
1
3
2
4

FIG. 1A

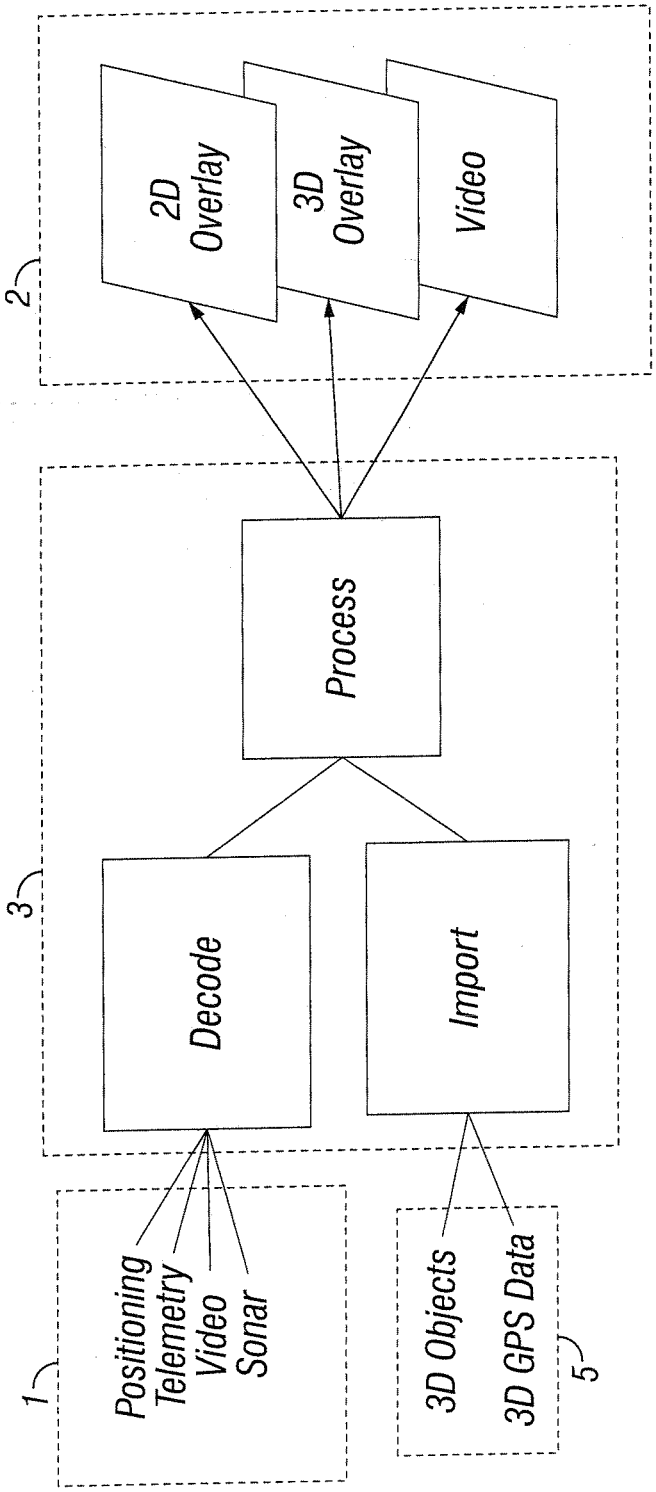

2D Overlay
3D Overlay
Video
2
Process
3
Decode
Import
Positioning
Telemetry
Video
Sonar
1
3D Objects
3D GPS Data
5

FIG. 1B

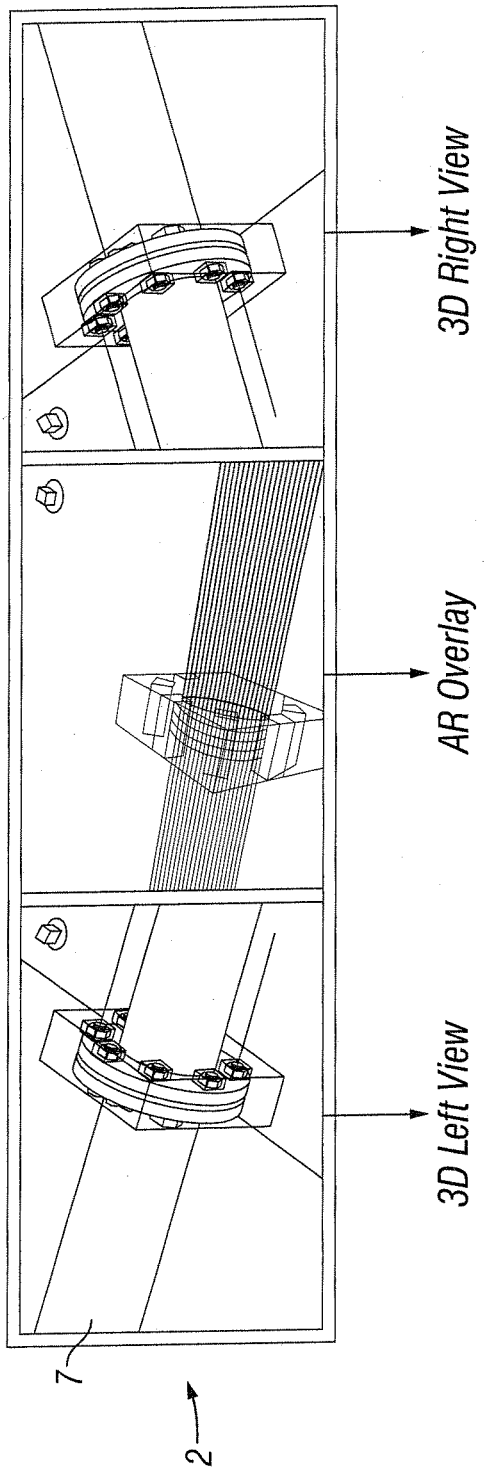


FIG. 2A

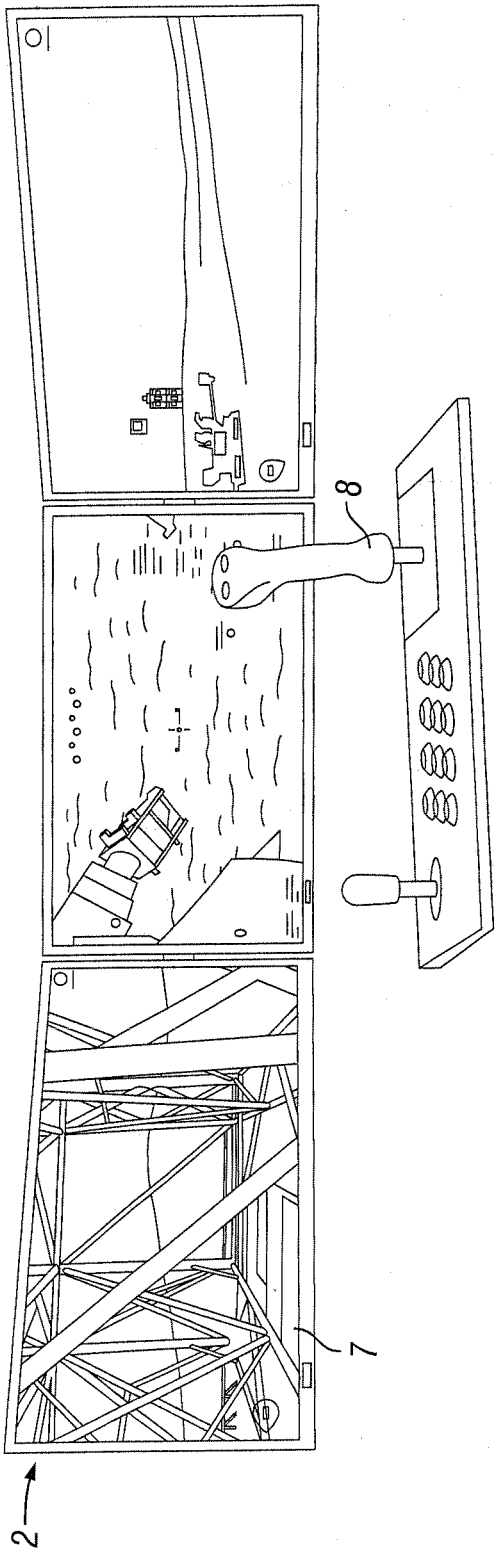


FIG. 2B

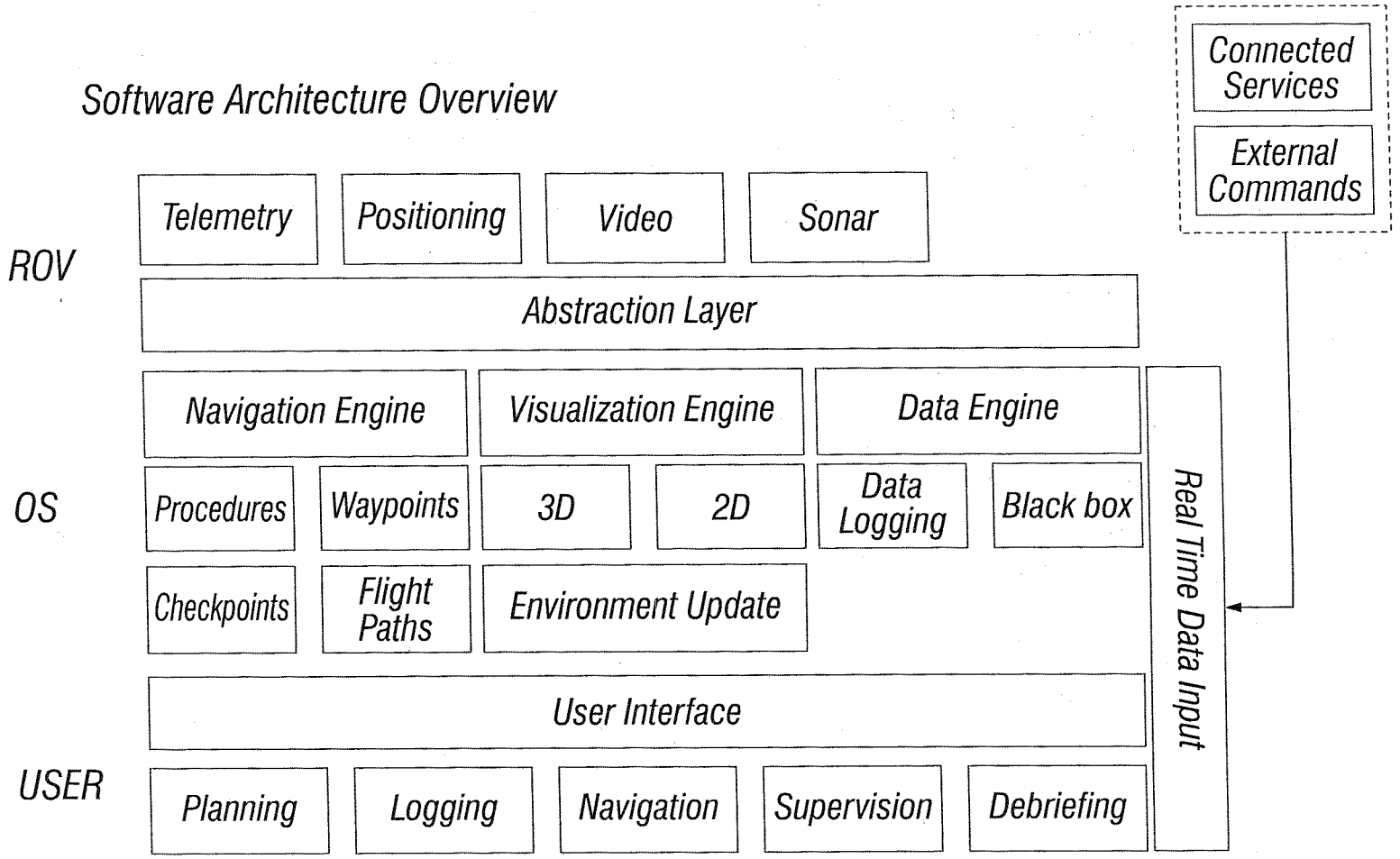

Software Architecture Overview
Connected Services
External Commands
ROV
Telemetry
Positioning
Video
Sonar
Abstraction Layer
OS
Navigation Engine
Visualization Engine
Data Engine
Procedures
Waypoints
3D
2D
Data Logging
Black box
Checkpoints
Flight Paths
Environment Update
Real Time Data Input
User Interface
USER
Planning
Logging
Navigation
Supervision
Debriefing

FIG. 3A

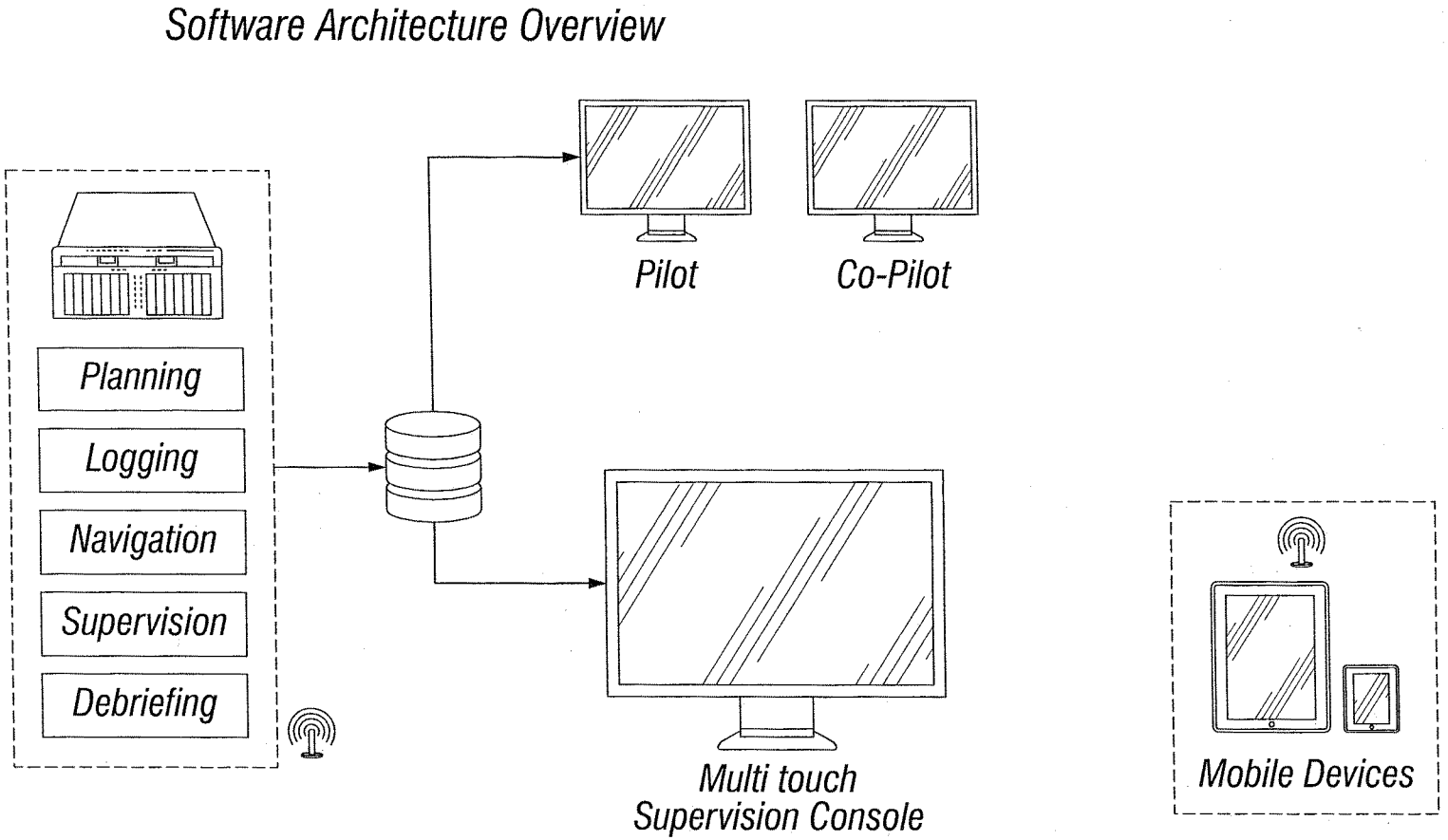

Software Architecture Overview
Pilot
Co-Pilot
Planning
Logging
Navigation
Supervision
Debriefing
Multi touch
Supervision Console
Mobile Devices

FIG. 3B

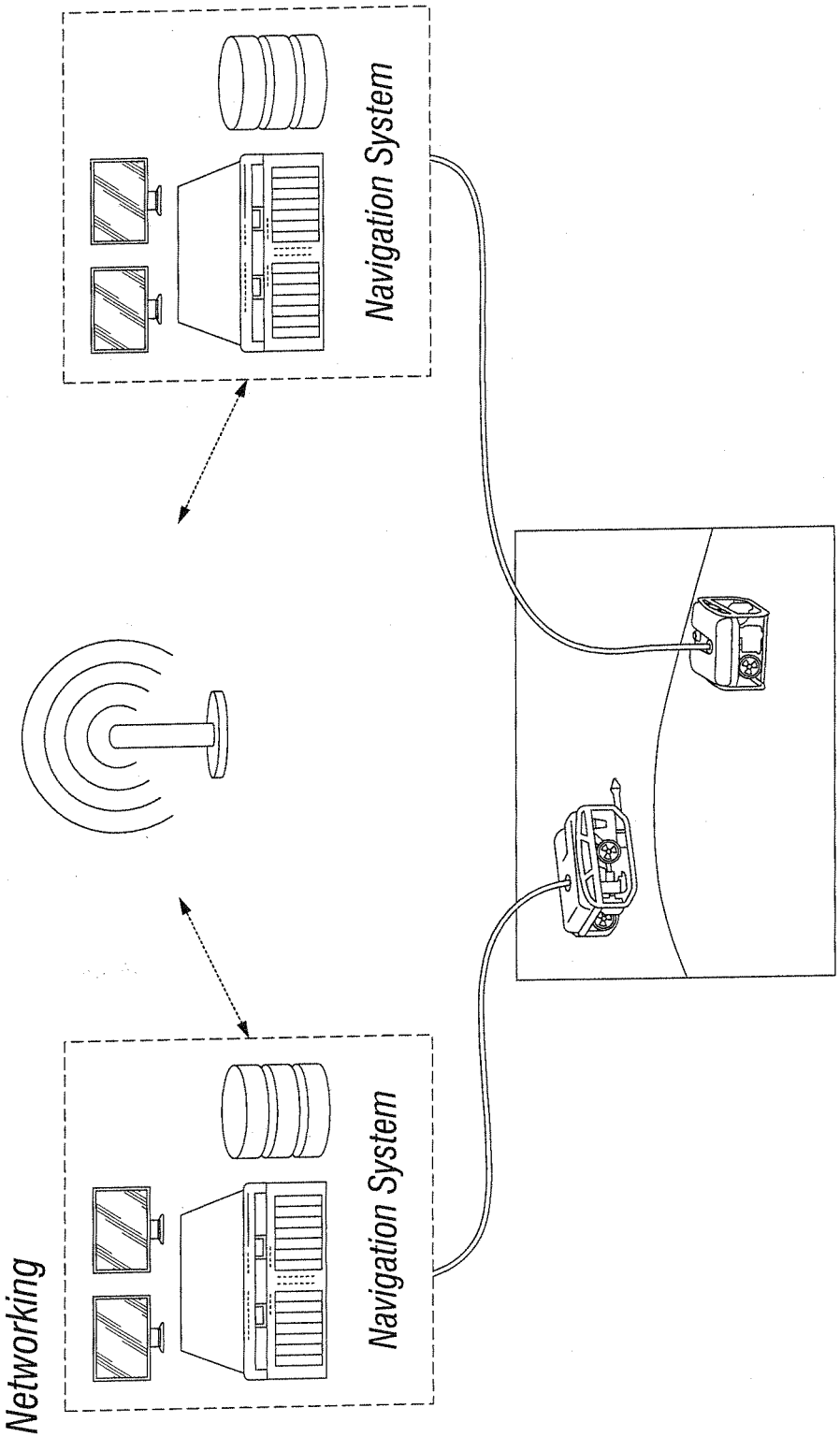


FIG. 3C

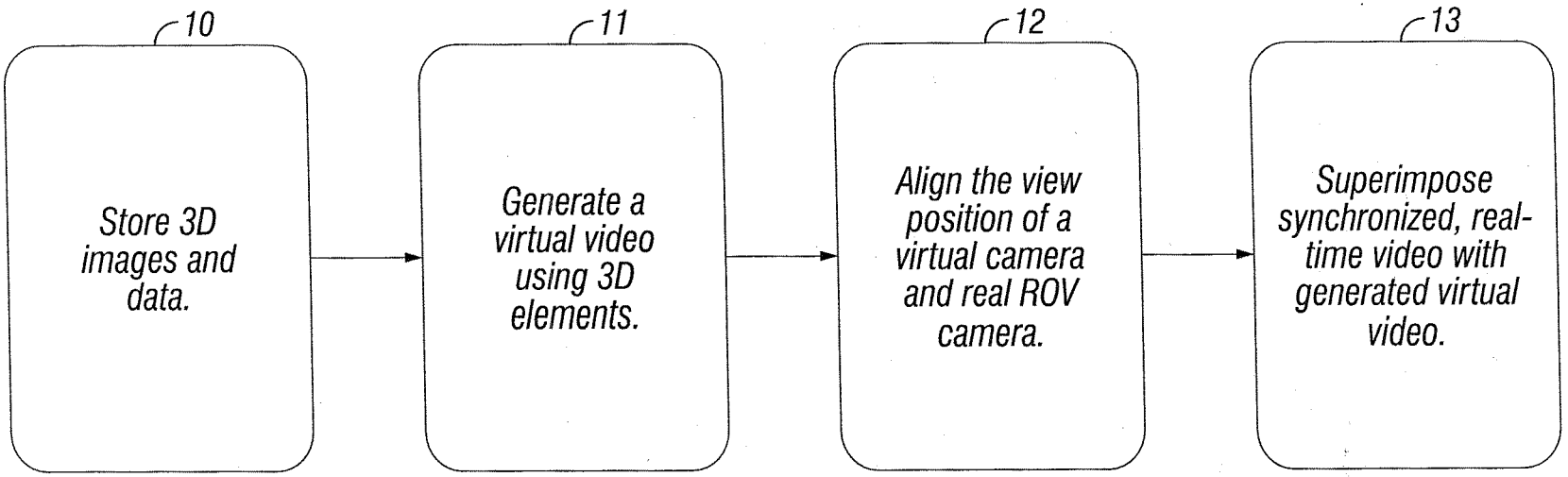

10
Store 3D images and data.
11
Generate a virtual video using 3D elements.
12
Align the view position of a virtual camera and real ROV camera.
13
Superimpose synchronized, real-time video with generated virtual video.

FIG. 4

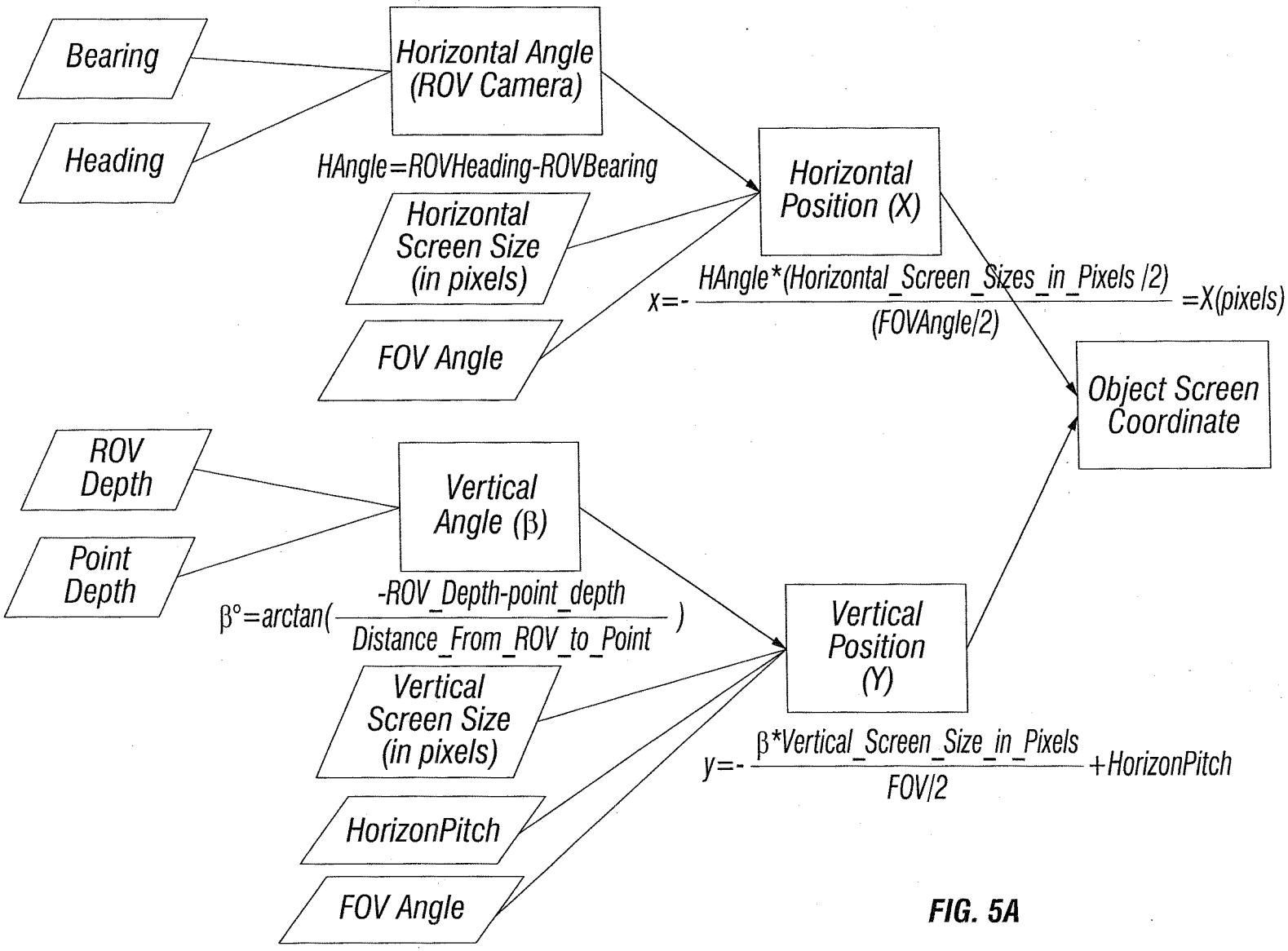

Bearing
Heading
Horizontal Angle (ROV Camera)
HAngle=ROVHeading-ROVBearing
Horizontal Screen Size (in pixels)
FOV Angle
Horizontal Position (X)
x=- HAngle*(Horizontal_Screen_Sizes_in_Pixels /2) / (FOVAngle/2) =X(pixels)
Object Screen Coordinate
ROV Depth
Point Depth
Vertical Angle (β)
β°=arctan(-ROV_Depth-point_depth / Distance_From_ROV_to_Point)
Vertical Screen Size (in pixels)
HorizonPitch
FOV Angle
Vertical Position (Y)
y=- β*Vertical_Screen_Size_in_Pixels / FOV/2 +HorizonPitch

FIG. 5A

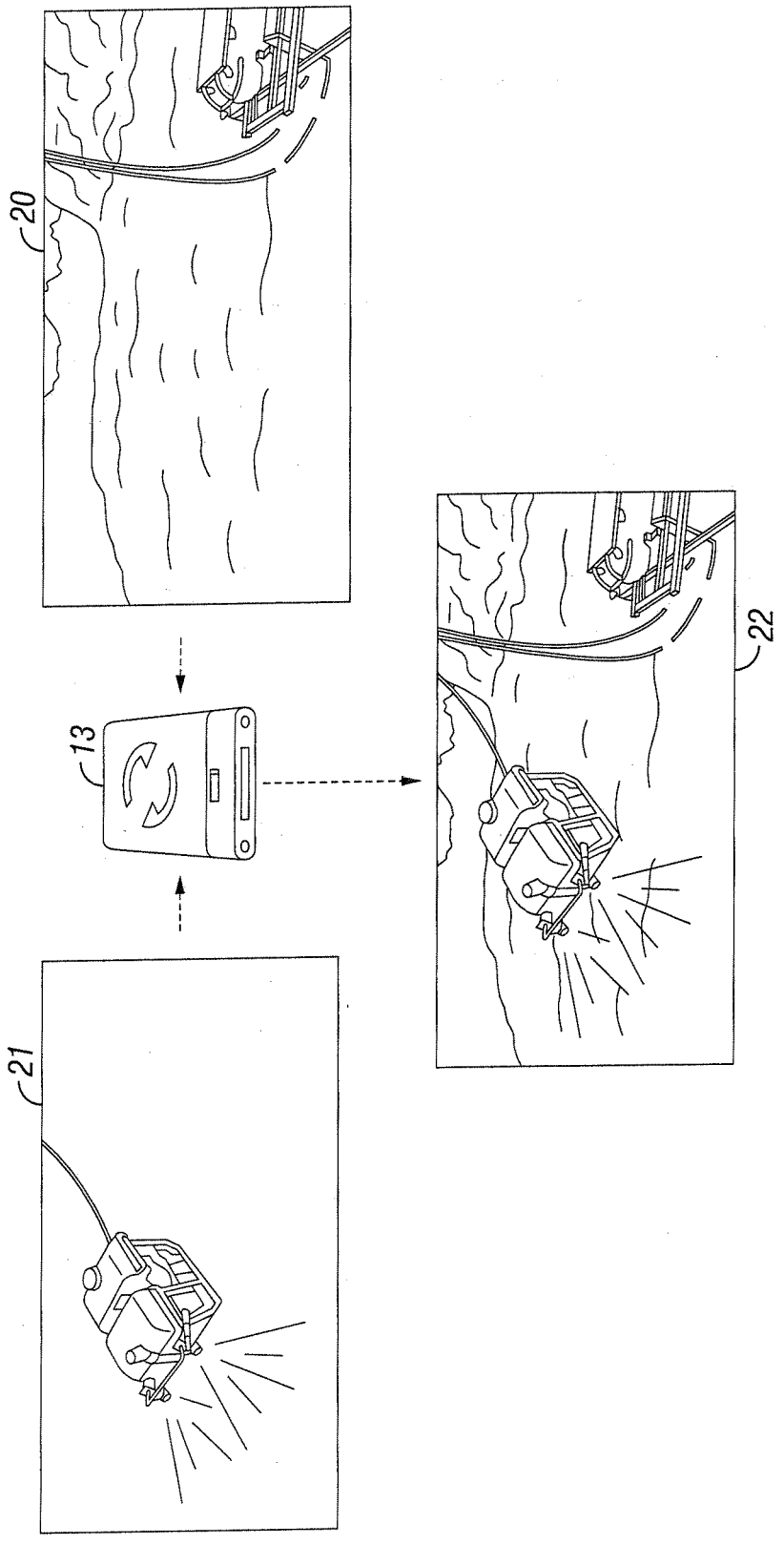


FIG. 5B

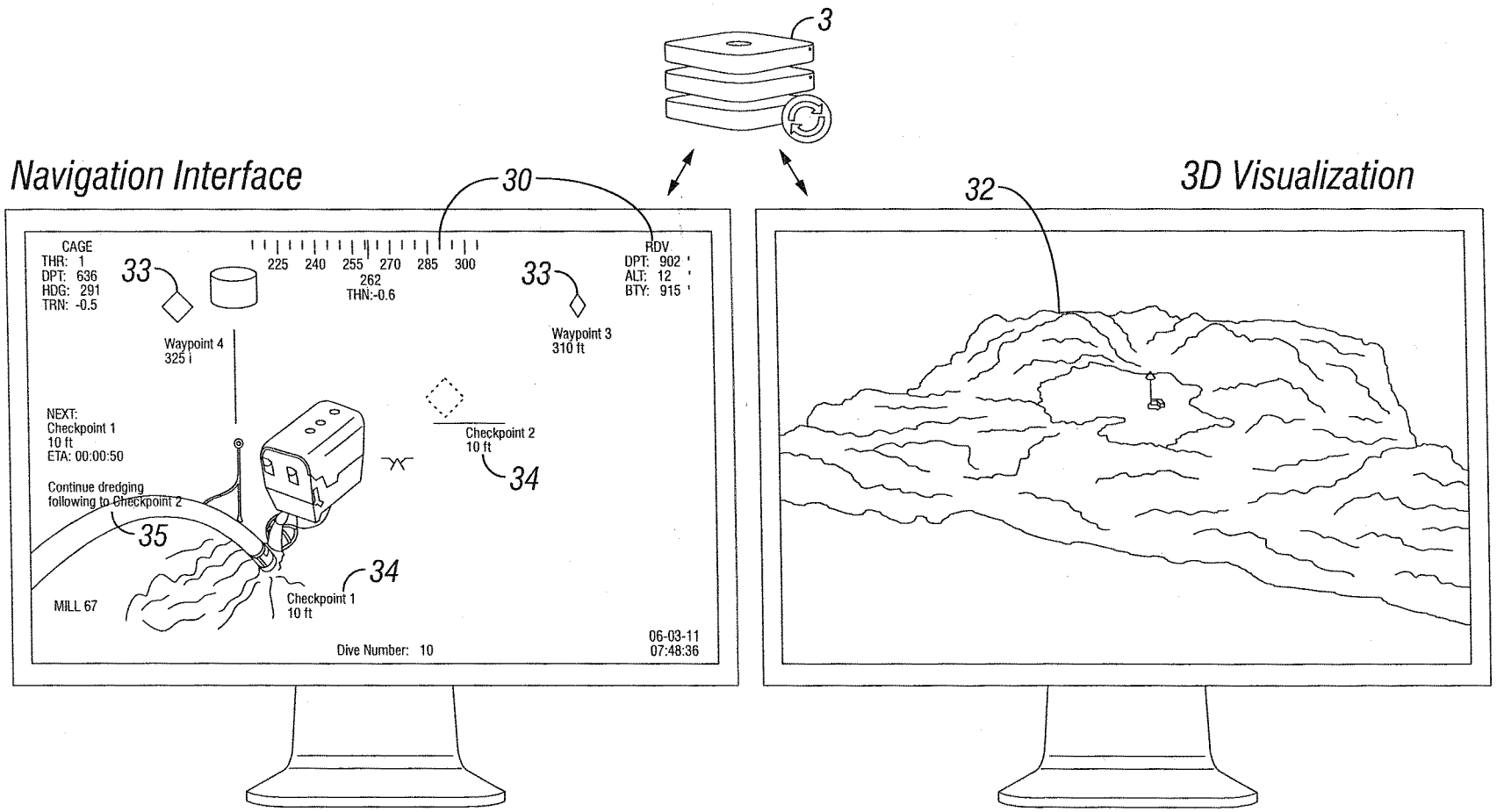

3
Navigation Interface
30
3D Visualization
32
CAGE
THR: 1
DPT: 636
HDG: 291
TRN: -0.5
225 240 255 270 285 300
262
THN:-0.6
RDV
DPT: 902 '
ALT: 12 '
BTY: 915 '
33
33
Waypoint 4
325 i
Waypoint 3
310 ft
NEXT:
Checkpoint 1
10 ft
ETA: 00:00:50
Checkpoint 2
10 ft
34
Continue dredging
following to Checkpoint 2
35
34
MILL 67
Checkpoint 1
10 ft
Dive Number: 10
06-03-11
07:48:36

FIG. 6A

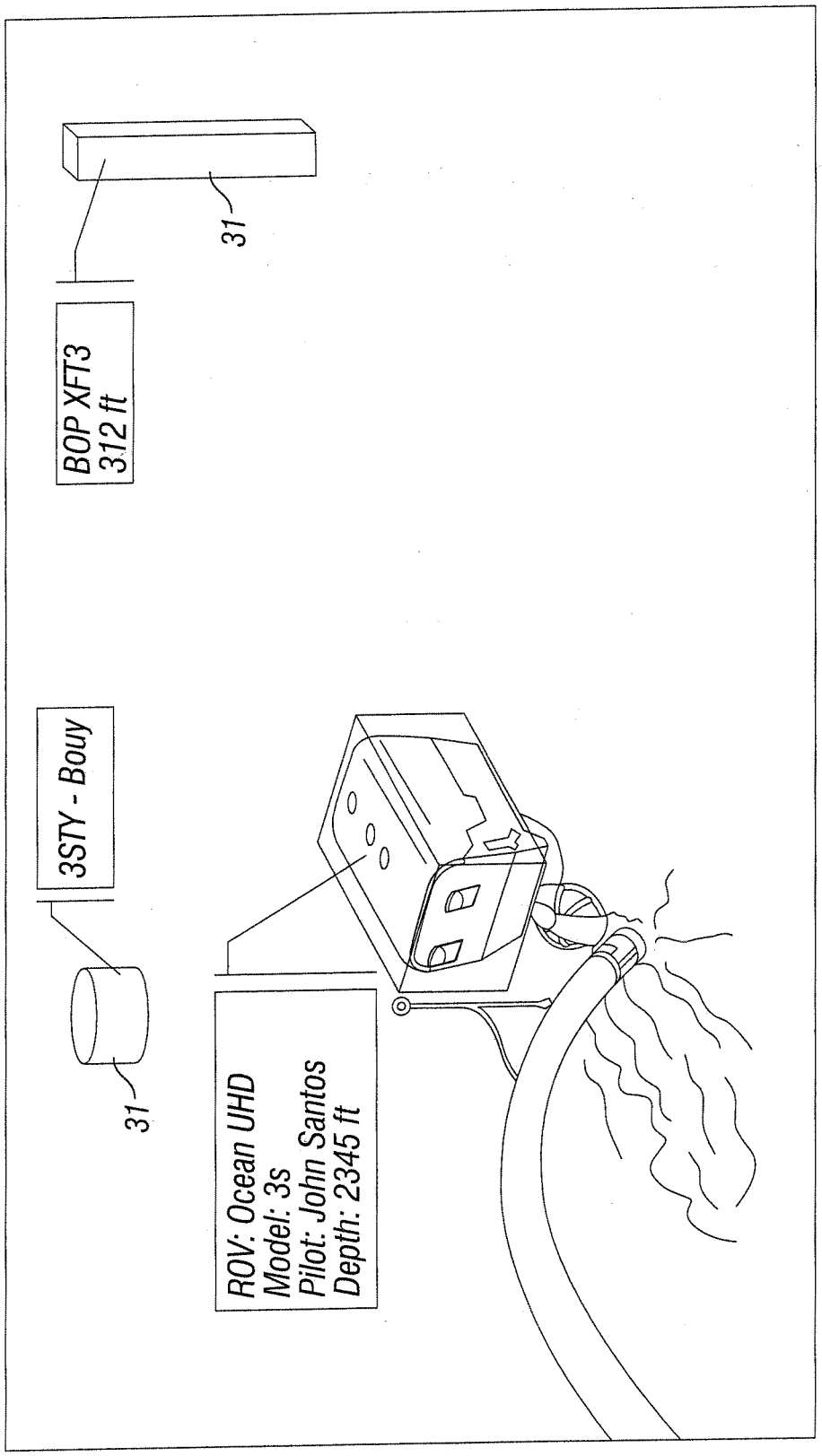

31
3STY - Bouy
31
BOP XFT3
312 ft
ROV: Ocean UHD
Model: 3s
Pilot: John Santos
Depth: 2345 ft

FIG. 6B

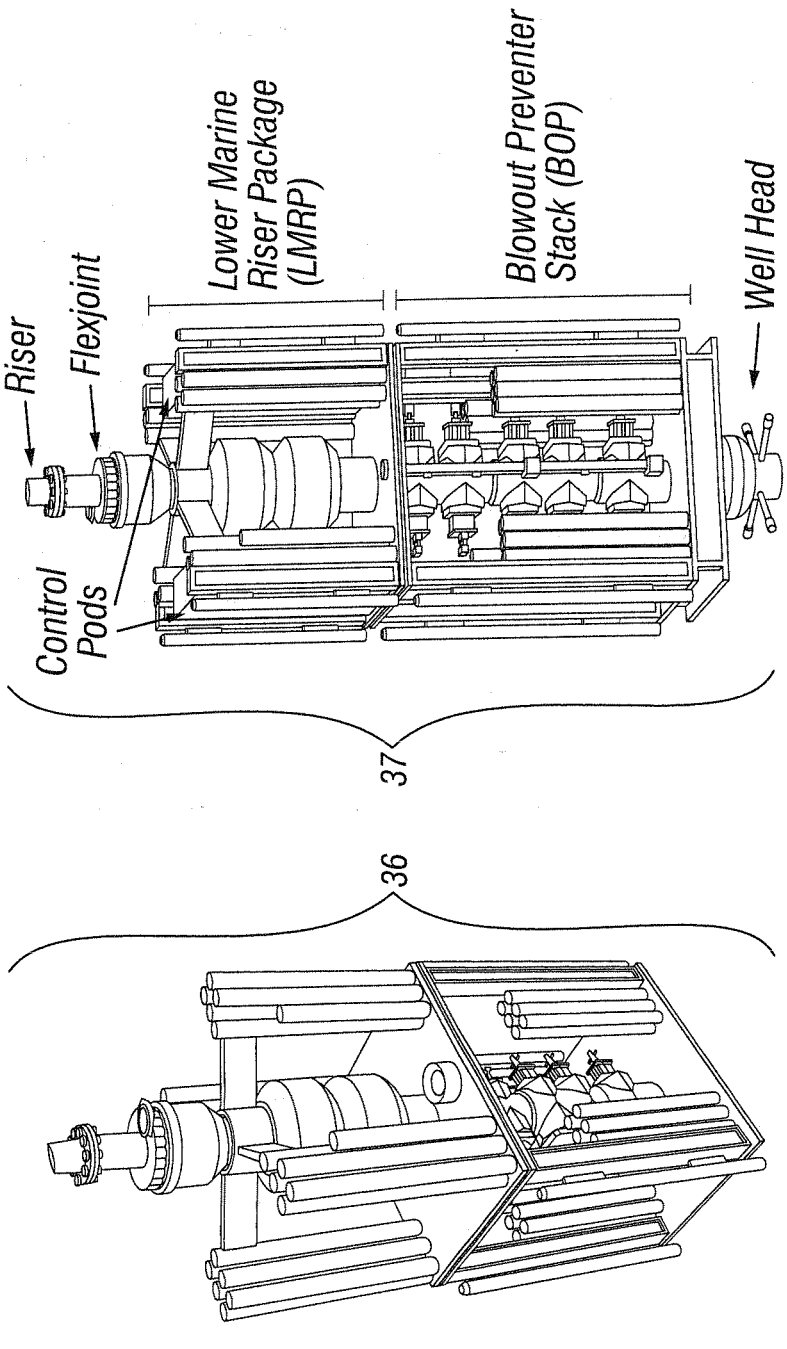

Riser
Flexjoint
Lower Marine
Riser Package
(LMRP)
Blowout Preventer
Stack (BOP)
Well Head
Control
Pods
37
36

FIG. 6C

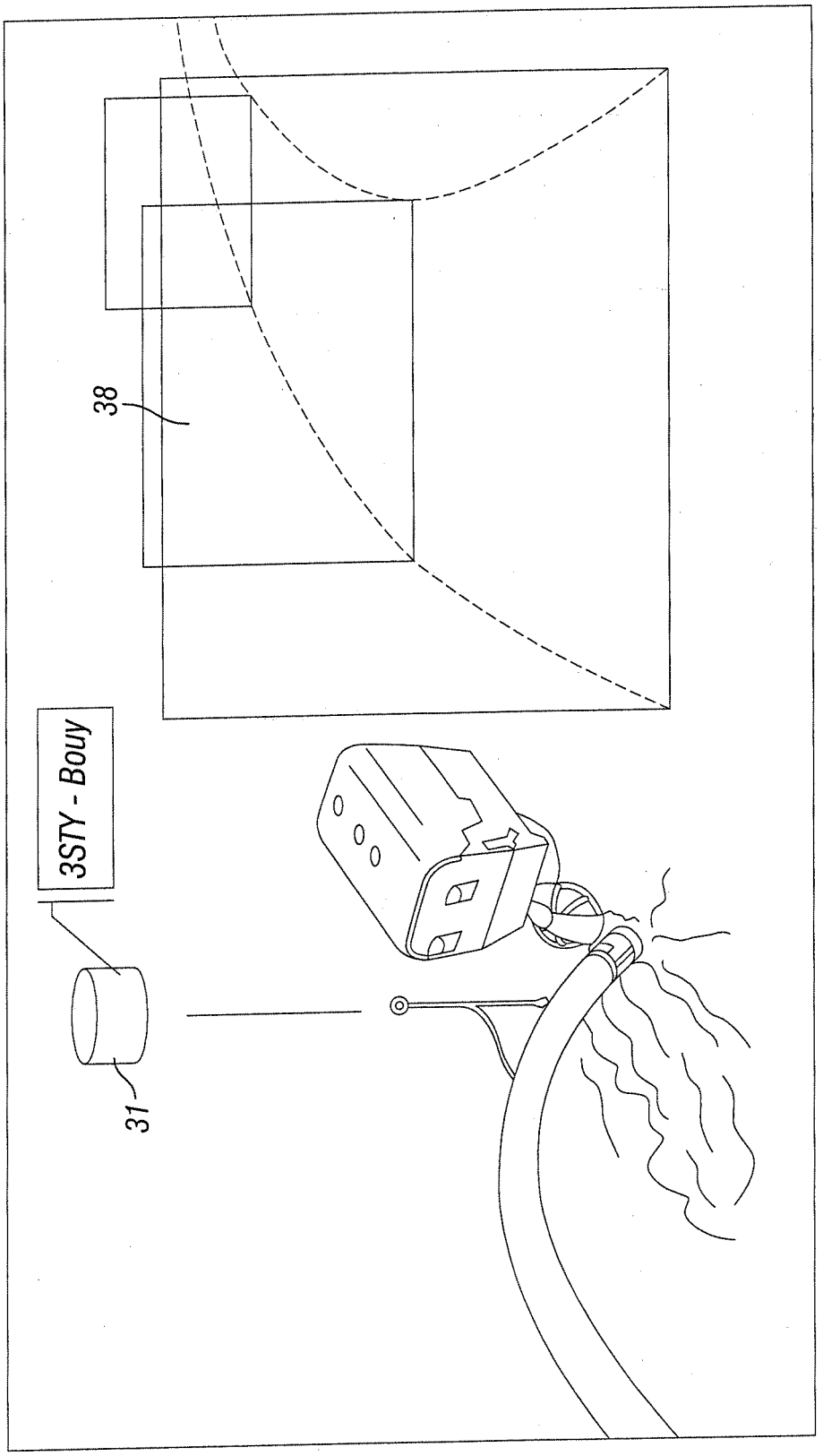


FIG. 6D

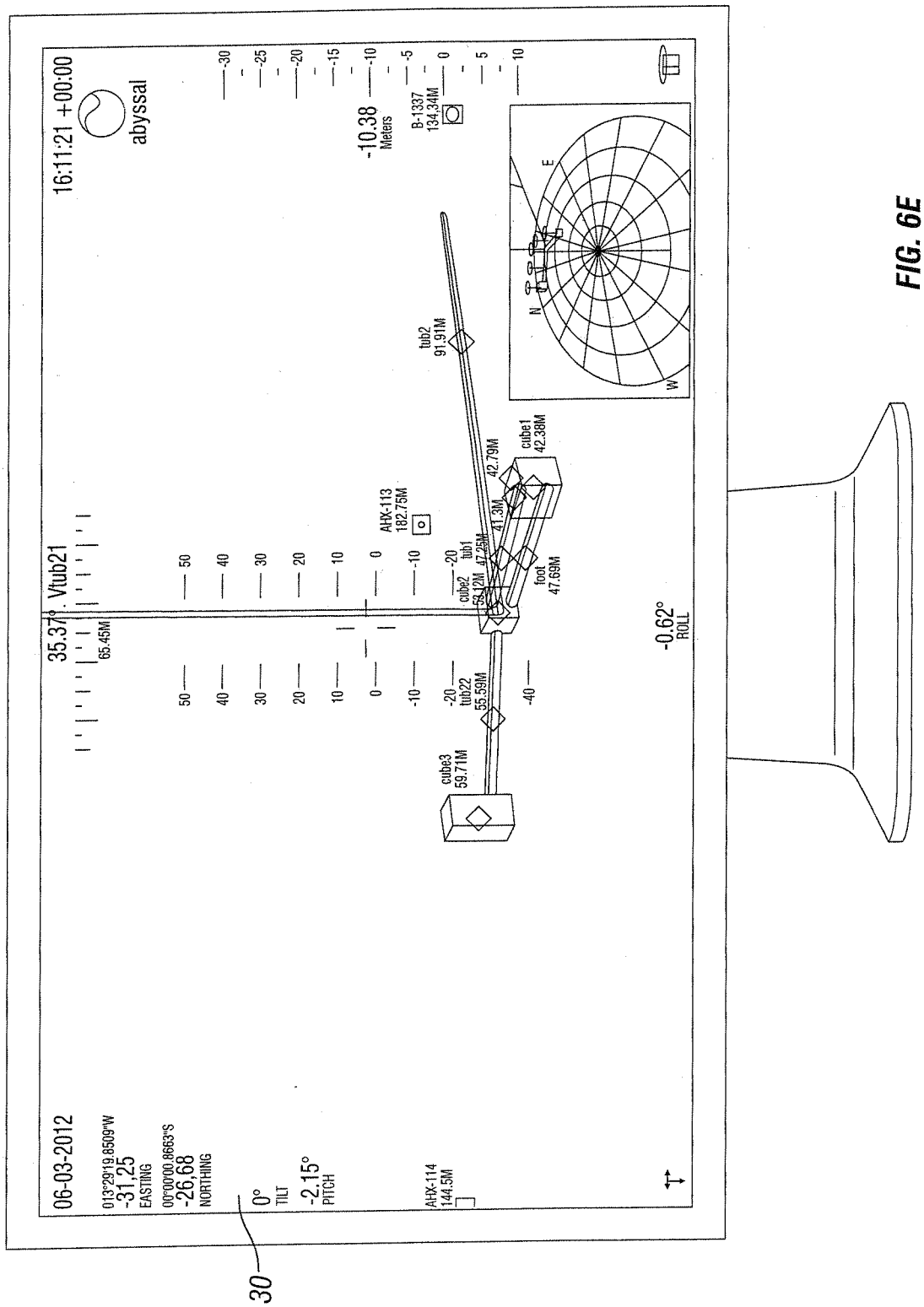

06-03-2012
16:11:21 +00:00
abyssal
013°29'19.8509"W
-31.25
EASTING
00°00'00.8663"S
-26.68
NORTHING
0°
TILT
-2.15°
PITCH
-0.62°
ROLL
-10.38
Meters
35.37
Vtub21
65.45M
AHX-114
144.5M
AHX-113
182.75M
B-1337
134.34M
tub2
91.91M
cube1
42.38M
42.79M
41.3M
tub1
47.25M
cube2
53.12M
foot
47.69M
tub22
55.59M
cube3
59.71M
N
E
W
30

FIG. 6E

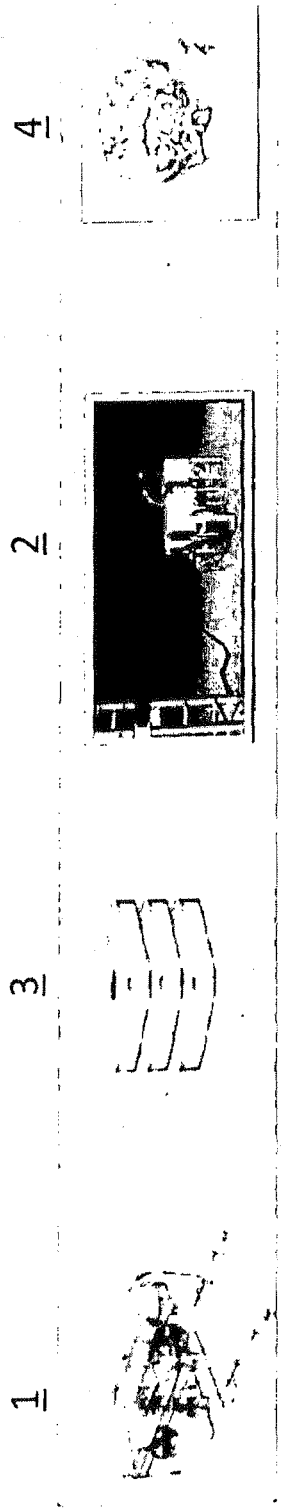

1
2
3
4

FIG. 1A

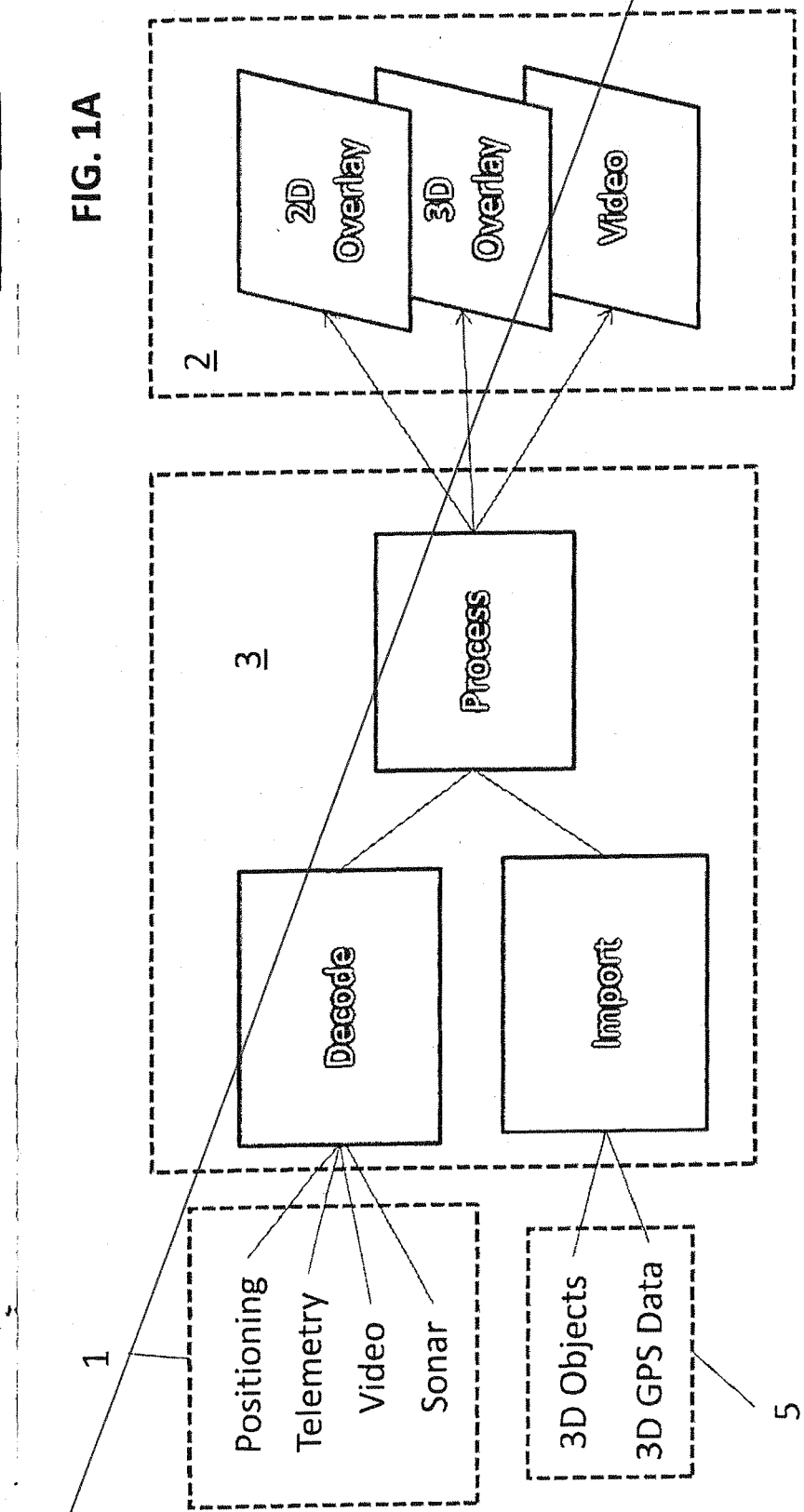

2D Overlay
3D Overlay
Video
2
3
Process
Decode
Import
Positioning
Telemetry
Video
Sonar
3D Objects
3D GPS Data
1
5

FIG. 1B

FIG. 2A

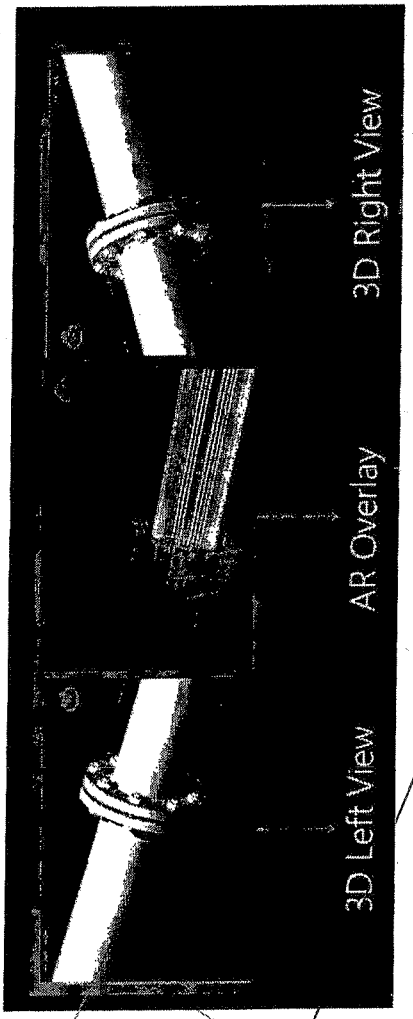
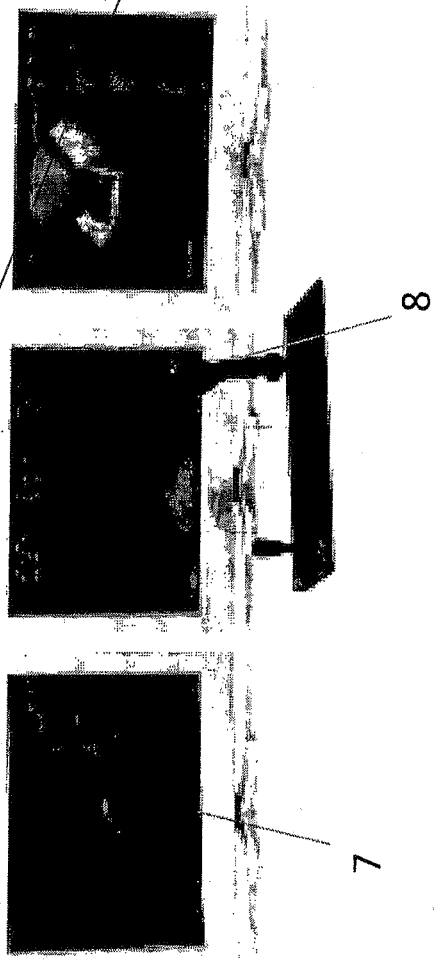


FIG. 2B



7

2

8

7

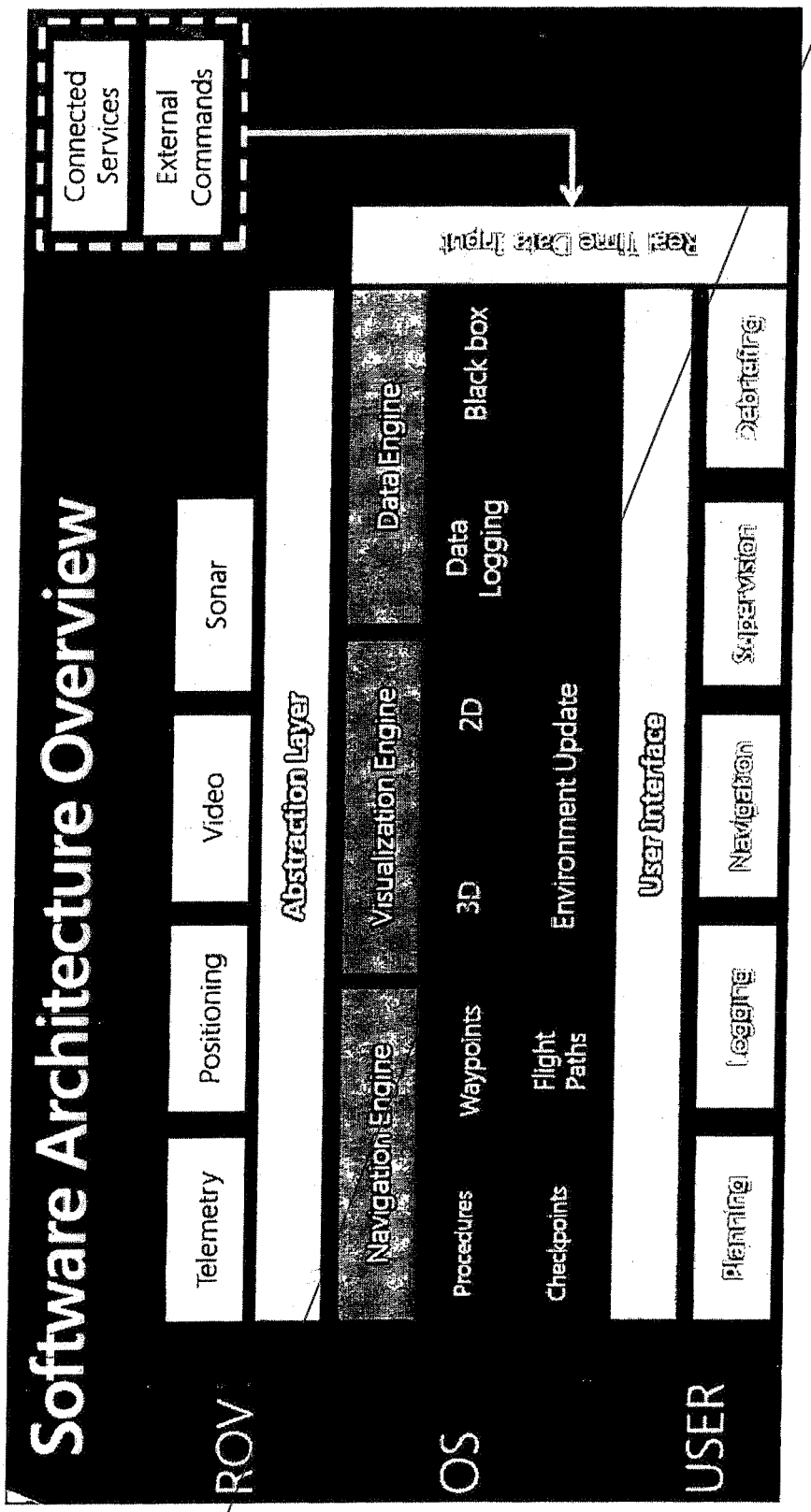

Software Architecture Overview
ROV
OS
USER
Connected Services
External Commands
Real Time Data Input
Telemetry
Positioning
Video
Sonar
Abstraction Layer
Navigation Engine
Visualization Engine
DataEngine
Procedures
Waypoints
Flight Paths
Checkpoints
3D
2D
Environment Update
Data Logging
Black box
User Interface
Planning
Logging
Navigation
Supervision
Debriefing

FIG. 3A

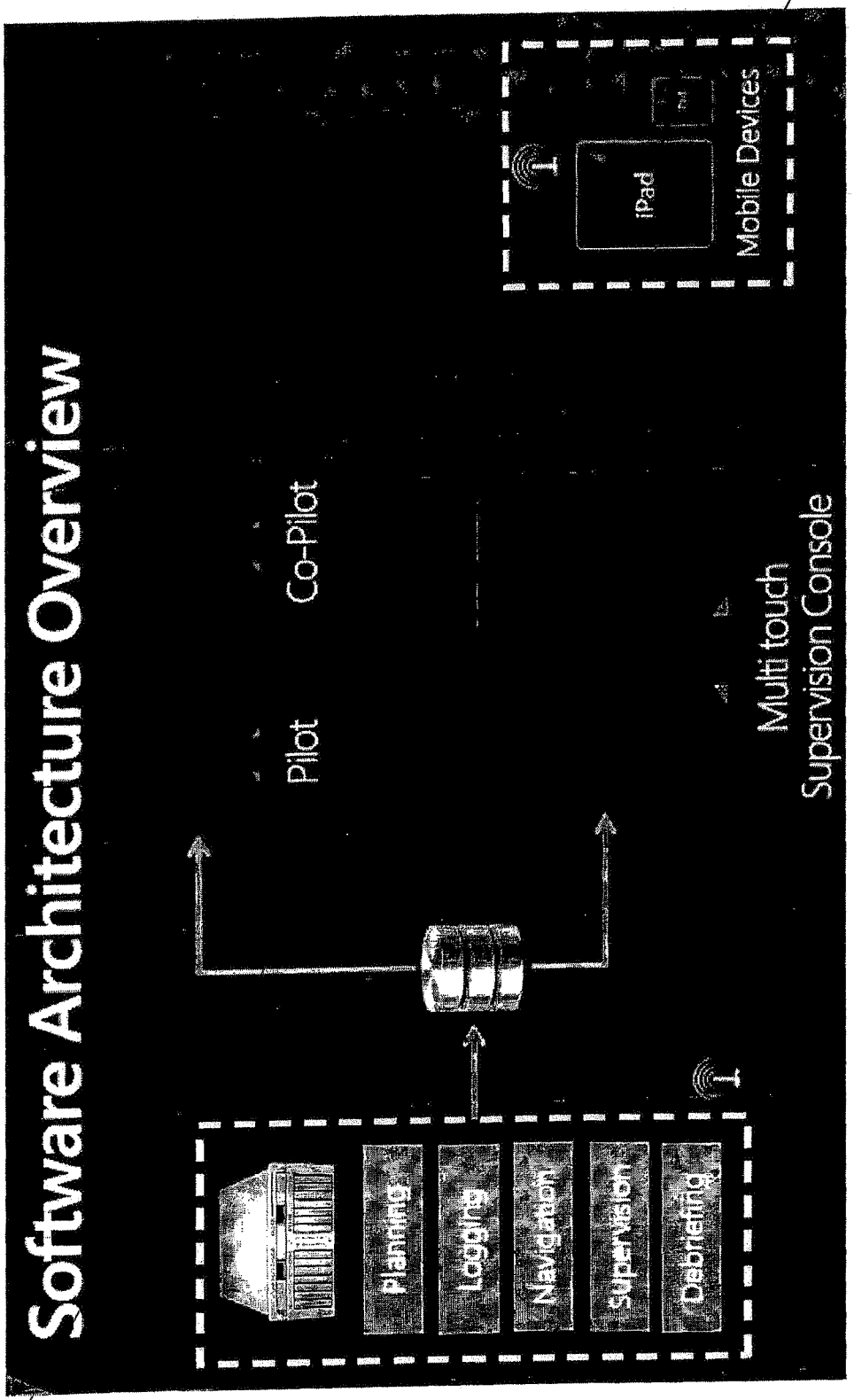

Software Architecture Overview
Mobile Devices
iPad
Co-Pilot
Pilot
Multi touch
Supervision Console
Planning
Logging
Navigation
Supervision
Debriefing

FIG. 3B

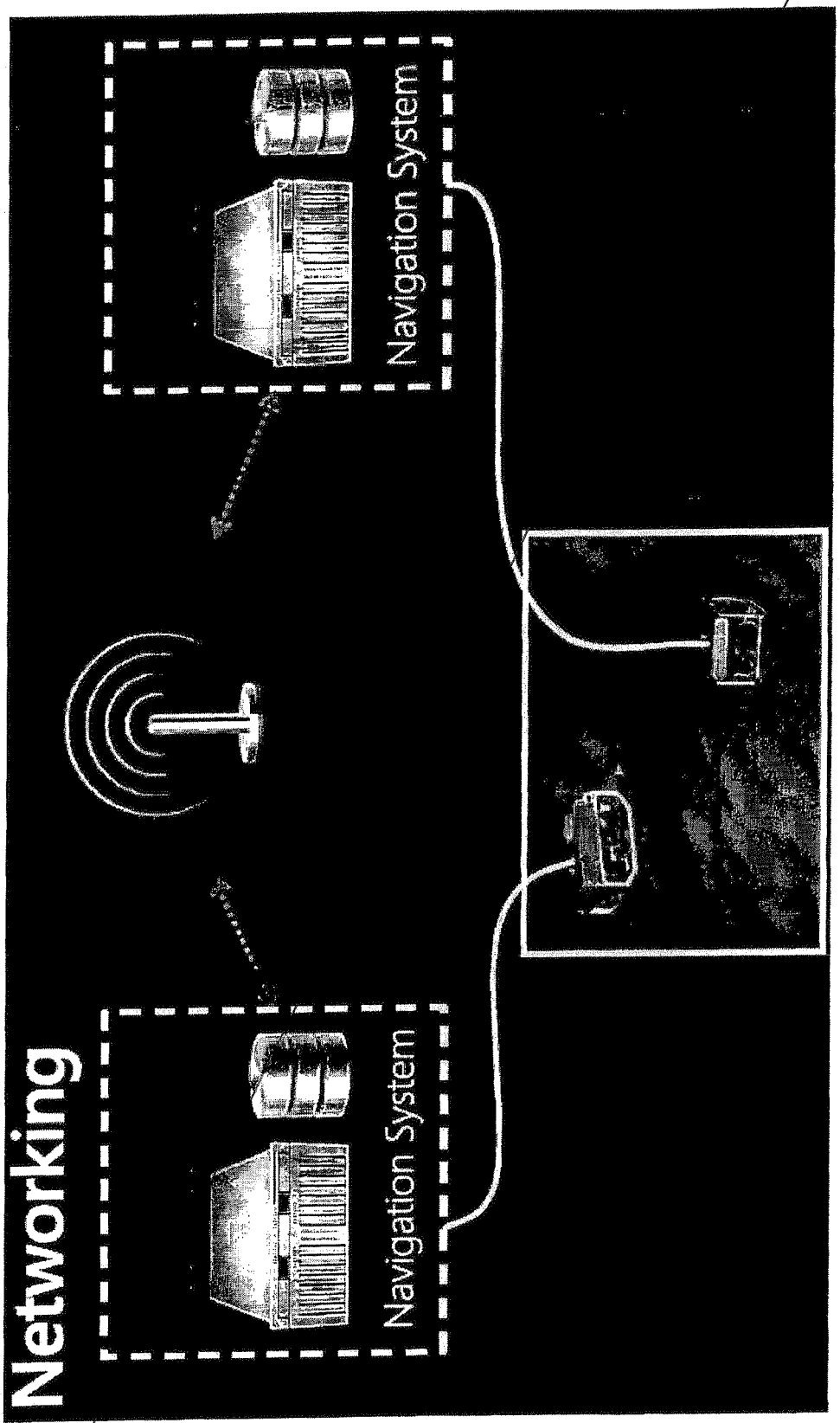


FIG. 3C

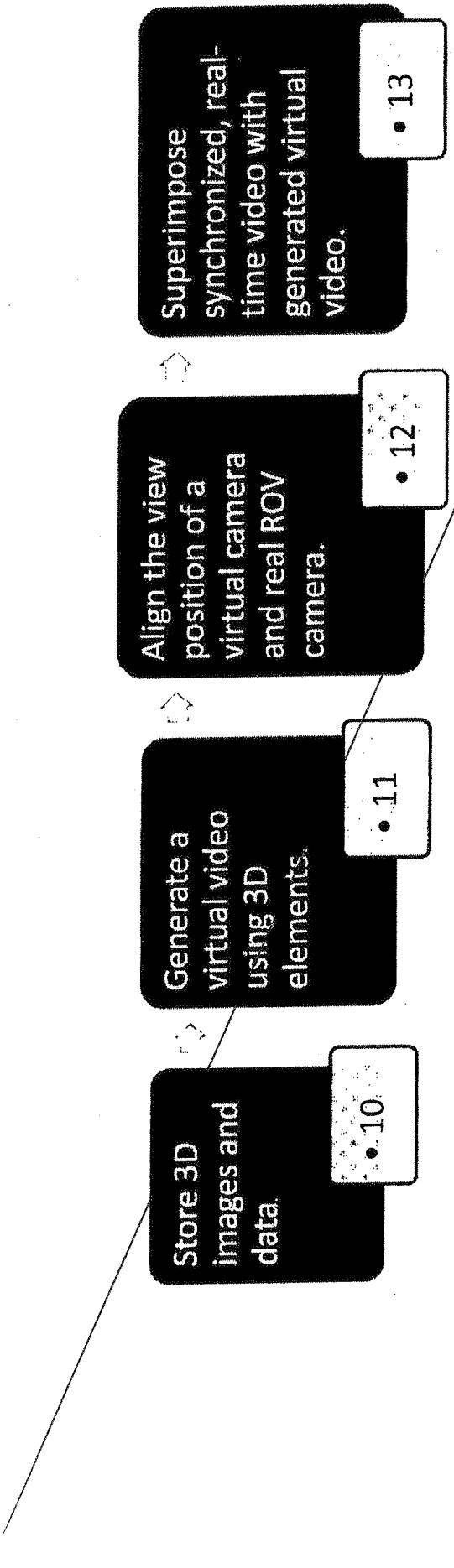

Store 3D images and data.
10
Generate a virtual video using 3D elements.
11
Align the view position of a virtual camera and real ROV camera.
12
Superimpose synchronized, real-time video with generated virtual video.
13

FIG. 4

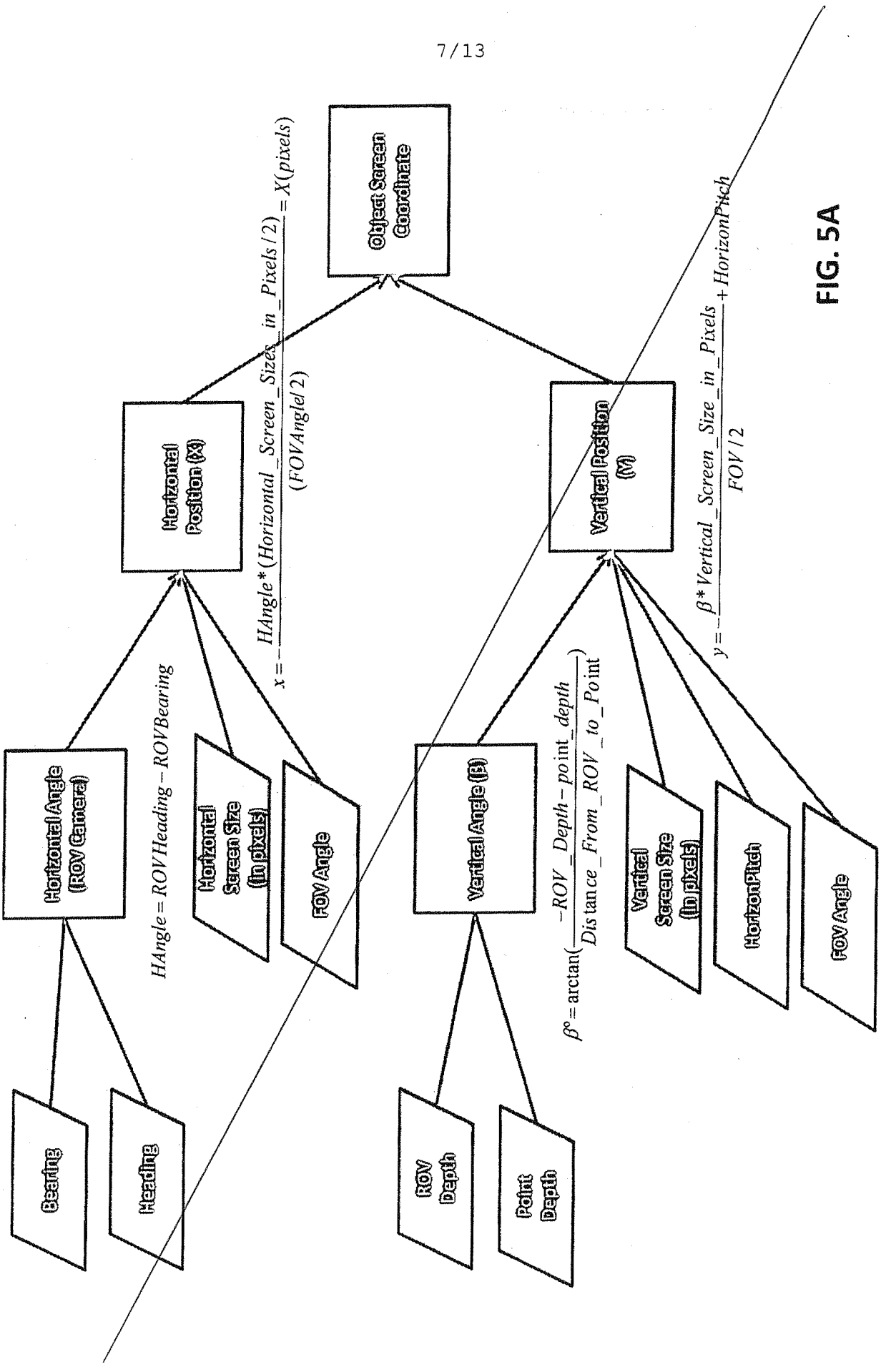

Object Screen Coordinate
Horizontal Position (X)
Vertical Position (Y)
Horizontal Angle (ROV Camera)
Horizontal Screen Size (In pixels)
FOV Angle
Bearing
Heading
Vertical Angle (β)
Vertical Screen Size (In pixels)
HorizonPitch
FOV Angle
ROV Depth
Point Depth
$HAngle = ROVHeading - ROVBearing$
$x = -\frac{HAngle * (Horizontal_Screen_Sizes_in_Pixels/2)}{(FOVAngle/2)} = X(pixels)$
$\beta° = \arctan(\frac{-ROV_Depth - point_depth}{Distance_From_ROV_to_Point})$
$y = -\frac{\beta * Vertical_Screen_Size_in_Pixels}{FOV/2} + HorizonPitch$

FIG. 5A

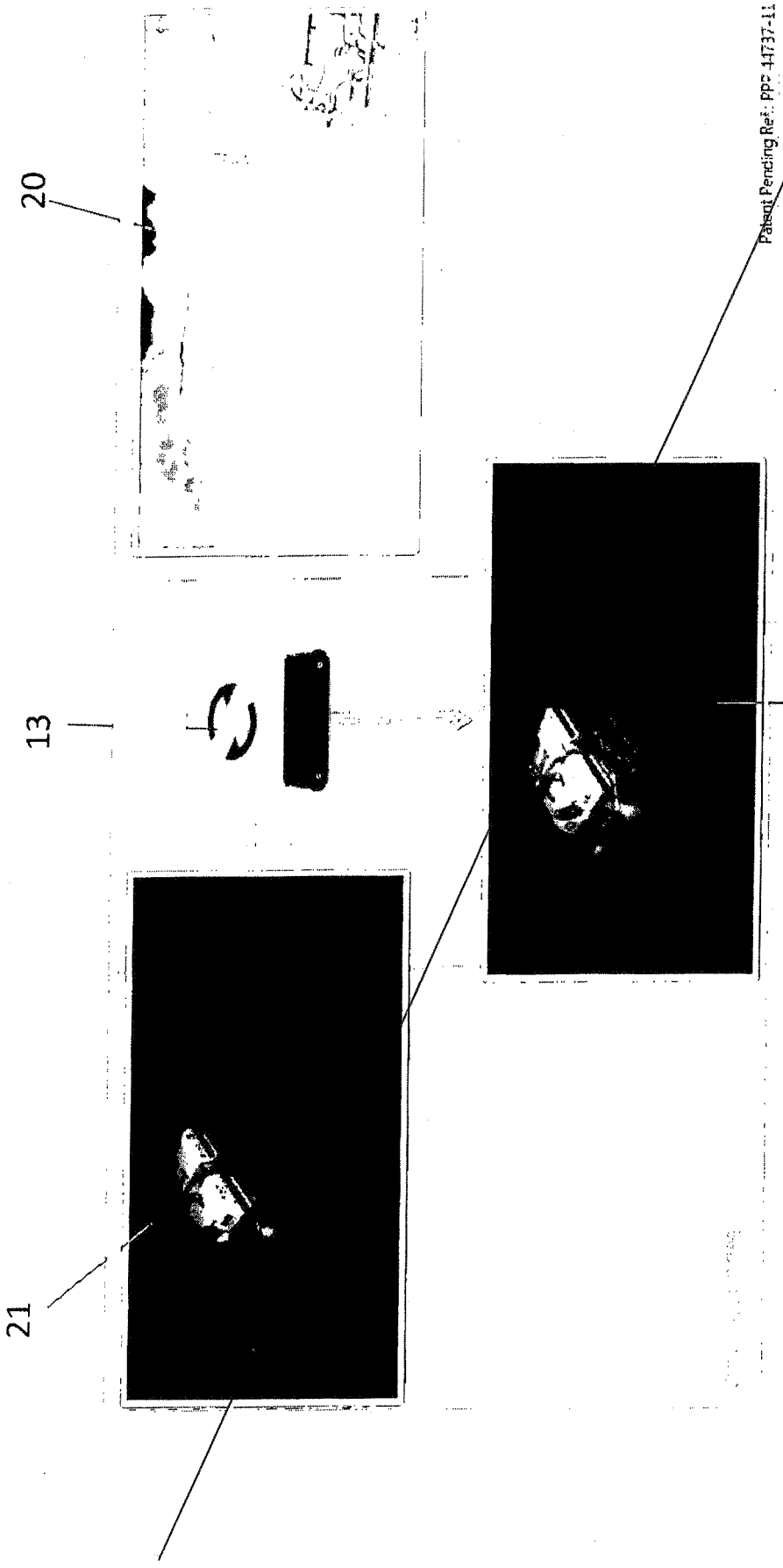


FIG. 5B

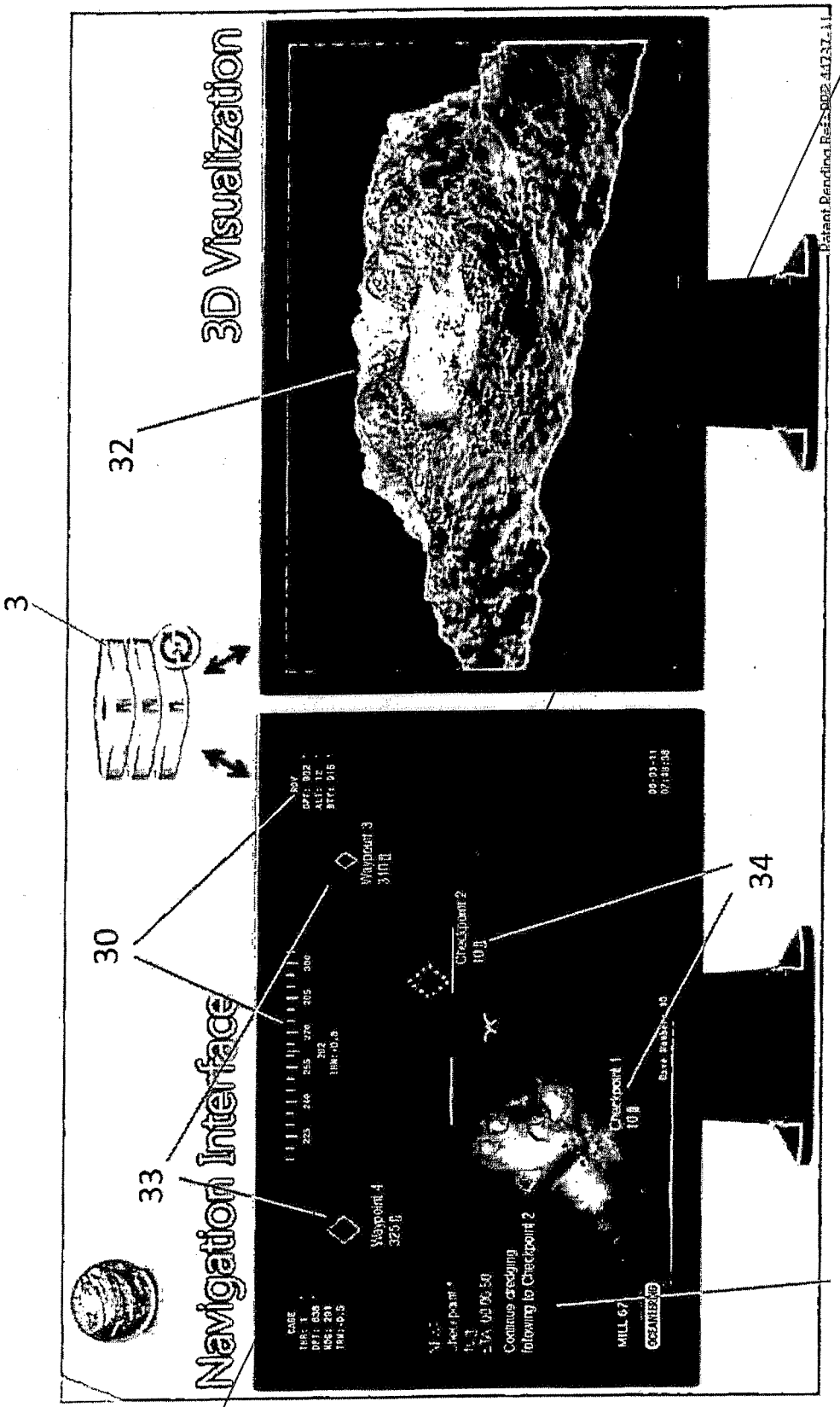

3D Visualization
Navigation Interface
3
30
32
33
34
35
Waypoint 4
325 ft
Waypoint 3
Checkpoint 2
10 ft
Checkpoint 1
10 ft
Continue dredging
following to Checkpoint 2
MILL 67
OSCAR18MG
Patent Pending

FIG. 6A

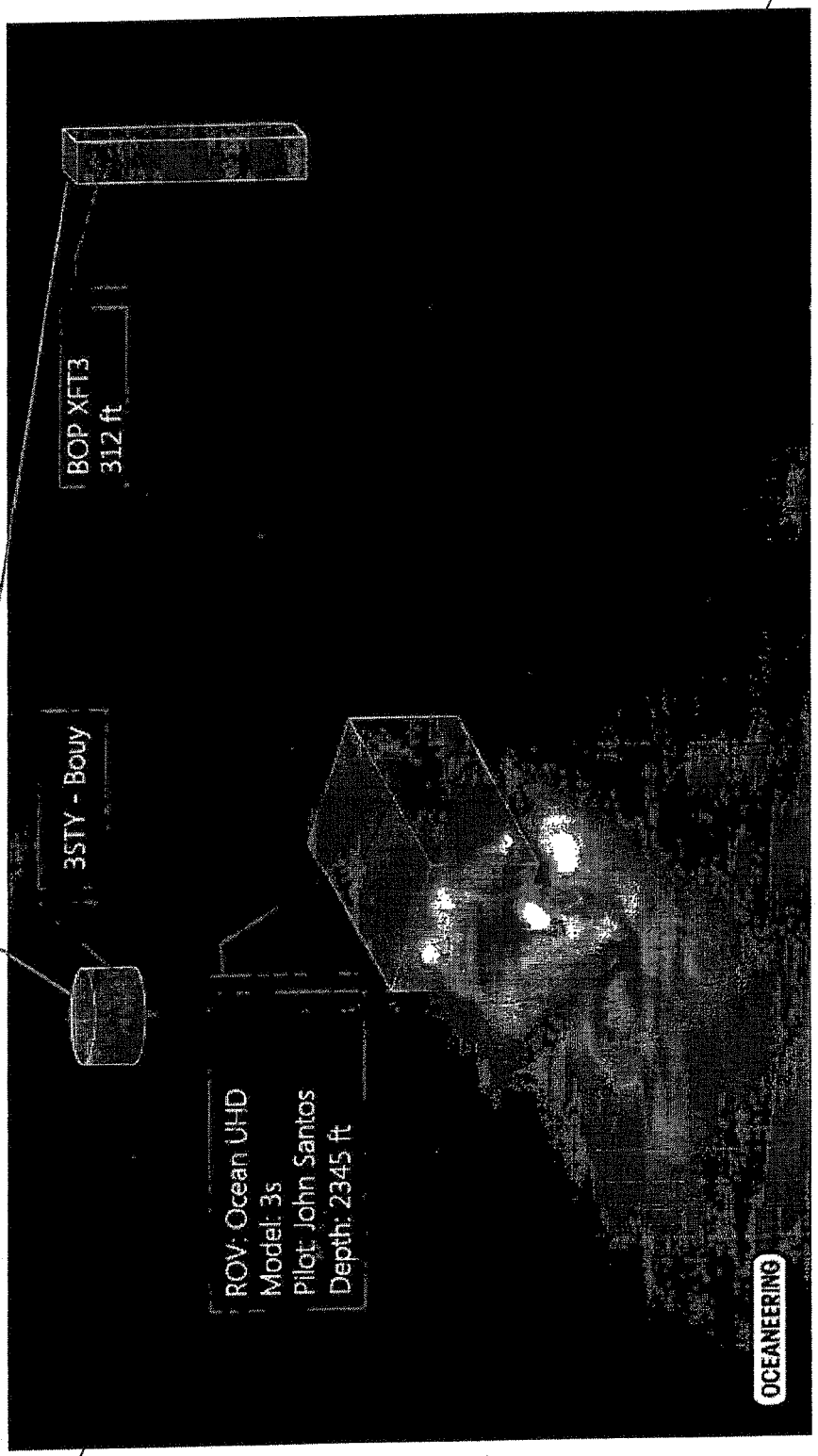

31
BOP XFT3
312 ft
3STY - Bouy
ROV: Ocean UHD
Model: 3s
Pilot: John Santos
Depth: 2345 ft
OCEANEERING

FIG. 6B

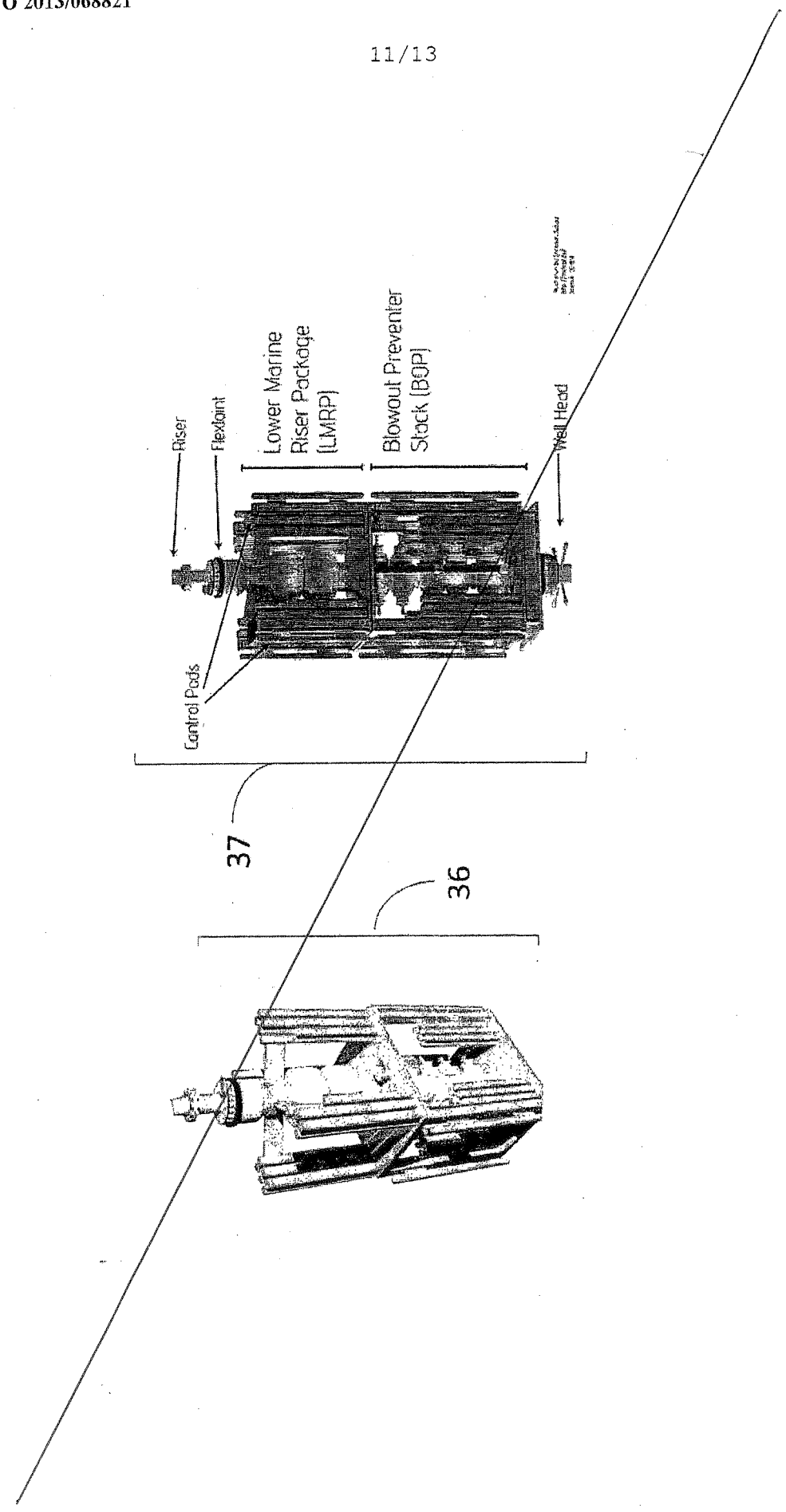

Riser
Flexjoint
Lower Marine Riser Package (LMRP)
Blowout Preventer Stack (BOP)
Well Head
Control Pods
37
36

FIG. 6C

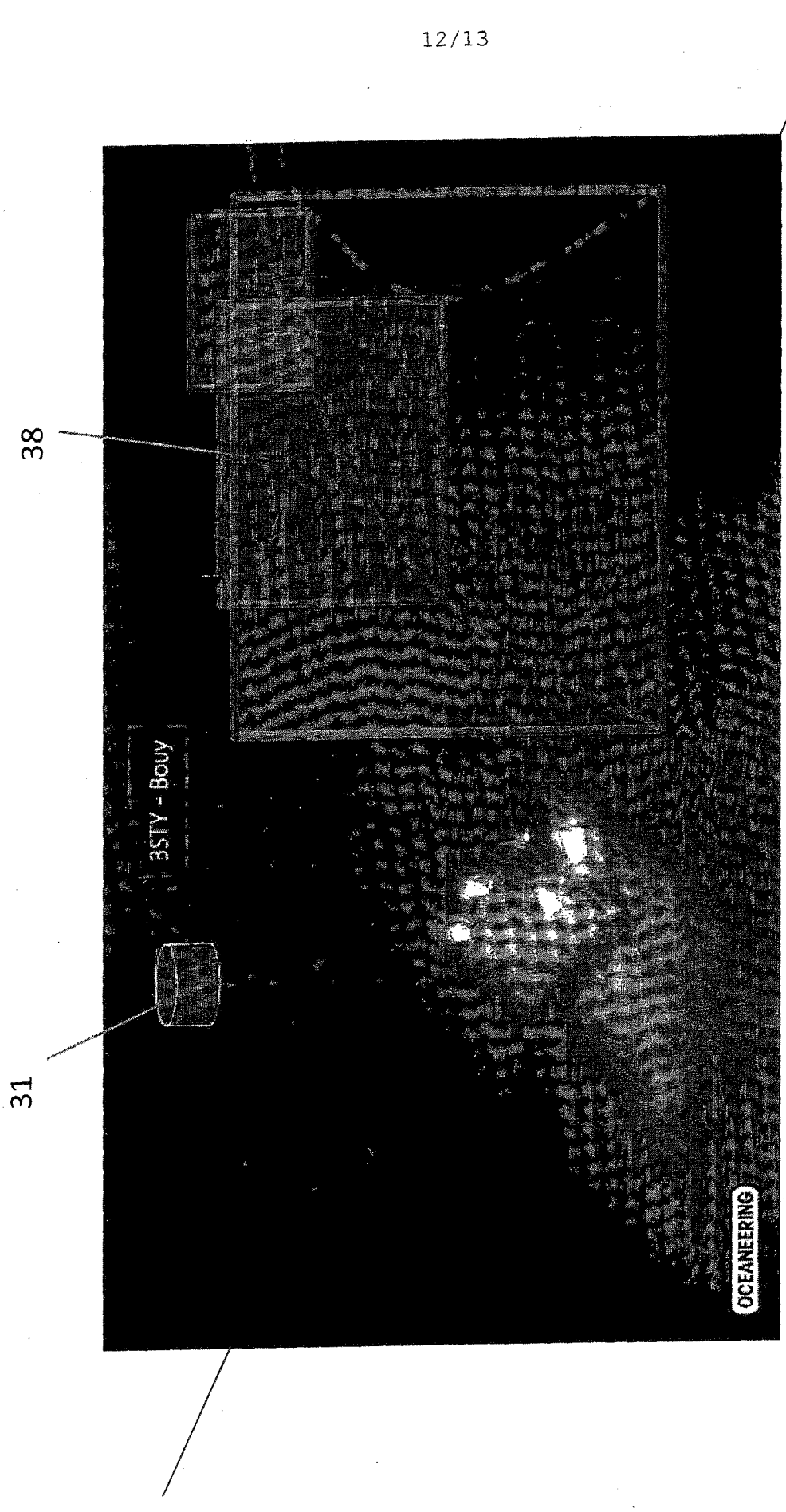


FIG. 6D

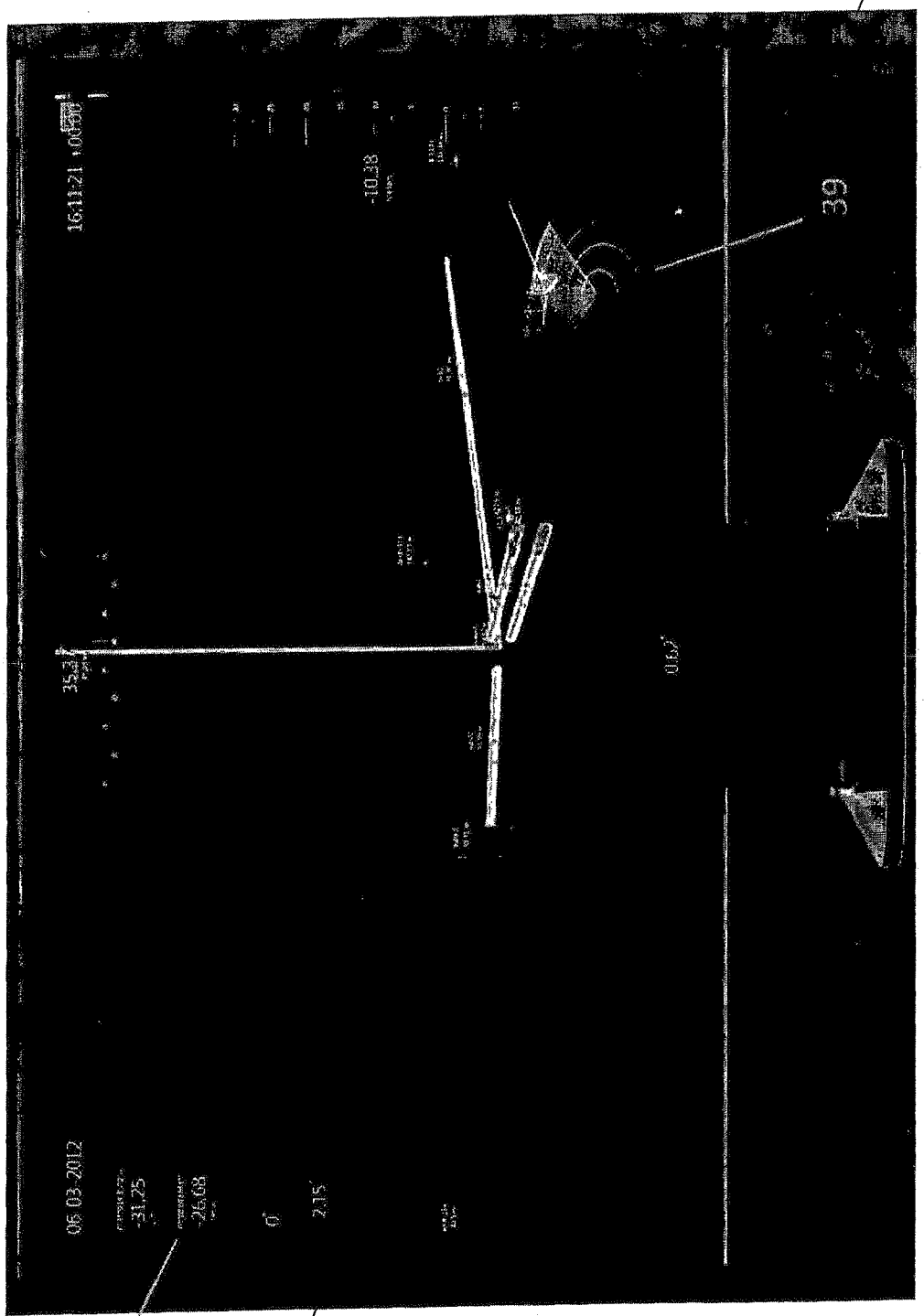


FIG. 6E