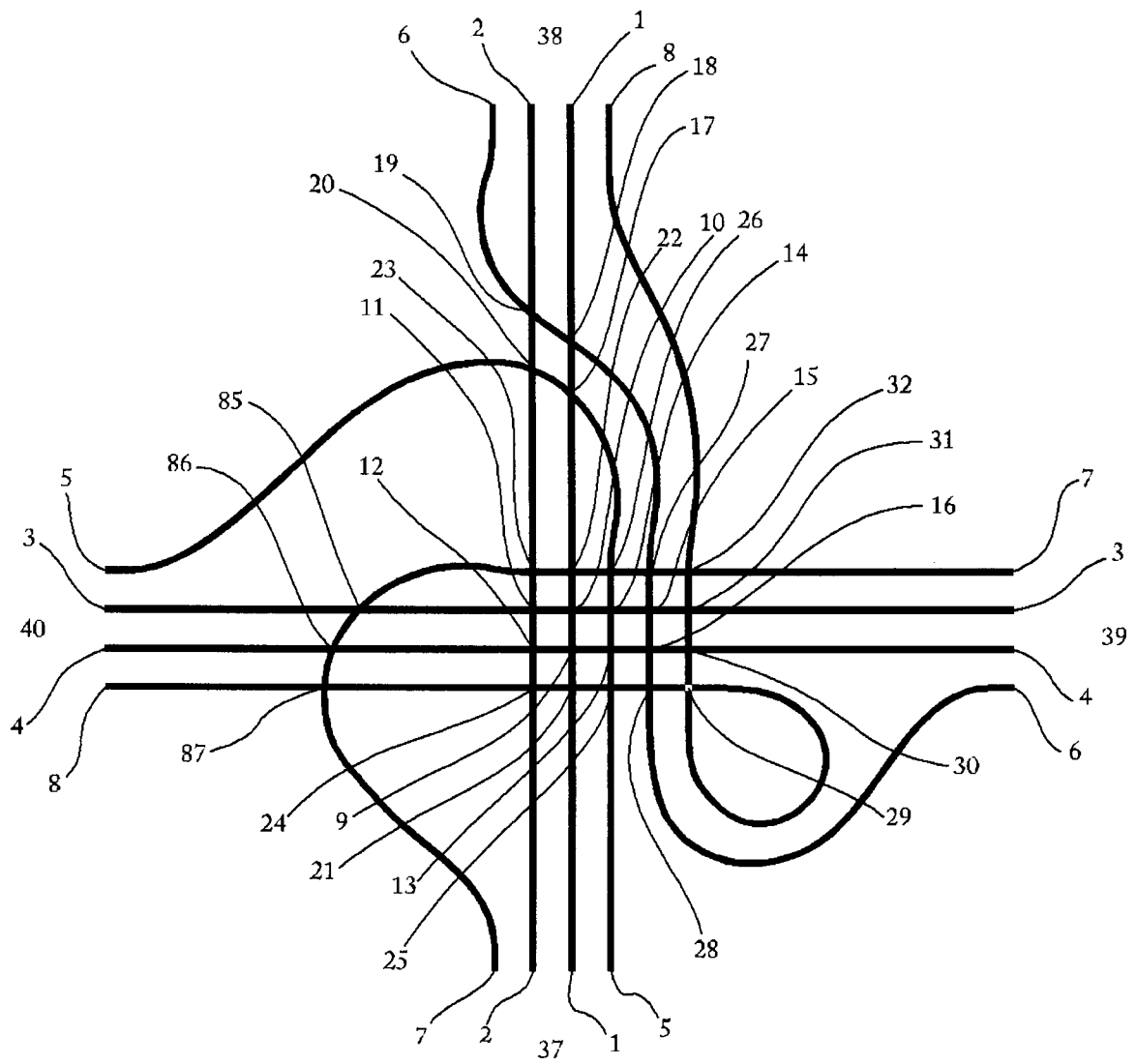


Fig. 7

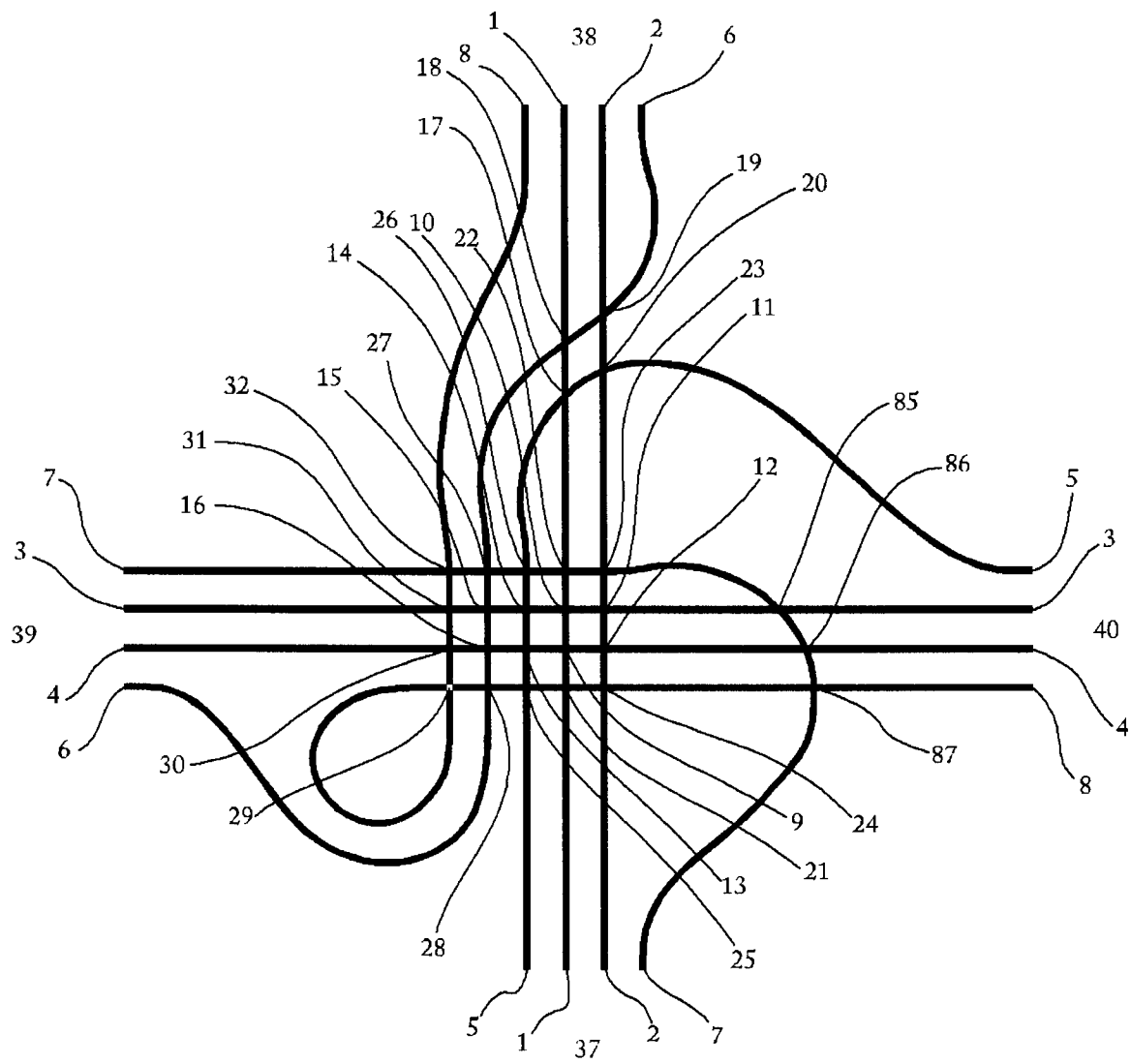


Fig. 8

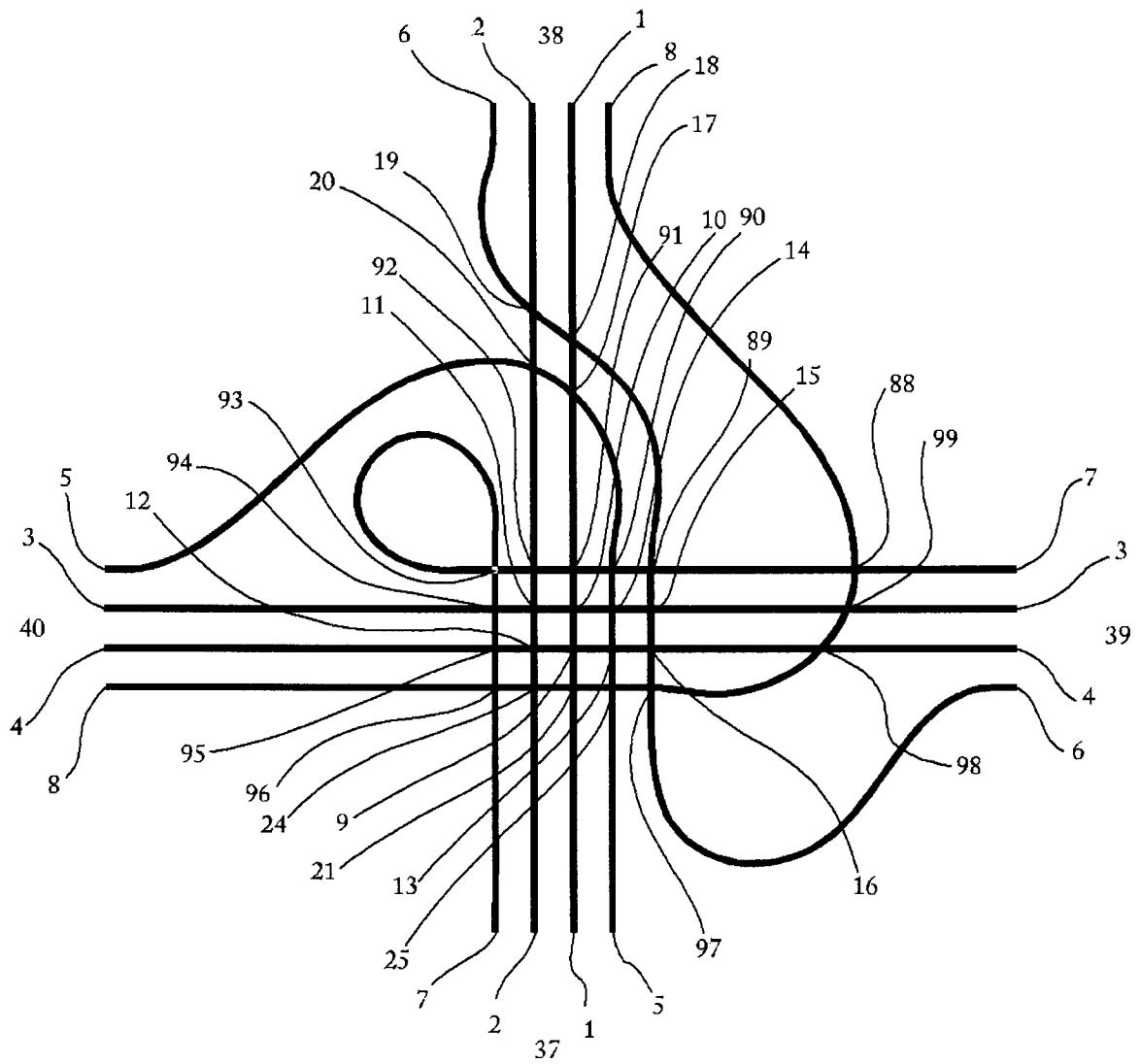


Fig. 9

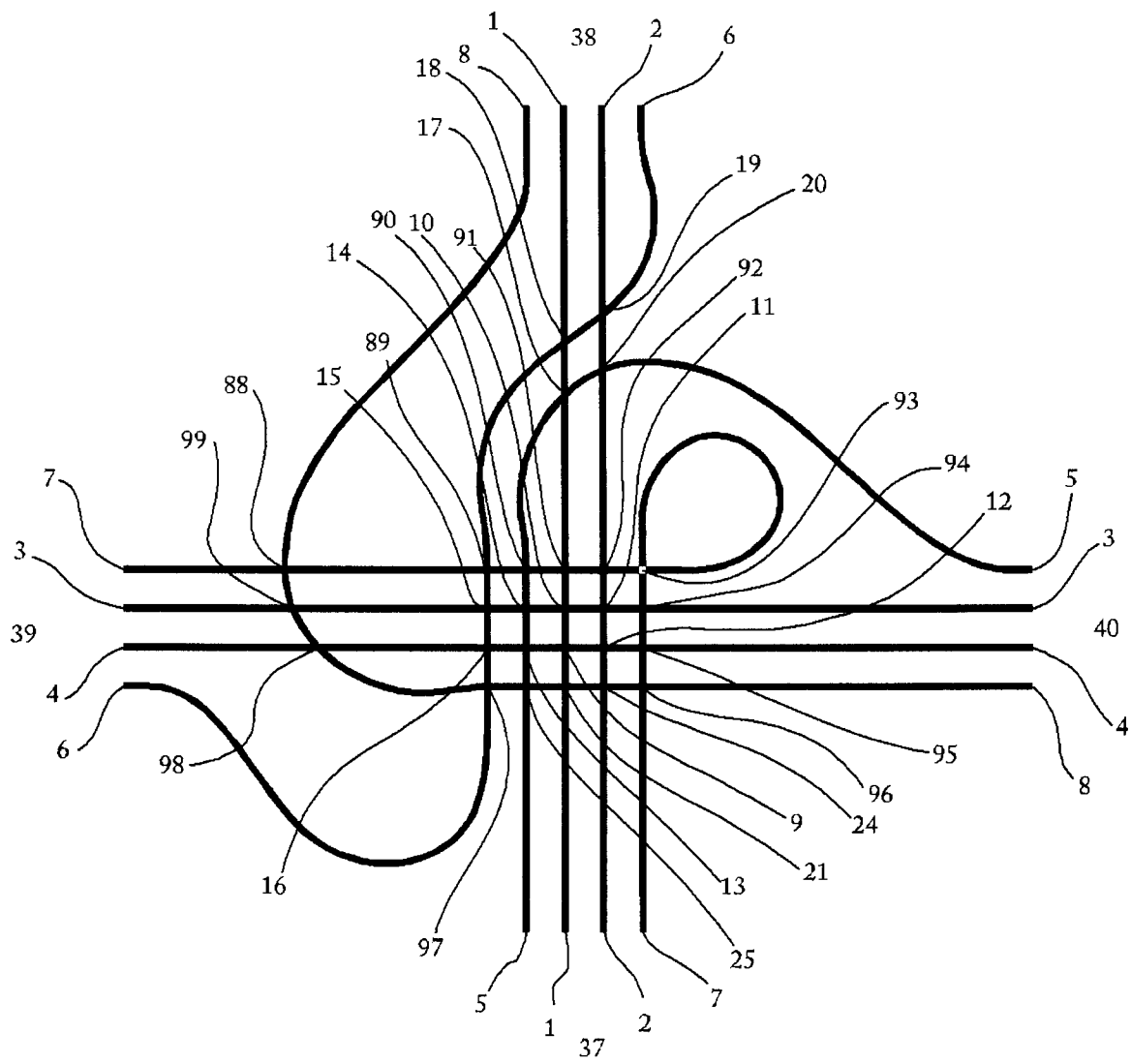


Fig. 10

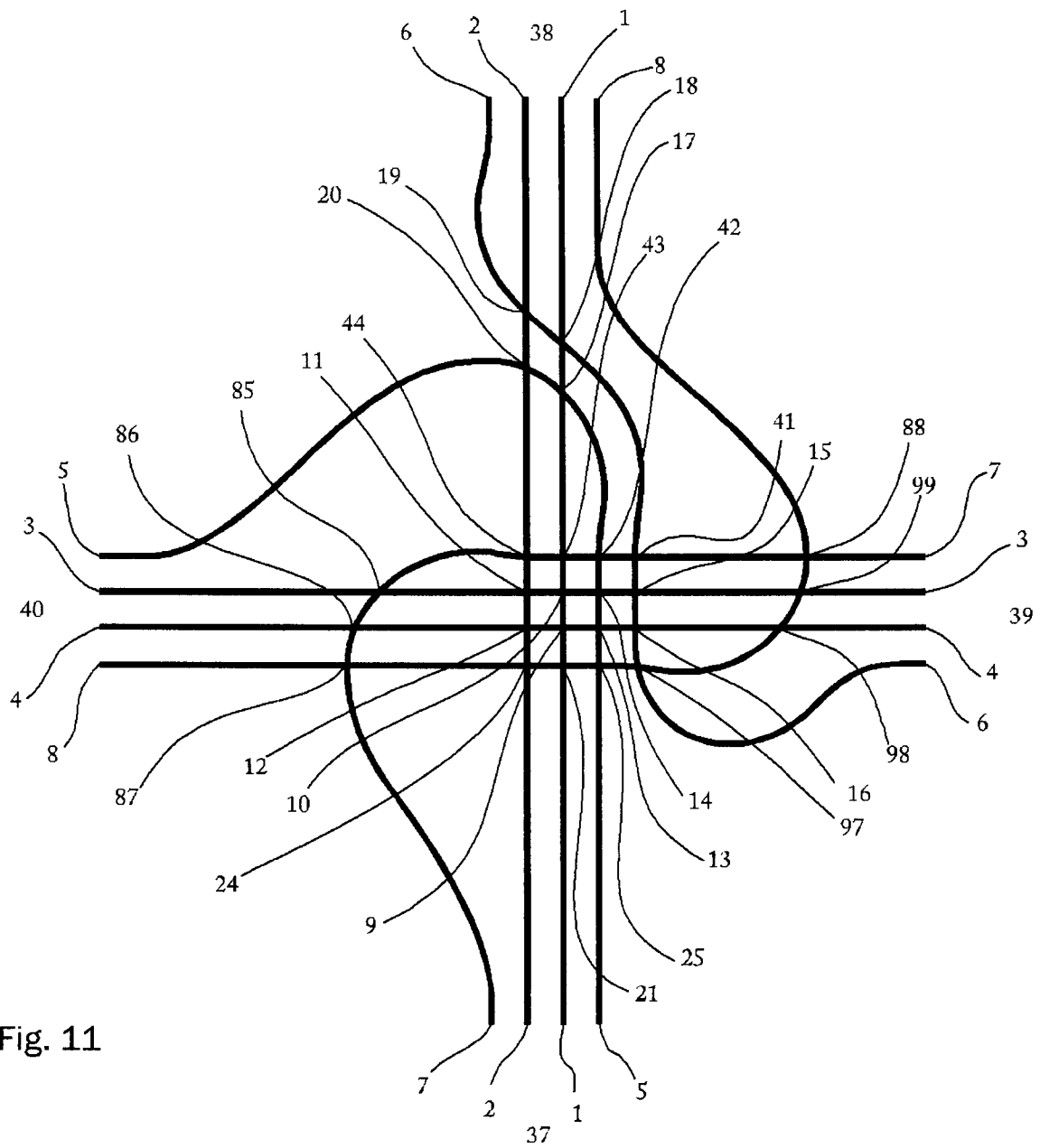


Fig. 11

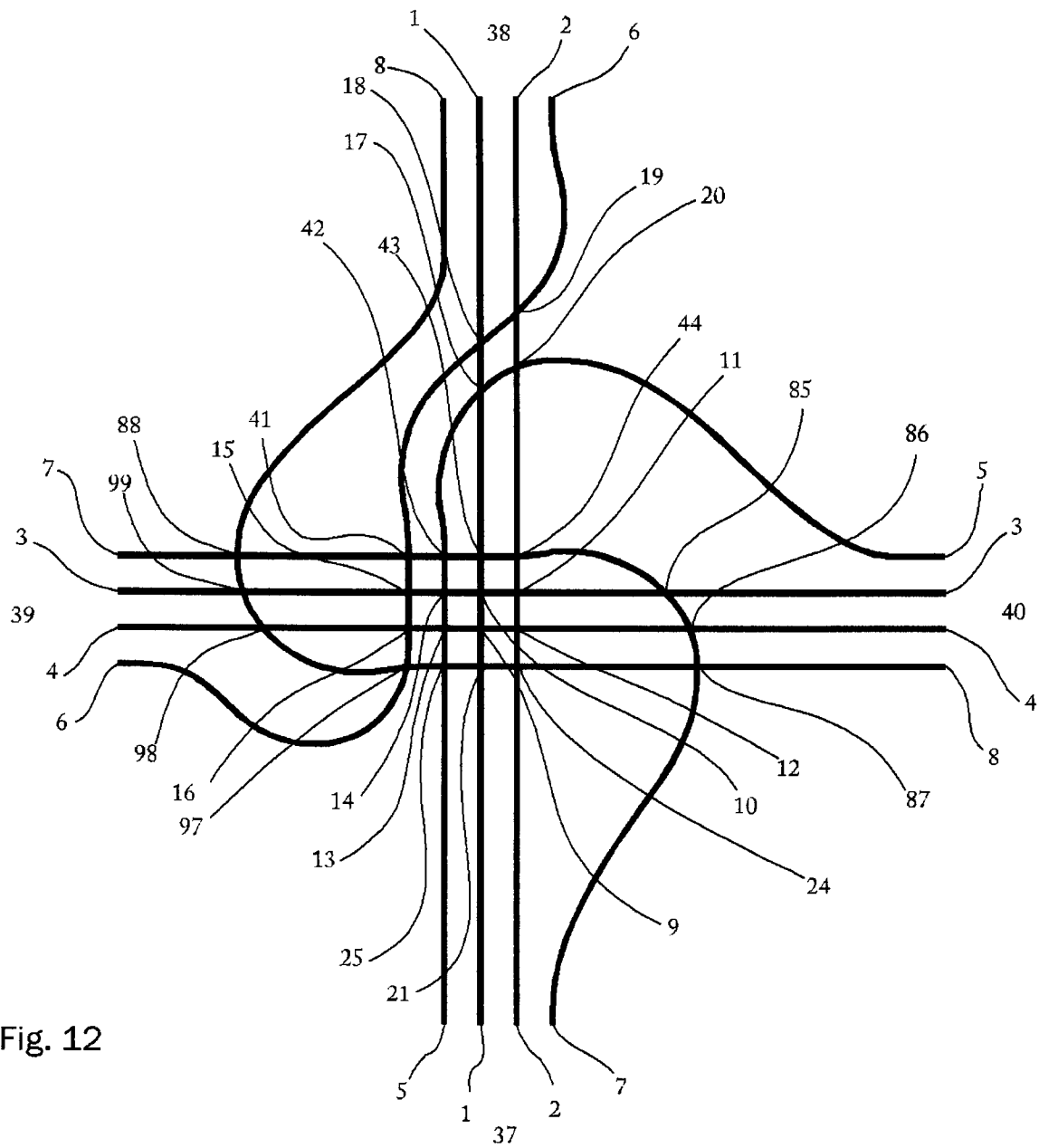


Fig. 12

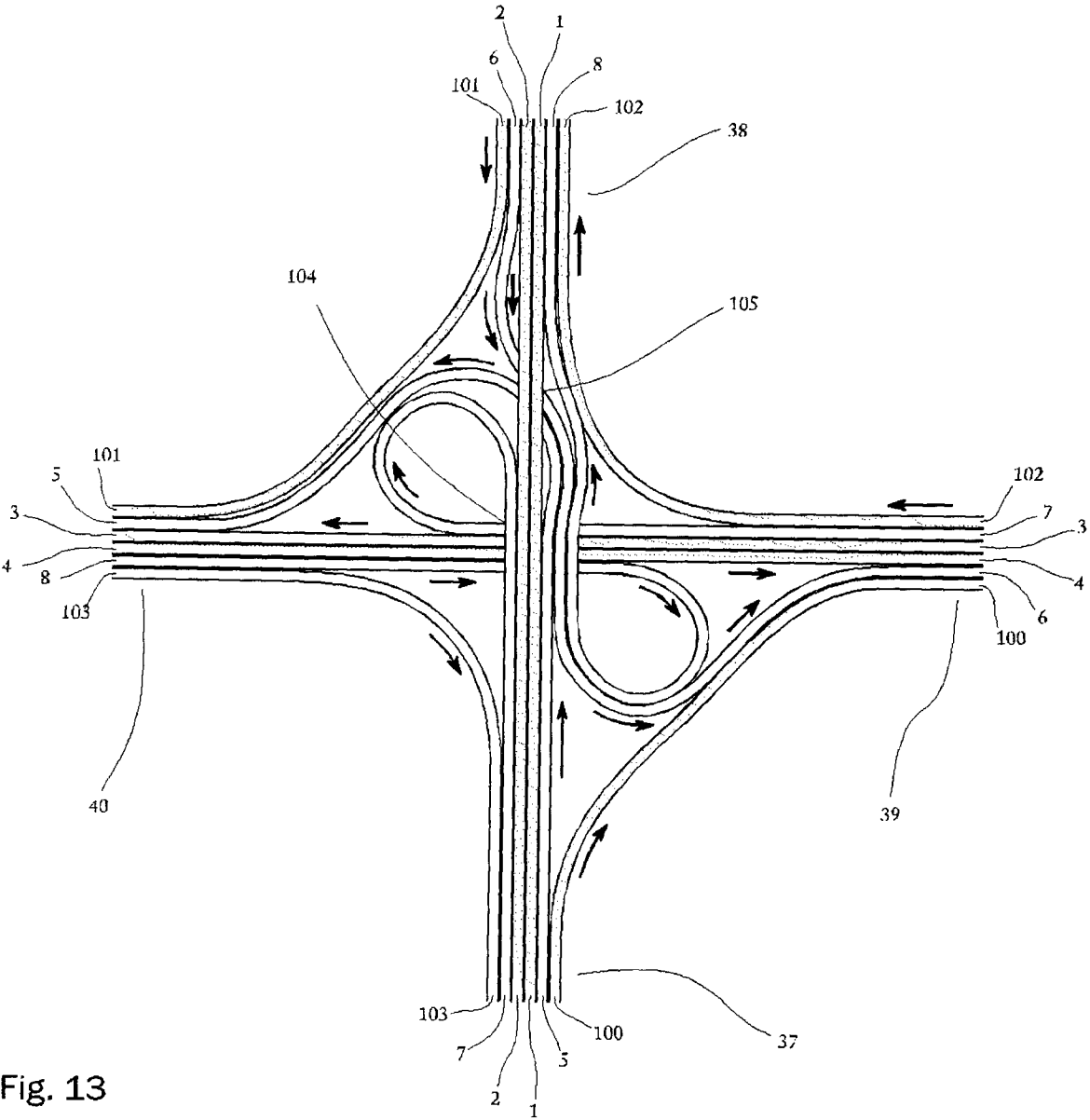


Fig. 13

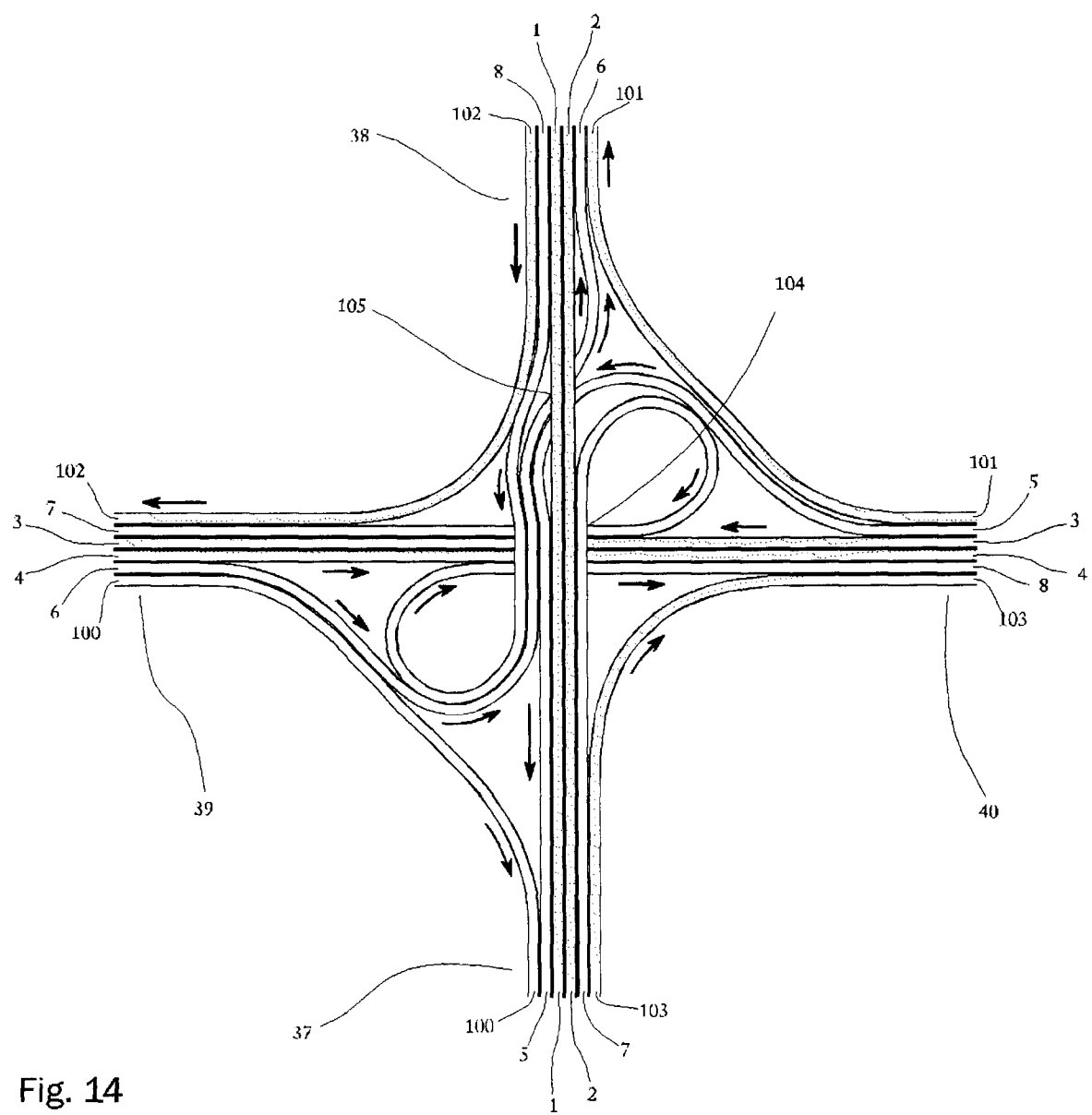


Fig. 14

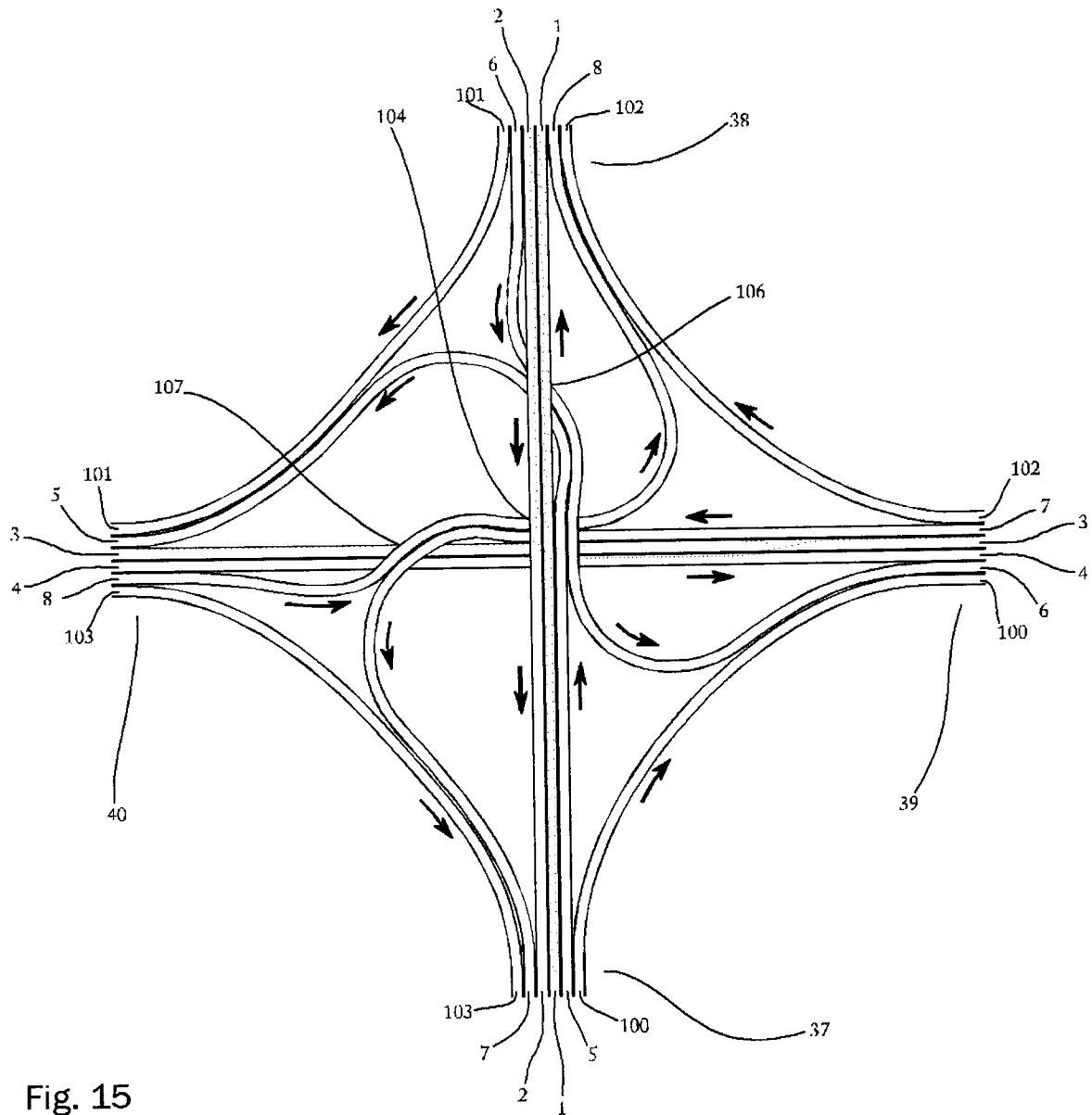


Fig. 15

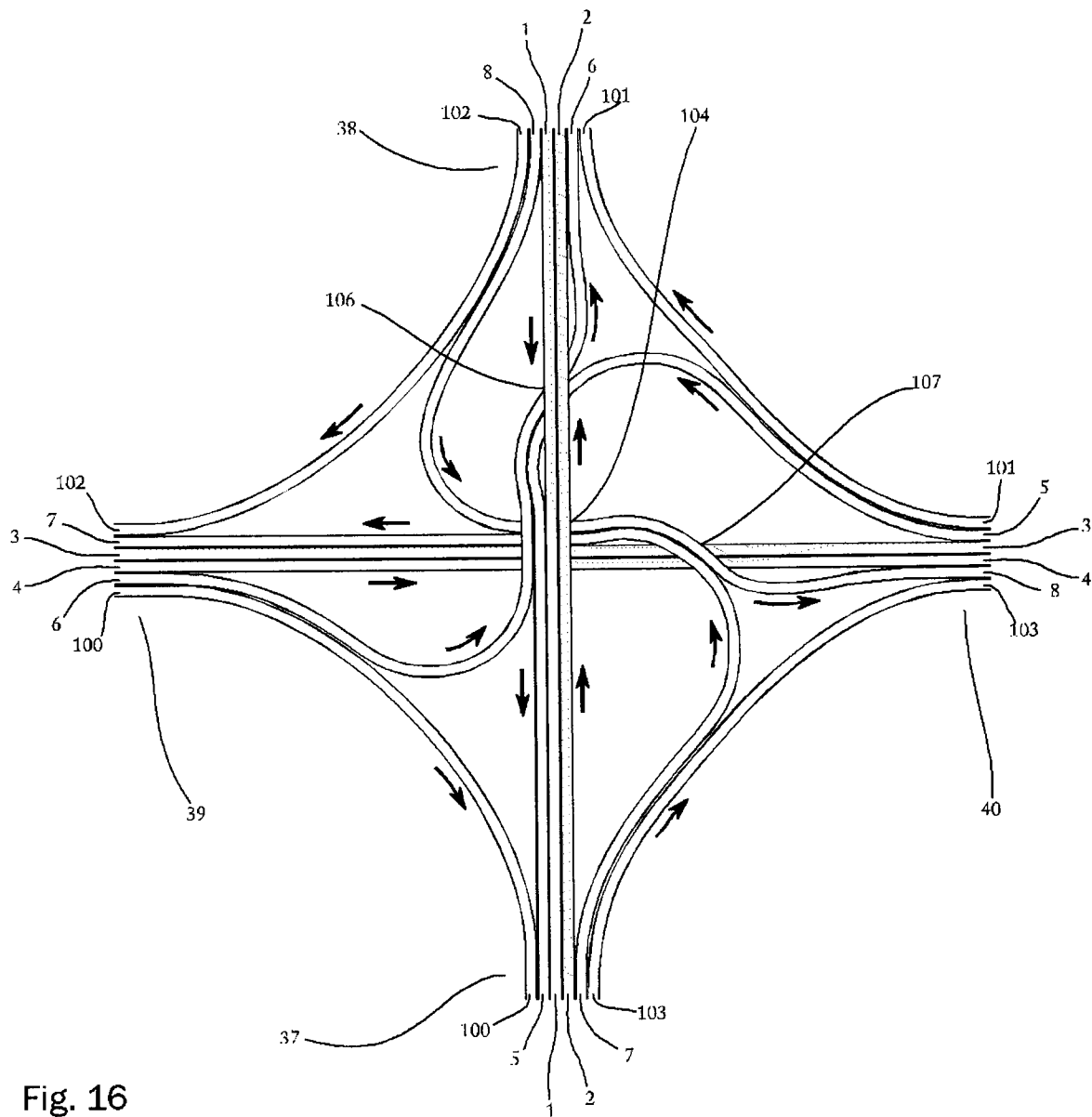


Fig. 16

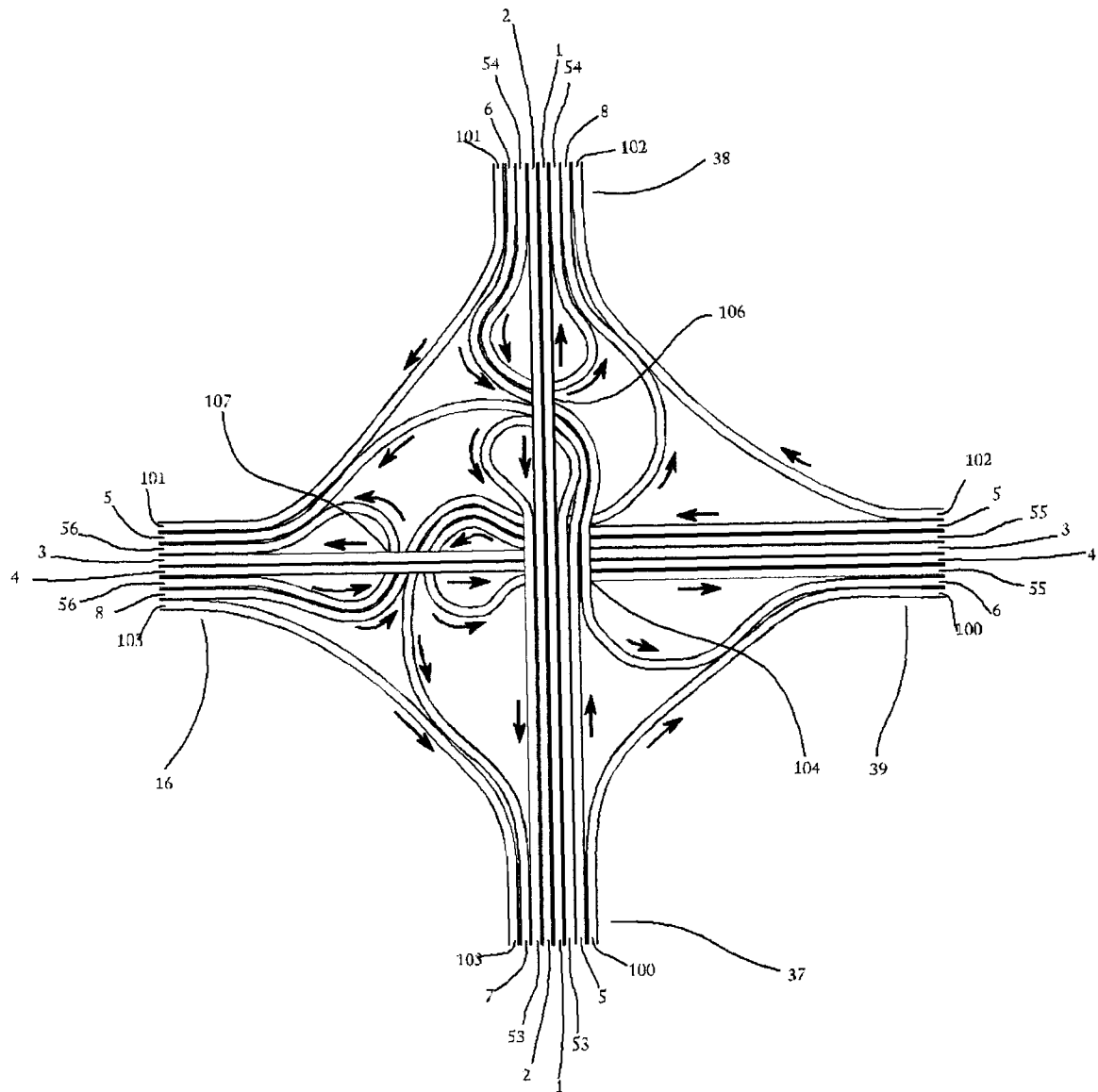


Fig. 17

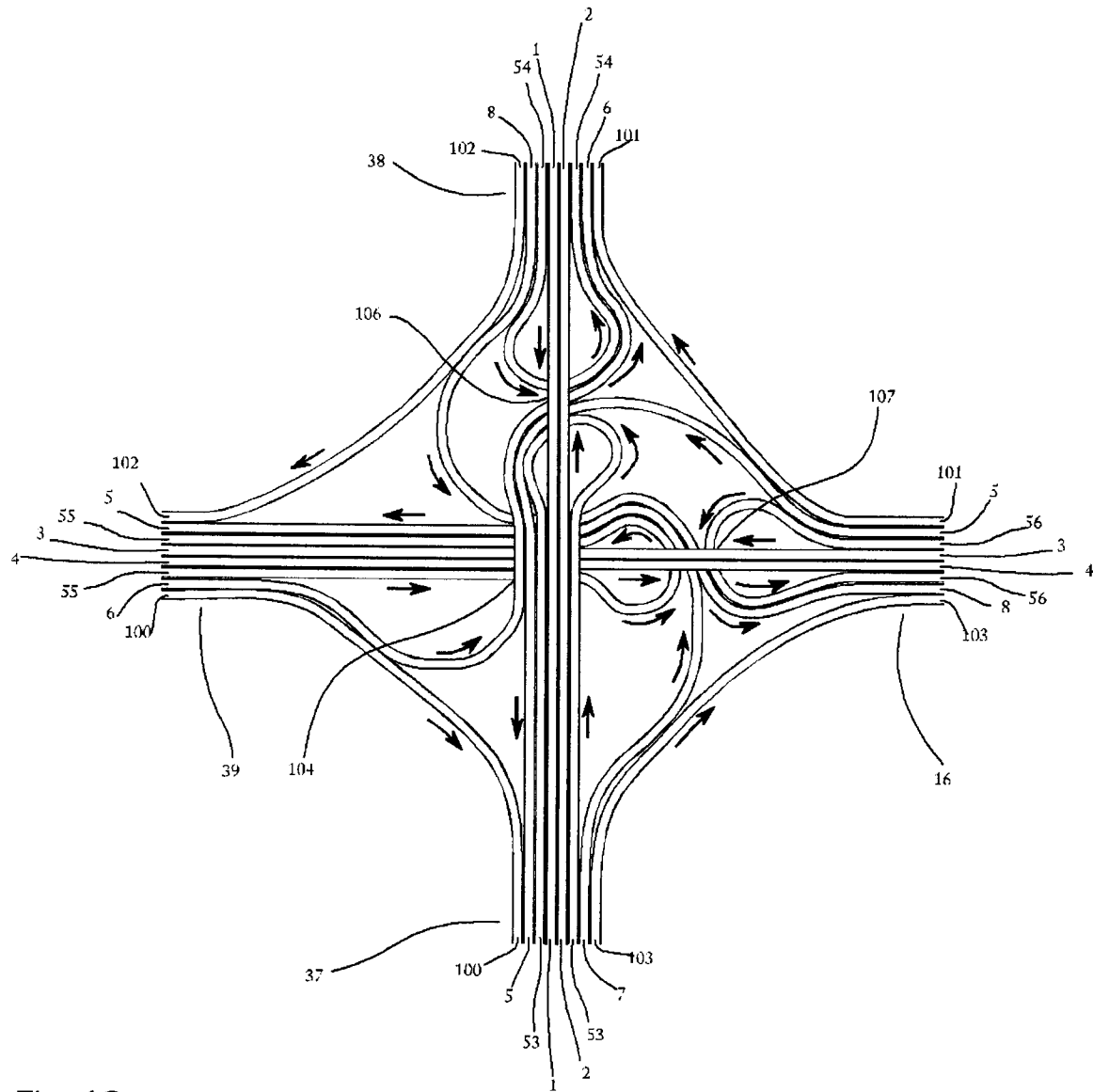


Fig. 18

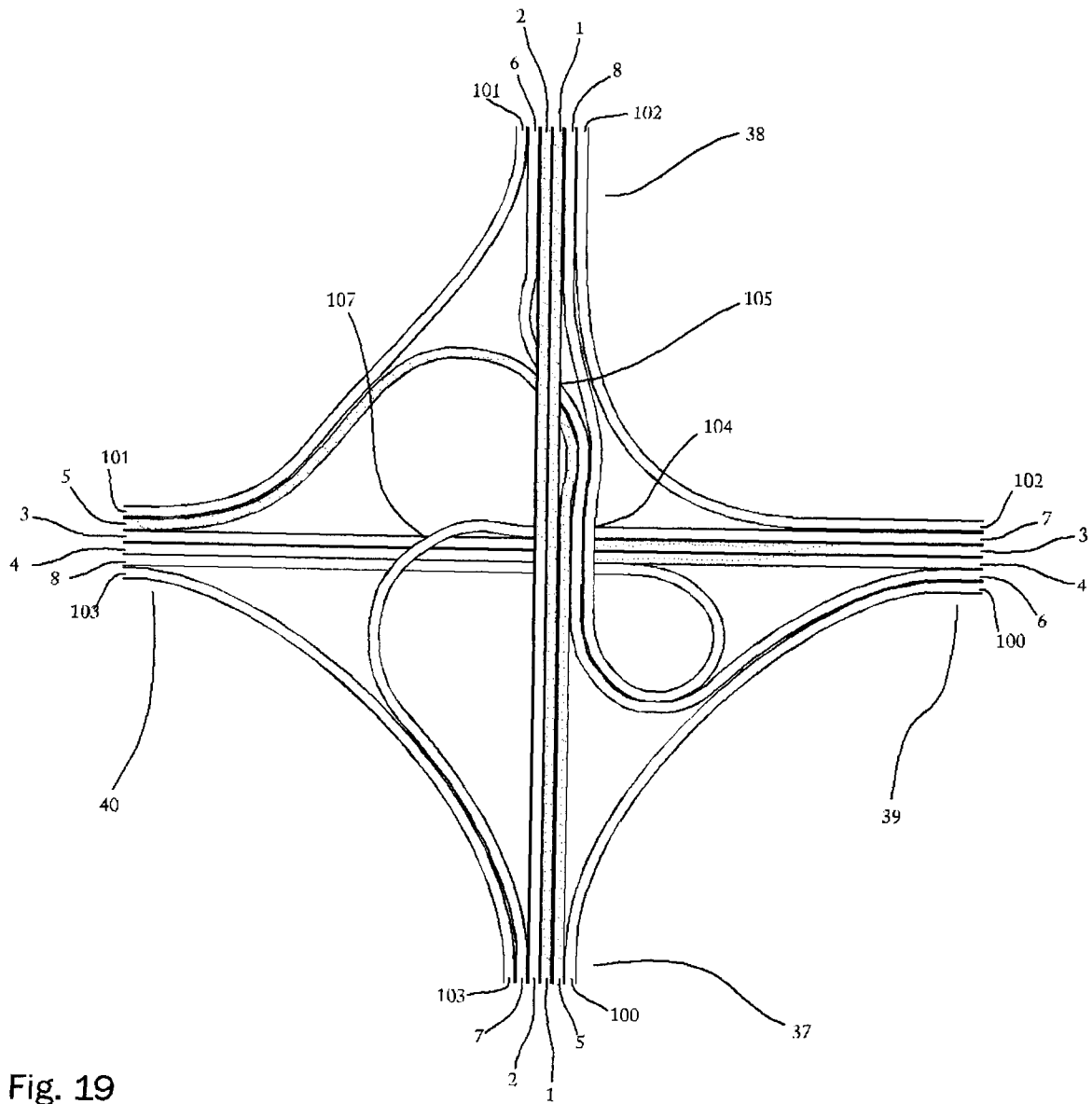


Fig. 19

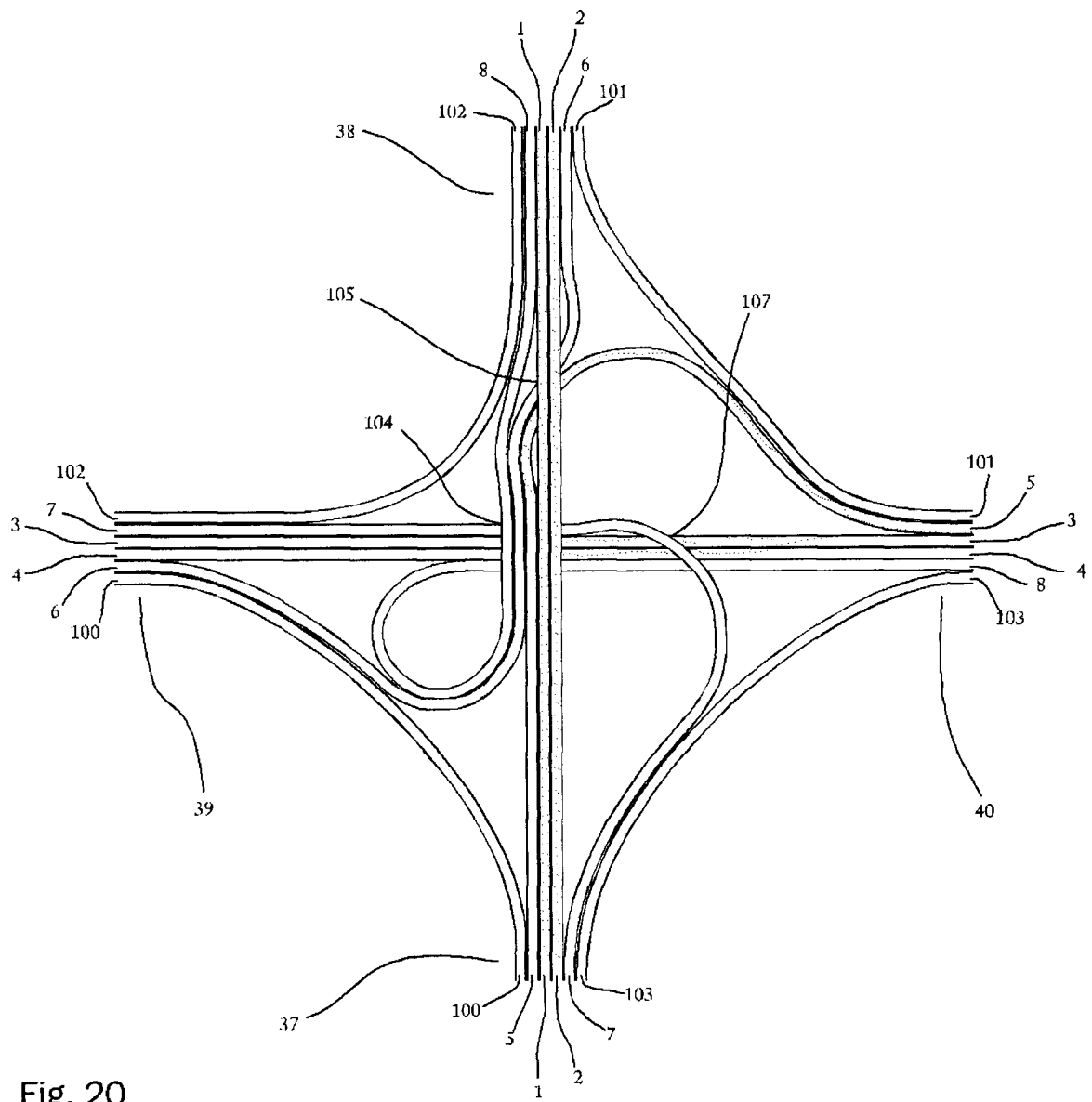


Fig. 20

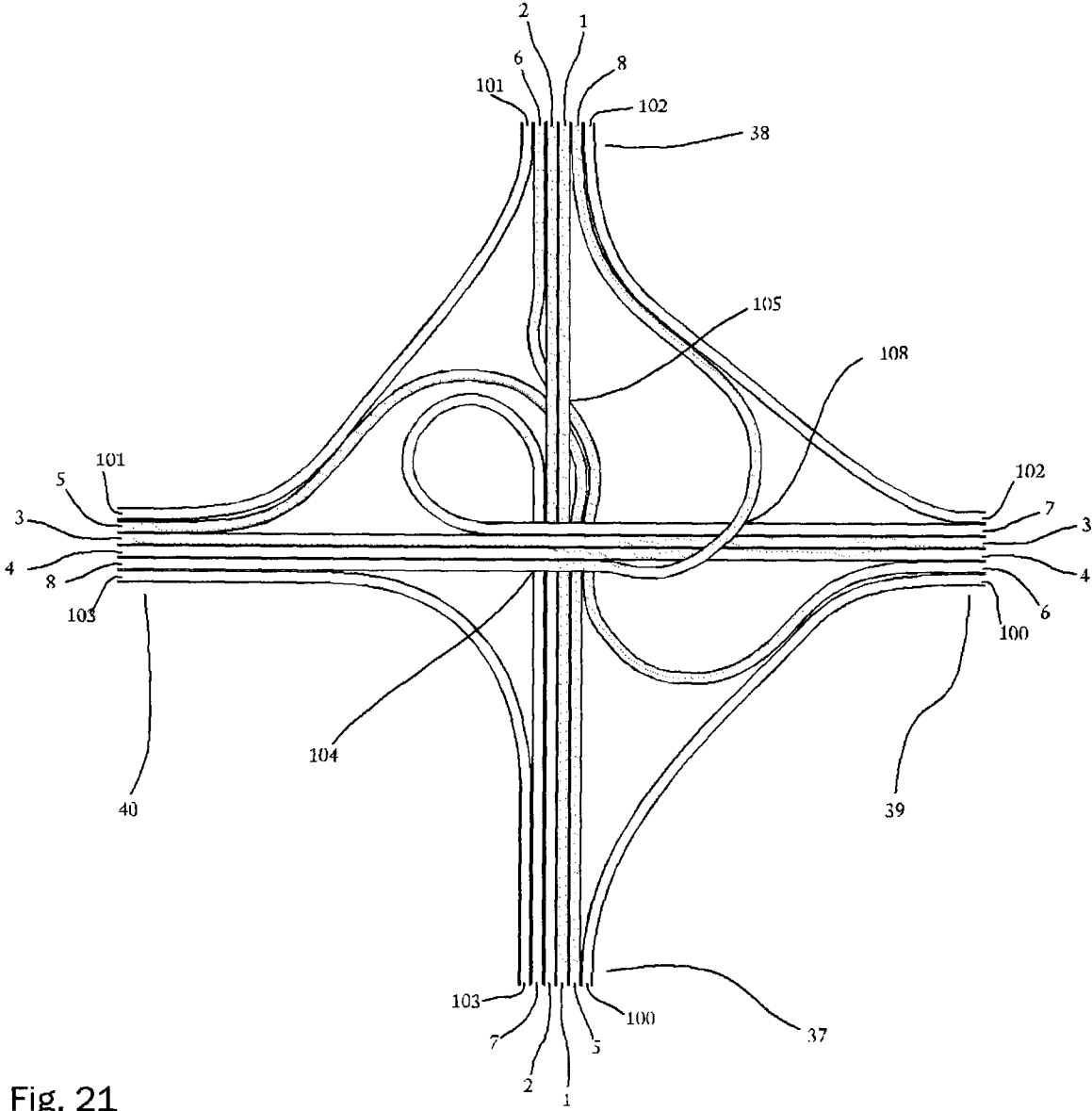
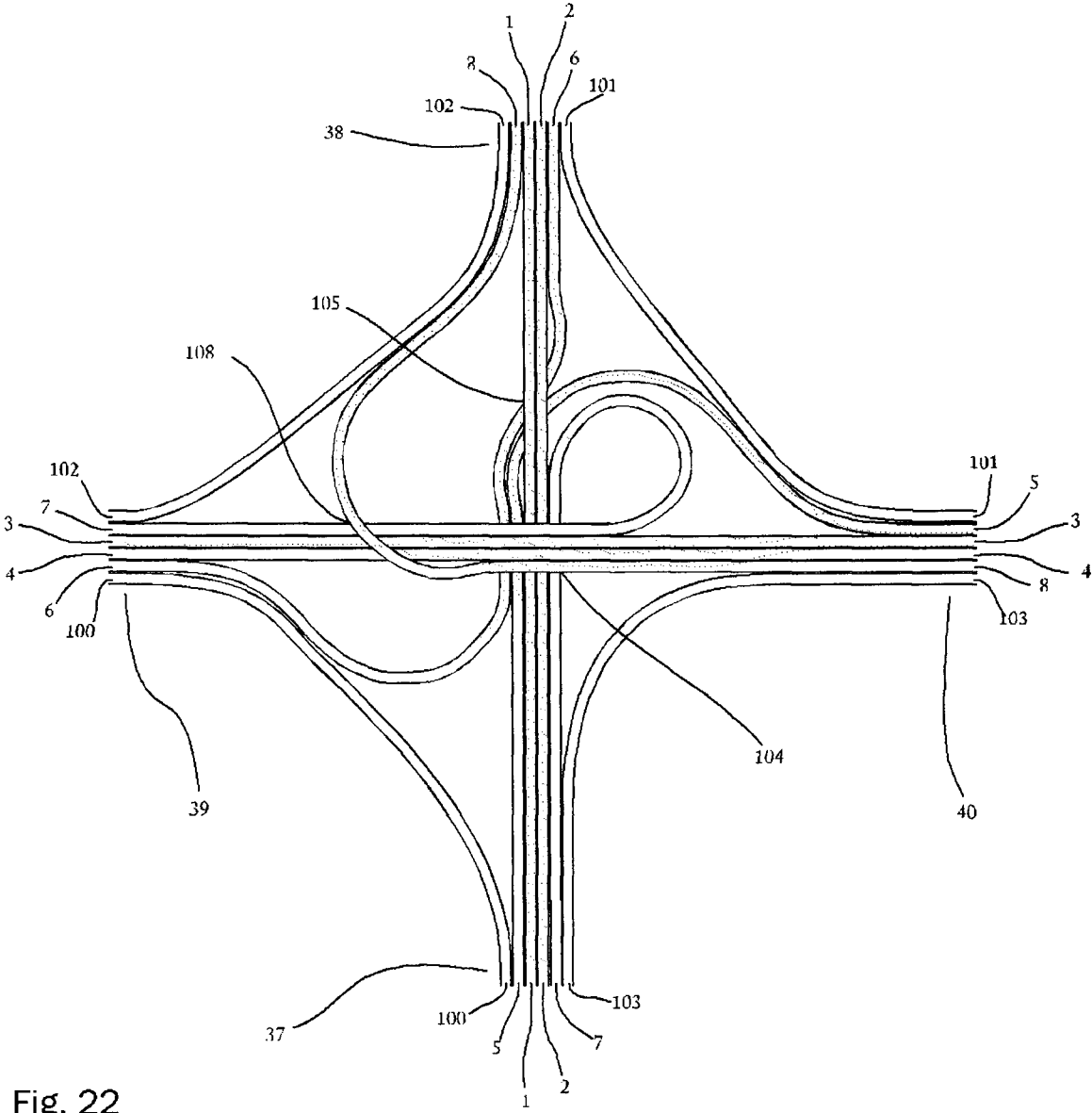


Fig. 21



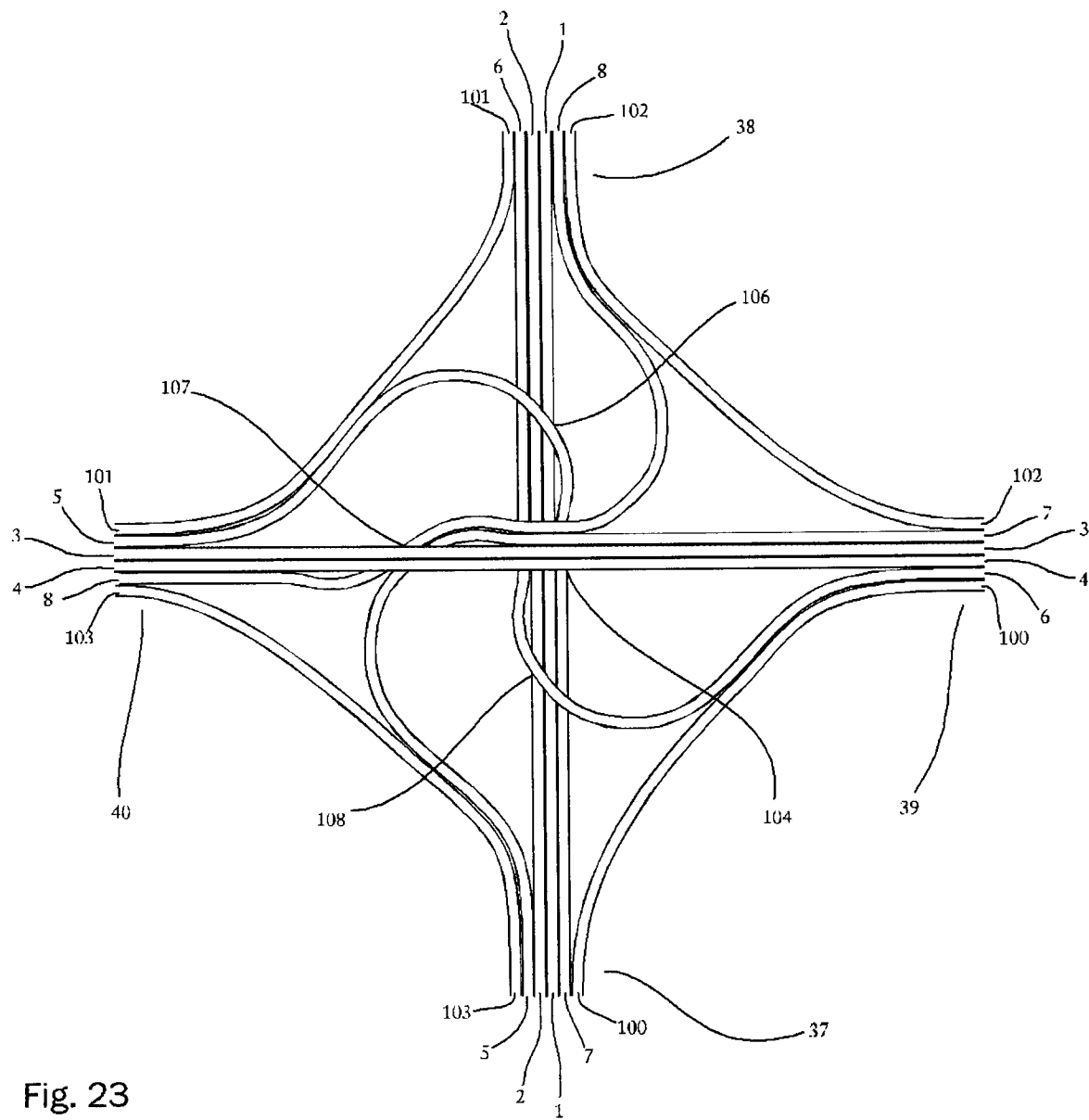


Fig. 23

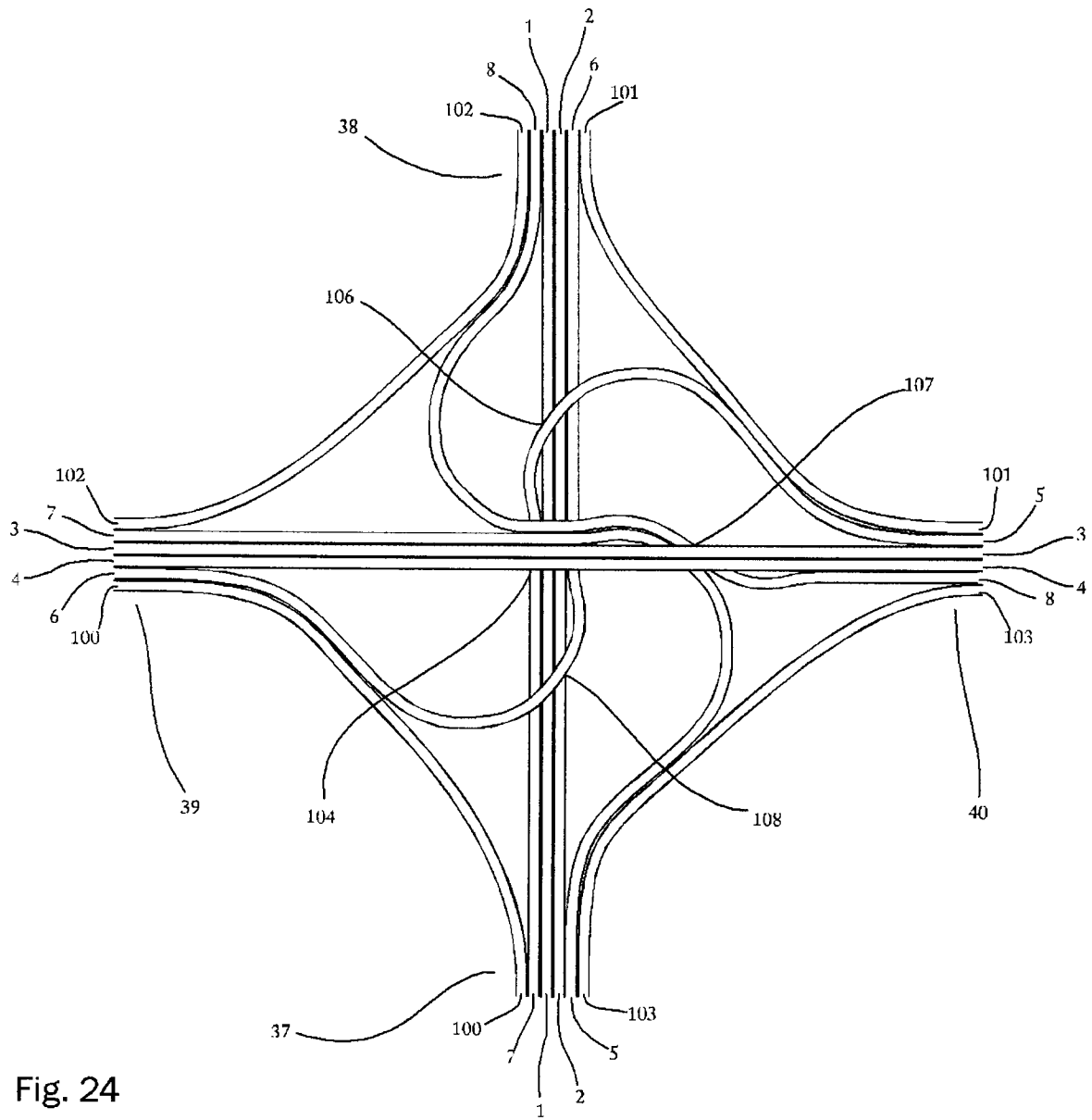


Fig. 24

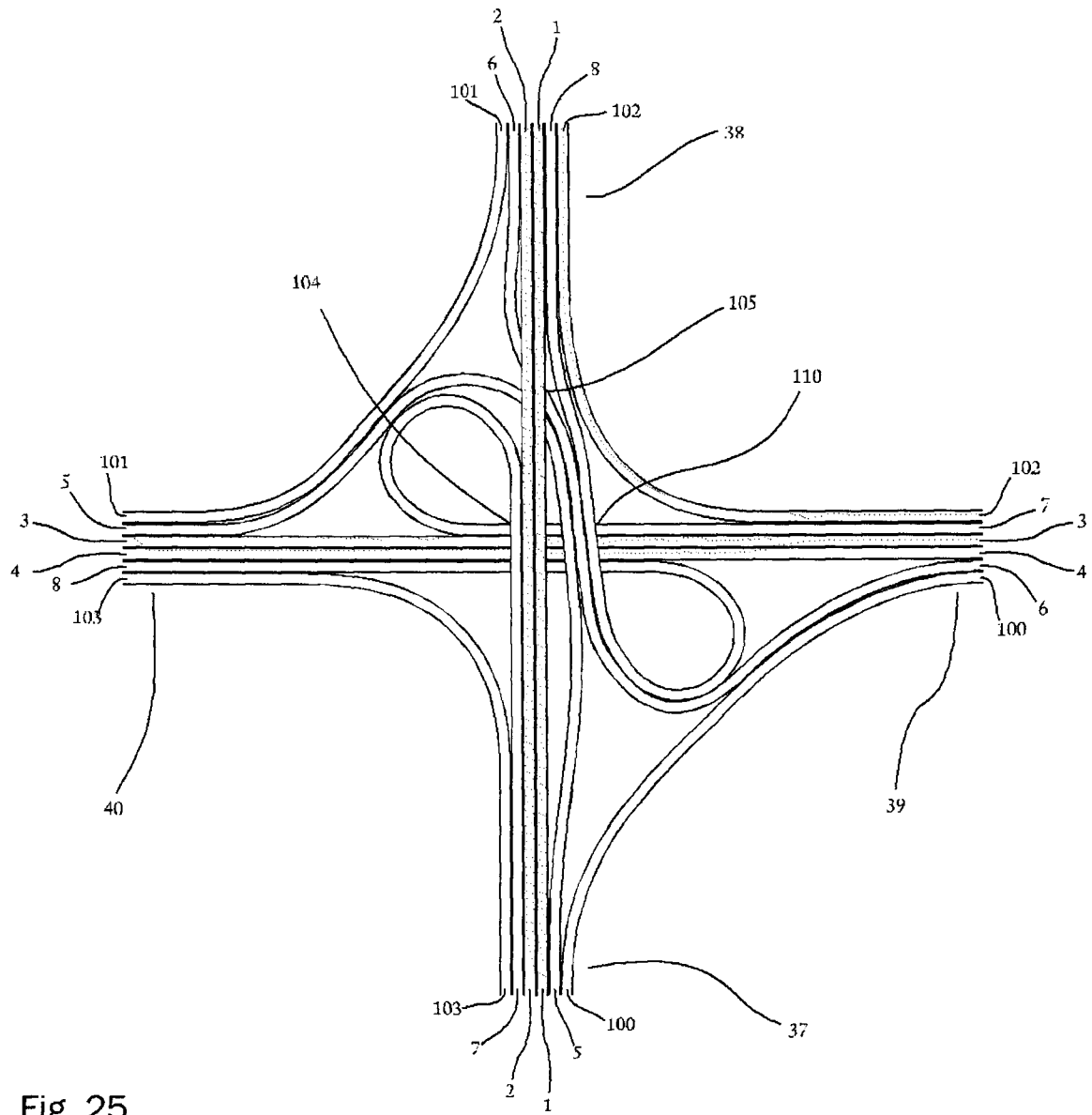


Fig. 25

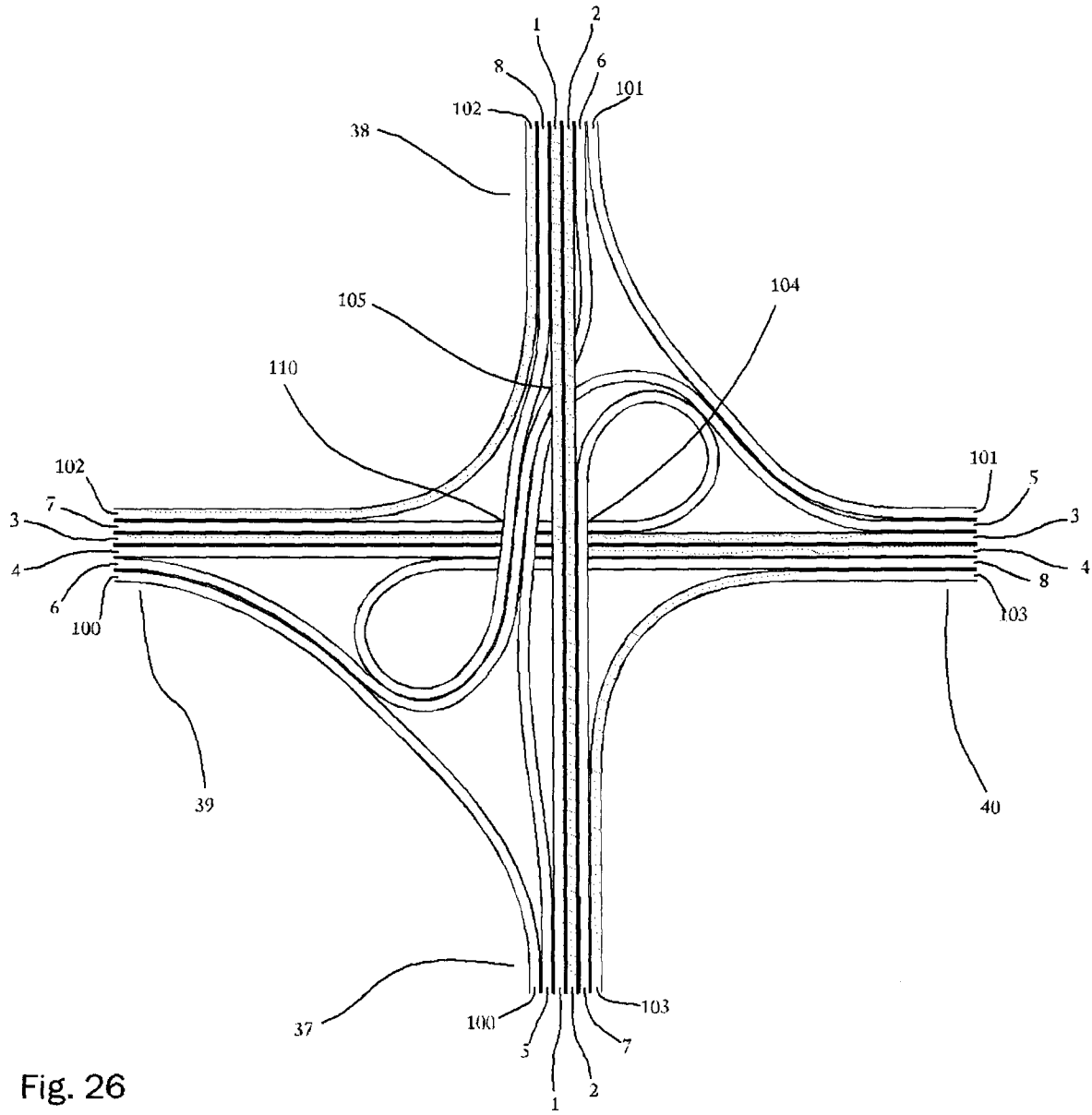


Fig. 26

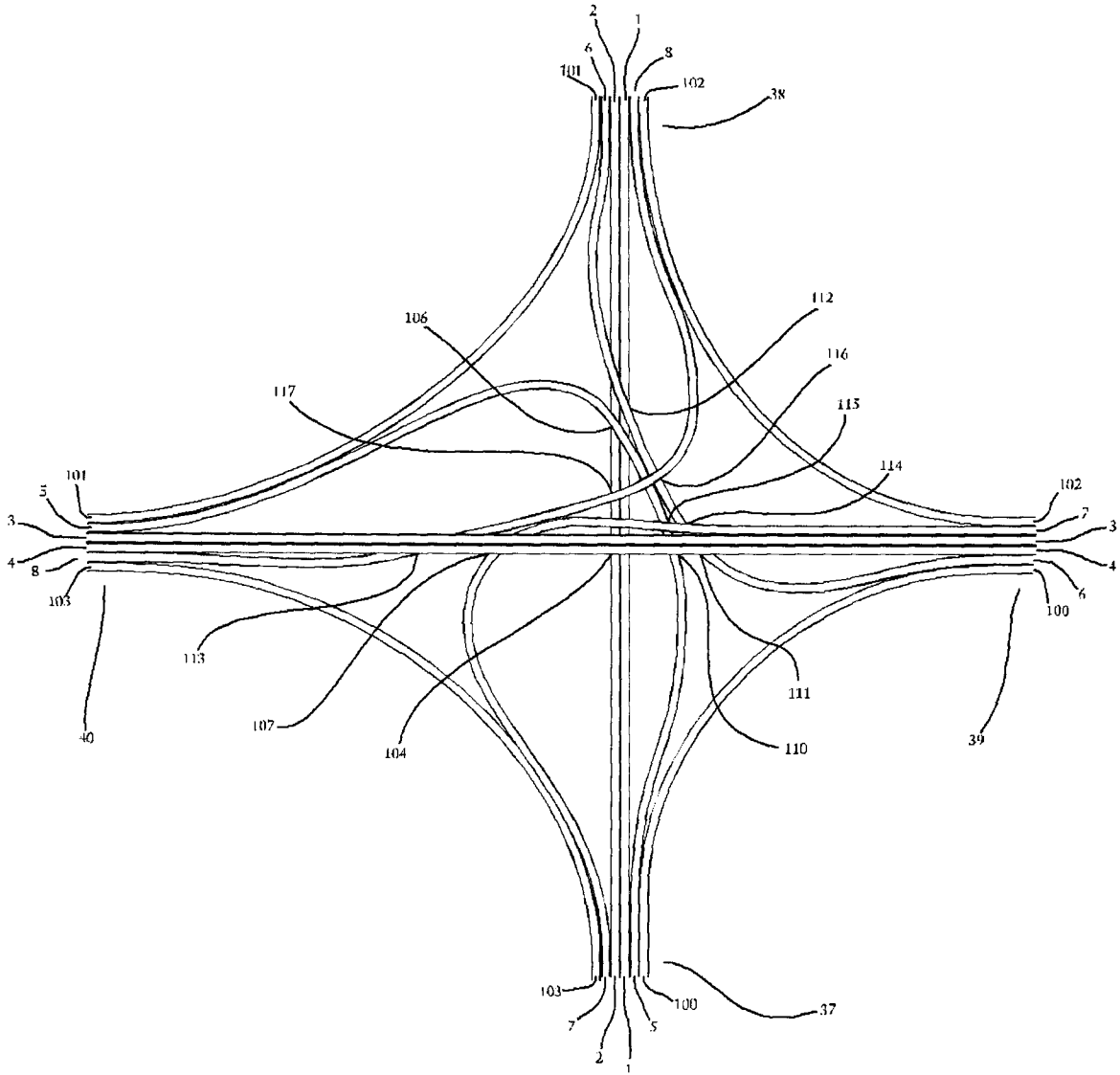


Fig. 27

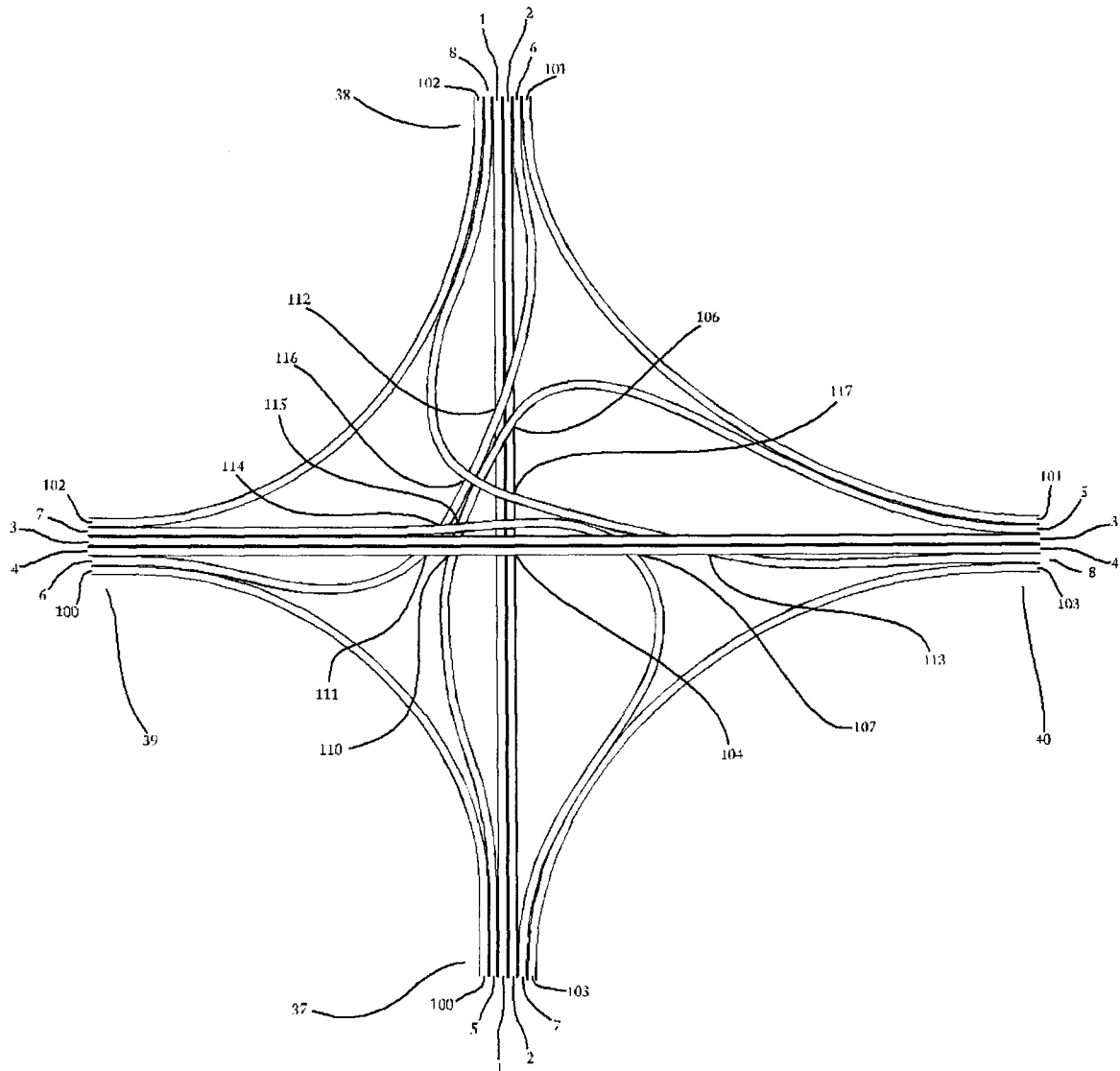


Fig. 28

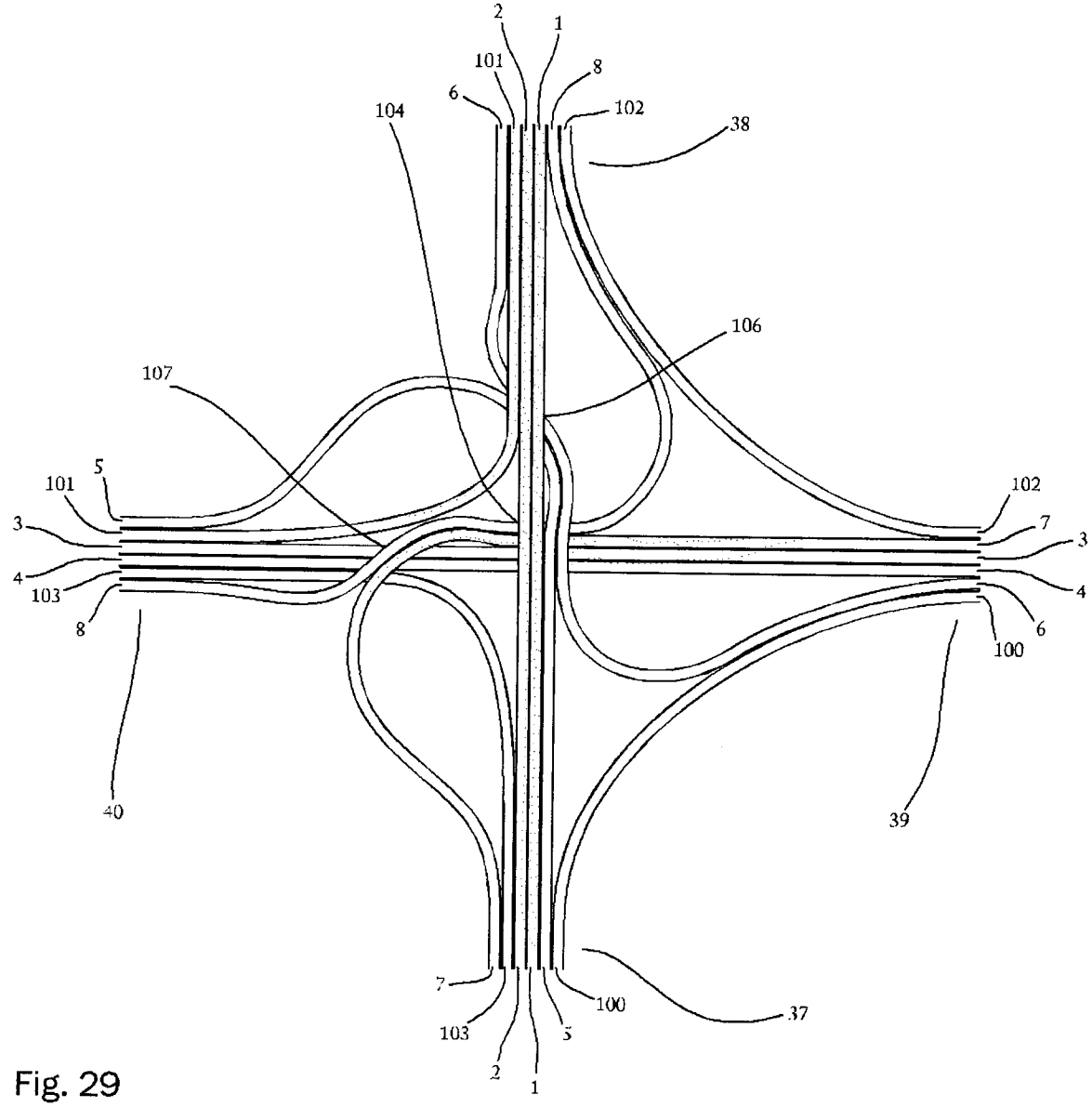


Fig. 29

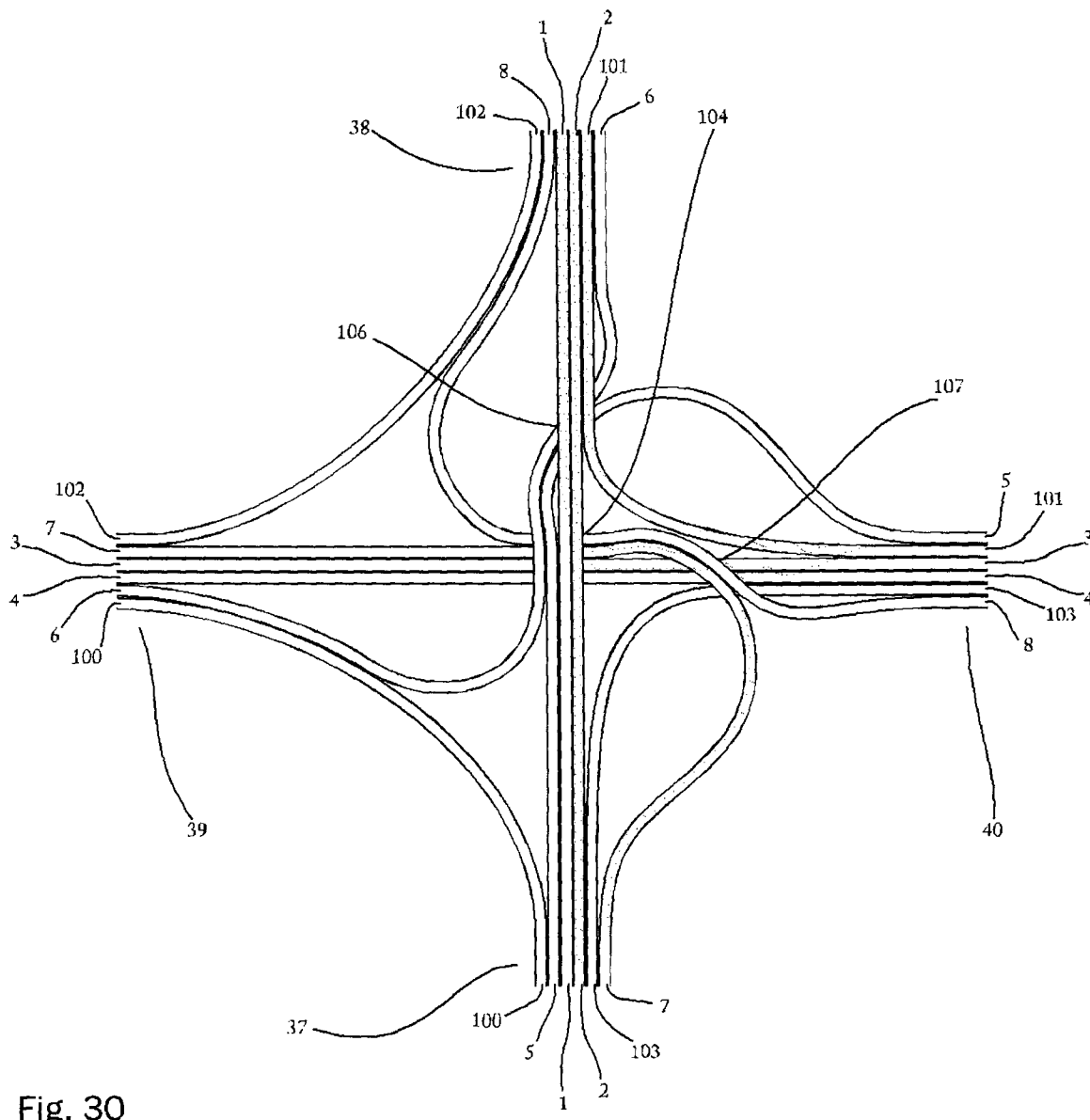


Fig. 30

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2011/001233

A. CLASSIFICATION OF SUBJECT MATTER IPC: E01C 1/04 (2006.01) , E01C 1/00 (2006.01) According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC(2012.01): E01C 1/04, E01C 1/00 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used) databases: EPOQUE(EPODOC), TotalPatent(all databases), Canadian Patent Database keywords: exit, off 2W ramp, exterior, weave		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 1580403 A (Li) 16 February 2005 (16-02-2005) figure 7	1-14
A	WO 2004/104301 A1 (Jung) 02 December 2004 (02-12-2004) figure 3f	1-14
A	CN 1587521 A (Yang) 02 March 2005 (02-03-2005) figure 1	1-14
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family	
Date of the actual completion of the international search 23 February 2012 (23-02-2012)		Date of mailing of the international search report 7 March 2012 (07-03-2012)
Name and mailing address of the ISA/CA Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 001-819-953-2476		Authorized officer Alison Canteenwalla 934-8534

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CA2011/001233

Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
CN1580403A	16 February 2005 (16-02-2005)	None	
WO2004104301A1	02 December 2004 (02-12-2004)	AU2003230340A1 KR20040094009A	13 December 2004 (13-12-2004) 09 November 2004 (09-11-2004)
CN1587521A	02 March 2005 (02-03-2005)	None	