FIG. 1

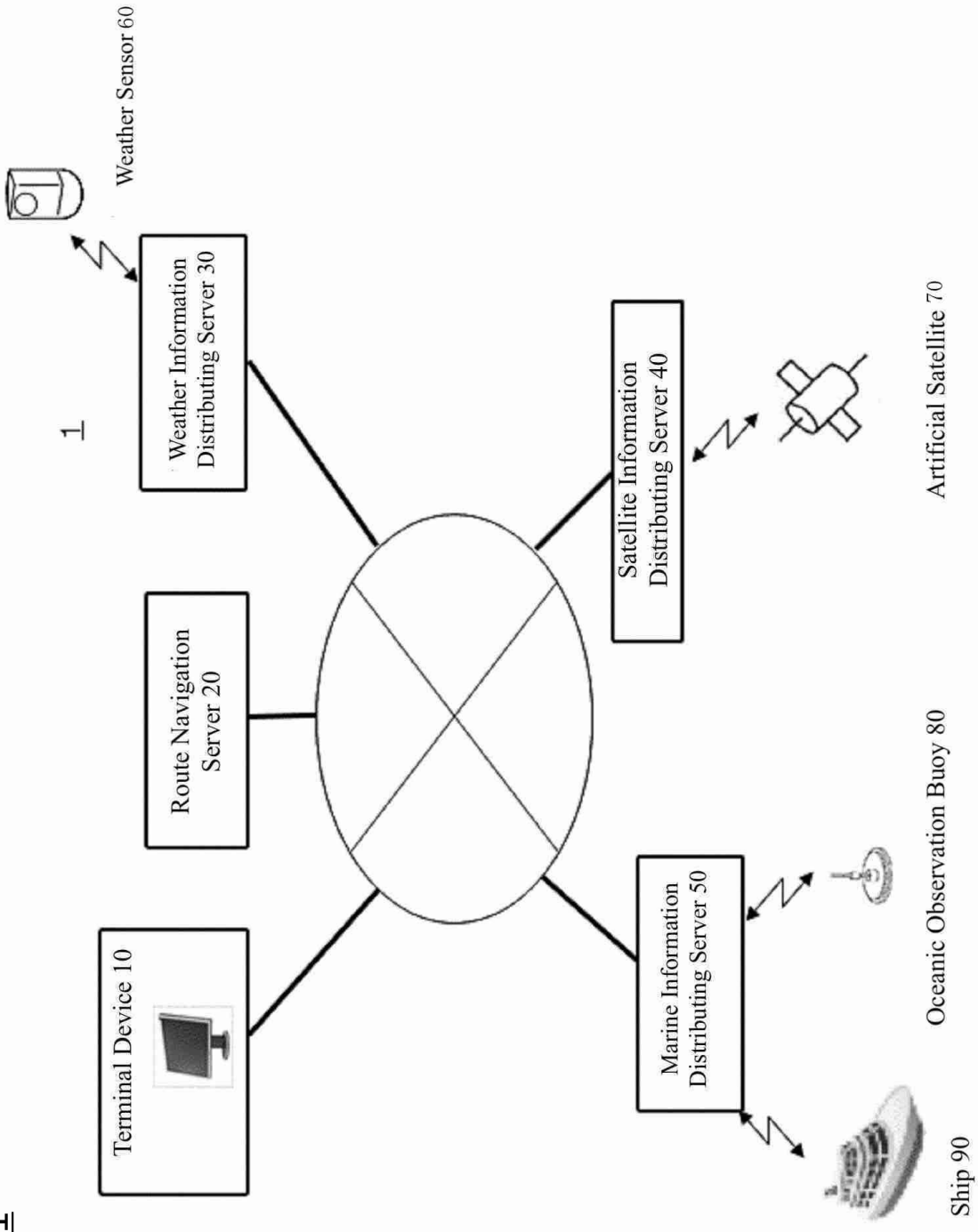

1
Weather Sensor 60
Weather Information Distributing Server 30
Route Navigation Server 20
Terminal Device 10
Satellite Information Distributing Server 40
Artificial Satellite 70
Marine Information Distributing Server 50
Oceanic Observation Buoy 80
Ship 90

FIG. 2

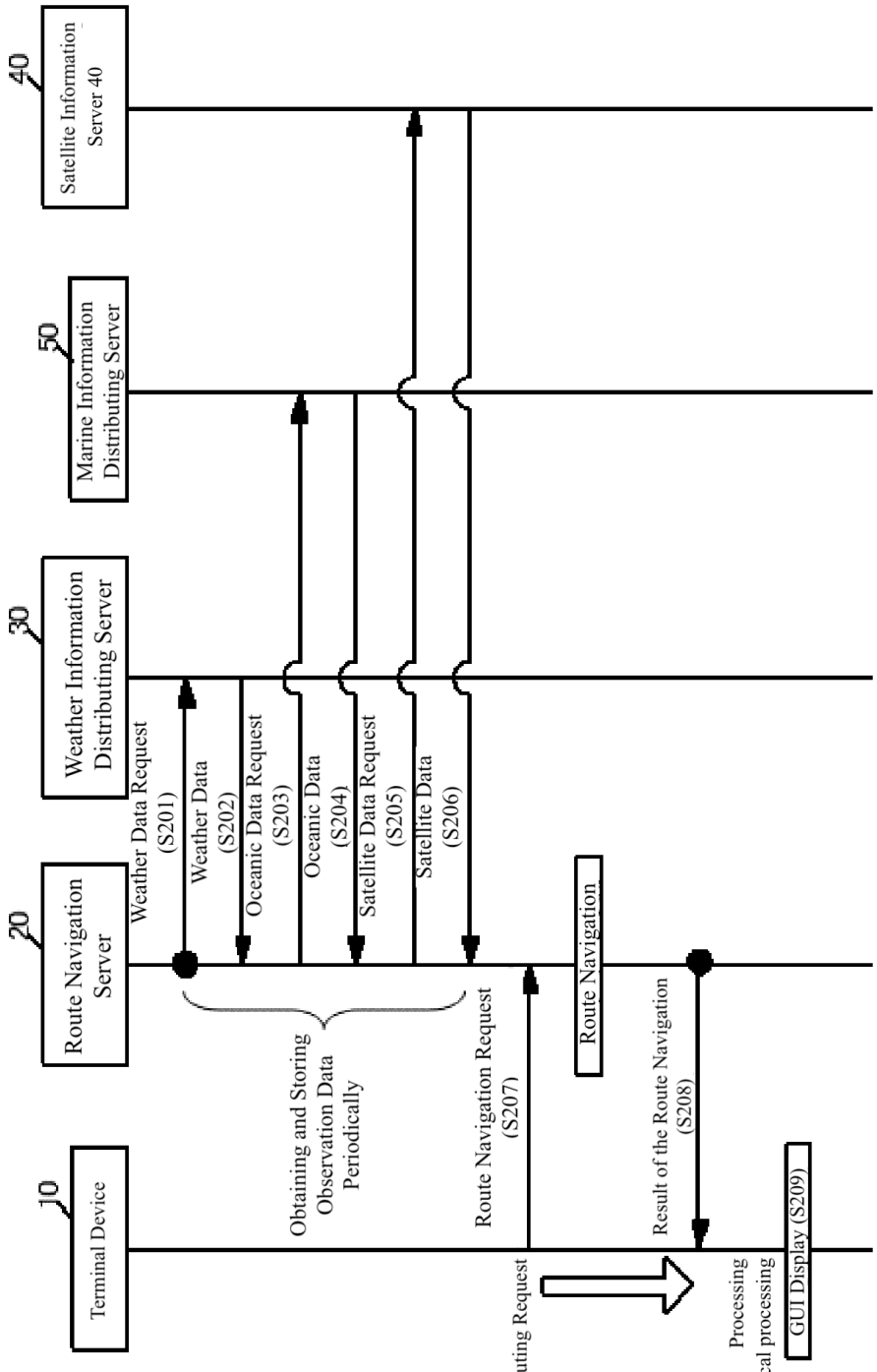

10
Terminal Device
20
Route Navigation Server
30
Weather Information Distributing Server
50
Marine Information Distributing Server
40
Satellite Information Server 40
Weather Data Request (S201)
Weather Data (S202)
Oceanic Data Request (S203)
Oceanic Data (S204)
Satellite Data Request (S205)
Satellite Data (S206)
Obtaining and Storing Observation Data Periodically
Route Navigation Request (S207)
Route Navigation
Result of the Route Navigation (S208)
Routing Request
Processing
Graphical processing
GUI Display (S209)

FIG. 3

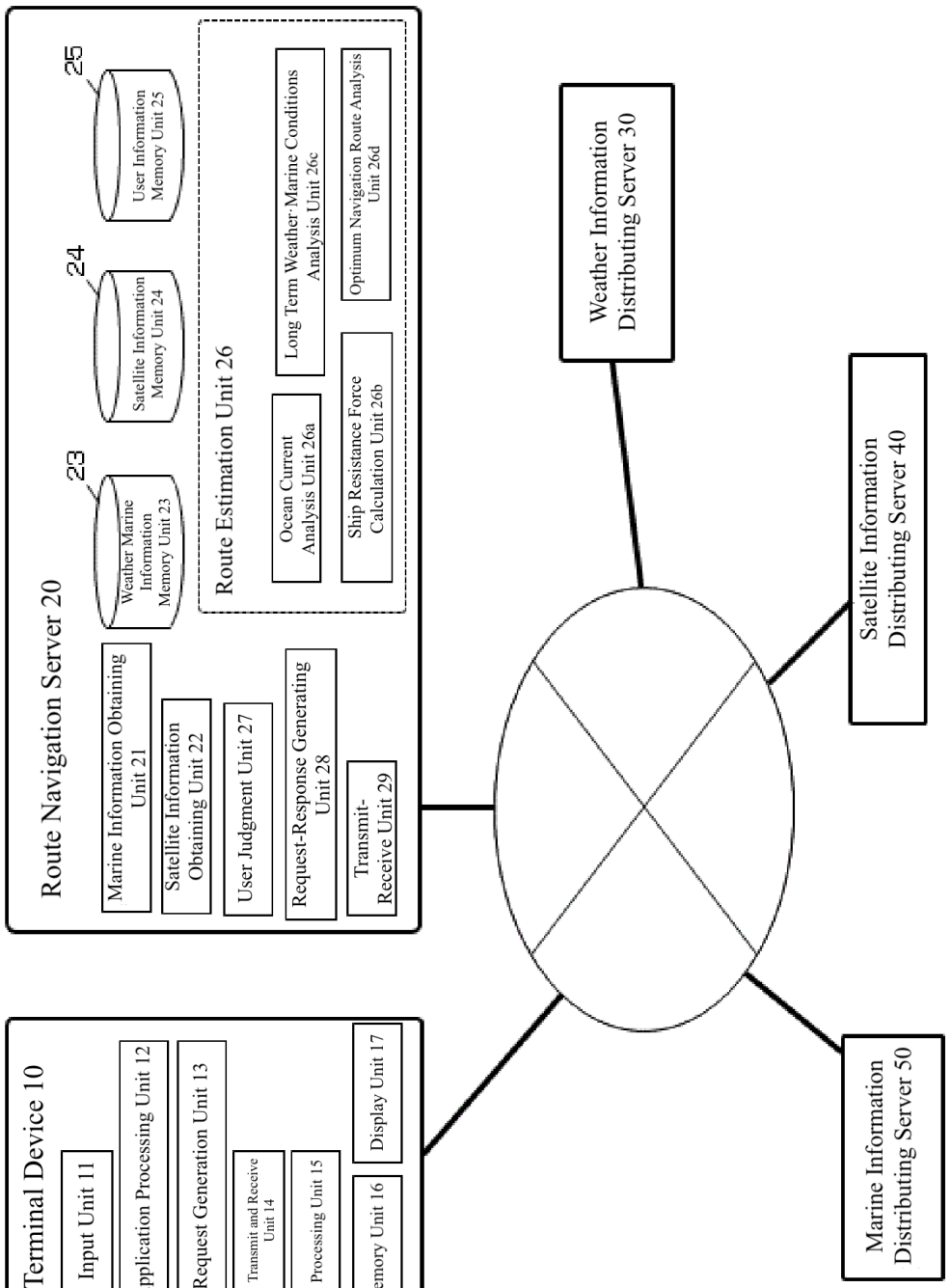

1
Terminal Device 10
Input Unit 11
Application Processing Unit 12
Request Generation Unit 13
Transmit and Receive Unit 14
Processing Unit 15
Memory Unit 16
Display Unit 17
Route Navigation Server 20
Marine Information Obtaining Unit 21
Satellite Information Obtaining Unit 22
User Judgment Unit 27
Request-Response Generating Unit 28
Transmit-Receive Unit 29
23
Weather Marine Information Memory Unit 23
24
Satellite Information Memory Unit 24
25
User Information Memory Unit 25
Route Estimation Unit 26
Ocean Current Analysis Unit 26a
Ship Resistance Force Calculation Unit 26b
Long Term Weather·Marine Conditions Analysis Unit 26c
Optimum Navigation Route Analysis Unit 26d
Weather Information Distributing Server 30
Satellite Information Distributing Server 40
Marine Information Distributing Server 50

FIG. 4(a)

401

	5	6.5	8.5	10.5	12.5	14	Wave Period
0.6	0.006	0.005	0.011	0.03	0.06	0.07	
0.75	0.009	0.0081	0.017	0.047	0.09	0.1	
1.75	0.05	0.044	0.094	0.24	0.48	0.54	
2.75	0.12	0.11	0.231	0.57	1.11	1.24	
3.75	0.23	0.2	0.424	1	1.92	2.12	
4.75	0.36	0.32	0.668	1.5	2.83	3.13	
5.75	0.52	0.46	0.96	2.07	3.81	4.21	
6.75	0.71	0.64	1.29	2.67	4.82	5.36	
7.75	0.92	0.83	1.66	3.31	6.23	7.09	
8.75	1.16	1.04	2.05	3.95	7.66	8.43	
9.75	1.41	1.27	2.47	4.62	8.77	9.42	
10.75	1.68	1.52	2.91	5.31	9.61	10.14	
11.75	1.97	1.78	3.36	6.41	10.21	10.81	
12.75	2.26	2.05	3.82	7.38	10.84	11.4	
13.75	2.57	2.34	4.28	8.21	11.39	11.88	
14.75	2.89	2.63	4.76	8.92	11.84	12.27	
Wave Height							

FIG. 4(b)

402

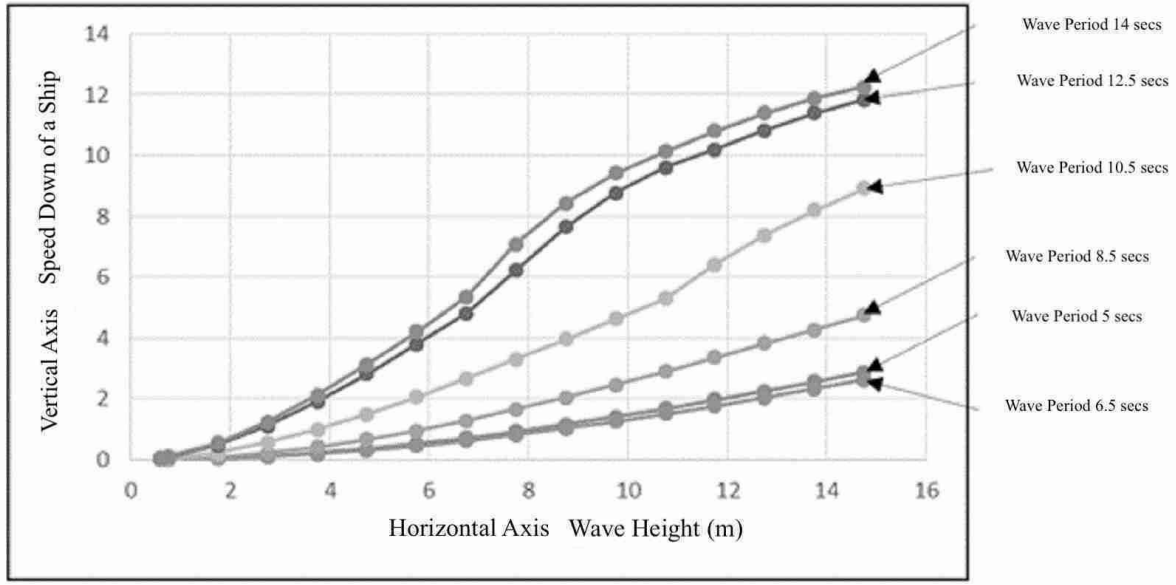


FIG. 5(a)

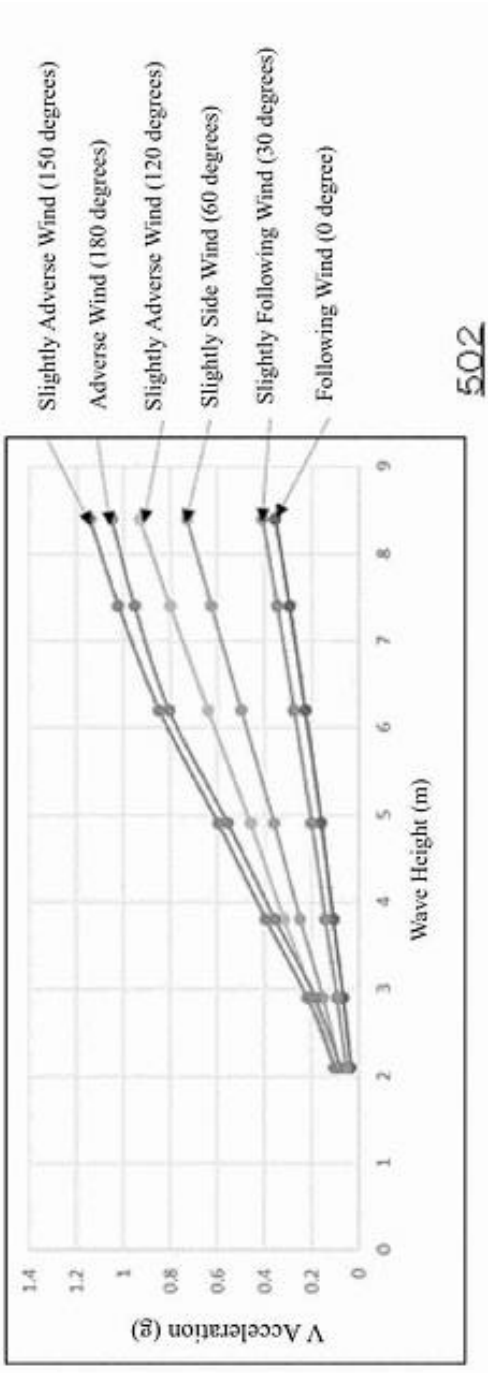


FIG. 5(b)

502

Wave Height (m)	2.1	2.9	3.8	4.9	6.2	7.4	8.4	
V Acceleration (g)	0.034	0.066	0.109	0.159	0.228	0.295	0.355	Following Wind (0 degree)
	0.053	0.0925	0.142	0.2	0.275	0.347	0.41	Slightly Following Wind (30 degrees)
	0.08	0.152	0.249	0.36	0.5	0.628	0.733	Slightly Side Wind (60 degrees)
	0.104	0.194	0.318	0.461	0.642	0.804	0.933	Slightly Adverse Wind (120 degrees)
	0.102	0.22	0.396	0.599	0.85	1.023	1.147	Slightly Adverse Wind (150 degrees)
	0.081	0.185	0.357	0.557	0.808	0.955	1.053	Adverse Wind (180 degrees)

FIG. 5(c)

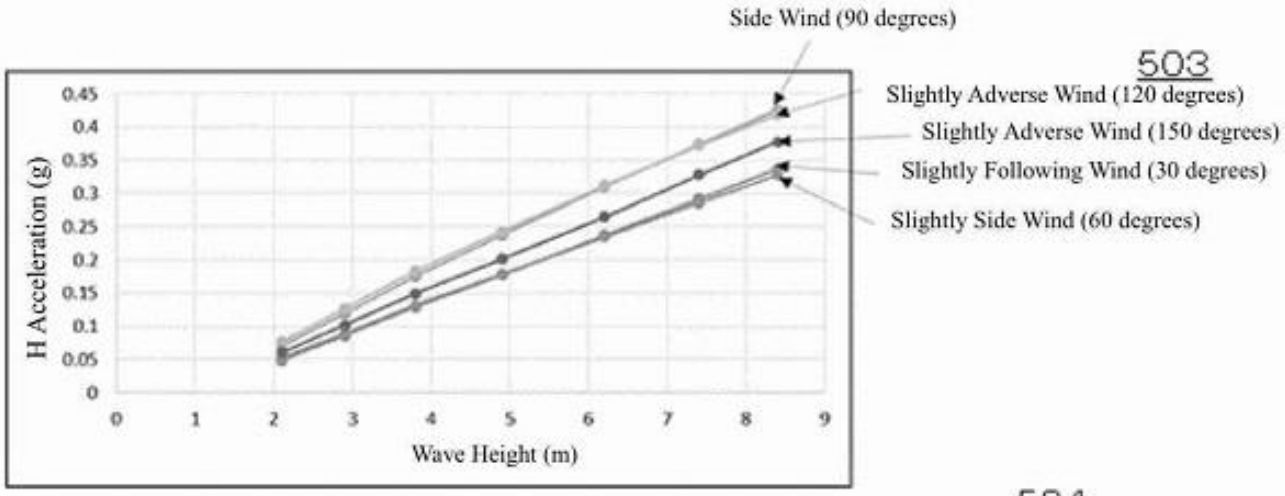


FIG. 5(d)

504

Wave Height (m)	2.1	2.9	3.8	4.9	6.2	7.4	8.4	
H Acceleration (g)	0.049	0.086	0.129	0.177	0.238	0.292	0.337	Slightly Following Wind (30 degrees)
	0.053	0.089	0.132	0.179	0.235	0.286	0.328	Slightly Side Wind (60 degrees)
	0.07	0.119	0.175	0.237	0.31	0.374	0.426	Side Wind (90 degrees)
	0.0768	0.127	0.183	0.243	0.312	0.373	0.419	Slightly Adverse Wind (120 degrees)
	0.061	0.102	0.149	0.202	0.265	0.328	0.378	Slightly Adverse Wind (150 degrees)

601

FIG. 6(a)

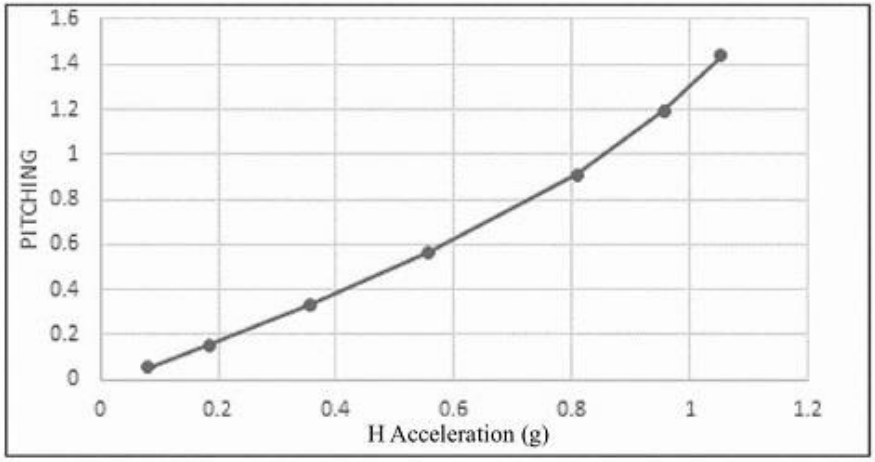


FIG. 6(b)

602

Wave Height (m)	2.1	2.9	3.8	4.9	6.2	7.4	8.4
H Acceleration (g)	0.081	0.185	0.357	0.557	0.808	0.955	1.053
PITCHING	0.057	0.156	0.336	0.568	0.909	1.193	1.437

FIG. 6(c)

603

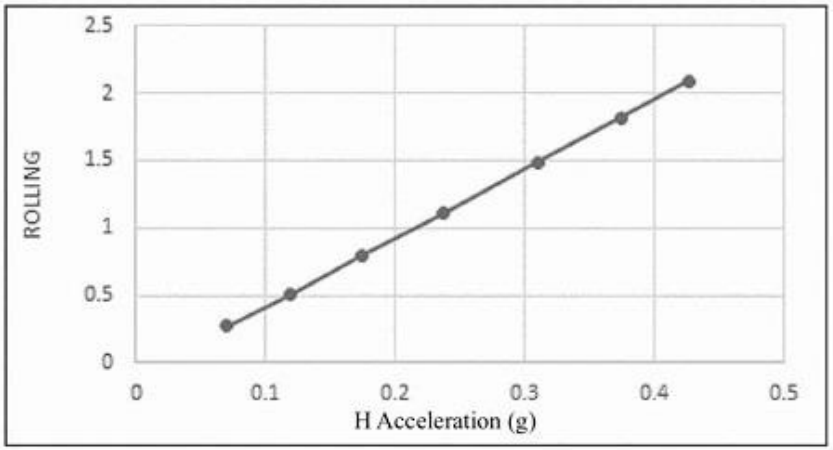


FIG. 6(d)

604

Wave Height (m)	2.1	2.9	3.8	4.9	6.2	7.4	8.4
H Acceleration (g)	0.07	0.119	0.175	0.237	0.31	0.374	0.426
ROLLING	0.272	0.508	0.798	1.11	1.487	1.82	2.093

FIG. 7

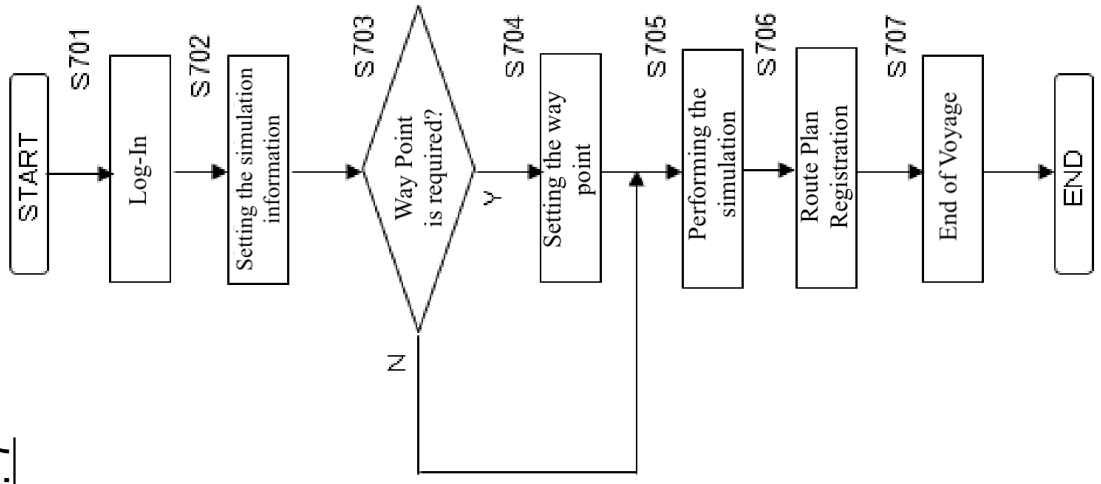

START
S701
Log-In
S702
Setting the simulation information
S703
Way Point is required?
Y
N
S704
Setting the way point
S705
Performing the simulation
S706
Route Plan Registration
S707
End of Voyage
END

FIG. 8

801

(Example)

Ship Name	XXX Ship	Remarks
FULL LOAD speed (kt)	15	No Sea-margin
FULL LOAD displacement (t)	300000	
FULL LOARD speed (kt)	16	No Sea-margin
HEAVY BALLAST displacement (t)	150000	
Horsepower (kw)	18000	
Fuel Consumption (ton/day)	75	
Engine Speed (rpm)	80	
Cargo Type	Coal	• Select the type of cargo from the list below 1 No Cargo 2 : Coal 3 : ORE 4 : Steel Coil 5 : Grain 6 : Cement • Please select "storage factor" if you can't select from 1-6.
stowage factor(ft^3/LT)	30	Not required to input if cargo type is filled.
Date of Manufacture	2015/7/3	
IMO No.	IMO0000000	

FIG. 9(a)

901

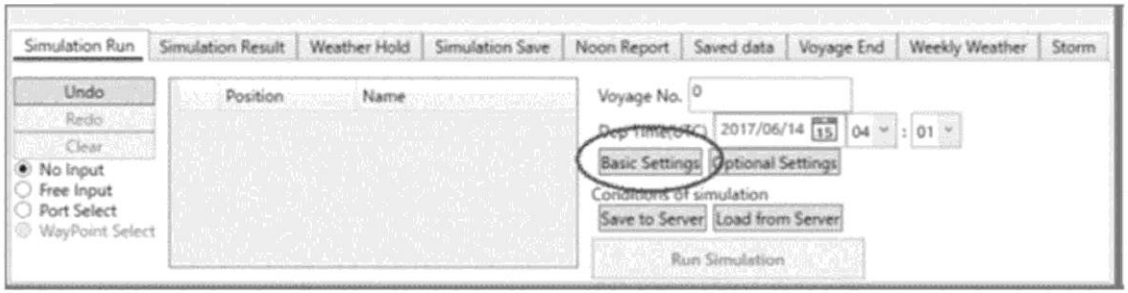


FIG. 9(b)

902

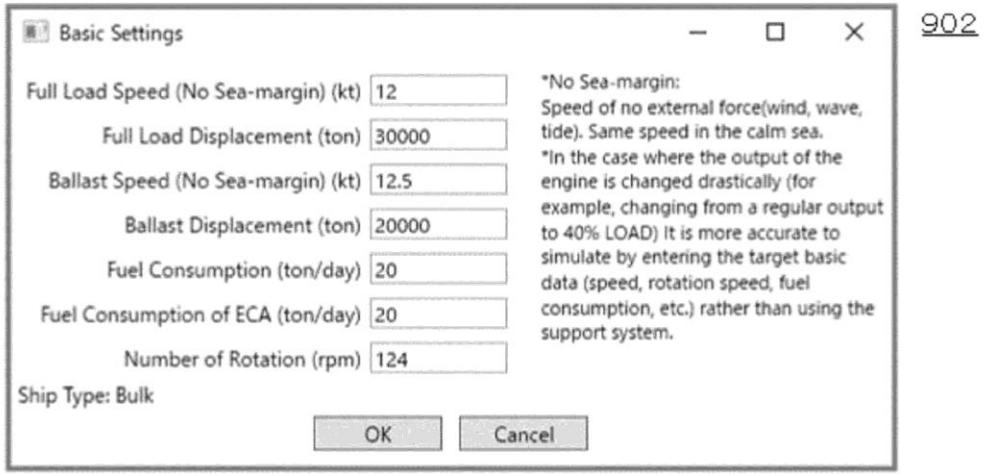


FIG. 10(a)

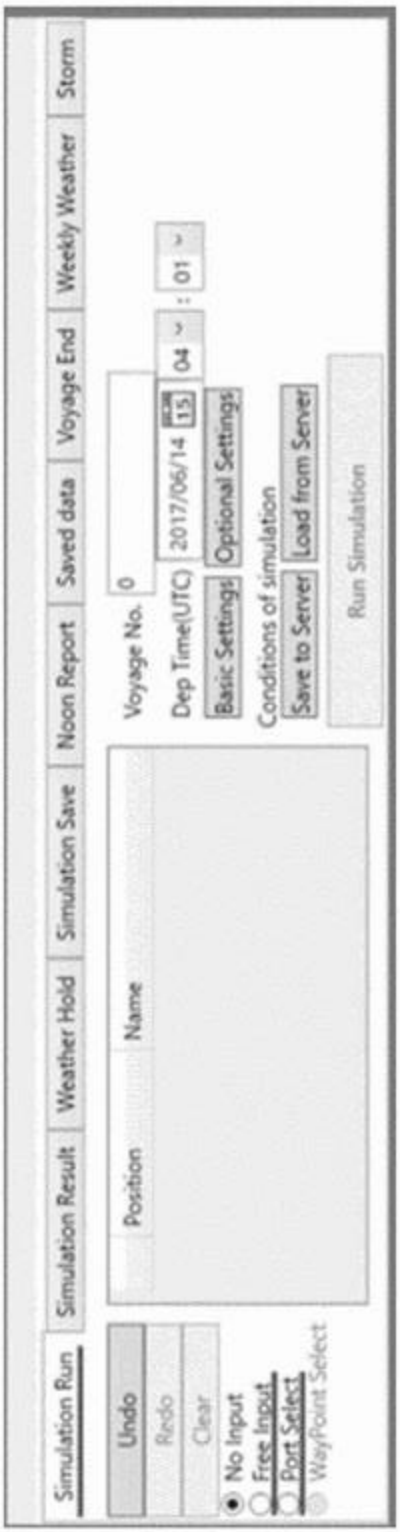


FIG. 10(b)

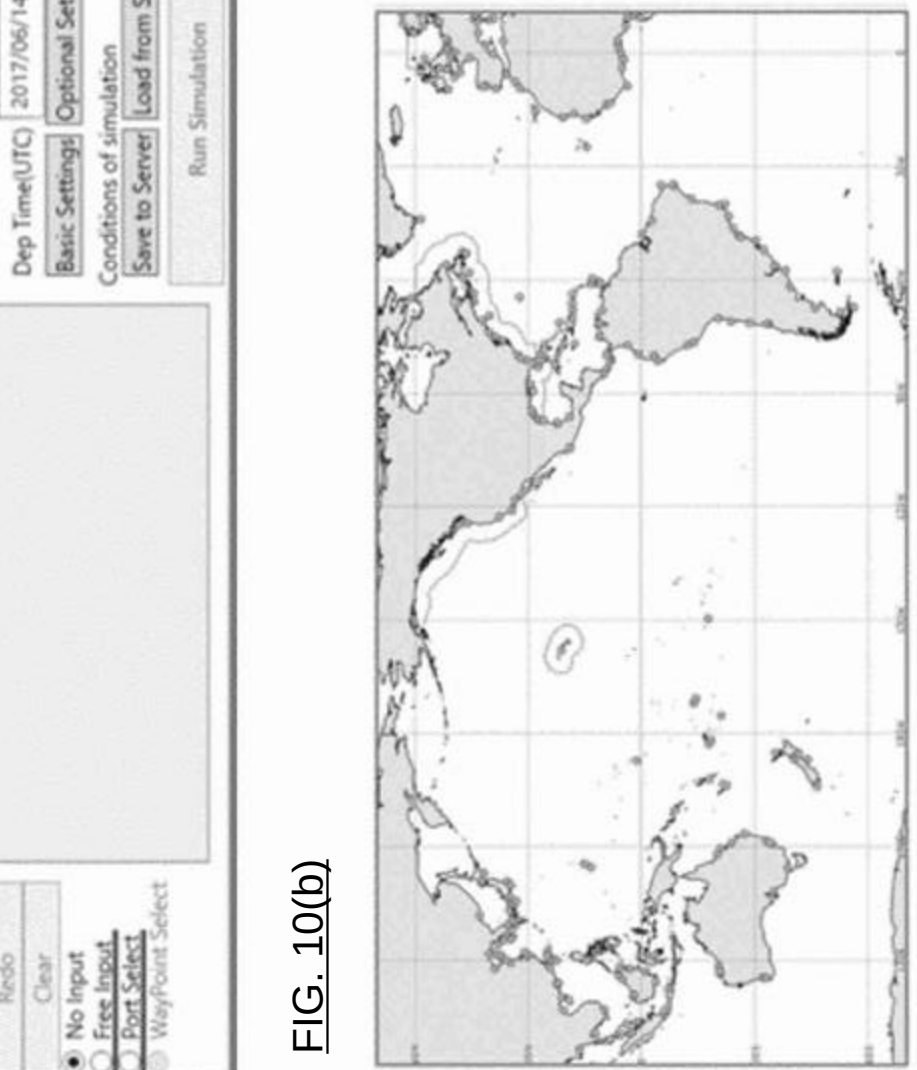


FIG. 11

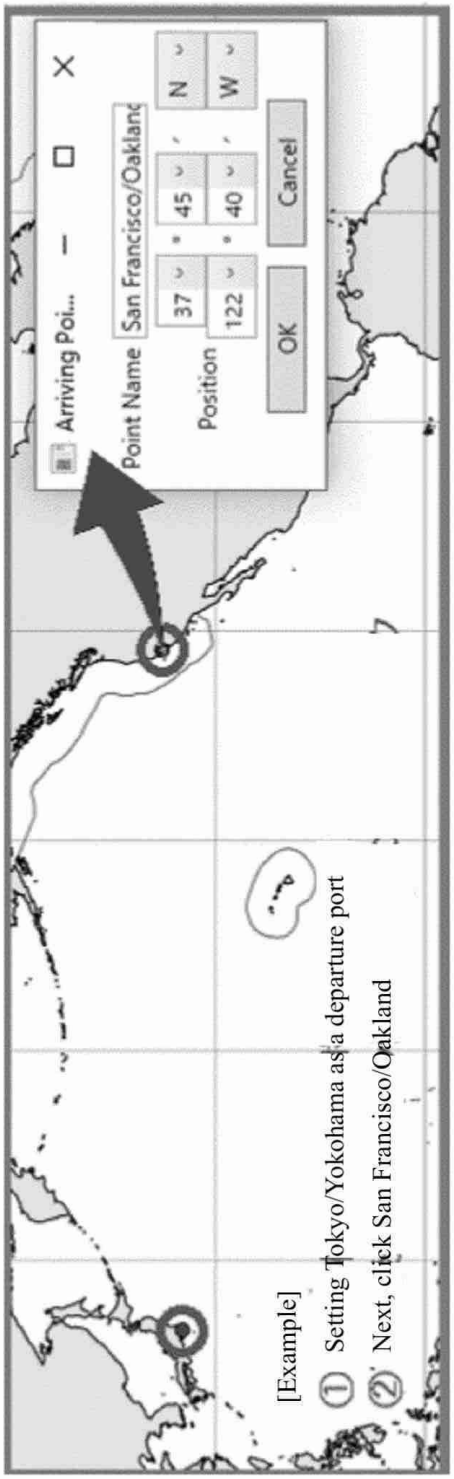
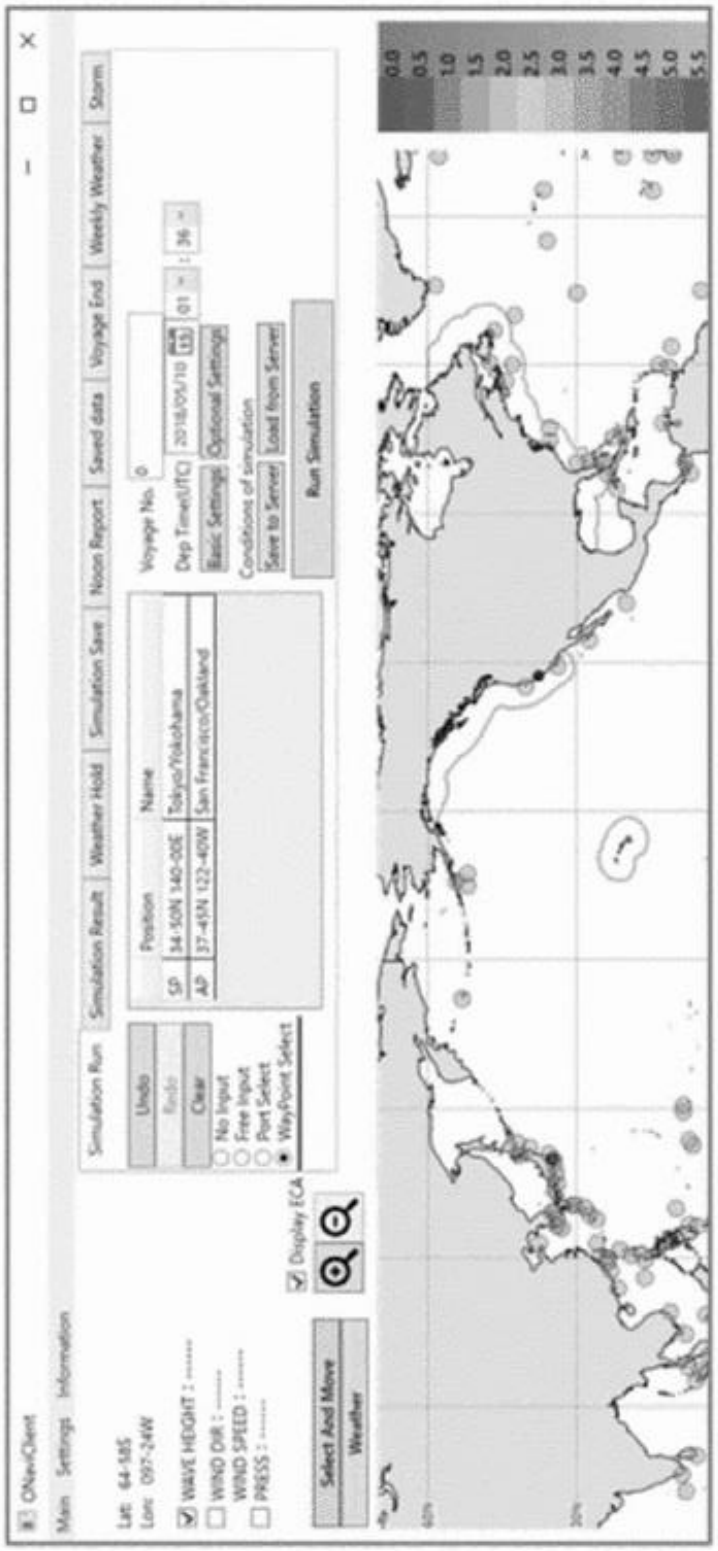

1101
Arriving Poi...
Point Name
San Francisco/Oakland
Position
37
45
N
122
40
W
OK
Cancel
[Example]
① Setting Tokyo/Yokohama as a departure port
② Next, click San Francisco/Oakland

FIG. 12(a)


1201
ONavi Client
Main
Settings
Information
Simulation Run
Simulation Result
Weather Hold
Simulation Save
Noon Report
Saved data
Voyage End
Weekly Weather
Storm
Undo
Redo
Clear
No Input
Free Input
Port Select
WayPoint Select
Position
Name
SP
34-50N 140-00E
Tokyo/Yokohama
AP
37-45N 122-40W
San Francisco/Oakland
Voyage No.
Dep Time(UTC)
Basic Settings
Optional Settings
Conditions of simulation
Save to Server
Load from Server
Run Simulation
Lat: 44-58S
Lon: 097-24W
WAVE HEIGHT : ------
WIND DIR : ------
WIND SPEED : ------
PRESS : ------
Display ECA
Select And Move
Weather
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5

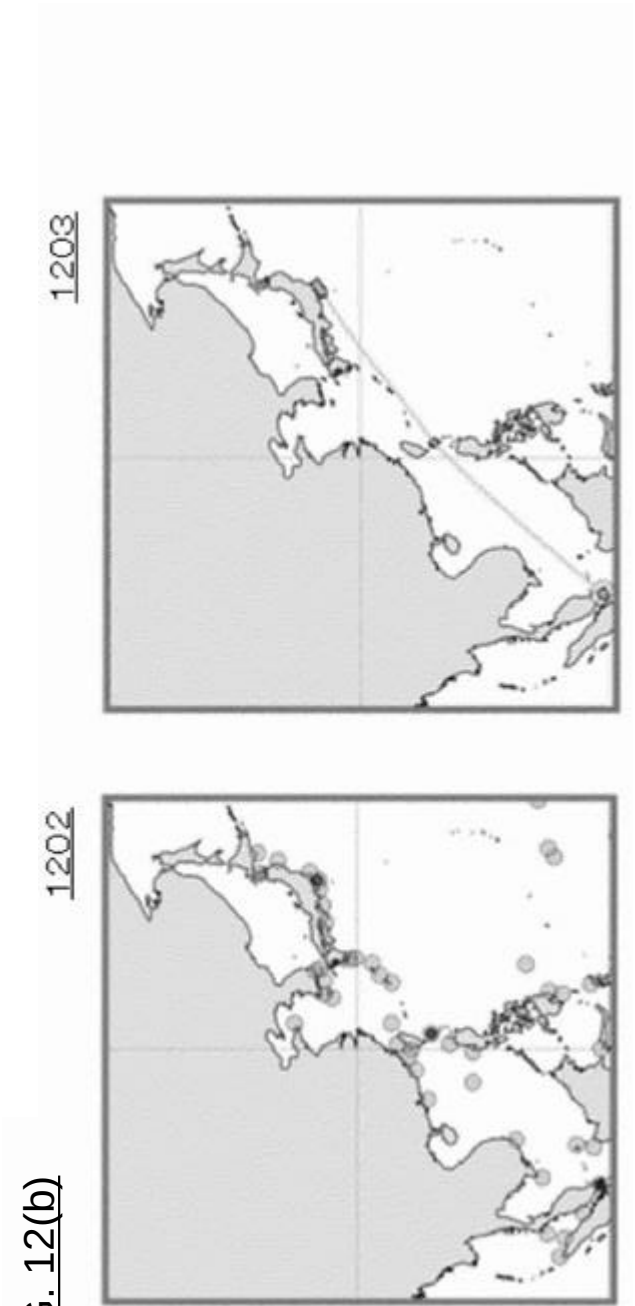


FIG. 12(b)

FIG. 13(a)

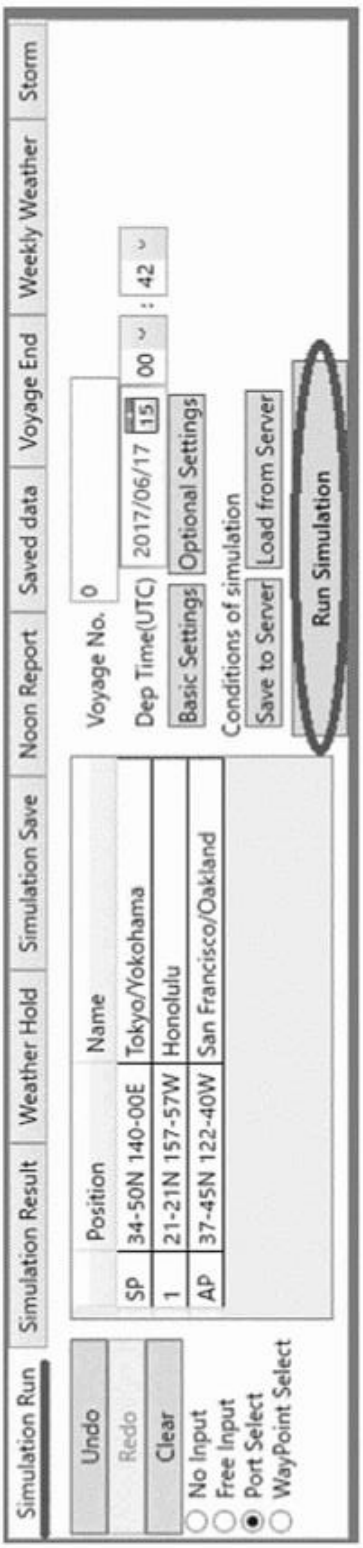


FIG. 13(b)

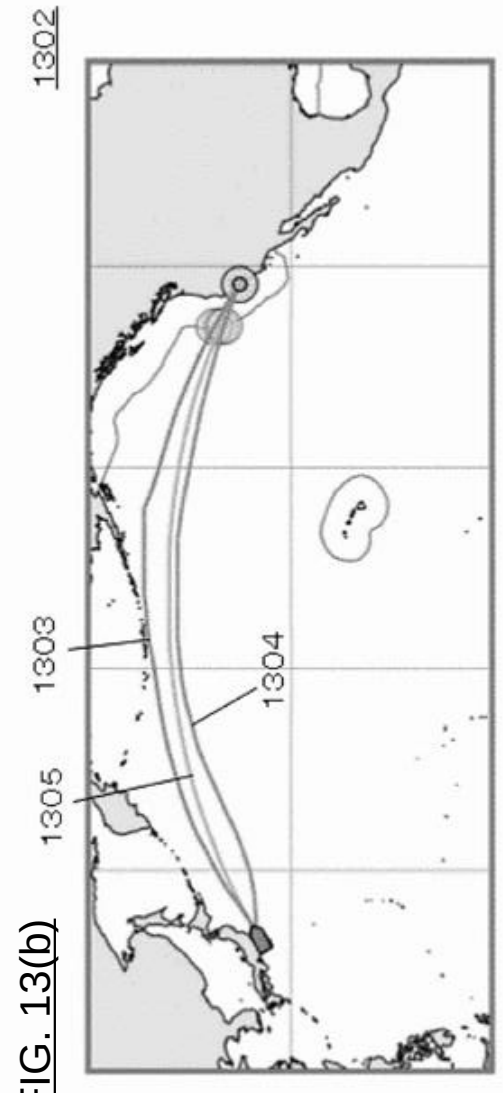


FIG. 14(a)

FIG. 14(b)

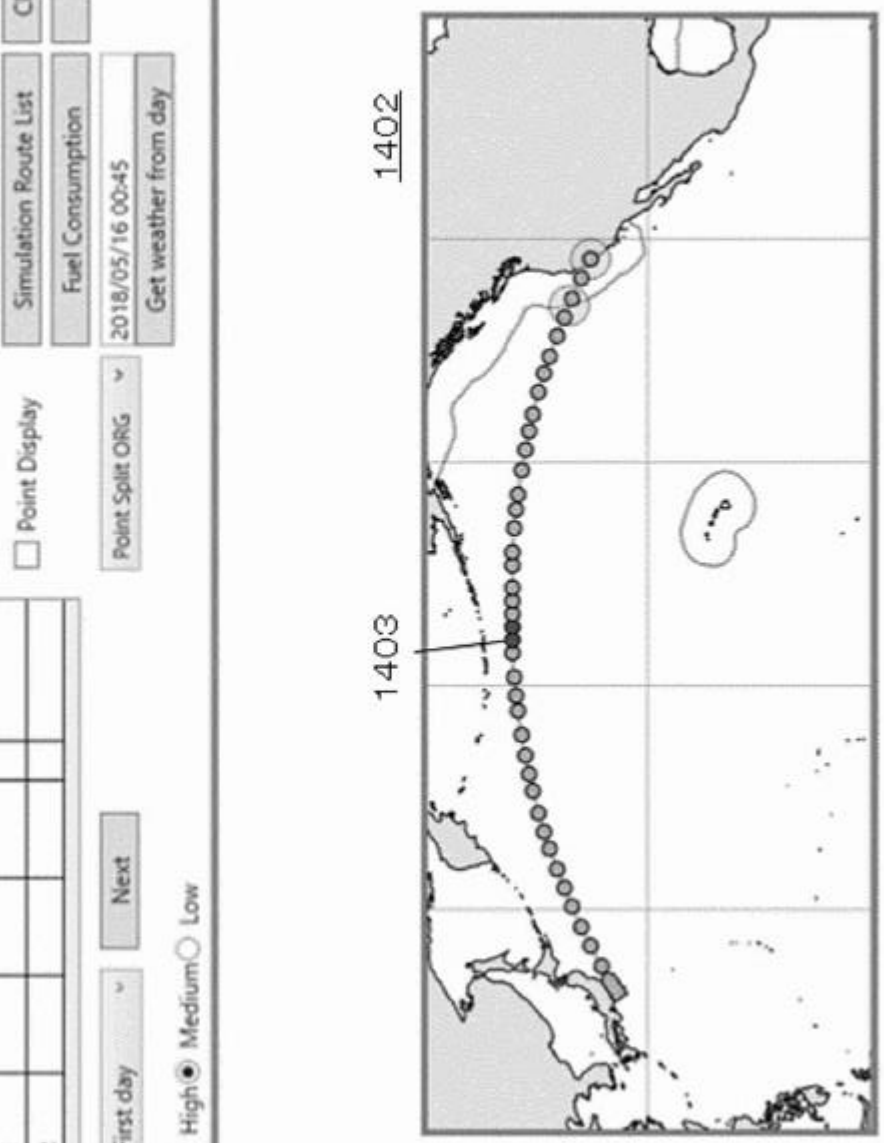


FIG. 15

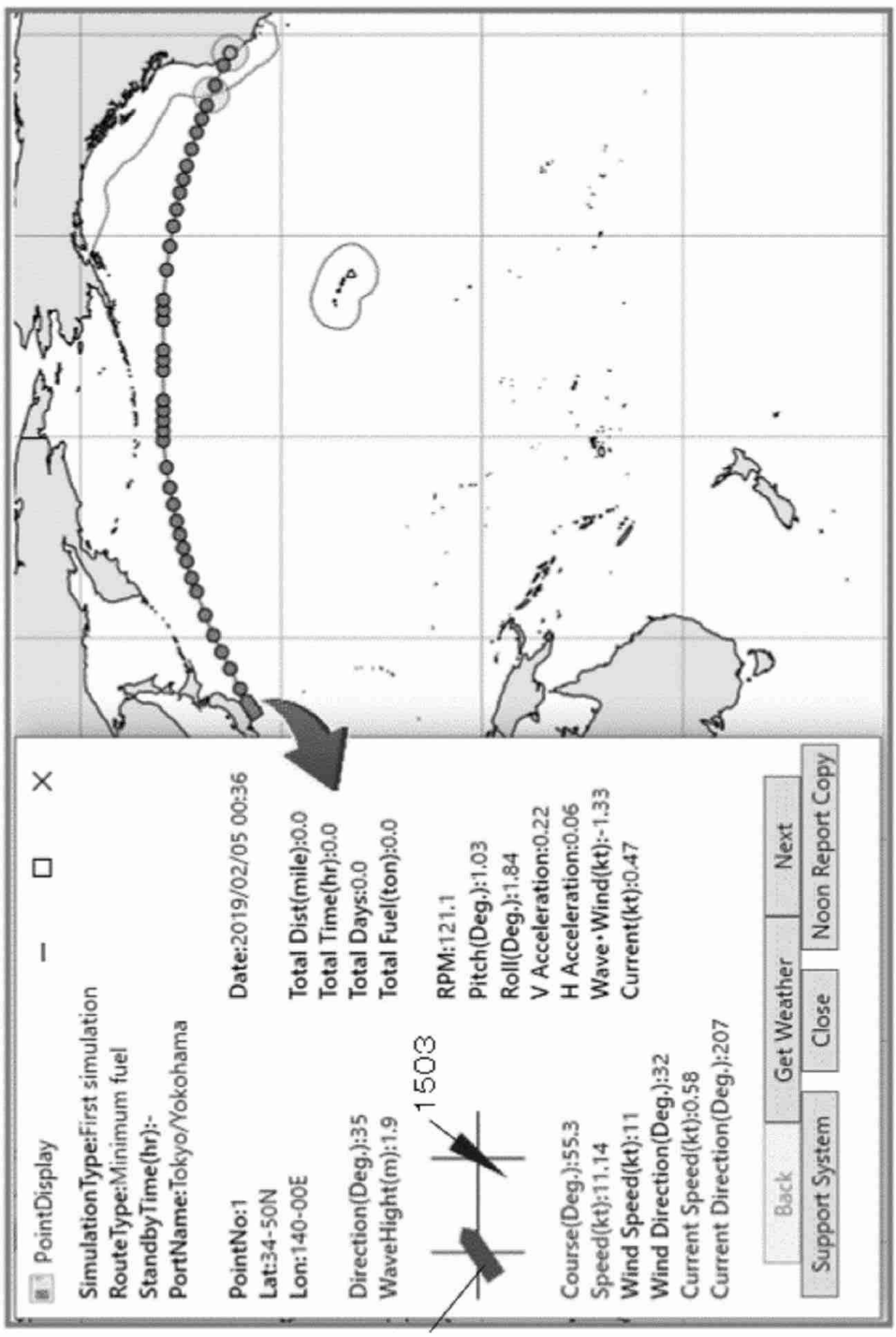

1501
PointDisplay
SimulationType:First simulation
RouteType:Minimum fuel
StandbyTime(hr):-
PortName:Tokyo/Yokohama
PointNo:1
Lat:34-50N
Lon:140-00E
Direction(Deg.):35
WaveHight(m):1.9
Course(Deg.):55.3
Speed(kt):11.14
Wind Speed(kt):11
Wind Direction(Deg.):32
Current Speed(kt):0.58
Current Direction(Deg.):207
Date:2019/02/05 00:36
Total Dist(mile):0.0
Total Time(hr):0.0
Total Days:0.0
Total Fuel(ton):0.0
RPM:121.1
Pitch(Deg.):1.03
Roll(Deg.):1.84
V Acceleration:0.22
H Acceleration:0.06
Wave•Wind(kt):-1.33
Current(kt):0.47
Back
Get Weather
Next
Support System
Close
Noon Report Copy
1502
1503

FIG. 16(a)

1601

Point No.	1	5	9	13	17	21	25	29	33	37	41	45	49	53	57	60
Lat.	01-48S	04-45S	11-30S	17-45S	23-30S	28-30S	33-00S	37-00S	37-45S	35-45S	30-30S	22-45S	13-15S	03-45S	06-00N	01-12N
Lon.	043-49W	035-00W	025-15W	015-45W	006-00W	004-00E	014-30E	026-00E	034-30E	044-00E	054-00E	064-30E	074-45E	085-00E	095-20E	103-23E
Course(Deg.)	100.0	119.4	124.1	122.2	118.6	117.4	113.5	110.6	90.0	61.0	55.5	48.1	44.6	48.2	105.0	
Speed(kt)	11.17	10.20	9.91	11.55	12.10	12.10	11.56	11.29	11.08	12.12	11.94	9.97	11.01	12.17	12.11	
Day	0.3	2.6	5.7	8.3	10.5	12.6	14.7	16.9	18.3	20.1	22.2	25.1	28.4	31.1	33.8	
Dist.(mile)	80.3	97.3	159.7	168.4	156.3	152.7	150.4	127.7	108.9	154.7	158.5	194.0	272.5	201.4	134.2	
Fuel(ton)	14.9	20.4	35.7	30.2	26.6	27.8	28.5	24.8	21.4	26.3	27.9	43.3	53.6	33.8	22.9	
RPM	69.2	68.4	67.6	69.2	69.3	69.2	67.9	67.9	67.6	69.4	68.8	67.5	68.2	69.6	69.3	
PITCH(Deg.)	0.19	0.30	0.75	0.26	0.40	0.39	0.93	0.47	0.54	0.54	0.42	0.58	0.44	0.42	0.46	
ROLL(Deg.)	0.69	0.93	2.36	0.94	2.47	2.70	6.29	3.72	3.51	3.04	3.04	2.71	2.85	2.27	2.77	
V Acceleration	0.04	0.05	0.14	0.05	0.10	0.10	0.22	0.14	0.14	0.10	0.12	0.13	0.12	0.08	0.11	
H Acceleration	0.03	0.05	0.07	0.03	0.06	0.07	0.14	0.12	0.11	0.07	0.09	0.08	0.09	0.05	0.07	
Sea Margin	25.1	42.9	47.7	17.2	4.8	4.7	16.9	22.6	26.9	4.4	8.4	46.7	28.4	3.1	4.5	
Wave·Wind(kt)	-0.85	-1.75	-2.35	-0.63	-0.18	-0.22	-0.79	-0.92	-1.51	-0.16	-0.37	-2.14	-1.14	-0.10	-0.20	
Current(kt)	-0.28	-0.33	-0.03	-0.07	-0.02	0.02	0.05	-0.09	0.29	-0.02	0.02	-0.19	-0.15	-0.03	0.01	
Wave Hight(m)	1.6	2.6	3.2	1.3	2.6	2.5	5.7	3.7	3.7	3.4	2.9	3.2	3.0	2.6	2.9	
Period(s)	8.0	8.0	14.0	10.0	16.0	12.0	12.0	10.0	10.0	13.0	12.0	10.0	10.0	19.0	14.0	
Direction(Deg.)	80.0	140.0	170.0	170.0	230.0	230.0	240.0	210.0	170.0	200.0	160.0	110.0	130.0	180.0	230.0	

FIG. 16(b)

1602

Point No.	Point Number
Lat.	Latitude of the ship
Lon.	Longitude of the ship
Course(Deg.)	Course (Degree)
Speed(kt)	Estimated speed (knot) when sailing
Day	Day based on the voyage period
Dist.(mile)	Distance (mile)
Fuel(ton)	Fuel Consumption (ton)
RPM	Engine Speed (rpm)
PITCH(Deg.)	Pitch (Degree)
ROLL(Deg.)	Roll (Degree)
V Acceleration	Vertical Acceleration
H Acceleration	Horizontal Acceleration
Sea Margin	Sea Margin
Wave·Wind(kt)	Influences on ship speed by wave · wind (kt)
Current(kt)	Influences on ship by ocean current (kt)
Wave Hight(m)	Average Wave Height (m)
Period(s)	Period
Direction(Deg.)	Direction of wave, wind from the ship side (Degree)

1701

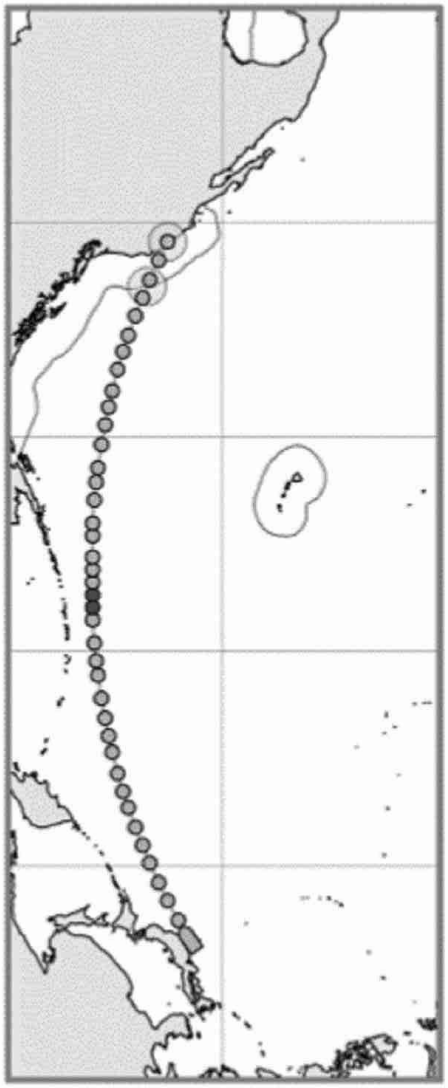


FIG. 17(a)

1702

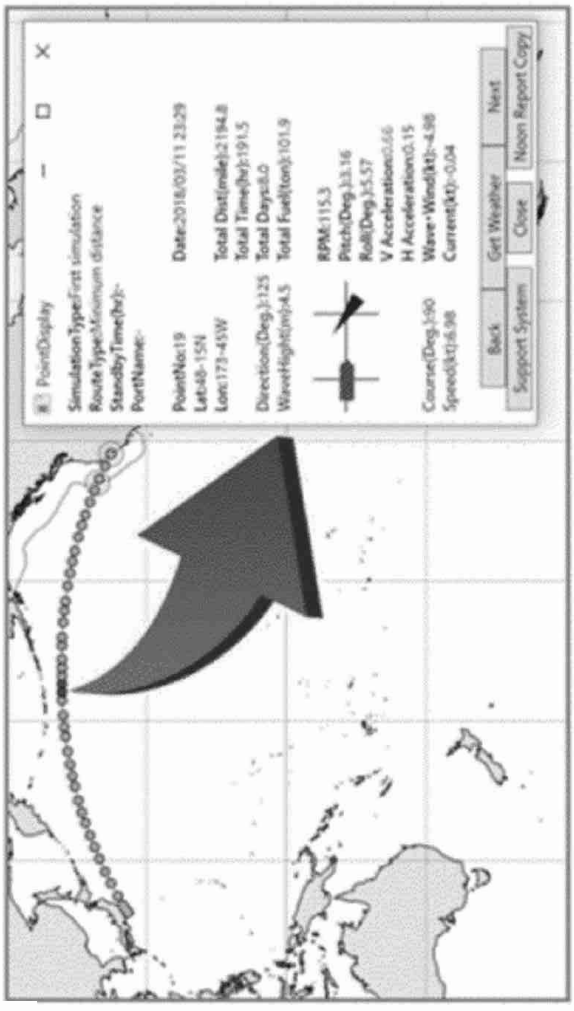


FIG. 17(b)

FIG. 18(a)

1801

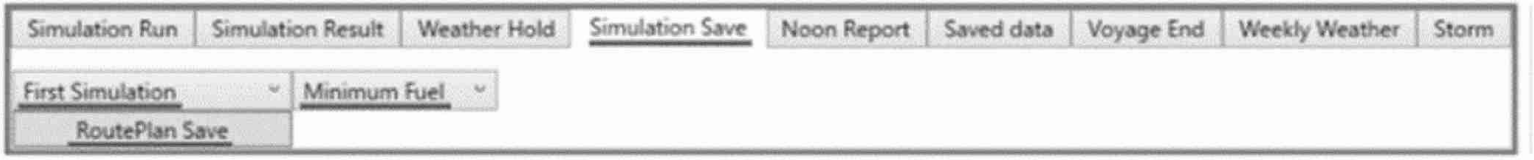
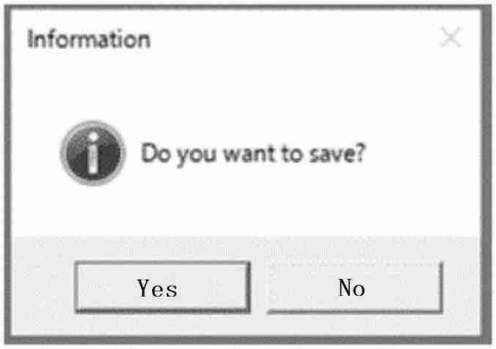


FIG. 18(b)



1802

FIG. 19(a)

1901

FIG. 19(b)

1902

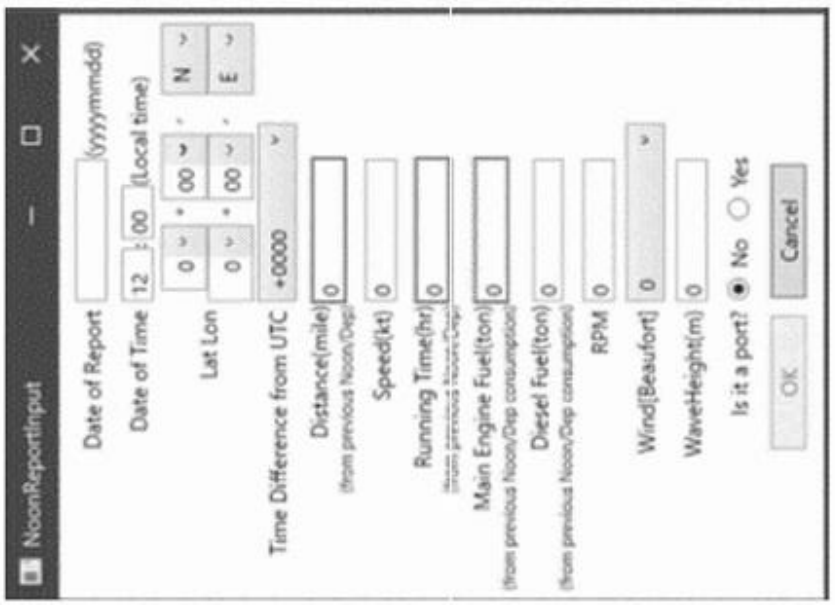


FIG. 20(a)

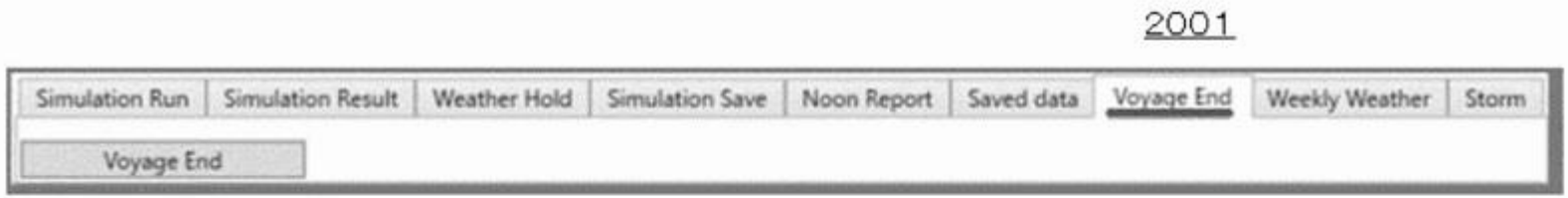


FIG. 20(b)

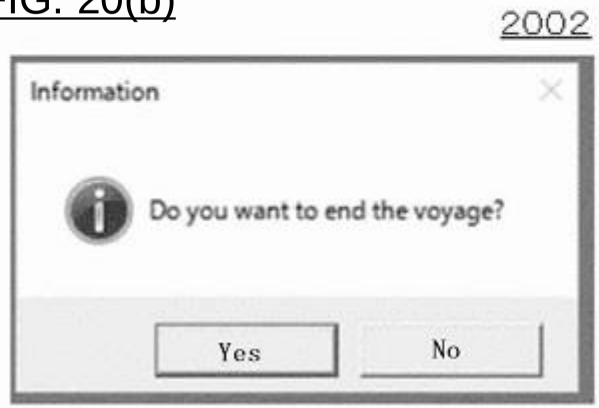


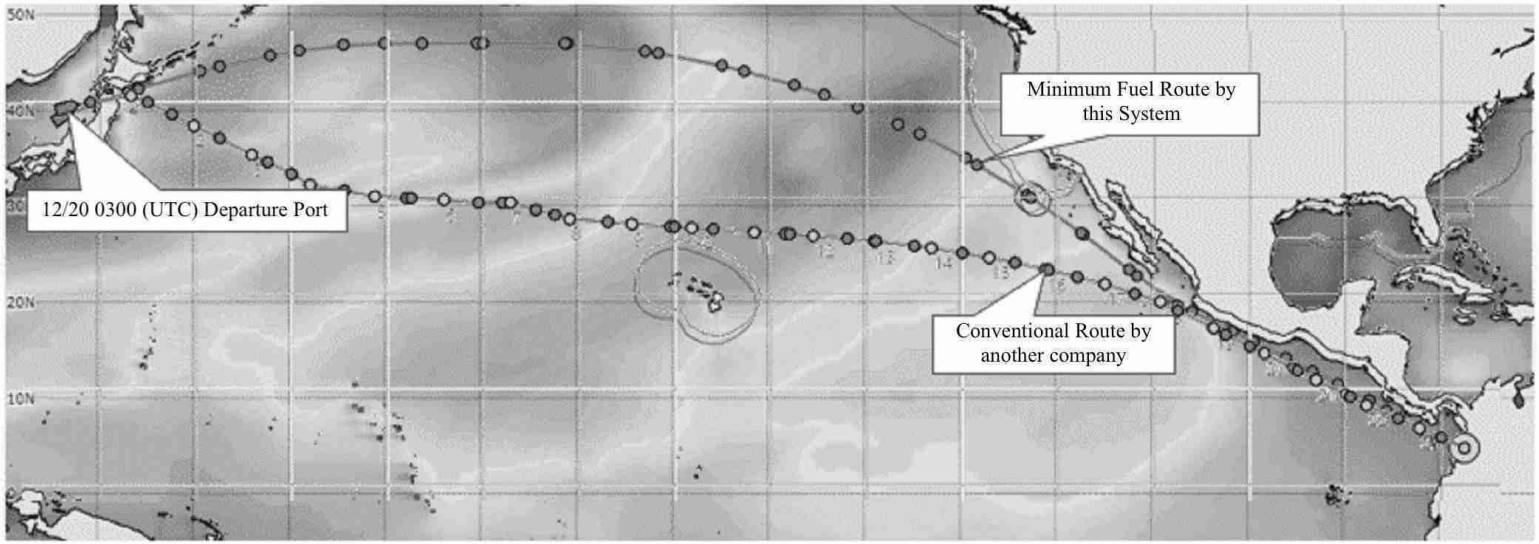
FIG. 21(a)

2101

Ship's Name	GOLDEN RAY
Full Load Speed (kt)	18
Full Load Displacement (t)	42428
Heavy Ballast Speed (kt)	-
Heavy Ballast Displacement (t)	-
Fuel Consumption (ton/day)	50
M/E Rotation (rpm)	77.2
Built Year	12/15/2017
IMO No.	9775816

FIG. 21(b)

2102



2201

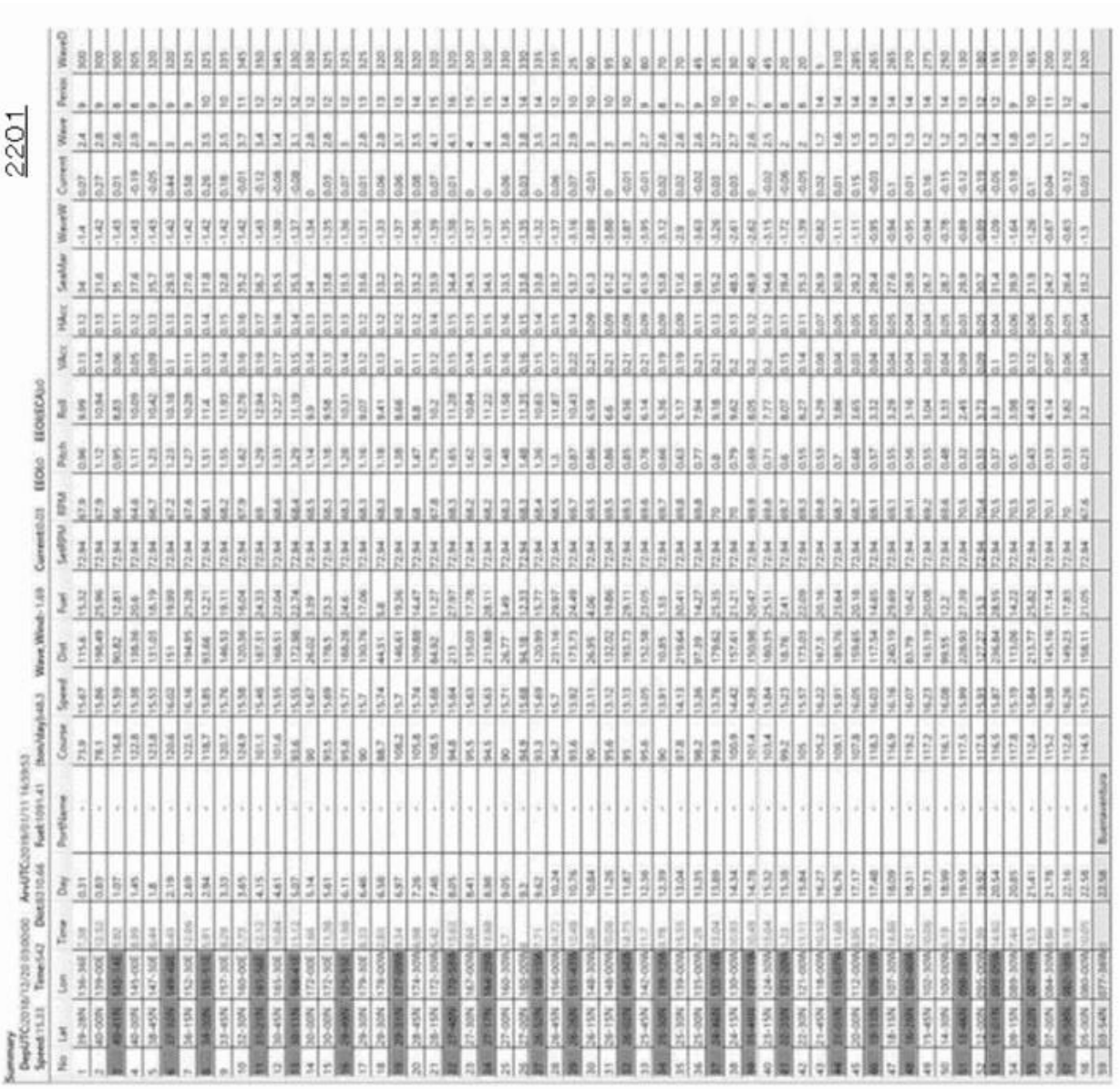


FIG. 22

FIG. 23

2301

	ETD(UTC)	ETA(UTC)	Speed(kt)	Time(hr)	Distance(mile)	Fuel(ton)
Abrog (Conventional Route)	2018/12/20 3:00	2019/1/11 16:59	15.33	542	8310.66	1091.41
Onavi (this system)	2018/12/20 3:00	2019/1/11 16:59	14.38	542	7794.86	892.1
Difference	-	-	0.95	0	515.8	199.31

FIG. 24

2401

Item	Average Speed	Total Hours	Total Distance	Total Fuel
Conventional Voyage Route	12.74	549.4	6998.0	479.3
Voyage Route by this System	11.45	545.7	6247.9	271.1

Reducing Fuel Rate

43.4%

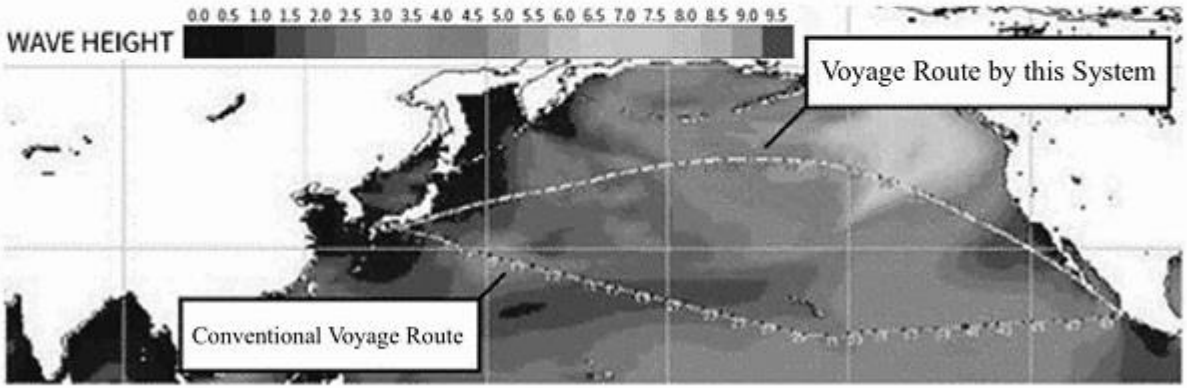


FIG. 25

2501

Items	Average Speed	Total Hours	Total Distance	Total Fuel
Conventional Voyage Route	11.63	846.5	9842.0	1981.5
Voyage Route by this System	11.49	845.4	9712.4	1787.0

Reducing Fuel Rate
9.8%

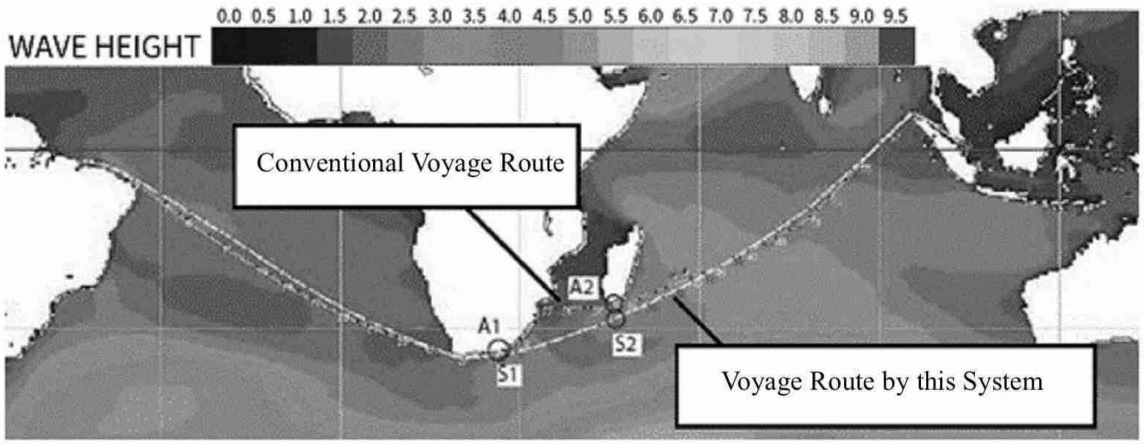


FIG. 26

2601

Items	Average Speed	Total Hours	Total Distance	Total Fuel
Conventional Voyage Route	10.33	444.3	4590.0	261.3
Voyage Route by this System	10.45	440.8	4604.1	200.0

Reducing Fuel Rate

23.5%

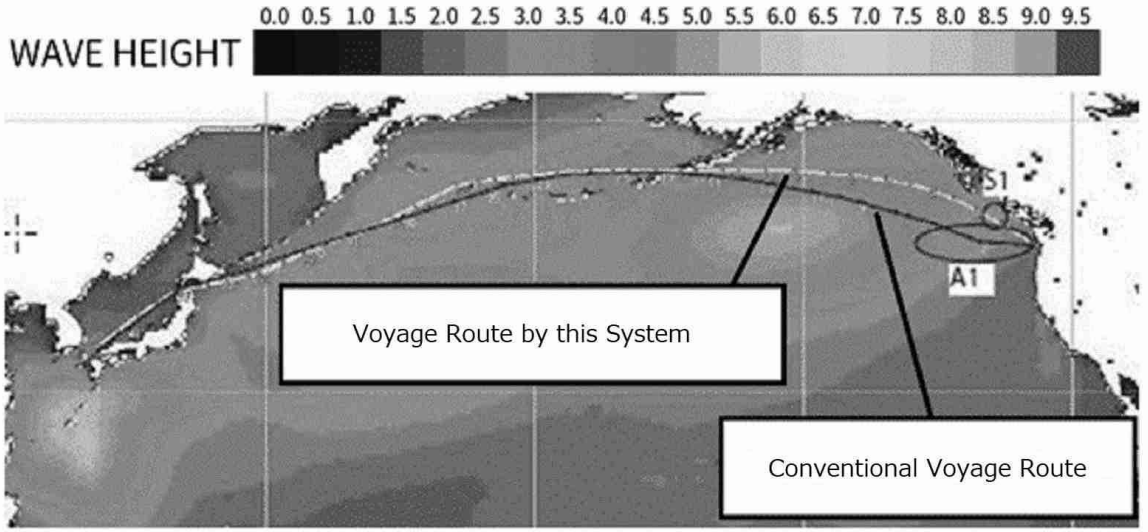


FIG. 27(a)

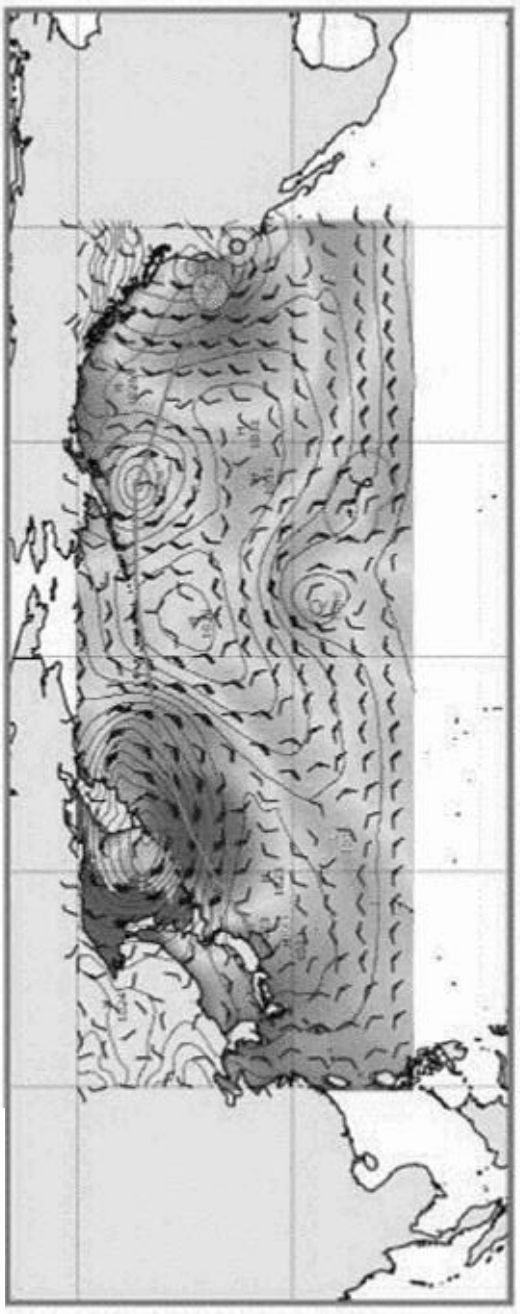


FIG. 27(b)

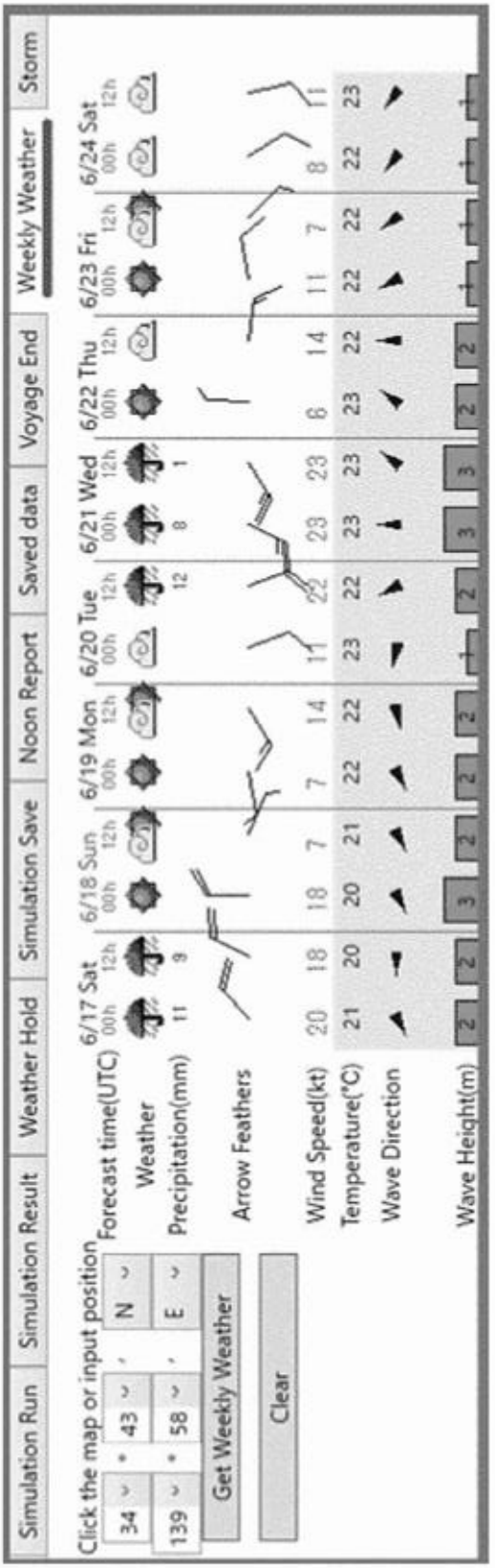
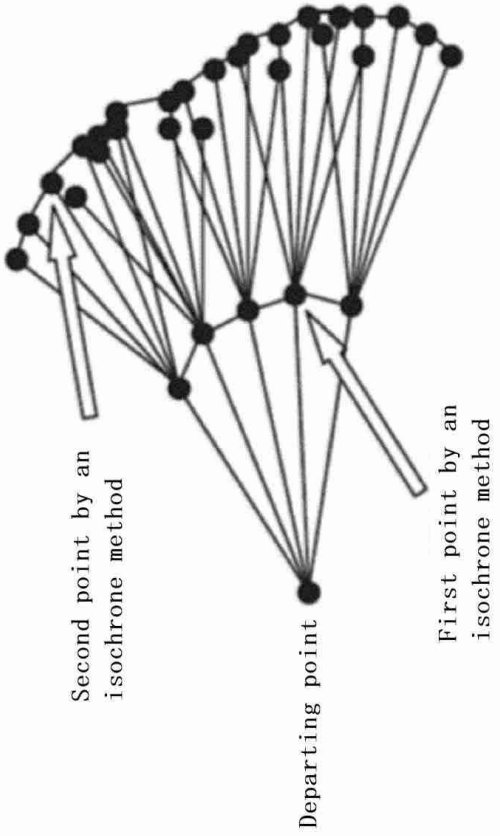


FIG. 28


Second point by an isochrone method
Departing point
First point by an isochrone method