Feb. 3, 1942. B. R. LEFFLER ET AL 2,271,697

VERTICAL LIFT BRIDGE CONSTRUCTION

Filed May 2, 1939 3 Sheets-Sheet 1

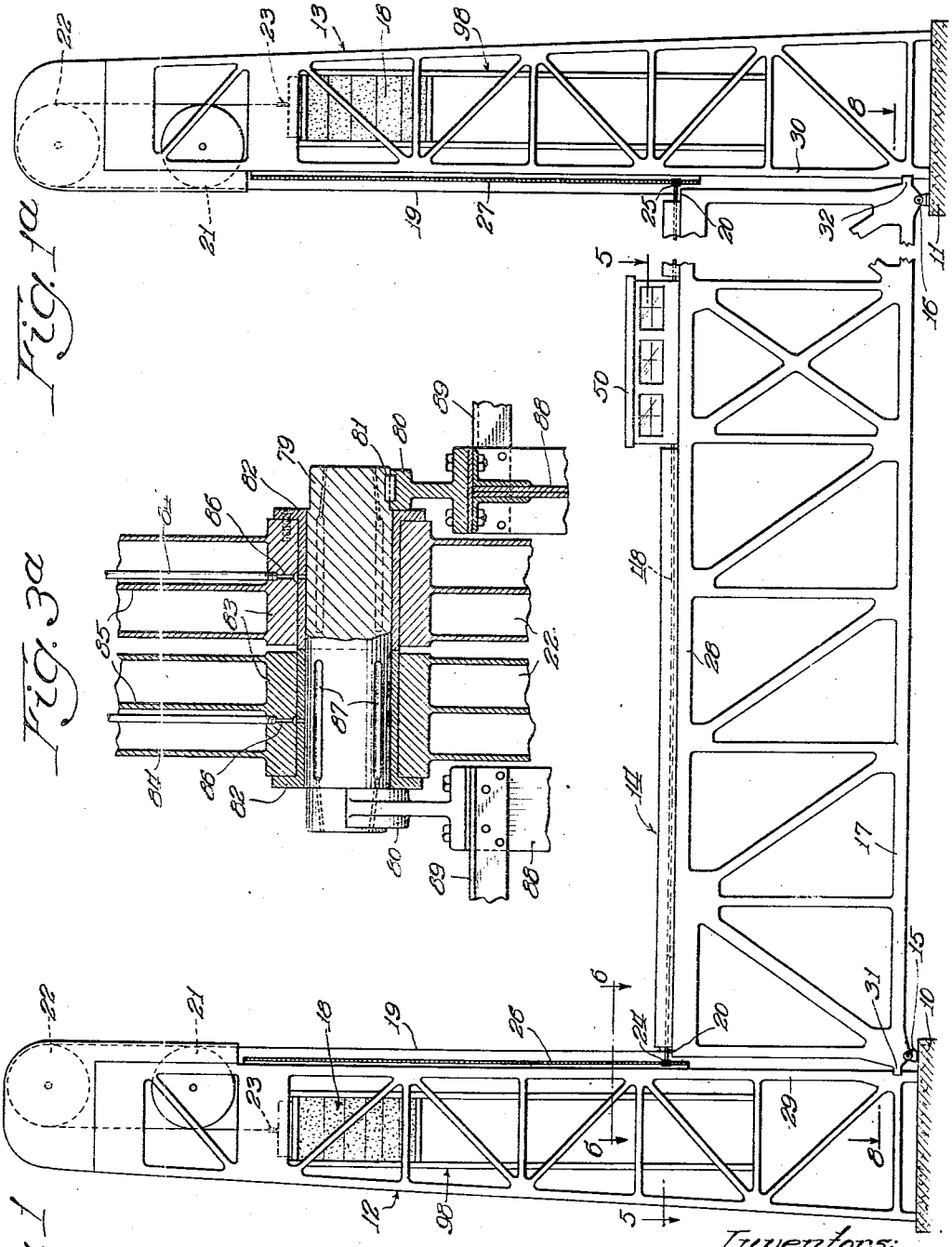


Fig. 1a

Fig. 3a

Fig. 1

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Fig. 3

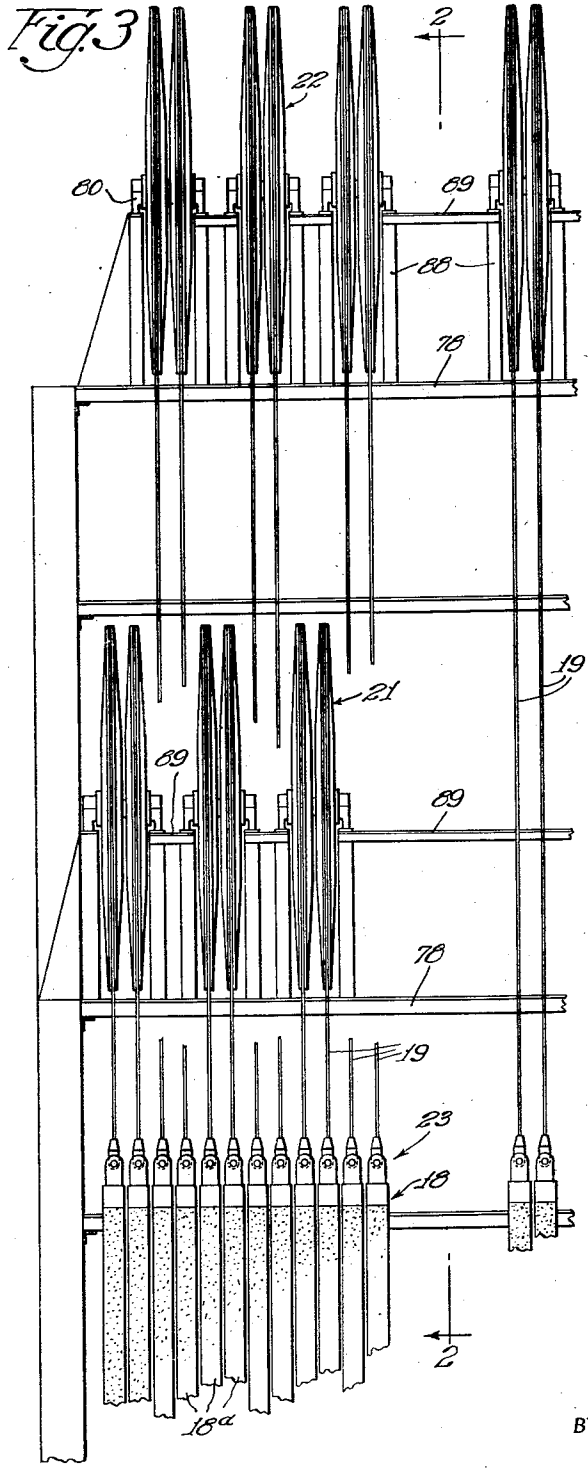
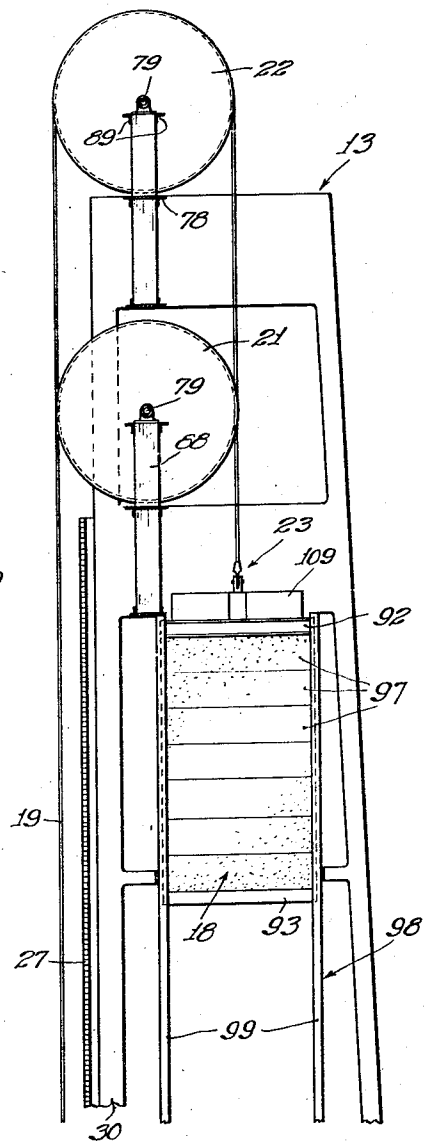


Fig. 2



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Fig. 4

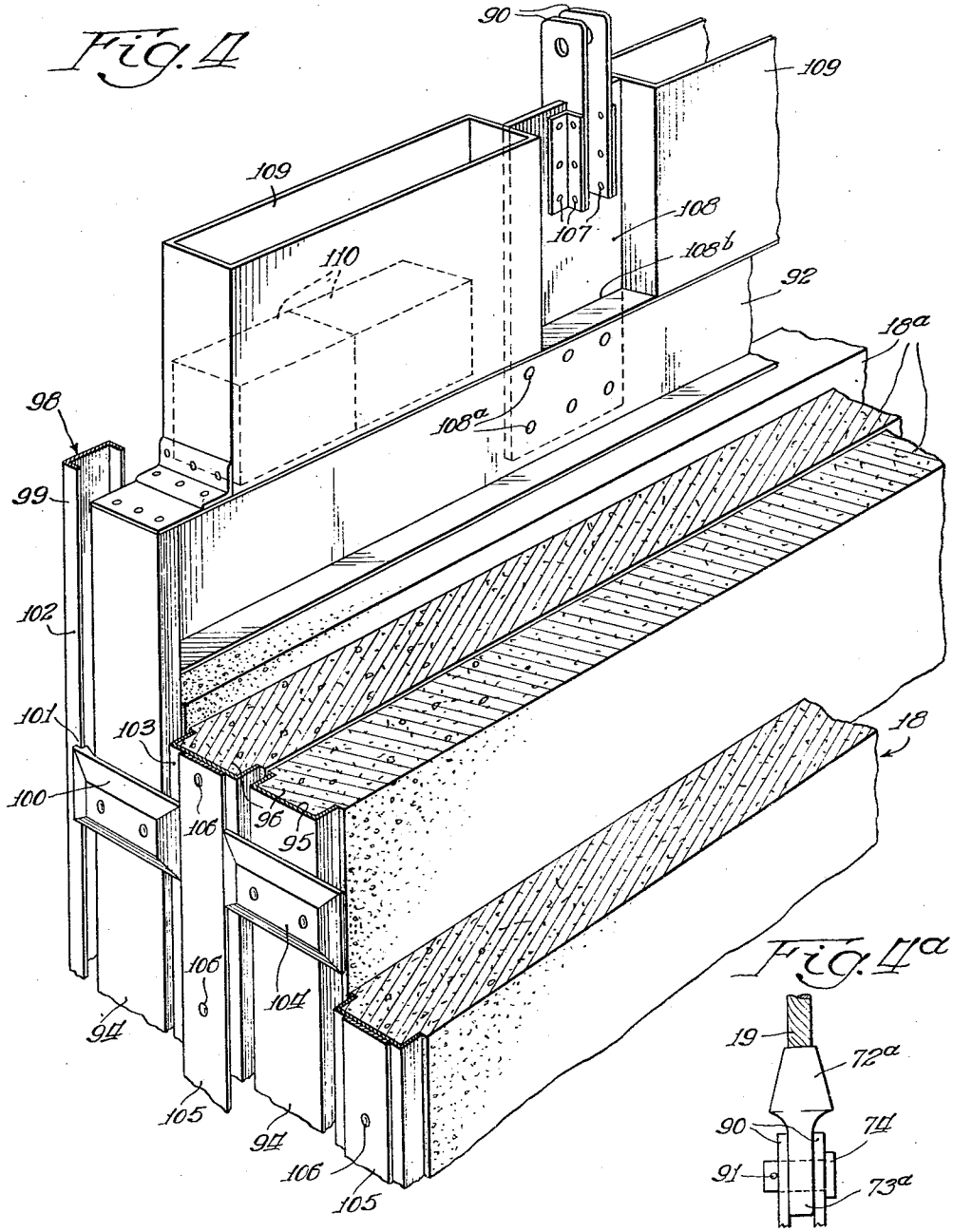


Fig. 4a

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VERTICAL LIFT BRIDGE CONSTRUCTION

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Application May 2, 1939, Serial No. 271,370

10 Claims. (Cl. 14—42)

This invention relates to vertical lift bridge construction and aims to provide an improved construction with enhanced efficiency of operation and maintenance.

In bridges of this class which are moved by a vertical translatory motion, as is desirable in many locations particularly on railroads, difficulties have been encountered in securing true rectilinear movement of the lift span, without canting which would be highly undesirable, both as causing excessive wear on the bridge parts and also unsatisfactory seating of the lift span in normal position. The present construction has been found to eliminate these difficulties in a marked degree and with accompanying enhanced strength, simplicity and economy of parts while rendering the operation more certain and dependable.

Other objects and advantages will be apparent from the following description, taken together with the accompanying drawings, in which—

Figure 1 is a general side elevational view of one end of a bridge construction embodying the present invention;

Figure 1*a* is a similar view of the other end of said bridge;

Figure 2 is a side elevational view of parts of the structure on a somewhat larger scale, taken on the line 2—2 of Fig. 3;

Figure 3 is a front elevational view of the portion of the structure of Fig. 2 on a still larger scale, parts being shown in section;

Figure 3*a* is an axial sectional more detailed view on a still larger scale of the sheave bearings shown more generally in Fig. 3;

Figure 4 is a somewhat still further enlarged view of a counterweight group constituted in accordance with the present invention with the various counterweights shown in stepped-off sections for clearness of description; and

Figure 4*a* is an elevational view of the cable socket and pin employed with the construction of Fig. 4.

Referring in detail to the illustrative construction shown in the drawings, the piers 10 and 11 may be of the usual concrete formation and on opposite sides of a navigable waterway, say, which is desired to be spanned by the bridge which has the vertically extending towers 12 and 13 and the vertically movable horizontal lift span 14, the towers being fixed in the usual way on the concrete piers 10 and 11 and the span 14 being carried by and movable on the towers while the span is being raised, the latter being otherwise also supported by the piers 10 and 11 as by chairs 15 and 16. It will be understood that there are two of the chairs 15 and two of the chairs 16 at opposite ends of the bridge and that it is desirable when the bridge is in normal position to have the chairs 15 and 16 all seat on the piers to insure a proper position of the span with respect to the roadway which passes through the open framework at the bases of the towers and is continued through the open frame work on the span, the roadbed itself being in the vicinity of the lower chords 17 of the lift span.

The towers 12 and 13 serve not only as supports and guides for the lift span but also as supports and guides for the counterweights 18 by which the weight of the span is equalized so that the span may be raised by a minimum expenditure of energy. A plurality of cables 19 at each end of the bridge have ends thereof fixedly secured to the span as at 20 and then pass upwardly over devices such as the sheaves 21 or 22 which change the direction of the cables and from which the free ends of the latter depend and are secured as at 23 to the counterweights.

In accordance with the present invention, at least less than half of the cables at one end of the span have independent counterweights attached thereto, by which is meant that at each end of the span the cables are not all attached to the same counterweight and desirably, as here shown, each cable has its individual counterweight which in gravitational response is substantially independent of every other counterweight while at the same time the counterweights advantageously have common means preventing substantial lateral movement of the individual counterweights but permitting individual vertical movement.

So counterbalanced, the span may be readily raised or lowered by the torque effect of rotation of pinions 24 and 25 carried by the lift span and engaging racks 26 and 27 respectively carried by the towers, there being interengaging guiding means on the towers and span for preventing lateral movement of the span while at the same time permitting slight limited longitudinal movement of the span at one end to accommodate variations in the length of the span due to expansion or contraction of the material thereof.

In accordance with the preferred construction, the racks 26 and 27 are each located in a vertical plane passing through the longitudinal center line of the span and these racks are so constructed as to serve also as guides engaged by guide rollers attached to the lift span and located approximately in the plane of the top

chords 28 of the span. Other guides are provided by the corner posts 29 and 30 of each tower engaged by shoes 31 and 32 respectively carried by the span in the vicinity of the lower chords 17 of the span. This arrangement provides a triangular or three-point guiding means at each end of the span, the apex of the triangle so defined being in the longitudinal center plane of the span, and adjacent the upper chords thereof, whereas the base of the triangle has its corners at the corner posts of the tower and in the region of the lower chords of the span, as is well known in the art.

Means for rotating the pinions 24 and 25 to actuate vertical movement of the span may be provided by motor mechanism suitably protected from the weather by a shed 50 carried by the upper chords 28 of the span and driving the pinions through a shaft 48 comprising suitable speed reduction means.

Turning now to the counterweight system, as already referred to, in accordance with the present invention and as best understood from Figs. 2 and 3, as here shown, each of the cables 19 passes over an individual sheave 21 or 22 as the case may be, and has attached thereto an individual counterweight 18. At this point it may be mentioned that one advantage of the present invention is that the individual sheaves may be desirably staggered to save space, in this case some of the cables 19 passing over the lower row of sheaves 21 and others passing over the upper row 22, but there being otherwise no difference in the construction, function and operation of the sheaves, cables and counterweights. It will be understood that the rows of sheaves 21 and 22 respectively are carried in each instance by the adjacent tower cross struts 78 as next described.

As here shown, in order further to save space, the sheaves are mounted in pairs, each pair having a common axle 79, as best shown in Fig. 3a. This short axle, one for each pair of sheaves, is carried as here shown, by a pair of semi-cylindrical bearings 80 to which the axle is keyed as at 81. Before the axle is set into the bearings 80 it has passed thereonto a transversely split bushing having the outwardly flanged bushing sections 82 upon one of each of which is pressed a sheave through its hub 83. The axial length of the combined bushing sections 82 is such that they are received with a snug rotative fit between bearings 80 and these bearings cooperate with the flanges of the bushing sections to prevent axial movement of the sheaves on their axle, the inner unflanged ends of the bushing sections abutting with a free running fit at the center of the axle and the hubs of the sheaves of a pair having suitable play therebetween to permit independent rotation of each sheave of a pair and its individual bushing section on their common axle. The bushing sections 82, for example, may be of bronze and the axle 79 of polished steel, to provide a good sliding contact with a minimum of friction, or, if desired, ball or roller bearings or other anti-friction devices may be employed. These bearings may be lubricated, for example, by conduits 84 carried by the web 85 of the sheave each having a mouth at the periphery of the sheave and communicating at their inner end with a duct 86 in the hub of the sheave, which may be continued through the bushing, and the axle 79 may have suitable lubrication grooves therein as at 87.

The pairs of bearings 80 may be suitably mounted on vertical supports 88 which project upwardly from and are suitably secured at one end to the cross struts 78 of the tower structure, the pair of sheaves thus turning not only between the bearings but also between the vertical supports, these being of a sufficient height to clear the sheaves above the cross struts. Horizontal reinforcing cross struts 89 between the vertical supports strengthen the supports 88 and bearings 80 against lateral stresses.

The connections of the free ends of the cables to the counterweights are shown in detail in Figs. 4 and 4a. The cable end as shown in Fig. 4a is suitably secured in the socket 72a and the clevis end 73a of the socket is received between a pair of lugs 90 attached to the individual counterweight as presently described, the headed pin 74 passing through the clevis 73a and lugs 90 and being secured therein by the cotter 91.

In the present novel counterweight system, the individual counterweights are desirably cast concrete slabs 18a, each carried by a steel frame comprising at the top and bottom I-beams 92 and 93 and, at the sides, inwardly facing channel bars 94 into which the concrete is grouted as at 95. The channel bars 94 are desirably of slightly less width than the thickness of the slabs so that the edge of the slab forms somewhat of a tongue 96 securedly embedded in the channel bar. For further securement if desired, anchors may project from the channel bars 94 into the concrete body, as is well known in the concrete art and need not be here described. The slab received in one of the frames just described may be made up of a plurality of edge-to-edge slab sections 97 as here shown, or may be cast as a monolith, but in either case, desirably the I-beams 92 and 93 are suitably secured to the side channel bars 94 so as to provide a frame constituting, with its concrete interior, a single independent counterweight 18 for one of the cables.

In order to guide the counterweights in their vertical movement within a tower 12 or 13 and to prevent lateral joint or relative displacement of the counterweights, each tower carries a cage 98 for its respective group of counterweights within which this movement of the counterweights is permitted and limited. In the present embodiment of the drawings, this cage includes four vertical uprights 99 placed at each corner of one of the joint counterweight groups. The uprights 99 are advantageously of channel form with the channels facing inwardly toward the counterweights and the two outermost counterweights of a group carry a runner plate 100 fixed to the side frame member or channel bar 94 of the counterweight and which projects laterally beyond the counterweight at each side. The outer side of this plate is formed with a vertically extending groove 101 which receives the flange 102 of the cage upright 99 slidingly therein. Runner plate 100 extends at its inner side to lap the margin 103 of the adjacent intermediate counterweight and this interconnection is continued throughout the group of counterweights in that every other counterweight has a similar runner plate 104 which laps slidingly one of the margins 103 of each next adjacent counterweight. The alternate counterweights which do not have the runner plates desirably have face strips 105 fixed to their side frame members 94 as by rivets 106 and which terminate short of the side margins 103 to cooperate in providing a track for the runner plates of the adjoining counterweights. Desirably, the counterweights which carry the runner plates have

four of these plates, two near the top of the counterweight and two near the bottom. Thus the counterweights themselves desirably provide their own common cage parts movable with the counterweights for preventing lateral joint and relative movements of the counterweights while permitting vertical joint and relative movements of the counterweights, the cage parts provided in this instance by the counterweights themselves moving vertically therewith within the fixed cage parts **99**.

The lugs **90** by which the cable is attached to its individual counterweight are each riveted as here shown at **107**, to a vertically extending hanger **108** suitably securely attached as by rivets **108***a* to the I-beam **92** of the counterweight, the flange of the beam being slotted as at **108***b* to receive the hanger, as best shown in Fig. 4. At each side of said hanger is conveniently located a pair of open-top boxes **109** into which adjustment counterweight increments may be placed, such for example as the concrete bricks **110** when it is desired to add to the weight of a counterweight.

It will be understood that the cage parts **99** that are carried within the towers in fixed position, within the framework of the tower, terminate short of the roadway-continuing lower portions of the towers, and the counterweights even in extreme upper position of the lift span never descend lower than the lower ends of the cage parts **99**.

In the present construction if the groove on the sheave becomes worn it can be re-cut and although this may result in a diameter slightly different from the diameters of the sheaves of the other counterweights, it will have no disturbing effect. Whether the length of the cable be actually increased by stretching or in effect increased by deepening of the groove in the sheave, each individual counterweight by the action of gravity acting independently thereon will seek its own level in the counterweight group necessary to keep its associated cable taut, the individual counterweights of a group sliding vertically relatively to each other for such purpose by the sliding interconnections **103** and **104** already described. The counterweights and their associated cables may thus be of unequal length without causing the span to get out of level, so long as the drive shaft **48** is common to both the pinions **24** and **25** and these pinions are of the same diameter. Also, when lowering the span and bringing it to rest upon its chairs in the fully closed position, application of the force at the rack on the longitudinal center line of the bridge and at the apex of the triangular connections already described forces the span down until the chairs are seated, the counterbalancing system offering no resistance to this operation. The present construction is therefore markedly self-equalizing.

By the present construction, the life of the cables is materially enhanced, and substantial economy in upkeep and maintenance of the bridge effected.

It will be understood that it is not essential that all features of the present invention be used conjointly, as various combinations and subcombinations may be advantageously employed. Furthermore, the invention is not limited to details of construction shown for purposes of illustration, and such changes may be made as fall within the scope of the claims without departing from the invention.

We claim:

1. In a structure of the class described embodying a pair of towers and a lift span carried by and movable vertically between the towers by translation in a vertical plane, the combination therewith of means for carrying and moving the span including cables, one end of each cable being attached to the span and the other end passing over a device at the top portion of one of the towers to depend freely therefrom and having an individual counterweight attached to each cable, wherein a plurality of the counterweights are jointly guided by and independently movable in a cage common to said counterweights, said cage preventing substantial lateral movement of the individual counterweights but permitting individual vertical movement and wherein the cage is provided in part by plates carried by alternate counterweights and slidingly lapping the common adjacent counterweight.

2. In a structure of the class described embodying a pair of towers and a lift span carried by and movable vertically between the towers by translation in a vertical plane, the combination therewith of means for carrying and moving the span including cables, one end of each cable being attached to the span and the other end passing over a device at the top portion of one of the towers to depend freely therefrom and having an individual counterweight attached to each cable, wherein a plurality of the counterweights are jointly guided by and independently movable in a cage common to said counterweights, said cage preventing substantial lateral movement of the individual counterweights but permitting individual vertical movement and wherein the cage is provided in part by plates carried by alternate counterweights and slidingly lapping the common adjacent counterweight and carried by the outermost counterweights of a group to slidingly engage cage uprights fixed to the tower.

3. In a structure of the class described embodying a pair of towers and a lift span carried by and movable vertically between the towers by translation in a vertical plane, the combination therewith of means for counterbalancing the span including a plurality of cables at each end of the span, one end of each cable being in supporting relation to the span and the other end passing over a sheave carried adjacent the top of the tower at that end, the sheaves being arranged in staggered relation in upper and lower rows on the tower with some of the cables passing over sheaves in the upper row and others passing over sheaves in the lower row, counterweights individual to each cable and a cage carried by each of the towers common to a plurality of the counterweights at that end of the span, said cage preventing substantial lateral movement of the counterweights but permitting both common and individual vertical movement of the counterweights.

4. In a structure of the class described embodying a pair of towers and a lift span carried by and movable vertically between the towers by translation in a vertical plane, the combination therewith of means for carrying and moving the span including cables, one end of each cable being attached to the span and the other end passing over a device at the top portion of one of the towers to depend freely therefrom and having an individual counterweight attached to each cable, wherein a plurality of the counterweights are jointly guided by and independently movable in a cage common to said counter-

weights, said cage preventing substantial lateral movement of the individual counterweights but permitting individual vertical movement and wherein the cage is provided in part by plates carried by alternate counterweights and slidingly lapping the common adjacent counterweight, and wherein the said plates are attached to channel bars forming side frame members for concrete bodies of the counterweights, said bars being narrower than the concrete body with and the concrete body being tongued into the channel bars.

5. In a structure of the class described embodying a pair of towers and a lift span carried by and movable vertically between the towers by translation in a vertical plane, the combination therewith of means for carrying and moving the span including cables, one end of each cable being attached to the span and the other end passing over a device at the top portion of one of the towers to depend freely therefrom and having an individual counterweight attached to each cable, wherein a plurality of the counterweights are jointly guided by and independently movable in a cage common to said counterweights, said cage preventing substantial lateral movement of the individual counterweights but permitting individual vertical movement and wherein the cage is provided in part by plates carried by alternate counterweights and slidingly lapping the common adjacent counterweight, said adjacent counterweight having a vertically extending face strip spaced from each of its vertical edges leaving margins providing tracks for said plates.

6. In a structure of the class described embodying a pair of towers and a lift span carried by and movable vertically between the towers by translation in a vertical plane, the combination therewith of means for counterbalancing the span including a plurality of cables at each end of the span, one end of each cable being in supporting relation to the span and the other end passing over a sheave carried adjacent the top of the tower at that end, the sheaves being arranged in staggered relation in upper and lower rows on the tower with some of the cables passing over sheaves in the upper row and others passing over sheaves in the lower row, the sheaves being arranged in pairs, every other of said pairs being in an opposite row on an axle common to each pair for free rotative movement of each sheave of a pair with respect to the other sheave of said pair, and counterweights individual to each cable, whereby relatively close spacing of the cables is permitted while affording access to the sheaves.

7. In a structure of the class described embodying a pair of towers and a lift span carried by and movable vertically between the towers by translation in a vertical plane, the combination therewith of means for counterbalancing the span including a plurality of cables at each end of the span, one end of each cable being in supporting relation to the span and the other end passing over a sheave carried adjacent the top of the tower at that end, the sheaves being arranged in staggered relation in upper and lower rows on the tower with some of the cables passing over sheaves in the upper row and others passing over sheaves in the lower row, counterweights individual to each cable and a cage carried by each of the towers common to a plurality of the counterweights at that end of the span, said cage being provided in part by plates carried by the counterweights and vertically slidingly lapping an adjacent counterweight.

8. In a structure of the class described embodying a pair of towers and a lift span carried by and movable vertically between the towers by translation in a vertical plane, the combination therewith of means for counterbalancing the span including a plurality of cables at each end of the span, one end of each cable being in supporting relation to the span and the other end passing over a sheave carried adjacent the top of the tower at that end, the sheaves being arranged in staggered relation in upper and lower rows on the tower with some of the cables passing over sheaves in the upper row and others passing over sheaves in the lower row, counterweights individual to less than half of the cables at that end, and a cage carried by each of the towers common to a plurality of the counterweights at that end of the span, said cage comprising cage parts movable with the counterweights and preventing substantial lateral movement of the counterweights but permitting both common and individual vertical movement of the counterweights.

9. In a structure of the class described embodying a pair of towers and a lift span carried by and movable vertically between the towers by translation in a vertical plane, the combination therewith of means for counterbalancing the span including a plurality of cables at each end of the span, one end of each cable being in supporting relation to the span and the other end passing over a sheave carried adjacent the top of the tower at that end, the sheaves being arranged in staggered relation in upper and lower rows on the tower with some of the cables passing over sheaves in the upper row and others passing over sheaves in the lower row, and counterweights individual to less than half of the cables at that end.

10. In a structure of the class described embodying a pair of towers and lift span carried by and movable vertically between the towers by translation in a vertical plane, the combination therewith of two vertically spaced apart rows of sheaves carried by each tower, the sheaves of each row being arranged in horizontally spaced apart pairs and pairs of the vertically spaced apart rows being staggered whereby to place a pair of one of the vertically spaced apart rows between a pair of pairs of the other vertically spaced apart rows, cables, one end of each cable being attached to the span and the other end passing over one of said sheaves and alternate pairs of said cables passing over a pair of the sheaves of the lowermost of the spaced apart rows and over a pair of the uppermost of the spaced apart rows, and an individual counterweight attached to each cable.

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