



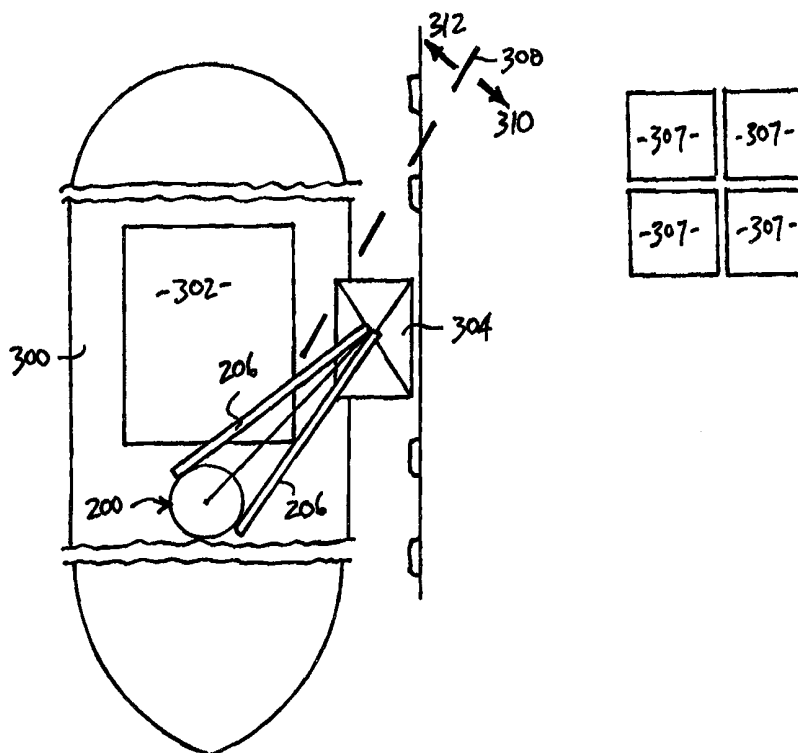
## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | (43) International Publication Date: 4 February 1999 (04.02.99) |
| (21) International Application Number: PCT/NZ98/00113<br>(22) International Filing Date: 23 July 1998 (23.07.98)<br>(30) Priority Data:<br>328406                      23 July 1997 (23.07.97)                      NZ<br>328673                      3 September 1997 (03.09.97)                      NZ<br>329287                      28 November 1997 (28.11.97)                      NZ<br>(71) Applicant (for all designated States except US): INTER-<br>NATIONAL STEVEDORING OPERATIONS LIMITED<br>[NZ/NZ]; Cnr Hull Road and Tasman Quay, P.O. Box 4169,<br>Mt. Maunganui (NZ).<br>(72) Inventor; and<br>(75) Inventor/Applicant (for US only): DICKSON, Gregory, John<br>[NZ/NZ]; Cnr Hull Road and Tasman Quay, P.O. Box 4169,<br>Mt. Maunganui (NZ).<br>(74) Agents: JONES, David, Westlake et al.; Knowles & Associates,<br>156 Vincent Street, P.O. Box 5073, Auckland (NZ). |  | (81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR,<br>BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE,<br>GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ,<br>LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW,<br>MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL,<br>TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO<br>patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian<br>patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European<br>patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR,<br>IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF,<br>CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).<br>Published<br>With international search report. |                                                                 |

(54) Title: CARGO TRANSFER SAFETY SYSTEM

## (57) Abstract

The invention relates to a cargo transfer system (200) that provides improved safety for users. When a cargo item (304) is being transferred from a transport vessel (300) to loading area (306), the system (200) provides a warning of the impending delivery of the cargo item (304) to persons in the loading area (306). Similarly, when cargo item (304) is being transferred onto vessel (300), a warning is provided to persons in the relevant area (306) of the vessel (300). The system uses sensors (226, 228, /10, 12, 40) provided adjacent to the side of a ship (300) to indicate the presence of the cargo item (304) to a programmable logic controller (PLC) which activates a strobe (53) and siren (57) to provide a warning to people in the hold or on shore (306). The system also makes provision for the position of the boom (206) of a crane (200) that loads or unloads cargo items (304) to be monitored by the PLC to provide an indication of cargo item (304) approaching the hold of the ship (300) or approaching the shore (306).



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## CARGO TRANSFER SAFETY SYSTEM

## FIELD OF THE INVENTION

This invention relates to safety apparatus and/or methods for the transfer of parcels of goods such as items of cargo. An application of the invention is to the transfer of cargo items from a wharf to the hold of a ship. However, the invention is not limited to this particular application.

## BACKGROUND TO THE INVENTION

Transportation of large items of cargo involves transferring each cargo item on to and off various conveyances, such as ships, trucks or trains. Often many transfers of each individual cargo item are required, so it is important that the transfer process is efficient. In the case of large cargo items, for example a pallet or shipping container of goods, there are inherent risks and dangers in transferring such items to and from various conveyances. The dangers exist because the cargo items are usually heavy or cumbersome and need to be lifted using heavy machinery, for example cranes and fork lifts, so there is a danger that failure of the lifting machinery or inadvertent operation of the machinery may cause an accident causing physical injury to persons in the vicinity of the area (for example the hold of the ship, to which the cargo is to be delivered).

To increase the efficiency of cargo transfer processes, it is desirable to be able to determine the down time during which the apparatus that is used to move the cargo, for example cranes or fork lifts, is inoperational, and the number of times during which cargo cannot be on-loaded or off-loaded for various reasons, for example insufficient physical assistance during the loading or unloading operations.

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## BRIEF SUMMARY OF THE INVENTION

It is an object of the present invention to provide cargo transfer safety apparatus and/or methods which will at least go some way toward overcoming the foregoing disadvantages, or which will at least provide the public with a useful choice.

30

Accordingly, in one aspect the invention may broadly be said to consist in cargo transfer safety apparatus, comprising sensing means to sense the impending delivery of a cargo item to a selected location, and warning means responsive to the sensing means to provide a warning of the impending delivery of the cargo item to the selected location.

In a further aspect the invention may broadly be said to consist in a method of warning of the impending delivery of a cargo item to a selected location, the method comprising the steps of:

- 5   sensing the impending delivery of the cargo item, and  
providing a warning before the item is delivered to the selected location.

In a further aspect the invention may broadly be said to consist in crane safety apparatus comprising sensing means to monitor the position of a part of the crane, and  
10   warning means to provide a warning if the position of the part exceeds a predetermined boundary.

In a further aspect the invention may broadly be said to consist in a cargo loading or unloading system comprising sensing means to sense the transition of cargo items or  
15   cargo transfer apparatus from a first location to a second location and recording means to record the transition.

To those skilled in the art to which the invention relates, many changes in construction and widely differing embodiments and applications of the invention will suggest themselves  
20   without departing from the scope of the invention as defined in the appended claims. The disclosures and the descriptions herein are purely illustrative and are not intended to be in any sense limiting.

The invention consists in the foregoing and also envisages constructions of which the  
25   following gives examples only.

#### BRIEF DESCRIPTION OF THE DRAWINGS

One preferred form of the invention and modifications thereof will now be described with reference to the accompanying drawings in which:

30   The invention consists of the foregoing and also envisages constructions of which the following gives examples.

One preferred form of the present invention will now be described with reference to the accompanying drawings in which;

- figure 1 is diagrammatic perspective view of a cage used in accordance with a first embodiment of the present invention,
- figure 2 is a diagrammatic plan view of the cage of figure 1 being used to load or unload cargo items to or from a ship,
- figure 3 is a schematic diagram of apparatus according to the first embodiment of the present invention
- figure 4 is a flow chart showing operation of the first embodiment,
- figure 5 is a diagrammatic front elevation of a crane used in accordance with a second embodiment of the present invention,
- figure 6 is a diagrammatic plan view in partial cross section through line A-A of figure 5
- figure 7 is a diagrammatic plan view of the crane of figure 5 being used to load or unload cargo items to or from a ship,
- figure 7A is a diagrammatic plan view showing an example of different crane work zones for the crane of figures 5 to 7, and
- figure 8 is a flow chart showing operation of the second embodiment.

## DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

Two embodiments of the invention will be described. Both are described with reference to the loading or unloading of cargo to, or from, a ship. It will be seen, however, that the invention is applicable to loading or unloading cargo in other situations, such as loading cargo to or from trucks, trains and the like.

A first embodiment of the invention will be described with reference to figures 1 to 4. Referring to figure 1, a cage for moving cargo items such as goods in palletised form is shown generally referenced 2. The cage has a floor 4 at the corners of which members such as steel beams 6 project to engage steel cross members 8 at the top of the cage. Mounted internally on opposing diagonal corners of the cage are sensors such as transmitter/receiver pairs 10 and 12. Transmitter/receivers 10 operate along one diagonal and transmitter/receivers 12 operate along another. Preferably one of the sensors in each pair transmits a signal and the other sensor either receives the signal,

or reflects it back to the transmitter. The beam of light or other electromagnetic radiation which is transmitted or reflected by the transmitter/receiver pairs 10 and 12 is illustrated by dashed line 14 for the transmitter/receiver pair 10; and by dotted line 16 for the transmitter/receiver pair 12.

5

The arrangement of transmitter/receivers in figure 1 ensures that any goods placed on the floor of the cage 4, which are of a sufficient height, will interrupt beams 14 or 16. This allows the apparatus, which will be described further below, to determine whether or not the cage has cargo loaded in it, i.e. whether it is full.

10

It will be seen that other sensing mechanisms could be used within the cage, for example a sensor pad mounted on the floor 4 or a whisker switch which is activated by brushing against the cargo item or items as they are loaded into the cage. The arrangement shown and described in figure 1 has the advantages of providing detection while still being sufficiently robust. The mounting of sensors within the internal corners makes it difficult for cargo items to contact and therefore damage the sensors in use and the floor 4 is left free to take the load of the palletised goods and any scraping or lateral movement which may occur while the goods are being placed on the floor 4 by fork lift tines or the like. The sensors preferably provide a signal to a radio transmitter mounted on the cage, the radio transmitter transmits the signal to a receiver from which it is supplied to control apparatus as described further below. A suitable radio transmitter is one marketed under the trade mark SCANTRONIC. Both the sensors, and the radio transmitter 10 and 12 are powered by one or more batteries mounted on the cage.

25

Turning to figure 2, the cage 2 referred to and described in figure 1 is shown suspended by cables 20 and 22 above a hold 24 and deck 26 of a ship generally referenced 28. The cage 2 includes goods to be loaded onto the ship, the cage and the goods together representing a cargo item.

30

Cables 20 and 22 are mounted from booms 30 and 32 respectively as each cable is slung over a pulley arrangement at the end of each boom 30 and 32. Winching in one of the cables while allowing the other to feed out allows the cage 2 to be moved laterally to or from the shore or wharf area 32. Winching in both cables allows the cage 2 to be

lifted, and releasing both cables allows the cage 2 to be lowered, thus the cage may be moved over the side 34 of the ship 28 and over the hold 24 so it may be lowered into the hold where apparatus such as a fork lift may unload goods from the cage for storage in the hold 24.

5

When the cage 2 is disposed on the shore 32, a fork lift 36 for example, or other goods transportation apparatus, is used to transfer goods such as palletised goods 38 into the cage 2 so that they may be delivered into the hold 24.

- 10 In accordance with the present invention, a sensor such as a light transmitter/receiver 40 is located adjacent to the side 34 of the ship. The apparatus may have a responder or receiving unit located separately at area 42 for example so that a beam of radiation such as light between units 40 and 42 is interrupted by passage of the cage 2 as it crosses the deck of the ship adjacent to side 34. Alternatively, the transmitter 40 may
- 15 also include a receiver which receives light from the transmitter which is reflected when the beam 44 is incident upon the cage. In order to assist reflection, the cage 2 may be coated with a reflective material to ensure adequate detection.

- Referring to figure 3, a diagrammatic representation of apparatus used in accordance
- 20 with the first embodiment of the present invention is shown. The detector 40 and cage sensors 10 and 12 have the same references as those used to describe these features in figures 1 and 2. The signal derived from the output of the detectors is provided to inputs of a known programmable logic controller (PLC) 50, such as an OMRON CPMIA-20 with a total of 20 I/O and an OMRON NT20S which runs software that monitors the
- 25 status of the detector outputs to determine whether the cage is full or empty, and to determine when the cage passes over, or is adjacent to, side 34 of the ship. Outputs of the PLC 50 are connected to at least one hold pendant 52 provided in the hold of the ship, at least one shore pendant 54 provided on the shore where the cargo is being loaded and a crane pendant 56. The PLC also has an output to a crane operator
- 30 display console.

Both the shore pendant and the hold pendant have a siren 51, a strobe 53, an alarm push button 55 and a "zone clear" push button 59.

The crane pendant 56 has a "ready" light 61, and alarm light 63, and/or a siren 65. It also preferably includes a footswitch or the like 67.

5 A user interface 57 is also provided in the form of a visual display and keypad (not shown). The interface 57 may comprise a portable unit which is only used to reprogram the PLC 50, or retrieve data from the PLC. Alternatively the interface 57 may be provided in a fixed location, such as part of the crane operator's console so that it may be used to enter certain data required for operation of the system and display system messages. The console 57 as shown in figure 3 has a start button 77 for starting the  
10 system, an alarm push button 79, a "system ready" light 69, a "cage full" light 71, a "zone clear" light 73, and an alarm light 75.

The purpose of the pendants 52, 54 and 56 and the times at which they are actuated will be described in further detail with reference to the flow diagram in figure 4. The  
15 pendants 52, 54, and 56 also have the capability of transmitting selected signals to the PLC 50 as will be described further below. The method of transmission or reception of signals to and from the apparatus 10, 12, 40, 52, 54 and 56 can be effected in a number of different ways, for example by cable connections, or by radio frequency transmission.

20 Turning to figure 4, a flow chart of the operation of the apparatus described in the preceding figures is shown. The operation typically begins with an operator, such as the crane operator, activating the apparatus by operating the start switch 77 or operating a certain key on the interface 57. As soon as the system has been activated by being switched on by the operator at step 60, the system requests (via the screen  
25 output) the operator to login at step 62.

The login procedure is an optional system requirement but is useful for collecting data as to use and operation of the system. If subsequent analysis of a loading or unloading operation reveals a desirable or undesirable characteristic then the login data allows  
30 identification of the operator. Discussion with the operator can be important in improving the loading or unloading operation and in improving the system hardware and software and monitoring the reliability of the system. By providing each operator such as each crane operator with a specific number for login purposes, the operator can be

identified at a later date in case such information is required in the event of a problem —  
with the equipment or the loading operation.

5 The system then registers the time and date at which the operator logged in, being the  
time at which the loading or unloading operation essentially begins instep 64. The  
operator is then prompted to select whether the operation is to be a loading operation  
( i.e. loading goods from shore in to the ship), or an unloading operation (i.e. moving  
goods from the hold of the ship onto the shore). This occurs in step 66. Again, this  
step is optional as the apparatus may be provided purely as a loading or as an  
10 unloading application. Once the required data has been entered, thePLC sends a  
system operational indication such as turning on indicator lamp 69 at step 68 to the  
console 57 to indicate that the system is ready for operation. Thus, for the operation to  
begin, goods are loaded into the cage 2 and the cage is lifted to approach the ship (step  
70). In step 72 the apparatus checks that the cage is full by monitoring the cage  
15 detectors 10 and 12. When the cage has been loaded, a "cage full" indication is  
provided on the console 57 for observation by the crane operator. Before commencing  
to transport the cage, the crane operator may optionally await illumination of the "zone  
clear" indicator light 73, which is illuminated in response to the activation of the "clear"  
button 59 on the hold or shore pendant. In step 74 the system checks to see whether  
20 the automatic alarm system has been manually overridden. If this has not occurred,  
then when the cage is detected by the deck sensor 40 at step 76, the hold alarm 52 is  
immediately sounded by the PLC. As soon as the alarm in the hold is sounded, the  
PLC registers the time and date and saves this information with an applicable pointer to  
indicate, in this instance, that it relates to a time at which the hold alarm was activated.  
25 The PLC is programmed to register date and time information at a number of different  
steps in the loading or unloading process and the informationis saved for subsequent  
retrieval and analysis. The time and date of each alarm actuation is preferably saved.  
In this way each loading or unloading operation can beanalysed if required. The hold  
alarm 52 need not be sounded immediately; a desired time interval may be allowed  
30 before the alarm is sounded if required.

The hold and shore alarms may be manually overridden if desired as indicated in step 80.

If any of alarm switches 55, 67 or 79 are activated any time, then the system ensures —  
that the crane pendant alarm and siren 63 and 65 are actuated so that the crane  
operator stops the crane and the time at which this occurs is registered. The alarm  
condition is removed by the hold or shore operators pressing the “zone clear” button 59  
5 or the crane operator deactivating the foot switch 67. Each time the manual alarm is  
enabled, the PLC monitors the time for which the alarm condition exists and saves this  
to a table for subsequent retrieval and analysis.

Once the goods have been unloaded from the cage, the person in the hold optionally  
10 presses the zone clear button 59 and the cage is lifted from the hold and directed back  
toward the shore by the crane operator so that it may be loaded again with further  
goods. The step of the cage approaching the shore is shown as step 82 in the flow  
chart. At step 84, the cage sensors 10 and 12 are monitored by the PLC 50 to ensure  
that they indicate there are no goods within the cage i.e. to ensure that the cage has  
15 been emptied. Again, the system checks to see whether the automatic alarm system  
has been manually overridden at step 86. If the system has been overridden, then the  
system returns to step 80 to disable the alarm and register the time at which the alarm  
was disabled. Should, however, the manual alarm override not be active, then the PLC  
monitors the detector 40 to determine when this is activated by the cage passing this  
20 detector. This occurs at step 88. As soon as the empty cage has been detected, the  
PLC instructs the shore alarm 54 to activate an alarm so as to provide a warning that  
the cage is approaching to be reloaded. If the cage has not been emptied in the hold,  
so that it is returning to shore still loaded, then an audibly or visually different alarm is  
activated. Again, a time delay may be provided between the time of detection of the  
25 cage and the time at which the shore alarm is activated if desired.

Throughout the process the system continually monitors whether a manual alarm input  
representative of an emergency situation has occurred. This monitoring is represented  
as step 92 in the flow chart. Should the manual alarm input be detected by the PLC,  
30 then both the shore and the hold alarms will be activated and the alarms on the  
operators pendant 56 will also be activated. An emergency input may be made by the  
crane operator, or by a person in the hold or on the shore as described above, or by  
using a further remote switch which they may carry. All, or only a selected number, of

the alarm units may be provided for wireless operation so that some may be carried by individuals working in the hold and on shore.

- 5 The operation described above with reference to the flow chart describes and depicts a ship loading operation. An unloading operation may be performed using the above steps, but altering the alarm sequences so that the shore alarm is sounded when the cage is approaching the shore with the cage being full, and the hold alarm being sounded when the cage is approaching the hold in the empty state.
- 10 Once the loading shift has been completed, the operator logs out of the system in step 94, and the PLC records the time at which the logout occurs. The system operational indicator lamp is then switched off. Should there be a system breakdown or malfunction, or machinery failure during the shift, the operator has the option of entering any such delay using the keypad provided. This possibility is monitored in step 96 and
- 15 the time at which the wait or break down switch is closed is recorded in step 98 as is the time at which the switch is opened again once the problem that caused the delay has ceased to exist.

- Turning to figure 5, this figure and the remaining figures are used to describe a second embodiment of the invention which is more suitable for use with a rotating pedestal type crane which is a form of crane that is frequently provided on ships to load heavy cargo items. The shore, hold and crane pendants, and the display console are preferably the same as those shown and described with reference to figure 3 of the first embodiment.

- 25 Figure 5 shows, in diagrammatic form, an elevational view of the pedestal type crane used in accordance with the second embodiment of the second invention. The crane in figure 5 is generally referenced 200 and has a base portion pedestal 202 which is attached to the superstructure of the ship. A rotatable part 204 is dependent from the pedestal 202 but rotatable relative thereto. Part 204 has a movable boom 206 which
- 30 carries a cable 208 for carrying items of cargo such as item 210. Usually, the rotatable section 204 has an operator compartment that includes a window or similar opening 212 from which the crane operator can view the movement and position of the crane. The rotatable portion 204 usually also has a flange such as flange 214 where it is bolted to a rotatable member provided coaxially inside stationary pedestal 202.

The boom 206 is usually pivotally, or otherwise rotatably mounted relative to part 204 at end 216. Thus the resultant crane movement is one whereby the rotatable part 204 can be rotated to rotate the boom 206 through a desired lateral arc, for example an arc that extends from the hold of the ship adjacent to which the crane 200 is located to a shore zone where the goods that are transported by the crane are either picked up or dispatched. The height of the boom 206 can also be adjusted by pivoting the boom about end 216 to describe a vertical arc.

Turning to figure 6, an internal view in partial cross section of the rotatable portion 204 of the crane of figure 5 is shown adjacent to flange 214. The rotatable portion 204 has an internal ring gear 218 the teeth of which engage with corresponding teeth on gear wheel 220 which is mounted on a shaft 222 the central axis of which remains stationary with respect to the pedestal 202 and is rotated by machinery on the ship so that the gears 220 and 218 may be made to move relative to each other to rotate the rotatable portion 204 with respect to the stationary pedestal 202. The adjacent flange 214 is shown together with the securing bolts 224 provided thereon.

Proximity sensors may be used in conjunction with the apparatus shown in figure 6 to provide appropriate indications of the angular position of the crane boom 206 relative to the remainder of the ship. As shown figure 6, a known rotary encoder represented by dotted outline 226 may be placed upon or in connection with a shaft 222 so that a digital representation of the position of shaft 222 may be obtained at any particular point in time during operation of the crane. Alternatively, or in conjunction with rotary encoder 226, a further proximity sensing device 228 may be provided, positioned so as to "count" the number of teeth on the internal ring gear 218. Such "counting" may be effected by the sensor 228 monitoring the time taken for pulses of electromagnetic radiation, for example, such as light represented by dashed line 230 to be reflected from the ring gear. In this way, the difference between the tooth peaks and the valleys between the teeth may be discerned, and valleys or peaks may be counted to provide an indication of angular position from any selected starting point.

A further feature which may be used to measure angular position by use of a proximity sensing device such as device 228 are the bolt heads 224 provided around the

periphery of flange 214. Thus a device such as device 228 may be located below bolts —  
or bolt heads 224 and be attached to pedestal 202 so as to be stationary relative to the  
ship and be used to "count" the bolt heads 224 as the rotatable portion 204 of the crane  
is rotated in use. These methods of determining angular position are examples of some  
5 of the methods which may be used, and it will be clear to a person skilled in the art that  
many other methods of determining angular position of the crane boom may be used.

Figure 7 shows a diagrammatic plan view of the crane when the ship is in position ready  
to load or unload goods.

10

Referring to figure 7 the crane 200 is shown provided on a vessel 300 adjacent to the  
hold 302. An item of cargo 304 is being lifted by the crane 200 for transfer into the hold  
302 having been picked up from the shore 306 where further cargo 307 is provided  
ready for transfer into the hold.

15

Thus the boom 206 of the crane swings through an arc that extends from the shore 306  
to the hold 302. A dividing line, or a plurality of dividing lines, in the arc that the boom  
travels may be selected between the hold and the shore. In figure 7 one dividing line is  
shown represented by dashed line 308, the region on the side of line 308 which is  
20 nearest to the shore may be referenced the shore zone and is indicated by arrow 310;  
the area on the side of line 308 which is nearest the ship's hold may be generally  
referred to as the hold zone and is indicated by arrow 312 in figure 7.

Although only one dividing line 308 is shown in figure 7, any number of different points  
25 in the arc of travel of the crane boom may be chosen to demark particular transition  
points. For example, points in the arc of movement may be chosen to demark; a deck  
zone, or a bulwark zone, a side deck zone, a hatch square zone, and a second side  
deck zone on the side of the ship furthest from the shore zone. Figure 7A provides an  
example of a number of different zones. As will be seen below any of these transition  
30 points may be selected and used by the system to enact specific events such as the  
activation of an alarm.

The PLC and alarm apparatus used to effect the invention for the second embodiment  
described with reference to figures 5 to 8 is essentially the same as the apparatus

shown in figure 3 and described with reference to the first embodiment. The operation of the second embodiment is described below and the PLC and alarm apparatus has the same reference numerals as the apparatus of figure 3. The main difference between the apparatus used in the two embodiments described is that the second embodiment uses sensors 226 and 228 rather than the sensors 10, 12 and 40 to provide the required cargo/crane position information to the system. This necessitates differences in the programming of the PLC, as will be seen from the flow chart of figure 8.

Figure 8 is a flow chart illustrating the basic operational steps of the system which is used in conjunction with the apparatus of figures 5 to 7. The process starts at step 350 with an operator, for example the crane operator, pressing switch 77 on the console 57 to make the system operational. The system begins by requesting the operator to login at step 352 by entering a unique identifier, such as an employee code number, for example, so that the operator may be identified and the time at which this occurs is registered in step 354 to determine the time and date at which the operation began. Once the operator has logged in, the system requests whether the operation is a loading or unloading operation i.e. whether the operation is to be one where a ship is being loaded with the cargo, or one where cargo is being unloaded from the ship to the shore. This request is satisfied by the operator selecting the required operation at step 356.

The next part of the procedure is to calibrate the system. Calibration is not necessarily required, but is generally desirable as the orientation of ships and other vessels relative to the shore changes with different locations and different vessels have different characteristics, for example differing amounts of wear between gears 220 and 218 (refer figure 6). Furthermore, the mechanical systems may change over time due to corrosion for example or changes brought about by factors such as collisions with other cranes or machinery.

To calibrate the system the operator works through an algorithm at the request of the system. Calibration begins at step 358 and the time and date at which calibration commences is recorded by the system at this step. At the request of the system, the operator centres the crane over the hold 302 (figure 7) and presses a key or the like

provided on the user interface 57 to inform the system that the boom 206 is centred over the hold. At the request of the system, the operator then moves the crane toward the shore and stops the boom 206 at the approximate desired dividing area represented by line 308 in figure 7 between the hold zone and the shore zone. The operator then  
5 activates a further key or signal to let the system know that this is the desired transition point between the hold zone and the shore zone. Again, at the request of the system, the operator moves the boom further toward the shore zone until it is in the approximate position at which goods will be picked up by the crane for subsequent transfer to the hold. Again, once this position has been reached, the operator activates a key to inform  
10 the system that this is the approximate shore zone position. The operator then moves the boom 206 back to the position at which it is centred over the hold 302 and actuates a key or button again to let the system know that it has returned to the original point. These steps occur in steps 360 and 362. If desired, the operator may set two transition points to denote the hold zone from the shore zone i.e. one zone transition from hold to  
15 shore, and a separate transition angle from shore to hold.

It will be seen that the calibration algorithm can be simplified. For example, the system could calculate the angles of the various zones without needing to be centred at the beginning or end, particularly if the system measures the crane angular position using  
20 features such as bolts on the rotatable crane portion 204 because there is no "slip" between gears to account for, as mentioned further below.

At step 362 the system requests whether the crane is to load a further hold which may be located on the opposite side of the crane from hold 302 (figure 7). If a further hold is  
25 to be loaded then steps 360 and 362 are repeated to prescribe the arc of movement between the second hold and the shore. The operator decides whether two holds are to be loaded or unloaded at step 364.

From the information that has been gathered through the calibration process, the  
30 system can calculate the play between the gears 220 and 218 which is the primary factor contributing to errors in the measurement of the angular position of the boom 206 by the rotary encoder. The calculation of the play or slip between the gears may also be checked by comparing the output of the rotary encoder 226 (refer figure 6) with the output of the sensor 228.

To ensure that the sensors 226 and 228 are working correctly, the outputs of these sensors are continually checked against each other by the system by an error checking algorithm which begins at step 366. The error checking algorithm takes into account the play between the gears 220 and 218 and compares the outputs of the sensors after they have been decoded to provide information as to the actual position of boom 206. If there is a significant error between the output of the two sensors, the error being greater than the predetermined error which has been considered one with which the system can safely operate, a system alarm is activated in step 368 to warn the operator and others that there is a system malfunction. The system is deactivated and the system operational indicator is accordingly also deactivated in step 370. Therefore, the system provides a safety mechanism whereby a malfunction of one of the sensors will result in a warning. This greatly reduces the possibility of the sensor malfunction resulting in an accident which may be caused by a reliance on the system providing appropriate warnings as will be described further below.

Once the system calibration is complete, the system operational indicator lamps 69 and 71 are switched on. This occurs in step 372. The operator then begins the loading or unloading operation. In the flow chart described in figure 8, the operation is a loading operation. Goods on the shore are being transferred to hold 302. Thus, the operator begins movement of boom 206 from the shore toward the hold at step 374. The operator may optionally wish to wait until the zone clear light 73 is on before moving the crane. As the transition zone between the shore zone and the hold zone represented by line 308 (figure 7) approaches, the hold alarm (siren 51 and strobe 53) is sounded by the system at step 376. When this occurs, the PLC registers the time and date and saves this information for later retrieval at step 378.

Similarly, as the operator moves the crane boom from the hold to the shore at step 380, the system determines when the transition zone 308 is being approached and an alarm sounds (siren 51 and strobe 53) on the shore at step 382. Upon the shore alarm sounding, the PLC registers the time and date and saves the information in step 384.

The shore and hold alarms may be manually overridden by the operator making the appropriate requests in step 386. The system records the time and date at which this was requested and disables the alarms accordingly.

- 5 As crane movement occurs between the shore and the hold and vice versa, the system at step 388 continually checks the angular position of the boom relative to the ship to ensure that the position of the boom does not exceed the original parameters established at calibration of the system by more than a predetermined amount. Thus, if the boom is rotated away from the shore zone beyond hold 302, the system provides an
- 10 appropriate alarm. Similarly, if the boom is rotated toward the shore zone beyond a predetermined point past the original calibration position for the boom position in the shore zone, then the system sounds an alarm (light 75, alarm 63 and siren 65) to the crane operator. The system may also optionally disable the crane if such a limit is reached to ensure that the boom does not exceed the predetermined limit. This occurs
- 15 at step 390 and the system also records the time at which any of the predetermined limits are exceeded.

- A further check which is performed by the system at step 388 is to compare the instantaneous angular position of boom 206 with the boom of a further crane which may
- 20 be operating adjacent to crane 206 locating another hold. If there is imminent danger of collision between the two crane booms, then the system takes appropriate steps to disable one or both cranes to avoid a collision.

- The system also has provision for an alarm being established by persons in the hold or
- 25 on the shore in response to emergency conditions. Activation of such an alarm (for example activation of button 55 on the shore or hold pendants, or button 79 on console 57) provides an alarm to the crane operator (by activating alarm 63 and siren 65 on the crane pendant and light 75 on console 57) to warn the operator that an emergency situation has occurred and to prevent further movement of the crane boom or the load
- 30 which the crane is carrying.

The operator also has an option for recording a delay situation at step 400. Such a delay may be as a result of a break down, or some other delay such as a loading delay on the shore zone or unloading delay in the hold for various reasons. Once the delay

has been entered, the time and date at which this occurs is recorded, as is the time and date at which the loading or unloading resumes after the problem which initiated the delay has been rectified. The time and date recordal is performed at step 402.

- 5 Once the loading or unloading operation is complete, the operator logs out by entering an appropriate code in step 404. At logout the time and date is recorded and the system is disabled until it is switched on and another operator logs in. Thus the process comes to an end at step 406.
- 10 It will be seen that the apparatus has the effect of providing an early warning, should an emergency situation arise, to persons present in the hold or the ship or other cargo receiving area if the cargo item is enroute. Similarly, a warning may also be provided to the shore zone to let persons know that the crane or other lifting device is ready to load another cargo item. The safety warning is particularly important in applications such as
- 15 loading ships in which persons within the ships hold may not be aware that cargo is being moved above their heads. This can lead to disastrous consequences if persons within the hold are not expecting the cargo to be delivered.

The invention allows the impending delivery of a cargo item to be sensed in a variety of

20 ways, for example by optical means or by electromagnetic radiation such as radio or microwave signals, or by other means, for example ultrasonically. Furthermore, this sensing may take place at a number of locations as long as sufficient warning time is provided. The warning may be provided in a number of different ways, for example it may be provided by a blanket radio transmission to the radio receivers of all persons in

25 the vicinity of the location to which the cargo item is to be delivered.

Although the methods of control of the apparatus have been described with reference to a programmable logic controller, many other methods of apparatus may be adopted for putting the invention into effect. For example, a micro processor may be used alone

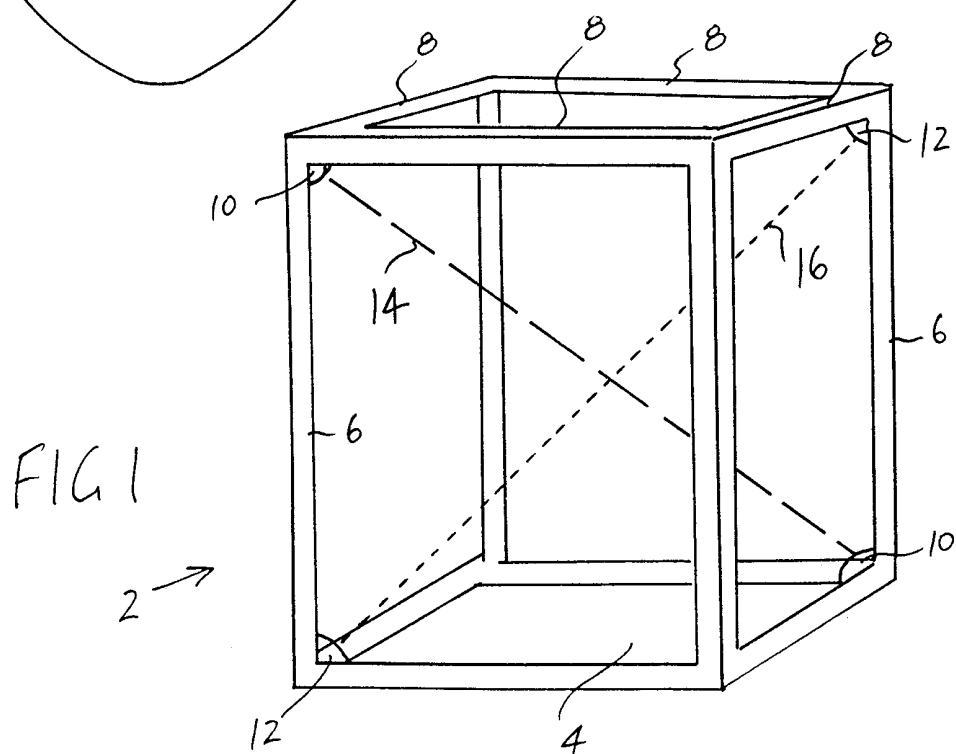
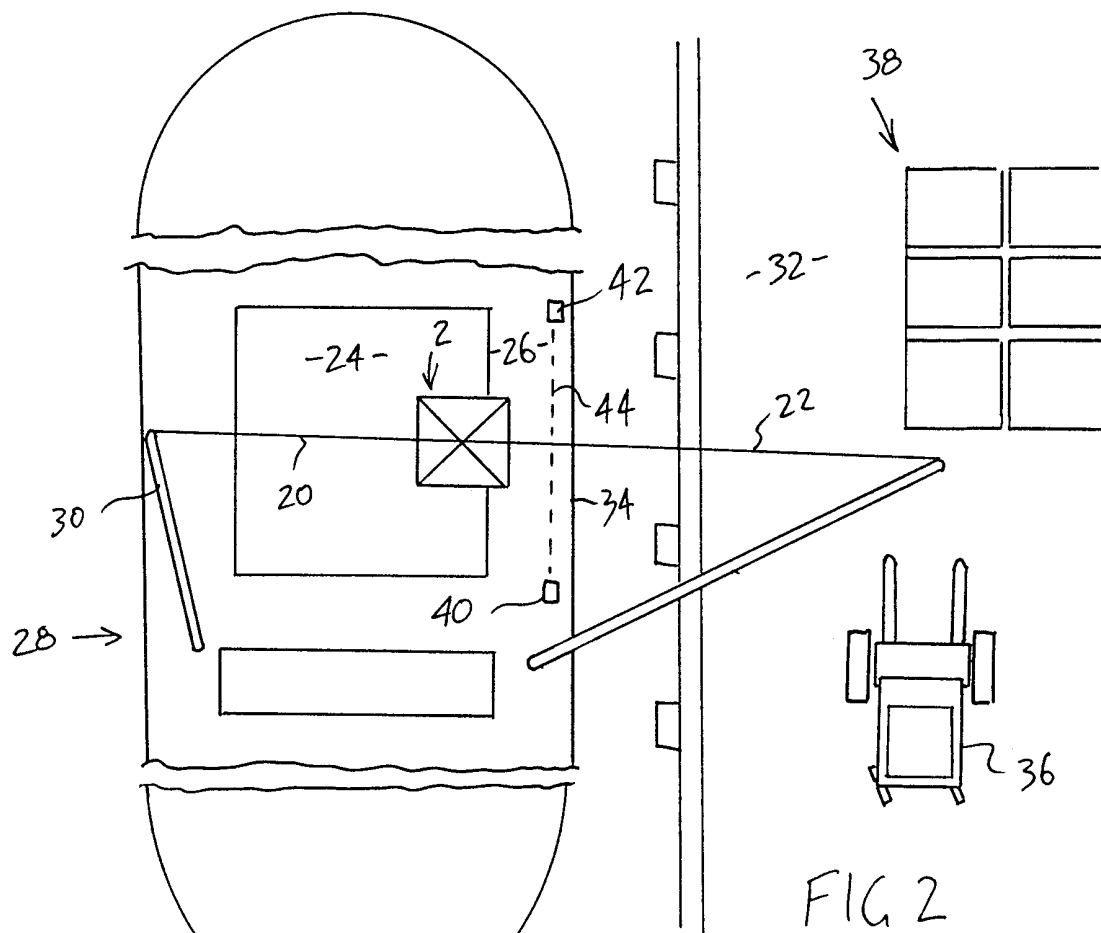
30 rather than in conjunction with a programmable logic control, or hardware electronics could be used, or even an electrical wired circuit could be used if required.

It will also be seen that the apparatus has many applications in transferring cargo items to or from other conveyances such as trains, trucks or the like.

## CLAIMS

1. Cargo transfer safety apparatus comprising sensing means to sense the  
5 impending delivery of a cargo item to a selected location, and warning means  
responsive to the sensing means to provide a warning of the impending delivery of the  
cargo item to the selected location.
2. Apparatus as claimed in claim 1 wherein the sensing means senses the  
10 presence or movement, at a predetermined locality, of transfer apparatus that delivers  
the cargo item.
3. Apparatus as claimed in claim 1 wherein the sensing means senses the  
presence or movement, at a predetermined locality, of the cargo item.  
15
4. Apparatus as claimed in claim 1 wherein the sensing means senses the  
presence or movement, at a predetermined locality, of a crane boom.
5. Apparatus as claimed in any one of the preceding claims including operation  
20 indication means to indicate whether the apparatus is operational.
6. Apparatus as claimed in any one of the preceding claims including an  
emergency indicator means to provide a warning signal to halt the transfer operation.
- 25 7. Apparatus as claimed in any one of the preceding claims wherein the  
emergency signal disables transfer apparatus that delivers the cargo item.
8. Apparatus as claimed in any one of the preceding claims wherein the sensing  
means comprise an optical sensing means.  
30
9. Apparatus as claimed in any one of the preceding claims wherein the sensing  
means comprise a switch.

10. Apparatus as claimed in any one of the preceding claims wherein the warning — means comprise a visual warning means.
11. Apparatus as claimed in any one of the preceding claims wherein the warning  
5 means also comprise an audible warning.
12. Apparatus as claimed in any one of the preceding claims wherein the warning means are selectively actuable by an operator of the transfer apparatus.
- 10 13. A method of warning of the impending delivery of a cargo item to a selected location, the method comprising the steps of:  
sensing the impending deliver of the cargo item, and  
providing a warning before the item is delivered to the selected location.
- 15 14. Cargo transfer safety apparatus comprising sensing means to sense the impending movement of a cargo item or carrying apparatus for a cargo item to a selected location, and warning means responsive to the sensing means to provide a warning of the impending movement of the cargo item or carrying apparatus to the selected location.
- 20 15. Apparatus substantially as herein described with reference to, and as illustrated by, the accompanying drawings.
16. A method of cargo transfer substantially as herein described with reference to,  
25 and as illustrated by, the accompanying drawings.
17. Any novel feature or combination of features disclosed herein.



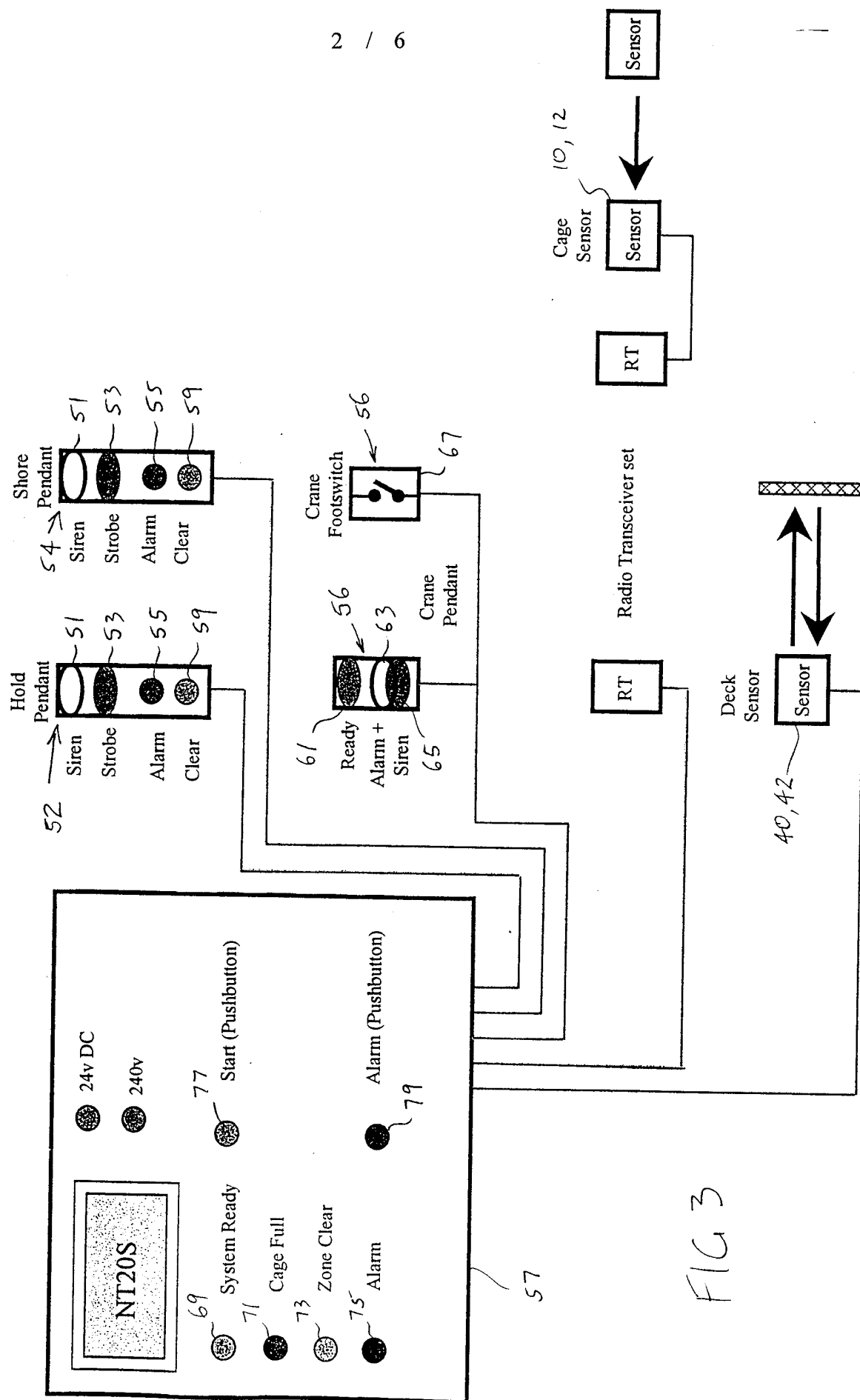
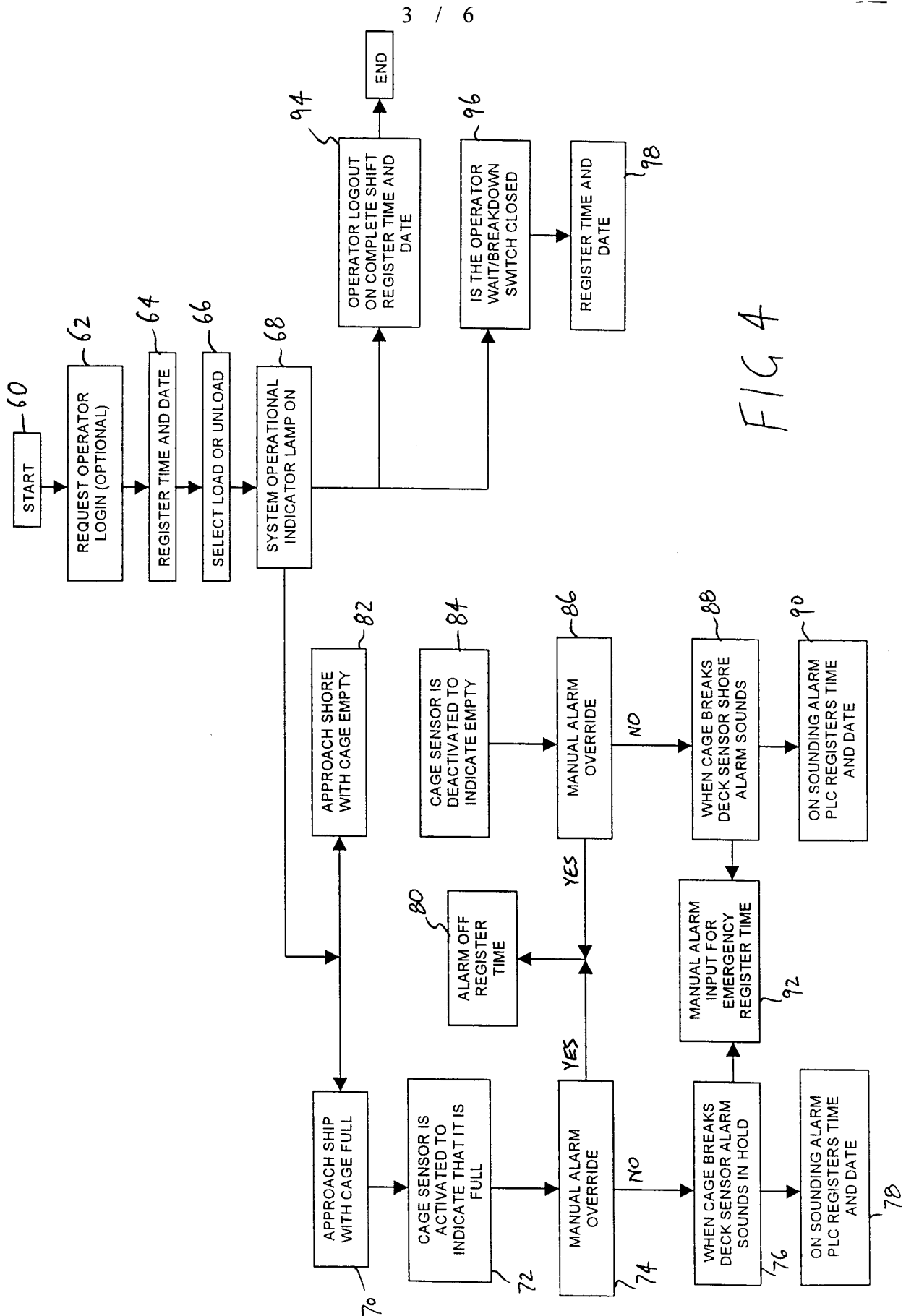


FIG 3

3 / 6



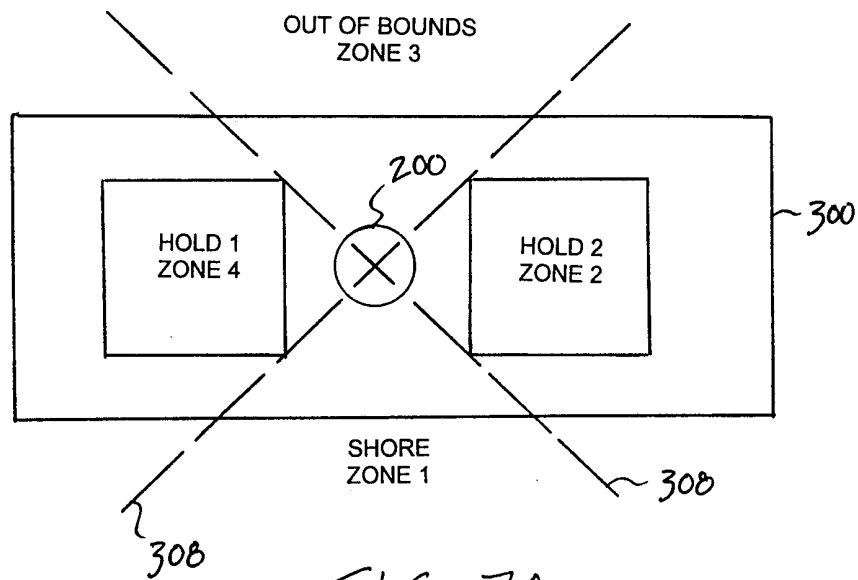


FIG 7A

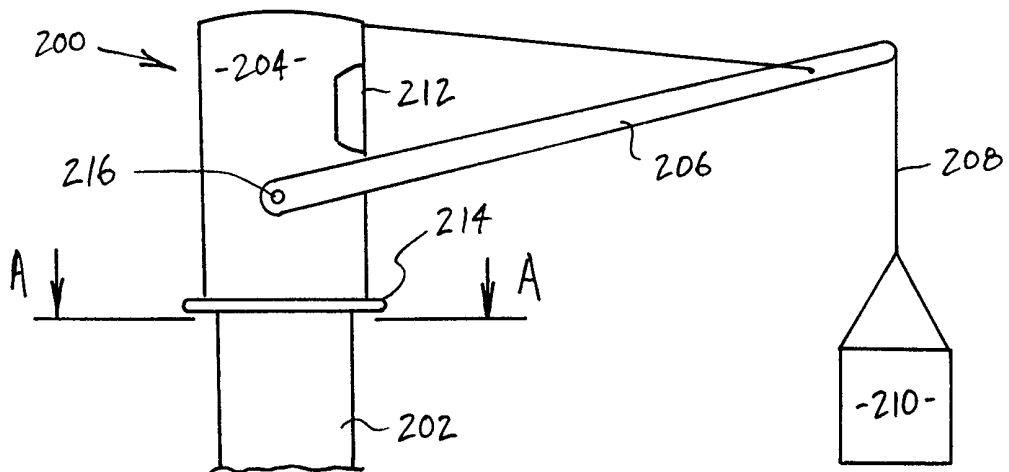


FIG 5

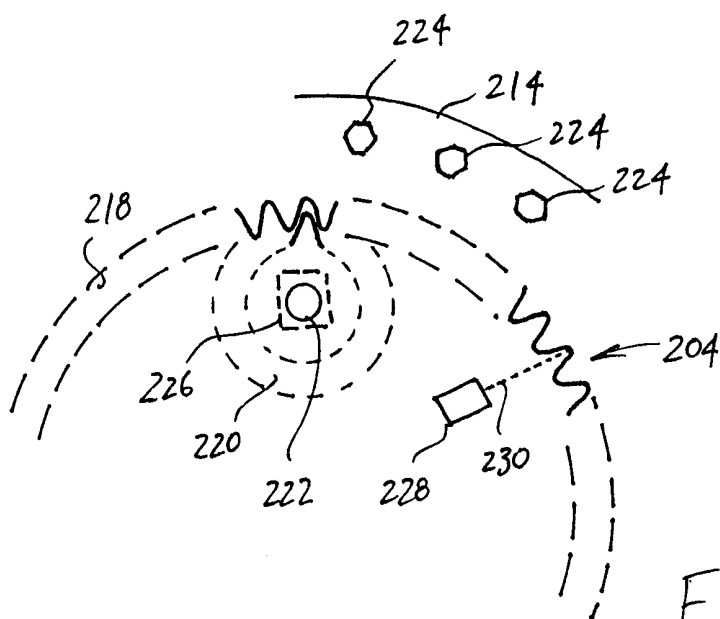


FIG 6

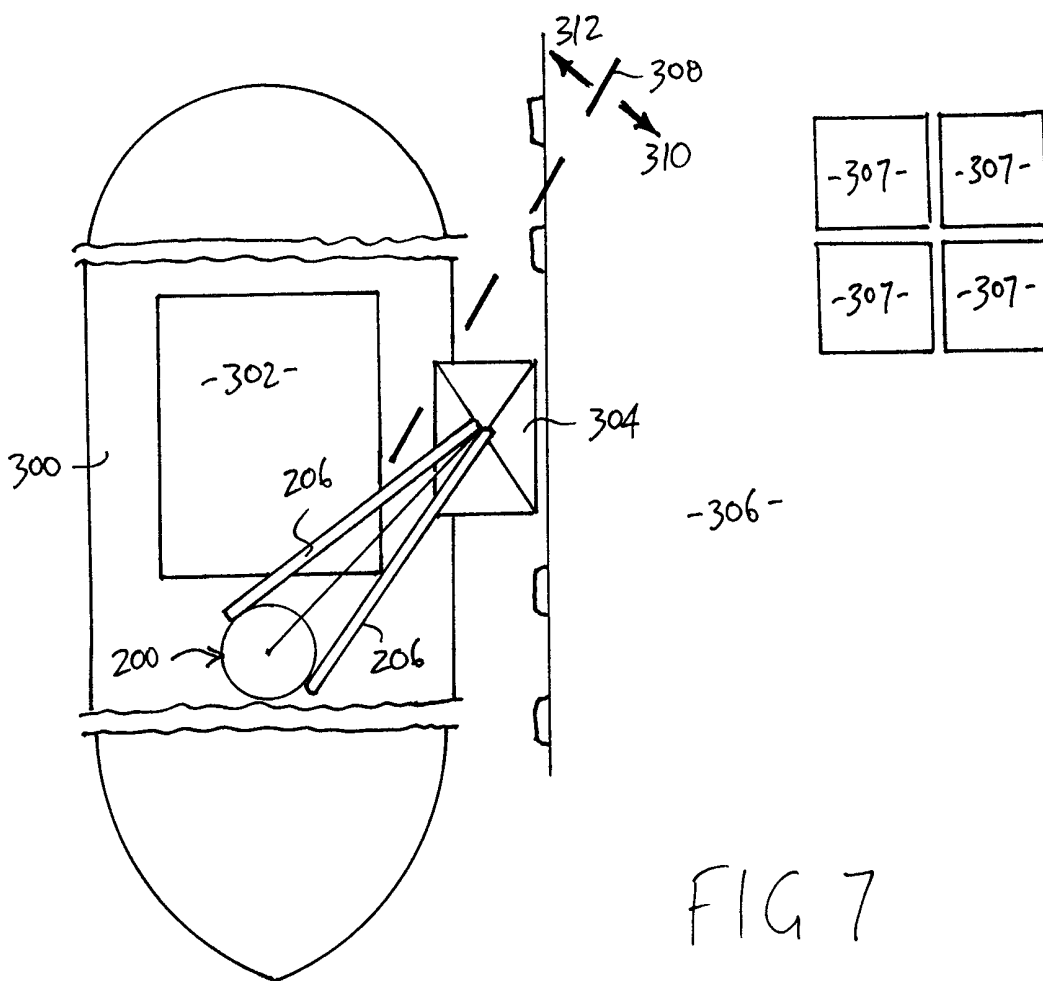
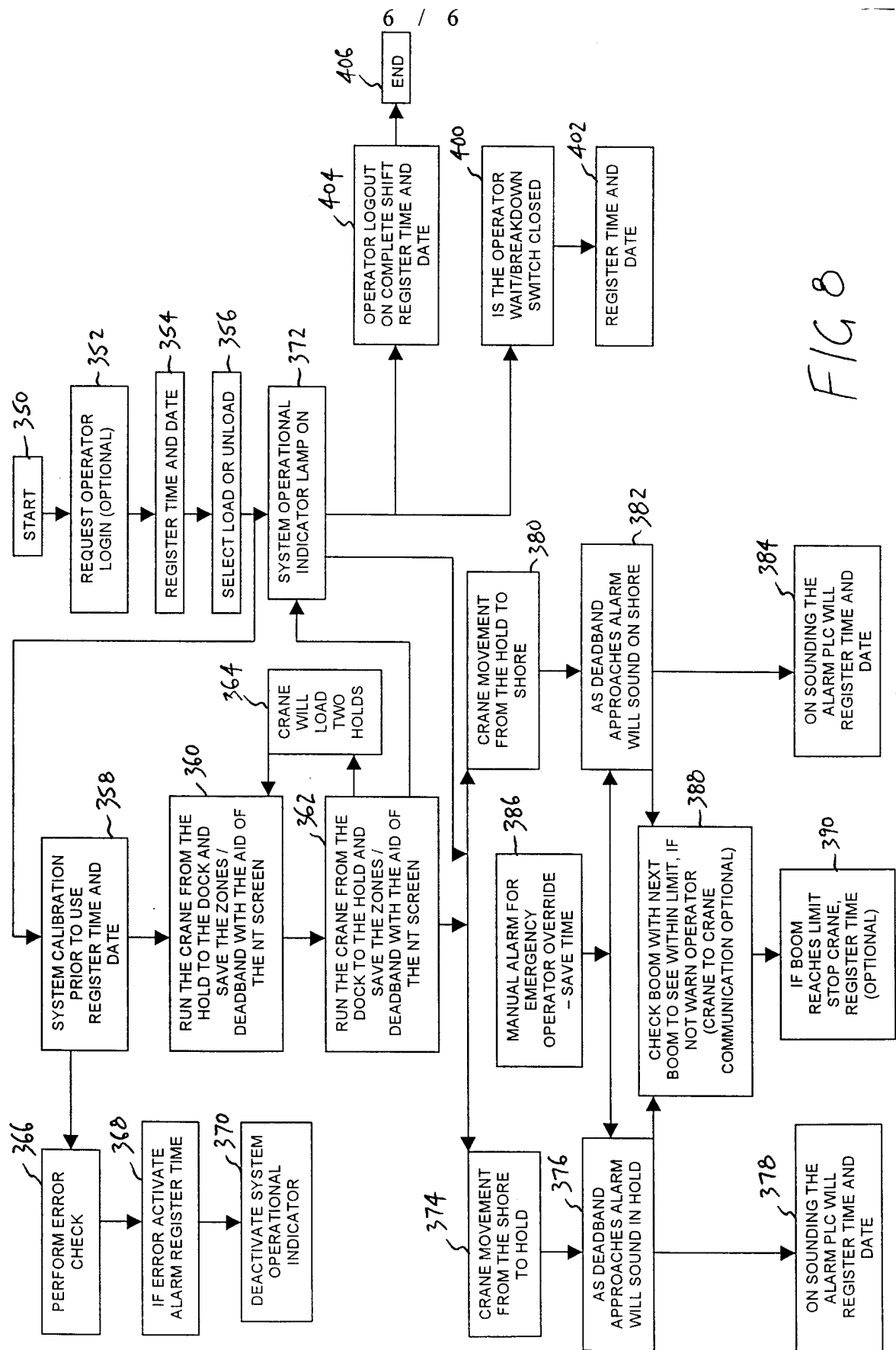


FIG 7



## INTERNATIONAL SEARCH REPORT

 International application No.  
**PCT/NZ 98/00113**

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                  |                                                                           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| <b>A. CLASSIFICATION OF SUBJECT MATTER</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                  |                                                                           |
| Int Cl <sup>6</sup> : G08B 1/08, 21/00; B65G 67/60; B66C 15/04                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                  |                                                                           |
| According to International Patent Classification (IPC) or to both national classification and IPC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                  |                                                                           |
| <b>B. FIELDS SEARCHED</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                  |                                                                           |
| Minimum documentation searched (classification system followed by classification symbols)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                  |                                                                           |
| IPC: G08B 1/00, 1/08, 3/00, 21/00; B65G 67/00, 67/60, 69/00; B66C 15/04, 15/06                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                  |                                                                           |
| Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                  |                                                                           |
| AU: IPC as above                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                  |                                                                           |
| Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                  |                                                                           |
| WPAT: GOODS OR CONTAINER# OR CARGO OR PALLET#; LOAD OR LOADING OR TRANSPORT: OR TRANSFER: OR DELIVER: OR CONVEY.; SIGNAL: OR ALERT: OR WARN: OR SENSE: OR DETERM: OR ALARM;; ACOUSTIC: OR OPTICAL;; DOCK OR WHARF OR PORT OR RAIL: OR ROAD#                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                  |                                                                           |
| <b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                  |                                                                           |
| Category*                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                                                               | Relevant to claim No.                                                     |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | GB 2273475 A (JSP LIMITED) 22 June 1994<br>entire document                                                                                                                                                                                       | 1-3, 5, 10-16                                                             |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | US 3913081 A (HAMILTON) 14 October 1975<br>entire document; particularly: abstract, column 1 lines 25-40, column 1 line 58 to column 2 line 47                                                                                                   | 1, 4, 10-14                                                               |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | US 5644489 (HAGENBUCH) 1 July 1997<br>entire document; particularly: abstract, columns 1-3, column 9, column 17 lines 30- 56, column 19 line 65 to column 20, column 36 line 26 to column 39 line 14, and column 54 line 65 to column 56 line 51 | 1-3, 5, 8-16                                                              |
| <input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                  |                                                                           |
| * Special categories of cited documents:<br>"A" Document defining the general state of the art which is not considered to be of particular relevance<br>"E" earlier application or patent but published on or after the international filing date<br>"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)<br>"O" document referring to an oral disclosure, use, exhibition or other means<br>"P" document published prior to the international filing date but later than the priority date claimed<br>"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<br>"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<br>"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<br>"&" document member of the same patent family |                                                                                                                                                                                                                                                  |                                                                           |
| Date of the actual completion of the international search<br>10 September 1998                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                  | Date of mailing of the international search report<br><b>17 SEP 1998</b>  |
| Name and mailing address of the ISA/AU<br>AUSTRALIAN PATENT OFFICE<br>PO BOX 200<br>WODEN ACT 2606<br>AUSTRALIA<br>Facsimile No.: (02) 6285 3929                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                  | Authorized officer<br><br><b>C BERKO</b><br>Telephone No.: (02) 6283 2169 |

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/NZ 98/00113

| C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT |                                                                                                                                                    |                        |
|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| Category*                                             | Citation of document, with indication, where appropriate, of the relevant passages                                                                 | Relevant to claim No.  |
| X                                                     | EP 192350 A (RITE-HITZ CORPORATION) 27 August 1986<br>entire document                                                                              | 1-3, 5-7, 9-14         |
| X                                                     | US 5428344 A (CURRY et al) 27 June 1995<br>entire document; particularly columns 1-3, and column 8 line 55 to column 11 line 24                    | 1-3, 5-7, 9, 10, 12-14 |
| X                                                     | US 5343739 A (CURRY) 6 September 1994<br>entire document; particularly: column 1 and claims                                                        | 1, 3, 4, 13, 14        |
| X                                                     | US 4937796 A (TENDLER) 26 June 1990<br>entire document                                                                                             | 1, 11, 13, 14          |
| X                                                     | US 4178591 A (GEPPERT) 11 December 1979<br>entire document; particularly: abstract, figures 1-7, column 1, column 3 line 8-24, column 5 line 40-57 | 1, 4-7, 13, 14         |
| X                                                     | JP 7125993 A (HITACHI KIDEN KOGYO KK) 16 May 1995<br>abstract                                                                                      | 1, 3, 13, 14           |
| X                                                     | JP 07309584 A (OHBAYA-SHI GUMI KK) 28 November 1995<br>abstract                                                                                    | 1, 3, 13, 14           |

## INTERNATIONAL SEARCH REPORT

International application No.  
**PCT/NZ 98/00113****Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims No.: 17  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

The claim is of indeterminate scope. It does not indicate the technical features of the invention, as such, the protection / monopoly sought by the claim is unclear and indefinite.

3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

**Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

# INTERNATIONAL SEARCH REPORT

## Information on patent family members

International application No.  
PCT/NZ 98/00113

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

| Patent Document Cited in Search Report |          |      | Patent Family Member |    |          |    |          |
|----------------------------------------|----------|------|----------------------|----|----------|----|----------|
| GB                                     | 2273475  | NONE |                      |    |          |    |          |
| US                                     | 3913081  | AU   | 74255/74             | CA | 1015702  | DE | 2450135  |
|                                        |          | FR   | 2248226              | GB | 1476525  | IT | 1022663  |
|                                        |          | JP   | 50078049             | US | 3913081  |    |          |
| US                                     | 5644489  | AU   | 41644/85             | CA | 1255797  | EP | 162608   |
|                                        |          | IN   | 164712               | IN | 167750   | JP | 61028826 |
|                                        |          | US   | 4630227              | ZA | 8503133  | US | 4845648  |
|                                        |          | US   | 4831539              | US | 4839835  | US | 5327347  |
|                                        |          | US   | 5416706              | US | 5528499  | US | 5631832  |
|                                        |          | US   | 5631835              | US | 5650928  | US | 5650930  |
|                                        |          | US   | 5742914              | CA | 1287888  | AU | 74142/87 |
|                                        |          | CA   | 1302567              | EP | 249487   |    |          |
| EP                                     | 192350   | AU   | 54067/86             | CA | 1251542  | JP | 61196075 |
|                                        |          | MX   | 160106               | US | 4692755  | US | 5453735  |
| US                                     | 5428344  | AU   | 34713/93             | CA | 2101931  | US | 5260688  |
|                                        |          | WO   | 93/20543             |    |          |    |          |
| US                                     | 5343739  | NONE |                      |    |          |    |          |
| US                                     | 4937796  | NONE |                      |    |          |    |          |
| US                                     | 4178591  | AU   | 48184/79             | CA | 1122709  | EP | 16109    |
|                                        |          | IT   | 1121838              | WO | 80/00076 |    |          |
| JP                                     | 7125973  | NONE |                      |    |          |    |          |
| JP                                     | 07309584 | NONE |                      |    |          |    |          |
| END OF ANNEX                           |          |      |                      |    |          |    |          |