

[54] TRANSPORTATION SYSTEM

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[*] Notice: The portion of the term of this patent subsequent to May 2, 1989, has been disclaimed.

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[21] Appl. No.: **248,735**

[52] U.S. Cl. **104/88; 104/121; 104/130; 104/131**

[51] Int. Cl. **B61b 13/02**

[58] Field of Search **140/130, 88, 89, 93, 96, 140/105, 119, 131**

[56] References Cited

UNITED STATES PATENTS

3,659,529 5/1972 Jacobs 104/121

Primary Examiner—M. Henson Wood, Jr.

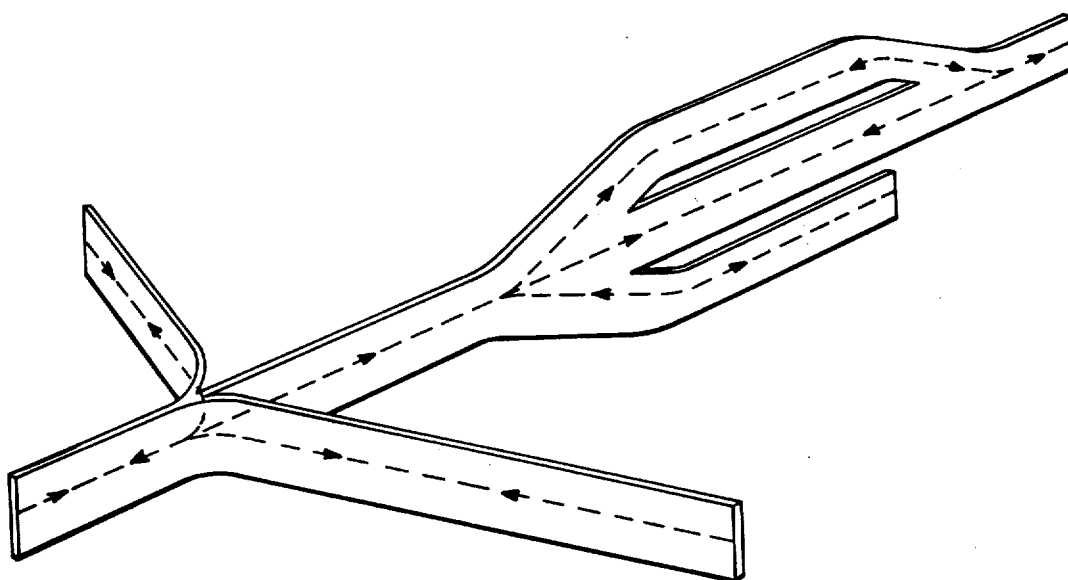
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Attorney, Agent, or Firm—Edward J. Keeling

[57] ABSTRACT

The disclosure is of a transportation system which includes an elongated guidebeam having three spaced apart running surfaces. Two of the running surfaces are substantially vertical to accommodate wheels rotating about vertical axes and the third running surface is substantially horizontal to accommodate wheels rotating on horizontal axes. Wheels which rotate on a vertical axis and wheels which rotate on a horizontal axis are connected to a rack which is adapted to move along the running surfaces of the guidebeam. The wheels connect the rack on the side of the guidebeam in cantilever fashion. Connecting switch sections are provided at desired locations on the elongated guidebeam to connect two or more guidebeams. The switch sections have no moving parts and cooperate with movable means, such as extendable and retractable wheels, of the rack to provide for selective high speed switching both in horizontal and vertical modes of a rack between an upline guidebeam and one or more spaced apart downline guidebeams and between two or more spaced apart upline guidebeams and a single downline guidebeam.

30 Claims, 72 Drawing Figures



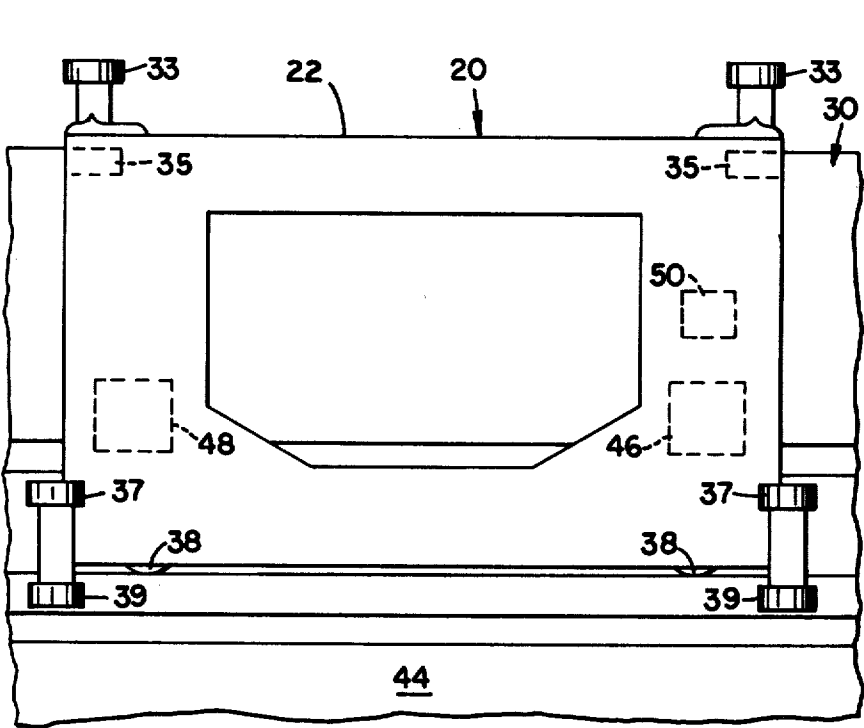


FIG_2

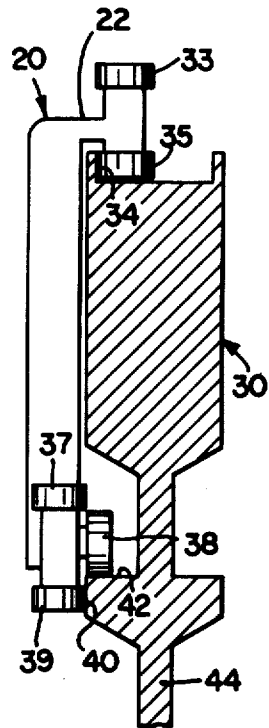


FIG_3

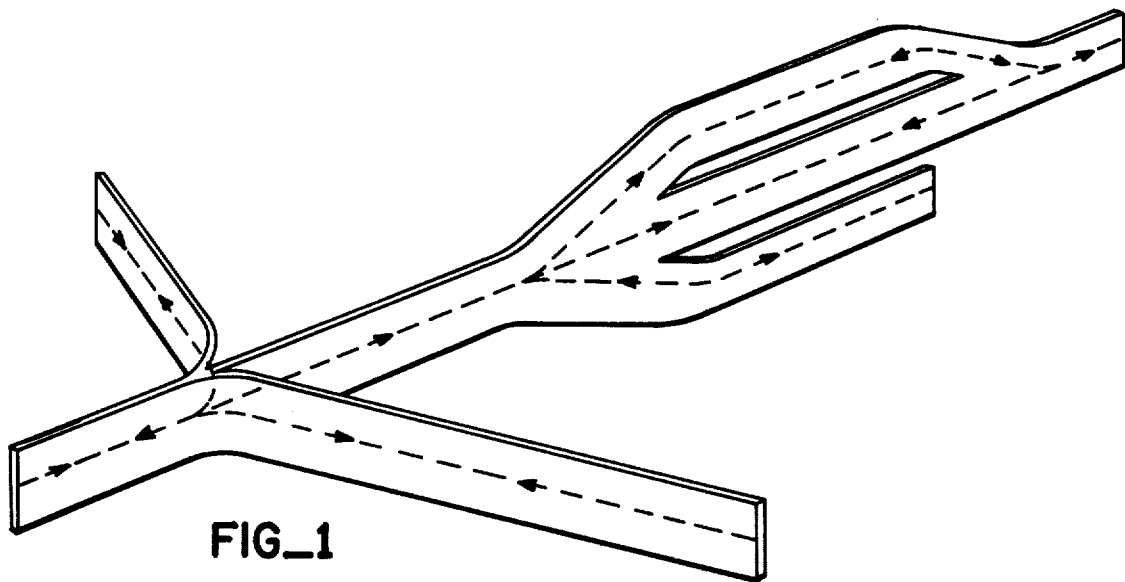
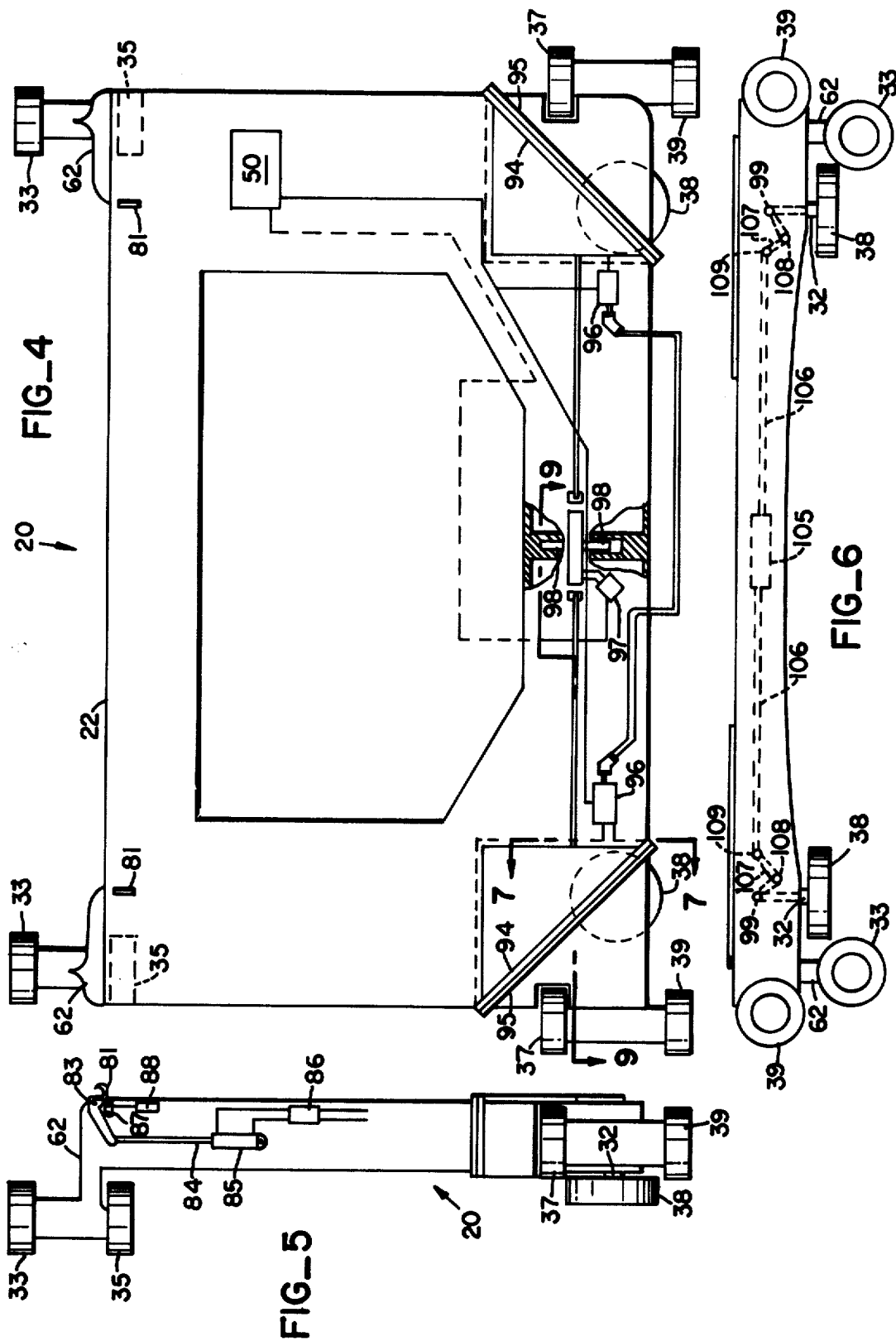
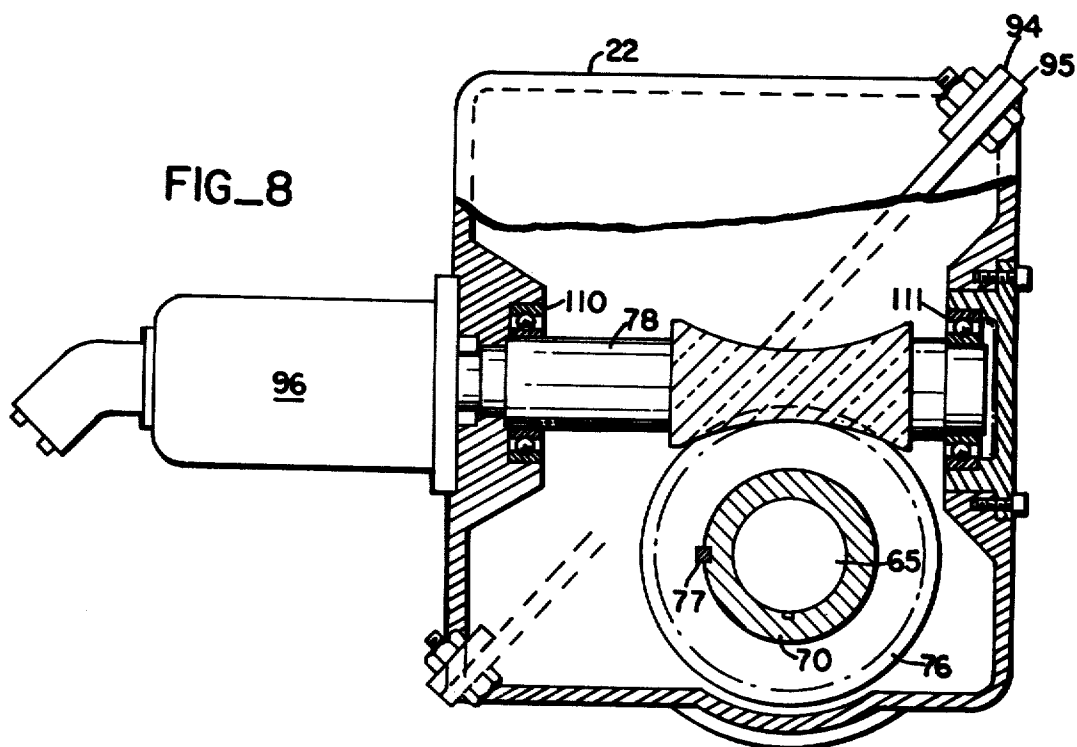
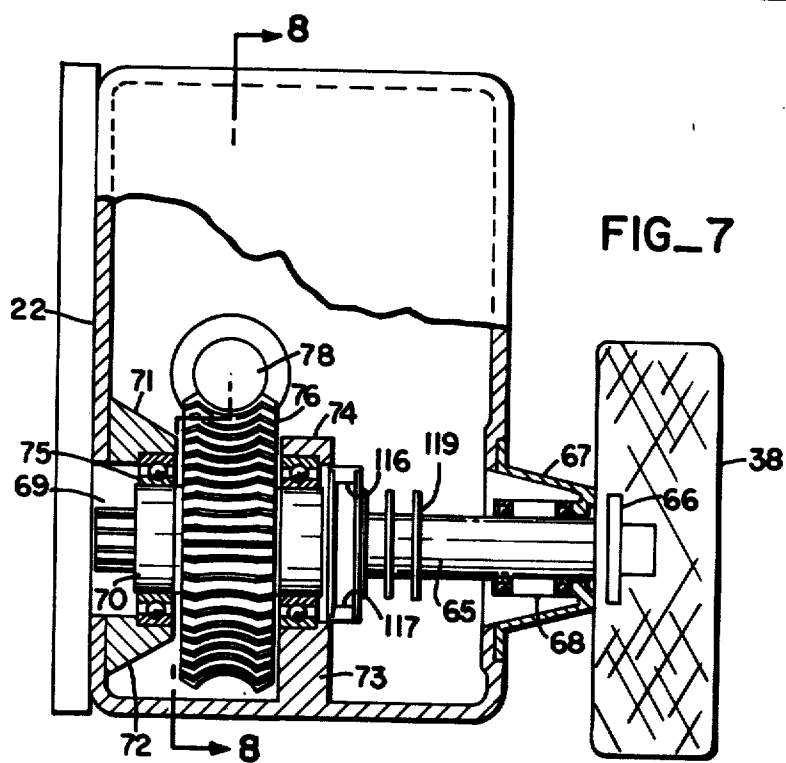
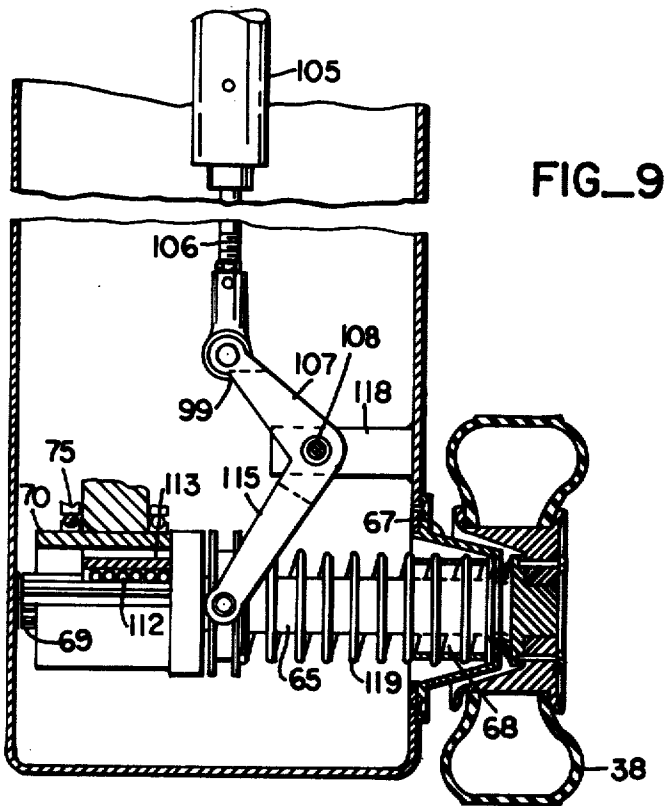
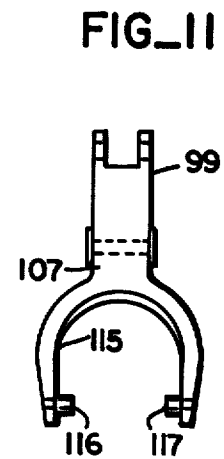
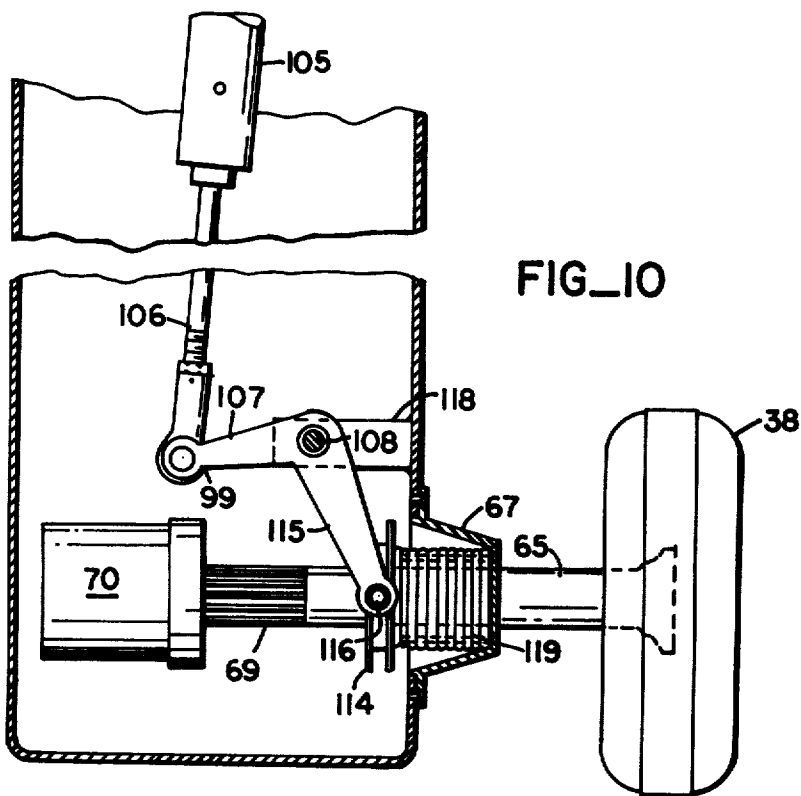


FIG_1







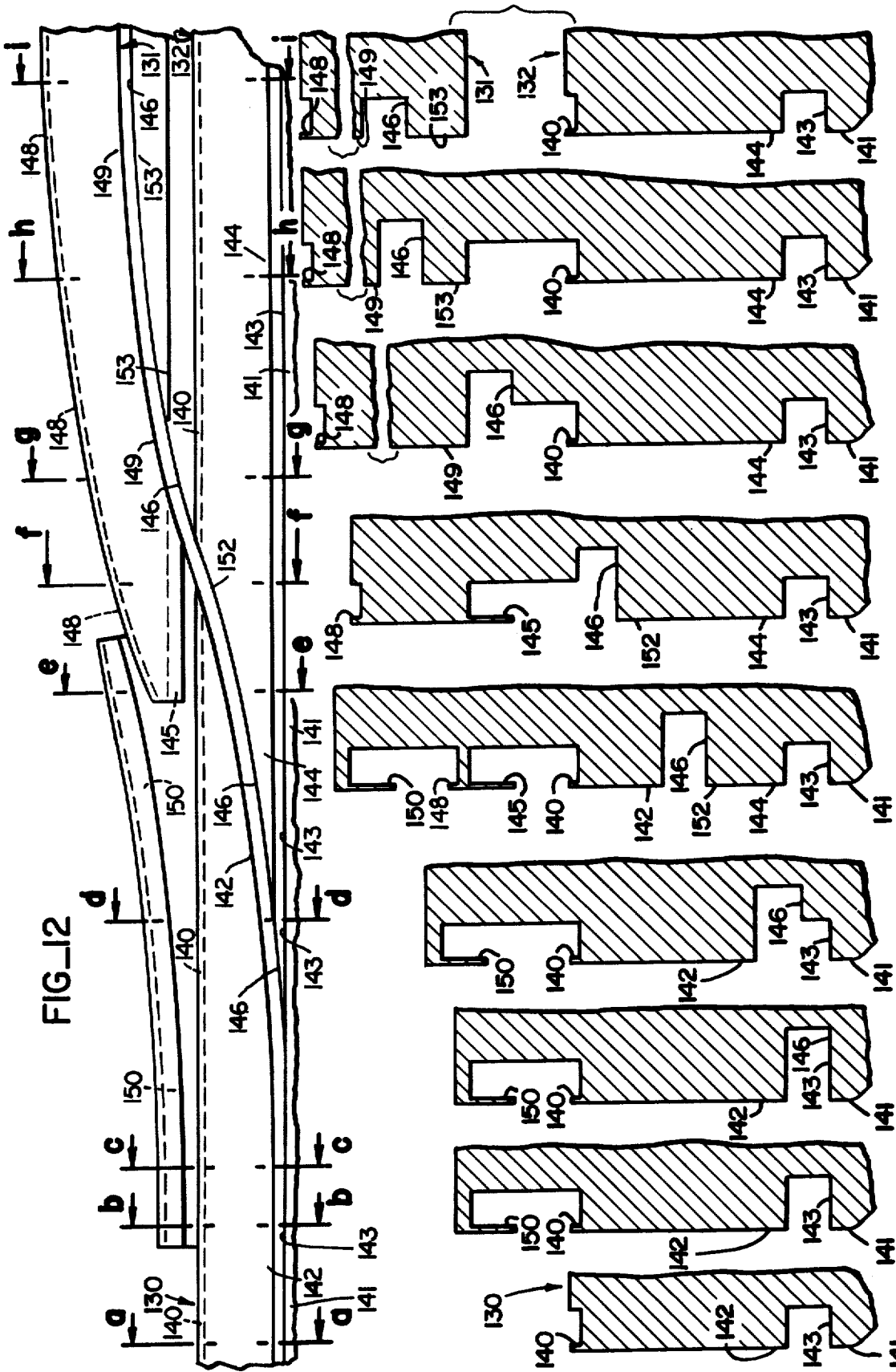


FIG.12a FIG.12b FIG.12c FIG.12d FIG.12e FIG.12f FIG.12g FIG.12h FIG.12i

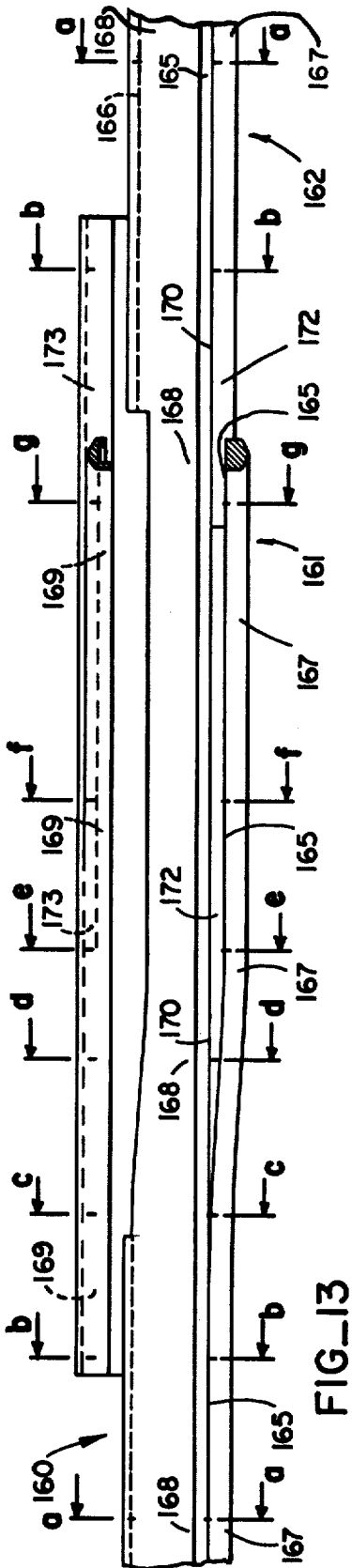
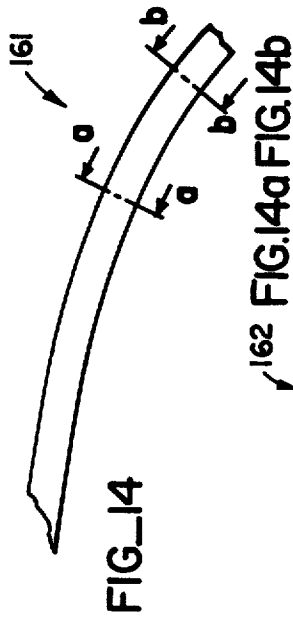
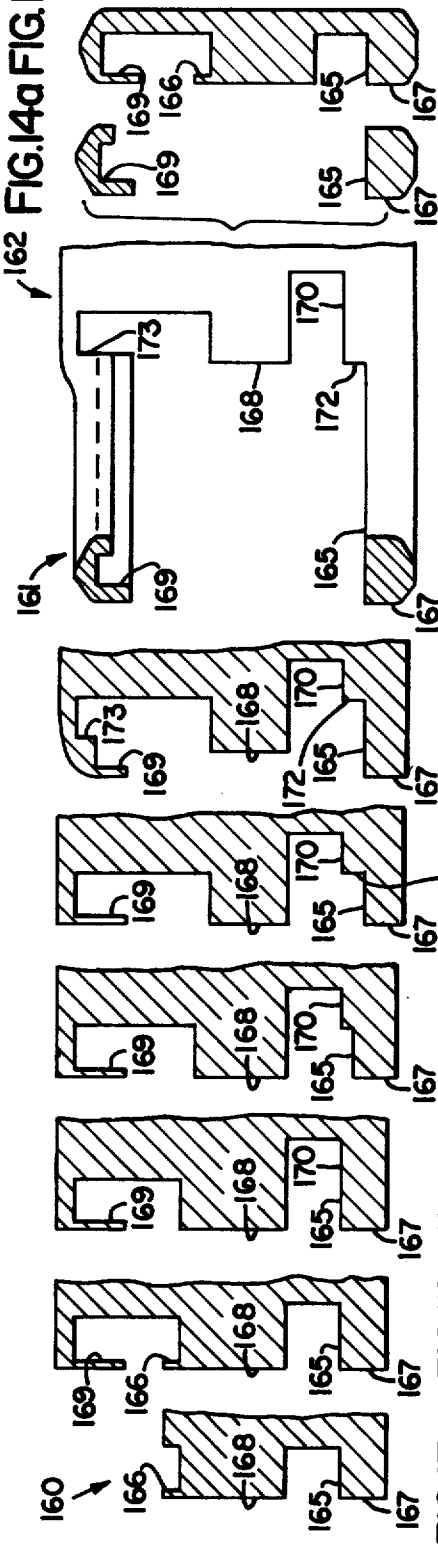


FIG_15

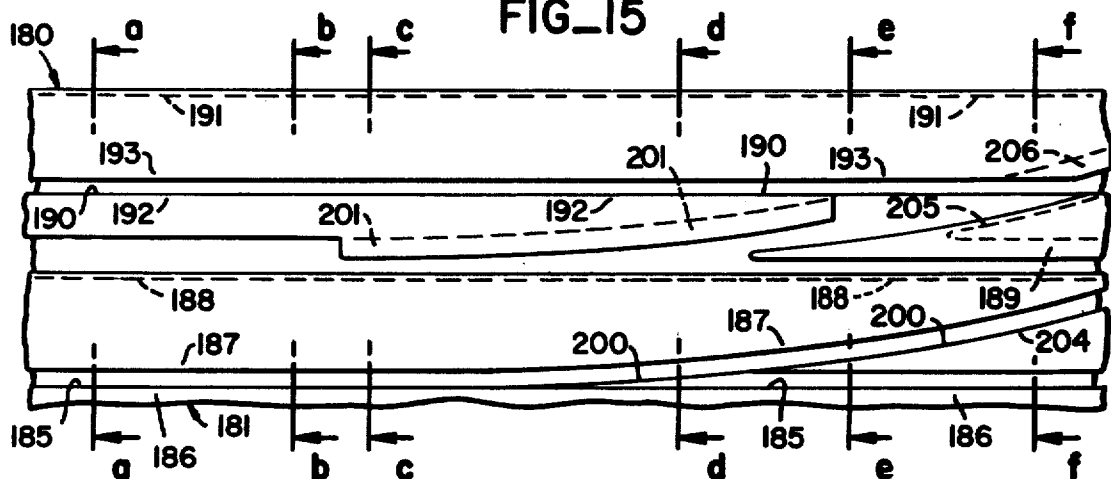


FIG.15a

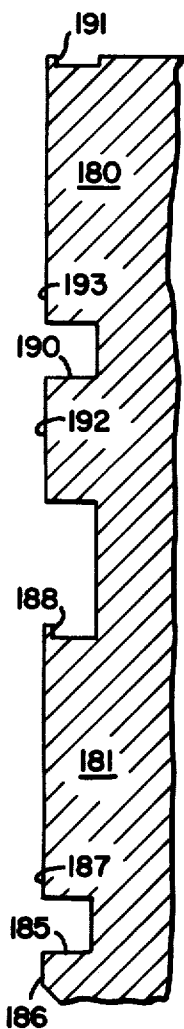


FIG.15b

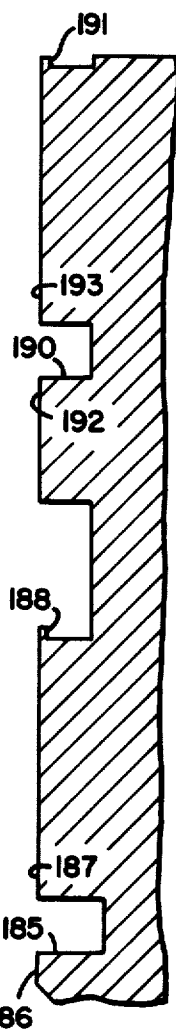


FIG.15c

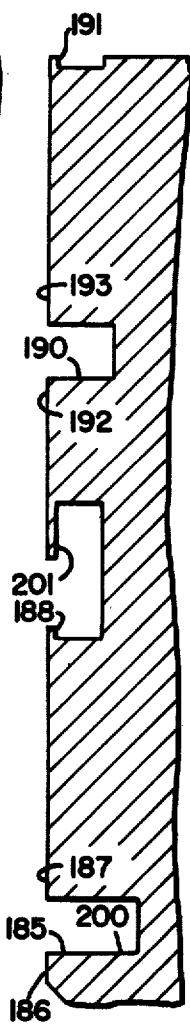


FIG.15d

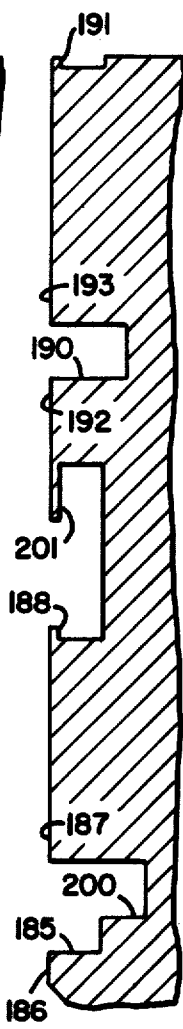


FIG.15e

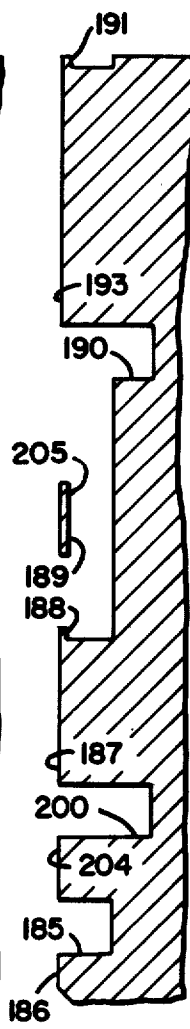
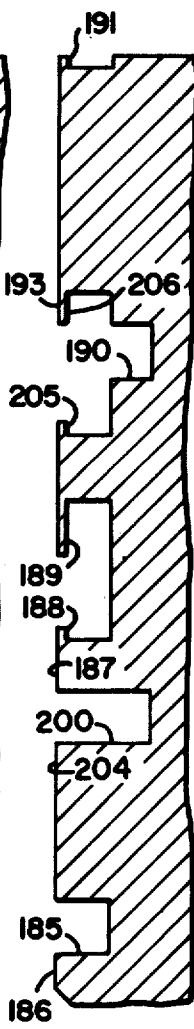


FIG.15f



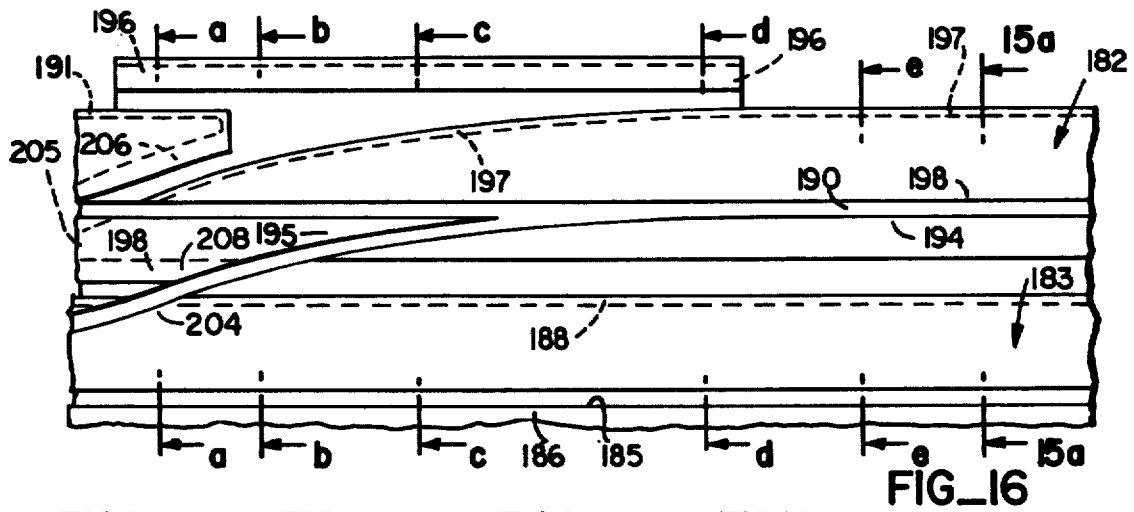
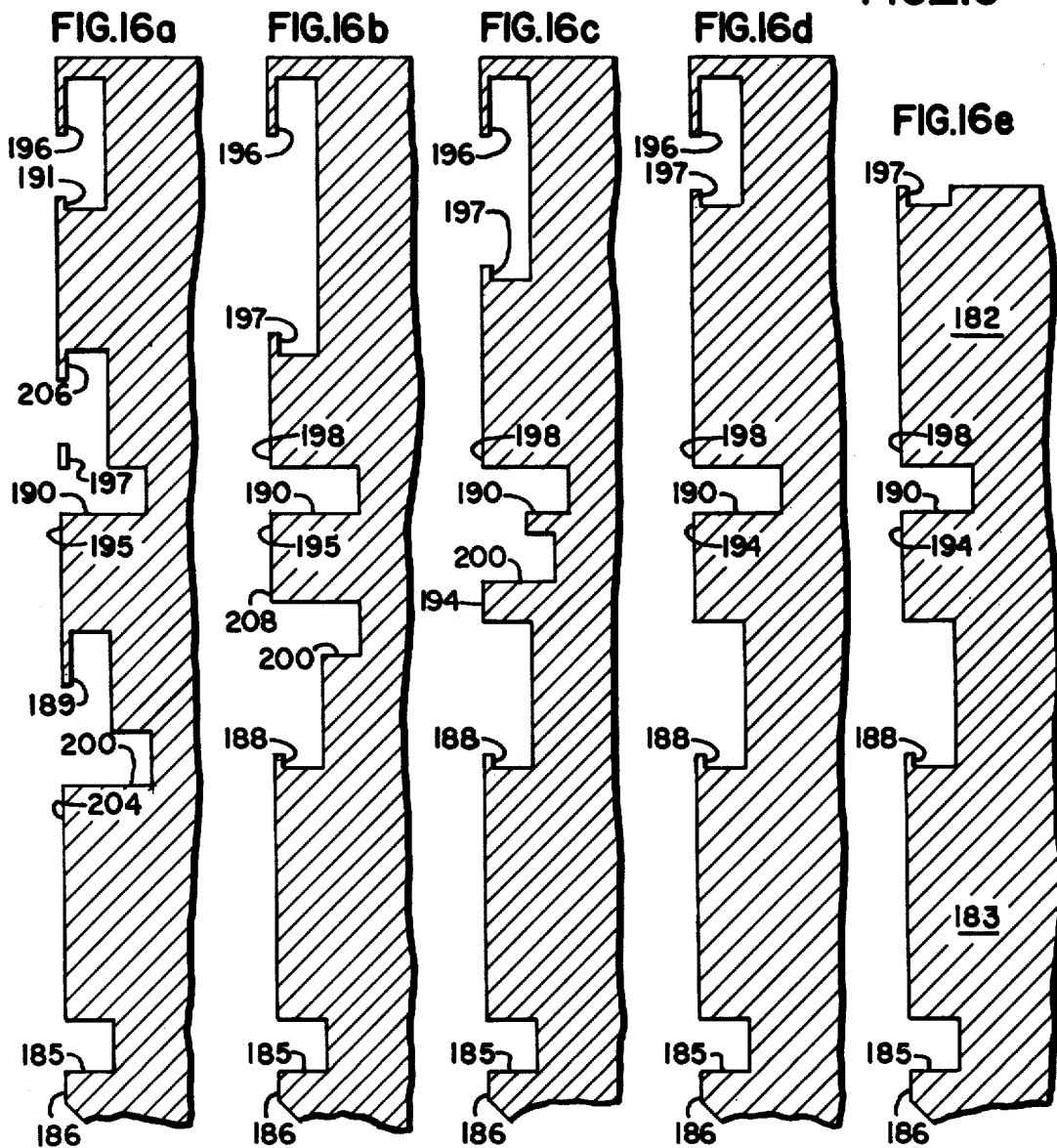


FIG_18

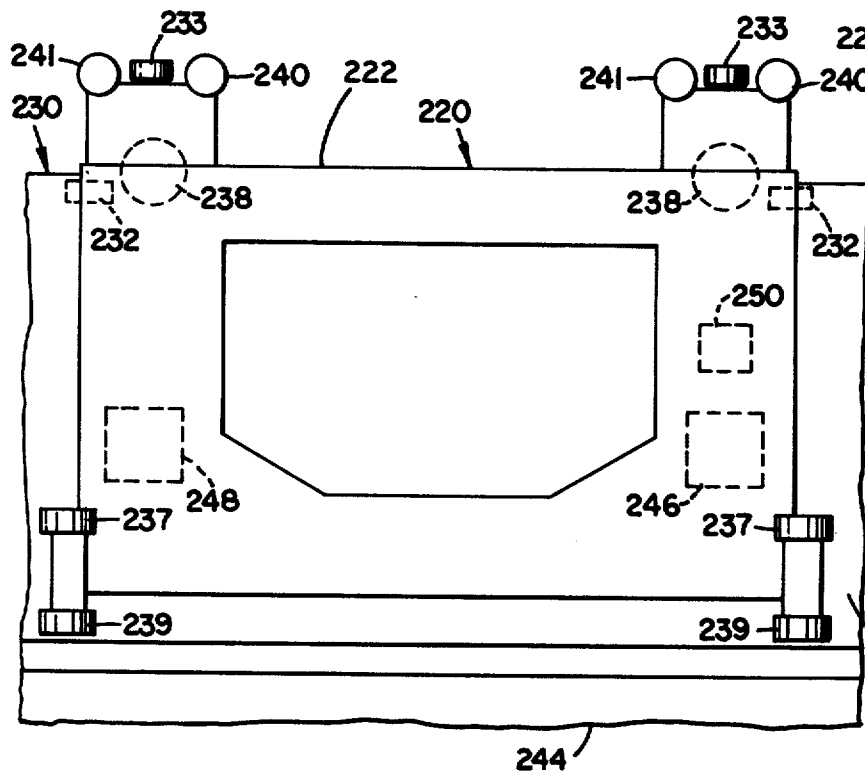


FIG_19

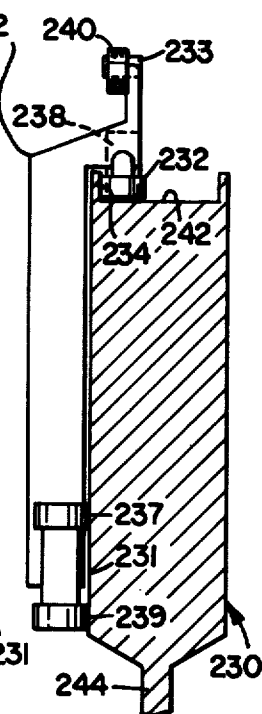
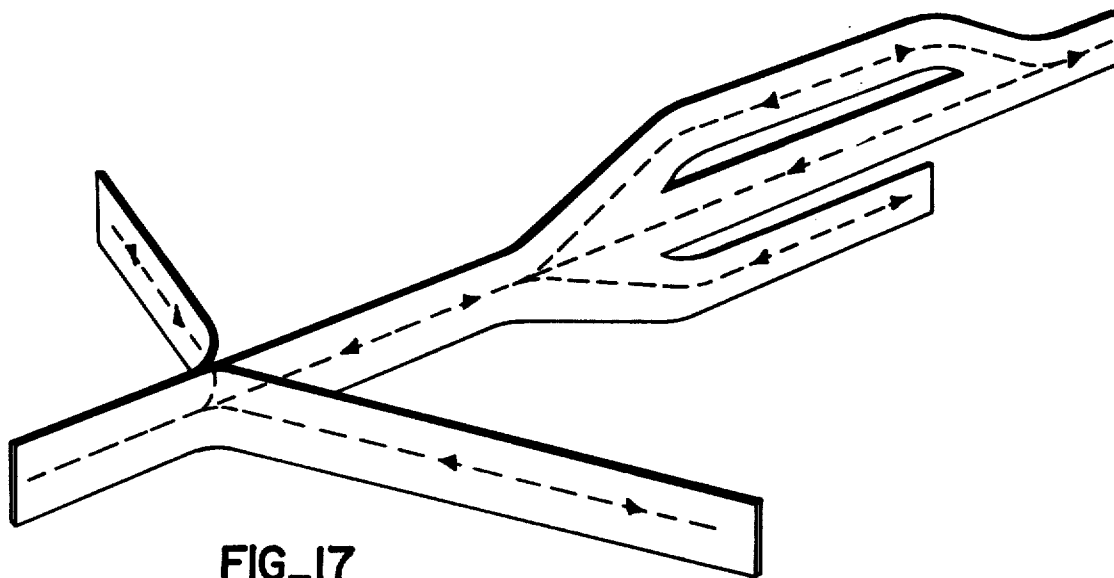
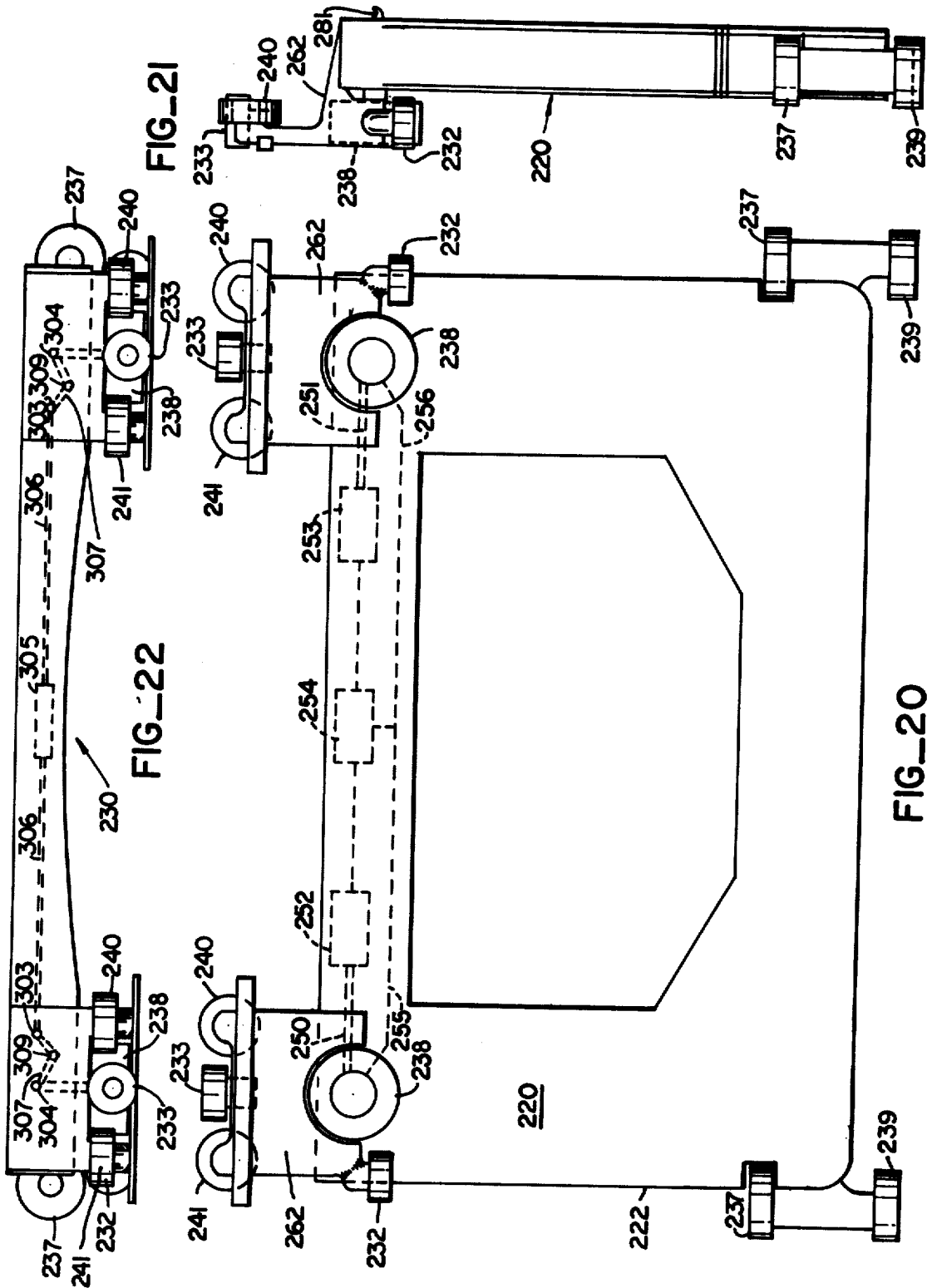


FIG_17



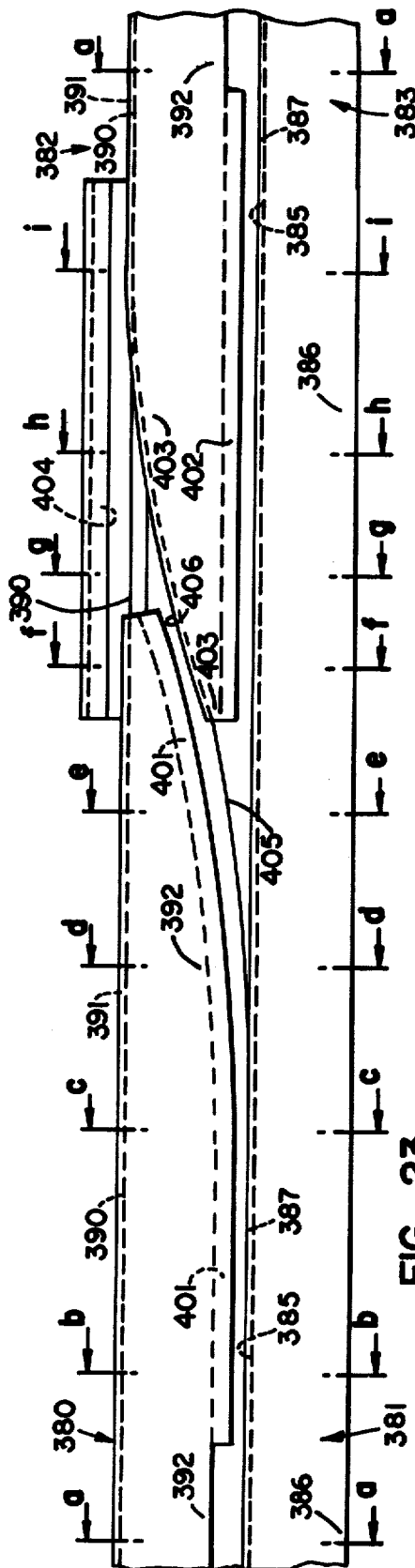


FIG. 23

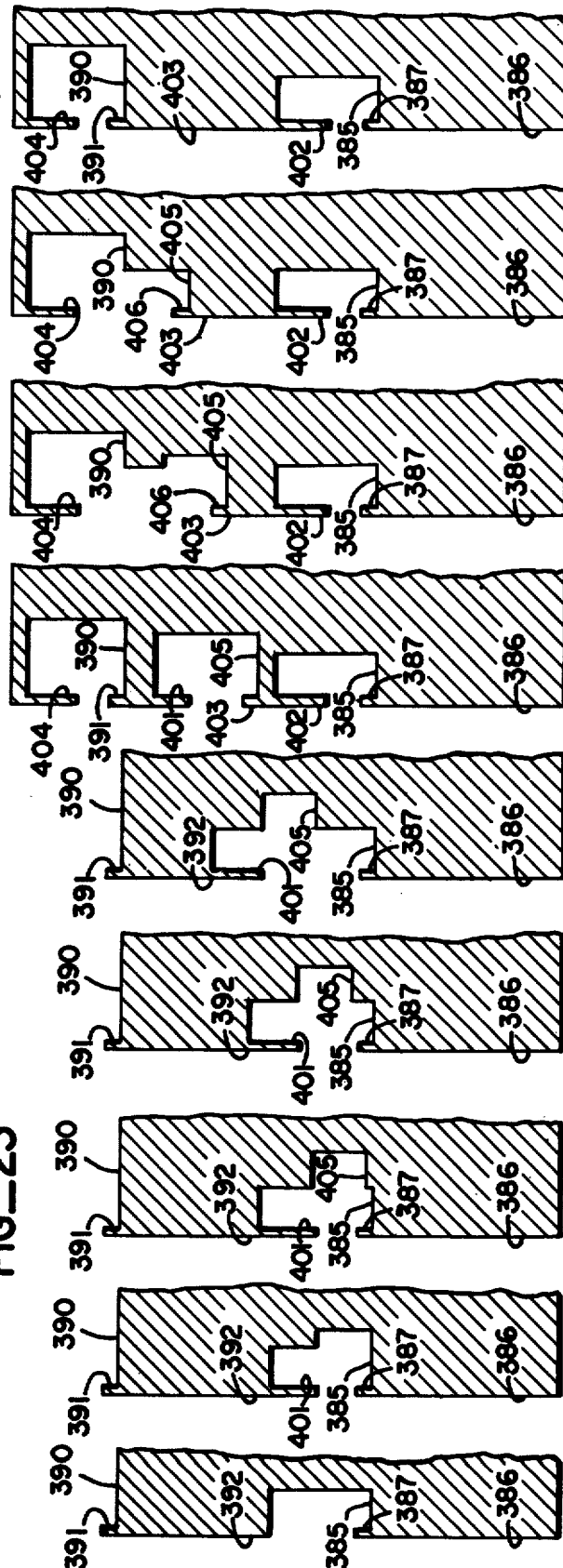


FIG. 23a

FIG. 23b

FIG. 23c

FIG. 23d

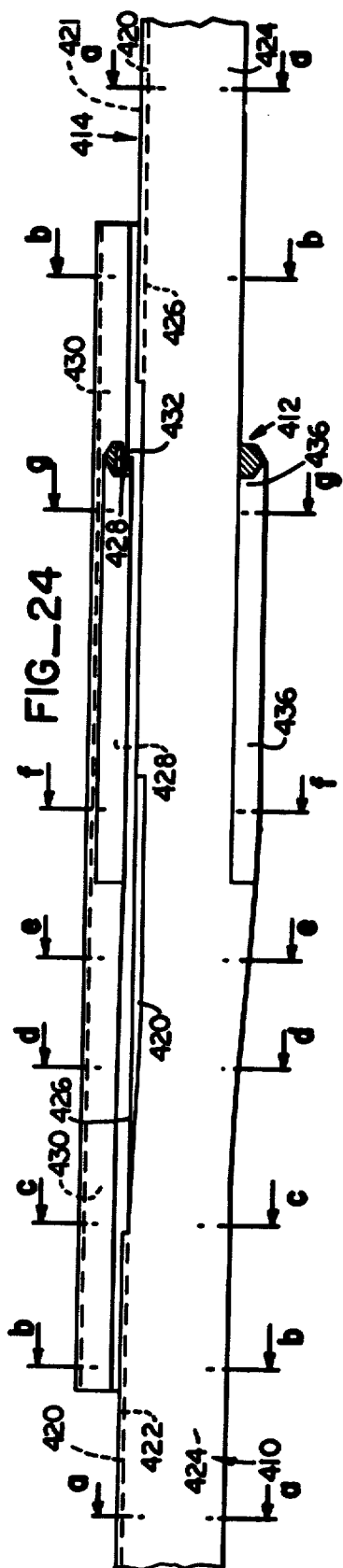
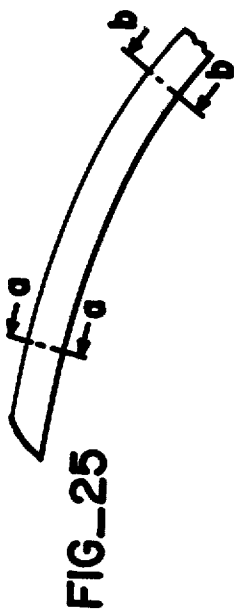
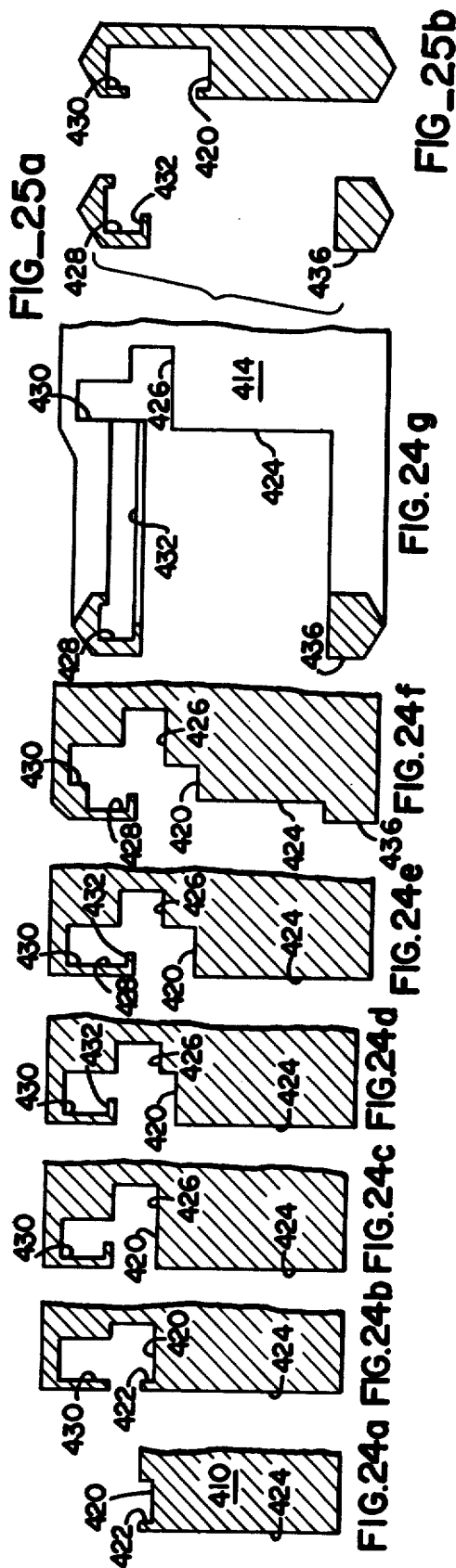
FIG. 23e

FIG. 23f

FIG. 23g

FIG. 23h

FIG. 23i



TRANSPORTATION SYSTEM RELATED APPLICATION

This application is related to our co-pending application Ser. No. 746,884 filed July 23, 1968 for TRANSPORTATION SYSTEM. The disclosure of such application is incorporated herein by reference.

FIELD OF THE INVENTION

This invention relates to a transportation system which includes an elongated guidebeam having running surfaces for carrying a rack thereon and more specifically the invention deals with a transportation system having connecting switch sections for switching a rack between upline and downline guidebeams without the necessity of moving parts in the connecting switch sections.

BACKGROUND OF THE INVENTION

A particular problem which has heretofore plagued most fixed rail and guidebeam transportation systems has occurred in switching a moving member from one fixed rail section to a second section which second section is either horizontally or vertically diverging from the main section. Heretofore, as exemplified by conventional railroad transportation systems, it has been necessary to provide a switch section which had a movable portion between the two diverging portions of the track or running surfaces to allow switching of the train from one rail section to the second diverging rail section. In our above-mentioned, previously filed, copending application we disclosed a method of vertically switching a rack from an upline guidebeam to one of two downline guidebeams utilizing a movable section positioned on an intermediate connecting guidebeam switch section between the two diverging downline guidebeams. It has been found that while movable switches of this nature are operative to provide for switching a rack, it is necessary, particularly where high density, high speed flow of a number of racks is desired, that switching be accomplished without need for a movable member in the guidebeam switching section. This is particularly necessary where a computerized transportation system is desired which will allow for closely spaced, high speed travel of a number of individual racks along a guidebeam system which may include many interchanges and switches. Thus there may be many racks moving at very closely spaced intervals along a main guidebeam in such a system and it may be desirable to switch some of the racks to alternate diverging guidebeams while allowing other of the racks to pass through on the main guidebeam. The time lag required by the movable portion of the heretofore disclosed connecting guidebeam switch section requires that a definite time interval be maintained between the racks travelling on the mainline guidebeam. That is, the racks must maintain certain space intervals depending on the speed and the time lag of the switch.

As noted above, a unique transportation system was described and claimed in our above-mentioned, earlier filed application. As disclosed in that application, a transportation system was provided which included an elongated guidebeam having three parallel rails or running surfaces. The running surfaces included an upper guide running surface, a lower guide running surface and a support or drive wheel running surface. A rack having wheels was provided for moving on the running

surfaces. The rack had load carrying means on one side and the wheels on the other side. The wheels of the rack included an upper guide wheel for running on the upper guide wheel running surface, a lower guide wheel for running on the lower guide wheel running surface and a support or drive wheel for running on the support or drive wheel running surface. The support or drive wheel was powered and moved the rack along the guidebeam. Switching means were disclosed in our earlier application. These switch means required, however, that at least some of the interconnecting running surfaces between two diverging elongated guidebeams be movable. Thus it was heretofore necessary in order to switch a rack from one elongated guidebeam to a second downline guidebeam to move at least some of the intermediate connecting running surfaces of the section between such guidebeams. While this operation can sometimes be handled efficiently, it has been found especially desirable to provide for high speed switching of racks from one guidebeam to a second spaced apart guidebeam. This high speed switching has been provided for by developing a rack and cooperating connecting switch sections so that it is not necessary that a portion of the connecting switch section be movable. Thus we have now developed an elongated guidebeam system which has connecting switch sections formed in a manner to cooperate with a rack so that switching of the rack from one guidebeam to another may be accomplished without the need of moving parts on the connecting switch section. In this manner high density traffic may pass to a switch section and rapidly select a path through the switch section to one or more downline guidebeams without the necessity of time delay caused by moving parts in the switch section.

BRIEF DESCRIPTION OF THE INVENTION

The present invention is directed to an arrangement of guidebeams interconnected by specially devised nonmovable connecting sections which cooperate with racks assembled in accordance with the invention to permit both horizontal left-right and vertical up-down switching of the racks from a main upline guidebeam to a selected guidebeam of two or more spaced apart downline guidebeams or vice versa without moving parts in the connecting guidebeam switch section. Two types of racks are disclosed in accordance with the invention. Connecting switch sections are described for each type of rack for switching the racks in both a horizontal mode or a vertical mode. The versatility of switching of the present transportation system is particularly helpful in providing a complete system which is compatible with a wide range of topographical and station requirements.

The present invention is directed to a transportation system which includes a powered rack adapted to move on a guidebeam. The guidebeam has an upper guide wheel running surface and a lower guide wheel running surface. These running surfaces are substantially vertically disposed in 180° opposing relationship with the upper guide surface formed on an interiorly facing wall of the guidebeam and the lower guide surface formed on an exteriorly facing wall of the guidebeam. A substantially horizontal support wheel running surface is also provided for on the guidebeam. A rack is provided with sets of wheels adapted to engage and to travel along the running surfaces of the guidebeam. Connecting sections are provided for connecting an upline

guidebeam with two spaced apart diverging downline guidebeams to provide for selectively moving a rack to one of such downline guidebeams and connecting sections are also provided for merging two upline guidebeams into a single downline guidebeam. The connecting section has no moving parts. The rack by virtue of a movable means carried thereon may selectively be guided through the connecting section to one of either of the two or more diverging or spaced apart downline guidebeams. Thus the switch section may be embodied to connect a single upline guidebeam with two diverging downline guidebeams. The switch section may also be embodied to provide switching between a pair of spaced apart parallel mainline guidebeams. And, of course, the switch section may be embodied to connect two upline guidebeams into a single downline guidebeam. The switching may be accomplished in either a vertical or a horizontal mode.

The elongated guidebeam of the present invention has in general three spaced apart running surfaces provided thereon for carrying a powered rack. The rack has sets of wheels which retain the rack on the guidebeam and which move on the running surfaces of the guidebeam to advance the rack along the guidebeam. More specifically the rack has sets of upper guide wheels, sets of lower guide wheels and support wheels. The sets of upper and lower guide wheels are usually made up of dual vertically spaced apart wheels although, as will be evident, other combinations of wheels or a single wheel may often be used in accordance with the invention. The running surfaces for the upper and lower guide wheels are formed in substantially vertical planes and the running surfaces for the support wheels are formed in substantially horizontal planes. The running surfaces for the upper and lower guide wheels are substantially vertical and are disposed 180° apart. The upper guide running surface is formed on an interior surface of the guidebeam while the lower guide running surface is formed on an exterior surface. Thus the guide wheels and the support wheels cooperate to hold the rack on the running surfaces of the guidebeam in cantilever fashion. Connecting switch sections are provided to connect upline guidebeams and downline guidebeams. The mainline guidebeams and the connecting switch sections are provided with upper and lower guide wheel running surfaces and support wheel running surfaces. The connecting switch section moreover has at least two sets of upper and lower guide wheel running surfaces. One set of upper and lower guide wheel running surfaces is connected between the mainline guidebeam and one of the spaced apart guidebeams and the other of such sets of upper and lower guide wheel running surfaces is connected between the mainline guidebeam and the other of the spaced apart guidebeams. The connecting switch guide wheel running surfaces connect the guide wheel running surfaces of the main guidebeam with the guide wheel running surfaces of the two separate spaced apart guidebeams. The connecting switch sections are provided with at least two horizontal running surfaces for the support wheels. The two horizontal support running surfaces diverge from a single support wheel running surface on a main guidebeam to the support wheel running surface of each of the two or more separate spaced apart guidebeams. The support wheels of the rack are adapted to selectively choose between one of the two or more horizontal support wheel running sur-

faces of the connecting switch section to determine to which one of the guidebeams that the rack will be directed. The connecting sections have no moving parts. An extendable and retractable support wheel of the rack selects one of the horizontal running surfaces of the connecting section to provide for switching the rack from one main guidebeam to a selected second main guidebeam. The guide wheels follow the appropriate guide wheel running surface to such selected second main guidebeam. Both horizontal and vertical switching of the rack are provided for by this invention.

Thus in one aspect the present invention is directed to a guidebeam transportation system for use by wheeled racks which guidebeam system permits switching of racks from the running surfaces of an upline guidebeam to the running surfaces of a spaced apart or diverging downline guidebeam or vice versa without the need for moving parts in the connecting guidebeam switch section. For example, an upline guidebeam is provided with appropriate horizontal and vertical running surfaces for the wheels of a rack. A connecting guidebeam switch section connects the upline guidebeam with a first diverging downline guidebeam and a second diverging downline guidebeam. The connecting guidebeam section is provided with a first set of horizontal and vertical running surfaces for each of the wheels of the rack between the running surfaces of the upline guidebeam and the running surfaces of the first downline guidebeam. The connecting guidebeam section is also provided with a second set of horizontal and vertical running surfaces between the running surfaces of the upline guidebeam and the running surfaces of the second downline guidebeam. Thus the running surfaces of the connecting switch section provide alternative diverging paths for the wheels of a rack between the upline guidebeam and the two diverging downline guidebeams. A rack having suitably arranged vertical and horizontal sets of wheels for running on such running surfaces is provided with movable means for selectively engaging either the first set or second set of running surfaces of the connecting guidebeam switch section to selectively direct the rack to the running surfaces of the selected diverging downline guidebeam. The connecting guidebeam switch sections can be embodied in a manner so that either horizontal or vertical switching of a rack from an upline guidebeam to a selected downline guidebeam is possible. The connecting switch sections have no moving parts and the mode of switching from one guidebeam to another guidebeam through the connecting guidebeam switch section is selected by movable means such as extendable and retractable support wheels of the rack. The rack utilizes sets of dual vertically spaced apart wheels for both upper and lower guide wheels to, by virtue of such vertical spacing, bridge openings in the guide wheel running surfaces that are necessary in the connecting switch section to pass portions of the rack through the section.

In a more specific aspect the present invention is directed to a transportation system utilizing an elongated guidebeam system. Connecting guidebeam switch sections are used to connect an upline guidebeam section with each of two or more downline guidebeams. All of the guidebeams have upper vertical guide wheel running surfaces formed on inner facing walls of the guidebeams, lower vertical guide wheel running surfaces formed on outer facing walls of the guidebeams and

horizontal support wheel running surfaces formed on horizontal walls of the guidebeams. The connecting guidebeams switch section includes stationary support means extending between an upline guidebeam and each of at least two downline guidebeams. A first horizontal support wheel running surface is provided on said stationary support means for accommodating support wheels rotating on a horizontal axis of a rack. First upper vertical guide wheel running surfaces are also located on said stationary support means to provide first upper running surfaces for the upper guide wheels of a rack. The first upper running surfaces are formed to cooperate with the vertically spaced apart upper guide wheels of the rack to permit bridging of gaps in the running surface needed to pass parts of the rack in the switch section. First lower vertical guide wheel running surfaces are provided on said stationary support means to provide first lower running surfaces for the lower guide wheels of the rack. The first lower running surfaces cooperate with the lower guide wheels to bridge gaps in the running surface necessary to pass parts of the rack. All of said first running surfaces serve to connect respective counterpart running surfaces of the upline guidebeam with the respective running surfaces of one of the downline guidebeams. A second support wheel running surface is located on the stationary support means. This second support wheel running surface diverges from the said first support wheel running surface. Second upper vertical guide wheel running surfaces are also provided on the stationary support means to provide second upper running surfaces for the upper guide wheels. The second upper running surfaces are formed to cooperate with the dual vertically spaced apart upper guide wheels of the rack to bridge gaps in this running surface which are necessary to pass parts of the rack through the switch section. Second lower vertical guide wheel running surfaces are also located on the stationary support means to provide second lower guide running surfaces for the lower dual guide wheels. The second lower running surfaces cooperate with the lower guide wheels to pass parts of the rack through gaps in the running surface which may be necessary to pass parts of the rack through the switch section. All of the second running surfaces serve to connect the respective counterpart running surfaces of the upline guidebeam with the respective running surfaces of the other of the downline guidebeams. A rack is provided with upper guide wheels and lower guide wheels for running on the upper guide running surfaces and the lower running surfaces respectively of the guidebeams. The guide wheels are adapted to engage the running surfaces in 180° spaced apart relationship with the upper guide wheels engaging a running surface formed on inward facing walls of the guidebeam. In this manner the rack is held in cantilever fashion on the guidebeam. The upper and lower guide wheel sets are formed of dual wheels spaced vertically apart to bridge gaps in the respective running surfaces which are necessary in the switch section to permit passage of portions of the rack through the switch during different modes of switching. The rack also has horizontal support wheels adapted to run on support wheel running surfaces to complete the engagement of the rack on the guidebeam. The guide wheels are arranged so that they may selectively run on either the first or the second guide wheel running surfaces of a connecting guidebeam switch section. By selectively requiring the sup-

port wheels to run on a given support wheel running surface of the connecting switch section, the rack is selectively directed to one of the two or more downline guidebeam sections. Specially adapted vertically spaced apart upper and lower guide wheels allow the guide wheels to bridge the gaps in the guide wheel running surface which are required to pass portions of the rack during such switching operations.

OBJECT OF THE INVENTION

A particular object of the present invention is to provide a transportation system for carrying people, freight and vehicles over a minimum right of way which transportation system includes an elongated guidebeam system having nonmoving switch sections for carrying a special rack at high speeds and which provides for switching the rack in both horizontal and vertical directions both diverging from an upline guidebeam to one of two or more downline guidebeams and merging to a downline guidebeam from two or more spaced apart upline guidebeams without the use of moving parts in the connecting switch section.

BRIEF DESCRIPTION OF THE DRAWINGS

Further objects and advantages of the present invention will become apparent from the following detailed description read in light of the accompanying drawings which are made a part of this specification and in which

FIG. 1 is a perspective schematic illustration of the modes of switching that are selectively accomplished in accordance with the preferred embodiment of apparatus of the present invention without the use of moving parts in the connecting switch sections;

FIG. 2 is a side elevation in schematic form of the preferred embodiment of apparatus assembled in accordance with the present invention;

FIG. 3 is an end elevation in schematic form of the preferred embodiment of apparatus assembled in accordance with the present invention;

FIG. 4 is a detailed elevation view with portions broken away for clarity of presentation of the preferred rack assembled in accordance with the present invention;

FIG. 5 is a detailed side elevation with portions broken away for clarity of presentation of the preferred rack assembled in accordance with the present invention;

FIG. 6 is a bottom view with portions broken away for clarity of presentation of the preferred rack assembled in accordance with the present invention;

FIG. 7 is an enlarged sectional view with parts removed for clarity of presentation taken at line 7—7 of FIG. 6 and illustrates the apparatus used to drive the support wheel;

FIG. 8 is a sectional view with parts removed for clarity of presentation taken at line 8—8 of FIG. 7 and illustrates the apparatus used to drive the support wheel;

FIG. 9 is an enlarged sectional view with parts removed for clarity of presentation taken at line 9—9 of FIG. 4 illustrating apparatus for extending and retracting the support wheel, and showing the support wheel in retracted position;

FIG. 10 is an enlarged sectional view similar to FIG. 9 illustrating the support wheel in extended position;

FIG. 11 is an elevation view of a portion of apparatus illustrated in FIGS. 9 and 10;

FIG. 12 is a side elevation view of a connecting switch section providing vertical switching in accordance with the preferred form of the present invention;

FIGS. 12a-12f are sectional views taken as indicated from FIG. 12;

FIG. 13 is a side elevation view of a connecting switch section providing horizontal switching in accordance with the preferred embodiment of apparatus assembled in accordance with the present invention;

FIGS. 13a-13g are sectional views taken as indicated from FIG. 13;

FIG. 14 is a partial top view of the connecting switch section shown in FIG. 13;

FIGS. 14a-14b are sectional views taken as indicated from FIG. 14;

FIG. 15 is a side elevation view of the first portion of a vertical switch connecting section providing interchange between two main guidebeams for the preferred embodiment of apparatus assembled in accordance with the present invention;

FIGS. 15a-15f are sectional views taken as indicated from FIG. 15;

FIG. 16 is a side elevation view of the second portion of the connecting section of FIG. 15 illustrating vertical interchange between two main guidebeam sections for the preferred embodiment of apparatus assembled in accordance with the present invention;

FIGS. 16a-16e are sectional views taken as indicated from FIG. 16;

FIG. 17 is a perspective schematic illustration of the modes of switching that are selectively done by the alternative embodiment of apparatus of the present invention without the use of moving parts in the connecting switch section;

FIG. 18 is a schematic side elevation of an alternative embodiment of apparatus assembled in accordance with the present invention;

FIG. 19 is a schematic end elevation of the alternative embodiment of apparatus assembled in accordance with the present invention;

FIG. 20 is a detailed elevation view of an alternative rack assembled in accordance with the present invention;

FIG. 21 is a detailed end elevation view of the alternative rack assembled in accordance with the present invention;

FIG. 22 is a detailed top view of the alternative rack assembled in accordance with the present invention;

FIG. 23 is a side elevation view of an alternative connecting guidebeam switch section useful to switch an alternative rack selectively between two vertically spaced apart guidebeam sections;

FIGS. 23a-23i are sectional views taken as indicated from FIG. 23;

FIG. 24 is a side elevation view of an alternative embodiment of connecting switch section providing for horizontal switching of an alternative rack between a first guidebeam section and two diverging downline guidebeam sections;

FIGS. 24a-24g are sectional views taken as indicated from FIG. 24;

FIG. 25 is a top view of a portion of the connecting switch section illustrated in FIG. 24; and

FIGS. 25a-25b are sectional views taken as indicated from FIG. 25.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

In the drawings, FIG. 1 shows a perspective schematic illustration of the modes of switching that may be selectively accomplished in accordance with the preferred embodiment of apparatus of the present invention. These modes of switching are accomplished without the use of moving parts in the connecting switch section. Thus in accordance with the invention a rack may switch horizontally from a main guidebeam to the left or to the right, to diverging downline guidebeams, or may continue through such a connecting switch section on the mainline guidebeam. As is evident by the reverse arrows, the switch section can be modified so that a rack may also be switched into a through mainline guidebeam from guidebeams merging from the left or the right. The rack may be switched from a mainline guidebeam vertically up or vertically down to vertically diverging guidebeams or may be directed through such a switch section on the mainline guidebeams. Switching may be done between two vertically spaced apart mainline guidebeams with through travel also provided on both guidebeams. As again indicated by the reverse arrows the switch section may be embodied to permit vertical switching from two spaced apart guidebeams to a single mainline guidebeam. Many combinations of switching are provided in accordance with the present invention. FIG. 1 is used to illustrate some of the modes of switching in accordance with the invention.

Refer now to FIGS. 2 and 3 in particular where the preferred embodiment of apparatus assembled in accordance with the present invention is shown in schematic form. FIG. 2 is a side elevation and FIG. 3 is an end elevation partially in section showing a rack generally indicated by the number 20 attached to and in running position on an elongated guidebeam which is generally indicated by the number 30. The guidebeam is formed to provide a path in the transportation system and serves to carry the running surfaces on which the rack 20 moves. The rack 20 is comprised of frame member 22 having a series of spaced apart wheels rotatably attached thereto. The wheels include sets of upper guide wheels 33, 35; sets of lower guide wheels 37, 39; and support wheels 38. The support wheels 38, as hereinafter will be discussed in detail, are usually driven by a power source and therefore also function as drive wheels to move the rack along the guidebeam. As indicated in the drawings, the preferred embodiment rack has sets of dual vertically spaced apart upper guide wheels which include wheels 33 and 35. These wheels form a set of upper guide wheels. The lower guide wheels comprise a pair of vertically spaced apart wheels 37 and 39. The sets of wheels are positioned on the frame 22 at suitable intervals depending on the load and length of the rack 20. It is usually desirable to have at least two sets of dual upper guide wheels, two sets of dual lower guide wheels, and at least two support wheels.

The guidebeam 30 is held in desired position by suitable support means, such as for example, by a series of columns, such as column 44, spaced apart along the right of way. The guidebeam 30 may be composed, for example, of prestressed sections resting end to end on a series of supports such as column 44. Suitable overall dimensions for such prestressed sections as a guide to understanding the present invention have been found

to be about 8 feet high by 6 feet wide and 100 feet long. The guidebeam may be formed as illustrated in FIGS. 2 and 3 so that racks can utilize both sides of the guidebeam. In this manner racks travelling in opposite directions may utilize the same guidebeam at the same time.

The guidebeam 30 provides at least three spaced apart running surfaces for the rack. Thus on each mainline right of way portion of the guidebeam there is provided an upper guide running surface 34; a lower guide running surface 40; and a support wheel running surface 42. The upper guide running surface 34 and the lower guide running surface 40 have substantially vertically disposed running surfaces to accommodate the upper and lower guide wheels respectively. The upper guide running surface 34 is formed on an inner wall of the guidebeam. The lower guide running surface 40 is formed on an outer facing wall of the guidebeam. The support wheel running surface is disposed in a substantially horizontal plane to accommodate the support wheels. As illustrated in FIGS. 2 and 3, the self-powered rack 20 is adapted to be held and to be moved on the three running surfaces of the guidebeam in cantilever fashion. Thus the upper guide surface 34 is formed on an inward facing wall of the guidebeam 30 while the lower guide running surface 40 is formed on an outward facing wall of the guidebeam 30. The upper guide wheels 33, 35 and the lower guide wheels 37, 39 cooperate with the support wheels 38 to position the rack on the running surfaces of the guidebeam in cantilever fashion.

The dual wheel configuration of the upper guide wheels 33, 35 and the lower guide wheels 37, 39 is provided to permit the rack to be switched from an upline guidebeam to one of two or more spaced apart downline guidebeams or vice versa without the need for moving parts in the connecting guidebeam switch section. The present invention provides for such switching of a rack 20 from the main upline guidebeam section to one of two or more downline guidebeams or vice versa, in either a vertical or horizontal mode. The dual guide wheel configuration of the upper and lower guide wheels permits continuous contact of one or the other of the respective dual upper and lower wheels with their respective guide running surfaces during the entire switching operation as the rack is switched from one guidebeam to another through the switch section. Since, as is fully explained later, it is necessary to have gaps in the guide running surfaces of the connecting switch guidebeam sections to permit passage of portions of the rack on different paths through such switch sections it is preferred to have dual guide wheels on both upper and lower guide wheels so that one of the dual wheels on each guide wheel is always in contact with its respective running surface. The dual upper and the dual lower guide wheels are necessary so that the same rack may utilize all of the various vertical and horizontal switch sections hereinafter described. It will be apparent that for some switches a dual configuration of both upper and lower guide wheels may not be necessary. As indicated in FIG. 2 and FIG. 3, the mainline sections of the guidebeam preferably only provide a running surface for one of the wheels of each of the upper guide wheels and the lower guide wheels. Thus it is desirable that only one upper and one lower guide wheel engage a running surface on a mainline section of the guidebeam system. However, it is of course pos-

sible to have mainline guidebeams which provide running surfaces for all the guide wheels.

The rack 20 is driven along the guidebeam means by a suitable power source supplying power to the support wheel 38. As noted it is preferred to use a wheel which rotates on a horizontal axis as the drive wheel. It is of course possible to provide either or both the upper guide wheels and the lower guide wheels with power. Motive power is supplied to the support wheel 38 by a suitable power source. Such a power source may be for example an electric motor or an internal combustion engine. Such a power source is schematically illustrated in FIG. 2 by the box indicated by the number 46. If it is desirable to drive more than one support wheel then a second power source 48 may be utilized. Suitable drive train means are provided to connect the power source 46 to the support wheel 38. Control means 50 are preferably carried on the rack 20 to control the power sources 46 and 48 and the movement of rack 20 along the guidebeam 30. Control means 50 is preferably electrically activated and in many instances will be tied into a computer network so that a number of racks may be moved at closely spaced intervals along the guidebeam.

Refer now to FIGS. 4, 5 and 6. FIG. 4 is an elevation view of the preferred rack assembled in accordance with the present invention. FIG. 5 is a side elevation view of the preferred rack and FIG. 6 is a top view of the preferred rack of the present invention. The rack has two sets of dual upper guide wheels 33, 35 and two set of dual lower guide wheels 37, 39. Support or power wheels 38 are used to move the rack 20 along the running surfaces of the guidebeam. The rack 20 includes a frame 22 which has overhanging arm members 62 which are adapted to extend over the upper portion of the guidebeam to cause the upper guide wheels to engage the inner running surface of the guidebeam which forms the upper guide wheel running surface. The support wheel 38 and the lower dual guide wheels 37, 39 are preferably formed in units and connected to the frame 22 mating flanges 95 and 94. In accordance with the invention the rack has a movable means which cooperates with the diverging or converging running surfaces of a connecting switch section to provide for directing the rack from a main upline guidebeam to one of two or more diverging downline guidebeams or vice versa. Certain wheels of the rack are useful as such a movable means. Thus the support wheels 38 of the preferred apparatus are extendable and retractable to direct the rack through a selected diverging or converging running surface of a connecting switch section.

The support wheels 38 are extended and retracted from the rack by suitable means as illustrated schematically in FIGS. 4-6. The wheels 38 are preferably extended or retracted in a direction normal to the direction of travel of the rack while the rack is moving along the guidebeam to reduce friction caused by such movement. Such friction is reduced to an acceptable minimum when rubber pneumatic tires are used. The axles 32 of the support wheels 38 are rotatably mounted on the frame 22 of the rack 20. In addition, these rotatably mounted axles 32 are also prepared so as to be capable of reciprocal motion, i.e., they can move in and out from the rack. Suitable bell cranks 107 are pivotably mounted on pins 108. One of the ends 99 of each of the bell cranks is connected to the ends of the axles. The other ends 109 of the bell cranks are connected to a

suitably arranged double acting hydraulic cylinder 105 through push rods 106. The hydraulic cylinder 105 is fixedly mounted in the frame 22 by suitable pins 98 which engage in the frame. Thus, when the hydraulic cylinder is activated the support wheels 38 are extended or retracted by the action of the above described mechanical linkage. Hydraulic fluid for the hydraulic cylinder is provided by hydraulic motor 97 which is controlled by control means 50 through suitable connections as shown. Although two positions of the support wheel are disclosed in the preferred embodiment, it is evident that the support wheel may be extended and retracted to operate on three or more running surfaces by suitable action of the hydraulic cylinder 105. The support wheels 38 are powered through axles 32 by appropriate power sources. The power source may be formed by an electric motor or internal combustion engine. Thus electric motors 96 are connected through suitable drive train linkage to the drive wheels 38 through axles 32. The powered support wheel 38 is preferably arranged for rotation about a horizontal axis and disposed to run on a surface located immediately above the lower of the dual lower guide wheels 39. The support wheel 38 power source is controlled by control means 50 carried on the frame 22. Suitable circuitry extends between the control means 50 and motors 96 for providing control. As described in our above-cited, co-pending application, suitable electrical rails may be provided on the guidebeams for pickup by a shoe carried on the rack to supply electricity to the rack.

Arranged on the load carrying side of the rack are a series of load hook means generally indicated by the number 81. The load hooks 81 are pivotly mounted on a shaft 83. The load hook 81 is controlled and pivoted by suitable linkage 84. The linkage 84 is connected to a hydraulic cylinder 85 which extends or retracts the hook 81. Motor 86 controls the extension and retraction of the cylinder 85. Thus, when a load is moved against the rack 20 the load hooks 81 are activated to secure the load to the rack by engaging suitable rings on the load. The load may be released by actuating the load hook 81 through the linkage 84. A locking arm 87 which is pivotly mounted on the frame is provided for use in locking hook 81 by means of switch 88 to prevent accidental movement of the hook.

The upper and lower dual guide wheels are vertically spaced apart on the frame member. The distance which is required between the top wheel 33 and the bottom wheel 35 of a set of upper dual guide wheels will vary depending on a number of considerations. These considerations will become apparent when the nonmoving switch sections are described later in detail. The distance that the top wheel 33 is located above arm 62 is also governed by a number of considerations. It is noted that the center of the top wheel is about two times farther from the center of the arm 62 than the center of the bottom wheel 35 of the upper dual guide wheels. This arrangement is necessary so that the support arm 62 may be allowed to pass through gaps in the running surface of the switch sections while maintaining one of the two upper guide wheels 33, 35 on the upper guide running surface. Similarly the lower guide wheels 37, 39 are vertically spaced apart to provide for bridging gaps in the running surfaces of the connecting switch section needed to pass the portions of the arm

62 and the support wheel axel 32 extending into the guidebeams.

FIGS. 7 through 11 illustrate the extendable and retractable support wheel and the means for driving the support wheel of the present invention which permits switching of a rack without moving parts on the switch. FIG. 7 is an enlarged sectional view taken at line 7—7 of FIG. 4 with parts removed for clarity of presentation illustrating the assembly of apparatus used to rotate the support wheel of the rack. FIG. 8 is a sectional view taken at line 8—8 of FIG. 7 with parts removed for clarity of presentation and also illustrates the drive means for the support wheel. Referring specifically now to FIGS. 7 and 8, a support wheel 38 is rotatably connected to the frame 22 of a rack. An axle 65 having a suitable flange 66 is connected to the support wheel by suitable bolts and the axle extends through housing 67 into the interior of the frame 22. A sleeve bearing member 68 supports the axle 65 inside of housing 67. This bearing member 68 is adapted to allow both rotating movement and reciprocal movement of the axle 65. The interior end portion of the axle is splined. The splined end 69 of the axle is captured in a bearing housing 70 and as will be further described below, the ball bearings in housing 70 are arranged in a manner to permit reciprocal, i.e., longitudinal stroking motion of the axle and to permit rotational motion of the axle within the housing 70. Thus when the housing 70 is rotated the axle 65 is also caused to be rotated. The ball bearing housing 70 is rotatably mounted in the frame 22 on suitable supports 71—74 by sleeve bearing member 75. A main gear member 76 is located around ball bearing housing 70 and is fixedly connected for rotation therewith by suitable means such as a key 77. Thus when the gear member 76 is rotated, the axle 65 is caused to rotate which in turn rotates support wheel 38 which moves the rack. A worm gear 78 is mated to the main gear member 76. The worm gear is mated to the main gear member 76. The worm gear is rotatably mounted on the frame 22 by sleeve bearings 110, 111. A shaft of the worm gear extends into motor 96. When the motor operates to drive the shaft the power is transmitted to the support wheel as described above.

The means for extending and retracting the support wheel are illustrated in detailed FIGS. 9—11. FIG. 9 is an enlarged sectional view with parts removed for clarity of presentation taken at line 9—9 of FIG. 4 and shows the support wheel 38 in retracted position. FIG. 10 is an enlarged sectional view similar to FIG. 9 and shows the support wheel in extended position. The power and driving mechanisms shown in detail in FIGS. 7 and 8 have been substantially removed from FIGS. 9 and 10 to allow for clarity of presentation. FIG. 11 is an elevation view of the bell crank and shows the yoke portion thereof.

As noted above, the axle 65 which carries the support wheel 38 enters the frame 22 through housing 67. A sleeve bearing member 68 rotatably and reciprocally mounts the axle in the housing. The other end 69 of the axle is splined and is constrained in bearing housing 70. The splines of the axle are captured between longitudinal rows of ball bearings 112 which in turn are held against rotation by ribs 113 of bearing housing 70.

The extension and retraction of the support wheel is accomplished by stroking the axle 69 in or out as desired. Thus the support wheel is stroked in a direction normal to the direction of travel of the rack to select

a running surface on which it moves. A flanged collar 114 is fixedly connected to the axle 65 and rotates therewith. A bell crank 107 having a yoke 115 at one end is adapted to engage pins 116, 117 into the collar 114. These pins 116, 117 allow the collar to rotate. However, as the pins are moved back and forth by the action of the bell crank 107 they cause the collar to extend and retract the support wheel 38 to the positions illustrated in FIGS. 9 and 10. The bell crank is rotatably mounted by means of pivot pin 108 on arm 118 of the frame. One end of a push rod 106 is connected to the end 99 of the bell crank 107. The other end of the push rod 106 is connected to a hydraulic cylinder 105 which is used to move the bell crank and to thus extend and retract the support wheel 38. A spring 119 is useful to assist in retracting the support wheel is desired. Additionally the spring 119 serves to move the support wheel to a retracted position should the linkage from the hydraulic cylinder fail.

In accordance with the present invention two positions are provided for the support wheels. That is to say that it has been found that when the support wheel is capable of being moved to two separate horizontal running surfaces that switching can be accomplished without the use of movable parts in the connecting switch section. In accordance with the invention then the rack is switched or is caused to continue along a given guidebeam depending on the running surface which the extendable and retractable support wheel elects to follow in the upstream portion of the connecting guidebeam section. A support wheel of the present invention is thus movable to at least two possible positions in a direction normal to the direction of rack travel. It will be apparent that the above discussed linkage can be modified to provide for three or more positions for the support wheel if such is desirable for any given switch configuration. In the first position, for example, the support wheel will follow a running surface which will permit a rack to continue along the main guidebeam right of way. In a second position the support wheel will cause a rack to be switched vertically or horizontally to an auxiliary guidebeam right of way by virtue of the support wheel following a support wheel running surface which causes the rack to be so switched.

FIGS. 12 through FIG. 16 illustrate a number of connecting switch sections arranged in accordance with the preferred embodiment of apparatus assembled in accordance with the present invention. These connecting switch sections afford various switching modes both in a vertical manner and in a horizontal manner for the preferred rack of the present invention. The preferred rack as set out above is of the type having a support wheel disposed well below the center of gravity of the rack. The vertical and horizontal modes of switching refer to the overall disposition of the rack through the connecting switch section. Thus when referring to a horizontal switch section it is understood that while there may be some vertical displacement of the rack going through the section, the switching operation is carried out primarily at a constant elevation. Vertical switch sections on the other hand require substantial displacement of the rack to achieve switching. It will also be evident that while many of the switch sections are described as proceeding from an upline guidebeam to one of two or more selected downline guidebeams, the opposite can also occur. That is, by reversing direction of travel of the rack and the sequence of stroking

of the support wheel (or by reversing the elements of the connecting section) a rack may come from one of two spaced apart guidebeams through a connecting switch section to merge with a single mainline guidebeam.

In FIG. 12 and FIGS. 12a-12i a vertical connecting switch section is illustrated. In this vertical switch section provision is made for selectively directing a rack from an upline guidebeam to one of two or more vertically spaced apart downline guidebeams. It is noted that one of the downline guidebeams forms essentially a through track with the upline guidebeam and therefore this switch section may, if desired, be aptly described as selectively permitting a rack to continue along on a mainline guidebeam or alternatively be vertically switched to an alternative vertically displaced downline guidebeam. As noted, if this switch section were set up for travel in the opposite direction, merging into a single guidebeam would occur. FIG. 13, FIGS. 13a-13g, FIG. 14 and FIGS. 14a-14b illustrate a horizontal switch connecting section for the preferred rack which provides for substantially horizontal switching of racks between an upline guidebeam and two or more spaced apart downline guidebeams. Here also it is obviously possible to think of selectively causing the rack to continue along a main guidebeam (both upline and downline of the switch section) or to be directed to a diverging downline guidebeam. FIG. 15, FIGS. 15a-15f, FIG. 16 and FIGS. 16a-16e show a vertical switch connecting section for selectively moving racks between two vertically spaced apart parallel mainline guidebeams. It is noted that while the embodiment of FIG. 15 and FIG. 16 provide a connecting switch section for selectively either directing a rack through the switch section to cause it to continue along the lower mainline or upper mainline or directing a rack from the lower mainline to the upper mainline that obviously the switch can be embodied to switch the rack from the upper mainline to the lower mainline in accordance with the invention. It is also noted that FIG. 15 and FIG. 16 illustrate both diverging switching and merging switching in the same switch section.

Thus in summary, FIGS. 12-16 inclusive illustrate various connecting switch sections for switching the preferred rack of the present invention in both a horizontal mode and a vertical mode. These connecting switch sections are all compatible with the preferred rack and thus a transportation system utilizing the preferred guidebeam construction may incorporate either or both horizontal switches and vertical switches at various places to be utilized by a single type of rack. Thus at one place because of space limitation it may be desirable to incorporate a vertical switch into the system while at another place a horizontal switch may be preferable and as further noted, the switch sections may be used to provide connection from an upline mainline guidebeam to one of two diverging downline guidebeams and in addition to provide merging to a single downline guidebeam from two upline guidebeams.

In order to specifically describe the various switch sections, first refer to FIG. 12 and FIGS. 12a-12i where a vertical connecting switch section of guidebeam is illustrated. This connecting switch section is used to vertically switch racks between an upline guidebeam and one of two downline guidebeams for continued travel along a selected route of the system. FIG. 12 is an elevation view and FIGS. 12a-12i are sectional views

taken at lines *a—i* through *i—i* of FIG. 12. FIG. 12*a* shows a typical cross section of a mainline guidebeam assembled in accordance with the invention. Such mainline guidebeam is indicated generally by the number 130. Two vertically spaced apart downline guidebeams 131 and 132 are also shown. A sectional view of the two downline guidebeams is shown in FIG. 12*i*. The two downline guidebeams 131 and 132 may travel along a common vertical plane or they may diverge in different directions to carry racks to different points. Thus the downline guidebeams 131 and 132 are complete and independent and each of them serve to independently carry a rack much as upline guidebeam 130. The connecting switch guidebeam section which provides for selectively directing a rack from upline guidebeam 130 to either one of the two downline guidebeams 131 or 132 is the portion intermediate to guidebeam 130 and 131 and 132 and is illustrated in sectional views in FIGS. 12*b—12h*.

The operation of the rack and connecting switch section will now be described in detail. A rack will be followed both passing through the switch section from guidebeam 130 to downline guidebeam 132 and vertically switching through the switch section from guidebeam 130 to vertically spaced apart guidebeam 131. Initially assume that a rack is moving along guidebeam 130 and that it is desired to move the rack through the connecting guidebeam switch section and have it proceed along downline guidebeam 132. As illustrated in FIG. 12*a* the mainline guidebeam 130 is provided with three spaced apart running surfaces. These running surfaces include an upper guide running surface 140 which is provided for an upper guide wheel of the rack. A lower guide running surface 141 is provided for a lower guide wheel of the rack. Optionally a second lower guide running surface 142 may also be provided for the upper of a pair of lower guide wheels of the preferred rack. As indicated heretofore however, it is only necessary that one upper guide running surface and one lower guide running surface be provided for one of each of the upper dual wheels and the lower dual wheels over the mainline portion of the guidebeam right of way. It is only necessary to provide dual upper and/or dual lower running surfaces in the switching sections where necessarily one or the other of the wheels must disengage a running surface which is interrupted to provide a gap or window for the rack or a portion of the rack to pass through. A substantially horizontal running surface 143 is provided for the support wheel of the rack. The support wheel of the preferred rack of the present invention is capable of being stroked from a normally retracted position to an extended position. This extension or retraction is normally done over a considerable length of guidebeam so as to reduce transverse stress on the wheel to a minimum and to permit a smooth transition of the support wheel between such running positions.

Assuming it is desired to move the rack from upline guidebeam 130 through the connecting switch section to downline guidebeam 132 the support wheel is maintained in a normal retracted position so as to ride on the normal portion of the horizontal running surface 143. More simply stated, the support wheel is left in its normal running position. In FIG. 12*b* the horizontal support running surface begins to widen out. However, since the support wheel of the rack is retracted it continues to run on the outer portion 143 of such surface.

The lower wheel of the dual upper guide wheels engages surface 140. The lower dual guide wheels of the rack continue to engage surfaces 142 and 141 respectively. As the rack continues through the connecting section to a location of FIG. 12*c*, the guide wheels and the support wheel continue to run on the same respective running surfaces. By this time the support wheel running surface has widened out to a point to provide an outer surface 143 and an inner surface 146. As will be described in detail later, the path that the rack will follow through the switch section depends on the path taken by the support wheel. Thus if it is desired to move the rack through the switch to guidebeam 132, as is now being described in detail, the support wheel is maintained in the retracted position and runs on the outer running surface 143. If, on the other hand, it is desired to shift the rack vertically in the switch section to guidebeam 131 then the support wheel would be moved to an extended position to run on surface 146.

As the rack continues along the connecting guidebeam switch section to a position illustrated in FIG. 12*d* the support wheel continues to run on surface 143. Now, however, guide wheel running surface 142 has moved up away from surface 143 and the upper wheel of the dual lower guide wheels loses contact therewith and is now freewheeling. However, the lower guide wheel of the lower dual guide wheels continues to run on running surface 141. The upper guide wheels by virtue of the lower of such dual wheels continues to be engaged on running surface 140. The support running surfaces 143 and 146 have now vertically separated. As the rack moves to a position shown in FIG. 12*e* a new lower guide wheel running surface 144 appears and now both lower guide wheels are in contact with the switch section. The lower wheel of upper guide wheels continues to engage surface 140 and the upper wheel now contacts surface 145. In FIG. 12*f* the support wheel and the two wheels of the lower guide wheels continue to run on running surfaces 143, 144 and 141 respectively. The running surface for the lower wheel of the upper guide wheels now has disappeared and this lower wheel is freewheeling. However, the upper wheel of the upper guide wheels continues to engage running surface 145 to maintain the rack in cantilever position on the connecting switch section. The window created by the temporary removal of running surface 140 allows the axle of the support wheel of a rack to clear when the rack is being vertically switched to guidebeam 131. As is evident, the total absence of an upper guide running surface cannot be tolerated since this would allow the rack to fall from the guidebeam. Thus the dual wheels forming the upper guide wheels permit release of the running surface of one wheel at a time to permit passage through the switch of portions of the rack which otherwise would not pass.

When the rack has moved to a position illustrated by FIG. 12*g* the lower portion of the guidebeam has for all intents and purposes returned to normal. That is, the support wheel continues to run on running surface 143 and the lower guide wheels run respectively on surfaces 144 and 141. The lower of the upper guide wheels has returned to engage running surface 140. The identical situation is also seen in FIG. 12*h* and FIG. 12*i*. As indicated by the phantom lines in FIG. 12*i* between the upper and the lower guidebeams 131 and 132 these guidebeams are now independent and can continue

vertically disposed along the same path or diverge on a new path to any desired location.

If it is desired to direct a rack through the switch section from upline guidebeam 130 to vertically spaced apart downline guidebeam 131, that is to affect a vertical switching operation from the mainline guidebeam which may be for example guidebeams 130-132, the following steps will occur. A rack as it enters the portion of the guidebeam illustrated in FIG. 12a will be engaging guidebeam 130 in a normal manner as was previously described for mainline operation. In the portion of the switch section located between FIG. 12a and FIG. 12c the support wheel of the rack will be extended normal to the direction of travel of the rack so that the support wheel runs on the interior running surface indicated by the number 146. The support wheel running surface of the connecting switch section is gradually widened out as illustrated in FIG. 12b to accommodate the gradual extension of the support wheel of the rack. During this time the upper and lower guide wheels continue to run on surfaces 141, 142 and 140 as before. In addition the upper wheel of the upper guide wheels has picked up surface 150 as shown in FIG. 12b. This arrangement continues to FIG. 12c while the support wheel is being fully extended onto surface 146. Just after passing the position of FIG. 12c the interior support wheel running surface 146 begins to ramp up to gain elevation. Thus the interior support running surface 146 has an elevation substantially above the outer support running surface 143.

The gain in elevation of the extended support wheel up the ramped support running surface 146 causes the entire rack to be moved upwardly. The upward movement of the rack of course is reflected in an upward movement of the upper guide wheels and the lower guide wheels. Therefore in the portion of the connecting switch section between FIG. 12c and FIG. 12d the upper wheel of the dual lower guide wheels continues to engage on running surface 142 which running surface also gains elevation through this portion of the switch section. The lower wheel of the dual lower guide wheels leaves running surface 141 and is freewheeling as it comes through FIG. 12d. The upper guide wheels of course are also elevated through this portion of the switch and the upper wheel of the dual upper guide wheels continues to engage upper guide wheel running surface 150 which also gains elevation through this portion of the connecting switch section. The lower wheel of the dual upper guide wheels disengages from running surface 140 and is freewheeling through the portion shown in FIG. 12d. As the ramped inner support wheel running surface 146 continues to gain elevation through FIG. 12e and and FIG. 12f one wheel or the other of both the dual upper wheels and dual lower guide wheels continues to engage their respective running surfaces to provide a cantilevered mode of connection for the rack on the guidebeam switch section. As shown in FIG. 12e both the wheels of the lower dual guide wheels are engaged respectively on surfaces 142 and 152. The upper wheel of the upper guide wheels engages surface 150 and the lower wheel of the upper guide wheels engages surface 148.

The support running surface 146 continues to ramp up through the positions shown in FIG. 12f and FIG. 12g. Going from FIG. 12e to FIG. 12f, the lower wheel of the upper dual guide wheels engages running surface 148. In this same stretch running surface 150 has

ended. This of course occurs after running surface 148 is made available for the upper guide wheels. The upper guide wheels will continue to use guide wheel running surface 148 throughout the rest of the connecting switch section. The lower guide wheels engage surface 152 through the portion of the connecting switch between FIG. 12e and FIG. 12f. That is the lower of the dual lower guide wheels engages surface 152. The upper wheel of the dual lower guide wheels freewheels through this portion of the switch section to provide a window for passage of an extending arm of a rack through the lower portion of the switch. As the rack moves to the position shown in FIG. 12g, however, the lower running surface for the lower wheel of the lower dual guide wheels has terminated and the upper of such lower guide wheels has engaged surface 149. Thus the dual lower guide wheels have allowed the rack to bridge the window without becoming detached from the switch section.

In FIG. 12h the ramped support wheel running surface 146 continues on its upward course. At this position the running surface 146 has narrowed down considerably so that the extended support wheel is now being retracted toward its normal running position. Both wheels of the lower dual guide wheels are engaging the lower guide wheel running surfaces 149 and 153 respectively. The lower wheel of the upper guide wheels continues to engage surface 148. In the section of the connecting switch between FIG. 12h and FIG. 12i the ramped running surface 146 has reached its final height. The running surface has also been narrowed down to the width of the normal support running surface. During this portion of the connecting switch section the support wheel is retracted to a normal running position. The upper and lower wheels of the lower guide wheels engage surfaces 149 and 153. The lower wheel of the upper guide wheels continues to engage surface 148. At this point the rack has completed the switching operation including that of retracting its support wheel and the guidebeam 131 is now autonomous and may leave guidebeam 132.

A horizontal switch for switching the preferred rack of the present invention is illustrated in FIG. 13, FIGS. 13a-13g, FIG. 14 and FIGS. 14a-14b. A mainline guidebeam is generally indicated by the number 160. Two substantially horizontally spaced apart guidebeams, 161 and 162, are shown downline of the upline guidebeam 160. A connecting switch guidebeam section which provides for selectively directing a rack from upline guidebeam 160 to either one of the two downline guidebeams, 161 or 162, is located between the upline and downline guidebeams. The switch portion is illustrated in FIGS. 13b-13g and FIGS. 14a-14b. The rack, as it moves into the connecting switch section, selects the path through which it will proceed. Thus the extendable and retractable support wheel of the preferred rack selects the path on which it will run through the connecting section. By virtue of making such a selection, the rack is directed to either of the desired downline guidebeams. The operation of the rack through the horizontal switch section illustrated in FIG. 13 and FIG. 14 will now be described in detail. The path of the rack through the switch section will be described both in moving the rack from upline guidebeam 160 to both downline guidebeams 161 and 162.

Assume for the purposes of description that it is desired to direct a rack from upline guidebeam 160 to

downline guidebeam 161. The support wheel of the rack is programmed to follow the appropriate support wheel running surface as herein before described. Thus referring to FIG. 13a it is seen that the support wheel of the rack will be in normal running position and will be moving over support wheel running surface 165. The support wheel is in retracted position with respect to the rack. An upper guide running surface 166 is provided for the lower wheel of the dual upper guide wheels of the rack. A lower guide running surface 167 is provided for the lower of the dual lower guide wheels. Optionally a second lower guide running surface 168 may also be provided for the upper of the dual lower guide wheels of the preferred rack. Since it is desired to move the rack from upline guidebeam 160 through the connecting switch section to downline guidebeam 161 in substantially a horizontal mode the support wheel of the rack is maintained in a normal retracted position so as to ride on the normal portion of the horizontal support running surface 165.

As the rack proceeds downline through the connecting section to a position illustrated in FIG. 13b a second upper guide running surface 169 is provided to engage the upper of the dual upper guide wheels. The upper wheel of the dual upper guide wheels has a long axle as herein before described so as to initially engage high up on running surface 169. The other wheels of the rack at this time continue to run respectively on surfaces 165, 166, 167 and 168. As the rack moves to the position indicated in FIG. 13c the upper guide running surface 166 terminates and the rack is held in cantilevered manner by means of its upper guide wheel engaging upper guide running surface 169. As was the case in FIG. 13b the other wheels of the rack are retained on running surfaces 165, 167 and 168. The support wheel running surface 165 begins to drop down a small amount in the portion of the switch between FIG. 13c and FIG. 13d and as is illustrated in FIG. 13d the upper wheel of the dual lower guide wheels begins to leave running surface 168. The lower wheel of the dual lower guide wheels continues to run on surface 167 while the top wheel of the dual upper guide wheels continues to run on surface 169 to hold the rack in cantilevered position on the guidebeam. This is true even though the rack has moved down somewhat since the long axle of the wheel initially caused it to contact well up on running surface 169. The support wheel running surface 165 has lowered to the required extent as illustrated in FIG. 13e. Again the rack continues to move in cantilevered fashion using running surfaces 167 and 169 for the lower and upper guide wheels respectively. Between FIG. 13e and FIG. 13f the connecting switch section begins to provide a horizontally diverging path for the rack to follow to downline guidebeam section 161. Thus the running surfaces 169, 165 and 167 begin to move out and away from the other downline guidebeam 162 and therefore a rack carried by the appropriate wheels on such surfaces also moves away from the other downline guidebeam 162. In FIG. 13g the rack has moved substantially away from guidebeam 162 and is cantilevered on surfaces 169, 165 and 167. The sectional views of FIG. 14a and FIG. 14b illustrate the running surfaces of the downline guidebeam 161 as the guidebeam returns to its normal form as shown in FIG. 13a. Thus the rack proceeds on running surfaces 169, 167 and 165 through the section shown in FIG. 14a. In FIG. 14b running surface 166 has reappeared for the

lower of the upper dual guide wheels. Progressing through to guidebeam 161 to FIG. 13a, the upper running surface 169 has been discontinued and the rack is moved on running surfaces 165, 166 and 167. Again an optional running surface 168 may be provided for the upper of the dual lower guide wheels.

When it is desired to move a rack from upline guidebeam 160 to the other downline guidebeam 162 the support wheel of the rack is beginning to be extended as the rack moves into the portion of the connecting switch section illustrated in FIG. 13b. The support wheel is fully moved so that it can run on running surface 170 as shown in FIG. 13c while the upper and lower guide wheels move on surfaces 169, 167 and 168 respectively. In FIG. 13d the lower guide running surface 167 begins to drop down and the lower of the dual lower guide wheels begins to come off of this surface 167 since the support wheel in running on the support running surface 170. Running surface 168 is available for the upper wheel of the lower guide wheels through this portion of the switch. The lower running surface 167 has dropped down far enough to free the lower wheel of the dual lower guide wheels by FIG. 13e when the support wheel is on surface 170. Since the elevation of the support wheel controls the elevation of the guide wheels the top wheel of the dual upper guide wheels continues to be located high up on running surface 169. Between FIG. 13e and FIG. 13f of the running surfaces leading to downline guidebeams 161 and 162 begin to diverge. In FIG. 13f the top wheel of the upper dual guide wheels is located on surface 173 which has smoothly developed and diverged from surface 169. The bottom wheel of the lower guide wheels is above surface 167 and therefore free to move in over surfaces 167 and 165 without touching them. Thus a window for passing the rack through guidebeam 161 onto guidebeam 162 matures between FIG. 13f and FIG. 13g. A rack located at FIG. 13g and having its support wheel on surface 170 would have the top wheel of the upper dual guide wheels on surface 173 and its lower dual guide wheels on surfaces 172 and 168. The body portion of the rack clears both the upper and lower portions of guidebeam 161 and the rack may now pass through to guidebeam 162 which returns to standard mainline configuration as shown in FIG. 13a.

Refer now to FIG. 15, FIGS. 15a-15f, FIG. 16 and FIGS. 16a-16e, FIG. 15 and FIG. 16 are side elevations and FIGS. 15a-15f and FIGS. 16a-16e are sectional views of a vertical switch connecting section providing interchange between two main guidebeams. Two vertically spaced apart upline guidebeams 180 and 181 are shown. Two downline vertically spaced apart guidebeams 183 and 182 are also shown. The connecting guidebeam switch section intermediate to these guidebeams permits vertical switching between guidebeam 181 and guidebeam 182. The connecting switch section also permits passage of a rack directly through the section on either mainline guidebeam to the corresponding downline guidebeam. Thus a rack may be directed from upline guidebeam 181 through the switch section to downline guidebeam 183. In a similar fashion a rack may also be directed through the connecting switch section from guidebeam 180 to guidebeam 182. Thus both merging and diverging switching are illustrated. Obviously the reverse mode of switching is also possible. For instance the switch section may be differently

embodied so that switching may be done between guidebeams 180 and 183.

Again refer to FIG. 15 and FIG. 16 and assume first that it is desired to direct a rack from guidebeam 181 through the connecting switch section to guidebeam 183. The support wheel of such a rack would be moving on surface 185 as illustrated in FIG. 15a. The lower of the dual lower guide wheels runs on surface 186. An upper guide surface is provided for the upper of the lower dual guide wheels and is noted by the numeral 187. This surface is optional and is not necessary on the main guidebeam. A running surface 188 is provided for the lower wheel of the upper dual guide wheels. As is evident by observing FIG. 15 and FIGS. 15a-15f, the rack being directed from guidebeam 181 through the switch section to guidebeam 183 will continue to run on these surfaces. The upper of the upper dual guide wheels contacts surface 201 for a short period as noted in FIG. 15f, surface 189 develops to serve the upper of the upper dual guide wheels. As the rack moves through the portion of the connecting switch section illustrated in FIG. 16a, running surface 188 disappears in order to permit a rack passing in an upward direction to clear through. During this portion of the connecting switch section, the rack is maintained in position by means of the upper wheel of the upper dual guide wheels contacting against surface 189. Surface 189 begins to develop about FIG. 15e and carries the rack across to the portion where surface 188 is removed. Surface 188 reappears in FIG. 16b and is available to move the rack through the remainder of the switch section to downline lower guidebeam 183.

When it is desired to direct the rack from guidebeam 180 through the connecting switch section to downline guidebeam 182 the following sequence of running surfaces are provided to move the rack in a cantilever fashion through the switch section. Support wheel running surface 190 is used to carry the rack along the upline guidebeam 180. An upper guide wheel running surface 191 is initially provided for the lower wheel of the upper dual guide wheels. Surfaces 192 and 193 are formed for use by the lower and upper wheels of the lower guide wheels. As the rack moves into the portion of the connecting switch section illustrated in FIG. 15c and FIG. 15d the support wheel running surface 190 is considerably widened out and through this section the support wheel of the rack is moved to a fully extended position. As noted in FIG. 15e the support wheel running surface 190 has been moved in considerably. This is to allow passage of a rack in an upward switching mode through the connecting switch section. The lower wheel of the upper dual guide wheels continues to move on surface 191. The lower guide wheel running surface 192 disappears in FIG. 15e and the rack is supported by the upper of the lower dual guide wheels moving on surface 193. As the rack moves through the portion of the connecting switch section between FIG. 16a and FIG. 16b, a lower guide wheel running surface 195 appears and supports the lower wheel of the lower dual guide wheels as running surface 193 terminates. A second upper guide running surface 196 also develops in this portion of the connecting switch section and is used by the upper wheel of the upper dual guide wheels through FIG. 16a to FIG. 16d during the period after guide running surface 191 terminates. This upper guide wheel running surface 196 is used to cantilever the rack across the opening which allows an upward travelling

rack to pass in a vertical manner between guidebeams 181 and 182. In the section of the switch illustrated in FIG. 16c to FIG. 16e the support wheel running surface 190 narrows up again and the support wheel through this portion of the switch is retracted to a normal running position. The lower guide wheels are now running respectively on surfaces 194 and 198. An upper guide running surface 197 develops again for the lower of the upper dual guide wheels and the upper guide running surface 196 terminates so that at FIG. 15a the guidebeam is back to a standard configuration.

The mode of switching a rack in a vertical manner from guidebeam 181 through the connecting switch section to guidebeam 182 will now be described in detail. The rack travels on guidebeam 181 on support running surface 185, lower guide wheel running surfaces 186 and 187 and upper guide wheel surface 188. As illustrated through FIG. 15a to FIG. 15c, an inner support guide wheel running surface 200 is developed in the connecting switch section by widening out the original support wheel running surface 185. When it is desired to shift a rack vertically to downline guidebeam section 182 the support wheel of the rack is extended as heretofore described to run on surface 200. A new upper guide running surface 201 also is developed at FIG. 15c for engaging the upper wheel of the dual upper guide wheels. In the portion of the connecting switch section illustrated in FIG. 15d the support running surface 200 is smoothly elevating and the rack utilizes lower guide wheel running surface 187 and upper guide running surface 201 to maintain itself in a cantilever position on the connecting switch section. As the rack moves on surface 200 between FIG. 15e and FIG. 15f, the lower guide wheels continue to engage surfaces 187 and newly developed surface 204. Through this section the upper wheel of the dual upper guide wheels leaves running surface 201 just after the lower wheel of the upper dual guide wheels engages behind surface 205 which is formed by an extending leaf of the guidebeam section. This leaf forms two running surfaces. These surfaces are 189 for the lower mainline path and 205 for the vertical switch path. The lower wheel of the upper dual guide wheels follows surface 205 through the portion of the connecting switch section illustrated in FIG. 15f. A new running surface 206 for the upper wheel of the dual upper guide wheels is provided as illustrated in FIG. 15f. This surface 206 is used to carry the upper guide wheels across the opening provided for the upper mainline support wheel 190. As the support wheel moves up the elevated support surface 200, it must cross the guide arm gap used for the straight through travel of a rack. This occurs at FIG. 16a. The upper and lower wheels of the dual lower guide wheels cooperate to bridge this gap. Thus when the upper wheel of the lower guide wheels leaves surface 187, the lower wheel of the dual lower guide wheels is retained on surface 204 until the upper wheel of the dual lower guide wheels contacts surface 208. Just after this contact has been made, the lower wheel of the lower dual guide wheels goes off surface 204 and crosses the void space illustrated in FIG. 16b. The lower wheel of the dual lower guide wheels then engages surface 194 prior to the time the upper wheel leaves surface 208. Running surface 194 is the prime lower guide running surface for the guidebeam 182. Upper guide running surfaces provide running surfaces for the upper guide wheels through the transition from

FIG. 16a to FIG. 16e as follows. Surface 206 is used to carry the upper guide wheels across opening 190 for the mainline support surface. Immediately above surface 190, as illustrated in FIG. 16a and FIG. 16b, a surface 197 is developed. Surface 197 is the main upper guide wheel running surface for the mainline guidebeam 182. After these mainline running surfaces of guidebeam 182 have been contacted by the wheels of the rack, the rack is transferred to guidebeam 182. The only remaining operation is to retract the support wheel to position for movement on running surface 190. This is accomplished as heretofore described with relation to the extension and retraction of the support wheel of the rack to thus direct the rack to the selected downline guidebeam.

DESCRIPTION OF THE ALTERNATIVE EMBODIMENT

Refer now to FIG. 17 where a perspective schematic illustration of the modes of switching that may be selectively done by the alternative embodiment of apparatus of the present invention without the use of moving parts in the connecting switch section is shown. The alternative embodiment of apparatus of the present invention incorporates a support wheel at the top of the rack. As schematically illustrated in FIG. 17, the alternative rack, having the top driven support wheel, can switch from a mainline guidebeam section either to the left or to the right in a horizontal fashion to a diverging downline guidebeam and can also switch from the mainline guidebeam section vertically either up or down to a diverging downline guidebeam. Again, as indicated by the reverse arrows in FIG. 17 the opposite course may be followed by a rack through such a switch section (or obviously a mirror image switch section) constructed to provide for merging from two downline guidebeams into a main upline guidebeam. In either a merging or diverging mode switching is accomplished by the rack without the use of moving parts in the connecting guidebeam switch section. A movable means carried on the rack and particularly extendable and retractable wheels of the rack, provide for selecting one or two or more paths on a guidebeam switch section to thus determine the course that the rack will take through the connecting switch section. Thus by selectively choosing a path by extending or retracting one or more of the wheels of the rack, the rack is directed through a predetermined course in the connecting guidebeam switch section. In the alternative embodiment of apparatus the top support wheels are stroked in and out to determine the path on which they will run and to thus determine the course of the rack through the switch section.

In FIG. 18 and FIG. 19 the alternative embodiment of apparatus assembled in accordance with the present invention is shown in schematic form. FIG. 18 is a side elevation and FIG. 19 is an end elevation partially in section showing an alternative rack generally indicated by the number 220 attached to and in running position on an alternative elongated guidebeam which is generally indicated by the number 230. The guidebeam is formed to provide a path in the transportation system and serves to carry the running surfaces on which the rack 220 moves. The rack 220 includes a frame member 222 having a number of sets of spaced apart wheels rotatably attached thereto. The sets of wheels include the upper guide wheels 233 and 232;

the lower guide wheels 237 and 239; the support wheels 238 and the auxiliary support wheels 240 and 241. The support wheels 238 as will hereinafter be discussed in detail, are usually driven by a power source and therefore also function as drive wheels to move the rack along the guidebeam. As indicated in the drawings, the alternative embodiment rack has dual spaced apart upper guide wheels which include wheels 233 and 232. The lower guide wheels comprise dual spaced apart wheels 237 and 239. The dual wheels are positioned on the frame at suitable intervals depending on the load and the length of the rack. It is usually desirable to have at least two sets of dual upper guide wheels and two sets of dual lower guide wheels and two support wheels for each rack. Dual upper auxiliary support wheels 240 and 241 are also provided for each support wheel in order that certain switching operations may be accomplished by the alternative rack.

As in the preferred embodiment of apparatus, the alternative guidebeam 230 is held in desired position by suitable support means such as for example by a series of columns such as column 244, spaced apart along the right of way. The guidebeam 230 may be composed, for example, of prestressed concrete sections resting end to end on a series of supports such as column 244. Suitable overall dimensions for such prestressed sections as a guide to understanding the present invention have been found to be about 8 feet high by 6 feet wide and 100 feet long. The guidebeam is formed as illustrated in FIGS. 18 and 19 so that racks having a top support wheel can utilize both sides of the guidebeam. In this manner racks travelling in opposite directions may utilize the same guidebeam at the same time.

The guidebeam 230 provides at least three spaced apart running surfaces for the rack. Thus on each mainline right of way portion of the alternative guidebeam there is provided an upper guide running surface 234; a lower guide running surface 231 and a support wheel running surface 242. The upper guide running surface 234 and the lower guide running surface 231 have substantially vertically disposed running surfaces to accommodate the upper and lower guide wheels respectively. The support wheel running surface 242 is in a substantially horizontal plane to accommodate the support wheels. As illustrated in FIG. 18 and FIG. 19, the self-powered rack 220 is adapted to be held and to be moved on the three running surfaces of the guidebeam 230 in cantilever fashion. Thus the upper guide surface 234 is formed on a vertical inward facing wall of the guidebeam 230 while the lower guide running surface 231 is formed on a vertical outward facing wall of the guidebeam 230. The upper guide wheels 233, 232 and the lower guide wheels 237, 239 cooperate with the support wheels 238 to position the rack in cantilever fashion on the guidebeam 230.

The dual wheel configuration of the upper guide wheels 232, 233 and the lower guide wheels 237, 239 and the auxiliary support wheels 240, 241 is provided to permit the rack to be switched from an upline guidebeam to one of two or more spaced apart downline guidebeams without the need for moving parts in the connecting guidebeam switch section. The alternative form of the present invention provides for such switching of a rack 220 having a top support wheel from a mainline upline guidebeam to one of two or more diverging downline guidebeams in either a vertical or a horizontal downline mode and also to be merged from

two upline guidebeams to a single downline guidebeam in either a vertical or horizontal mode. The dual guide wheel configuration of the upper and lower guide wheels and the dual auxiliary support wheels permit continuous contact of one or the other of the respective dual upper and lower guide wheels and one or the other of the forward or rearward dual auxiliary support wheels with their respective running surfaces during the entire switching operation as the rack is switched from one guidebeam to another through the switch section. Since, as is fully explained later, it is necessary to have gaps in the running surfaces of the guide running surfaces and the support running surfaces in the connecting switch sections to permit passage of portions of a rack on different paths through such section it is necessary to have dual vertically spaced apart guide wheels on both upper and lower guide wheels and dual auxiliary support wheels so that one of the wheels of the set is always in contact with its respective running surface. The dual wheels as above described, are necessary so that the same alternative rack may utilize all of the various alternative vertical and horizontal switch sections hereinafter described. It will be obvious that for some switches a dual configuration of all the wheels is not necessary.

The rack 220 is driven along the guidebeam 230 by means of a suitable power source supplying power to the support wheel 238. As noted, it is preferred in the alternative embodiment of apparatus to use a wheel which rotates on a horizontal axis as a drive wheel. It is of course possible to provide either or both the upper and lower guide wheels with power. Motive power is supplied to the support wheel 238 by a suitable power source. Such a power source may for example be an electric motor or an internal combustion engine. Such a suitable power source is schematically illustrated in FIG. 18 by the box indicated by the number 246. If it is desired to drive more than one support wheel, then a second power source 248 may be utilized. Suitable drive train means are provided to connect power source 248 to the support wheels 238. Control means 250 are preferably carried on the rack 220 to control the power sources 246 and 248 and the movement of the rack 220 along the guidebeam 230. Control means 250 is preferably electrically activated and in many instances will be tied into a computer network so that a number of racks may be moved at closely spaced intervals along the guidebeam system.

Refer now to FIG. 20, FIG. 21 and FIG. 22 which show respectively an elevation view, a side view and a top view of the alternative rack assembled in accordance with the present invention. The rack has dual upper guide wheels 232 and 233 and lower dual guide wheels 237 and 239. Support or power wheels 238 are used to move the rack 220 along the running surfaces of the guidebeam. The upper guide wheels 232, 233 and the auxiliary support wheels 240, 241 and the main support wheel 238 are held in position by overhanging arm member 262. These wheels are adapted to extend over the upper portion of the guidebeam and engage the inner running surfaces of the guidebeam. In accordance with the invention the rack has a movable means which cooperates with dual running surfaces on the connecting switch section to provide for directing the rack from a main upline guidebeam to one of two or more diverging downline guidebeams or vice versa. Certain wheels of the rack are useful as such a means

movable. Thus support wheels 238 of the alternative embodiment of apparatus are extendable and retractable to select one of two or more diverging running surfaces of a connecting switch section.

The support wheels 238 are extended and retracted from the rack by suitable means such as illustrated schematically in FIGS. 20-22 inclusive. Suitable bell cranks 307 are pivotally mounted on pins 309. One of the ends 304 of each of the bell cranks is connected to one of the ends of the axles of the support wheels 238. The other ends 303 of each of the bell cranks are connected to a suitably arranged double acting hydraulic cylinder 305 through push rods 306. The hydraulic cylinder 305 is fixedly mounted to the frame 222 by suitable means. Thus when the hydraulic cylinder is activated, the support wheels 238 are extended or retracted by the action of the above described mechanical linkage.

The support wheels 238 are powered through suitable axles by appropriate power sources. The power source may be formed by an electric motor or an internal combustion engine. Thus electric motors 252 and 253 are connected through suitable drive train linkage indicated as 250 and 251 to the support wheels 238. The support wheel power sources are controlled by control means 254 carried on the frame 222. Suitable circuitry 255, 256 extends between the control means and the power means and the wheels to accomplish such control. Arranged on the load carrying side of the rack are a series of load hooks generally indicated by the number 281. The load hooks are used to carry loads on the side of the rack.

Thus in accordance with the alternative embodiment of the present invention at least two positions are provided for the support wheel. That is to say, a support wheel can be moved normal to the rack to two separate horizontal running surfaces and switching can be accomplished without the use of movable parts in the connecting switch section. In accordance with the invention the rack is switched or is caused to continue along a given guidebeam depending upon the running surface which the extendable and retractable support wheel elects to follow in the upstream portion of the connecting switch section. A support wheel of the present invention is thus movable between one or at least two possible positions. In the first position for example, a support wheel will follow a running surface which will permit the rack to continue along the main guidebeam right of way. In the second position the support wheel will cause the rack to be switched vertically or horizontally to an auxiliary downline guidebeam by virtue of the support wheel following a diverging support wheel running surface. The auxiliary support wheels and the dual upper and lower guide wheels follow surfaces dictated by the selection of running surface of the support wheel.

FIG. 23 and FIGS. 23a-23i show views of a vertical switch connecting section providing interchange between two main guidebeams. These FIGURES also illustrate both diverging switching and merging switching. Two vertically spaced apart upline guidebeams 380 and 381 are shown. Two downline vertically spaced apart guidebeams 382 and 383 are also shown. The connecting switch section intermediate to these guidebeams permits vertical switching between guidebeam 381 and guidebeam 382. The connecting switch section also permits passage of a rack directly through the sec-

tion on either mainline guidebeam to the corresponding downline guidebeam. Thus a rack may be directed from upline guidebeam 381 through the switch section to downline guidebeam 383. A rack may also be directed through the connecting switch section from guidebeam 380 to guidebeam 382. Obviously, the reverse mode of vertical switching is also possible in accordance with the invention. Thus the switch section may be differently embodied so that switching may be done between guidebeam 380 and guidebeam 383.

Referring again to FIG. 23, assume first that it is desired to direct a rack from guidebeam 381 through the connecting switch section to guidebeam 383. The support wheel of such a rack would be moving on surface 385 as illustrated in FIG. 23a. The lower dual guide wheels run on surface 386. An upper guide surface 387 is provided for the lower wheel of the upper dual guide wheels. As is evident by observing FIG. 23 and FIGS. 23a-23i, the rack being directed from guidebeam 381 through the switch section to guidebeam 383 will continue to run on the surfaces. The upper of the upper dual guide wheels will contact surface 401 for a short period shown in FIG. 23b and FIG. 23c, however, this does not affect the travel of the rack.

When it is desired to direct the rack from guidebeam 380 through the connecting switch section to downline guidebeam 382 the following sequence of running surfaces are provided to move the rack in cantilever fashion through the switch section. Support wheel running surface 390 is used to carry the support wheel of the rack along the upline guidebeam 380 and through the initial part of the connecting switch section. An upper guide wheel running surface 391 is initially provided for the lower wheel of the dual upper guide wheels. Surface 392 is used for the dual lower guide wheels. As the support running surface 390 moves into the portion of the connecting switch section between FIG. 23f and FIG. 23g the surface is cammed in substantially and thus the support wheel of the rack must be extended to maintain the support wheel on such surface. The surface is cammed in to permit the vertical support wheel surface coming from the lower guidebeam to come together with the upper support surface. The wheels of the rack will continue to run on surfaces 390, 391 and 392 through the portion of the connecting switch section between FIG. 23a and FIG. 23e. The upper wheel of the dual lower guide wheels leaves surface 392 in the portion between FIG. 23f and FIG. 23g. However, by this time the lower wheel of the lower dual guide wheels has made contact with surface 403 and will run on that surface during the transition period across the connecting switch section. A new running surface 404 develops between FIG. 23e and FIG. 23i. This running surface is provided for the upper wheel of the upper dual guide wheels while the lower wheel of the upper dual guide wheels leaves surface 391 as the guide wheel crosses the vertical portion of the switch. It is evident that the rack will be maintained in cantilever fashion through the switch section of FIGS. 23f-23i by means of the upper guide wheel running on surface 404, the support wheels running on surface 390 and the lower guide wheels running on surface 403. After the rack has passed the portion of the connecting switch section shown in FIG. 23i the configuration of the guidebeam 382 returns to a normal mainline configuration as illustrated in FIG. 23a.

When it is desired to vertically switch a rack from upline guidebeam 381 to merge with downline guidebeam 382 or diverge from downline guidebeam 383 the following sequence of events will occur. As the rack moves on guidebeam 381 the support wheel is extended and engages surface 405 which develops between FIG. 23b and FIG. 23c. Surface 405 is ramped up through this portion of the switch and continues to ramp up through FIG. 23i where it reaches the level of upper support running surface 390 whereupon the two surfaces merge into one. As the support wheel follows the ramped up portion of the support connecting surface 405 the upper and lower guide wheels cooperate to bridge the gaps in the running surfaces. Thus the upper wheel of the upper guide wheels contacts surface 401 prior to the time that the lower wheel of the upper dual guide wheels leaves surface 387. Then the lower wheel of the upper dual guide wheels engages surface 406 prior to the time that the upper wheel leaves surface 401. Surface 406 serves to carry the lower wheel of the upper guide wheels across the gap shown in FIG. 23g and FIG. 23h. At the section illustrated in FIG. 23i, surface 406 merges with and becomes guide surface 391. The lower dual guide wheels cooperate to bridge the gaps between surfaces 386 and 402. The guide wheels cooperate to maintain the rack on the surfaces across the gaps needed for passage of a rack on a different course. It is noted that for this mode of vertical switching that the auxiliary support wheels discussed in detail in relation to the alternative rack are not necessary. These support wheels are only necessary during certain aspects of horizontal switching as will be discussed below.

A horizontal switch for the alternative embodiment of apparatus is illustrated in FIG. 24, FIGS. 24a-24g, FIG. 25 and FIGS. 25a-25b. In this switch a rack may be directed from upline guidebeam 410 to either of a pair of diverging downline guidebeams 412 and 414. If it is desired, for example, to direct a rack from guidebeam 410 to guidebeam 414 the following running surfaces would be utilized. A support running surface 420 is used as the mainline support running surface. A guide wheel running surface 422 is provided for the lower wheel of the upper dual guide wheels and a guide running surface 424 is provided for the lower guide wheels. The support running surface 420 widens out substantially as shown in FIG. 24b and FIG. 24c to form a new guide running surface 426. When it is desired to go to guidebeam 414 the support wheel is extended to move on surface 426. An upper guide running surface 430 begins in FIG. 24b and serves to carry the upper wheel of the dual upper guide wheels through the switch section. The lower guide wheels run on surface 424 through the entire connecting switch section to guidebeam 414.

When it is desired to switch the rack from guidebeam 410 to guidebeam 412 the support wheel is maintained in a normal running position on running surface 420. This running surface is lowered beginning between FIG. 24c and FIG. 24d and finally is lowered far enough so that the auxiliary support wheels contact running surface 432 and the auxiliary wheels run on this surface through the portion of the window section of the switch illustrated in FIG. 25a. The auxiliary support wheels, of course, may be powered or momentum may be used to carry the rack through this portion of the switch. The upper dual guide wheels operate on surface 428

through the connecting switch section while the lower guide wheels pick up section 436 in FIG. 24f and utilize this surface through the window section of the switch. Thus the rack is switched to guidebeam 412.

SUMMARY OF ADVANTAGE AND SCOPE OF INVENTION

The transportation system of the present invention includes a rack having dual guide wheels and extendable and retractable support wheels for use on elongated guidebeams having improved non-moving connecting switch sections incorporated therein. The rack cooperating with the guidebeam system of the invention utilizes a movable wheel to select a path through connecting guidebeam switch sections which permit the rack to be selectively switched through the switch section in a vertical or in a horizontal mode to one or more diverging downline guidebeams or from two upline guidebeams to a single downline guidebeam. The switching is accomplished by the rack without the use of moving parts in the connecting switch section of the guidebeam system. The extendable and retractable wheel carried on the rack and preferably the support wheel of the rack is adapted to select between one of two or more paths on a guidebeam to thus determine the course that the rack will take through a connecting switch section. Thus by selectively choosing a path by extending or retracting the support wheel, the rack is directed to a predetermined course in the connecting guidebeam switch section. Racks having both lower support wheels and upper support wheels are disclosed, as are connecting switch sections for both varieties of racks.

A significant advantage of the present invention is provided by the ability to shift a rack in both vertical and horizontal modes through a connecting guidebeam section without the need for moving parts in the connecting switch. This advantage permits rapid switching of a rack which is closely followed by a second rack and thus eliminates any problem of time delay inherent in movable switch mechanisms.

Another particularly important advantage of the present invention is the plurality of choices that are available in the switching modes of the rack. That is, depending on local conditions it may be desirable to have left horizontal, right horizontal or up vertical or down vertical switching. It is also, as is evident, possible to have a combination of such switching to provide for an almost limitless variety of switching of a rack through such sections.

Another significant advantage of the present invention is that, as is evident from an understanding of the mode of switching of the present invention, if, for example, the support wheels failed to retract or to extend the rack would simply continue on the other of two or more possible downline courses. That is, a fail safe feature is built into the present switch system which, should a mechanical failure occur, would not result in a collision or derailment of the rack.

Although the invention has been described in reference to certain preferred and alternative embodiments intended for use in the transportation system, it will be appreciated that other embodiments suitable for applications in the transportation system may be provided. For example, it is clear that it is possible to make extendable and retractable one or more of the guide wheels to provide for non-moving switches which are

selected by moving the guide wheels to a predetermined path and having the guide wheels perform the directional function rather than the support wheels as the rack moves through the connecting switch section. Similarly the guide wheels may be driven by a power source and provide the driving means for the rack. Thus as mentioned, although the invention is described with reference to the preferred and alternative embodiment, it will be apparent to those skilled in the art, that additions, deletions, modifications, substitutions and other changes not specifically described and illustrated in the discussed embodiments may be made which will fall within the purview of the appended claims.

Although specific embodiments of the present invention have been described in detail, the invention is not to be limited to any such specific embodiments, but is meant to include all embodiments coming within the scope of the appended claims.

We claim:

1. A transportation system having non-moving connecting switch or merge sections comprising a main guidebeam, a first spaced apart guidebeam, a second spaced apart guidebeam, all of said guidebeams having an inwardly facing vertical upper guide running surface, an outwardly facing vertical lower guide running surface and a substantially horizontal support running surface formed thereon, a connecting guidebeam switch or merge section extending between said main guidebeam and each of said spaced apart guidebeams, first non-moving connecting running surfaces on said switch or merge section between said main guidebeam and said first spaced apart guidebeam, said first running surfaces comprising an inwardly facing vertical upper guide running surface, an outwardly facing vertical lower guide running surface and a substantially horizontal support running surface, each of said first running surfaces being connected between the counterpart running surfaces of said main guidebeam and said first spaced apart guidebeam, second non-moving connecting running surfaces on said connecting switch or merge section between said main guidebeam and said second spaced apart guidebeam, said second running surfaces comprising an inwardly facing vertical upper guide running surface, an outwardly facing vertical lower guide running surface and a substantially horizontal support running surface, each of said second running surfaces being connected between the counterpart running surface of said main guidebeam and said second spaced apart guidebeam, a rack for cantilevering on a guidebeam having wheels for use in moving on the running surfaces of said guidebeams, said wheels including a support wheel for running on said support surface, and upper and lower guide wheels for running on said upper and lower guide surfaces, and movable means on said rack for selectivity moving on one of said connecting running surfaces to selectively move said rack through said switch or merge section between said main guidebeam and one of the said spaced apart guidebeams.

2. The apparatus of claim 1 further characterized in that the main guidebeam is an upline guidebeam and the spaced apart guidebeams are diverging downline guidebeams.

3. The apparatus of claim 2 further characterized in that the downline guidebeams are horizontally spaced apart.

4. The apparatus of claim 1 further characterized in that the spaced apart guidebeams are diverging upline guidebeams which merge downline into the main guidebeam.

5. The apparatus of claim 4 further characterized in that the upline guidebeams are horizontally spaced apart.

6. The apparatus of claim 1 further characterized in that the movable means on said rack are extendable and retractable support wheels movable between at least two positions.

7. The apparatus of claim 6 further characterized in that the support wheels are located near the lower part of said rack.

8. The apparatus of claim 6 further characterized in that the support wheels are located near the top of said rack.

9. The apparatus of claim 8 further characterized in that an auxiliary support wheel is located adjacent to each support wheel.

10. The apparatus of claim 6 further characterized in that the rack has a pair of dual vertically spaced apart lower guide wheels.

11. The apparatus of claim 10 further characterized in that each of the support wheels is located between each set of dual lower guide wheels.

12. The apparatus of claim 1 further characterized in that the connecting running surfaces of the connecting guidebeam sections contain gaps to pass portions of a rack.

13. The apparatus of claim 12 further characterized in that the dual lower guide wheels cooperate to bridge such gaps as the rack is moved through the connecting switch section.

14. The transportation system of claim 1 further characterized in that said first or said second running surface of said connecting guidebeam switch section includes an inwardly facing vertical upper guide running surface formed by a depending wall of said connecting guidebeam switch section.

15. A rack for use in cantilever fashion on a guidebeam comprising a frame, at least two upper guide wheels rotatably mounted on a normally vertical axis on an overhanging arm of said frame, at least two lower guide wheels rotatably mounted on a normally vertical axis on said frame, at least two support wheels rotatably and reciprocally mounted on a normally horizontal axis on said frame and means for extending and retracting at least two of said support wheels in a direction normal to said frame.

16. The apparatus of claim 15 further characterized in that the support wheels are located near the lower part of said frame.

17. The apparatus of claim 16 further characterized in that the frame has power means attached thereto for rotatably driving at least one of said support wheels.

18. The apparatus of claim 15 further characterized in that the support wheels are located near the top of said frame.

19. The apparatus of claim 18 further characterized in that the frame has power means attached thereto for rotatably driving at least one of said support wheels.

20. Apparatus comprising a frame, at least three types of wheels rotatably mounted on said frame, said types comprising at least a pair of spaced apart upper guide wheels rotatably mounted on a normally vertical axis, at least two spaced apart lower guide wheels rotatably mounted on a normally vertical axis and at least two spaced apart support wheels rotatably mounted on a normally horizontal axis, means for driving at least one of said wheels and means for extending and retracting the wheels of at least one of said types in a direction normal to the direction of the plane of rotation of the wheels of one of said types.

21. The apparatus of claim 20 further characterized in that the support wheels are the extendable and retractable wheels.

22. A method of moving a rack cantilevered on three running surfaces of a guidebeam between a main guidebeam and one of two or more spaced apart guidebeams comprising moving said rack along one of said guidebeams in cantilevered position, determining which of the other of said guidebeams to move said rack, moving a means movable on said rack to select a running surface for said rack, and moving said rack to said selected guidebeam.

23. The method of claim 22 further characterized in that the rack is switched horizontally.

24. The method of claim 22 further characterized in that the rack is switched from an upline guidebeam to one of two or more diverging downline guidebeams.

25. The method of claim 22 further characterized in that the rack is merged from one or more diverging upline guidebeams to a downline guidebeam.

26. The method of claim 22 further characterized in that wheels of said rack are moved in a direction normal to the direction of travel of said rack to select a running surface for said wheels.

27. The method of claim 22 further characterized in that a portion of said rack is passed through a gap in said running surface causing said rack to move on said running surface to the selected guidebeam while bridging said gap with wheels of said rack.

28. The method of claim 27 further characterized in that the rack is switched horizontally.

29. A method of switching a rack cantilevered on a guidebeam to another guidebeam comprising moving a rack longitudinally along a guidebeam, moving said rack transversely on said guidebeam to a new running surface on said guidebeam and directing said rack on said new running surface to another guidebeam.

30. The method of claim 29 further characterized in that support wheels are connected to the rack and are extended or retracted normal to the direction of travel of the rack to selectively engage the new running surface to move the rack to another guidebeam.

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