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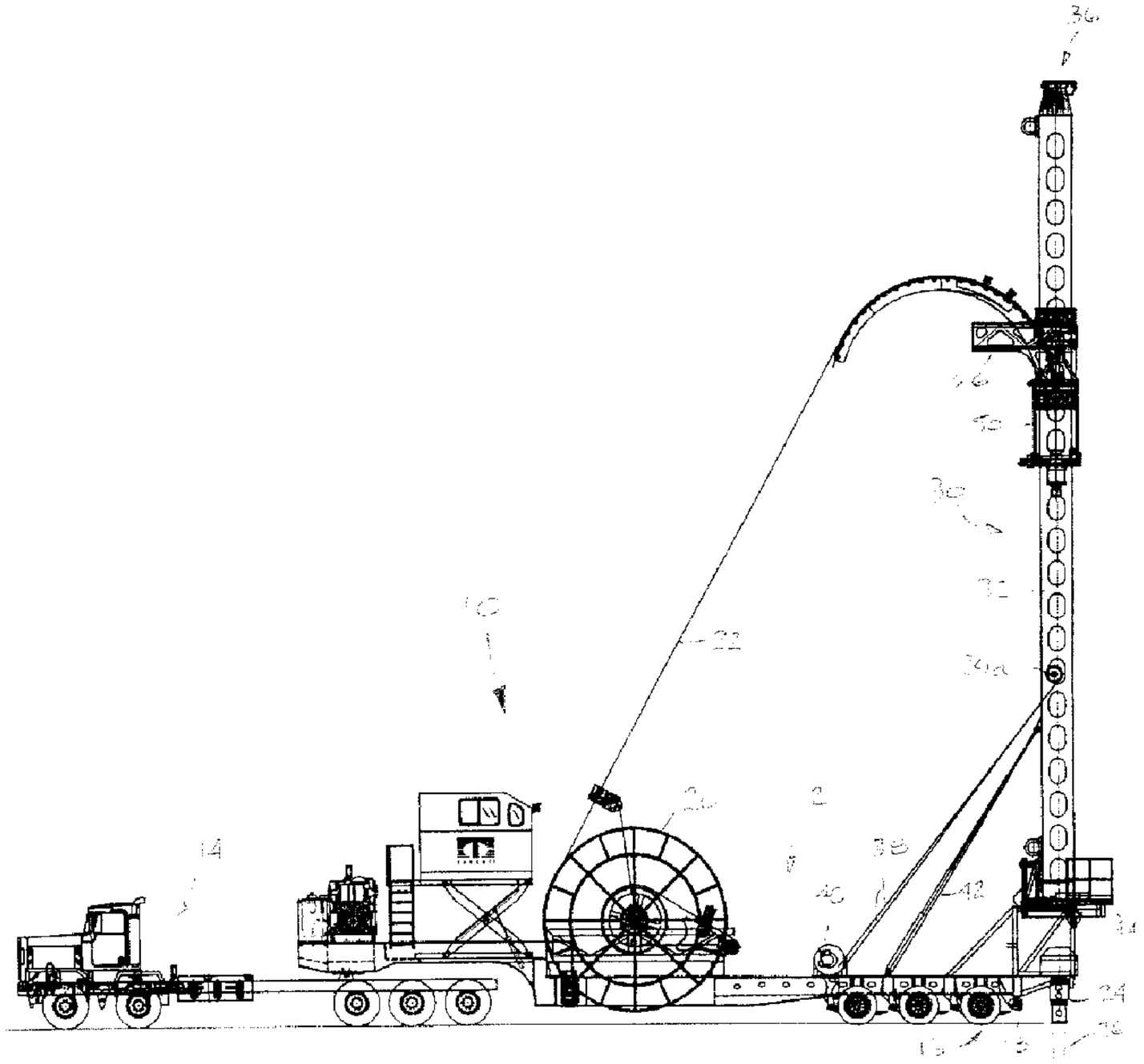
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(54) Titre : ENSEMBLE AMELIORE DE MAT ET DE CHARIOT POUR APPAREIL DE FORAGE MULTIFONCTIONS MOBILE

(54) Title: IMPROVED MAST AND TROLLEY ARRANGEMENT FOR MOBILE MULTI-FUNCTION RIG



(57) Abrégé/Abstract:
An improved mast arrangement for a mobile multi-function rig has a winch line extending from an upper end of the mast and a traveling block supported thereon. A trolley mountable on the mast is adapted for coupling to the traveling block. The trolley works primarily as a guide for a given load, and therefore is of a lightweight design since loads mounted to the trolley are

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(57) Abrégé(suite)/Abstract(continued):
transferred directly to the traveling block and the supporting winch line. The trolley provides the capability to readily switch between various rig operations, including manipulating coiled tubing with an injector, setting surface casing using a top drive, operating the winch and traveling block for joined pipe operations, and interchanging between top drive and joined pipe operations without removing the top drive from the mast or rig. The rig can run deeper joined pipe applications than previous mobile rigs by providing means for employing the top drive, namely the trolley is adapted to counteract the torsion exerted by the top drive during operation. The trolley is able to work the entire length of the mast after quickly parking the injector near the bottom of the mast. The winch and traveling block have unobstructed travel along the entire length of the mast without disengaging the trolley from the mast and with the injector parked near the bottom end.

ABSTRACT

An improved mast arrangement for a mobile multi-function rig has a winch line extending from an upper end of the mast and a traveling block supported thereon. A trolley mountable on the mast is adapted for coupling to the traveling block. The trolley works primarily as a guide for a given load, and therefore is of a lightweight design since loads mounted to the trolley are transferred directly to the traveling block and the supporting winch line. The trolley provides the capability to readily switch between various rig operations, including manipulating coiled tubing with an injector, setting surface casing using a top drive, operating the winch and traveling block for joined pipe operations, and interchanging between top drive and joined pipe operations without removing the top drive from the mast or rig. The rig can run deeper joined pipe applications than previous mobile rigs by providing means for employing the top drive, namely the trolley is adapted to counteract the torsion exerted by the top drive during operation. The trolley is able to work the entire length of the mast after quickly parking the injector near the bottom of the mast. The winch and traveling block have unobstructed travel along the entire length of the mast without disengaging the trolley from the mast and with the injector parked near the bottom end.

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TITLE: IMPROVED MAST AND TROLLEY ARRANGEMENT FOR MOBILE MULTI-FUNCTION RIG

FIELD OF THE INVENTION

The present invention relates to drilling and servicing equipment for oil and gas wells generally, and in particular relates to an improved mast and trolley design for use in rigs which transport and/or operate equipment for continuous coiled tubing drilling, for conventional joined pipe handling and drilling, and/or for wireline applications.

BACKGROUND OF THE INVENTION

Our co-pending US patent application 09/688,979 and corresponding Canadian patent application 2,322,917 for a "Trolley and Traveling Block System" disclose a novel trolley hoisting system for use in rigs, particularly multi-task rigs, which transport and/or operate equipment for oil and gas operations, including continuous coiled tubing drilling and conventional joined pipe handling and drilling operations. The novel system allows a single winch arrangement to perform various tasks without having to detach from or connect to the injector, as in some conventional rig arrangements, when switching between tasks. In particular, the winch system is capable of moving the injector along the rig's mast, or derrick, and, upon fixing the injector at a desired location along the mast, the winch is immediately available for performing other desired tasks, such as a joined pipe operation.

However, the above system can not readily accommodate a top drive mechanism to rotate joined pipe or to set surface casing. It is therefore an object of the present invention to provide a mobile rig with such capability. In particular, the mast of the present invention should allow for a winch arrangement to perform various tasks in combination with a trolley which is movable along the mast, and to perform other tasks when detached from the trolley in a solo configuration. The trolley should be adapted to accept various other equipment, including an injector and lubricator for continuous or coiled tubing. The trolley and mast should allow an injector to be parked near the bottom of the mast out of the plane of the mast to allow the trolley to travel along the entire length of the mast. Further, the winch should be capable of working the entire length of the mast without undue interference from the trolley. Any load carried by the trolley should be transferred directly to the winch arrangement so that the trolley acts primarily as a guide for the load along the mast, thus streamlining the trolley's structure and weight.

SUMMARY OF THE PRESENT INVENTION

According to the present invention, there is provided in one aspect an improved mast arrangement for mobile multi-function rig comprising a winch line extending from an upper end of the mast having, a traveling block supported by the winch line, and a trolley mountable on the mast having side members for operatively engaging the mast, rail portions extending perpendicularly from the side members, a cross-beam extending transversely between the rail portions and adapted to roll therealong, and a collar slidably mounted on the cross-beam for movement therealong and adapted for coupling to the traveling block, wherein a load mounted to the collar is transferred through the collar directly to the traveling block and the supporting winch line.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

The invention will now be described, by way of example only, with reference to the accompanying drawings, wherein:

Figure 1a is a side view of a mobile multi-function rig which employs a mast and trolley according to a preferred embodiment of the present invention showing the trolley at a selected location along the mast and an injector coupled to the trolley;

Figure 1b is an end view of the rig from the right side of fig.1a;

Figure 2a is a view similar to fig.1a but showing only the trailer portion of the rig omitting several features such as the cab and cartridge assembly, and showing the trolley located at the lower end of the mast and the injector fixed, or "parked", out of the plane of the mast on the bed of the trailer with the traveling block still attached;

Figure 2b is an end view of the rig from the right side of fig.2a;

Figure 3a is a close-up side view of the back of the trailer and the lower end of the mast of fig.2a, with the traveling block and a user platform and railing omitted for a better view of the injector and trolley;

Figure 3b is an end view from the right side of fig.3a with the traveling block;

Figure 4a is a view similar to fig.1a but showing the injector parked on the back of the rig's trailer and the trolley at a selected location along the mast with a top drive operatively engaged to the trolley;

Figure 4b is an end view from the right side of fig.4a with the injector omitted;

Figure 5a is a close-up side view of the mast, trolley and top drive of fig. 4a;

Figure 5b is an end view from the right side of fig.5a;

Figure 6a shows the mast and trolley of fig.5a with the top drive omitted;

Figure 6b an end view of the rig from the right side of fig.6a;

Figure 7a is a view similar to fig.4a but showing only a portion of the rig's, the trolley at a lower end of the mast with the top drive moved out of the plane of the mast toward the parked injector, and the traveling block disengaged from the trolley; and,

Figure 7b is an end view from the right side of fig.7a.

LIST OF REFERENCE NUMBERS IN DRAWINGS

10	mobile rig
12	trailer portion of 10
14	tractor portion of 10
16	rear end of 12
18	hydraulic stabilizers
20	cartridge assembly
22	coiled tubing
24	BOP
26	wellhead
30	mast / derrick
32	column members of 30
34	crown pulleys
36	crown of 30
38	cables
39a,b	first and second pulleys
40	winch assembly
42	hydraulic leg(s)
44	platform

46	bottom end of 30
48	traveling block
49	nut / bolt arrangement
50	injector
52	hydraulic cylinders
54	locking pin
56	aperture
60	trolley
62	side members of 60
64a,b	upper and lower guides
65	pin(s)
66	rail portions of 62
68	cross-beam
70	rollers
72	collar
74	sleeve portion of 72
76	head of 72
78	tail of 72
80	top drive
82	support arms of 80
84	hydraulic jacks

DESCRIPTION OF PREFERRED EMBODIMENTS

Figure 1a shows a mobile rig (generally indicated by reference numeral 10) for transporting drilling and servicing equipment to an oil or gas well site. The equipment, such as a cartridge assembly 20 capable of holding various sizes of continuous or coiled tubing ("CT") 22, is located aboard a trailer portion 12 of the rig which is adapted to be towed by a self-propelled tractor portion 14. A triple axle rear end 16 of the trailer 12 includes a number of hydraulically operated stabilizers 18 for enhancing the trailer's lateral stability once its rear end is located over a wellhead 26 and during well operations. The term "well" is understood herein to mean either an oil or gas well to be drilled, or an existing well or wellhead which is to be tested or serviced. The rig's design is generally symmetrical about its longitudinal axis.

The rig 10 incorporates a number of drilling and servicing features aboard the trailer 12, including a mast 30 (also referred to as a "derrick") pivotally mounted to the rear end 16 of the trailer, which can also carry a blow-out-preventor ("BOP"). The mast is capable of supporting an injector 50 for moving the CT 22 into and out of the well. The mast 30 has two longitudinally spaced column members 32 (as best seen in figs.1b), each formed by a hollow structural section having a longitudinal central passage along its length. The columns 32 are joined at their top ends by a generally hollow structural tie member, or crown 36, housing a number of conventional pulley wheels 34 (also referred to as "sheaves") about which pass the cables 38 of a winch assembly 40. In the embodiment shown the mast is about 72 feet (about 22 m) in length from ground to crown so as to accommodate multiple sections of conventional joined pipe. A telescoping hydraulic cylinder or leg 42 is attached to each column 32, and is operated from a control panel at the rear of the trailer, to tilt the mast 30 between a generally

horizontal transportation mode and a generally vertical operating mode. A operator's platform 44 with safety railing is provided at the bottom end 46 of the mast.

The winch assembly 40, in conjunction with the novel features of the trolley 60, is designed to perform multiple tasks, such as:

raising and lowering the injector 50 and lubricator, as well as running joined pipe segments;

handling various lengths of down hole tools;

hoisting other equipment as may be needed, including wireline equipment; and,

importantly, allowing a top drive 80 (as shown in figs. 4a - 5b) to be supported and operated in the mast.

The winch assembly 40 incorporates at least two sets of steel cables 38, where at least some of which extend about a first pulley 39a and then up a respective column through its hollow interior over a second pulley 39b and to the crown pulleys 34. The cables 38 then extend downwardly away from the crown to engage and support a "traveling" block 48 in a known manner. The block 48 has a nut and bolt arrangement 49 at the far, or lower, end of the block to provide a means of manually coupling and decoupling the block and the trolley 60. The winch assembly therefore controls the movement of the traveling block and trolley along the elevated mast for performing desired functions.

Referring now more particularly to the trolley 60 as shown in detail in figs.6a and 6b, the trolley is adapted to ride on the columns 32 to any number of desired locations longitudinally along the mast, with two selected vertical locations being illustrated in figs. 1b & 2b. The trolley has a pair of opposed elongate side members 62 extending generally parallel to the columns 32. Upper and lower c-shaped guides 64a and 64b, respectively, at the ends of each side member 62 engage the columns 32 to space the side members

inwardly from the masts and to guide the trolley therealong. Each guide 64a, 64b is pinned to its side member by pins 65 to allow for some differential twist between the guides themselves and the side members. Each side member 62 has a truss-like lateral rail portion 66 which extends generally perpendicularly out of the plane of the mast, namely horizontally when the mast is elevated vertically. An elongate cross-beam 68 spans perpendicularly between the trolley's side members 62, and has two pairs of rollers 70 at each end for guiding the cross-beam 68 laterally out of the mast along the rail portions 66 to a desired location therealong. The cross-beam 68 carries a collar 72 which has an intermediate sleeve portion 74 adapted to slide side-to-side along the cross-beam with the use of TEFLON pads or the like. The head 76 of the collar has apertures for coupling to the traveling block 48 via the nut and bolt arrangement 49, and the tail 78 of the collar is adapted for coupling to equipment, such as to the injector 50 (fig. 1b) or the top drive 80 (fig. 5b).

The trolley is relatively lightweight since the design provides for a direct transfer of load of any machinery coupled to the tail 78 to the traveling block 48 and cables 38 via the collar 72. The load remains generally linearly aligned with the load bearing cables 38 as the machinery is slid side-to-side along the cross-beam 68, and as the machinery and cross-beam are rolled front-to-back along the rails 66. The traveling block 48 and cables merely follow the collar as the cross-beam is rolled toward the back of the rails 66 and out of the plane of the mast. Hence, the trolley acts primarily as a guide for the machinery along the mast and carries little, if any, of the machine's weight.

Figures 1a to 3b illustrate use of the injector 50 by the rig of the present invention. A top end of the injector is pinned to the tail 78 of the trolley's collar 72, and the traveling block 48 is coupled to the collar's head 76 so that the injector's weight is carried directly

by the cables 38 up to the crown. Since the winch assembly 40 controls movement of the cables, it is therefore used to move the trolley and injector along the mast, as for example to an operating position shown in figs. 1a and 1b. Opposed sides of the injector are further engaged with the lower end of the trolley's side members 62 by a pair of hydraulically operated cylinders 52 to manipulate the orientation of the injector in a plurality of aspects, such as rotating and tilting the bottom of the injector relative to the wellhead 26. Hence, the trolley's side members 62 and the guides 64a, 64b serve to transfer twisting and bending moments from the injector to the mast's columns. When the injector is not needed for operation, the injector is rolled to the back end of the rails 66 out of the plane of the mast by the cylinders 52, and the trolley is then brought to the bottom end 46 of the mast to rest the injector on the trailer's deck, as shown in figs.2a to 3b. Prior to disconnecting the injector the trolley should be securely fixed by actuating a hydraulically operated locking pin 54 from the mast's column to an opposed aperture 56 in the trolley's side member 62. The injector is then removed from the trolley by decoupling the injector's top end from the collar's tail 78 and the cylinders 52 from the side members 62. Upon decoupling the locking pin, the unloaded trolley (as seen in figs. 6a and 6b) is then free to operate without obstruction along the entire length of the mast.

Alternately, if the trolley is not needed for a desired rig operation, then the trolley may also be parked at the bottom end of the mast and fixed thereto by the locking pin. The cross-beam 68 is rolled to the back end of the rails 66 out of the plane of the mast, and the traveling block 48 is then decoulped from the trolley at the collar 72. The winch and traveling block arrangement is then used along the entire length of the mast to perform certain rig operations independently of the trolley, such as handling joined pipe.

A particular advantage of the present invention is the capability to readily switch from an injector operation to a top drive operation. With the injector 50 at rest on the trailer 12 and the trolley at the mast's bottom end, the top drive 80 may be secured to the trolley by coupling the drive's top end to the collar's tail 78, and pinning two lateral support arms 82 to the trolley's side members 62, as shown in figs. 5a and 5b. The support arms 82 provide important torsional resistance to the top drive during operation, without which the top drive could not function. Once attached, the top drive and trolley arrangement may then be maneuvered along the mast by the winch assembly and elevated to an operating position (as in figs, 4a and 4b) for performing desired operations, such as setting surface casing. The reverse procedure is followed to remove the top drive from the trolley. The top drive also incorporates a pinion gear arrangement, or alternately hydraulic jacks 84, to pivot the top drive about the tail 78 from the vertical position illustrated to a generally horizontal orientation facing away from the trailer's rear end to facilitate the loading and unloading of casing to and from the mast.

Another advantage of the present invention is the capability to readily switch between top drive and joined pipe operations without removing the top drive off the mast or rig. This feature is best illustrated by first referring again to figs. 4a & 4b showing the traveling block 48 connected to the trolley 60 with the top drive 70 mounted therein for setting surface casing. From this configuration the rig may be switched to a joined pipe operation by lowering the trolley toward the mast's bottom end and rolling the trolley's cross-beam 68 toward the back end of the rails 66 to take the top drive out of the plane of the mast 30 (i.e. "off-centre") and bring it to a position beside and above the parked injector 50, as shown in figs. 7a & 7b. The trolley may be fixed in position to the mast as described earlier using the locking pin 54 or the like. The traveling block 48 is then

disengaged from the trolley and may operate unobstructed along the length of the mast for handling joined pipe and other rig operations. This aspect of the invention allows the top drive to be quickly re-engaged along the mast if an obstruction or other problem is encountered during the joined pipe operation which requires use of the top drive.

In sum, the many advantages of the rig of the present invention include:

the ability to readily switch between various rig operations which heretofore have not been possible on mobile rigs, such operations including manipulating CT with the injector 50, setting surface casing using the top drive 80, operating the winch and traveling block for joined pipe operations, and interchanging between top drive and joined pipe operations without removing the top drive from the mast or rig;

the ability to run deeper joined pipe applications than are available on current mobile rigs by providing means for employing the top drive 80, namely the trolley is adapted to counteract the torsion exerted by the top drive during operation (for instance, the top drive could not function by mere pinning to the traveling block);

the ability for the trolley to work the entire length of the mast after quickly parking the injector near the bottom of the mast;

providing the winch and traveling block with unobstructed travel along the entire length of the mast without disengaging the trolley from the mast and with the injector parked near the bottom end;

providing a trolley of relatively simple and lightweight design by having the trolley work primarily as a guide for a given load since its configuration allows for a direct transfer of load to the traveling block and winch cables; and,

providing a mast design which is not top heavy by parking equipment at the bottom end and having the aforementioned lightweight trolley design.

The above description is intended in an illustrative rather than a restrictive sense, and variations to the specific configurations described may be apparent to skilled persons in adapting the present invention to other specific applications. Such variations are intended to form part of the present invention insofar as they are within the spirit and scope of the claims below.

We claim:

1. An improved mast and trolley for use in a rig comprising:

a mast mounted to the rig;

a winch line extending from an upper end of the mast;

a traveling block located at a terminal end of the winch line;

a trolley mountable to said block for travel along said mast, and adapted to carry drilling and servicing equipment for oil and gas wells.

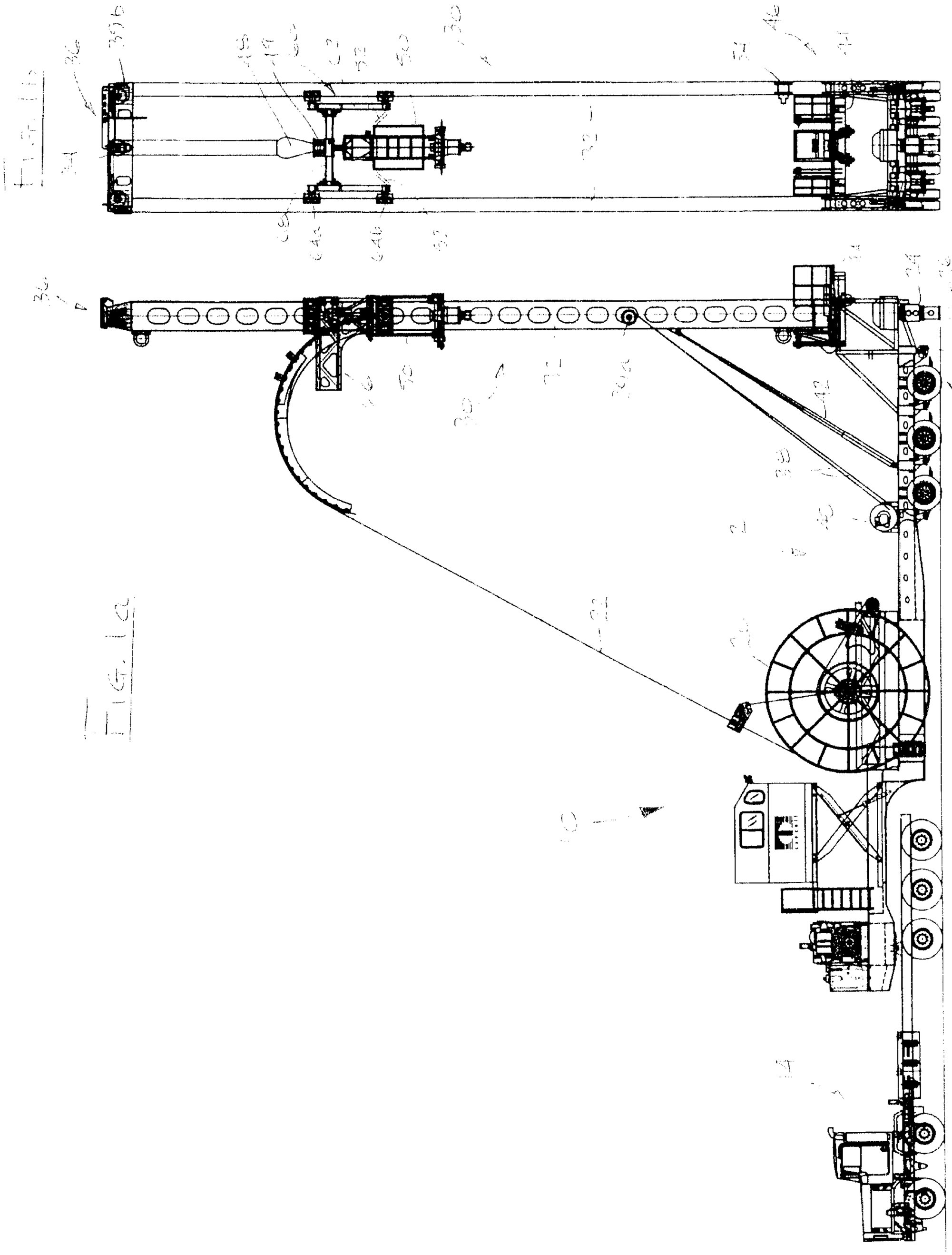


FIG. 1a

FIG. 2a

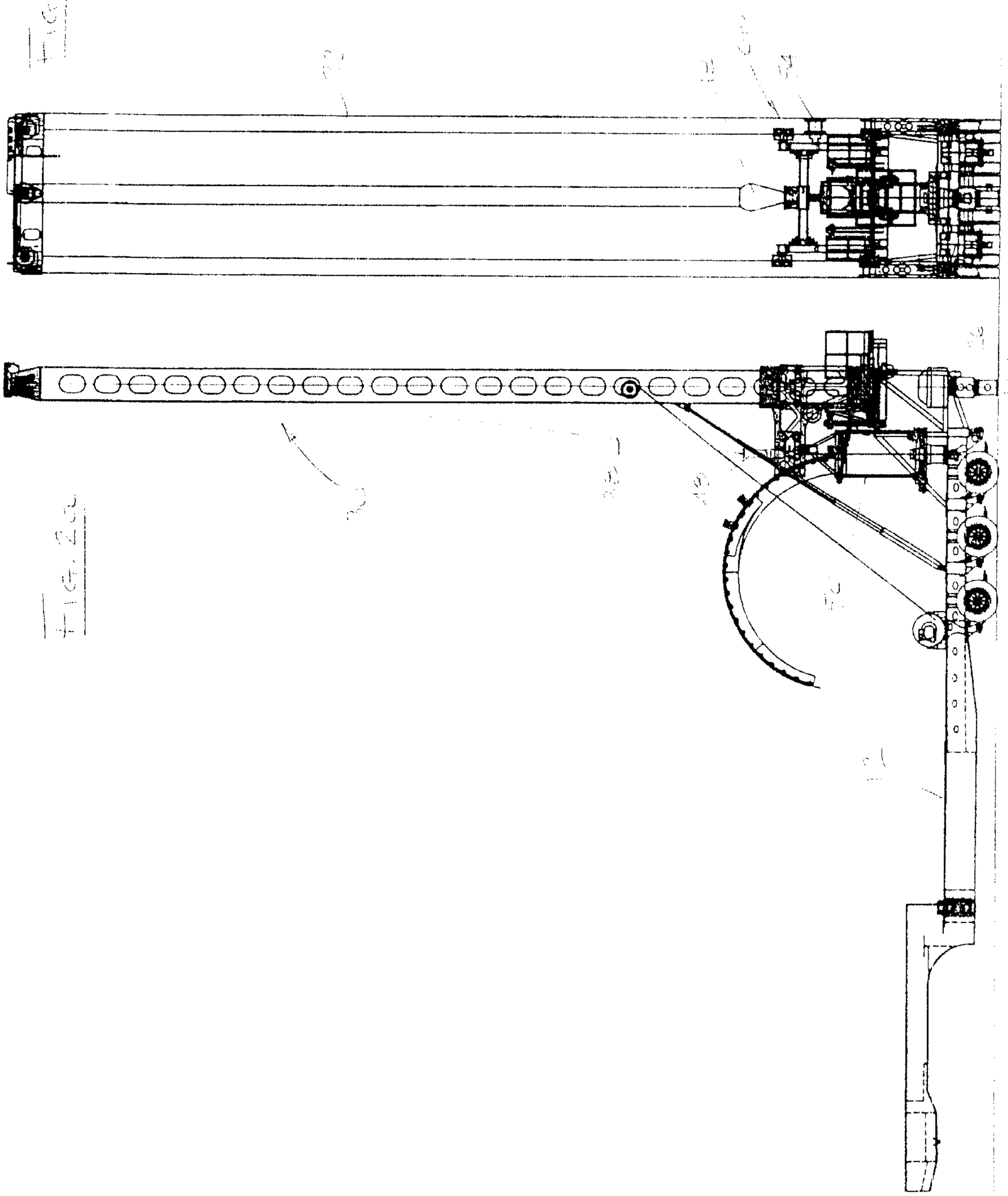
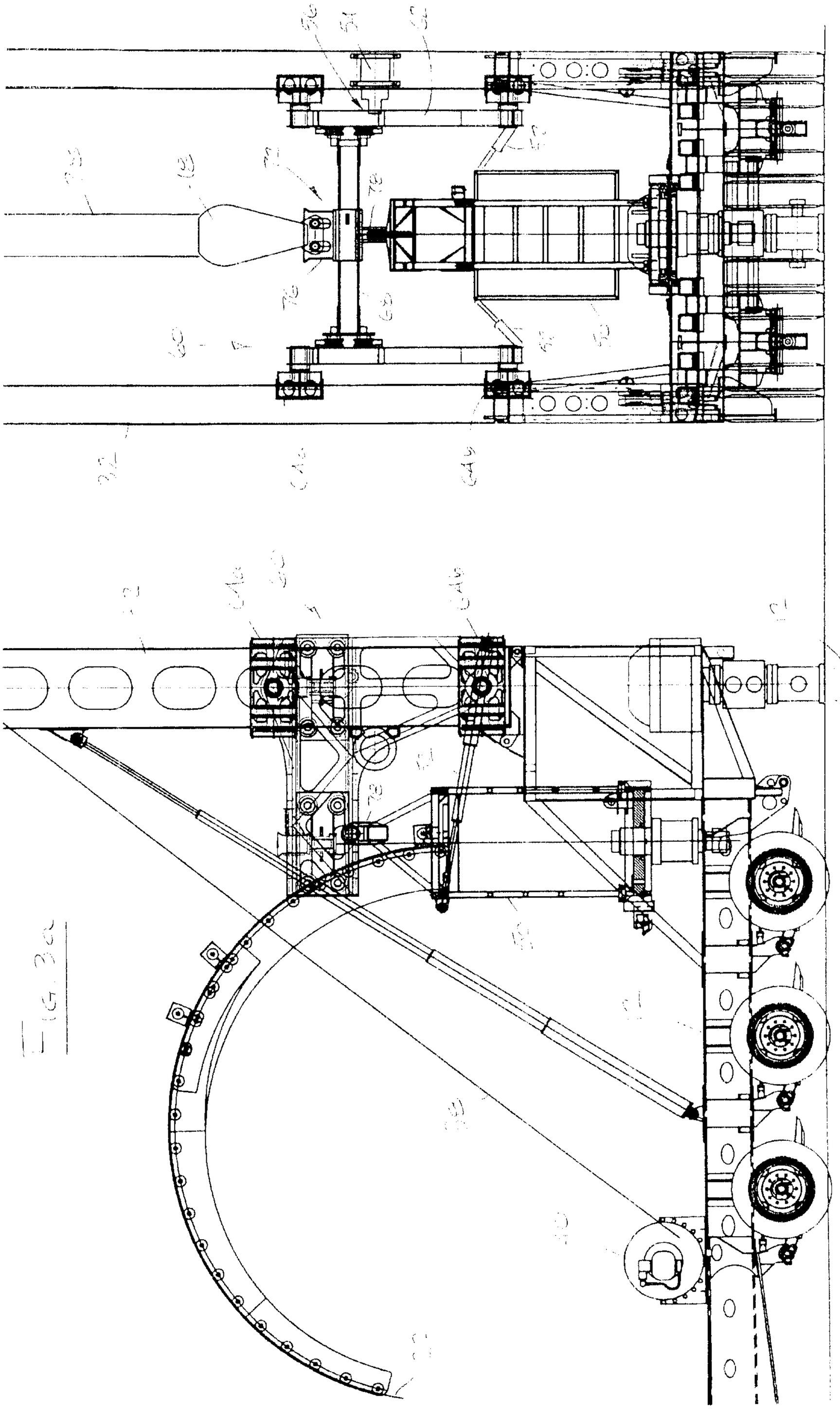
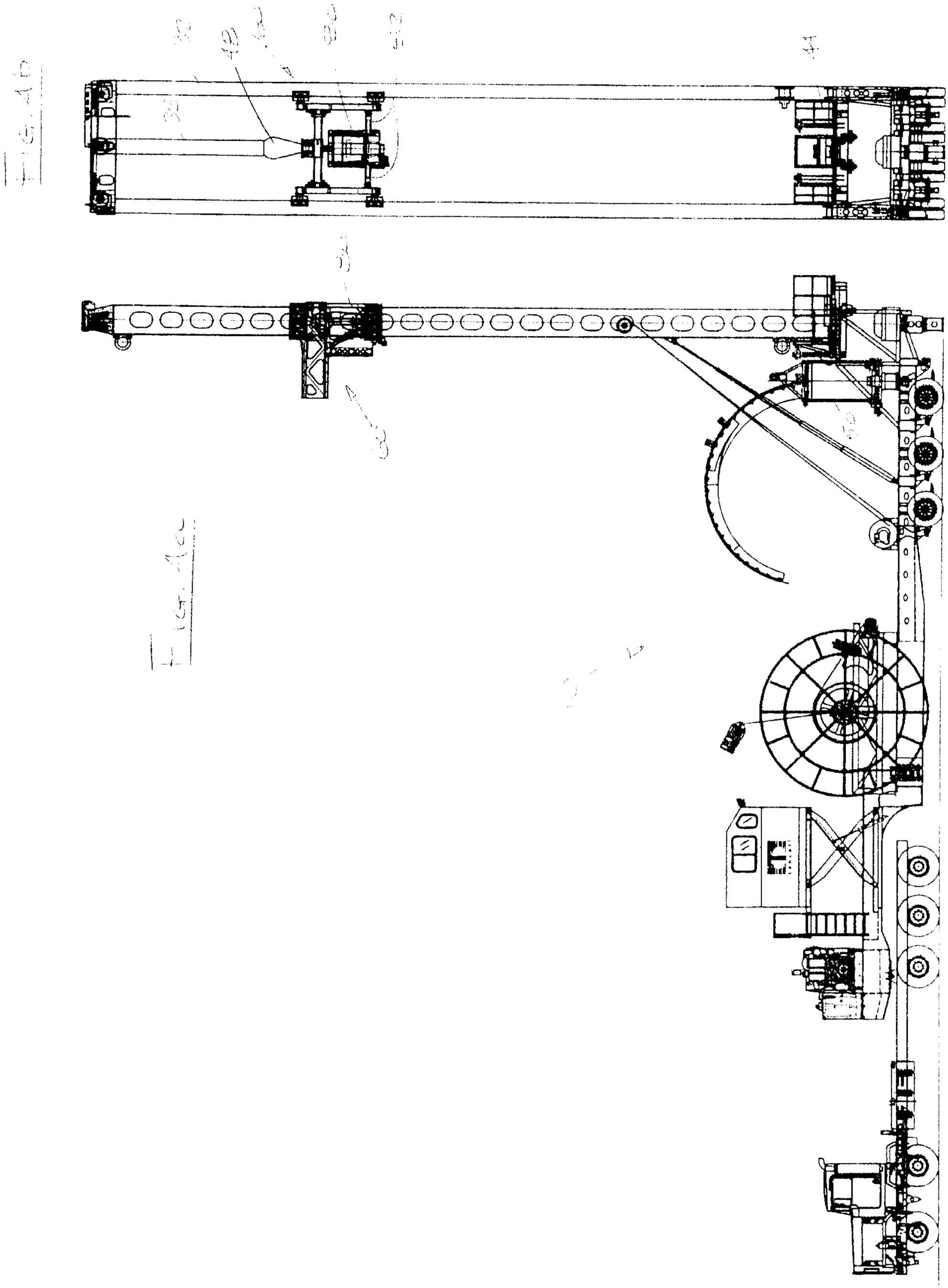
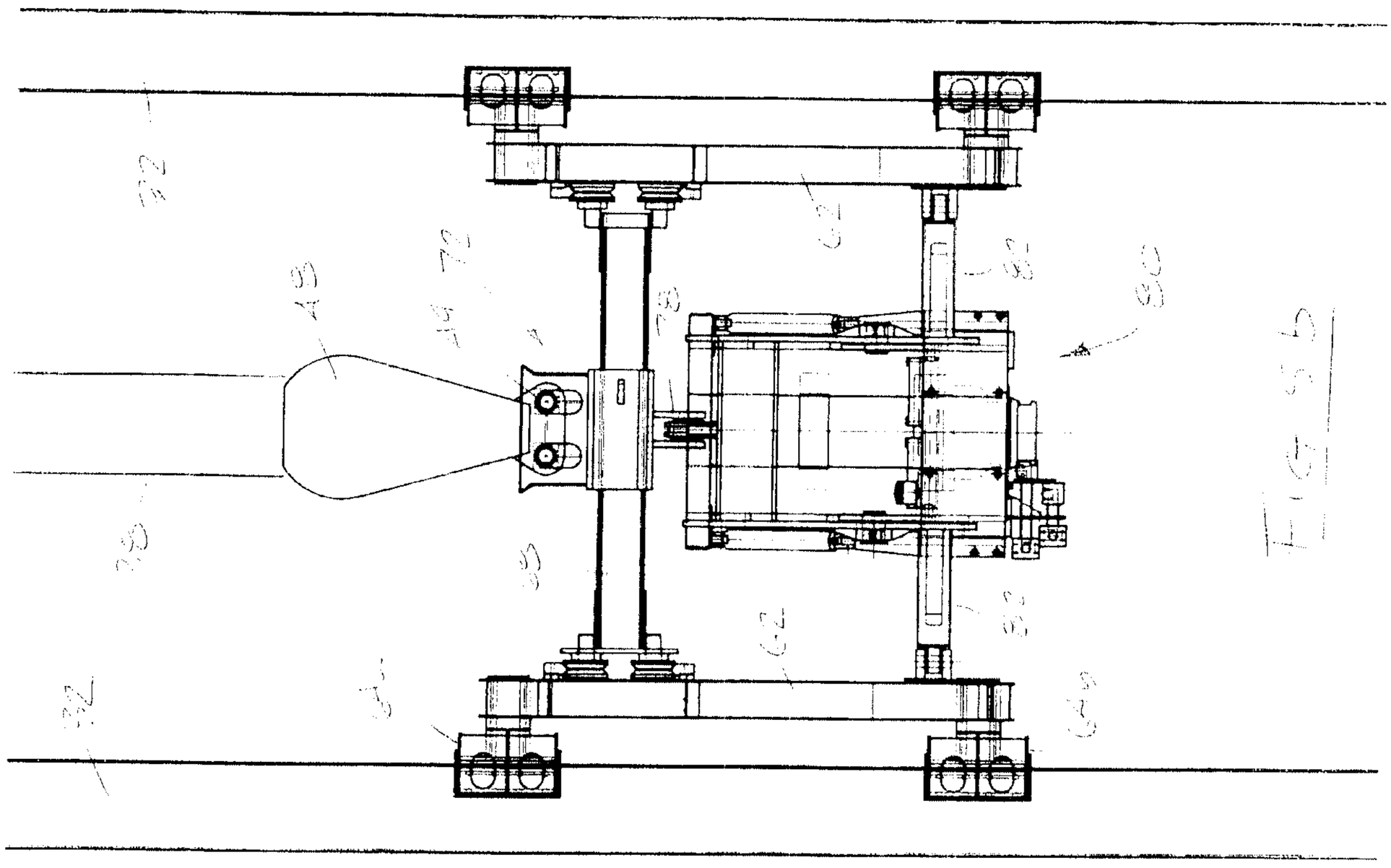
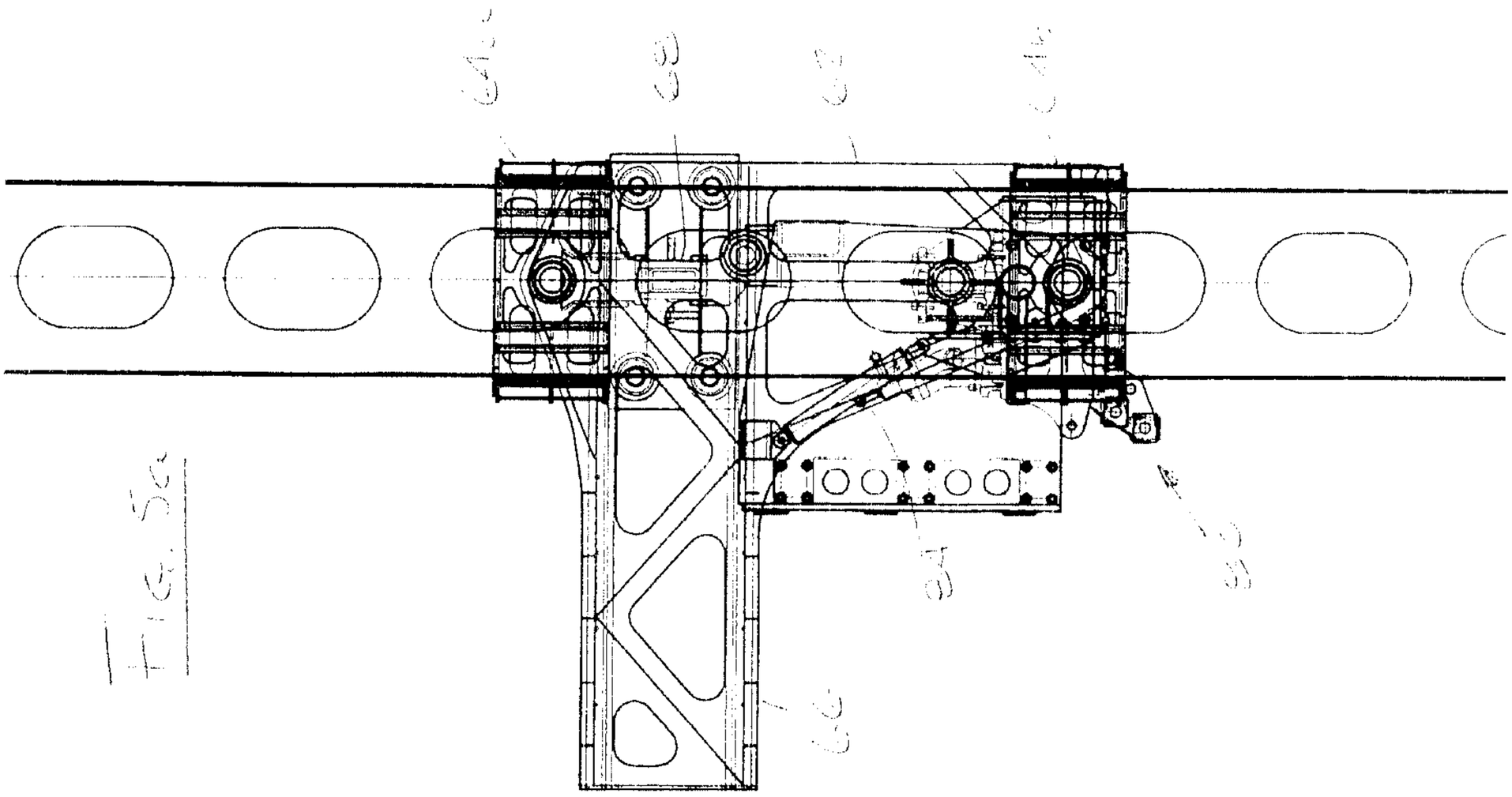


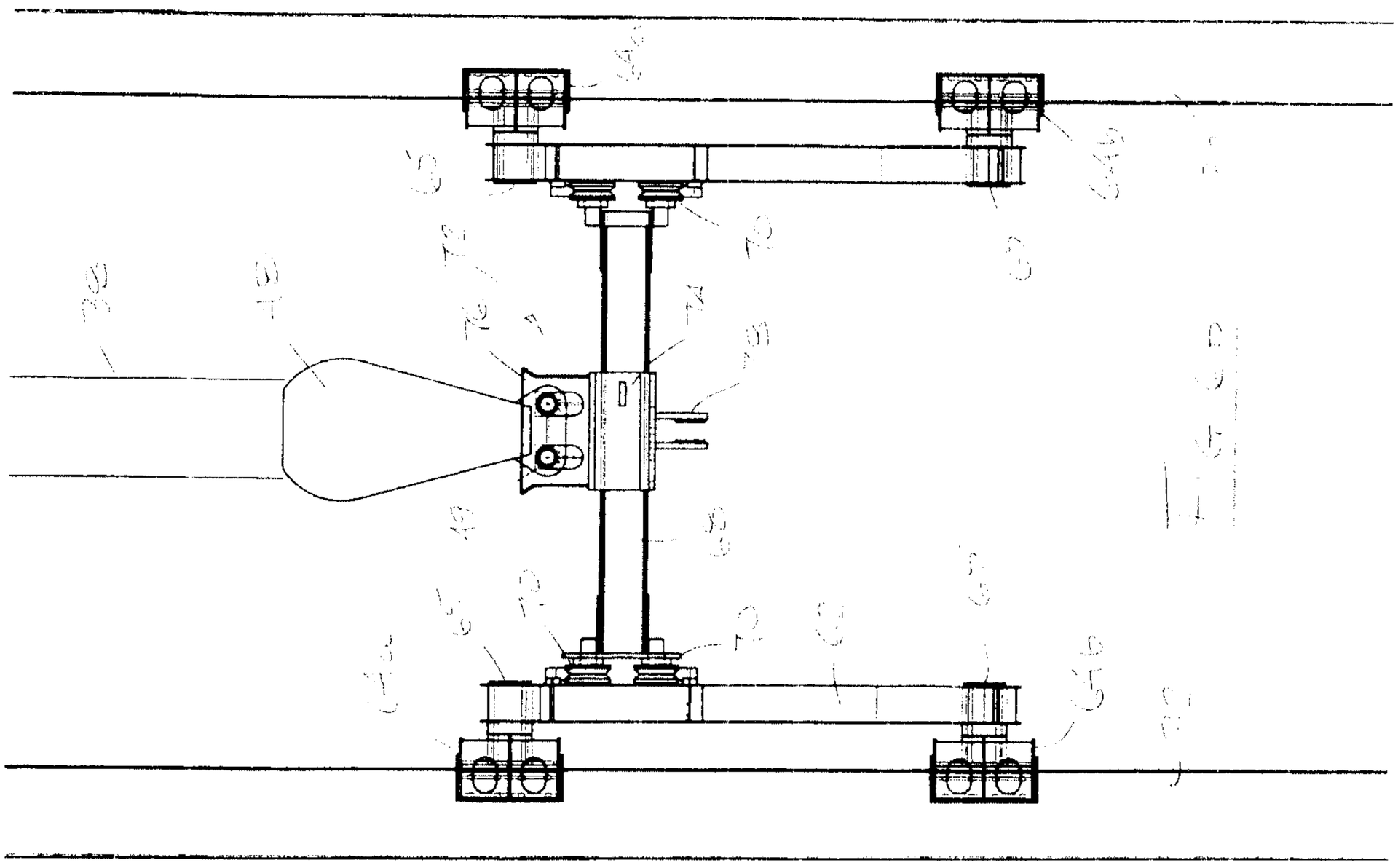
FIG. 2b

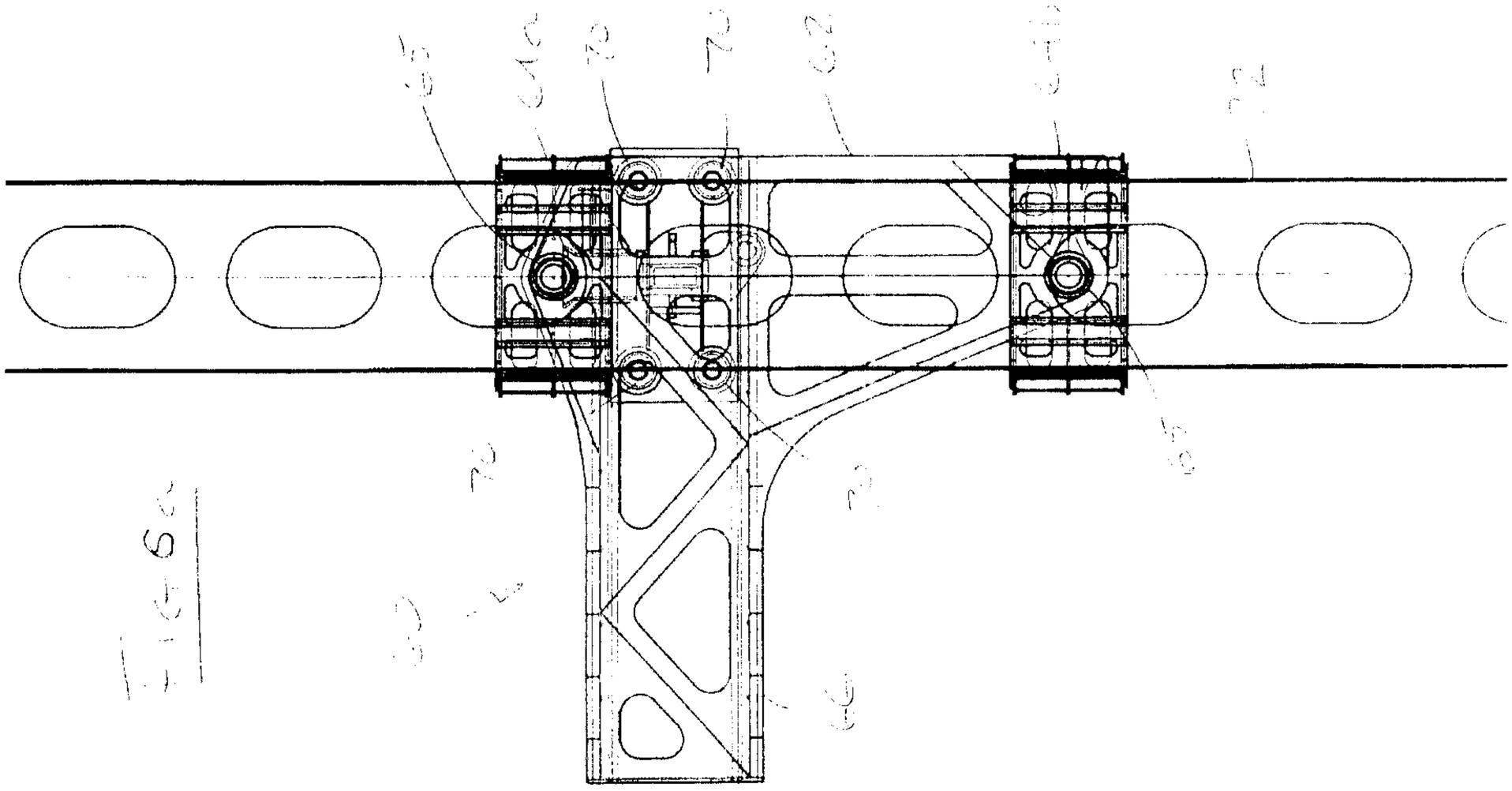












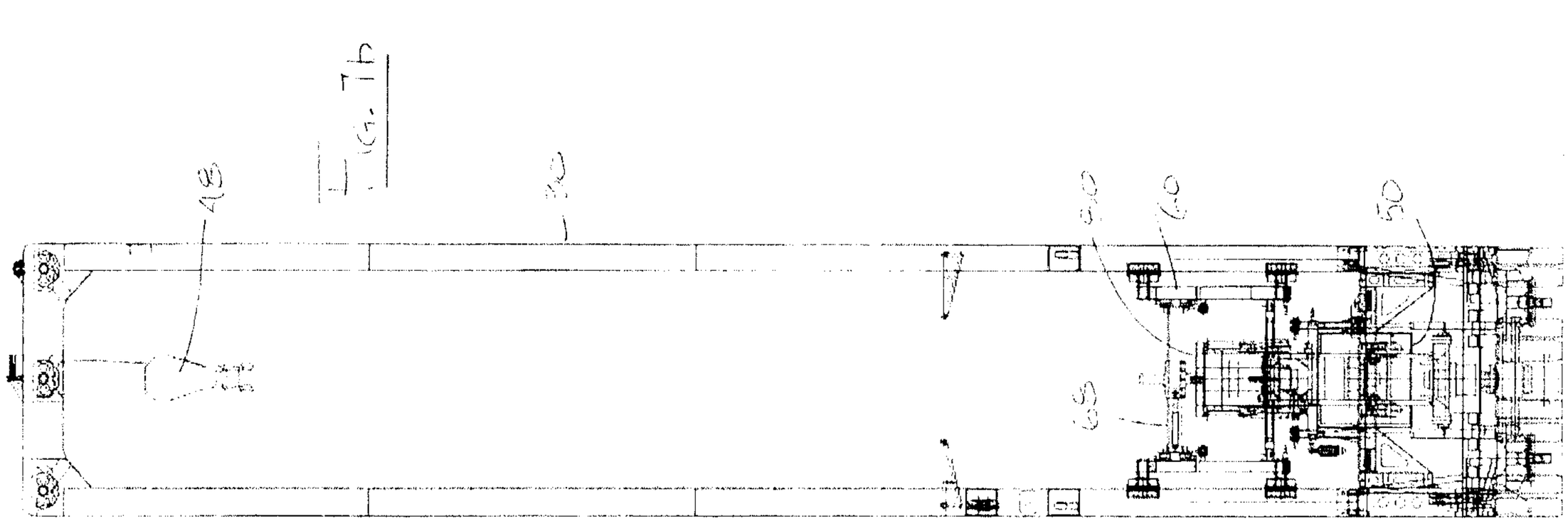


FIG. 7b

FIG. 7a

