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(54) **INFORMATION SYSTEM FOR A ROBOTIC PARKING GARAGE**

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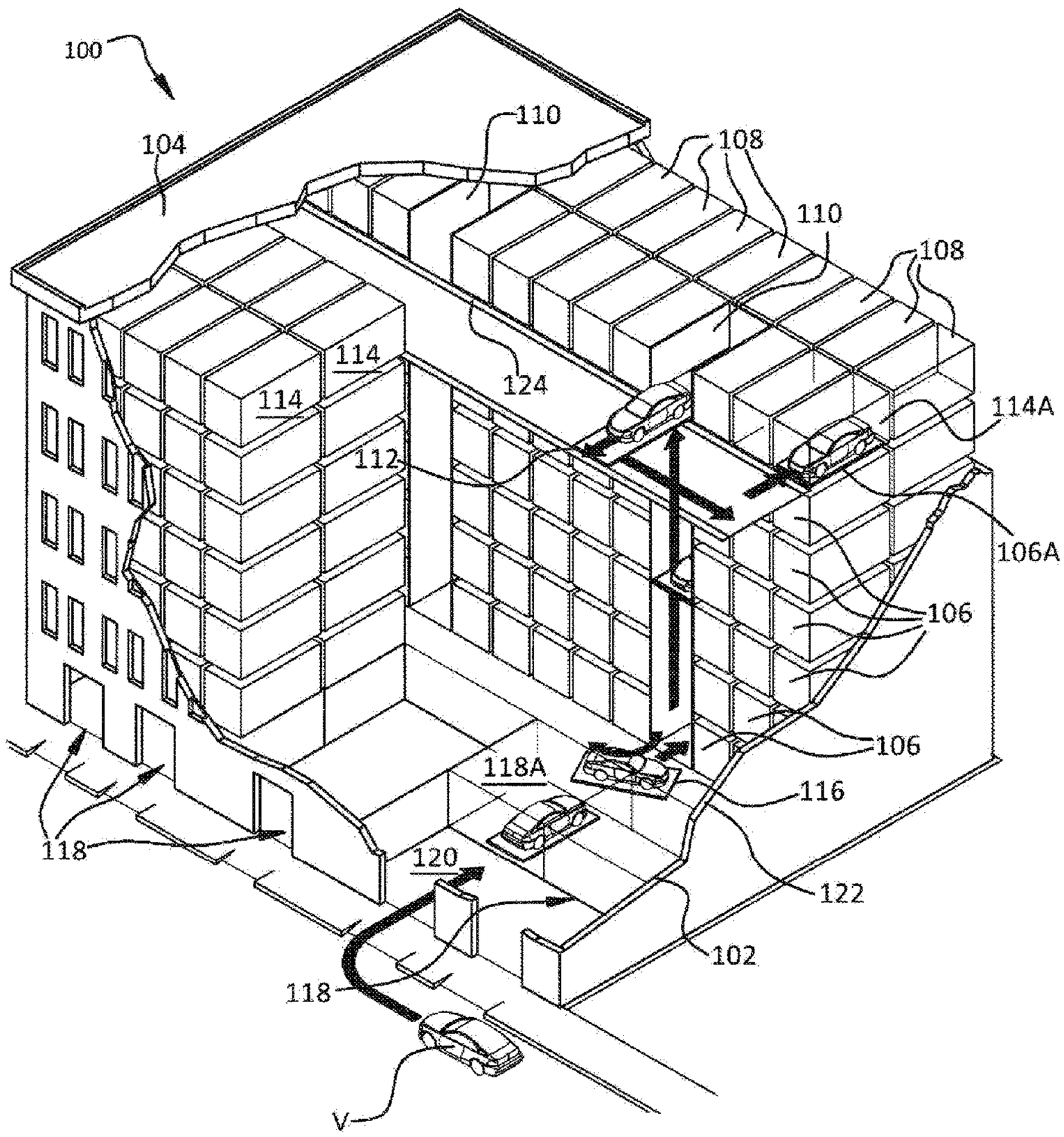
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(52) **U.S. Cl.**
CPC ***E04H 6/424*** (2013.01)

(57) **ABSTRACT**

Disclosed herein is a user interface for an automated parking garage that is coupled to a controller. The controller is coupled with a machine associated with the operation of an automated, or robotic, parking garage and a sensor operable to obtain data from the machine. In an example embodiment, the user interface displays a runtime value and a threshold value corresponding to the runtime value. The user interface is operable to receive a change to the threshold value via the input. In an example embodiment, the user interface comprises diagnostic screens corresponding to machines that are operating in the automated parking garage. Status data for a machine to displayed on its corresponding diagnostic screen and in response to receiving an input, the controller causes the machine, or one or more of its components, to move a predefined distance or to a predefined position when operating in a certain modes.



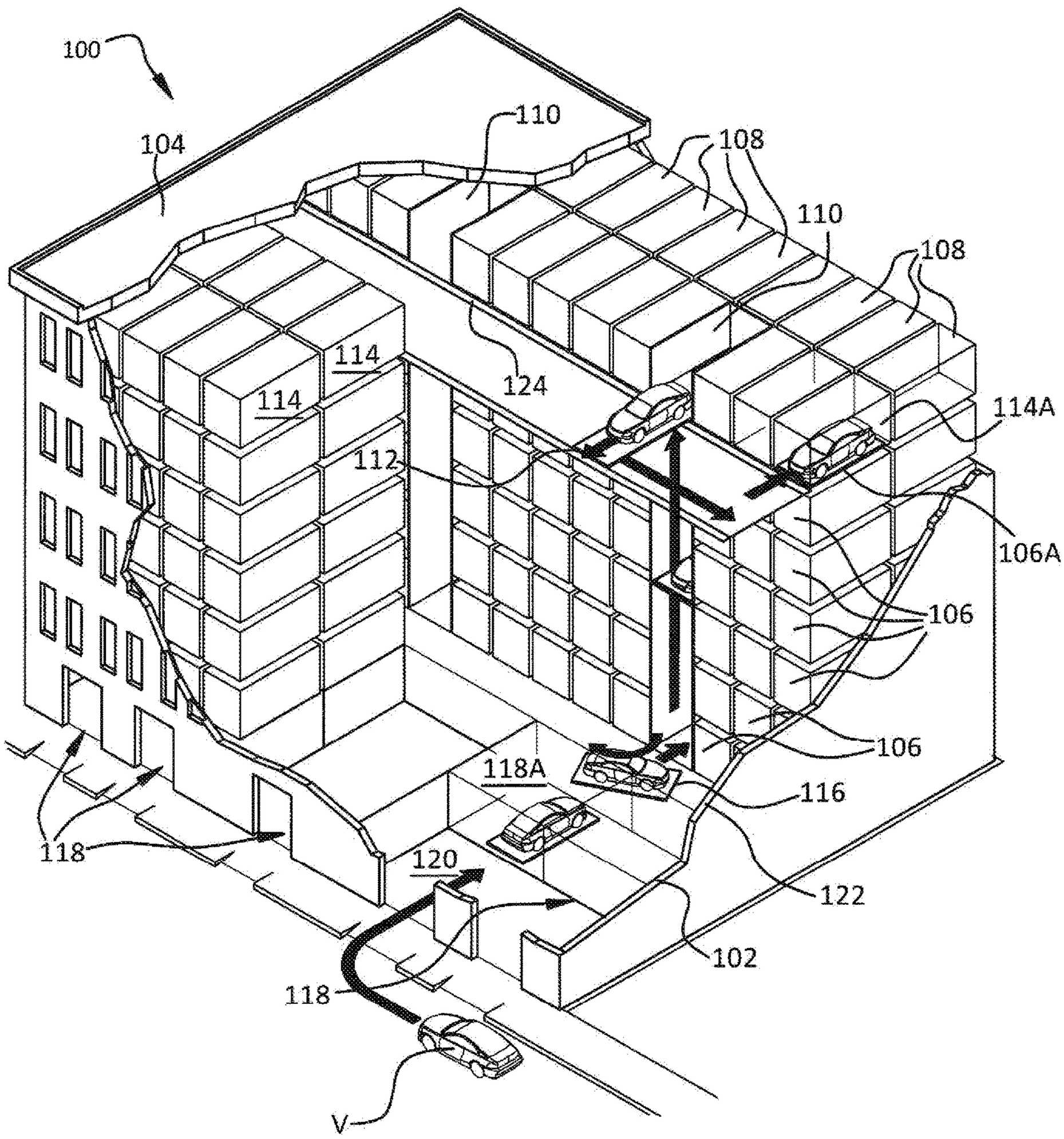

100
104
110
108
110
108
114
114
124
114A
112
106A
106
106
118A
116
118
120
122
102
118
V

FIG. 1

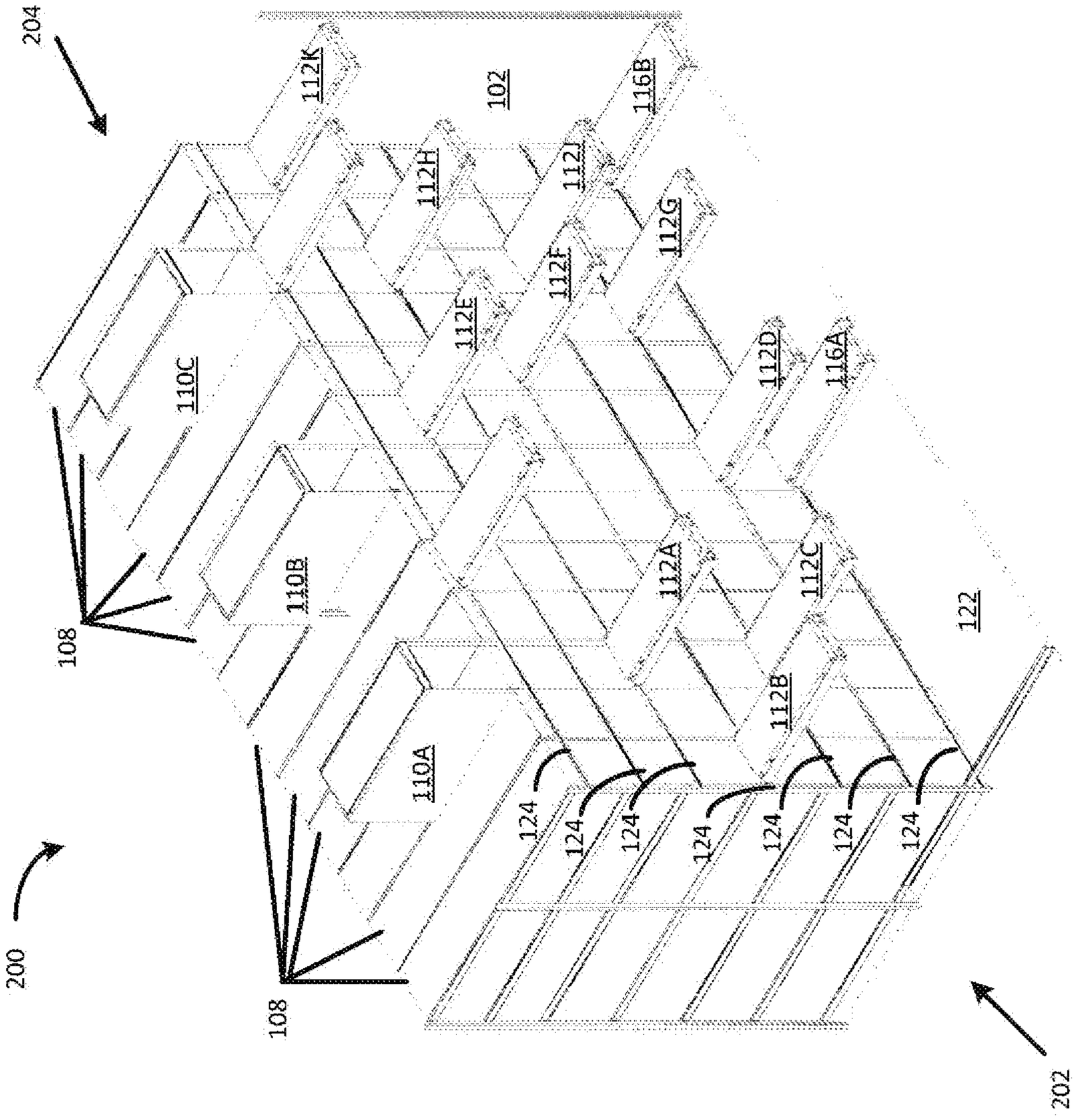

204
112K
102
116B
112H
112J
112E
112F
112G
110C
112D
116A
110B
112A
112C
108
122
110A
112B
124
124
124
124
124
124
124
200
108
202

FIG. 2

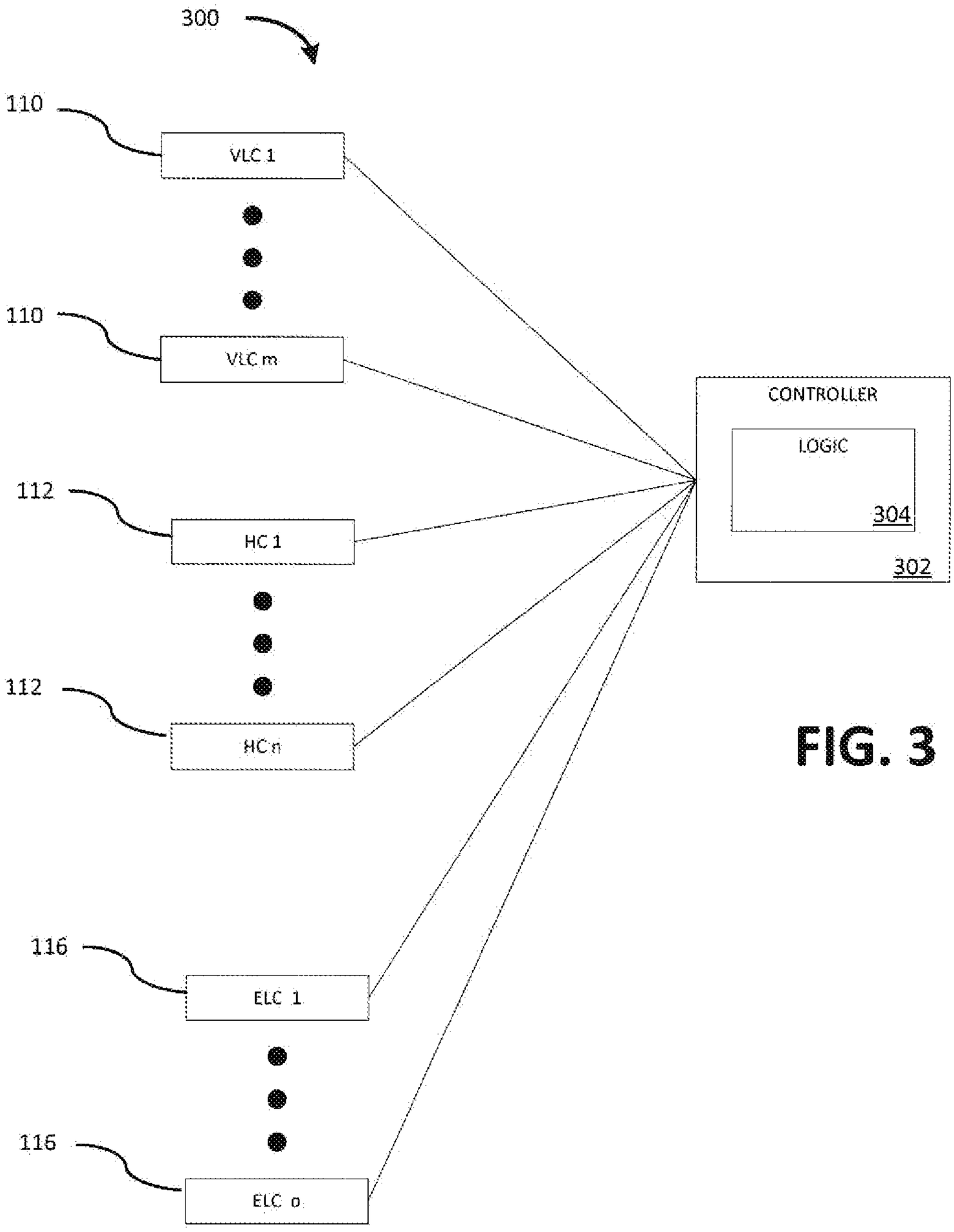

300
110
VLC 1
110
VLC m
112
HC 1
112
HC n
116
ELC 1
116
ELC o
CONTROLLER
LOGIC
304
302

FIG. 3

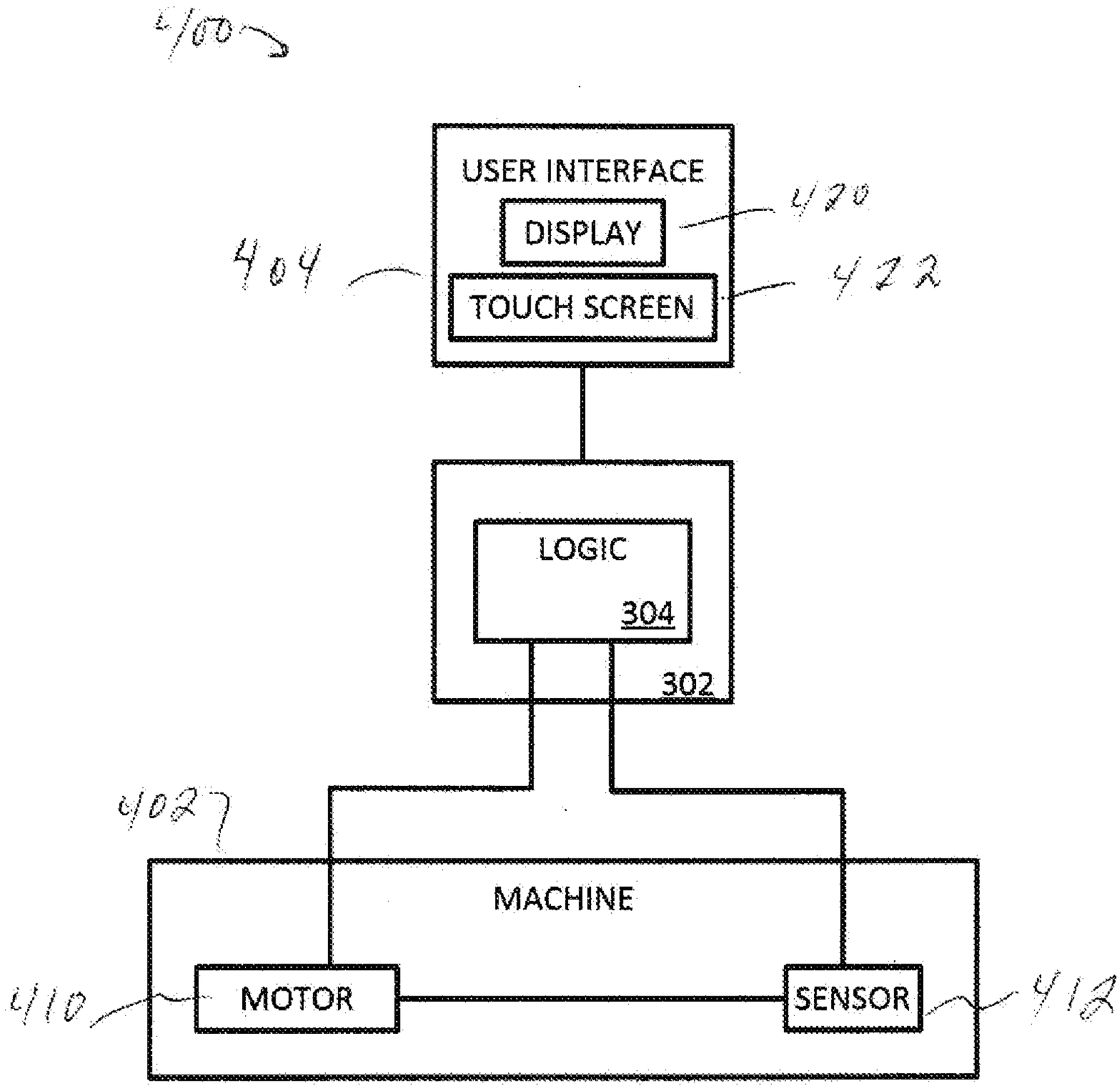

400
USER INTERFACE
DISPLAY
420
404
422
TOUCH SCREEN
LOGIC
304
302
402
MACHINE
410
MOTOR
SENSOR
412

FIG. 4

Diagnostics 544

MACHINE RUNTIMES / TRAVELS

512 514 516 518

Device	Runtime (no. of revs.)	Runtime (hhh.mm)	TT Runtime (no. of rots.)	Cable Reel (hhh.mm)	RESET Button	Device	Runtime (no.of revs.)	Runtime (hhh.mm)	REM Lift Up/Down (nos)	RESET Button
CM_FLR6_01	3003.7	000.53	00053	030.34	RESET ALL	REM_FLR1_01	3203.2	000.45	00026	RESET ALL
CM_FLR6_02	2562.2	000.40	00033	028.04	RESET ALL	REM_FLR1_02	1091.6	000.15	00000	RESET ALL
CM_FLR6_03	2937.8	000.41	00038	030.20	RESET ALL	REM_FLR1_03	1975.4	000.22	00000	RESET ALL
CM_FLR7_04	3435.3	000.49	00061	033.07	RESET ALL	REM_FLR1_04	1014.3	000.15	00007	RESET ALL
CM_FLR7_05	2007.2	000.44	00037	030.17	RESET ALL	REM_FLR1_05	2293.9	000.32	00007	RESET ALL
CM_FLR7_06	3541.5	000.58	00060	031.01	RESET ALL	REM_FLR1_06	1873.5	000.27	00033	RESET ALL
CM_FLR8_01	2861.7	000.45	N/A	028.24	RESET ALL	REM_FLR2_01	306.8	000.04	00010	RESET ALL
CM_FLR8_02	547.0	000.03	N/A	000.11	RESET ALL	REM_FLR2_02	50.8	000.00	00002	RESET ALL
CM_FLR8_03	2947.2	000.44	N/A	027.57	RESET ALL	REM_FLR2_03	50.8	000.00	00003	RESET ALL
CM_FLR9_01	2746.7	000.42	N/A	027.57	RESET ALL	REM_FLR3_01	50.9	000.00	00004	RESET ALL
CM_FLR9_02	2472.5	000.40	N/A	027.56	RESET ALL	REM_FLR3_02	119.1	000.01	00004	RESET ALL
CM_FLR9_03	888.9	000.06	N/A	000.20	RESET ALL	REM_FLR3_03	0.0	000.00	00001	RESET ALL
CM_FLR10_01	2755.8	000.42	N/A	027.56	RESET ALL	REM_FLR4_01	0.0	000.00	00000	RESET ALL
CM_FLR10_02	600.1	000.04	N/A	000.02	RESET ALL	REM_FLR4_02	84.1	000.00	00002	RESET ALL
CM_FLR10_03	859.9	000.06	N/A	000.01	RESET ALL	REM_FLR4_03	68.5	000.00	00002	RESET ALL
CM_FLR11_01	1452.7	000.14	N/A	000.12	RESET ALL	REM_FLR5_01	746.7	000.10	00026	RESET ALL
CM_FLR11_02	673.7	000.05	N/A	000.18	RESET ALL	REM_FLR5_02	762.2	000.08	00035	RESET ALL
CM_FLR11_03	1704.4	000.14	N/A	000.15	RESET ALL	REM_FLR5_03	736.4	000.09	00028	RESET ALL

502 504 506 508 510 530 500 RUNTIME 2 RUNTIME_PS 532

540 542

FIG. 5A

520 Runtime (no. of revs.) Alarm Limit	522 Runtime (hours) Alarm Limit	524 Cable Reel (hours) Alarm Limit	526 Lift up/down (nos) Alarm Limit	528 Turntable Runtime (no. of rots) Alarm Limit
67536.0	10	50	2000	2000
67536.0	10	50	2000	N/A
67536.0	10	50	2000	N/A
67536.0	10	50	2000	N/A
67536.0	10	50	2000	N/A

500

FIG. 5B

Diagnostics 544

MACHINE RUNTIMES / TRAVELS

512 514 516 518

Device	Runtime (no. of revs.)	Runtime (hhh.mm)	TT Runtime (no. of rots.)	Cable Reel (hhh.mm)	RESET Button	Device	Runtime (no.of revs.)	Runtime (hhh.mm)	REM Lift Up/Down (nos)	RESET Button
CM_FLR6_01	2239.9	000.23	N/A	000.21	RESET ALL	REM_FLR6_01	1433.3	000.18	00040	RESET ALL
CM_FLR6_02	2201.8	000.21	N/A	000.20	RESET ALL	REM_FLR6_02	1359.6	000.17	00042	RESET ALL
CM_FLR6_03	1578.9	000.16	N/A	000.29	RESET ALL	REM_FLR6_03	1712.6	000.19	00051	RESET ALL
CM_FLR7_01	3145.9	000.33	N/A	000.35	RESET ALL	REM_FLR7_01	1795.4	000.22	00050	RESET ALL
CM_FLR7_02	1412.9	000.13	N/A	000.42	RESET ALL	REM_FLR7_02	217.4	000.04	00004	RESET ALL
CM_FLR7_03	2919.0	000.27	N/A	000.32	RESET ALL	REM_FLR7_03	1498.4	000.19	00046	RESET ALL
CM_FLR8_01	3071.6	000.32	N/A	000.23	RESET ALL	REM_FLR8_01	1322.9	000.17	00039	RESET ALL
CM_FLR8_02	2499.1	000.27	N/A	000.30	RESET ALL	REM_FLR8_02	1110.4	000.14	00028	RESET ALL
CM_FLR8_03	2294.6	000.19	N/A	000.54	RESET ALL	REM_FLR8_03	1640.2	000.17	00035	RESET ALL
CM_FLR9_01	1679.1	000.19	N/A	007.55	RESET ALL	REM_FLR9_01	425.4	000.06	00039	RESET ALL
CM_FLR9_02	2456.3	000.27	N/A	000.26	RESET ALL	REM_FLR9_02	959.2	000.12	00031	RESET ALL
CM_FLR9_03	1698.4	000.14	N/A	000.20	RESET ALL	REM_FLR9_03	762.7	000.09	00028	RESET ALL
CM_FLR10_01	1380.6	000.14	N/A	000.05	RESET ALL	REM_FLR10_01	317.4	000.04	00012	RESET ALL
CM_FLR10_02	620.6	000.04	N/A	000.01	RESET ALL	REM_FLR10_02	51.0	000.00	00002	RESET ALL
CM_FLR10_03	3182.6	000.47	N/A	028.04	RESET ALL	REM_FLR10_03	305.5	000.05	00012	RESET ALL
CM_FLR11_01	2139.6	000.21	N/A	000.57	RESET ALL	REM_FLR11_01	1131.9	000.14	00032	RESET ALL
CM_FLR11_02	1533.4	000.14	N/A	000.54	RESET ALL	REM_FLR11_02	755.1	000.09	00022	RESET ALL
CM_FLR11_03	1781.9	000.17	N/A	001.00	RESET ALL	REM_FLR11_03	1182.6	000.14	00034	RESET ALL
CM_FLR12_01	758.1	000.13	N/A	000.01	RESET ALL	REM_FLR12_01	101.7	000.01	00004	RESET ALL
CM_FLR12_02	1645.4	000.41	N/A	000.04	RESET ALL	REM_FLR12_02	254.4	000.03	00010	RESET ALL
CM_FLR12_03	1363.6	000.20	N/A	000.01	RESET ALL	REM_FLR12_03	101.9	000.01	00004	RESET ALL

502 504 506 508 510 530 RUNTIME 1 RUNTIME_PS 532

602 542

FIG. 6A

520 Runtime (no. of revs.) Alarm Limit	522 Runtime (hours) Alarm Limit	524 Cable Reel (hours) Alarm Limit	526 Lift up/down (nos) Alarm Limit	528 Turntable Runtime (no. of rots) Alarm Limit
67536.0	10	50	2000	N/A
67536.0	10	50	2000	N/A
67536.0	10	50	2000	N/A
67536.0	10	50	2000	N/A
67536.0	10	50	2000	N/A
67536.0	10	50	2000	N/A
67536.0	10	50	2000	N/A

FIG. 6B

Diagnostics 544

MACHINE RUNTIMES / TRAVELS

502 Device	504 Runtime (no. of revs.)	506 Runtime (hhh.mm)	702 Lift Up/Down (nos)	704 RESET Button	520 Runtime (no. of revs) Alarm Limit	522 Runtime (hours) Alarm Limit	524 Lift up/down (nos) Alarm Limit
PS_FLR1_01	299.2	000.08	53	RESET ALL	67536.0	10	2000
PS_FLR1_02	11790.5	004.26	1840	RESET ALL			
PS_FLR1_03	2317.8	000.39	231	RESET ALL			
PST_01		000.01		RESET ALL		10	
PST_02		000.01		RESET ALL		10	
PST_03		000.02		RESET ALL		10	
PVL_01		001.13		RESET ALL		10	
PVL_02		000.13		RESET ALL		10	
PVL_03		005.24		RESET ALL		10	
VLC_01		000.26		RESET ALL		20	
VLC_02		002.27		RESET ALL		20	
VLC_03		000.11		RESET ALL		20	
VLC_04		000.27		RESET ALL		20	
VLC_05		000.11		RESET ALL		20	
VLC_06		000.36		RESET ALL		20	

700

602 RUNTIME 1

542 RUNTIME 2

FIG. 7

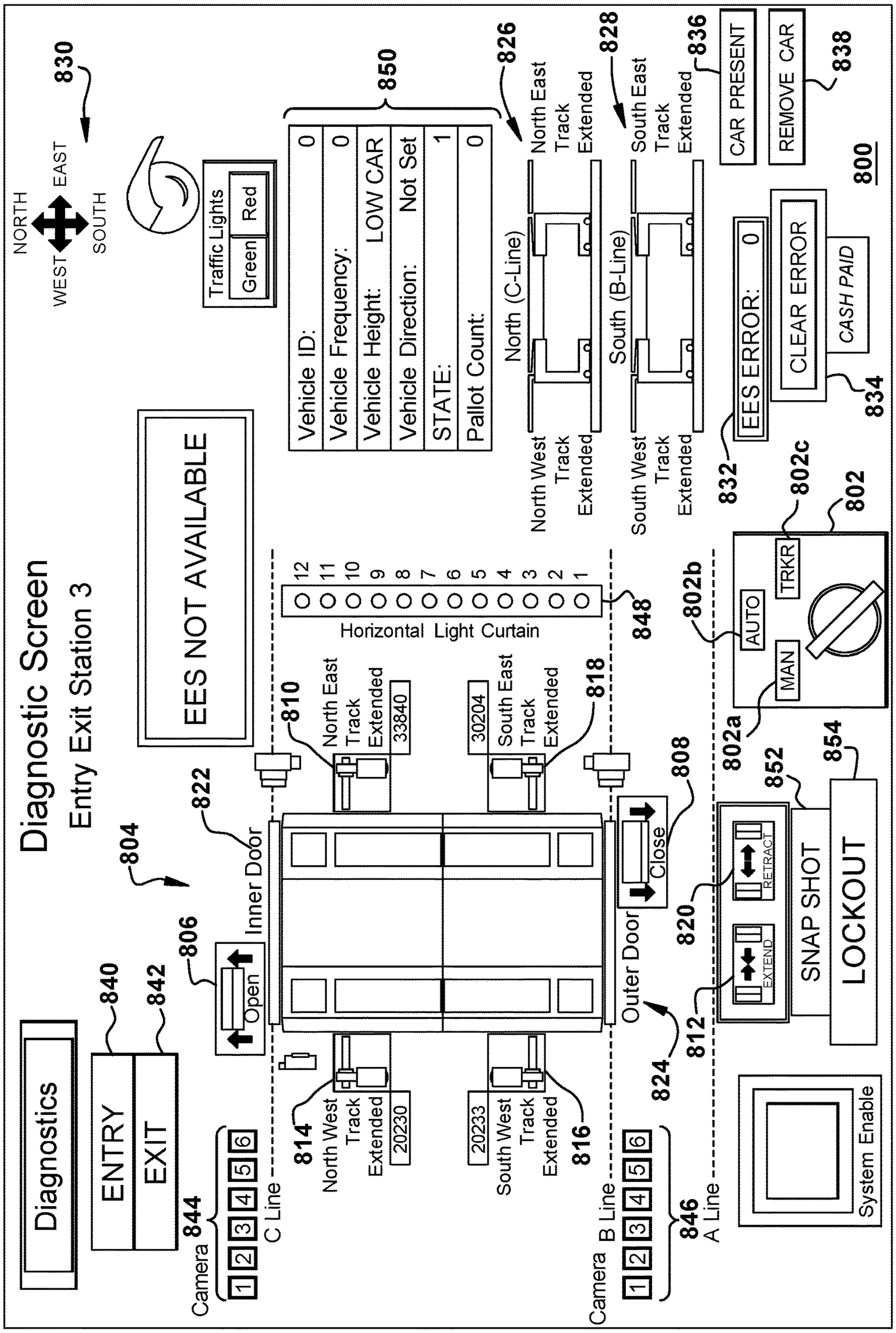

Diagnostic Screen
Entry Exit Station 3
NORTH
WEST
EAST
SOUTH
830
Traffic Lights
Green
Red
Vehicle ID: 0
Vehicle Frequency: 0
Vehicle Height: LOW CAR
Vehicle Direction: Not Set
STATE: 1
Pallot Count: 0
850
826
North East Track Extended
828
South East Track Extended
836
CAR PRESENT
838
REMOVE CAR
North (C-Line)
South (B-Line)
North West Track Extended
South West Track Extended
EES ERROR: 0
CLEAR ERROR
CASH PAID
834
800
EES NOT AVAILABLE
832
802c
802
802b
AUTO
TRKR
MAN
802a
Horizontal Light Curtain
12 11 10 9 8 7 6 5 4 3 2 1
848
810
North East Track Extended
33840
30204
South East Track Extended
818
804
822
Inner Door
808
Close
852
854
RETRACT
EXTEND
SNAP SHOT
LOCKOUT
820
806
Open
Outer Door
812
824
840
842
ENTRY
EXIT
Diagnostics
Camera 844
1 2 3 4 5 6
C Line
814
North West Track Extended
20230
20233
South West Track Extended
816
Camera B Line
1 2 3 4 5 6
846
A Line
System Enable

FIG. 8

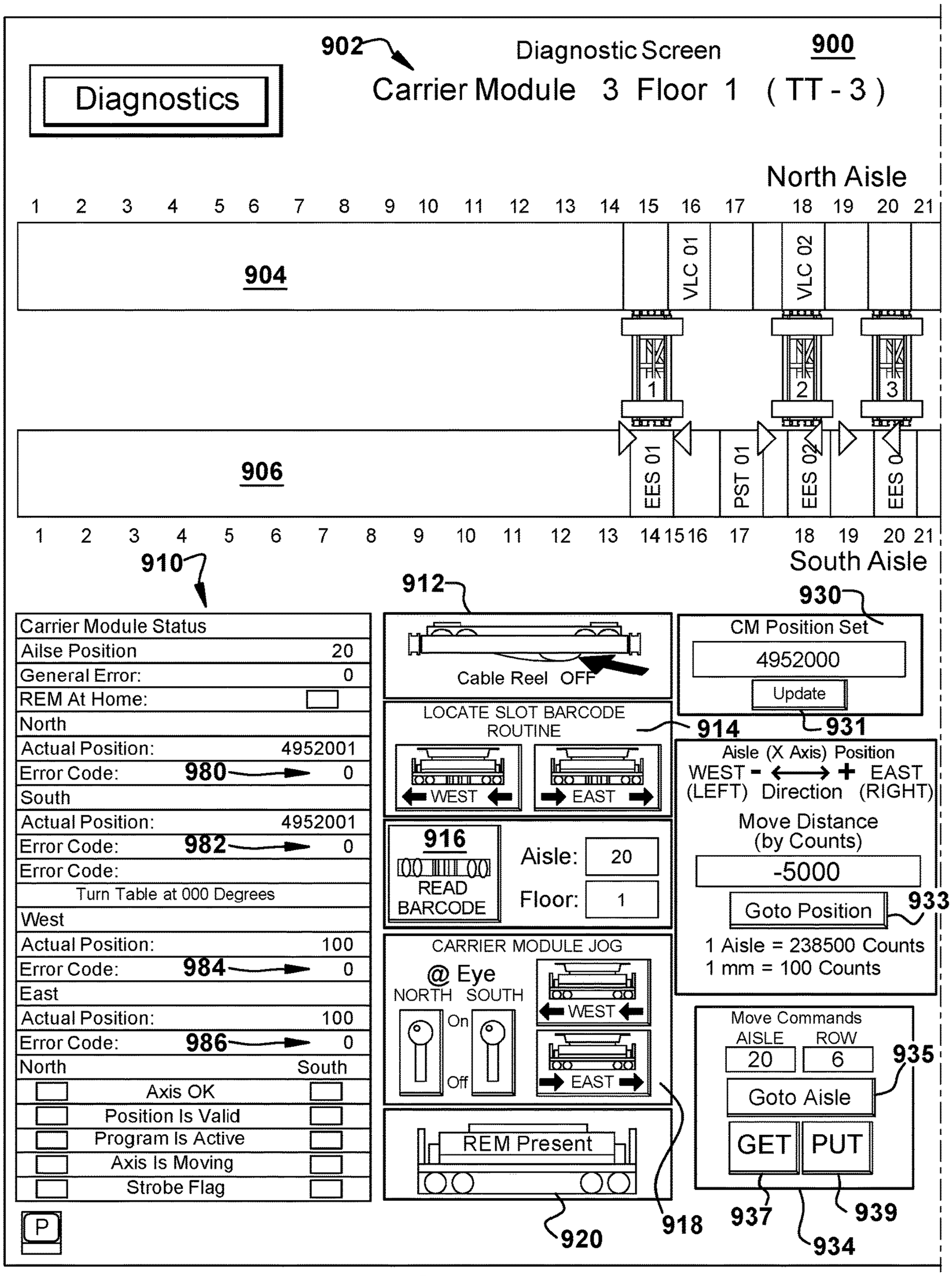

902
Diagnostic Screen
900
Diagnostics
Carrier Module 3 Floor 1 (TT - 3)
North Aisle
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
904
VLC 01
VLC 02
1
2
3
906
EES 01
PST 01
EES 02
EES 03
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
South Aisle
910
912
930
Carrier Module Status
Ailse Position 20
General Error: 0
REM At Home:
North
Actual Position: 4952001
Error Code: 980 0
South
Actual Position: 4952001
Error Code: 982 0
Error Code:
Turn Table at 000 Degrees
West
Actual Position: 100
Error Code: 984 0
East
Actual Position: 100
Error Code: 986 0
North South
Axis OK
Position Is Valid
Program Is Active
Axis Is Moving
Strobe Flag
P
Cable Reel OFF
CM Position Set
4952000
Update
931
LOCATE SLOT BARCODE ROUTINE
914
WEST
EAST
Aisle (X Axis) Position
WEST - ⟷ + EAST
(LEFT) Direction (RIGHT)
916
READ BARCODE
Aisle: 20
Floor: 1
Move Distance (by Counts)
-5000
Goto Position
933
1 Aisle = 238500 Counts
1 mm = 100 Counts
CARRIER MODULE JOG
@ Eye
NORTH SOUTH
On
Off
WEST
EAST
Move Commands
AISLE ROW
20 6
935
Goto Aisle
GET PUT
REM Present
920
918
937
939
934

FIG. 9A

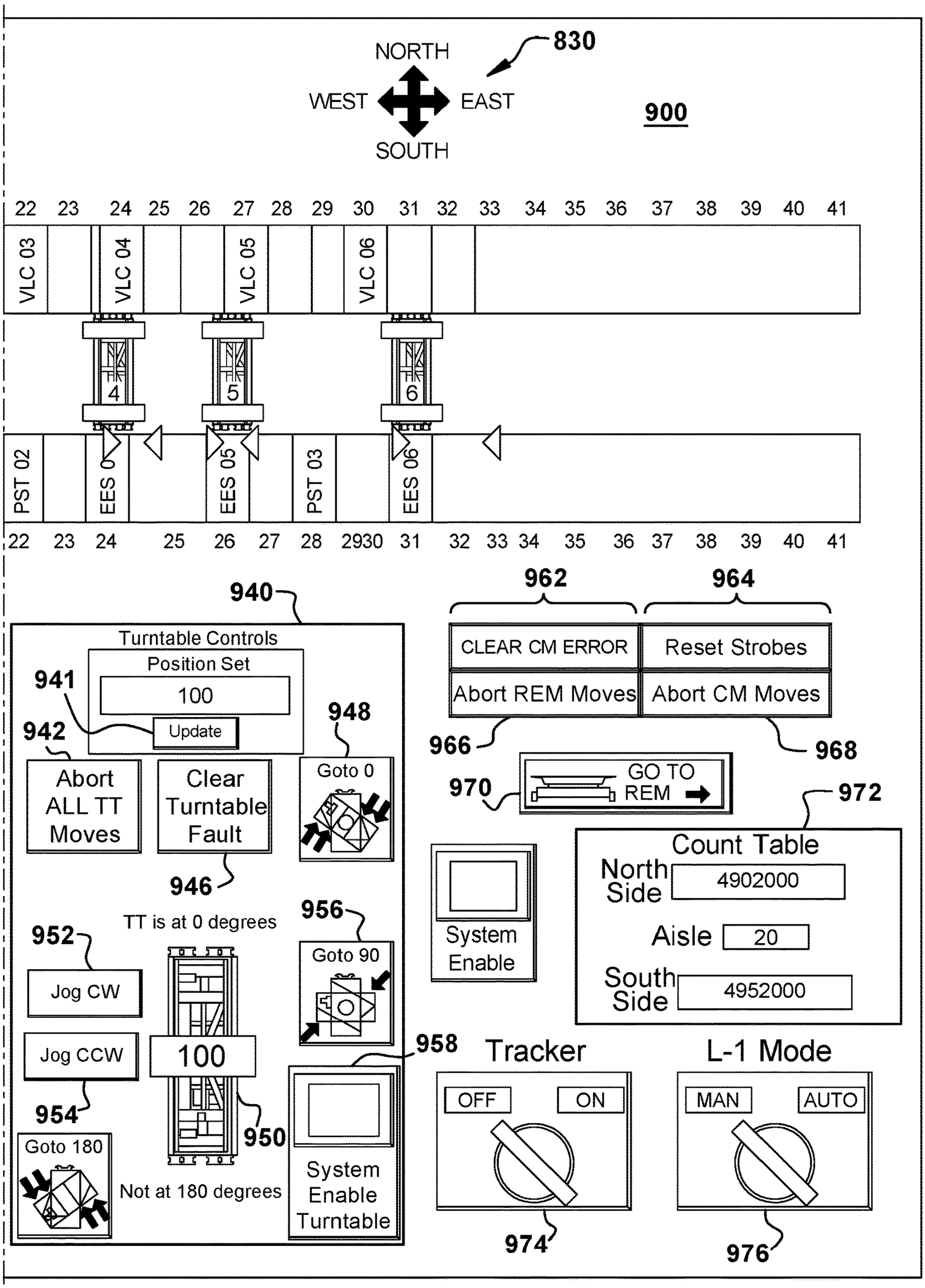

830
NORTH
WEST
EAST
SOUTH
900
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41
VLC 03
VLC 04
VLC 05
VLC 06
4
5
6
PST 02
EES 0
EES 05
PST 03
EES 06
22 23 24 25 26 27 28 2930 31 32 33 34 35 36 37 38 39 40 41
940
Turntable Controls
Position Set
941
100
Update
942
948
Abort ALL TT Moves
Clear Turntable Fault
Goto 0
946
TT is at 0 degrees
952
956
Jog CW
Goto 90
Jog CCW
100
954
958
Goto 180
950
Not at 180 degrees
System Enable Turntable
962
964
CLEAR CM ERROR
Reset Strobes
Abort REM Moves
Abort CM Moves
966
968
970
GO TO REM
972
Count Table
North Side
4902000
Aisle
20
South Side
4952000
System Enable
Tracker
OFF
ON
974
L-1 Mode
MAN
AUTO
976

FIG. 9B

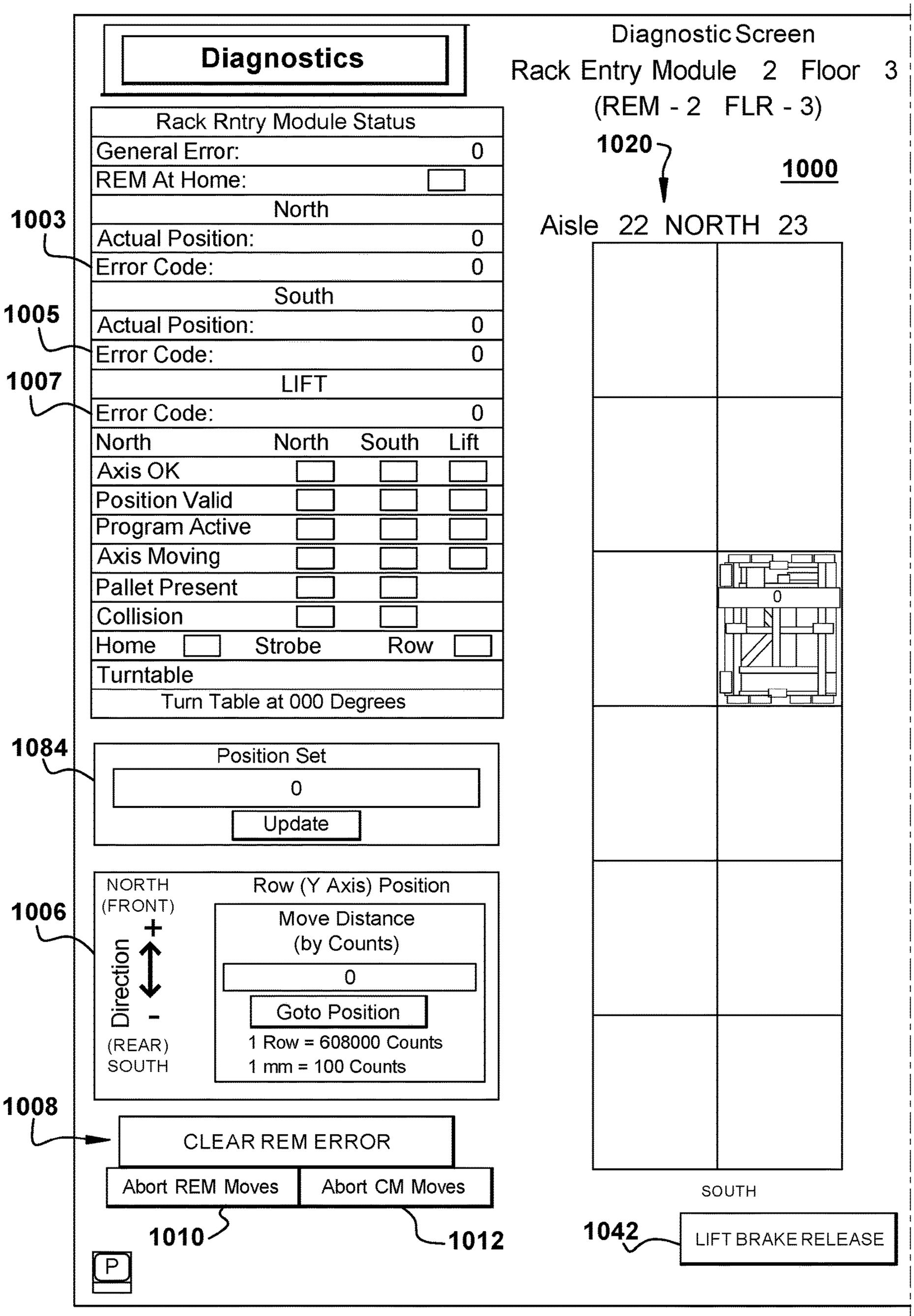

Diagnostics
Rack Rntry Module Status
General Error: 0
REM At Home:
North
Actual Position: 0
Error Code: 0
South
Actual Position: 0
Error Code: 0
LIFT
Error Code: 0
North North South Lift
Axis OK
Position Valid
Program Active
Axis Moving
Pallet Present
Collision
Home Strobe Row
Turntable
Turn Table at 000 Degrees
1003
1005
1007
1084
Position Set
0
Update
1006
NORTH (FRONT)
Direction
+
-
(REAR) SOUTH
Row (Y Axis) Position
Move Distance (by Counts)
0
Goto Position
1 Row = 608000 Counts
1 mm = 100 Counts
1008
CLEAR REM ERROR
Abort REM Moves
Abort CM Moves
1010
1012
P
Diagnostic Screen
Rack Entry Module 2 Floor 3
(REM - 2 FLR - 3)
1020
1000
Aisle 22 NORTH 23
0
SOUTH
1042
LIFT BRAKE RELEASE

FIG. 10A

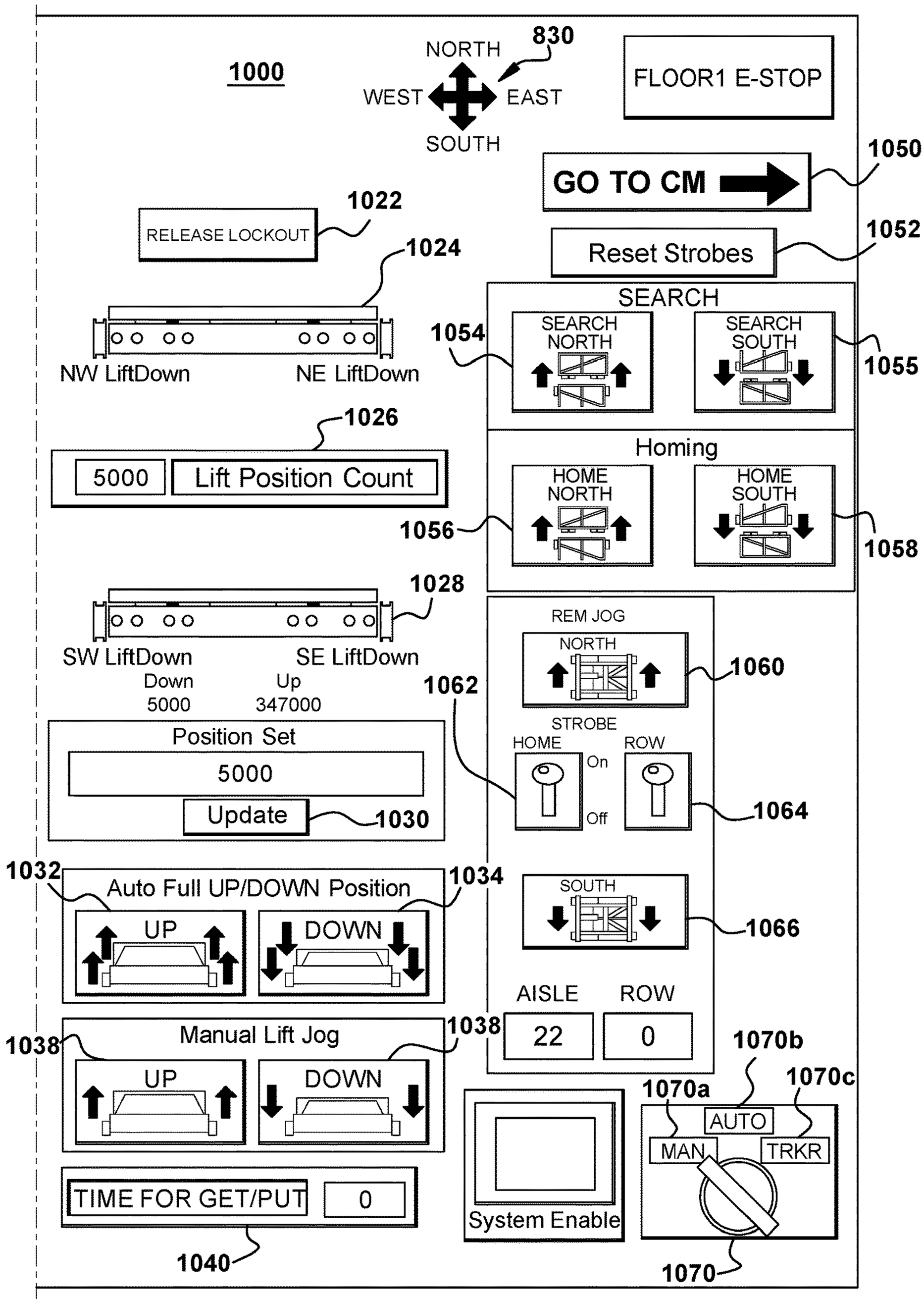

1000
NORTH
830
WEST
EAST
SOUTH
FLOOR1 E-STOP
GO TO CM
1050
RELEASE LOCKOUT
1022
1024
Reset Strobes
1052
SEARCH
SEARCH NORTH
SEARCH SOUTH
1054
1055
NW LiftDown
NE LiftDown
1026
5000
Lift Position Count
Homing
HOME NORTH
HOME SOUTH
1056
1058
1028
SW LiftDown
SE LiftDown
Down
5000
Up
347000
REM JOG
NORTH
1060
1062
Position Set
5000
STROBE
HOME
ROW
On
Off
Update
1030
1064
1032
Auto Full UP/DOWN Position
1034
UP
DOWN
SOUTH
1066
AISLE
ROW
22
0
1038
Manual Lift Jog
1038
UP
DOWN
1070b
1070a
1070c
AUTO
MAN
TRKR
TIME FOR GET/PUT
0
System Enable
1040
1070

FIG. 10B

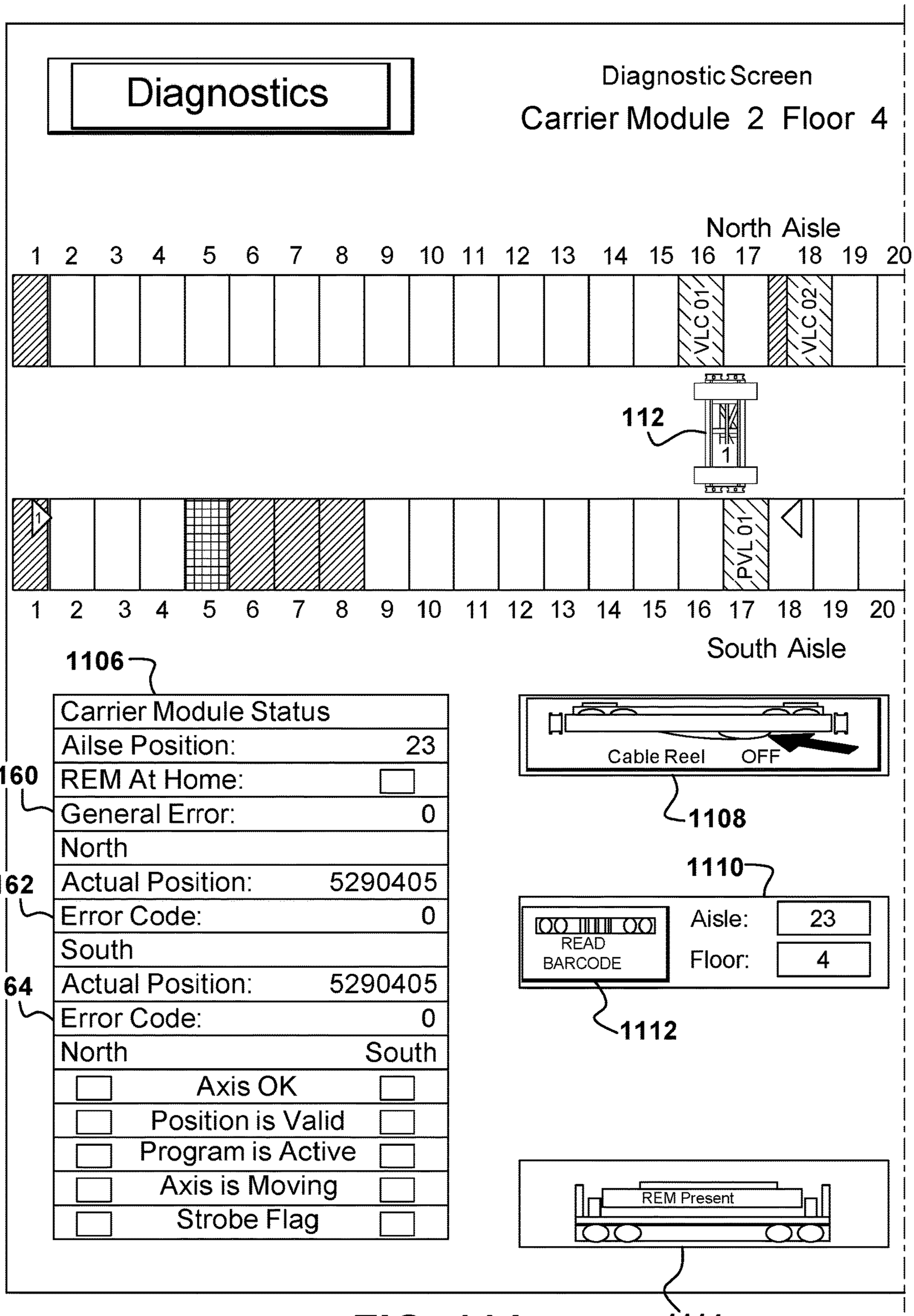

Diagnostics
Diagnostic Screen
Carrier Module 2 Floor 4
North Aisle
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
VLC 01
VLC 02
112
1
PVL 01
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
South Aisle
1106
Carrier Module Status
Ailse Position: 23
1160
REM At Home:
General Error: 0
North
1162
Actual Position: 5290405
Error Code: 0
South
1164
Actual Position: 5290405
Error Code: 0
North South
Axis OK
Position is Valid
Program is Active
Axis is Moving
Strobe Flag
Cable Reel OFF
1108
1110
READ BARCODE
Aisle: 23
Floor: 4
1112
REM Present
1114

FIG. 11A

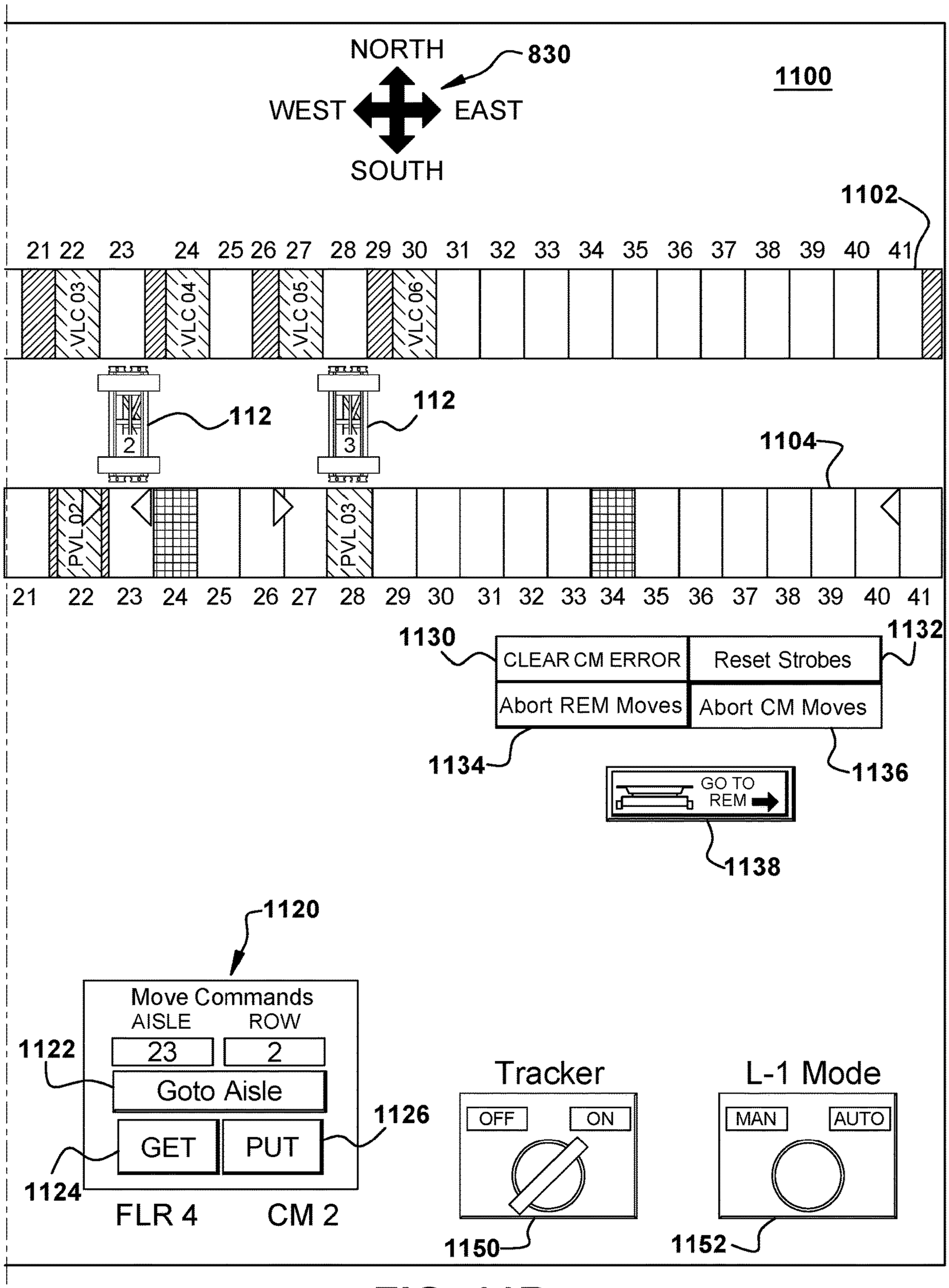

NORTH
WEST
EAST
SOUTH
830
1100
1102
21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41
VLC 03
VLC 04
VLC 05
VLC 06
112
2
112
3
1104
PVL 02
PVL 03
21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41
1130
CLEAR CM ERROR
Reset Strobes
1132
Abort REM Moves
Abort CM Moves
1134
1136
GO TO REM
1138
1120
Move Commands
AISLE
ROW
1122
23
2
Goto Aisle
GET
PUT
1126
1124
FLR 4
CM 2
Tracker
OFF
ON
1150
L-1 Mode
MAN
AUTO
1152

FIG. 11B

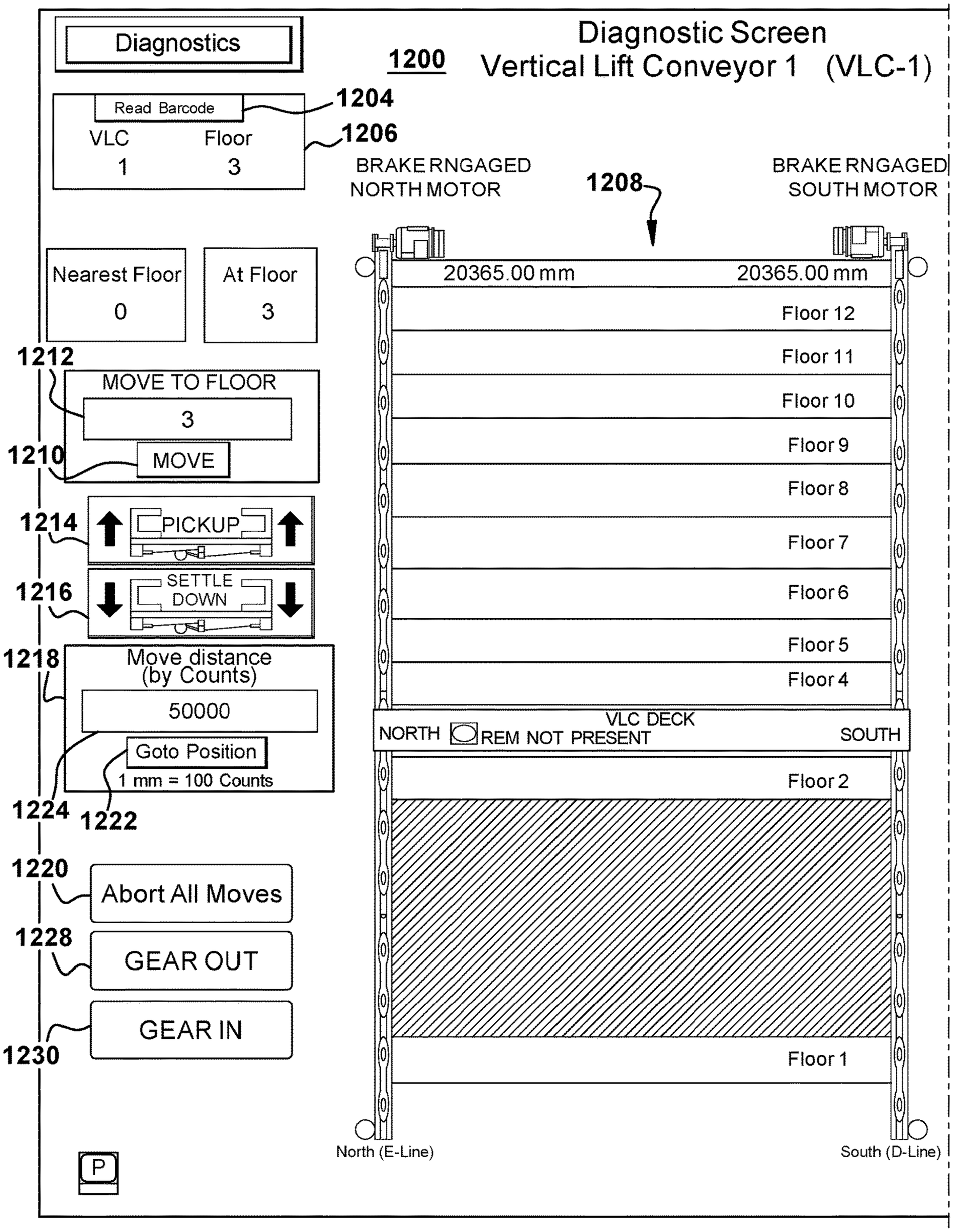

Diagnostics
Diagnostic Screen
1200
Vertical Lift Conveyor 1 (VLC-1)
Read Barcode
1204
VLC
Floor
1206
1
3
BRAKE RNGAGED
NORTH MOTOR
1208
BRAKE RNGAGED
SOUTH MOTOR
Nearest Floor
0
At Floor
3
20365.00 mm
20365.00 mm
Floor 12
Floor 11
1212
MOVE TO FLOOR
3
Floor 10
1210
MOVE
Floor 9
Floor 8
1214
PICKUP
Floor 7
1216
SETTLE
DOWN
Floor 6
Floor 5
1218
Move distance
(by Counts)
Floor 4
50000
VLC DECK
NORTH
REM NOT PRESENT
SOUTH
Goto Position
1 mm = 100 Counts
Floor 2
1224
1222
1220
Abort All Moves
1228
GEAR OUT
GEAR IN
1230
Floor 1
North (E-Line)
South (D-Line)
P

FIG. 12A

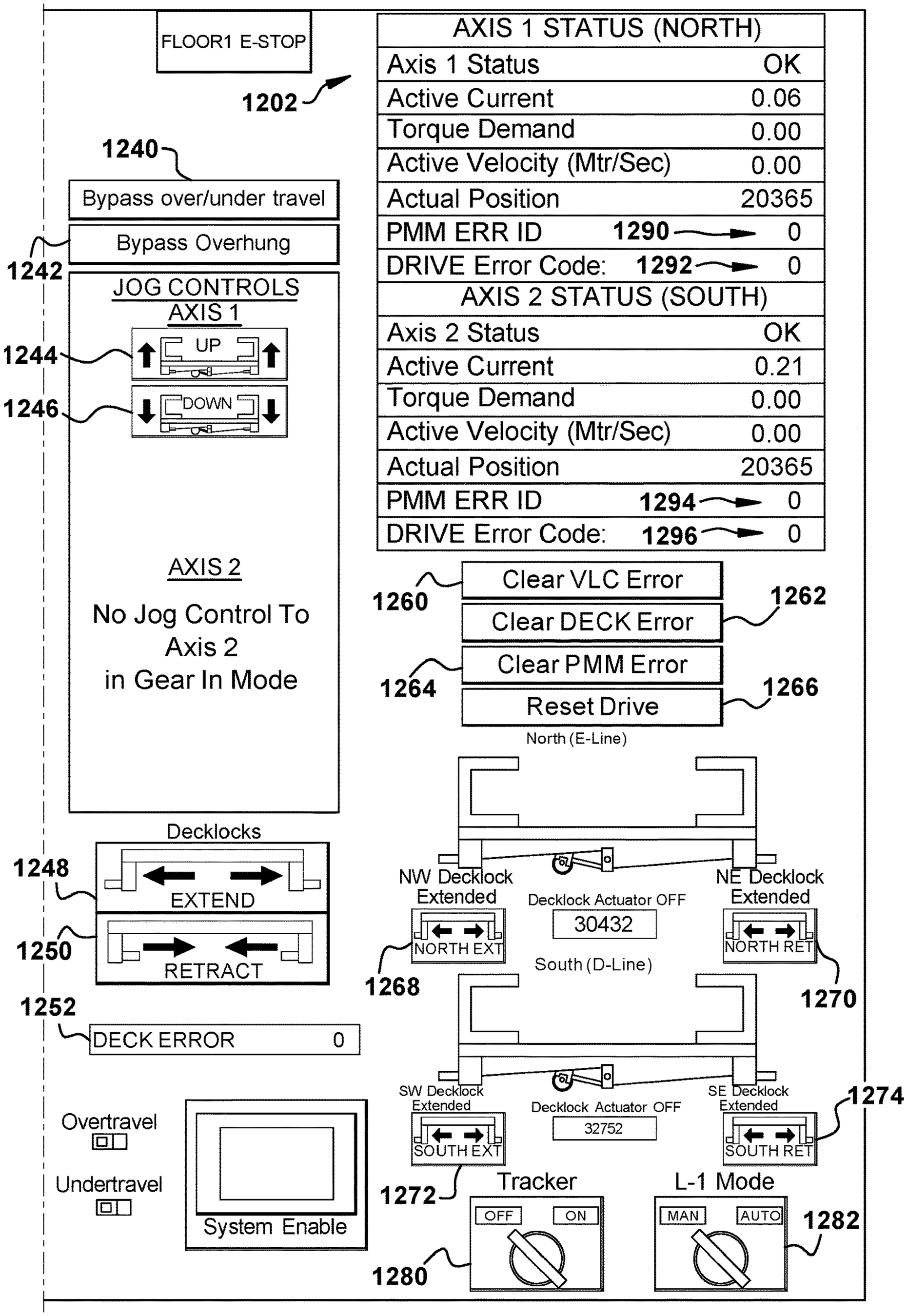

FLOOR1 E-STOP
1202
1240
Bypass over/under travel
Bypass Overhung
1242
JOG CONTROLS
AXIS 1
1244
UP
1246
DOWN
AXIS 2
No Jog Control To
Axis 2
in Gear In Mode
Decklocks
1248
EXTEND
1250
RETRACT
1252
DECK ERROR 0
Overtravel
Undertravel
System Enable
AXIS 1 STATUS (NORTH)
Axis 1 Status OK
Active Current 0.06
Torque Demand 0.00
Active Velocity (Mtr/Sec) 0.00
Actual Position 20365
PMM ERR ID 1290 0
DRIVE Error Code: 1292 0
AXIS 2 STATUS (SOUTH)
Axis 2 Status OK
Active Current 0.21
Torque Demand 0.00
Active Velocity (Mtr/Sec) 0.00
Actual Position 20365
PMM ERR ID 1294 0
DRIVE Error Code: 1296 0
1260
Clear VLC Error
Clear DECK Error
1262
Clear PMM Error
1264
Reset Drive
1266
North (E-Line)
NW Decklock Extended
Decklock Actuator OFF
30432
NE Decklock Extended
NORTH EXT
NORTH RET
1268
South (D-Line)
1270
SW Decklock Extended
Decklock Actuator OFF
32752
SE Decklock Extended
1274
SOUTH EXT
SOUTH RET
1272
Tracker
OFF
ON
L-1 Mode
MAN
AUTO
1282
1280

FIG. 12B

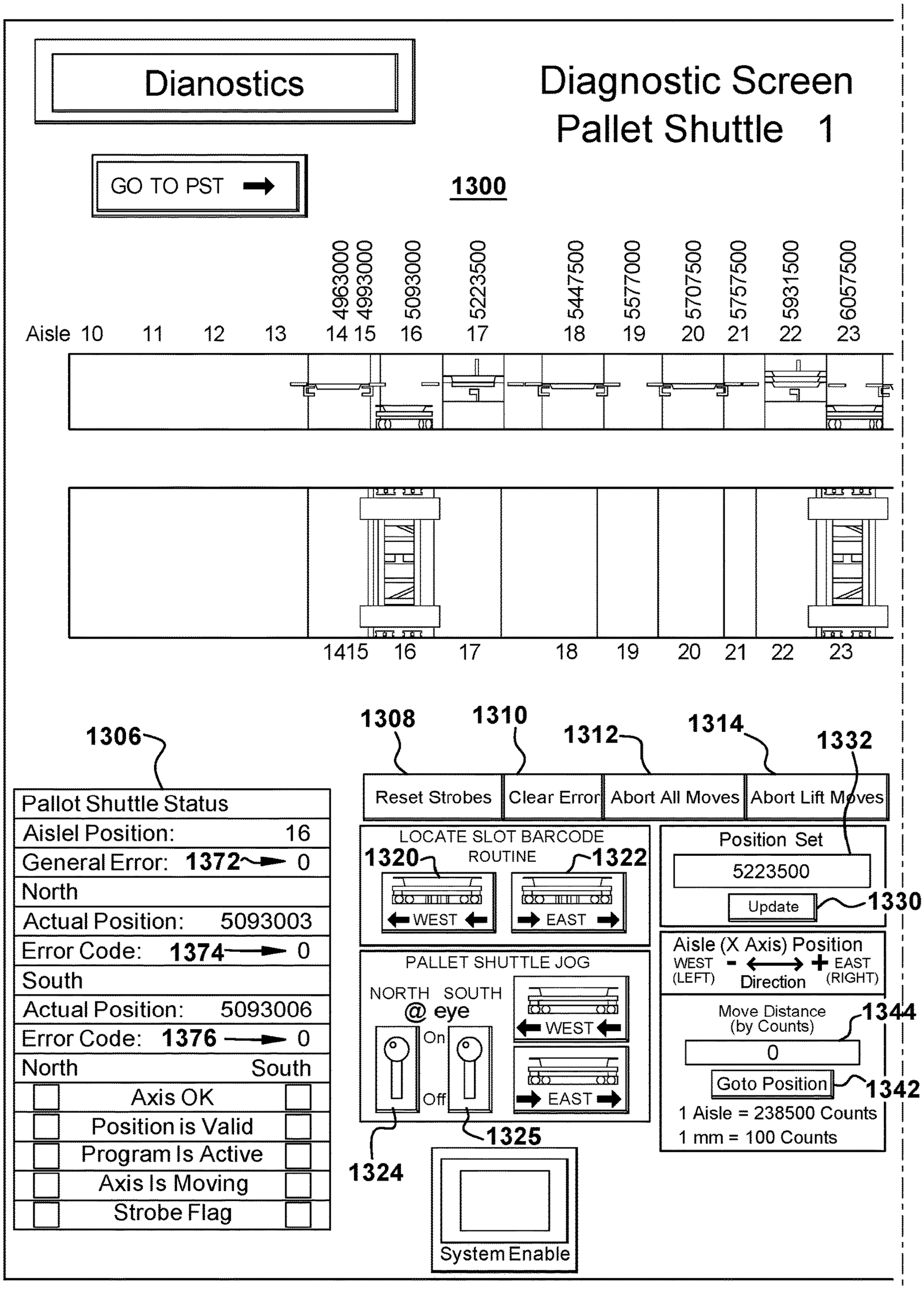

Dianostics
Diagnostic Screen
Pallet Shuttle 1
GO TO PST
1300
4963000
4993000
5093000
5223500
5447500
5577000
5707500
5757500
5931500
6057500
Aisle 10 11 12 13 14 15 16 17 18 19 20 21 22 23
1415 16 17 18 19 20 21 22 23
1306
Pallot Shuttle Status
Aislel Position: 16
General Error: 1372 0
North
Actual Position: 5093003
Error Code: 1374 0
South
Actual Position: 5093006
Error Code: 1376 0
North South
Axis OK
Position is Valid
Program Is Active
Axis Is Moving
Strobe Flag
1308
1310
1312
1314
1332
Reset Strobes
Clear Error
Abort All Moves
Abort Lift Moves
LOCATE SLOT BARCODE ROUTINE
1320
1322
WEST
EAST
Position Set
5223500
Update
1330
Aisle (X Axis) Position
WEST (LEFT) - Direction + EAST (RIGHT)
PALLET SHUTTLE JOG
NORTH SOUTH
@ eye
On
Off
WEST
EAST
1324
1325
Move Distance (by Counts)
1344
0
Goto Position
1342
1 Aisle = 238500 Counts
1 mm = 100 Counts
System Enable

FIG. 13A

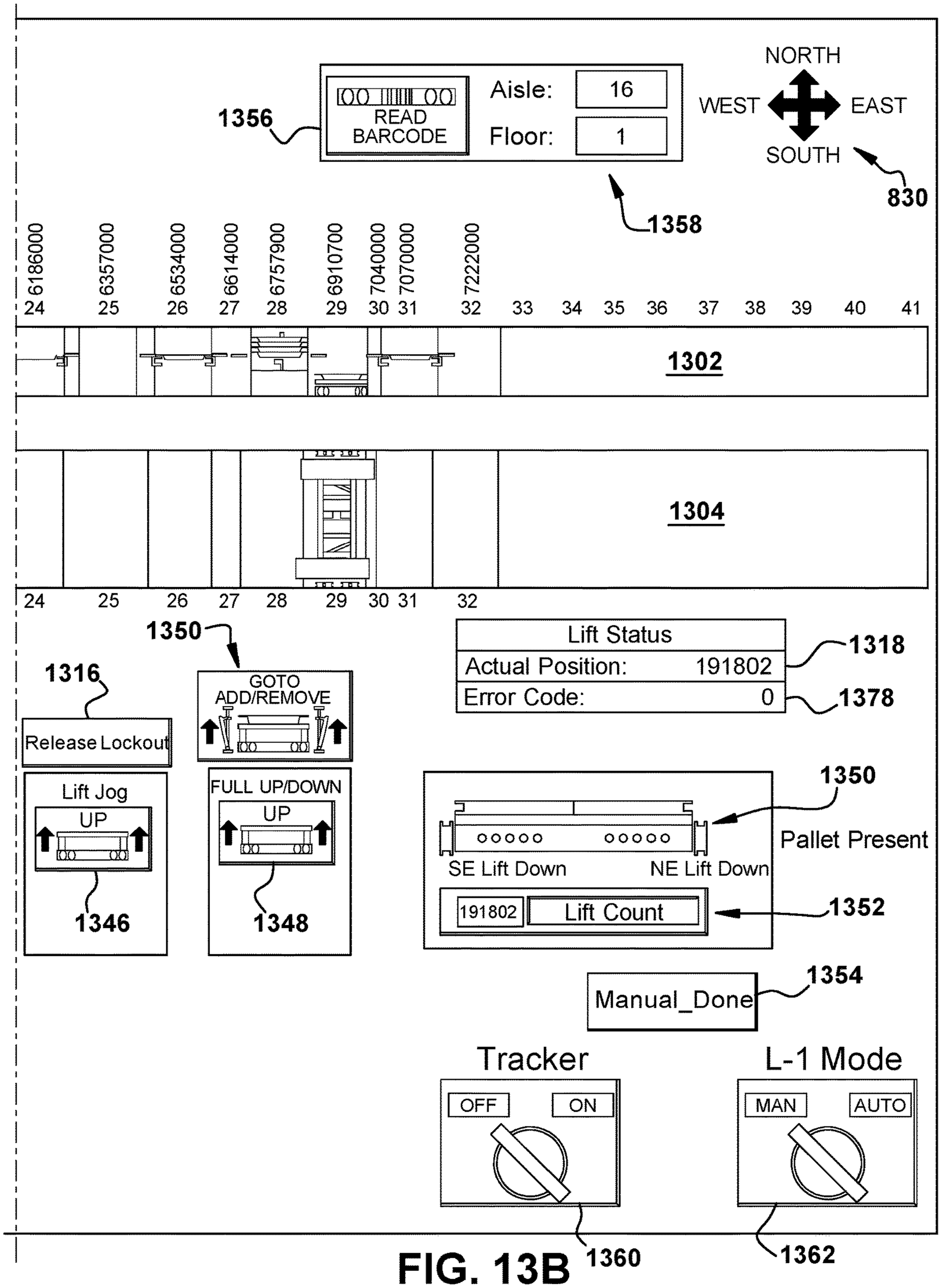

1356
READ BARCODE
Aisle: 16
Floor: 1
1358
NORTH
WEST
EAST
SOUTH
830
24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41
1302
1304
24 25 26 27 28 29 30 31 32
1350
1316
Release Lockout
GOTO ADD/REMOVE
Lift Jog
UP
1346
FULL UP/DOWN
UP
1348
Lift Status
Actual Position: 191802
Error Code: 0
1318
1378
1350
Pallet Present
SE Lift Down
NE Lift Down
191802
Lift Count
1352
Manual_Done
1354
Tracker
OFF
ON
L-1 Mode
MAN
AUTO
1360
1362

FIG. 13B

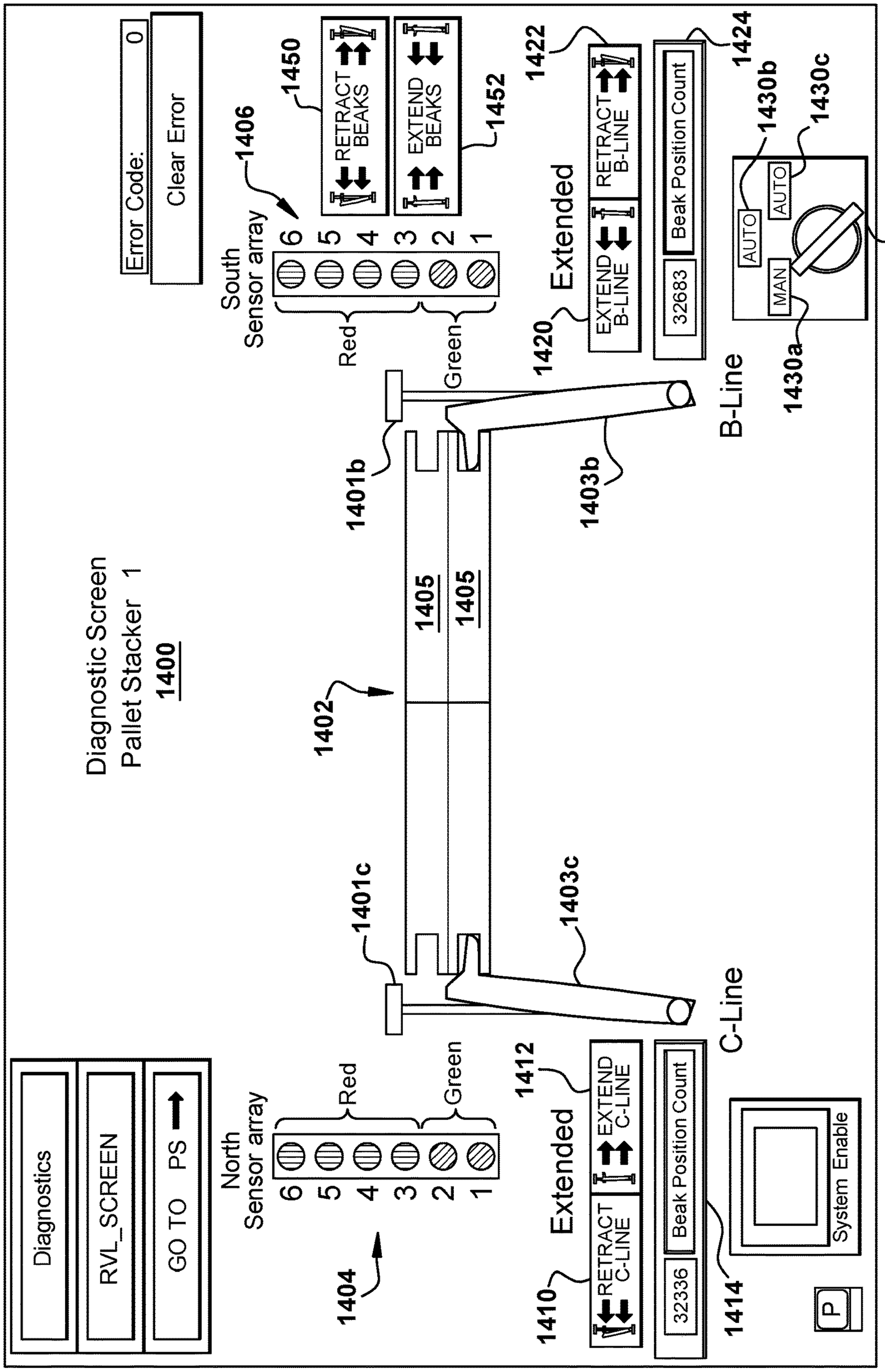

Diagnostic Screen
Pallet Stacker 1
1400
Error Code: 0
Clear Error
South
Sensor array
1406
6 5 4 3 2 1
Red
Green
1450
RETRACT BEAKS
EXTEND BEAKS
1452
1420
EXTEND B-LINE
1422
Extended
RETRACT B-LINE
32683
Beak Position Count
1424
AUTO
MAN
AUTO
1430b
1430c
1430
1430a
B-Line
1401b
1403b
1402
1405
1405
1401c
1403c
C-Line
Diagnostics
RVL_SCREEN
GO TO PS
North
Sensor array
6 5 4 3 2 1
Red
Green
1404
1410
RETRACT C-LINE
Extended
1412
EXTEND C-LINE
32336
Beak Position Count
1414
System Enable
P

FIG. 14

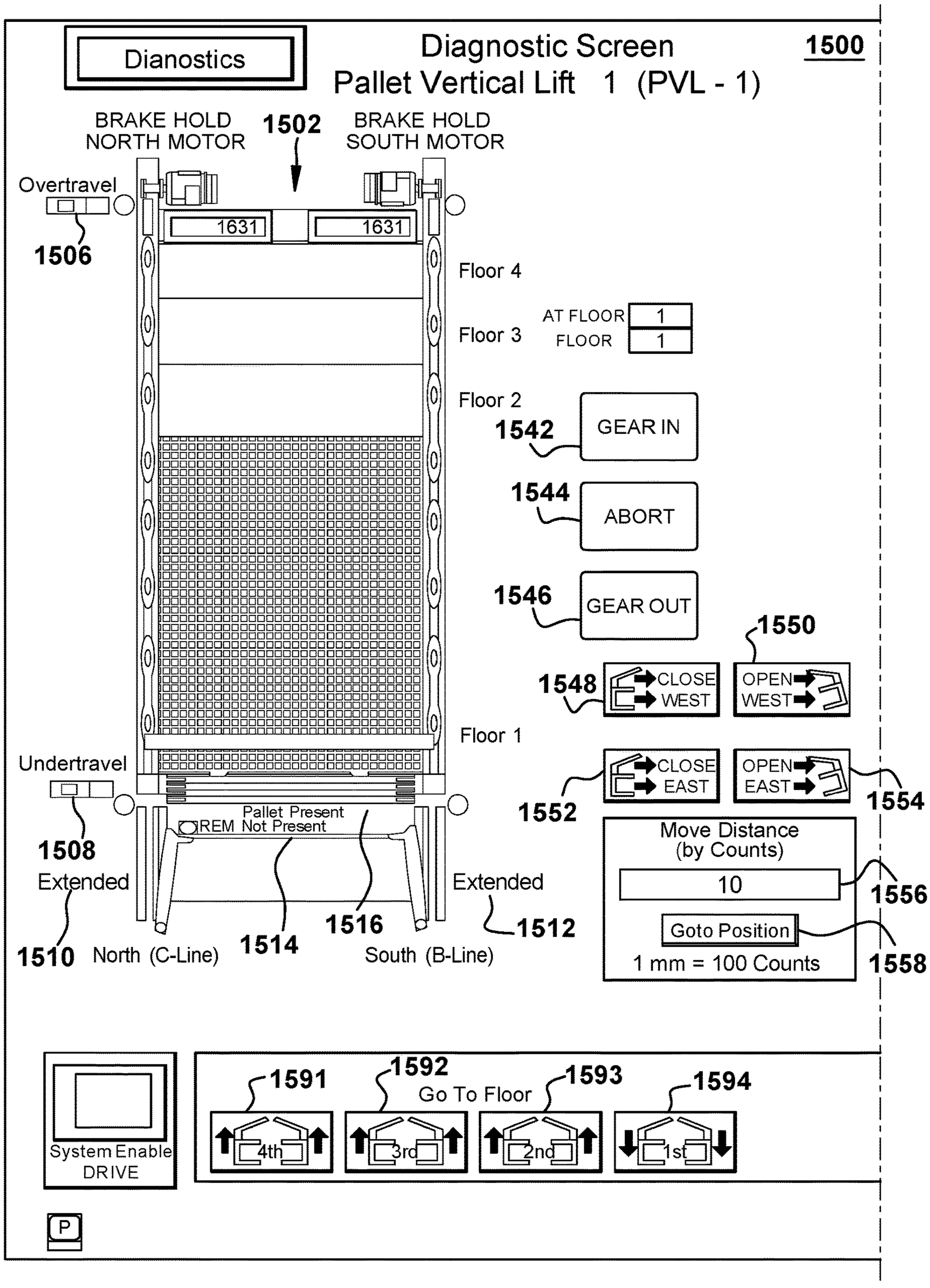

Dianostics
Diagnostic Screen
Pallet Vertical Lift 1 (PVL - 1)
1500
BRAKE HOLD NORTH MOTOR
1502
BRAKE HOLD SOUTH MOTOR
Overtravel
1506
1631
1631
Floor 4
Floor 3
AT FLOOR 1
FLOOR 1
Floor 2
1542
GEAR IN
1544
ABORT
1546
GEAR OUT
1550
1548
CLOSE WEST
OPEN WEST
Floor 1
Undertravel
CLOSE EAST
OPEN EAST
1552
1554
Pallet Present
REM Not Present
1508
Move Distance (by Counts)
10
1556
Extended
Extended
Goto Position
1 mm = 100 Counts
1558
1516
1512
1510
North (C-Line)
1514
South (B-Line)
System Enable DRIVE
1591
1592
Go To Floor
1593
1594
4th
3rd
2nd
1st
P

FIG. 15A

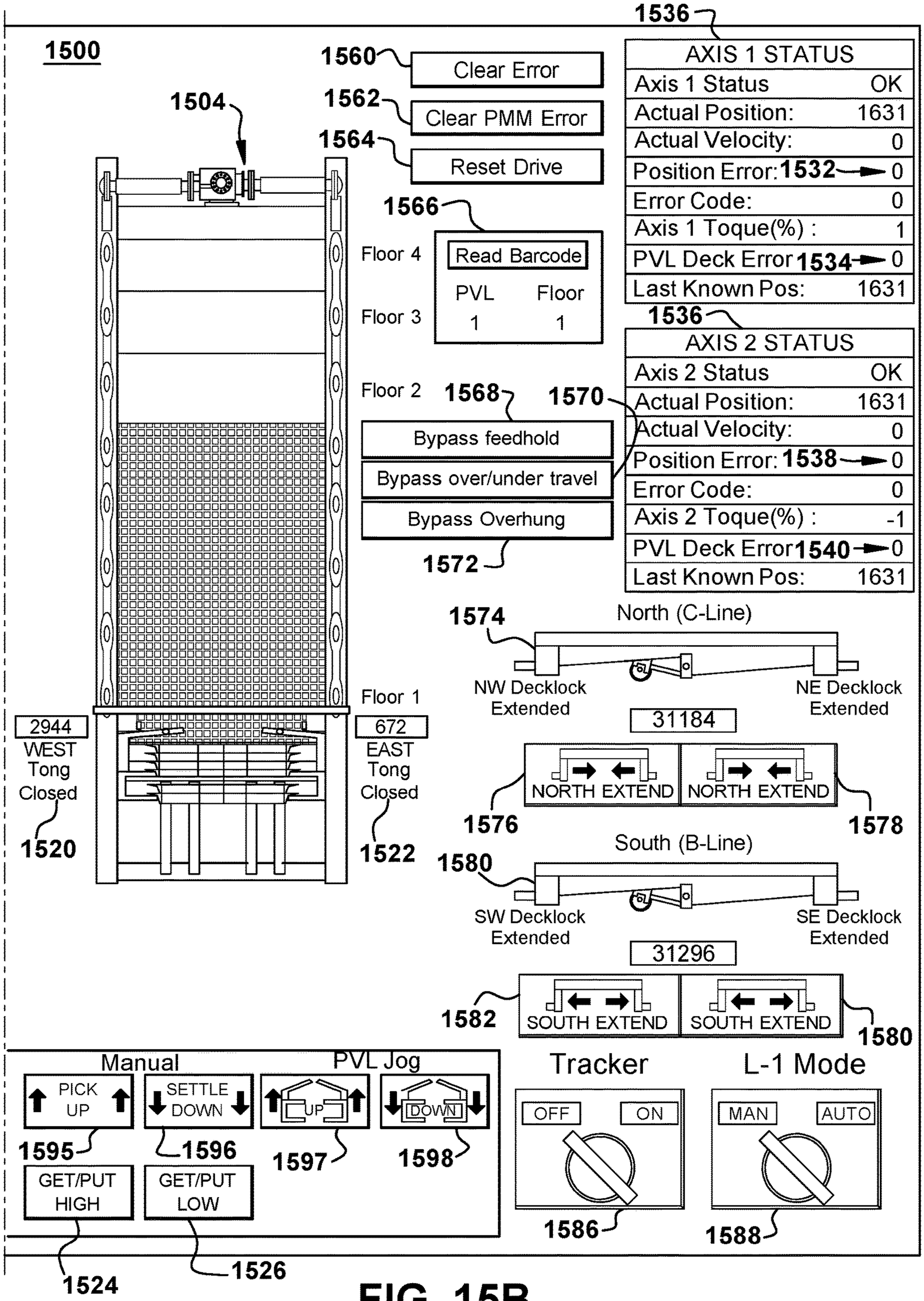
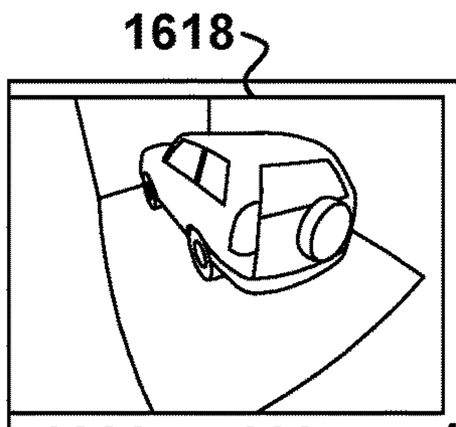
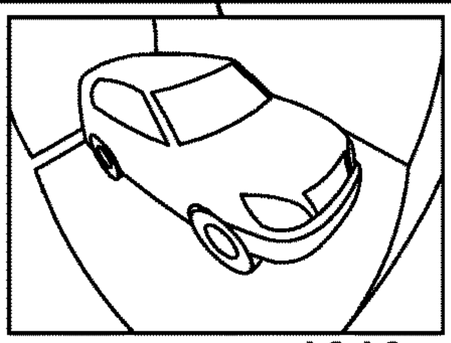

1500
1504
1560
Clear Error
1562
Clear PMM Error
1564
Reset Drive
1566
Read Barcode
PVL
Floor
1
1
Floor 4
Floor 3
Floor 2
1568
1570
Bypass feedhold
Bypass over/under travel
Bypass Overhung
1572
Floor 1
2944
WEST
Tong
Closed
1520
672
EAST
Tong
Closed
1522
1536
AXIS 1 STATUS
Axis 1 Status OK
Actual Position: 1631
Actual Velocity: 0
Position Error: 1532 0
Error Code: 0
Axis 1 Toque(%) : 1
PVL Deck Error 1534 0
Last Known Pos: 1631
1536
AXIS 2 STATUS
Axis 2 Status OK
Actual Position: 1631
Actual Velocity: 0
Position Error: 1538 0
Error Code: 0
Axis 2 Toque(%) : -1
PVL Deck Error 1540 0
Last Known Pos: 1631
1574
North (C-Line)
NW Decklock Extended
NE Decklock Extended
31184
NORTH EXTEND
NORTH EXTEND
1576
1578
South (B-Line)
1580
SW Decklock Extended
SE Decklock Extended
31296
1582
SOUTH EXTEND
SOUTH EXTEND
1580
Manual
PVL Jog
PICK UP
SETTLE DOWN
UP
DOWN
1595
1596
1597
1598
GET/PUT HIGH
GET/PUT LOW
1524
1526
Tracker
OFF
ON
1586
L-1 Mode
MAN
AUTO
1588

FIG. 15B



IN



00d:00h:22m

1600

5.00

1618 1620 1602 1604 1606 1608 1610 1612 1614 1616

	V3d	M18	Name	Time In	EES In	Time Out	EES Out	CarOut
	4043	0	4043	Jul 26 07:21	EE50294	Jul 26 13:49	6	☑
	1082	1082	AL RASHED	Jul 26 07:27	EE50294	Jul 26 10:47	5	☑
	4021	0	4021	Jul 26 08:58	EE50294	Jul 26 10:10	5	☑
	4045	0	4045	Jul 26 09:37	EE50294	Jul 26 11:52	5	☑
	4007	0	4017	Jul 26 10:41	EE50294	Jul 26 10:59	5	☑
▶	4002	0	4002	Jul 26 11:20	EE50294	Jul 26 11:42	5	☑
	4006	0	4014	Jul 26 11:35	EE50294	Jul 26 10:21	5	☑
	4041	0	4048	Jul 26 12:10	EE50294	Jul 26 10:21	6	☑
	4003	0	4033	Jul 26 12:34	EE50294	Jul 26 12:54	5	☑
	4047	0	4047	Jul 26 13:17	EE50294	Jul 26 10:28	5	☑
	4040	0	4040	Jul 26 07:21	EE50294	Jul 26 10:56	6	☑
	4043	0	4018	Jul 26 10:45	EE50294	Jul 26 11:24	5	☑
	4005	0	4015	Jul 26 11:21	EE50294	Jul 26 10:02	5	☑
	4004	0	4014	Jul 26 11:51	EE50294	Jul 26 12:12	5	☑
	1001	1001	QAQEER AHMED	Jul 26 06:47	EE50294	Jul 26 14:06	8	☑
	4005	0	4005	Jul 26 10:47	EE50294	Jul 26 10:40	6	☑
	4008	0	4008	Jul 26 11:22	EE50294	Jul 26 12:11	7	☑
	4046	0	4046	Jul 26 07:20	EE50294	Jul 26 14:00	8	☑
	4041	0	4041	Jul 26 07:32	EE50294	Jul 26 12:01	8	☑
	1004	1074	MOHAMMAD TAY	Jul 26 07:40	EE50294	Jul 26 09:08	8	☑
	4004	0	4004	Jul 26 07:55	EE50294	Jul 26 10:06	8	☑
	4001	0	4001	Jul 26 08:20	EE50294	Jul 26 09:39	8	☑
	4003	0	4022	Jul 26 05:38	EE50294	Jul 26 12:53	8	☑
	4007	0	4027	Jul 26 10:07	EE50294	Jul 26 10:54	8	☑
	1065	1065	ABCULWAHAB A	Jul 26 10:27	EE50294	Jul 26 10:56	8	☑
	1006	1066	IBRAHAM AL M	Jul 26 08:17	EE50294	Jul 26 12:54	7	☑
	4009	0	4238	Jul 26 08:20	EE50294	Jul 26 08:42	8	☑
	4007	0	4007	Jul 26 08:47	EE50294	Jul 26 09:29	7	☑
	4006	0	4006	Jul 26 09:32	EE50294	Jul 26 10:13	7	☑
	4001	0	4001	Jul 26 10:20	EE50294	Jul 26 12:30	8	☑
	4000	0	4000	Jul 26 10:54	EE50294	Jul 26 13:49	8	☑

FIG. 16A

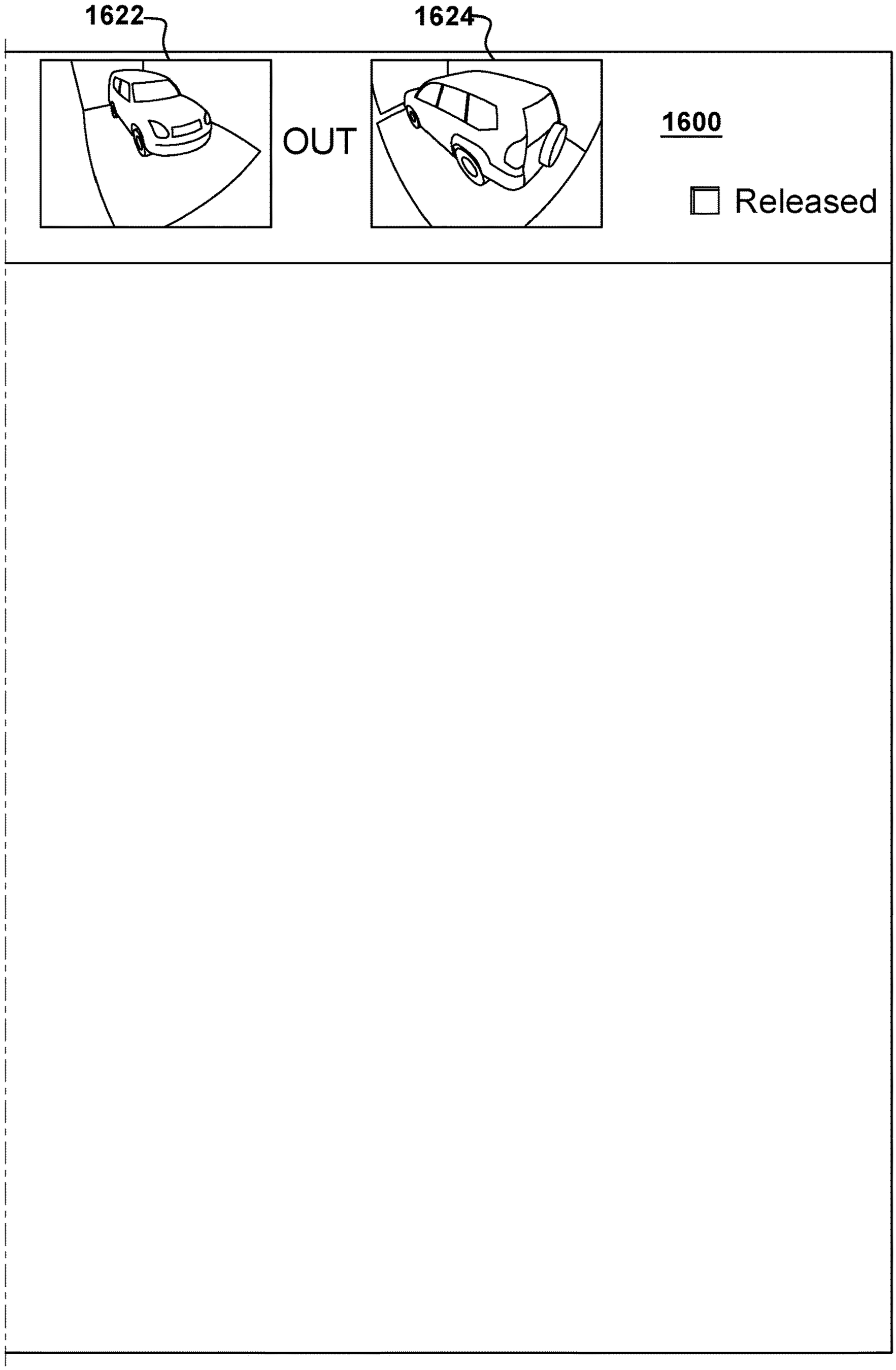


FIG. 16B

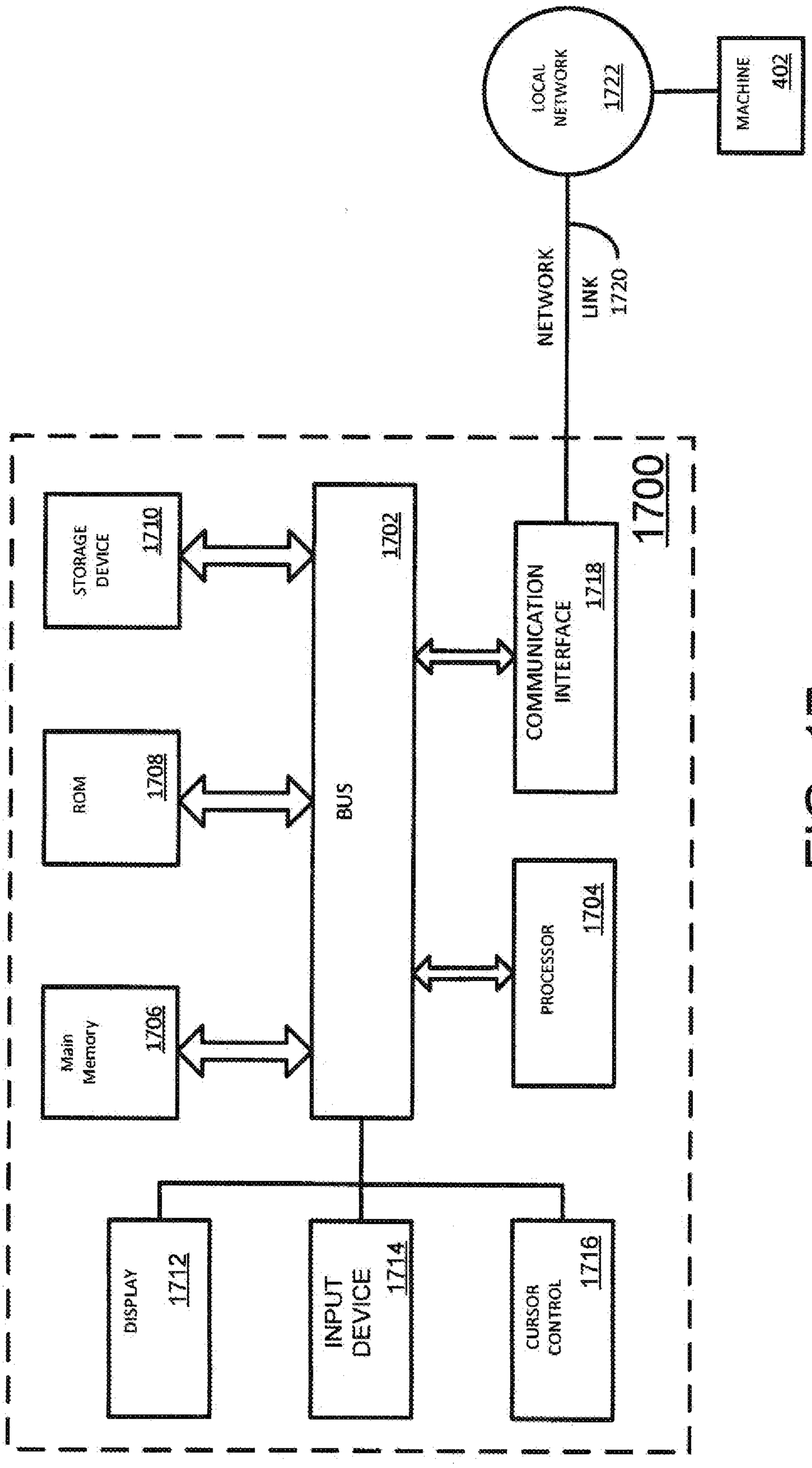

LOCAL NETWORK 1722
MACHINE 402
NETWORK LINK 1720
1700
STORAGE DEVICE 1710
ROM 1708
BUS 1702
COMMUNICATION INTERFACE 1718
PROCESSOR 1704
Main Memory 1706
DISPLAY 1712
INPUT DEVICE 1714
CURSOR CONTROL 1716

FIG. 17

INFORMATION SYSTEM FOR A ROBOTIC PARKING GARAGE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a divisional of U.S. patent application Ser. No. 18/496,622, filed Oct. 27, 2023..

TECHNICAL FIELD

[0002] The present disclosure relates generally to runtime control, tracking, and diagnostics of machines employed in robotic parking garages.

BACKGROUND

[0003] Robotic parking garages have been around since the late 1950s. Early automated parking garages utilized crane systems, conveyors, hydraulics, and pneumatics for transporting vehicles for storage and retrieval. More recently, automated parking garages have employed more advanced systems that include computer-controlled, specialized equipment for storing and retrieving systems. However, these systems have rudimentary user interfaces for monitoring and controlling the equipment.

OVERVIEW OF EXAMPLE EMBODIMENTS

[0004] The following presents a simplified overview of the example embodiments in order to provide a basic understanding of some aspects of the example embodiments. This overview is not an extensive overview of the example embodiments. It is intended to neither identify key or critical elements of the example embodiments nor delineate the scope of the appended claims. Its sole purpose is to present some concepts of the example embodiments in a simplified form as a prelude to the more detailed description that is presented later.

[0005] In accordance with an example embodiment, there is disclosed herein an apparatus comprising a machine associated with an operation of an automated parking garage that comprises a motor, a controller coupled with the machine and operable to control and monitor operation of the motor, and a sensor coupled with the motor and the controller, and a user interface coupled with the controller that comprises a display and an input. The sensor is operable to obtain data representative of a movement of the motor and provide the data representative of the movement of the motor to the controller. The user interface displays a runtime value for the machine. A threshold value corresponding to the runtime value is displayed on the user interface. The user interface is operable to receive a change to the threshold value via the input.

[0006] In accordance with an example embodiment, there is disclosed herein a user interface that comprises diagnostic display screens corresponding to machines for operating an automated, or robotic, parking garage. The user interface is coupled with a controller that is coupled with the machines. The diagnostic display screens comprise an input that are operable to control the operation of the corresponding machines. The controller is operable to cause status data for the machine to be displayed on a corresponding diagnostic screen and responsive to receiving an input when the machine is in certain modes from the corresponding diagnostic screen to move the machine an amount specified in the input.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The accompanying drawings incorporated herein and forming a part of the specification illustrate the example embodiments.

[0008] FIG. **1** is a cutaway view illustrating the interior of an automated parking garage upon which an example embodiment is implemented.

[0009] FIG. **2** is a block diagram illustrating an example of a plurality of automated parking garage modules that further comprise additional entry level carriers and terminals where multiple items can be moved at the same time and an example embodiment is implemented.

[0010] FIG. **3** is a block diagram illustrating an example of a system for operating an automated parking garage in accordance with an example embodiment.

[0011] FIG. **4** is a block diagram illustrating an example of a system employed by a robotic parking garage that comprises a controller for controlling a machine associated with the robotic parking garage and a user interface allowing an operator to obtain real time data about the machine and interact with the controller to control operation of the machine.

[0012] FIG. **5**A illustrates an example of a first section of a first user interface screen for providing runtime data and providing inputs for maintaining a first plurality of robotic parking garage machines.

[0013] FIG. **5**B is a continuation of the user interface screen illustrated in FIG. **5**A.

[0014] FIG. **6**A illustrates an example of a first section of a second user interface screen for providing runtime data and providing inputs for maintaining a second plurality of robotic parking garage machines.

[0015] FIG. **6**B s a continuation of the user interface screen illustrated in FIG. **6**A.

[0016] FIG. **7** illustrates an example of a third user interface screen for providing runtime data and providing inputs for maintaining a third plurality of robotic parking garage machines.

[0017] FIG. **8** illustrates an example diagnostic screen for an Entry Exit Station (EES).

[0018] FIG. **9**A illustrates an example of a first section of a diagnostic screen for a first floor Carrier Module with Turn Table (CM TT).

[0019] FIG. **9**B is a continuation of the diagnostic screen illustrated in FIG. **9**A

[0020] FIG. **10**A illustrates an example of a first section of diagnostic screen for a Rack Entry Module (REM).

[0021] FIG. **10**B is a continuation of the diagnostic screen illustrated in FIG. **10**A.

[0022] FIG. **11**A illustrates an example of a first section of a diagnostic screen for an upper-floor Carrier Module. (UCM).

[0023] FIG. **11**B is a continuation of the diagnostic screen illustrated in FIG. **11**A.

[0024] FIG. **12**A illustrates an example of a first section of a diagnostic screen for a Vertical Lift Conveyer. (VLC).

[0025] FIG. **12**B is a continuation of the diagnostic screen illustrated in FIG. **12**A.

[0026] FIG. **13**A illustrates an example of a first, section of a diagnostic screen for a Pallet Shuttle. (PS).

[0027] FIG. **13**B is a continuation of the diagnostic screen illustrated in FIG. **13**A.

[0028] FIG. **14** illustrates an example diagnostic screen for a Pallet Stacker. (PST)

[0029] FIG. **15**A illustrates an example of a first section of diagnostic screen for a Pallet Vertical Lift. (PVL)

[0030] FIG. **15**B is a continuation of the diagnostic screen illustrated in FIG. **15**A.

[0031] FIG. **16**A illustrates an example of first section of an operator interface to view the status of vehicles that were parked in the parking garage.

[0032] FIG. **16**B is a continuation of the operator interface illustrated in FIG. **16**A.

[0033] FIG. **17** is a block diagram that illustrates a computer system upon which an example embodiment may be implemented.

DESCRIPTION OF EXAMPLE EMBODIMENTS

[0034] This description provides examples not intended to limit the scope of the appended claims. The figures generally indicate the features of the examples, where it is understood and appreciated that like reference numerals are used to refer to like elements. Reference in the specification to "one embodiment" or "an embodiment" or "an example embodiment" means that a particular feature, structure, or characteristic described is included in at least one embodiment described herein and does not imply that the feature, structure, or characteristic is present in all embodiments described herein.

[0035] FIG. **1** is a cutaway view illustrating the interior of an automated parking garage **100** upon which an example embodiment is implemented. In the illustrated example, portions of the exterior wall **102** and roof **104** are removed in order to view the interior of the automated parking garage **100**.

[0036] In the illustrated example, the automated parking garage **100** comprises a plurality of levels (or floors) **106** and a plurality of vertical storage units **108** (which are used for parking vehicles but can also be used to store storage containers, thus storage units **108** may also be referred to herein as "parking spaces" or "storage spaces" on the plurality of levels **106**. The automated parking garage **100** further comprises a vertical lift carrier ("VLC") **110**, upper horizontal carriers ("UCM") **112**, and entry level carrier ("EES") **116**, and a plurality of entry exit stations (also referred to herein as "terminals") **118**. In the illustrated example, the storage (or parking) units **108** have two storage spaces **114** that can be parking space configured to parking cars and/or storing containers. Thus, storage space **114** may also be referred to as a parking space.

[0037] The entry level carrier **116** transports a vehicle along the entry level of the automated parking garage **100**. For example, the ELC **116** can transport vehicle V from an entry/exit station **118** to a vertical lift carrier **110** and/or to storage units **108** on the entry level. The vertical lift carrier **110** transports the vehicle V between floors and the upper horizontal carrier **112** transports the vehicle V along a floor, such as for example to or from a VLC **110** and a storage unit **108**.

[0038] In an example embodiment, the parking garage **100** has storage spaces **114** on both sides of the aisle **122** as illustrated in FIG. **1**. Those skilled in the art can readily appreciate that in other embodiments there may be vertical storage units **108** located on one side of the aisle **122**.

[0039] In the illustrated example, the vertical storage unit **108** has two storage spaces **114** per level **106**. As those skilled in the art can readily appreciate, other embodiments may have a single storage space **114** or any other physically realizable number of storage spaces.

[0040] In operation, when a vehicle V enters an entry exit station **118**A, the vehicle V drives onto a pallet **120**. In an example embodiment, the pallet is made of steel, however, those skilled in the art can readily appreciate that any suitable material can be employed for pallet **120**. The pallet **120** with vehicle V thereon are transferred to entry level carrier **116** located in aisle **122**.

[0041] In an example embodiment, the entry level carrier **116** is rotated one hundred and eighty degrees. Thus, when the vehicle V is later retrieved for departure, it is facing the entrance of a terminal **118** obviating the need for the driver to back out of the garage **100**. In the illustrated example, the vehicle V is being parked on a different level than the terminal **118**A. The vehicle is transferred to a vertical lift carrier **110** for transport to the appropriate level. Once at the appropriate level **106** **106**A in this example, the vehicle V is transferred to an upper horizontal carrier **112**. The upper horizontal carrier **112** is motorized and is operable to travel horizontally via rail **124**. The upper horizontal carrier **112** transports the vehicle V adjacent to storage (parking) space **114**A, and the vehicle is transferred into storage (parking) space **114**A.

[0042] As those skilled in the art can readily appreciate, the number of levels **106**, vertical storage units **108**, vertical lift carriers **110**, upper horizontal carriers **112** parking spaces **114**, entry level carriers **116**, and terminals **118** were merely selected for ease of illustration, and that the principles described herein can be applied to automated parking garages having any desired, physically realizable number of levels **106**, vertical storage units **108**, vertical lift carriers **110**, upper horizontal carriers **112** parking spaces **114**, entry level carriers **116**, and terminals **118**. Thus, the example embodiments described herein should not be construed as being limited to the configuration of the automated parking garage **100** illustrated in FIG. **1**.

[0043] FIG. **2** is a block diagram illustrating a second example of a section **200** of an automated parking garage **100** that comprises a plurality of modules that further comprise additional entry level carriers **116** and terminals **118**. In this example there are two entry level carriers **116** and two upper horizontal modules **112** for an arrangement of three vertical lift carriers **110** and ten vertical storage units **108**. In this example, there are two vertical storage units **108** on each end **202**, **204** of the section **200** and three vertical storage units **108** between each vertical lift carrier **110** to further illustrate the flexibility of the modular configuration described herein.

[0044] FIG. **3** is a block diagram illustrating an example of a system **300** for operating an automated parking garage (e.g., automated parking garage **100**) in accordance with an example embodiment. The system comprises a plurality of vertical lift carriers (VLC 1 . . . VLC m, where m is an integer greater than 1) **110**. upper horizontal carriers (HC 1 . . . HC n, where n is an integer greater than 1) **112**, and a plurality of entry level carriers (ELC 1 . . . ELC o, where o is an integer greater than 1) **116** that are coupled with a controller **302**. As will be described herein, the controller **302** is operable to control the movement of the plurality of vertical lift carriers **110**, upper horizontal carriers **112**, and entry level carriers **116** so that a plurality of vehicles can be moved concurrently or simultaneously. The control **302** comprises logic **304** that performs the functionality

described herein. "Logic," as used herein, includes but is not limited to hardware, firmware, software and/or combinations of each to perform a function(s) or an action(s), and/or to cause a function or action from another component. For example, based on a desired application or need, logic may include a software controlled microprocessor, discrete logic such as an application specific integrated circuit (ASIC), a programmable/programmed logic device, memory device containing instructions, or the like, or combinational logic embodied in hardware. Logic may also be fully implemented in software that is embodied on a tangible, non-transitory computer-readable medium that performs the described functionality when executed by processor.

[0045] FIG. **4** is a block diagram illustrating an example of a system **400** that can be employed by a robotic parking garage **100** that comprises a controller **302** for controlling a machine **402** associated with the robotic parking garage and a user interface **404** that enables an operator to obtain real time data about the machine and interact with the controller to control operation of the machine.

[0046] The machine **402** comprises a motor **410** and a sensor **412**, and may be any suitable type of equipment employed in a robotic parking garage. Examples, include, but are not limited to a carrier module (e.g., an upper horizontal carrier **112** and/or an entry level carrier **116**, which may also include a turn table), a vertical lift carrier **110**, a rack entry module, a pallet vertical lift, and pallet shuttle (see e.g., U.S. Pat. No. 6,851,921, which is incorporated by reference herein in its entirety for an example of a rack entry module, a pallet vertical lift, and a pallet shuttle; see also, US Patent Application Publication No.2015/0175354, incorporated by reference herein in its entirety for an example of a turn table).

[0047] The motor **410** is controlled and monitored by controller **302**. Examples of the type of motor for motor **410** include, but are not limited to, an electric motor, a servo-mechanism, and a stepper motor. The movement of the motor **410** is controlled by the controller **302**. In an example embodiment, the controller sends a signal to the motor **410** which causes the motor **410** to move a distance specified by the controller **302**. In another example embodiment, the controller **302** can cause motor **410** to rotate a specified number of times, and in particular embodiments at a specified speed (e.g., revolutions per minute or "RPMs").

[0048] The sensor **412** can be any suitable device for measuring a desired movement of the motor **410** and provides data representative of movement of the motor **410** to the controller **302**. In an example embodiment, the sensor **414** can employ an encoder to measure rotation of a shaft. In another example embodiment, the sensor **414** comprises reflective tape and an optical scanner and measures the number of rotations. In an example embodiment, the sensor **412** can sense the position of an object coupled with the controller and for example can determine when the object has moved from a first position to a second position and the second position to the first position (e.g., lift up or down for a pallet stacker). In an example embodiment, the controller **302** monitors how many times the motor performs a certain function (e.g., lift up or down for a pallet stacker). Further examples of the types of sensors **412** and data provided by the sensors **412** and the data maintained by the controller **302** will be described herein infra.

[0049] The user interface **404** comprises a display **420** and an input device **420**, which in the illustrated example is touch screen but in other embodiments can employ other devices, such as for example, a mouse and/or keyboard. The data displayed on display **420** and the inputs that can be received by the input device **422** can improve an operator's ability to interact with the control system **302** for controlling and/or maintaining the machine **402**. FIGS. **5-7** illustrate three embodiments of the user interface **400** that provide runtime data, thresholds where an alarm is generated if exceeded, and the ability change the thresholds and reset the runtime data when maintenance on a machine **402** and/or a machine's motor **404** is completed.

[0050] As those skilled in the art can readily appreciate, the number of controllers **302**, machines **402**, and user interfaces **420** were selected merely for ease of illustration. In example embodiments, the system **400** can comprise any physically realizable number of controllers **302**, machines **402**, and user interfaces **420**. Thus, the principles described herein should not be limited to the number of elements described in FIG. **4**.

[0051] FIGS. **5**A and **5**B illustrates an example of a first user interface screen **500** for providing runtime data and providing inputs for maintaining a first plurality of robotic parking garage machines. The display **420** is broken down into three parts for each machine, for example columns **502** and **512** identify the machine. Columns **504**, **506**, **508** [provide runtime data for the corresponding machine in column **502** and columns **514**, **516**, **518** provide runtime data for the corresponding machine in column **512**. Columns **520**, **522**, **524**, **526**, **528** provide threshold data for generating alarms.

[0052] For example, column **502** provides data representative of the identification of the carrier modules (CM, which can be an ELC **116** on the first floor or an HC **112** on upper floors), the floor (FLR) the module is located on, and a module number for the floor. For example, for the first floor there are six carrier modules (CM_FLR1_01, CM_FLR1_02, CM_FLR1_03, CM_FLR1_04, CM_FLR1_05, CM_FLR1_06) on the second floor three carrier modules (CM_FLR2_01, CM_FLR2_02, CM_FLR2_03), on the third floor three carrier modules (CM_FLR3_01, CM_FLR3_02, CM_FLR3_03), on the fourth floor three carrier modules (CM_FLR4_01, CM_FLR4_02, CM_FLR4_03) and on the sixth floor three carrier modules CM_FLR5_01, CM_FLR5_02, CM_FLR5_03). Column **512** provides the identification of the Rack Entry Module (REM) corresponding to the carrier module identified in column **512** (e.g., REM_FLR1_01 corresponds to CM_FLR_01, REM_FLR1_02 corresponds to CM_FLR1_02, etc.).

[0053] Column **504** provides a Runtime, number of revolutions for the corresponding machine in column **502**. Column **506** provides a Runtime operating time (hours:minutes or "hh:mm) for the corresponding machine in column **502**. Column **508** provides the turntable (TT) Runtime operating time for the corresponding machine in column **502**. Column **510** provides a Runtime operating time for the corresponding machine in column **502**. Columns **520**, **522**, **524** provide the alarm threshold limits for the data in columns **504**, **506**, **508**, **510** respectively. If a runtime value exceeds the threshold value, then the controller **302** causes the runtime data that exceeds the value to be displayed in a second color (e.g., red). In particular embodiments, if a runtime value is within a predefined threshold of the alarm threshold (e.g., with a certain %, number of revolutions, time, and/or number of

rotations), the controller causes the runtime data to displayed a third color (e.g., yellow, indicating maintenance is due soon).

[0054] Column **514** provides a Runtime, number of revolutions for the corresponding machine in column **512**. Column **516** provides a Runtime operating time for the corresponding machine in column **512**. Column **516** provides the number of times the Rack Entry Module ("REM") lifted has moved up and down for the corresponding machine in column **512**. Columns **520**, **522**, **526**, provide the alarm threshold limits for the data in columns **514**, **516**, **518** respectively. If a runtime value exceeds the threshold value, then the controller **302** causes the runtime data that exceeds the value to be displayed in a second color (e.g., red). In particular embodiments, if a runtime value is within a predefined threshold of the alarm threshold (e.g., with a certain %, number of revolutions, time, and/or number of rotations), the controller causes the runtime data to displayed a third color (e.g., yellow, indicating maintenance is due soon).

[0055] Columns **520**, **522**, **524**, **526**, **528** provide alarm data that for any row can be modified by an operator of the user interface **402**. For example using an input such as a touch screen **422** or other input device such as a mouse, the operator can select an alarm threshold value to modify and type in a new value with a keyboard or scroll through values and select a new value with a pointing device or touch screen **422**. In the illustrated example, the alerts are set for devices by floor. For example for the all the floors the threshold for the number of revolutions for carrier modules is 67536.0, however, the operator can change the limits for any floor to another value.

[0056] Column **530** is an input to reset the runtime values (columns **504**, **506**, **508**) for the machine in column **502** on the same row. The operator can select the button in column **530** to reset (e.g., set the accumulated values to 0) the runtime values for a machine after maintenance on the machine is completed. Similarly, Column **532** is an input to reset the runtime values (columns **504**, **506**, **508**) for the machine in column **512** on the same row. The operator can select the button in column **532** to reset (e.g., set the accumulated values to 0) the runtime values for a machine after maintenance on the machine is completed.

[0057] Button **540** is an input for switching the user interface **404** to the second runtime screen (Runtime 2, an example of which is provided in FIG. **6** described herein infra) for carrier modules. Button **542** is an input for switching the user interface to the Runtime Pallet Shuttle screen. Button **544** is an input for switching the user interface **404** to the Pallet Shuttle runtime screen (Runtime_PS), an example of which is provided in FIG. **7**).

[0058] In the above examples, some of the columns may not display any data (or N/A) because that data is either not pertinent or available for the corresponding machine. For example, in the illustrated example turntables are only located on the first floor, so there would be turntable data for the first floor and no turntable data floors 2-5.

[0059] FIGS. **6**A and **6**B illustrates an example of a second user interface screen **600** for providing runtime data and providing inputs for maintaining a second plurality of robotic parking garage machines. The interface **600** provides data for carrier modules (HC **112**) on floors 6-12. Like the example in FIG. **5**, the colors of values displayed in columns **504**, **506**, **508**, **514**, **516**, **518** can change if they exceed the appropriate threshold displayed in columns **520**, **522**, **524**, **526**, **528**. Likewise the values stored in any row of columns **520**, **522**, **524**, **526** can be changed, Button **602** is an input that provides the ability to switch the user interface **404** to screen **500** described in FIG. **5**.

[0060] FIG. **7** illustrates an example of a third user interface screen **700** for providing runtime data and providing inputs for maintaining a third plurality of robotic parking garage machines. Screen **700** is able to provide data representative of runtime data for a Pallet Shuttle (PS), a Pallet Stacker (PST), a Pallet Vertical Lift (PVL), and a Vertical Lift carrier (VLC) **110**. The data provides by this screen **700** comprises data identifying the machine in column **502**. Column **504** provides a Runtime, number of revolutions for the corresponding machine in column **502**. Column **506** provides a Runtime operating time (hours:minutes or "hh:mm) for the corresponding machine in column **502**. Column **702** provides a Runtime value for the number of lifts performed by the motor. Column **704** Column is an input to reset the runtime values (columns **504**, **506**, **702**) for the machine in column **502** on the same row. The operator can select the button in column **704** to reset (e.g., set the accumulated values to 0) the runtime values for a machine after maintenance is completed. In an example embodiment, the color for a value in columns **504**, **506**, **702** that exceed the pertinent threshold in one of columns **520**, **522**, **526** are displayed in a different (e.g., second) color from those values that do not exceed the pertinent threshold in one of columns **520**, **522**, **526** (e.g., first color). The values in columns **520**, **522**, **526** are modifiable. For example using an input such as a touch screen **422** or other input device such as a mouse, the operator can select an alarm threshold value to modify and type in a new value with a keyboard or scroll through values and select a new value with a pointing device or touch screen **422**. In an example embodiment as illustrated in FIG. **7**, the devices on the screen **700** are grouped by device type (PS, PST, PVL, VLC) and not by device type and floor like in FIGS. **5** and **6**.

[0061] FIGS. **8-15** illustrate examples of diagnostic screens for machines associated with a robotic parking garage **100**. In certain modes the user provided inputs cause components of the machine to move and/or perform a designated function. Code in the machine or machine component moves or performs the user input function. These modes are sometimes referred to herein as L−1 mode. For example, in manual mode operator inputs are employed to control the machine with safety interlocks bypassed. This mode can be useful when performing maintenance on a machine. In a first auto mode (also a L−1 mode), the machine is operated in response to user inputs with safety interlocks engaged. In a second auto mode (which may be referred to herein as "autonomous" or "L−2 mode", the computer (or controller) inputs operate the machines. In L−2 mode, a plurality of machines can be operated concurrently and/or simultaneously by the computer with safety interlocks engaged. Although three modes are described herein, those skilled in the art can readily appreciate that any physically realizable number of modes can be employed and that the number of modes were selected merely for ease of illustration.

[0062] As those skilled in the art can readily appreciate, not all of the visual representations and/or inputs for a particular diagnostic screen are available for all modes of operation. For example, inputs that allow a machine to

bypass certain limits may be available in manual mode for maintenance and testing operations and unavailable in other modes.

[0063] FIG. **8** illustrates an example diagnostic screen **800** for an Entry Exit Station **118** that can be employed by user interface **404** to allow an operator to interact with the components of the Entry Exit Station **118**. This screen **800** provides the status of the components of an entry exit station **118** and if there is a malfunction, what component of the entry exit station **118** or what sensor is not working or causing a problem. Additionally, in certain (e.g., L1) modes (see e.g., description of switch **802** below), the operator can cause the entry exit station **118** to perform any function.

[0064] The switch **802**, allows the operator to control how the entry exit station **118** operates. For example, in MAN (Manual) mode **802***a*, the operator manually operates the components within the entry exit station **118** by inputting commands and safety interlocks are bypassed. AUTO mode **802***b* corresponds to the first auto mode where the operator inputs commands to operate the components within the entry exit station with the safety interlocks engaged. TRKR mode **802***c* corresponds to the autonomous (or L−2) mode where the EES **118** a computer provides the inputs to the EES **118**.

[0065] The screen **800** further comprises a graphical display **804** illustrating the status of the components of the entry exit station **118**. An input **806** allows the operator in L-**1** modes **802***a* or **802***b* to cause the controller **302** to send a signal to the entry exit station **118** to open or close the inner door of the entry exit station **118**. Area **822** provides a graphical illustration of the inner door (e.g., one color, such as green, for the door being open and a second color, such as red, for the being closed). In the illustrated example, the inner door is closed, the input **806** indicates that selecting the input **806** will cause the controller **302** to send a signal to the entry exit station **118** to cause a motor coupled with the inner door to open the inner door.

[0066] The screen **800** further comprises an input **808** that allows the operator in the L−1 modes **802***a*, **802***b* to provide an input that cause the controller **302** to send a signal to the entry exit station **118** to open or close the outdoor door of the entry exit station **118**. Area **824** provides a graphical illustration of the inner door (e.g., one color, such as green, for the door being open and a second color, such as red, for the being closed). In the illustrated example, the outer door is open, thus the input **808** indicates that selecting the input **808** will cause the controller **302** to send a signal to the entry exit station **118** to cause a motor coupled with the out door to close the outer door.

[0067] The screen **800** further comprises indicators **810**, **812**, **814**, **816** that provide the status of the track (extended or retracted) for the North East, South East, North West, and South West tracks respectively. In L−1 modes **802***a*, **802***b*, inputs **818** and **820** can be employed to cause the controller **302** to send a signal to the entry exit station **118** to extend or retract, respectively, the tracks. The status of the tracks is also displayed in areas **826**, **828** where area **826** provides a graphical illustration of the North (East and West) side of the entry exit station **118** and area **828** provides a graphical illustration of the South (East and West) side of the entry exit station **118**. The directional orientation (North, South, East, West) is provided in the upper left area of screen **800** as indicated by **830**.

[0068] If an error is detected, an error code is displayed in the area represented by **832**. Some example error codes that can be displayed are 1=Tracks Have Taken Too Long to Open or Close, 5=Outer Door Timeout When Opening Door. 6=Outer Door Timeout When Closing Door, 7=Inner Door Timeout When Opening Door, 8=Inner Door Timeout When Closing Door, 17=An EES Door Overload Has Tripped, 20=EES System Not Enabled, 31=The EES is Not in a Valid State, 32=The EES State is Zero, and 88=A Pallet Shuttle is Requesting an Interlock, But the Floor and Row Don't Match. The error code represented by **832** can be cleared by selecting input **834**.

[0069] The area represented by **836** indicates whether a car is present in the Entry Exit Station **118**. In an example embodiment, a first color (e.g., red) can be employed to indicate when a car is present in the Entry Exit Station **118** and a second color (e.g., green) can be employed to indicate there is no car present in the Entry Exit Station **118**. If there is a car present in the Entry Exit Station, input **838** can be employed to remove the car from the Entry Exit Station **118**. For example, the car can be transferred to an Entry Level Carrier **116**.

[0070] Areas **840**, **842** can be employed as both a display to indicate whether the EES **118** is operating in Entry or Exit mode, and as an input to cause the controller **302** to send a signal to the entry exit station **118** to change the operating mode when in the L−1 modes **802***a*, **802***b*. For example, a first color (e.g., green) can be employed to by one of areas **838**, **840** to indicate whether the EES **118** is operating as in Entry or Exit mode. In the L−1 modes **802***a*, **802***b*, the operator can selecting area **840** to put the EES **118** into Entry Mode or select area **842** to put the EES **118** into exit mode.

[0071] The screen **800** further comprises inputs **844**, **846** that allow an operator to select a camera for viewing the interior of the EES **118**. The buttons along input **844** are employed to select one of five cameras on the North (or inner) side of the EES **118**. The buttons along input **846** are employed to select one of five cameras on the South (or outer) side of the EES **118**.

[0072] The screen further comprises an area **848** which indicates the status of the horizontal light curtain. In an example embodiment, the horizontal light curtain **848** employs a first color (e.g., green) to indicate to a driver they can safely move their vehicle, and a second color (e.g., red) to indicate to a driver they should stop moving.

[0073] In an example embodiment, the screen **800** further comprises an area **850** for providing information regarding a vehicle in the EES **118** and whether there is a pallet in the EES **118**. For example, the area **850** can display an identification associated with the vehicle, vehicle height, vehicle direction/orientation (front side pointed toward inner door or outer door).

[0074] In an example embodiment, the screen **800** comprises area **850**, **852** which provide status data and are also inputs for either obtaining a snap shot of the current diagnostics of the EES **118** or to lockout the EES **118**. A first color (e.g., red) can be employed to indicate whether the EES **118** is in snap shot (area **852**) or lockout (area **854**) mode. Selecting area **852** will provide a diagnostic screen **800** of the EES **118**. Selecting area **854** is employed to lockout the EES **118**.

[0075] FIGS. **9**A and **9**B illustrates an example diagnostic screen **900** for a first floor Carrier Module. which is also referred to herein as an Entry Level Carrier module (ELC) **116** that can be employed by user interface **404** to allow an operator to interact with the components of the ELC **116**.

The screen **900** provides the status of the components of an ELC **116** and if there is a malfunction, what component of the ELC **116** or what sensor is not working or causing a problem. In manual mode (see e.g., description of switch **976** below), the operator can cause the ELC module **116** to perform any function employing the inputs described herein..

[0076] Data representative of the Carrier Module that is being displayed is represented by **902**. Data representative of the aisles associated with the carrier module **116** are represented by **904**, **906**. On the north aisle **904** are indicated the location of vertical lift carriers (VLC) and on the south aisle **906** the locations of entry exit stations, and

[0077] Status data of the carrier module **116** is displayed in the area indicated by **910**. This data may include, but is not limited to, The position, presence of a rack entry module (REM), and as will be described in more detail herein, infra, error codes **980**, **982**, **984**, **986**. Button **912** indicates whether the cable reel is on or off and can be employed to turn the cable reel on and off by pressing button **912**. In an example embodiment, button **912** is red in the off state and green in the ON state. The area represented by **914** can be employed to manually cause the controller **302** to send a signal to the ELC **116** to move the carrier module in one direction or another to locate a barcode associated with various destinations (e.g., VLC, EES, PST). The area represented by **916** provides data from a barcode reader that indicates the location of the ELC **116**. The carrier module jog button **918** is employed to move at a pre-defined velocity, and the major Interlocks are bypassed in this state. This button is operable in manual mode. The area represented by **920** indicates whether a REM is present on the ELC **116**.

[0078] In an example embodiment, the area represented by **930** provides the coordinates of the ELC **116**. The update button **931** allows an operator to manually update the position of the ELC **116**.

[0079] In an example embodiment, the area represented by **932** provides an X-axis position of the ELC **116**. Input button **933** allows an operator to cause the controller **302** to send a signal to the ELC **116** to move the ELC **116** along the axis a designated distance.

[0080] In an example embodiment, the area represented by **934** provides an interface that displays location data of an ELC **116** and allows an operator to move the ELC **116**. Input button **935** is a manual command to cause the controller **302** to send a signal to the ELC **116** to move the ELC **116** to a designated location. Button **937** is employed to get a pallet (which may or may not have a vehicle) from a storage location, and input button **939** is employed to put the pallet currently on the ELC **116** into a storage location.

[0081] In an example embodiment, turntable control is provided by the interface illustrated in the are designated by **940**. The position of the turntable is indicated by the graphic indicated at **950**. The position of the turntable can be updated by employing input button **941**. The operator can abort all turntable moves by selecting input button **942**. A turntable fault is cleared by selecting input button **946**. The operator employs input button **948** to cause the controller **302** to send a signal to the ELC **116** to move the turntable to a predefined position ("0" in this example). The operator can jog (e.g., move the machine at a very show speed while in Manual mode which can be helpful for performing maintenance on the machine) the turntable in the clockwise direction by selecting input button **952**. The operator can jog the turntable in the counterclockwise direction by selecting input button **954**. Input buttons **956**, **960** cause the turntable to move to predefined positions. Input button **958** is employed to enable the turntable.

[0082] In an example embodiment, input button **962** is employed to clear a carrier module error. Input button **964** resets the carrier module's strobes. Input button **970** switches the display to the REM diagnostic screen **1000** described in FIG. **10**. Area **972** provides data representative of a count table which provides data representative of a distance from various points of interest. In an example embodiment, one count equals one millimeter. Switches **974**, **976** are employed to select the operating mode. In an example embodiment, Switch **974** OFF and switch **976** MAN is a manual mode of operation (operator inputs, at least one safety interlock bypassed), switch **974** OFF and switch **976** AUTO is a first auto operating mode (operator inputs, safety interlocks engaged), and switch **974** ON and switch **976** AUTO is a second auto mode, or autonomous mode (computer inputs and safety interlocks on).

[0083] The Error code displayed at **980** is for the REM on the North Aisle in the illustrated example. The Error code displayed at **982** is for the REM on the South Aisle in the illustrated example. The Error code displayed at **984** is for the turntable West of the ELC **116** in the illustrated example. The Error code displayed at **986** is for the turntable East slot of the ELC **116** in the illustrated example. Examples of error codes and their meanings displayed at one of **980**, **982**, **984**, **986** include but are not limited to 2=System Not Enabled, 3=Collision Detected, 13=Master Control Relay Not On, 14=South Amplifier Contactor Not On, 15=North Amplifier Contactor Not On, 16=West Turn Table Amplifier Contactor Not On, 17=East Turn Table Amplifier Contactor Not On, 18=Turn Table Not At 0 Degrees, 19=Turn Table Not At 180 Degrees, 30=North Strobe Not Seen When Moving to North Side Aisle, 31=South Strobe Not Seen When Moving to South Side Aisle, 35=One Axis Moving When Other is Stopped, 40=Turn Table Too Close to Object to Rotate, 47=Barcode Read Doesn't Match Commanded Aisle to Move to, 48=Move Completed but Barcode Not Read, 49=Commanded Aisle To Go To Overlaps with Deckmate, 50=Window Overlaps with Deckmate's Window, 58=Turn Table Program Running Timeout, 60=Cable Reel Motor Overload Tripped, 102=Collision Sensor Not On When Next to Wall, 103=Collision Sensor Not On When Next to Deckmate, 104=EGD Exchange to West Deckmate Down, 105=EGD Exchange to East Deckmate Down, 122=Cable Reel Did Not Pull in Cable After REM Movement, and 150=Abort All Servo Moves Occurred.

[0084] FIGS. **10**A and **10**B illustrates an example diagnostic screen **1000** for a Rack Entry Module (REM) that can be employed by user interface **404** to allow an operator to interact with the components of the REM This screen **1000** provides the status of the components of an REM and if there is a malfunction, what component of the REM or what sensor is not working or causing a problem.

[0085] The screen **1000** comprises a first area **1002** that provides status data for the REM. In an example embodiment, the status data includes the position of the REM, and whether there is a pallet present on the REM. As will be described herein, infra, the status information includes data representative any error conditions detected.

[0086] At **1004**, there is provided an input to update the position of the REM. An update is provided to perform this function.

[0087] The area bounded by **1006**, provides an input to move the REM to another position. Entering a value (counts) for how to move the REM and selecting the GoTo Position button causes the controller **302** to send a signal to the REM to move the amount (value) specified.

[0088] Input **1008** enables an operator to clear an REM error. Input **1010** will cause the REM to abort moves and input **1012** will abort the moves of the CM associated with the REM.

[0089] The area represented by **1020** provides a graphical view of the real-time position of the REM within the robotic parking garage **100**. In the illustrated example, the REM is in front of EES3.

[0090] Input **1022** provides an input to release a lockout. The area represented by **1024** illustrates the position of the (Northwest) NW and (Northeast) NE (or first and second) corners of the lift of the REM. Input **1026** provides the ability for an operator to move the lift position by a specified amount (count). The area represented by **1028** illustrates the position of the (Southwest) SW and (Southeast) SE (or third and fourth) corners of the lift of the REM. Input **1032** causes the controller **302** to send a signal to the REM to moves the lift to the full up position. Input **1034** moves the lift to the full down position. Input (or lift jog button) **1036** causes the controller **302**, when in manual mode, to send a signal to the REM to move (jog) the lift in the up direction at a predefined velocity, which is typically a very show speed that is useful while performing maintenance. Similarly, Input **1038** causes the controller **302**, when in Manual mode, to send a signal to the REM to move the lift in the down position at a predefined velocity. The Time for Get/Put area **1040** of the screen displays the total time for getting or putting a vehicle or pallet from a slot or VLC. The Brake Release area of the screen **1042** displays the status of the brake in the lift motor. In an example embodiment, the color green represents that the break is released and the color red indicates that the brake is not released.

[0091] Input **1050** retrieves the carrier module diagnostic screen for the carrier module associated with the REM. For example, the carrier diagnostic screen can be screen **900** for an entry level carrier or screen **1100** for an upper level carrier.

[0092] In an example embodiment, a Search area on screen **1000** provides two inputs for searching for a position strobe. The position strobes are reflectors located at different positions. The REM employs a laser sensor installed in the REM to search for a position strobe to determine the position of the sides of the lift. Input **1054** searches the South (or first) side of the REM. Input **1055** searches the North (or second) side of the REM.

[0093] In an example embodiment, a Homing area of screen provides two inputs. Homing North . . . Homing South that bring the REM back to the home position, which is on top of the carrier module. If the REM is towards the South, Homing North is employed and vice versa.

[0094] In an example embodiment, the New Jog area of diagnostic screen provides inputs to jog (move a predefined distance) the REM The inputs comprise jog North **1060** (move a predefined distance in a first direction, e.g., North), and jog South **1066** (move a predefined distance in a second direction, e.g., South/Input **1062** switches the home strobe lights for the REM on or off., Input **1064** switches the strobe lights for the rows in the parking garage on or off.

[0095] Switch **1070** selects the operating mode for the REM. Position **1070***a* for manual operation, position **1070***b* for the first automatic operation mode (inputs from operator), and position **1070***c* (for a second (or fully) automatic operation mode (inputs from computer, e.g., autonomous).

[0096] Any errors that are detected with the REM are displayed at one of positions **1003** (North), **1005** (South) or **1007** (Lift). Examples of error codes and definitions for the error codes for a REM include, but are not limited to 2=System Not Enabled, 3=Collision Detected, 31=Move Aborted, 51=REM Commanded Aisle Doesn't Match CM Aisle, 52=REM Commanded Row Doesn't Match CM Row, 53=Commanded Row Out of Range, 54=Obstruction in Rows 2, 3, or 5, 55=Obstruction in Rows 2 or 3 when Getting from Row 1 or 4, 56=Ethernet Global Data (EGD) Communication Down with CM, 59=Pallet Not Present When Put Command Issued, 60=Pallet Present When Get Command Issued, 61=Lift in Up Position With No Pallet Present When Get/Put Issued, 62=Lift is in Down Position With a Pallet Present When Get/Put Issued, 63=Communication Down with VLC (which in this example is Ethernet Data Protocol "EGD", a protocol to communicate between machines in the garage, however those skilled in the art can readily appreciate any suitable communication protocol can be employed), 64=EGD Communication Down with CM, 65=EGD Communication Down with PVL, 70=No Pallet Present When Get Command Issued, 75=Commanded Slot to Go To is Not Valid, 82=Cable Reel Overload When REM Moving to a Slot, 100=Command Timeout–No Movement after 30 Seconds, 101=Cable Reel Overload from CM, 102=Command Timeout–Carrier is Not in Position for REM to Move, 104=Pallet Not Seen by Collision Sensor in the destination Slot, 108=PUT Command Issued with PUT in Process, 109=GET Command Issued with GET in Process.

[0097] FIGS. **11**A and **11**B illustrates an example diagnostic screen for an upper floor Carrier Module, also referred to herein as an upper Horizontal Carrier (HC) Module **112** that can be employed by user interface **404** to allow an operator to interact with the components of the HC module **112**. Screen **1100** provides the status of the components of an HC module **112** and if there is a malfunction, what component of the HC module **112** or what sensor is not working or causing a problem. Additionally, as will be described below, the operator can manually control the HC Module by interacting with diagnostic screen **1100**.

[0098] In the illustrated example, a first (North) aisle is represented by **1102** and a second (South) aisle is represented by **1104**. The location of the vertical lift carriers (VLCs) are indicated on the North aisle **1102** and the location of Pallet Vertical Lifts (PLVs) are indicated on the South aisle **1104**. The locations of the carrier modules **112** with respect to the North aisle **1102** and South aisle **1104** are provided.

[0099] Data representative of the carrier module **112** status is provided in the area represented by **1106**. This data can include position of the module and as will be explained in more detail herein infra, any detected errors.

[0100] A graphical representation of the cable reel and its status is represented at **1108**. Data representative of the aisle and floor of the carrier module is represented at **1110**. An input **1112**, can be employed manually causes the controller **302** to send a signal to the bar code reader on the carrier

module **112** to read the bar code at the carrier module's **112** present location. A graphical representation of the REM position is provided at **1114**.

[0101] Move commands are provided in the area represented by **1120** which also provides data representative of the aisle and floor of the carrier module. There is also provided an input **1122** where an operator can causes the controller **302** to send a signal to the carrier module **112** to move to a particular aisle. The input **1124** can be employed to causes the controller **302** to send a signal to the carrier module **112** to get a pallet from the current location. The input **1126** can be employed to causes the controller **302** to send a signal to the carrier module **112** to put a pallet at the current location.

[0102] In an example embodiment, the input represented at **1130** enables an operator to clear an error. The input represented at **1132** enables the operator to reset the strobes, which clears the last position search. The input represented at **1134** is employed to causes the controller **302** to send a signal to the carrier module **112** to abort REM moves. The input represented at **1136** is employed to causes the controller **302** to send a signal to the carrier module **112** to abort the carrier module's moves. The input represented by **1138** is employed to change the screen on the user interface **404** to the REM diagnostic screen **1000** (FIG. **10**).

[0103] In an example embodiment, switches **1150**, **1152** are employed to select the operating mode. In an example embodiment, Switch **1150** OFF and switch **1152** MAN is a manual mode of operation (operator inputs, at least one safety interlock bypassed), switch **1150** OFF and switch **1152** AUTO is a first auto operating mode (operator inputs, safety interlocks engaged), and switch **1150** ON and switch **1152** AUTO is a second auto mode, or autonomous mode (computer inputs and safety interlocks on).

[0104] In an example embodiment, detected errors are identified by error codes at the locations represented **1160**, **1162**, **1164**. Examples of error codes and their meanings displayed at one of **1160**, **1162**, **1164** include but are not limited to 2=System Not Enabled, 3=Collision Detected, 13=Master Control Relay Not On, 14=South Amplifier Contactor Not On, 15=North Amplifier Contactor Not On, 30=North Strobe Not Seen When Moving to North Side Aisle, 31=South Strobe Not Seen When Moving to South Side Aisle, 35=One Axis Moving When Other is Stopped, 47=Barcode Read Doesn't Match Commanded Aisle to Move to, 48=Move Completed but Barcode Not Read, 49=Commanded Aisle To Go To Overlaps with Deckmate, 50=Window Overlaps with Deckmate's Window, 60=Cable Reel Motor Overload Tripped, 102=Collision Sensor Not On When Next to Wall, 103=Collision Sensor Not On When Next to Deckmate, 104=EGD Exchange to West Deckmate Down, 105=EGD Exchange to East Deckmate Down, 122=Cable Reel Did Not Pull in Cable After REM Movement, and 150=Abort All Servo Moves Occurred.

[0105] FIGS. **12**A and **12**B illustrates an example diagnostic screen for a Vertical Lift Conveyer, also referred to herein as a Vertical Lift Carrier (VLC) module **110** that can be employed by user interface **404** to allow an operator to interact with the components of the VLC module **110**. Screen **1200** provides the status of the components of an VLC module **110** and if there is a malfunction, what component of the HC module **112** or what sensor is not working or causing a problem. Additionally, as will be described below, the operator can manually control the VLC module **110** by interacting with diagnostic screen **1200**.

[0106] The area represented by **1202** provides status information for the VLC module **110**. The status information can include current location information, and as will be explained in more detail herein infra error codes for any detected errors.

[0107] The input at **1204** will cause the controller **302** to send a signal to a barcode reader (not shown) on the VLC **110** to read a barcode and the data read by the barcode reader (VLC number and floor) are displayed in the area represented by**1206**.

[0108] The area represented by **1208** provides a graphical representation of the VLC **110**. The graphical representation of the VLC **110** comprises the present position of the VLC **110**.

[0109] In an example embodiment, the input **1210** is employed to causes the controller **302** to send a signal to VLC **110** to move the VLC **110** to a desired floor. The desired floor is input into the area represented by **1212**.

[0110] In an example embodiment, the input **1214** causes the controller **302** to send a signal to VLC **110** to move the pallet shuttle up. Input **1216** causes the controller **302** to send a signal to VLC **110** to move the pallet shuttle down.

[0111] In an example embodiment, the area represented by **1218** is employed for moving the VLC **110** a desired distance. Selecting input **1222** moves the VLC **110** the distance specified at **1224**.

[0112] In an example embodiment, input **1226** is employed to causes the controller **302** to send a signal to VLC **110** to abort all moves of the VLC **110**. Inputs **1228** and **1230** are employed to control whether the motors in the VLC are in synch. Input **1228** causes the controller **302** to send a signal to VLC **110** to move the gear out (motors not in synch). Input **1230** causes the controller **302** to send a signal to VLC **110** to move the gear in (motors in synch).

[0113] In an example embodiment, selecting input **1240** causes the controller **302** to send a signal to VLC **110** to bypasses over/under travel. This is used to operate in Manual mode for testing the full up and down positions of VLC. Clicking this button will bypass the Auto Limit of Up and Down of the Lift. Input **1242** is selected to causes the controller **302**, when in Manual mode, to send a signal to VLC **110** to bypass overhung limits. The overhung sensor is triggered if any object slips out of the pallet or protrudes out of the pallet while the lift is carrying the pallet.

[0114] In an example embodiment, selecting input **1244** causes the controller **302**, while in manual mode, to send a signal to VLC **110** to move the shuttle lift a predefined distance in the upward direction. Selecting input **1246** causes the controller **302**, while in Manual mode, to send a signal to VLC **110** to move the shuttle lift in a predefined distance in the downward direction.

[0115] In an example embodiment, selecting input **1248** causes the controller **302** to send a signal to VLC **110** to extend the deck locks. Selecting input **1250** causes the controller **302** to send a signal to VLC **110** to retract the deck locks. If there is a deck error, the error code is displayed at **1252**. Examples of deck error codes include, but are not limited to 60=DC Power Supply Not OK, 61=North Decklock Overloaded, 62=South Decklock Overloaded, 63=Cable Reel Overloaded, 64=Decklock Extend/Retract Fault, 65=South Decklock Contactor Energized but Not

Pulling In, 66=North Decklock Contactor Energized but Not Pulling In, and 67=Cable Reel Contactor Energized but Not Pulling In.

[0116] In an example embodiment, selecting input **1260** clears the VLC error. Selecting input **1262** clears the deck error. In an example embodiment, selecting input **1264** clears an error received from a servo control module (in this example a Pac Motion Module or "PMM" available from Emerson Electric Co.). Selecting input **1262** will reset the drive.

[0117] In an example embodiment, selecting input **1268** causes the controller **302** to send a signal to VLC **110** to extend the firs (e.g., Northwest) deck lock. Selecting input **1270** causes the controller **302** to send a signal to VLC **110** to extend the second (e.g., Northeast) deck lock. Selecting input **1262** causes the controller **302** to send a signal to VLC **110** to extend the third (e.g., Southwest) deck lock. Selecting input **1274** causes the controller **302** to send a signal to VLC **110** to extend the fourth (e.g., southwest) deck lock.

[0118] In an example embodiment, switches **1280**, **1282** are employed to select the operating mode. In an example embodiment, Switch **1280** OFF and switch **1282** MAN is a manual mode of operation (operator inputs, at least one safety interlock bypassed), switch **1280** OFF and switch **1282** AUTO is a first auto operating mode (operator inputs, safety interlocks engaged), and switch **1280** ON and switch **1282** AUTO is a second auto mode, or autonomous mode (computer inputs and safety interlocks on).

[0119] In an example embodiment, if an error or fault is detected, an error code is displayed at one of the areas represented by **1290**, **1292**, **1294**, **1296**. Examples of error codes that can displayed at **1290**, **1292**, **1294**, **1296** include but are not limited to 17=Stall Fault-The Deck Has Not Moved For Too Long, 26=Drive Fault, 33=Decklocks Did Not Retract, 34=Decklocks Did Not Extend, 35=Did Not Complete Set Down Move, 42=Did Not Get Chain Slack When Landed, 70=Destination Floor is Higher Than Allowed, 71=Destination Floor is Lower Than Allowed, 74=Position is Not Valid (e.g., the position obtained from the Digital Signal Module "DSM" available from Emerson Electric Co. although any suitable module can be employed), 81=Deck Not In Auto, 83=Communication from Deck Down, 85=EGD Communication with Deck Down, and 865=REM Present In Deck When Move Command Issued.

[0120] FIGS. **13**A and **13**B illustrates an example diagnostic screen for a Pallet Shuttle(PS) that can be employed by user interface **404** to allow an operator to interact with the components of the Pallet Shuttle. Screen **1300** provides the status of the components of an Pallet Shuttle and if there is a malfunction, what component of the Pallet Shuttle or what sensor is not working or causing a problem. Additionally, as will be described below, the operator can manually control the Pallet Shuttle by interacting with diagnostic screen **1300**.

[0121] In an example embodiment, a graphical representation of aisle is represented by **1302** which illustrates the locations of entry exit stations (EES), Pallet Stackers (PS)/Packet Vertical Lifts (PVT), and whether a pallet is present in an EES. At **1304** there is represented a graphical representation of the real time position of Pallet Shuttles (PS) in the garage.

[0122] In an example embodiment, the status of the pallet shuttle is represented at **1306**. The status date data includes, but is not limited to position data and if any errors or faults are detected, a code associated with the detected error or fault.

[0123] In an example embodiment, input **1308** is employed to reset the strobes, which clears the last position search. Input **1310** is employed to clear an error. Input **1312** is employed to cause the controller **302** to send a signal to abort all movements of the pallet shuttle. Input **1314** is employed to cause the controller **302** to send a to abort lift moves of the pallet shuttle. Input **1316** is employed to cause the controller **302** to send a signal to release a lockout of the pallet shuttle.

[0124] In an example embodiment, input **1320** is employed to cause the controller **302** to send a signal to locate a slot/barcode to the West of the current pallet position. Input **1322** is employed to cause the controller **302** to send a signal to locate a slot/barcode to the East of current pallet position.

[0125] In an example embodiment, icon **1324** is employed to provide a graphical representation of whether a strobe on a first (e.g., North) side of the pallet shuttle is detected (ON=detected, Off=strobes not detected). Icon **1325**, is employed to provide a graphical representation of whether a strobe on a second (e.g., South) side of the pallet shuttle is detected (ON=detected, Off=strobes not detected). The input at **1330** is employed to update the position of the shuttle to the position indicated at **1332**. The position of the pallet shuttle is moved by inputting a distance (or count, e.g., 1 count=1 mm) in **1340**, where to move in a first direction (e.g., left or West) a negative number in input, and to move in a second direction (e.g., right or East a positive number is input. Input **1342** is employed to cause the controller **302** to send a signal to the REM to move the pallet shuttle a predefined distance (counts) specified at **1344**. The input at **1346** causes a lift to move a predefined distance (jog) up. In input at **1348** is employed to cause the controller **302** to send a signal to the REM to move the lift into the Full up position. The input at **1350** is employed to enable an operator to manually add or remove a pallet and a specified location.

[0126] In an example embodiment, the lift status is specified. The position of the lift is specified at **1318**. If an error is detected with the lift, an error code is displayed at **1378**. Examples of lift error codes and their definitions include but are not limited to 74=Position Not Valid for Lift Axis and 75=Not In Auto When Lift Command Given.

[0127] In an example embodiment, status of the first (e.g., SE) Lift and a second (e.g., NE) Lift are displayed at **1350**. The lift count is displayed at **1352**.

[0128] In an example embodiment, selecting the input at **1354** causes all the bits in the program which were set for manual Operations to reset and the Machine can be switched to Auto mode. Although the software takes care of resetting the bits, this is an extra safety feature provided to the operator.

[0129] In an example embodiment, input **1356** causes the pallet shuttle's barcode reader to read a barcode. The aisle and floor provided by the barcode that was read by the barcode reader are displayed at **1358**.

[0130] In an example embodiment, error codes for errors detected with the pallet shuttle are displayed at locations **1372**, **1374**, **1376**. Examples of error codes and their definitions include, but are not limited to 1=One Axis is Still Moving After (Other Axis Has Stopped, 2=System Not Enabled, 3=Collision Detected, 13=MCR Main Control

Relay, provides power to Motor Amplifiers) Not On, 14=South Amp Contactor (where a Contractor is a Unit which controls power supplied to Amplifiers (Amps) of Motors located in the declared direction.) Not On, 15=East Amp Contactor Not On, 16=West Amp Contactor Not On, 17=North Amp Contactor Not On, 30=Move Done With South Strobe Not Seen, 31=Move Done With North Strobe Not Seen, 40=Dropped Pallet Laser Sensor Broken After Get or Put, 47=Barcode Read Doesn't Match Commanded Aisle to Move to, 48=Move Completed but Barcode Not Read, 49=Commanded Aisle To Go To Overlaps with Deckmate, 50=Window Overlaps with Deckmate's Window, 51=Windows Overlap. 88=The Machine the Shuttle is Locking out Doesn't Match it's Floor and Row, 89=The Machine About to Be Locked Out Doesn't Match the Type it Should Be, 90=EGD Problem, 102=West Collision Sensor Not On When Next to Wall or Deckmate, 103=East Collision Sensor Not On When Next to Wall or Deckmate, 104=EGD to West Deckmate Down, and 105=EGD to East Deckmate Down.

[0131] In an example embodiment, switches **1360**, **1362** are employed to select the operating mode. In an example embodiment, Switch **1360** OFF and switch **1362** MAN is a manual mode of operation (operator inputs, at least one safety interlock bypassed), switch **1360** OFF and switch **1362** AUTO is a first auto operating mode (operator inputs, safety interlocks engaged), and switch **1360** ON and switch **1362** AUTO is a second auto mode, or autonomous mode (computer inputs and safety interlocks on).

[0132] FIG. **14** illustrates an example diagnostic screen **1400** for a Pallet Stacker (PST) that can be employed by user interface **404** to allow an operator to interact with the components of the Pallet Stacker. Screen **1400** provides the status of the components of an Pallet Stacker and if there is a malfunction, what component of the Pallet Stacker or what sensor is not working or causing a problem. Additionally, as will be described below, the operator can manually control the Pallet Stacker by interacting with diagnostic screen **1400**.

[0133] In an example embodiment, the screen comprises a graphical representation of the pallet stacker as represented by **1402**. The graphical representation comprises the positions of Garage representation lines. In the illustrated example, the A line is the Entry or starting of Garage, the B-Line is starting of the entry-exit station, the C-Line is the end of entry-exit station and the beginning of the Aisle, and the D-line is the end of the Aisle and the beginning of VLC the and so on.

[0134] In the illustrated example a position of a first (B-Line) pallet support mechanism and second pallet support mechanism are illustrated by **1401**C and **1401**B respectively. Beaks associated with the pallet supports mechanisms **1401**, **1401**B are illustrated by **1403***c* and **1403**B respectively. The position of the pallet support mechanism represented by **1401**C is controlled by inputs **1410** and **1412**. Input **1410** moves the pallet support mechanism represented by **1401**C in a first direction ("Retract") and input **1412** moves the pallet support mechanism represented by **1401**C in a second direction ("Extend"). The position of the pallet support mechanism represented by **1401**B is controlled by inputs **1420** and **1422**. Input **1420** moves the pallet support mechanism represented by **1401**B in a first direction ("Extend") and input **1422** moves the pallet support mechanism represented by **1401**B **1401**B in a second direction ("Extend"). A visual representation of the beaks associated with the pallet support mechanisms are represented by **1403**C and **1403**C. Input **1450** retracts the beaks represented by **1403**C, **1403**B and input **1452** extends the beaks represented by **1403**C, **1403**B. A visual representation of the pallets on the pallet stack are provided by **1405**.

[0135] In an example embodiment, pallets detected by a first side (e.g., North) sensor array is indicated at **1404**. A first color (e.g., green) is employed to indicate the presence of a pallet and a second color (e.g., red) is employed to indicate the absence of a pallet. A visual representation of pallets detected by a second (e.g., South) sensor array is indicated at **1406**. A first color (e.g., green) is employed to indicate the presence of a pallet and a second color (e.g., red) is employed to indicate the absence of a pallet.

[0136] In an example embodiment, the switch **1430**, allows the operator to control how the mode of operation of the pallet stacker. For example, in manual mode **1430***a*, the operator manually operates the pallet stacker. In auto mode **1430***b*, the controller **302** operates pallet stacker **1070***b* for a first automatic operation mode (inputs from operator), and position **1070***c* (for a second automatic operation mode (inputs from computer, e.g., autonomous).

[0137] In an example embodiment, if an error is detected, a code the error is displayed at **1440**. Examples of error codes and their definitions include, but are not limited to 51=The Pallet Shuttle is Requesting a Put with the Stacker Full, 52=The Pallet Shuttle is Requesting a Get with No Pallets in the Stacker, 54=The Beaks Have Taken Too Long to Extend or Retract, 61=A Request for An Interlock is Being Made, but the Stacker is in Manual Mode, 62=A Request for An Interlock is Being Made, but the Stacker is Locked by the PVL, and 88=A Pallet Shuttle is Requesting an Interlock, But the Floor and Row Don't Match, Input **1442** is employed to clear the error code. A visual representation of a rack position count is provided by **1414**.

[0138] FIGS. **15**A and **15**B illustrates an example diagnostic screen **1500** for a Pallet Vertical Lift (PVL) that can be employed by user interface **404** to allow an operator to interact with the components of the Pallet Vertical Lift. Screen **1500** provides the status of the components of an Pallet Vertical Lift and if there is a malfunction, what component of the Pallet Vertical Lift or what sensor is not working or causing a problem. Additionally, as will be described below, the operator can manually control the Pallet Shuttle by interacting with diagnostic screen **1500**.

[0139] A graphical representation of the PVL viewed from a first direction (West in the illustrated example) is represented by **1502**. A graphical representation of the PVL viewed from a second direction (South in the illustrated example) is represented by **1504**.

[0140] In an example embodiment, the graphical representation **1502** provides a graphical indication of the location of the PVL (Floor 1), and whether an overtravel (exceeding the limit of travel for the PVL in the first or 'up' direction) was detected represented by **1506**, and/or whether an undertravel (e.g., exceeding the limit of travel in a second or downward direction) was detected is represented by **1508**. In particular embodiments, the graphical representation **1502** further provides whether the beaks of a pallet stacker below the PVL are extended. The status of the beak on the first (e. g, North) side is represented by **1510** and the status of the second (e.g., South) side is represented by **1512**. In an example embodiment, the graphical representation further provides an indication of whether a REM is present at the

pallet stacker at **1514** and whether a pallet is present on the pallet stacker represented at **1516**.

[0141] In an example embodiment, the graphical representation **1504** provides an indication of the status of the Pallet Vertical Lift's tongs. The status of a first (e.g., West in this example) tong is represented by **1520** and the status of a second (e.g., East in this example) tong is represented by **1522**.

[0142] In an example embodiment, the status of a first axis (Axis 1) is represented by **1530**. Status information includes the position, velocity, position error, and if an error is detected for the PVL an error code at **1532** and if a PVL deck error is detected an error code at **1534**.

[0143] In an example embodiment, if an error on the first axis is detected, a code the error is displayed at **1532**. Examples of PVL error codes include, but are not limited to 26=Drive Not Ready, 27=Overtravel Detected, 28=Under travel Detected, 29=Chain Broken Detected, 30=Chain Slack Detected When Deck locks Retracted, 31=Tongs Have Not Closed Completely in Time Allotted, 32=Tongs Have Not Opened Completely in Time Allotted, 33=Deck locks Did Not Retract in Deck, 34=Deck locks Did Not Extend in Deck, 35=Stacker Beaks Did Not Retract, 36=There is a Fault in the Stacker with the Beaks, 37=Pallet Not Present on Deck When Beaks Told to Retract or PVL Ready to Lift After Get, 38=Dropped Pallet Laser Sensor Blocked When Beaks Told to Retract or PVL Ready to Lift After Get, 39=Pallet Present Prox Still On After Pallets Put in Stacker, 40=Dropped Pallet Laser Sensor Blocked When Opening Tongs, 41=Quantity of Pallet Present Sensors on Stacker North and South Side are not the Same, 42=Landed Position Not OK When Chain Slack Detected, 43=Get Requested by REM With No Pallet Present on Deck, 44=Put Requested by REM With A Pallet Present on Deck, 45=Put Requested by REM With Car Detection Laser Sensor Blocked, 52=Get Command Given with No Pallets in Stacker, 53=Put Command Given with Pallets in Stacker, 54=Put Command Given with No Pallets in the Deck, 56=Get Command Given with Pallets Already Present on Deck, 70=Destination Floor is More Than the Maximum Floor, 71=Destination Floor is Less Than the Minimum Floor, 72=Destination Floor is the Same as the Floor it's at, 73=Deck Should Be Landed but Chain Slack Not Being Seen, 74=Position is Not Valid, 75=The Selector Switch at the Stacker is Not in Auto When the PVL is in Auto, 76=Stall Fault–The Deck Has Not Moved For Too Long, 77=Jogging Up With Tongs Not Closed, 78=Jogging Up With Deck locks Not Retracted, 79=Get Command Given with Beaks Not Extended, 80=PVL Deck Moving Down with Beaks Not Retracted, 81=The PVL Deck is Not In Auto Ready Mode, 82=There Are Faults in the Stacker when PVL Told to Move, 83=There Are Faults in the Deck when PVL Told to Move, 84=EGD Down to Stacker when PVL Told to Move, 85=EGD Down to Deck when PVL Told to Move, 86=EGD Not OK in Stacker when PVL Told to Move, 87=REM Present when PVL Told to Move, 88=Jogging Down With Tongs Not Open, and 100=Get or Put Operation Has Taken Too Long to Complete.

[0144] In an example embodiment, if a deck error is detected, a code for the error is displayed at **1534**. Examples of deck error codes include, but are not limited to 10=The Deck locks Have Taken Too Long to Extend or Retract and 20=The Tongs Have Taken Too Long to Extend or Retract.

[0145] In an example embodiment, the status of a second axis (Axis 2) is represented by **1536**. Status information includes the position, velocity, position error, and if an error is detected for the PVL an error code at **1538** and if a PVL deck error is detected an error code at **1540**.

[0146] In an example embodiment, if an error is detected for the second axis, a code the error is displayed at **1538**. Examples of PVL error codes include, but are not limited to 26=Drive Not Ready, 27=Overtravel Detected, 28=Under travel Detected, 29=Chain Broken Detected, 30=Chain Slack Detected When Deck locks Retracted, 31=Tongs Have Not Closed Completely in Time Allotted, 32=Tongs Have Not Opened Completely in Time Allotted, 33=Deck locks Did Not Retract in Deck, 34=Deck locks Did Not Extend in Deck, 35=Stacker Beaks Did Not Retract, 36=There is a Fault in the Stacker with the Beaks, 37=Pallet Not Present on Deck When Beaks Told to Retract or PVL Ready to Lift After Get, 38=Dropped Pallet Laser Sensor Blocked When Beaks Told to Retract or PVL Ready to Lift After Get, 39=Pallet Present Prox Still On After Pallets Put in Stacker, 40=Dropped Pallet Laser Sensor Blocked When Opening Tongs, 41=Quantity of Pallet Present Sensors on Stacker North and South Side are not the Same, 42=Landed Position Not OK When Chain Slack Detected, 43=Get Requested by REM With No Pallet Present on Deck, 44=Put Requested by REM With A Pallet Present on Deck, 45=Put Requested by REM With Car Detection Laser Sensor Blocked, 52=Get Command Given with No Pallets in Stacker, 53=Put Command Given with Pallets in Stacker, 54=Put Command Given with No Pallets in the Deck, 56=Get Command Given with Pallets Already Present on Deck, 70=Destination Floor is More Than the Maximum Floor, 71=Destination Floor is Less Than the Minimum Floor, 72=Destination Floor is the Same as the Floor it's at, 73=Deck Should Be Landed but Chain Slack Not Being Seen, 74=Position is Not Valid, 75=The Selector Switch at the Stacker is Not in Auto When the PVL is in Auto, 76=Stall Fault–The Deck Has Not Moved For Too Long, 77=Jogging Up With Tongs Not Closed, 78=Jogging Up With Deck locks Not Retracted, 79=Get Command Given with Beaks Not Extended, 80=PVL Deck Moving Down with Beaks Not Retracted, 81=The PVL Deck is Not In Auto Ready Mode, 82=There Are Faults in the Stacker when PVL Told to Move, 83=There Are Faults in the Deck when PVL Told to Move, 84=EGD Down to Stacker when PVL Told to Move, 85=EGD Down to Deck when PVL Told to Move, 86=EGD Not OK in Stacker when PVL Told to Move, 87=REM Present when PVL Told to Move, 88=Jogging Down With Tongs Not Open, and 100=Get or Put Operation Has Taken Too Long to Complete.

[0147] In an example embodiment, if a deck error for the second axis is detected, a code for the error is displayed at **1540**. Examples of deck error codes include, but are not limited to 10=The Deck locks Have Taken Too Long to Extend or Retract and 20=The Tongs Have Taken Too Long to Extend or Retract.

[0148] In an example embodiment, the input at **1542** (GEAR IN) to cause the controller **302** to send a signal to the PVL to move the gear in which synchs the motors. In an example embodiment, the input at **1544** (ABORT), causes the controller **302** to send a signal to the PVL to abort which would stop the motion or last command. In an example embodiment, the input at **1546** (GEAR OUT) causes the motors to move unsynchronized.

[0149] In an example embodiment, the input at **1548** causes the controller **302** to send a signal to the PVL to close the first tongs. the input at **1550** causes the controller **302** to send a signal to the PVL to the first tongs to open. The input at **1552** causes the controller **302** to send a signal to the PVL to close the second tongs. The input at **1554** causes the controller **302** to send a signal to the PVL to the second tongs to open.

[0150] In an example embodiment, the PVL can be caused to move to a predefined position represented by **1556** by selecting the input represented by **1558**.

[0151] In an example embodiment, the input represented by **1560** is employed to clear any error codes listed under the first axis status **1530** and/or the second axis status **1532**. The input represented by **1562** is employed to clear an error returned by a servo controller (e.g., a PMM error). The input represented by **1564** is employed to clear an error in the Drive Memory (Reset the Drive).

[0152] In an example embodiment, barcode stickers are located in each Aisle for horizontal moving machines or at Floors for Vertical moving machines. A barcode reader installed on the machine can read a barcode sticker and determine its location. The input represented by **1566** is employed to cause the controller **302** to send a signal to the PVL barcode reader to read a barcode. Upon reading the barcode, the PVL number and Floor to be displayed.

[0153] In an example embodiment, the PVL is prevented from moving down past a certain position when Tongs are not opened, referred to as a Feed hold. The input represented by **1568** is employed to cause the controller **302** to send a signal to the PVL to bypass the Feed hold.

[0154] In an example embodiment, the input represented by **1570** is employed to cause the controller **302** to send a signal to the PVL to bypass over/under travel (e.g., ignore over and/or under limits). As those skilled in the art can readily appreciate, this input may be provided in a manual mode when testing the PVL.

[0155] In an example embodiment, input **1572** is employed to cause the controller **302** to send a signal to the PVL to bypass overhung. For example, ignore overhung limits. As those skilled in the art can readily appreciate, this input may be provided in a manual mode when testing the PVL.

[0156] In an example embodiment, the status of the two of the deck locks on a first side (e.g., Northeast, Northwest) of the PVL is represented by **1574**. The input **1576** is employed to cause the controller **302** to send a signal to the PVL to extend the deck locks (e.g., lock the deck at its current position). The input **1578** is employed to cause the controller **302** to send a signal to the PVL retract the deck locks (e.g., allow the deck to move).

[0157] In an example embodiment, the status of the two of the deck locks on a second side (e.g., Southeast, Southwest) of the PVL is represented by **1580**. The input **1582** is employed to cause the controller **302** to send a signal to the PVL extend the deck locks (e.g., lock the deck at its current position). The input **1584** is employed cause the controller **302** to send a signal to the PVL to retract the deck locks (e.g., allow the deck to move).

[0158] In an example embodiment, switches **1582**, **1584** are employed to select the operating mode. In an example embodiment, Switch **1582** OFF and switch **1584** MAN is a manual mode of operation (operator inputs, at least one safety interlock bypassed), switch **1582** OFF and switch **1584** AUTO is a first auto operating mode (operator inputs, safety interlocks engaged), and switch **1582** ON and switch **1584** AUTO is a second auto mode, or autonomous mode (computer inputs and safety interlocks on).

[0159] In an example embodiment, inputs **1591**, **1592**, **1593**, **1594** are employed to cause the controller **302** to send a signal to the PVL to move the PVL to a specified floor. Input **1591** causes the controller to move the PVL to the fourth floor. Input **1592** causes the controller to move the PVL to the third floor. Input **1593** causes the controller to move the PVL to the second floor. Input **1594** causes the controller to move the PVL to the first floor.

[0160] In an example embodiment, input **1595** causes the controller **302** to send a signal to the PVL to cause a predefined (small) move from the landing position to the hanging position(or pick up. input **1596** causes the controller **302** to send a signal to the PVL to cause the PVL to move a predefined (e.g., small) distance from a hanging position to the landing position (or settle down).

[0161] In an example embodiment, input **1597** causes the controller to send a signal to the PVL to cause the PVL to move a predefined distance (jog) in the upward direction. The input **1598** causes the controller to send a signal to the PVL to cause the PVL to move a predefined distance (jog) in the downward direction.

[0162] In an example embodiment, the input **1524** (Get/Put High) causes the controller **302** to send a signal to cause the PVL to move to the highest position while getting or putting pallet bundles in a PST. The input **1526** (Get/Put Low) causes the controller **302** to send a signal to the PVL to cause the PVL to move ot the lowest position while getting or putting a pallet bundle.

[0163] FIGS. **16**A and **16**B illustrates an example of an operator interface **1600** to view the status of vehicles that were parked in the parking garage. As will be described herein, this includes whether the vehicle has exited the parking garage, and if so, when.

[0164] Column **1602** displays the _ VM. Column **1604** displays a _ for the vehicle. Column **1606** displays a name, if known (e.g., a registered customer), or an assigned transaction number which matches the number in column **1602**. Column **1608** displays the time the vehicle was parked in the parking garage **100** and column **1610** displays the entry exit station **118** where the arrived.

[0165] If the vehicle has been retrieved, column **1612** displays the time the vehicle left the parking garage **100** and the entry exit station **118** where the vehicle departed. Column **1616** indicates whether the vehicle has left.

[0166] In an example embodiment, two views of the vehicle when the vehicle arrived are displayed at **1618**, **1620**. The views at **1618**, **1620** are associated with a particular transaction and time stamped. If the vehicle is departed, two views of the vehicle when the vehicle departed are displayed at **1622**, **1624**. The views at **1622**, **1624** are time stamped. These views **1618**, **1620**, **1622**, **1624** provide proof of the condition of the vehicle and if there was any damage when the vehicle arrived and when the vehicle departed in case there is a dispute or claim of damage to the vehicle while it was parked in the robotic parking garage **100**.

[0167] FIG. **17** is a block diagram that illustrates a computer system **1700** upon which an example embodiment may be implemented. For example, computer system **1700** can be

employed by controller **302** to implement the logic **304** for performing the functionality described herein.

[0168] Computer system **1700** includes a bus **1702** or other communication mechanism for communicating information and a processor **1704** coupled with bus **1702** for processing information. Computer system **1700** also includes a main memory **1706**, such as random-access memory (RAM) or other dynamic storage device coupled to bus **1702** for storing information and instructions to be executed by processor **1704**. Main memory **1706** also may be used for storing a temporary variable or other intermediate information during execution of instructions to be executed by processor **1704**. Computer system **1700** further includes a read only memory (ROM) **1708** or other static storage device coupled to bus **1702** for storing static information and instructions for processor **1704**. A storage device **1710**, such as a magnetic disk or optical disk, is provided and coupled to bus **1702** for storing information and instructions.

[0169] Computer system **1700** may be coupled via bus **1702** to a user interface that comprises a display **1712**, an input device **1714**, and a cursor control **1716**. The display **1712** can be any suitable type of device for displaying information such as a cathode ray tube (CRT), liquid crystal display (LCD), or light emitting diode (LED) for displaying information to a computer user. An input device **1714**, such as a keyboard including alphanumeric and other keys is coupled to bus **1702** for communicating information and command selections to processor **1704**. Another type of user input device is cursor control **1716**, such as a mouse, a trackball, or cursor direction keys for communicating direction information and command selections to processor **1704** and for controlling cursor movement on display **1712**. This inputs device typically has two degrees of freedom in two axes, a first axis (e.g., x) and a second axis (e.g., y) that allows the device to specify positions in a plane. In an example embodiment, the input device **1714** is a touch screen. In an example embodiment, the user interface comprises a touch screen which can include the functionality of the input device **1714** and/or cursor control **1716**.

[0170] An aspect of an example embodiment is related to the use of computer system **1700** for implementing an information system for a robotic parking garage. According to one embodiment, implementing an information system for a robotic parking garage is provided by computer system **1700** in response to processor **1704** executing one or more sequences of one or more instructions contained in main memory **1706**. Such instructions may be read into main memory **1706** from another computer-readable medium, such as storage device **1710**. Execution of the sequence of instructions contained in main memory **1706** causes processor **1704** to perform the process steps described herein. One or more processors in a multi-processing arrangement may also be employed to execute the sequences of instructions contained in main memory **1706**. In alternative embodiments, hard-wired circuitry may be used in place of or in combination with software instructions to implement an example embodiment. Thus, embodiments described herein are not limited to any specific combination of hardware circuitry and software.

[0171] The term "computer-readable medium" as used herein refers to any medium that participates in providing instructions to processor **704** for execution. Such a medium may take many forms, including but not limited to non-volatile media. Non-volatile media include for example optical or magnetic disks, such as storage device **710**. Common forms of computer-readable media include for example RAM, PROM, EPROM, FLASHPROM, CD, DVD, SSD or any other memory chip or cartridge, or other medium from which a computer can read.

[0172] Computer system **1700** also includes a communication interface **1718** coupled to bus **1702**. Communication interface **1718** provides a two-way data communication coupling to a network link **1720** that is connected to a local network **1722**. For example, communication interface **1718** may be an integrated services digital network (ISDN) card or a modem to provide a data communication connection to a corresponding type of telephone line. As another example, communication interface **1718** may be a local area network (LAN) card to provide a data communication connection to a compatible LAN. Wireless links may also be implemented. In any such implementation, communication interface **1718** sends and receives electrical, electromagnetic, or optical signals that carry digital data streams representing various types of information.

[0173] Network link **1720** typically provides data communication through one or more networks to another machine **402**. For example, network link **1720** may provide a connection through local network **1722** to a machine **402** in the robotic parking garage **100**. In an example embodiment, the local network **1722** provides data communications through the worldwide packet data communication network, now commonly referred to as the "Internet". Local networks **1722** and Internet both use electrical, electromagnetic, or optical signals that carry the digital data to and from computer system **1700**, are exemplary forms of carrier waves transporting the information.

[0174] Described above are example embodiments. It is, of course, not possible to describe every conceivable combination of components or methodologies, but one of ordinary skill in the art will recognize that many further combinations and permutations of the example embodiments are possible. Accordingly, this application is intended to embrace all such alterations, modifications and variations that fall within the spirit and scope of the appended claims interpreted in accordance with the breadth to which they are fairly, legally and equitably entitled.

1. An apparatus comprising:

a user interface comprising a display and an input coupled with a controller, the controller is coupled with an entry exit module, a rack entry module, an upper-level horizontal carrier module, a vertical lift carrier module, a pallet shuttle, a pallet stacker, and a pallet vertical lift;

the user interface includes but not limited to diagnostic screens for the entry exit module, the entry level carrier module, the rack entry module, the upper level horizonal carrier module, the vertical lift carrier module, the pallet shuttle, the pallet stacker, and the pallet vertical lift;

the user interface is operable to receive a diagnostic screen selection input from the user interface input and to select a diagnostic screen corresponding to a machine selected from the group consisting of the entry exit module, the entry level carrier module, the rack entry module, the upper level horizonal carrier module, the vertical lift carrier module, the pallet shuttle, the pallet stacker, and the pallet vertical lift; and

the user interface is operable to display a status of the machine corresponding to the selected diagnostic screen and when operating in a predefined mode selected from a plurality of operating modes, the controller is responsive to receiving an input from the selected diagnostic screen to cause the corresponding machine to move a predefined distance.

2. The apparatus set forth in claim **1**, wherein the selected diagnostic screen is an entry exit diagnostic screen that corresponds to the entry exit module, the entry exit diagnostic screen comprising:

the input comprises a first input operable to cause a motor coupled to the inner door to switch the inner door between an open and closed position, wherein the status of the inner door is displayed;

the display further displays the status of the outer door of the entry exit module and the input comprises a second input cause a motor coupled with the outer door to switch the outer door between an open and closed position;

the display is further operable to output a status of tracks in the entry exit module;

the display is further operable to output whether a vehicle is present in the entry exit area, and the input comprises a third input further causes a vehicle to be moved out of the entry exit module;

the display is further operable to output whether the entry exit module is operating entry mode or exit mode, the input comprises a fourth input causes the entry exit station to switch between entry mode and exit mode;

the display further comprises an output that indicates a height of a vehicle and an output that indicates an orientation of a vehicle when a vehicle is present in the entry exit module; and

The display further comprises an output that indicates the overall maximum length, maximum width, maximum weight and maximum height.

3. The apparatus set forth in claim **1**, wherein the selected diagnostic screen is an entry level carrier module, Carrier module with Turn Table (CM-TT), diagnostic screen that corresponds to the entry level carrier module, the entry level carrier module diagnostic screen comprising:

the display is operable to provide a graphical representation of a location of a vertical lift carrier and an entry exit station;

the display is further operable to provide a visual indication of a status of a cable reel;

the input comprises a first input for switching the cable reel on and off;

the input comprises a second input operable to cause the entry level carrier to move and locate a barcode;

the display is operable to provide data obtained from the barcode that provides data on aisle location and floor number;

the input comprises a third input operable to move the entry level carrier module a predefined distance;

the display is further operable to provide a visual indication of whether a rack entry module is present;

the display is further operable to provide a visual representation of coordinates for the entry level carrier;

the input comprises a fourth input to manually update the position of the entry level carrier;

the display further comprises a visual representation of the entry level carrier along an axis;

the input comprises a fifth input operable to cause the carrier to move along the axis a designated distance;

the display is further operable to provide location data representative of an aisle and row of the entry level carrier;

the input comprises a sixth input operable to cause the entry level carrier to a designated aisle;

the input comprises a seventh input operable to cause the entry level carrier to get a pallet;

the input comprises an eighth input operable to cause the entry level carrier to store a pallet;

the display is further operable to provide a visual indication of an orientation of a turntable associated with the entry level carrier;

the input comprises a ninth input operable to cause the turntable to rotate a predefined distance in a first direction;

the input comprises a tenth input operable to cause the turntable to rotate a predefined distance in a second direction;

the input comprises an eleventh input operable to cause the turntable to move to a predefined position;

the input comprises a twelfth input operable to clear an error code from the display;

the input comprises a thirteenth input operable to cause the display to display a rack entry module diagnostic screen; and

a reset strobe input that is operable to reset a plurality of strobes, and clears a last position search.

4. The apparatus set forth in claim **1**, wherein the selected diagnostic screen is a rack entry module diagnostic screen that corresponds to the rack entry module, the rack entry module diagnostic screen comprising:

a first area that provides status data for the rack entry module, the status data comprises data representative of a position of the rack entry module, whether a pallet is present on the rack entry module, and data representative whether an error was detected;

a first input operable to update a position of the rack entry module;

a second input operable to cause the rack entry module to a specified distance;

a third input operable to clear an error message from the display;

a fourth input operable to cause the rack entry module to abort a move;

a fifth input operable to cause the rack entry module to abort a move of a carrier module associated with the rack entry module;

a second area that provides a graphical view of a real-time position of the rack entry module within the robotic parking garage;

a third area operable to display a position of a first and second corners of a lift of a lift of the rack entry module;

a sixth input operable to release a lockout;

a fourth area operable to display a position of third and fourth corners of the lifts of the rack entry module;

a seventh input operable to cause a lift to move to a specified position in a first direction;

an eighth input operable to cause the lift to move to a specified position in a second direction;

a fifth area that displays a total time for moving a vehicle selected form a group consisting of getting and putting

the vehicle or pallet from a device adjacent from the rack entry module from a group consisting of a slot and a vertical lift carrier;

a sixth area that provides a visual indication of a status of a brake in a lift motor;

a ninth input that is operable to retrieve a carrier module diagnostic screen for the carrier module;

a tenth input that is operable to cause a search for a strobe on a first side of the rack entry module;

an eleventh input that is operable to cause a search for a strobe on a second side of the rack entry module;

a first homing input that is operable to cause the rack entry module to move to a first position on the carrier module;

a second homing input that is operable to cause the rack entry module to move to a second position on the carrier module;

a first jog input that is operable to cause the rack entry module to move a predefined distance in a first direction;

a second jog input that is operable to cause the rack entry module to move a predefined distance in a second direction;

a first switch input that is operable to cause a strobe light at a home position to selectively operate in one of a group consisting of an on and off position;

a second switch input that is operable to cause a strobe light associated with a row to selectively operate in one of a group consisting of an on and off position;

a mode switch that is operable to selectively operate the rack entry module in a mode selected from a manual, a first automatic mode that employs operator inputs, and a second automatic mode that employs computer inputs; and

a reset strobe input that is operable to reset a plurality of strobes, and clears a last position search.

5. The apparatus set forth in claim **1**, wherein the selected diagnostic screen is an upper-level horizontal carrier diagnostic screen that corresponds to the upper-level horizontal carrier module, the upper-level horizontal carrier diagnostic screen comprising:

a visual representation of a first aisle and a second aisle adjacent to the upper-level horizontal carrier module;

a visual representation of a location of a vertical lift carrier located in an aisle selected from a group consisting of the first aisle and the second aisle;

a visual representation of a location of a pallet vertical lift located in an aisle selected from a group consisting of the first aisle and the second aisle;

a visual representation of a location of the upper-level horizontal carrier module with respect to the first aisle and the second aisle;

a visual representation of the upper-level horizontal carrier module's position;

a visual representation of whether an error condition was detected;

a graphical representation of a cable reel and a status of the cable reel;

a bar code read input operable to cause a bar code scanner associated with the upper-level horizontal carrier modules to read a bar code and a visual representation of an aisle and floor of a barcode read by the bar code scanner;

a visual representation of a position of a rack entry module;

a move commands section that provides data representative of the aisle and the floor where the upper level horizontal carrier modules is located, a first move command input that is operable to cause the upper level horizontal carrier modules to move to a particular aisle, a second move command input **1124** can be employed to cause the upper level horizontal carrier module to get a pallet, a third move command input that is operable to cause the upper level horizontal carrier module remove a pallet off of the upper level horizontal carrier module;

a clear error input that enables an operator to clear an error detected for the upper-level horizontal carrier module;

a reset strobe input operable to cause a reset a strobe light and clears a last position search;

a rack entry module abort input that is operable to cause upper-level horizontal carrier module to abort a rack entry module move;

an upper-level horizontal carrier module abort input operable to cause the upper level horizontal carrier module to abort a movement;

a change diagnostic screen input that is operable to cause the selected diagnostic screen to change to a remote entry module diagnostic screen;

at least one mode input operable to select an operating mode of the upper-level horizontal carrier module; and

a reset strobe input that is operable to reset a plurality of strobes, and clears a last position search.

6. The apparatus set forth in claim **1**, wherein the selected diagnostic screen comprises a Vertical lift conveyor Drive diagnostic screen and a vertical lift conveyor deck diagnostic screen where the vertical lift conveyer deck moves from floor to floor, the diagnostic screen comprising:

a visual representation of a location of the vertical lift conveyor module and when an error is detected, an error code corresponding to the detected error;

a barcode read input operable to cause a barcode reader on the Vertical lift conveyor Deck to read a barcode and present a visual representation of machine number and a floor read by the barcode reader;

a graphical representation of the status of a brake on a first motor and a break on a second motor;

a move to floor input operable to obtain data representative of a specified floor and is operable to cause the vertical lift carrier module to move to the specified floor;

a pickup vertical lift conveyor deck input that is operable to cause the deck to move into an up position;

a settle down vertical lift conveyor deck input that is operable to cause the deck to move into a down position;

a move distance input operable to receive a data representative of a desired distance to move the vertical lift conveyor deck with data inputted;

an abort input operable to cause the vertical lift conveyor drive module to stop all movements of the vertical lift conveyor deck module;

a Vertical lift conveyor Drive gear out input causes the first and second motors to move individually without synchronization;

a Vertical lift conveyor Drive gear-in input to operate the first and second motors in synchronization

a bypass over/under travel input operable to allow the vertical lift conveyor deck to move past an over limit position or an under-limit position;

a bypass overhang limit that is operable to allow the vertical lift conveyor deck to move past an overhang limit;

a jog up input operable to cause the vertical lift conveyor deck to move up a predefined jog speed;

a jog down input operable to cause the vertical lift conveyor deck to move down a predefined jog speed;

a deck locks extend input operable to cause a vertical lift conveyor deck's locks to extend;

a deck locks retract input operable to cause the vertical lift conveyor deck's locks to retract;

a visual representation of a vertical lift conveyor deck error code;

a clear Vertical lift conveyor Drive clears a lift error detected on the drive;

a vertical lift conveyor deck clear error input operable to clear a detected deck error;

a PMM error input operable to clear an error received from a servo control module associated with the Vertical lift conveyor Drive

a first deck lock extend input operable to cause a pair of first deck locks to extend;

a second deck locks extend input operable to cause a pair of second deck locks to extend;

a first deck locks retract input operable to cause the pair of first deck locks to retract; and

a second deck locks retract input operable to cause a pair of second deck locks to retract.

7. The apparatus set forth in claim **1**, wherein the selected diagnostic screen is a pallet shuttle diagnostic screen that corresponds to the pallet shuttle, the pallet shuttle diagnostic screen comprising:

a visual representation of an aisle, which provides a location of an entry exit station, a pallet stacker, and a pallet vehicle lift, and whether a pallet is present in an entry exit station;

a visual representation of a real time position of the Pallet Shuttles;

a visual representation of a status of the pallet shuttle that comprises position data and data representative of a detected error, and a code associated with the detected error;

a reset strobe input that is operable to reset a plurality of strobes, and clears a last position search;

an abort pallet shuttle input operable to abort a pallet shuttle lift move;

a release lockout input operable to cause a Rack Entry Module to release a lockout of the pallet shuttle;

a clear error input operable to clear an error for the pallet shuttle;

an abort input operable to cause the pallet shuttle to stop;

a first locate slot input operable to cause the pallet shuttle to move in a first direction and locate a barcode;

a second barcode slot input operable to cause the pallet shuttle to move in a second direction to locate a barcode;

a visual representation that provides a graphical representation of whether a strobe is being detected in a first direction;

a visual representation that provides a graphical representation of whether a strobe is being detected in a second direction;

a first pallet shuttle jog input operable to cause the pallet shuttle to move a predefined distance in a first direction;

a second pallet shuttle jog input operable to cause the pallet shuttle to move a predefined distance in a second direction;

a position set update input operable to cause a position of the pallet shuttle to be updated;

a move distance input operable to move the pallet shuttle to a selected position;

an update position input operable to update the position of the pallet shuttle;

a move distance by counts input operable to receive a selected distance and a go to position input operable to move the pallet shuttle the selected distance;

a lift jog up input operable to cause a lift on the pallet shuttle to move a predefined distance in a first direction;

a lift full up down input operable to cause the lift on the pallet shuttle to move to a full up and full down position respectively;

an add/remove pallet input operable to cause a pallet shuttle lift to go to a position where a pallet is to be one of a group consisting of added to and removed from a pallet stacker;

a visual representation of an actual lift position and an error code for the lift;

a visual representation indicating whether a pallet is present;

a visual representation of a first lift position;

a visual representation of a second lift position; and

a visual representation of a number of times the lift has been raised and lowered.

8. The apparatus set forth in claim **1**, wherein the selected diagnostic screen is a pallet stacker diagnostic screen that corresponds to the pallet stacker, the pallet stacker diagnostic screen comprising:

a visual representation of a position of a first and a second pallet support mechanisms;

a visual representation of a position first and second beaks associated with the first and second pallet support mechanisms;

a visual representation of how many pallets are on the pallet stacker;

a visual representation provided by a first sensor array of pallets detected on a first side of the pallet stacker;

a visual representation provided by a second sensor array of pallets detected on a second side of the pallet stacker;

a first retract pallet support mechanism input operable to cause the first pallet support mechanism to move in a first direction;

a first extend pallet support mechanism input operable to cause the first pallet support mechanism to move in a second direction;

a second retract pallet support mechanism input operable to cause the second pallet support mechanism to move in the second direction;

a second extend pallet support mechanism input operable to cause the second pallet support mechanism to move in the first direction;

a retract beaks input operable to cause the first and second beaks to move to a retracted position;

an extend beaks input operable to cause the first and second beaks to move to an extended position;

a visual representation of an error code;

a clear error input operable to clear an error associated with the error code; and

a visual representation of a rack position count.

9. The apparatus set forth in claim **1**, wherein the selected diagnostic screen is a pallet vertical lift diagnostic screen that corresponds to the pallet vertical lift, the pallet vertical lift diagnostic screen comprising:

a visual representation of the pallet vertical lift for a first direction;

a visual representation of the pallet vertical lift for a second direction;

a visual representation of a floor where the pallet vertical lift is located;

a visual representation of whether an overtravel limit was exceeded;

a visual representation of whether an under-travel limit was exceeded;

a visual representation of a position of a plurality of beaks of a pallet stacker below the pallet vertical lift;

a visual representation of whether a beak on a first side of the pallet stacker are extended;

a visual representation of whether a beak on a second side of the pallet stacker are extended;

a visual representation indicating whether a rack entry module is present;

a visual representation of whether a pallet is present on the pallet stacker;

a visual representation of a status of a tong on a first side;

a visual representation of a status of a tong on a second side;

a visual representation of a status of a first axis that comprises a position, a velocity, a position error code, and a deck error code on the first axis;

a visual representation of a status of second first axis that comprises a position, a velocity, a position error code, and a deck error code on the second axis;

a gear in input operable to cause a plurality of pallet vertical lift drive motors to operate synchronized;

an abort input operable to cause the pallet vertical lift drive to stop moving;

a gear out input operable to cause the plurality of pallet vertical lift drive motors to operate unsynchronized;

a first close input operable to cause the tong on the first side to close;

a first open input operable to cause the tong on the first side to open;

a second close input operable to cause the tong on the second side to close;

a second open input operable to cause the tong on the second side to open;

a position input operable to receive data representative of a position and a go to position input operable to cause the pallet vertical lift deck to move the position that was input into the position input;

a clear error input operable to clear a detected error;

a clear PMM error input operable to reset a drive motor on pallet vertical lift drive;

a read barcode input operable to cause a barcode reader associated with a deck of pallet vertical lift to read a barcode and provide a visual representation of a pallet vertical lift number and floor of the barcode that was read;

a bypass feed hold input operable to allow the pallet vertical lift to exceed a feed hold limit;

a bypass over-under travel input operable to allow the pallet vertical lift deck to exceed an over travel limit and an under-travel limit;

a bypass overhang input operable to allow the pallet vertical lift to exceed an overhang limit;

a visual representation of a position of deck locks on a first side of the pallet vertical lift;

a visual representation of a position of deck locks on a second side of the pallet vertical lift;

an extend deck locks input operable to extend deck locks and lock the pallet vertical lift at a current position;

an retract deck locks input operable to retract deck locks and allow the pallet vertical lift to move;

a plurality of go to floor input operable to cause the pallet vertical lift to move to a designated floor;

a pick-up input operable to cause the pallet vertical lift to move to a hanging position;

a settle down input operable to cause the pallet vertical lift to move to a landing position;

a PVL jog up input operable to cause the pallet vertical lift to move the deck up with predefined job velocity;

a PVL jog down input operable to cause the pallet vertical lift to move down with predefined jog velocity;

a get put High input operable to cause the pallet vertical lift deck to move to a highest position in the pallet stacker while performing a get or put of pallet bundle; and

a get put low input operable to cause the pallet vertical lift deck to move to a lowest position in the pallet stacker while performing a get or put of pallet bundle.

10. A method, comprising:

providing a user interface comprising a display and an input coupled with a controller, the controller is coupled with an entry exit module, a rack entry module, an upper-level horizontal carrier module, a vertical lift carrier module, a pallet shuttle, a pallet stacker, and a pallet vertical lift, the user interface provides diagnostic screens for the entry exit module, the entry level carrier module, the rack entry module, the upper level horizonal carrier module, the vertical lift carrier module, the pallet shuttle, the pallet stacker, and the pallet vertical lift;

receiving a diagnostic screen selection input from the user interface input and selecting a diagnostic screen corresponding to a machine selected from the group consisting of the entry exit module, the entry level carrier module, the rack entry module, the upper level horizonal carrier module, the vertical lift carrier module, the pallet shuttle, the pallet stacker, and the pallet vertical lift; and

displaying a status of the machine corresponding to the selected diagnostic screen and when operating in a predefined mode selected from a plurality of operating modes, the controller is responsive to receiving an input from the selected diagnostic screen to cause the corresponding machine to move a predefined distance.

11. The method of claim **10**, wherein the selected diagnostic screen is an entry exit diagnostic screen that corresponds to the entry exit module, the method further comprising:

receiving a first input operable to cause a motor coupled to the inner door to switch the inner door between an open and closed position, wherein the status of the inner door is displayed;

displaying the status of the outer door of the entry exit module and the input comprises a second input cause a motor coupled with the outer door to switch the outer door between an open and closed position;

displaying a status of tracks in the entry exit module;

displaying whether a vehicle is present in the entry exit area, and the input comprises a third input further causes a vehicle to be moved out of the entry exit module;

displaying whether the entry exit module is operating entry mode or exit mode, the input comprises a fourth input causes the entry exit station to switch between entry mode and exit mode;

displaying a height of a vehicle and an orientation of a vehicle when a vehicle is present in the entry exit module; and

displaying the overall maximum length, maximum width, maximum weight and maximum height of the vehicle.

12. The method of claim **10**, wherein the selected diagnostic screen is an entry level carrier module, Carrier module with Turn Table (CM-TT), diagnostic screen that corresponds to the entry level carrier module, the method further comprising:

displaying a graphical representation of a location of a vertical lift carrier and an entry exit station;

displaying a visual indication of a status of a cable reel;

receiving a first input for switching the cable reel on and off;

receiving a second input operable to cause the entry level carrier to move and locate a barcode;

displaying data obtained from the barcode that provides data on aisle location and floor number;

receiving a third input operable to move the entry level carrier module a predefined distance;

displaying a visual indication of whether a rack entry module is present;

displaying a visual representation of coordinates for the entry level carrier;

receiving a fourth input to manually update the position of the entry level carrier;

displaying a visual representation of the entry level carrier along an axis;

receiving a fifth input operable to cause the carrier to move along the axis a designated distance;

displaying location data representative of an aisle and row of the entry level carrier;

receiving a sixth input operable to cause the entry level carrier to a designated aisle;

receiving a seventh input operable to cause the entry level carrier to get a pallet;

receiving an eighth input operable to cause the entry level carrier to store a pallet;

displaying a visual indication of an orientation of a turntable associated with the entry level carrier;

receiving a ninth input operable to cause the turntable to rotate a predefined distance in a first direction;

receiving a tenth input operable to cause the turntable to rotate a predefined distance in a second direction;

receiving an eleventh input operable to cause the turntable to move to a predefined position;

receiving a twelfth input operable to clear an error code from the display;

receiving a thirteenth input operable to cause the display to display a rack entry module diagnostic screen; and

receiving a reset strobe input that is operable to reset a plurality of strobes, and clears a last position search.

13. The method of claim **10**, wherein the selected diagnostic screen is a rack entry module diagnostic screen that corresponds to the rack entry module, the method further comprising:

displaying in a first area of the diagnostic screen status data for the rack entry module, the status data comprises data representative of a position of the rack entry module, whether a pallet is present on the rack entry module, and data representative whether an error was detected;

receiving a first input operable to update a position of the rack entry module;

receiving a second input operable to cause the rack entry module to a specified distance;

receiving a third input operable to clear an error message from the display;

receiving a fourth input operable to cause the rack entry module to abort a move;

receiving a fifth input operable to cause the rack entry module to abort a move of a carrier module associated with the rack entry module;

displaying in a second area of the diagnostic screen a graphical view of a real-time position of the rack entry module within the robotic parking garage;

displaying in a third area of the diagnostic screen a position of a first and second corners of a lift of a lift of the rack entry module;

receiving a sixth input operable to release a lockout;

displaying in a fourth area of the diagnostic screen a position of third and fourth corners of the lifts of the rack entry module;

receiving a seventh input operable to cause a lift to move to a specified position in a first direction;

receiving an eighth input operable to cause the lift to move to a specified position in a second direction;

displaying in a fifth area of the diagnostic screen a total time for moving a vehicle selected form a group consisting of getting and putting the vehicle or pallet from a device adjacent from the rack entry module from a group consisting of a slot and a vertical lift carrier;

displaying in a sixth area are the diagnostic screen a visual indication of a status of a brake in a lift motor;

receiving a ninth input that is operable to retrieve a carrier module diagnostic screen for the carrier module;

receiving a tenth input that is operable to cause a search for a strobe on a first side of the rack entry module;

receiving an eleventh input that is operable to cause a search for a strobe on a second side of the rack entry module;

receiving a first homing input that is operable to cause the rack entry module to move to a first position on the carrier module;

receiving a second homing input that is operable to cause the rack entry module to move to a second position on the carrier module;

receiving a first jog input that is operable to cause the rack entry module to move a predefined distance in a first direction;

receiving a second jog input that is operable to cause the rack entry module to move a predefined distance in a second direction;

operating a first switch input to cause a strobe light at a home position to selectively operate in one of a group consisting of an on and off position;

operating a second switch input that is operable to cause a strobe light associated with a row to selectively operate in one of a group consisting of an on and off position;

operating a mode switch that is operable to selectively operate the rack entry module in a mode selected from a manual, a first automatic mode that employs operator inputs, and a second automatic mode that employs computer inputs; and

receiving a reset strobe input that is operable to reset a plurality of strobes, and clears a last position search.

14. The method of claim **10**, wherein the selected diagnostic screen is an upper-level horizontal carrier diagnostic screen that corresponds to the upper-level horizontal carrier module, the method further comprising:

displaying on the diagnostic screen a visual representation of a first aisle and a second aisle adjacent to the upper-level horizontal carrier module;

displaying on the diagnostic screen a visual representation of a location of a vertical lift carrier located in an aisle selected from a group consisting of the first aisle and the second aisle;

displaying on the diagnostic screen a visual representation of a location of a pallet vertical lift located in an aisle selected from a group consisting of the first aisle and the second aisle;

displaying on the diagnostic screen a visual representation of a location of the upper-level horizontal carrier module with respect to the first aisle and the second aisle;

displaying on the diagnostic screen a visual representation of the upper-level horizontal carrier module's position;

displaying on the diagnostic screen a visual representation of whether an error condition was detected;

displaying on the diagnostic screen a graphical representation of a cable reel and a status of the cable reel;

receiving a bar code read input operable to cause a bar code scanner associated with the upper-level horizontal carrier modules to read a bar code and a visual representation of an aisle and floor of a barcode read by the bar code scanner;

displaying on the diagnostic screen a visual representation of a position of a rack entry module;

displaying on the diagnostic screen at a move commands section data representative of the aisle and the floor where the upper level horizontal carrier modules is located, receiving a first move command input that is operable to cause the upper level horizontal carrier modules to move to a particular aisle, receiving a second move command input to cause the upper level horizontal carrier module to get a pallet, receiving a third move command input that is operable to cause the upper level horizontal carrier module remove a pallet off of the upper level horizontal carrier module;

receiving a clear error input that enables an operator to clear an error detected for the upper-level horizontal carrier module;

receiving a reset strobe input operable to cause a reset a strobe light and clears a last position search;

receiving a rack entry module abort input that is operable to cause upper-level horizontal carrier module to abort a rack entry module move;

receiving an upper-level horizontal carrier module abort input operable to cause the upper level horizontal carrier module to abort a movement;

receiving a change diagnostic screen input that is operable to cause the selected diagnostic screen to change to a remote entry module diagnostic screen;

receiving at least one mode input operable to select an operating mode of the upper-level horizontal carrier module; and

receiving a reset strobe input that is operable to reset a plurality of strobes, and clears a last position search.

15. The method of claim **10**, wherein the selected diagnostic screen comprises a Vertical lift conveyor Drive diagnostic screena vertical lift conveyor deck diagnostic screen, the method further comprising:

displaying a visual representation of a location of the vertical lift conveyor module and when an error is detected, an error code corresponding to the detected error;

receiving a barcode read input operable to cause a barcode reader on the Vertical lift conveyor Deck to read a barcode and present a visual representation of machine number and a floor read by the barcode reader;

displaying a graphical representation of the status of brake on a first motor and a second motor;

receiving a move to floor input operable to obtain data representative of a specified floor and is operable to cause the vertical lift carrier module to move to the specified floor;

receiving a pickup vertical lift conveyor deck input that is operable to cause the deck to move into an up position;

receiving a settle down vertical lift conveyor deck input that is operable to cause the deck to move into a down position;

receiving data representative of a desired distance to move the vertical lift conveyor deck, and cause the deck to move to the desired distance;

receiving an abort input operable to cause the vertical lift conveyor drive module to stop all movements of the vertical lift conveyor deck module;

receiving a Vertical lift conveyor Drive gear out input that causes the first motor and second motor to move individually without synchronization;

receiving a Vertical lift conveyor-Drive a gear-in input that causes the first motor and second motor to operate in synchronization;

receiving a bypass over/under travel input operable to allow the vertical lift conveyor deck to move past an over limit position or an under-limit position;

receiving a bypass overhang limit that is operable to allow the vertical lift conveyor deck to move past an overhang limit;

receiving a jog up input operable to cause the vertical lift conveyor deck to move up a predefined jog speed;

receiving a jog down input operable to cause the vertical lift conveyor deck to move down a predefined jog speed;
receiving a deck locks extend input operable to cause the vertical lift conveyor deck's locks to extend;
receiving a deck locks retract input operable to cause the vertical lift conveyor deck's locks to retract;
receiving a visual representation of a vertical lift conveyor deck error code;
receiving a clear Vertical lift conveyor Drive clears a lift error detected on the drive;
receiving a vertical lift conveyor deck clear error input operable to clear a detected deck error;
receiving a PMM error input operable to clear an error received from a servo control module associated with the Vertical lift conveyor Drive
receiving a first deck lock extend input operable to cause a pair of first deck locks to extend;
receiving a second deck locks extend input operable to cause a pair of second deck locks to extend;
receiving a first deck locks retract input operable to cause the pair of first deck locks to retract; and
receiving a second deck locks retract input operable to cause a pair of second deck locks to retract.

16. The method of claim **10**, wherein the selected diagnostic screen is a pallet shuttle diagnostic screen that corresponds to the pallet shuttle, the method further comprising:

providing a visual representation of an aisle, which provides a location of an entry exit station, a pallet stacker, and a pallet vehicle lift, and whether a pallet is present in an entry exit station;
providing a visual representation of a real time position of the Pallet Shuttles;
providing a visual representation of a status of the pallet shuttle that comprises position data and data representative of a detected error, and a code associated with the detected error;
receiving a reset strobe input that is operable to reset a plurality of strobes, and clears a last position search;
receiving an abort pallet shuttle input that aborts a pallet shuttle lift move;
receiving a release lockout input operable to cause a Rack Entry Module to release a lockout of the pallet shuttle;
receiving a clear error input operable to clear an error for the pallet shuttle;
receiving an abort input operable that causes the pallet shuttle to stop;
receiving a first locate slot input operable to cause the pallet shuttle to move in a first direction and locate a barcode;
receiving a second barcode slot input operable to cause the pallet shuttle to move in a second direction to locate a barcode;
providing a visual representation of whether a strobe is being detected in a first direction;
providing a visual representation of whether a strobe is being detected in a second direction;
receiving a first pallet shuttle jog input operable to cause the pallet shuttle to move a predefined distance in a first direction;
receiving a second pallet shuttle jog input operable to cause the pallet shuttle to move a predefined distance in a second direction;
receiving a position set update input operable to cause a position of the pallet shuttle to be updated;
receiving a move distance input operable to move the pallet shuttle to a selected position;
receiving an update position input operable to cause the position set of the pallet shuttle;
receiving a move distance by counts input operable to receive a selected distance and a go to position input operable to move the pallet shuttle the selected distance;
receiving a lift jog up input operable to cause a lift on the pallet shuttle to move a predefined distance in a first direction;
receiving a lift full up down input operable to cause the lift on the pallet shuttle to move to a full up and full down position respectively;
receiving an add/remove pallet input operable to cause a pallet shuttle lift to go to a position where a pallet is to be one of a group consisting of added to and removed from a pallet stacker;
providing a visual representation of an actual lift position and an error code for the lift;
providing a visual representation indicating whether a pallet is present;
providing a visual representation of a first lift position;
providing a visual representation of a second lift position; and
providing a visual representation of a number of times the lift has been raised and lowered.

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