



(22) Date de dépôt/Filing Date: 2012/05/04

(41) Mise à la disp. pub./Open to Public Insp.: 2013/07/27

(30) Priorité/Priority: 2012/01/27 (US61/591,644)

(51) Cl.Int./Int.Cl. *B65D 88/12* (2006.01),
B65D 88/10 (2006.01), *B65D 90/04* (2006.01)

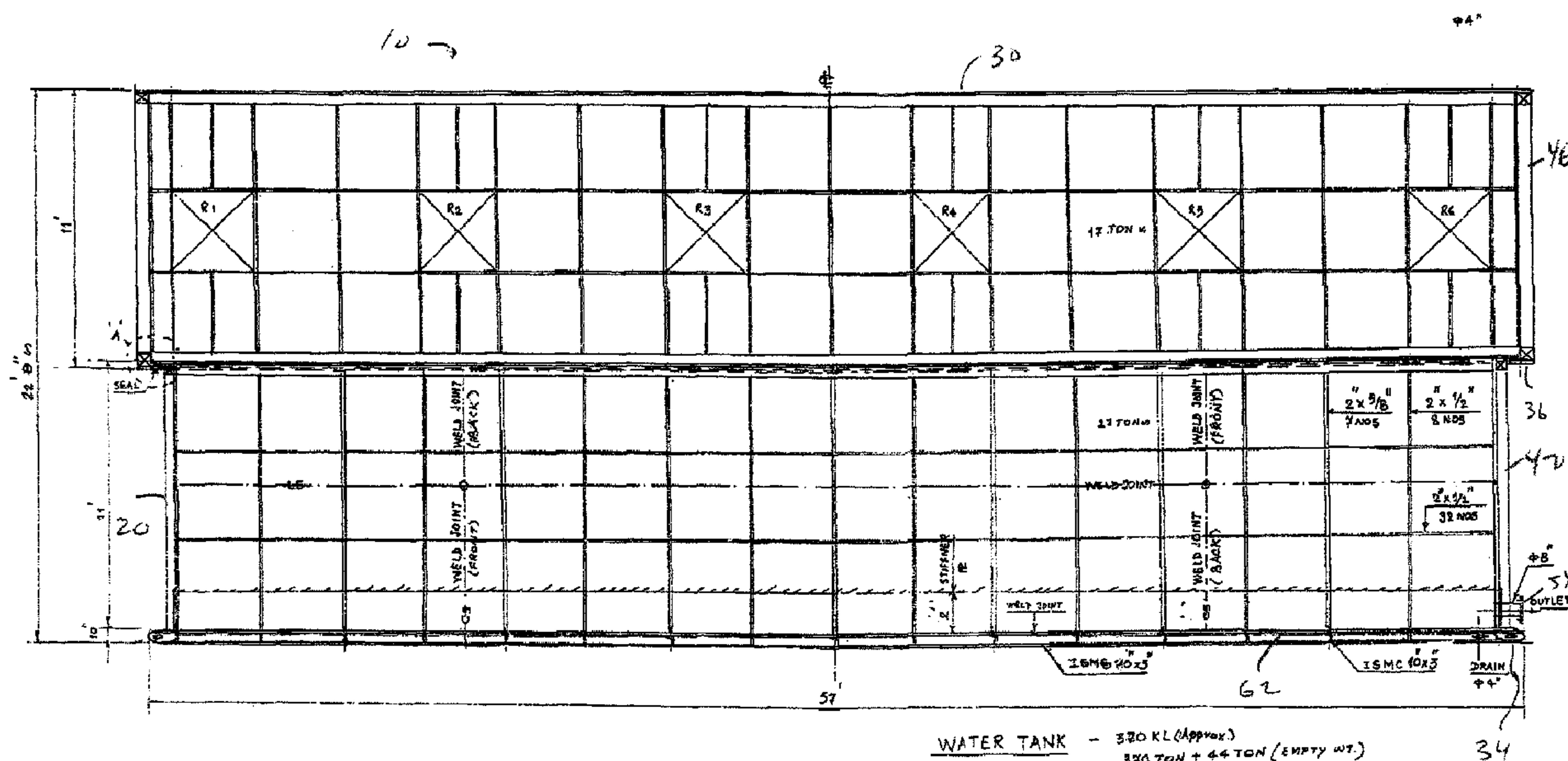
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(54) Titre : RESERVOIR DE FRACTURATION TELESCOPIQUE

(54) Title: TELESCOPIC FRAC TANK



(57) Abrégé/Abstract:

A frac tank has two or more telescoping sections. Each of the sections may be rectangular. When an upper section is lifted on site, the telescoping tank has about twice the height of a standard frac tank. The tank may be fitted with an attached lifting system such that the telescoping operation involves only a small amount of on-site labour. An inflatable seal between the telescoping sections allows the telescoped sections to contain water. A membrane inside the tank unfolds when the tank is telescoped and also contains water. Both containment systems may be used together to provide a double walled containment system and reduce the risk of a leak allowing frac water to reach the environment. The frac tank is transported by a winch truck with the sections collapsed.

ABSTRACT

A frac tank has two or more telescoping sections. Each of the sections may be rectangular. When an upper section is lifted on site, the telescoping tank has about twice the height of a standard frac tank. The tank may be fitted with an attached lifting system such that the telescoping operation involves only a small amount of on-site labour. An inflatable seal between the telescoping sections allows the telescoped sections to contain water. A membrane inside the tank unfolds when the tank is telescoped and also contains water. Both containment systems may be used together to provide a double walled containment system and reduce the risk of a leak allowing frac water to reach the environment. The frac tank is transported by a winch truck with the sections collapsed.

TELESCOPIC FRAC TANK**FIELD**

[0001] This specification relates to liquid storage tanks, particularly frac tanks, and to hydraulic fracturing and well stimulation operations.

BACKGROUND

[0002] The following discussion is not an admission that anything described below is common knowledge in the field or citable as prior art.

[0003] Hydraulic fracturing, also called fracking or hydrofracking, involves pumping pressurized water, typically mixed with a proppant, down a well bore and into an underground formation. The water pushes open fractures in the formation, and the proppant helps keep the fractures open after the pressurized water is removed. Opening the fractures allows additional oil to be removed from a reservoir, or allows natural gas, shale gas or coal bed gas to be produced. A similar process used in more permeable reservoirs may be referred to as well stimulation, but for the purposes of this specification well stimulation will be included in the term hydraulic fracturing unless discussed separately.

[0004] A hydraulic fracturing site requires tanks, typically called "frac tanks", sufficient to store large volumes of water. The volume of water required may range from roughly 50,000 gallons for a well stimulation operation to one or two million gallons or more for a high-volume hydraulic fracturing operation. After the fracturing operations, used frac water (alternatively called blowback or brine) needs to be stored in the frac tanks until it can be treated for discharge or re-used. The frac tanks must be transported to the site, set up, and later removed. The site may be a remote lease, beyond the reach of ordinary roads. The lease, and particularly the prepared drilling pad area of the lease, is often barely larger than the frac tanks and other equipment used on the site, with large vehicles moving about the site.

[0005] A standard rectangular frac tank is a 21,000 gallon (500 barrels) steel walled tank. These tanks are roughly 45 feet long, 8 or 9 feet high, and 10 or 11 feet wide. These tanks often have a rear axle which allows them to be moved by a fifth wheel tractor truck. Some examples are shown in US Patent Application Publication 2011/0186581 and US Patent 7,997,623 B2. At the site, these tanks are placed on a mat foundation typically made of squared timbers bolted together.

[0006] Another type of tank is an inflatable bladder, or pillow tank. These tanks may be a few feet high, with various lengths and widths. The bladder is transported in a deflated state on a truck. At the site, a thick membrane is placed on the ground to cover sharp spots in the earth and the tank is folded out over the ground cover membrane.

5 **[0007]** A third type of tank is a round surface tank. These tanks are made by fastening many steel panels together to form a ring on the ground over a ground covering membrane. The seams between the panels are not watertight to each other or the ground and a second membrane is installed in the ring to contain the water. The tanks may be up to 11 feet high and over 100 feet in diameter, with capacities ranging from about 10,000 to 10 40,000 barrels.

[0008] A fourth type of tank is a cylindrical 400 barrel tank of about 12 feet in diameter. This type of tank has skid rails on its bottom and along one side. The skid rails allow the tank to be transported on a winch truck. The tank is transported to the site on its side, balanced on the rear roller for placement at the site, and then tipped to stand vertically 15 on a mat foundation. The need to tip the tank up during unloading, and to pull the tank back down on reloading, requires a skilled driver and limits the height of these tanks to about 20 feet.

[0009] The choice between frac tanks is influenced by trucking costs, set up time, site constraints and safety. In many remote areas, such as Northern Alberta, there are no proper 20 roads to the site and the work must be done in the winter when the ground is frozen. The cost of transporting a 400 barrel cylindrical tank from Calgary to Fort McMurray is about \$5,000 in 2012. Shipping costs for standard rectangular frac tanks are similar. Since up to 100 of these tanks may be required for a large frac operation, the trucking costs are significant. Further, cylindrical and rectangular tanks must often be placed on the drilling pad 25 essentially one at a time to give room for the truck movements required to unload a tank. This increases the set up time required, particularly for the cylindrical tanks which require a multi-step unloading and tip up procedure. The cylindrical 400 barrel tanks are higher than standard rectangular tanks, but they do not double the liquid storage per unit area of ground covered because cylindrical tanks inherently do not cover the ground as efficiently as 30 rectangular tanks, and some clearance room is required for tipping the cylindrical tanks in place.

[0010] Pillow tanks can be moved by smaller trucks but they must be unfolded on site, they occupy a large land area per unit volume, and the membrane is directly exposed to

the environment and UV degradation. Fear of leaks makes these tanks unpopular, particularly for use in holding brine. Brine can cause more environmental damage than unused frac water if there is a spill.

[0011] Round surface tanks can hold large volumes of water, but they require many hours of high priced on-site labour to fasten the panels together and, for very large tanks, to weld membrane pieces together. The large size of these tanks helps to efficiently cover the ground by avoiding spaces between multiple tanks, but this is offset by the circular shape which creates unusable spaces in the corners of the site. The size of the tank also inherently increases the risk that a tank failure, caused for example by a truck hitting the tank wall, could cause environmental harm. Another disadvantage is that these tanks have no drain ports. The tanks must be filled and emptied by siphon tubes over the side of the tank. This can cause pumping problems or prevent a complete drain of the tank. Canadian Patent Number 2692016 describes a panel fastening system that is used by one surface tank manufacturer.

INTRODUCTION TO THE INVENTION

[0012] The following discussion is intended to introduce the reader to the invention and the detailed description to follow, but not to limit or define the claims.

[0013] A liquid storage tank described in this specification has two or more telescoping sections. Each of the sections may be rectangular and the tank may be transported, for example by truck, with its sections collapsed. When an upper section is lifted on site, the telescoping tank has about twice the height of a standard rectangular frac tank. Accordingly, the amount of space occupied on site, and the area of mat foundation, are approximately cut in half. Optionally, the tank may be fitted with an attached lifting system such that the telescoping operation involves only a small amount of on-site labour. The lifting system may use one or more hydraulic rams which may be mechanically pinned after the upper section of the tank is raised to avoid the need to maintain hydraulic pressure.

[0014] An inflatable seal, optionally located within a boxed space formed between flanges and the walls of the telescoping sections, allows the telescoped sections to contain water. Alternatively, a membrane inside the tank unfolds when the tank is telescoped and contains the water. Optionally, but preferably, both containment systems are used. In this way, the telescoping frac tank provides a double barrier containment system with a rugged outer shell and a UV and impact protected inner membrane. This reduces the risk of a leak

allowing frac water to reach the environment. The telescoping frac tank may be used to hold brine. Optionally, a sensor at the bottom of the tank between the membrane and the tank wall allows a leak in the barrier to be detected before water leaks from the outer walls of the tank.

- 5 **[0015]** The telescoping frac tank is adapted to be transported by a winch truck and rolled off the bed of the truck at the site. This mode of delivery is similar to the way in which large skids are delivered to the site. There is no need to tip the tank, or even to tilt the tank onto a rear axle, and so the telescoping frac tank can be made 45 or 50 feet long or more. The tank may be made to the maximum size allowed for transportation through rural Alberta.
- 10 When the upper section of the telescoping frac tank lifted, the height may be 15 or 20 feet or more. Total volume may be 1500 or 2000 barrels or more. This is sufficient to handle many well stimulation operations with a single tank, and to handle high-volume fracking operations with a manageable number of tanks.
- 15 **[0016]** Because the telescoping tank is rectangular and tall, it provides more storage per unit land area than any of the tanks discussed in the background section. Transportation costs and truck movements on the drilling pad are reduced relative to typical 400 and 500 barrel tanks. The number of hydraulic connections is also reduced, while optional large ports of 8 inches or more in diameter allow the telescoping frac tank to be filled and emptied quickly.

20

FIGURES

- [0017]** Figure 1 is a side view of a frac tank in a telescoped position.
- [0018]** Figure 2 is an end view of the frac tank of Figure 1.
- [0019]** Figure 3 is a top view of the frac tank of Figure 1.
- 25 **[0020]** Figure 4 is an enlarged cross-section of an inflatable seal of the frac tank of Figure 1.
- [0021]** Figure 5 is an enlarged view of a hydraulic ram of the frac tank of Figure 1.
- [0022]** Figure 6 is a schematic cross-section view showing an internal membrane of the frac tank of Figure 1.
- 30 **[0023]** Figure 7 is an orthographic projection and one detailed view of a second frac tank in a telescoped position.
- [0024]** Figure 8 is a front, cross section and two detailed views of the tank of Figure 7.

[0025] Figure 9 is an elevation, cross-section and two detailed views of the tank of Figure 7.

[0026] Figure 10 is an isometric view of the tank of Figure 7.

[0027] Figure 11 is an orthographic projection and one detail view of the tank of Figure 7 in a collapsed position.

[0028] Figure 12 is a front, cross section and two detail views of the tank of Figure 7 in a collapsed position.

[0029] Figure 13 is an elevation, cross-section and two detailed views of the tank of Figure 7 in a collapsed position.

[0030] Figure 14 is an isometric view of the tank of Figure 7 in a collapsed position.

[0031] Figure 15 is a front view of a skid assembly for the tank of Figure 7.

[0032] Figure 16 shows plan, elevation, cross sections and a detail view of the skid assembly of Figure 15.

[0033] Figure 17 is an isometric view of the skid assembly of Figure 16.

[0034] Figure 18 is a front view of a base-plate for the tank of Figure 7.

[0035] Figure 19 is a plan, elevation and cross section of the base-plate of Figure 18.

[0036] Figure 20 is an isometric view of the base-plate of Figure 20.

DETAILED DESCRIPTION

[0037] Figures 1 to 3 show a liquid storage tank 10, or frac tank, having a lower section 20 and an upper section 30. The overall length of the tank 10 is 57 feet. Its overall width is 12'4". Its overall height in the raised or telescoped position shown is 22 feet. Height when collapsed is about 11'. The tank 10 holds about 370 KL of water.

[0038] The tank 10 is transported in a collapsed position with the upper section 30 lowered and nested over the lower section 20. The upper section 30 rests on the lower section 20. On site, the tank 10 may be placed on a rig mat foundation. The tank 10 has a pair of slings 34 at each end which allow the tank 10 to be attached to a cable. The tank 10 may be placed on a skid frame, or the bottom of the tank 10 may be reinforced so that the tank 10 can operate as a skid itself. The tank 10 is transported by a truck, which may be a tractor trailer combination, having a flat bed. Vehicles of this type may be called a bed truck, winch tractor, winch truck or similar names. The bed has a first roller at one end and, typically, a second roller part way along the length of the bed. The front of the bed, or the tractor, has a winch.

[0039] The tank 10 is loaded by backing the bed of the truck up to the end of the tank 10 and connecting the winch cable to the slings 34 or to a skid frame below the tank 10.

Pulling in the winch cable first pulls the truck back towards the tank 10 and then lifts one end of the tank 10 up and over the first roller. The tank 10 is then moved further on to the bed by
5 backing up the truck. When the first roller is near the middle of the tank 10, the tank 10 pivots downwards to lie flat on the bed. A slight forward movement can soften the fall of the tank 10 onto the bed. The winch cable can be pulled in further to advance the tank 10 along the bed if the tank 10 will be transported over a long distance.

[0040] Alternatively, to move the tank 10 a short distance or position it on a site, the
10 winch cable can be brought in by a small amount while the tank 10 is leaning against the first roller to balance the tank 10 on the first roller rather than dropping the tank 10 on to the bed. The tank 10 can be moved in this position and easily unloaded by loosening the winch cable until one end of the tank 10 touches the ground and then driving the truck away.

[0041] To unload the tank 10 from a fully loaded long distance transport position, the
15 truck is reversed and its brakes applied hard. The momentum of the tank 10 causes it to roll backward on the bed. Two or three repetitions of these steps may be required until one end of the tank 10 travels to the end of the winch line, which is set to allow the tank 10 to pivot on the first roller. The tank 10 can be moved into a final position while it balances on the first roller. Letting the winch cable out further allows one end of the tank 10 to contact the
20 ground. The truck then drives ahead to complete unloading the tank 10.

[0042] Referring to Figures 1 to 4, the bottom of the upper section 30 of the tank 10 has an opening that is defined by an upper section flange 36. This opening is larger than the outside of lower walls 44 of the lower section 20 except at a lower section flange 38. The ends of the flanges 36, 38 have bushings or wheels 40 made of a slippery plastic such as
25 Teflon™ or a high molecular weight plastic. The bushings 40 of the upper section flange 36 bear against the outside of lower walls 44. The bushings 40 of lower section flange 38 bear against the inside of upper walls 46. The bushings 40 help the sections 20, 30 move relative to each other when the upper section 30 is raised or lowered.

[0043] The flanges 36, 38 also help to contain an inflatable seal 42 between an outer
30 surface of the lower section 20 and an inner surface of the upper section 30. The inflatable seal 42 expands when filled with compressed air to seal between the flanges 36, 38, between the lower walls 44 and upper walls 46, or both. An air inflation valve is closed when the seal 42 has been inflated to a suitable pressure. Suitable inflatable seals 42 are sold, for

example, by Mechanical Research & Design Inc. under the Sealfast trade mark. These seals are made from durable elastomer extrusions and can provide a pressure tight closure to 500 psig. The seal 42 prevents water from leaking between the upper section 30 and lower section 20.

5 **[0044]** The upper section 30 may have an open top, but it is preferably covered with a roof 48. The roof 48 provides strength for the upper section 30. The roof 48 also isolates the contents of the tank 10 from UV radiation and reduces chemical transfers between the inside of the tank 10 and the environment. One or more vents 50 are provided in the roof 48 to allow the tank 10 to be filled and emptied. One or more hatches 52 are provided in the
10 roof 48 to allow for repairs and servicing.

[0045] The tank 10 is filled and emptied through a port 54 at the bottom of one end of the tank 10. The port 54 connects a flange 56 with the inside of the tank 10, or the inside of bladder 70 (see Figure 6) if one is used. The port 54 may be a section of pipe with a diameter of 8" or more. The flange 56 is configured to be bolted to a header (not shown).
15 The header is a pipe, preferably with a diameter of 12" or more. The port 54 is preferably located at an end of the tank so that the port 54 is exposed when several tanks 10 are arranged side by side in a row.

[0046] Referring to Figure 5, hydraulic rams 34 are placed at the four corners of the tank 10. Optionally, additional rams 34 may be placed along the length of the tank 10. The
20 rams 34 are driven by a hydraulic compressor, which is typically available on site for other purposes. A lower end of the ram 34 is attached to a base 60 extending outwards from below the floor 62 of the lower section 20. An upper end of the ram 34 is attached to the side of the upper section 30. Alternatively, mechanical or electrical lifting columns may be used.

[0047] The rams 34 are preferably linked to a controller (not shown) which is further
25 linked to position sensors in each ram 34. The controller monitors the position of each ram 34 and adjusted the flow of hydraulic fluid to the rams 34 as required to have them rise or lower at equal rates. This reduces binding of the upper section 30 against the lower section. When the upper section 30 has been fully raised, one or more pins 64 are inserted through part of the ram 34 to maintain the ram 34 in an extended position when hydraulic pressure is
30 removed. The inflatable seal 42 is then inflated and closed to maintain a seal between the upper section 30 and the lower section 20. The rams 34 may be welded to the tank 10. Optionally, quick connect fittings may be provided on the rams 34 and tank 10, and a set of portable rams 34 may be moved from tank 10 to tank 10 as required. In this case, pins are

inserted into sockets in the lower section 20 at the bottom of the upper section 30, or posts are inserted between the base 60 and the upper section 30, to support the upper section 30 when the rams 34 are removed.

[0048] The tank 10 is constructed primarily of carbon steel. Optionally, the tank may be galvanized or epoxy coated to inhibit rusting. Further, referring to Figure 6, an optional bladder or membrane 70 within the tank 10 can be used to prevent corrosive chemicals from contacting the metal of the tank 10.

[0049] The bladder 70 also creates a second containment barrier preventing water from leaking from the tank. Either of the bladder 70 or the inflatable seal 42 may be used to hold water within the tank 10, but it is preferable to use both to provide a double wall containment system. Further, a water sensor 72 may be added near the bottom of the tank 10 to send an alert if water appears between the bladder 70 and the inside of the tank 10. In this way, a leak in the bladder can be found and fixed before any water 10 leaks from the tank 10 as a whole. Optionally, the water sensor 72 may be connected to a pressure guage on the inflatable seal 42 to send a further alert if the seal 42 is not at its required pressure when a leak is detected, or to run a pump that adds air to the inflatable seal 42 through a one way valve if a leak is detected.

[0050] All structural reinforcing, such as corrugation or bracing, is preferably built on the outside of the tank 10. The inside surfaces of the tank 10 can therefore be kept smooth to reduce stresses on the bladder 70. The bladder 70 is held in position in the tank 10 primarily by a supporting frame 74 bolted to the roof 48 of the tank 10 through holes with grommets in the bladder 70. Optionally, additional straps 76 between the outside of the bladder 70 and the inside of the tank 10 may be added to reduce wrinkles in the bladder 10 as the tank is emptied or filled. The frame 74 may end inside of the inner surfaces of the lower section 20. In this way, when there is no water in the upper section 30, the bladder 70 will drape into the lower section 20 rather than resting on the lower section flange 38. This prevents the bladder 70 from being pinched between the lower section flange 38 and the inside of the upper section walls 46 when the upper section 30 is lowered. The frame 74 also surrounds openings in the top of the bladder 70 corresponding with the hatches 52.

[0051] The bladder 70 is made of a flexible geomembrane material that is resistant to any chemicals expected to be in the liquid stored in the tank 10. The bladder 70 does not need to be UV resistant if the tank 10 has a roof 48. Suitable materials include low density polyethylene (LPDE), high density polyethylene (HPDE) and polyvinyl chloride (PVC).

Another suitable material is linear low density polyethylene (LLDPE) as used in Enviro Liner 4000™ liners sold by Layfield Environmental Systems Corp. The bladder 70 may be about 0.5 to 1.0 mm thick.

5 **[0052]** Figure 7 to 20 show another tank generally similar to tank 10. As shown in detail D on Figure 9, rollers are not required in the seal between the two parts of the tank. Optionally, a non-inflatable seal may be used. As shown in Figures 18-20, the tank may have a base plate with sloping sides and a drainage channel leading an inlet nozzle. As shown in Figure 15 to 17, that tank may be combined with a skid assembly.

10 **[0053]** The tank 10 described in Figures 1 to 6 and the tank of Figures 7 to 20 are intended to provide examples of embodiment of the claims, and to help provide an enabling disclosure of the claimed inventions, but the claims are not limited to the tank 10 of Figures 1 to 6 or the tank of Figure 7 to 20.

CLAIMS:

I claim:

- 5 1. A liquid storage tank comprising,
 A) a telescoping structure comprising,
 a) a lower section comprising a floor and one or more lower walls, and
 b) an upper section comprising one or more upper walls,
 wherein the one or more walls of one of the sections are located inside of the one or
 10 more walls of the other section; and,
 B) a containment system comprising a) a membrane liner adapted to surround the inside
 surfaces of the floor and the walls or b) a seal between the one or more upper walls the one
 or more lower walls.
- 15 2. The storage tank of claim 1 having a storage capacity of 1000 barrels or more.
3. The storage tank of claim 1 or 2 wherein the upper and lower sections are
 rectangular.
- 20 4. The storage tank of claim 3 having a length of 45 feet or more.
5. The storage tank of any preceding claim wherein the lower section further comprises
 winch cable connection points.
- 25 6. The storage tank of any preceding claim wherein the containment system comprises
 a liner and a seal.
7. The storage tank of any preceding claim wherein the containment system comprises
 a liner and the liner is suspended from an upper part of the upper section.
- 30 8. The storage tank of any preceding claim wherein the containment system comprises
 a seal, and the seal comprises an inflatable bladder between the upper section and the lower
 section.

9. The storage tank of claim 8 wherein the upper and lower sections comprise flanges wherein, when the upper section is raised, the walls and flanges enclose the bladder.

5 10. The storage tank of any preceding claim having bushings or wheels between the sections.

11. The storage tank of any preceding claim having one or more lifting devices connected between the upper and lower sections.

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12. The storage tank of any preceding claim having a securing mechanism attachable between the sections in the telescoped position.

13. The storage tank of claim 11 wherein the lifting device comprises a hydraulic ram
15 connected between the sections and a pin to secure the telescoping sections in a telescoped position.

14. The storage tank of any preceding claim having a height in a telescoped position of 15 feet or more.

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15. The storage tank of any preceding claim having at least one port having a diameter of 8 inches or more.

16. The storage tank of any preceding claim have a liner and a leak sensor outside of the
25 liner.

17. A liquid storage system comprising a storage tank according to any preceding claim and a truck having a generally flat bed, a roller at one end of the bed, and a winch near another end of the bed.

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18. A liquid storage system comprising a plurality of storage tanks according to any of claims 1 to 16 wherein an outlet of each tank is connected to a header pipe having a diameter of 12 inches or more.

Application number / numéro de demande: 2776171

Figures: 10, 14, 17, 20

Pages: _____

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Documents reçu avec cette demande ne pouvant être balayés
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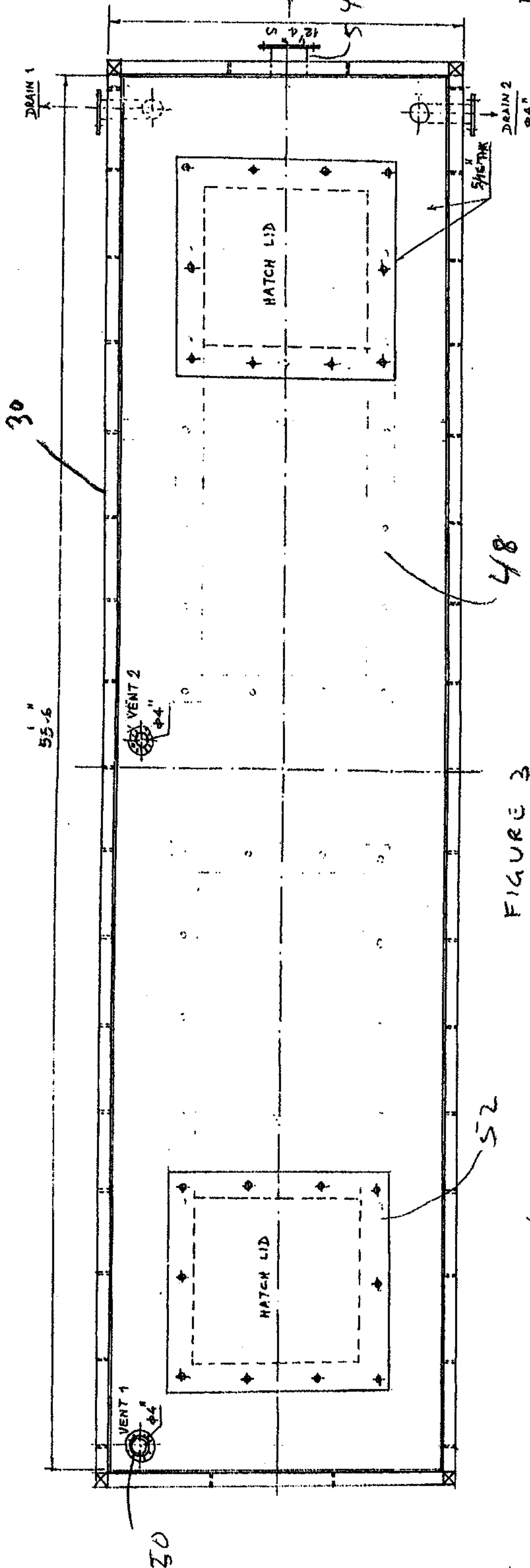


FIGURE 3

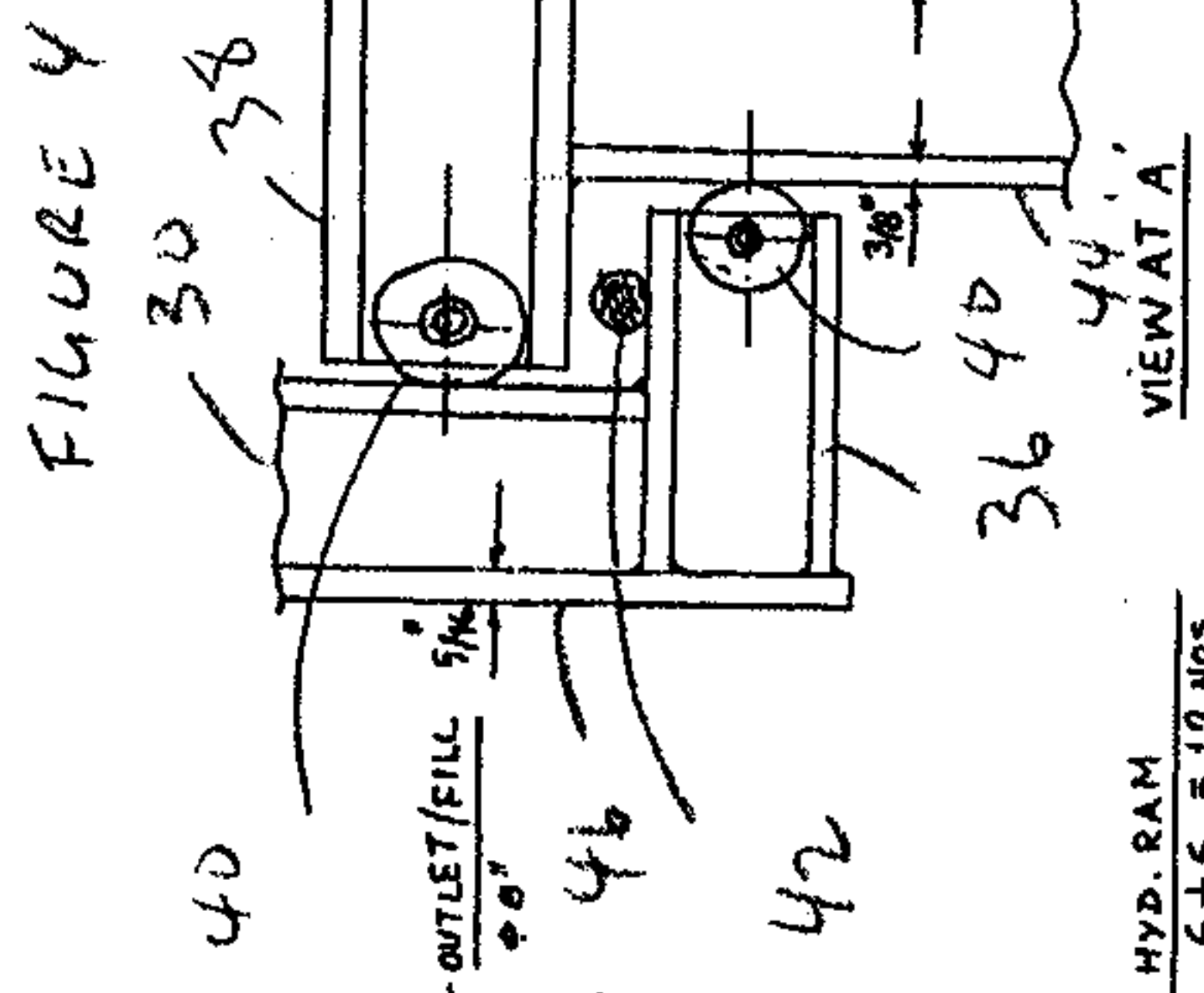


FIGURE 4

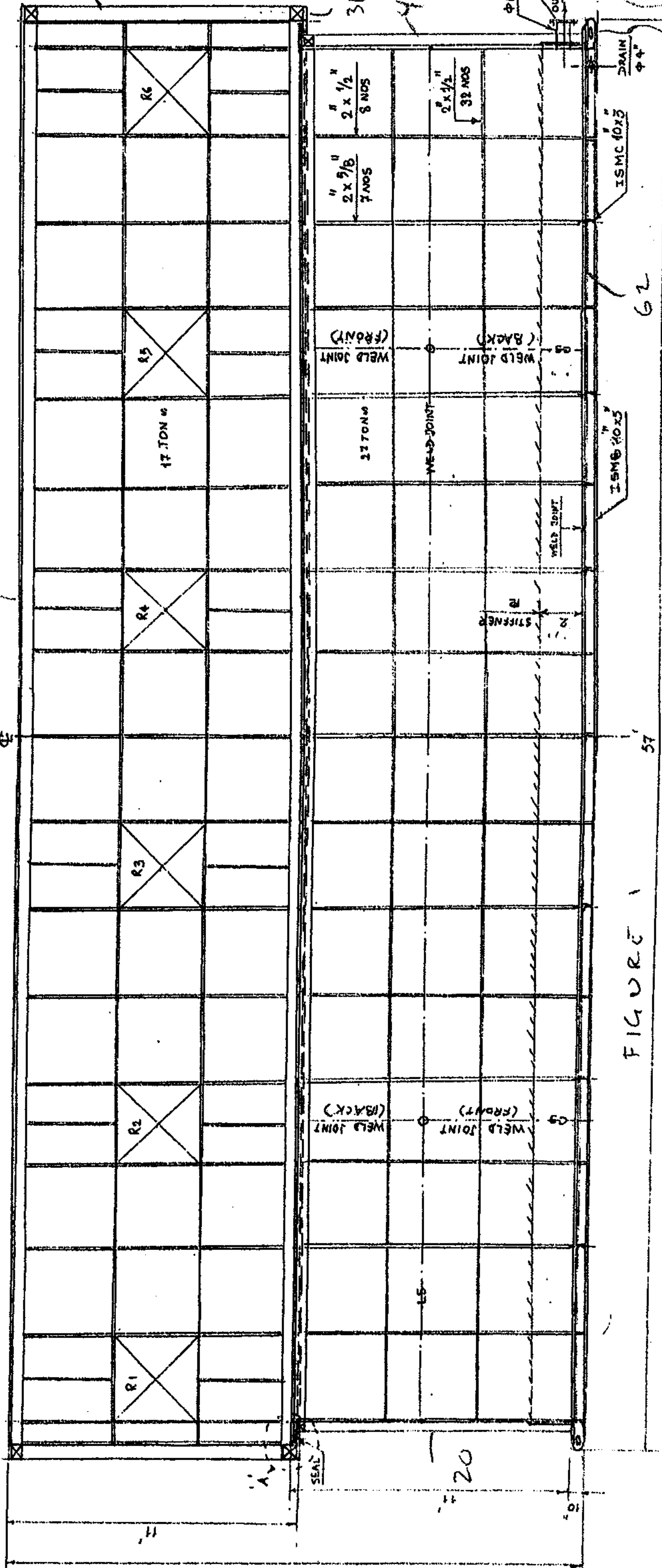


FIGURE 1

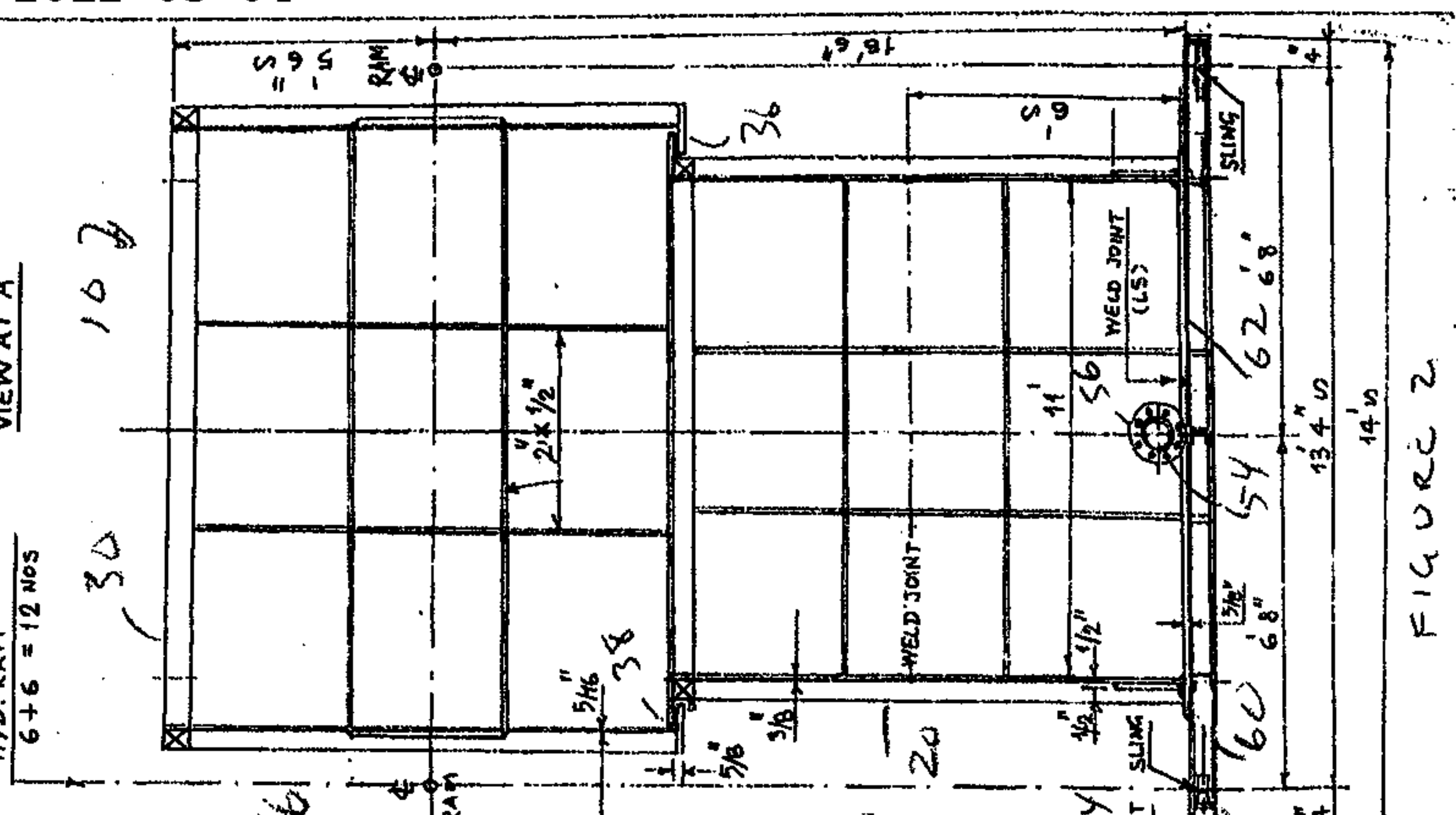


FIGURE 2

WATER TANK - 320 KL (APPROX.)
370 TON + 44 TON (EMPTY WT.)

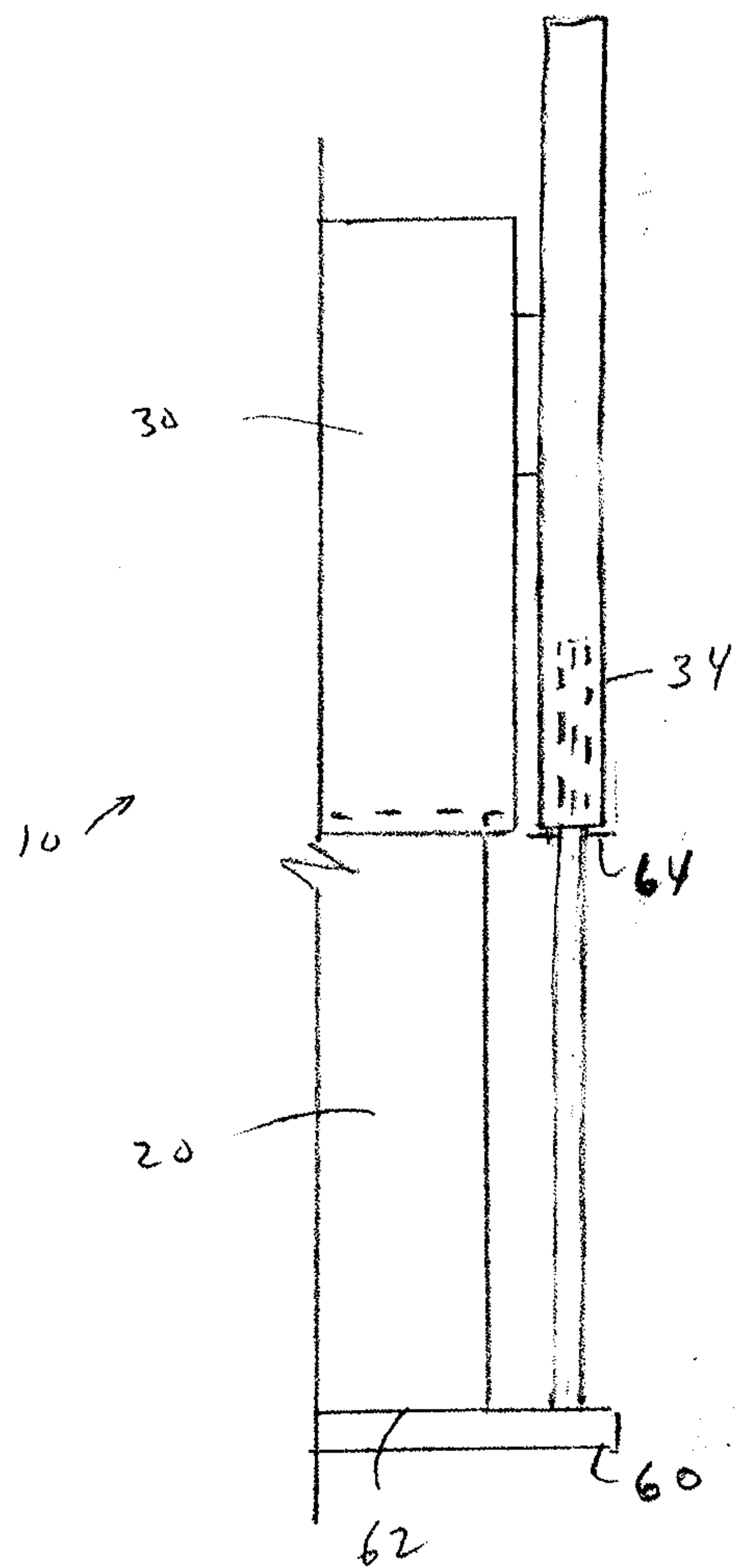


FIGURE 5

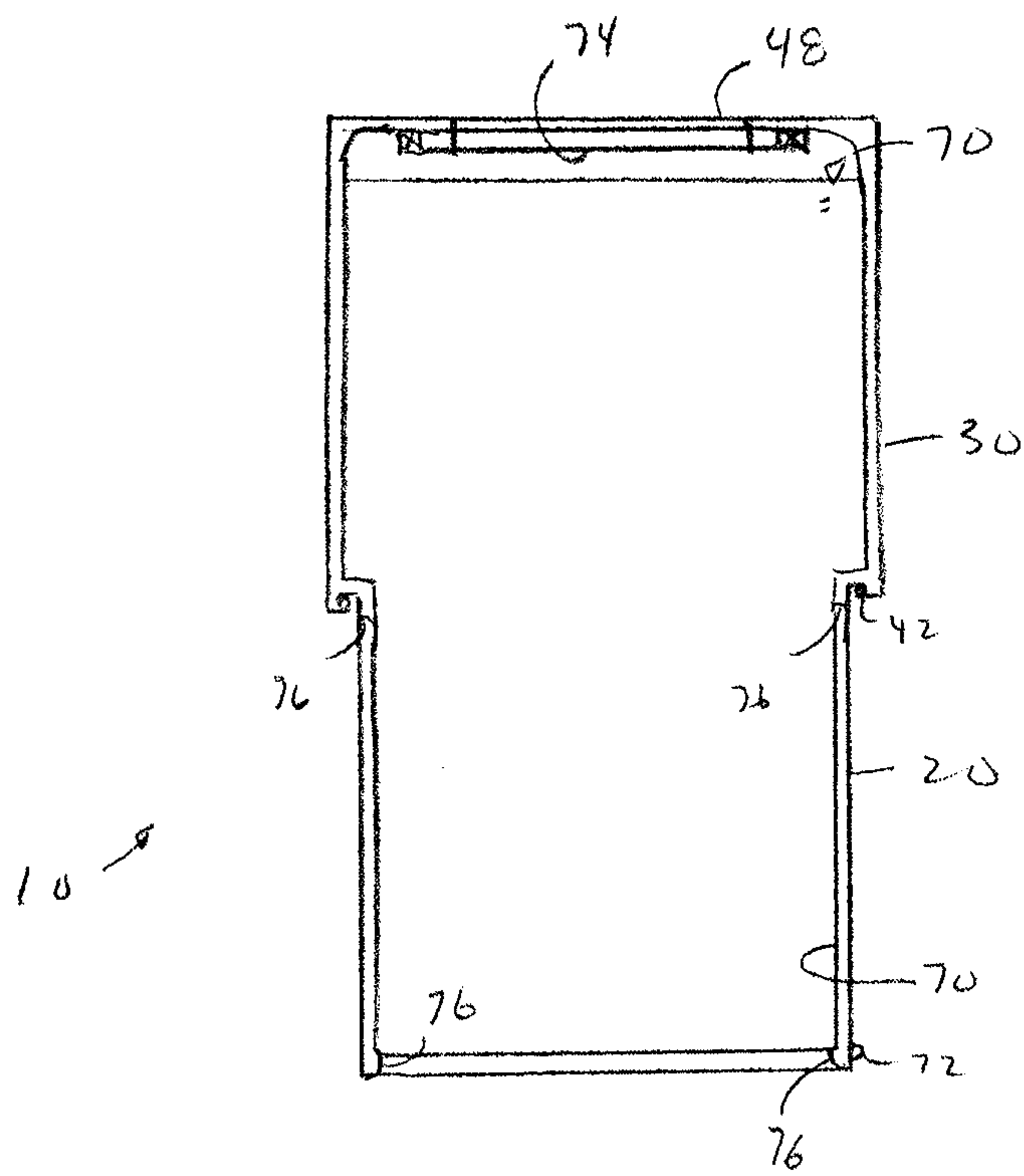


FIGURE 6

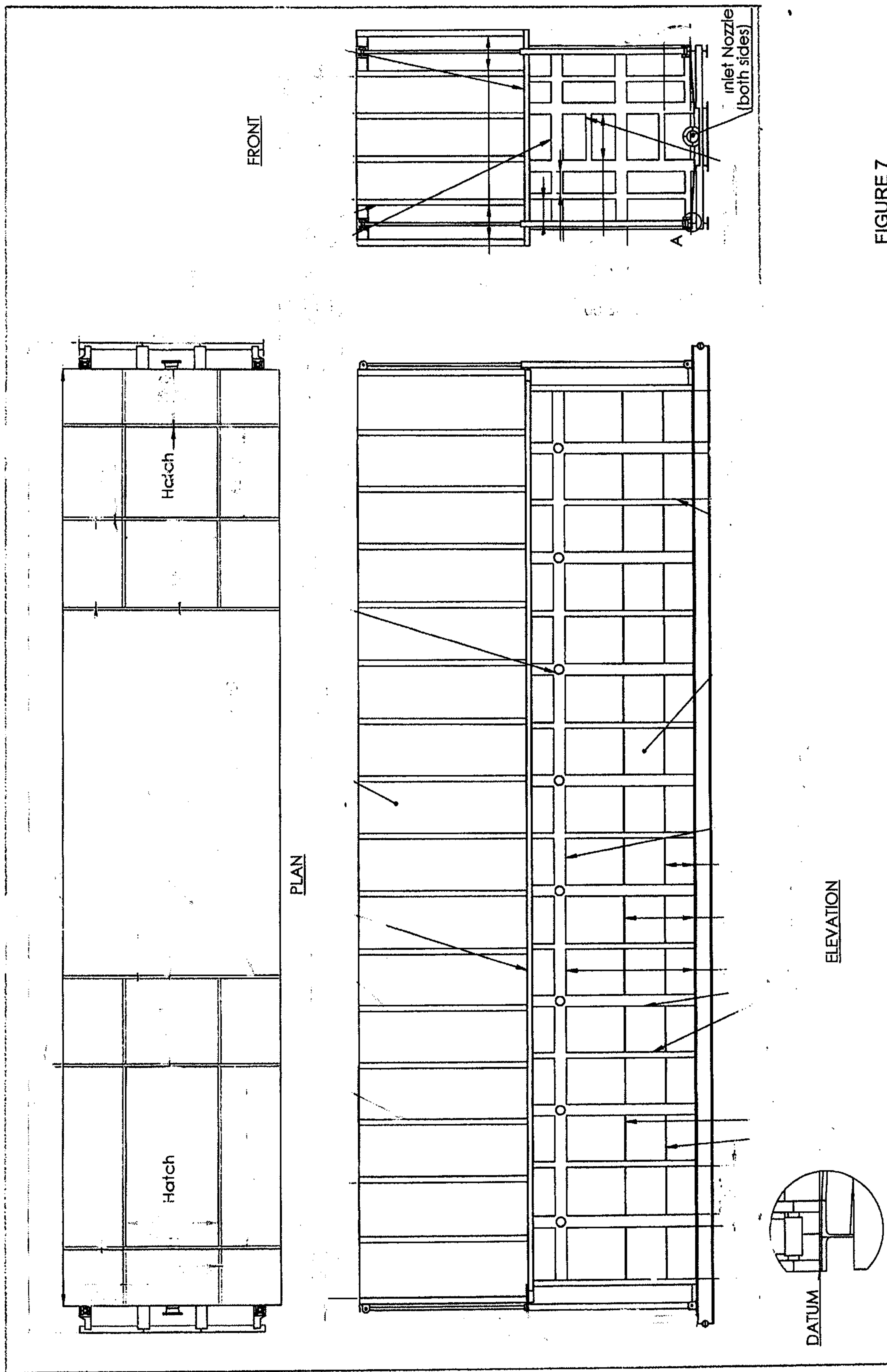


FIGURE 7

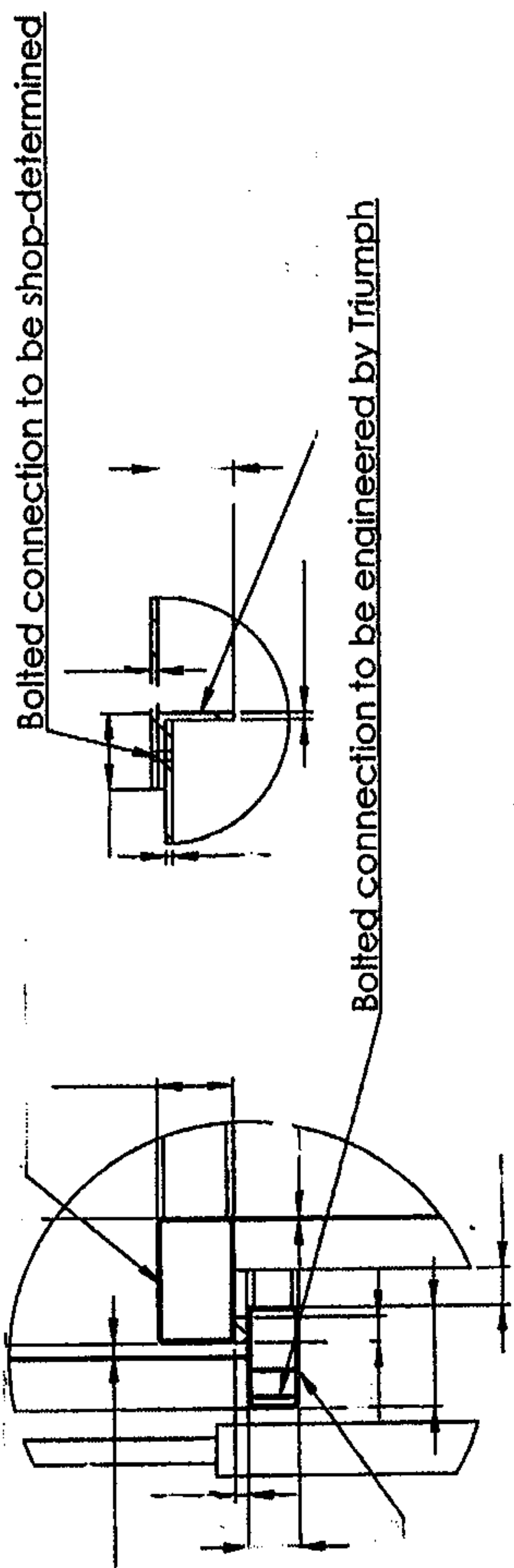
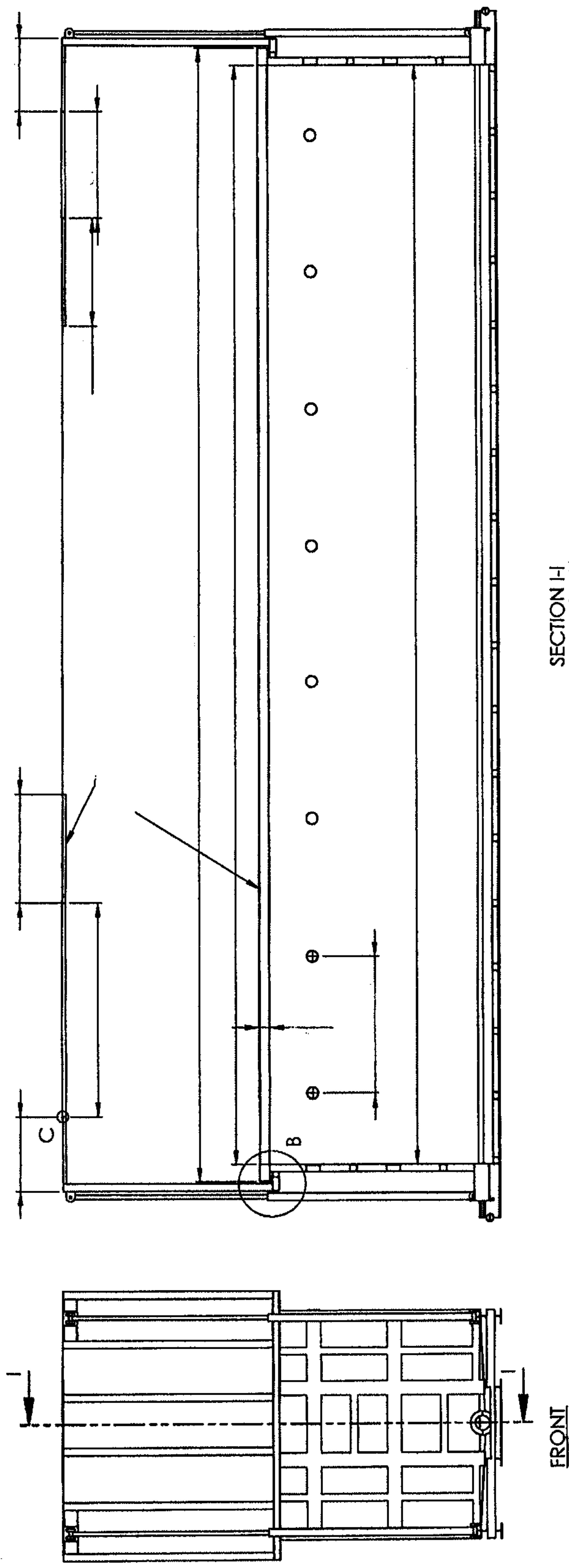
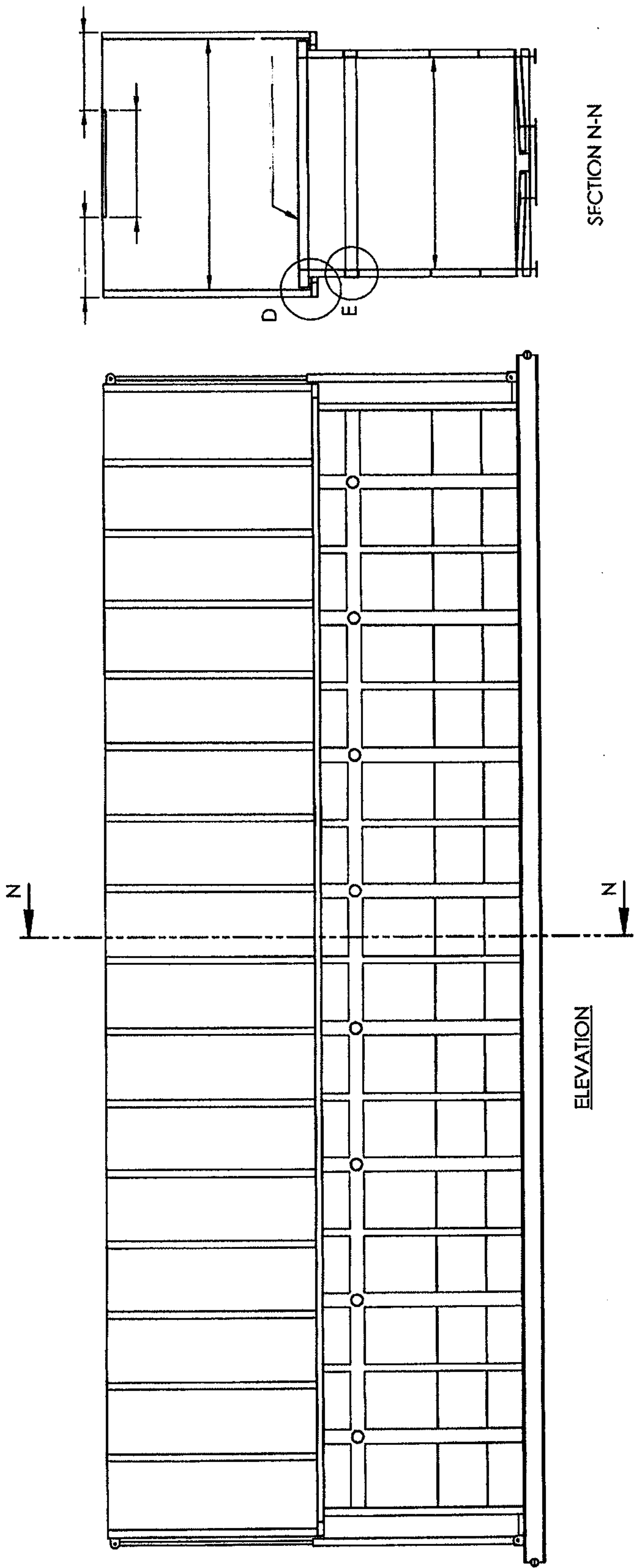


FIGURE 8

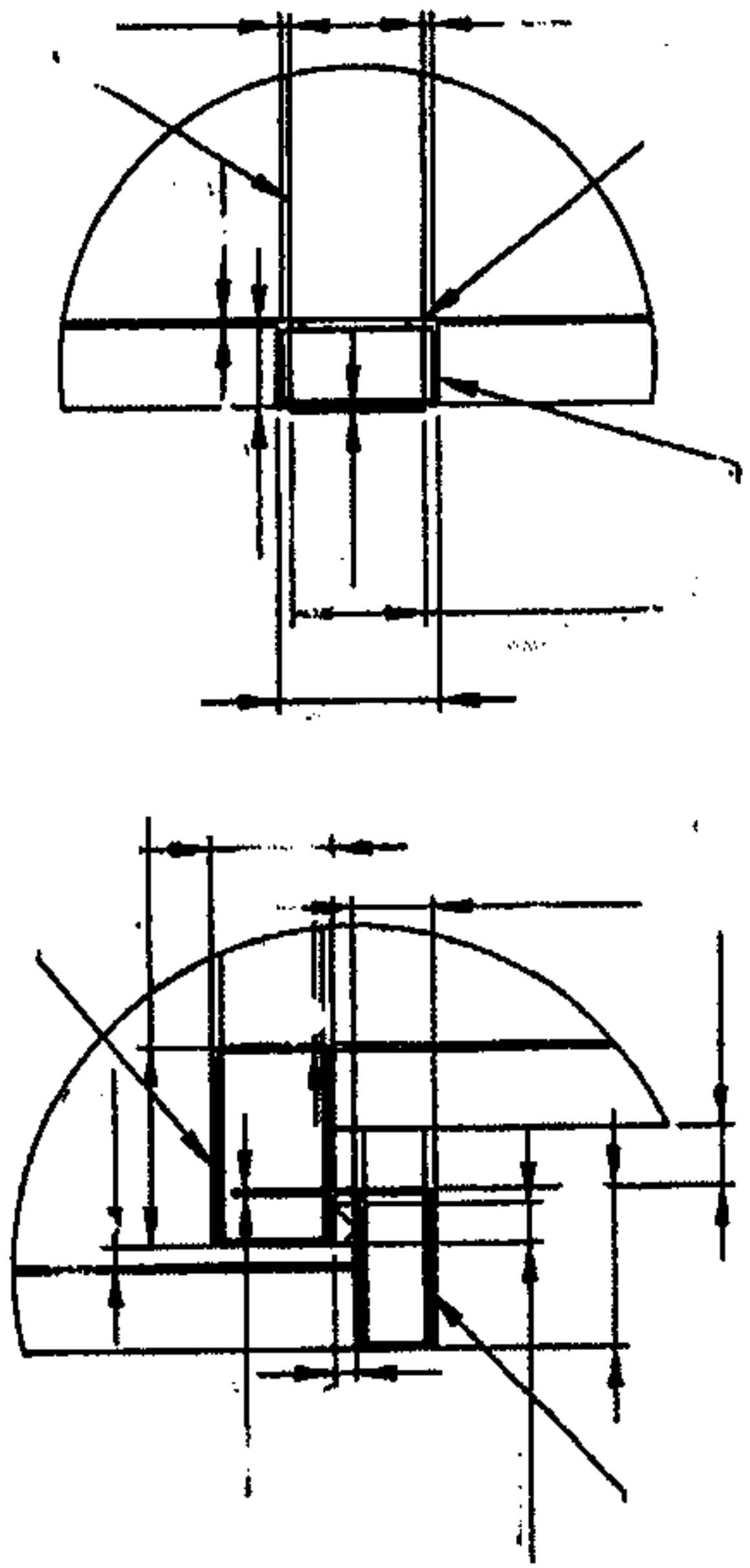
DETAIL C

DETAIL B



SECTION N-N

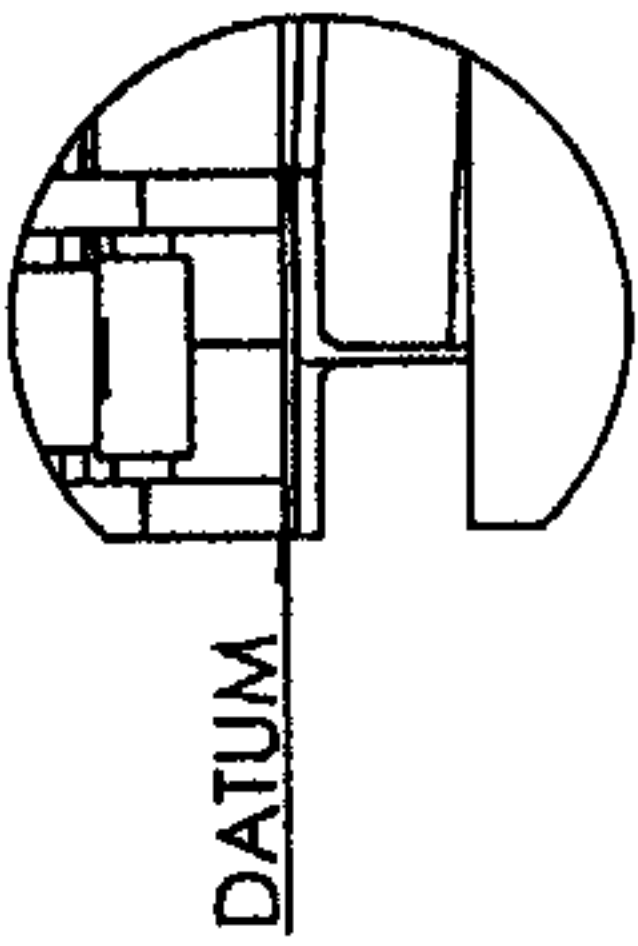
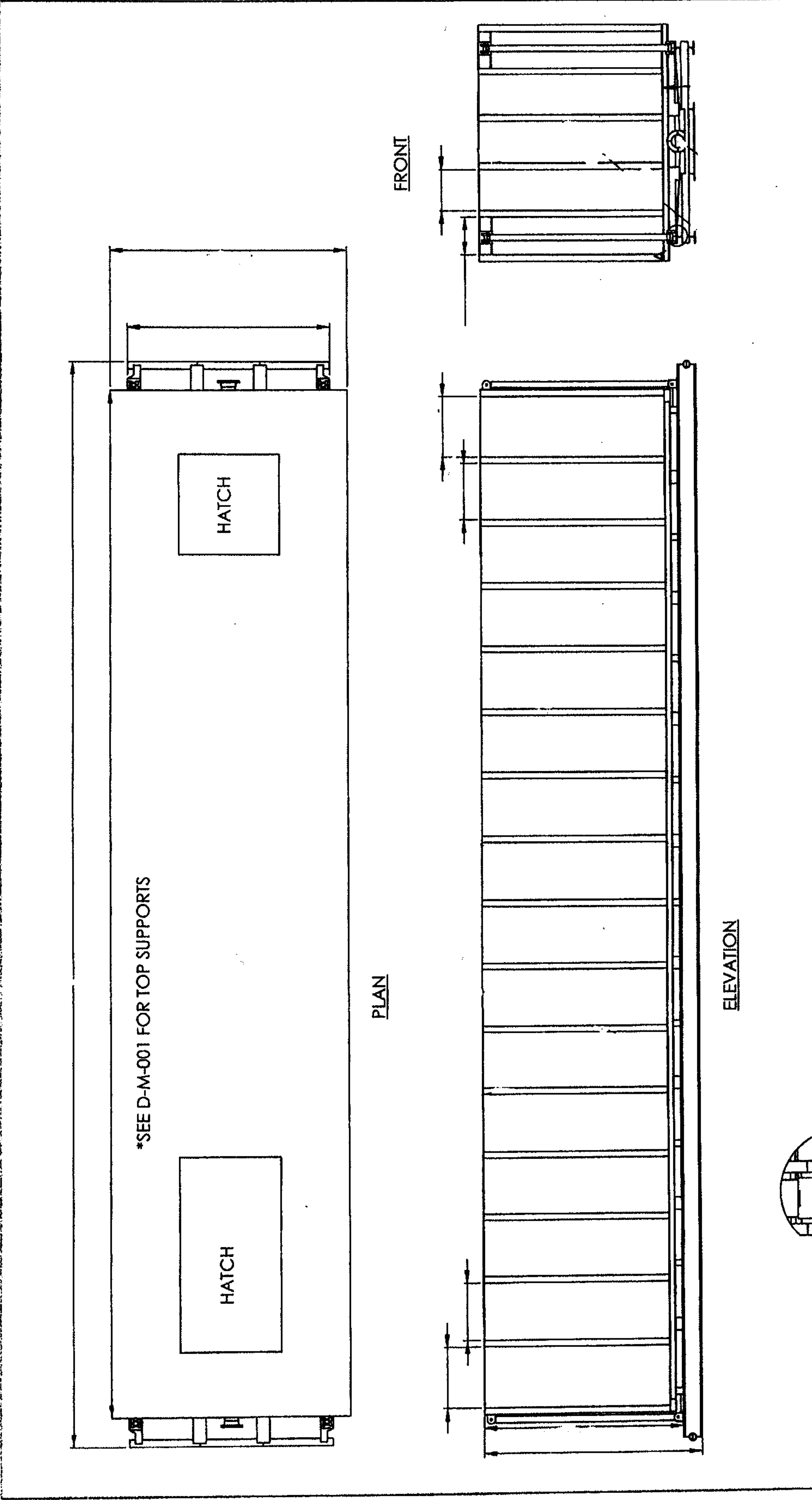
ELEVATION



DETAIL E

DETAIL D

FIGURE 9



DETAIL A

FIGURE 11

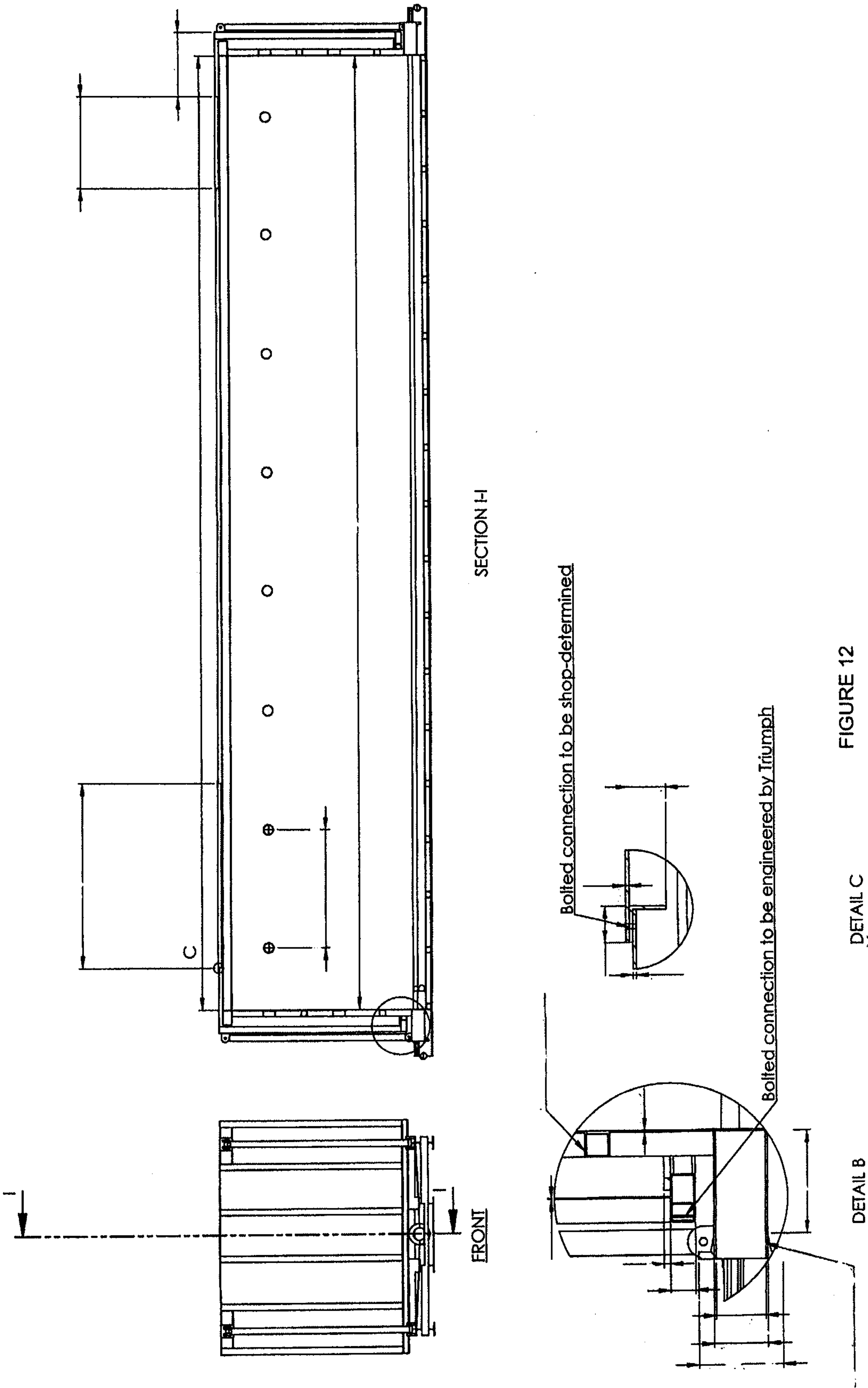
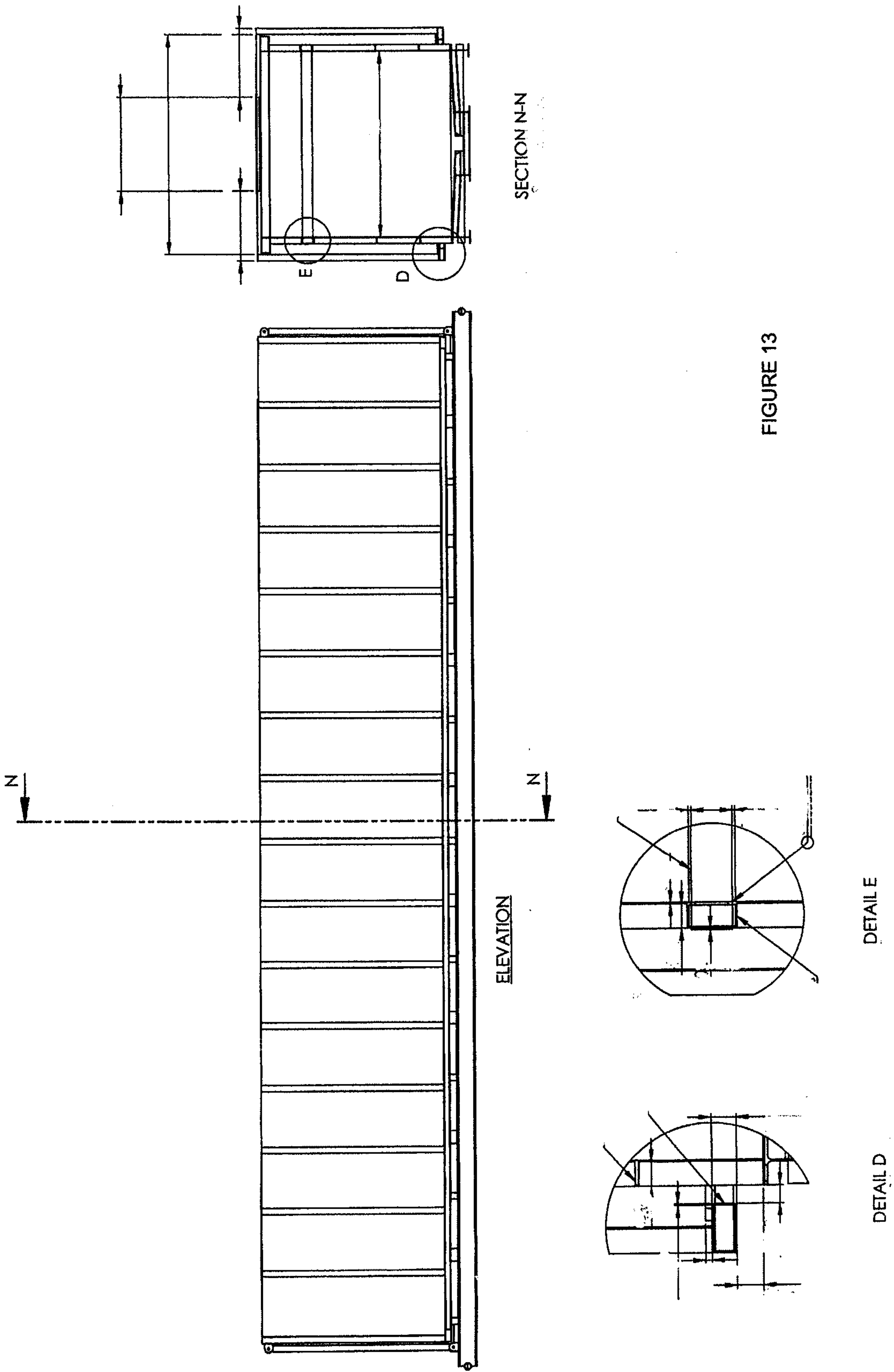
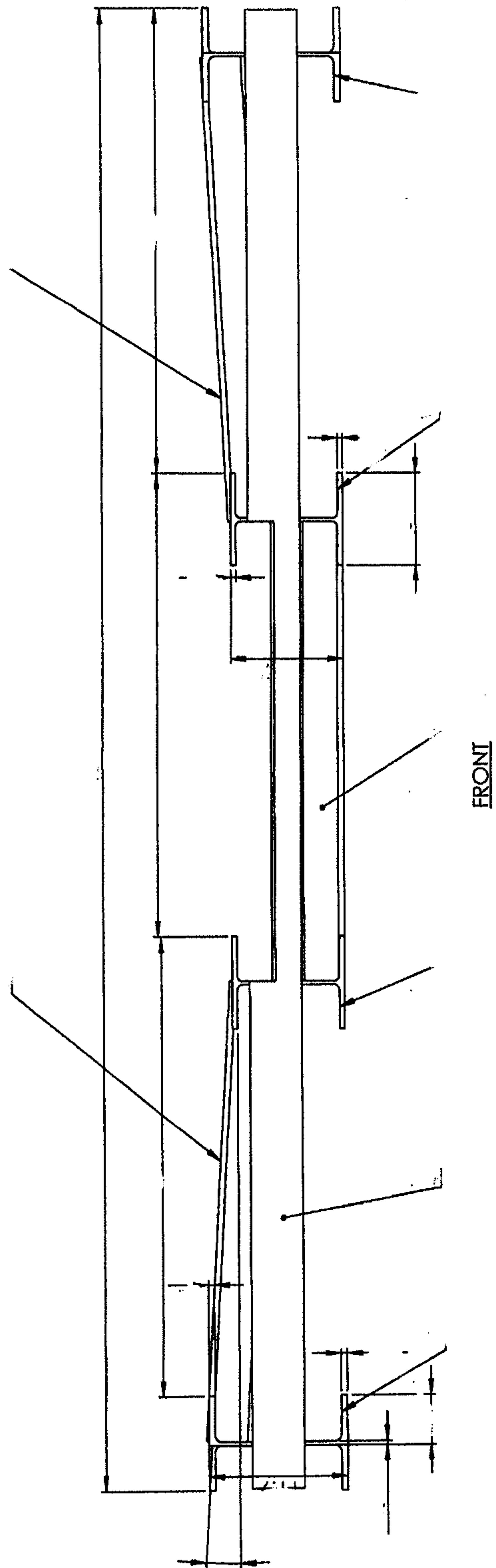


FIGURE 12





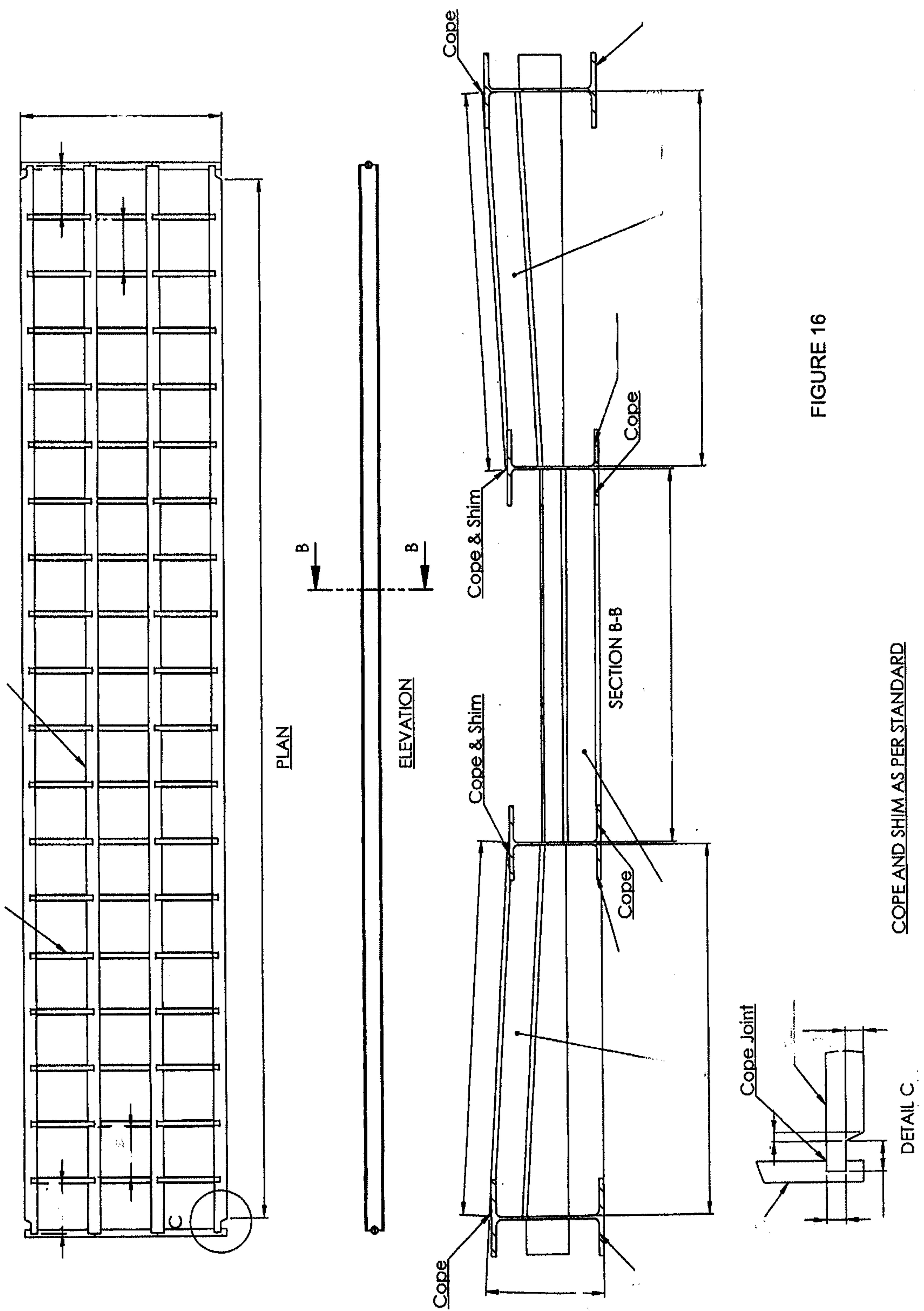
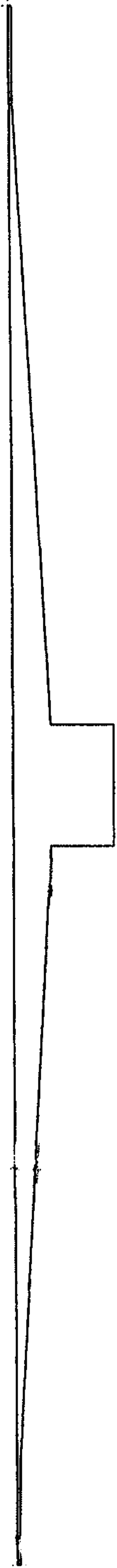


FIGURE 16

COPE AND SHIM AS PER STANDARD



FRONT

FIGURE 18

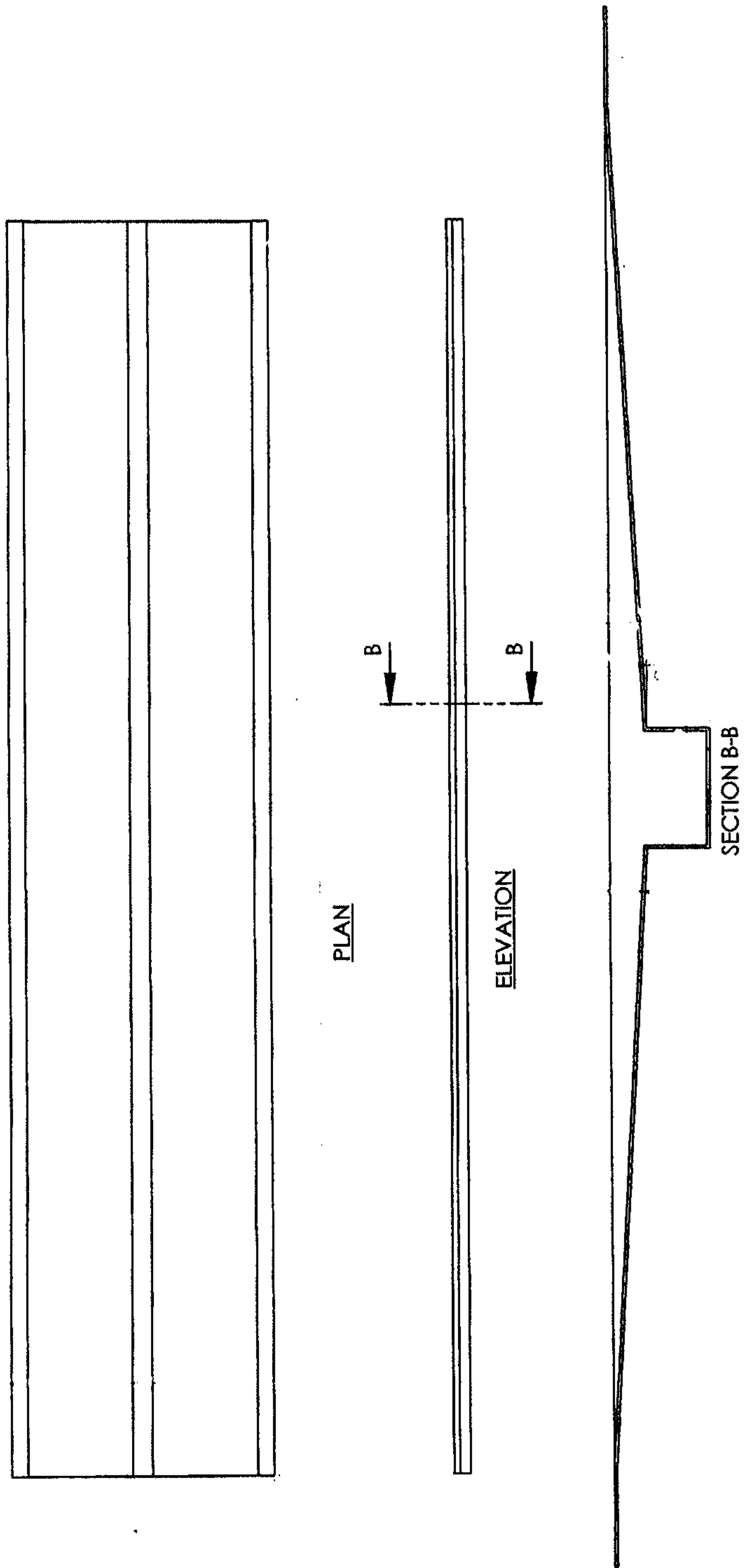
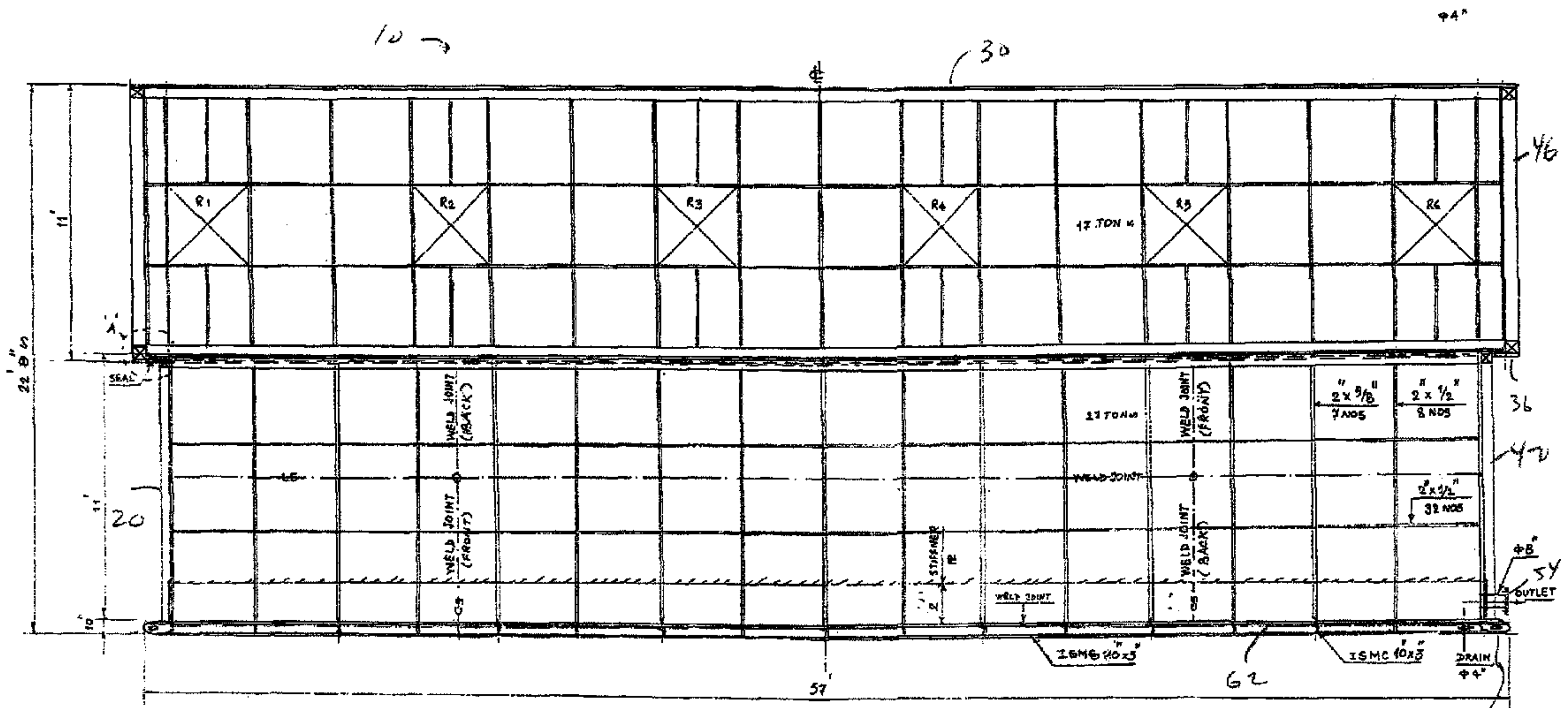


FIGURE 19



WATER TANK - 320 KL (Approx)
 370 TON + 44 TON (EMPTY WT.)