US009688163B2

(12) **United States Patent**
Hotary et al.

(10) **Patent No.: US 9,688,163 B2**
(45) **Date of Patent: *Jun. 27, 2017**

(54) **SYSTEM, METHODOLOGIES, AND COMPONENTS ACQUIRING, ANALYZING, AND USING OCCUPANT BODY SPECIFICATIONS FOR IMPROVED SEATING STRUCTURES AND ENVIRONMENT CONFIGURATION**

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(73) Assignee: **Faurecia Automotive Seating, LLC**, Troy, MI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **15/227,103**

(22) Filed: **Aug. 3, 2016**

(65) **Prior Publication Data**

US 2016/0339804 A1 Nov. 24, 2016

Related U.S. Application Data

(63) Continuation of application No. 14/591,822, filed on Jan. 7, 2015, now Pat. No. 9,428,082, which is a (Continued)

(51) **Int. Cl.**

B60R 22/00 (2006.01)
E05F 15/00 (2015.01)
(Continued)

(52) **U.S. Cl.**

CPC ***B60N 2/0244*** (2013.01); ***B60N 2/002*** (2013.01); ***B60N 2/0228*** (2013.01);
(Continued)

(58) **Field of Classification Search**

CPC .. B60N 2/0228; B60N 2/0244; B60N 2/0248; B60N 2/0252; B60N 2/0276; B60N 2/448; B60N 2/449; B60N 2/66; B60N 2/4415
(Continued)

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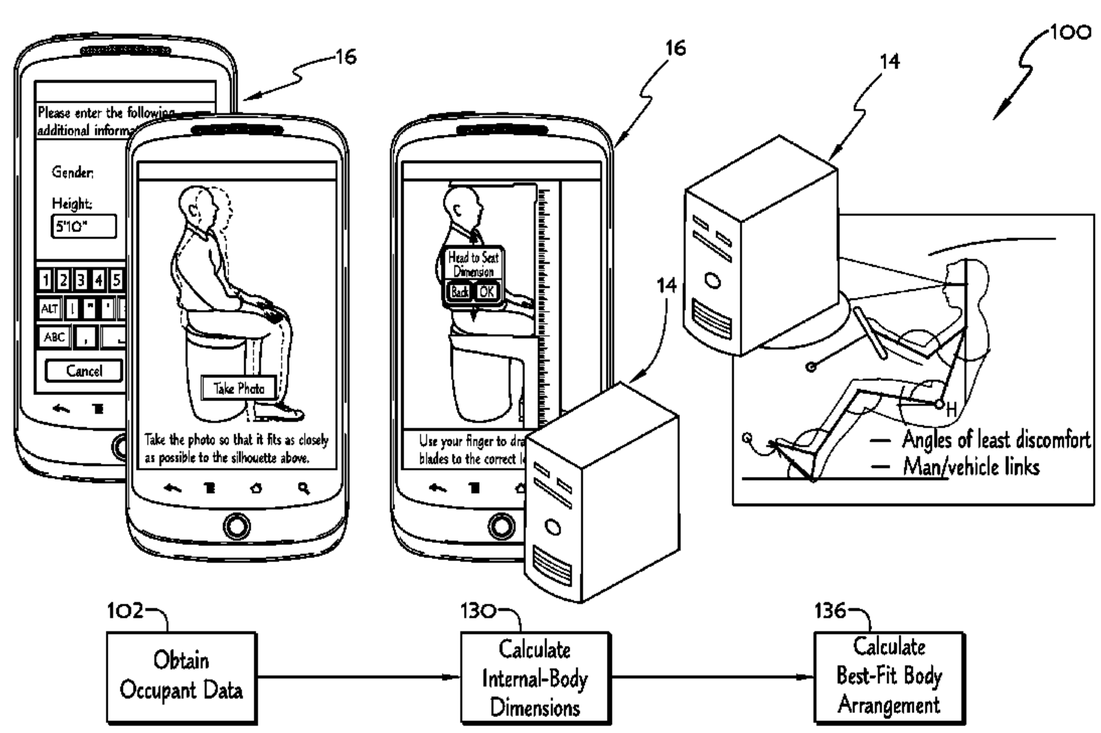
(74) *Attorney, Agent, or Firm* — Barnes & Thornburg LLP

(57) **ABSTRACT**

Equipment and processes generate a seating solution by obtaining occupant data, calculating body dimensions from the occupant data, and calculating a best-fit body arrangement for an occupant. Occupant data may be obtained in various ways using available computational devices and software or by manually measuring the relevant dimensions on the occupant. A user interface for inputting occupant metrics and/or occupant measurements may be provided in
(Continued)



a mobile terminal included in the vehicle or separate from the vehicle, thus giving users increased flexibility while maximizing simplicity and usability for the user or other personnel obtaining the data. Once an occupant's best-fit body arrangement is determined, it may be altered by changing the predetermined criteria to achieve optimum comfort, safety, and therapeutic benefit as well as used for providing improved comfort on a continuous basis and/or in response to detected or predicted vehicle, road, or atmospheric conditions.

20 Claims, 56 Drawing Sheets

Related U.S. Application Data

continuation of application No. 13/267,463, filed on Oct. 6, 2011, now Pat. No. 8,958,955.

(60) Provisional application No. 61/390,863, filed on Oct. 7, 2010, provisional application No. 61/506,508, filed on Jul. 11, 2011, provisional application No. 61/533,408, filed on Sep. 12, 2011.

(51) **Int. Cl.**

G05D 1/00	(2006.01)
G05D 3/00	(2006.01)
G06F 7/00	(2006.01)
G06F 17/00	(2006.01)
B60N 2/02	(2006.01)
B60N 2/44	(2006.01)
B60N 2/66	(2006.01)
B60N 2/06	(2006.01)
B60N 2/16	(2006.01)
B60N 2/20	(2006.01)
B60N 2/22	(2006.01)
B60N 2/48	(2006.01)
B60N 2/00	(2006.01)

(52) **U.S. Cl.**
CPC ***B60N 2/0248*** (2013.01); ***B60N 2/0252*** (2013.01); ***B60N 2/0276*** (2013.01); ***B60N 2/06*** (2013.01); ***B60N 2/16*** (2013.01); ***B60N 2/20*** (2013.01); ***B60N 2/22*** (2013.01); ***B60N 2/448*** (2013.01); ***B60N 2/449*** (2013.01); ***B60N 2/4415*** (2013.01); ***B60N 2/4808*** (2013.01); ***B60N 2/4838*** (2013.01); ***B60N 2/66*** (2013.01); ***B60N 2/665*** (2015.04); *B60N 2002/026* (2013.01); *B60N 2002/0268* (2013.01)

(58) **Field of Classification Search**
USPC 701/36, 48, 49; 297/284.3; 280/735; 382/104
See application file for complete search history.

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2010/0178906	A1	7/2010	Kennedy	
2010/0179438	A1	7/2010	Heneghan	

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JP	2006341637		12/2006
JP	2006341637	A	12/2006
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JP	2010006163	A	1/2010
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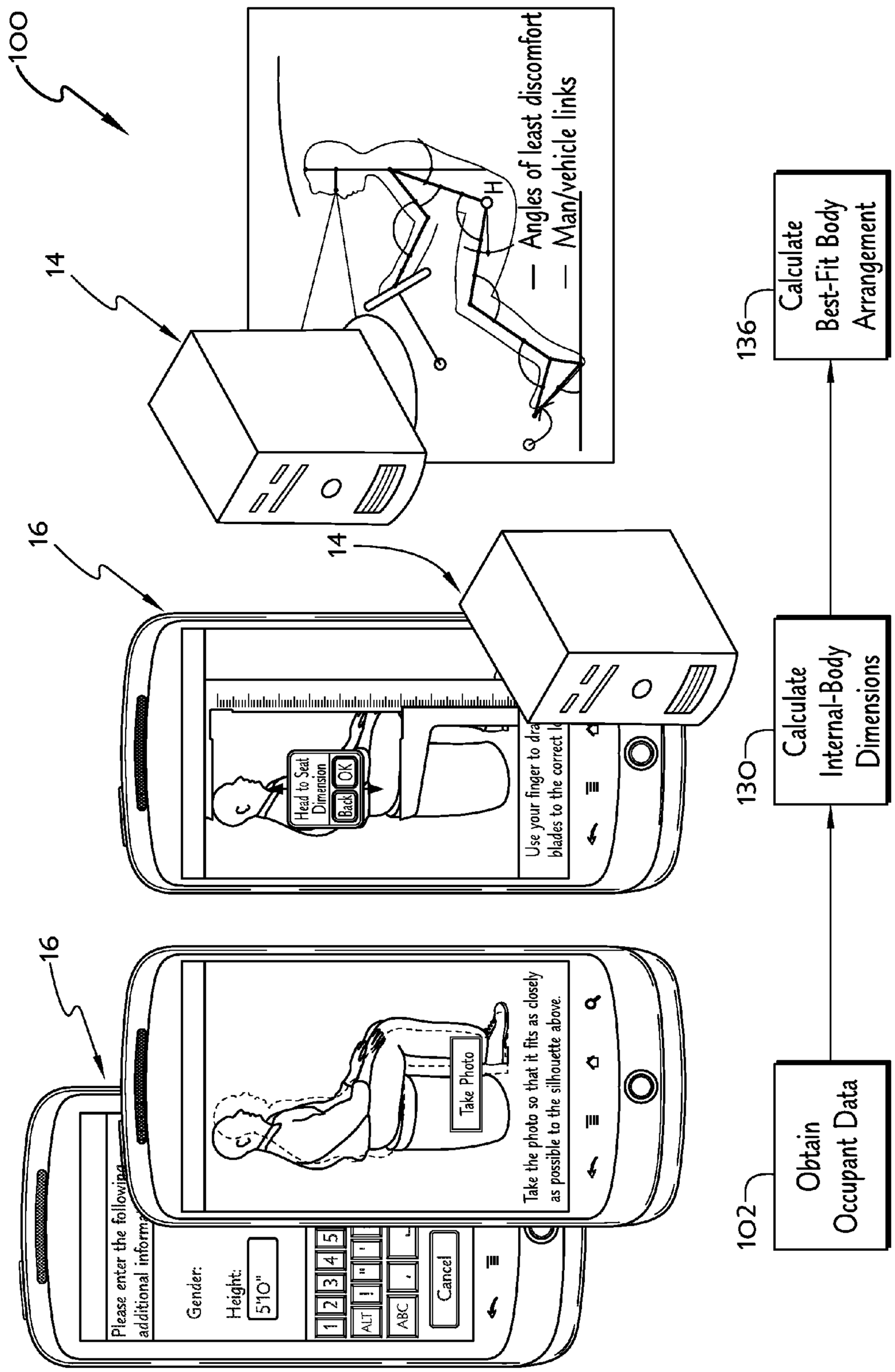

100
14
— Angles of least discomfort
— Man/vehicle links
H
16
14
Head to Seat Dimension
Back
OK
Use your finger to dra
blades to the correct l
16
Please enter the following
additional informa
Gender:
Height:
5'10"
1 2 3 4 5
ALT
ABC
Cancel
Take Photo
Take the photo so that it fits as closely as possible to the silhouette above.
136
Calculate Best-Fit Body Arrangement
130
Calculate Internal-Body Dimensions
102
Obtain Occupant Data

FIG. 1

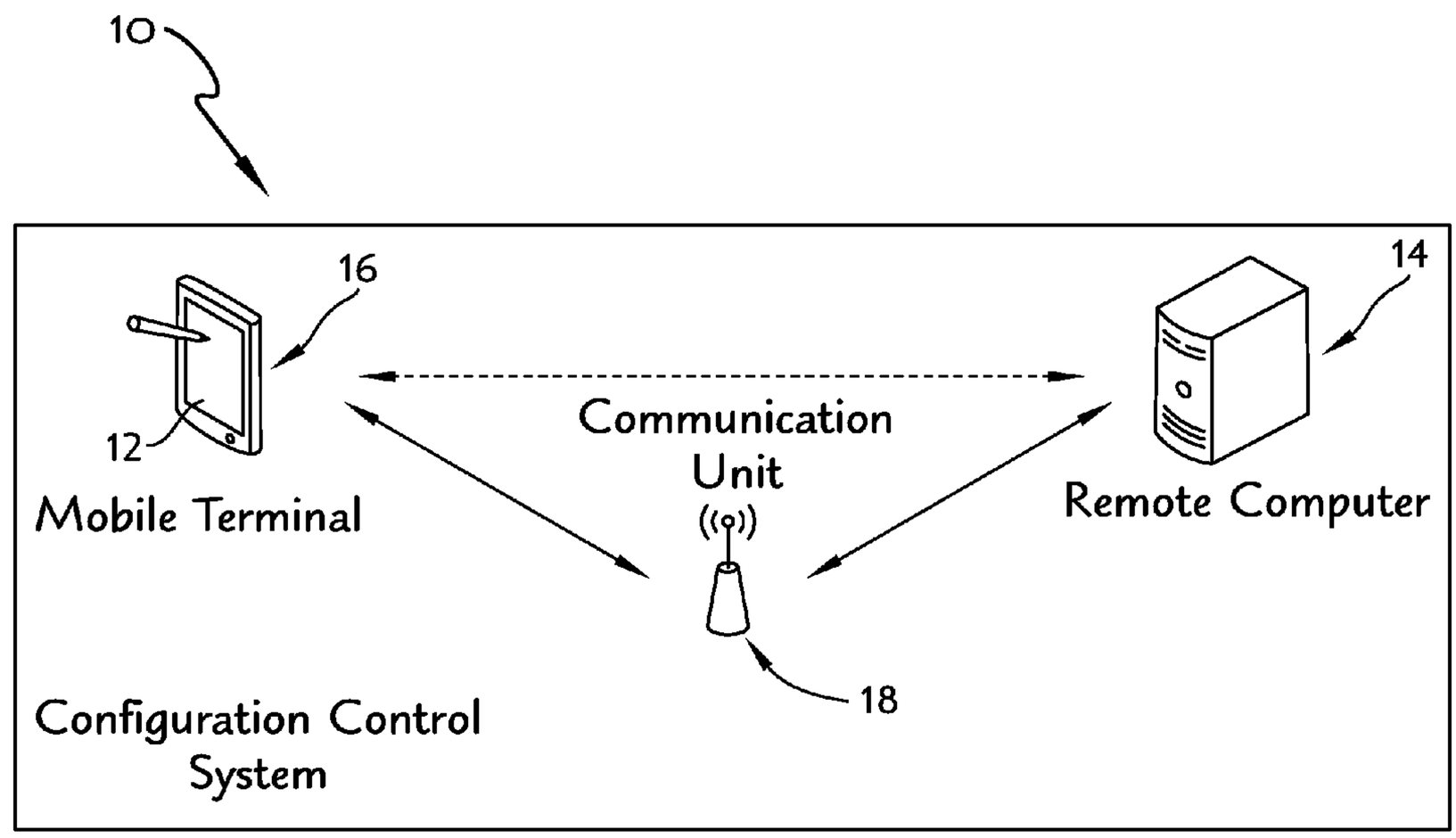

10
16
14
12
Communication
Unit
Mobile Terminal
Remote Computer
18
Configuration Control
System

FIG. 2

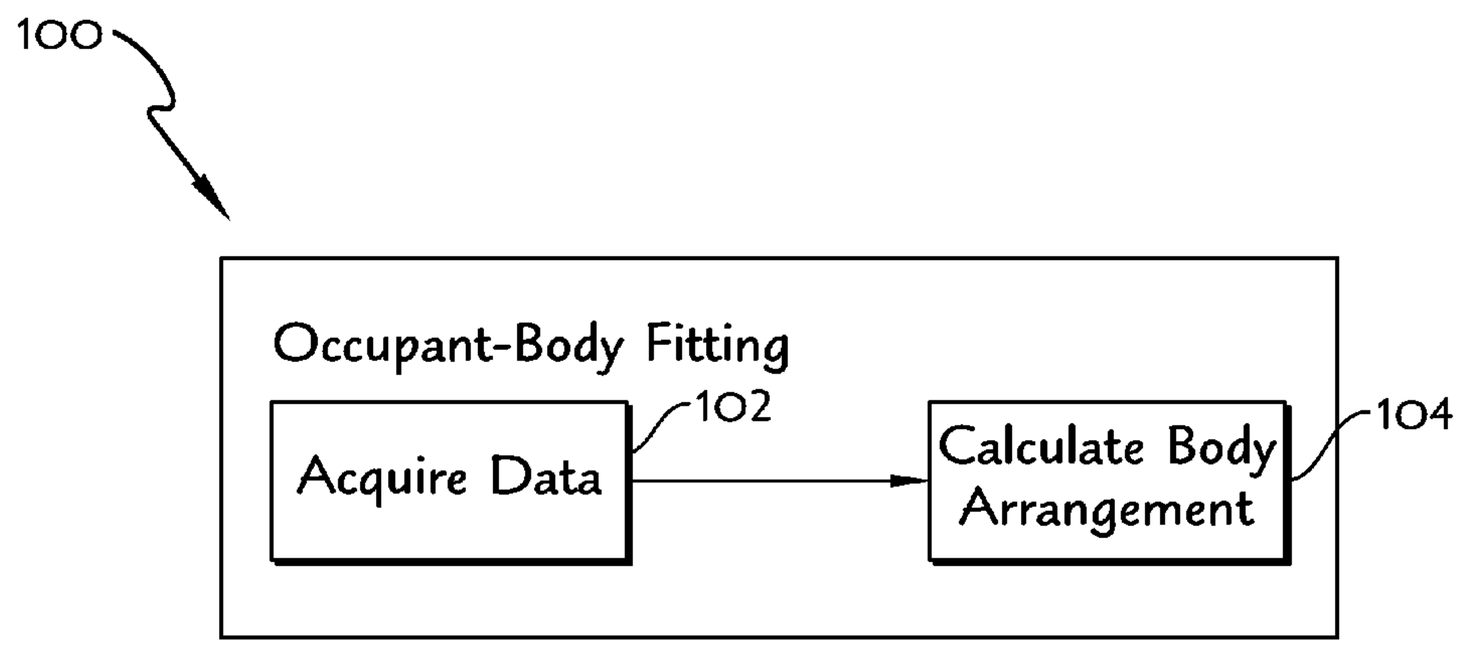

100
Occupant-Body Fitting
102
Acquire Data
Calculate Body
Arrangement
104

FIG. 3

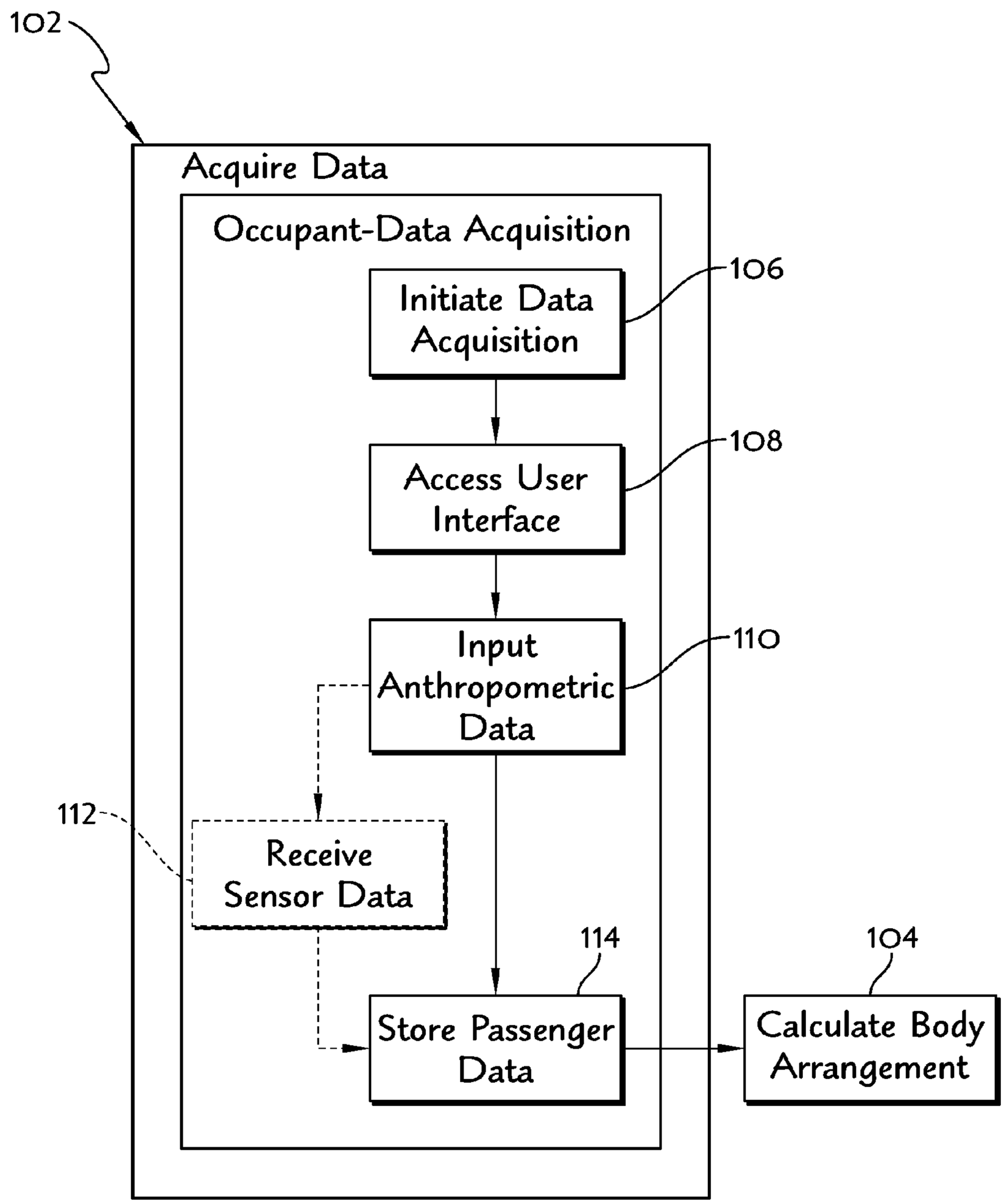

102
Acquire Data
Occupant-Data Acquisition
Initiate Data Acquisition
106
Access User Interface
108
Input Anthropometric Data
110
112
Receive Sensor Data
114
Store Passenger Data
104
Calculate Body Arrangement

FIG. 4

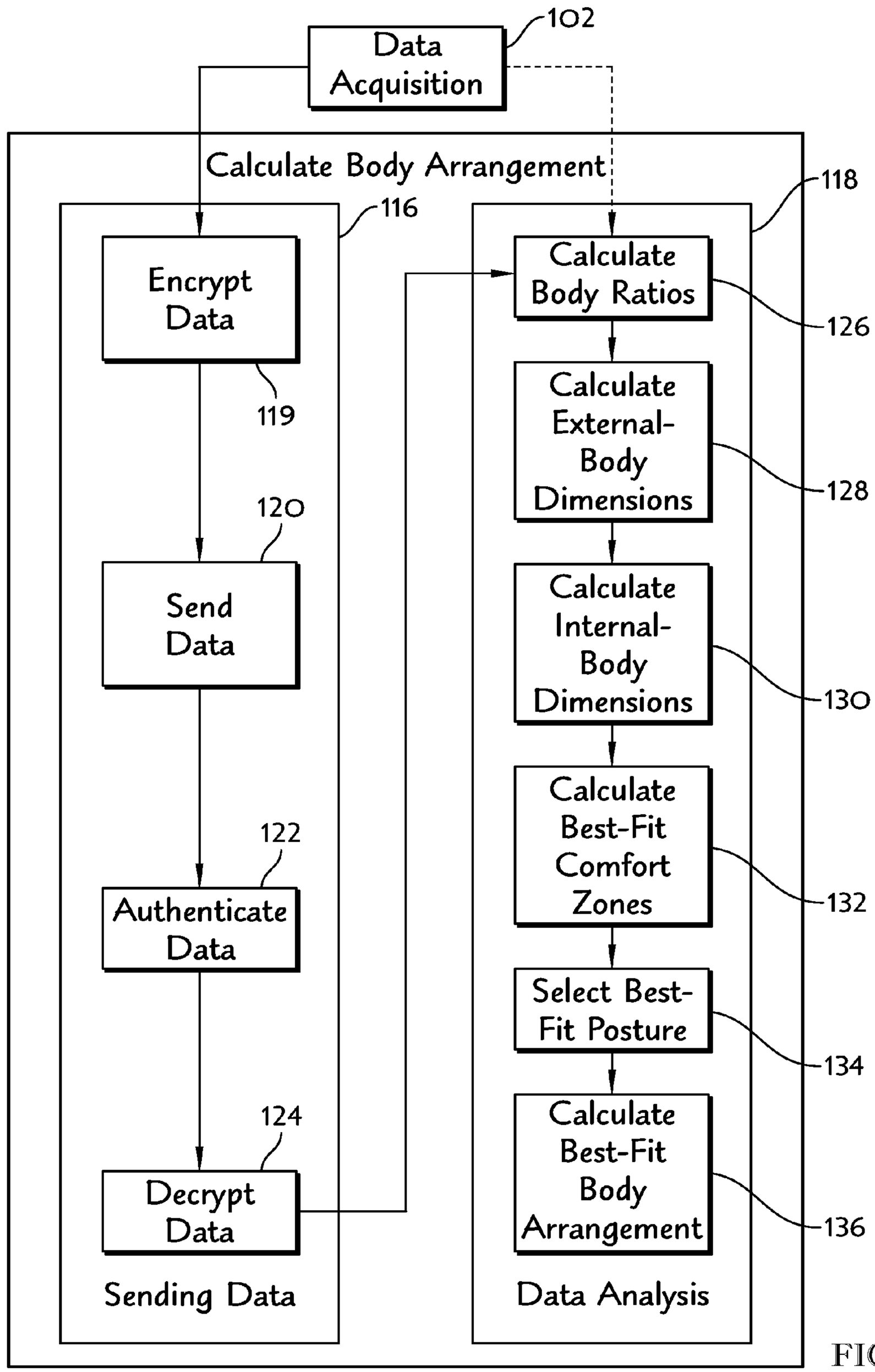

Data Acquisition
102
Calculate Body Arrangement
116
118
Encrypt Data
119
Send Data
120
Authenticate Data
122
Decrypt Data
124
Sending Data
Calculate Body Ratios
126
Calculate External-Body Dimensions
128
Calculate Internal-Body Dimensions
130
Calculate Best-Fit Comfort Zones
132
Select Best-Fit Posture
134
Calculate Best-Fit Body Arrangement
136
Data Analysis

FIG. 5

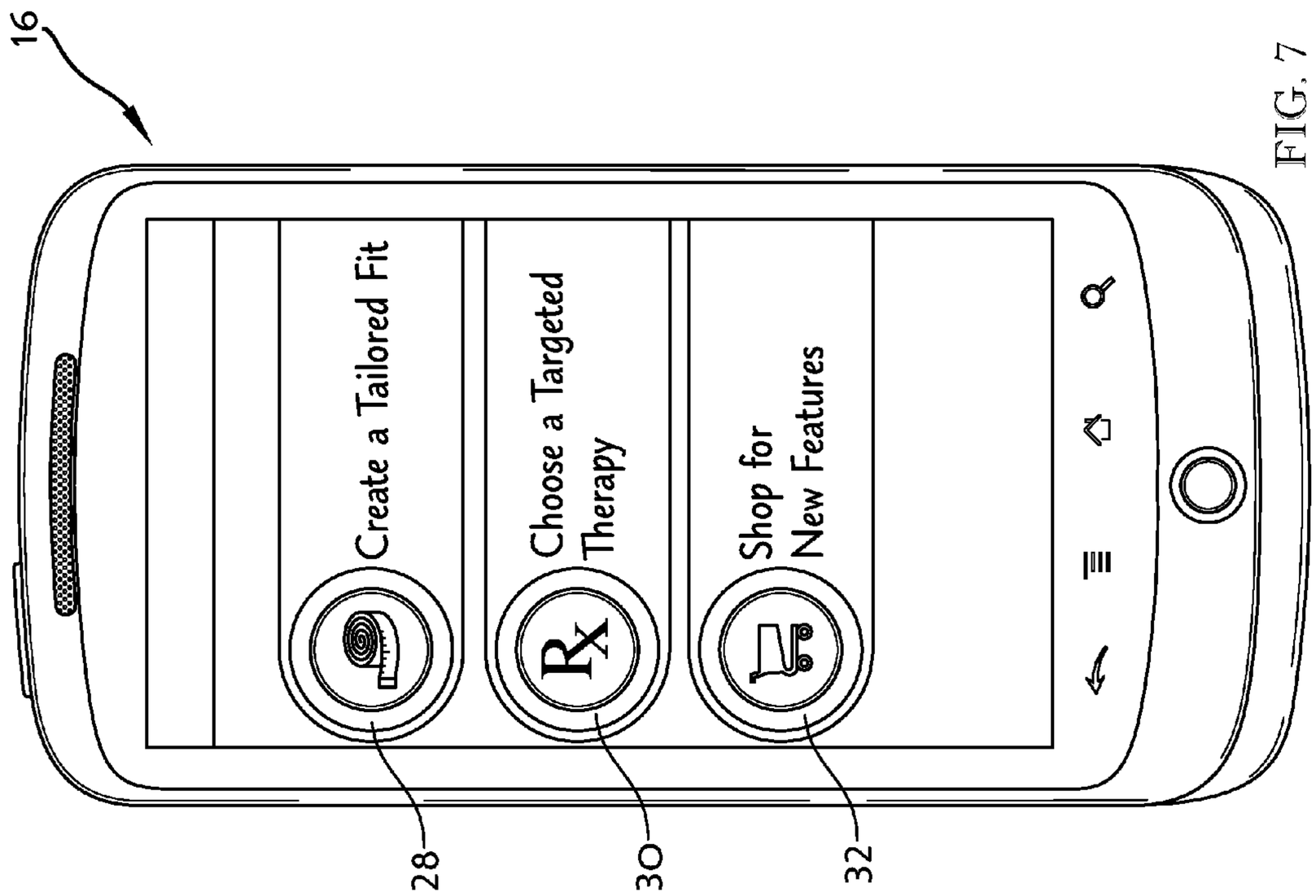

16
Create a Tailored Fit
Choose a Targeted Therapy
Shop for New Features
28
30
32

FIG. 7

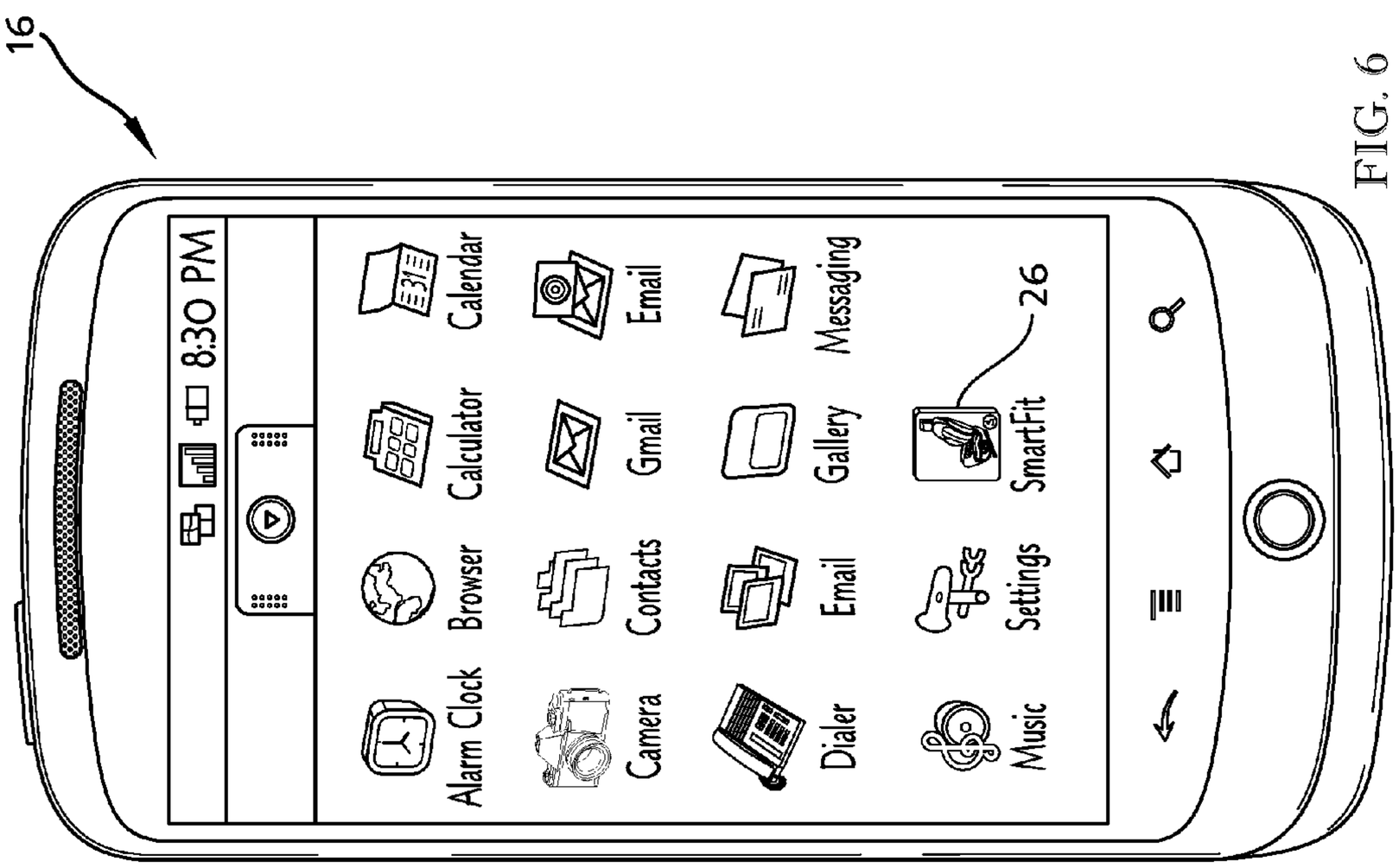

16
8:30 PM
Calendar
Calculator
Email
Gmail
Messaging
Gallery
Browser
Contacts
Email
SmartFit
26
Settings
Alarm Clock
Camera
Dialer
Music

FIG. 6

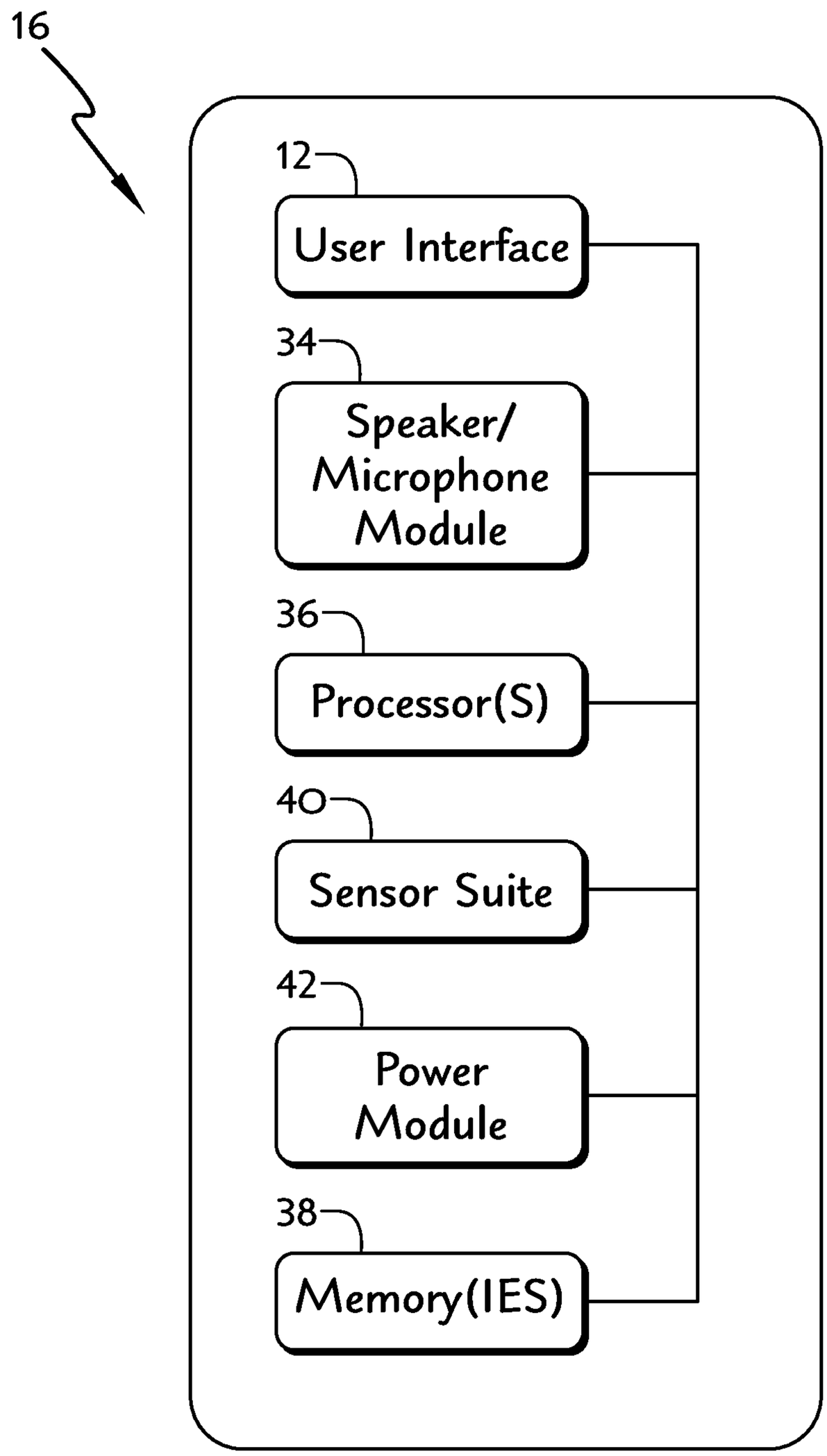

16
12
User Interface
34
Speaker/
Microphone
Module
36
Processor(S)
40
Sensor Suite
42
Power
Module
38
Memory(IES)

FIG. 8

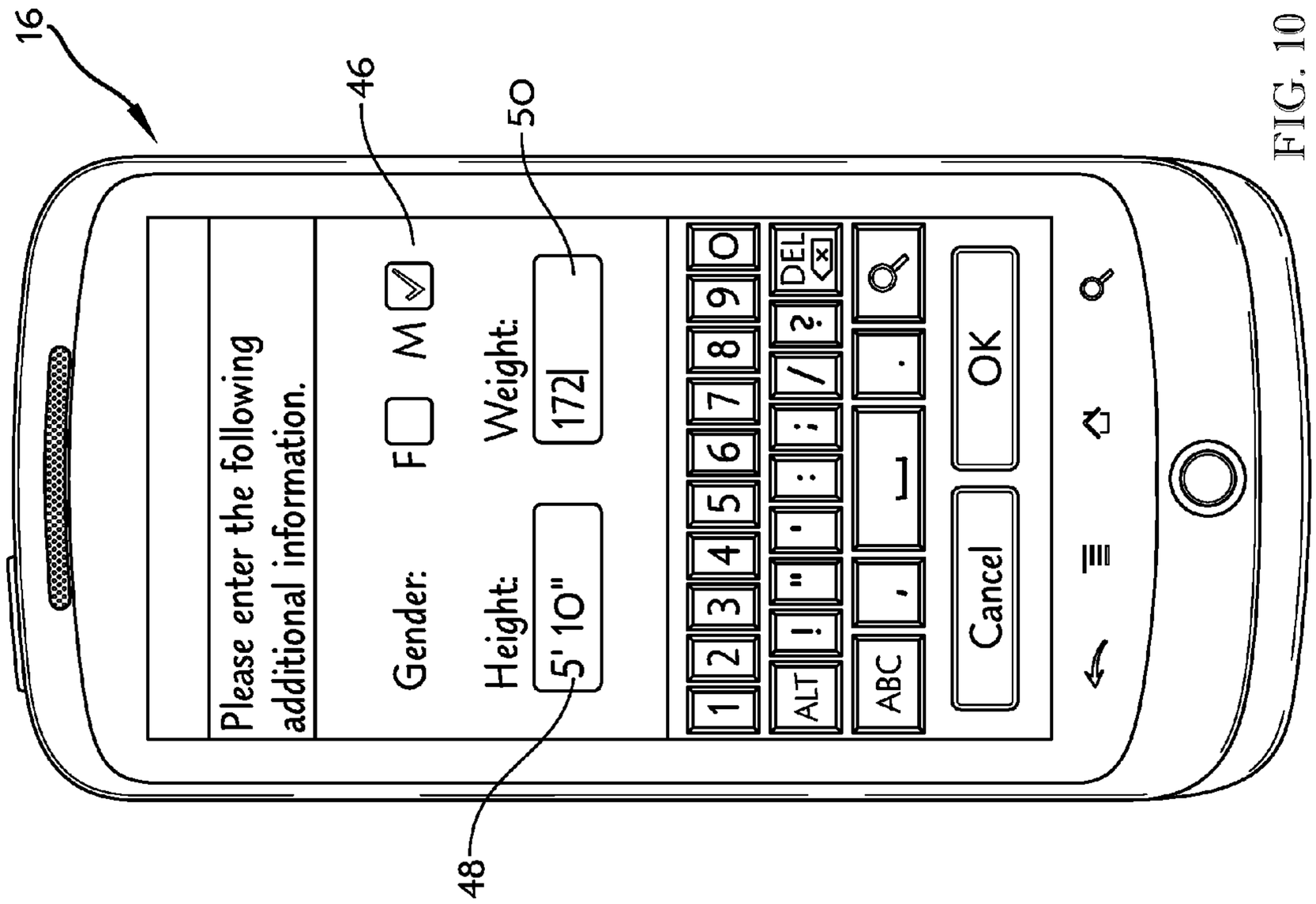

16
46
50
Please enter the following additional information.
Gender:
F
M
Height:
5' 10"
Weight:
172
48
1 2 3 4 5 6 7 8 9 0
ALT
ABC
DEL
Cancel
OK

FIG. 10

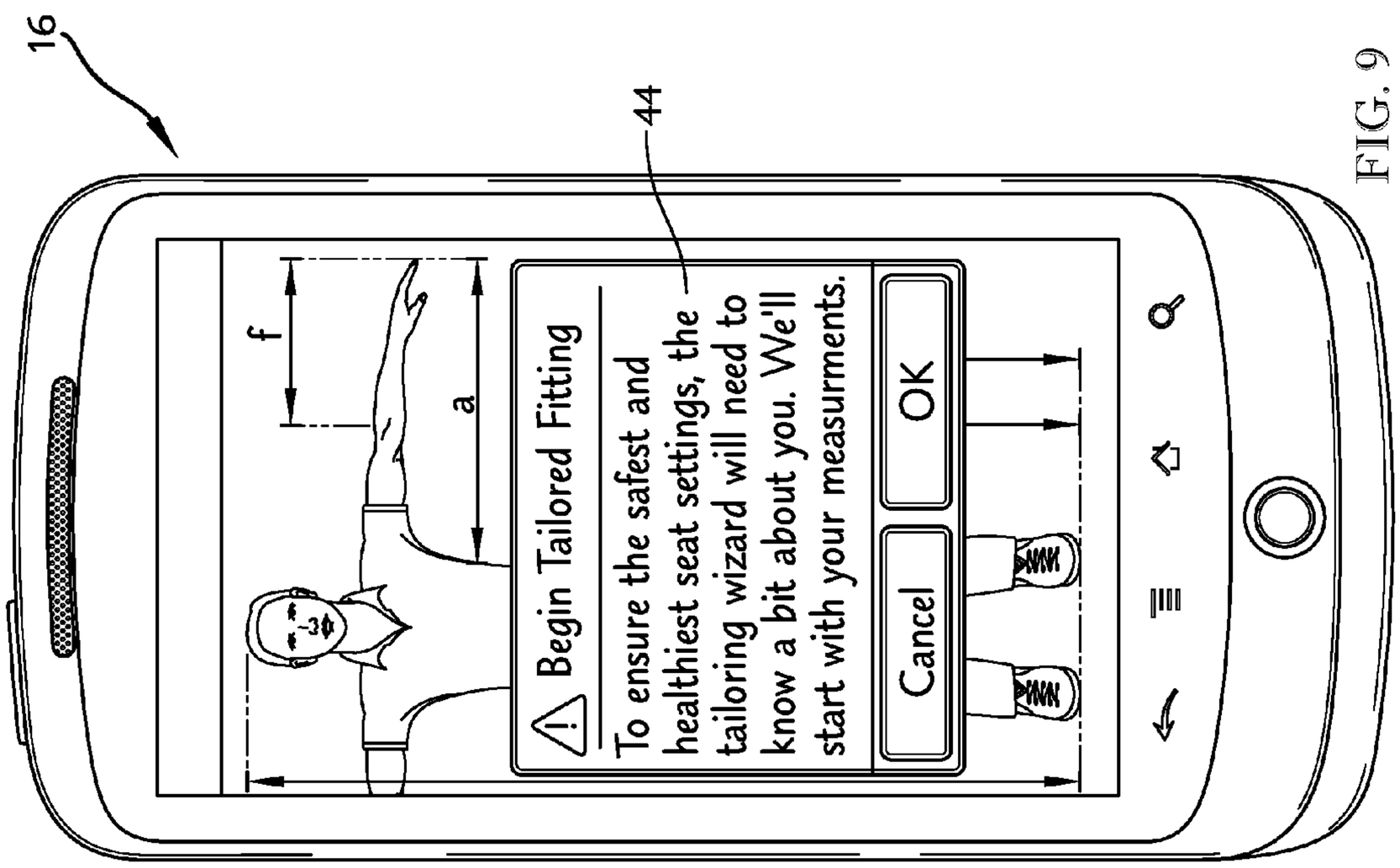

16
44
f
a
Begin Tailored Fitting
To ensure the safest and healthiest seat settings, the tailoring wizard will need to know a bit about you. We'll start with your measurments.
Cancel
OK

FIG. 9

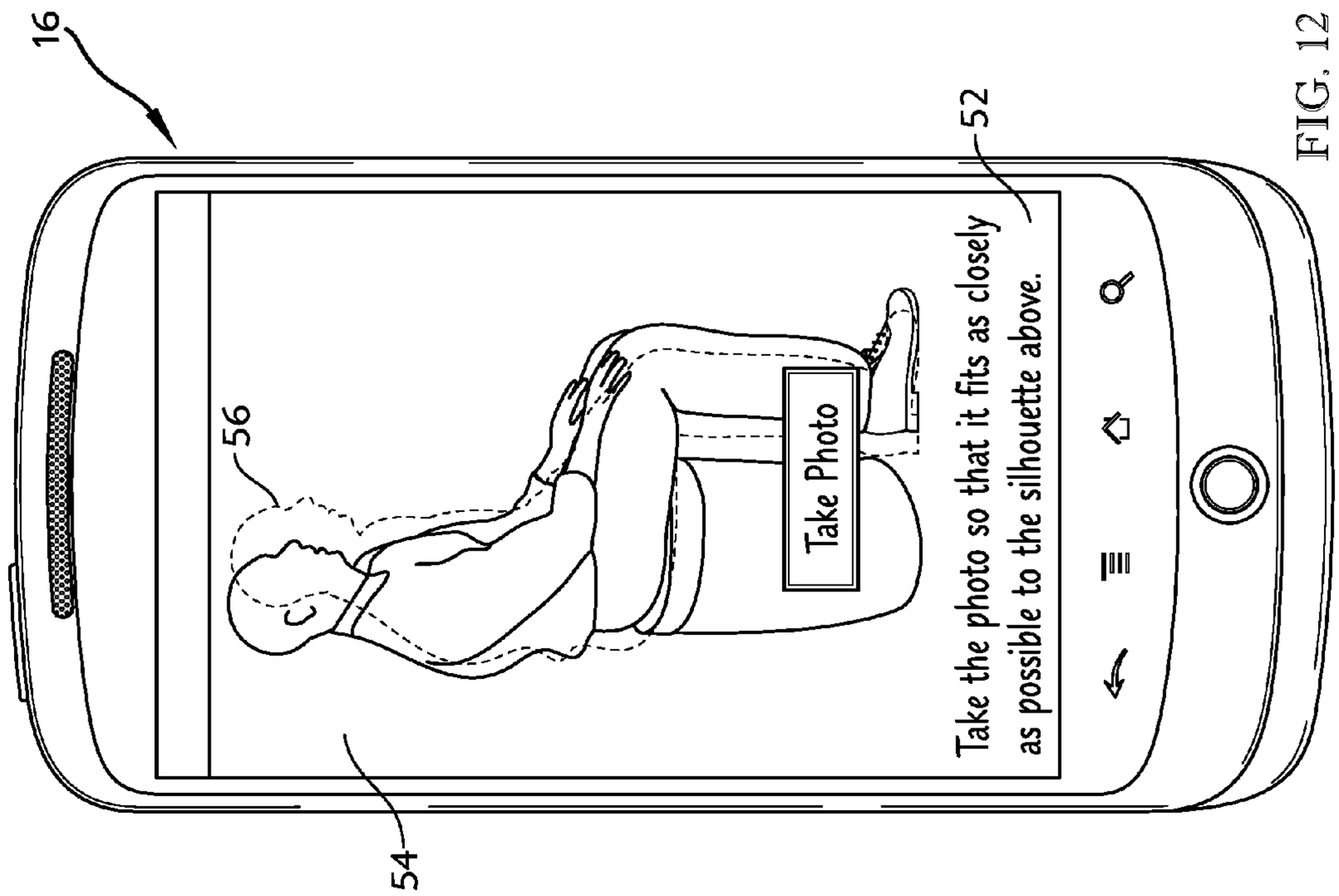

16
52
56
54
Take Photo
Take the photo so that it fits as closely as possible to the silhouette above.

FIG. 12

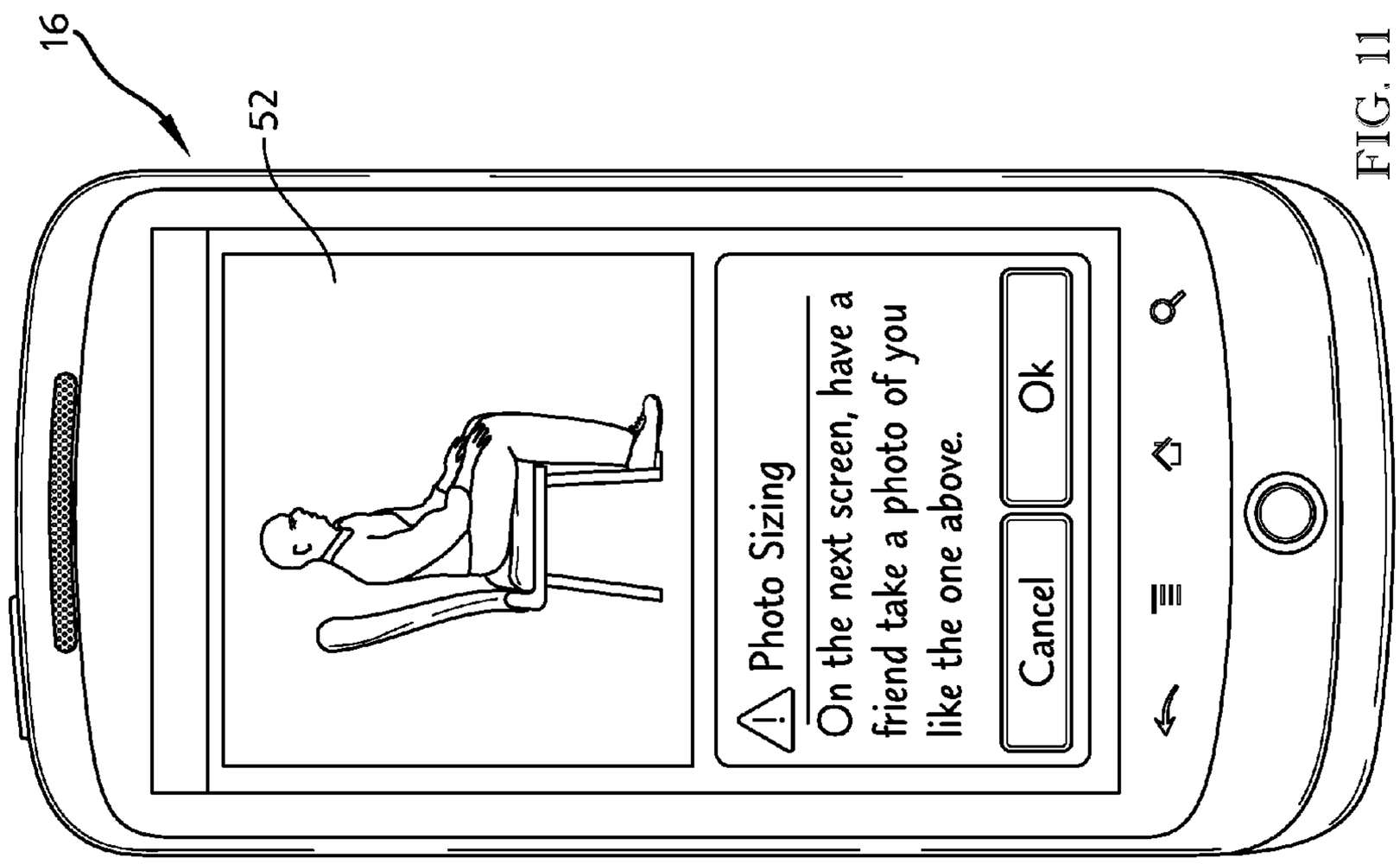

16
52
Photo Sizing
On the next screen, have a friend take a photo of you like the one above.
Cancel
Ok

FIG. 11

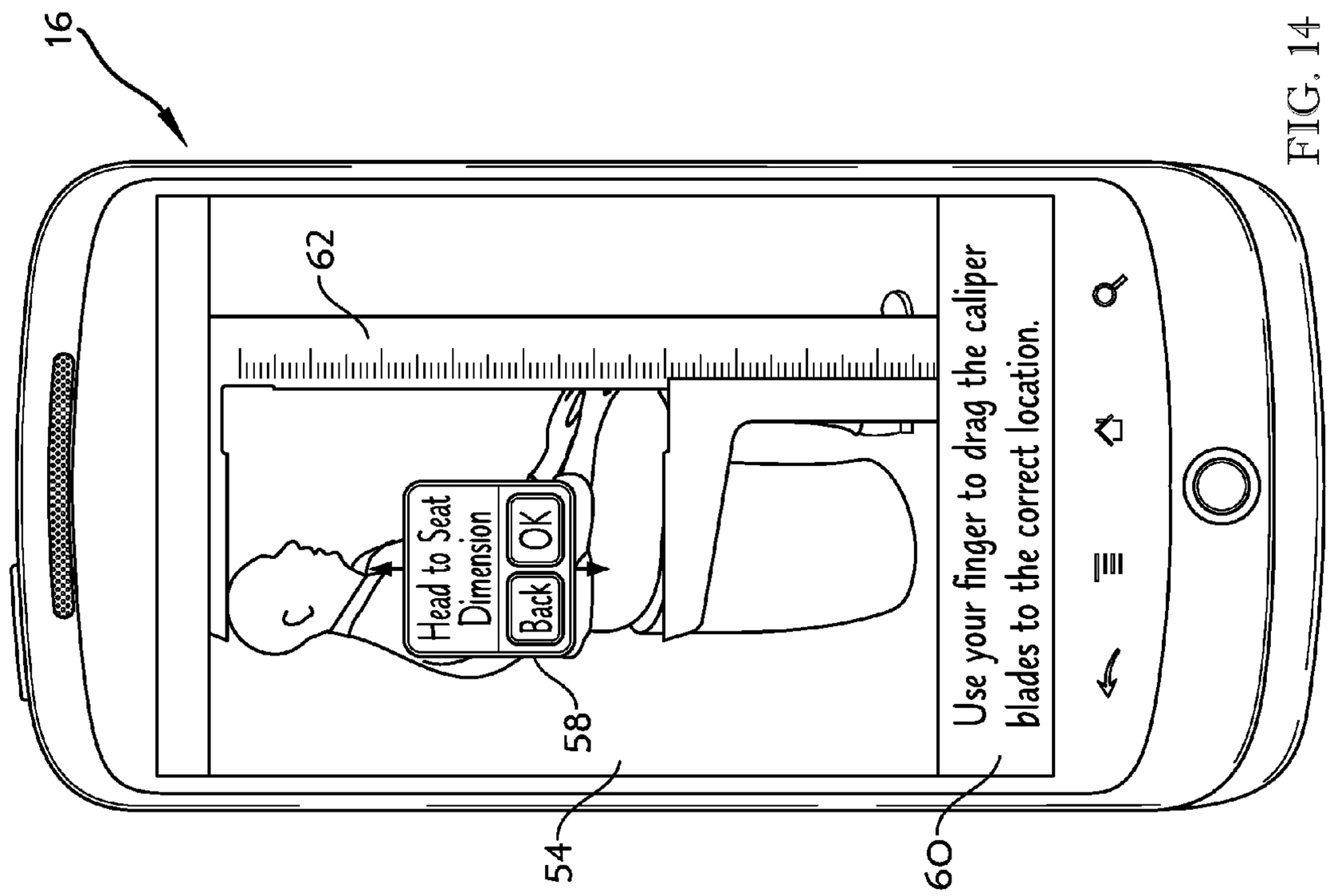

16
62
Head to Seat Dimension
Back
OK
58
54
Use your finger to drag the caliper blades to the correct location.
60

FIG. 14

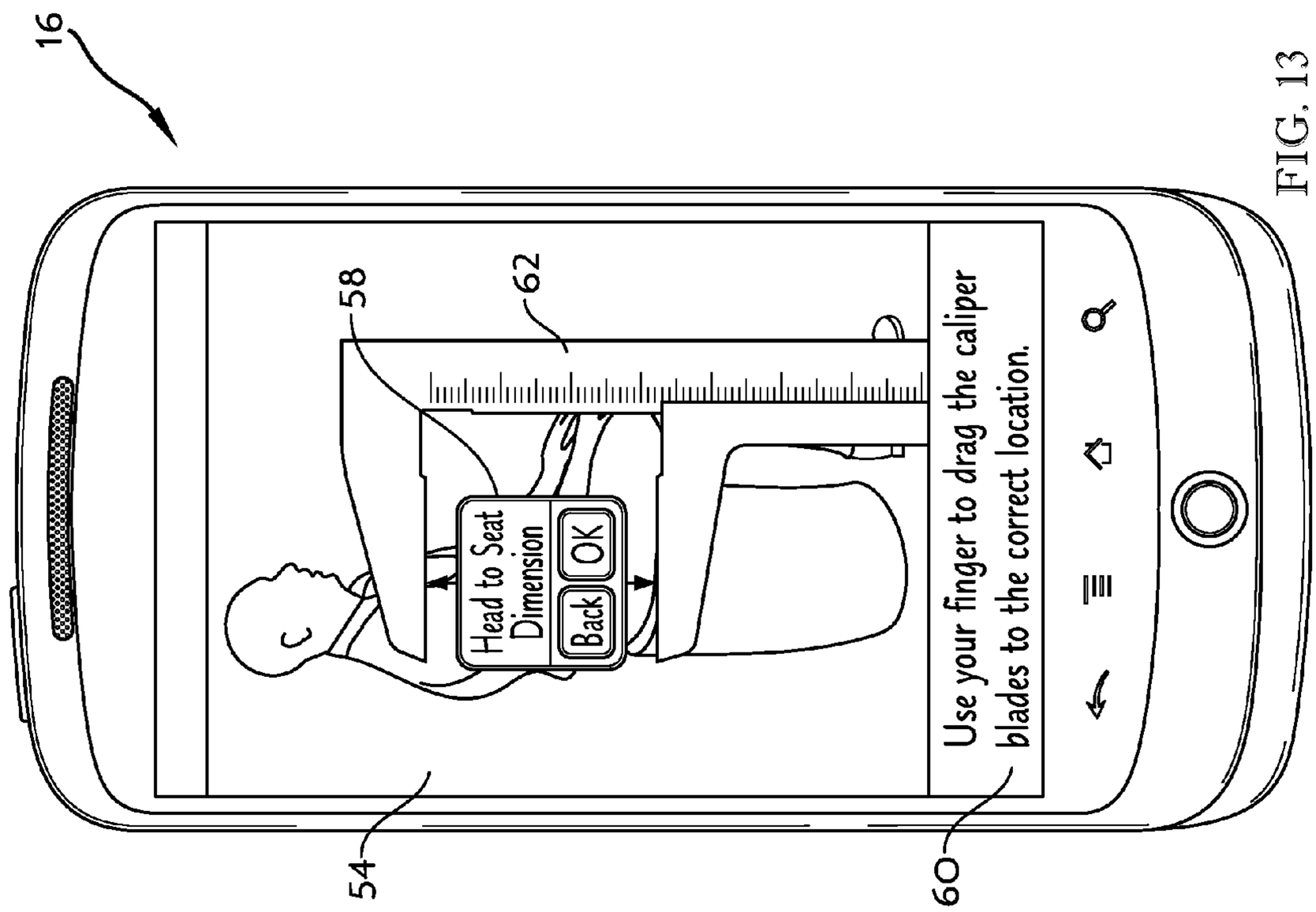

16
58
62
Head to Seat Dimension
Back
OK
54
Use your finger to drag the caliper blades to the correct location.
60

FIG. 13

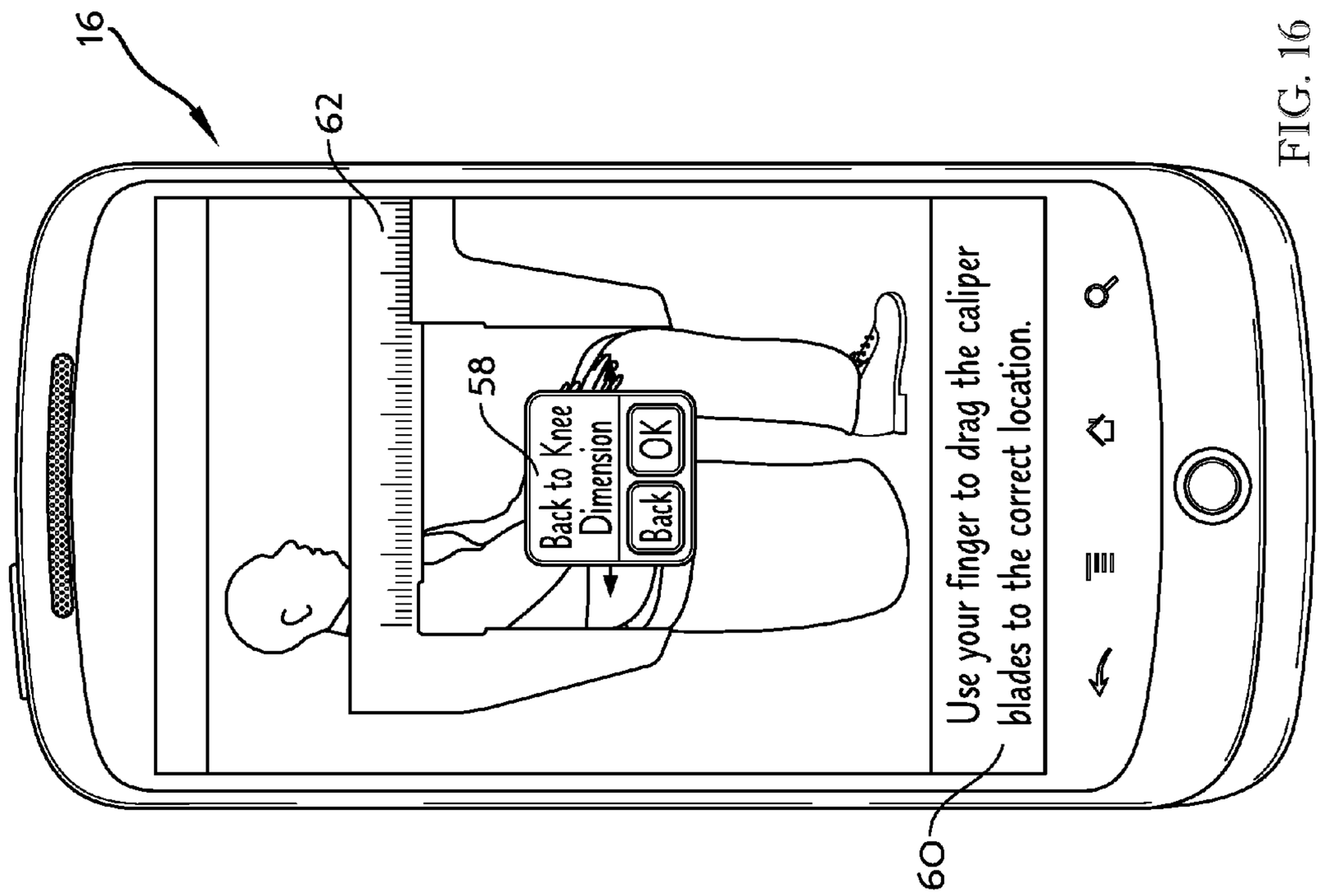

16
62
58
Back to Knee Dimension
Back
OK
Use your finger to drag the caliper blades to the correct location.
60

FIG. 16

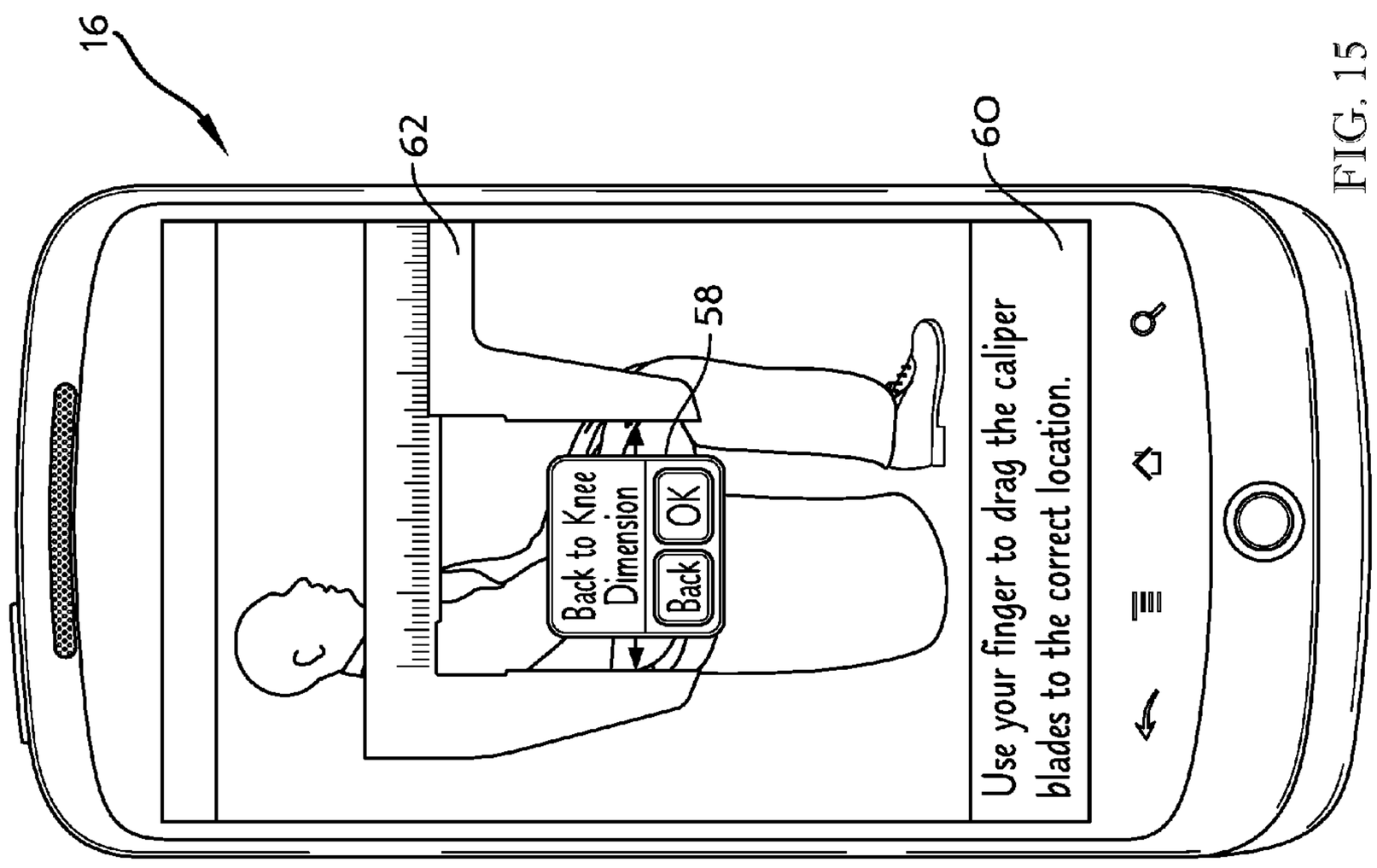

16
62
60
58
Back to Knee Dimension
Back
OK
Use your finger to drag the caliper blades to the correct location.

FIG. 15

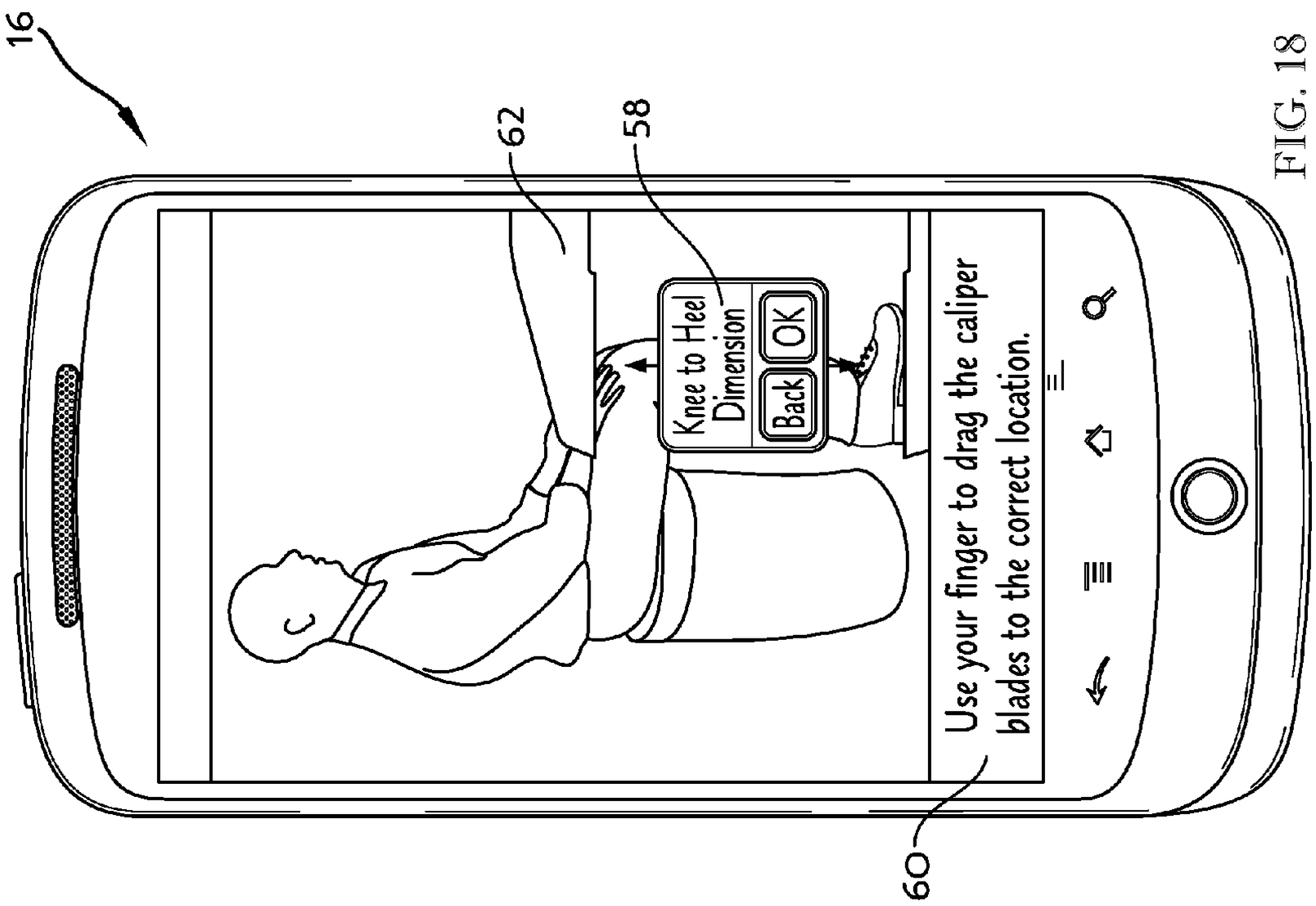

16
62
58
Knee to Heel Dimension
Back
OK
Use your finger to drag the caliper blades to the correct location.
60

FIG. 18

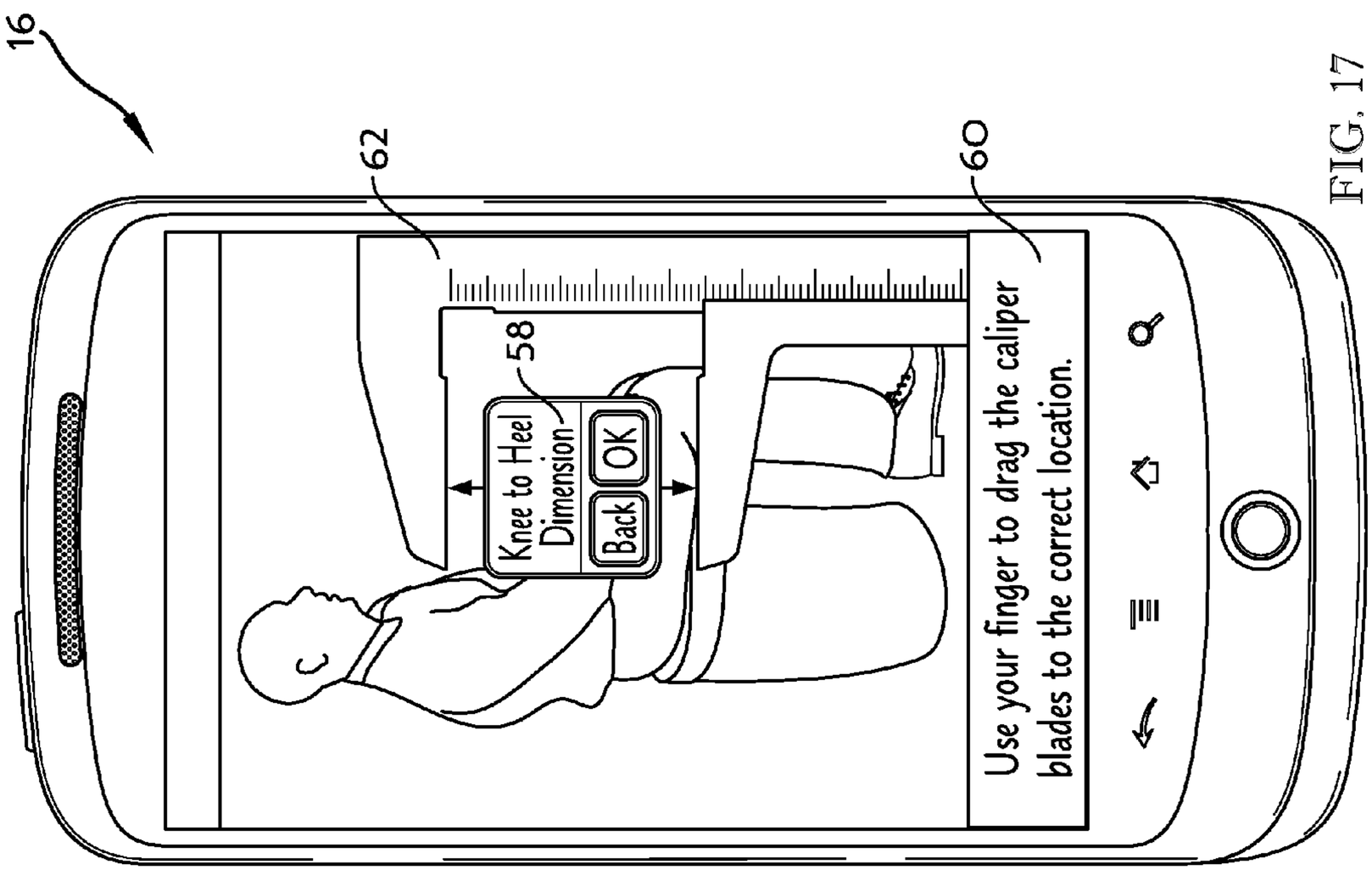

16
62
60
58
Knee to Heel Dimension
Back
OK
Use your finger to drag the caliper blades to the correct location.

FIG. 17

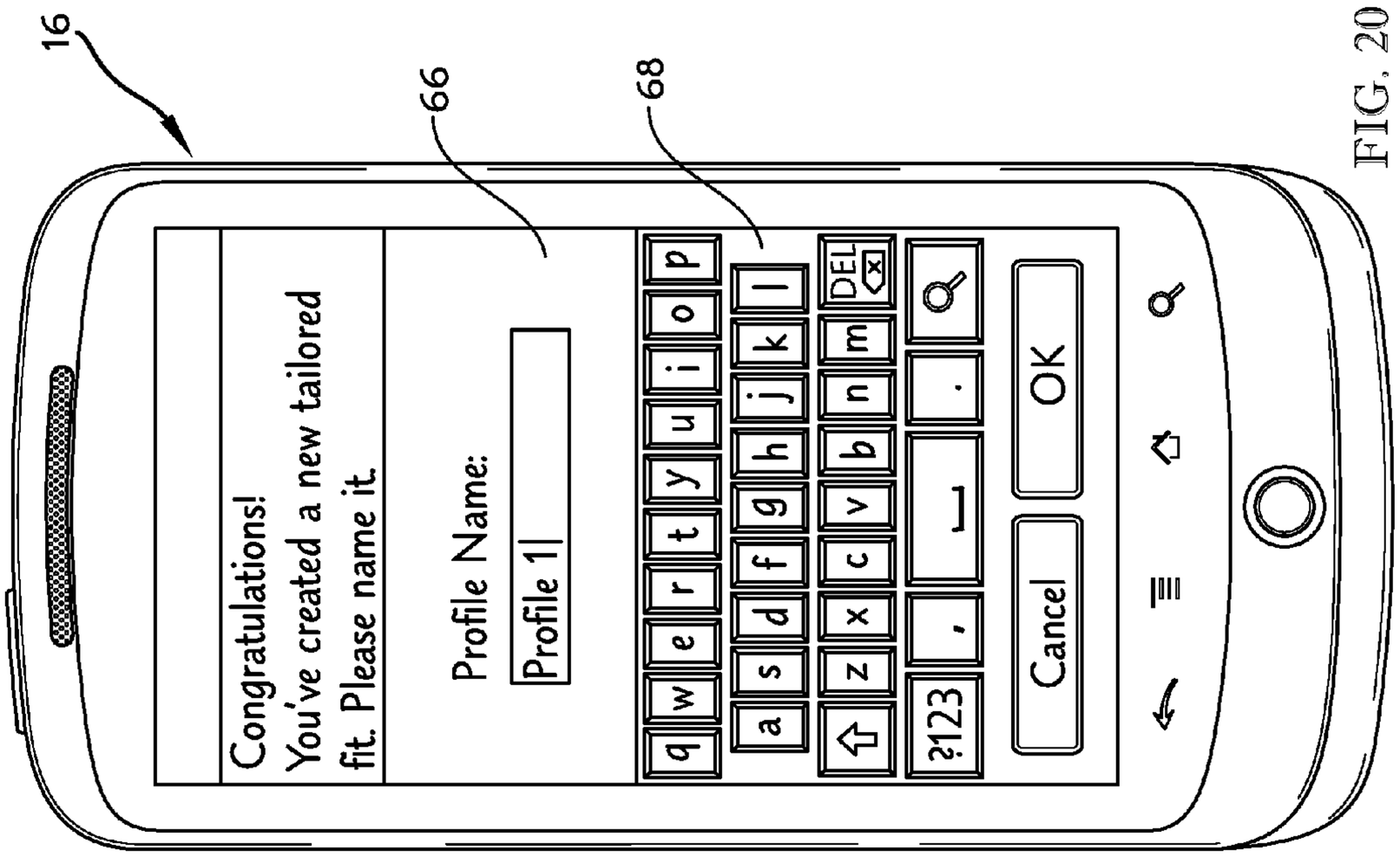

16
66
68
Congratulations!
You've created a new tailored fit. Please name it.
Profile Name:
Profile 1
Cancel
OK

FIG. 20

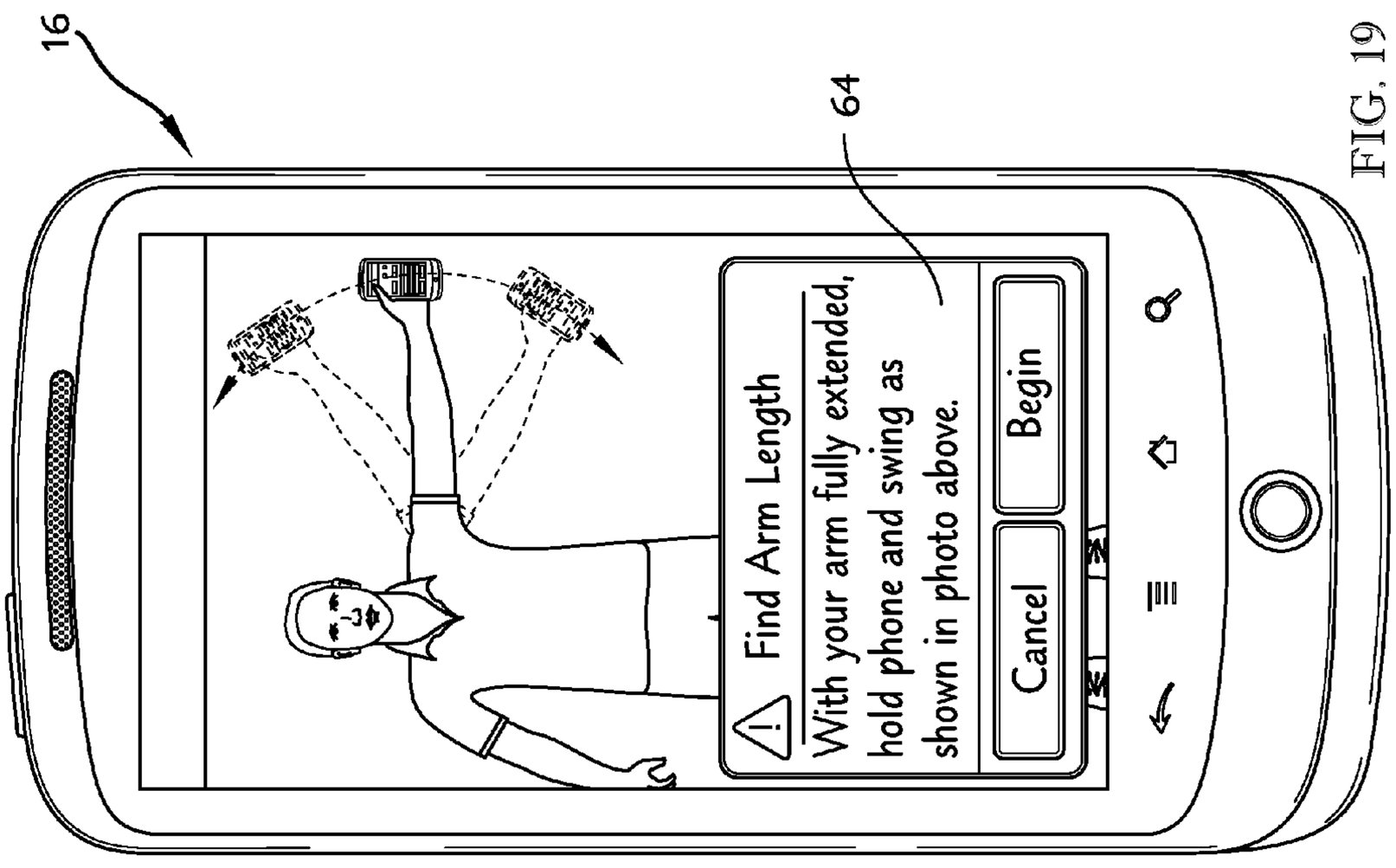

16
64
Find Arm Length
With your arm fully extended, hold phone and swing as shown in photo above.
Cancel
Begin

FIG. 19

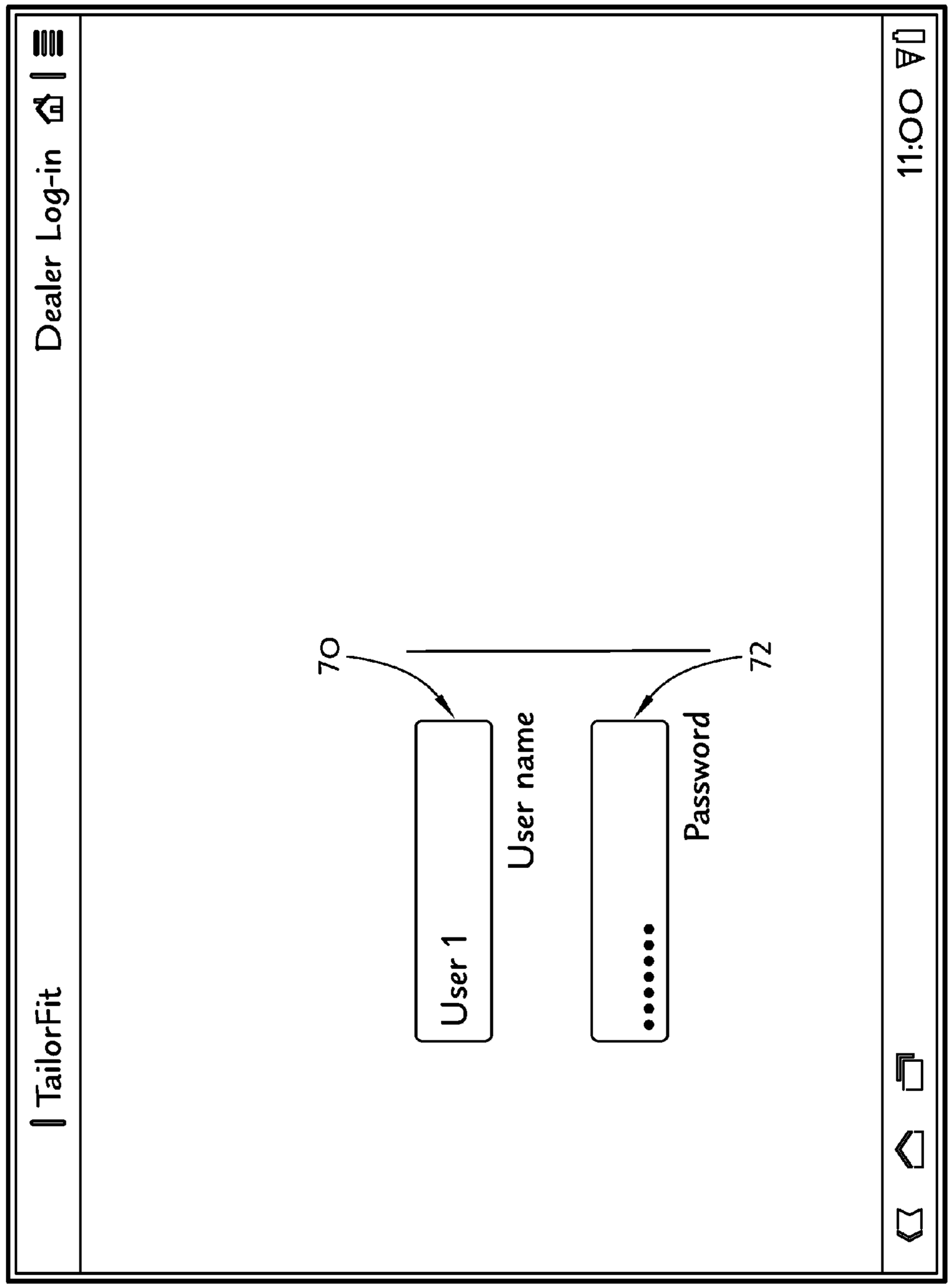


FIG. 21

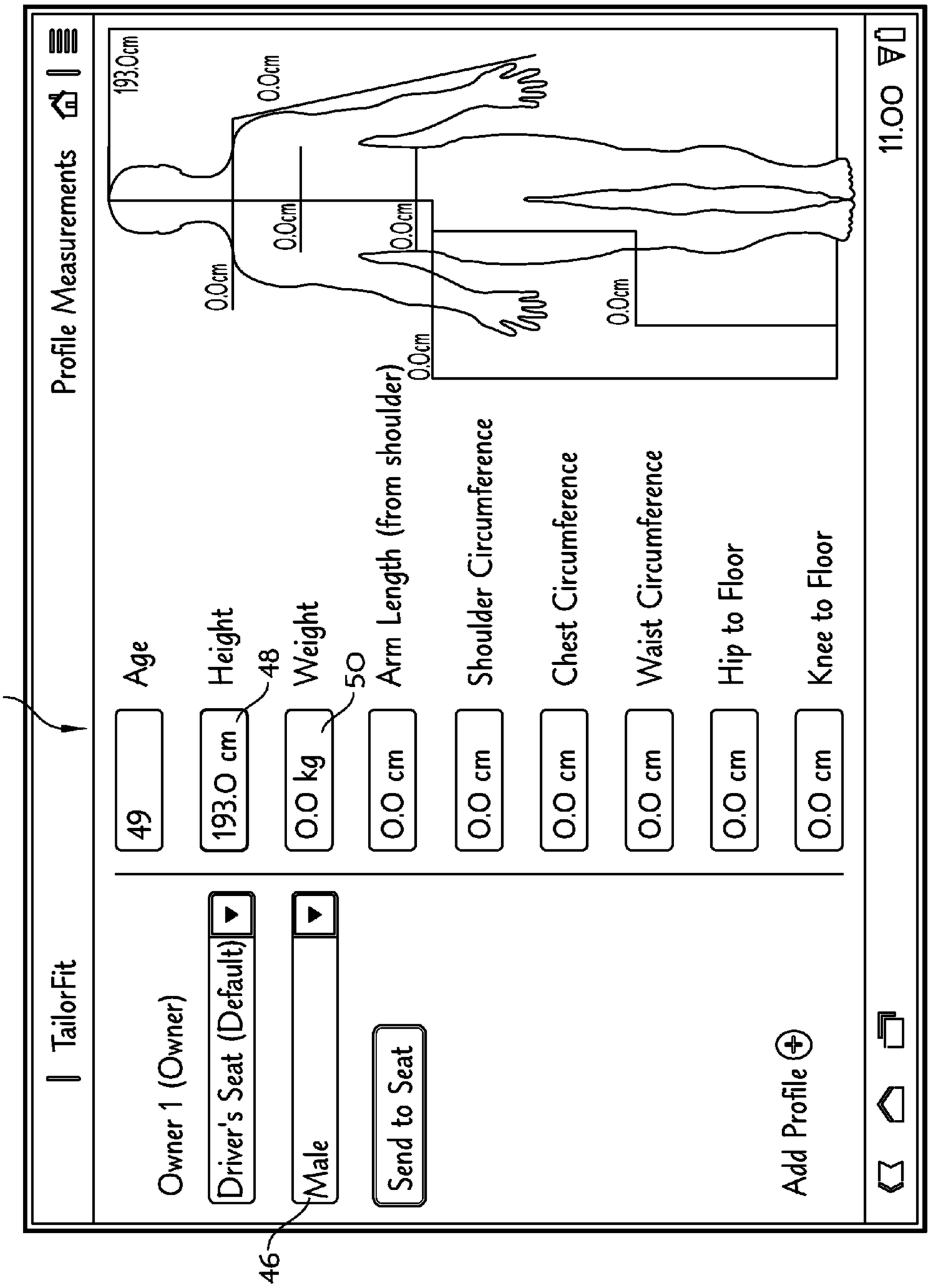

565
TailorFit
Profile Measurements
Owner 1 (Owner)
Driver's Seat (Default)
Male
46
Send to Seat
Age
49
Height
193.0 cm
48
Weight
0.0 kg
50
Arm Length (from shoulder)
0.0 cm
Shoulder Circumference
0.0 cm
Chest Circumference
0.0 cm
Waist Circumference
0.0 cm
Hip to Floor
0.0 cm
Knee to Floor
0.0 cm
Add Profile
193.0cm
0.0cm
0.0cm
0.0cm
0.0cm
0.0cm
11.00

FIG. 22

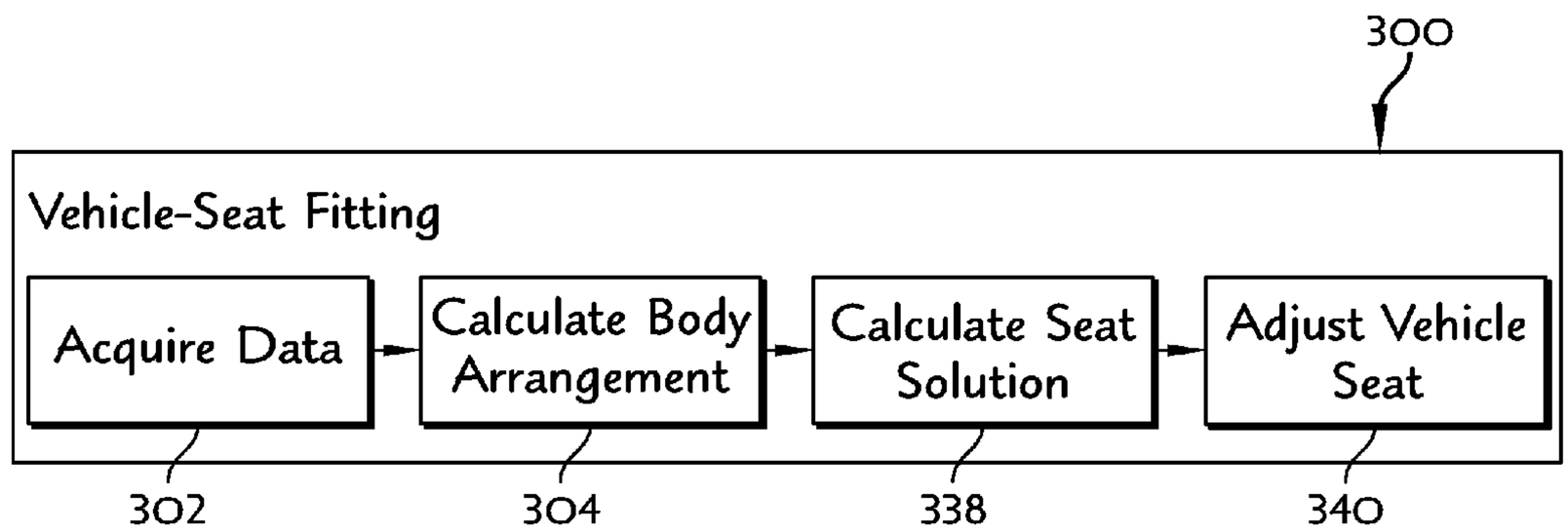

300
Vehicle-Seat Fitting
Acquire Data
Calculate Body Arrangement
Calculate Seat Solution
Adjust Vehicle Seat
302
304
338
340

FIG. 23

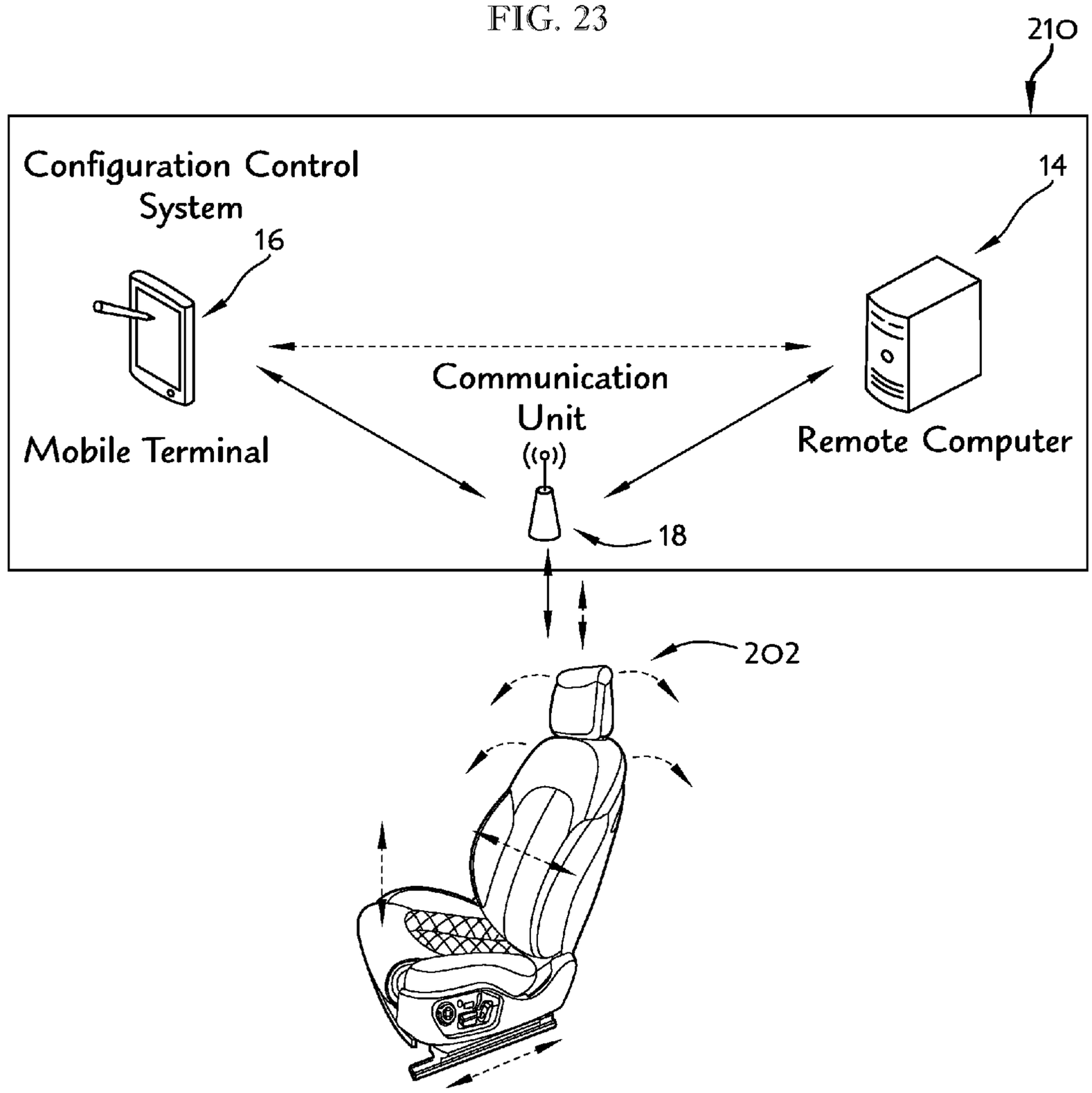

210
Configuration Control System
16
14
Communication Unit
Mobile Terminal
Remote Computer
18
202

FIG. 24

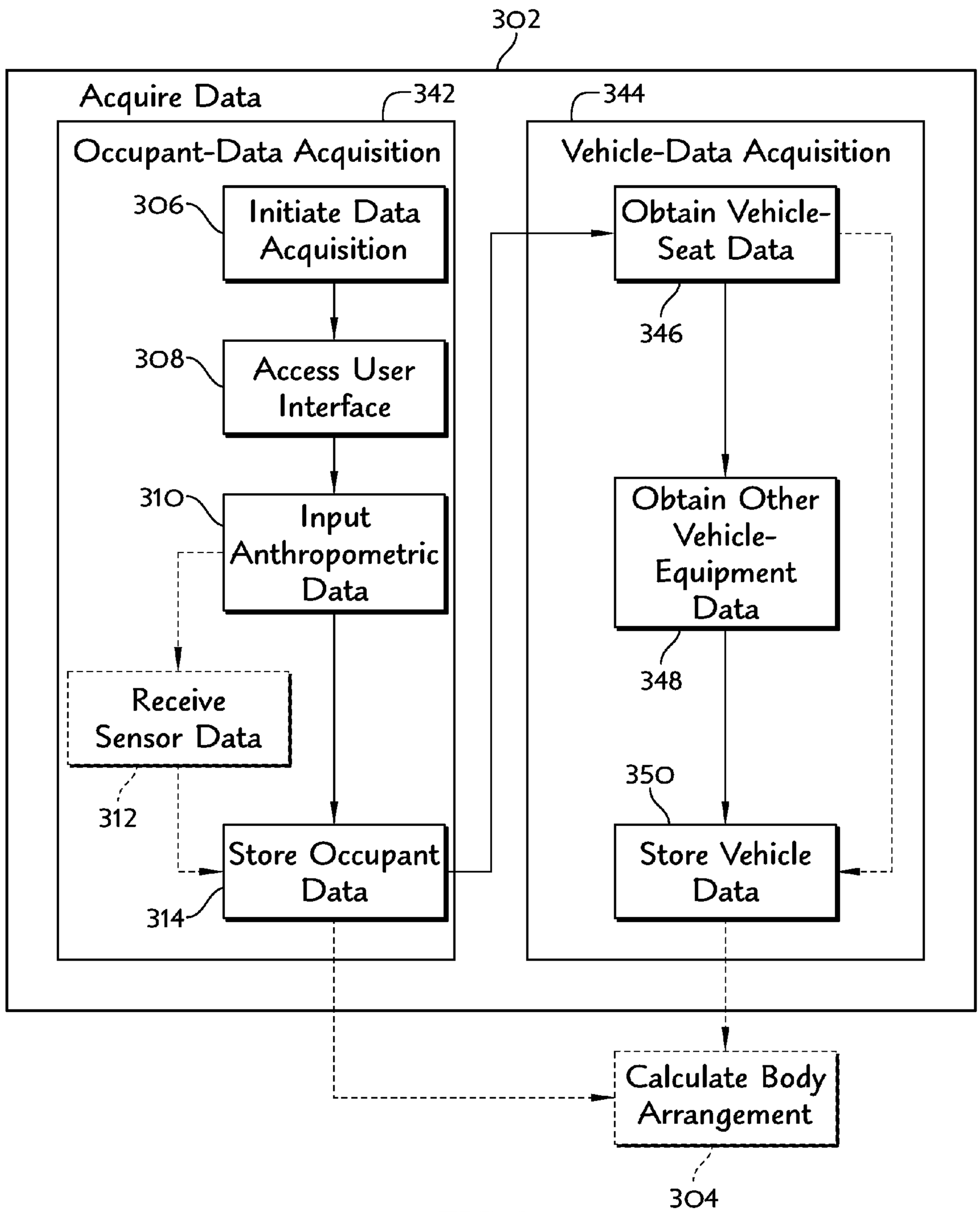

302
Acquire Data
342
344
Occupant-Data Acquisition
Vehicle-Data Acquisition
306
Initiate Data Acquisition
Obtain Vehicle-Seat Data
346
308
Access User Interface
310
Input Anthropometric Data
Obtain Other Vehicle-Equipment Data
348
Receive Sensor Data
312
350
Store Occupant Data
Store Vehicle Data
314
Calculate Body Arrangement
304

FIG. 25

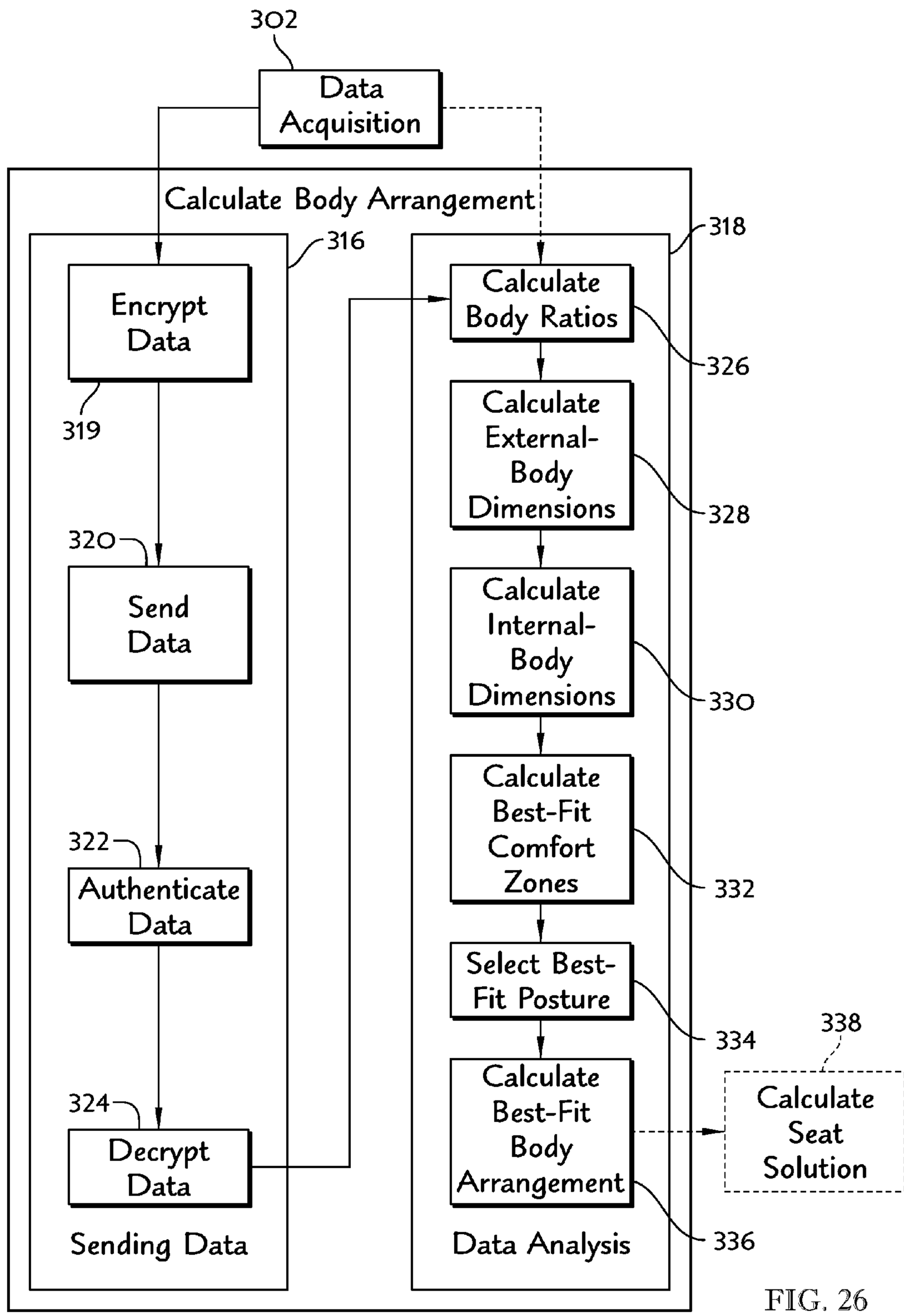

302
Data Acquisition
Calculate Body Arrangement
316
318
Encrypt Data
319
320
Send Data
322
Authenticate Data
324
Decrypt Data
Sending Data
Calculate Body Ratios
326
Calculate External-Body Dimensions
328
Calculate Internal-Body Dimensions
330
Calculate Best-Fit Comfort Zones
332
Select Best-Fit Posture
334
Calculate Best-Fit Body Arrangement
336
Data Analysis
338
Calculate Seat Solution

FIG. 26

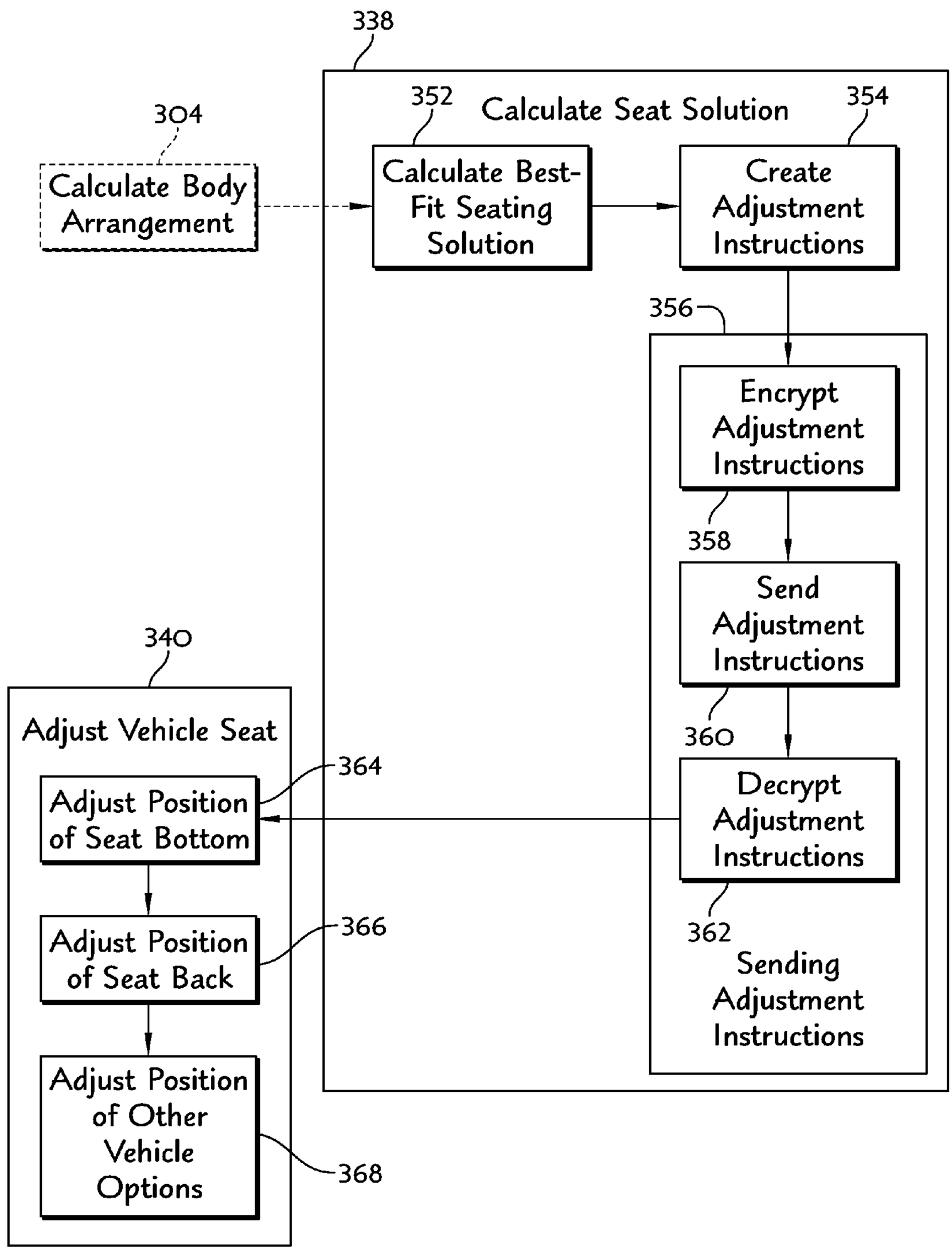

338
352
Calculate Seat Solution
354
304
Calculate Body Arrangement
Calculate Best-Fit Seating Solution
Create Adjustment Instructions
356
Encrypt Adjustment Instructions
358
Send Adjustment Instructions
340
360
Adjust Vehicle Seat
364
Adjust Position of Seat Bottom
Decrypt Adjustment Instructions
362
Adjust Position of Seat Back
366
Sending Adjustment Instructions
Adjust Position of Other Vehicle Options
368

FIG. 27

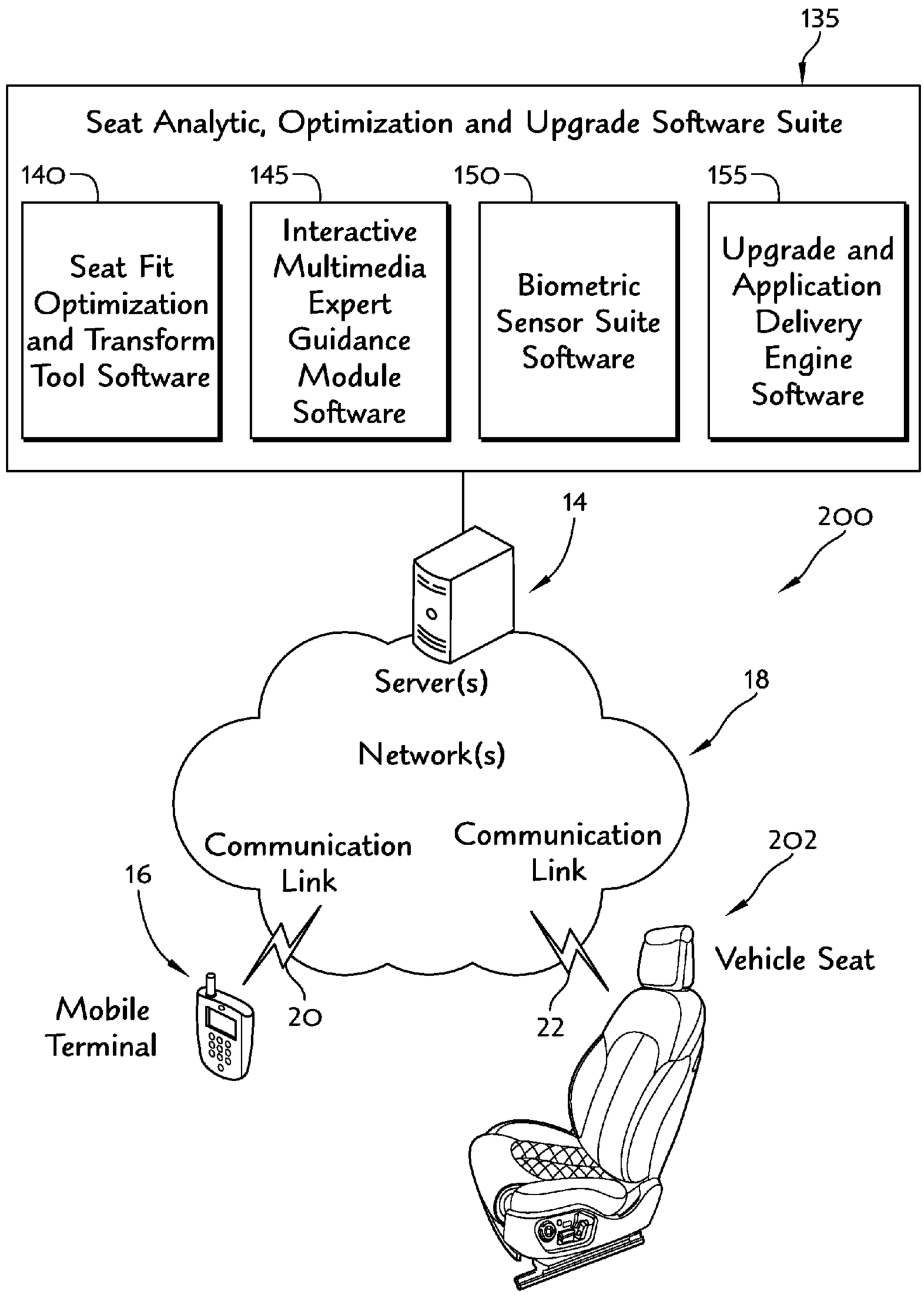

135
Seat Analytic, Optimization and Upgrade Software Suite
140
Seat Fit Optimization and Transform Tool Software
145
Interactive Multimedia Expert Guidance Module Software
150
Biometric Sensor Suite Software
155
Upgrade and Application Delivery Engine Software
14
200
Server(s)
18
Network(s)
Communication Link
Communication Link
202
16
Vehicle Seat
Mobile Terminal
20
22

FIG. 28

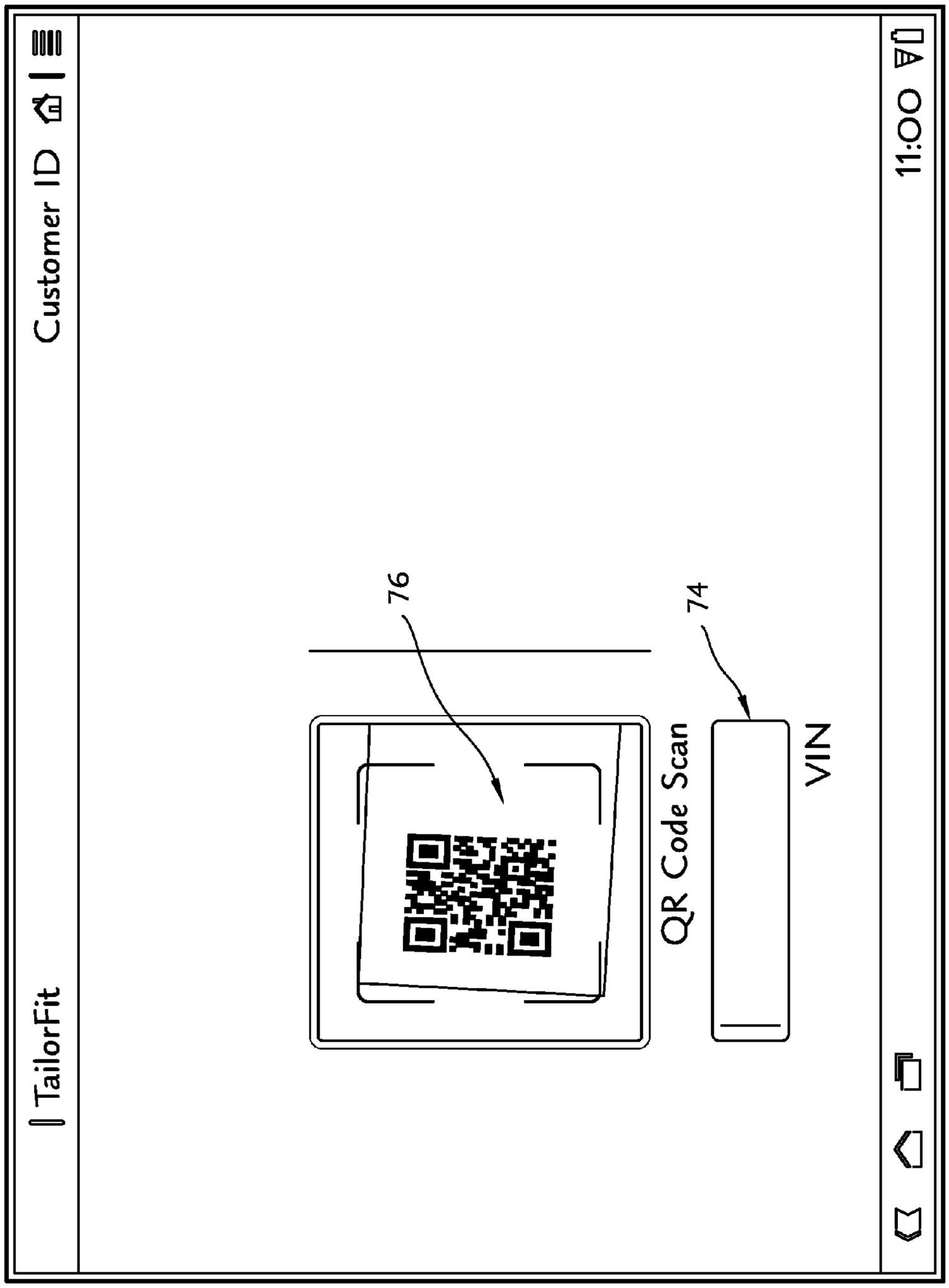


FIG. 29

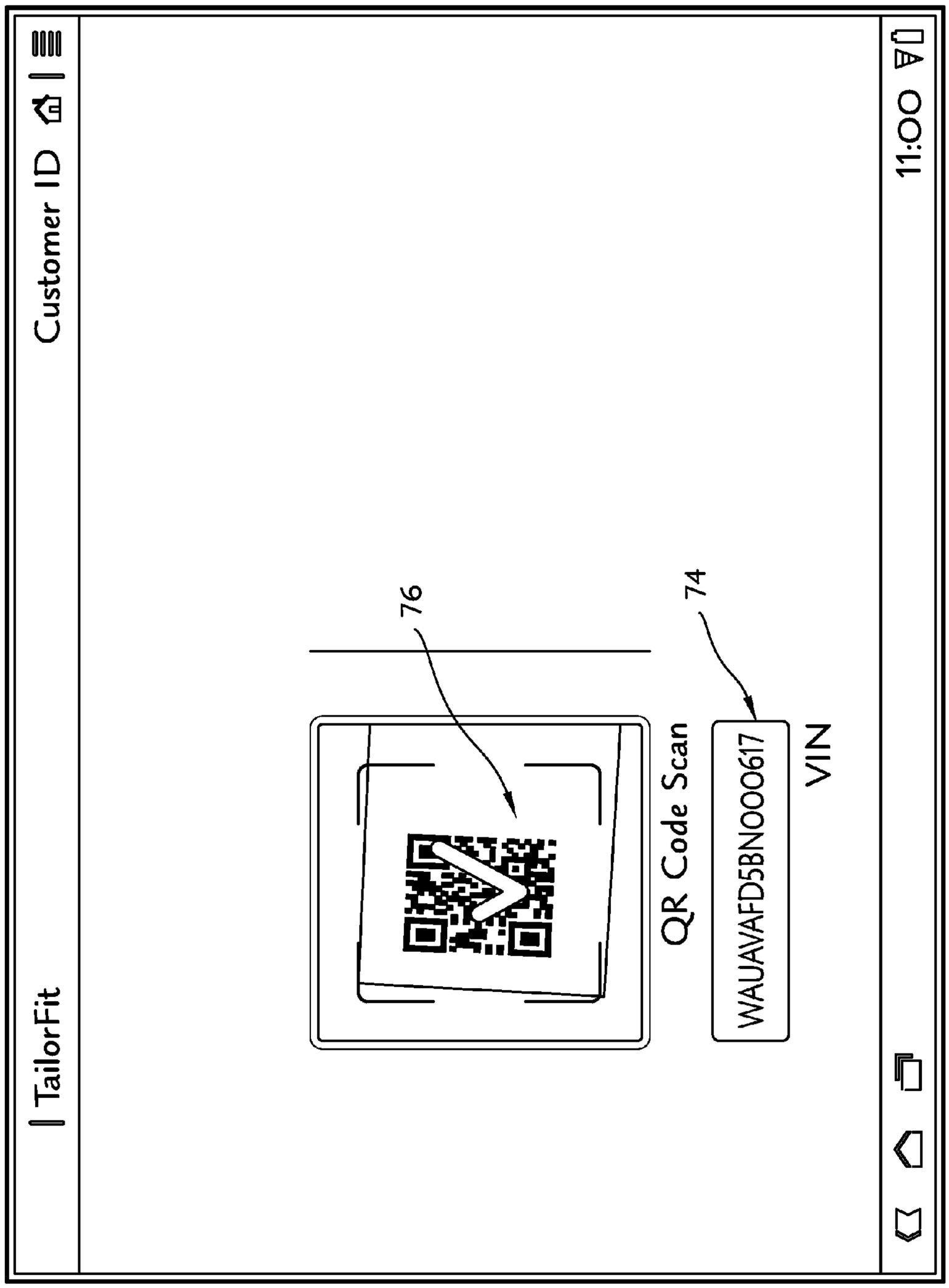

TailorFit
Customer ID
11:00
76
74
QR Code Scan
WAUAVAFD5BN000617
VIN

FIG. 30

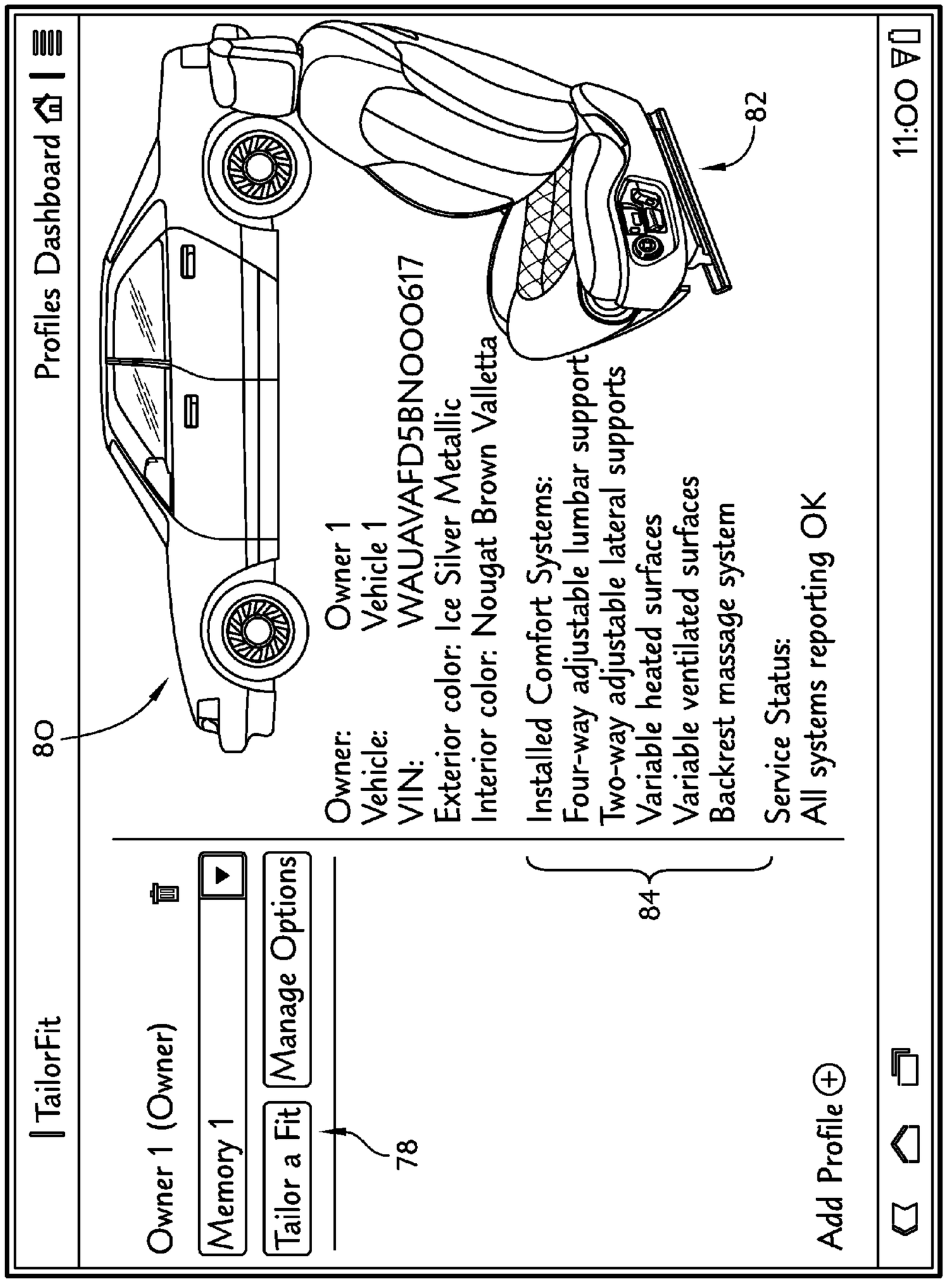

TailorFit
Profiles Dashboard
11:00
80
82
Owner 1 (Owner)
Memory 1
Tailor a Fit
Manage Options
78
Owner: Owner 1
Vehicle: Vehicle 1
VIN: WAUAVAFD5BN000617
Exterior color: Ice Silver Metallic
Interior color: Nougat Brown Valletta
Installed Comfort Systems:
Four-way adjustable lumbar support
Two-way adjustable lateral supports
Variable heated surfaces
Variable ventilated surfaces
Backrest massage system
84
Service Status:
All systems reporting OK
Add Profile

FIG. 31

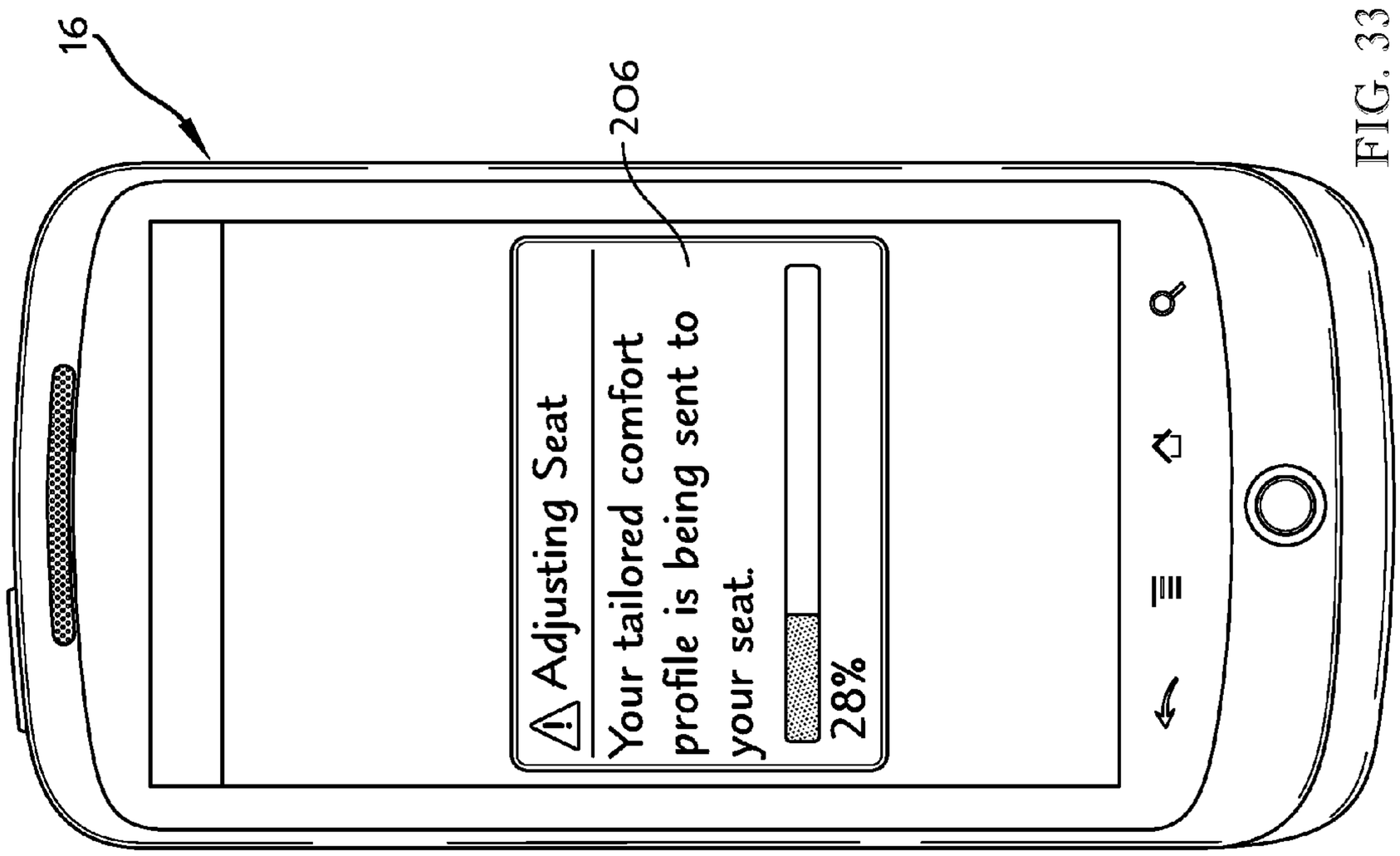

16
206
Adjusting Seat
Your tailored comfort profile is being sent to your seat.
28%

FIG. 33

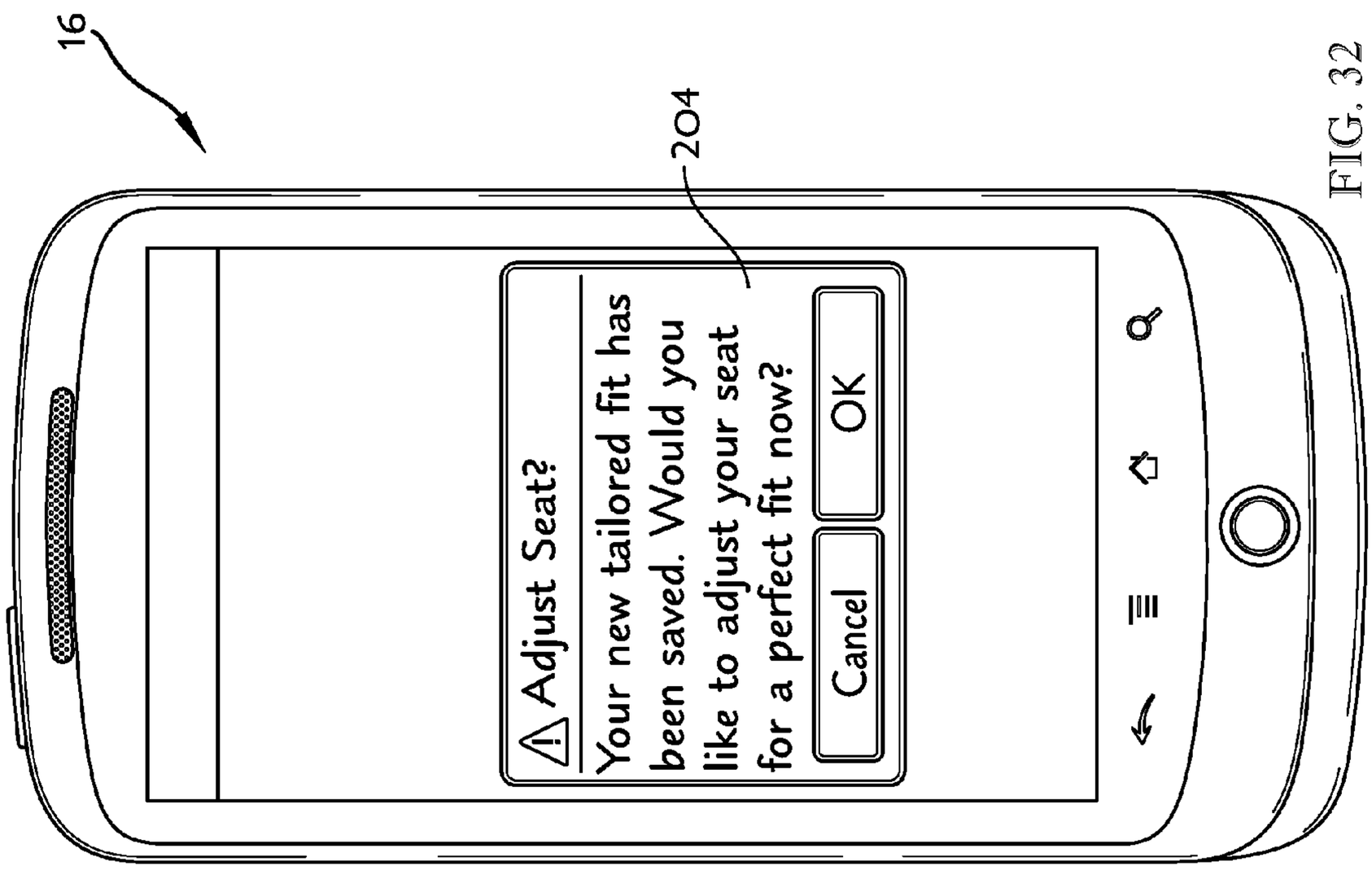

16
204
Adjust Seat?
Your new tailored fit has been saved. Would you like to adjust your seat for a perfect fit now?
Cancel
OK

FIG. 32

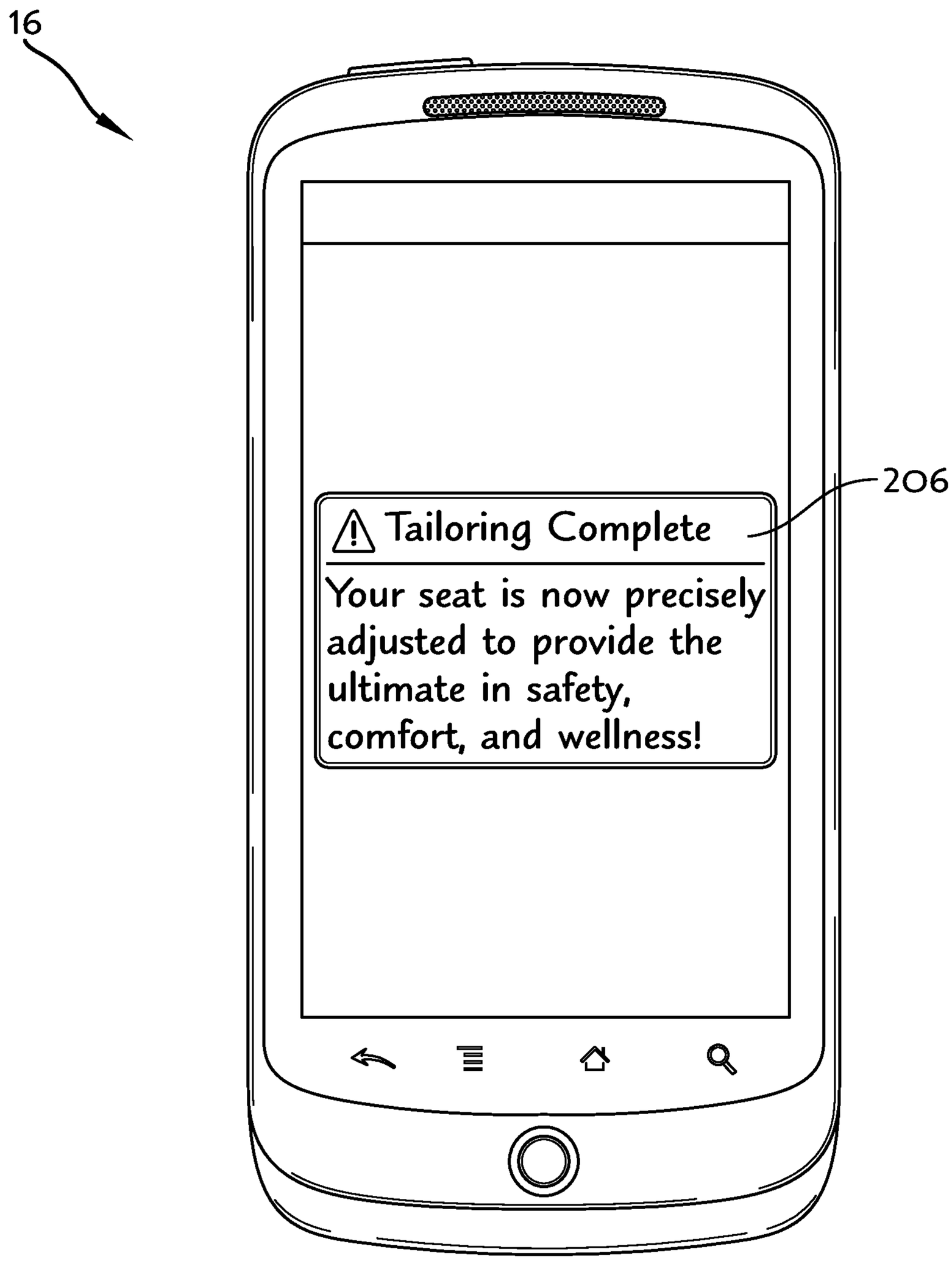

16
206
Tailoring Complete
Your seat is now precisely adjusted to provide the ultimate in safety, comfort, and wellness!

FIG. 34

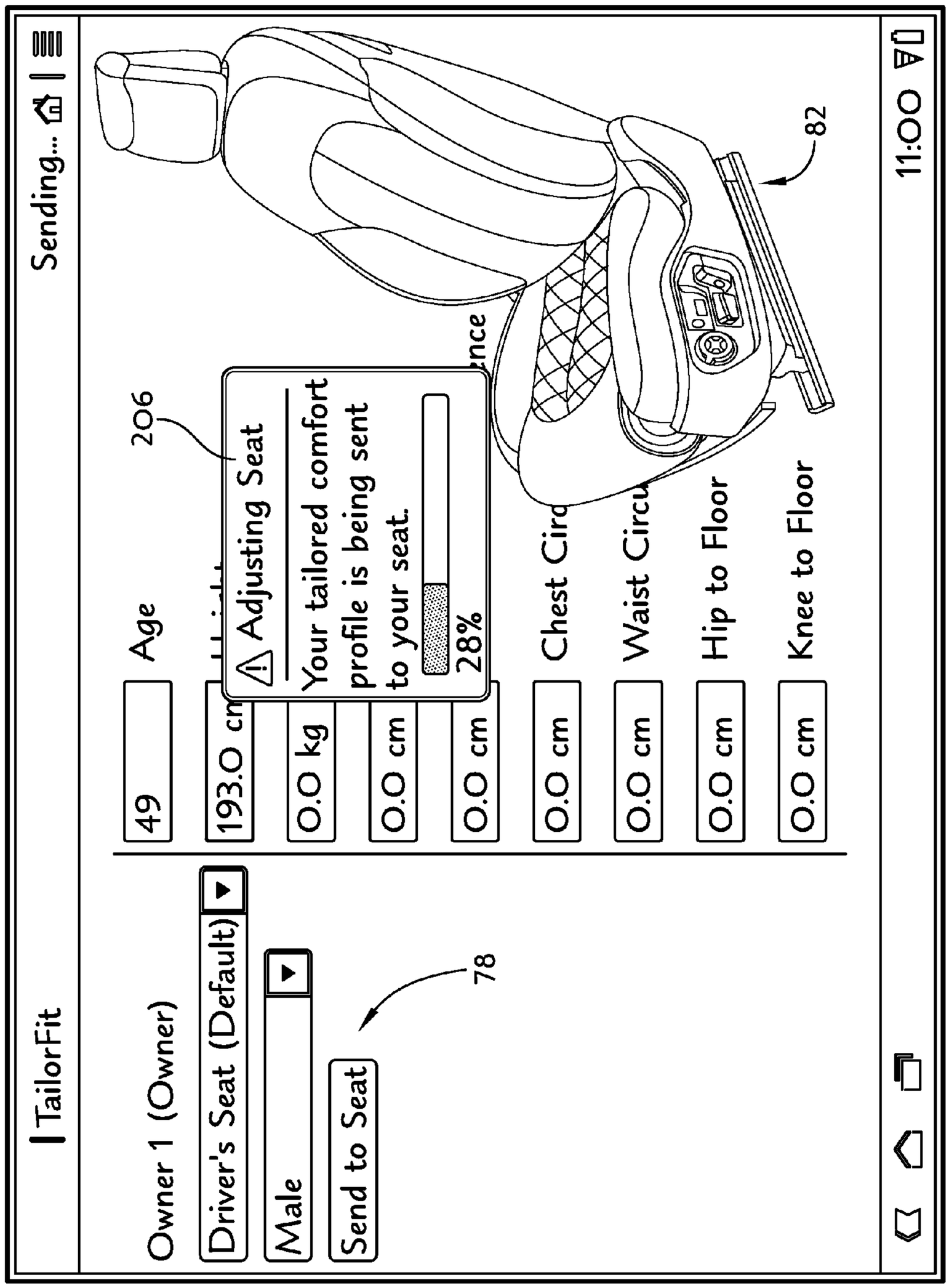

TailorFit
Sending...
11:00
Owner 1 (Owner)
Driver's Seat (Default)
Male
Send to Seat
78
Age
49
193.0 cm
0.0 kg
0.0 cm
0.0 cm
0.0 cm
0.0 cm
0.0 cm
0.0 cm
Chest Circ
Waist Circu
Hip to Floor
Knee to Floor
206
Adjusting Seat
Your tailored comfort profile is being sent to your seat.
28%
82

FIG. 35

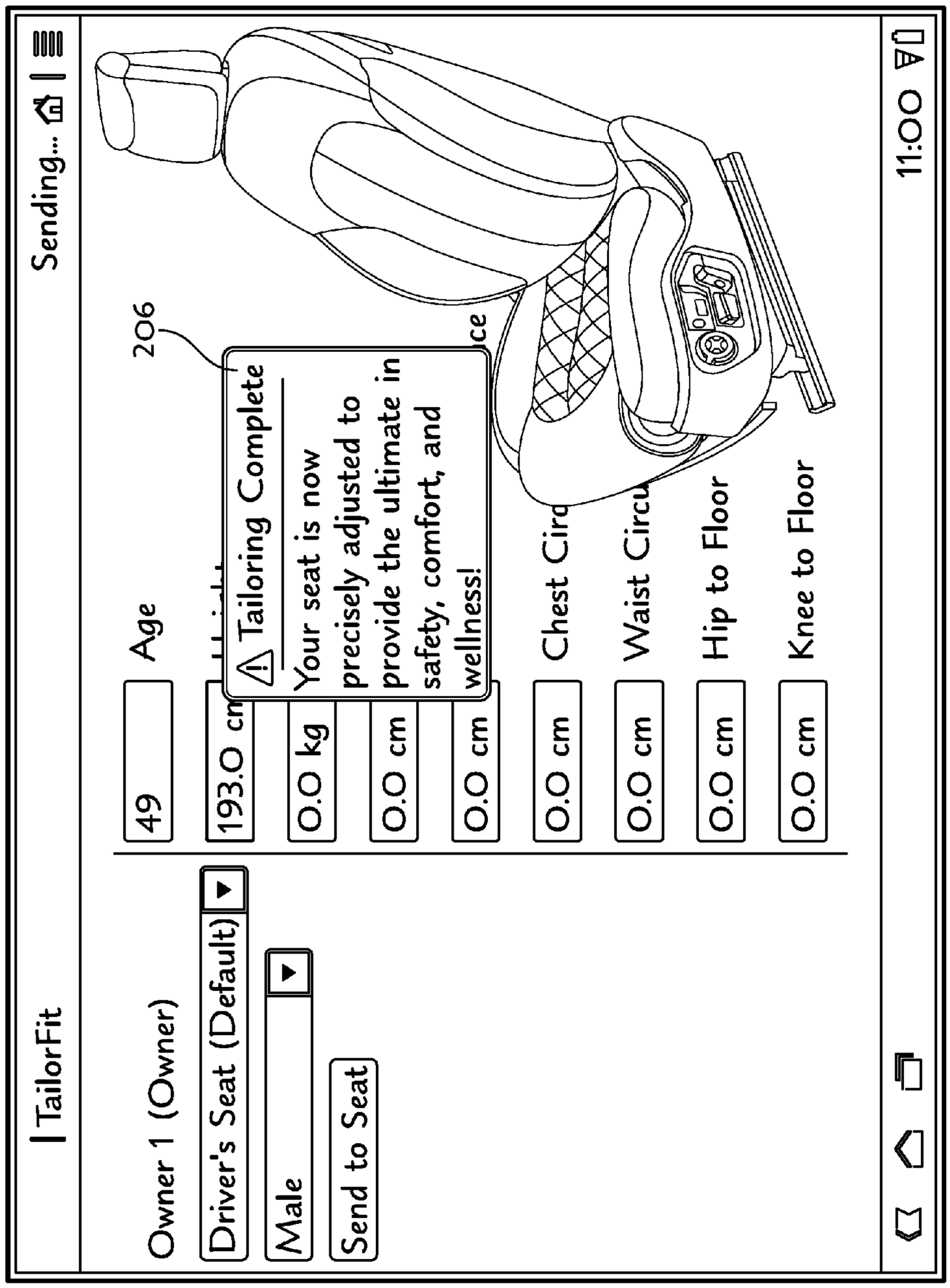

TailorFit
Sending...
11:00
Owner 1 (Owner)
Driver's Seat (Default)
Male
Send to Seat
Age
49
193.0 cm
0.0 kg
0.0 cm
0.0 cm
0.0 cm
0.0 cm
0.0 cm
0.0 cm
Chest Circ
Waist Circu
Hip to Floor
Knee to Floor
206
Tailoring Complete
Your seat is now precisely adjusted to provide the ultimate in safety, comfort, and wellness!

FIG. 36

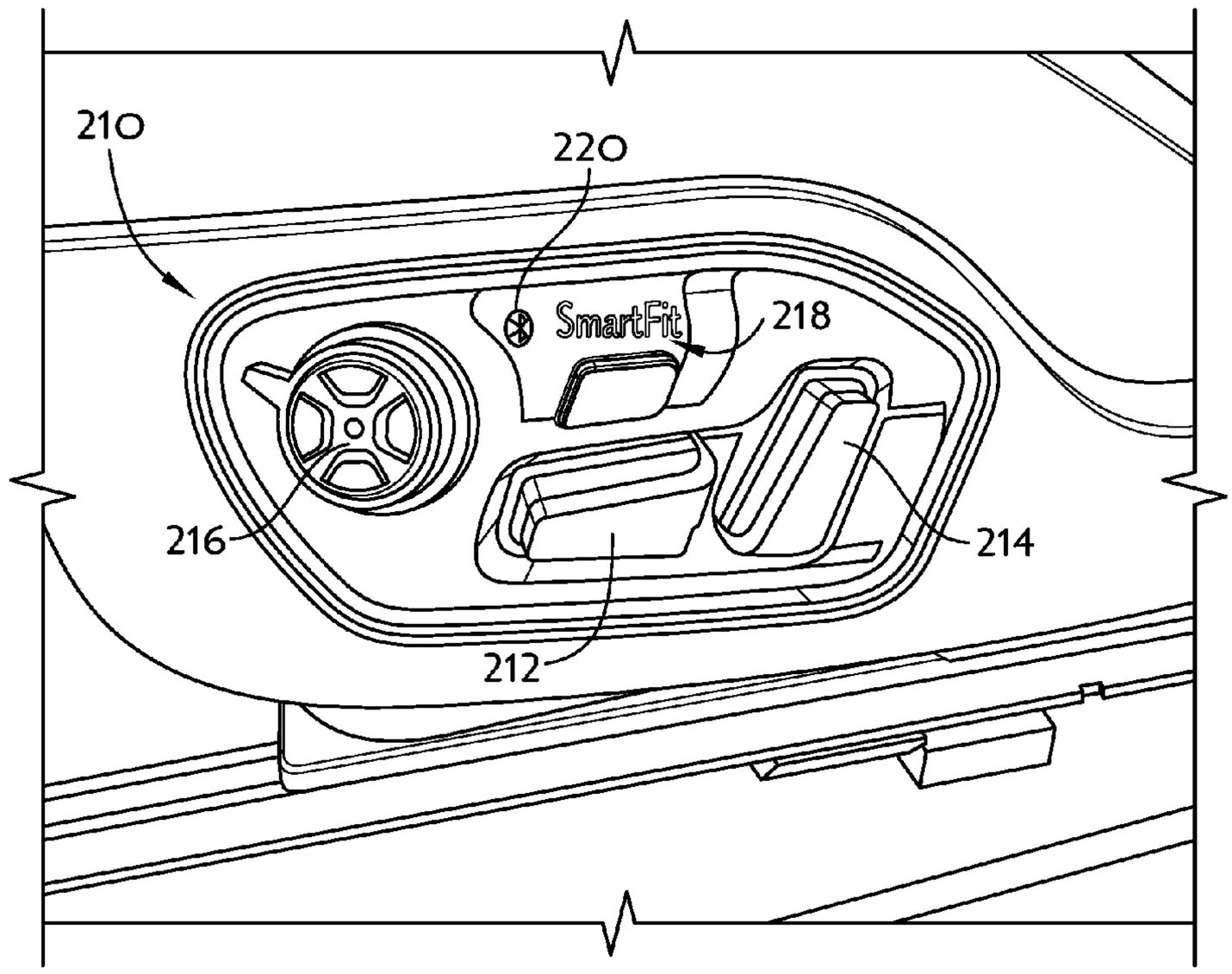

210
220
SmartFit
218
216
214
212

FIG. 37

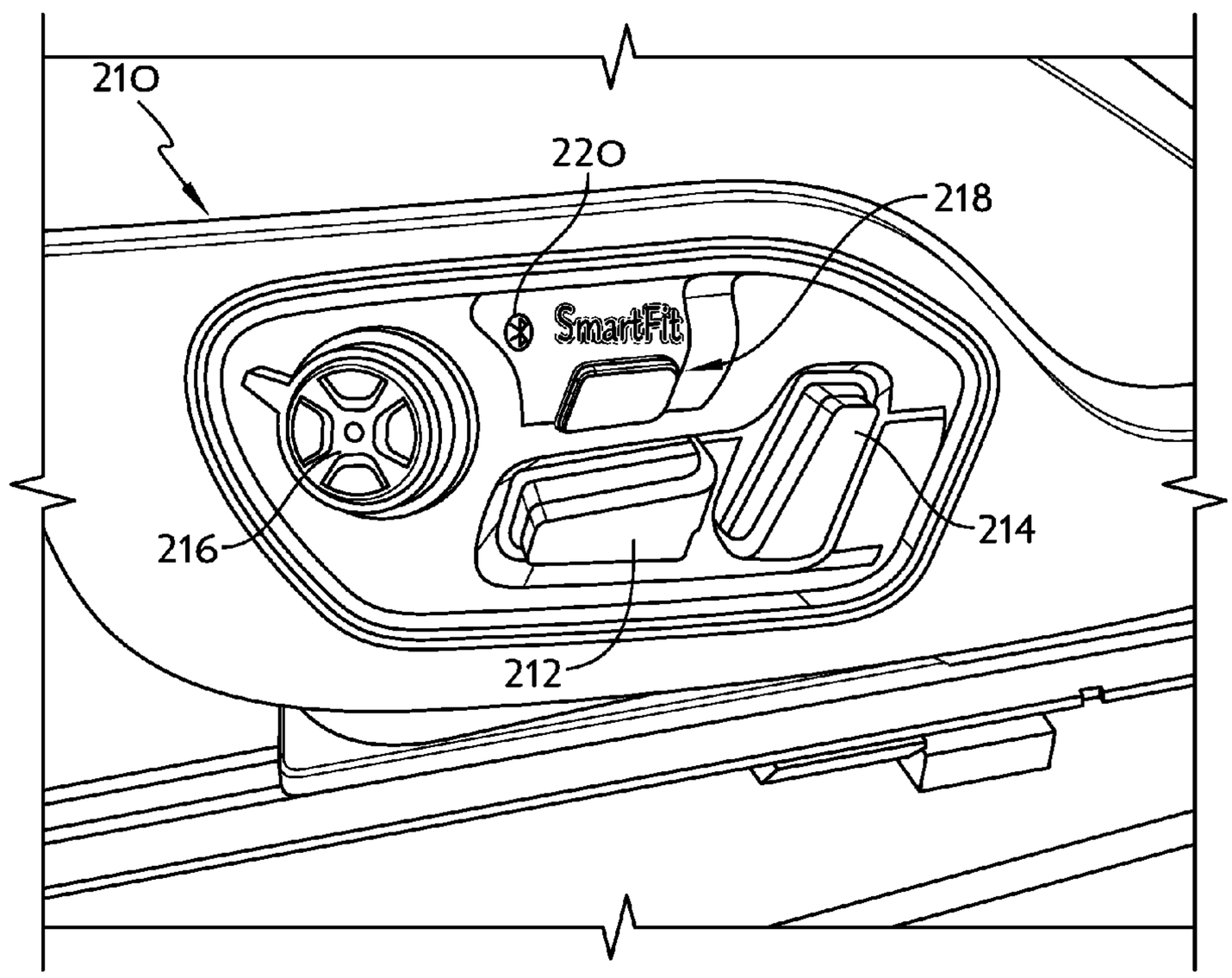

210
220
218
SmartFit
216
214
212

FIG. 38

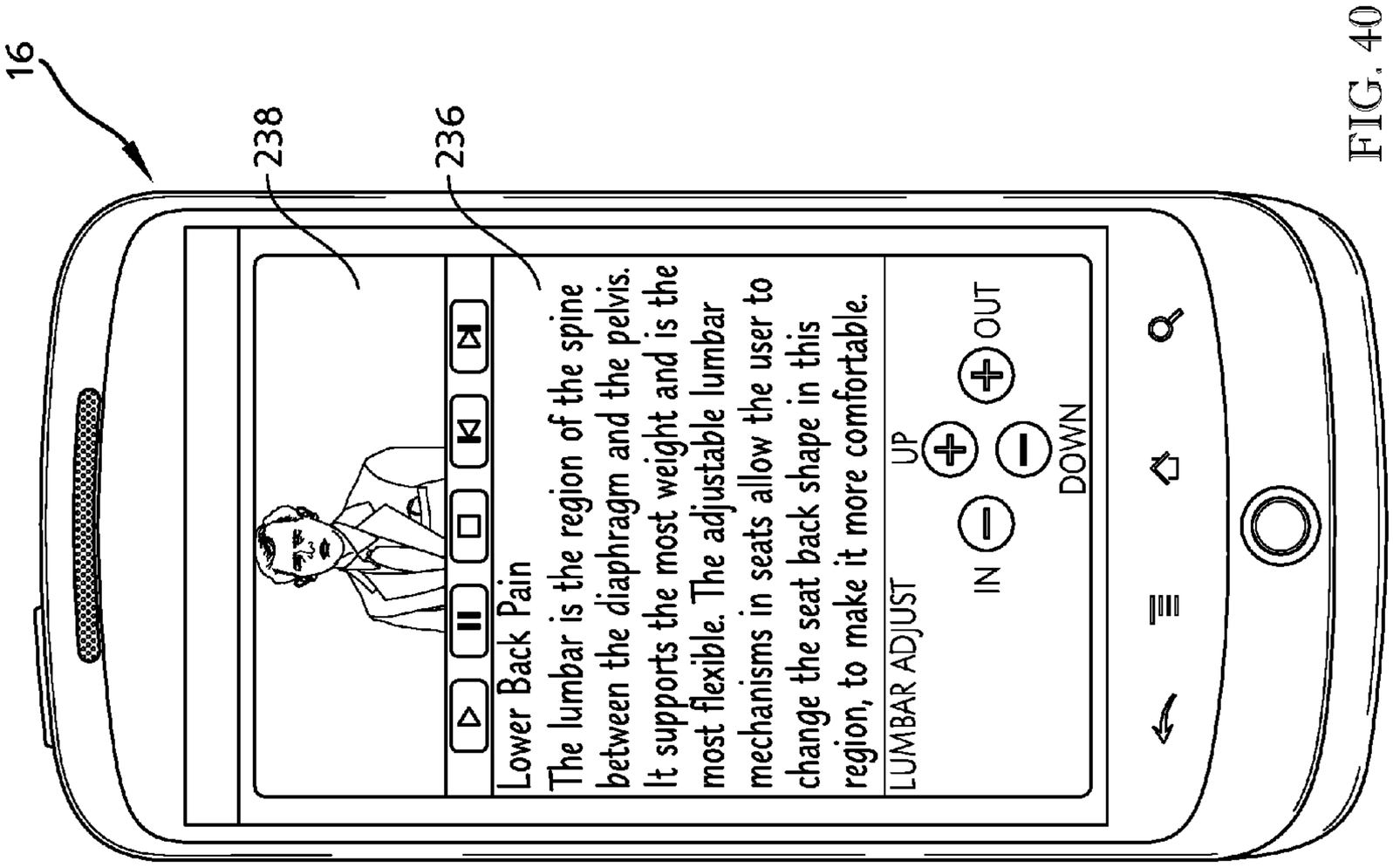

16
238
236
Lower Back Pain
The lumbar is the region of the spine between the diaphragm and the pelvis. It supports the most weight and is the most flexible. The adjustable lumbar mechanisms in seats allow the user to change the seat back shape in this region, to make it more comfortable.
LUMBAR ADJUST
UP
IN
OUT
DOWN

FIG. 40

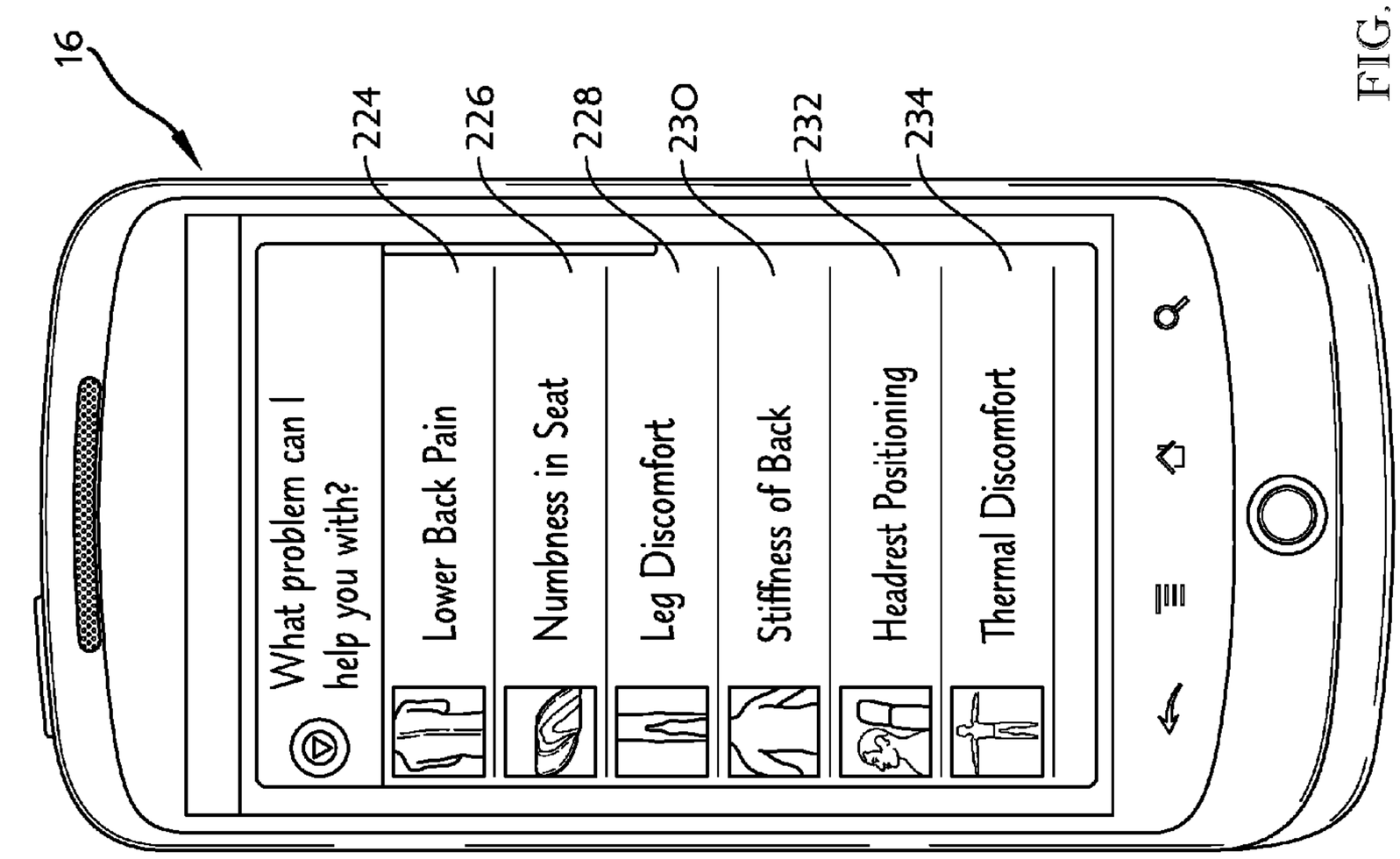

16
224
226
228
230
232
234
What problem can I help you with?
Lower Back Pain
Numbness in Seat
Leg Discomfort
Stiffness of Back
Headrest Positioning
Thermal Discomfort

FIG. 39

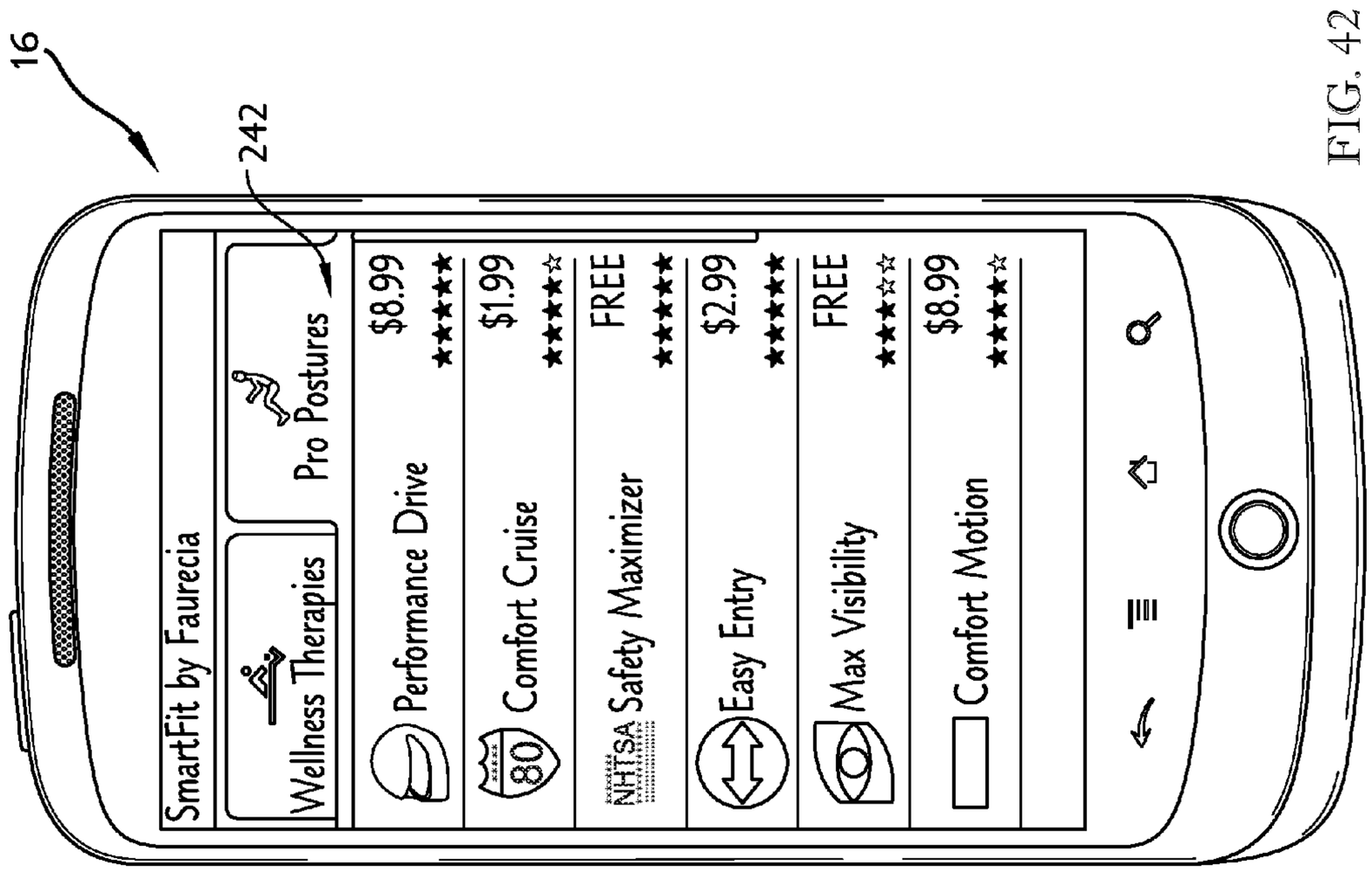

16
242
SmartFit by Faurecia
Wellness Therapies
Pro Postures
Performance Drive
$8.99
Comfort Cruise
$1.99
Safety Maximizer
FREE
Easy Entry
$2.99
Max Visibility
FREE
Comfort Motion
$8.99

FIG. 42

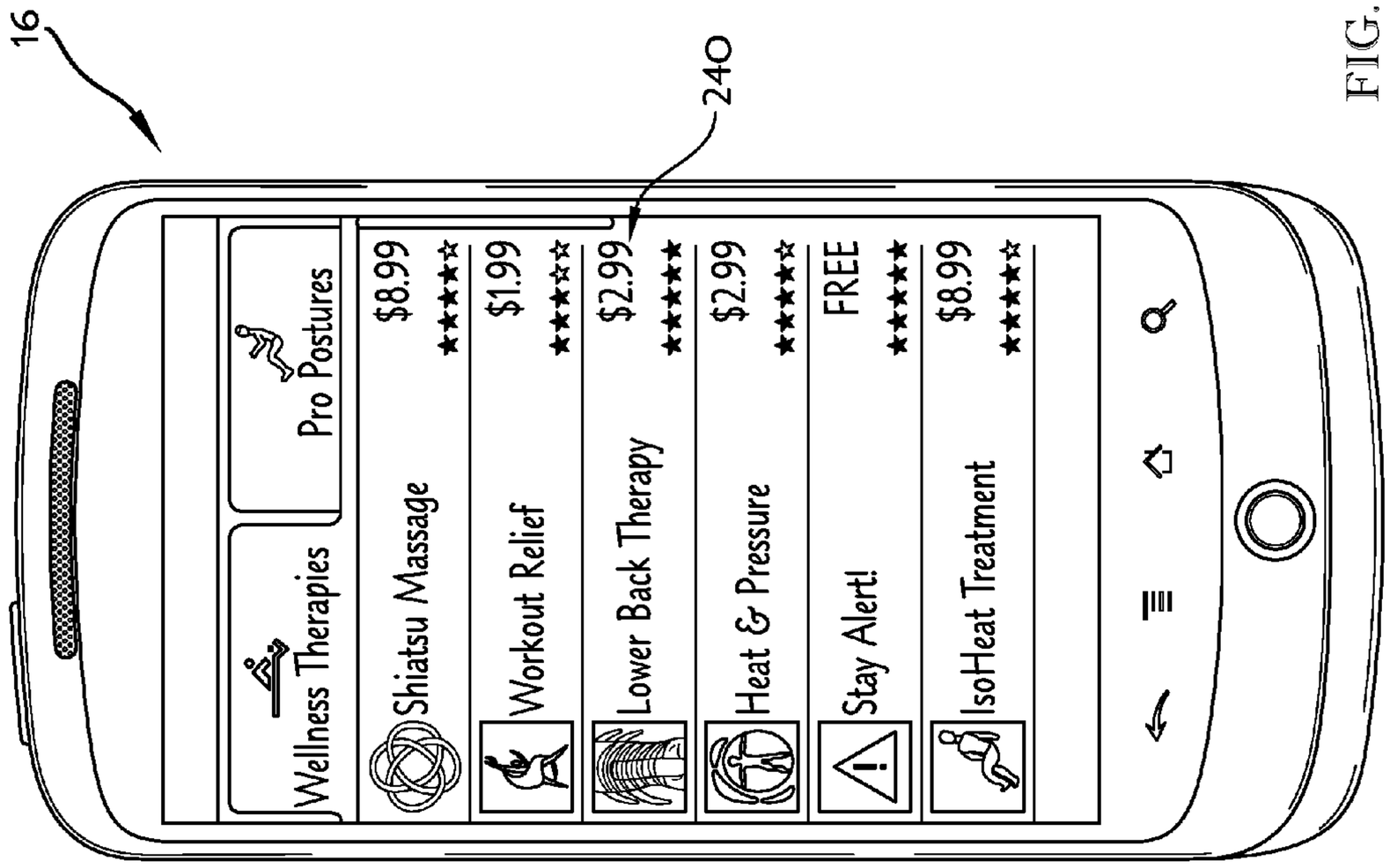

16
240
Wellness Therapies
Pro Postures
Shiatsu Massage
$8.99
Workout Relief
$1.99
Lower Back Therapy
$2.99
Heat & Pressure
$2.99
Stay Alert!
FREE
IsoHeat Treatment
$8.99

FIG. 41

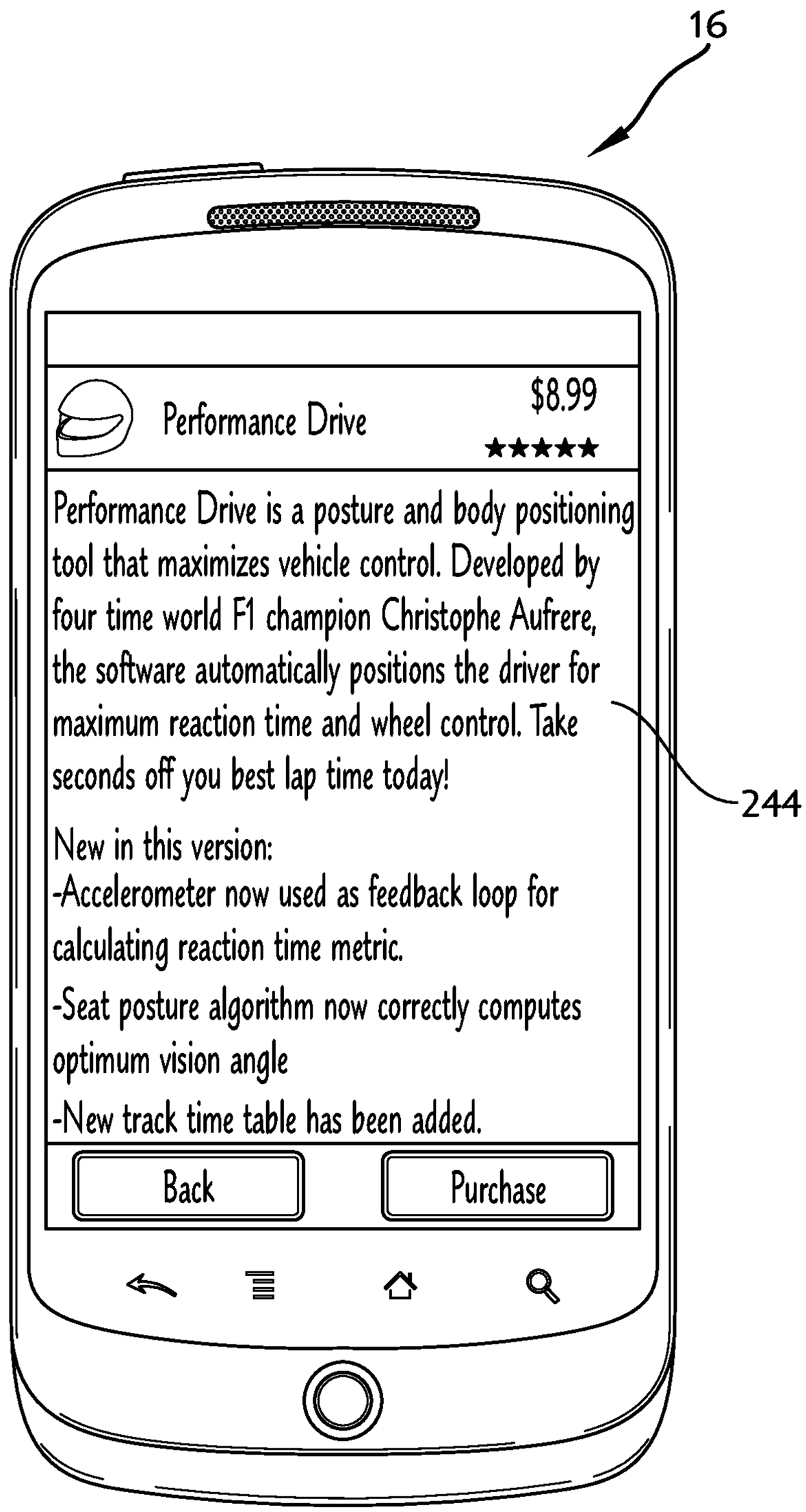

16
Performance Drive
$8.99
★★★★★
Performance Drive is a posture and body positioning tool that maximizes vehicle control. Developed by four time world F1 champion Christophe Aufrere, the software automatically positions the driver for maximum reaction time and wheel control. Take seconds off you best lap time today!
New in this version:
-Accelerometer now used as feedback loop for calculating reaction time metric.
-Seat posture algorithm now correctly computes optimum vision angle
-New track time table has been added.
Back
Purchase
244

FIG. 43

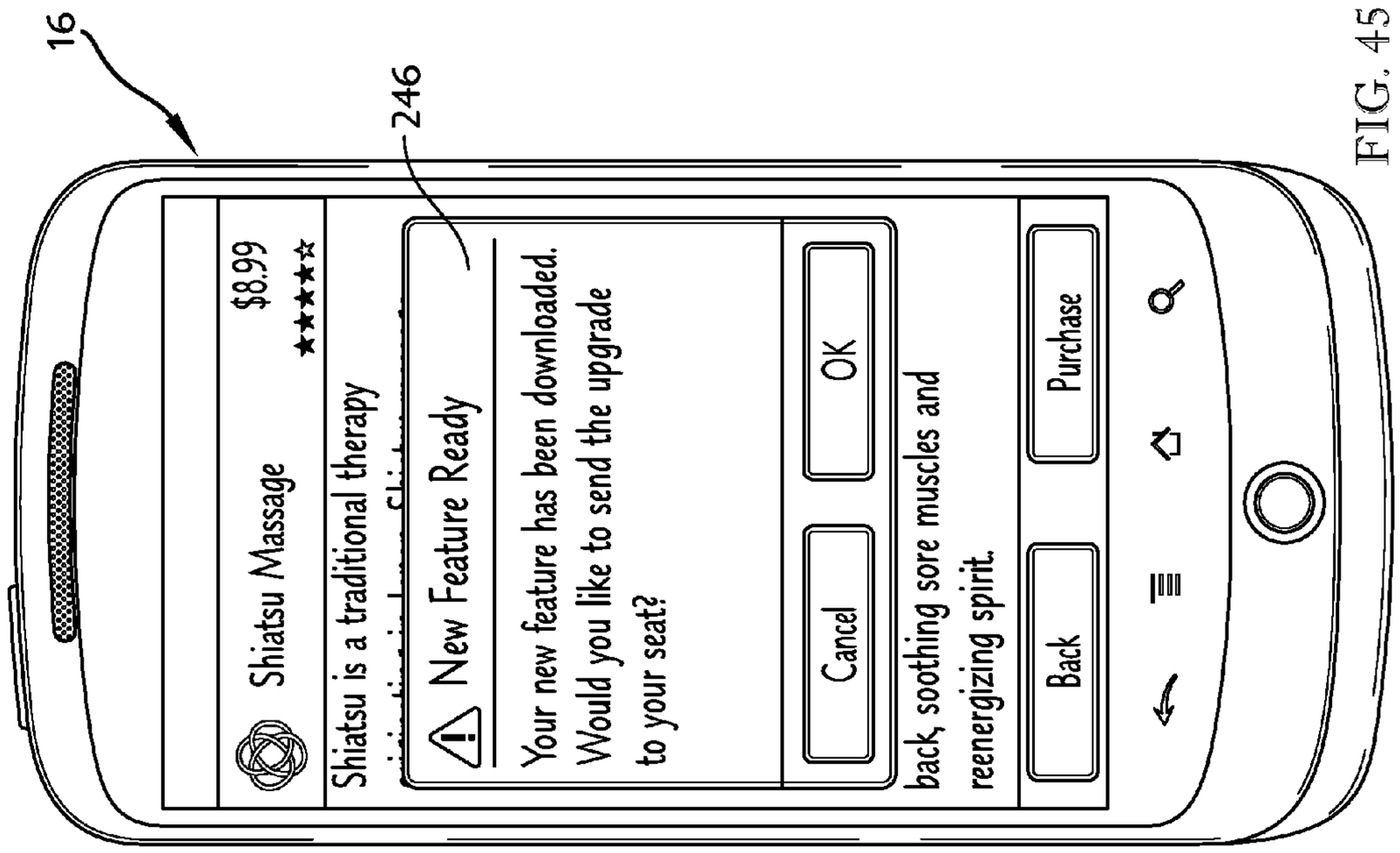

16
246
Shiatsu Massage
$8.99
Shiatsu is a traditional therapy
New Feature Ready
Your new feature has been downloaded.
Would you like to send the upgrade
to your seat?
Cancel
OK
back, soothing sore muscles and
reenergizing spirit.
Back
Purchase

FIG. 45

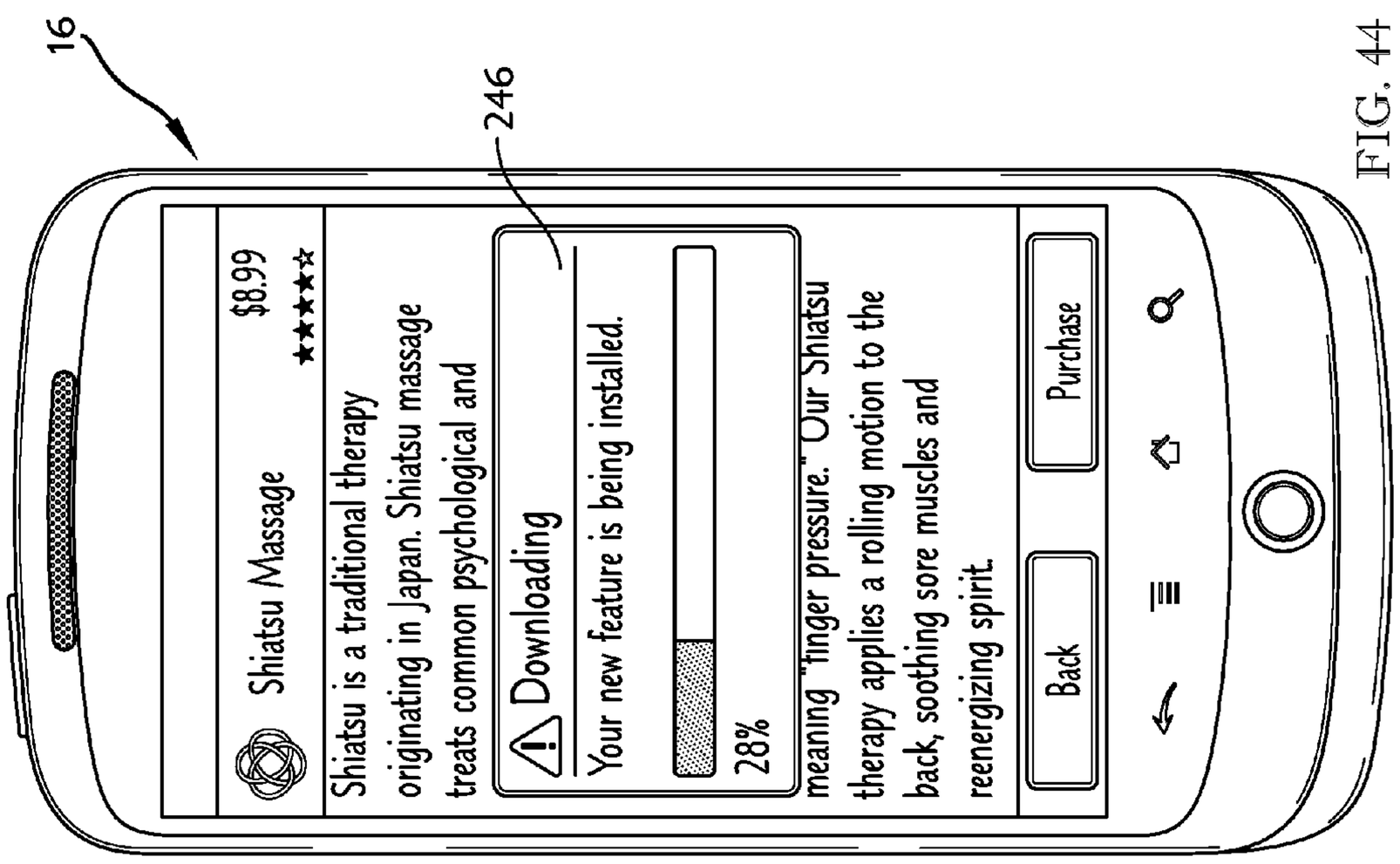

16
246
Shiatsu Massage
$8.99
Shiatsu is a traditional therapy
originating in Japan. Shiatsu massage
treats common psychological and
Downloading
Your new feature is being installed.
28%
meaning "finger pressure." Our Shiatsu
therapy applies a rolling motion to the
back, soothing sore muscles and
reenergizing spirit.
Back
Purchase

FIG. 44

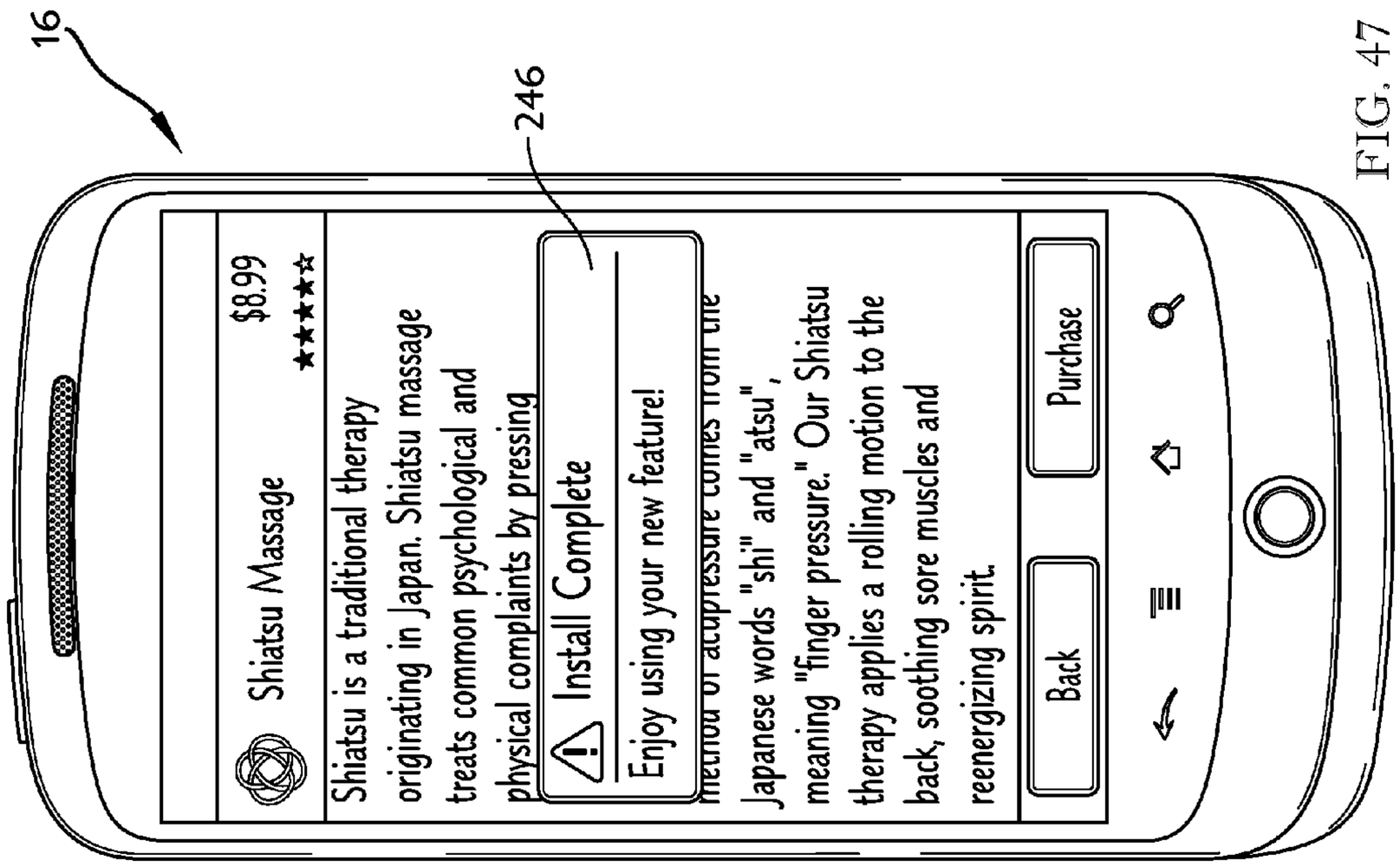

16
246
Shiatsu Massage
$8.99
Shiatsu is a traditional therapy originating in Japan. Shiatsu massage treats common psychological and physical complaints by pressing
Install Complete
Enjoy using your new feature!
Japanese words "shi" and "atsu", meaning "finger pressure." Our Shiatsu therapy applies a rolling motion to the back, soothing sore muscles and reenergizing spirit.
Back
Purchase

FIG. 47

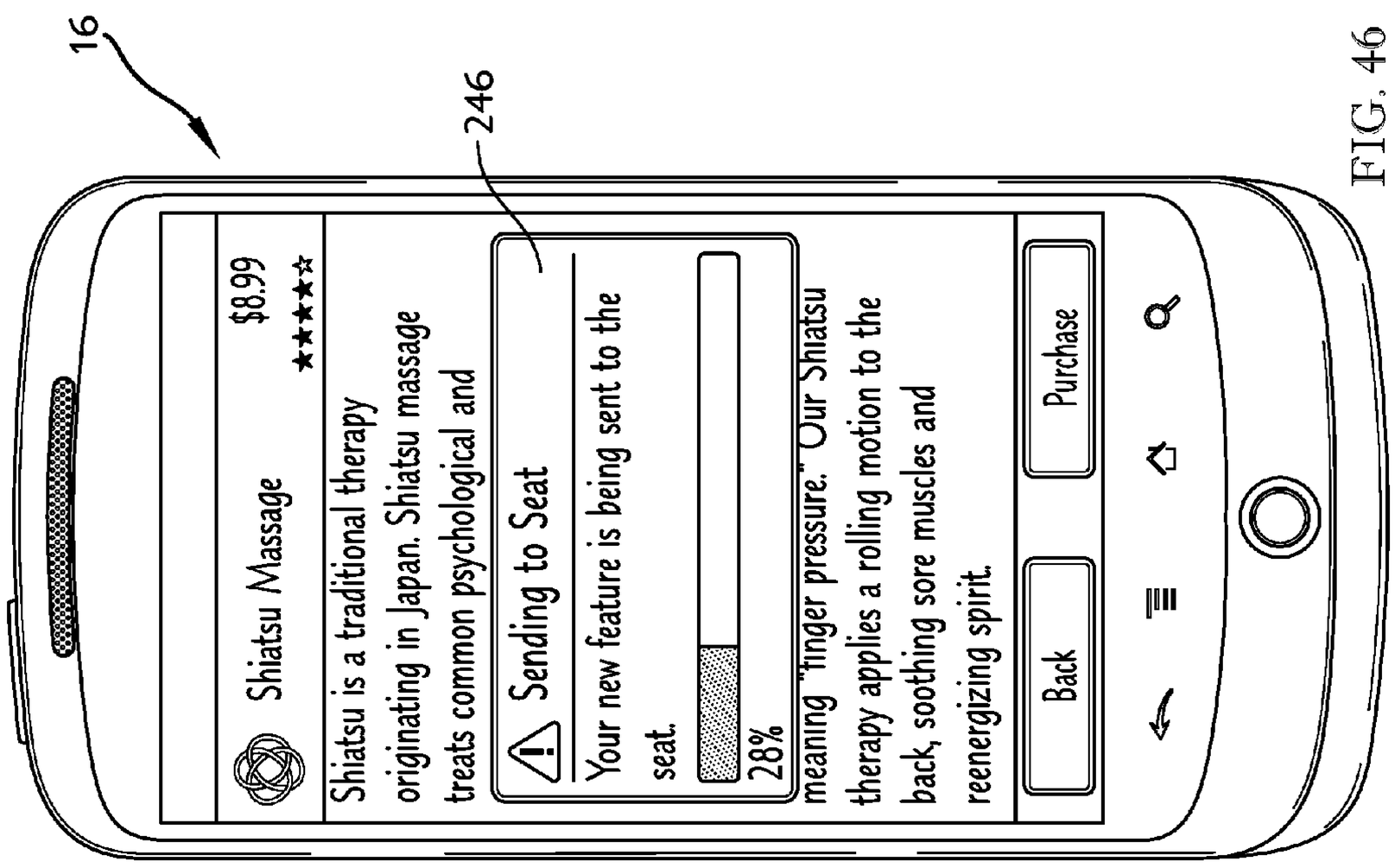

16
246
Shiatsu Massage
$8.99
Shiatsu is a traditional therapy originating in Japan. Shiatsu massage treats common psychological and
Sending to Seat
Your new feature is being sent to the seat.
28%
meaning "finger pressure." Our Shiatsu therapy applies a rolling motion to the back, soothing sore muscles and reenergizing spirit.
Back
Purchase

FIG. 46

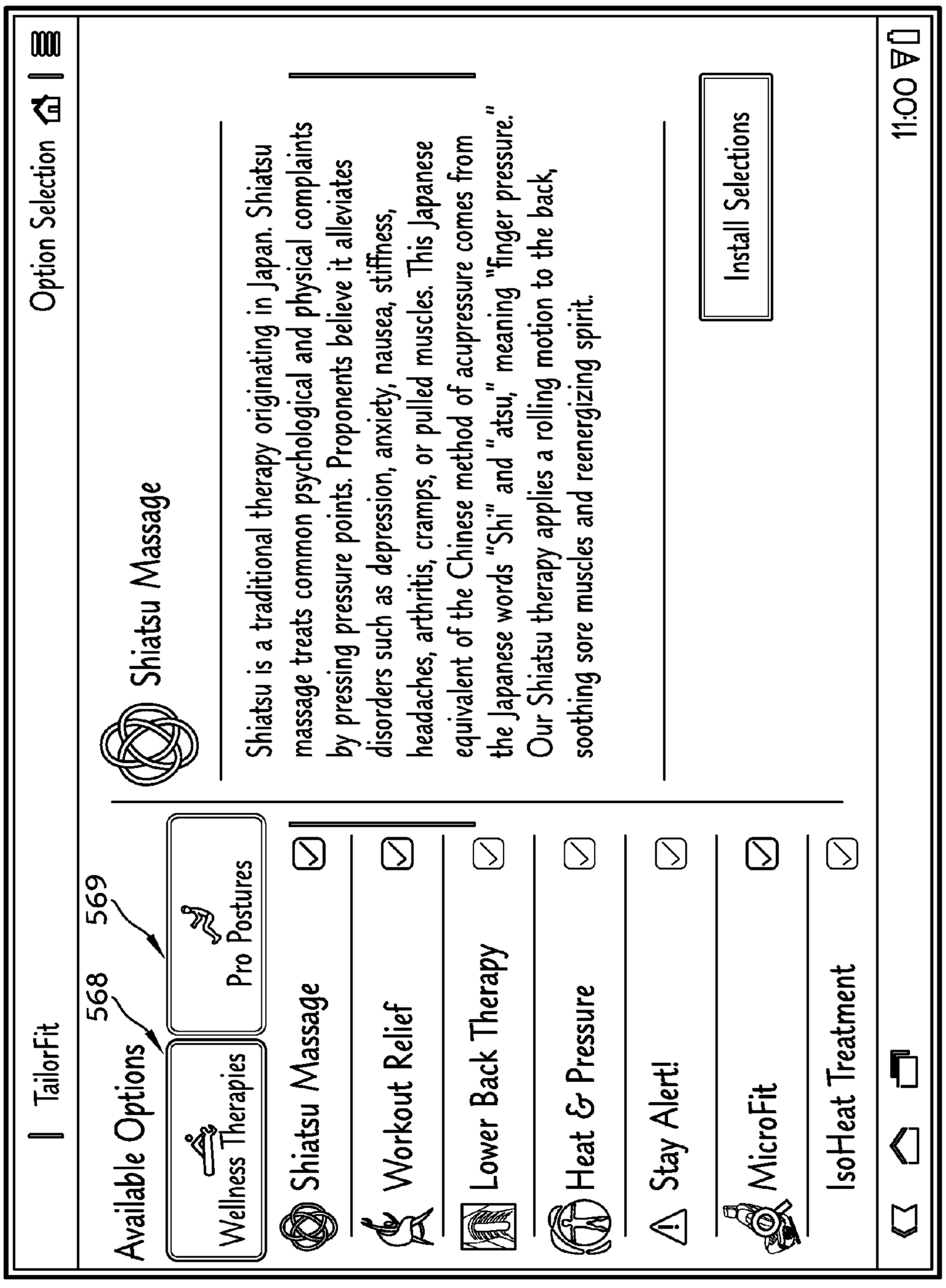

TailorFit
Option Selection
Available Options
568
569
Wellness Therapies
Pro Posture
Shiatsu Massage
Workout Relief
Lower Back Therapy
Heat & Pressure
Stay Alert!
MicroFit
IsoHeat Treatment
Shiatsu Massage
Shiatsu is a traditional therapy originating in Japan. Shiatsu massage treats common psychological and physical complaints by pressing pressure points. Proponents believe it alleviates disorders such as depression, anxiety, nausea, stiffness, headaches, arthritis, cramps, or pulled muscles. This Japanese equivalent of the Chinese method of acupressure comes from the Japanese words "Shi" and "atsu," meaning "finger pressure." Our Shiatsu therapy applies a rolling motion to the back, soothing sore muscles and reenergizing spirit.
Install Selections
11:00

FIG. 48

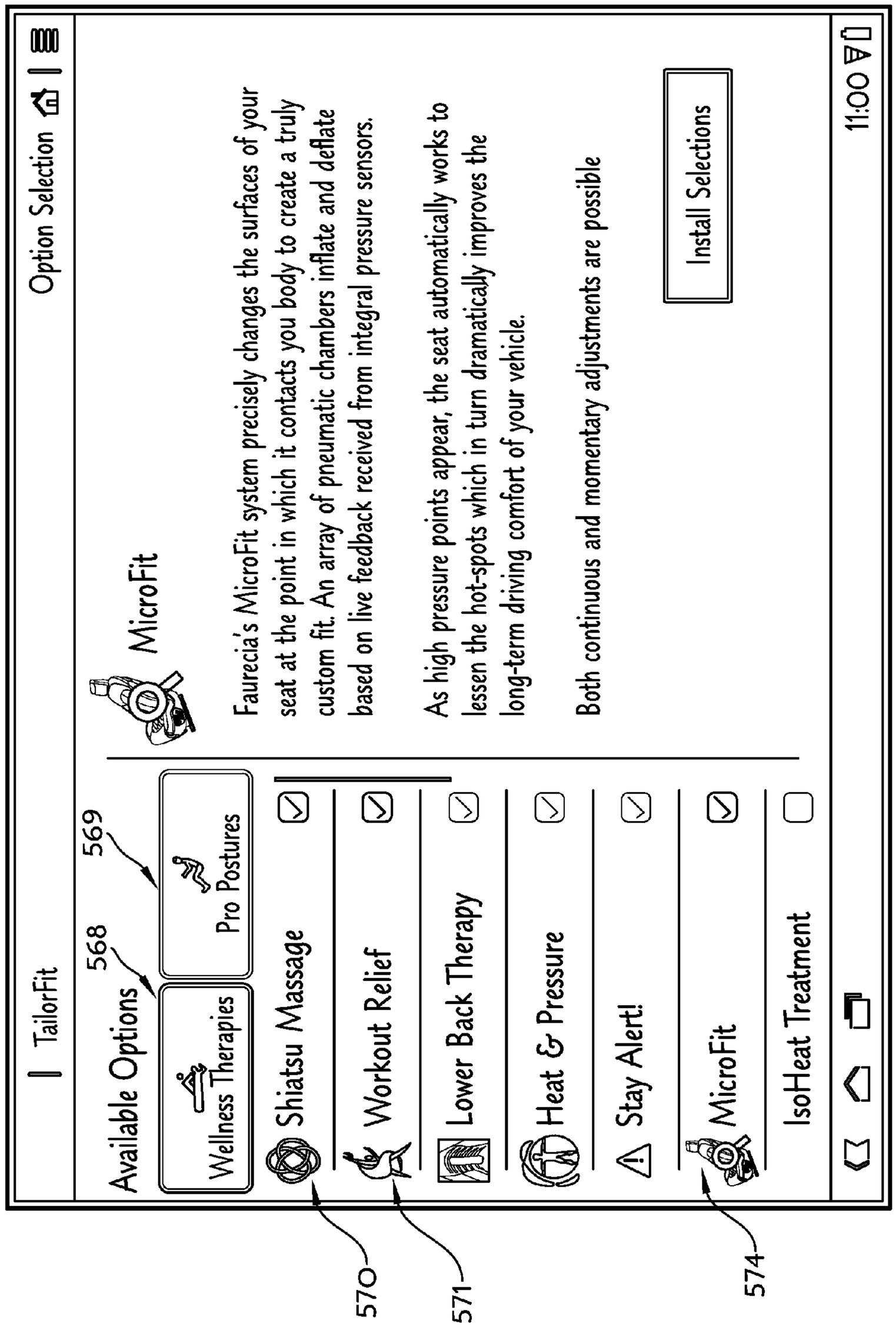

TailorFit
Option Selection
Available Options
568
Wellness Therapies
Pro Postures
569
Shiatsu Massage
Workout Relief
Lower Back Therapy
Heat & Pressure
Stay Alert!
MicroFit
IsoHeat Treatment
570
571
574
MicroFit
Faurecia's MicroFit system precisely changes the surfaces of your seat at the point in which it contacts you body to create a truly custom fit. An array of pneumatic chambers inflate and deflate based on live feedback received from integral pressure sensors.
As high pressure points appear, the seat automatically works to lessen the hot-spots which in turn dramatically improves the long-term driving comfort of your vehicle.
Both continuous and momentary adjustments are possible
Install Selections
11:00

FIG. 49

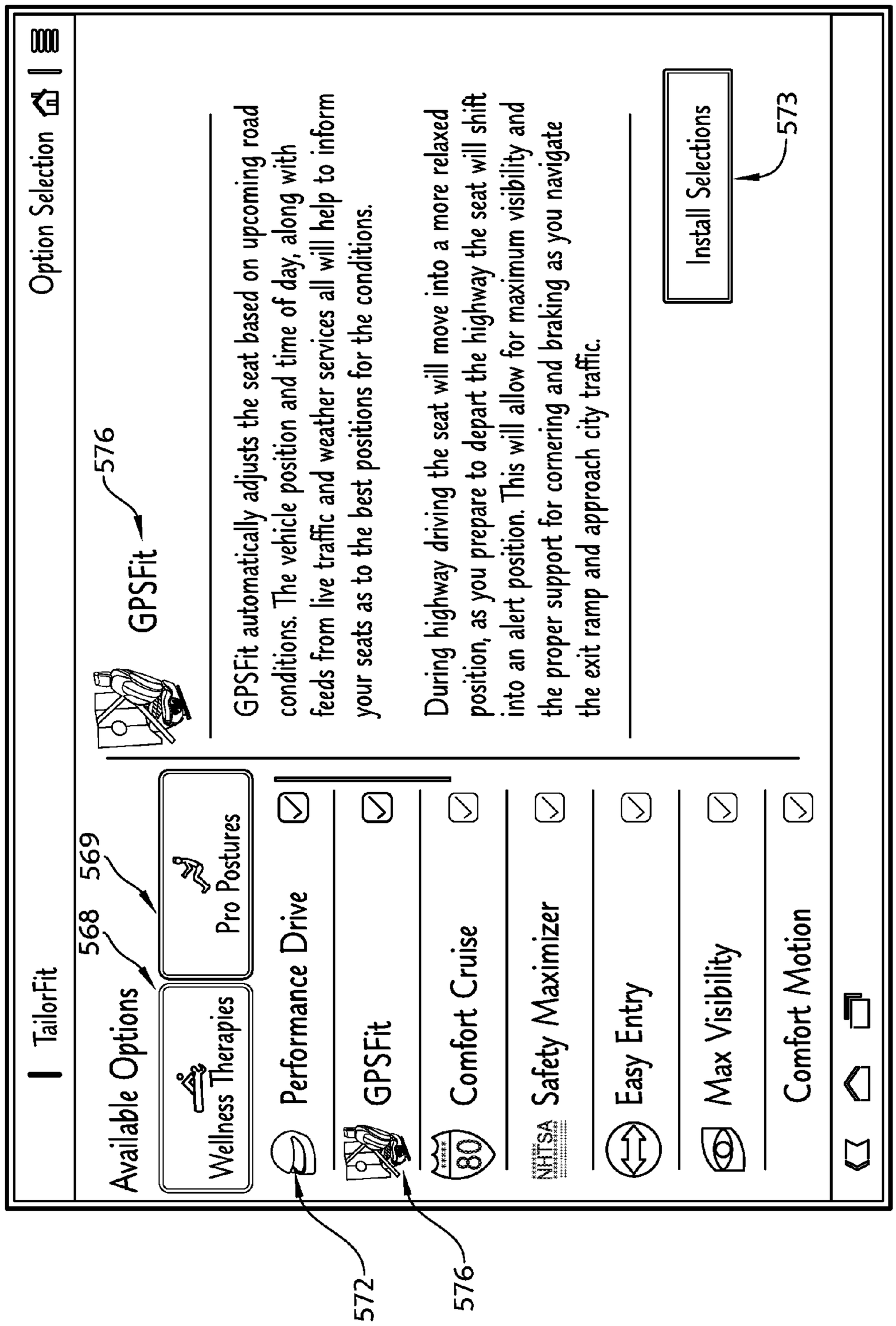

TailorFit
Option Selection
Available Options
568
569
Wellness Therapies
Pro Postures
Performance Drive
GPSFit
Comfort Cruise
Safety Maximizer
Easy Entry
Max Visibility
Comfort Motion
572
576
576
GPSFit
GPSFit automatically adjusts the seat based on upcoming road conditions. The vehicle position and time of day, along with feeds from live traffic and weather services all will help to inform your seats as to the best positions for the conditions.
During highway driving the seat will move into a more relaxed position, as you prepare to depart the highway the seat will shift into an alert position. This will allow for maximum visibility and the proper support for cornering and braking as you navigate the exit ramp and approach city traffic.
Install Selections
573

FIG. 50

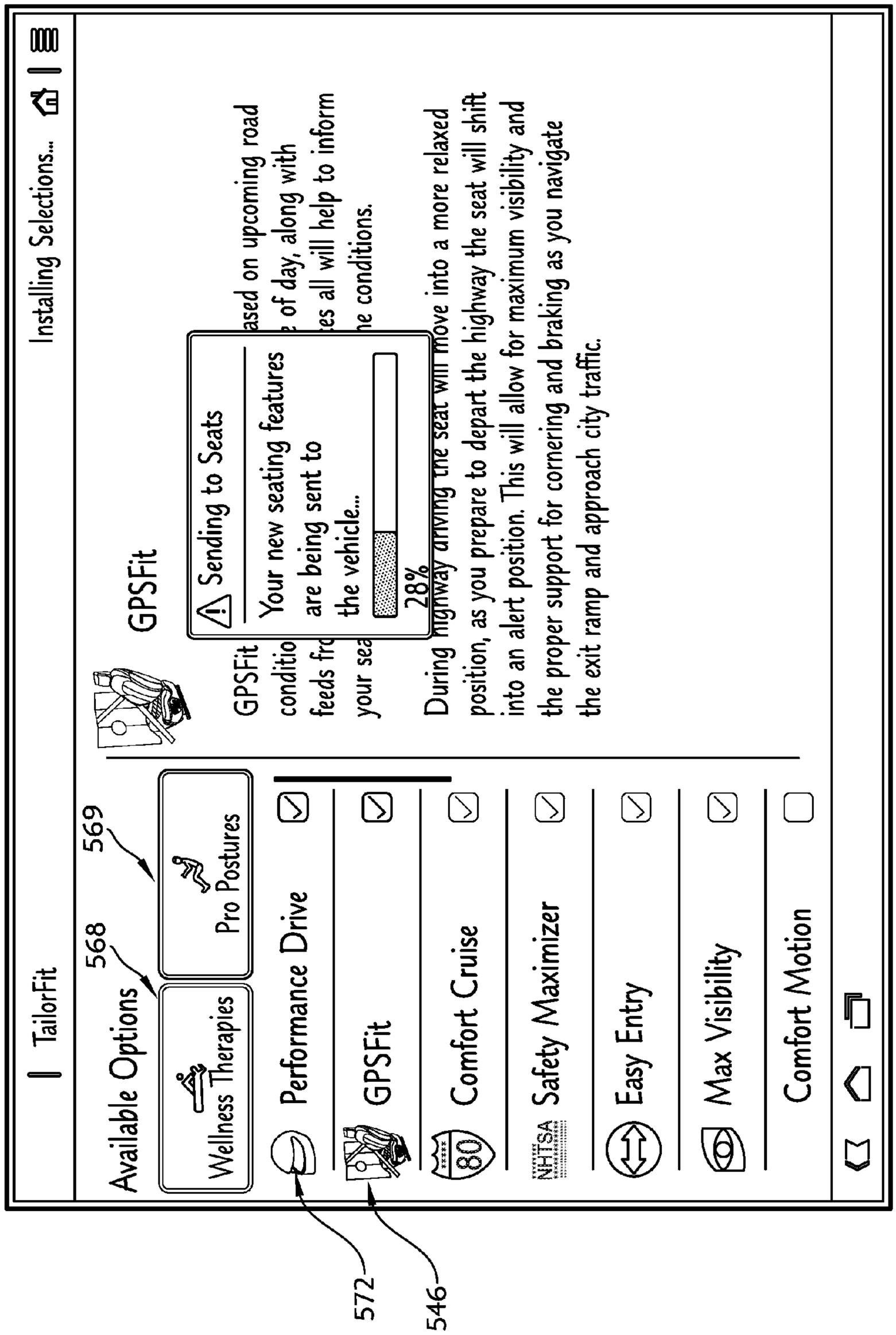

TailorFit
Installing Selections...
Available Options
568
569
Wellness Therapies
Pro Postures
Performance Drive
GPSFit
Comfort Cruise
Safety Maximizer
Easy Entry
Max Visibility
Comfort Motion
572
546
GPSFit
Sending to Seats
Your new seating features are being sent to the vehicle...
28%
GPSFit based on upcoming road conditions of day, along with feeds from sensors all will help to inform your seat conditions.
During highway driving the seat will move into a more relaxed position, as you prepare to depart the highway the seat will shift into an alert position. This will allow for maximum visibility and the proper support for cornering and braking as you navigate the exit ramp and approach city traffic.

FIG. 51

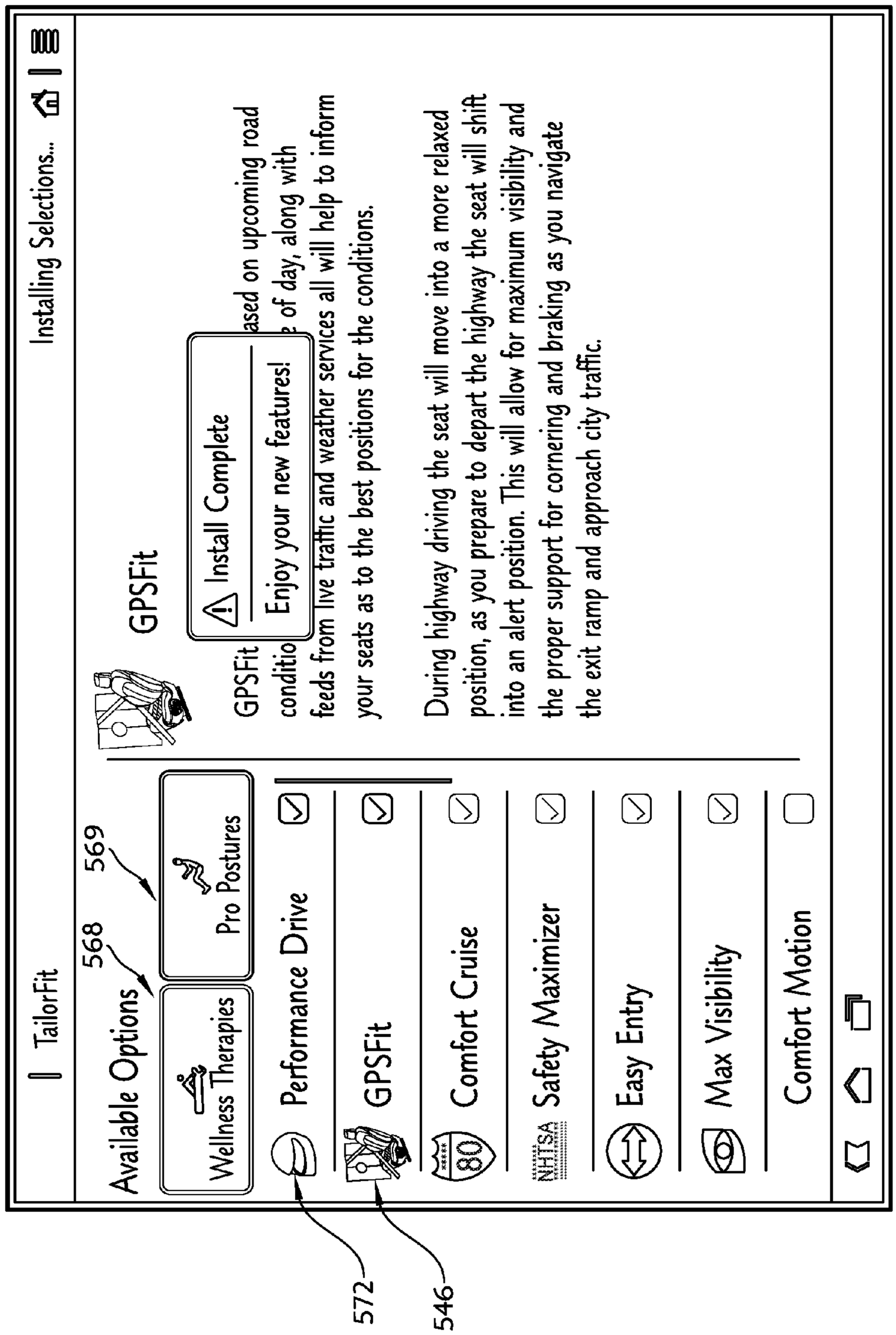

TailorFit
Installing Selections...
Available Options
568
569
Wellness Therapies
Pro Postures
Performance Drive
GPSFit
Comfort Cruise
Safety Maximizer
Easy Entry
Max Visibility
Comfort Motion
572
546
GPSFit
Install Complete
Enjoy your new features!
GPSFit based on upcoming road conditions along with time of day, along with feeds from live traffic and weather services all will help to inform your seats as to the best positions for the conditions.
During highway driving the seat will move into a more relaxed position, as you prepare to depart the highway the seat will shift into an alert position. This will allow for maximum visibility and the proper support for cornering and braking as you navigate the exit ramp and approach city traffic.

FIG. 52

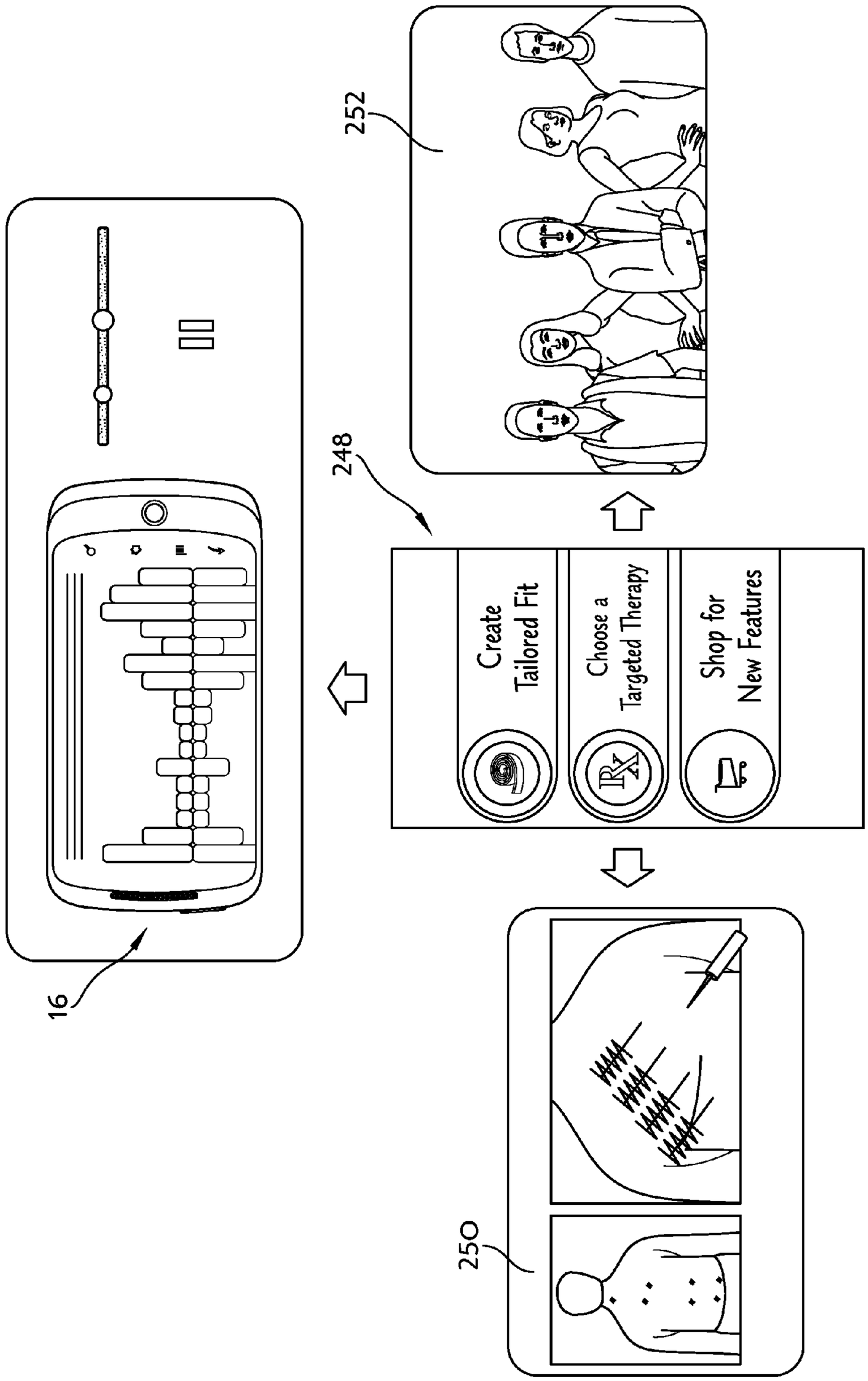

16
248
Create Tailored Fit
Choose a Targeted Therapy
Shop for New Features
250
252

FIG. 53

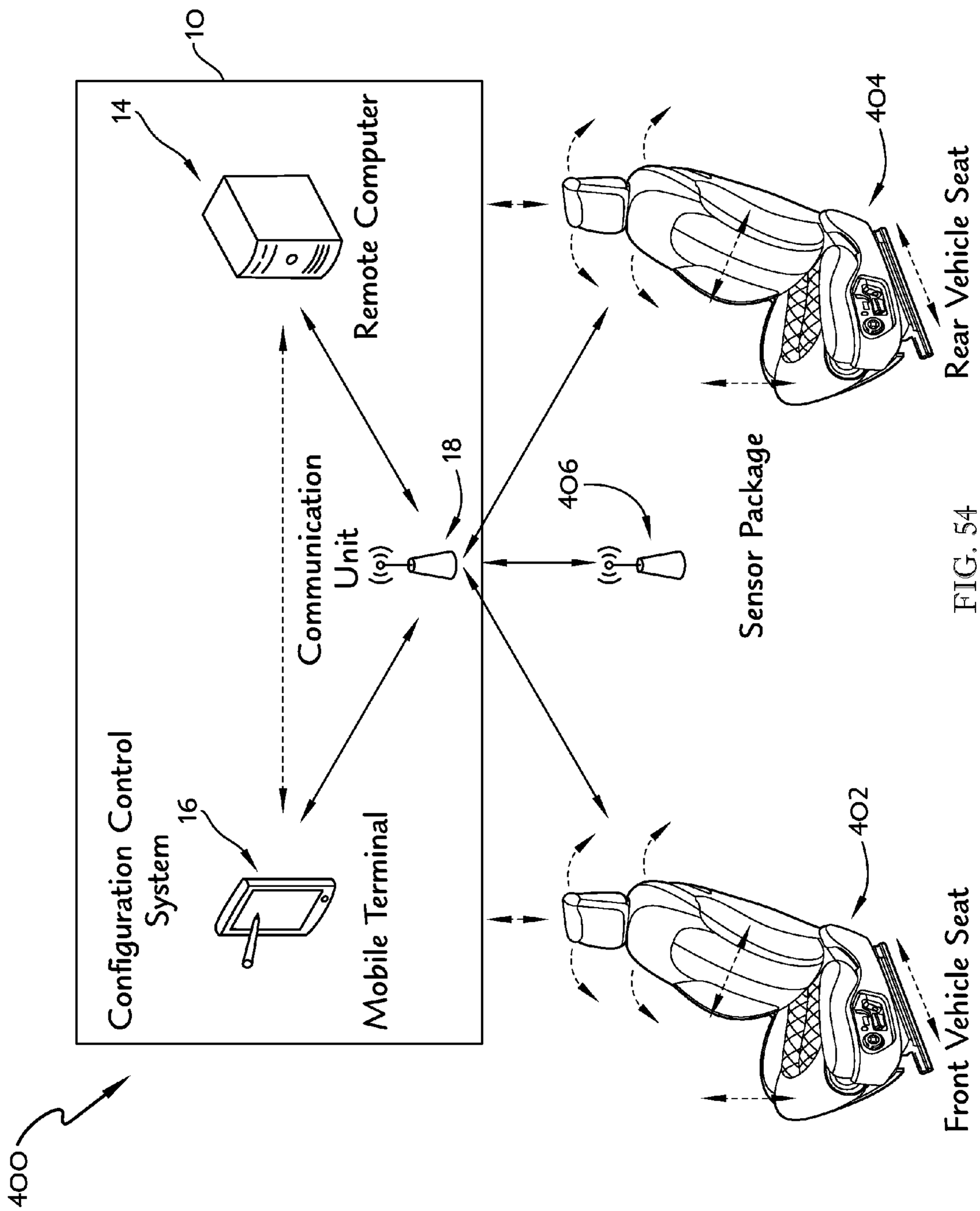

400
10
Configuration Control System
Mobile Terminal
16
14
Remote Computer
Communication Unit
18
406
Sensor Package
402
404
Front Vehicle Seat
Rear Vehicle Seat

FIG. 54

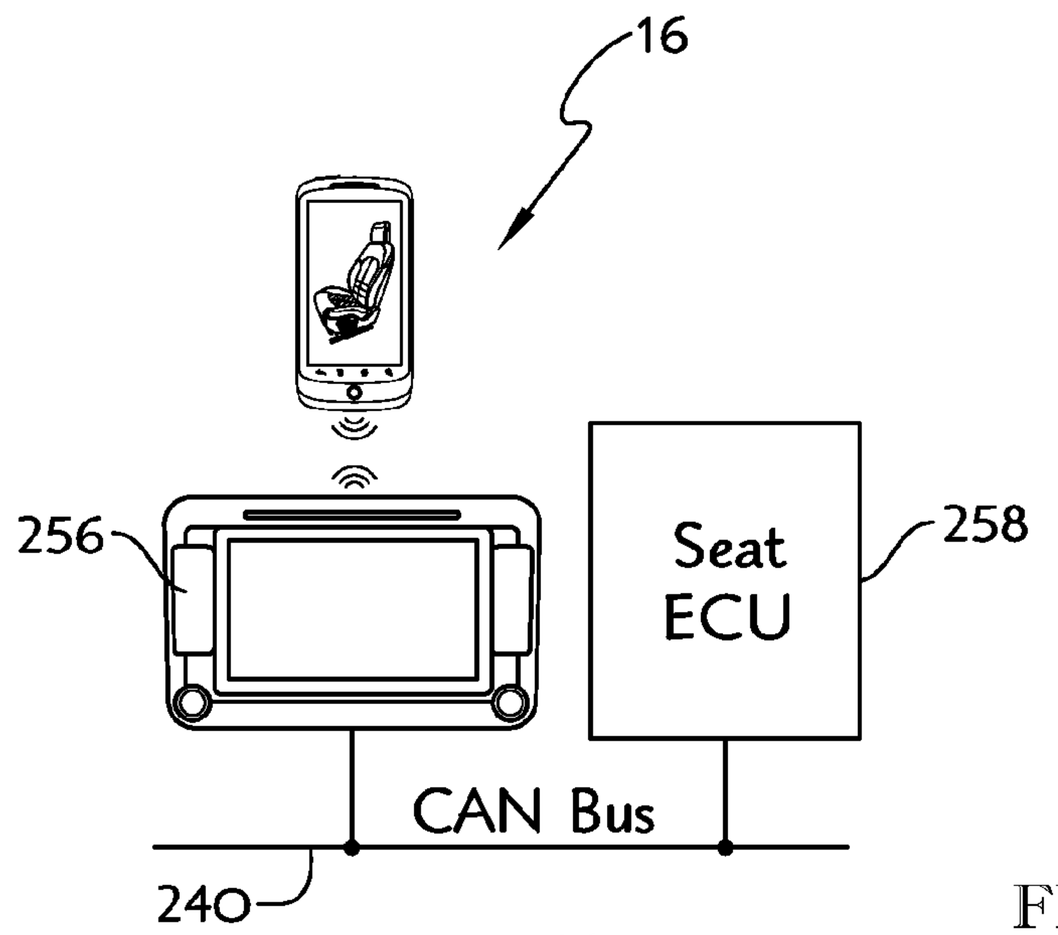


FIG. 55

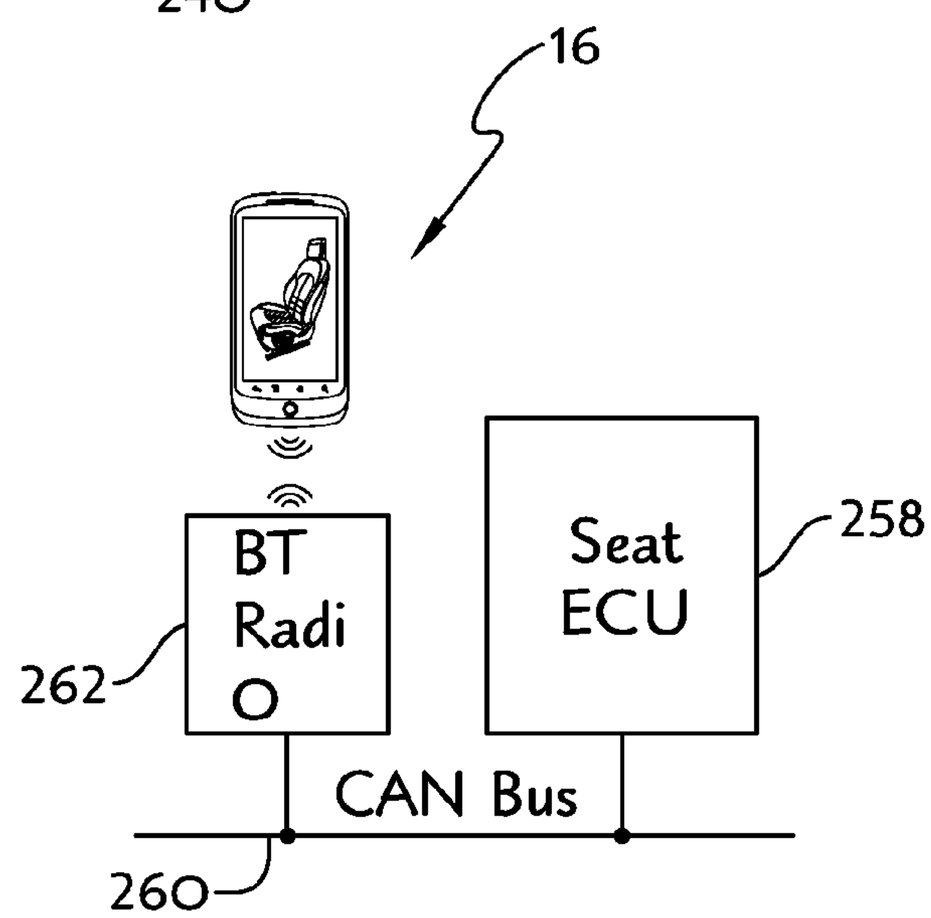


FIG. 56

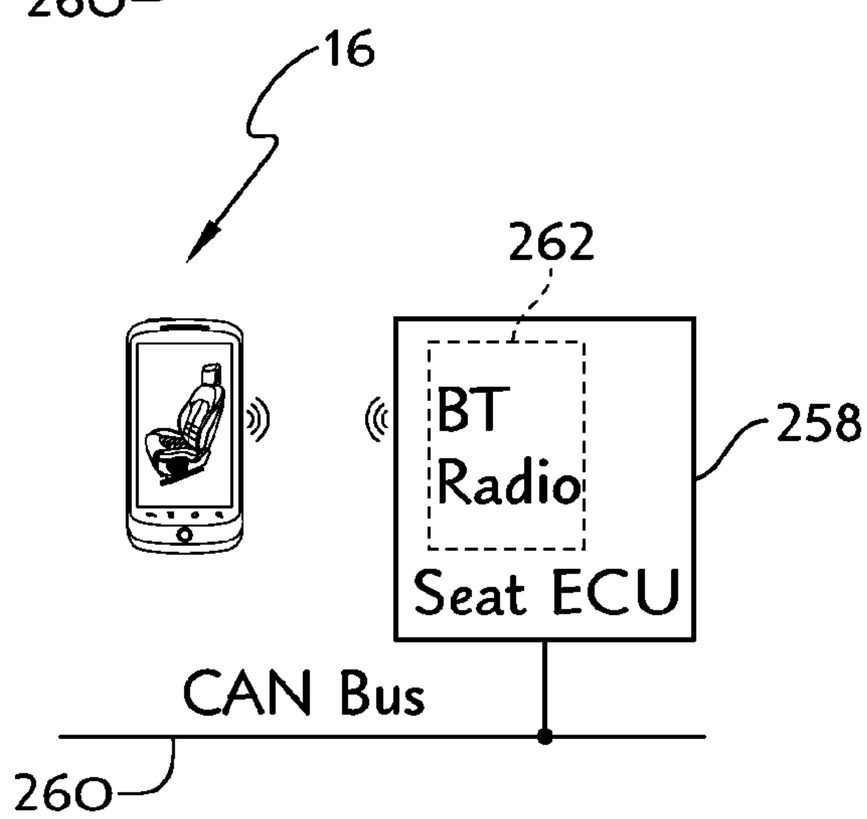


FIG. 57

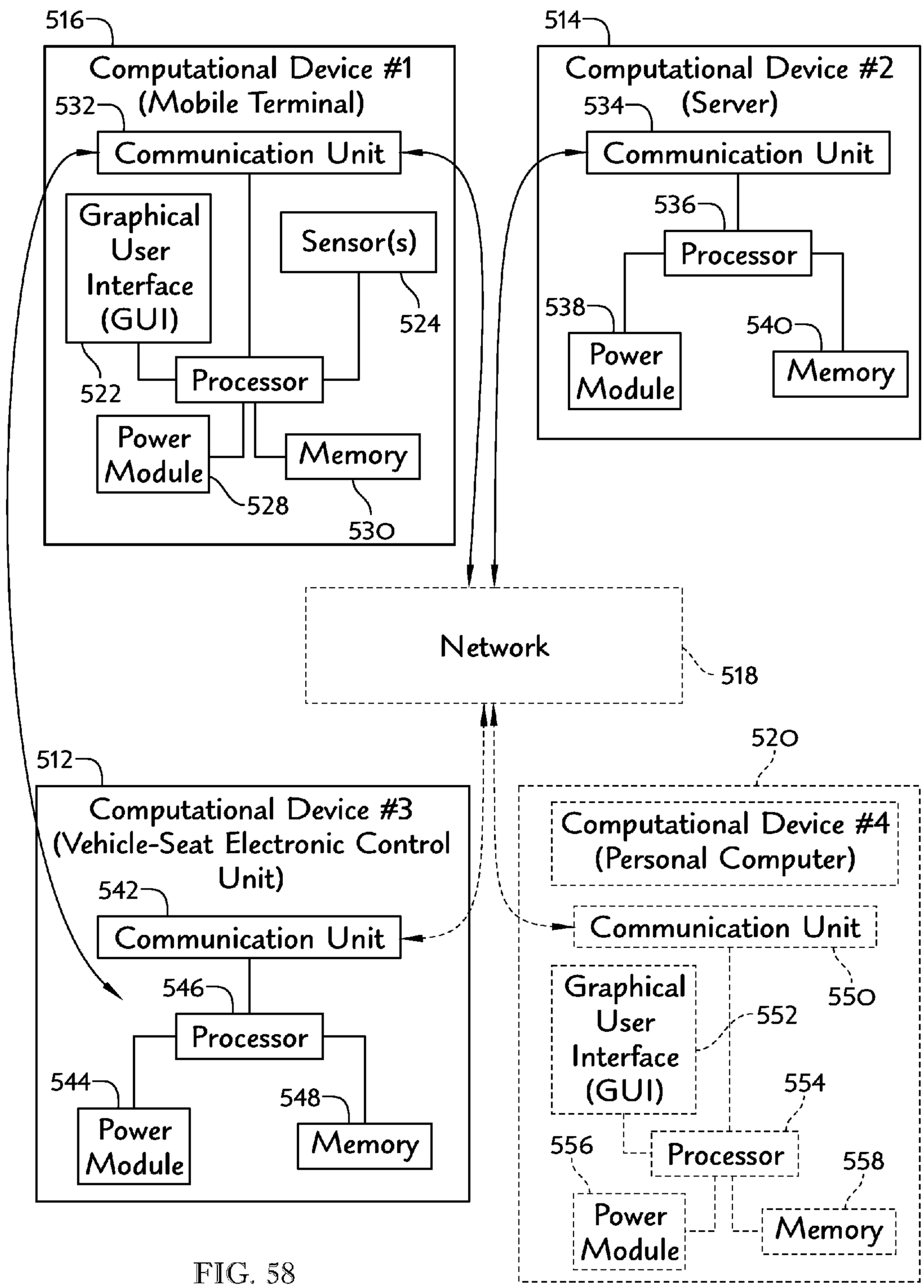
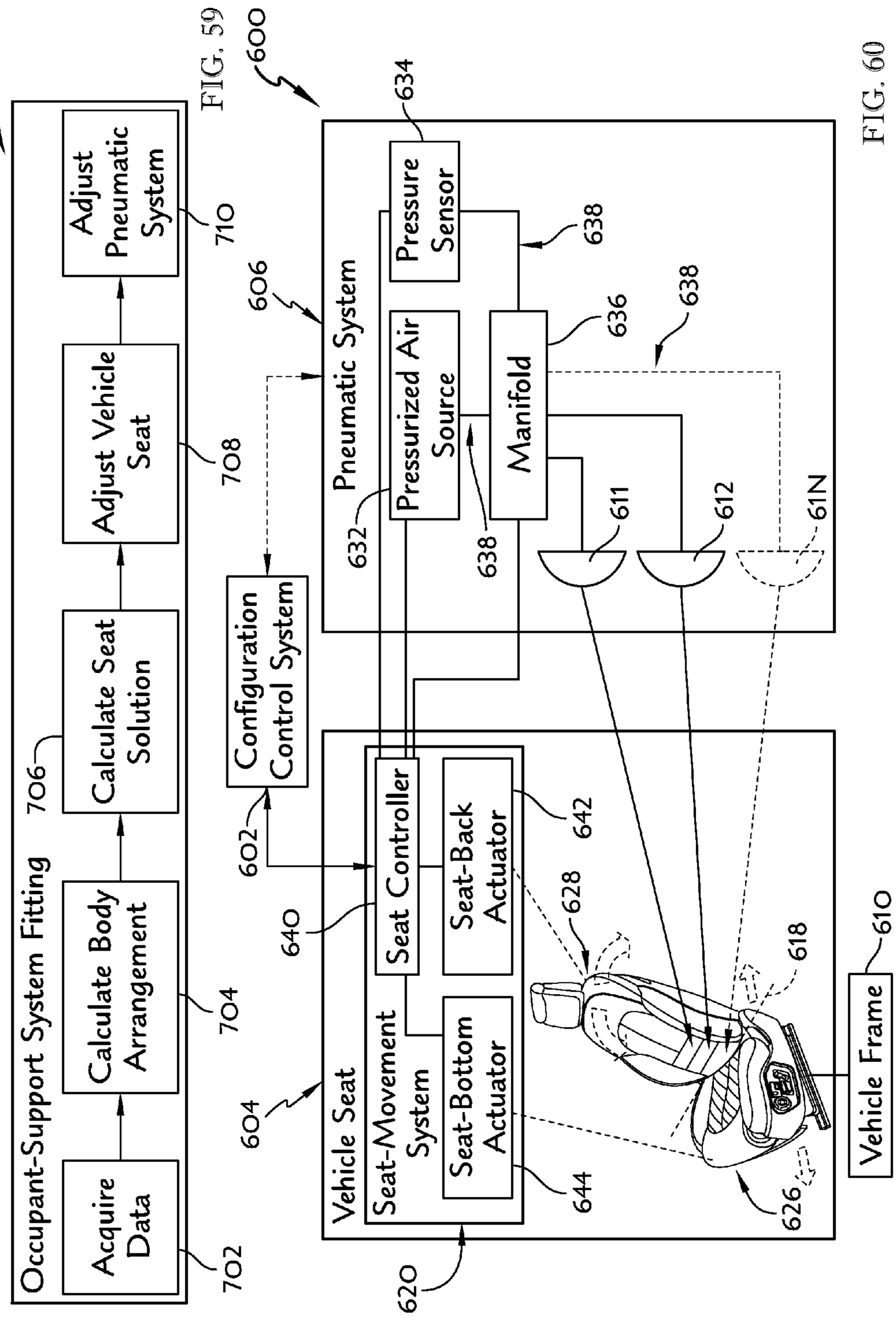

516
Computational Device #1
(Mobile Terminal)
532
Communication Unit
Graphical User Interface (GUI)
522
Sensor(s)
524
Processor
Power Module
528
Memory
530
514
Computational Device #2
(Server)
534
Communication Unit
536
Processor
538
Power Module
540
Memory
Network
518
520
512
Computational Device #3
(Vehicle-Seat Electronic Control Unit)
542
Communication Unit
546
Processor
544
Power Module
548
Memory
Computational Device #4
(Personal Computer)
Communication Unit
550
Graphical User Interface (GUI)
552
554
Processor
556
Power Module
558
Memory

FIG. 58


700
Occupant-Support System Fitting
Acquire Data
702
Calculate Body Arrangement
704
Calculate Seat Solution
706
Adjust Vehicle Seat
708
Adjust Pneumatic System
710
FIG. 59
600
Pneumatic System
606
Pressure Sensor
634
Pressurized Air Source
632
Manifold
636
638
638
638
611
612
61N
Configuration Control System
602
Vehicle Seat
604
Seat-Movement System
Seat Controller
640
Seat-Back Actuator
642
Seat-Bottom Actuator
644
620
628
618
626
Vehicle Frame
610
FIG. 60

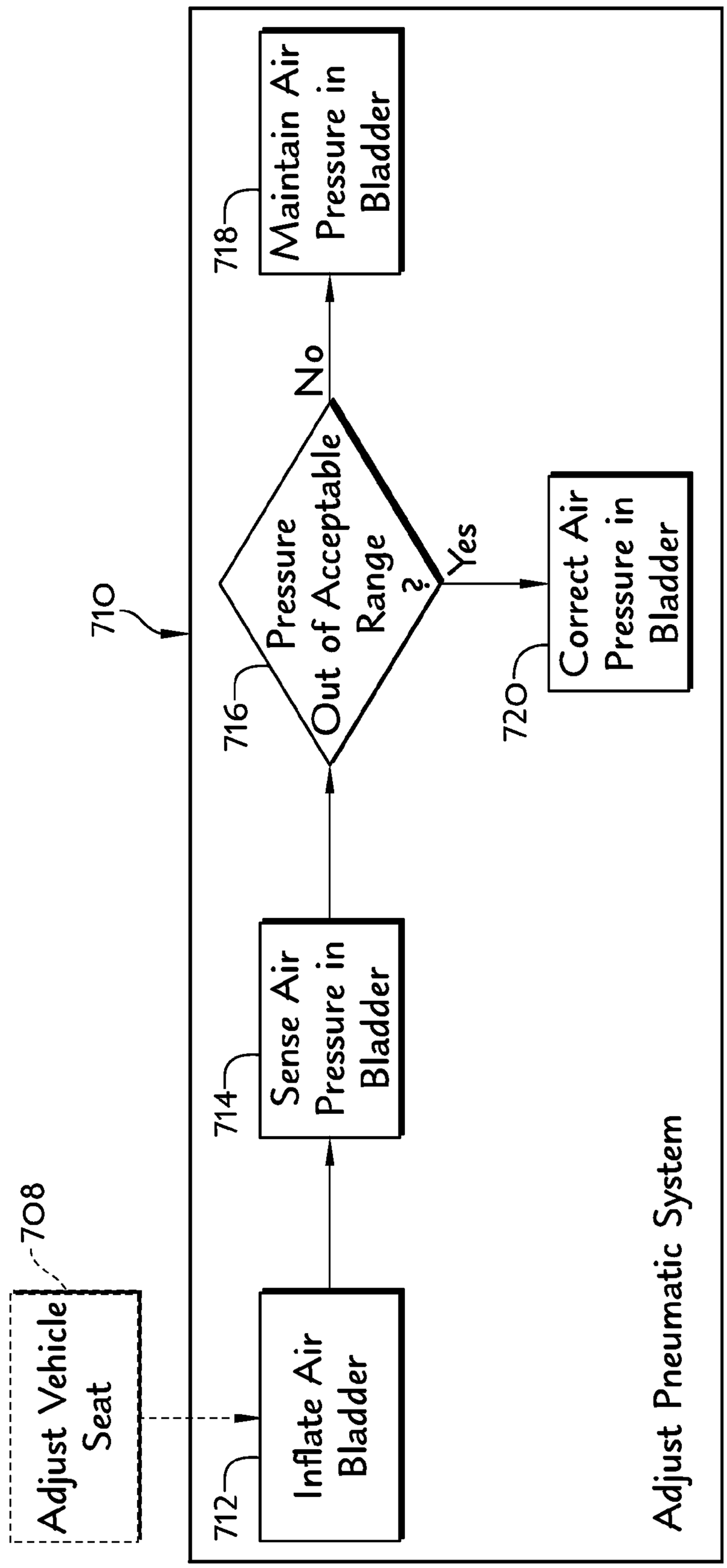

Adjust Vehicle Seat
708
710
Adjust Pneumatic System
712
Inflate Air Bladder
714
Sense Air Pressure in Bladder
716
Pressure Out of Acceptable Range ?
No
Yes
718
Maintain Air Pressure in Bladder
720
Correct Air Pressure in Bladder

FIG. 61

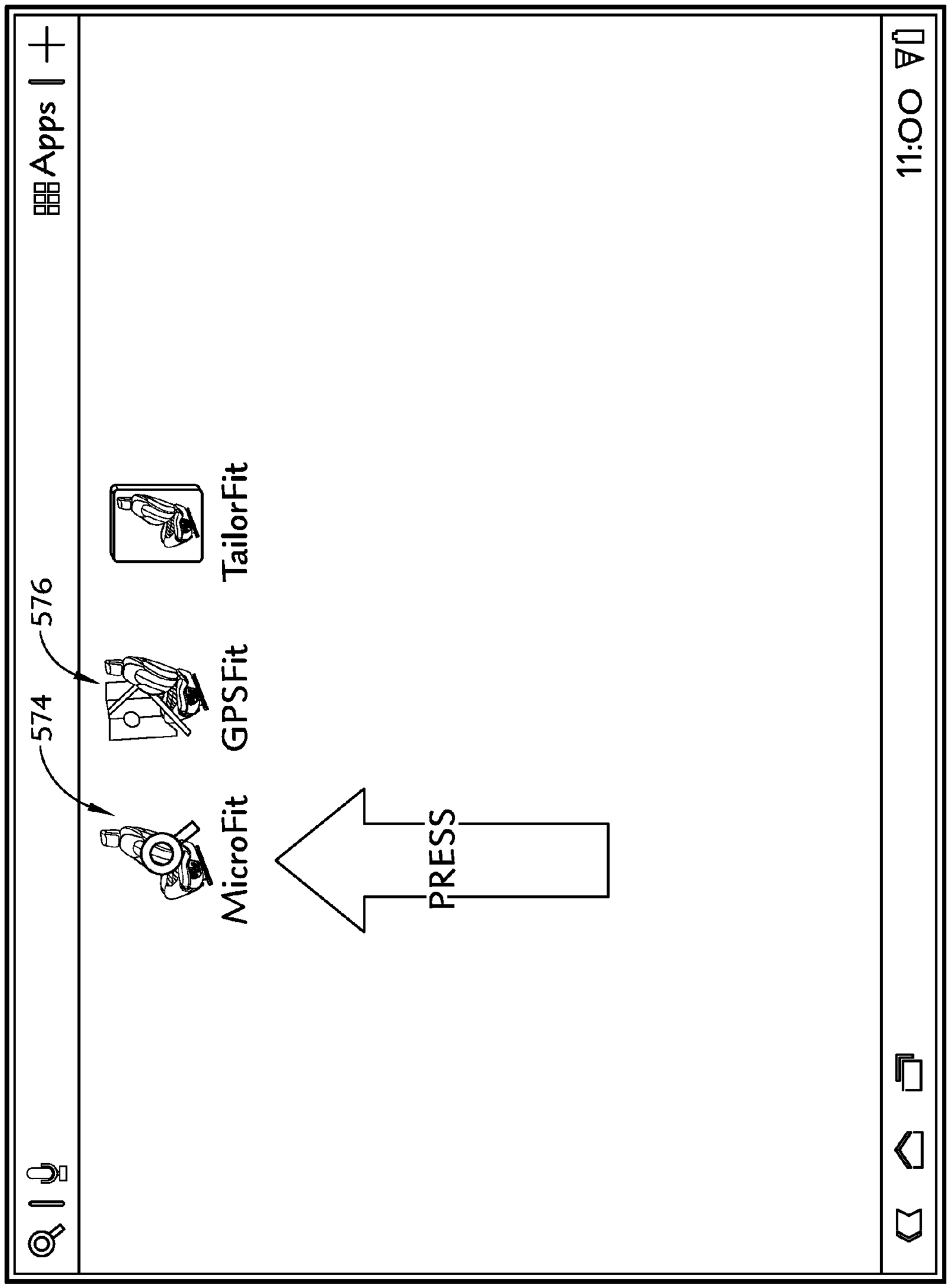


FIG. 62

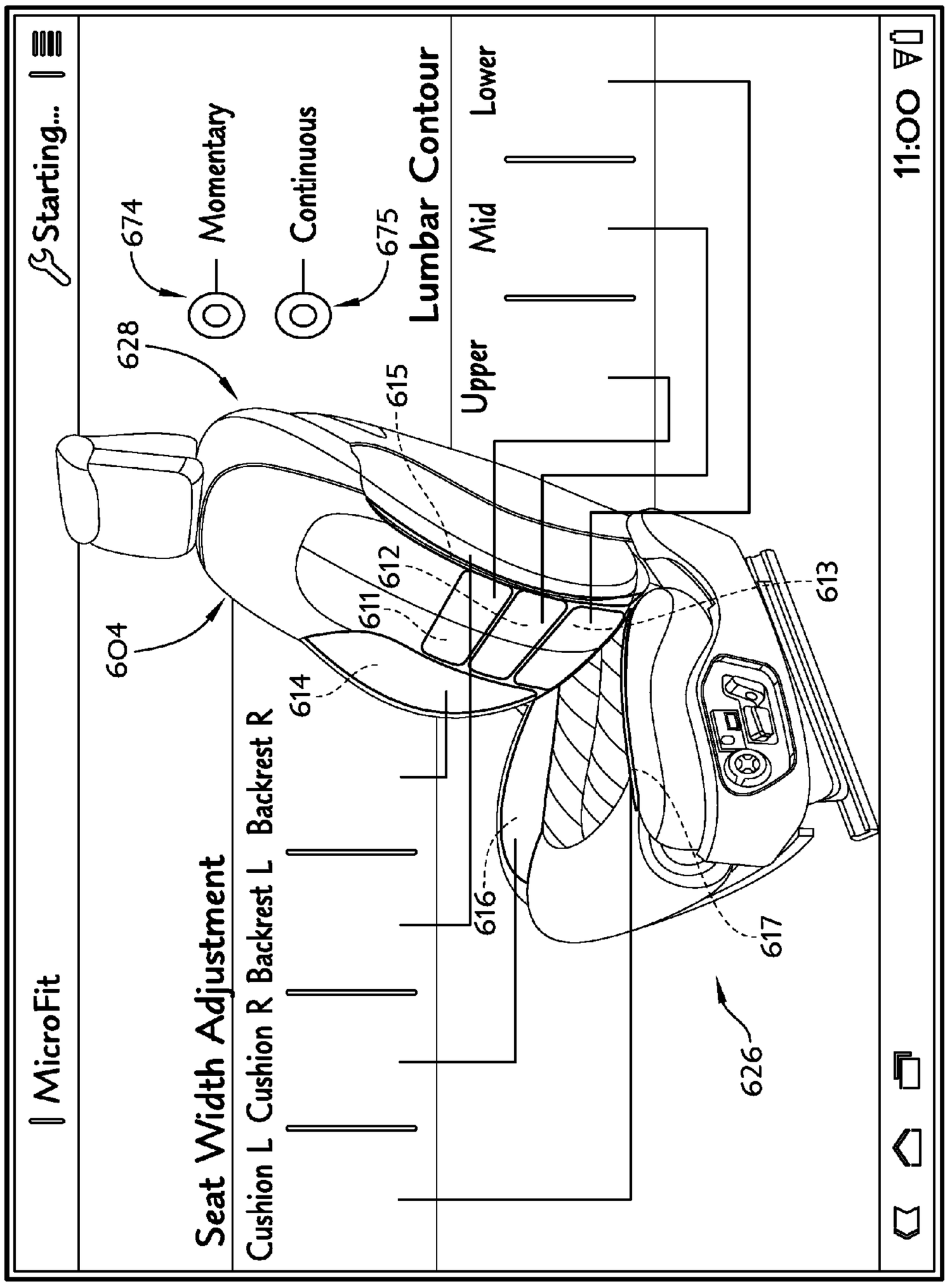

MicroFit
Starting...
Seat Width Adjustment
Cushion L
Cushion R
Backrest L
Backrest R
Momentary
Continuous
Lumbar Contour
Upper
Mid
Lower
11:00
604
611
612
613
614
615
616
617
626
628
674
675

FIG. 63

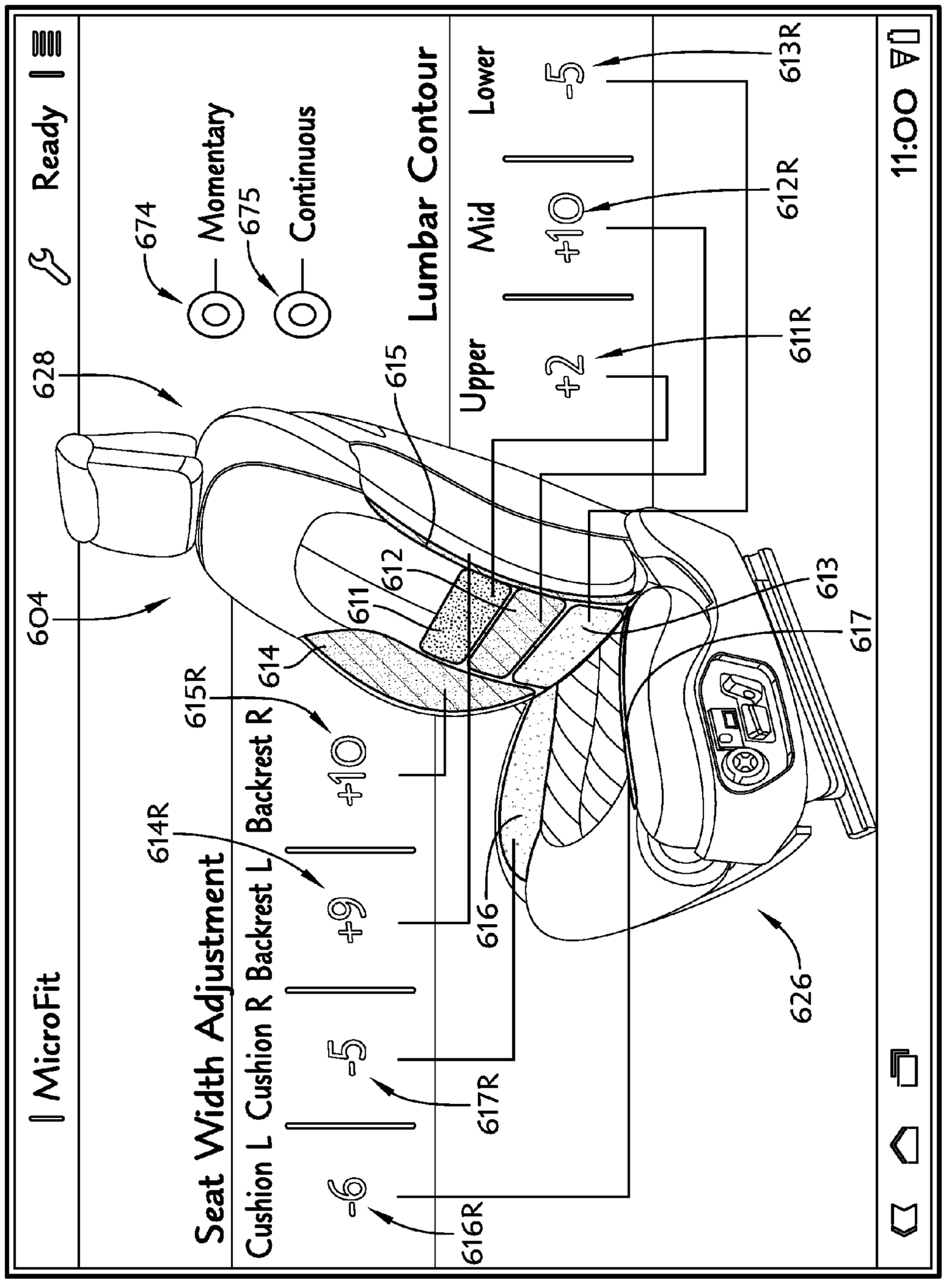

MicroFit
Ready
Seat Width Adjustment
Cushion L Cushion R Backrest L Backrest R
-6
-5
+9
+10
Momentary
Continuous
Lumbar Contour
Upper
Mid
Lower
+2
+10
-5
628
604
674
675
615
612
611
614
615R
614R
616
617
613
616R
617R
626
613R
612R
611R
11:00

FIG. 64

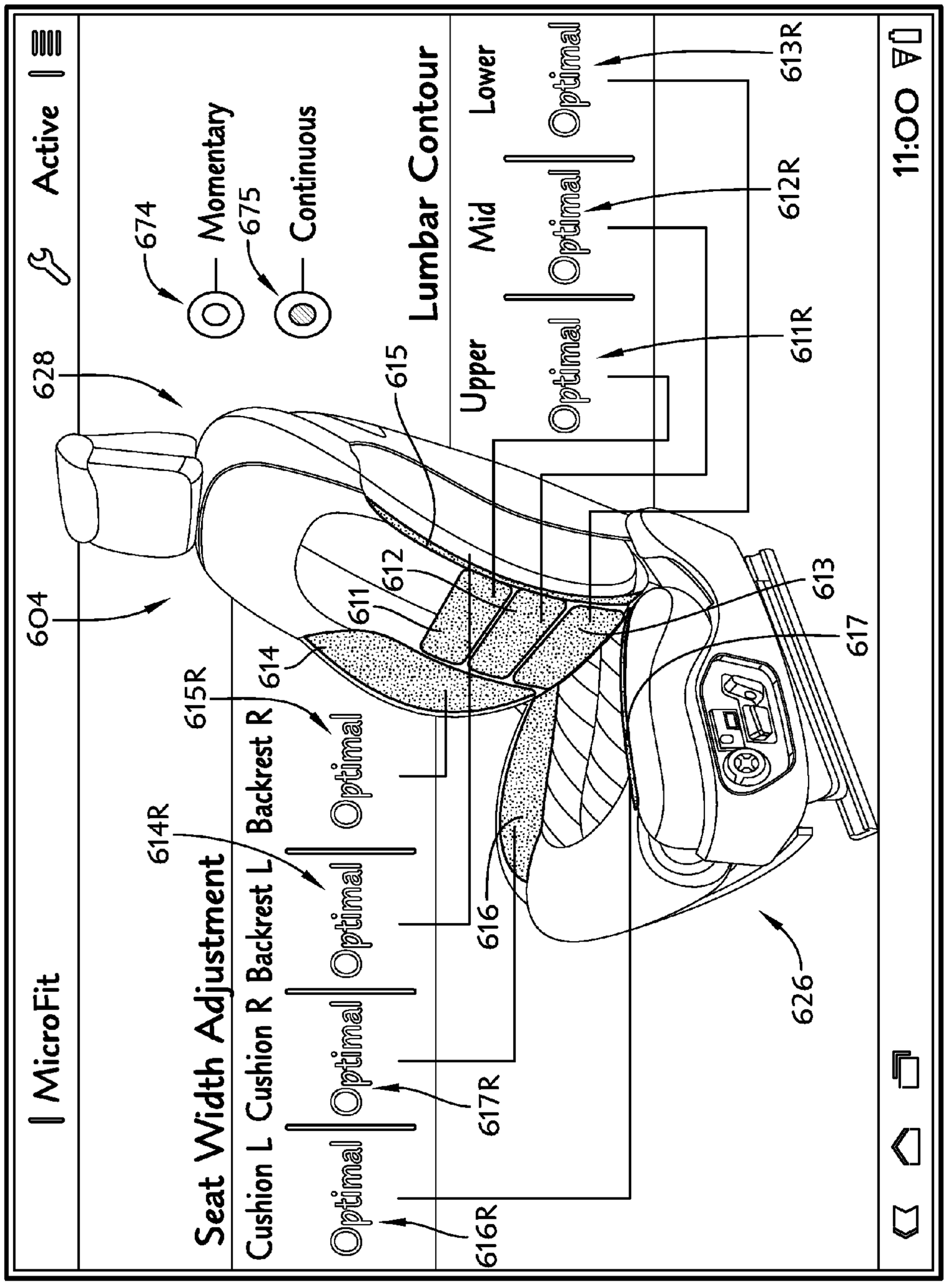

MicroFit
Active
674
Momentary
675
Continuous
Seat Width Adjustment
Cushion L
Cushion R
Backrest L
Backrest R
Optimal
Optimal
Optimal
Optimal
Optimal
Optimal
Lumbar Contour
Upper
Mid
Lower
Optimal
Optimal
Optimal
628
604
615
612
611
614
615R
614R
616
617
613
616R
617R
612R
613R
611R
626
11:00

FIG. 65

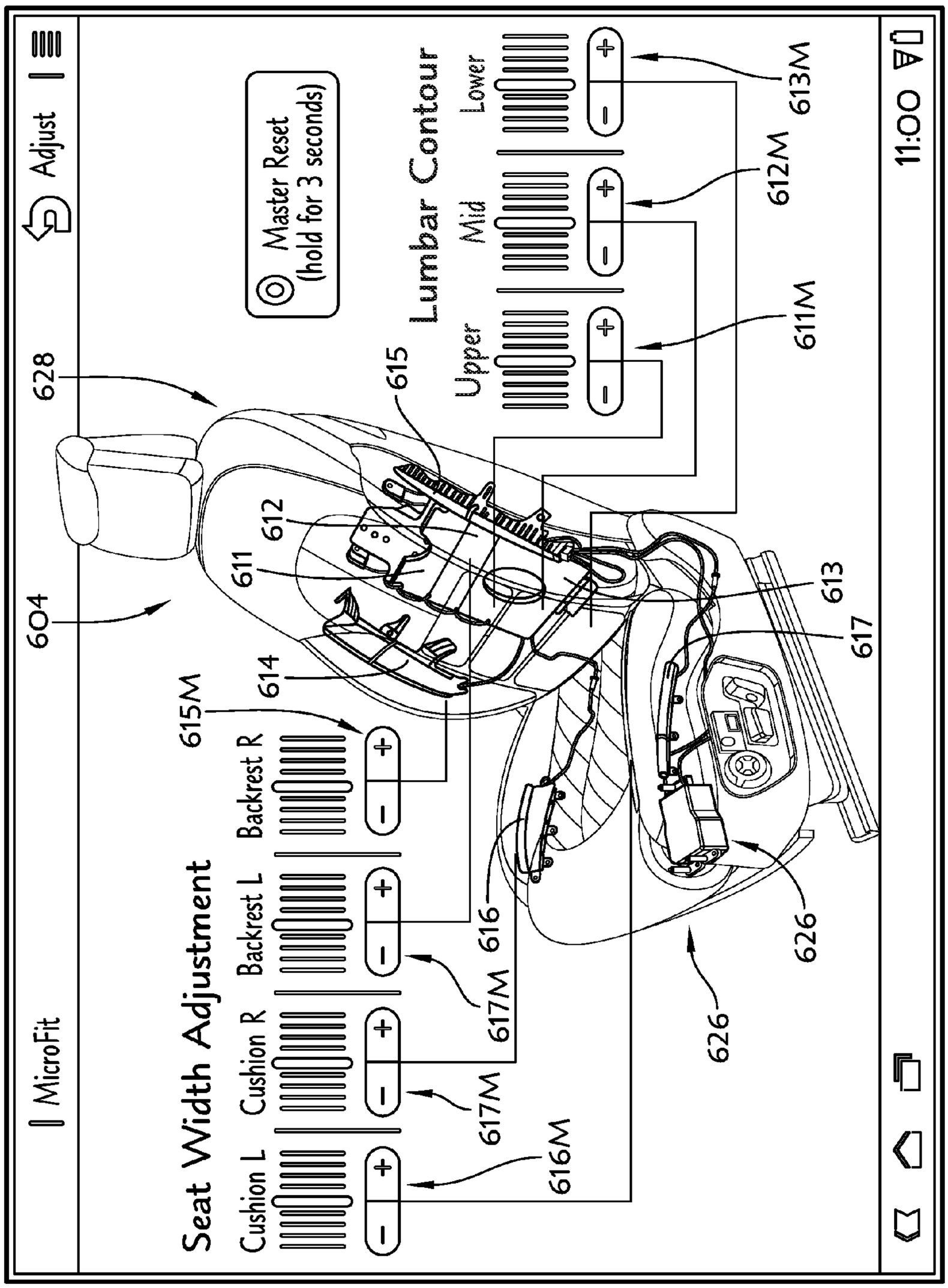

MicroFit
Adjust
Master Reset
(hold for 3 seconds)
Seat Width Adjustment
Cushion L
Cushion R
Backrest L
Backrest R
Lumbar Contour
Upper
Mid
Lower
11:00
604
611
612
613
614
615
616
617
626
628
611M
612M
613M
615M
616M
617M

FIG. 66

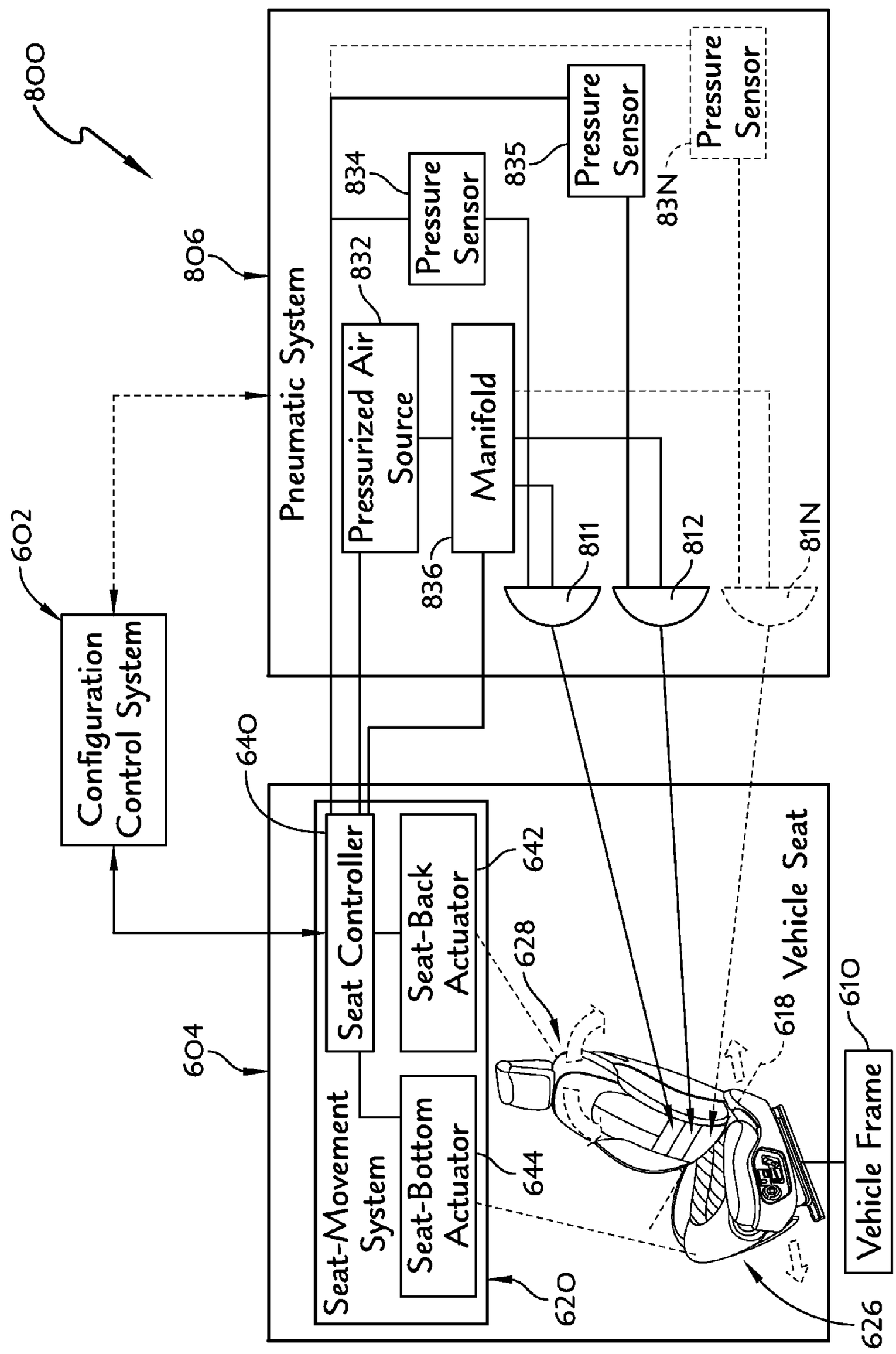

800
806
Pneumatic System
832
Pressurized Air Source
834
Pressure Sensor
835
Pressure Sensor
83N
Pressure Sensor
836
Manifold
811
812
81N
602
Configuration Control System
640
Seat Controller
642
Seat-Back Actuator
628
604
Seat-Movement System
Seat-Bottom Actuator
644
620
618
Vehicle Seat
610
Vehicle Frame
626

FIG. 67

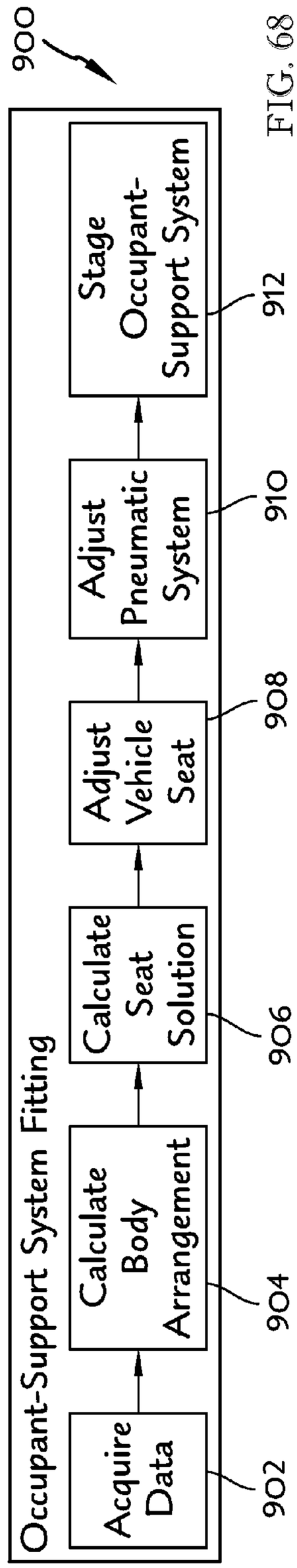

900
Occupant-Support System Fitting
Acquire Data
902
Calculate Body Arrangement
904
Calculate Seat Solution
906
Adjust Vehicle Seat
908
Adjust Pneumatic System
910
Stage Occupant-Support System
912

FIG. 68

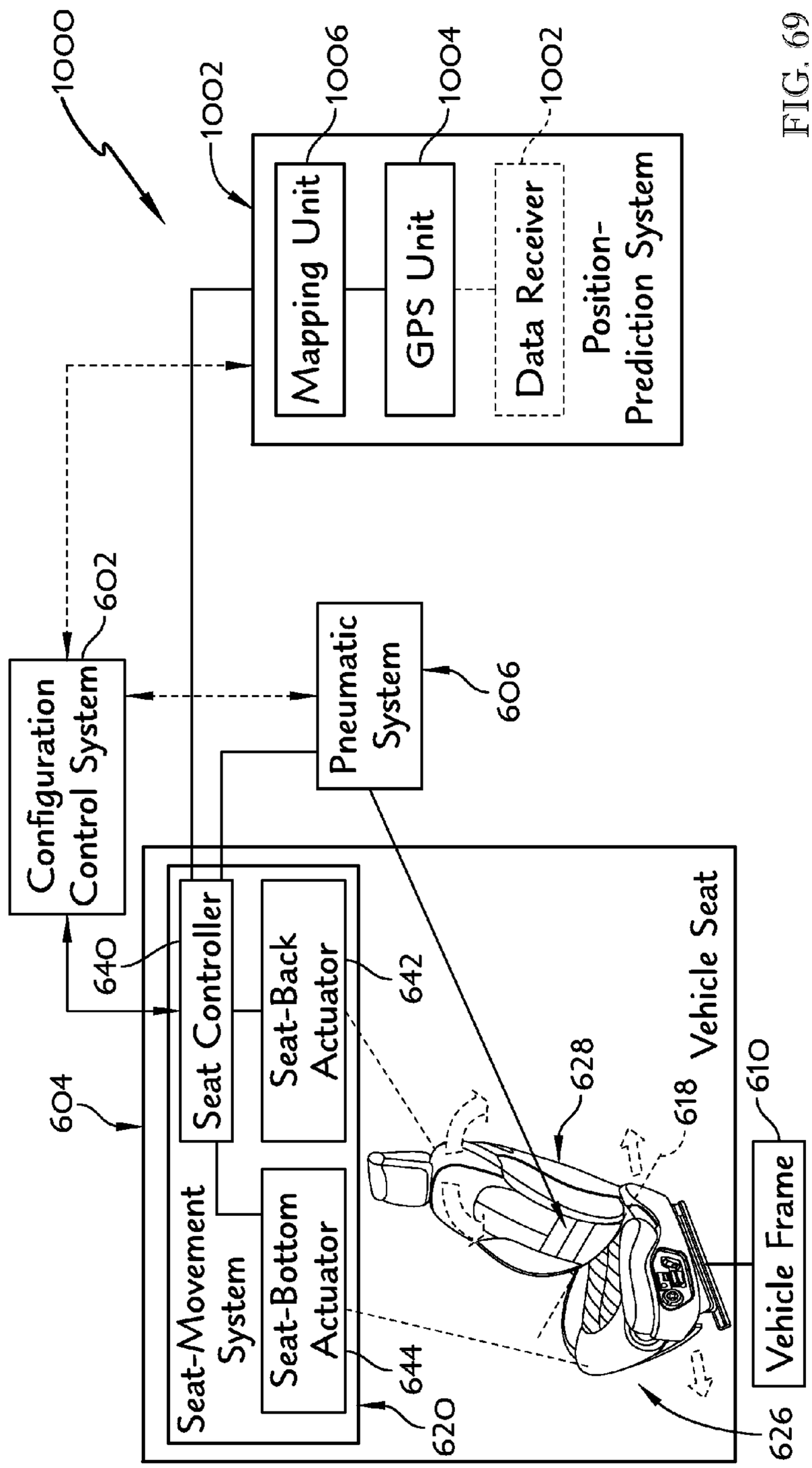

1000
1002
Mapping Unit
1006
GPS Unit
1004
Data Receiver
1002
Position-Prediction System
Configuration Control System
602
Pneumatic System
606
604
Seat-Movement System
Seat Controller
640
Seat-Back Actuator
642
Seat-Bottom Actuator
644
620
628
618
Vehicle Seat
610
Vehicle Frame
626

FIG. 69

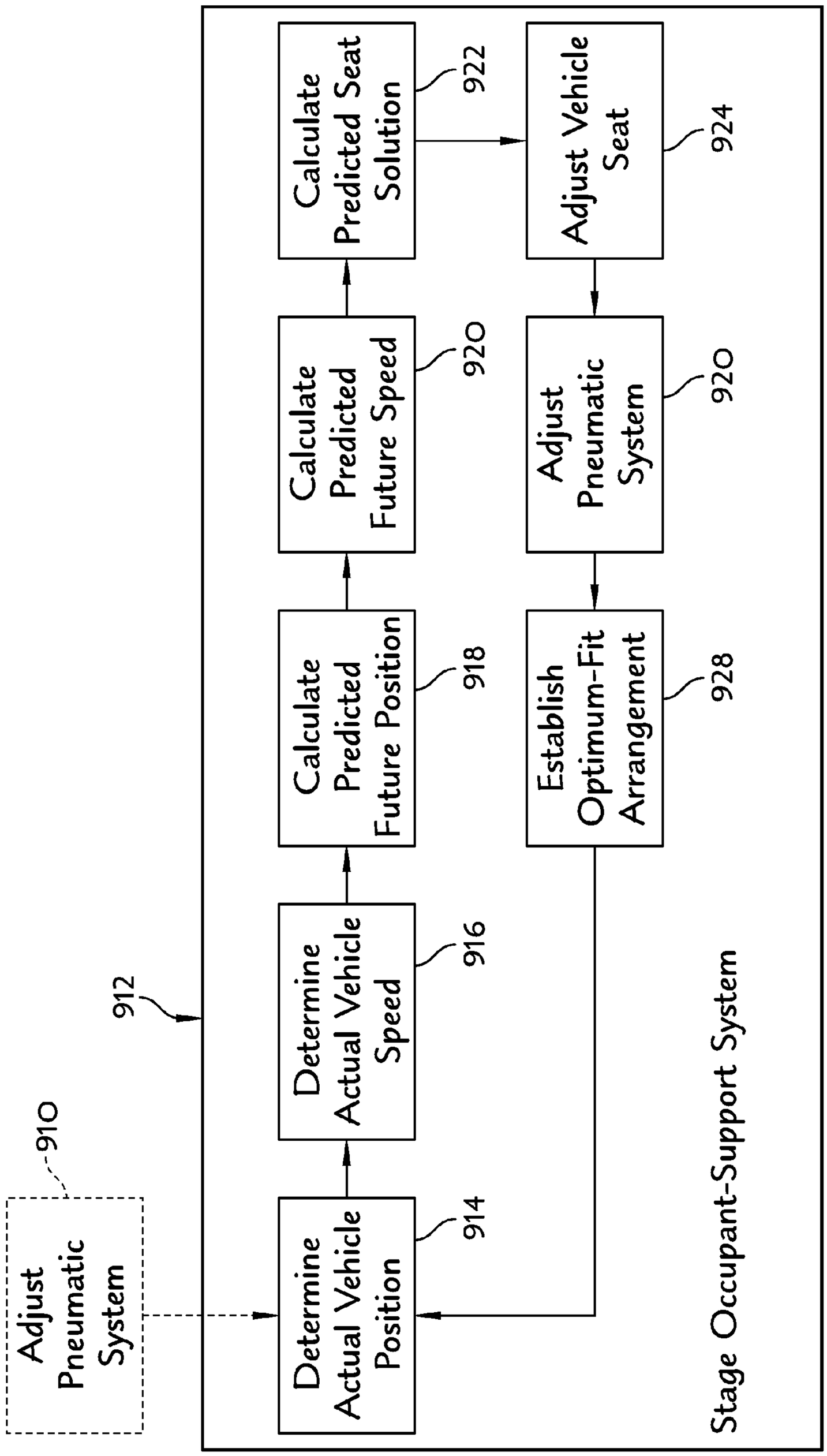

Adjust Pneumatic System
910
912
Determine Actual Vehicle Position
914
Determine Actual Vehicle Speed
916
Calculate Predicted Future Position
918
Calculate Predicted Future Speed
920
Calculate Predicted Seat Solution
922
Establish Optimum-Fit Arrangement
928
Adjust Pneumatic System
920
Adjust Vehicle Seat
924
Stage Occupant-Support System

FIG. 70

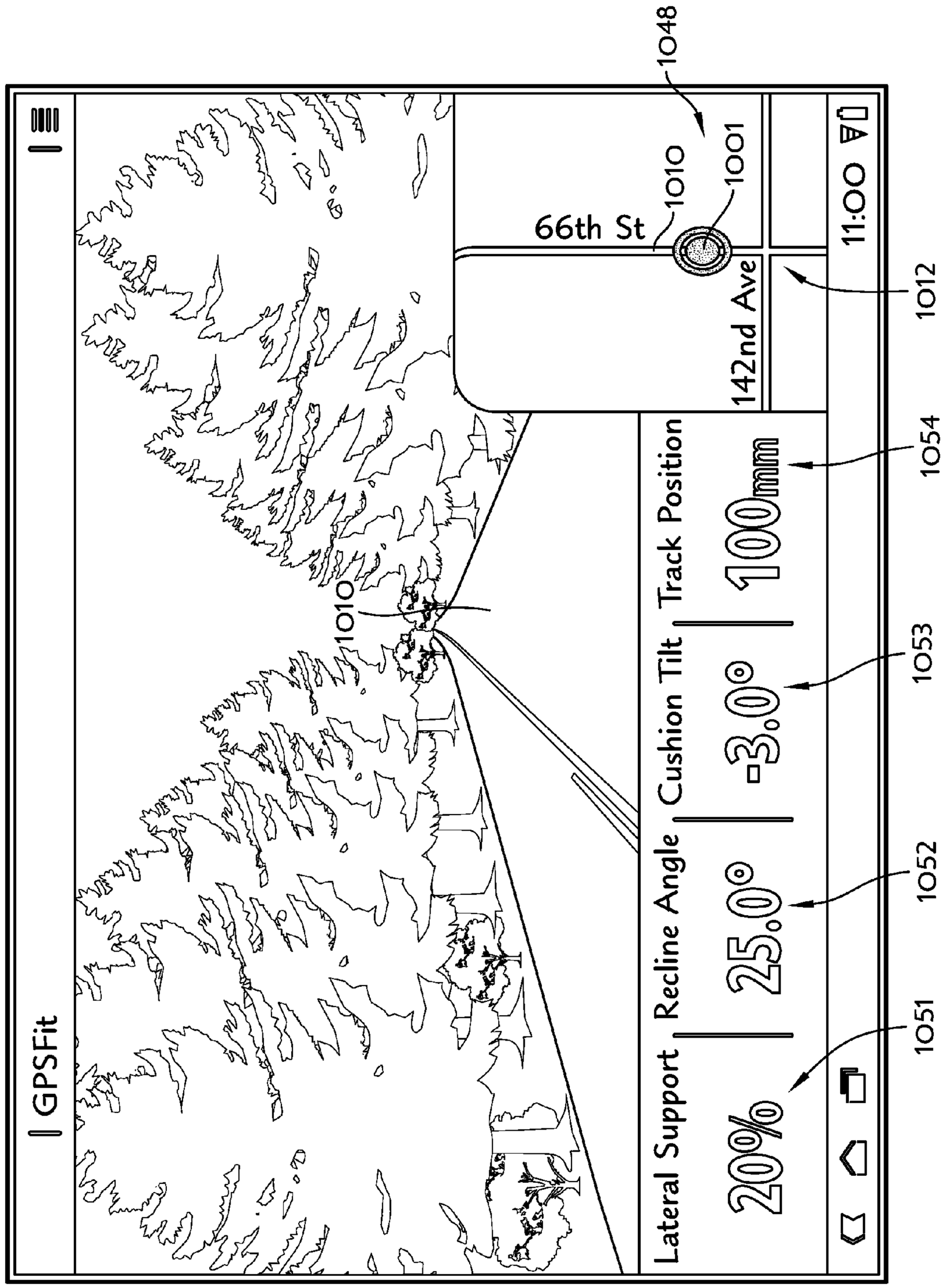

GPSFit
1048
66th St
1010
1001
142nd Ave
11:00
1012
1010
Lateral Support
20%
Recline Angle
25.0°
Cushion Tilt
-3.0°
Track Position
100mm
1051
1052
1053
1054

FIG. 71

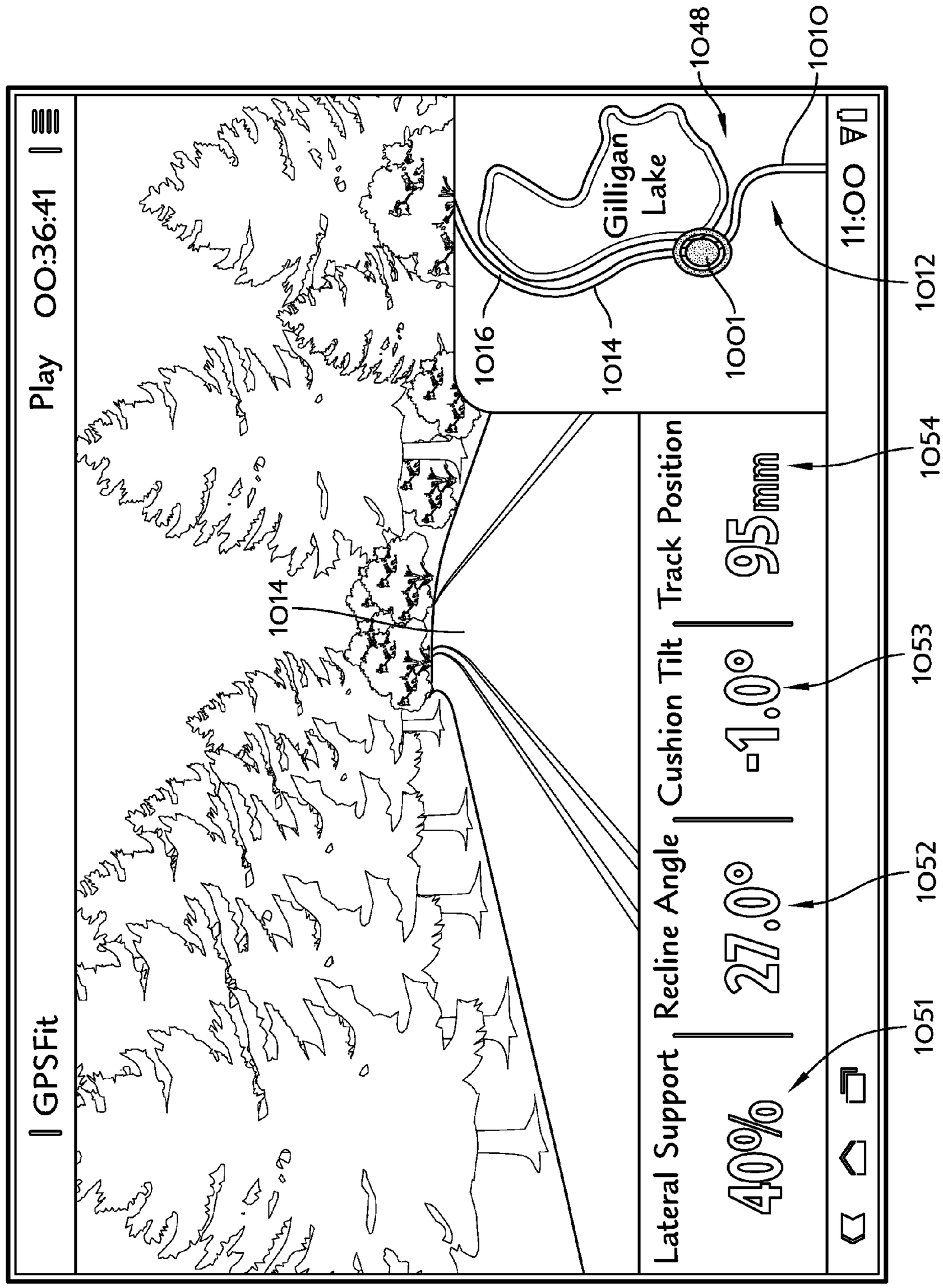

GPSFit
Play 00:36:41
Gilligan Lake
11:00
1048
1010
1012
1016
1014
1001
1014
Lateral Support
40%
Recline Angle
27.0°
Cushion Tilt
-1.0°
Track Position
95mm
1051
1052
1053
1054

FIG. 72

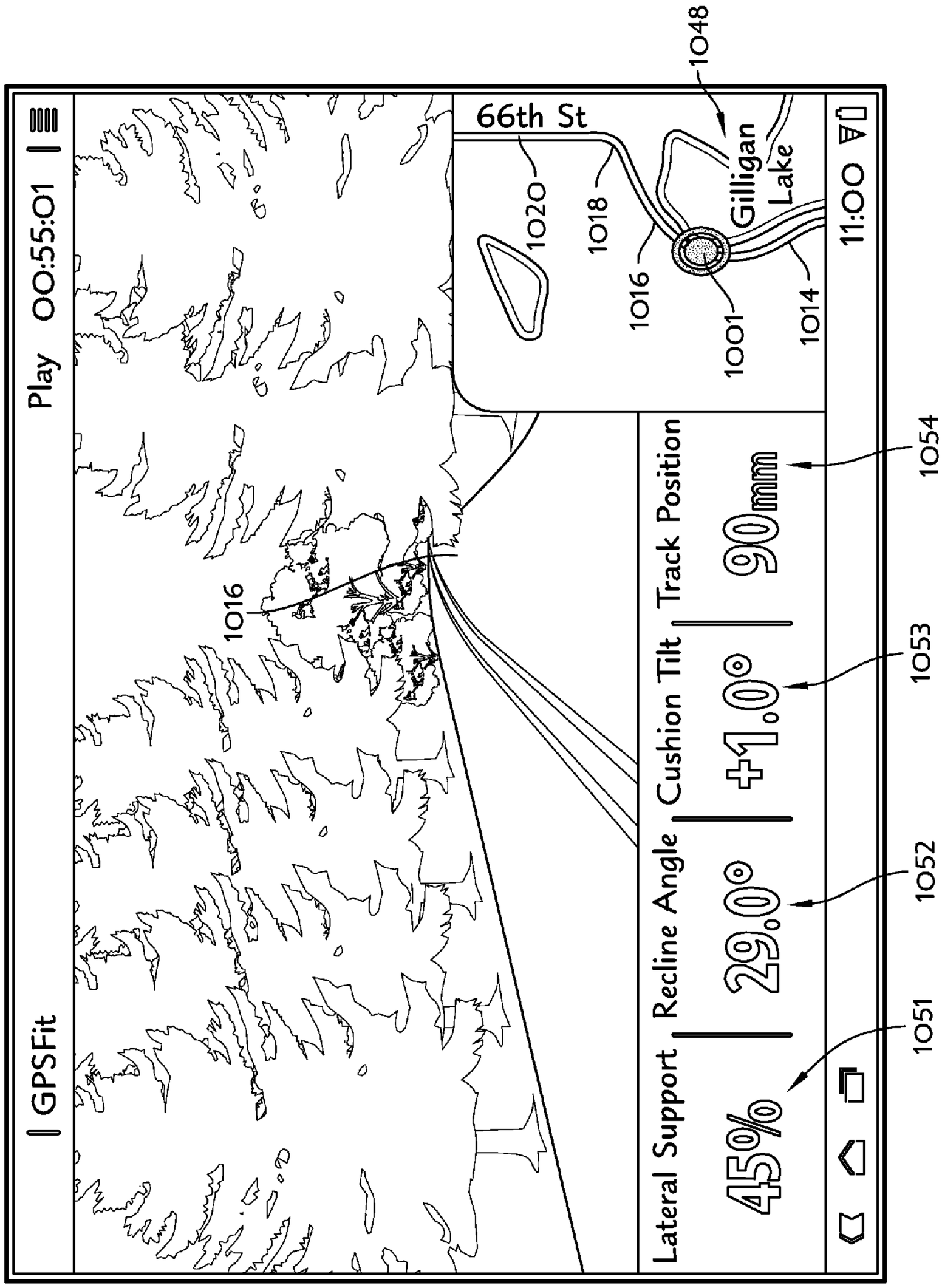

GPSFit
Play 00:55:01
66th St
1020
1018
1016
1001
1014
1048
Gilligan Lake
11:00
1016
Lateral Support
45%
Recline Angle
29.0°
Cushion Tilt
+1.0°
Track Position
90mm
1051
1052
1053
1054

FIG. 73

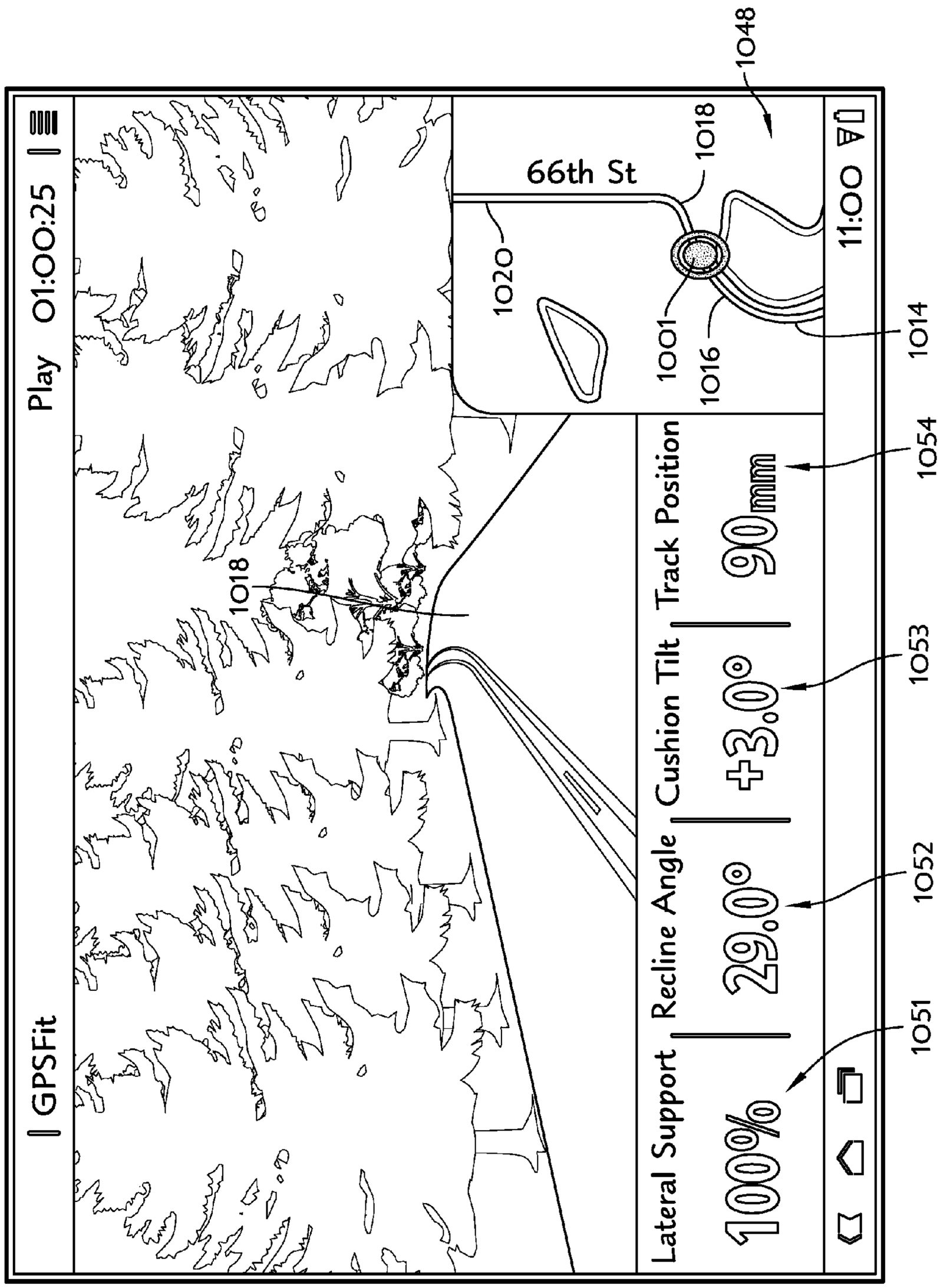

GPSFit
Play 01:00:25
66th St
11:00
1048
1018
1020
1001
1016
1014
1018
Lateral Support
100%
Recline Angle
29.0°
Cushion Tilt
+3.0°
Track Position
90mm
1051
1052
1053
1054

FIG. 74

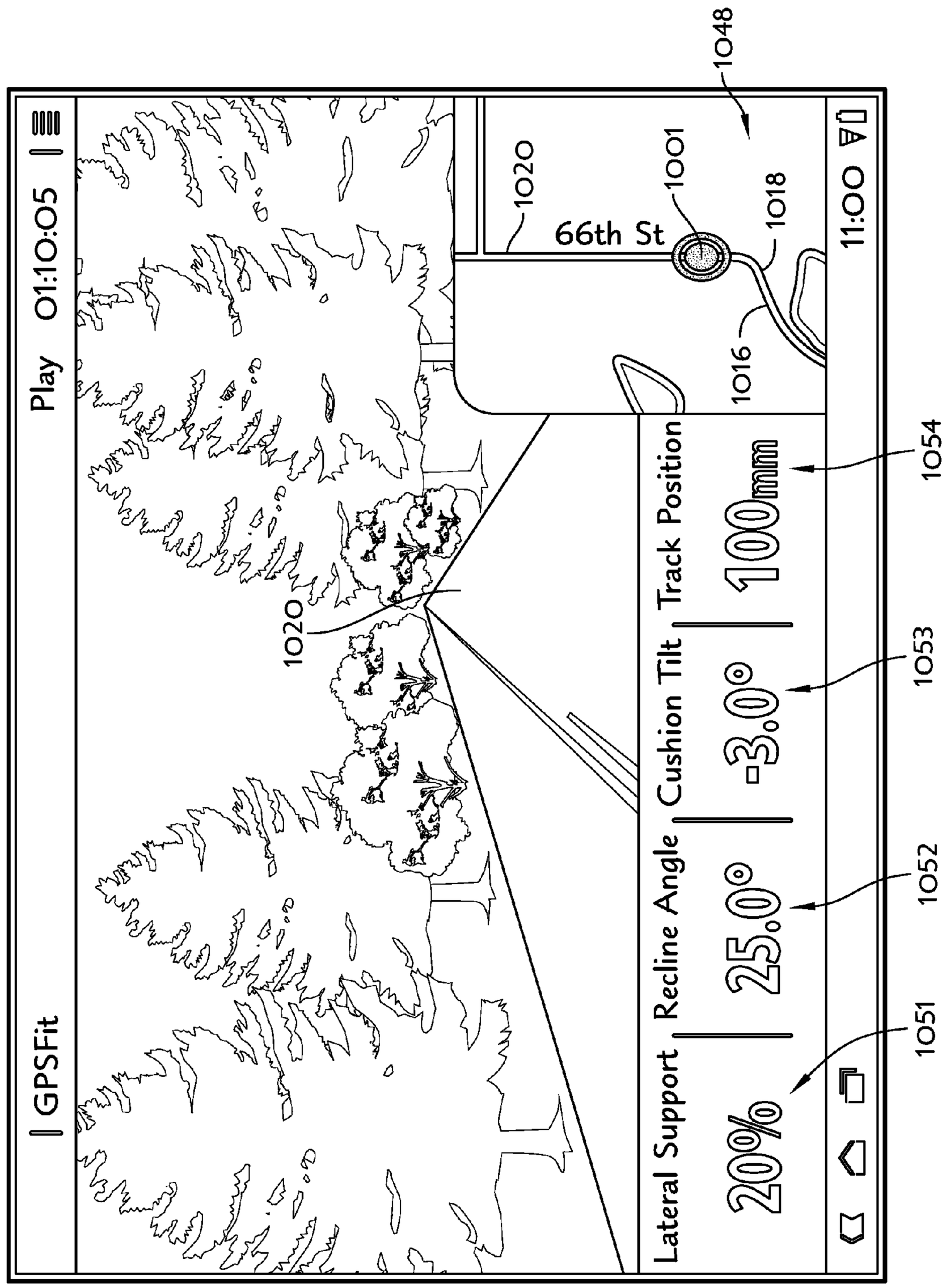

GPSFit
Play
01:10:05
1020
66th St
1001
1018
1016
1048
11:00
1020
Lateral Support
20%
Recline Angle
25.0°
Cushion Tilt
-3.0°
Track Position
100mm
1051
1052
1053
1054

FIG. 75

SYSTEM, METHODOLOGIES, AND COMPONENTS ACQUIRING, ANALYZING, AND USING OCCUPANT BODY SPECIFICATIONS FOR IMPROVED SEATING STRUCTURES AND ENVIRONMENT CONFIGURATION

PRIORITY CLAIM

This application is a continuation of U.S. application Ser. No. 14/591,822, filed Jan. 7, 2015, which is a continuation of U.S. application Ser. No. 13/267,463, filed Oct. 6, 2011, which claims priority under 35 U.S.C. §119(e) to U.S. Provisional Application No. 61/390,863, filed Oct. 7, 2010, U.S. Provisional Application No. 61/506,508, filed Jul. 11, 2011, and U.S. Provisional Application No. 61/533,408, filed Sep. 12, 2011, each of which is expressly incorporated by reference herein.

BACKGROUND

The present disclosure relates to seating, and particularly to seating used in conjunction with vehicles or other seating in which comfort and/or fit is valued. More particularly, the present disclosure relates to a system, methodologies, and components for improving fit of seating so as to be customized to an occupant.

SUMMARY

In accordance with illustrated embodiments, equipment and processes provide the ability to adjust manually and/or automatically various dimensions of a vehicle seat so that the vehicle is customized to an occupant's preferences. Such adjustment mechanisms enable the occupant to conform the seat dimensions and position to the occupant's comfort preferences and to customize the seat dimensions and positions for the occupant's height, weight, and gender. This type of customization is not limited to height adjustment or seat positioning but may also include control of the cushion tilt, fore/aft slide, upper back angle adjustment, cushion length adjustment, headrest adjustment, lumbar support, etc.

In illustrative embodiments, equipment and processes may generate a best-fit body arrangement for each occupant according to the occupant's anthropometric data rather than from generalizations. The anthropometric data may be obtained in various ways using computational devices and software or by manually measuring the relevant dimensions on the occupant's body. As a result, flexibility in obtaining the occupant data is provided.

In illustrative embodiments, a computational device may be a mobile terminal that includes a user interface. The user interface may be used for inputting occupant data. The mobile terminal may be included in the vehicle or separate from the vehicle, thus giving users increased flexibility while maximizing simplicity and usability for the user or other personnel obtaining the occupant data. Once an occupant's best-fit body arrangement is determined, it may be altered by changing predetermined criteria to achieve optimum, comfort, safety, and/or therapeutic benefit. The best-fit body arrangement may also be used to provide improved comfort on a continuous basis and/or in response to detected or predicted vehicle, road, or atmospheric conditions.

In illustrative embodiments, equipment and processes may generate a best-fit seating solution that provides an arrangement of a vehicle seat that causes an occupant's body to assume the best-fit body position when the occupant rests on the vehicle seat. The best-fit seating solution may be determined for each occupant according to the occupant's anthropometric data rather than from generalizations. As a result, a personalized or customized arrangement of the vehicle seat for the occupant may be achieved.

In illustrative embodiments, equipment and processes may be provided for generating a best-fit seating solution by obtaining occupant data, calculating body dimensions from the occupant data, and calculating a best-fit body arrangement for the occupant using the body dimensions and predetermined criteria. Occupant data may be obtained by receiving sensor data, receiving data directly input from a user interface, or a combination of the two. Obtaining occupant data may include inputting general occupant metrics (e.g., height, weight, and gender) and collecting sensor data. Collected sensor data may include a digital photograph showing overall dimensions of the occupant and/or accelerometer data obtained during predetermined movements of the accelerometer by the occupant. Sensor data and occupant data may be obtained on a mobile terminal that may be separate from the vehicle or included in or coupled to the vehicle.

In illustrative embodiments, occupant data may be used to calculate a set of body dimensions which model the occupant's body. Body dimensions may be calculated using occupant anthropometric data and sensor data. First, the sensor data and occupant data are converted into body ratios. The body ratios and occupant metrics are then used to calculate external-body dimensions. Thickness of the occupant's flesh may then be estimated and used to calculate internal-body dimensions that are representative of the occupant's skeleton.

In illustrative embodiments, the internal-body dimensions may then be used to calculate a best-fit body arrangement for the occupant by using predetermined criteria. A plurality of possible orientations of the occupant's internal body dimensions may then be calculated using a set of predetermined criteria, such as the angle of the occupant's femur relative to the floor of the vehicle. These various orientations may correspond to various postures the occupant may assume while sitting in the vehicle seat and satisfying a set of predetermined criteria. Finally, an average posture may be selected, and the corresponding arrangement of the occupant's body may be selected as the best-fit body arrangement.

In illustrative embodiments, equipment and processes may be provided for adjusting user-adjustable equipment in a vehicle by generating a best-fit seating solution, and generating equipment-adjustment instructions for automatic, powered, and/or manual vehicle seats. The best-fit seating solution may be generated using occupant data supplied to a computer. The computer may then determine the best-fit body arrangement for the occupant according to predetermined criteria. The computer may then generate equipment-adjustment instructions using known information about equipment in the vehicle. Relevant information may include the movement capability of the equipment, whether the equipment is moved manually or by powered actuators, and the position of the equipment in the vehicle.

In illustrative embodiments, the best-fit seating solution and the equipment-adjustment instructions may be generated on a remote computer that may be located away from the vehicle. The equipment-adjustment instructions may be communicated automatically or in a semi-autonomous manner to the equipment in the vehicle and adjusted using

powered actuators included in the equipment, or may be communicated to a user in the field to adjust manually the equipment.

In illustrative embodiments, an occupant-support system may include a communication unit, at least one intelligent vehicle seat, and a source of data to be used by the intelligent vehicle seat. The occupant-support system may be configured to obtain data and optimize the occupant's seating experience using that data. The sources of data include a sensor integrated into the vehicle seat and configured to sense an occupant's anthropometric data and an occupant's comfort data, a sensor integrated into a vehicle cabin, input received from a mobile terminal, input received from a user interface, and input received from a remote server.

In illustrative embodiments, an occupant-support system illustratively includes a communication unit, at least one intelligent vehicle seat, and a source of data to be used by the intelligent vehicle seat. The communication unit included in the vehicle may be configured to provide means for communicating data to the intelligent vehicle seat from the data source. As a result, the data source may be a mobile terminal and a remote server working together to obtain occupant data and calculate seat-adjustment instructions, which are communicated back to the intelligent vehicle seat and carried out by the intelligent vehicle seat. In illustrative embodiments, the data source may be a user interface included in the vehicle that receives data from a user and displays data to the user.

In illustrative embodiments, the data source may be a sensor package included in a vehicle cabin or in the intelligent vehicle seat or a combination of the previously discussed data sources. The sensor package may be one or more sensors included in the vehicle seat and configured to obtain occupant data, e.g., weight, height, body dimensions, topography, and data relating to the occupant's perceived comfort. The occupant and comfort data may be sent across the communication network to a remote server and used to continually update and modify the best-fit seating solution applied to the intelligent vehicle seat.

In illustrative embodiments, an occupant-support system may include the communication unit, a front intelligent vehicle seat, and a rear intelligent vehicle seat. The front and rear intelligent vehicle seats may be coupled to the communication unit and may be configured to exchange data about the position and state of each seat with the other seat either directly or through the communication unit. As a result, the intelligent seats may act as sources of data that are then used to calculate a best-fit cabin solution. The best-fit cabin solution may be the arrangement of intelligent vehicle seats relative to one another that maximizes comfort and safety of each occupant sitting in his or her seat.

In illustrative embodiments, an occupant-support system may include a communication unit, at least one intelligent vehicle seat, and a source of data to be used by the at least one intelligent vehicle seat. The occupant-support system may be further configured to use data regarding an occupant's size and seating preferences to optimize the occupant's seating experience and to provide additional customization of an occupant's seating configuration performed on an initial or continuous basis.

In illustrative embodiments, an occupant support system may include a vehicle seat and a pneumatic system coupled to the vehicle seat. The pneumatic system may includes a pneumatic bladder coupled to the vehicle to inflate and change a seat surface included in the vehicle seat, a pressurized air source coupled to the bladder to change the air pressure in the bladder, and a pressure sensor coupled to the pneumatic bladder to sense the air pressure in the bladder. The pressure sensor may be further coupled to a control unit included in the vehicle seat to cause the control unit to command the pressurized air source to alter the air pressure in the bladder when the air pressure is sensed to be outside an acceptable range.

In illustrative embodiments, an occupant-support system may be configured to alter the occupant's seating configuration parameters to adjust for vehicle handling and/or speed variations resulting from predicted driving conditions resulting from detection of the occupant's vehicle based on Global Positioning System (GPS) detection. The occupant-support system may be further configured to adjust for detected weather and/or traffic conditions.

In illustrative embodiments, an occupant's vehicle seat arrangement may be adjusted based on data generated by a sensor package that may include one or more sensors coupled to the occupant's vehicle seat. These vehicle-seat sensors may be configured to obtain occupant data (e.g., weight, height, body dimensions, topography) and data relating to the occupant's perceived comfort. The occupant and comfort data may be sent across the communication unit to a remote computer and used to continually update and modify the best-fit seating solution applied to the intelligent vehicle seat.

Additional features of the present disclosure will become apparent to those skilled in the art upon consideration of illustrative embodiments exemplifying the best mode of carrying out the disclosure as presently perceived.

BRIEF DESCRIPTION OF THE DRAWINGS

The detailed description particularly refers to the accompanying figures in which:

FIGS. **1-22** are a series of views showing various embodiments and configurations of a configuration control system and their illustrative use, wherein:

FIG. **1** is an illustrative diagram of the configuration control system components acquiring, analyzing and using occupant body specifications to determine a best-fit body arrangement for an occupant;

FIG. **2** is a diagrammatic view of a configuration control system in accordance with the present disclosure showing that the configuration control system includes a mobile terminal, a remote computer, and a communication unit configured to facilitate communication between the mobile terminal and the remote computer;

FIG. **3** is a diagrammatic view of a vehicle-seat fitting process performed by the configuration control system of FIG. **2** showing that the vehicle-seat fitting process includes acquiring data and calculating body arrangements;

FIG. **4** is a diagrammatic view showing that acquiring data includes acquiring occupant data through a series of illustrative steps including initiating data acquisition, accessing a user interface, inputting anthropometric data associated with an occupant, and storing the occupant data for use during calculation of body arrangements as suggested in FIG. **5**;

FIG. **5** is a diagrammatic view showing that calculating body arrangement includes sending data by encrypting the occupant data, sending the occupant data, authenticating the occupant data, and decrypting the occupant data and analyzing data by calculating body ratios, calculating external-body dimensions, calculating internal-body dimensions, calculating best-fit comfort zones, selecting best-fit postures, and calculating a best-fit body arrangement for the occupant;

FIG. **6** is an enlarged view of a mobile terminal running at least one software application configured to perform acquisition and analysis of occupant body specifications for modifying seating structure and environment configuration;

FIG. **7** is an enlarged view of the mobile terminal of FIG. **2** displaying, on the user interface, a main menu of functions for acquiring, analyzing and using occupant body specifications for improved seating structure, and environment configuration;

FIG. **8** is an illustrative diagram of the components of the mobile terminal illustrated in FIG. **6** and configured to cooperate to support and implement the menu of functions for acquiring, analyzing, and using occupant body specifications as shown in FIG. **7** for improved seating structure and environment configuration;

FIGS. **9-20** provide a series of screen shots illustrating the user interface functionality provided by at least one software application and used to perform optimization and/or customization of an occupant's vehicle seat based on physical dimensions of the occupant, wherein:

FIG. **21** is a view of another mobile terminal running at least one software application configured to receive input of occupant data as suggested in FIG. **22** after a service provider logs in via a login screen;

FIG. **22** is a view of the mobile terminal of FIG. **21** showing an interface that allows the user to provide a gender of the occupant and input anthropometric data measured manually from the occupant;

FIGS. **23-57** are a series of views showing various embodiments and configurations of an occupant-support system including the configuration control system of FIGS. **1-22** and an adjustable vehicle seat, wherein:

FIG. **23** is a diagrammatic view of an illustrative vehicle-seat fitting process performed on an occupant-support system showing that the vehicle-seat fitting process includes acquiring data, calculating a body arrangement, calculating a seat solution, and adjusting the vehicle seat;

FIG. **24** is a diagrammatic view of an occupant-support system in accordance with the present disclosure showing that the occupant-support system includes a configuration control system and an adjustable vehicle seat;

FIG. **25** is a diagrammatic view showing that acquiring data includes acquiring occupant data and acquiring vehicle data, acquiring occupant data includes initiating data acquisition, accessing a user interface, inputting anthropometric data associated with an occupant, and storing the occupant data for use during calculation of body arrangements, as suggested in FIG. **26**, and acquiring vehicle data includes obtaining vehicle-seat data, obtaining other vehicle-equipment data, and storing the vehicle data for use during calculating of the seat solution as suggested in FIG. **27**;

FIG. **26** is a diagrammatic view showing that calculating body arrangement includes (i) sending data by encrypting the occupant data, sending the occupant data, authenticating the occupant data, and decrypting the occupant data and (ii) analyzing data by calculating body ratios, calculating external-body dimensions, calculating internal-body dimensions, calculating best-fit comfort zones, selecting best-fit postures, and calculating a best-fit body arrangement for the occupant for use during calculating of the seat solution as suggested in FIG. **27**;

FIG. **27** is a diagrammatic view showing that calculating the seat solution includes (i) calculating a best-fit seating solution, (ii) creating seat-adjustment instructions, and (iii) sending adjustment instructions by encrypting the adjustment instructions, sending the seat-adjustment instructions, and decrypting the seat-adjustment instructions, and showing that adjusting the vehicle seat includes (i) adjusting a position of the seat bottom per the seat-adjustment instructions, (ii) adjusting a position of the seat back per the seat-adjustment instructions, and (iii) adjusting a position of the other vehicle seat options;

FIG. **28** is a diagrammatic view of the system components acquiring, analyzing, and using occupant body specifications for improving seating structure and environment configuration;

FIG. **29** is a screen shot of a mobile terminal running at least one software application that is configured obtain vehicle data by scanning by scanning a QR Code so that the mobile terminal is able to lookup relevant vehicle data including vehicle seat type and other vehicle equipment capabilities or by manually inputting a vehicle VIN;

FIG. **30** is a view similar to FIG. **29** showing that the QR Code has been accepted and that the associated vehicle VIN has been input;

FIG. **31** is a screen shot of the mobile terminal showing stored data associated with the vehicle VIN including at least one occupant profile that may contain occupant data, vehicle data, buttons that allow adding a new occupant profile, inputting occupant data, and managing other options including adding other functional programs;

FIGS. **32-34** provide a series of screen shots illustrating the user interface functionality provided by at least one software application and used to deliver optimized and/or customized vehicle seat parameters from a user's mobile terminal to the occupant's vehicle seat, wherein

FIG. **35** is another screen shot of a mobile terminal showing that after occupant data has been obtained, a best-fit arrangement of the vehicle seat is calculated and then instructions are communicated to a seat-movement system included in the vehicle seat that causes the vehicle seat to move to the best-fit arrangement;

FIG. **36** is a view showing that adjustment of the vehicle seat has been completed;

FIGS. **37** and **38** provide perspective illustrations of examples of control panels coupled to a vehicle seat;

FIG. **39** provides a screen shot illustrating the user interface provided functionality by at least one software application for enabling a user to select from one or more physical ailments or treatment conditions for which he is seeking assistance;

FIG. **40** provides a screen shot illustrating the user interface functionality provided by at least one software application for disseminating treatment information and/or recommendations for positioning of a vehicle seat;

FIGS. **41-43** provide screen shots illustrating the user interface functionality provided by at least one software application for enabling a user to select from one or more upgrade options for upgrading functionality provided by the occupant's vehicle seat via wireless Over The Air (OTA) configuration;

FIGS. **44** and **45** provide a series of screen shots illustrating the user interface functionality provided by at least one software application and used to deliver data and/or software programming associated with the upgraded functionality to the user's mobile terminal;

FIGS. **46** and **47** provide a series of screen shots illustrating the user interface functionality provided by at least one software application and utilized to deliver the data and/or software programming associated with the upgraded functionality from a user's mobile terminal to the occupant's vehicle seat;

FIG. **48** is a screen shot of the mobile terminal showing that the user can select from one of a Wellness Therapies

button and a Pro Postures button and suggesting that the user has selected the Wellness Therapies button;

FIG. **49** is a view similar to FIG. **48** showing that the user has selected a Shiatsu Massage application, a Workout Relief application, and the MicroFit application among various other Wellness Therapies;

FIG. **50** is a screen shot of the mobile terminal showing that the user has selected a Performance Drive application and a GPSFit application and that the user has pressed the Install Selections button causing the selected applications to be installed into the seat-movement system;

FIG. **51** is a view showing that the user selected applications are being sent to the vehicle seat for installation in the seat-movement system;

FIG. **52** is a view similar to FIG. **51** showing that the installation of the selected applications are complete;

FIG. **53** is a diagrammatic view used to explain functionality that may be provided to a user via the system, methodologies and components for acquiring, analyzing and using occupant body specifications to provide for improved seating structure and environment configuration;

FIG. **54** is a diagrammatic view of another embodiment of an occupant-support system showing that the occupant-support system includes a front vehicle seat and a rear vehicle seat communicating between on another to achieve a best-fit arrangement of both the front and the rear vehicle seat;

FIGS. **55-57** provide various illustrative diagrams describing various configurations for providing certain communication functionality used by the system;

FIG. **58** is a diagrammatic view of another embodiment of an occupant-support system showing that the occupant-support system includes an illustrative mobile terminal, a server, a seat-movement system included in a vehicle seat, a personal computer and other equipment that may be used to provide communication between the equipment components.

FIGS. **59-67** are a series of views showing various embodiments and configurations of an occupant-support system including the configuration control system of FIGS. **1-22**, an adjustable vehicle seat, and a pneumatic system, wherein:

FIG. **59** is a diagrammatic view of an illustrative occupant-support fitting process performed on the occupant-support system showing that the occupant-support fitting process includes acquiring data, calculating a body arrangement, calculating a seat solution, adjusting the vehicle seat, and adjusting the pneumatic system to achieve an optimum-fit arrangement of the occupant-support system;

FIG. **60** is a diagrammatic view of a second embodiment of an occupant-support system in accordance with the present disclosure showing that the occupant-support system includes the configuration control system, an adjustable vehicle seat in communication with the configuration control system, and a pneumatic system including a pair of pneumatic bladders and a single pressure sensor coupled to both pneumatic bladders to sense the air pressure in each pneumatic bladder in series one at a time;

FIG. **61** is a diagrammatic view of the pneumatic adjustment portion of the occupant-support fitting process showing that pneumatic adjustment is accomplished by inflating an air bladder included in the pneumatic system, sensing air pressure in the pneumatic bladder, determining if the air pressure is out of an acceptable range, maintaining the air pressure in the bladder if the air pressure is in the acceptable range, and correcting the air pressure in the bladder if the air pressure is out of the acceptable range;

FIG. **62** is an illustrative screen shot of a mobile terminal in which a user activates an application on the mobile terminal called MicroFit which, as an example, causes the seat-movement system to perform the pneumatic adjustment portion of the occupant-support fitting process that receives an air-pressure reading from the pneumatic bladder and commands a pressurized air source to adjust the air pressure in the pneumatic bladder to achieve the acceptable pressure range so that an interface pressure between the occupant and the pneumatic bladder is minimized;

FIG. **63** is a screen shot of the mobile terminal showing the MicroFit application beginning to start and showing that a plurality of pneumatic bladders coupled to the vehicle seat may be adjusted in (i) a momentary mode in which one or more pressure sensors included in the pneumatic system send air-pressure readings to the seat-movement system to cause the air pressures in the bladders to be adjusted to be in the acceptable pressure range once as shown in FIG. **61** or (ii) a continuous mode in which the pressure sensors continuously send air-pressure readings to the seat-movement system and the system continuously maintains the pressure in the bladders in the acceptable pressure range as suggested in FIG. **61** (in phantom);

FIG. **64** is a screen shot of the mobile terminal showing initial readings of the various pneumatic bladders and showing that both seat-back wing bladders and a middle lumbar bladder have very high pressure that should be reduced, that both seat-bottom wing bladders and a lower lumbar bladder have low pressure that should be increased, and that the upper lumbar bladder is in the acceptable pressure range;

FIG. **65** is a screen shot of the mobile terminal showing that the user has selected the continuous mode and that the seat-movement controller will cause the pneumatic system to continuously sense and adjust the pressure in the pneumatic bladders to maintain the pressure in the acceptable range as suggested in phantom in FIG. **61**;

FIG. **66** is another screen shot of the mobile terminal showing that the seat-movement system may be reset to its initial configuration when a user presses and holds a master-reset button and that pressure in each of the pneumatic bladders may be adjusted manually by the user;

FIG. **67** is a diagrammatic view of a third embodiment of an illustrative occupant-support system showing that the occupant-support system includes the configuration control system, the adjustable vehicle seat in communication with the configuration control system, and a pneumatic system that includes two pneumatic bladders that are coupled to two separate pressure sensors that are configured to sense air pressure in each pneumatic bladder in parallel;

FIGS. **68-76** are a series of views showing various embodiments and configurations of an occupant-support system including the configuration control system of FIGS. **1-22**, an adjustable vehicle seat, a pneumatic system, and a prediction system that predicts a future position and speed of the vehicle and provides the future position and speed of the vehicle to the vehicle seat to cause the configuration control system and vehicle seat to calculate a predicted optimum-fit of the occupant-support system to support the occupant in the vehicle appropriately as the vehicle seat passes through the future position, wherein

FIG. **68** is a diagrammatic view of an illustrative occupant-support staging process performed on the occupant-support system showing that the occupant-support predicted fitting process includes acquiring data, calculating a body arrangement, calculating a seat solution, adjusting the vehicle seat, adjusting the pneumatic system, and staging the

occupant-support system to achieve a predicted optimum-fit arrangement of the occupant-support system;

FIG. **69** is a diagrammatic view of a second embodiment of an occupant-support system in accordance with the present disclosure showing that the occupant-support system includes the configuration control system, an adjustable vehicle seat in communication with the configuration control system, the pneumatic system, and a prediction system that includes a Global Positioning System (GPS) unit and mapping unit that cooperate to predict the future position and speed of the vehicle as suggested in FIG. **70**;

FIG. **70** is a diagrammatic view of the staging the occupant-support system portion of the occupant-support predicted fitting process showing that staging the occupant-support system portion is determining an actual position of the vehicle, determining an actual speed of the vehicle, calculating a predicted future position of the vehicle, calculating a predicted future speed of the vehicle, calculating a predicted seat solution of the vehicle seat, adjusting the vehicle seat to achieve the predicted seat solution, adjusting the pneumatic system to establish a predicted optimum-fit arrangement of the occupant-support system;

FIG. **71** is a screen shot of a mobile terminal showing an initial arrangement of the vehicle seat and the pneumatic system that is associated with normal-driving conditions and showing that the vehicle seat and pneumatic system have not been adjusted because the vehicle is moving along a straight section of road;

FIG. **72** is a view similar to FIG. **71** showing that the vehicle is about to enter a wavy portion and that the prediction system has provided a predicted future position and speed to the seat-movement system included in the vehicle seat that causes the vehicle seat to move its track position from 100 mm to 95 mm, a seat bottom included in the vehicle seat to decrease cushion tilt from −3.0 degrees to −1.0 degrees, and a seat back included in the vehicle seat to decrease the recline angle from 29 degrees to 27 degrees and simultaneously increasing lateral support from 20% to 40%;

FIG. **73** is a view similar to FIG. **72** showing that the vehicle has exited the wavy portion and is about to enter a large right-hand curve and that the prediction system has provided another predicted future position and speed to the seat-movement system causing the vehicle seat to move its track position from 95 mm to 90 mm, the seat bottom to increase cushion tilt from −1.0 degrees to +1.0 degrees, and the seat back to increase the recline angle from 27 degrees to 29 degrees and simultaneously increasing lateral support from 40% to 45%;

FIG. **74** is a view similar to FIG. **73** showing that the vehicle has exited the right-hand curve and is about to enter a left-hand turn and that the prediction system has provided another predicted future position and speed to the seat-movement system causing the vehicle seat to maintain the track position at 90 mm, the seat bottom to increase cushion tilt from +1.0 degrees to +3.0 degrees, and the seat back to maintain the recline angle at 29 degrees and simultaneously increasing lateral support from 45% to 100%; and

FIG. **75** is a view similar to FIG. **74** showing that the vehicle has exited the left-hand curve and is about to enter a second straight portion and that the prediction system has provided another predicted future position and speed to the seat-movement system causing the vehicle seat to move its track position from 90 mm to 100 mm, the seat bottom to decrease cushion tilt from +3.0 degrees to −3.0 degrees, and the seat back to decrease the recline angle from 29 degrees to 25 degrees and simultaneously decreasing lateral support from 100% to 20%.

DETAILED DESCRIPTION

A configuration control system **10** is shown in FIG. **2** and may be configured to perform an occupant-body fitting process **100** that is shown in FIG. **1**. Configuration control system **10** may perform occupant-body fitting process **100** to determine a best-fit body arrangement for an occupant that maximizes occupant comfort and safety.

A first embodiment of an occupant-support system **200** is shown in FIG. **24** and may be configured to perform a vehicle-seat fitting process **300** that is shown in FIG. **23**. Occupant-support system **200** may perform vehicle-seat fitting process **300** to generate a best-fit seating solution so that a vehicle seat **202** included occupant-support system **200** may be arranged to cause an occupant sitting on vehicle seat **202** to be in the best-fit body arrangement.

A second embodiment of an occupant-support system **400** is shown in FIG. **54**. Occupant-support system **400** may include front and rear vehicle seats **402**, **404** and a sensor package **406** that cooperate together with configuration control system **10** to determine a best-fit seating solution for both vehicle seats **402**, **404**.

A third embodiment of an occupant-support system **600** is shown in FIG. **60** and may be configured to perform an occupant-support system fitting process **700** that is shown in FIG. **59**. Occupant-support system **600** may further include a pneumatic system **606** that cooperates with a vehicle seat **604** and configuration control system **602** to perform occupant-support system fitting process **700** to cause vehicle seat **604** and pneumatic system **606** to be arranged in an optimum-fit arrangement that further maximizes comfort and safety of the occupant sitting on vehicle seat **604**. Pneumatic system **606** may be configured to control air pressure in multiple air bladders in series.

A fourth embodiment of an occupant-support system **800** is shown in FIG. **67** in which occupant-support system **800** may include a different embodiment of a pneumatic system **806**. Pneumatic system **806** may be configured to control air pressure in multiple air bladders in parallel.

A fifth embodiment of an occupant-support system **1000** is shown in FIG. **69** and may be configured to perform an occupant-support system predicted fitting process **900** as shown in FIG. **68**. Occupant-support system **1000** may further include a prediction system **1002** that uses sensor information to determine a predicted future position of the vehicle to cause a predicted optimum-fit arrangement of vehicle seat **604** and pneumatic system **606** to be established before the vehicle arrives at the predicted future position.

Returning to FIG. **2**, a configuration control system **10** may obtain anthropometric data about an occupant and calculates a best-fit arrangement of the occupant's body that maximizes comfort and safety for the occupant as suggested in that Fig. Configuration control system **10** may be configured to perform an occupant-body fitting process **100** as shown in FIG. **1**. An occupant-support system **200** may include configuration control system **10** and a vehicle seat **202**. Occupant-support system **200** may be configured to perform a vehicle-seat fitting process **300** that may adjust and move vehicle seat **202** to a best-fit arrangement that causes the occupant's body to assume the best-fit body arrangement.

In accordance with the first embodiment, the equipment and processes for generating a best-fit seating solution may provide several advantages. First, a best-fit body arrangement may be determined for each occupant according to the occupant's anthropometric data, thus giving a best-fit arrangement for the occupant. Second, the data input to the

body dimension calculation algorithm may be obtained using available mobile terminals and software or by manually measuring the relevant dimensions on the occupant, thus giving increased flexibility. Third, the user interface for inputting occupant metrics and/or occupant measurements may be provided in a mobile terminal included in the vehicle or separate from the vehicle, thus giving users increased flexibility. Fourth, body dimensions may be calculated using a minimized set of occupant data and sensor data, maximizing simplicity and usability of the process. Fifth, the determination of the best-fit body arrangement may be altered by changing the predetermined criteria to achieve optimum comfort, safety, and therapeutic benefit without requiring any other adjustments to hardware or software used to calculate the best-fit seating solution.

A configuration control system **10** may perform an occupant-body fitting operation **100** as shown in FIGS. **1-3**. Configuration control system **10** may include a user interface **12** included in a terminal **16**, a computer **14**, and a communication unit **18** as shown in FIG. **2**. User interface **12** may obtain occupant data that is associated with the occupant. Occupant data may include the occupant's weight, gender, and anthropometric measurements taken from the occupant's body. Occupant data may then be communicated to computer **14** by communication unit **18**. Computer **14** may be configured to provide means for receiving occupant data, calculating internal body dimensions of the occupant using the occupant data, and calculating a best-fit body arrangement of the occupant using the internal body dimensions along with other predetermined criteria. Occupant comfort and safety may be maximized when the occupant's body is arranged in the best-fit body arrangement.

Occupant-body fitting operation **100**, which may be performed by configuration control system **10**, may include the operations of acquiring data **102** and calculating a body arrangement **104** as shown in FIG. **3**. Acquiring data **102** may be accomplished illustratively by initiating data acquisition **106**, accessing user interface **108**, inputting anthropometric data **110** associated with the occupant, optionally receiving sensor data **112**, and storing occupant data **114** for use in calculating body arrangement **104** as shown in FIG. **4**.

Calculating a body arrangement **104** may be accomplished by sending data **116** and data analysis **118** as shown in FIG. **5**. Sending data **116** in the illustrative embodiment may include the operations of encrypting data **119**, sending encrypted data **120**, authenticating data **122**, and decrypting data **124**. As an example, encrypting data **119** and sending encrypted data **120** may be performed on a terminal **16** (mobile or incorporated into a vehicle as explained herein) including user interface **12**. Authenticating data **122** and decrypting data **124** may be performed on computer **14** which is in communication with terminal **16**.

Data analysis **118** may include, for example, calculating body ratios **126**, calculating external-body dimensions **128**, calculating internal-body dimensions **130**, calculating best-fit comfort zones **132**, selecting a best-fit posture **134**, and calculating best-fit body arrangement **136** as shown in FIG. **5**. Calculating body ratios **126** may be performed on computer **14** and may use, for example, the occupant data. Calculating external-body dimensions **128** may be performed on computer **14** and may use body ratios obtain during calculating body ratios **126**. Calculating internal-body dimensions **130** may be performed on computer **14** and may use external-body dimensions and the occupant data. Calculating best-fit comfort zones **132** may be performed on computer **14** and may use internal-body dimensions to calculate several body arrangements for various occupant postures. Selecting best-fit posture **134** may be performed on computer **14** and may use best-fit comfort zones, occupant data, and other predetermined criteria. Calculating best-fit body arrangement **136** may be performed on computer **14** and may use selected best-fit posture and other predetermined criteria to determine a best-fit body arrangement for the occupant.

Configuration control system **10** may include various components for acquiring, analyzing, and using occupant data for improved seating structure and environment configuration in accordance with the present disclosure. As shown in FIG. **1**, terminal **16** may be used to communicate with, among other components, computer **14** by way of communication unit **18**. Communication unit **18** may be one or more public and/or private communication networks that may include any type of communications network including but not limited to a second Generation (2G) network, a 2.5 Generation network, a third Generation (3G) network using Global System for Mobile Communications (GSM), Wideband Code Division Multiplex Access (WCDMA), Code Division Multiplex Access (CDMA), or Time Division Multiplex Access (TDMA), General Packet Radio Services (GPRS), Universal Mobile Telephone System (UMTS). Further, the one or more communication networks may also include local area networks, such as Wireless Local Area Networks (WLAN), BLUETOOTH® (BT) and optionally use one or more other technologies, such as WiMax (Worldwide Interoperability for Microwave Access).

Communication unit **18** may also include any other type of network of interconnected devices or device networks, e.g., interconnected computers or computer networks. Communication unit **18** may also be a combination of a plurality of different types of networks forming one or more hybrid networks.

Terminal **16** may include user interface **12**. As shown for example in FIG. **1**, terminal **16** may be a mobile terminal **16**. Mobile terminal **16** may communicate via communication unit **18** using a communication link **20**. Access to computer **14** may be also provided by communication unit **18** using another communication link **22**. Communication links **20**, **22** need not be dedicated connections and may be conventionally understood transitory communication links that provide wireless transmission and reception of data for a communication session during the length of that session. Thus, in illustrative embodiments, one or more software applications which may be running on the mobile terminal **16** and other information to computer **14**. As an example, computer **14** may be at least one remote computer or server that may be spaced apart from mobile terminal **16**. Computer **14** may be configured to process data received via communication unit **18** from the mobile terminal **16** to provide various types of functionality. For example, as suggested in FIG. **28**, computer **14** may be running a seat analytic, optimization and upgrade software suite **135** that includes various different types of software algorithms for performing analysis of received data and providing configuration data, upgrades and/or guidance to a user via the mobile terminal **16**.

FIG. **6** is an enlarged perspective view of a mobile terminal **16** running at least one software application configured to perform acquisition and analysis of occupant data for determining a best-fit body arrangement of the occupant in accordance with the present disclosure. As shown in FIG. **6**, mobile terminal **16** may display user interface **12** that may be configured to display a short cut **26** associated with a main menu of services and functionality provided in accor-

dance with the present disclosure. Thus, user interface **12** may be further configured to receive input from a user such activating shortcut **26**, e.g., by tapping on the graphic associated with shortcut **26**. As a result, activating shortcut **26** may trigger display of a main menu associated with the services and functionality provided in accordance with the present disclosure.

For example, FIG. **7** provides an enlarged perspective view of mobile terminal **16** of FIG. **6** displaying, on user interface **12**, a main menu of functions for acquiring, analyzing, and using occupant data for determining a best-fit body arrangement. Thus, a user may select the "Create a Tailored Fit" application **28** that is configured to acquire and analyze occupant data to provide a best-fit body arrangement for the occupant. The best-fit body arrangement may be used to adjust a vehicle seat in a vehicle so that the best-fit body arrangement is achieved or to adjust a position of other equipment in a seating environment.

A user may also select the "Choose a Targeted Therapy" application **30** to obtain guidance and expert advice regarding a particular physical condition or ailment that may be improved by positioning or repositioning of an occupant's vehicle seat or components of that vehicle seat. Further, the user may select a "Shop for New Features" application **32**, which may be configured to provide the option of purchasing one or more additional software implemented treatment applications or customized seating configurations associated with an occupant's physical condition(s) or interests.

As shown in FIG. **8**, the mobile terminal illustrated in FIG. **6** may include various hardware and software components configured to cooperate to support and implement the menu of functions for acquiring, analyzing, and using occupant data. Thus, mobile terminal **16** may include user interface **12** that is configured to provide the ability to input data and review outputted data from terminal **16**. Thus, user interface **12** may include a display screen such as a touch screen for review and manipulation of data by the user. Mobile terminal **16** may also include input/output capabilities by including a speaker/microphone control module **34** configured to enable input and output of audio data in communication with mobile terminal **16**. Mobile terminal **16** may also include one or more processors **36** configured to perform software instructions included in one or more software applications included in one or more memory units **38**. These software instructions may be application specific or may be associated with functionality of the mobile terminal **16** embodied, for example, as a mobile telephone, wireless Internet browser, etc.

Mobile terminal may also include a suite of sensors **40** used to obtain occupant data. Such sensors **40** may include a digital camera configured and operational to acquire image data under the direction of the user, one or more accelerometers configured to sense and quantify data regarding the acceleration experienced by the sensor when manipulated by the occupant (such accelerometers are conventionally included in mobile terminals that provide the ability to participate in video games provided by software applications running on an occupant's mobile terminal **16**). Further, mobile terminal **16** may include a power module **42**, configured to govern the power requirements of mobile terminal **16** and provide power to the various components of mobile terminal **16**, as conventionally understood.

Mobile terminal **16** may be implemented as a Smartphone, feature rich mobile phone, lap top, PDA, multimedia computer, etc. Accordingly, mobile terminal **16** may include a processor connected to a user interface, computer readable memory and/or other data storage and a display and/or other output device. The mobile device may also include a battery, speaker and at least one antenna. The user interface may further include a keypad, a touch screen, a voice interface, one or more arrow keys, a joy-stick, a data glove, a mouse, a roller ball, a touch screen, or the like.

Accordingly, computer executable instructions and data used by a processor **36** and other components in mobile terminal **16** may be stored in the computer readable memory (ies) **38** included in mobile terminal **16**. Further, memory **38** may be implemented with any combination of read only memory modules or random access memory modules, optionally including both volatile and nonvolatile memory. Thus, software may be stored in the memory and/or storage to provide instructions to the mobile device's processor for enabling the mobile device to perform various functions. Alternatively, some or all of the mobile device computer executable instructions may be embodied in hardware or firmware (not illustrated).

FIGS. **9-20** provide a series of screen shots illustrating user interface **12** functionality provided by at least one software application to obtain occupant data that may be used to determine the best-fit body arrangement for the occupant. Thus, a user may select the "Create a Tailored Fit" application icon **28** from the main menu illustrated in FIG. **7**, thereby causing a welcome screen to be generated and output on the user interface **12**, as illustrated in FIG. **9**, providing directions **44** for beginning occupant-body fitting operation **100** as shown in FIG. **1**. Subsequently, the user may be prompted by a series of input screens to input various pieces of information in various fields including an occupant's gender **46**, an occupant's height **48**, an occupant's weight **50**, etc. That information may be entered, for example, using check boxes and/or using a keyboard of the terminal as shown in FIG. **10**.

Additionally, as illustrated in FIGS. **11-18**, the user may be prompted by a series of screens to use the mobile terminal's digital camera to obtain images of the occupant so that occupant-body fitting operation **100** will have occupant data indicating the relative proportions of the occupant's body. Note, the occupant may be using the assistance of another person to take these photographs of the occupant. It should be appreciated that the user may be provided with preliminary instructions that may instruct the user on where to position the modeled occupant when the photographing user is taking photographic images. This may or may not be necessary depending on whether the software is configured to make a determination of distance between the occupant to be modeled and the photographing user and whether the software compensates for such information.

As illustrated in FIG. **11**, the user may review instructions **52** for positioning the occupant's body to be photographed. As shown in FIG. **9**, user interface **12** may be configured to prompt the user to locate the occupant's image **54** in a positioning outline **56** as close as possible based on instructions **58** generated by the software application running on mobile terminal **16**. User interface **12** may be further configured to receive inputs from the user that locates occupant's image **54** in positioning outline **56**. Once in that position, the user may be prompted to take the photographic image, which will trigger the storage of the image data in conjunction with the mobile terminal application.

Next, the user may be prompted by instructions **58**, **60** to obtain various measurements on the occupant's body by adjusting the distance shown between the blades of a virtual caliper **62** displayed over the image **54**. The user may be able to adjust the caliper blade locations by using their finger to drag the caliper blades to the correct location. User interface

12 is configured to receive inputs from the user associated with adjusting virtual calipers **62**. As a result, the user may be prompted by user interface **12** to click on an OK icon when the user has positioned the calipers **62** to span a distance specified in the instructions **58**, e.g., head to seat dimension, as shown in FIGS. **13** and **14**. FIG. **13** illustrates a beginning location of the caliper blades and FIG. **14** illustrates the final location of the caliper blades for that measurement. Likewise, the user may be prompted to click on an OK icon when the user has positioned the calipers **62** to span a distance specified in the instructions **58** for the back to knee dimension, as shown in FIGS. **15** and **16**. FIG. **15** illustrates a beginning location of the caliper blades. FIG. **16** illustrates the final location of the caliper blades for that measurement. Also, the user is prompted to click on an OK icon when the user has positioned the calipers **62** to span a distance specified in the instructions **58**, e.g., knee to heal dimension, as shown in FIGS. **17** and **18**. FIG. **17** illustrates a beginning location of the caliper blades. FIG. **18** illustrates the final location of the caliper blades for that measurement.

Subsequently, the user may be prompted by instructions **64** to perform various movements while holding the mobile terminal **16** as suggested in FIG. **19**. This phase of the data acquisition subroutine may enable one or more accelerometers included in the mobile terminal **16** to obtain information regarding the arm length of the user based on the acceleration experienced by the accelerometer(s).

Once the data acquisition subroutine has obtained all the necessary data used for generating a data representation of the occupant, the user may be prompted by instructions **66** to input identifying information, e.g., a name, for the data representation as shown in FIG. **20**. As an example, user interface **12** may include a keyboard **68** provided by mobile terminal **16**.

As another example, a user may input occupant data manually by logging into a user interface **12** with a user name **70** and a password **72** as shown in FIG. **21**. As shown in FIG. **22**, the user may then enter the occupant's gender **46** as well as anthropometric data **565** measured manually by the user as shown in FIG. **22**. Thus, occupant data may be obtained by mobile terminal **16** without the use of sensors for measuring anthropometric data associated with the occupant.

As explained above, the software required to model the occupant via a data representation and associated occupant-body fitting may be performed using the software application running on mobile terminal **16** alone, or as illustrated in FIG. **1**, in combination with a server-implementation using occupant-body fitting operation **100** (which may or may not be implemented as server software depending on the "fatness" of the mobile terminal application deemed acceptable). The mobile terminal application may rely on increasingly large amounts of software residing on a server, it the mobile terminal application is meant to be "thin," i.e., requiring less memory on the mobile terminal for operation.

An occupant-support system **200** includes a configuration control system **210** and an adjustable vehicle seat **202** as shown in FIG. **24**. The occupant-support system **200** is configured to implement a vehicle-seat fitting process **300** that provides a best-fit arrangement of vehicle seat **202** as suggested in FIG. **23**.

Vehicle-seat fitting process **300** includes the operations of acquiring data **302**, calculating body arrangement **304**, calculating seat solution **338**, and adjusting vehicle seat **340** as shown in FIG. **23**. Acquiring data **302** is accomplished by obtaining the occupant's anthropometric data and the vehicle's equipment data. The occupant data is then used in calculating body arrangement **304** and vehicle-equipment data is used in calculating seat solution **338** to determine how the vehicle's equipment should be positioned to achieve the best-fit arrangement described previously. Adjusting vehicle seat **340** uses the instructions generated in calculating seat solution **338** to adjust the position of the vehicle seat **202**. Adjusting vehicle seat **340** may also be used to adjust the position of a steering wheel, mirrors, heads-up display, and control pedals to further improve the fit to the occupant.

Acquiring data **302** may include the operations of acquiring occupant data **342** and acquiring vehicle data **344** as shown in FIG. **25**. As shown there, acquiring occupant data **342** illustratively includes initiating data acquisition **306**, accessing user interface **308**, inputting anthropometric data **310**, optionally receiving sensor data **312**, and storing occupant data **314**. Acquiring vehicle data **344** illustratively includes obtaining vehicle-seat data **346**, obtaining other vehicle-equipment data **348**, and storing vehicle data **350** as shown in FIG. **25**.

Initiating data acquisition **306** may be performed illustratively on mobile terminal **16** as discussed previously. Accessing user interface **308** may be performed by the user accessing user interface **12** included in mobile terminal **16** to input occupant data during the operation of inputting anthropometric data **310**. Inputting anthropometric data **310** may include inputting data which includes occupant's weight (W), occupant's height (H), and occupant's gender (G). Other body measurements may be input as well. Receiving sensor data **312** may include receiving data from sensors included in one of mobile terminal **16**, vehicle seat **202**, or a vehicle interior. Sensor data may include a measurement representative of a distance (A) between an occupant's head and an occupant's seat, a distance (B) between an occupant's back and an occupant's knee, and a distance (C) between an occupant's knee and an occupant's heel. Storing occupant data **314** may include storing the occupant data on mobile terminal **16**, in memory included in the vehicle, or remotely on computer **14**, which is also called server **14**.

Obtaining vehicle-seat data **346** may be performed illustratively by mobile terminal **16** communicating with vehicle seat **202** to determine a configuration and capability of vehicle seat **202**. Vehicle-seat configuration and capability may be stored on memory included in vehicle seat **202** or on memory included in the vehicle. Vehicle-seat configuration and capability may also be stored on server **14** or another server and retrieved through the use of a vehicle-seat identifier which may be associated with the vehicle-seat configuration and capability.

Obtaining other vehicle-equipment data **348** of vehicle-data acquisition may be performed illustratively by mobile terminal **16** communicating with the vehicle to determine a make and model of the vehicle so that internal cabin geometry may be determined. As an example, a profile of the windshield and a distance between the windshield and the floor of the vehicle may be obtained and used later during calculating seat solution **338**. Vehicle cabin data may be stored in memory included in the vehicle seat, memory included in the vehicle, or on server **14** and retrieved using a vehicle identifier which may be associated with the vehicle. As an example, the vehicle identifier may be a Vehicle Identification Number (VIN) of the vehicle.

Obtaining vehicle-seat data **346** and other vehicle-equipment data **348** may obtained from inputting manually a VIN **74** as shown in FIG. **29**. The user may also hold a card having a QR code **76** thereon in front of a sensor included in mobile terminal **16**. The sensor may be a camera which scans the QR code and determines automatically vehicle

data as suggested in FIGS. **29** and **30**. Once the VIN is known and input into mobile terminal **16**, an occupant profile **78** including known occupant data, a vehicle picture **80**, a vehicle-seat picture **82**, and vehicle data **84** may be displayed as shown FIG. **31**.

After the occupant data and vehicle data have been obtained during data acquisition **302**, the data may then be used during calculating body arrangement **304** as shown in FIG. **26**. Calculating body arrangement **304** may include the operations of sending data **316** and data analysis **318**. Sending data **316** by way of illustration may include vehicle and occupant data encryption **319**, sending encrypted data **320**, data authentication **322**, and data decryption **324**. Sending data **316** may be used in the situation where data analysis **318** is not performed on the same device as data acquisition **302**. As an example, data acquisition **302** may be performed on mobile terminal **16** while portions of calculating body arrangement **304** may be performed by remote server **14**. Calculating body arrangement **304** may be performed on the same device as data acquisition **302** such that the operation of sending data **316** may not be performed.

Data analysis **318** may include the operations of calculating body ratios **326**, calculating external-body dimensions **328**, calculating internal-body dimensions **330**, calculating best-fit comfort zones **332**, selecting a best-fit posture **334**, and calculating best-fit body arrangement **336** as shown in FIG. **26**. During data analysis **318**, the measurements and data taken during data acquisition **302** may be used to calculate a best-fit arrangement of the occupant's body which maximizes comfort and minimizes safety risks. The best-fit body arrangement may then be used during calculating seat solution **338** to generate seat-adjustment instructions which may be sent to various pieces of equipment for either manual or automatic adjustment during adjusting of vehicle seat **340**. Sending adjustment instructions **356** may include encrypting adjustment instructions **358**, sending encrypted instructions **360**, and decrypting vehicle adjustment instructions **362**.

During calculation of body ratios **326**, distances (A, B, and C) obtained during data acquisition **302** may be used to calculate a set of ratios. The ratios and the occupant data (weight W, height H, and gender G) obtained during inputting anthropometric data **310** may be provided as inputs to calculating external-body dimensions **328**. Calculating external-body dimensions **328** may produce additional dimensions beyond those measured during data acquisition **302**.

External-body dimensions may then be used as inputs during calculating internal-body dimensions **330** to calculate a set of internal-body dimensions. Calculating internal-body dimensions **330** may include a first operation, which is performed by estimating distances between an occupant's flesh and the occupant's bones included in the occupant's skeleton, and a second operation, which is performed by using the estimated flesh thicknesses to calculate a set of internal-body dimensions that may be associated with an occupant's skeleton. As an example, the first operation may calculate the thickness of flesh between an occupant's pelvis and an outer surface of the occupant's back and calculate the thickness of flesh between the occupant's knee joint and an outer surface of the occupant's knee. The second operation may then subtract the two thicknesses previously calculated to determine an internal body dimension associated with an occupant's femur.

At least one of the internal-body dimensions calculated during calculating internal-body dimensions **330** may then be used with predetermined criteria as inputs to calculating best-fit comfort zones **332** for the occupant as shown in FIG. **26**. Calculating best-fit comfort zones **332** may include a first operation and a second operation. The first operation may be calculating all of the possible best-fit comfort zones that may be established for a particular occupant based on the occupant data obtained during data acquisition **302**. The second operation may include eliminating best-fit comfort zones based on the available positions in which the vehicle seat, vehicle pedals, and steering wheel may be arranged. As a result, a set of best-fit comfort zones may be established. Each best-fit comfort zone in the set may be associated with one of several seating postures that the occupant may assume while sitting in the vehicle.

During selection of best-fit posture **334**, one best-fit comfort zone may be selected from the set of best-fit comfort zones established during calculation of best-fit comfort zones **332**. As an example of selecting the best-fit posture, the best-fit comfort zone associated with a slouching posture and the best-fit comfort zone associate with an erect posture may be determined. An intermediate best-fit comfort zone associated with a moderate amount of slouch between the slouching posture and the erect posture may be chosen as the output of selecting best-fit posture **334**.

Finally, calculating a best-fit body arrangement **336** may use the best-fit posture determined during selection of the best-fit posture **334** to determine an arrangement of the occupant's body that maximizes comfort and minimizes risk to the occupant while sitting on vehicle seat **202**. The best-fit body arrangement may then be used during calculation of seat solution **338** as shown in FIG. **27**.

Calculating seat solution **338** may include calculating best-fit seating solution **352**, creating adjustment instructions **354**, and sending adjustment instructions **356** as shown in FIG. **27**. Calculating best-fit seating solution **352** may use the best-fit body arrangement and vehicle data to determine an arrangement of vehicle seat **202** and other vehicle equipment which allows the occupant's body to be in the best-fit body arrangement. After the best-fit seating solution **352** has been determined, the best-fit seating solution may be used to create adjustment instructions **354**. These instructions may be used to change the position of the vehicle seat, steering wheel, and vehicle pedals, among other equipment in the vehicle, to achieve the best-fit body arrangement determined earlier. After the adjustment instructions have been generated, the adjustment instructions may be communicated to vehicle seat **202** during sending adjustment instructions **356**.

Sending adjustment instructions **356** may include encrypting adjustment instructions **358**, sending encrypted instructions **360**, and decrypting adjustment instructions **362** as shown in FIG. **27**. As an illustrative example, data analysis **318** may be performed on remote server **14**. As a result, adjustment instructions may be sent during sending adjustment instructions **356** to mobile terminal **16**. Remote server **14** may encrypt adjustment instructions **358** and send encrypted instructions **360**. Mobile terminal **16** may be used to receive the encrypted adjustment instructions and communicate those adjustment instructions to vehicle seat **202**. A control unit included in vehicle seat **202** may then decrypt the adjustment instructions.

In another embodiment of calculating body arrangement **304** and calculating seat solution **338**, data analysis **318** may be performed on mobile terminal **16** without any communication with remote server **14**. Mobile terminal **16** may perform data analysis **318**, calculating best-fit seating solution **352**, creating adjustment instructions **354**, encrypting

adjustment instructions **358**, and sending encrypted instructions **360** to the control system of the vehicle seat or the vehicle.

Decrypted adjustment instructions may then be used by the control unit of the vehicle seat during adjusting vehicle seat **340** as shown in FIG. **27**. Adjusting vehicle seat **340** may include adjusting a position of a seat bottom **364** included in the vehicle seat, adjusting a position of a seat back **366** included in the vehicle seat, and adjusting positions of other vehicle options **368**. As an example, other vehicle options could be other adjustments of the vehicle seat such as a movable headrest, adjustment of a steering wheel, and adjustment of vehicle pedals. The vehicle seat, steering wheel, and vehicle pedals may move automatically if powered. However, the vehicle seat, steering wheel, and vehicle pedals may be moved manually should the vehicle not be equipped with powered equipment. In that circumstance, decryption of the adjustment instructions may be performed by mobile terminal **16**.

Various embodiments may be implemented with a vehicle seat that includes various types of functionality including powered adjustable seatback angle, height adjust, cushion tilt, fore/aft slide, upper back angle, cushion length adjust, powered headrest etc. Additionally, such a seat may include a pneumatic system that includes, for example, upper side bolsters, cushion bolsters, 4-way lumbar adjust, a 10 point programmed massage system, etc. Further, such a seat may include various types of climate control functionality including seat heating, active cooling, ventilation, and/or a full seat memory system. Navigating all of these options is sometime overwhelming to a user; further, the user may not understand fully how the various setting interact with one another or which setting are objectively more beneficial for an occupant's body size, dimensions, and physical conditions.

As suggested in FIGS. **11-19**, sensors included in mobile terminal **16** may be used to determine occupant data that can be used to model the occupant's body and proportions. Such sensors may include the camera provided in the mobile terminal, one or more accelerometers. Thus, one or more sensors included in mobile terminal **16** may work in conjunction with one or more software application running on mobile terminal **16** to obtain anthropometric data associated with occupant. In accordance with at least one embodiment, at least one sensor may be used in conjunction with a software application running on mobile terminal **16** and, optionally, sensors and/or transponders in the occupant's seating area to also provide anthropometric data associated with the occupant's body in relative relationship to the interior of a vehicle including the seating area.

Thus, in accordance with the present disclosure, a Graphical User Interface (GUI) and associated software application (s) may run on mobile terminal **16** and be configured to determine human body size and proportion data using the mobile terminal's camera and analyzing body segment lengths, height, weight, clothes size, etc. Software algorithms for performing analysis of the occupant's body size and proportion data may be running on the user's mobile terminal and/or in a server(s) accessible via the Internet that may receive raw or preliminarily analyzed data from the mobile terminal. That server(s) may run software configured to provide analytical functionality that may provide an optimized or customized fit for the occupant in the occupant's vehicle seat. Utility of the software for analyzing an occupant's size and proportional dimensions may also be used to improve or customize fit of seats other than automotive seats and may be used to improve seating in aircraft, watercraft, or motorcycles as well. Moreover, there is additional utility in using the software to optimize or customize a seat that is home or office furniture; additionally, such software may be used to improve fit of wheelchairs and other mobility assistance devices.

GUI and applications may be implemented on a PDA and/or via server-application context as shown in FIG. **28**. Alternatively, or in addition, some or all of such applications may be implemented on or in connection with software and/or hardware provided on a vehicle. Thus, one or more software applications analyzing the determined human body size and proportion data may be used to select optimized seat adjustment parameters for comfort, fit, safety, etc. In an implementation where the collected data is acquired in relationship with the occupant's interaction with their vehicle, this software may optionally be configured to detect position(s) of view mirrors, operation peddles, steering wheel, heads up display, etc. to optimize occupant's experience.

As shown in FIG. **28**, equipment and processes for adjusting user-adjustable equipment in a vehicle provides improved utility. First, the process for adjusting user-adjustable equipment provides instructions to the user that allows the user to customize the vehicle seat and other user-adjustable equipment so that safety and comfort is maximized. Second, the specific algorithms used to obtain the best-fit seating solution may be managed and updated on servers. Third, centrally locating the generation of the best-fit seating solution provides the ability to control dissemination of the algorithms used to generate the best-fit seating solution. Fourth, by generating the equipment-adjustment instructions and communicating them automatically to powered actuators included in the user-adjustable equipment, vehicles built to include best-fit seating solution technology may automatically respond to the instructions. Fifth, by generating the equipment-adjustment instructions and communicating them to a user in the field, all vehicle seats may be adjusted according to the presently disclosed process. Sixth, the process of generating a best-fit seating solution and generating equipment-adjustment instructions is done remotely from the equipment. As a result, equipment in other fields may be adjusted such as other vehicle seating (airplanes, trains, boats, motorcycles), wheel chairs, and office furniture.

FIGS. **32-36** provide a series of screen shots illustrating user interface functionality provided by at least one software application and used to deliver best-fit seating solution to vehicle seat **202**. As shown in FIG. **32**, the mobile terminal **16** may provide the user with the option **204** of adjusting their vehicle seat **202** to provide the best-fit arrangement. If the user selects that option, mobile terminal **16** may provide a series of status messages **206** providing an indication of adjusting vehicle seat **340** as shown in FIGS. **33** and **34**. Another indication of adjusting vehicle seat **340** is also shown FIGS. **35** and **36**.

Vehicle seat **202** may include powered and/or manual adjustment mechanisms. FIGS. **37** and **38** provide perspective illustrations of examples of on-seating unit control panels **208** provided in accordance with the present disclosure. On-seating unit control panels **208** may include a control panel **208** that includes adjustment controls **212** for adjusting the horizontal component of the vehicle seat, controls **214** for adjusting the vertical component of the vehicle seat, various massage/heating/cooling functionality controls **216**, controls **218** for adjusting the headrest of the vehicle seat, in addition to an indicator **220** of whether the vehicle seat is presently receiving or transmitting data and/or instructions via communication unit **18** to mobile terminal

16 or another component via a communication protocol such as a BLUETOOTH® system. Further, the control panel **208** also includes an indicator **222**, which is configured to signify whether the vehicle seat is in the best-fit arrangement as shown in FIG. **38**.

Optionally, the seat connectivity interface may also be configured to provide communication and control interfaces that enable a user or the user's mobile terminal to interface with the occupant's vehicle seat or seating area to both acquire data (e.g., data from other products/zones than the vehicle seat including steering wheel, foot pedals, rear view mirrors, etc.) to control structural or environment configuration of the vehicle seat or seating area.

As explained above, services and functionality provided in accordance with the present disclosure may provide the user with the option of receiving expert guidance from one or more guidance sources regarding how the occupant's vehicle seat should be configured for one or more physical ailments or conditions or to provide a specified goal of the user.

Accordingly, as illustrated in FIG. **39**, the user interface functionality provided by at least one software application may include selection of one or more items provided on a menu for enabling a user to select from one or more physical ailments or treatment conditions for which he is seeking assistance in accordance with the present disclosure. Such physical ailments or treatment conditions may include, for example, lower back pain **224**, numbness in seat **226**, leg discomfort **228**, stiffness of back **230**, headrest positioning **232** for increased safety or a stiff neck, thermal discomfort **234**, etc.

Once a user has selected from one of the displayed options, the mobile application may be configured to display expert guidance **236** pertaining to the selected condition in combination with educational information such as videos and/or audio programs **238** regarding treatment of the specified condition and/or positioning of the occupant's vehicle seat to obtain relief from certain symptoms or undesirable experiences. FIG. **40** provides a screen shot illustrating the user interface functionality provided by at least one software application for disseminating treatment information and/or recommendations for positioning of a vehicle seat in accordance with the present disclosure.

As explained above with connection to the seat-fit optimization and transform software **140** illustrated in FIG. **28**, the dissemination of interactive multimedia expert guidance may be performed in whole or in part by the mobile application(s) running on the mobile terminal **16**. However, it is also foreseeable in accordance with the present disclosure, that some portion of the functionality, e.g., storage, analysis, etc. may be performed using software running on a servers **14** accessible via one or more communication units **18** (also called networks **18**) from the mobile terminal **16**, e.g., interactive multimedia expert guidance module software **145**.

As explained above, services and functionality provided in accordance with the present disclosure provide the occupant with the option of upgrading one or more features of the occupant's vehicle seat to provide increased comfort, physical therapies, optimized seating configurations for particular occupant activities or interests, etc. For example, the occupant may be provided with the opportunity to upgrade their vehicle seat features in conjunction with the dissemination of queried expert advice, e.g., "You should consider a lower back therapy treatment, downloadable for $2.99 to your mobile terminal as a source of relieve for your lower back pain."

FIGS. **41-47** provide screen shots illustrating the user interface functionality provided by at least one software application for enabling a user to select from one or more upgrade options for upgrading functionality provided by the occupant's vehicle seat via wireless Over The Air (OTA) configuration in accordance with the present disclosure.

The menu of upgrade options may not be limited to therapeutic treatments as shown in FIG. **41**, but may also include positioning application options **242** for optimizing certain aspects of the occupant's experience including driver performance, cruising comfort safety maximization, ease of entry, increased driver visual acuity, and motion comfort improvement, etc. The upgrade application and delivery software running on the mobile terminal may also be configured to provide additional information **244** explaining the performance, value or benefit resulting from the upgrade (see FIG. **43**). Moreover, the software application for providing various customization and/or upgrade options may, itself, be an upgradeable application.

Once the user has selected at least one upgrade from a menu of upgrades **240**, such upgrades may be downloaded to the occupant's mobile terminal **16**. As a result, such upgrades may be installed in the occupant's vehicle seat via communication unit **18**. FIGS. **44** and **45** provide a series of screen shots illustrating the user interface functionality provided by at least one software application and used to deliver data and/or software programming associated with the upgraded functionality to the user's mobile terminal.

FIGS. **46** and **47** provide a series of screen shots illustrating the user interface functionality provided by at least one software application and used to provide status update information **246** regarding the delivery of the data and/or software programming associated with the upgraded functionality from an occupant's mobile terminal **16** to the occupant's vehicle seat.

Another series of screen shots illustrating the user interface functionality provided by at least one software application are shown in FIGS. **48-53**. The user interface functionality enables a user to select from one or more upgrade options for upgrading functionality provided by the occupant's vehicle seat via the communication unit. A user may be presented with an option to select a Wellness Therapies button **568** or a Pro Postures button **569** as shown in FIG. **48**. As an example, the user has selected Wellness Therapies button **568**. The user is then able to select one or more options to include in the occupant support system. As shown in FIG. **49**, the user has selected a Shiatsu Massage application **570**, a Workout Relief application **571**, and MicroFit application **574** among various other Wellness Therapies.

The user may also select Pro Postures button **569**. As an example, the user may select a Performance Drive application **572** and the GPSFit application **576** as shown in FIG. **50**. Once the user has selected the desired options, the user presses an Install Selections button **573** causing the selected options to be installed into the seat-movement system as suggested in FIG. **51** and verified in FIG. **52**.

As explained above with connection to the seat-fit optimization and transform software **140** illustrated in FIG. **28**, the upgrade and application delivery functionality may be provided in whole or in part by the mobile application(s) running on the mobile terminal **16**. However, it is also foreseeable within the scope of the present disclosure that some portion of the functionality, e.g., storage, analysis, etc. may be performed using software running on a servers (e.g. server **14**) accessible via communication unit **18** from the mobile terminal **16**, e.g., upgrade and application delivery engine software **155**.

As explained above, services and functionality provided in accordance with the present disclosure provide a vehicle seat that may include a plurality of sensors that monitor the health and well being of the user. The vehicle seat may transmit the monitored data to a server based application (either directly wirelessly or through a mobile terminal based software application) that provides analysis of the data to monitor the health and well being and/or provide further analysis regarding optimization and/or customization of one or more vehicle seat parameters.

Furthermore, the suite **135** may include biometric sensor suite software **150** configured to receive biometric data for the user acquired by sensors included within vehicle seat **202**. That biometric data may be analyzed by the software suite to diagnose a physical condition or ailment and/or provide recommendations for positioning or altering the position of the occupant's vehicle seat to address or remedy the physical condition or ailment. Additionally, the software **150** may also be configured to provide recommendations on one or more upgrades that may be made to the occupant's vehicle seat **202** via upgrade and application delivery engine software **155**, also included in the suite **135** (as explained herein in conjunction with FIGS. **25-31**.

As explained above, services and functionality provided in accordance with the present disclosure provide the user with the option of optimizing or customizing their vehicle seat based on analysis performed by the seat-fit optimization and transform tool software (that may be implemented on server **14** and/or within an application running on the mobile terminal **16** illustrated in FIG. **28**.

As explained above, a communication unit may be configured to provide communication and control interfaces that enable a user or the user's mobile terminal to interface with the occupant's vehicle seat or seating area to both acquire data (e.g., data from other products/zones than the vehicle seat including steering wheel, foot pedals, rear view mirrors, etc.) to control structural or environment configuration of the vehicle seat or seating area. This aspect may provide information to software included in the system for providing customization of seat positioning to enable optimization of seat positioning through feedback, as explained in FIG. **53**.

FIG. **53** provides an illustrative diagram used to explain functionality that may be provided to a user via the system, methodologies and components for acquiring, analyzing and utilizing user body specifications to provide for improved seating structure and environment configuration. By using the main menu **248** of the software applications provided in the present disclosure as a mechanism to gather and analyze data regarding occupants' experiences with vehicle seats and their associated physical conditions, the system can provide a mechanism for further analyzing occupant well being data as well as further improving upon seating technology. As a result, the main menu, and its associated back end software can be used to coordinate data acquisition for sensors **250** included in vehicle seats to provide additional information about the way that certain vehicle-seat settings and configurations affect the well being of the occupant. That information can then be output to the occupant's mobile terminal **16** to enable them to participate actively in the treatment and/or track the progress or regression of their physical conditions.

For example, if the vehicle seat were that of a long distance truck driver, sensors within the vehicle seat could be used to provide status information regarding the blood flow, temperature or other biometric data indicating his well being throughout his work day. Such information could be used to give recommendations for driving breaks, advice for alteration of the driver's vehicle seat parameters, application of heat or cold, etc. Furthermore, that data could also be used by one or more experts **252** to further optimize modeling and therapeutic treatments for individuals. As a result, the centralize function of the system services and functionality further improve the manner in which data is acquired, analyzed, and used to improve well being for individuals using seats of all kinds.

As shown for example in FIG. **54**, another embodiment of an occupant-support system **400** may include configuration control system **10**, a front vehicle seat **402**, a rear vehicle seat **404**, and a sensor package **406**. Front and rear vehicle seats **402**, **404** may be configured to communicate with communication unit **18** to achieve a best-fit arrangement of both the front and rear vehicle seat **402**, **404**. Sensor package **406** may include a sensor integrated into the vehicle seat and configured to sense an occupant's anthropometric data and an occupant's comfort data, and a sensor integrated into a vehicle cabin and configured to receive an input from mobile terminal **16**, an input received from user interface **12**, and an input received from computer **14**.

As shown in FIG. **54**, occupant-support system **400** may include front intelligent vehicle seat **402** and rear intelligent vehicle seat **404**. Front and rear intelligent vehicle seats **402**, **404** may be coupled to communication unit **18** and configured to exchange data about the position and state of each vehicle seat **402**, **404** with one another. As a result, intelligent vehicle seats **402**, **404** act as sources of data which may then be used to calculate a best-fit arrangement of both vehicle seats **402**, **404**. The best-fit arrangement of vehicle seats **402**, **404** may be the arrangement of intelligent vehicle seats **402**, **404** relative to one another that maximizes comfort and safety of each occupant sitting in his or her seat.

FIGS. **55-57** provide various illustrative diagrams describing various configurations for providing certain communication functionality provided in conjunction with an occupant's vehicle seat. As shown in FIG. **55**, terminal **16** may communicate wirelessly with an occupant's vehicle communication and navigation system **256** that is coupled to the occupant's vehicle seat Electronic Control Unit (ECU) **258** via the CAN communication bus **260** (resident within the occupant's vehicle) to obtain sensor data from seat ECU **258** and provide configuration instructions to seat ECU **258** to optimize positioning and download upgrades. Alternatively, as shown in FIG. **56**, mobile terminal **16** may communicate with a BLUETOOTH® radio **262** coupled to the Seat ECU **258** via the CAN communication bus **260**. Further, as shown in FIG. **57**, mobile terminal **16** may communicate wirelessly with Bluetooth® radio **262**, which may be incorporated in the seat ECU **258** that is sitting on the CAN communication bus **260**.

As shown in FIG. **58** another embodiment of a configuration control system **510** may include a first computational device **516**, a second computational device **514**, a third computational device **512**, a fourth computational device **520**, and a network **518**. First computational device **516** is illustratively a mobile terminal. Second computational device **514** may be illustratively a remote computer. Third computational device **512** may be illustratively a vehicle-seat electronic control unit. Fourth computational device **520** may be illustratively a personal computer. First, second, third, and fourth computational devices **512**, **514**, **516**, **518** may communicate with one another through network **518**.

First computational device **516** may include a graphical user interface **522**, a sensor **524**, a processor **526**, a power module **528**, a memory **530**, and a communication unit **532** as shown in FIG. **58**. Memory **530** could be implemented as discussed above. Power module **528** may be coupled to

processor **526** to provide power thereto and to other components included in first computational device **516**. Graphical user interface **522**, sensor **524**, and communication unit **532** may be coupled to processor **526** to provide data to processor **526** for processing according to instructions stored in memory **530**. Additionally, data may also be stored in memory **530**. Graphical user interface **522** and communication unit **532** may also coupled to processor **526** to communicate calculated results and/or data from processor **526** to a user or to other computational devices **514**, **512**, **520**.

Second computational device **514** may include a processor **536**, a power module **538**, a memory **540**, and a communication unit **534** as shown in FIG. **58**. Memory **540** could be implemented as discussed above. Power module **538** may be coupled to processor **536** to provide power thereto and to other components included in second computational device **514**. Communication unit **534** may be coupled to processor **536** to provide data from other computational devices **516**, **512**, **520** to processor **536** for processing according to instructions stored in memory **540**. Additionally, data may also be stored in memory **540**. The results of data calculated are communicated through communication unit **534**.

Third computational device **512** may include a processor **546**, a power module **544**, a memory **548**, and a communication unit **542** as shown in FIG. **58**. Memory **548** could be implemented as discussed above. Power module **544** may be coupled to processor **546** to provide power thereto and to other components included in third computational device **512**. Communication unit **542** may be coupled to processor **546** to send data between other computational devices **516**, **514**, **520** and processor **546** for processing according to instructions stored in memory **548**. Additionally, data may also be stored in memory **548** for use at a later time.

Fourth computational device **520** may include a processor **554**, a power module **556**, a memory **558**, a graphical user interface **552**, and a communication unit **550** as shown in FIG. **58**. Memory **558** could be implemented as discussed above. Power module **556** may be coupled to processor **554** to provide power thereto and to other components included in second computational device **520**. Communication unit **550** may be coupled to processor **554** to send data between other computational devices **516**, **514**, **512** to processor **554** for processing according to instructions stored in memory **558**. Additionally, data may also be stored in memory **558**. Data may also be displayed or input via graphical user interface **552** for use by processor **554**.

Configuration control system **510** may provide improved utility. First, a communication network and an intelligent vehicle seat facilitate multiple input and output methods for acquiring data about the occupant and modifying the arrangement of the vehicle seat. Second, each possible source of data and the intelligent vehicle seats may be configured as stand alone nodes on the communication network which facilitates simplified troubleshooting and communication across the network. Furthermore, interference with other equipment is minimized. Third, the user interface for inputting data and commands may be included in the vehicle, the mobile terminal, and the personal computer. As a result, convenience is maximized. Fourth, a communication network included in the vehicle provides the ability for intelligent equipment (e.g., front and rear vehicle seats), mobile terminals, and personal computers to communicate with one another and achieve an optimized arrangement of the entire vehicle cabin rather than just an optimized vehicle seat arrangement. Fifth, sensors included in the intelligent vehicle seats or vehicle cabin may provide feedback data to the remote server about changes in the occupant's anthropometric data and the occupant's comfort so that the best-fit seating solution may continually be updated.

An occupant-support system **600** in accordance with the present disclosure may include a configuration control system **602**, a vehicle seat **604**, and a pneumatic system **606** as shown diagrammatically in FIG. **60**. Occupant-support system **600** may be configured to perform an occupant-support system fitting process **700** that provides an optimum-fit arrangement of occupant-support system **600**.

Vehicle seat **604** may be mounted on a vehicle frame **610** included in a vehicle to move relative to vehicle frame **610**. Vehicle seat **604** may include a seat bottom **626** coupled to vehicle frame **610** to slide back and forth relative to vehicle frame **610**, a seat back **628** coupled to seat bottom **626** to pivot back and forth about a seat-back pivot axis **618** relative to seat bottom **626**, and a seat-movement system **620** as shown in FIG. **60**. Configuration control system **602** may provide instructions to seat-movement system **620** that causes seat-movement system **620** to move seat bottom **626** and seat back **628** to a best-fit arrangement associated with the occupant's anthropomorphic data.

Vehicle seat **604** may include additional functionality that includes height adjustment of vehicle seat **604**, tilt of seat bottom **626**, adjustment of upper back angle of seat back **628**, adjustment of seat bottom length, movement of the headrest, etc. These various adjustments may be powered, manually operated, or a combination of powered and manual features. Further, such vehicle seat may include various types of climate control functionality including seat heating, active seat cooling, ventilation, and/or a full seat memory system.

Configuration control system **602** may include mobile terminal **16**, remote computer **14**, and communication unit **18**. Mobile terminal **16** may include at least one software application that acquires the dimensions of an occupant using sensors included in mobile terminal **16**, manual input of data, or a combination of the two. Occupant data may be used to model a best-fit arrangement that may be transferred to seat-movement system **620** via wired and/or wireless communication unit **18**. As a result, seat-movement system **620** may move vehicle seat **604** to the best-fit arrangement associated with the occupant data collected previously.

Seat-movement system **620** may be able to move various portions of vehicle seat **504** because seat-movement system **620** illustratively includes a seat controller **640**, a seat-back actuator **642**, and a seat-bottom actuator **644** as shown diagrammatically in FIG. **60**. Seat controller **640** may be a computer that may be in communication with seat-bottom actuator **644** and seat-back actuator **642**. Seat-bottom actuator **644** may be an electric motor that provides force necessary to move seat bottom **626** back and forth on seat tracks **646**. Seat-back actuator **642** may be an electric motor that provides force necessary to pivot seat back **628** back and forth relative to seat-back pivot axis **618**.

Pneumatic system **606** may include a pressurized air source **632**, at least one pressure sensor **634**, and at least one pneumatic bladder **611** as shown in FIGS. **60** and **63**. As an illustrative example, pneumatic system **606** may include an upper lumbar bladder **611**, a middle lumbar bladder **612**, a lower lumbar bladder **613**, a left seat-back wing bladder **614**, a right seat-back wing bladder **615**, a left seat-bottom wing bladder **616**, and a right seat-bottom wing bladder **617**. Each pneumatic bladder **611**, **612**, **613**, **614**, **615**, **616**, **617** may be coupled to pressurized air source **632** to receive pressurized

air therein to inflate or to exhaust air to deflate each of the pneumatic bladders **611**, **612**, **613**, **614**, **615**, **616**, **617**.

Each pneumatic bladder **611**, **612**, **613**, **614**, **615**, **616**, **617** may be further coupled to at least one pressure sensor **634** that may be configured to measure the air pressure in each pneumatic bladder **611**, **612**, **613**, **614**, **615**, **616**, **617** and communicate that pressure to seat-movement system **620**. As a result, seat-movement system **620** may command pressurized air source **632** to inflate or deflate each pneumatic bladder **611**, **612**, **613**, **614**, **615**, **616**, **617** to cause the air pressure in each pneumatic bladder **611**, **612**, **613**, **614**, **615**, **616**, **617** to be in an acceptable pressure range as suggested in FIG. **65**. As an example of use, pressure sensor **634** may sense a high pressure in middle lumbar bladder **612** and communicate the high pressure to seat-movement system **620** which in turn commands pressurized air source **632** to release air from middle lumbar bladder **612** causing the air pressure sensed in middle lumbar bladder **612** to decrease and be in the acceptable pressure range as suggested in FIG. **65**.

As shown in FIG. **60**, pneumatic system **606** may include pressurized air source **632**, a bladder system including a plurality of pneumatic bladders **611**, **612**, **61**N, a manifold **636** including separate valves associated with each bladder **611**, **612**, **61**N, a pressure sensor **634**, and an air-tubing system **638**. Air-tubing system **638** may be configured to interconnect manifold **636** to associated air bladders **611**, **612**, **61**N so that a common line from pressurized air source **632** may be used to supply manifold **636** with pressurized air. Air-tubing system **638** may be further configured to interconnect pressure sensor **634** to the common line so that the pressure in each bladder **611**, **612**, **61**N may be sensed using only one pressure sensor by opening one valve and closing the other remaining valves, thereby sensing the pressure in each bladder **611**, **612**, **61**N one at a time.

As a result of only one pressure sensor being used, the control of the air pressure in each bladder **611**, **612**, **61**N may be handled in a serial manner. As an example, the air pressure in first bladder **611** may be sensed by pressure sensor **634**. The pressure signal may then be communicated to seat-movement system **620** and seat-movement system **620** commands pressurized air source **632** to inflate, deflate, or maintain first pneumatic bladder **611** as required. Seat-movement system **620** may then command a first valve included in manifold **636** and associated with first bladder **611** to close and a second valve associated with second bladder **612** to open. The pressure in second bladder **612** may then sensed by pressure sensor **634**. The pressure signal associated with second bladder **612** may then communicated to seat-movement system **620** wherein seat-movement system **620** takes action to maintain second bladder **612** in the acceptable range. As shown by the example, all additional bladders must be cycled in series before seat-movement system **620** is updated with the air pressure in first bladder **611**.

Occupant-support system fitting process **700** may include acquiring data **702**, calculating body arrangements **704**, calculating seat solution **706**, adjusting vehicle seat **708**, and adjusting pneumatic system **710** as shown in FIG. **59**. As discuss previously, acquiring data **702**, calculating body arrangement **704**, calculating seat solution **706**, and adjusting vehicle seat **708** may operate to arrange vehicle seat **604** in a best-fit arrangement of vehicle seat **604** so that occupant's body is supported on vehicle seat **604** is positioned in a best-fit body arrangement. Adjusting pneumatic system **710** may fit vehicle seat **604** to the occupant using pneumatic bladders **611**, **612**, **613**, **614**, **615**, **616**, **617** so that an optimum-fit arrangement of occupant-support system **600** is established.

Adjusting pneumatic system **710** may include inflating air bladders **712**, sensing air pressure in bladders **714**, determining if pressure is out of an acceptable range **716**, maintaining air pressure in the bladders **718** if the air pressure is in the acceptable range, and correcting air pressure in the bladders **720** if the air pressure is out of the acceptable range as shown in FIG. **61**. Once the air pressure in the bladders has been maintained or corrected, the air pressure in the bladders may be sensed again as suggested in by phantom lines in FIG. **61**.

As an example, a user accesses and uses occupant-support system fitting process **700** by accessing a MicroFit application **574** stored in memory included in mobile terminal **16** as shown in FIG. **62**. After MicroFit application **574** has been launched, Graphical User Interface (GUI) may show that a user may select either a momentary mode **674** or a continuous mode **675** of operation as shown in FIGS. **63** and **64**. Momentary mode **674** of operation may cause adjusting of pneumatic system **710** to be executed once by seat-movement system **620**. Continuous mode **675** of operation may cause adjusting of pneumatic system **710** to be executed continuously at predetermined intervals by seat-movement system **620**.

In an example of momentary mode **674**, during adjusting of pneumatic system **710**, sensing air pressure in bladders **714** may determine an initial pressure in each pneumatic bladder **611**, **612**, **613**, **614**, **615**, **616**, **617**. Air pressure in bladders **611**, **612**, **613**, **614**, **615**, **616**, **617** may be maintained or adjusted as needed.

As an example, sensing air pressure in bladders **714** may display a relative pressure differential for each pneumatic bladder **611**, **612**, **613**, **614**, **615**, **616**, **617** as shown in FIG. **64**. A first output **611**R associated with upper lumbar bladder **611** may show a pressure differential of +2 which is in the acceptable pressure range. A second output **612**R associated with middle lumbar bladder **612** may show a pressure differential of +10 which is above the acceptable pressure range. A third output **613**R associated with lower lumbar bladder **613** may show a pressure differential of −5 which is below the acceptable pressure range. A fourth output **614**R associated with left seat-back wing bladder **614** may show a pressure differential of +9 which is above the acceptable pressure range. A fifth output **615**R associated with right seat-back wing bladder **615** may show a pressure differential of +10 which is above the acceptable pressure range. A sixth output **616**R associated with left seat-bottom wing bladder **616** may show a pressure differential of −6 which less than the acceptable pressure range. A seventh output **617**R associated with the right seat-bottom wing bladder **617** may show a pressure differential of −5 which is below the acceptable pressure range.

These pressure signals may then be communicated to seat-movement system **620** which in turn commands pressurized air source **632** to adjust those pressure differentials outside of the acceptable pressure range to be within the acceptable pressure range. As an example, pressurized air source **632** may lower the air pressure in middle lumbar bladder **612** and in seat-back wing bladders **614**, **615** so that the pressure differential returns to the acceptable range as shown in FIG. **65**. Pressurized air source **632** may also increase the air pressure in lower lumbar bladder **613** and seat-bottom wing bladders **616**, **617** so that the pressure differential returns to the acceptable range. At the same time,

pressurized air source **632** may maintain the air pressure in upper lumbar bladder **611** as it is already in the acceptable range.

In an example of the continuous mode, during adjusting of pneumatic system **710**, sensing air pressure in bladders **714** may determine an initial pressure in each pneumatic bladder **611**, **612**, **613**, **614**, **615**, **616**, **617**. Air pressure in bladders **611**, **612**, **613**, **614**, **615**, **616**, **617** may be maintained or adjusted as needed. Adjusting of pneumatic system **710** may then keep performing adjusting of pneumatic system **710** at a predetermined interval so that all bladders remain in the acceptable pressure range.

MicroFit application **574** may also include a manual mode in which the user can adjust the air pressure of each pneumatic bladder **611**, **612**, **613**, **614**, **615**, **616**, **617** and override the pre-defined acceptable pressure range as suggested in FIG. **66**. As an example, the user may desire a lower pressure in the upper lumbar bladder **611**, a higher pressure in the middle lumbar bladder **612**, and the default acceptable pressure in the lower lumbar bladder **613**. The user may adjust manually the air pressure in each pneumatic bladder **611**, **612**, **613**, **614**, **615**, **616**, **617** by using associated controls **611**M, **612**M, **613**M, **614**M, **615**M, **616**M, and **617**M as shown in FIG. **66**.

In one illustrative embodiment, a pneumatic system **806** may include pressurized air source **832**, a plurality of air bladders **811**, **812**, **81**N, a manifold **836** including separate valves associated with each bladder **811**, **812**, **81**N, a plurality of pressure sensors **834**, **835**, **83**N, and an air-tubing system **838** arranged to interconnect each bladder **811**, **812**, **81**N, pressurized air source **832**, and each pressure sensor **834**, **835**, **83**N. Each bladder **811**, **812**, **81**N may be coupled to pressurized air source **832** by a tube included in air-tubing system **838** so that each bladder **811**, **812**, **81**N can be inflated and deflated separately. Each pressure sensor **834**, **835**, **83**N may be coupled to a separate bladder **811**, **812**, **81**N by a tube so that the air pressure in each bladder **811**, **812**, **81**N can be monitored at the same time. Continuous pressure signals from separate pressure sensors **834**, **835**, **83**N may be sent to seat-movement system **620** causing seat-movement system **620** to continuously command pressurized air source **832** to continuously maintain the air pressure in each bladder **811**, **812**, **81**N in the acceptable range. As a result of having separate pressure sensors **834**, **835**, **83**N for each bladder **811**, **812**, **81**N, the control of the air pressure in each bladder **811**, **812**, **81**N may be handled in a parallel manner.

Another embodiment of an occupant-support system **1000** may include configuration control system **602**, vehicle seat **604**, pneumatic system **606**, and a prediction system **1002** as shown diagrammatically in FIG. **69**. Occupant-support system **1000** may be configured to perform occupant-support system predicted fitting process **900** that that includes arranging vehicle seat **604** in an initial best-fit arrangement using configuration control system **602**, calculating a predicted future position of a vehicle using prediction system **1002**, and configuring both the position of vehicle seat **604** and pneumatic system **606** to cause the occupant to be supported appropriately when the vehicle moves through the predicted future position.

Prediction system **1002** may include a Global Positioning Satellite (GPS) unit **1004** and a mapping unit **1006**. As an example, GPS unit **1004** may be coupled to communicate with mapping unit **1006** and configured to determine a real-time position of the vehicle relative to earth and a real-time speed of the vehicle. GPS unit **1004** may transmit the real-time position and speed to mapping unit **1006**. Mapping unit **1006** may use the real-time position and speed to calculate a predicted future position and speed of the vehicle using map data stored in memory included in mapping unit **1006**. Mapping unit **1006** may be further coupled to communicate with seat-movement system **620** to send corresponding predicted future-position data and predicted future-speed data to seat-movement system **620** to cause vehicle seat **604** and pneumatic system **606** to be adjusted so that vehicle seat **604** and pneumatic system **606** may be in an optimum-fit arrangement appropriate for the predicted future position and speed.

In some embodiments, seat controller **640** of seat-movement system **620** may communicate with configuration control system **602** during the operations of staging occupant-support system **912** included in occupant-support system predicted fitting process **900**. As an example, prediction system **1002** may communicate a predicted future position and/or predicted future-position data to seat controller **640** that requires movement of seat bottom **626** forward relative to vehicle frame **610** which may cause an occupant's head to contact a roof of the vehicle. As a result, seat controller **640** may request a new best-fit arrangement for vehicle seat **604** that takes into account the desired change in the seat bottom location. In this scenario, staging-occupant support system **912** may further include a reconfiguring operation in which seat controller **640** sends revised vehicle data via communication unit **18** to remote computer **14** so that a revised optimum-fit arrangement may be determined and sent back to seat controller **640** by way of communication unit **18**.

As shown in FIG. **68**, occupant-support system predicted fitting process **900** illustratively includes acquiring data **902**, calculating a body arrangement **904**, calculating a seat solution **906**, adjusting a vehicle seat **908**, adjusting a pneumatic system **910**, and staging occupant-support system **912** as shown in FIG. **68**. As discussed previously, acquiring data **902**, calculating body arrangement **904**, calculating seat solution **906**, adjusting vehicle seat **908**, and adjusting pneumatic system **910** may operate to arrange vehicle seat **604** in an optimum-fit arrangement of vehicle seat **604** that arranges an occupant's body in a best-fit body arrangement while minimizing an interface pressure between the occupant and vehicle seat **604**. Staging occupant-support system **912** may arrange vehicle seat **604** and pneumatic system **606** so that the occupant is supported as the vehicle passes through a future position at a future speed.

Staging occupant-support system **912** may include the operations of determining actual vehicle position **914**, determining actual vehicle speed **916**, calculating predicted future position of the vehicle **918**, calculating predicted future speed of the vehicle **920**, calculating predicted seat solution **922**, adjusting vehicle seat **924**, adjusting pneumatic system **926**, and establishing optimum-fit arrangement **928** of occupant-support system **1000**. As an example, a user may access and use occupant-support system predicted fitting **900** by accessing a GPSFit application **576** stored in memory that may be included in mobile terminal **16**. After GPSFit application **576** has been launched, the GUI may show an initial arrangement of vehicle seat **604**, pneumatic system **606**, and a map **1048** showing the location of vehicle **1001** and surrounding roads and terrain. Activating GPSFit application **576** may cause occupant-support system predicted fitting **900** to start the staging occupant-support system process **912**.

Prediction system **1002** may include a data receiver **1008** that may be configured to obtain weather data and/or traffic data as suggested in FIG. **69**. Data receiver **1008** may be

coupled to seat-movement system **620** to provide the weather and/or traffic data to seat-movement system **620** to cause movement of vehicle seat **604** and pneumatic system **606** to be altered so that the occupant sitting in vehicle seat **604** may be positioned to respond appropriately for weather and traffic conditions associated with the weather and traffic data.

In an example of use, the user has activated the GPSFit application causing the occupant-support system predicted fitting **900** to begin. As shown in FIG. **71**, vehicle **1001** may be traveling along a relatively straight section **1010** of a road **1012**. Staging occupant-support system **912** begins with vehicle seat **604** and pneumatic system in an initial optimum-fit arrangement that is suitable for typical driving conditions. As an example, a lateral-support output **1051** indicates that lateral support begins at 20%, a recline-angle output **1052** indicates that recline angle is at 25 degrees, a cushion-tilt output **1053** indicates that cushion tilt is at −3 degrees, and a track-position output **1054** indicates that track position is at 100 mm as shown in FIG. **71**.

Staging occupant-support system **912** may calculate predicted future position and speed **918**, **920** in which GPS unit **1004** and mapping unit **1006** look ahead and calculate that vehicle **1001** will be in a wavy portion **1014** of road **1012** as shown in FIG. **72**. Prediction system **1002** may provide a predicted future position and speed to seat-movement system **620** causing vehicle seat **604** to move its track position from 100 mm to 95 mm as indicated by track-position output **1054**, seat bottom **626** to increase cushion tilt from −3.0 degrees to −1.0 degrees as indicated by cushion-tilt output **1053**, and seat back **628** to increase the recline angle from 25 degrees to 27 degrees as indicated by recline-angle output **1052**, and simultaneously increasing lateral support from 20% to 40% as indicated by lateral-support output **1051** as shown in FIG. **72**. While vehicle **1001** may be in wavy portion **1014**, prediction system **1002** provides a new predicted future position and speed.

The new predicted future position and speed may be associated with a large right-hand curve **1016** as shown in FIG. **73**. Prediction system **1002** may then send the third new future position and speed to seat-movement system **620** to cause vehicle seat **604** to move its track position from 95 mm to 90 mm as indicated by track-position output **1054**, seat bottom **626** to increase cushion tilt from −1.0 degrees to +1.0 degrees as indicated by cushion-tilt output **1053**, and seat back **6** to increase the recline angle from 27 degrees to 29 degrees as indicated by recline-angle output **1052** and simultaneously increasing lateral support from 40% to 45% as indicated by lateral-support output **1051** as shown in FIG. **73**.

Prediction system **1002** may then calculate another new predicted future position and speed that may be associated with another left-hand turn **1018** in road **1012** as shown in FIG. **74**. Prediction system **1002** may then send the newest predicted future position to seat-movement system **620** that causes vehicle seat **604** to maintain the track position at 90 mm as indicated by track-position output **1054**, seat bottom **626** to increase cushion tilt from +1.0 degrees to +3.0 degrees as indicated by cushion-tilt output **1053**, and seat back **628** to maintain the recline angle at 29 degrees as indicated by recline-angle output **1052**, and simultaneously increasing lateral support from 45% to 100% as indicated by lateral-support output **1051** as shown in FIG. **74**.

Finally, prediction system **1002** may calculate yet another new predicted future position and speed that may be associated with another straight portion **1020** in road **1012** as shown in FIG. **75**. The newest predicted future position and speed may then be sent to seat-movement system **620** to cause vehicle seat **604** to move its track position from 90 mm to 100 mm as indicated by track-position output **1054**, seat bottom **626** to decrease cushion tilt from +3.0 degrees to −3.0 degrees as indicated by cushion-tilt output **1053**, and seat back **628** to decrease the recline angle from 29 degrees to 25 degrees as indicated by recline-angle output **1052**, and simultaneously decreasing lateral support from 100% to 20% as indicated by lateral-support output **1051** as shown in FIG. **75**. As vehicle **1001** remains on second straight portion **1020**, seat-movement system **620** may maintain the configuration of vehicle seat **604** and pneumatic system **606** as shown in FIG. **75**.

Prediction system **1002** may also cause vehicle data to be updated by seat controller **640**. Prediction system **1002** may provide additional limitations to movement of vehicles eat **604** as a result of mapping unit **1006** of prediction system **1002** providing a predicted future position and speed to seat controller **640** that arranges the occupant's eyes at a specific location relative to the vehicle frame or windshield. As an example, traffic or weather data may suggest that the occupant have improved visibility requiring that the occupant's eyes be at a higher elevation thus improving visibility. As a result, a different set of adjustment instructions may be needed as a revised best-fit arrangement of vehicle seat **604** thus causing calculating body arrangement **904**, calculating seat solution **906**, and adjusting vehicle seat **908** to be re-initiated using the updated vehicle data.

Occupant-support systems **400**, **600**, **800**, **1000** provide improved utility. First, communication unit **18** and vehicle seats **402**, **404**, **604** facilitate further customized seating fit to the occupant based on data provided by one or more sensors within the occupant's vehicle seat and/or vehicle. This customized seating fit can be provided optionally on a continuous basis. Second, the data used to customize the occupant's seating fit may be generated using professional personnel's manual measurement of the occupant's dimensions and inputting of that data into a customized computer application on behalf of the occupant, thereby improving ease of implementation. Third, Occupant-support systems **400**, **600**, **800**, **1000** can compensate for sensed and/or predicted future physical conditions based on GPS detection of the location of the occupant's vehicle and mapping to vehicle road configurations and/or conditions so as to target the occupant's seating experience to compensate for predicted vehicle handling and speed.

The description of specific embodiments is not intended to be limiting of the present disclosure. To the contrary, those skilled in the art should appreciate that there are numerous variations and equivalents that may be employed without departing from the scope of the present disclosure. Those equivalents and variations are intended to be encompassed by the present disclosure.

In the following description of various present disclosure embodiments, reference is made to the accompanying drawings, which form a part hereof, and in which is shown, by way of illustration, various embodiments in which the present disclosure may be practiced. It is to be understood that other embodiments may be used and structural and functional modifications may be made without departing from the scope and spirit of the present disclosure.

Moreover, it should be understood that various connections are set forth between elements in the following description; however, these connections in general, and, unless otherwise specified, may be either direct or indirect,

either permanent or transitory, and either dedicated or shared, and that this specification is not intended to be limiting in this respect.

While this present disclosure has been described in conjunction with the specific embodiments outlined above, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. Accordingly, the various embodiments of the present disclosure, as set forth above, are intended to be illustrative, not limiting. Various changes may be made without departing from the spirit and scope of the present disclosure.

Additionally, it should be understood that the functionality described in connection with various described components of various present disclosure embodiments may be combined or separated from one another in such a way that the architecture of the present disclosure is somewhat different than what is expressly disclosed herein. Moreover, it should be understood that, unless otherwise specified, there is no essential requirement that methodology operations be performed in the illustrated order; therefore, one of ordinary skill in the art would recognize that some operations may be performed in one or more alternative order and/or simultaneously.

Further, it should be understood that, in accordance with at least one embodiment of the present disclosure, system components may be implemented together or separately and there may be one or more of any or all of the disclosed system components. Further, system components may be either dedicated systems or such functionality may be implemented as virtual systems implemented on general purpose equipment via software implementations.

Although the utility of various present disclosure embodiments has been described in connection with the distribution of promotional content, it should be understood that distributed information is not limited to promotional content but may also or alternatively include non-promotional material.

As a result, it will be apparent for those skilled in the art that the illustrative embodiments described are only examples and that various modifications can be made within the scope of the present disclosure as defined in the appended claims.

The invention claimed is:

1. An occupant support system comprising a configuration control system, the configuration control system comprising:

an interface configured to obtain occupant data associated with an occupant; and

a computer configured to receive the occupant data, calculate external body dimensions, calculate internal body dimensions using at least the external body dimensions, and calculate a best-fit body arrangement of the occupant using the internal body dimensions and predetermined criteria.

2. The occupant support system of claim **1**, further comprising a pneumatic system including a pneumatic bladder coupled to a vehicle seat, a pressurized air source coupled to the pneumatic bladder to provide pressurized air to the bladder and coupled to the computer to receive commands from the computer, and a pressure sensor coupled to the pneumatic bladder to sense air pressure in the bladder and configured to communicate the sensed pressure to the computer to cause the computer to command the pressurized air source to maintain the air pressure in the pneumatic bladder in an predetermined pressure range.

3. The occupant support system of claim **2**, wherein the vehicle seat includes a seat bottom configured to be mounted to a vehicle frame included in a vehicle for movement relative to the vehicle frame, a seat back coupled to the seat bottom to pivot about a seat-back pivot axis relative to the seat bottom, and a seat-movement system coupled to the seat back and seat bottom to control movement of the seat back and seat bottom.

4. The occupant support system of claim **3**, wherein the interface is further configured to obtain vehicle data associated with the vehicle seat and the computer is further configured to calculate a best-fit seating solution using the best-fit body arrangement, the vehicle data, and the predetermined criteria, communicate the best-fit seating solution to the seat-movement system to cause the seat bottom and seat back to move to positions that cause the best-fit seating solution of the vehicle seat to be established, and communicate the best-fit seating solution to the pneumatic system to cause the pneumatic bladder to be in the predetermined pressure range.

5. The occupant support system of claim **4**, further comprising a prediction system including a GPS unit configured to determine a position of a vehicle relative to earth and a mapping unit coupled to the GPS unit to receive the position of the vehicle and determine a predicted future position of the vehicle relative to earth as the vehicle moves along a path and the mapping unit is coupled to the computer to send corresponding predicted future-position data to the computer.

6. The occupant support system of claim **5**, wherein the computer is further configured to calculate a revised best-fit seating solution using the predicted future-position data, the best-fit seating solution, and the vehicle data, communicate the revised best-fit seating solution to the seat-movement system to cause the seat bottom and seat back to move to a revised best-fit arrangement, and communicate the revised best-fit seating solution to the pneumatic system to cause the pneumatic bladder to be in the predetermined pressure range.

7. The occupant support system of claim **6**, wherein the prediction system further includes a receiver configured to receive weather data, the receiver is coupled to the computer to communicate the weather data to the computer, the computer is further configured to calculate an enhanced predicted arrangement of the vehicle seat using the predicted future position of the vehicle and the weather data and command the seat-movement system to move the seat bottom and seat back to cause the enhanced predicted arrangement of the vehicle seat to be achieved so that the occupant is supported by the vehicle seat as the vehicle moves through the predicted future position.

8. The occupant support system of claim **6**, wherein the prediction system further includes a receiver configured to receive traffic data, the receiver is coupled to the computer to communicate the traffic data to the computer, the computer is further configured to calculate an enhanced predicted arrangement of the vehicle seat using the predicted future position of the vehicle and the traffic data and command the seat-movement system to move the seat bottom and seat back to cause the enhanced predicted arrangement of the vehicle seat to be achieved so that the occupant is supported by the vehicle seat as the vehicle moves through the predicted future position.

9. The occupant support system of claim **2**, further comprising a seat-movement system coupled to the vehicle seat and configured to move the vehicle seat to the best-fit body arrangement and the computer is further configured to receive a pressure signal from the pressure sensor and command the pneumatic system to minimize an interface pressure between an occupant resting on the vehicle seat and the pneumatic bladder.

10. The occupant support system of claim **1**, further comprising a front vehicle seat, a rear vehicle seat spaced-apart from the front vehicle seat, and a seat-movement system coupled to the front vehicle seat and the rear vehicle seat and configured to move the front and rear vehicle seats in response to commands from the computer.

11. The occupant support system of claim **10**, wherein the interface is further configured to obtain vehicle data associated with the front vehicle seat and the rear vehicle seat and the computer is further configured to calculate a best-fit seating solution using the best-fit body arrangement, the vehicle data, and the predetermined criteria and to communicate the best-fit seating solution to the seat-movement system to cause the front vehicle seat and rear vehicle seat to move so that the best-fit seating solution is established.

12. The occupant support system of claim **1**, further comprising a prediction system including a GPS unit configured to determine position data for a vehicle relative to earth and a mapping unit coupled to the GPS unit to receive the position data for the vehicle and determine a predicted future position of the vehicle relative to earth as the vehicle moves along a path and the mapping unit is coupled to the computer to send corresponding predicted future-position data of the vehicle to the computer.

13. The occupant support system of claim **12**, wherein the computer is further configured to calculate a revised best-fit body arrangement using the predicted future-position data and the occupant data.

14. The occupant support system of claim **12**, further including a vehicle seat having a seat bottom, a seat back coupled to the seat bottom to pivot about a seat-back pivot axis relative to the seat bottom, and a seat-movement system coupled to the seat back and seat bottom to control movement of the seat back and seat bottom,

wherein the interface is further configured to obtain vehicle data associated with the vehicle seat and the computer is further configured to calculate a best-fit seating solution using the best-fit body arrangement, the vehicle data, and the predetermined criteria, and

wherein the computer is further configured to calculate a revised best-fit seating solution using the predicted future-position data, the best-fit seating solution, and the vehicle data and to communicate the revised best-fit seating solution to the seat-movement system to cause the vehicle seat to move to a revised best-fit arrangement.

15. The occupant support system of claim **14**, wherein the prediction system further includes a receiver configured to receive weather data, the receiver is coupled to the computer to communicate the weather data to the computer, the computer is further configured to calculate an enhanced predicted arrangement of the vehicle seat using the predicted future position of the vehicle and the weather data and command the seat-movement system to move the vehicle seat to cause the enhanced predicted arrangement of the vehicle seat to be achieved so that the occupant is supported by the vehicle seat as the vehicle moves through the predicted future position.

16. The occupant support system of claim **15**, wherein the receiver is further configured to receive traffic data, the receiver is coupled to the computer to communicate the traffic data to the computer, the computer is further configured to calculate the enhanced predicted arrangement of the vehicle seat using the predicted future position of the vehicle, the weather data, and the traffic data.

17. The occupant support system of claim **14**, wherein the prediction system further includes a receiver configured to receive traffic data, the receiver is coupled to the computer to communicate the traffic data to the computer, the computer is further configured to calculate an enhanced predicted arrangement of the vehicle seat using the predicted future position of the vehicle and the traffic data and command the seat-movement system to move the vehicle seat to cause the enhanced predicted arrangement of the vehicle seat to be achieved so that the occupant is supported by the vehicle seat as the vehicle moves through the predicted future position.

18. The occupant support system of claim **1**, wherein the interface is a sensor.

19. The occupant support system of claim **1**, wherein the interface is a computer.

20. The occupant support system of claim **19**, wherein the computer is a smartphone.

* * * * *