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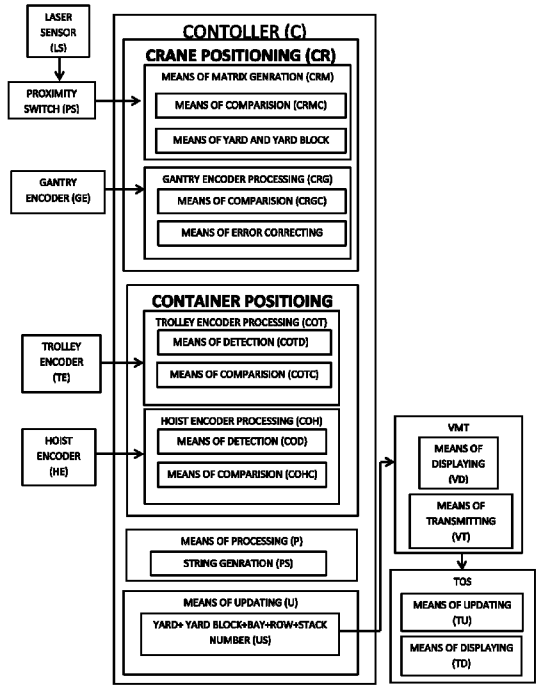


Fig.6

(57) Abstract: An automatic container position detection system comprising of a Rubber Tyre Gantry (RTG) crane further comprising: Laser sensors (LS), Proximity Switches (PS), Gantry Encoder (GE), Trolley Encoder (TE), Hoist Encoder (H), Controller (C), Vehicle Mounted Terminal (VMT), Terminal Operating System (TOS); wherein: said controller (C) further comprises of: Means for crane positioning (CR), Means for container positioning (CO), Means for processing (P), which further comprises of a means for string generation (PS); and Means for Updating (U). In the present invention, the existing RTG requires the installation of following to provide present automatic container position detection system (A): Reference Plates(RP), Laser sensors (LS), Proximity Switches (PS); wherein, said Reference Plates (RP) are installed on said bus bar (BB) for providing reference to the Laser Sensor (LS)and Proximity Switches (PS) and the said Laser Sensor (LS) and Proximity Switches (PS) are installed on said Drive-In Trolley (DT).

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"AN AUTOMATIC CONTAINER POSITION DETECTION SYSTEM"

FIELD OF THE INVENTION

The present invention relates to an automatic container position detection system. More particularly, present invention relates to an automatic container position detection system for a rubber tyre gantry crane (RTG crane)that ensures that correct container location is recorded and updated automatically in the Terminal Operating System (referred here as TOS) without human Intervention.

BACKGROUND OF THE INVENTION AND PRIOR ART:

A rubber tyre gantry crane (RTG crane) (also transtainer) is a mobile gantry crane used in intermodal operations to ground or stack containers. Inbound containers are stored for future pickup by drayage trucks, and outbound are stored for future loading on to vessels. RTGs typically straddle multiple lanes, with one lane reserved for container transfers.

Being mobile, RTGs are often powered by Diesel generator systems (gensets) of 100 to 600kW. The first *electrified rubber-tyred gantry cranes* (ERTG) in the China was unveiled in Aug 2008by The She Kou container terminal (SCT). The new technology reduces fuel consumption by an estimated 95 percent.

Typical RTGs comprises of:

- the vertical girders
- two horizontal girders mounted on said vertical girders,

- spreader
- hoist
- trolley

said vertical girdersare in pair on each side, travelling on the track using tyres below vertical girders;

said spreader attached to the hoist mounted on the trolley and is used to unload containers from truck in stack and load containers on truck for the movement outside the terminal,

said structure achieves the task by travelling on the horizontal girder over the containers stack.

In a container terminal, containers are stacked in the yard, before being sent to the ship or outside container terminal. This stacking of the containers in the container yards is done by said Rubber Tyre Gantry (RTG) crane that travels on wheels over the container stack (CS).

A container terminal has two parts i.e. Quay and Yard. Quay is the area where vessel berth and Quay cranes are mounted. Quay Cranes receive the containers loaded (L) on the truck (TR) below them for loading on to the vessel or empty trucks (TR) for the container to be unloading (UL) from the vessel for inland movement.

The second part is the yard, which serve the purpose of the intermediary storage area for the containers unloaded (UL) for the vessel and waiting for the pick-up trucks(TR) for inland movement or for

the containers waiting for the vessel for outward deliveries. As the number of containers coming in and out of the container terminal is very large it is imperative to have a strong system that records each container position in the yard. For the purpose of assigning position address to each container, every yard is sub divided into Block (BL), Bay (BA), Row (RO) and Tier (TI) **(Fig. 2)**.

A Rubber Tyre Gantry (RTG) crane operator operates fromoperator cabin (HE) of Rubber Tyre Gantry (RTG) Crane, at a height of 18.1 meter from ground. The crane operatorhave a Vehicle Mounted Terminal (VMT) in his cabin (HE), at which operator receives regular information of the jobs i.e. Loading (L) or Unloading(UL), to be performed. The operator receives the said informationfrom the Terminal Operating System (TOS) for executing loading or unloading job.

A job could either to load (L) the container from the container stack (CS) on the Truck (TR) or to unload (UL) a container into the container stack (CS) from the Truck (TR).

Primarily there are two sources from which a container terminal receives the containers. The first source is the vessel and the second source is the inland factories/Container depots.

For the containers that are unloaded (UL) from the vessel, the checker (an individual deployed on the quay) records the container number on the Vehicle Mounted Terminal (VMT) and the planner assigns an unloading position to the truck (TR) driver.

Similarly when a container is received from the inland factory or container depot at the gate of the container terminal the gate checker

checks the mandatory documents and on his satisfaction, feeds the container number in the Terminal Operating System (TOS). Based on the inputs entered by the gate checker the position is generated by the Terminal Operating System (TOS) and same is assigned to the truck (TR) driver.

The second task performed by a container terminal is the dispatch of the container. During dispatch, the containers are to be dispatched to two locations. First is to the vessel and second is to the inland factories/container depots.

For the containers to be delivered to the vessel, planner, on arrival of a vessel on the quay, through Terminal Operating System (TOS) assigns the loading (L) job to the Rubber Tyre Gantry (RTG) Crane. A job contains container number and its position.

Similarly, in case of dispatch to the inland factories/container depot, the loading (L) job is assigned to the Rubber Tyre Gantry (RTG) Crane as soon as the truck (TR) enters the container terminal gate. The gate checker checks the documents and on his satisfaction, assigns the position to the truck (TR). Once the position is assigned to the truck the loading (L) job is assigned to Rubber Tyre Gantry (RTG) Crane.

While performing loading (L) and unloading (UL) of the container, it is responsibility of the Rubber Tyre Gantry (RTG) crane operator to update the position of the container in the Vehicle Mounted Terminal (VMT). For the purpose of assigning position address to each container, every container terminal is divided into Yard, Block (BL), Bay (BA), Row (RO) and Tier (TI). The yards are marked with Yard Numbers, Block Number and Bay Numbers. In a conventional system the Rubber Tyre Gantry

(RTG) crane operator checksand update the yard and its block number in which crane is being operated, refers the bay number marking in yard, the row in which container is loaded (L) or unloaded (UL) and the tier number manually.

This manual checking and updating of the container position on the Vehicle Mounted Terminal (VMT) have risk of mistake being made by the Rubber Tyre Gantry (RTG) crane operator. Any mistake, for example: A container is to be unloaded (UL) in: *Yard Number: 4, Block: K, Bay: 57, Row: F and Tier: 1* of the container terminal. During unloading (UL) the container, the Rubber Tyre Gantry (RTG) crane operator due to negligence unloads the container in Bay: 58, instead of Bay 57. On completion of the unloading (UL) the operator updates container unloading position as 4K57F1 Vehicle Mounted Terminal (VMT). Once the wrong position is updated on the Vehicle Mounted Terminal (VMT), the Terminal Operating System (TOS) is wrongly updated.

Now since the position is wrongly updated while unloading (UL), same position shall be used for reference when the container is to be loaded (L). Continuing with the above example on vessel arrival on the quay the same container is to be loaded (L). Planner, based on the information available in the Terminal operating System (TOS) assigns a loading (L) job to the Rubber Tyre Gantry (RTG) crane with job positions as *Yard Number: 4, Block: K, Bay: 57, Row: F and Tier: 1.*

On reaching at the job position, in scenario one- the operator, without checking the container number, picks the container placed at 4K57F1 position and loads same on the truck. This way a wrong container is

loaded and delivered instead of the correct container actually lying at 4K58F1 position.

In scenario two- the Rubber Tyre Gantry (RTG) crane operator reaches at the designated job position i.e. 4K57F1 and check the container number. Since the container number is not same as the one reflected on the Vehicle Mounted Terminal (VMT) the operator informs the ground staff to locate the container in the yard.

This way in both of the scenarios the productivity and efficiency of the container terminal is affected. In scenario one, where a wrong container is delivered, could attract huge cost to the container terminal with legal liabilities.

Similarly, in scenario two, where container was not found at the designated position, time is wasted in locating the container in the terminal having container inventory running in thousands, thus affecting the terminal productivity.

There is a need to mitigate the above highlighted problems, and to provide a system where the container position address is recorded and updated automatically in the Terminal Operating System (TOS) without any reliance on the judgments of the Rubber Tyre Gantry (RTG) crane operator and therefore there is an unmet need to develop an automatic container position detection system for a rubber tyre gantry crane (RTG crane)that ensures correct containerlocation is recordedand updated in the Terminal Operating System (TOS) of said rubber tyre gantry crane,automatically, without human intervention; such that said system can be developed to fit within available resources and infrastructure.

PRIOR ART AND ITS DISADVANTAGES

- **US9177210B2** relates to Processing container images and identifiers using optical character recognition and geo-position. This Prior art uses GPS for gantry positioning which is not accurate as compared to the invented Automatic Container Positing System. GPS based system increases dependency on satellite signallingand environmental conditions. In this prior art the productivity of Rubber Tyre Gantry (RTG) Crane is dependent on the GPS working. Thus in case of any lapse in GPS signalling the container terminal productivity is directly affected.Also the GPS based positioning system requires Yard and its block number to be entered manually by the vehicle operator.

- **US8525671 B2**discloses Method and apparatus for making status reporting devices for container handlers. This prior art is based on Optical character recognition (OCR) and Radio Frequency Identification (RFID) technology and uses it with Hoist (H) and trolley encoder (TE) integration for position detection but this system doesnot capture yard and block position automatically. The Optical character recognition (OCR) and Radio Frequency Identification (RFID) technology are used only to detect the container, though same are not used to position ofthe container.

- **US20090109295 A1**Method and apparatus for operating at least one camera from a position estimate of a container to estimate its container code. This prior art is related to Optical character recognition (OCR) and camera based technology which being used to

capture container number. This art is not for capturing the container position in the yard.

In Summary, Conventional RTG crane requires manual operations for recording and updating the container position, thus suffers from at least one of the following disadvantages:

- Has risks of manual errors in making note of the location of the containers and thereby mismanagement making the existing system inefficient.
- The operator has to be watchful for the containers stack, trolley, hoist, ITV and yard staff, while sitting at a height of approx. 18.1 meter in the RTG Crane Cabin, which increases the possibility of error being made by the RTG crane operator in recording the container position.
- Efficiency of the container inventory recording and reliability of the container database, in a conventional system, depends upon the efficiency of the Crane Operator, thus output varies with the efficiency of the operator.
- In addition, it also poses threat to the security of the cargo of customers and associates, thereby directly effecting Port's credibility.

Thus, there is an unmet need to provide an automatic container position detection system that ensures correct containerlocation is recordedand updated in the Terminal Operating System (referred here as TOS), automatically, without human intervention thereby automatically recording the container location address in the terminal's

record for future use; eliminating the risk of human error which may be made while updating container location address in terminal's record.

OBJECT OF THE INVENTION

The main object of this invention is to provide an automatic container position detection system that ensures correct containerlocation is recorded and updatedin the Terminal Operating System (referred here as TOS),automatically, without human intervention.

Another object of this invention is to provide an automatic container position detection system whereby container location address is recorded automatically in the terminal's record for future use.

Yet other object of this invention is to provide an automatic container position detection system that eliminates the risk of human error which may be made while updating container location address in terminal's record.

Yet other object of this invention is to provide an automatic container position detection system that eliminates the problems associated with the prior art.

BREIF DESCRIPTION OF DRAWINGS

FIGURE		DESRIPTION
Fig. 1	:	Shows RTG (Rubber Tyre Gantry) Crane
Fig. 2	:	Block (BL), Bay (BA), Row (RO) and Tier (TI)
Fig. 3	:	In section A shows the Rubber Tyre Gantry (RTG) crane having Drive-In Trolley (DT) with Laser Sensor (LS) and

		Proximity Switches (PS) installed on it. It also shows the bus bar (BB) with Reference Plates (RP).
Fig. 4	:	Bus Bar (BB) with Reference Plates (RP)
Fig. 5	:	Shows the Drive In trolley (DT) with Laser Sensor (LS) and Proximity Switch (PS) indicating the positions for installation of said Laser Sensor (LS) and Proximity Switch (PS)
Fig. 6	:	Block diagram of present automatic container position detection system
Fig. 7	:	Shows the illustrative example of unloading wherein RTG Crane is at Yard: 4, Block: K with matrix generated.
Fig. 8	:	Shows Matrix: Combination of Inputs received from Proximity Switches and their Output
Fig. 9	:	RTG crane at Bay Number: 57
Fig. 10	:	RTG Crane at bay number 57 with spreader (S) over container
Fig. 11	:	Container unloaded (UL) and position address generated
Fig. 12	:	Flow chartshowing Unloading Cycle
Fig. 13	:	Flow Chart showing loading Cycle

Meaning of Reference numerals of said component parts of present automatic container position detection system:

(A) : Automatic container position detection system

(RTG) : **Rubber Tyre Gantry**

(S) : Spreader

(TR) : Truck

(DT) : Drive In Trolley

(LS) : Laser Sensor
(PS) : Proximity Switch
(LB) : Laser Beam
(RP) : Reflecting Plate
(BB) : Bus Bar
(T) : Trolley
(OCR) : Optical character recognition
(RFID) : Radio Frequency Identification
(L) : Load
(UL) : Unload
(DT) : Drive-In Trolley
(RP) : Reference Plates
(HE) : Operator Cabin
(LS) : Laser sensors
(PS) : Proximity Switches
(GE) : Gantry Encoder
(TE) : Trolley Encoder
(H) : Hoist and Hoist Encoder
(C) : Controller
(CR) : Means for crane positioning
(CRM) : Means for matrix generation
(CRMC) : Means for comparison (part of CRM)
(CRMY) : Means for yard and yard block identification
(CRG) : Gantry Encoder Processing
(CRGC) : Means for comparison (part of CRG)
(CRGE) : Means for error correction
(CO) : Means for container positioning

(COT) : Trolley Encoder Processing
(COTD) : Means for detection
(COTC) : Means for comparison
(COH) : Hoist encoder processing
(COHD) : Means for detection
(COHC) : Means for comparison
(P) : Means for processing
(CPS) : means for string generation
(UP) : Means for Updating
(VMT) : Vehicle Mounted Terminal
(VD) : Means for display
(VT) : Means for transmitting
(TOS) : Terminal Operating System
(TU) : Means for updating
(TD) : Means for displaying
(TI) : Tier
(BA) : Bay
(RO) : Row
(BL) : Block
(HD) : Hoist Drive
(HM) : Hoist Motor
(GD) : Gantry Drive
(GM) : Gantry Motor
(TD) : Trolley Drive
(TM) : Trolley Motor
(Y) : Yard

SUMMARY OF INVENTION

The present invention embodies an automatic container position detection system (A) that ensures correct containerlocation is recordedand updatedin the Terminal Operating System (TOS),automatically, without human intervention.

Present an automatic container position detection system mainly comprises of a Rubber Tyre Gantry (RTG) crane further comprising:

- Laser sensors (LS),
- Proximity Switches (PS),
- Gantry Encoder (GE),
- Trolley Encoder (TE),
- Hoist Encoder (H),
- Controller (C),
- Vehicle Mounted Terminal (VMT),
- Terminal Operating System (TOS);

wherein:

- said **controller** (**C**) further comprises of:

  - Means for crane positioning (CR), which is further comprised of:
    - Means for matrix generation (CRM) is in turn comprised of:
      - Means for comparison (CRMC), and
      - means for yard and yard block identification(CRMY); and
    - Gantry Encoder Processing (CRG) is in turn comprised of:

- Means for comparison (CRGC),
- Means for error correction (CRGE);

➢ Means for container positioning (CO), which is further comprised of:

- Trolley Encoder Processing (COT) which is in turn comprised of:
  - means for detection (COTD),
  - means for comparison (COTC);
- Hoist Encoder Processing (COH)which is in turn comprised of:
  - means for detection (COD),
  - means for comparison (COHC);

➢ Means for processing (P), which further comprises of a means for string generation (PS);

➢ Means for Updating (U);

- said **Vehicle Mounted Terminal (VMT)** is further comprised of:

➢ Means for display (VD), and

➢ Means for transmitting (VT);

- said **Terminal Operating System (TOS)** further comprises of:

➢ Means for updating (TU),

➢ Means for displaying (TD).

DESCRIPTION OF THE INVENTION

The present invention embodies an automatic container position detection system that ensures correct container location is recorded and updated in the Terminal Operating System (referred here as TOS), automatically, without human intervention.

Present automatic container position detection system (A) is installed in the existing infrastructure of the container terminal. The position detection is essential for RTG crane while loading and unloading the containers.

Referring to **Fig. 1 to 13**, The RTG crane used in the present automatic container position detection system (A) uses existing RTG with:

- the vertical girders (VG)
- two horizontal girders (HG) mounted on said vertical girders,
- spreader (S)
- hoist (H)
- trolley (T)
- Bus Bar (BB),
- Drive-In Trolley (DT),
- Terminal Operating System (TOS)
- Encoders (GE, TE and H).

and requires installation of following for installing present automatic container position detection system (A) (**refer fig. 3, 4 and 5**):

- Reference Plates(RP),
- Laser sensors (LS),
- Proximity Switches (PS),

Wherein said bus bar (BB) is a physical structure that supplies electricity to the Rubber Tyre Gantry (RTG) Crane. Each yard (Y) of a container terminal have bus bar (BB) structure installed across its length. The Drive In trolley (DT) of RTG crane gets attached to this bus bar (BB), whenever RTG crane enters yard (Y). Said Reference Plates

(RP) are installed on said bus bar (BB) for providing reference to the Laser Sensor (LS) and Proximity Switches (PS). Said Laser Sensor (LS) and Proximity Switches (PS) are installed on said Drive-In Trolley (DT) as shown in **Fig.5**. Said figure shows the drive in trolley (DT) front and cross section view with one laser sensor (LS) and eight Proximity switches (PS) installed.

The Rubber Tyre Gantry (RTG) is remotely operated in the present invention wherein the Rubber Tyre Gantry (RTG) crane operator sits in the remote operations station where he have access of Rubber Tyre Gantry (RTG) through wi-fi network and job information through Vehicle Mounted Terminal (VMT).

Referring to **fig. 1 to 13** present an automatic container position detection system (A) mainly comprises of a Rubber Tyre Gantry (RTG) crane further comprising:

- Laser sensors (LS)
- Proximity Switches (PS)
- Gantry Encoder (GE)
- Trolley Encoder (TE)
- Hoist Encoder (H)
- Controller (C)
- Vehicle Mounted Terminal (VMT)
- Terminal Operating System (TOS)

wherein:

Laser sensor (LS) is used where small object or position is to be detected. The input of Proximity Switch (PS) is captured by the controller (C) only when the Laser Sensor (LS) senses the Reference Plate (RP).Refer Figure 5 showing Laser Sensor (LS) installed on the Drive In trolley (DT). Since proximity switches remains active throughout the movement of the RTG crane in the yard (Y), their input is captured by the controller (C), only when the Laser Beam is sensed.

Said **proximity switch (PS)** is provided for the purpose of detecting the presence of the nearby object without any physical contact. This absence of physical contact between proximity switch (PS) and sensed object adds to the life and reliability of the proximity switch (PS). Also a proximity switch (PS) does not detect any foreign object apart from metal, thus making it more reliable and thereby making the invention more reliable. Said proximity switch (PS) are in plurality in present system, enabling better detection of objects. In a preferred embodiment of the present invention, there are 8 proximity switches (**refer figure 5**); wherein 6 out of 8 Proximity Switches (PS) are installed to give binary output in order to make a matrix for Controller (C) to identify yard and block number. Remaining two Proximity switch (PS) are used to bring auto correction in the gantry encoder input of the correct position of the RTG crane, thereby assisting the sharing accurate bay number with the controller.Every time a reference plate (RP) is sensed by the proximity switch (PS) 7 and 8 it makes the correction in the bay number recorded by the controller (C).

Similarly an encoder is an electro-mechanical device that converts the angular position or motion of a shaft or axle to an analogy or digital code and transfers same to the controller (C).

Trolley Encoder (TE) is installed with Trolley (T) and Hoist Encoder (H) is installed with Hoist (H) of RTG crane as shown in **Fig.3.** The Gantry Encoder (GE) is installed with shaft of the RTG crane (RTG).

The gantry encoder (GE) starts working only when the command is passed by the RTG crane operator to move the RTG crane. The command is transmitted first to the Gantry Drive (GD), then to the Gantry Motor (GM). RTG crane starts moving with the movement of the Gantry Motor (GM). Since the gantry encoder (GE) is installed on the shaft of the RTG crane, they start converting the motion of a shaft to digital code and transfer same to the controller (C).

On reaching at the designated bay, The Trolley Encoder (TE) starts working only when the command is passed by the RTG operator to move the trolley. The RTG crane operator starts to position the spreader (S) over the designated row for which trolley is required to be moved. Trolley starts moving upon the command of the RTG crane operator. The command is first transmitted to the Trolley Drive (TD) and from Trolley Drive (TD)to the Trolley Motor (TM).

Lastly, once the trolley is positioned over the designated row, the RTG crane operator positions the spreader (S) over the tier from which container is to be loaded (L) or unloaded (UL). To position the spreader (S) the RTG crane operator transmits the command firstly to the Hoist Drive (HD) and then the command is transmitted from the Hoist Drive

(HD) to the Hoist Motor (HM). The Hoist Encoder (H) starts working as soon as the Hoist Motor (HM) starts moving.

A drive is an electrical component which controls the motion of the electrical machines like motors.

Said **Controller (C)** processes the inputs to it, for generating the container position address. Said controller receives the inputs from Laser Sensor (LS), Eight Proximity Switch (PS), Gantry Encoder (GE), Trolley Encoder (TE), and Hoist Encoder (H). Said controller (C) generates container position address which is a combination of: Yard (Y) Number, Block Number, Bay Number, Row Number and Tier Number. For the same, referring to fig. 6, Said **controller** (**C**) further comprises of:

- **Means for crane positioning (CR)**, provides for detection of crane position; which is further comprised of:
    - Means for matrix generation (CRM) in is turn comprised of:
        - Means for comparison (CRMC), and
        - means for yard and yard block identification(CRMY); and
    - Gantry Encoder Processing (CRG) isin turn comprised of:
        - Means for comparison (CRGC),
        - Means for error correction (CRGE);

Said controller (C) receives in its means for crane positioning (CR), the inputs from the Laser Sensor (LS) and six proximity switches (PS) to generate a matrix of the binary codes using its

matrix generating means (CRM). Once the matrix is generated the binary codes are compared using **comparison means (CRMC).** Each combination generated by the matrix is assigned with a yard (Y) and block number.Thus, based on the comparison means (CRMC) **yard and its block numbers (CRMY)** are identified.

Also, **Gantry Encoder Processing (CRG)** generates bay number; for which, said controller (C) uses the inputs of the Gantry Encoder (GE). Further, said **Means for comparison (CRGC) and Means for error correction (CRGE)** of said Gantry Encoder Processing (CRG) enables the movement of the RTG crane (RTG) towards correct target location from the current location. For the same, said Proximity switch 7 (PS) and proximity switch 8 (PS) are used to bring auto correction in the gantry encoder input given to the controller (C). These Proximity Switches (PS) senses by the reference plates (RP) installed in the block at bus bar structure to make controller sense accurate bay number. Every time a reference plate (RP) is sensed by the proximity switch (PS) 7 and 8 it makes the correction in the bay number recorded by the controller (C) using its Means for error correction (CRGE). Further, controller (C) makes a comparison of last the input of the gantry encoder (GE) using its Means for comparison (CRGC) and makes RTG crane (RTG) move toward the destination bay by taking input from the gantry encoder (GE).

This way when the current position of the RTG crane becomes equal to the target position, RTG crane stops and the Bay number is captured.

- **Means for container positioning (CO)**, is provided for the detection of container position; which is further comprised of:
    - Trolley Encoder Processing (COT) which is in turn comprised of:
        - means for detection (COTD),
        - means for comparison (COTC);
    - Hoist Encoder Processing (COH)which is in turn comprised of:
        - means for detection (COD),
        - means for comparison (COHC);

Said controller (C) receives input of Trolley Encoder (TE) in its Means for container positioning (CO) for identification of the row of operation. This is done using means for detection (COTD), and means for comparison (COTC) of said Trolley Encoder Processing (COT).

To capture the row number, controller (C) refers the pre-defined distance matrix. The system distance matrix has distance and equivalent row number pre-defined in the controller (C). Thus when the target and current position of the trolley becomes equal, the controller (C) refers the distance matrix and the row number is recorded.

Similarly said controller (C) receives input of Hoist Encoder (H) in its Means for container positioning (CO) for identification of the tier of operation. This is done using means for detection (COD), and means for comparison (COHC) of said Hoist Encoder Processing (COH).

To capture the tier number, controller (C) refers the pre-defined distance matrix. The system distance matrix has distance and equivalent tier number pre-defined in the controller (C). Thus when the target and current position of the hoist become equal, the controller (C) refers the distance matrix and the tier number is recorded.

- **Means for processing (P)**, which further comprises of a means for string generation (PS);

  Once the inputs from the means of yard and yard block identification (CRMY), gantry encoder processing (CRG), trolley encoder processing (COT) and hoist encoder processing (COH) are recorded, the controller (C) generates the string of the container location address which comprises of Yard Number, Block Number, Row Number, Bay Number and tier Number using means of String Generation (PS).

- **Means for Updating (U)**; enables Controller (C), having generated the container location address, to update the container location address comprising of Yard Number, Block Number, Row Number, Bay Number and tier Number in the Terminal Operating System (TOS) through VMT.

A **Vehicle Mounted Terminal (VMT)** is a mobile electronic device having a means of Display (VD), a keypad and a means of transmitting (VT) of data transmission. The user or Rubber Tyre Gantry (RTG) Crane operator receives the visuals on the display of the container number and its position on which either a loading (L) or unloading (UL) job is to be performed. Once the job is completed the Rubber Tyre Gantry (RTG)

Crane operator can punch in the completion status and container position using keypad. This display of the jobs on the screen and inputs of the Rubber Tyre Gantry (RTG) Crane operator communicated to and fro with the Terminal Operating System (TOS). Where in case a Rubber Tyre Gantry (RTG) is remotely operated the Rubber Tyre Gantry (RTG) crane operator sits in the remote operations station where he have access of Rubber Tyre Gantry (RTG) through Wi-Fi network and job information through Vehicle Mounted Terminal (VMT).

A **Terminal Operating System (TOS)** is a system used at the container terminals to record and interpret the container terminal information. It records the database of the container coming in and out of the container terminal, containers stored in the yard with their respective position, vehicles coming In and out of the container terminal, vessel schedules, containers to be loaded (L) or unloaded (UL) from a vessel, and job allocated the Rubber Tyre Gantry (RTG) Cranes. The Terminal Operating System (TOS) acts as an interface for the planner of the container terminal. Said Terminal Operating System (TOS) further comprises of: Means for displaying (TD) for displaying said records and other container terminal information; and Means for updating (TU) for updating the container terminal information and the records of the database including the details of the container coming in and out of the container terminal, containers stored in the yard with their respective position, vehicles coming In and out of the container terminal, vessel schedules, containers to be loaded (L) or unloaded (UL) from a vessel, and job allocated the Rubber Tyre Gantry (RTG) Cranes.

WORKING OF THE INVENTION

An unloading (UL) and loading (L) cycle for the detailed explanation on the stepwise working of the invention is provided below, referring to the numerals given in the flow chart illustrated in **Fig. 12**:

- **1 and 2**- the unloading (UL) process starts with Truck (TR) carrying container, which arrives at the Pre Gate of the Port.
- **3, 4 and 5** - Upon its arrival a gate entry operator checks the shipping documents and allows the movement of the truck inside the terminal; if the shipping documents meet standards else truck (TR) is directed towards buffer yard to unload (UL) the container.
- **6, 7 and 8**- On arrival of the truck (TR), carrying container, at the terminal gate position is generated by the gate operator. This position is given to the truck driver and simultaneously displayed on the VMT of the RTG crane.
- **9 and 10**- RTG Crane moves to the yard using Job Information. Yard and its block number are detected (CRMY) by Laser sensor (LS) and Proximity switches (PS) through matrix generation (CRM).
- **10**- RTG crane stops at the target position using inputs received from the gantry encoder (GE) and corrections made using inputs of Proximity switches (PS) 7 and 8. RTG crane operator moves the trolley (T) over the truck (TR) lane, brings the spreader (S) down over the container and locks the container to move it to the target row and tier.

- **11 and 12**- While spreader (S) with container moves from Truck (TR) lane to the planned target position, controller (C) gets the input from Trolley Encoder (TE) and Hoist encoder (H) and compares it with target position using pre-set values.
- **13**- The position on the container is displayed (VD) on the VMT as soon as spreader (S) is unlocked from the container.
- **14 and 15**- Controller generates the string (US) and transmits it to the VMT. VMT compares the string with target position. If the position generated immediately after unlock command is given is same to the target position, TOS is updated (TU).
- **16**- If string generated (US) on spreader (S) "unlock" command is not same as of planned target position, an error message displayed (VD) on the VMT of the RTG crane.
- **17**- RTG crane operator updates the new position of the container on the VMT (VD/VT) and same is automatically updated in the TOS (TU/TD).
- **18**- Unloading (UL) job is finished.

Similarly, the loading cycle is illustrated stepwise in the flow chart in **Fig.13** and detailed explanation is provided as under:

- **1 and 2**- The loading (L) cycle starts with arrival of the truck (TR) at the container terminal. On arrival of the truck, an import Job is created by the TOS.
- **3 and 4**- This position is given to the truck (TR) driver and simultaneously displayed (VD) on the VMT of the RTG crane.

- **5**- RTG Crane moves to the yard using Job Information. Yard and its block number detected (CRMY) by Laser sensor (LS) and Proximity switches (PS) through matrix generation (CRM).
- **6**- RTG crane stops at the target position using inputs received from the gantry encoder (GE) and corrections made using inputs of Proximity switches (PE) 7 and 8. RTG crane operator moves the trolley (T) over the truck (TR) lane, brings the spreader (S) down over the container and locks the container to move it to the target row and tier.
- **7 and 8**- The position of the trolley (T) and spreader (S), through trolley (TE) end Hoist encoders (H)are shared with the controller (C) at the time spreader (S) "lock" command is given and same are compared with pre-set values to identify the Row number and Tier number.
- **9**- Once the string made up of all inputs is generated, the string is transmitted to the VMT and the container is moved towards truck (T) bay.
- **10 and 11**- At truck (TR) bay, once the container is placed on the truck (TR) and the spreader (S) is unlocked from the container; the job completion is updated on the TOS (TU).
- **12**- If position detected at the time of spreader (S) lock command is different from planned position an error message is displayed (VD) on the VMT.
- **13, 14 and 15**- The RTG crane operator checks the container number physically. If the container number is found correct, the operator updates the current spreader (S) position as actual

position of the container in VMT and container is allowed to be moved on truck bay.

- **16**- In case, on physical check if the container number is found to be different from the one that is displayed on the VMT the RTG crane operator may ask for operation team help and on identification of the correct position, may move the spreader (S) to the correct position.

- Once the correct position is identified, RTG crane operator moves the crane to the correct location and loads the container on truck. The position, generated from controller (C) is compared with the planned position and if both are found same loading (L) job completion status is updated on the TOS.

EXAMPLE

The working of the present invention is further explained through following example:

A container unloading (UL) job is given to the RTG crane to unload (UL) the container in the terminal at position **4K57F1**. This means the container has to be unloaded at Yard Number: 4, Block Number: K, Bay Number: 57, Row Number: F and Tier Number: 1 by the RTG crane.

As soon as RTG crane operator gets the job on the VMT, he moves the RTG crane to the Yard Number: 4, Block: K based on the yard and its block number marking boards.

On reaching at position 4K, as shown in **Fig.7**the laser sensor (LS) present on the Drive In trolley (DT) is sensed by the corresponding Reference Plate (RP) present on the Bus Bar (BB).

For the purpose of illustration, the installation position of reference plates (RP) and installation number proximity switches (PS) is done for a terminal having three yards and ten blocks. This could vary in accordance to the number of yard and block number in a container terminal.

Once the laser sensor (LS) is sensed, the controller (C) starts receiving the input from said six proximity switches (PS). At the entrance and exit of each block, reference plates (RP) area installed such that when sensed by the proximity switches (PS), it identifies either of any one of the three yards and one of the ten blocks.

The input of Proximity Switch 6 (PS) and Proximity Switch 5 (PS) is used to identify the Yard number by the controller (C). A matrix as shown in **Figure 8** generates with binary codes. In the present illustrations as RTG crane has reached at Yard 4, Proximity Switch 6 (PS) is be sensed 0 (since there is no reference plate (RP) installed) and Proximity Switch 5 (PS)is sensed 1 (Reference Plate (RP) is sensed) thus the controller considers the yard position as 4.**(Fig. 7)**

Similarly Proximity Switch 1, 2, 3 and 4 are sensed to identify the block. In our illustration Proximity Switch 1, 3, and 4 is be sensed 1 (Since reference plates (RP) are installed) and Proximity Switch 2 is be sensed 0 (Since reference plate is not installed). Thus the controller (C) considers the block number as K **(Fig. 7).** The working of proximity switches is shared below:

YARD IDENTIFICATION		
PROXI-6	**PROXI-5**	**MAIN YARD**

1	O	4

YARD IDENTIFICATION				
PROXI-4	**PROXI-3**	**PROXI-2**	**PROXI-1**	**YARD BLOCK**
1	**1**	**0**	**1**	**K**

The controller (C) has captured two inputs i.e. Yard Number and Block number. Now the RTG crane operator gives the command to the crane to move to bay number 57. As RTG cranes starts moving to the destination bay the controller uses the input of Gantry Encoder (GE) installed on the shaft of the RTG Crane to fetch bay position.

Here proximity switch (PS) 7 and proximity switch 8 (PS) are used to bring auto correction in the gantry encoder input of the correct position of the RTG crane. These Proximity Switches are sensed by the reference plates (RP) installed in the block at bus bar (BB) structure to make controller sense accurate bay number. Every time a reference plate (RP) is sensed by the proximity switch (PS) 7 and 8 it makes the correction in the bay number recorded by the controller (C).

The controller (C) makes a comparison of last the input of the gantry encoder (GE) and makes RTG crane move toward the destination bay by taking input from the gantry encoder (GE).

This way when the current position of the RTG crane becomes equal to the target position, RTG crane stops and the Bay number is captured. In our case bay number 57 is identified. (**Fig.9**)

So far out of five elements that make a container position address three have been identified.

After reaching at the bay 57 the RTG crane operator finds the truck (TR) loaded (L) with the container number as reflected on the VMT. The RTG crane operator brings the Trolley (T) over the truck (TR) and then brings the Spreader (S) downwards.(**Fig. 10**)

The spreader (S) locks itself over the container and picks up the same using twist locks. After locking the container, the RTG crane operator moves the container upward, moves the trolley over the **container stack (CS),** brings the container downward after reaching the destination row, and lastly gives unlock command to detach the spreader (S) from the container.

Here once the spreader (S) is unlocked, the controller (C) records the input of the trolley encoder (TE) and hoist encoder (H) and makes comparison pre-set values as shown in the tables below:

TROLLEY POSITION (mm)		
mm From	**mm To**	**ASSIGNED ROW NUMBER**
3480	4980	A
6120	7620	B
8850	10350	C
11490	12990	D
14400	15900	E
17080	18580	F

(Table 1: Pre-set values for Row number identification)

HOIST POSITION (mm)		
mm From	**mm To**	**ASSIGNED TIER NUMBER**
2790	4940	5
5690	7540	4
8590	10140	3
11490	12740	2
14390	15340	1
13000	14000	TRUCK (TR)

(Table 2: Pre-set values for Tier number identification)

In present illustration as target row number is F and Tier number is 1, as shown in **Fig. 11**, same is recorded by the controller.

Thus the final string comprising of Yard: 4, Block: K, Bay: 57, Row: F and Tier: 1 is made and updated in the Terminal Operating System (TOS) through Vehicle Mounted Terminal (VMT).

COMPARISON WITH THE PRIOR ART

In a conventional Rubber Tyre Gantry (RTG) crane operation the operator on completion of the job updates the container position on the Vehicle Mounted Terminal (VMT). This means the operator has to

update Yard, Block, Bay, Row and Tier number on the Vehicle Mounted Terminal (VMT).

If updating of any of the above five input goes wrong because of negligence, the position of the container gets wrongly updated in the Terminal Operating System (TOS), which could make tracking the container in the yard difficult and thereby effecting container terminal productivity.

The invented Automatic Container Position Detection system, removes the human interface through automation while updating the position of the container in the yard. This helps removing the possibility of human made errors that could occur while updating the container position and thus ensuring Terminal Operating System (TOS) getting updated with correct position.

ADVANTAGES OF PRESENT INVENTION

The present invention provides following advantages over the existing arts:

1. Present automatic container position detection system ensures correct containerlocation is recorded and updated in the Terminal Operating System (referred here as TOS),automatically, without human intervention.
2. Present system eliminates the risk of human error which may be made while updating container location address in terminal's record. Thus further eliminates mismanagement; inturn making the system efficient and reliable.

3. Present system of Auto Container Positing Detection system is invented using the resources already available of bus bar structure and encoders; i.e. it uses the already present infrastructure of the port to make technical advancements and to bring about accurate position detection; while there is no reoccurring cost of GPS and its maintenance. It is thus cost effective and efficient.
4. The present system uses Hoist encoder (H), Trolley encoder (TE), Gantry Encoder (GE), proximity switches (PS), Laser Sensor (LS) and its matrix for yard, block, bay, rowand tier identification thus making system more accurate and reliable.
5. The present system captures and updates complete container position address, using hoist (H) position, trolley position and gantry position, yard block position automatically in Terminal Operating System.
6. There is no variation in output with the efficiency of the operator.
7. It eliminates the problems associated with the prior art.
8. In addition, it eliminates the threat to the security of the cargo of customers and associates, thereby directly effecting Port's credibility.

CLAIMS:

1. An automatic container position detection system mainly comprises of a Rubber Tyre Gantry (RTG) crane further comprising:

- Laser sensors (LS),
- Proximity Switches (PS),
- Gantry Encoder (GE),
- Trolley Encoder (TE),
- Hoist Encoder (H),
- Controller (C),
- Vehicle Mounted Terminal (VMT),
- Terminal Operating System (TOS);

wherein:

- said controller (C) further comprises of:

  - Means for crane positioning (CR), which is further comprised of:
    - Means for matrix generation (CRM) is in turn comprised of:
      - Means for comparison (CRMC), and
      - means for yard and yard block identification(CRMY); and
    - Gantry Encoder Processing (CRG) isin turn comprised of:
      - Means for comparison (CRGC),
      - Means for error correction (CRGE);
  - Means for container positioning (CO), which is further comprised of:
    - Trolley Encoder Processing (COT) which is in turn comprised of:

- means for detection (COTD),
- means for comparison (COTC);

o Hoist Encoder Processing (COH)which is in turn comprised of:

- means for detection (COD),
- means for comparison (COHC);

➢ Means for processing (P), which further comprises of a means for string generation (PS);

➢ Means for Updating (U);

- said **Vehicle Mounted Terminal (VMT)** is further comprised of:

➢ Means for display (VD), and

➢ Means for transmitting (VT);

- said **Terminal Operating System (TOS)** further comprises of:

➢ Means for updating (TU),

➢ Means for displaying (TD).

wherein:

said **Laser sensor (LS)**is installed on the Drive In trolley (DT) and is provided for detection of small object or position whereby the input of Proximity Switch (PS) is captured by the controller (C) only when the Laser Sensor (LS) senses the Reference Plate (RP);

said **proximity switch (PS)** areprovidedin plurality, preferably eight, for the purpose of detecting the presence of the nearby object without any physical contact; which does not detect any foreign object apart from metal; wherein 6 out of 8 Proximity Switches (PS) are installed to give

binary output in order to make a matrix for Controller (C) to identify yard and block number; and remaining two Proximity switch (PS) are used to bring auto correction in the gantry encoder input of the correct position of the RTG crane;

said **Trolley Encoder (TE)** is installed with said Trolley (T), said **Hoist Encoder (H)** is installed with Hoist (H) of RTG crane and said **Gantry Encoder (GE)** is installed with shaft of the RTG crane (RTG); wherein gantry encoder (GE) starts working only when the command is passed by the RTG crane operator to move the RTG crane and said command is transmitted first to the Gantry Drive (GD), then to the Gantry Motor (GM) whereby the RTG crane starts moving with the movement of the Gantry Motor (GM);since the gantry encoder (GE)is installed on the shaft of the RTG crane, they start converting the motion of a shaft to digital code and transfer same to the controller (C);

said Trolley Encoder (TE) starts working only when the command is passed by the RTG operator to move the trolley, once it reaches the designated bay; whereby the RTG crane operator starts to position the spreader (S) over the designated row for which trolley is required to be moved; then the Trolley starts moving upon the command of the RTG crane operator wherein the command is first transmitted to the Trolley Drive (TD) and from Trolley Drive (TD)to the Trolley Motor (TM); and when the trolley is positioned over the designated row, the RTG crane operator positions the spreader (S) over the tier from which container is to be loaded (L) or unloaded (UL); wherein further, to position the spreader (S) the RTG crane operator transmits the command firstly to the Hoist Drive (HD) and then the command is transmitted from the

Hoist Drive (HD) to the Hoist Motor (HM) and the Hoist Encoder (H) starts working as soon as the Hoist Motor (HM) starts moving

Said **Controller (C)** processes the inputs to it, for generating the container position address for which, the controller receives the inputs from Laser Sensor (LS), Eight Proximity Switch (PS), Gantry Encoder (GE), Trolley Encoder (TE), and Hoist Encoder (H);said controller (C) generates container position address which is a combination of: Yard (Y) Number, Block Number, Bay Number, Row Number and Tier Number; For which, **controller** (**C**) further comprises of:

- **Means for crane positioning (CR)**, provides for detection of crane position; which is further comprised of:
    - Means for matrix generation (CRM) in is turn comprised of:
        - Means for comparison (CRMC), and
        - means for yard and yard block identification(CRMY); and
    - Gantry Encoder Processing (CRG) isin turn comprised of:
        - Means for comparison (CRGC),
        - Means for error correction (CRGE);

said controller (C) receives in its means for crane positioning (CR), the inputs from the Laser Sensor (LS) and six proximity switches (PS) to generate a matrix of the binary codes using its **matrix generating means (CRM)**;once the matrix is generated the binary codes are compared using said **comparison means (CRMC)**; each combination generated by the matrix is assigned with a yard (Y) and block number;

thus, based on the comparison means (CRMC) **yard and its block numbers (CRMY)** are identified;

further, **Gantry Encoder Processing (CRG)** generates bay number; for which, said controller (C) uses the inputs of the Gantry Encoder (GE); further, said **Means for comparison (CRGC) and Means for error correction (CRGE)** of said Gantry Encoder Processing (CRG) enables the movement of the RTG crane (RTG) towards correct target location from the current location; For the same, said Proximity switch 7 (PS) and proximity switch 8 (PS) are used to bring auto correction in the gantry encoder input given to the controller (C);these Proximity Switches (PS) are sensed by the reference plates (RP) installed in the block at bus bar structure to make controller sense accurate bay number wherein every time a reference plate (RP) is sensed by the proximity switch (PS) 7 and 8 it makes the correction in the bay number recorded by the controller (C) using its Means for error correction (CRGE);Further, controller (C) makes a comparison of last the input of the gantry encoder (GE) using its Means for comparison (CRGC) and makes RTG crane (RTG) move toward the destination bay by taking input from the gantry encoder (GE);

and when the current position of the RTG crane becomes equal to the target position, RTG crane stops and the Bay number is captured;

- **Means for container positioning (CO)**, is provided for the detection of container position; which is further comprised of:
    - Trolley Encoder Processing (COT) which is in turn comprised of:
        - means for detection (COTD),

- means for comparison (COTC);
- Hoist Encoder Processing (COH)which is in turn comprised of:
  - means for detection (COD),
  - means for comparison (COHC);

said controller (C) receives input of Trolley Encoder (TE) in its Means for container positioning (CO) for identification of the row of operation; which is done using means for detection (COTD), and means for comparison (COTC) of said Trolley Encoder Processing (COT);

further, to capture the row number, controller (C) refers the pre-defined distance matrix wherein the system distance matrix has distance and equivalent row number pre-defined in the controller (C);thus when the target and current position of the trolley becomes equal, the controller (C) refers the distance matrix and the row number is recorded; Similarly said controller (C) receives input of Hoist Encoder (H) in itsMeans for container positioning (CO) for identification of the tier of operation which is done using means for detection (COD), and means for comparison (COHC) of said Hoist Encoder Processing (COH);

further, to capture the tier number, controller (C) refers the pre-defined distance matrix wherein the system distance matrix has distance and equivalent tier number pre-defined in the controller (C); thus when the target and current position of the hoist become equal, the controller (C) refers the distance matrix and the tier number is recorded;

- **Means for processing (P)**, which further comprises of a means for string generation (PS);

wherein once the inputs from the means of yard and yard block identification (CRMY), gantry encoder processing (CRG), trolley encoder processing (COT) and hoist encoder processing (COH) are recorded, the controller (C) generates the string of the container location address which comprises of Yard Number, Block Number, Row Number, Bay Number and tier Number using means of String Generation (PS);

- **Means for Updating (U)**;enables Controller (C), having generated the container location address, to update the container location address comprising of Yard Number, Block Number, Row Number, Bay Number and tier Number in the Terminal Operating System (TOS) through VMT;

Said **Vehicle Mounted Terminal (VMT)** is a mobile electronic device having a means of Display (VD), a keypad and a means of transmitting (VT) of data transmission wherein the user or Rubber Tyre Gantry (RTG) Crane operator receives the visuals on the display of the container number and its position on which either a loading (L) or unloading (UL) job is to be performed and once the job is completed the Rubber Tyre Gantry (RTG) Crane operator can punch in the completion status and container position using keypad wherein this display of the jobs on the screen and inputs of the Rubber Tyre Gantry (RTG) Crane operator communicated to and fro with the Terminal Operating System (TOS);where in case a Rubber Tyre Gantry (RTG) is remotely operated the Rubber Tyre Gantry (RTG) crane operator sits in the remote operations station where he have access of Rubber Tyre Gantry (RTG)

through wifi network and job information through Vehicle Mounted Terminal (VMT);

Said **Terminal Operating System (TOS)** is a system used at the container terminals to record and interpret the container terminal information; which records the database of the container coming in and out of the container terminal, containers stored in the yard with their respective position, vehicles coming In and out of the container terminal, vessel schedules, containers to be loaded (L) or unloaded (UL) from a vessel, and job allocated the Rubber Tyre Gantry (RTG) Cranes; said Terminal Operating System (TOS) acts as an interface for the planner of the container terminal. Said Terminal Operating System (TOS) further comprises of: Means for displaying (TD) for displaying said records and other container terminal information; and Means for updating (TU) for updating the container terminal information and the records of the database including the details of the container coming in and out of the container terminal, containers stored in the yard with their respective position, vehicles coming In and out of the container terminal, vessel schedules, containers to be loaded (L) or unloaded (UL) from a vessel, and job allocated the Rubber Tyre Gantry (RTG) Cranes.

wherein further, for the present invention as aforesaid, the exiting RTG requires the installation of following to provide preset automatic container position detection system (A):

- Reference Plates(RP),
- Laser sensors (LS),
- Proximity Switches (PS);

wherein, said Reference Plates (RP) are installed on said bus bar (BB) for providing reference to the Laser Sensor (LS)and Proximity Switches (PS) and the said Laser Sensor (LS) and Proximity Switches (PS) are installed on said Drive-In Trolley (DT);

Wherein said existing RTG crane, mainly comprises of:

- the vertical girders (VG),
- two horizontal girders (HG) mounted on said vertical girders,
- spreader (S),
- hoist (H),
- trolley (T),
- Bus Bar (BB),
- Drive-In Trolley (DT),
- Terminal Operating System (TOS),
- Encoders (GE, TE and HE).

2. The automatic container position detection system (A) as claimed in claim 1, which works either from the RTG crane operator cabin (HE) or remotely from a remote operations station working on Wi-Fi technology wherein the crane operator have access of Rubber Tyre Gantry (RTG) through wi-fi network and job information through Vehicle Mounted Terminal (VMT).

3. The automatic container position detection system (A) as claimed in claim 1 and 2, which is operated either on diesel or on electricity using bus bar system or cables for power supply.

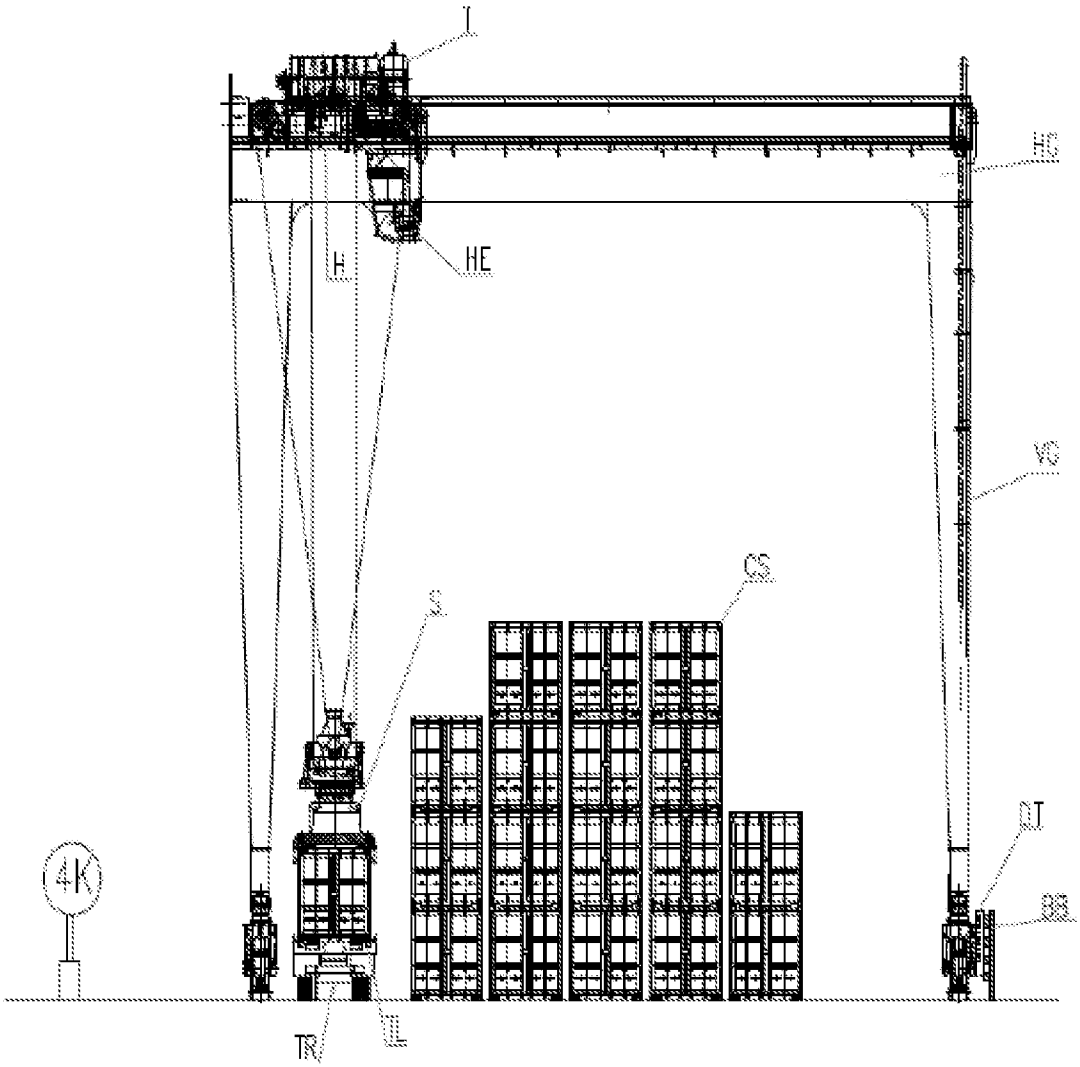


FIG. 1

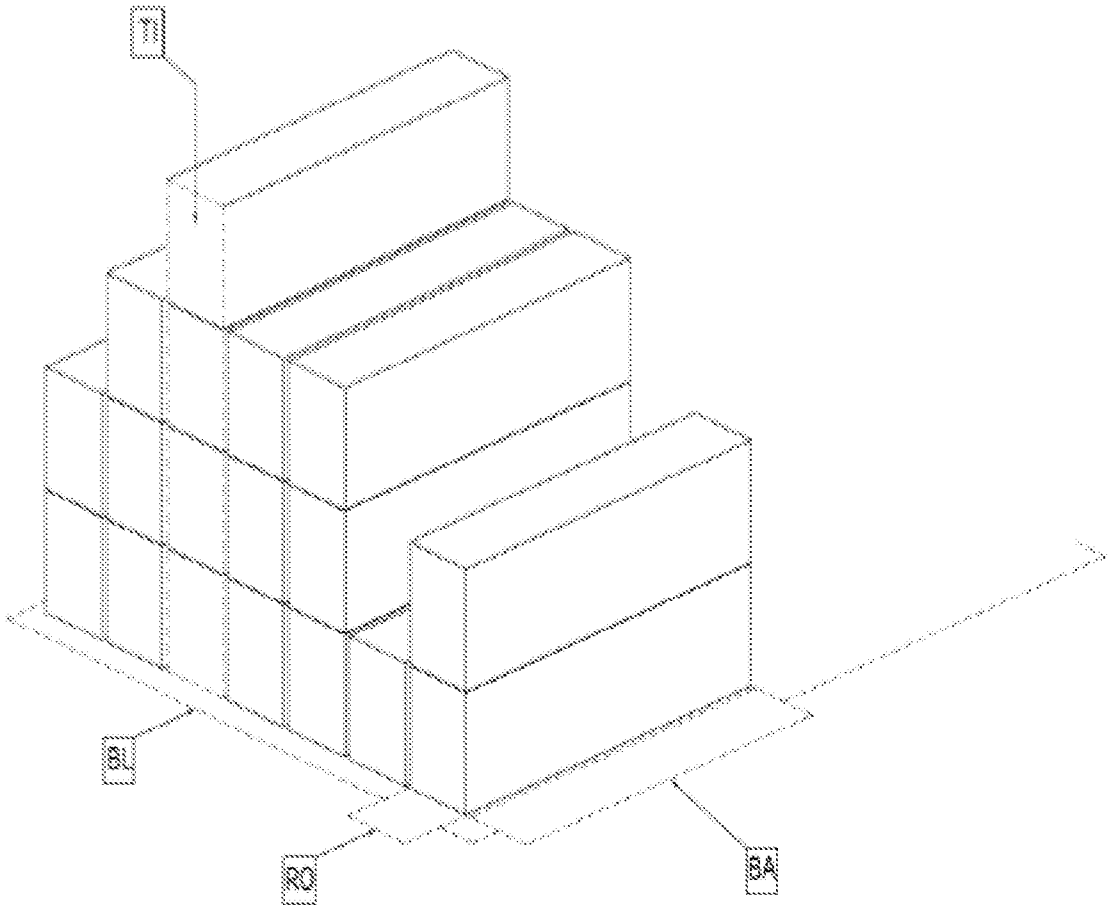


Fig.2

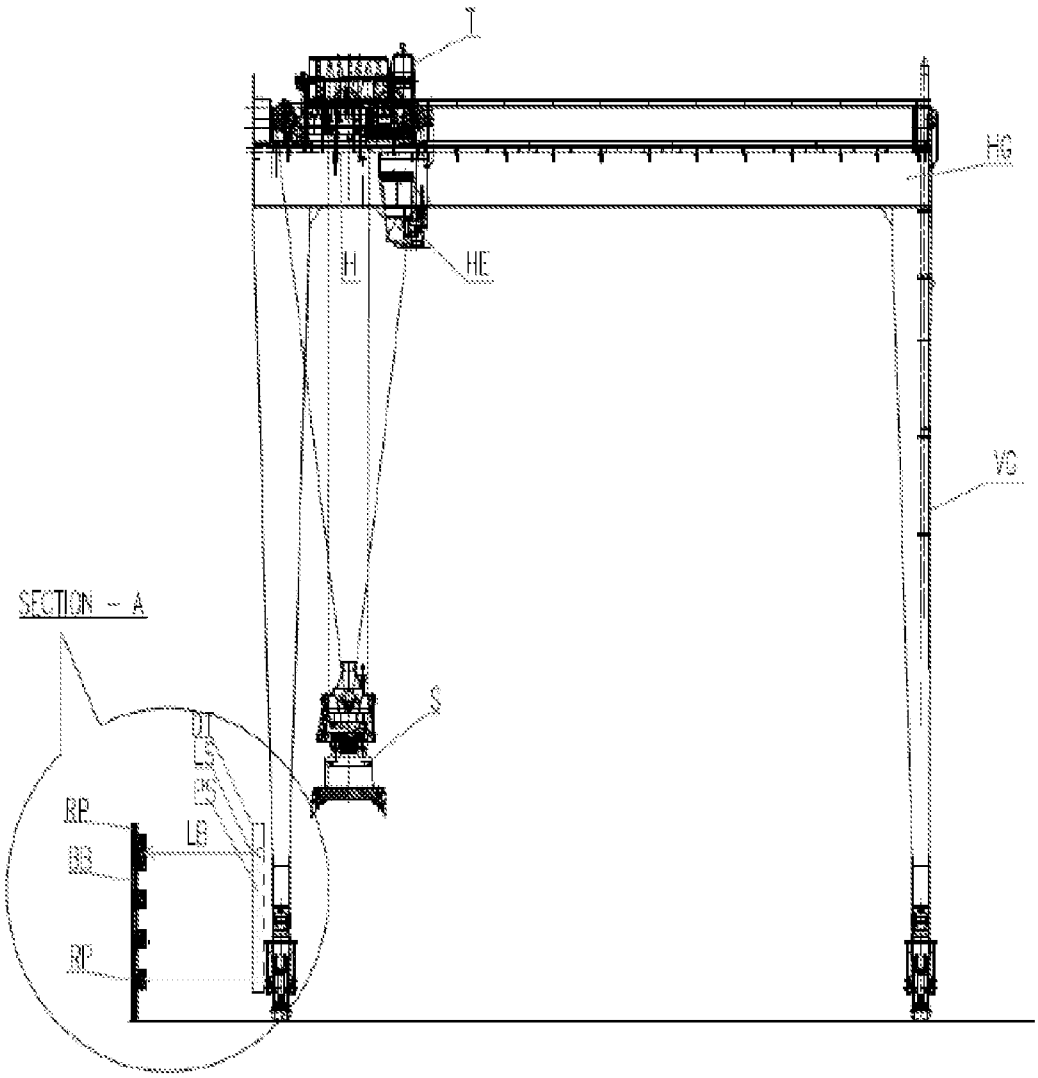


FIG. 3

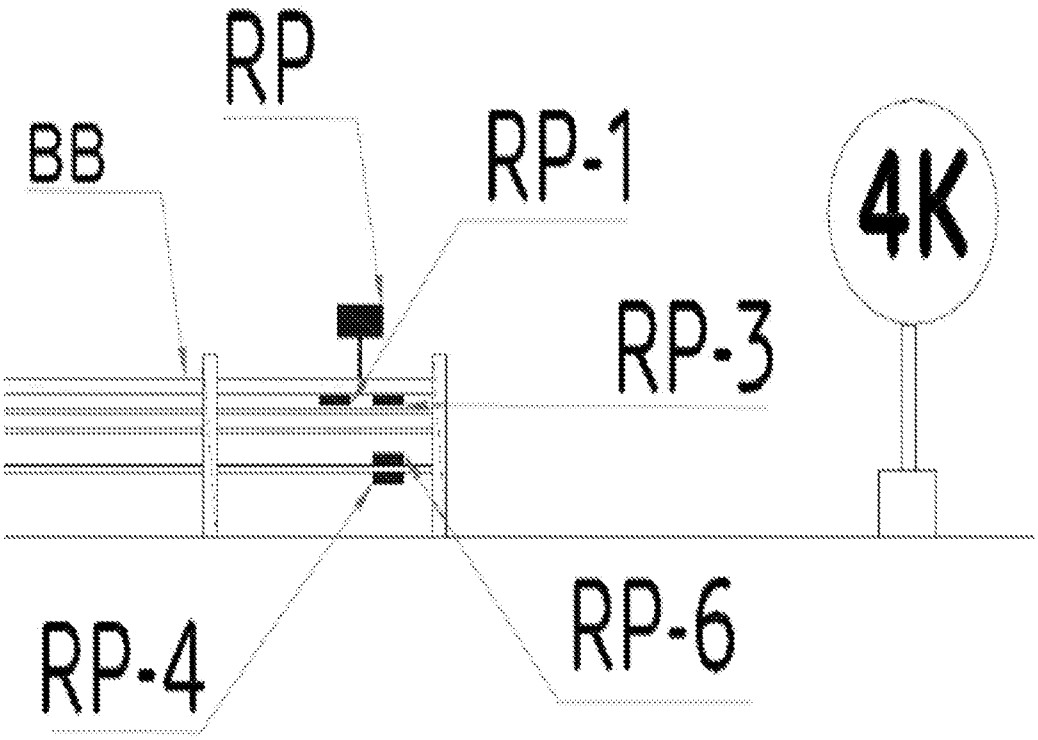


FIG. 4

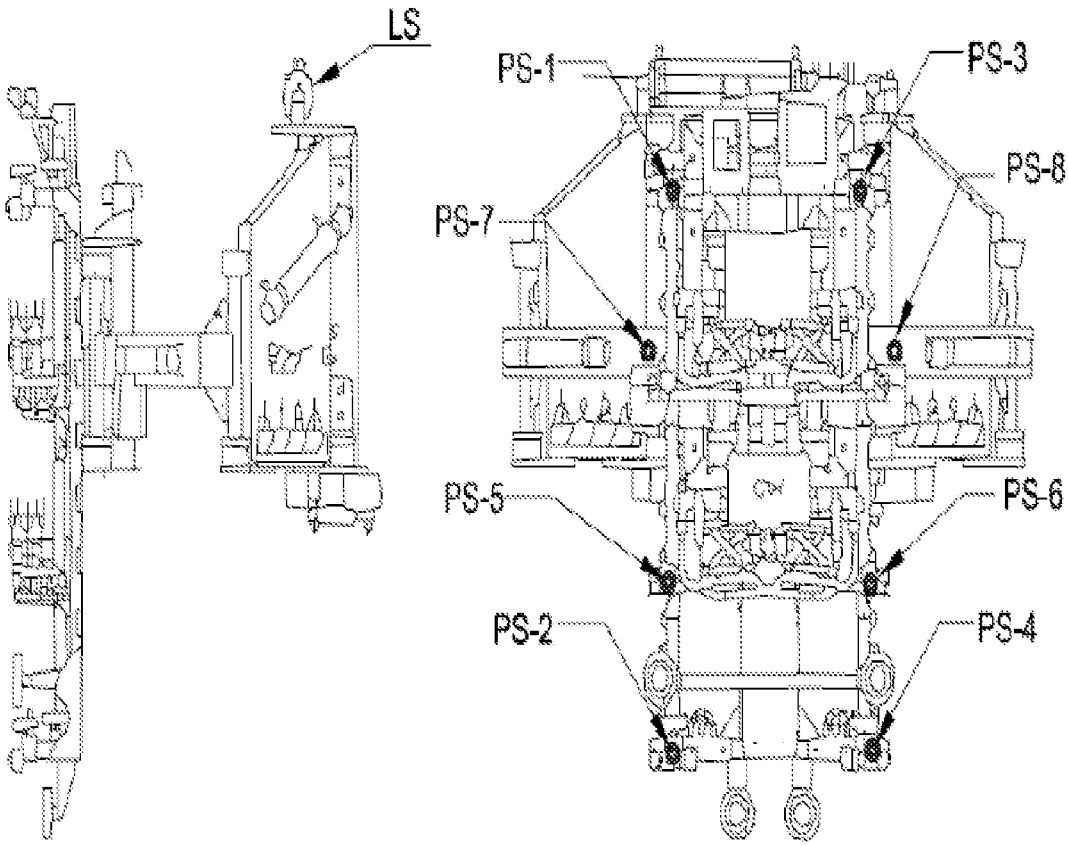


FIG. 5

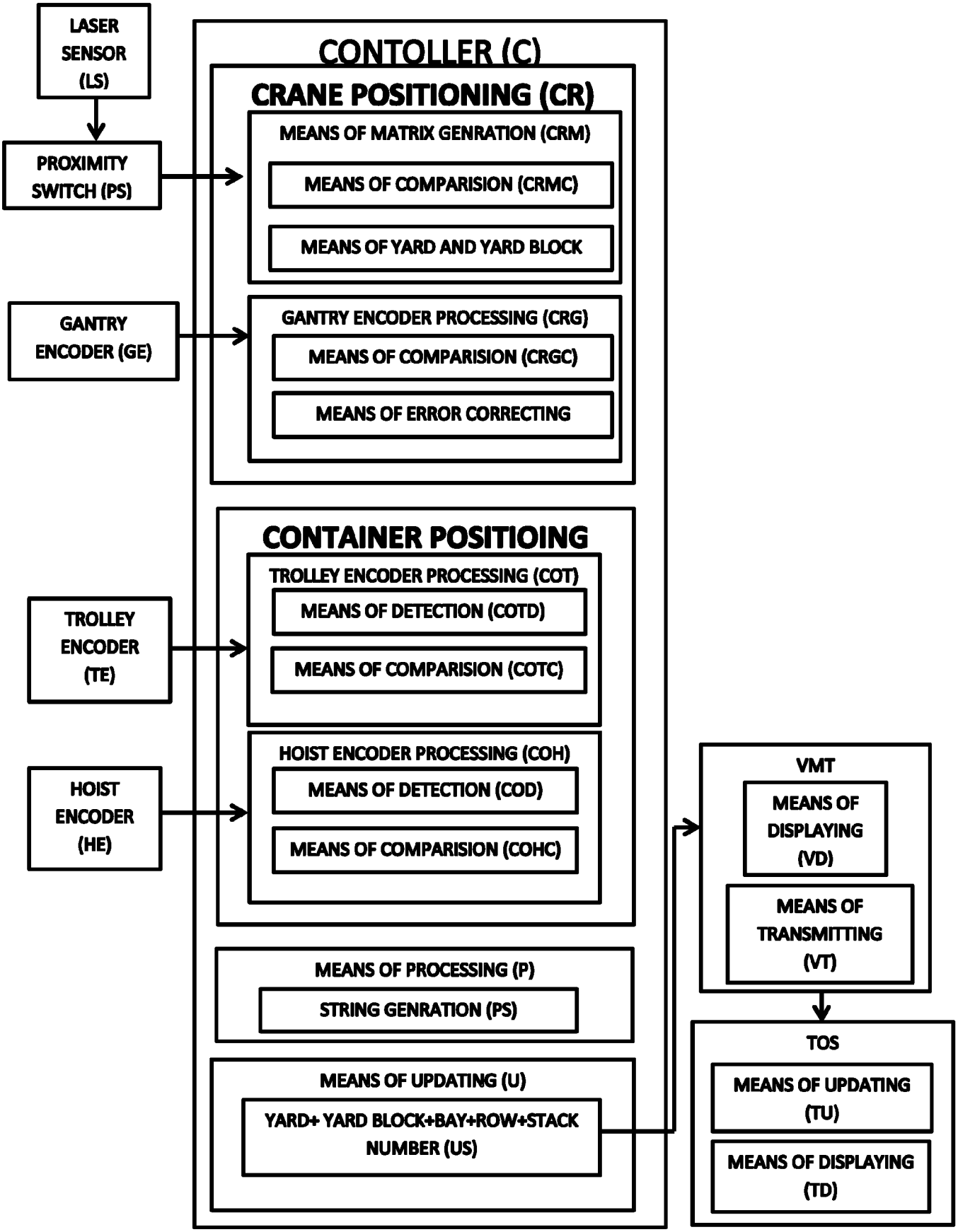

LASER SENSOR (LS)
PROXIMITY SWITCH (PS)
GANTRY ENCODER (GE)
TROLLEY ENCODER (TE)
HOIST ENCODER (HE)
CONTOLLER (C)
CRANE POSITIONING (CR)
MEANS OF MATRIX GENRATION (CRM)
MEANS OF COMPARISION (CRMC)
MEANS OF YARD AND YARD BLOCK
GANTRY ENCODER PROCESSING (CRG)
MEANS OF COMPARISION (CRGC)
MEANS OF ERROR CORRECTING
CONTAINER POSITIOING
TROLLEY ENCODER PROCESSING (COT)
MEANS OF DETECTION (COTD)
MEANS OF COMPARISION (COTC)
HOIST ENCODER PROCESSING (COH)
MEANS OF DETECTION (COD)
MEANS OF COMPARISION (COHC)
MEANS OF PROCESSING (P)
STRING GENRATION (PS)
MEANS OF UPDATING (U)
YARD+ YARD BLOCK+BAY+ROW+STACK NUMBER (US)
VMT
MEANS OF DISPLAYING (VD)
MEANS OF TRANSMITTING (VT)
TOS
MEANS OF UPDATING (TU)
MEANS OF DISPLAYING (TD)

Fig.6

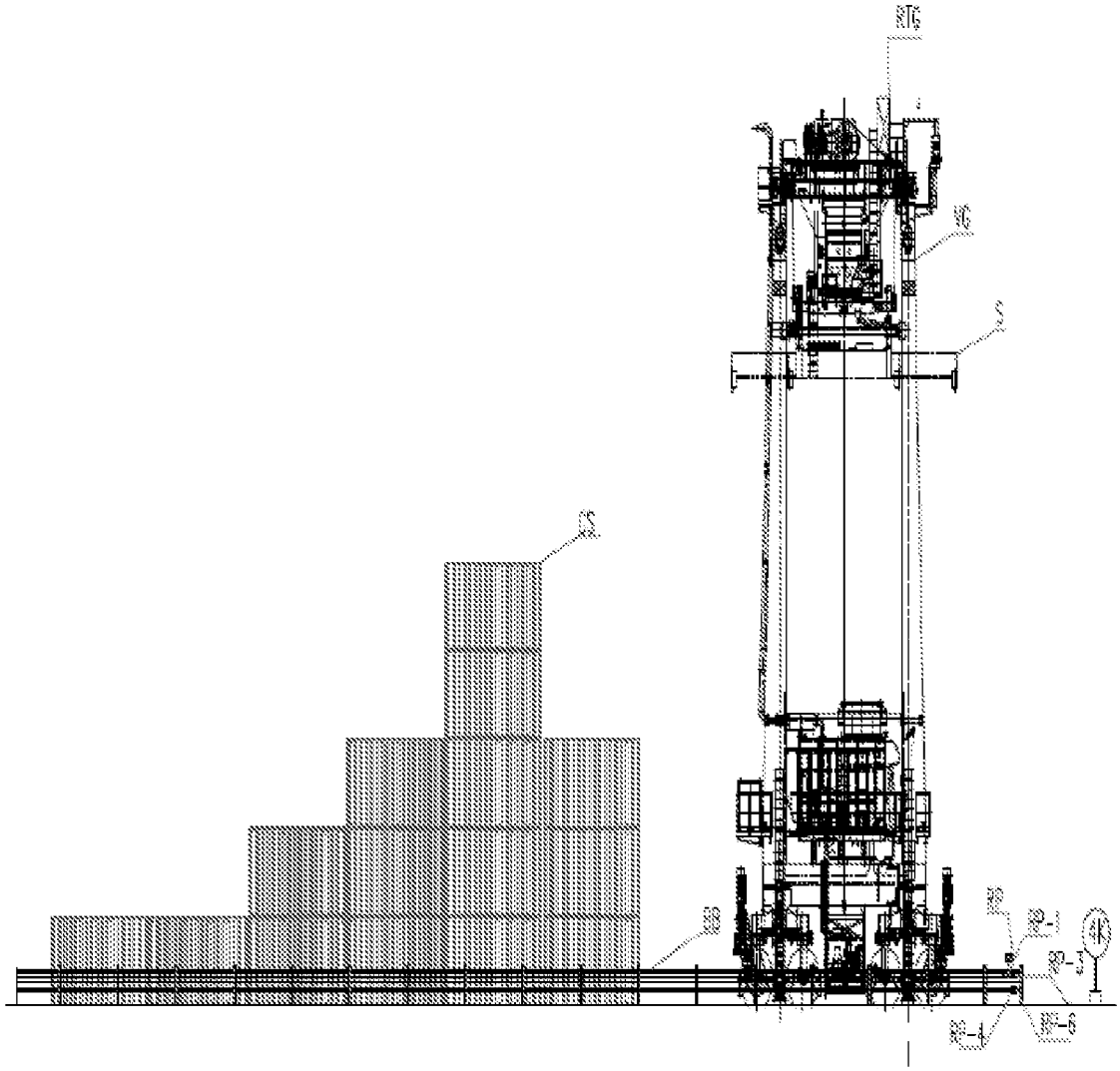


FIG.7

YARD IDENTIFICATION

- Combination of proxy 1 to 4, Proxy 5 and 6 as per following table.

Proxy-6	PROXY-5	Main Yard
0	0	NA
0	1	3
1	0	4
1	1	5

Proxy-4	Proxy-3	Proxy-2	Proxy-1	Yard Block
0	0	0	1	A
0	0	1	0	B
0	0	1	1	C
0	1	0	0	D
0	1	0	1	E
0	1	1	0	F
0	1	1	1	G
1	0	0	0	H
1	1	0	0	J
1	1	0	1	K

Fig.8

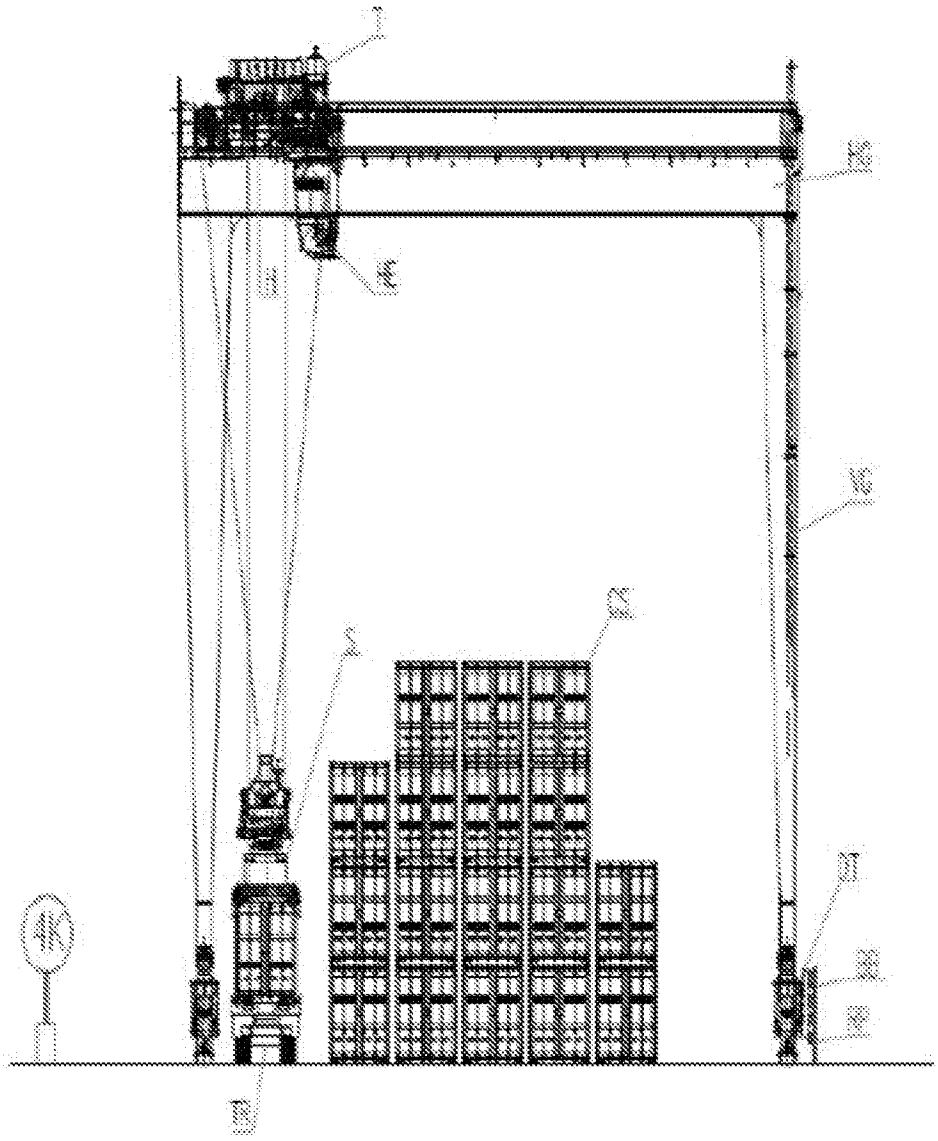


Fig.9

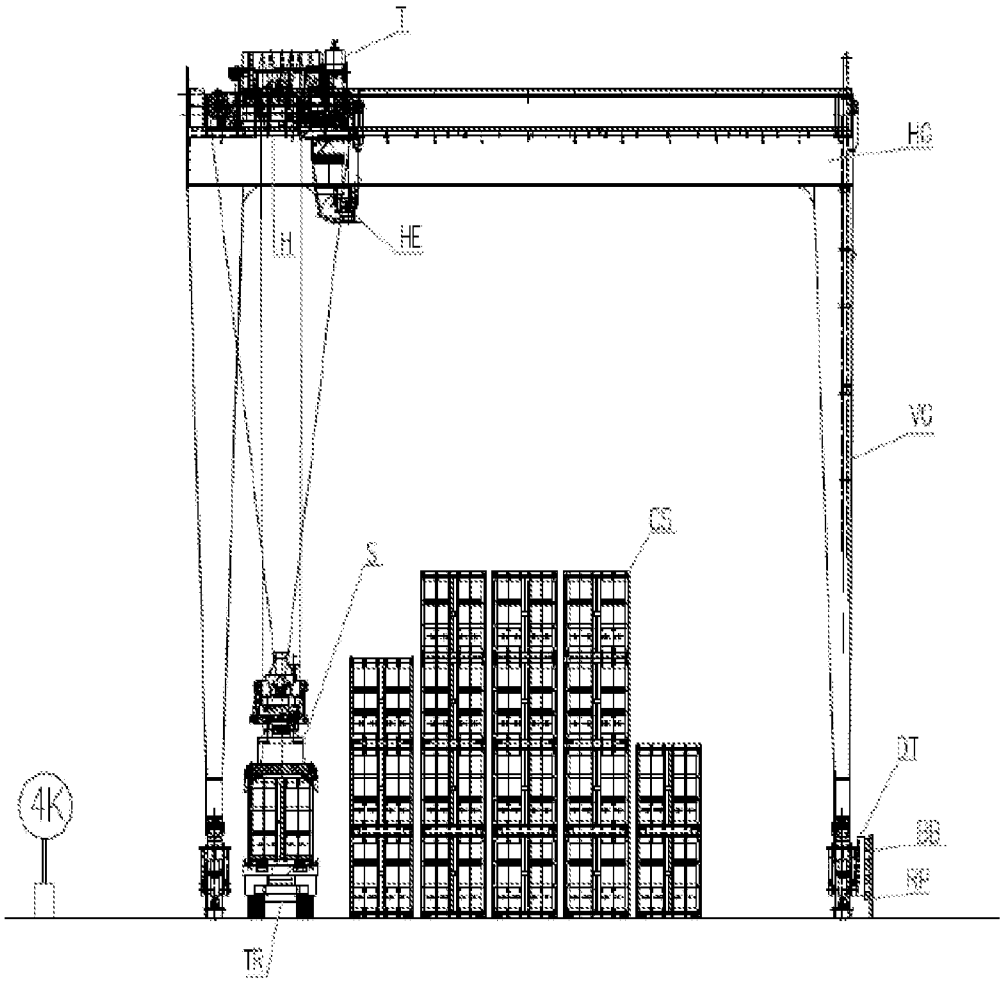


FIG. 10

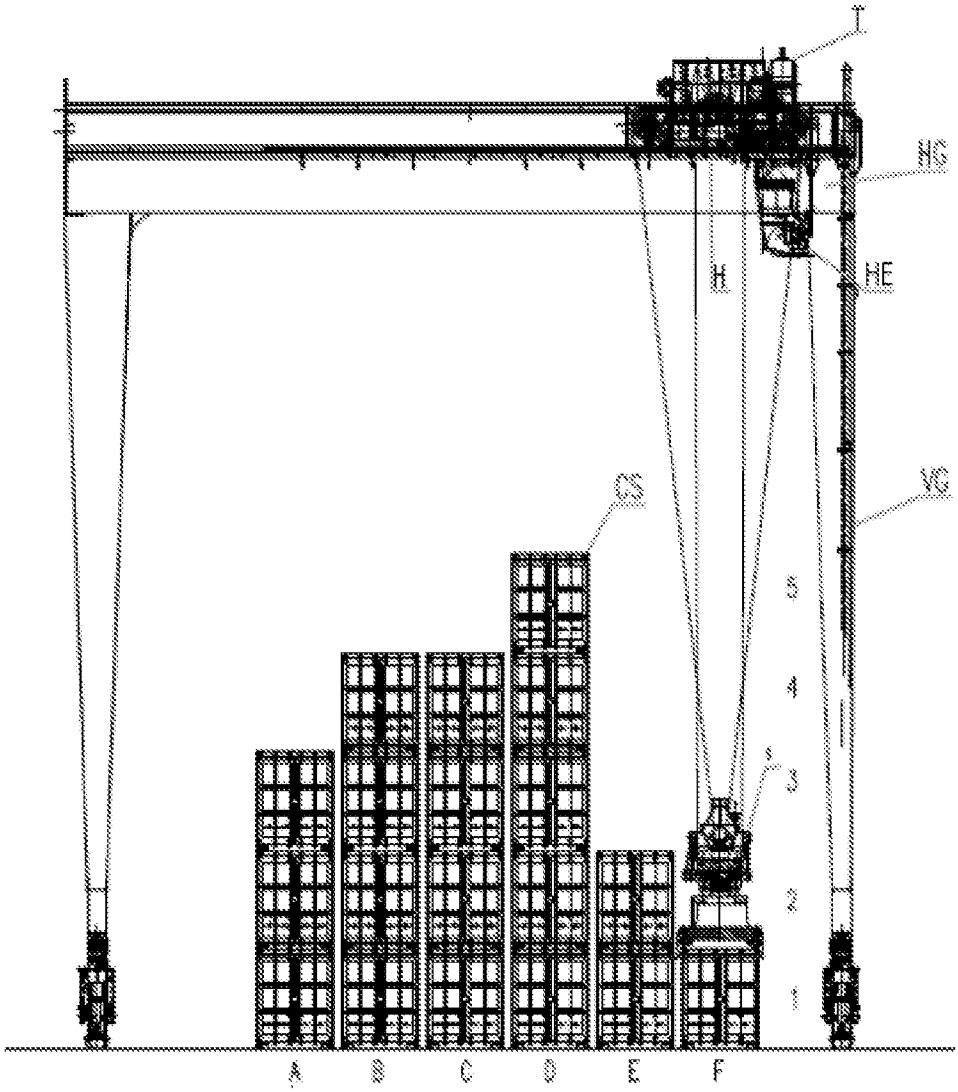


FIG. 11

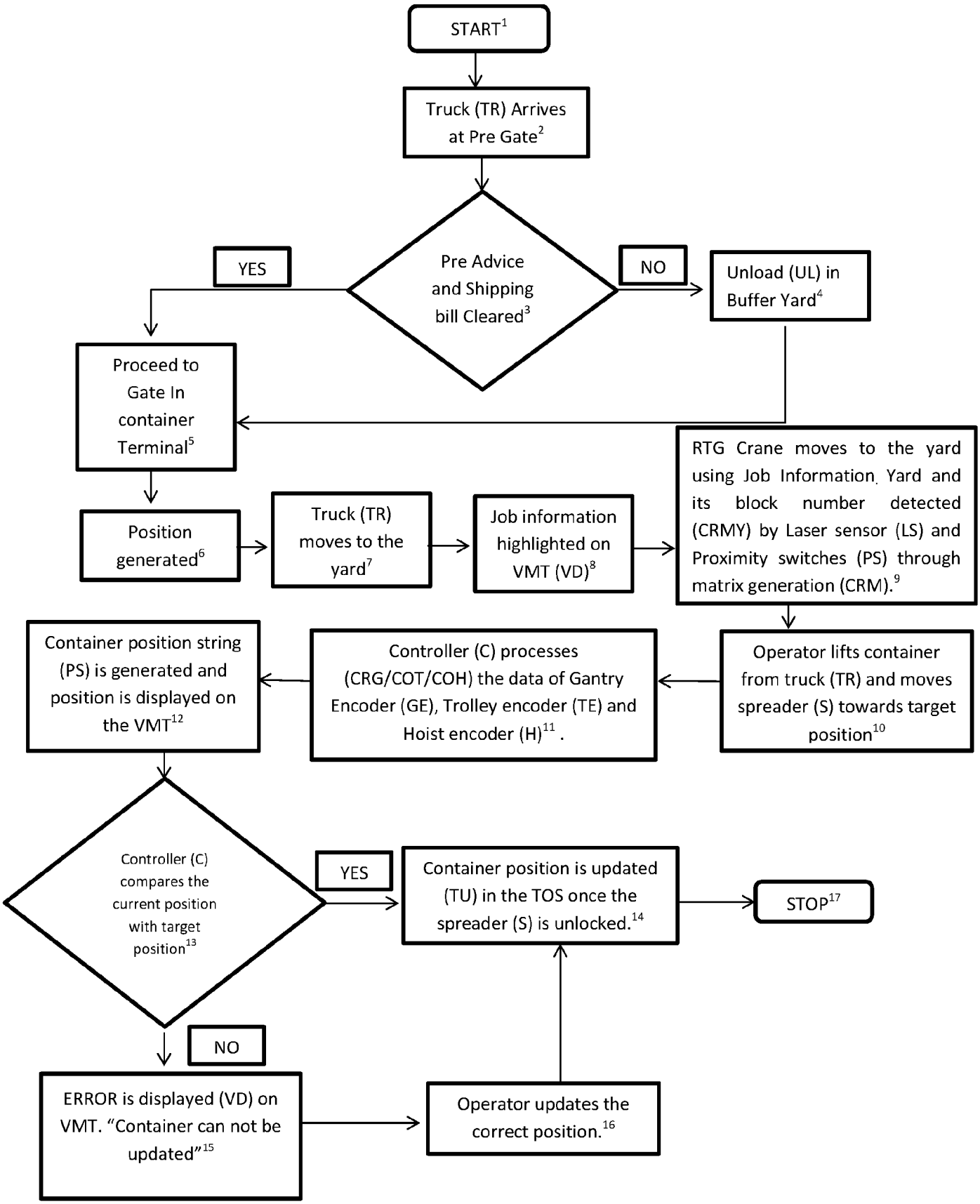

START[1]
Truck (TR) Arrives at Pre Gate[2]
Pre Advice and Shipping bill Cleared[3]
YES
NO
Unload (UL) in Buffer Yard[4]
Proceed to Gate In container Terminal[5]
Position generated[6]
Truck (TR) moves to the yard[7]
Job information highlighted on VMT (VD)[8]
RTG Crane moves to the yard using Job Information. Yard and its block number detected (CRMY) by Laser sensor (LS) and Proximity switches (PS) through matrix generation (CRM).[9]
Operator lifts container from truck (TR) and moves spreader (S) towards target position[10]
Controller (C) processes (CRG/COT/COH) the data of Gantry Encoder (GE), Trolley encoder (TE) and Hoist encoder (H)[11] .
Container position string (PS) is generated and position is displayed on the VMT[12]
Controller (C) compares the current position with target position[13]
YES
Container position is updated (TU) in the TOS once the spreader (S) is unlocked.[14]
STOP[17]
NO
ERROR is displayed (VD) on VMT. "Container can not be updated"[15]
Operator updates the correct position.[16]

Fig 12

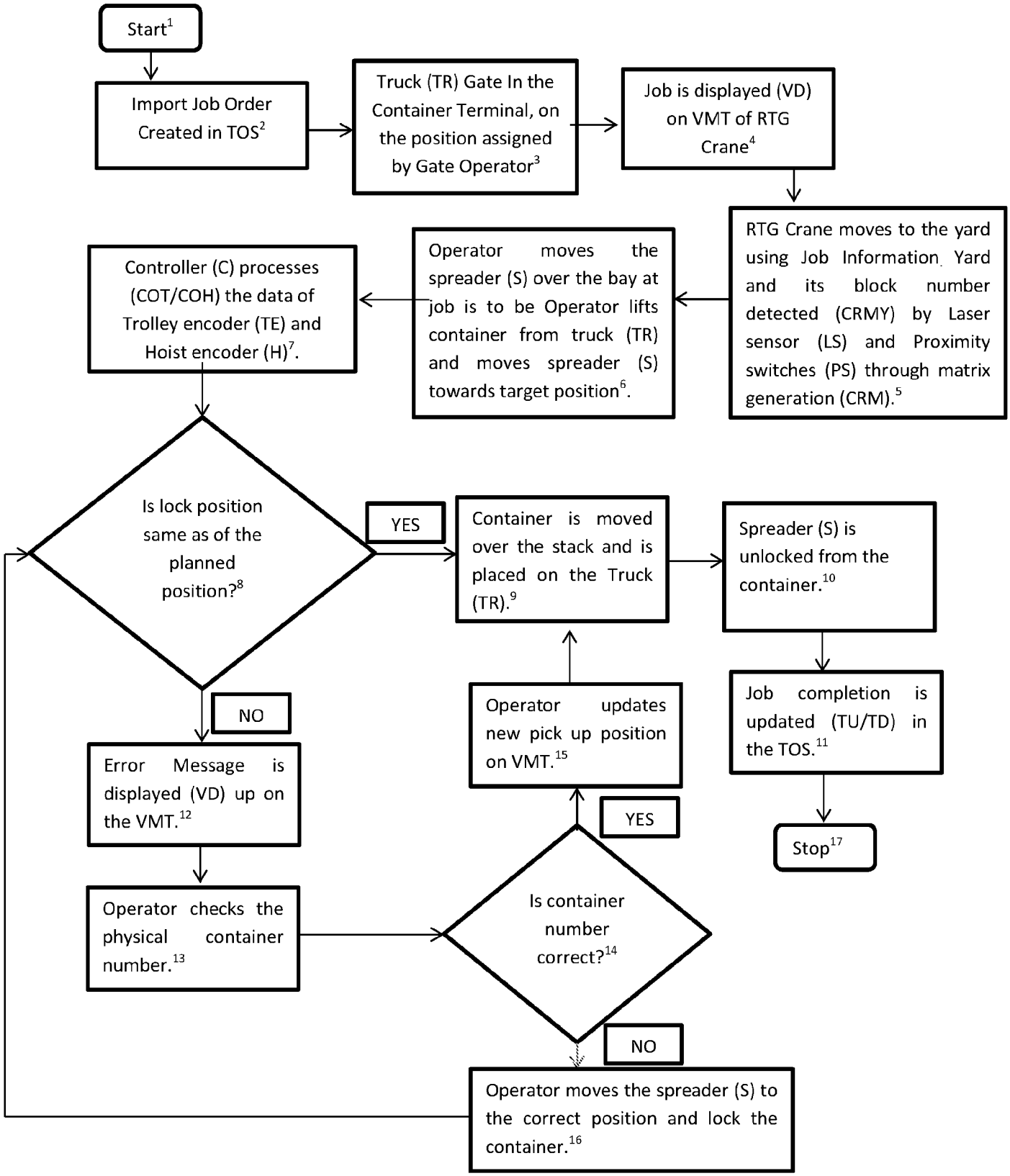

Start[1]
Import Job Order Created in TOS[2]
Truck (TR) Gate In the Container Terminal, on the position assigned by Gate Operator[3]
Job is displayed (VD) on VMT of RTG Crane[4]
RTG Crane moves to the yard using Job Information Yard and its block number detected (CRMY) by Laser sensor (LS) and Proximity switches (PS) through matrix generation (CRM).[5]
Operator moves the spreader (S) over the bay at job is to be Operator lifts container from truck (TR) and moves spreader (S) towards target position[6].
Controller (C) processes (COT/COH) the data of Trolley encoder (TE) and Hoist encoder (H)[7].
Is lock position same as of the planned position?[8]
YES
Container is moved over the stack and is placed on the Truck (TR).[9]
Spreader (S) is unlocked from the container.[10]
Job completion is updated (TU/TD) in the TOS.[11]
Stop[17]
NO
Error Message is displayed (VD) up on the VMT.[12]
Operator checks the physical container number.[13]
Is container number correct?[14]
YES
Operator updates new pick up position on VMT.[15]
NO
Operator moves the spreader (S) to the correct position and lock the container.[16]

Fig. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN2017/050336

A. CLASSIFICATION OF SUBJECT MATTER
B66C13/46,B66F9/075,G06Q50/28 Version=2017.01

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B66C, B66F, G06Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Patseer, IPO Internal Database

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US7344037 B1 (MI-JACK PRODUCTS, INC.) 18 March 2008 (18.03.2008) Column 4; line 1 - Column 6; line 20, Column 9; line 7-26	1-3
A	JP5354509 B1 (HARADA Hideaki) 27 November 2013 (27.11.2013) Para [0013]-[0020]	1-3

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28-11-2017	28-11-2017

Name and mailing address of the ISA/	Authorized officer
Indian Patent Office Plot No.32, Sector 14,Dwarka,New Delhi-110075 Facsimile No.	Seetha Raman A Telephone No. +91-1125300200

International application No.
PCT/IN2017/050336

Citation	Pub.Date	Family	Pub.Date
US 7344037 B1	18-03-2008	US 7032763 B1	25-04-2006