

June 4, 1968

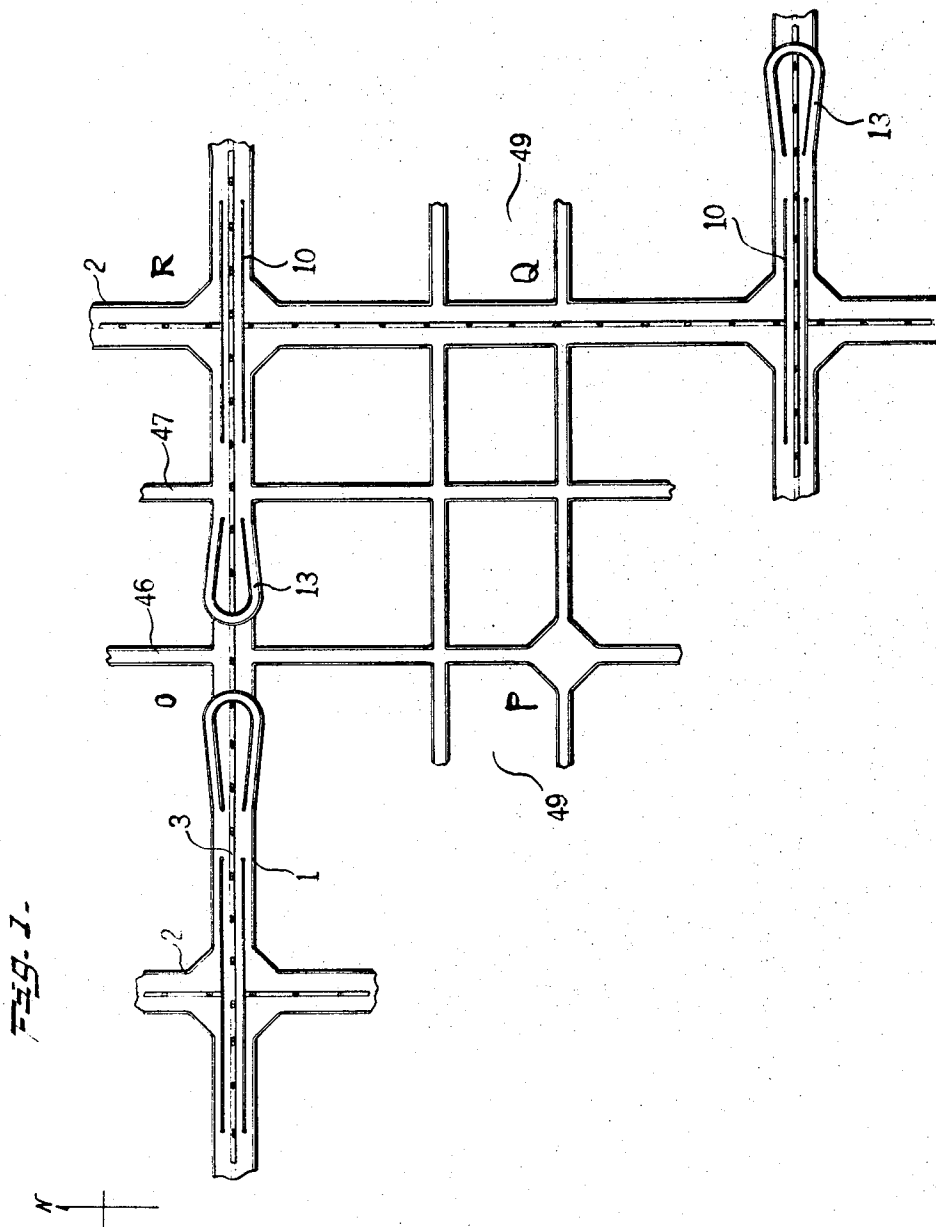
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3,386,351

SYSTEM OF GRADE SEPARATION AND ALSO UNDERROAD PARKING

Original Filed March 26, 1964

8 Sheets-Sheet 1



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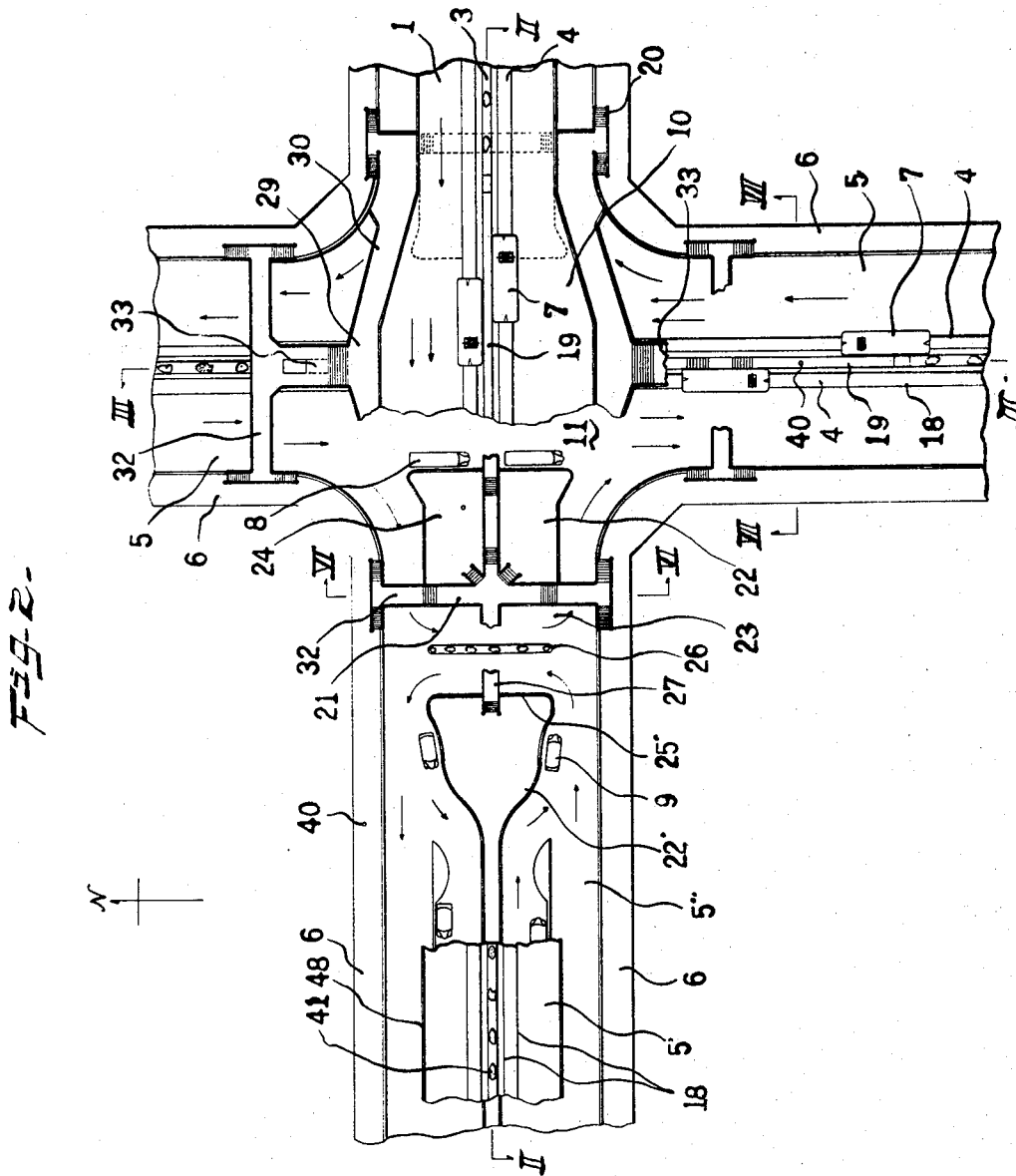
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SYSTEM OF GRADE SEPARATION AND ALSO UNDERROAD PARKING

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8 Sheets-Sheet 2



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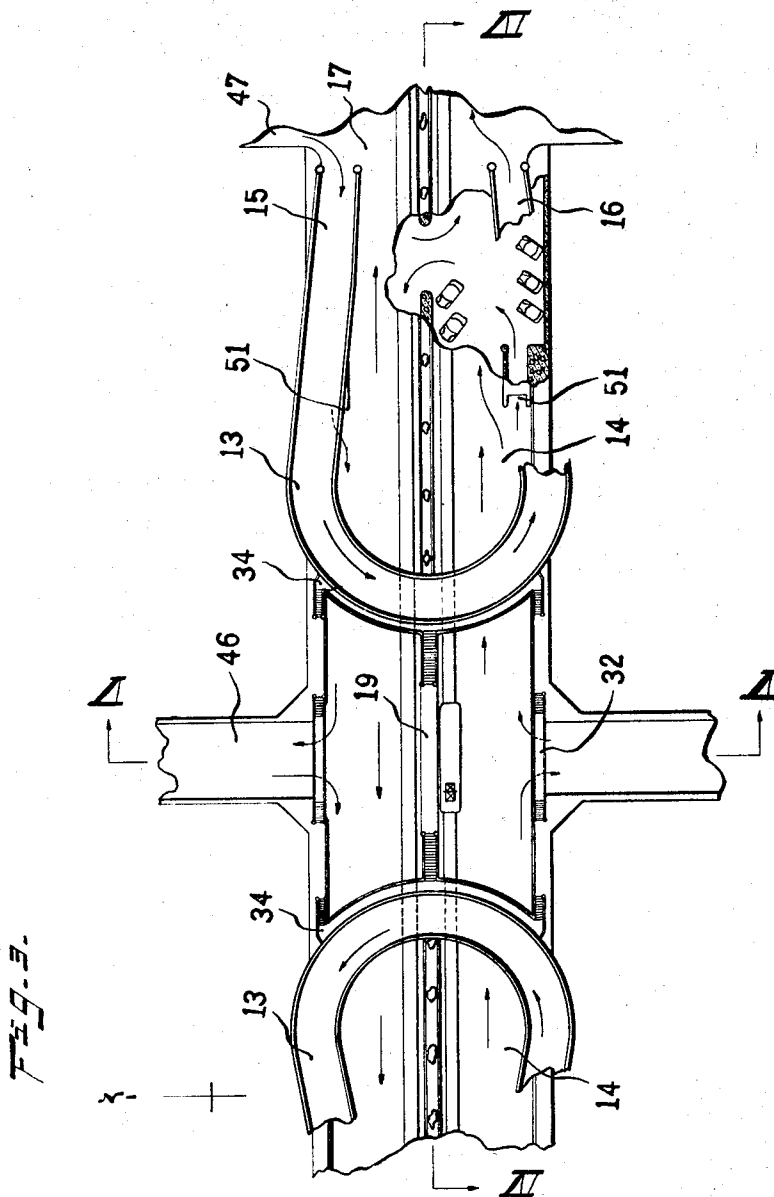
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SYSTEM OF GRADE SEPARATION AND ALSO UNDERROAD PARKING

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Fig. 7.

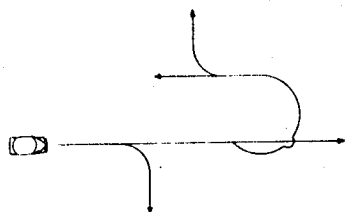


Fig. 5.

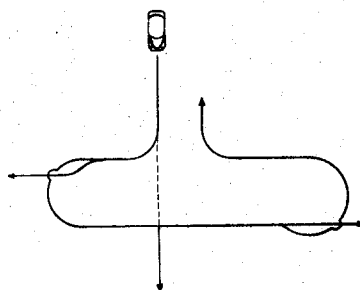


Fig. 6.

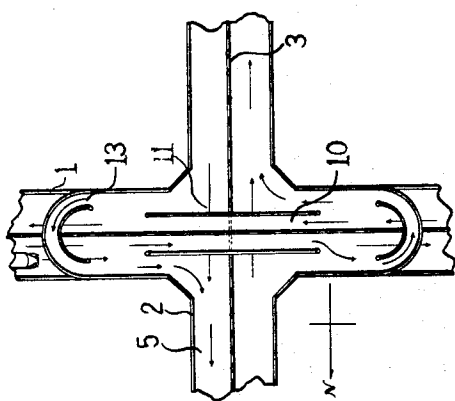
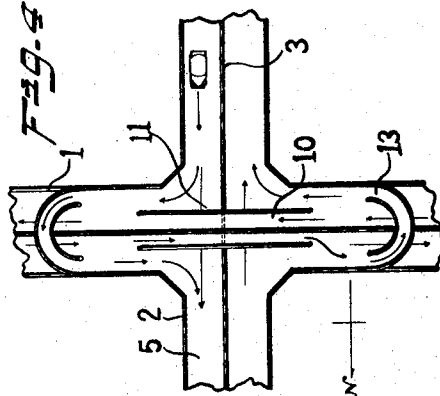


Fig. 8.



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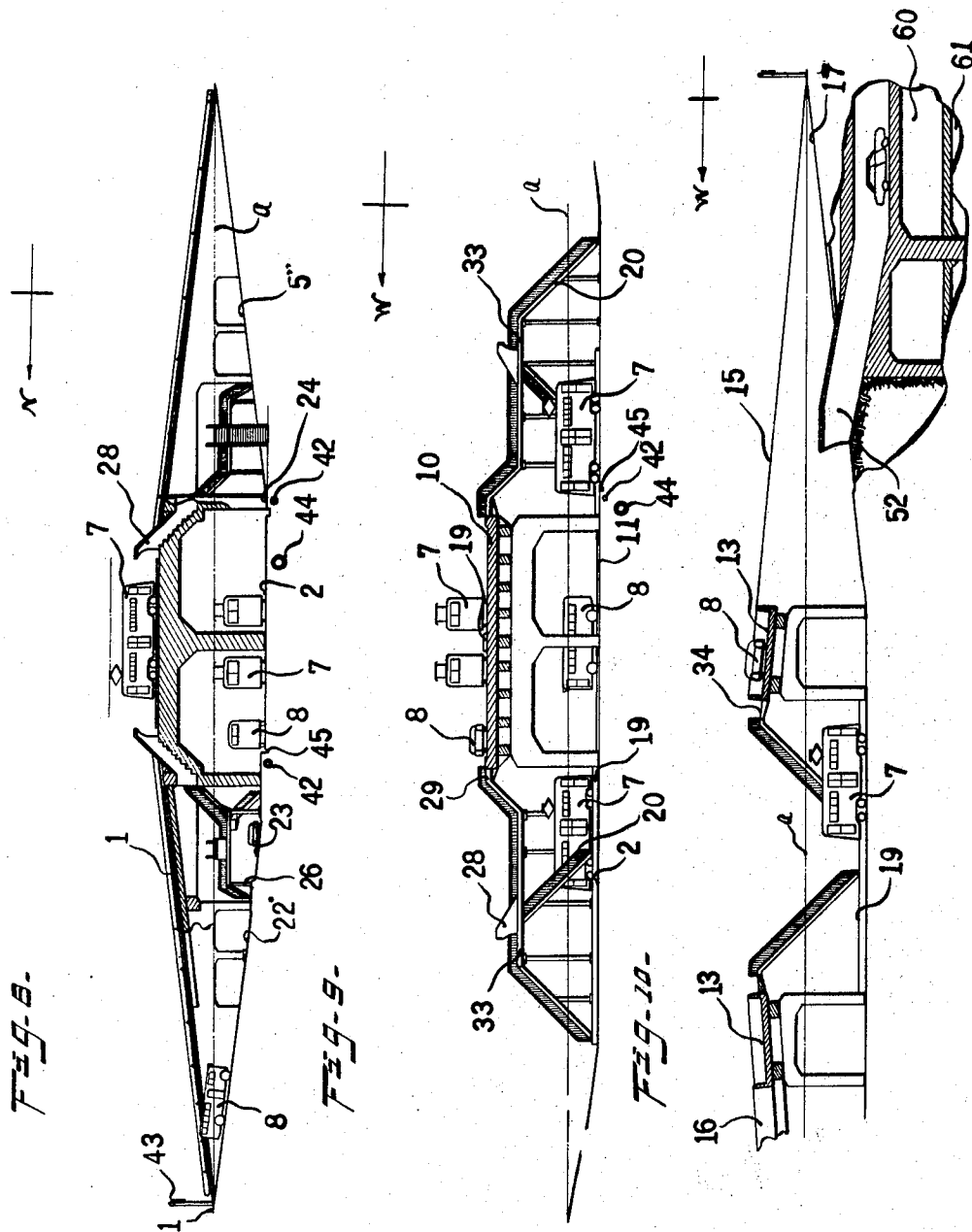
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Fig. 11-

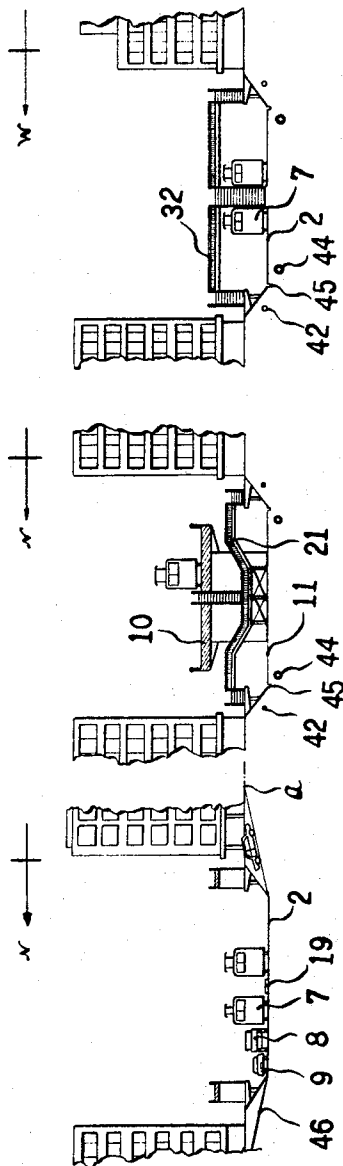


Fig. 12-

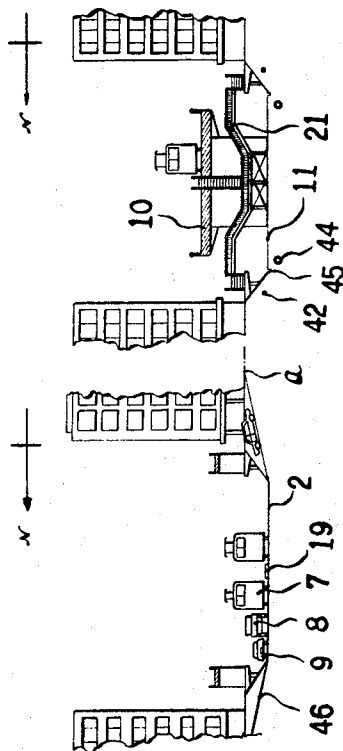
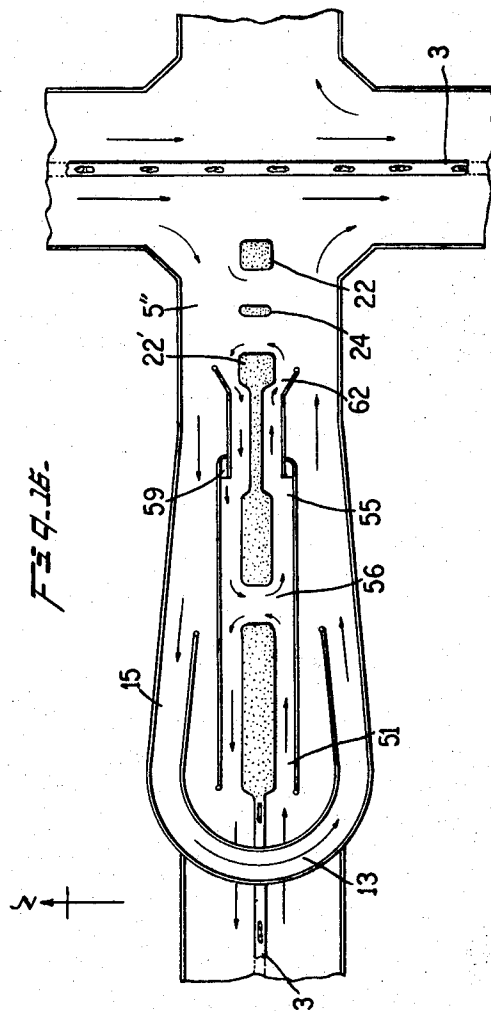


Fig. 15-



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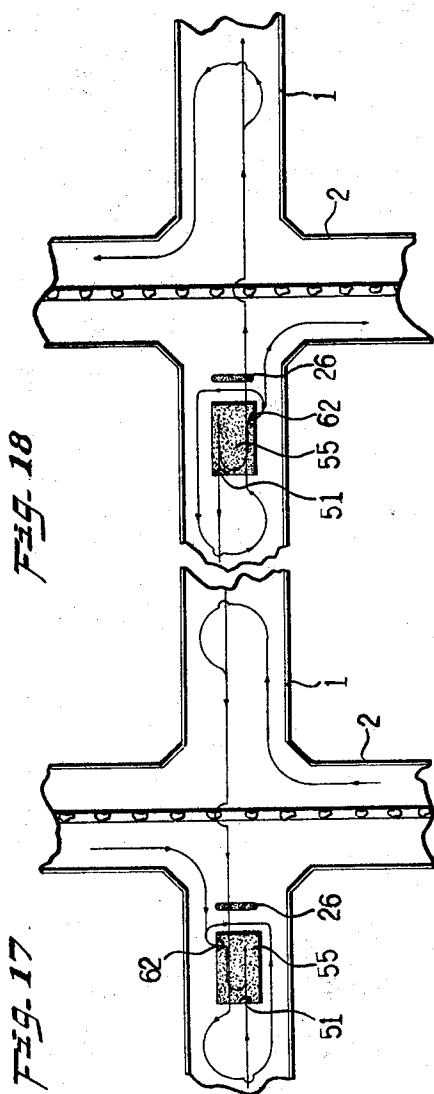
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SYSTEM OF GRADE SEPARATION AND ALSO UNDERROAD PARKING

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Continuation of application Ser. No. 354,938, Mar. 26,
1964. This application May 8, 1967, Ser. No. 637,003
Claims priority, application Japan, Sept. 14, 1963,
38/49,679

2 Claims. (Cl. 94—1)

ABSTRACT OF THE DISCLOSURE

A roadway interchange for two intersecting trunk streets which has a straight overbridge over one street, and a single pair of U-turn overbridges over the other street for runs over the straight overbridge, the U-turn overbridges being disposed on opposite sides of the intersection from each other, and the interchange further having turning rods between the corresponding side lanes of the streets with merging and diverging areas between the ends of the U-turn overbridges and the ends of the straight overbridge, whereby the vehicles entering the interchange can turn either right or left by using the U-turn overbridges without having to cross oncoming traffic.

This application is a continuation of application Ser. No. 354,938 filed on Mar. 26, 1964, and is in accordance with the notice of Feb. 11, 1966 (824 O.G. 1).

This invention relates to a system of grade separation and, also, under-road parking facilities in said system.

In the present system of grade separation two intersecting trunk streets comprise semi-elevated and semi-depressed streets and U-turn overbridges are provided over one street on opposite sides of said intersection.

An under-street parking lot is provided under said intersection, one entrance-exit to said parking lot being provided under said U-turn overbridge and the other entrance-exit located nearer to said trunk street intersection in such a manner that it communicates with a turning roadway, and both of said entrance exits being connected with each other through a parking car guiding road having a U-turn way within said parking lot.

This invention has as one of its objects to provide an efficient system of grade separation in a very confined area at the intersection of downtown trunk streets, said system requiring a minimum of new land acquisition.

Another object of this invention is to provide a system of grade separation which requires no traffic signals for a smooth traffic flow at high speeds.

Still another object of this invention is to make the parking of vehicles easier at and around intersections.

Other objects and advantages of this invention will become apparent as it is hereinafter described in detail, reference being had to the accompanying drawings, in which:

FIG. 1 is a plan view illustrating a system of grade separation according to the invention;

FIG. 2 is a plan view, partly broken away, of an essential part of the grade separation of the invention;

FIG. 3 is a plan view, partly broken away, of the U-turn part of the invention;

FIG. 4 is a plan view illustrating turning of a vehicle moving in the north direction;

FIG. 5 is a plan view illustrating diagrammatically the path of movement of the vehicle in FIG. 4;

FIG. 6 is a plan view illustrating turning of a vehicle moving in the west direction;

FIG. 7 is a plan view illustrating diagrammatically the path of movement of the vehicle in FIG. 6;

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FIG. 8 is a sectional view taken along II—II line in FIG. 2;

FIG. 9 is a sectional view taken along III—III line in FIG. 2;

FIG. 10 is a sectional view taken along IV—IV line in FIG. 3;

FIG. 11 is a sectional view taken along V—V line in FIG. 3;

FIG. 12 is a sectional view taken along VI—VI line in FIG. 2;

FIG. 13 is a sectional view taken along VII—VII line in FIG. 2;

FIG. 14 is a perspective view, partly broken away, illustrating the under-road parking on one floor;

FIG. 15 is a perspective view, partly broken away, illustrating the under-road parking on a second or third floor;

FIG. 16 is a plan view illustrating the connection of the intersection in FIG. 14 and the other parts;

FIG. 17 is a plan view illustrating the methods of turning into the parking from each street; and

FIG. 18 is a plan view illustrating the method of turning into each street from the parking area.

Referring, now, to FIG. 1 through FIG. 13, an east-west trunk street 1 and a north-south trunk street 2, respectively, comprise two lanes on which two-way street car tracks 4, 4 are laid, said lanes being divided by a median 3, four drive lanes 5, 5 which are located adjacent to each of said lanes 4, 4 and curb or pavements 6, 6 which are provided on the outer side of said drive lanes 5, 5.

The drive lanes 5 of said street 1 at the intersection, comprise straight lanes 5' extending from the median 3 to the two drive lanes of the drive lanes 5, 5 including the street car tracks 4, and the two lanes located adjacently thereto comprise turning roads 5'', while all the drive lanes of said street 2 are straight drive lanes 5'. At the intersection of said two streets, and in communication with the straight drive lane 5' of said east-west trunk street 1, a semi-elevated intersection portion 10 is provided with an upgrade, e.g. about 4%, with respect to the standard street plane *a*. On the other hand, the north-south trunk street 2 is connected to straight drive lane 5' with a downgrade, e.g. about 4%, with respect to the standard street plane *a* to provide a semi-depressed intersection tunnel road 11.

The headroom of said tunnel road 11 at the intersection is 4.5 meters at the minimum, and the total height of 6.5 meters arrived at by adding the height of 4.5 meters to the height of 2 meters which is the thickness of the bridge girder and road foundation of the semi-elevated road 10 at the intersection is shared by and between the semi-elevated road 10 and the tunnel road 11 in vertical relation with respect to the standard street plane *a*.

Referring to the east-west trunk street 1, the drive lane 5 of said east-west trunk street is connected to the drive lane 5 of said north-south trunk street 2 through the turning drive lanes 5'', 5' of about 5% grade located adjacently to said straight drive lane 5'. On the east-west trunk street 1, a pair of U-turn overbridges 13, 13 having a U-turn a U-curved portion with and radius of curvature of about 5 to 20 meters and an inward width of more than about 2 meters and a lop-sided grade of about 6% are disposed in diagonal relation with respect to each other about the intersection and about 230 meters away from said intersection on either side thereof. Each of said U-turn overbridges 13, 13 is semi-elevated by way of the drive lane 5 of about 4% grade, and that portion of the east-west trunk street 1 extending from the intersection semi-elevated road 10 to the point immediately under the U-turn overbridge descends at a downgrade of about 4%

forming U-turn bridge tunnel roads 14, 14. The U-turn overbridge 13 and the corresponding U-turn overbridge tunnel road 14 are disposed in semi-elevated and semi-depressed relation with a difference in height of 6.5 meters which represents the sum of the head room of about 4.5 meters and the combined thickness of the bridge girder and road foundation of 2 meters.

Between the U-turn bridge and the intersection, and through the downgrade ramps 15, 15 and 16, 16 leading to and from the U-turn bridge 13, respectively, at a grade of about 4%, the U-turn overbridge 13 and the straight drive lane 5' and turning drive lane 5'' of about 4% downgrade converge on the standard street plane *a*, so as to form car merging and diverging area 17, 17.

The U-turn overbridge 13 is provided on the trunk street where the amount of traffic and the degree of importance are relatively low, and it may be located, in this example, on the east-west trunk street 1 depending upon local downtown street conditions. On the street-car tracks 4 disposed on both sides of the median 3 of each of said trunk streets 1 and 2 are laid street car rails 18, 18 on which street cars 7, 7 run. Stations 19, 19 are provided at the medians 3.

Thus, on the east-west trunk street 1, stations are centrally located on the intersection semi-elevated road 10 and on the north-south trunk street 2, stations are provided at the median 3 and in positions adjacent to the intersection. At said intersection, the pedestrian ways 6 of the north-south trunk street 2 are connected to the pedestrian tunnel roads 21, 21 through stairways 20. Each of said pedestrian tunnel roads 21 is located between the plane of the semi-elevated road 10 and that of the turning drive lane 5''.

Under the semi-elevated road 10 and including a safety zone 22, 22, and exclusive by-pass 23, 23 for taxicabs is provided, both ends of said by-pass being connected to the drive lane 5 of the north-south trunk street 2.

The safety zone 22, 22 is further connected to the pedestrian tunnel way 21 through a stairway, and the portion of said safety zone which faces the north-south trunk street 2 on the drive lane 5 is expanded by a width equivalent to one lane to provide a bus stop 24, 24 for buses going north to south or vice versa, while a stop 25, 25 for taxicabs going north to south or vice versa is provided at the safety zone 22, 22 and in the position facing the exclusive by-pass 23, 23 for taxicabs. The above safety zone 22, 22 and the safety zone 22', 22' which is approximately of the same shape as the safety zone 22, 22 are disposed in diagonal relation with respect to each other about a taxicab divisional island 26, 26, and a stop 25', 25' for taxicabs going east to west or vice versa is provided at the point facing the exclusive by-pass 23', 23' in said safety zone 22', 22' and at the point facing the turning drive lane 5'', 5'', respectively.

The above-mentioned safety zones 22 and 22' are connected, via a stairway, to an intermediate pedestrian way 27, 27 communicable with said pedestrian tunnel way 21, 21. The intermediate pedestrian way 27, 27 is also connected to the street car stations 19, 19 at the median 3 of the east-west trunk street 1 through roofed stairways 28, 28 at both ends.

Centrally located on the semi-elevated portion 10 of the east-west trunk street 1 around the intersection is a stop for buses going east to west or vice versa, said bus stop being formed by enlarging said drive lane 5', 5' by a width equivalent to one lane, while the part of the pedestrian way adjacent to said bus stop comprises a bus platform. The pedestrian tunnel way 21, 21 is connected to a pedestrian ramp-bridge 30, 30 which is connected to the pedestrian way adjacent to said expanded portion.

The bus platform 29, 29 on the pedestrian ramp-bridge 30 is connected to the corresponding pedestrian overbridge 32 through a roofed car platform pedestrian road 33, 33, which is connected to the car station 19, 19 located at the median 3 of the north-south trunk street 2

through a stairway. If desired, at positions outside the intersection of said two trunk streets may be disposed pedestrian overbridges 32 which interconnect the pedestrian ways 6.

5 Pedestrian overbridges 34, 34 may be provided along said U-turn overbridges 13, and each of said pedestrian overbridges 34 is connected to the pedestrian way 6 and the street car platform 19, 19 located at the median 3 through stairways.

10 Indicated by numeral 40 are pedestrians, 41 are mall trees standing on the median 3, 42 are city-gas and water mains, 43 are signposts, 44 is an under the trunk street sewage duct, 45 is a rain gutter, 46 are auxiliary streets, 47 are side streets, 48 are semi-elevated road rails, and 49 are street blocks.

15 Thus, among the vehicles heading from south to north along the north-south trunk street 2 (FIG. 5), those which are destined to go further north go straight through the tunnel 11 at the intersection, while the vehicles heading east turn to the right and enter the east-west trunk street 1. The west bound vehicles turn to the right and run eastward for a while before they emerge onto the westward lane by way of the east U-turn overbridge 13. From then on, said vehicles drive west along the east-west trunk street 1 through the semi-elevated road 10. If the same vehicles then go eastward by way of the west U-turn overbridge and, then, turn to the right at said intersection, they will be headed south along the north-south trunk street 2.

20 In effect, the vehicles can do a U-turn on the same road, or, for that matter, can run in every direction. The vehicles heading from west to east along the east-west trunk street (FIG. 3) may go straight through the semi-elevated road 10 at the intersection, while the south-bound vehicles turn to the right. The north-bound vehicles should go straight for a while, do a U-turn by way of the east overbridge 13, and turn to the right.

25 Thus, with respect to either of the two trunk streets, vehicles may run in every direction easily, positively, quickly and safely. The described intersection and a pair of overbridges 13 helps omit the provision of traffic signals because there is no intersection on the same plane.

30 Stated differently, vehicles need not stop at signals, and, therefore, may run safely at high speeds.

35 This smooth traffic flow is not only conducive to a reduced frequency of traffic stagnations and jams, but also helps avoid traffic accidents, thereby improving the overall efficiency of downtown trunk roads. Furthermore, a more efficient mass transportation of commuters by street cars and buses may also be expected, and these advantages would undoubtedly contribute to the development of municipal activities.

40 Referring, further to FIG. 1, O, P, Q, and R, respectively, indicate a group of street blocks 49 surrounded by trunk streets.

45 Thus, the vehicle starting at Q and heading for O will run northward and turn right onto the east-west trunk road 1. Then, the vehicle runs eastward and over a U-turn overbridge 13 and then westward.

50 It then turns to the right onto an auxiliary road 46 leading to O.

55 Thus, a free traffic flow may be established among these centers through the intersection and overbridges described above.

60 Generally speaking, the intersection of this invention consists of a semi-elevated and semi-depressed arrangement. In other words, the longitudinal section grades of passageways may be held as small as about 4% and the distances may also be relatively short so that vehicles may run up and down easily. Furthermore, since its relatively flat configuration is not imposing, the intersection of the described type is also conducive to the maintenance of urban beauty.

65 The pedestrians 40 on one of the roads 6 may have access to all other roads 6 through the pedestrian over-

bridges 13 and pedestrian tunnels 21, and, also, to the stations 19, 19 for street cars 7 and bus stops 29, 29 on the median 3 without crossing any driveway on the same plane.

Thus, they are not only protected from accidents but also may efficiently utilize various means of mass transportation, so that some of the important urban activities may be accomplished more efficiently than ever before.

It will be apparent from the foregoing description that the right-turning traffic may be smoothly dealt with by the adoption of U-turn overbridges and, at the same time, the new requisition of land may be held to the minimum.

Thus, this invention makes it possible to adopt such intersections where it has been considered impossible because of the difficulty of acquiring the necessary land in a well-developed downtown area.

Referring to FIGS. 14-18, car entrance and exits 51 are provided immediately under the entrance ramp 15 and exit ramp 16 for each of the U-turn overbridges, and said entrance and exits 51 are connected, through ramps to the first level 54 which lies under the east-west trunk street. On the first the ramps are connected to the exclusive bypasses 23 for taxicabs through parking approaches 62. On either side of each of the parking lanes is provided a parking area 55, and said parking lanes are interconnected at desired positions through turning driveways 56 within the parking zone. The safety zone 57 extending centrally through the parking zone is connected to the pedestrian ways on the trunk streets through stairways. The parking zone may also be provided with service area 56 at required positions. At the desired positions of said parking lanes are parking zone ramps 59, through which said approaches are connected to parking lanes located on the second level 60 and the third level 61.

As shown in FIGS. 16-18a vehicle running north along the north-south trunk street turns to the right at the intersection and, then, after crossing both U-turn bridges 13 turns along the turning drive lane 5". The vehicle then enters the underground parking zone through the ramp 62 and runs westward along the parking lane. Or, the vehicle may continue running westward to emerge onto the east-west trunk street 1 through the overbridge gate 51 provided under the north ramp of the U-turn overbridge 13. Another alternative is that the vehicle does a U-turn on the U-turn driveway 56 within the parking zone, runs eastward along the parking lane in the south section of the parking zone and, finally emerges onto the turning driveway 5" through the ramp 62. On the other hand, the vehicle entering the parking zone through the overbridge-side gate 51 provided under the south ramp of said U-turn overbridge 13 may do a U-turn on the U-turn driveway 56 within the parking zone and emerge through the overbridge-side exit 51. Alternatively, without doing a U-turn, the same vehicle may proceed eastward to emerge onto the south turning driveway 5" via the exclusive bypass 23' for taxicabs and, then, re-enter the underground parking zone through the ramp 62 which is nearer to the intersection.

Thus, a free traffic flow is maintained on all trunk streets. On its trip around the intersection, the vehicle may, of course, be parked in the parking area 55 if there is a vacancy, but in case there is no vacancy at all, it may run into the second and third levels to find a vacant parking space.

FIG. 15 shows that on the second level and thereunder, a central U-turn driveway within the parking zone is flanked by one-way parking ramps 59 which are connected to parking approaches on all the levels.

A parking area 55 is located on either side of each of said parking lane, and there may also be provided, at strategical points, a control office, repair shop, buffet, rest room, check-out desk, and other facilities.

On the first level, a parking safety zone or pedestrian way 57 as wide as 1.5 meters runs centrally through the

space and a parking control and service area 58 is provided near the intersection. The parking control and service area 58, includes a control room where the work involved in the entrance and exit of cars and exit of cars and people is carried out, a taxicab waiting room, a buffet, a rest room and so forth, and is connected to the central pedestrian way 57. The other end of said pedestrian way 58 serves to connect the pedestrian way lying alongside the gate 51 near the parking zone overbridge side, with the pedestrian gate to the parking zone.

This arrangement provides maximum benefits to pedestrians who have parked their cars. The underground parking zone is so designed that its gates are located by utilizing the height between the intersection semi-elevated road 10 and the turning drive lane 5" and the height between the ramps 15 and 16 and the overbridge tunnel 14. Moreover, since a parking zone of predetermined standards is provided between one gate 51 and the other gate 62, cars may be parked easily and quickly in the neighborhood of the intersection. It should also be noted that because the parking zone is located on one trunk street between the U-turn overbridge and the intersection, the parking zone need not be located outside the proprietary land so that the acquisition of new land and the accompanying compensation problems are largely eliminated.

I claim:

1. A roadway interchange comprising two intersecting trunk streets, one street having semi-depressed straight lanes, a straight overbridge over the straight lanes of said intersecting trunk street over which the other intersecting street runs, the said other street having a median therealong, turning roads between the corresponding side lanes of said trunk streets, a single pair of U-turn overbridges over only the said other trunk street which runs over said straight overbridge over the intersection, said U-turn overbridges being disposed on opposite sides of the intersection from each other, each U-turn overbridge being disposed with the ends toward the straight overbridges so as to be utilized by vehicles coming to the intersection from two different trunk streets to enable the vehicles to turn to the left without crossing oncoming traffic, and two groups of merging and diverging areas, one group consisting of two merging and diverging areas separated by the median and positioned between the free ends of one U-turn overbridge and one free end of the straight overbridge and another group consisting of two merging and diverging areas divided by the median and positioned between one end of the other U-turn overbridge and the other end of the straight overbridge, each merging and diverging area communicating with a free end of a U-turn overbridge, a free end of the straight overbridge, a turning road and being sufficiently long from the free end of the straight overbridge to the free end of said U-turn overbridge to facilitate entry of a vehicle from different directions and to facilitate exit of a vehicle in different directions therefrom, the free end of one U-turn overbridge communicating with the free end of the other U-turn overbridge by the straight overbridge, whereby even when a vehicle after it has entered the straight overbridge can turn to the left or right, or reverse its original course.

2. A roadway as claimed in claim 1 and further comprising a parking garage substantially under each of said merging and diverging areas, each parking garage having an entrance and exit disposed under the ramps of the U-turn overbridge on the same side of the straight overbridge as the respective garage through the space between said ramps and the said other trunk street so as to be directly connected with said other trunk street, and having another entrance and exit disposed under the outer edges of said straight overbridge into the space between a turning road and said overbridge, and a bypass disposed immediately under each end of said overbridge connecting two turning roads on both sides of said overbridge, whereby said entrance and exit under the overbridge is con-

nected with said one trunk street, and said entrance and exit under the overbridge is connected with the other trunk street.

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