United States Patent [19]

Gottlieb et al.

[11] **3,858,928**

[45] **Jan. 7, 1975**

[54] **SYSTEM FOR PLACING FACTORY PREFABRICATED HOUSING UNITS**

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[73] Assignee: **Diamonhead Corporation,** Mountainside, N.J.

[22] Filed: **Jan. 22, 1974**

[21] Appl. No.: **435,458**

Related U.S. Application Data

[62] Division of Ser. No. 312,575, Dec. 6, 1972, Pat. No. 3,831,770.

[52] **U.S. Cl.** ..... **294/81 SF,** 294/67 DB, 212/44

[51] **Int. Cl.** **B66c 1/28**

[58] **Field of Search** ..... 294/67 R, 67 B, 67 BC, 294/67 D, 67 DA, 67 DB, 81 R, 81 SF; 212/11, 14, 42, 44, 125, 127, 129; 214/392, 394, 396

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Primary Examiner—Evon C. Blunk
Assistant Examiner—Johnny D. Cherry
Attorney, Agent, or Firm—Lane, Aitken, Dunner & Ziems

[57] **ABSTRACT**

A self transportable system and method for placing full size, interiorly finished factory constructed housing units the system having as basic components, a vehicular rotary crane, a snubbing frame mountable on the crane to swing with the boom thereof, a load spreader to be handled by the crane during house placement operations and a transporter to position a housing unit relative to the crane and adapted to receive the spreader for site-to-site travel.

8 Claims, 19 Drawing Figures

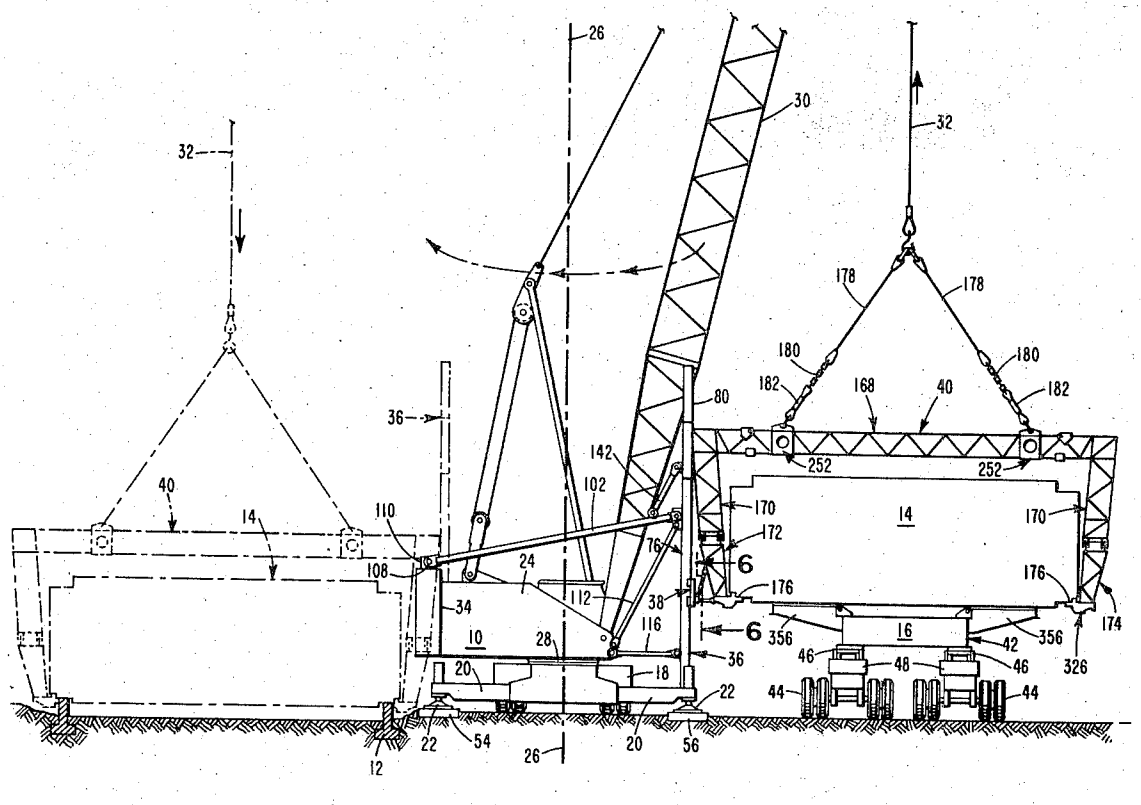


FIG. 1

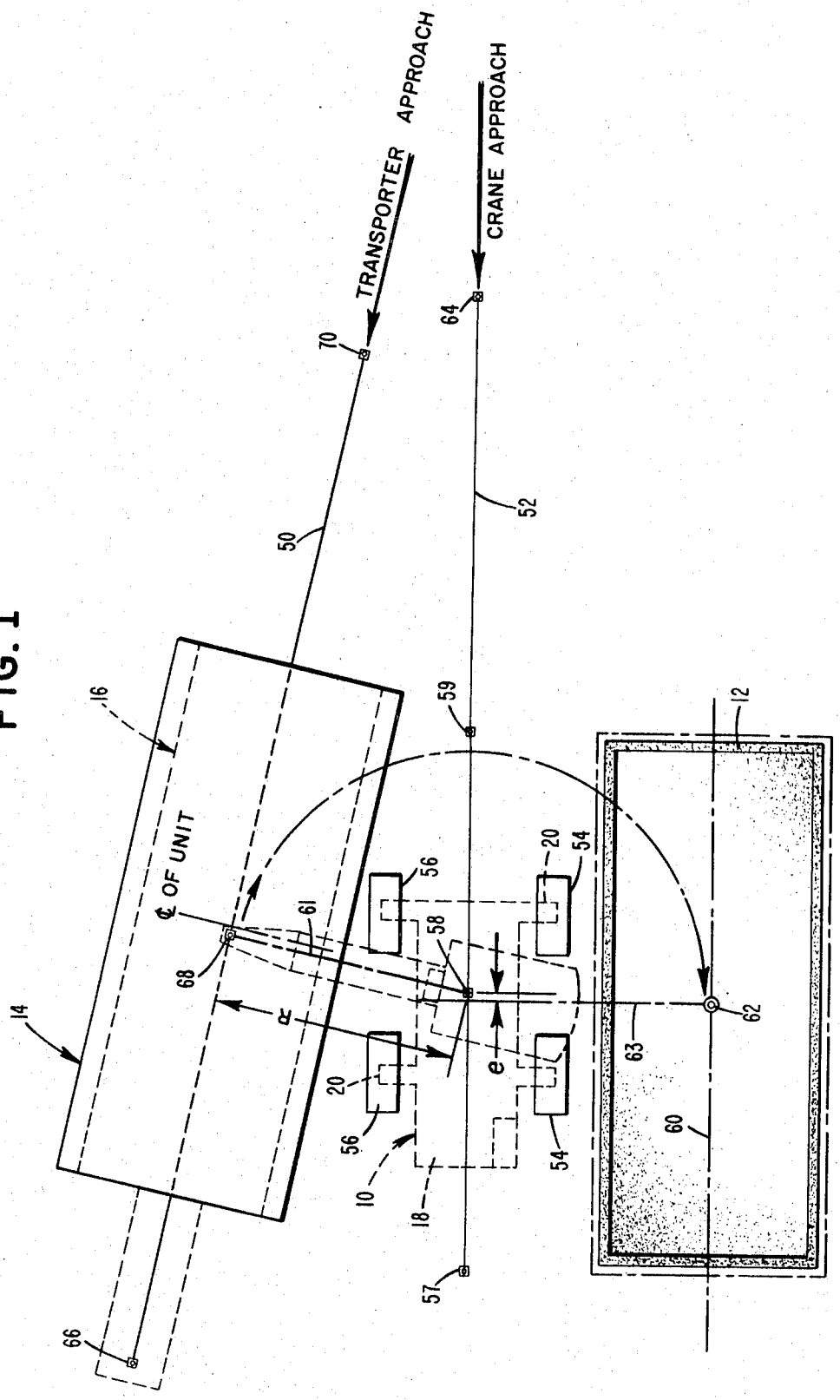
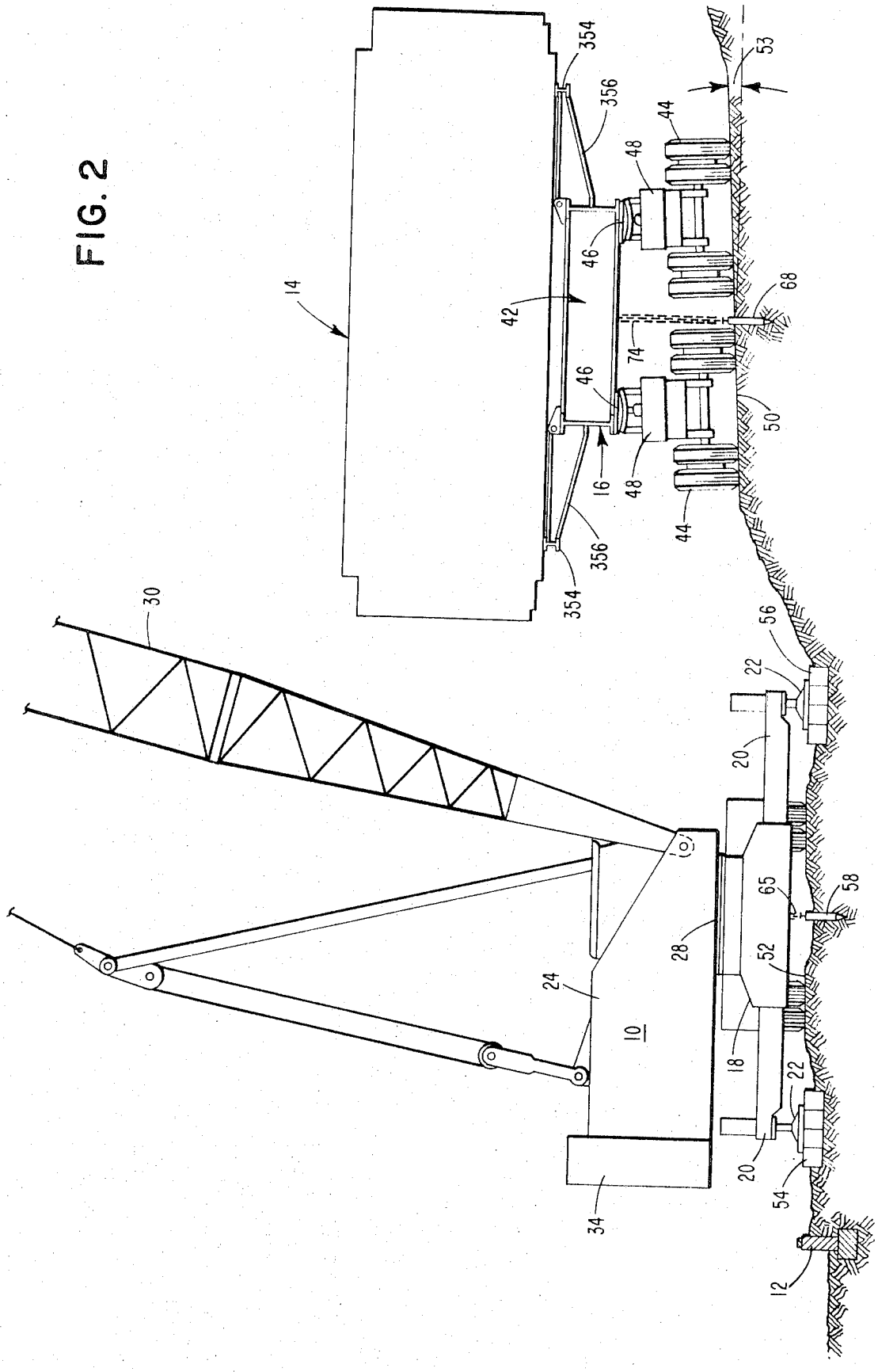

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CRANE APPROACH
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FIG. 2


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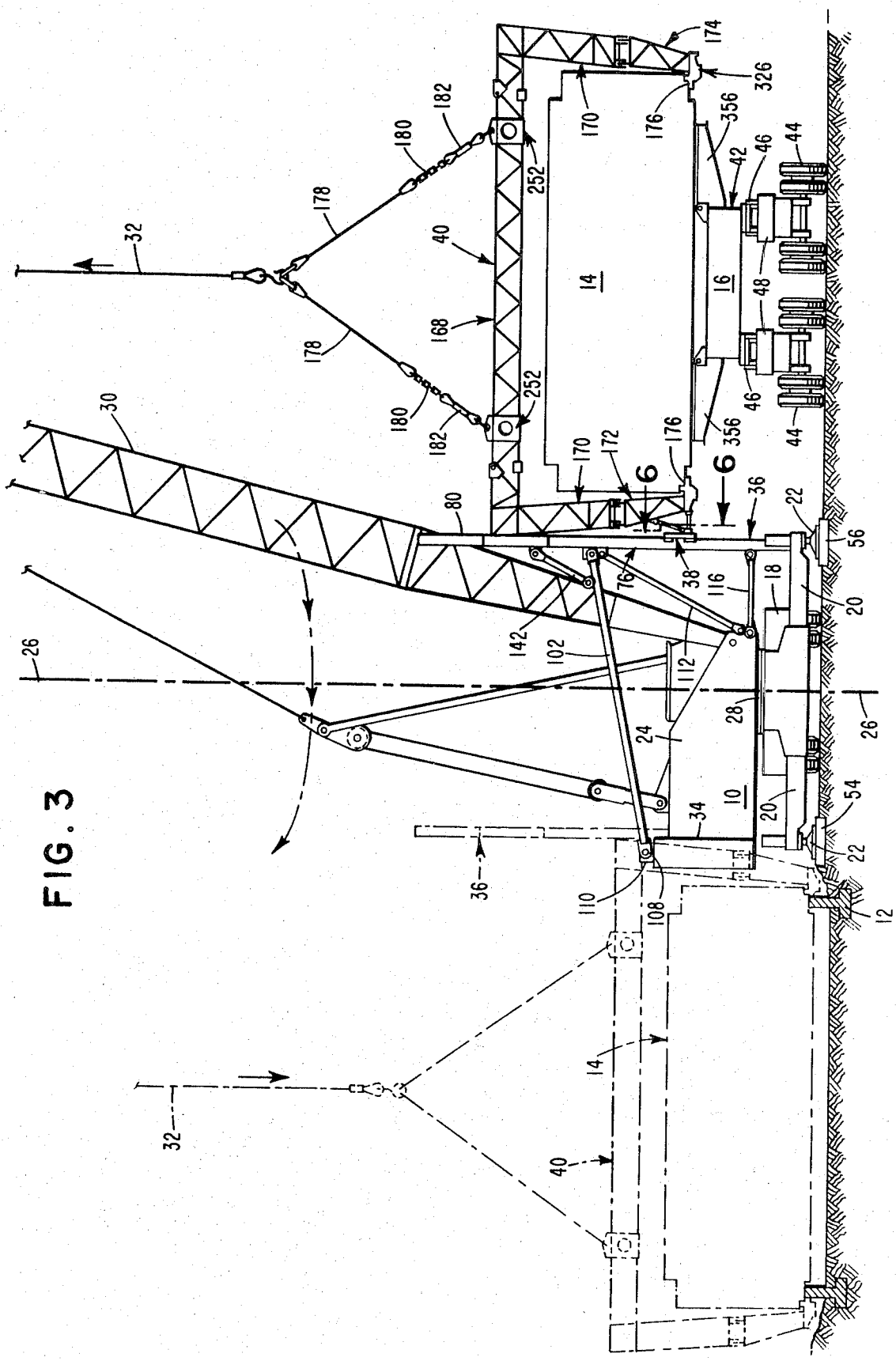

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FIG. 3

FIG. 4

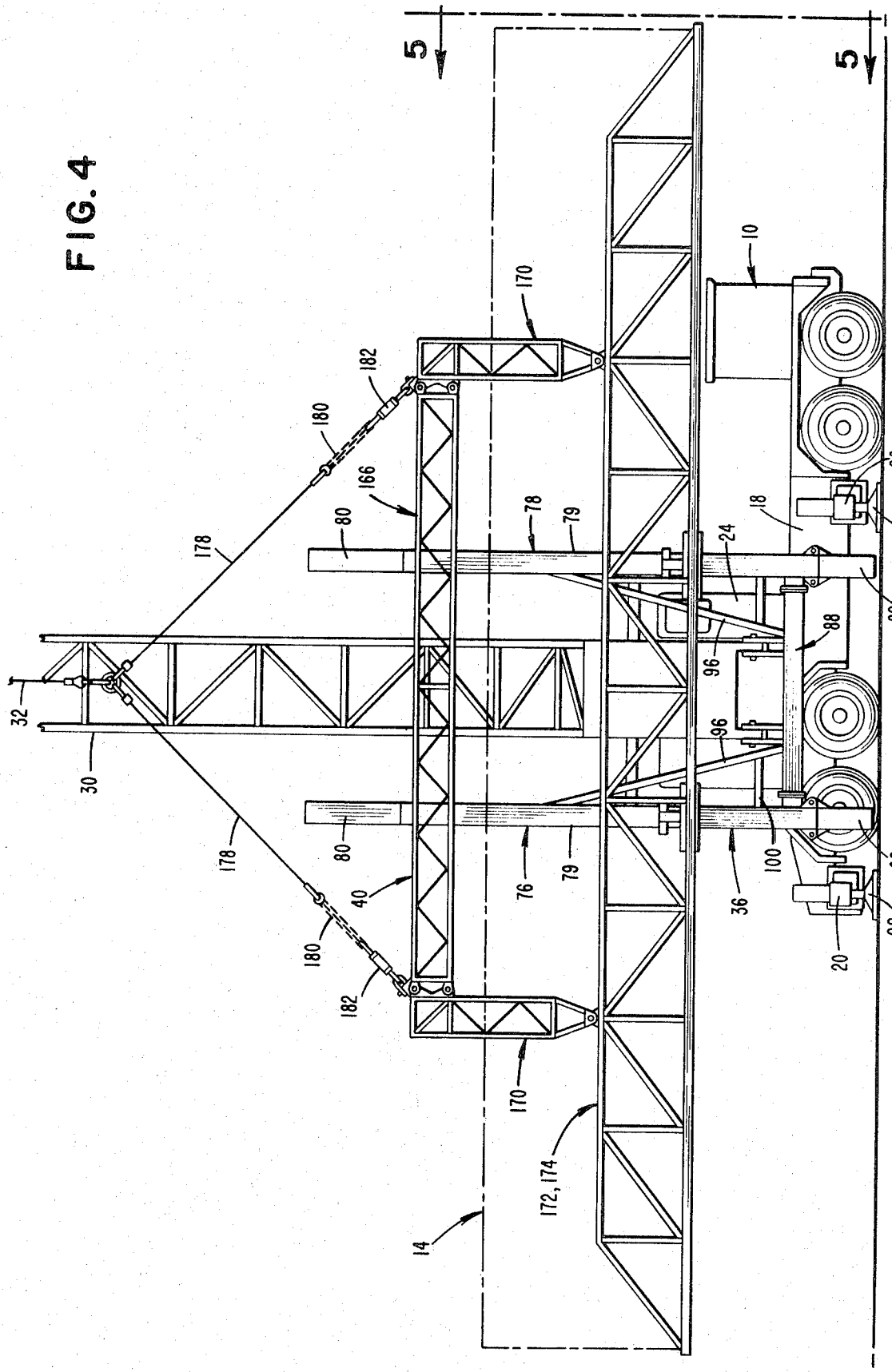
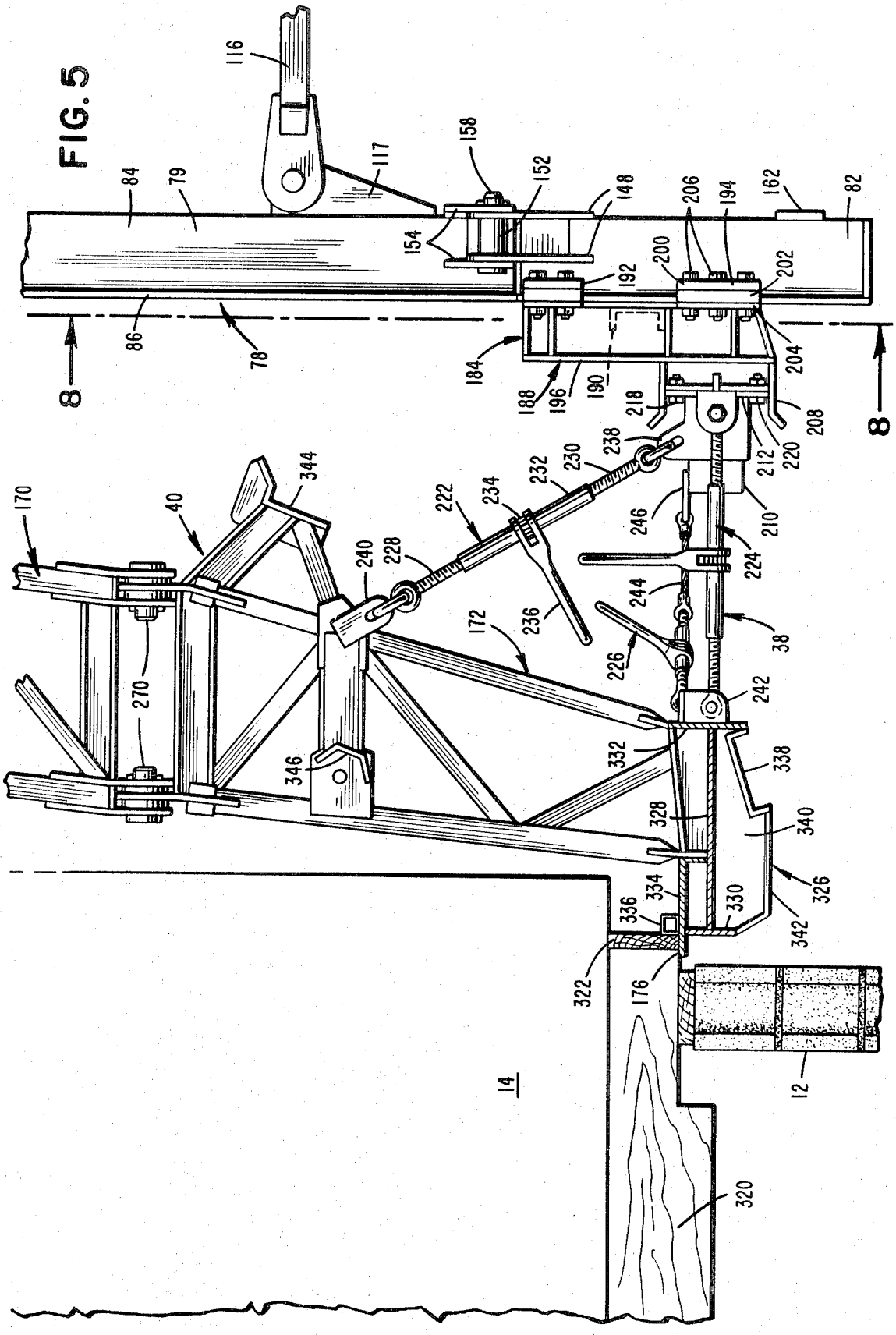

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FIG. 5


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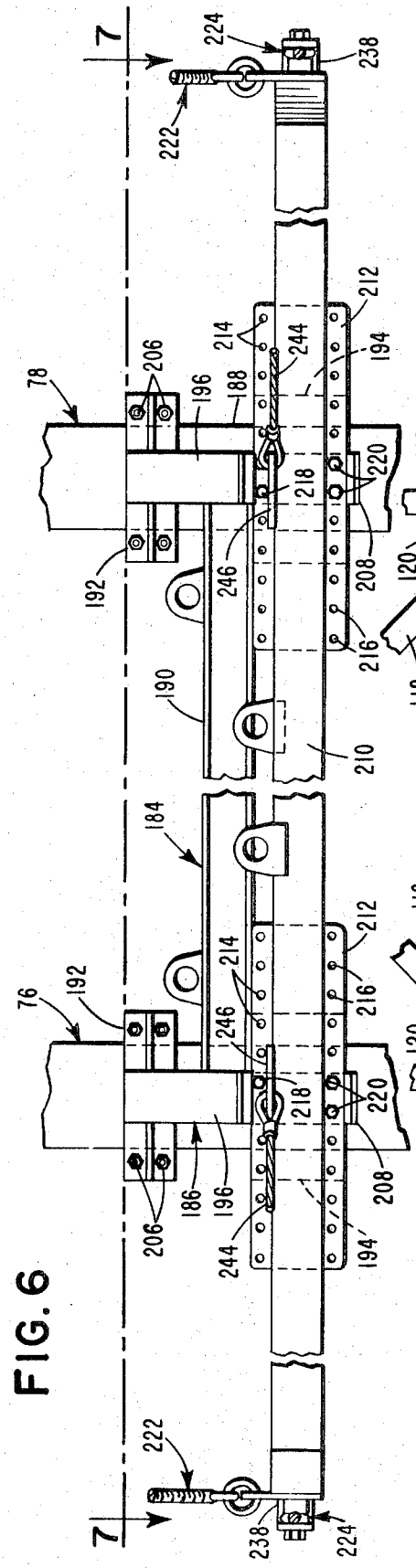


FIG. 6

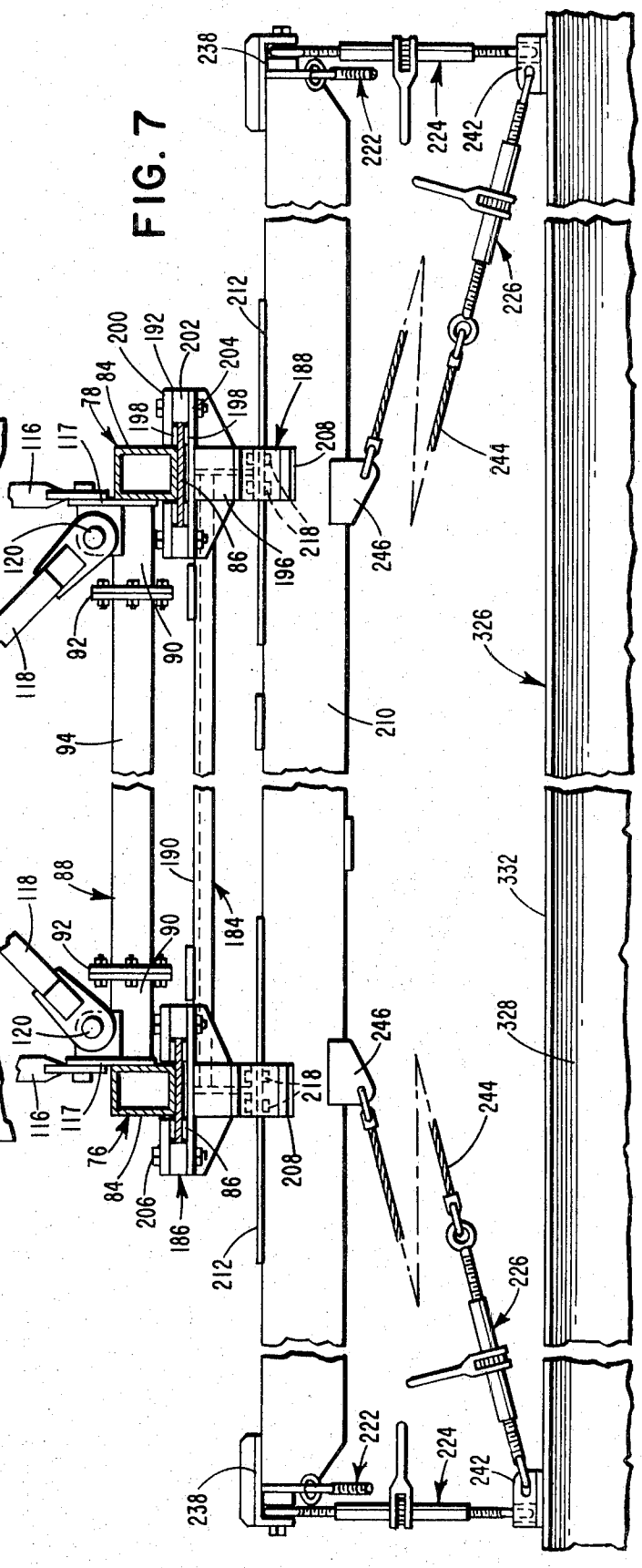


FIG. 7

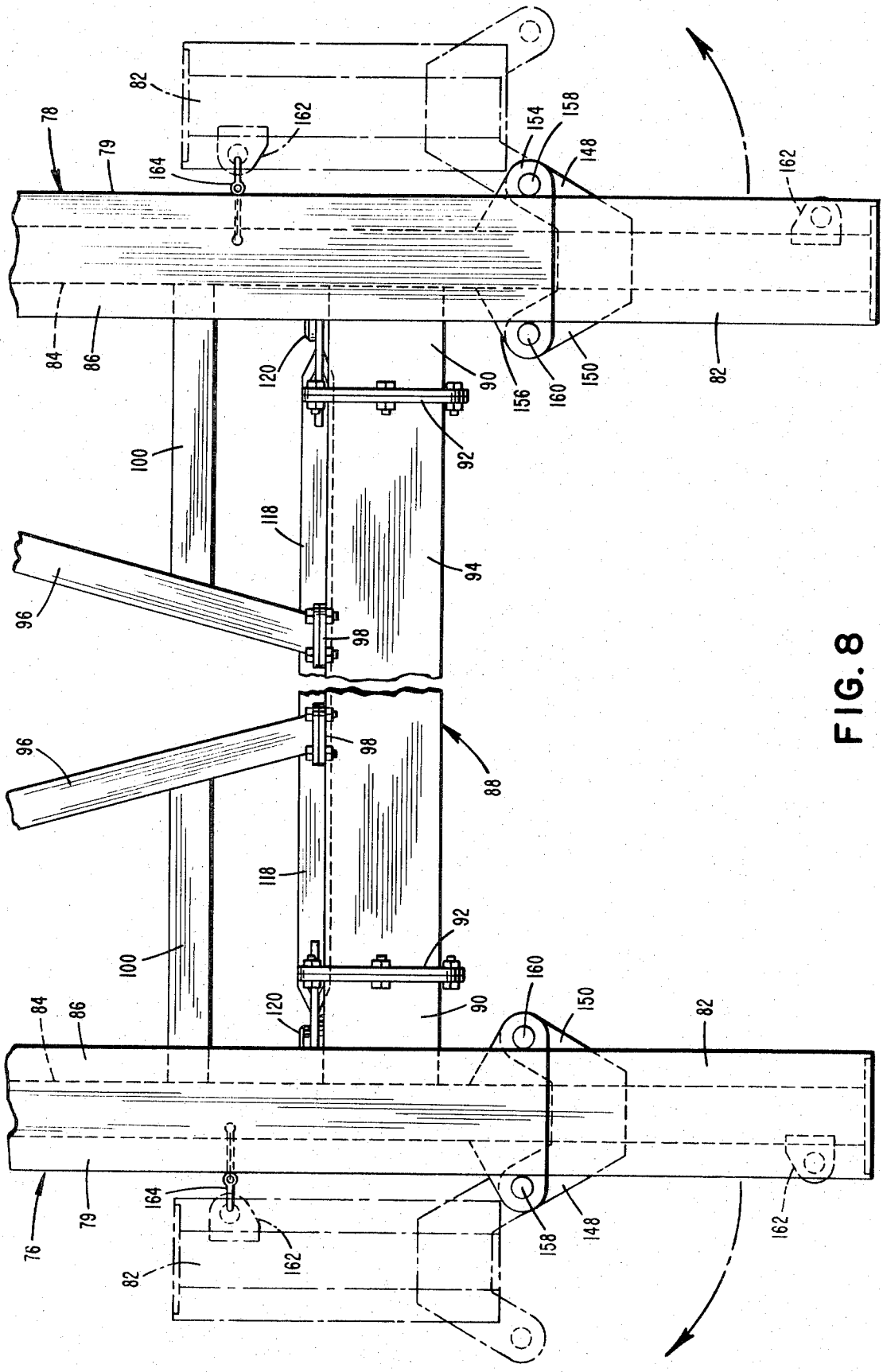

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FIG. 8

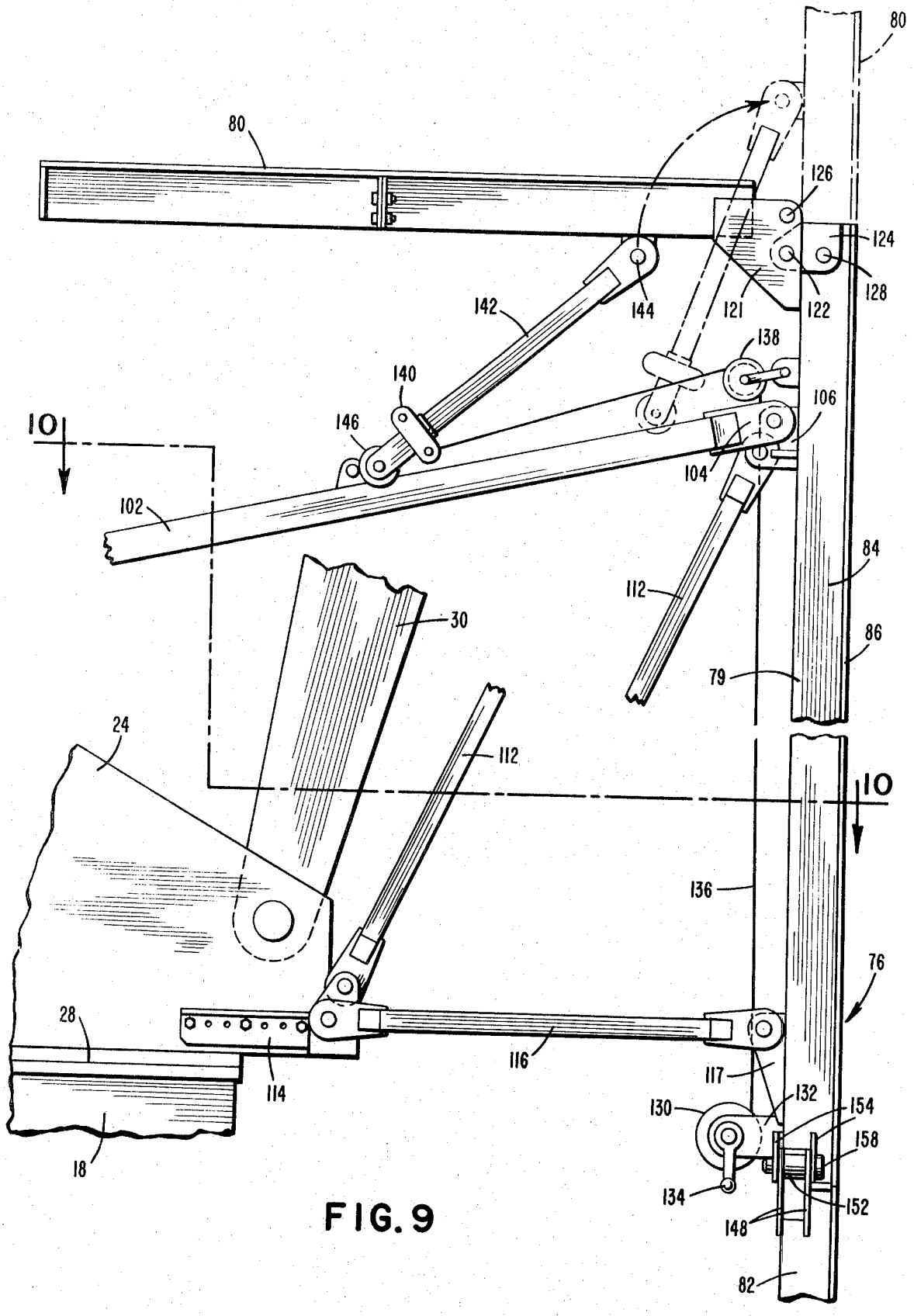
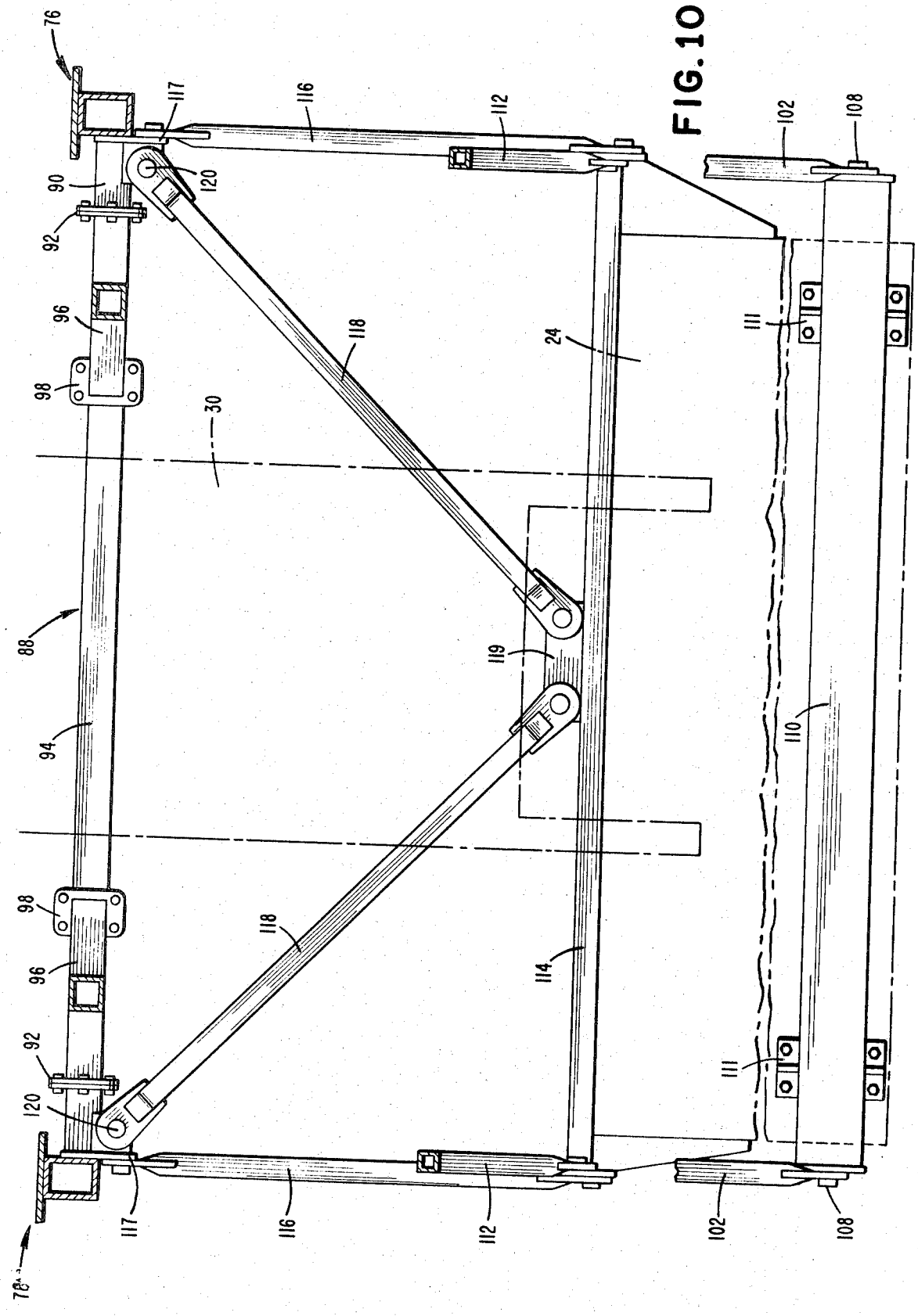

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FIG. 9

FIG. 10


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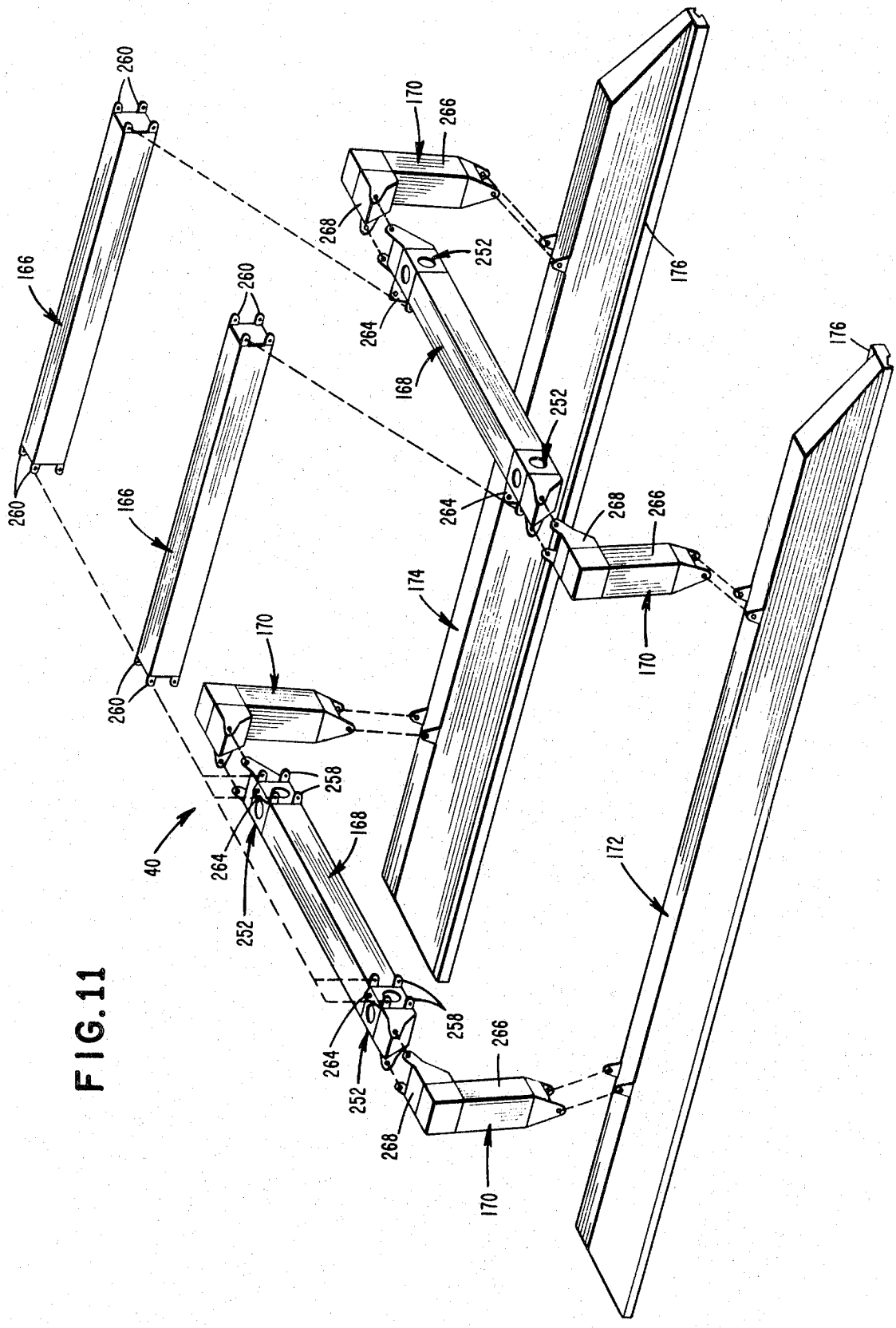


FIG. 11

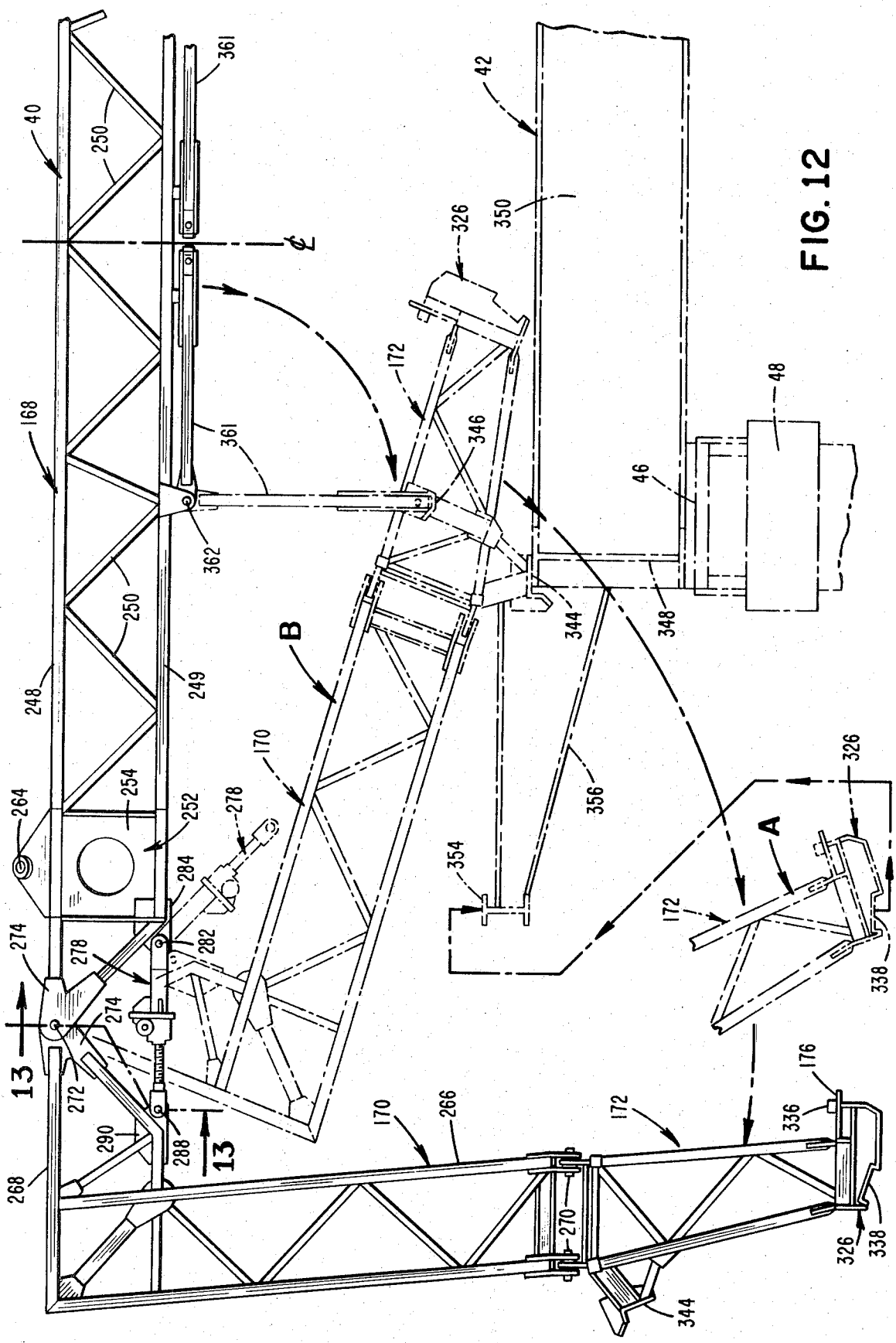

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FIG. 12

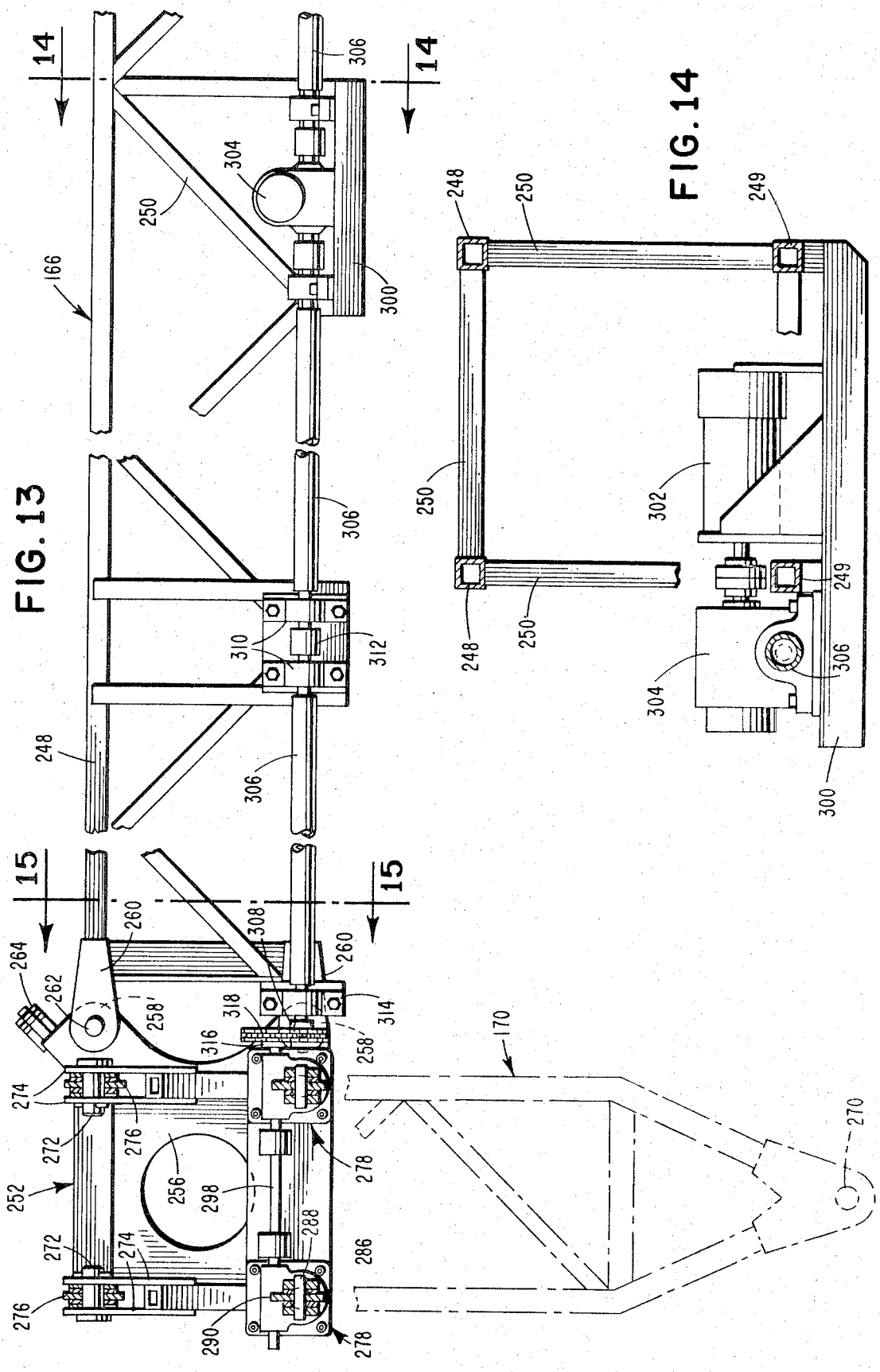

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FIG. 13

FIG. 14

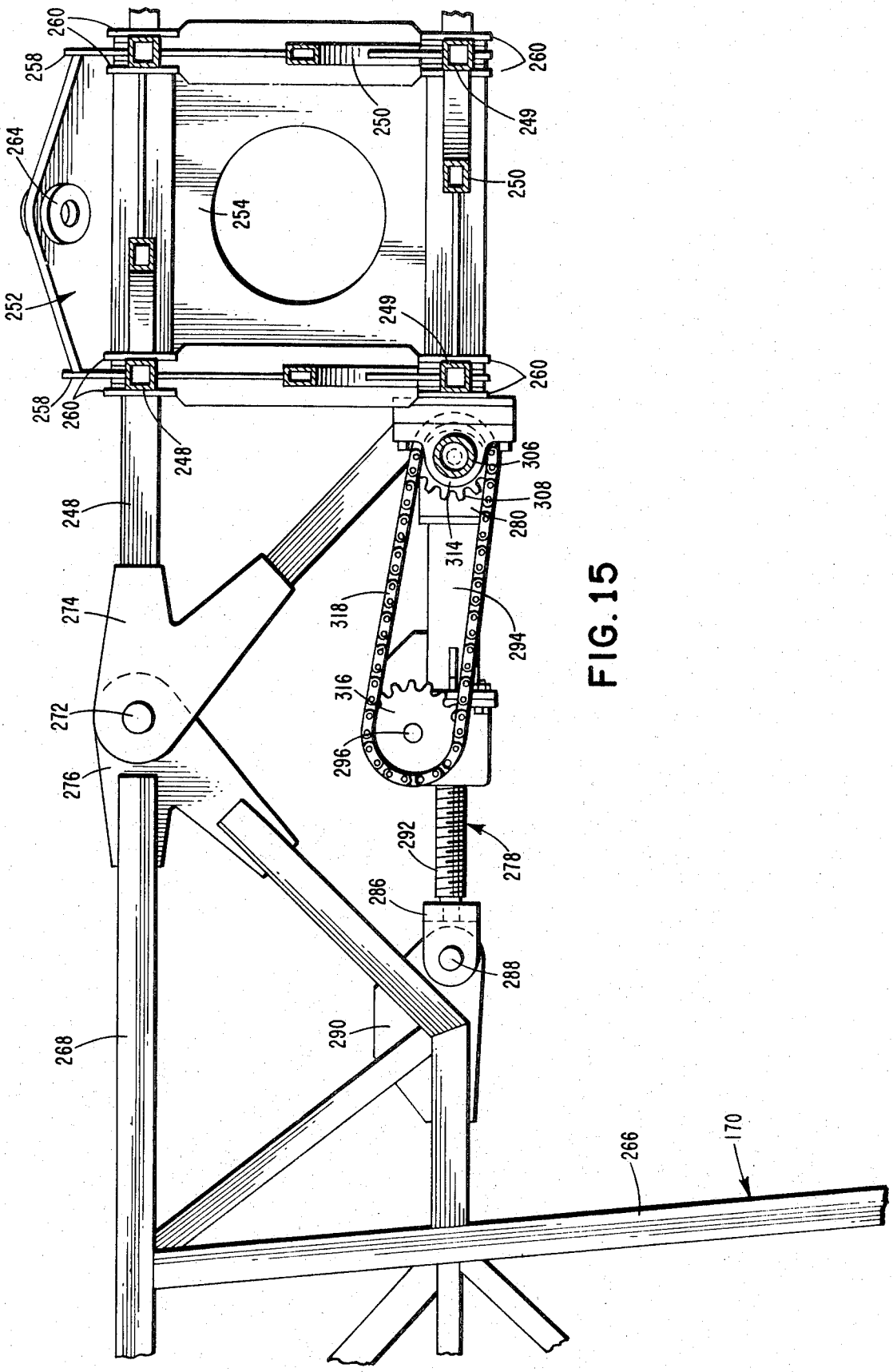

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FIG. 15

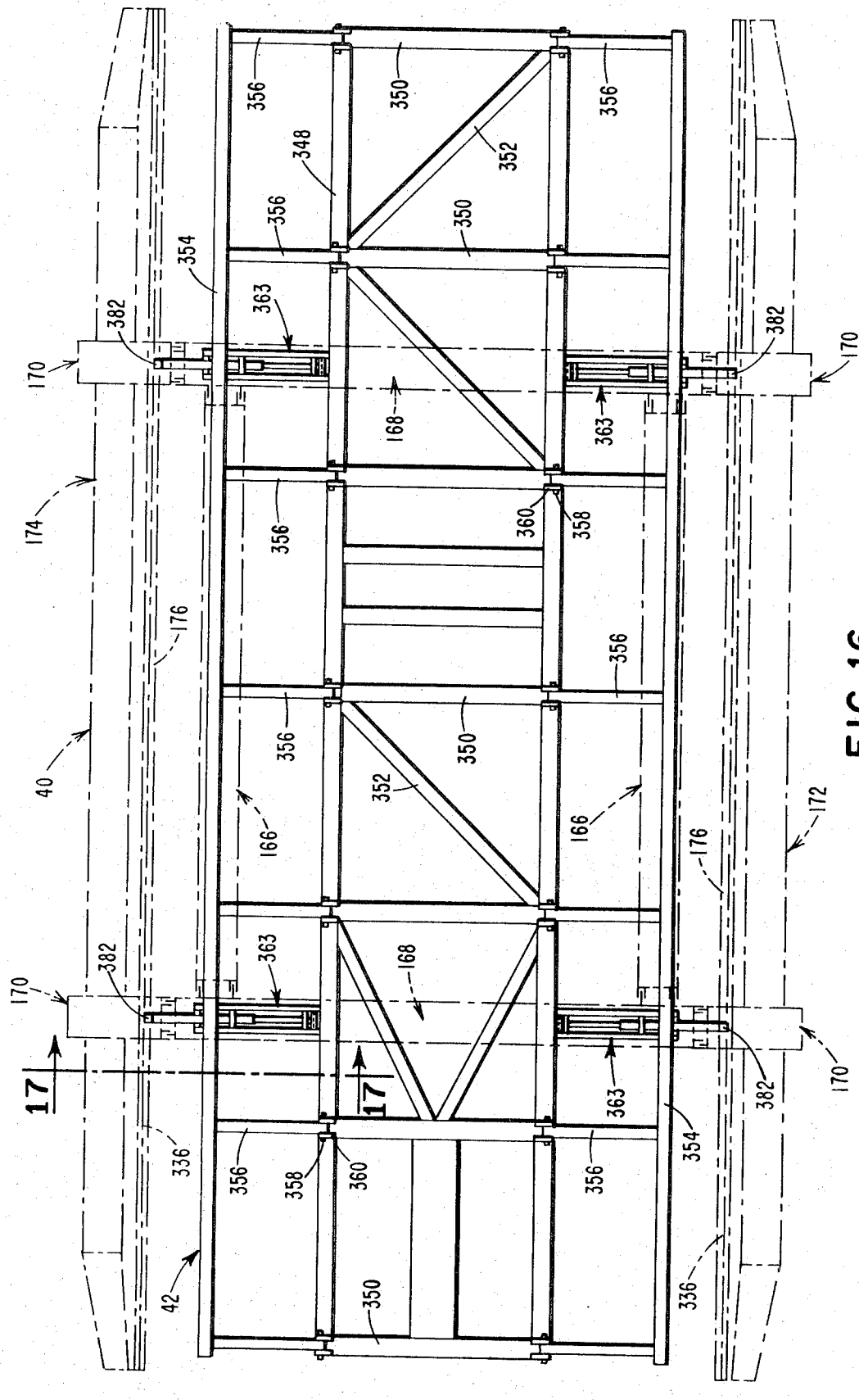
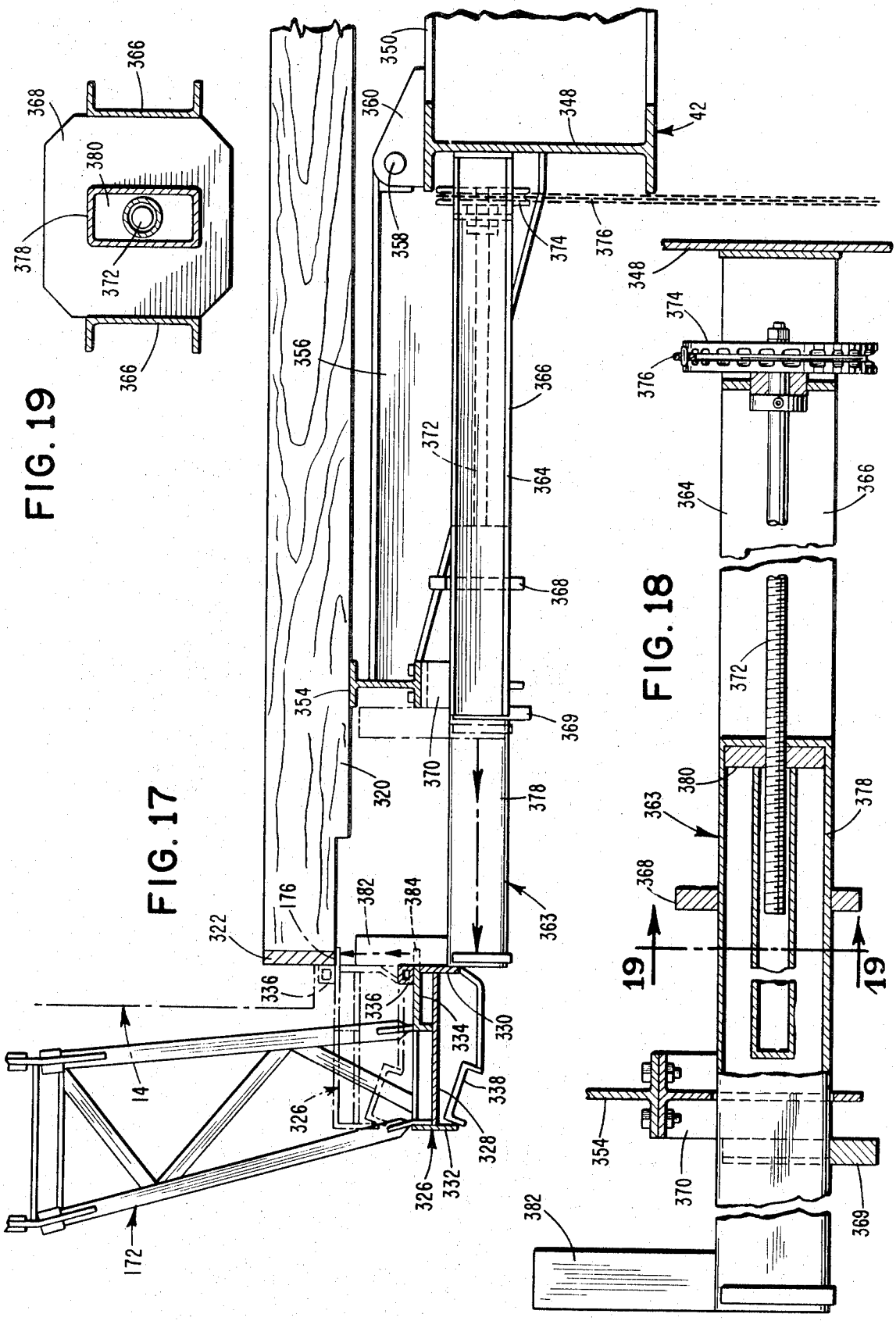

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FIG. 16


FIG. 19
FIG. 17
FIG. 18
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SYSTEM FOR PLACING FACTORY PREFABRICATED HOUSING UNITS

CROSS-REFERENCE TO RELATED APPLICATION

This is a division of application Ser. No. 312,575 filed Dec. 6, 1972, now U.S. Pat. No. 3,831,770.

BACKGROUND OF THE INVENTION

This invention relates to systems for placing factory prefabricated housing units on individual lot site foundations and more particularly, it concerns a novel method and apparatus providing a capability for positive and precise handling of the relatively large, heavy and delicate load represented by such housing units as well as for self transportability of equipment components of the apparatus between a plurality of individual lot sites in a land project under development.

In a co-pending application Ser. No. 163,935, filed July 19, 1971 by Eugene C. Lewis, C. Robert Gottlieb and Robert M. Macy and assigned to the assignee of the present invention, there is disclosed a method and apparatus for transporting prefabricated housing units from a factory in which the units are constructed to a remotely located land development project on which the units are to be placed permanently. In essence, the disclosed system contemplates factory prefabrication of mechanically operable, interiorly finished housing units using traditional building materials and structures, followed by the transfer of the units to a marine vessel such as a barge for transportation by water to a project terminal at the land project under development. At the project terminal, the units are transferred to pairs of elevated storage rails from which they may be picked up by a land vehicle or "transporter" having a load bed capable of being positioned under the units on the elevated storage rails and raised to lift each unit from the rails for subsequent land travel to the individual lot site on which the unit is to be placed. The housing units manufactured and transported in this way may vary considerably in both size and design but to facilitate handling and transporting operations, a common width or joist span is employed in all units. To optimize versatility in interior floor plan design, a common width of 30 feet has been selected and units as long as 68 feet have been built and transported using the system without damage even though the units have included completely finished and painted dry wall interiors as well as operating fixtures such as ranges, refrigerators, dishwashers, lamp fixtures and the like.

Although the system disclosed in the aforementioned co-pending application has proven in practice to be highly effective in the handling and transporting such housing units from the factory to the particular lot on which a foundation has been erected to receive the housing unit, several problems were encountered in the transfer of a unit from the vehicular transporter to its final or ultimate position on the lot site foundation. For example, a mobile rotary crane was found to be the most versatile lifting and transfer mechanism to be used at individual lot sites, taking into account such factors as capability for operating in minimal areas of low overhead clearance due to trees, utility lines for example, lifting capacity, transportability, direct commercial availability and the like. Also it has been appreciated that because of the structural characteristics of the housing unit to be lifted and transferred, specifically its

lack of inherent structural integrity and corresponding need for a continuous foundation-like support at all times in transit, a load lifting or handling spreader would be needed for the final transfer and placement operation. Although the spreader structures employed in transferring the housing units to the barge provided a solution to the achievement of adequate strength to supply structural integrity to the housing unit, the combined weight of such a spreader and the housing unit could not be handled effectively by the rotary crane. Also and because of its required overall size, transportability of the spreader itself from lot site to lot site on the project under development had to be accounted for. Perhaps the most critical problem posed by the final transfer and placement operation was the handling of a load spreader both during movement into a load engaging position with respect to the housing and during movement of the loaded spreader to a position by which the house would be set on the foundation. For example, it was found that although it was technically possible to position a housing unit on a lot foundation using tag lines and the like, the lack of positive control over the crane suspended load made it exceedingly difficult to achieve placement of the house on the foundation with adequate precision. The slightest of breezes, for example, were found to have a critical adverse effect on achieving and retaining a proper horizontal orientation of the unit with respect to the foundation for a long enough period of time so that it could be lowered gently onto the foundation.

The overall scheme of factory prefabrication of full size mechanically operable, interiorly finished housing units constructed with traditional building materials and transportation thereof largely by water from the location of the factory to the building project, all as disclosed in the aforementioned co-pending application Ser. No. 163,935, has therefore been found in practice to be a highly efficient and economically sound solution to the major problems of the housing industry. A need has been demonstrated, however, for improved techniques and equipment for the final positioning of such units on a foundation located at the ultimate individual lot sites.

SUMMARY OF THE PRESENT INVENTION

In accordance with the present invention, a system including novel procedures and apparatus is provided by which interiorly finished housing units have single floor areas as large as 30 by 68 feet and weighing as much as 67,000 pounds are effectively transferred from a vehicular transporter to a foundation or stacked on top of another such housing unit located at the individual lot sites of a land development project. The aforementioned problems encountered as a result of actual practice have been substantially overcome by an integrated system in which the position of the housing unit suspended from the hoist line of a conventional rotary crane is positively controlled with facility for adjustment so that the unit may be located within extremely close tolerances in a highly efficient manner. In a more specific sense, the system includes a novel load spreader capable not only of providing structural integrity to the housing unit during transfer but which is of minimal weight and capable of being readily transported both from lot site to lot site and also over land as a result of ease of disassembly. The positive control over the load represented by the housing units engaged

by the spreader and suspended from a rotary crane boom is effected by an unique snubbing frame arrangement which adjustably anchors the load spreader and the housing unit in a horizontal reference plane with respect to the crane supported during transfer in conventional fashion on outrigger beams and jacks. In addition, the invention contemplates an unique method involving both the precise location of the component pieces of equipment to effect the ultimate transfer as well as the operation of those components during the transfer.

Among the objects of the present invention are therefore: the provision of a highly effective, integrated and self transportable system for placing full size, interiorly finished, factory prefabricated housing units on individual lot site foundations; the provision of such a system by which precise positive control of housing unit positions can be maintained throughout the complete transfer operation; the provision of an unique load spreader possessing both adequate strength to supply needed structural integrity to the housing unit during transfer as well as minimal weight and operating capabilities for effective handling during operation; the provision of an unique snubbing frame arrangement by which movement of the load spreader is precisely and accurately controlled during all phases of the operation; the provision of such a snubbing frame arrangement capable of positive adjustability thereby enabling a precise positioning of the housing unit with respect to a foundation; the provision of such a system capable of both placement of such housing units directly on foundations and also for stacking such housing units to provide multistory building structures; the provision of such a system which is self transportable in a highly efficient manner; the provision of an unique method for precisely positioning the individual crane and transporter components of the system in relation to a lot site foundation; and the provision of a novel method for operating the components of the system to maximize efficiency of the transfer operation as well as facilitate movement of the system component from lot site to lot site.

Other objects and further scope of applicability of the present invention will become apparent to those skilled in the art from the detailed description of a preferred embodiment to follow and taken in conjunction with the accompanying drawings in which like parts are designated by the same reference numeral.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic plan view illustrating the general arrangement of system components of the present invention on a lot site and relative to a foundation to which a housing unit is to be transferred;

FIG. **2** is an enlarged fragmentary cross-section of the lot site and components illustrated in FIG. **1**;

FIG. **3** is a cross-section similar to FIG. **2** but illustrating in more detail the structural organization of the system components of the present invention;

FIG. **4** is a side elevation showing the crane and spreader components of the house transfer system of the invention;

FIG. **5** is an enlarged fragmentary end elevation in partial cross-section illustrating the connection of the spreader to a crane snubbing frame of the invention and also the relative position of these components to a housing unit on a foundation as seen generally from line **5—5** of FIG. **4**;

FIG. **6** is an enlarged fragmentary cross-section taken on line **6—6** of FIG. **3**;

FIG. **7** is a fragmentary cross-section taken on line **7—7** of FIG. **6**;

FIG. **8** is an enlarged fragmentary front elevation of the lower portion of the snubbing frame as seen generally on line **8—8** of FIG. **5**;

FIG. **9** is an enlarged fragmentary end elevation illustrating in more detail, crane mounting parts of the snubbing frame, the overall assembly of these parts being shown in FIG. **3**;

FIG. **10** is a fragmentary plan view in partial cross-section on line **10—10** of FIG. **9** and further illustrating the crane mounting parts of the snubbing frame;

FIG. **11** is an exploded perspective view illustrating the structural parts of the load spreader component of this invention as well as the general mode for connecting such parts;

FIG. **12** is an enlarged fragmentary end elevation of the load spreader of the invention with phantom line illustrations of alternate positions to which it may be adjusted for movement on the house transferring vehicle or transporter component of the invention;

FIG. **13** is an enlarged fragmentary cross-section taken on line **13—13** of FIG. **12**;

FIG. **14** is an enlarged fragmentary cross-section taken on line **14—14** of FIG. **13**;

FIG. **15** is an enlarged fragmentary cross-section taken on line **15—15** of FIG. **13**;

FIG. **16** is a plan view of the load carrying bed on the transporter component of the invention with a phantom line illustration of the load spreader in position to lift and transfer a house therefrom;

FIG. **17** is an enlarged fragmentary cross-section taken on line **17—17** of FIG. **16**;

FIG. **18** is an enlarged side elevation in partial cross-section illustrating one of four spreader positioning devices mounted on the transporter component of the invention; and

FIG. **19** is an enlarged fragmentary cross-section taken on line **19—19** of FIG. **18.**

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

To facilitate an initial overall understanding of the system of the present invention, the components of equipment used in the system, as well as the method of house placement effected by the system, reference is first made to FIG. **3** of the drawings wherein a rotary or swinging boom vehicular crane generally designated by the reference numeral **10**, is situated in operative relation to a permanent lot foundation **12** on which a housing unit **14** carried by a semitrailer-like vehicle or transporter **16** is to be placed. The crane, in itself, is a conventional, commercially available, heavy duty, truck crane to the extent that it includes a vehicular chassis **18** provided with usual outrigger beams **20** and stabilizing jacks **22**, a cab **24** adapted to swing or rotate about a vertical axis **26** on a turntable **28** and having a boom **30** and hoisting line **32**, the weight of the boom and load carried by the line **32** being balanced with a counterweight **34**. In accordance with the present invention, however, the crane **10** is equipped with a novel snubbing frame **36** which is connected by way of a vertical slide and adjustable linkage assembly **38** to one side of a load spreader designated generally by the ref-

erence numeral **40**, all to be described in more detail below.

Although the transporter **16** incorporates structure having a direct correlation to and thus forming part of the system of the present invention, it will suffice for the present to note that the transporter generally includes a load carrying bed **42** supported at its rear end by a pair of multi-wheel trucks **44** each carrying a fifth-wheel bearing plate **46** adapted for vertical adjustability with respect to the truck chassis **48** by virtue of a hydraulic jacking system (not shown). The forward end of the bed **42** is carried by a fifth-wheel tractor (not shown) also having a provision for vertical adjustability thereby completing a vertically adjustable three-point suspension by which the bed **42** may be raised, lowered or leveled. The latter of these operations is possible because each of the three points of suspension is vertically adjustable independent of the others.

At this point it will be apparent that with the house **14** located in the position illustrated in FIG. **3**, and the crane **10** and spreader **40** in the positions illustrated in this figure, the house **14** may be transferred to the foundation **12** by first lifting the spreader **40** and house **14** upwardly off of the bed **42** of the transporter **16**, swinging the boom **30** and spreader **40** from the solid-line position shown to a position over the foundation **12** as shown in phantom lines in FIG. **3**, and the housing unit **14** lowered onto the foundation **14**. While this operation would appear reasonably basic in terms of rotary crane operation, several very important factors must be accounted for to complete the operation in practice. In the first place, it will be borne in mind that the housing unit **14** to be handled may be mechanically operable single story housing unit weighing as much as 67,000 lbs. and having dimensions as large as 30 feet in width and 68 feet in length. Moreover, the unit **14** preferably is completed finished interiorly with plaster or plasterboard walls and may incorporate a full complement of delicate equipment including lighting fixtures, thereby establishing a load not only of substantial weight and size, but also one which is extremely delicate. Moreover, to meet building code requirements applicable to conventional houses, the unit **14** must be placed on the foundation **12** within extremely close tolerances; e.g., within ¼ inch or less. It will be noted also that the slide and linkage assembly **38** effects a connection of the spreader **40** and the crane **10** so that the housing unit **14** is at all times during its swinging movement from the transporter **16** to the foundation **14** positively or rigidly held in a generally preestablished horizontal orientation with respect to the crane **10**. This positive or rigid connection between the load represented by the housing **14** and the crane **10** is essential to avoid any possibility of the housing swinging freely and erratically as a result of even the lightest winds or breezes, for example. While the linkage assembly **38** facilitates a measure of adjustability as will be apparent from the description to follow below, the connection thereof with the crane by the snubbing frame **36** establishes a relatively fixed swinging radius of the crane, thus requiring the crane **10** and also the transporter **16** to be accurately positioned with respect to the foundation **12**.

The manner in which the crane **10** and transporter **16** are positioned accurately with respect to the foundation **12** in accordance with the present invention may be understood by reference to FIGS. **1** and **2** of the drawings. In this respect, it will be appreciated that the foundation **12** will be permanently constructed on a lot most likely to form a part of a land subdivision to be developed by using the system of the present invention as well as that of the aforementioned copending application Ser. No. 163,935. In accordance with customary practice, the lot on which the foundation is constructed is laid out using conventional surveying techniques both to establish the boundary lines of the lot and the precise location on each lot of the foundation **12**. In addition, earth grading operations are carried out in conjunction with the construction of the foundation. In accordance with the present invention, however, and because of the system thereof contemplates the transport of a substantially complete housing unit to each lot site with the aforementioned transfer of the housing unit to the constructed foundation, provision is made in the planning and construction of the foundation for the specific operative location of both the crane **10** and the transporter **16** as well as the route of access to that location in each instance. Hence, when the lot is graded to receive the foundation **12**, it is graded also as necessary to provide a transporter approach roadway **50** and a crane approach roadway **52**. Although these roadways are of a temporary nature, it has been found in practice that they should meet certain basic requirements to accommodate the components of the system. For example, the roadway **50** should provide a firm surface for the transporter tires using temporary steel mats as necessary to insure support of the loaded transporter. Also, the transverse slope **53** of the roadway should not exceed the limits of transport bed adjustability with respect to the wheels thereof in order that the bed **42** of the transporter can be adjusted to a truly level position.

Inasmuch as the crane roadway **52** need only accommodate the unloaded crane **10**, the roadway **52** itself need not be made to meet any particular specifications other than those needed to enable movement of the unloaded crane. In this instance, however, inside and outside mats **54** and **56** are placed in a proper relation with respect to the foundation in advance of the time the crane **10** is brought into position. The mats **54** and **56** are positioned to underlie the pedestal jacks **22** on the crane thereby to provide a firm foundation for the crane **10** on the outrigger beams **20** during the transfer operation.

An illustrative example of the relative horizontal location of the crane **10** and transporter **16** with respect to the foundation **12** is shown in FIGS. **1** and **2** of the drawings. The procedure used to achieve the relative locations of the crane and transporter with respect to the foundation is important to efficient use of the system of the invention and is correlated directly with the location and placement of the foundation **12** within preestablished dimensional tolerances to receive a particular housing unit **14** and meet existing building code requirements. Specifically the personnel who locate and place the foundation within such tolerances also place three aligned crane location hubs **57**, **58** and **59** taking care to meet the same relatively close tolerances as those applicable to the foundation. The line on which the hubs are located in parallel with the longitudinal center line **60** of the foundation **12** and is spaced from the center line **60** by a distance the same as the radial distance R between the hoist line or cable **32** and the swing axis **26**. The radial distance R is selected by proper adjustment of the boom **30** in a vertical plane

61 including the swing axis 26 to be optimum for the crane 10 to lift the unit 14. In a more direct sense, the optimum radial distance R is predetermined by the geometry of the snubbing frame 36 and load spreader 40 though some measure of boom adjustment is contemplated to locate the cable 32 in line with the center of gravity of the unit 14 while the spreader 40 is centered on the geometric center of the unit. It will be noted that the geometric center 62 of the foundation 12 and correspondingly the geometric center of the housing unit 14 are likely to be offset horizontally from the center of gravity of the unit. Inasmuch as the housing units are factory prefabricated according to plan specifications, the center of gravity may be calculated for each particular housing unit 14 to establish, for example, a distance *e* equal to the longitudinal distance between the longitudinal center of the unit and the center of gravity thereof. To correlate the location of unit center of gravity and the lifting plane of the boom 30, the center hub 58 is located at a point offset from the transverse axis 63 of the foundation by the distance *e*. Prior to moving the crane into position, the approach line of the crane is established by tying a string between the hubs 57–59 to a fourth hub 64. A plum chain 65 (FIG. 2) suspended on the swing axis of the crane will enable crane operating personnel to position the crane with reasonable accuracy over the hub 58. Having located the crane in this manner, the crane personnel may then locate additional hubs 68, 66 and 70 to establish the transporter approach center line 50 as well as the ultimate position thereof which is optimum for the transfer operation. The location of the hub 68 may be determined simply by measuring the distance R from the hub 58 and selecting an optimum point on the arc defined by the radius. The hubs 66 and 70 are then set at a right angle to the plane 61. The transporter 16 and housing unit may then driven along the line 50 using plum chain 74 until the appropriate location is reached.

It might be noted that in the preceding discussion, the offset distance *e* applies only to the longitudinal distance between the center of gravity and the geometric center of the housing unit 14. Obviously the center of gravity may also be displaced transversely of the geometric center of the unit. Since this latter offset involves merely an adjustment of the angle of the boom 30 to change the radial distance R, it is not a factor in locating the crane along the line 52.

A more complete understanding of the snubbing frame 36 and slide and linkage assembly 38 may be had by reference to FIGS. 3–9 of the drawings. As shown most clearly in FIGS. 4, 7, 8 and 10, the snubbing frame 36 includes a pair of vertical guide posts 76 and 78 each having in addition to a main intermediate section 79, upper and lower guide post extensions 80 and 82, respectively. The structure of both guide posts 76 and 78 as well as the upper and lower extensions 80 and 82 is the same throughout the total length of the posts and is illustrated in FIG. 7 to include a tubular column 84 of rectangular cross-section and a laterally projecting guide flange or plate 86 welded or otherwise suitably secured to the front face of each column 84.

The guide posts 76 and 78 are secured rigidly to each other near the lower end of the intermediate or main section 79 by a beam 88 illustrated most clearly in FIGS. 4, 8 and 10 of the drawings to include a pair of end sections 90 welded in cantilever fashion to the tubular column of each guide post and connected rigidly by bolted flange joints 92 to an intermediate beam section 94. To enable the boom 30 of the crane 10 to be lowered into a horizontal travelling position without interference by the snubbing frame 36, the beam 88 near the lower end of the guide posts 76 and 78 constitutes the sole direct interconnection of the guide posts thereby to define with the guide posts a generally U-shaped subassembly as may be seen in FIG. 4, for example. To provide necessary strength against bending or deflection of the relatively long vertical lever arm represented by the guide posts 76 and 78 about the ends of the beam 88, a pair of diagonal column struts 96 extend from bolted flange connections 98 on the top of the beam section 94 upwardly and outwardly to pin and weld connections (not shown) with the posts 76 and 78 near the upper portion of the intermediate or main sections 79. Additional tube struts 100 may extend between the column struts 96 to the guide posts 76 and 78, as shown in FIG. 8 of the drawings to lend structural integrity to the posts 76, 78 and the struts 96 as units such as when the snubbing frame is disassembled.

The guide post subassembly thus defined by the guide posts 76, 78, the beam 88 and struts 96 is supported from the rotatable cab 24 of the crane 10 by a system of struts illustrated most clearly in FIGS. 3, 9 and 10 of the drawings. Thus, a pair of struts 102 extend from clevis pin connections 104 with gusset plates 106 welded or otherwise secured to the rear of the guide posts 76, 78 near the upper end of the intermediate or main sections 79, rearwardly to clevis-pins 108 for connection to opposite ends of a beam 110 secured by brackets 111 to the top of the counterweight 34 on the crane cab 24. Compression struts 112 extend in similar fashion between the gusset plates 106 and a bracket 114 bolted or otherwise suitably fixed to the front and of the cab 24 near the base of the boom 30. To restrain pivotal movement of the posts 76 and 78 about a point represented by the gusset plates 106, a pair of compression-tension struts 116 extend from the bracket 114 to gusset plates 117 located near the lower end of the intermediate section of the guide posts 76. As shown in FIGS. 8 and 10, a pair of diagonal struts 118 extend from a plate 119 at the center and front of the bracket 114 to pins 120 on the top of the beam and section 90 to insure lateral rigidity in the connection of the guide posts 76 and 78 to the crane cab 24.

Although the function of the upper and lower extensions 80 and 82 of the guides posts 76 and 78 is obviously to extend the range of vertical distance through which the guide posts are operative, it is important to the overall efficiency of the system of this invention that these extensions be easily retractable to an out-of-the-way position. For example, the upper guide post extensions 80 would, if not retractable in this manner, inhibit translating movement of the crane 10 from lot to lot in the project being developed particularly where overhead obstructions such as trees, utility wires and the like are present. Thus, as shown in FIG. 9, each of the upper extensions 80 has secured to its lower end a pair of plates 121 pivotally connected by pin 122 to a rearwardly projecting lug 124 secured at the upper end of the main section 79 of each of the guide posts 76 and 78. The plates 120 are provided with an additional hole 126 such that when the extension 80 and plates 120 are pivoted through 90° to an upright position illustrated in phantom lines in FIG. 9, the hole 126 registers with a

hole **128** in the guide post to facilitate the insertion of a pin to secure the connection. Inasmuch as the extensions **80** represent a substantial weight to be moved in this fashion, mechanical means are provided for erecting them. As shown in FIG. **9**, a light cable winch **130** supported by a bracket **132** near the lower end of the guide post main sections **79** and operated by a hand crank **134** is connected by cables **136** about idling pulleys **138** to clamps **140** secured at one end of erecting struts **142**. The struts **142** are connected pivotally near the lower end of the upper extensions **80** by pins **144** and support rollers **146** at their opposite ends to ride on the tension struts **102**. With this arrangement it will be appreciated that by operating the hand crank **134** and taking up the cables **136**, the upper extensions **80** may be moved readily from their retracted position illustrated in solid lines in FIG. **9** to an upright position depicted by the phantom line illustration in FIG. **9**.

The manner in which the lower guide post extensions **82** are supported at the lower ends of the guide posts **76** and **78** is illustrated most clearly in FIGS. **5** and **8** of the drawings. As shown, each lower extension **82** has secured at the upper end thereof a pair of upwardly and outwardly projecting ears **148** and **150** formed with a sleeve boss **152** to facilitate connection of the ears to a pair of complementing ear lugs **154** and **156** by pins **158** and **160**. As can be seen in FIG. **5** of the drawing, the ears **148**, **150** and **154**, **156** are spaced rearwardly of the guide flange or plate to avoid interference of operation of the slide and linkage assembly **38** to be described in more detail below.

Retraction of the lower extensions **82** from the solid line positions shown in FIG. **8** to the phantom line position shown in this figure is effected simply by removing the pin **160** and pivoting the lower extension about the other pin **158**. A lug **162** secured to the lower extensions **82** enables retention in the retracted position by hook and chain connectors **164** secured at an appropriate positions on the guide post main sections **79**.

It should be noted at this point that the lower extensions **82** increase the vertical limits of the guide posts **76** and **78** downwardly to a point slightly above the ground on which the crane **10** is situated. Because however, the distance from the guide posts to the swing axis **26** of the crane is less than the distance between that axis and the outrigger jacks **22**, the lower extensions **82** must be lifted to their retracted positions in order for the guide posts **76** and **78** to clear the outrigger beams **20** on the crane. Since most often the level of the housing unit **14** on the transporter **16** will be well above the lower limits of vertical movement of the slide and linkage assembly **38**, the transfer operation can be initiated with the lower extensions **82** in their retracted positions and simply allowed to fall into their extended position when the housing unit **14** is positioned over the foundation **12**, assuming the level of the foundation is sufficiently low as to require the use of the lower extensions **82**. Also because of the simple connection of the lower extensions to the guide posts **76** and **78**, it is contemplated that in situations where the level of the foundation **12** is extremely low in relation to the level of the crane **10**, special length lower extensions might be used to accommodate such extreme conditions.

To facilitate a clear understanding of the slide and linkage assembly **38** as shown most clearly in FIGS. **5–7** of the drawings, which assembly functions primarily to effect an adjustable connection of the load spreader **40** to the snubbing frame **36** and the crane **10**, reference is first made to FIGS. **3**, **4** and **11** of the drawings for an over view or general description of the load spreader structure. As shown, the spreader **40** is formed of an assembly of lightweight fabricated components including a superstructure formed by a pair of longitudinal struts **166** and a pair of transverse struts **168**. Depending from pivotal connections at opposite ends of the transverse struts **168** is a load engageable substructure formed by arms **170**, in turn rigidly connected in pairs at their lower ends to the upper edges of two elongated trusses **172** and **174**. The trusses **172** and **174** support near their bottom edge inwardly and upwardly facing continuous load bearing cleats or rails **176** and possess sufficient structural integrity against bending to maintain the cleats **176** truly linear irrespective of variations in load along their length effected by the structure of the housing unit **14**.

Although a more complete description of the load spreader **40** will follow, it will be apparent from this general description that by virtue of the pivotal connection of the arms **170** to the transverse struts **168**, that the trusses **172** and **174** can be retracted or spread and lowered over the housing unit **14** and then closed to the position illustrated for example in FIG. **3** of the drawings to provide continuous rail-like support along the longitudinal sides of the housing unit **14**. Also it might be noted at this point that the spreader **40** is supported from the crane hoist line **32** by a suspension cable system including four high tension cable assemblies **178**, each including a length of link chain **180** and turnbuckles **182**. By virtue of this arrangement, the length of the cables **178** can be adjusted in increments by the selection of particular links in the chains **180** and further through a vernier-like adjustment with the turnbuckles **182**. In this way, the center of lift or location of the crane hoist cable **32** can be adjusted to overlie the center of gravity of the housing unit **14** while the geometric center of both the spreader and the unit are vertically aligned. Although the spreader **40** incorporates several additional structural features which are important to the overall efficiency of the system of the present invention, the brief description of this spreader thus given will enable a full understanding of the slide and linkage assembly **38** shown and the manner in which this assembly interconnects the spreader **40** to the guide posts of the snubbing frame **36**.

As shown in FIGS. **5–7**, the slide and linkage assembly **38** includes a slide unit **184** formed by a pair of guide shoes **186** and **188** interconnected by a channel beam **190**. The structure of the guide shoes **186** and **188** is identical and each includes upper and lower pairs of mutually facing bearing slides **192** and **194** respectively interconnected by a guide shoe body **196**. As shown most clearly in FIGS. **5** and **7**, each of the bearing slide pairs include sets of bearing pads **198** retained on opposite sides of the guide post flanges **86** by the assembly of a back plate **200**, spacer blocks **202** and the back flange **204** of the guide shoe body **196**, all of which is secured by a plurality of bolts **206**. As a result of this arrangement, it will be appreciated that the guide shoes **186** and **188** will be free to slide vertically on the respective guide posts **76** and **78** and yet be retained against all other movement with respect to the guide posts. Moreover, because of the interconnection of the guide shoes by the beam **190**, the slide unit **184**, in itself, will provide a measure of structural intercon-

nection between the guide posts **76** and **78**, thus serving to augment the static structure previously described for maintaining them in generally parallel relation.

Projecting forwardly of each of the guide shoe bodies **196** is a flared channel-shaped header mount **208** for receiving an elongated box-section beam or header **210** having a pair of longitudinally spaced mounting plates **212** each formed with a series of upper and lower equally spaced bolting holes **214** and **216** respectively. As can be seen most clearly in FIG. **6** of the drawings, the mounting plates **212** are spaced on the header by the same distance as the center-to-center distance of the guide posts **76** and **78**, thereby to enable a detachable connection of the header **210** to the mounts **208** and guide shoes **186** and **188** by upper and lower bolt pairs **218** and **220**. As will become more apparent from the description to follow, the longitudinal position of the header **210** with respect to the guide shoes **186, 188**, the guide posts **76** and **78** and ultimately the lifting axis **26** of the crane **10** will correspond directly to the longitudinal position of the load spreader **40**. As described above, the longitudinal position of the load spreader relative to the lifting axis of the crane will vary depending on the distance between the center of gravity of the housing unit **14** and its longitudinal center. Because of the series of upper and lower bolt holes **214** and **216** in the header mounting plates **212**, the longitudinal position of the header **210** on the guide shoes can be varied by the spacing increments between the holes depending on the spacing increment *e* which exists between the longitudinal center and the center of gravity in the housing units to be transferred.

The linkage connecting the load spreader **40** to the snubbing frame **36** by way of the header **210** and guide shoes **186, 188** is shown most clearly in FIGS. **5** and **7** to include at each end of the header **210** a triaxial array of screw jacks **222, 224** and **226**. Each of the screw jacks is identical in structure and includes a pair of oppositely threaded eye bolts **228** and **230** secured by a sleeve nut **232** having a ratchet **234** adapted to rotated by a two-way pawl (not shown) carried by handle **236**. Thus it will be appreciated that effective length of each screw jacks may be varied by manual operation of the appropriate handle.

As shown also in FIGS. **5** and **7**, the connection of the screw jacks **222** and **224** between the slide **184** and the inboard truss **172** of the load spreader **40** is effected by an anchorage of one end of each of the jacks **222** and **224** to a bracket **238** on each end of the header **210** and by connections of the other ends of these two jacks to brackets **240** and **242** respectively both of which are secured such as by welding to the truss **172** of the spreader **40**. In this respect it will be noted that the preferred length of the header **210** is that equal to the spacing between the arms **170** on the spreader connected to the inboard truss **172**. In this way, the ability of the spreader to absorb the forces of the jacks will be maximized. The third jack **226** is connected at one end also to the lower bracket **242** and at its other end to a cable **244** in turn connected to a lug **246** located near the connection of the header to the guide shoes **186** and **188**.

In light of the arrangement of screw jacks on opposite ends of the header **210**, it will be appreciated that in point of function, the jack **222** serves primarily as a tension link between the spreader truss **172** and the slide **184** so that vertical movement of the load spreader **40** by the crane **10** will result in corresponding vertical movement of the slide **184** on the guide posts **76** and **78**. The screw jack **224** will serve primarily to adjust the horizontal transverse distance of the spreader from the snubbing frame **36** whereas the jack **226** will function primarily to adjust the location of the spreader relative to the snubbing frame in a longitudinal horizontal direction. As a result of the triaxial orientation of the screw jacks and the intersection of all jack axes with the header **210**, positive positioning of the truss **172** and thus of the spreader **40** can be obtained in a plane radiating from the longitudinal axis of the header without impairing pivotal movement of the arm about the header axis as may be required for example in operating the spreader to engage or release a housing unit. Hence, very accurate positioning of the housing unit **14** with respect to the foundation **12** is possible in spite of its large size and weight. Moreover, the operator of the crane **10** need concern himself only with one crane operating function during this positioning; that is, raising or lowering the spreader and housing unit **14**.

A more complete understanding of the load spreader **40** than that available from the general description given above with respect to FIGS. **3–5** and **11** of the drawings may be had by further reference to FIGS. **12–15**. As shown, each of the major components of the spreader **40** (i.e., the longitudinal struts **166**, the transverse struts **168**, the arms **170** and the trusses **172** and **174**) preferably is in the form of a box-like truss to maximize strength for a given weight of structural material employed in the spreader. As shown most clearly in FIGS. **12, 14** and **15**, each of the transverse and longitudinal struts employ upper and lower primary tension-compression members or chords **248** and **249** interconnected along their length by diagonal struts **250** to establish the box-like truss formation. While this type of box-truss construction is not in itself novel in structures where a combination of maximum strength and minimum weight is desired, the manner in which this type of construction is carried throughout the basic components of the spreader **40** to achieve such a combination of maximum strength and rigidity with minimal weight is important to overall efficiency of operation in the system of the present invention.

As shown, for example, in FIGS. **12, 13** and **15**, each of the transverse struts **168** is formed with a pair of reinforced junction sections **252** to facilitate both a detachable connection of the longitudinal struts **166** and also to provide appropriately located points of connection for the four lifting cables **178**. Thus, the sections **252** are established by a cube-like welded assembly of apertured plates **254**, the transverse vertical plates **256** of which extend inwardly as apertured ears **258** to enable the connection thereto of clevis extensions **260** on the longitudinal struts by pins **262**. The apertured plate forming the top of the connecting section **252** extends inwardly and upwardly to enable the formation of a grommet **264** by which the lifting cables **178** may be attached to the spreader **40**.

Each of the arms **170** is identically constructed, again employing the box truss-type construction. As shown in FIGS. **11** and **12**, for example, each of the arms **170** is further characterized as being of inverted L-shaped configuration to establish vertical and horizontal leg portions **266** and **268** respectively. The lower end of the vertical leg of each arm **170** is connected by the pair of clevis and pin-type connections **270** to the

upper side of the trusses **172** and **174.** The upper ends of the arms **170,** specifically the horizontal legs **268** thereof are pivotally connected to the ends of the transverse struts **168** by pins **272** extending through apertured ears **274** and **276** welded or otherwise suitably secured respectively at the end of the transverse strut **168** and the horizontal leg **268** of the arms. As shown in FIGS. **12** and **15,** the axis of the pivotal connection of arms **170** to the transverse struts **168** effected by the pins **272** lies in the plane of the upper chords **248** of both the transverse strut **168** and the horizontal leg **268** of each arm **170.** To enable pivotal adjustment of the arms about the pins **272,** a pair of screw jacks **278** are connected at their inboard ends by clevises **280** and pins **282** (FIG. **12**) to gusset plates **284** secured at the lower side of the transverse strut **168** and at their outboard end by clevises **286** and pins **288** to similar gussets **290** secured at the lower portion of the horizontal legs **268** of the arms **170.** The jacks **278,** therefore, are aligned with the lower chords of the horizontal arm legs **268** and of the transverse struts **168** and effect an extensible link of such chords. Thus it will be appreciated that by extension of the jacks **278,** the arms **170** as well as the trusses **172** and **174** carried directly thereby, will be moved outwardly to a retracted or splayed position in which the cleats or rails **176** at the lower ends of the trusses may be lowered downwardly over the housing unit **14.** Conversely, operation of the jacks **278** to shorten the lower chord distance between the clevis pins **282** and **288** will swing the arms **170** and trusses **172** and **174** inwardly about the axis of the pins **272.**

The jacks **278** in themselves are conventional and as such include a non-rotatable screw **292** adapted to be advanced or retracted in an elongated housing **294** by a running nut (not shown) and adapated to be driven by torque applied to an input shaft **296.** To insure synchronous operation of both jacks in each pair associated with each arm **170,** the input shafts **296** of both jacks in each such pair is interconnected by a shaft coupling **298** shown in FIG. **13** of the drawings. The drive to each pair of jacks **278** connected respectively to each of the pair of arms **170** supporting one or the other of the trusses **172** and **174** is illustrated in FIGS. **13–15** of the drawings. As shown, each of the longitudinal struts **166** carries approximately at its longitudinal center a platform **300** supporting an electric motor **302** drivingly connected through a gear box **304** to drive shafting **306** extending in opposite directions to a sprocket **308** at each end of the longitudinal strut **166.** As shown in FIG. **13,** the shafting **306** is supported intermediate its length by appropriate bearing journals **310** and may include one or more universal joints **312** to accommodate misalignment in the shaft as is well known to those familiar with the drive shaft art. Also, a bearing **314** at the end of the shafting serves to fix the rotational axis of the sprocket **308.** The sprocket **308** is drivingly connected to a sprocket **316** by a drive chain **318,** the sprocket **316** being keyed or otherwise non-rotatably fixed to the input shaft **296** of the screw jacks **278.** In light of this drive organization, it will be apparent that because of the direct mechanical connection between the electric motor **302** and both pairs of jacks associated with each of the trusses **172** and **174** supported at the lower ends of the arms **170,** equal movement or synchronization of the jacks causing movement of either of the trusses will be effected. Moreover, inasmuch as independent electric motors are used to operate the movement of the respective trusses **172** and **174,** they may be operated independently by appropriate independent electrical controls (not shown) for the motors.

The construction of the trusses **172** and **174** is identical with the exception of the facility for connecting the inboard truss to the slide and linkage assembly **38** as described above. Also, the box-truss structure described above with respect to the longitudinal and transverse struts **166** and **168** is also generally incorporated within the trusses except that here, the depth in the box-truss section is considerably greater than in the case of the other components of the spreader because of the need for adequate strength in the trusses against bending under variations in loading along the cleats or rails **176** which directly engage and carry the load of the housing unit **14.** In this respect, it is to be noted that one of the principal requirements for handling the housing units is that sufficient structural rigidity must be provided in the trusses **172** and **174** to maintain linearity in the cleats **176** and thus to retain the planar orientation of the housing unit floor. As described in the aforementioned copending application Ser. No. 163,935, and also as illustrated in FIGS. **5** and **17** of the attached drawings, the floor structure of the housisng units **14** may be constructed of conventional transverse wooden joists **320** extending continuously across the width of the house and nailed or otherwise suitably secured at their ends to longitudinal end headers **322.** To accommodate the relatively long span between the headers **322,** the depth of the joist is increased over that normally used, the ends of the joists being notched as at **324** so that the level of the upper joist surfaces are not increased over that in conventional homes. To maintain the planar orientation of the joists during handling in the same manner as they would be maintained by a permanent foundation, it will be apparent that linearity in the continuous cleats **176** must be maintained. In addition to linearity in the cleats **176,** both the cleats in both trusses **172** and **174** must be maintained in coplanar relation. Although the organization of the longitudinal and transverse struts **166** and **168** will not in itself maintain the coplanar orientation of the trusses **172** and **174,** this characteristic is readily maintained by adjusting the lifting cables **178** so that the center of lift by the crane hoist line **32** is positioned precisely over the center of gravity of the unit **14** as described above.

Referring now to FIGS. **5, 12** and **17** of the drawings, it will be seen that the cleats **176** are each formed as an integral part of a fabricated welded foot **326** formed with a central web **328** secured on opposite sides to perpendicular flanges **330** and **332,** these members extending continuously throughout the length of the lower portion of the trusses **170** and **172.** The cleats **176** are established by angle members **334** also extending the length of the lower portion of each truss and secured by welding to the upper surface of the web **330** and the central portion of the transverse web **328.** A tube **336** of square or rectangular cross-section is welded on top of the angle member **334** continuously along the length thereof to establish an outer abutment edge for the cleats **176.**

At intervals along the length of the base or foot **326** of each truss are bearing brackets including lengths of inverted channel sections **338** welded to gusset webs **340,** the flange **332** and gusset web flanges **342.** Se-

cured to the outer portion of each truss **172** and **174** near the upper portion thereof and in the vicinity of the clevis and pin connections **270** by which the trusses are supported from the arms **170,** are inverted L-shaped bearing brackets **344.** Also in the same general location on the truss **172** and **174** are trough-like nesting members **346** facing in a direction opposite to that of the bearing brackets **344.**

The function served by the channels **338,** the bearing brackets **344** and the nesting brackets **346** will be understood from the insuing discussion taken in conjunction with FIG. **12** of the drawings. In this respect it will be borne in mind that the spreader may weigh as much as 30,000 pounds and is of a size which is capable of handling a single story housing unit in which the overall floor dimensions may be as large as 30 by 68 feet. Hence, movement of the spreader from lot to lot in the project being developed is not without difficulty. For example, it is not possible for the crane **10** to travel while the spreader **40** is supported from the line **32** both because of the load represented by the spreader itself and also because of a requirement for the boom **30** of the crane to be lowered during such travelling movement of the crane to clear overhead obstructions. In accordance with the system of the present invention, movement of the spreader from lot to lot, for example, is effected by the transporter **16.** As shown in FIGS. **12, 16** and **17,** and also to some extent in FIG. **3,** the load bed **42** of the transporter **16** is established by a main frame of longitudinal beams **348** interconnected at intervals along their lengths by transverse beams **350** and diagonal struts **352.** Extending outwardly in opposite directions from the longitudinal beams **348** are pivotal outrigger sections defined by longitudinal rails or beams **354** supported at the projecting ends of tapered beam sections **356** pivotally connected by pins **358** to clevis-like brackets **360** secured along the upper surface of the beams **348.** Because of the pin connection of the upper portion of the tapered beams **356** in this manner, coupled with the compressive or abutting bearing of the lower inboard end portion of the beams **356** against the beams **348** and transverse beams **350,** a retractable cantilevered structure is effected by which the housing unit may be supported in foundation-like fashion on the continuous rails or beams **354.**

The rails **354** are also employed to support the spreader **40** for movement from lot to lot where overhead clearance conditions permit. Specifically, after the completion of a housing transfer operation, the spreader **40** is disconnected from the snubbing frame **36** by removing the header bolts **218** and **220** and then operating the spreader jacks **278** to move the arms **170** and trusses **172** and **174** to the phantom line position depicted at A in FIG. **12** so that the heel channels **338** become aligned vertically over the house supporting rail beams **354** on the transporter **16.** The spreader **40** is then lowered onto the transporter and moved to the next lot on which the house transfer operation is to be effected. In situations where overhead clearance is lower so that the height of the spreader on the transporter in the condition described cannot be tolerated and also in situations where the spreader is to be moved through relatively larger distances, the spreader arms **170** and trusses **172** and **174** are oriented to the position designated at B in FIG. **12** of the drawings. To achieve this position, the spreader jacks **278** are first disconnected by removing the clevis pins **288** and allowing the jacks to fall to a suspended position as shown by phantom lines in FIG. **12.** The assembly of the arms and trusses is then lifted by an auxiliary line (not shown) on the crane to the position B in FIG. **12** so that the bearing brackets **344** overlie the longitudinal beams **348** of the transporter bed. To retain this position, a pair of retractable struts **361** pivotally supported by pins **362** on the underside of the transverse struts **166** are lowered to a vertical position to engage the nesting brackets **346** thereby to support the upper portion of the spreader including the transverse and longitudinal struts **166** and **168** at a fixed vertical location above the collapsed arms and trusses.

On the basis of the preceding description of the spreader **40** and snubbing frame **36** it will be appreciated that with the crane **10** and loaded transporter **16** in the respective positions illustrated in FIG. **1** of the drawings, the spreader **40** may be brought into a lifting position with respect to the housing unit **14** on the transporter by operating the spreader jacks **278** to expand or retract the arms **170** and trusses **172** and **174** to their outermost or spread position with the spreader being elevated by the crane to a position above the housing unit. While retaining the arms **170** in their retracted or spread condition, the crane is operated to lower the spreader downwardly over the housing unit until the cleats **176** reach an elevation below the level of the joists **320** and joist header **322.** The spreader jacks are then operated to move the trusses **172** and **174** inwardly until the joist headers **322** engage the box tube stops **336** whereupon the spreader is lifted until the cleats **176** engage the end of the joists and the joist headers. Inasmuch as the spreader at this time is connected by the slide and linkage assembly **38** to the snubbing frame **36,** this operation can be effected in reasonably efficient manner merely by operation of the crane **10** in conjunction with operation of the manually operated linkage jacks **222, 224** and **226.** Also it will be noted that although the width of the cleats **176** is relatively narrow primarily to insure proper positioning of the housing unit on the foundation **12,** the danger of the house slipping from the cleats is mitigated by the inverted L-shaped configuration of the truss supporting arms **170** on the spreader **40** and more particularly by virtue of the pivotal axis established by the pins **272** lying inwardly of the cleats **176** when the trusses **172** and **174** are in position to engage the housing unit **14.** This position of the loading cleats **176** in relation to the pivotal axis of the arms **170** established by the pins **272** is illustrated in FIG. **12** of the drawings and is significant to the extent that any forces tending to move the arms **170** about the axis of the pins **272** as a result of a lifting force being applied by the crane **10** will operate in a closing direction against the joist headers **322** of the housing unit **14** in a manner resembling that of the operation of an ice tong.

Though as indicated, the organization of the snubbing frame **36** allows the spreader to be moved into a lifting position with respect to the housing unit **14,** a further provision for facilitating this operation is illustrated in FIGS. **16–19** of the drawings. As shown most clearly in FIGS. **16** and **17,** the bed **42** of the transporter **16** is equipped with four manually adjustable spreader locating assemblies **363,** two such assemblies being positioned at each side of the load bed **42** and in the approximate longitudinal position of the spreader arms **170** positioned to lift a housing unit **14** from the

bed. Each of the assemblies **363** includes an elongated mounting body **364** formed by a pair of outwardly facing channel beams **366** secured at spaced intervals by a centrally apertured guide plates **368** and a U-shaped end plate **369.** The body **364** is retained in position on the load bed **42** by securing its inner end against the web of the longitudinal frame beams **348** and having its outer end supported by a bracket **370** suspended from the bottom of the rail beams **354.** Positioned centrally within the body **364,** is an axially fixed rotatable feed screw **372** keyed at its inner end to a sheave **374** about which a chain loop **376** is suspended. Thus it will be seen that the screw **372** can be rotated manually by appropriate manipulation of the chain loop **376.** The aperatured guide plate **368** and the end plate **369** on the body **364** support slidably a telescopic tubular portion **378** which carries at it inner end a non-rotatable nut **380** threadably engaged with the feed screw **372.** The telescopic member **378** in turn supports at its outer end an upstanding abutment post **382** which extends vertically from the top of the telescopic guide member upwardly to a level slightly under the load carrying surface of the rail-beams **354.**

As a result of the spreader locating assemblies, prior to lowering the spreader **40** downwardly over the housing unit **14** to initiate the transfer of the unit from the transporter to the foundation **12,** for example, the abutment posts **382** are adjusted by manipulation of the jacks chains **376** until all four jack posts are in line with the outer surface of the joist headers **322** as shown in FIG. **17.** With the abutment posts **382** in this position, the spreader, with the arms **170** retracted or splayed to their outermost position, is lowered over the housing unit and down to a position under the joists **320** where the arms are moved inwardly by the spreader jacks **278** until the flanges **330** on the foot of the spreader truss move into engagement with the abutment posts **382.** To enable the feet of the trusses to be moved into this position, the cleats **176** are cut out as at **384.** After the spreader has been adjusted to the position illustrated in solid lines in FIG. **17,** it is merely lifted so that the cleats **176** advance upwardly into a proper engaging position with the joists **320** and joist headers **322** of the housing unit.

Use of the system thus described as well as the operation of the several components thereof in the placement of housing units may be now be understood assuming the cycle of placement operation to begin with the crane **10,** the transporter **16** and thus the housing unit **14** in the relative positions illustrated for example, in FIGS. **1** and **3** of the drawing. Assuming further that the beam **210** has been fixed to the slides **186** and **188** to be oriented longitudinally with respect to the particular housing unit to be placed by proper selection of the bolt holes **214** for securement by the bolts **218** and that the suspension cables **178** have been properly adjusted all to account for the longitudinal distance between the center of gravity of the housing unit and its geometric center, the spreader **40** will be in an elevated position above the housing unit **14.** Also, prior to the spreader being elevated in this manner, the jacks **224** and **226** are adjusted so that the lateral distance between the inboard truss **172** and the snubbing frame posts **76** and **78** will be as short as possible. It will be appreciated, therefore, that the slide member **184** and the header **210,** being connected directly to the inboard truss **172** of the spreader **40** by the ratchet jacks **222, 224** and **226,** will be located near the upper ends of the snubbing frame posts **76** and **78** and also that the lateral distance between the header **210** and the inboard truss **172** will be relatively fixed. When the spreader jacks **278** are now elongated to their full or maximum length to splay the trusses **172** and **174** outwardly with respect to each other, the total or composite spreading movement of the trusses will be experienced solely in the outboard truss **174.** In addition, the superstructure of the spreader **40** including the struts **166** and **168** will be moved outwardly as a result of such elongation of the spreader jacks **278.** The spreader is then lowered until the rail cleat **176** of at least the inboard truss **172** reaches a position at a level slightly below the floor joists **320** and joist headers **322.** Because of the positioning of the crane **10** and snubbing frame **36** together with the outwardly splayed condition of the spreader trusses **172** and **174** with respect to each other, the cleat **176** on the inboard truss **172** at that level will be reasonably close to the position in which it engages the underside of the joist headers whereas the cleat **176** on the outboard truss will be positioned more remotely from its load engaging position. Upon the cleat **176** on the inboard truss **172** reaching such proximity to its load engaging position, operation of the crane **10** is ceased and the jacks **222, 224** and **226** adjusted manually until the cleat **176** on the inboard truss **172** is in engagement with the header **322** and end of the joist **320** on the housing unit **14** substantially as shown in FIG. **5** of the drawings. Thereafter, the spreader jacks **278** are operated to shorten their respective lengths so that the outboard truss **174** moves into its position of engagement with the other side of the unit floor joist and the spreader superstructure moves back to its proper position centered on the longitudinal center of the housing unit. Although the pivotal relation of the boom **30** at this time is fixed, some measure of lowering or raising the crane hoist cable **32** may be required to bring the outboard truss **174** into its final load engaging position.

Operation of the spreader in the aforementioned manner to attain a load engaging position with respect to the housing unit **14** may be effected without the use of the spreader locating assemblies **363** because of the positive interconnection of the spreader with the snubbing frame by way of the slide and linkage assembly **38.** Quite obviously, this procedure is enhanced significantly where the transporter **16** is equipped with the locating assemblies **363** both from the standpoint of the amount of time required to adjustably position the spreader in its load engaging position and also from the standpoint of avoiding unnecessary and possibly damaging contact with the lower edge portions of the housing unit in the positioning operation. As mentioned above, the complete horizontal relation of the spreader **40** with respect to the housing unit **14** may be established by use of the spreader locating assemblies **363** without any contact whatsoever with the housing unit **14,** thereby alleviating much of the concern for the accuracy in the spreader positioning operation.

Once the spreader **40** is in the position illustrated in FIG. **3** of the drawing, the crane is operated first to lift the spreader and the housing unit from the transporter **16** and then to swing the unit to a position above the foundation **12.** Once having reached this position and assuming that the elevation of the foundation is such as to require use of the lower guide post extensions **82,** the

chain hooks **164** are disconnected so that the lower guide post extensions **82** may be dropped into their operative positions as shown in solid lines, for example in FIG. **8** of the drawings. In this connection, it will be recalled that the lower extensions **82** must be in their retracted positions in order for the guide posts **76** and **78** to clear the outrigger beams **20** on the crane **10.** Once the lower guide post extensions are fixed in their operative positions, the crane operator lowers the spreader **40** and the housing unit to a position slightly above its final position of support on the foundation **12.** With the crane retained in this position and braked against movement about its swing axis **26,** the jacks **222, 224** and **226** at each end of the header **210** are now adjusted manually until the housing unit **14** is precisely located in a proper horizontal relationship with respect to the foundation **12.** Because of the proximity of the ratchet jacks **222, 224** and **226** to the lower side of the housing unit at this time, the final lateral positioning of the housing unit may be visually determined very accurately by the personnel operating the manual ratchet jacks. Also the relative proximity of the jack handles in each triaxial set of three jacks on opposite ends of the header **210** enables each such set to be operated easily by one person. When the proper horizontal position of the house has been obtained, the crane operator merely lowers the spreader and the housing unit until it seats on the upper surface of the foundation **12.** Thereafter, the spreader is dropped to a position slightly below the load engaging position thereof with the floor joists and joist headers **320** and **322.** The spreader trusses **172** and **174** are again splayed outwardly, reversing the procedure described above in moving the spreader to a load engaging position about the housing unit **14,** and the spreader lifted vertically to clear the housing unit.

In situations where the units **14** are to be stacked as in the erection of multi-unit apartment or condominium building units, system operation is merely repeated for each position of the crane, it being understood that the transporter will be repositioned in the manner described above with respect to FIG. **1** after having picked up another housing unit to be placed on top of the unit previously placed on the foundation **12.** Placement of an upper unit on a lower unit will involve essentially the same operation with the exception that the upper guide post extensions **80** will be used more extensively.

Movement of the crane **10** and spreader **40** between individual lot sites in a land project under development is also important to overall operation of the present invention. In this respect it is to be noted that the weight and size of the spreader **40** is such as to require support of the crane **10** on the outrigger jacks **22** thus preventing travel of the crane **10** while supporting the weight of the spreader. Accordingly, any movement of the crane between individual lot sites requires independent transport of the spreader **40.** To this end, and after the house placement operation has been completed at a given site, the spreader **40** is disconnected from the snubbing frame **36** by removing the bolts **218** and **220** to disconnect the header **210** from the slides **186** and **188.** Assuming in absence of overhead clearance problems in moving between sites, the spreader **40** is first elevated to a position above the transporter **16** and the spreader jacks **278** contracted to advance the arms **170** and trusses **172** and **174** to the contracted loading position designated at A in FIG. **12** of the drawings. The spreader with the ratchet jacks **222, 224** and **226** as well as the header **210** remaining attached is then lowered so that the heel-like channels **338** at the bottom of each truss **172** and **174** come into engagement with the beams **354** on the bed of the transporter **16.** After the hoist line **32** has been detached from the cables **178,** the spreader is fully supported by the transporter **16** and may be moved onto the next lot on which the house placement operation is to be effected. If inadequate horizontal or overhead clearance exists in the route between lot sites, then the spreader **40** is positioned on the transporter in the condition illustrated at B in FIG. **12** and in the manner described above. When the spreader **40** has been disconnected from the snubbing frame and supported by the transporter **16,** the crane **10** can be moved in conventional fashion merely by retracting the outrigger beams **20** and outrigger jacks **22** and lowering the boom **30** into a travelling position. In this respect, it might be mentioned that in the interest of overall efficiency of placement of housing on lot sites in a project under development, two sets of the crane mats **54** and **56** are employed. In this manner, the lot to which the crane is to be moved can be laid out to include the crane location hubs **57–59** and as well, the crane mats **54** and **56** can be preplaced by a foundation crew in advance of the house placement operation.

Upon arrival at the succeeding lot site, and after positioning the crane **10** in the manner described above with respect to FIG. **1,** the transporter **16** with the spreader **40** loaded thereon is first brought roughly into position to enable the spreader to be removed by the crane **10.** During the period of time required for the transporter to return to a loading terminal (not shown) to pick up another housing unit **14,** the crane crew completes the connection of the spreader **40** to the snubbing frame **36** and in addition, sets the transporter locating hubs **66, 68** and **70** as well as selecting the most desirable transporter approach route **50** in setting these hubs. Thereafter the loaded transporter is moved into position in the manner described and the placement operation repeated.

In light of the foregoing, it will be appreciated that the system of this invention as well as the individual components thereof are particularly well suited not only for accurate and gentle placement of housing units but also to enable effective movement of the system components into proper operating position on successive lot sites to receive the housing units **14.** In addition, it will be noted that the general clevis pin interconnection of component parts in both the snubbing frame **36** and the load spreader **40** greatly facilitate disassembly of these units as may be required for overland travel of relatively long distances as may exist, for example, between different projects. This facility for disassembling the spreader **40** to provide an assembly of generally linear load components for transport on a conventionally high semi-trailer is illustrated most clearly in FIG. **11** of the drawings. The manner in which the components of the snubbing frame **36** may be disassembled for transport in similar fashion can be appreciated from FIGS. **8–10** of the drawings.

Thus it will be seen as a result of the present invention, a highly effective method and apparatus is provided for the ultimate placement of factory prefabricated housing units and by which the above mentioned objectives are completely fulfilled. It will be appreci-

ated also that numerous modifications can be made in the invention embodied in the described structure without departure from inventive spirit or scope. It is expressly intended therefore, that the foregoing description is illustrative of a preferred embodiment only, not limiting, and that the true spirit and scope of the present invention be determined by reference to the appended claims.

We claim:

1. A portable load spreader adapted to be suspended on a hoist line for handling large, delicate loads such as interiorly finished housing units, said spreader comprising:

a detachable assembly of box-truss components including a pair of transversely spaced longitudinal struts, a pair of longitudinally spaced transverse struts, each of said transverse and longitudinal struts including interconnected spaced upper and lower pairs of tension-compression chords, detachable means rigidly interconnecting opposite ends of said longitudinal struts to said transverse struts to establish a generally rectangular superstructure, a pair of arm members also having interconnected spaced pairs of tension-compression chords, means pivotally suspending a pair of said arm members from each side of said superstructure, one from each end of said transverse struts, said pivotal suspending means detachably connecting one pair of said chords in said arm members to one pair of said chords in said transverse struts, thereby to restrict pivotal movement of said arms to a single pivotal axis and a pair of parallel truss members detachably but rigidly suspended one from each of said pair of arm members;

linear load engaging and supporting means extending inwardly from each of said truss members continuously along the length thereof; and

means connected between said arms and said superstructure for swinging said arms and said truss members toward and away from each other while maintaining the parallel relation of truss members.

2. The apparatus recited in claim **1** wherein said arm members are of inverted L-shaped configuration to establish in each arm member, generally horizontal and vertical leg portions, said horizontal portion being pivotally connected at an inwardly projecting end point to the ends of said transverse struts and being of a length such that the vertical plane of said linear load engaging and supporting means in a load engaging position lies outwardly of said end point.

3. The apparatus recited in claim **2** wherein the box-truss construction of said horizontal arm leg defines upper and lower pairs of chord members, and wherein said means for swinging said arms comprises extensible jack means associated with each of said arms connected between and operative in line with the other pair of said chord members in said transverse struts and said horizontal arm leg, respectively.

4. The apparatus recited in claim **3** wherein said arm leg end point pivotal connection and said jack means are aligned respectively with said upper and lower pairs of chord members.

5. The apparatus recited in claim **3** including inner and outer pivot pins connecting the inner and outer ends of said jack means to said transverse struts and said arm legs respectively, and including a common drive shaft for operating said jack means associated with each pair of arms on opposite sides of said superstructure.

6. The apparatus recited in claim **5** including two of said drive shafts, one supported on each of said longitudinal struts for driving rotation on an axis aligned with said inner pivot pins so that upon removal of said outer pins to disconnect said jack means from said arms, said jack means can be swung about to an out-of-the-way position about said inner pivot pins without disconnection of said drive shaft.

7. The apparatus recited in claim **1** wherein said transverse struts each include a pair of junction sections near opposite ends thereof having means to effect a clevis pin connection to opposite ends of each of said chord members in said upper and lower pairs of chord members of said longitudinal struts.

8. The apparatus recited in claim **7** wherein said junction sections further include grommet means for connection to a suspension cable system.

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