

Dec. 7, 1965

S. J. GROSSMAN

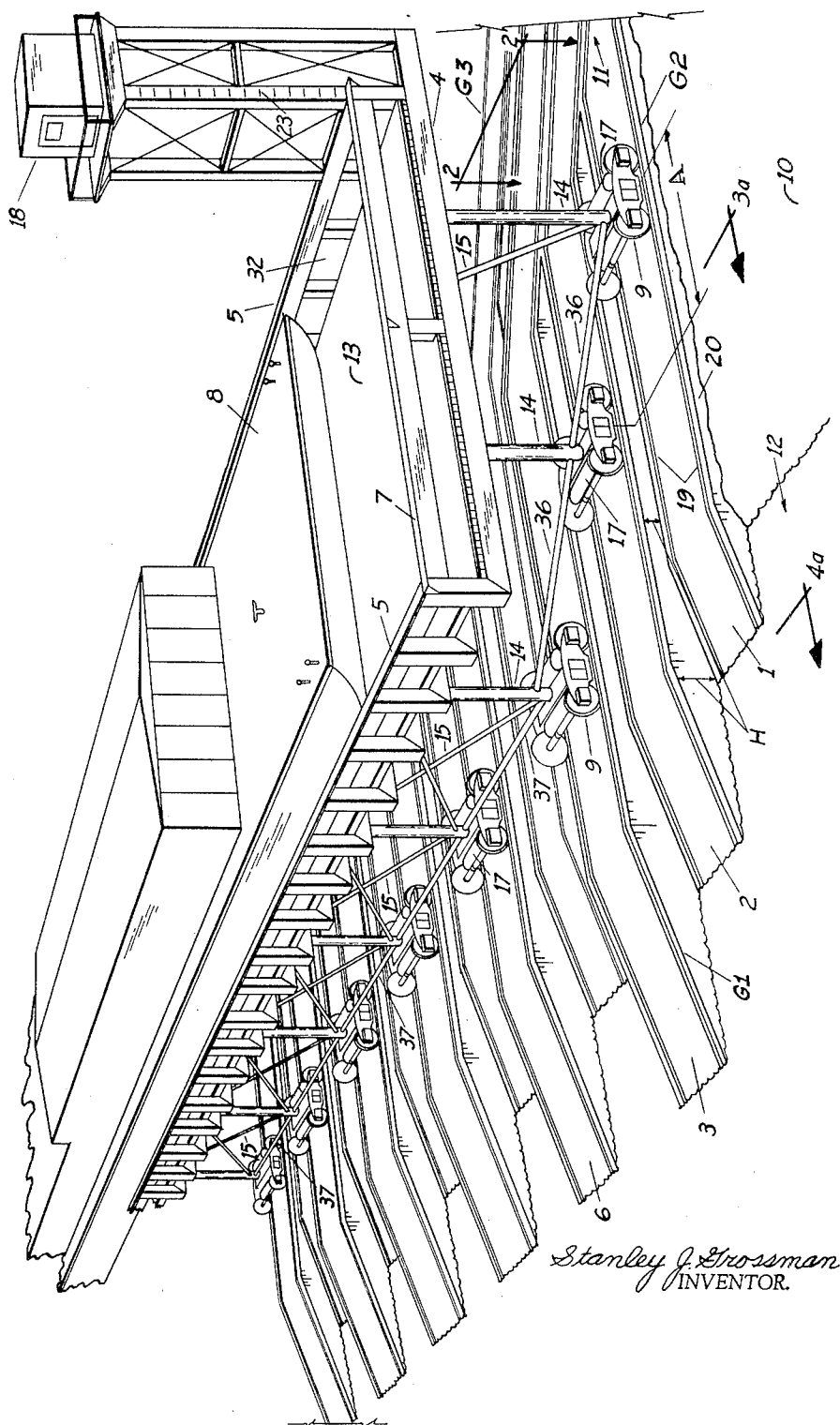
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DIFFERENTIAL INCLINED RAILWAY TRANSIT MEANS

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Fig. 1



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Fig. 2

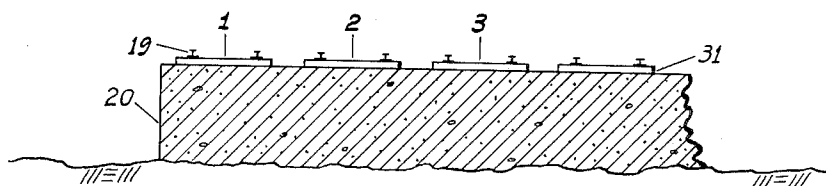


Fig. 3

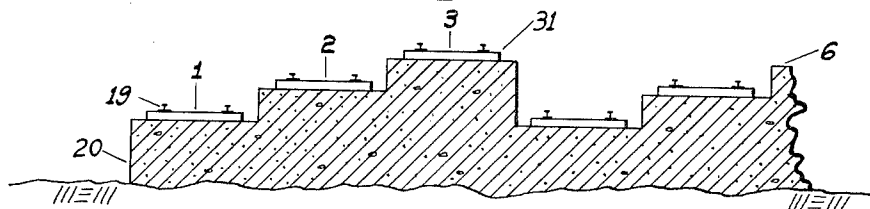


Fig. 4

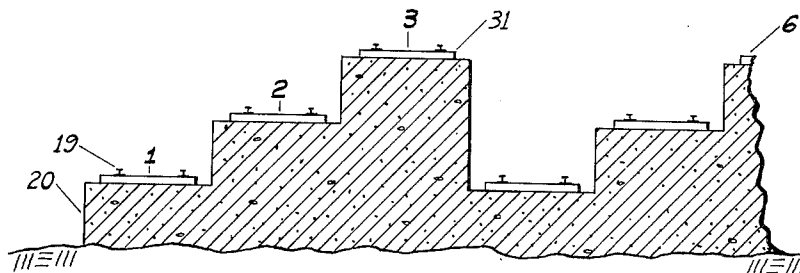
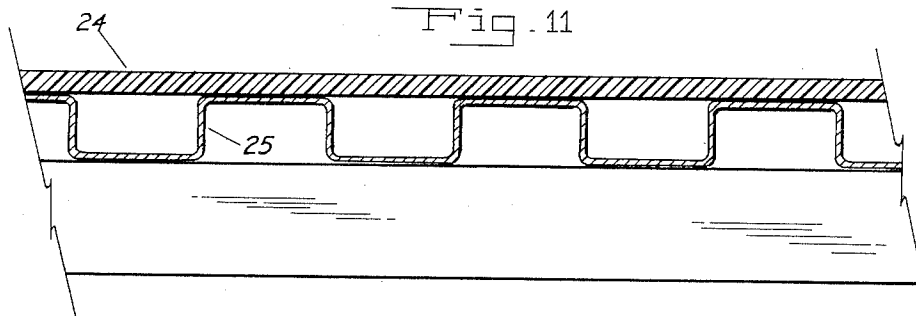


Fig. 11



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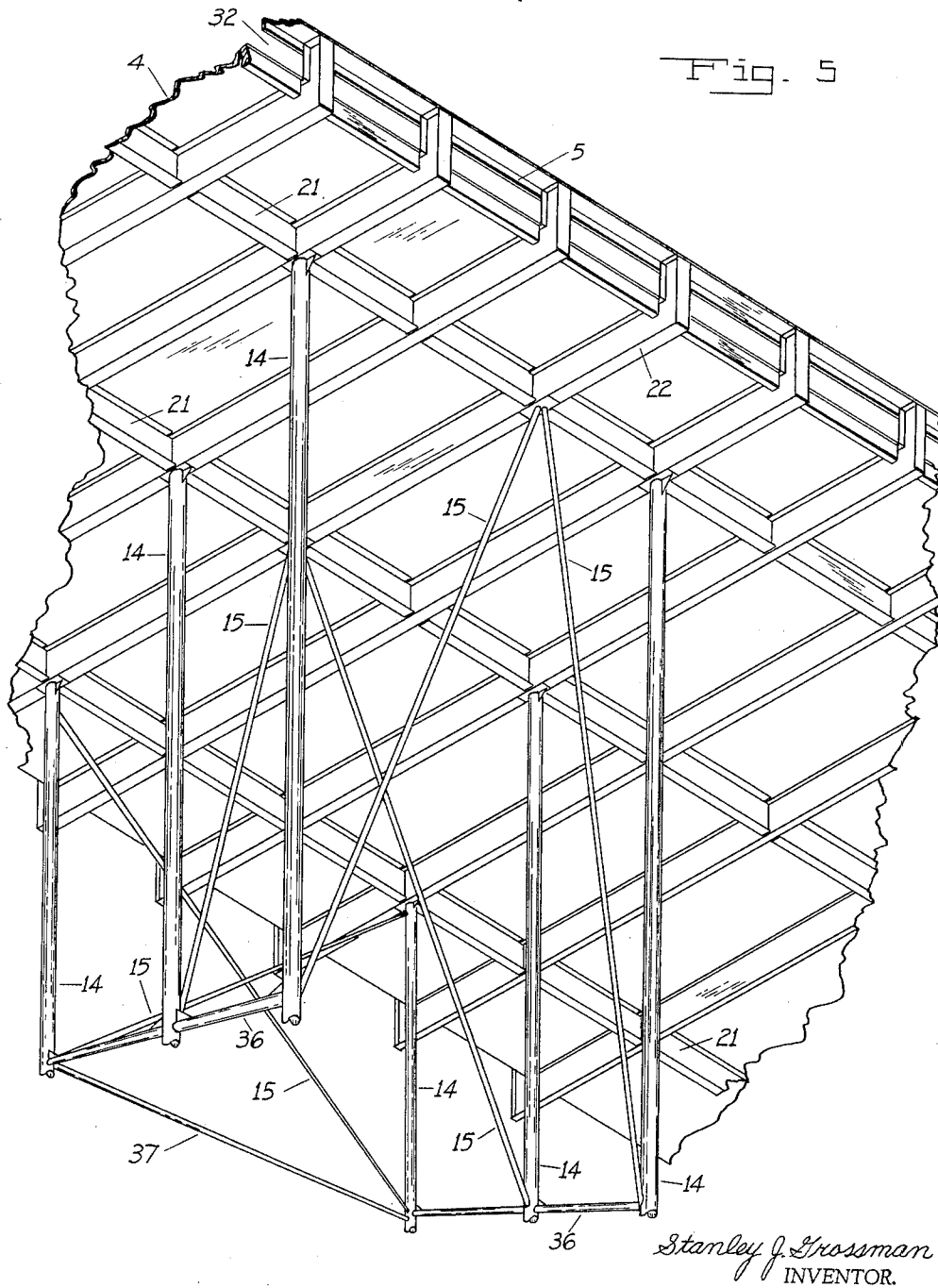
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Fig. 6

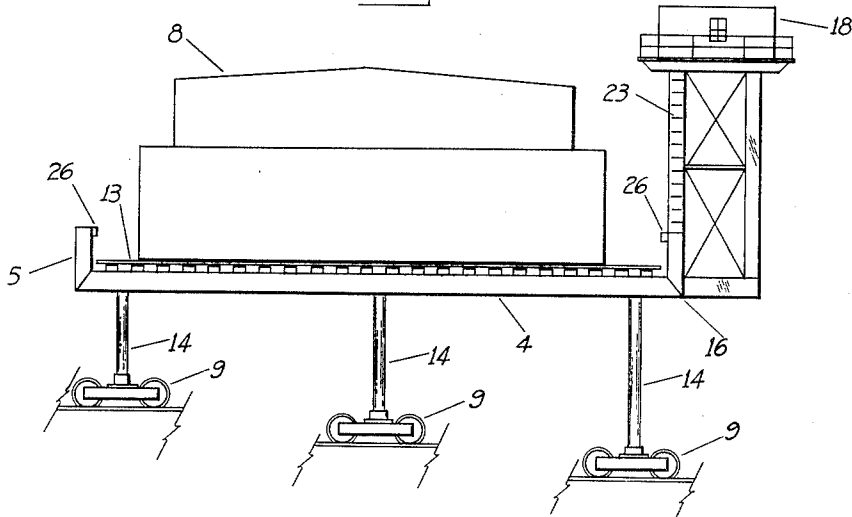
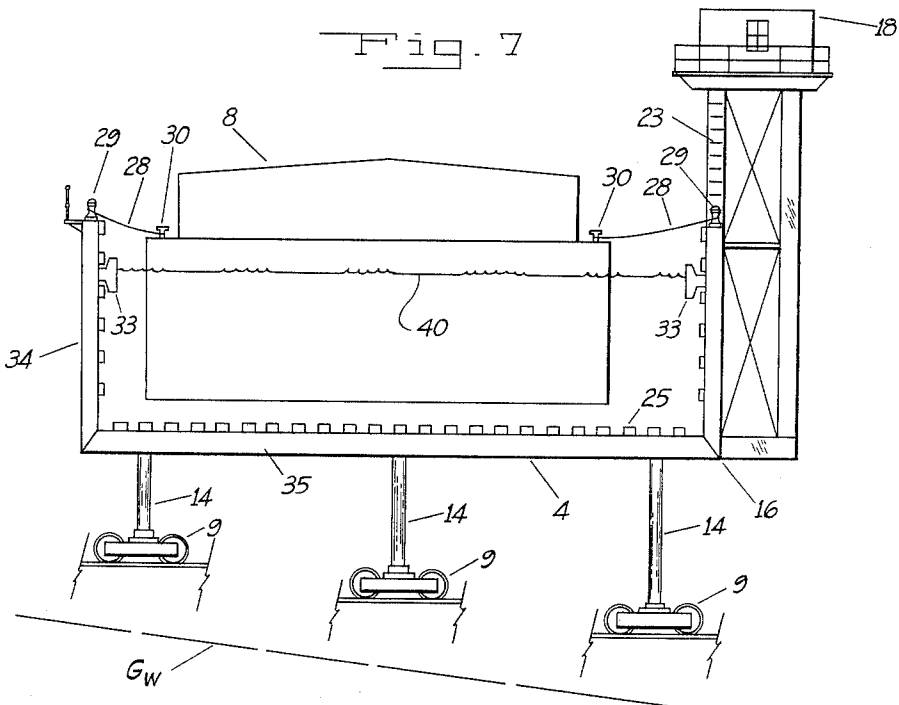


Fig. 7



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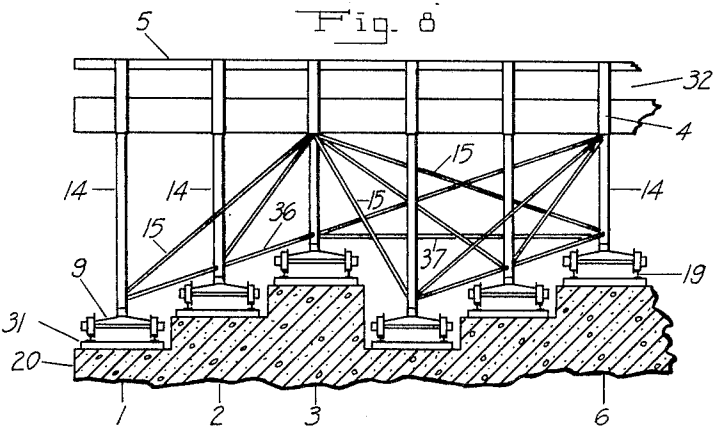
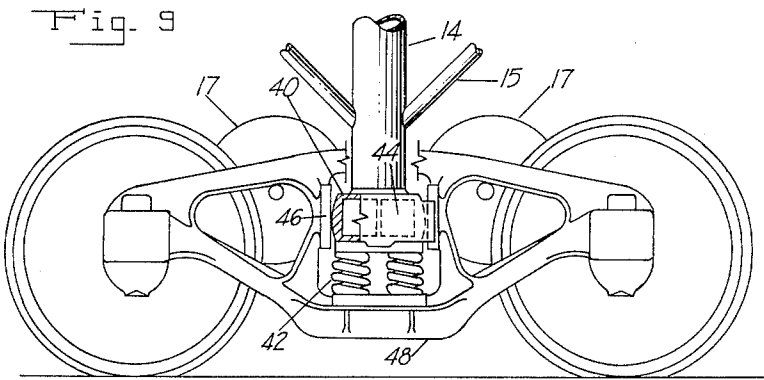
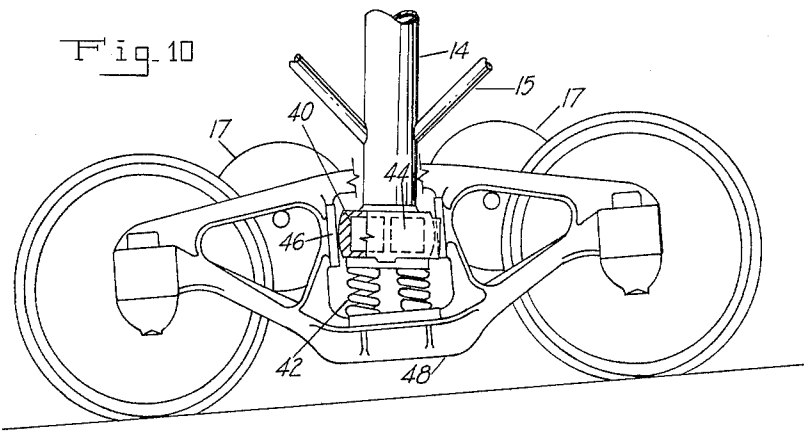
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DIFFERENTIAL INCLINED RAILWAY TRANSIT MEANS

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8 Claims. (Cl. 61—67)

This is a continuation-in-part of my copending application Serial Number 126,628, filed July 25, 1961, and now abandoned.

The present invention relates to a novel transit means for transporting vehicles or other loads from one level to another. More particularly it is concerned with an improvement in canal and river lock operation in which ships or other water borne loads are transported by means of a carriage or a tray running on an inclined railway, the carriage or tray and its load remaining entirely level during the trip from one water level over a crest and into another water level notwithstanding the fact that the distance from the bottom of the wheel assemblies to the water level in the tray varies as does the distance from the bottom of the wheel assemblies to the bed of the tray.

Modern day water locks are extremely expensive installations due principally to the complicated hydraulic system required and the enormity of the gates and walls used to confine and to control the flow of water within the various chambers of the lock. In the operation of the conventional lock system, a ship or barge heading for a higher level enters the lock chamber through gates at the lower end. Gates at the upper end remain closed. When the ship is completely within the lock chamber, the lock master in his control station closes the lower gates and then opens the intake valves. This permits water from the upper level to flow through the intakes and into the lock chamber. When the water inside the lock chamber is even with that of the upper level, the lock master closes the intake valves, opens the gates at the upper end, and signals the ship to continue on its journey up the waterway. In going from a higher to a lower level, the procedure is just the reverse of that described.

In the past, systems have been devised involving the use of rail mounted carriages to transport a barge or ship from one water level to another with the load and the tray remaining entirely level during the trip from one water level over a crest and into another water level. However such systems have a major drawback in that, because the distance from the bottom of all wheel assemblies to the water level in the tray is the same as is the distance from the bottom of the wheel assemblies to the bed of the tray, differential ways are required on both sides of the crest to keep the load level. Stated otherwise, each set of tracks is depressed or offset vertically by an amount sufficient to keep the carriage level as it travels along either incline. As a result complex way construction is required on both the long and the short inclines. On the other hand, as will be seen from the description that follows, the tracks or ways of my invention need to be set at different levels only in the area of the crest and the short incline for the upper water level. The ways on the long lower water level incline are all in the same plane. This results in less expensive way construction than is required by prior art lifts of this general type.

In the drawings, FIGURE 1 is a perspective view of the ship lift with ways displaced from each other at the crest in all three directions.

FIGURE 2 is a fragmentary sectional view taken along line 2—2 of FIGURE 1.

FIGURE 3 is a fragmentary sectional view taken along line 3a of FIGURE 1.

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FIGURE 4 is a fragmentary sectional view taken along line 4a of FIGURE 1.

FIGURE 5 is a fragmentary isometric view of the underneath side of the carriage showing details of the supporting structure employed.

FIGURE 6 is an end elevational view of the ship lift holding a barge or similar vessel. The end protective railing has been removed in this view.

FIGURE 7 is a modification of FIGURE 6 in which said vessel is transported from one level to another in a body of water.

FIGURE 8 is a fragmentary elevational view, partly in section, looking at the low side of the carriage illustrating the varying supporting column lengths required to maintain the ship lift level during its travel on said ways and also showing the bracing arrangement necessary to avoid interference with the ways.

FIGURE 9 is a fragmentary elevational view of an individual wheel assembly on a flat grade with an electric motor mounted thereon to power said assembly.

FIGURE 10 is a modification of FIGURE 9 showing the truck wheel assembly when the carriage is on an incline of about 6 degrees.

FIGURE 11 is a fragmentary section of the bed of ship lift shown in FIGURE 6.

Briefly, my invention combines the use of a multiple wheeled carriage and differential ways arranged to support the carriage in a level position throughout the installation. The arrangement of ways is such that the difference in elevation, which I designate as H , between any two tracks along the portions of the installation where the tracks are parallel to each other should be equal to the product of the distance between the centers of the groups of wheels running on the two tracks measured in the direction of the track (dimension A) and the algebraic difference between the grade of the track, G_T (either G_1 , G_2 , or G_3 of FIGURE 1), and the grade of the line tangent to the groups of wheels running on the two tracks, G_W (see FIGURE 7), when the carriage tray is level where G_W is any grade except zero or:

$$H=A(G_T-G_W)$$

Expressed otherwise, the way for each group of wheels has the same shape in that each of said ways has the same level length across the crest and the same slope on either side of the crest. The ways are displaced from each other at the crest in all three directions, distances equal to the spacing in these three directions between the groups of wheels running on the ways.

Referring again to the drawings in which corresponding parts in all figures have the same numbers, FIGURE 1 shows a multiple wheeled ship lift 4 equipped with side railings 5 and end railings 7 carrying a barge 8. The portion of the installation shown is at the crest where each of the equal ways carrying the ship lift 4 are displaced in three directions from each other, distance equal to the spacing between their respective wheel assemblies in these three directions. For example, way 2 is higher than way 1 a distance equal to the difference in elevation of the two wheel assemblies running on said ways when the bed of the ship lift is level. Also way 2 is moved way from way 1 in the direction of the track, a distance equal to the spacing in this direction of the wheel assemblies running on the two ways. And finally, way 2 is displaced from way 1 in a direction perpendicular to the direction of the track a distance equal to the spacing in this direction of the wheel assemblies running on said ways.

In FIGURE 7 one tangent line on a grade of G_W is tangent to all of the wheel assemblies. Although this requirement is not necessary to comply with the theory underlying this invention, it does permit the ways on one

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side of the crest 10 to be level across the tracks, as shown in FIGURE 2. In FIGURE 1 the side of the crest that has ways level with respect to one another is side 11, the lower water level side. In this manner the construction of the varying height ways, i.e., the more complicated construction, is confined to the crest 10 and to the upper water level side 12, which is a shorter side than the lower water level side.

The ways on the lower water level side 11 of the crest have equal slopes as do the ways on the upper water level side 12 and the ways at the crest 10. Since each of the ways has the same crest length their shapes are equal. The bed 13 of shift lift 4 is supported by columns 14 which, in the pictured installation, increase in length from the upper water level side 12 of the ship lift 4 to the lower water level side 11. Columns 14 are supported on wheel assemblies 9 and are stabilized by angular braces 15 and 36 and horizontal connecting braces 37. The length of the columns 14 should be sufficient to allow for adequate clearance of the upper water level side 12 between the trailing edge 16 of lift 4 and the high ways such as, for example, ways 3 and 6.

Ship lift 4 may be propelled by any of a number of well known methods such as, for example, by the use of axle mounted, submersible, electric (D.C.) motors 17 distributed in a suitable pattern on several of the wheel assemblies, one of which is shown in FIGURE 9. These motors may be powered by diesel electric generators located in the control house 18, which is built on the lift. Alternatively, the power may be provided by an outside source through a trolley wire arrangement.

FIGURES 2 to 4 are detailed sectional views taken along line 2-2, 3a and 4a, respectively, of FIGURE 1. They show rails 19 supported on ties 31 which are in turn supported by concrete ways 20. Since FIGURE 3 represents a section taken at the crest of the installation, the difference in the heights of any two ways is equal to the difference in the elevation of the wheel assemblies running on the two ways, as previously indicated.

The development of this difference in height can also be seen from the formula, $H=A(G_T-G_W)$. In this equation A equals the distance in the direction of the track between the centers of the wheel assemblies 9 running on ways 1 and 2. G_T , the grade of the track, is equal to G_2 at the crest, which is zero percent in this case since the crest is level. Using a sign convention for grades, based on a plus grade going up from left to right and a minus grade going down from left to right, the grade of the wheels, G_W , would be a minus grade. Therefore, H at the crest between ways 1 and 2 is equal to $A(0-(-G_W))$ or $A(G_W)$.

Applying the same formula to the same two ways in FIGURE 4, G_T is equal to G_1 , which is a plus grade according to the previously described criteria, and therefore H at this location is equal to $A(G_1-(-G_W))$ or $A(G_1+G_W)$.

In FIGURE 5 the structural details below the deck of ship lift 4 are shown. Columns 14 support beams 21 and 22 at the intersections thereof. Beams 21 and 22 are shown as solid web members such as, for example, wide flange beams, but if fewer ways and large wheel spacings are required the solid web beams can be replaced by deeper, stronger open web members. The bracing 15, 36 and 37 has been placed in locations where it will not interfere with the high ways on the upper water level side 12 of crest 10.

FIGURE 6 is an end view of ship lift 4 with the end railing 7 removed. The ladder 23 provides access to the control house 18. As shown in detail in FIGURE 11, barge 8 rests on cushioning material 24 such as, for example, neoprene, which is in turn supported by corrugated, corrosion resistant steel flooring 25. A restraining cushioning bumper 26 is placed on the inside of the side railings 5 and the end railing 7 (not shown).

In FIGURE 7, barge 8 is carried in water 40 and is

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secured therein by means of hawsers 28 which are tied to a post 29 on the lift from a post 30 on the barge. The bumpers 33 protect the sides 34 of the lift. As shown in FIGURE 7, the floor 35 and the sides 34 of the lift are lined with corrugated, corrosion resistant steel 25.

FIGURE 8 is a fragmentary view of shift lift 4 viewed from the low water level side 11 of the installation. The bracing 15, 36 and 37 has been so placed to avoid interference with the high way 3 on crest 10 and on the upper water level side 12. Side railing 5 is shown along with the side opening 32, which permits the water to escape when the ship lift raises the barge out of the water.

FIGURE 9 is a modified railroad car truck wheel assembly having axle mounted motors 17 on either side of column 14 which is fixed to the center of bolster 40 which in turn rest on springs 42. The assembly is shown resting on a level grade. The bolster can move only in a vertical direction. Movement in a direction transverse to the track is prevented by keeper plates 44 (shown partially cut away) on both sides of the bolster which fit against the ends of the truck frame bolster bearing plates 45. Movement in the direction of the track is prevented by the curved slides of the bolster being in contact with the truck frame bolster bearing plates. The springs 42 are held in place by studs on the bolster and frame that are centered in the springs.

FIGURE 10 is a modification of FIGURE 9 showing the truck wheel assembly as it is on a relatively slight incline, i.e., less than about 6 degrees. The bracing 15 maintains the column 14 and the bolster 40, to which it is attached, in an erect position and therefore the frame 43 must rotate to accommodate an incline. In the event that relatively steep grades are required, i.e., in excess of about 6 degrees, the column is attached to the bolster with a journal type bearing to permit the frame to rotate more freely with respect to the column, than the springs will allow.

The procedure for picking the ship up with the ship lift 4 shown, for example, in FIGURE 6 involves running the lift into the water below the bottom of the ship before the ship moves into a specified pick-up position. After the ship is moved into this position, lift 4 moves upward along the slope (either G_1 for the upper water or G_3 for the lower water side). The bed 13 of the lift engages the bottom of the ship and thereby lifts it. To release the ship the lift moves down into the water a sufficient distance to allow the ship to float off.

It will be apparent to those skilled in the art to which my invention relates that numerous variations or modifications thereof may be made in the structure described above without departing from the scope thereof. In general, it may be said that my invention is considered to cover any transit means wherein the relationship of any two of the differential ways to each other along the portions of the installation where the two ways are parallel to each other is based on the relationship of the carriage wheel assemblies running thereon according to the following equation:

$$H=A(G_T-G_W)$$

wherein H equals the difference in elevation between any two ways along the portions of the installation where the two ways are parallel to each other; A equals the horizontal distance in the direction of the track between the centers of the wheel assemblies running on the two tracks; G_T equals the grade of the track along the portion of the installation under consideration; and G_W equals the grade of a line tangent to said wheel assemblies at their point of contact with the tracks, where G_W is any grade except zero, which is the G_W in the case of prior art structures such as that shown, for example, in French Patent No. 757,137.

I claim:

1. A transit means having ascending and descending ways, a horizontal crest section connecting said ways, said

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ways having positive and negative slopes of the same numerical value on opposite sides of said crest section, a plurality of ways on said crest running parallel with the longitudinal axis of said means, the ways on said crest and on only one side thereof being displaced vertically from one another, a mobile carriage having a plurality of wheel assemblies, equal in number to said ways, adapted to run thereon, the difference in elevation (H) between any two adjacent of the aforesaid vertically displaced ways and the alignment of said wheel assemblies on said two ways being defined by the equation:

$$H=A(G_T-G_W)$$

where A is the distance between centers of wheel assemblies on said two ways, G_T is the grade of said two ways at the location of said wheel assemblies, G_W represents the grade, other than zero, of a line tangent to the wheels on said two ways, whereby said carriage remains substantially level on said ways when moved from one side of said crest to the other.

2. A transit means having ascending and descending ways, a horizontal crest section connecting said ways, a plurality of ways on said crest running parallel with the longitudinal axis of said means, the ways on said crest and on one side thereof being displaced vertically from one another, a mobile carriage having a generally flat bed, individual support members attached to said bed, a wheel assembly affixed to each of said support members and adapted to run on said ways, said support members varying in length from one side of said bed to the other, the difference in elevation (H) between any two adjacent of the aforesaid vertically displaced ways and the alignment of said wheel assemblies on said two ways being defined by the equation:

$$H=A(G_T-G_W)$$

wherein A, G_T and G_W are defined as in claim 1.

3. A transit means having ascending and descending ways, a horizontal crest section connecting said ways, said ways having positive and negative slopes of the same numerical value on opposite side of said crest section, a plurality of ways on said crest running parallel to the longitudinal axis of said means, the ways on said crest and on the descending side thereof being displaced vertically from one another, a mobile carriage having a generally flat bed, individual support members attached to said bed, a wheel assembly affixed to each of said support members and adapted to run on said ways, said support members varying in length from one side of said bed to the other, the difference in elevation (H) between any two adjacent of the aforesaid vertically displaced ways being defined by the equation:

$$H=A(G_T-G_W)$$

wherein A, G_T and G_W are defined as in claim 1.

4. In a canal locks transit means, the combination which comprises ascending and descending ways, a horizontal crest section connecting said ways, a plurality of horizontally disposed ways on said crest running parallel with the longitudinal axis of said means, each of said ways being the same level distance across said crest, the ways on said crest and on the descending side thereof being displaced vertically from one another, a mobile carriage having a plurality of wheel assemblies equal in number to said ways and adapted to run thereon, the differences in elevation (H) between any two adjacent of the aforesaid vertically displaced ways and the alignment of the wheel assemblies on said two ways being defined by the equation:

$$H=A(G_T-G_W)$$

wherein A, G_T and G_W are as defined in claim 1.

5. A transit means for supporting a load from one level to another with the load being in a stationary position at all times, said means having in combination a plurality of ways disposed perpendicularly to the direc-

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tion of travel of said load, said ways having inclined and substantially level portions in which all ways are parallel, the ways on said inclined and substantially level portions being vertically displaced from one another, and a carriage holding said load supported on wheel assemblies running on said ways, the difference in elevation (H) between any two adjacent of the aforesaid vertically displaced ways and the alignment of said wheel assemblies on said two ways being defined by the equation:

$$H=A(G_T-G_W)$$

wherein A is the horizontal distance in the direction of the ways between the centers of the wheel assemblies running on said two ways, G_T is the grade of said two ways at the location of said wheel assemblies, and G_W represents the grade, other than zero, of a line tangent to said wheel assemblies at their point of contact with said ways.

6. In a transit means, the combination which comprises a set of inclined parallel ways vertically displaced from one another, a mobile carriage having a generally flat bed, individual support members attached to said bed, a wheel assembly affixed to each of said support members and adapted to run on said ways, said support members varying in length from one side of said bed to the other, the difference in elevation (H) between any two adjacent of the aforesaid vertically displaced ways and the alignment of said wheel assemblies on said two ways being defined by the equation:

$$H=A(G_T-G_W)$$

wherein A, G_T and G_W are defined as in claim 1.

7. A transit means for transporting a load from one water level over a crest and into another water level with said load in a horizontal position, said means comprising ascending and descending ways disposed perpendicularly to the direction of travel of said load, said descending ways being vertically displaced from one another, a mobile carriage having a generally flat bed, individual support members attached to said bed, a wheel assembly affixed to each of said support members and adapted to run on said ways, said support members varying in length from one side of said bed to the other, the difference in elevation (H) between any two adjacent of the aforesaid vertically displaced ways and the alignment of said wheel assemblies on said two ways being defined by the equation:

$$H=A(G_T-G_W)$$

wherein A, G_T and G_W are defined as in claim 1.

8. In a transit means, the combination which comprises a substantially level crest portion having a plurality of vertically displaced parallel ways running the length of said crest, a mobile carriage having a generally flat bed, individual support members attached to said bed, a wheel assembly affixed to each of said support members and adapted to run on said ways, said support members varying in length from one side of said bed to the other, the difference in elevation (H) between any two adjacent of the aforesaid vertically displaced ways and the alignment of said wheel assemblies on said two ways being defined by the equation:

$$H=A(G_T-G_W)$$

wherein A, G_T and G_W are defined as in claim 1.

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