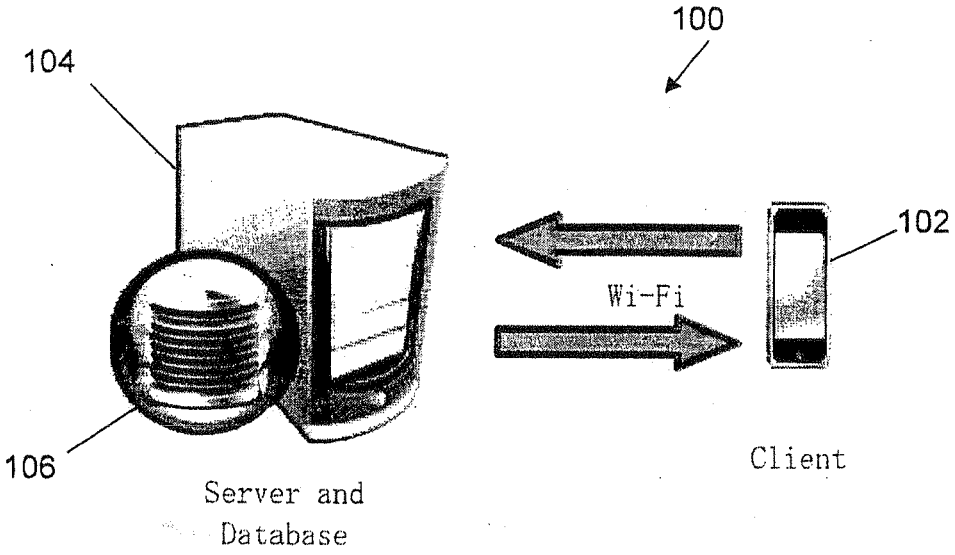


Figure 1

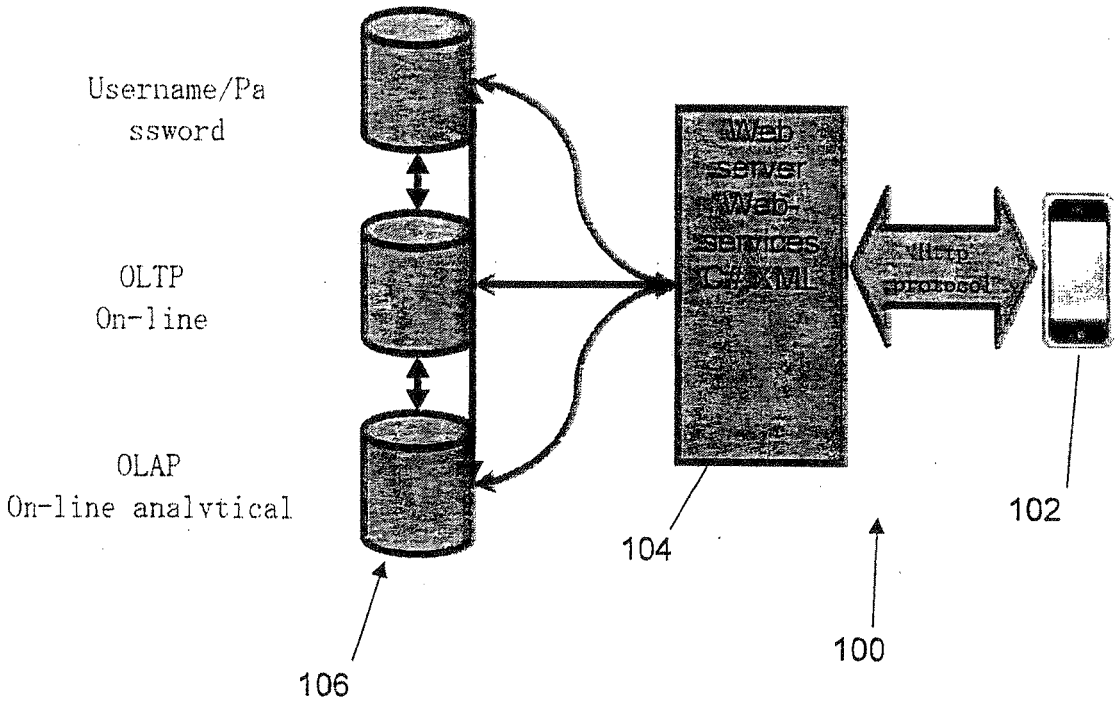


Figure 2

	OLTP System Online Transaction Processing (Operational System)	OLAP system Online Analytical Processing (DataWarehouse)
Source data	Operational data, OLTPs are the original source of data	Consolidation data; OLAP data comes from the various OLTP databases
Purpose of data	To control and run fundamental business tasks	To help with planning, problem solving and decision support
What the data reveals	A snapshot of ongoing business processes	Multi-dimensional views of various kinds iif business activities
Inserts and updates	Short and fast inserts and updates initiated by end users	Periodic long-running batch jobs refresh the data
Queries	Relatively standard and simple queries returning relatively few records	Often complex queries involving aggregation
Processing Speed	Typically very fast	Depends on the amount of the data involved; batch data refreshes and complex queries may take many hours, query speed can be improved by creating indexes
Space requirements	Can be relatively small if historical data is archived	Larger due to the existence of aggregation structures and history data
Database design	Highly normalized with many tables	Typically de-normalized with fewer tables
Back up and recovery	Back up religiously, operational data is critical to run the business, data loss is likely to entail significantly money loss and legal liability	Instead of regular backups, some environments may consider simply reloading the OLTP data as a recovery method

Figure 3

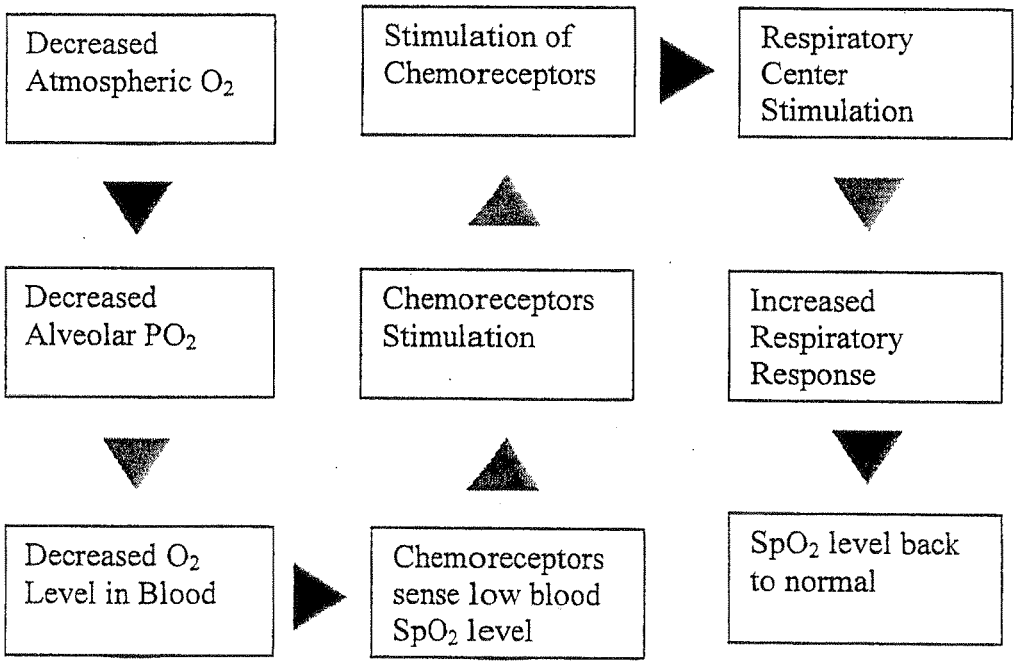


Figure 4: Respiratory response to decreased SpO2 level

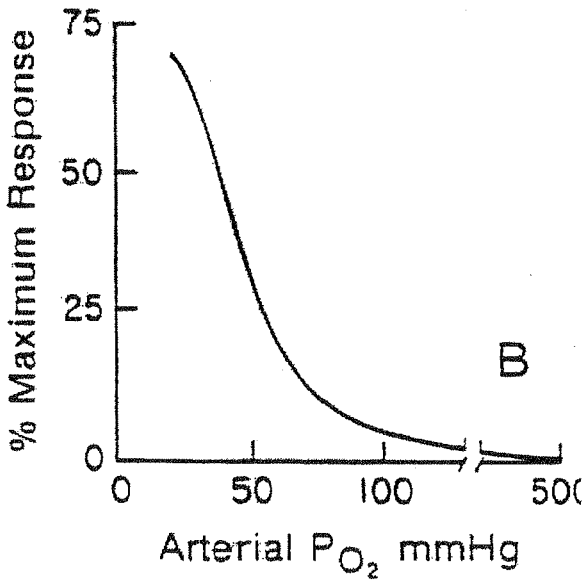


Figure 5: Relationship between SpO2 and respiratory response

Respiratory rate (bpm)	Category / Band
less than 5 or more than 30	Group I
21 to 30	Group II
6 to 9	Group III
10 to 12 and 18 to 20	Group IV
13 to 17	Group V

Figure 6

SpO2 (%)	Category / Band
0-74	Group I
75-84	Group II
85-94	Group III
95-96	Group IV
97-98	Group V
More than 98	Group VI

Figure 7

Age	18-25	26-35	36-45	46-55	56-65	65+	
Athletes	69-75	69-74	70-76	70-77	71-76	70-75	Group VII
Excellent	76-81	75-81	77-82	78-83	77-81	76-81	Group VI
Good	82-85	82-85	83-86	84-87	82-87	82-85	Group V
Abv avg	86-89	86-90	87-90	88-91	88-91	86-89	Group IV
Avg	90-93	91-94	91-95	92-96	92-95	90-93	Group III
Blw avg	94-101	95-101	96-102	97-103	96-101	94-99	Group II
Poor	102+	102+	103+	104+	102+	100+	Group I

Figure 8a: Normal heart rate values for male subject

Age	18-25	26-35	36-45	46-55	56-65	65+	
Athletes	74-80	74-79	74-79	74-80	74-79	74-79	Group VII
Excellent	81-85	80-84	80-84	81-85	80-84	80-84	Group VI
Good	86-89	85-88	85-89	86-89	85-88	85-88	Group V
Abv avg	90-93	89-92	90-93	90-93	89-93	89-92	Group IV
Avg	94-98	93-96	94-98	94-97	94-97	93-96	Group III
Blw avg	99-104	97-102	99-104	98-103	98-103	97-104	Group II
Poor	105+	103+	105+	104+	104+	104+	Group I

Figure 8b: Normal heart rate values for female subject

Figure 8

Column (Score)	0	1	2	3	4	5	6	7
RR	Group I <5 or >30	Group II 21-30	Group III 6-9	Group IV 10-12 or 18-20	Group V 13-17			
SpO2	Group I 0-74	Group II 75-84	Group III 85-94	Group IV 95-96	Group V 97-98	Group VI >98		
HR		Group I	Group II	Group III	Group IV	Group V	Group VI	Group VII

Figure 9

Total scores	Health indication	Grade
1-2	Dangerous	F
3-4	Very Poor	D
5-6	Poor	C
7-8	Below Average	B-
9-10	Average	B
11-12	Good	A
13-14	Very Good	A+
15-16	Excellent	A*

Figure 10

RR (Column)	SpO2 (Column)	HR (Group)	Defined Group	Interpretations
I	I	I	F	d
:	:	:	:	:
I	I	III	Imp	Imp
:	:	:	:	:
I	II	IV	Imp	Imp
:	:	:	:	:
I	II	VI	C	d'
:	:	:	:	:
I	III	V	C	d'
:	:	:	:	:
I	III	VII	B	a
:	:	:	:	:
I	VI	VII	B-	a
:	:	:	:	:
II	II	I	D	V
II	II	II	D	V
II	III	III	C	V
:	:	:	:	:
II	IV	I	C	V/C
:	:	:	:	:
III	III	II	C	f
III	III	VII	B	ff
:	:	:	:	:
III	III	VII	B-	WI
:	:	:	:	:
III	IV	VII	A	β
III	V	I	B-	β
III	V	II	B-	β
:	:	:	:	:
IV	IV	III	B	ϕ'
IV	IV	III	B	ϕ
:	:	:	:	:
V	V	IV	A	ϕ
:	:	:	:	:
V	VI	II	B	ϕ'
V	VI	III	A	ϕ
V	VI	IV	A+	ϕ
V	VI	V	A+	ϕ
V	VI	VI	A*	ϕ
V	VI	VII	A*	ϕ

1102
1134
1104
1120
1132
1106
1122
1108
1130
1110
1112
1128
1114
1126
1118
1124
1116

Figure 11

	Example Interpretation
Imp	Impossible combination, error returned. No interpretation is required..
WI	No definitive interpretation may be made. The parameters measured are not indicative of a particular condition or state.
N/C	A normal compensatory process is in place. e.g. increased RR is in place to maintain good SpO2 levels.
a	SpO2 & HR are in the normal range. However, an abnormal Respiratory rate has been detected.
a'	SpO2 level is still in the normal range. However, an abnormal Respiratory rate has been detected and HR is on the low side.
d	SpO2 is on the low range and HR is increased to compensate for the condition.
d'	SpO2 is on the low range despite increased HR to compensate for the condition.
f	User may be in a dangerous condition with all parameters detected to be on the low side. HR and RR are unable to compensate to improve low SpO2 level.
γ	SpO2 is on the low side. Both HR and RR are detected to be increasing to compensate for the condition.
β	All parameters indicates that the user is in a calm condition.
Φ	Good health condition!
φ'	Normal health condition. There can be more exercises to improve HR.

Figure 12

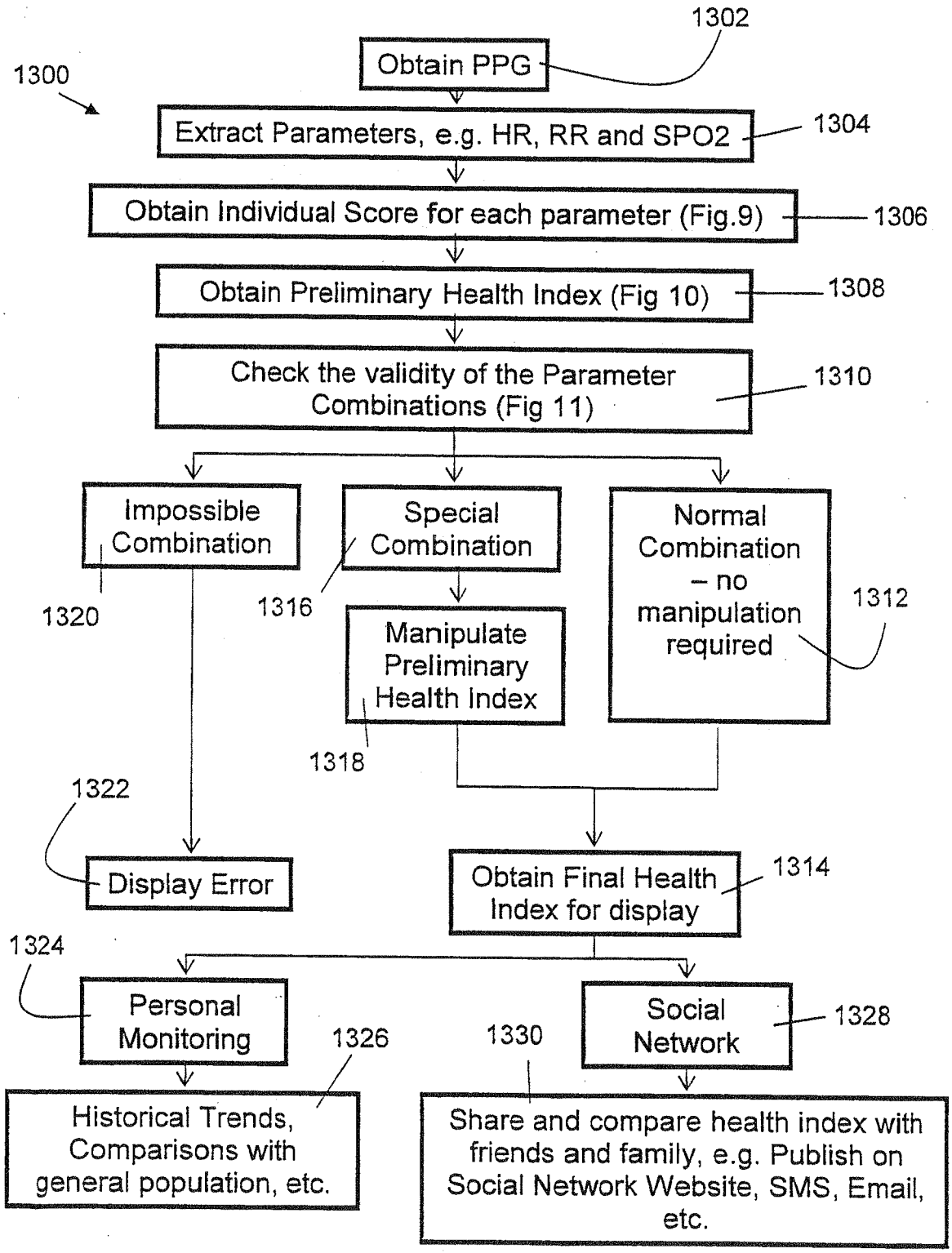

1300
1302
Obtain PPG
Extract Parameters, e.g. HR, RR and SPO2
1304
Obtain Individual Score for each parameter (Fig.9)
1306
Obtain Preliminary Health Index (Fig 10)
1308
Check the validity of the Parameter Combinations (Fig 11)
1310
Impossible Combination
1320
Special Combination
1316
Manipulate Preliminary Health Index
1318
Normal Combination – no manipulation required
1312
1322
Display Error
Obtain Final Health Index for display
1314
1324
Personal Monitoring
1326
Historical Trends, Comparisons with general population, etc.
1330
Social Network
1328
Share and compare health index with friends and family, e.g. Publish on Social Network Website, SMS, Email, etc.

Figure 13

OLT

User ID	Date	I/P Data
User 1		-x-
User 2	D1	-x-
User 2	D2	-x-
User 3		-x-

OLAP

User ID	Date	Data	Average	Social Ranking
User 1				

User ID	Date	Data	Average	Social Ranking
User 1				

User ID	Date	Personal Data	Data	Average	Social Ranking
User n					

Figure 14

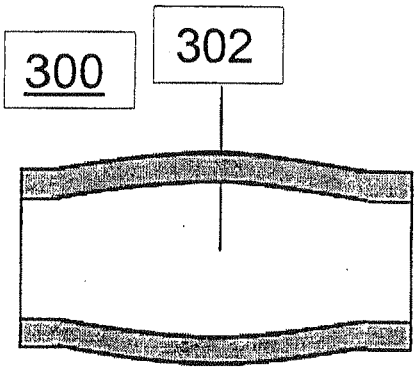


Figure 15

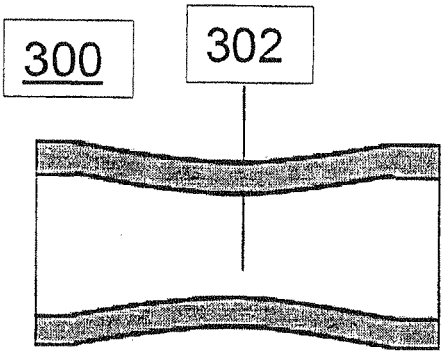


Figure 16

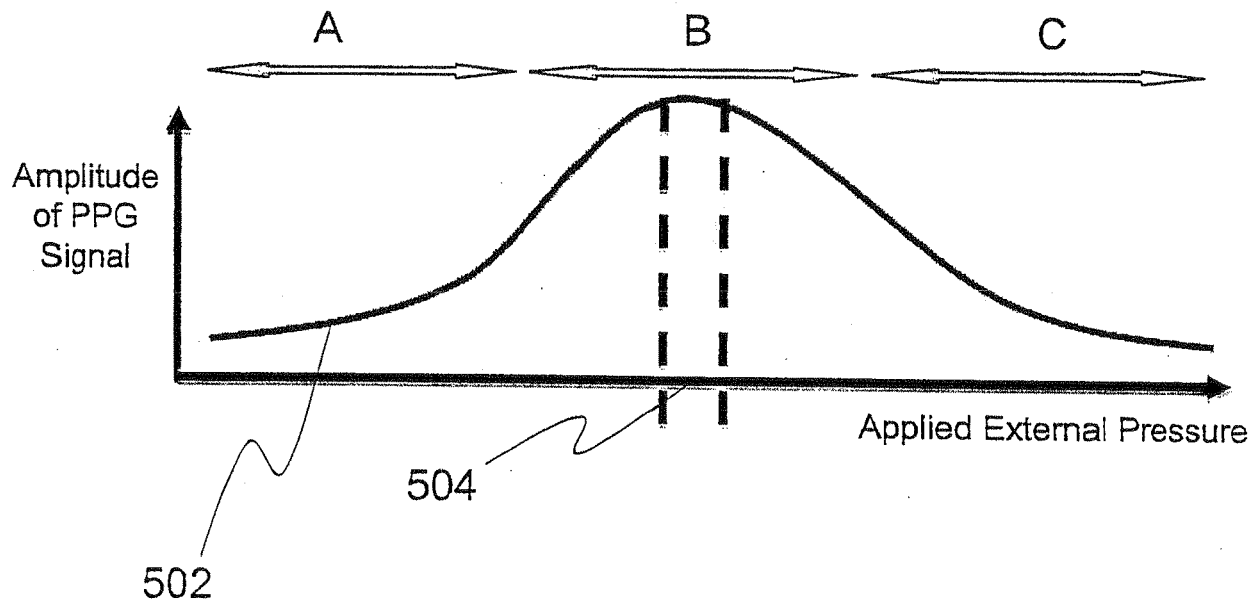

A
B
C
Amplitude of PPG Signal
Applied External Pressure
504
502

Figure 17

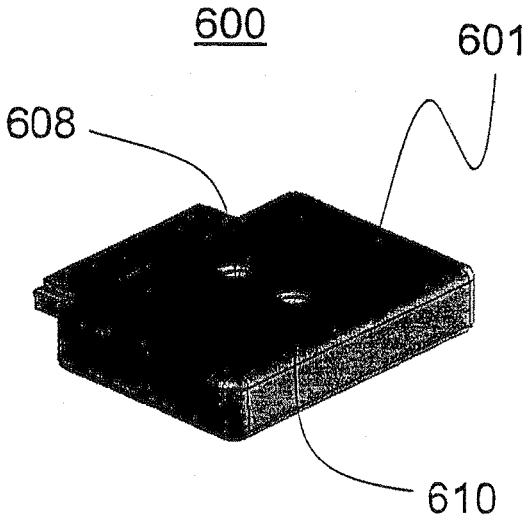


Figure 18A

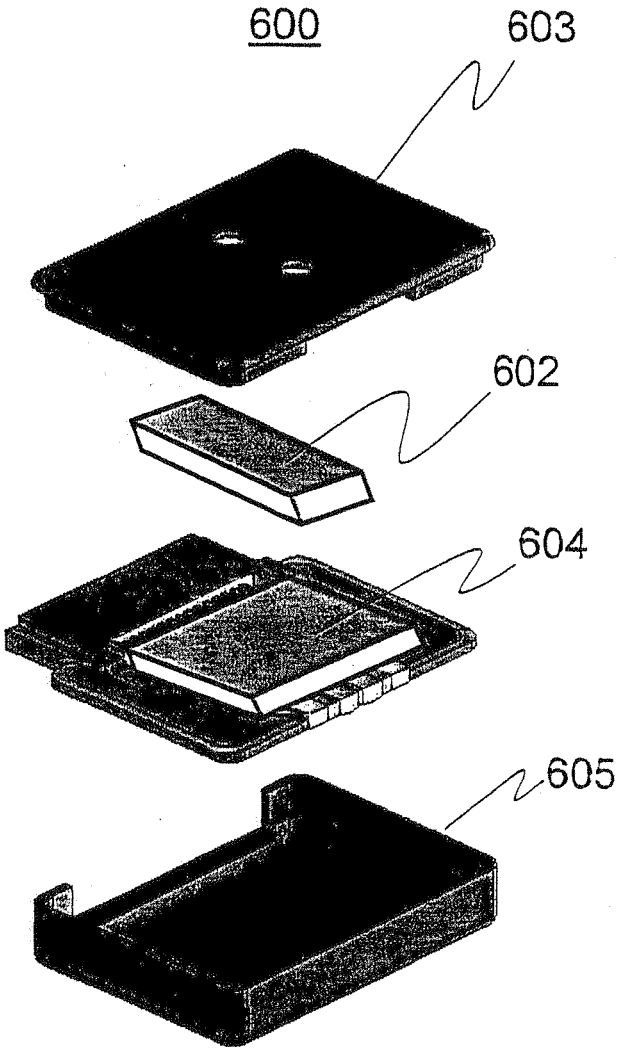


Figure 18B

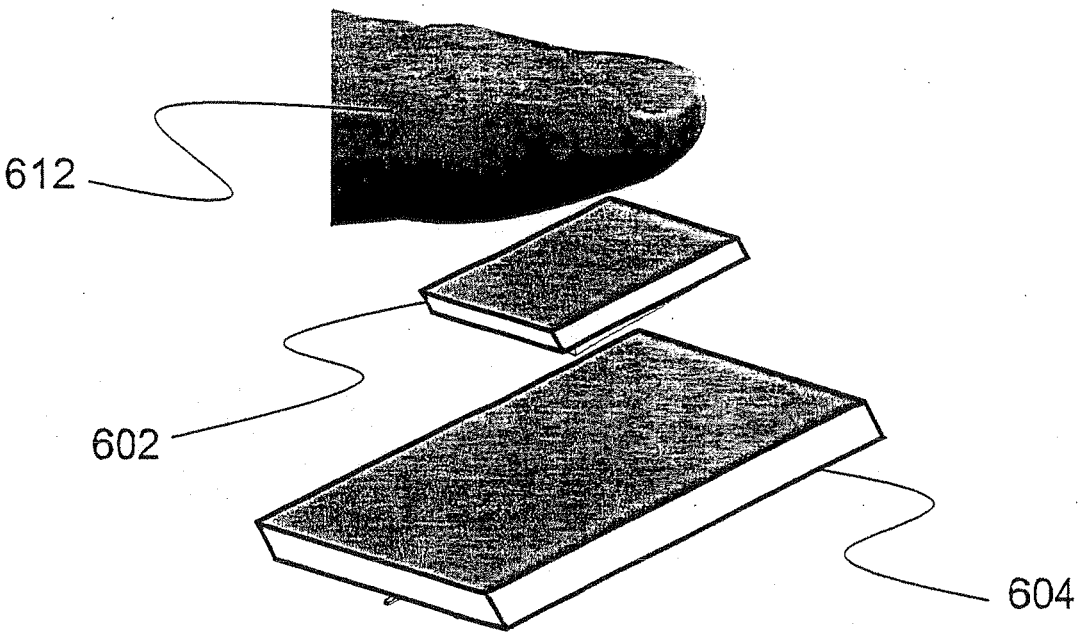


Figure 19A

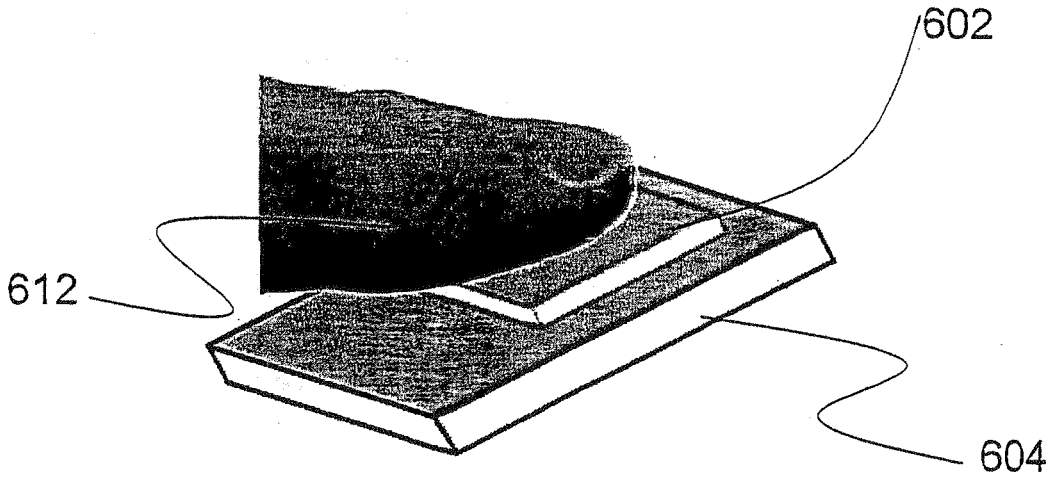


Figure 19B

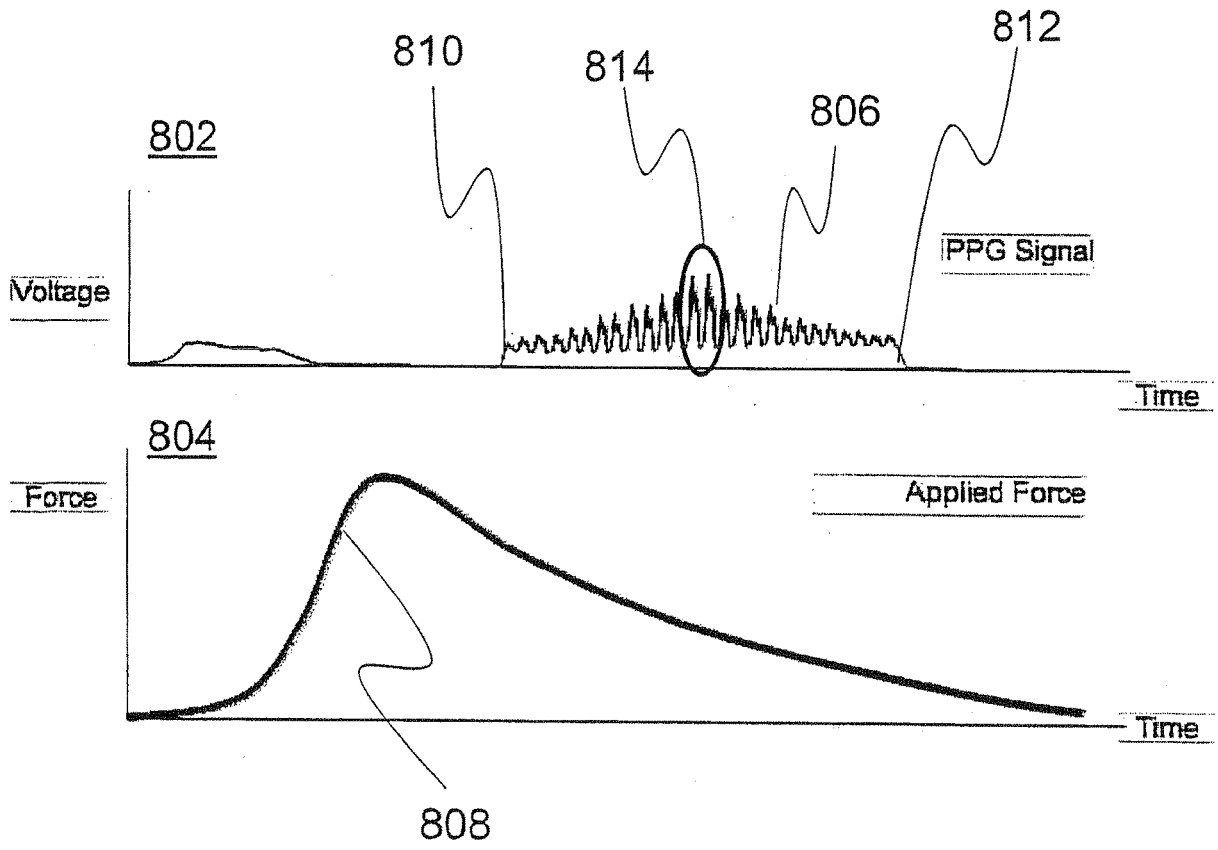

810
814
812
806
802
PPG Signal
Voltage
Time
804
Force
Applied Force
Time
808

Figure 20

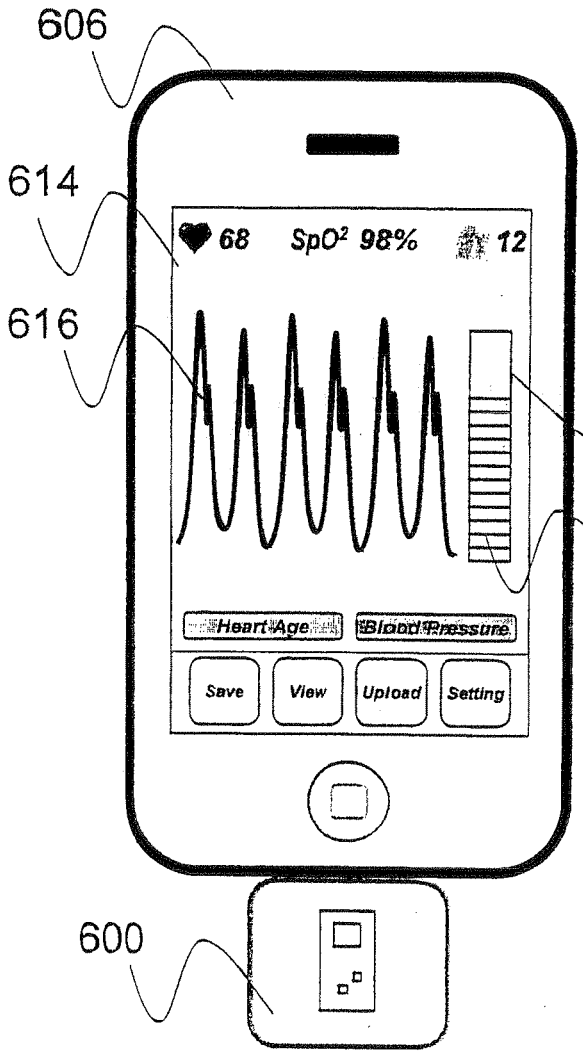


Figure 21A

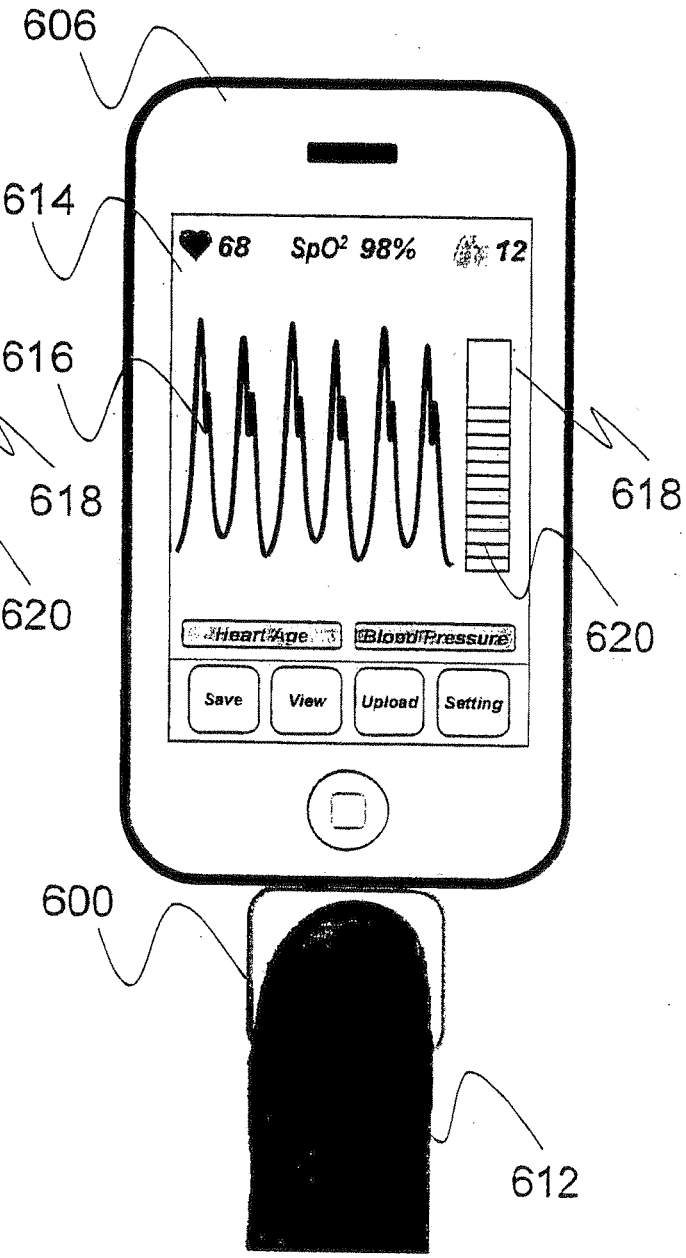


Figure 21B

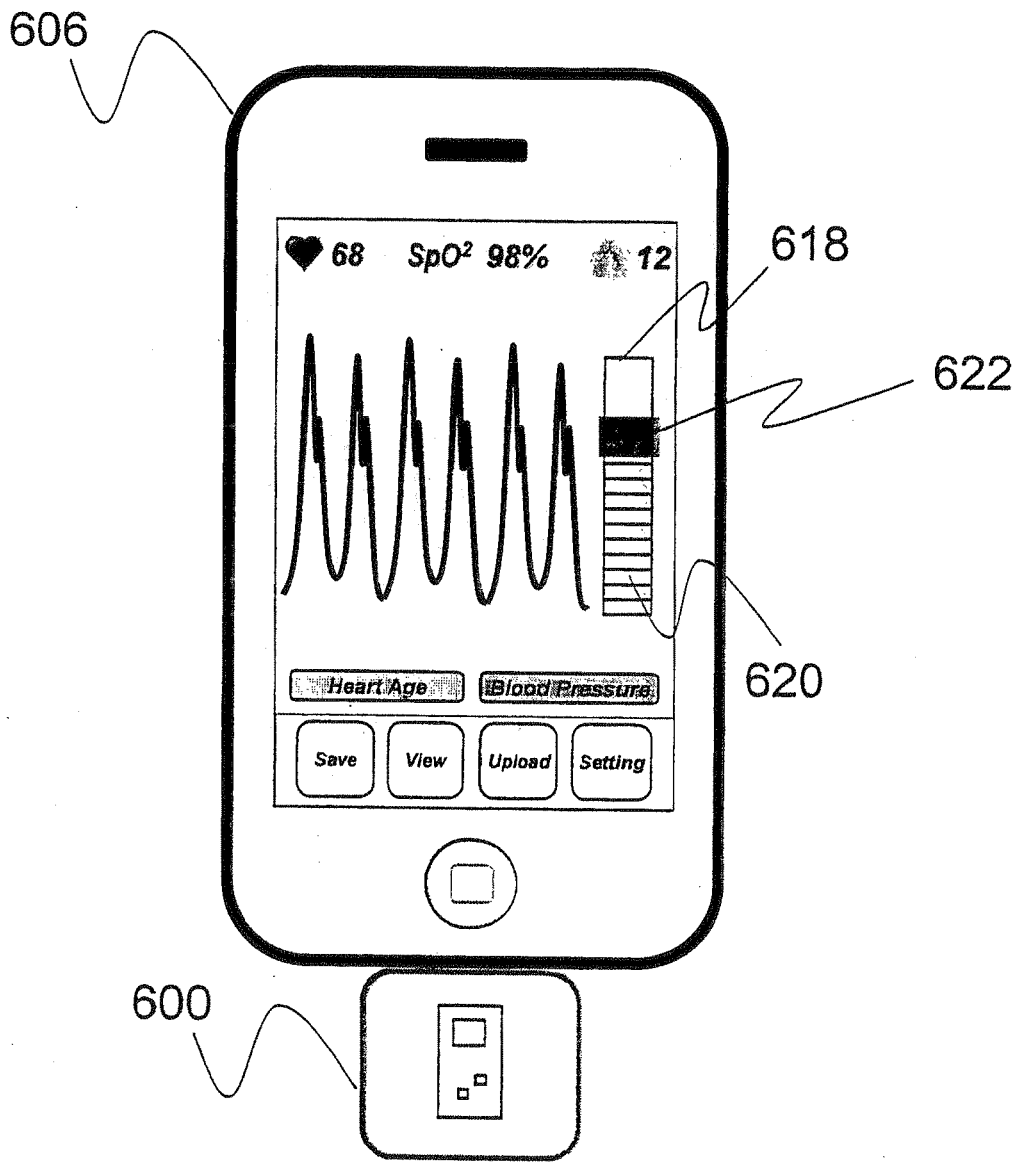

606
618
622
620
600
68
SpO2 98%
12
Heart Age
Blood Pressure
Save
View
Upload
Setting

Figure 22

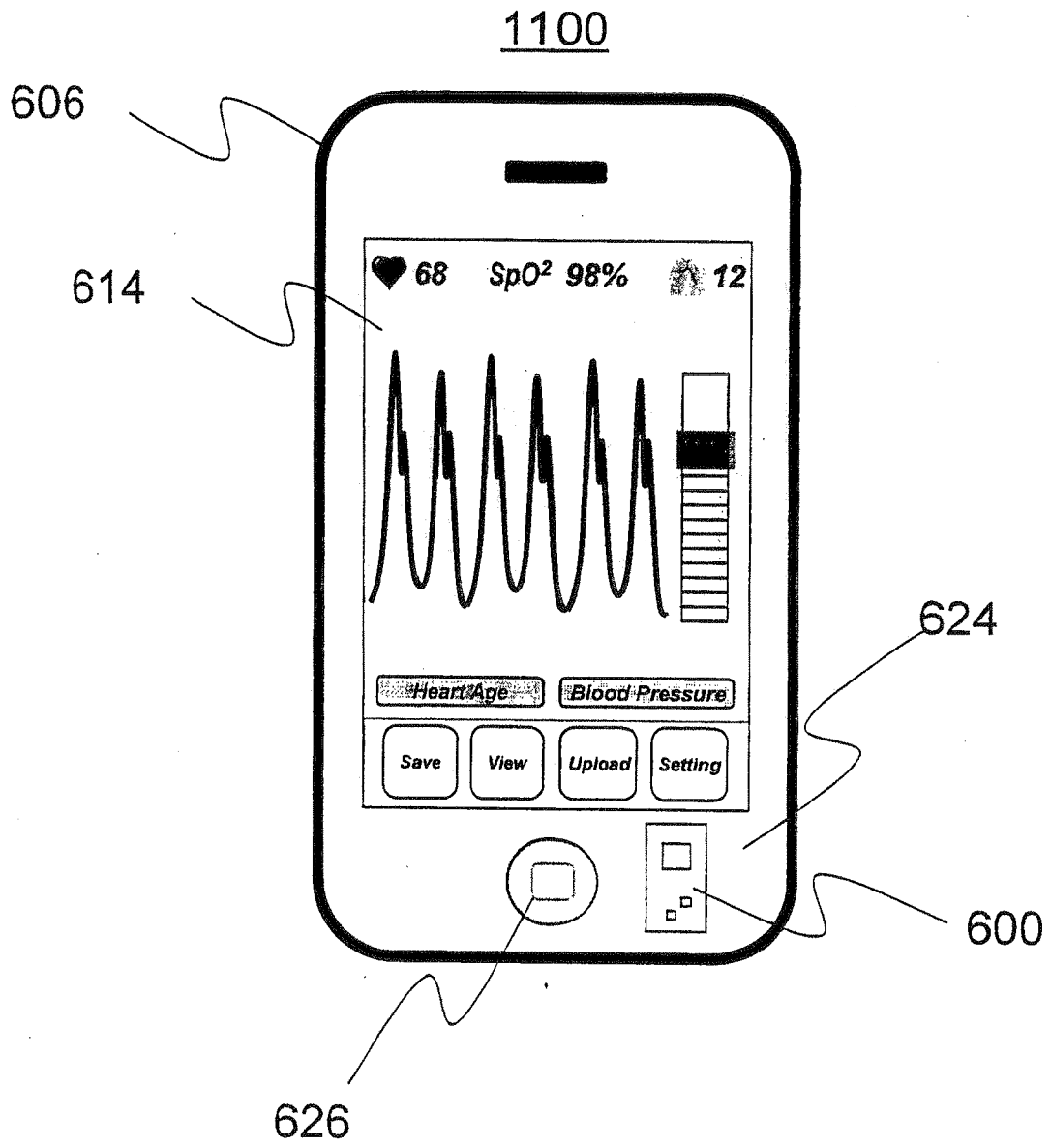

1100
606
614
68
SpO2 98%
12
Heart Age
Blood Pressure
Save
View
Upload
Setting
624
600
626

Figure 23

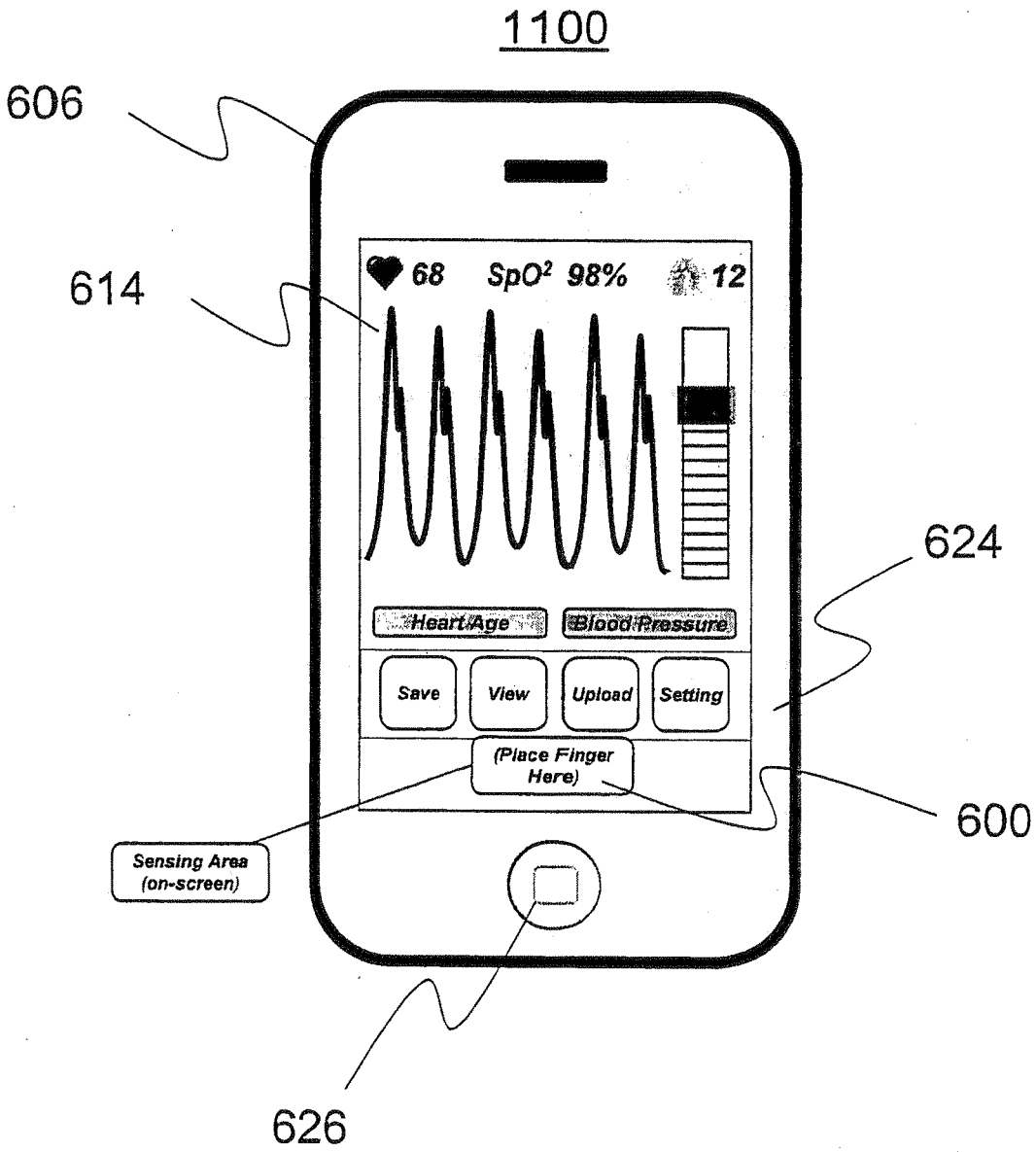

1100
606
614
68
SpO² 98%
12
624
Heart Age
Blood Pressure
Save
View
Upload
Setting
(Place Finger Here)
600
Sensing Area (on-screen)
626

Figure 24

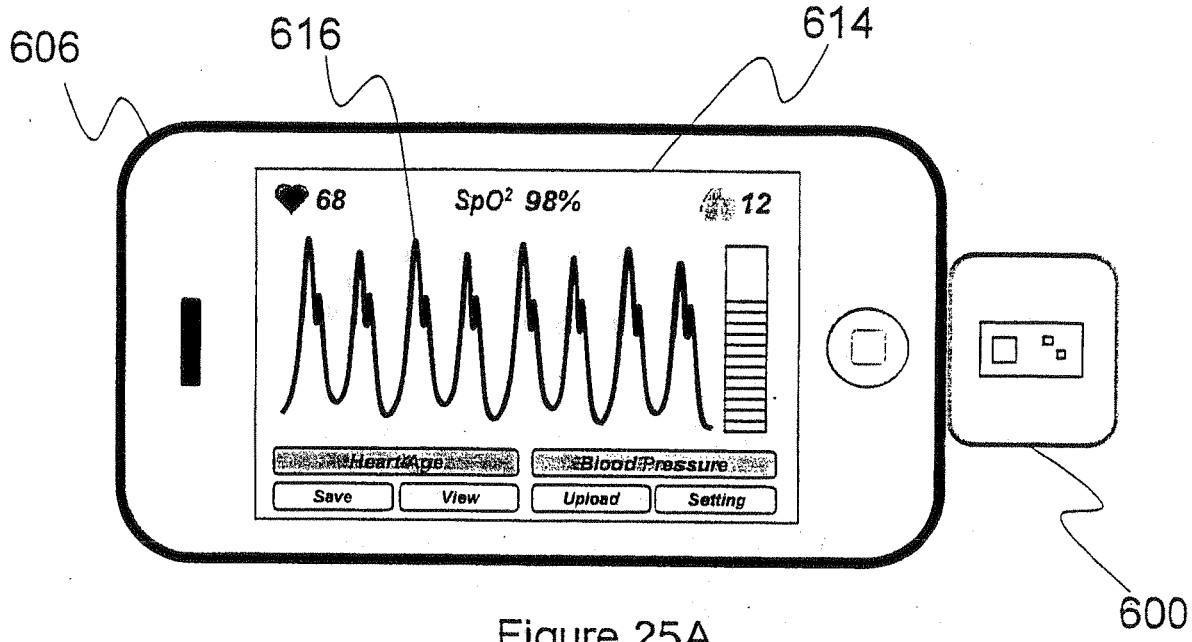


Figure 25A

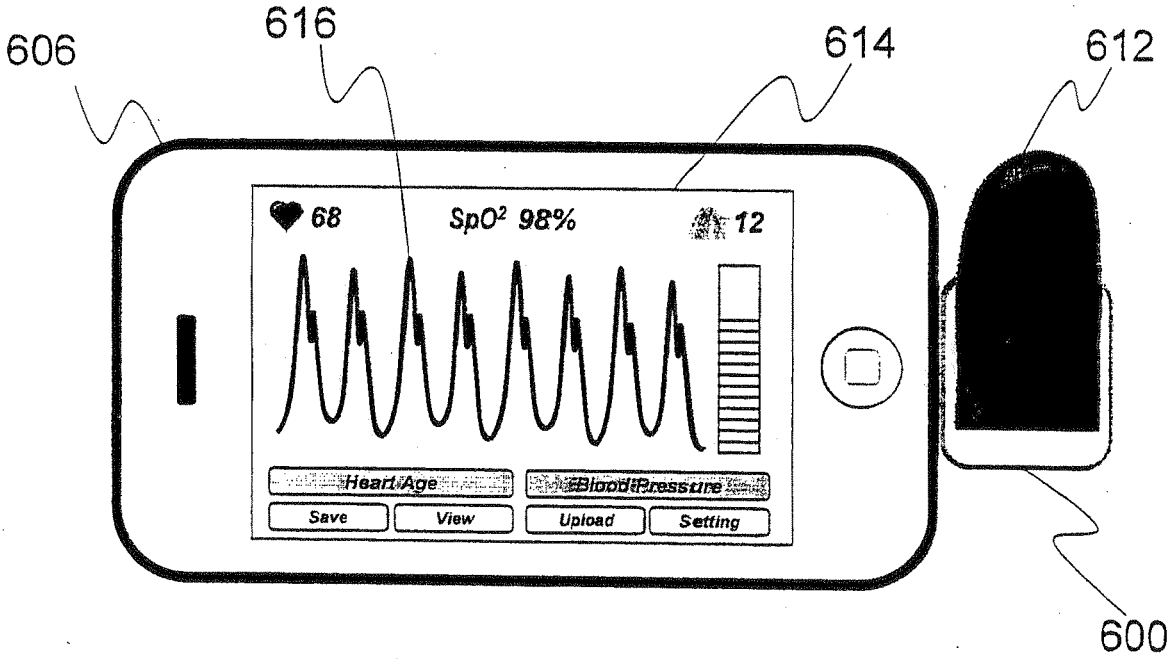


Figure 25B

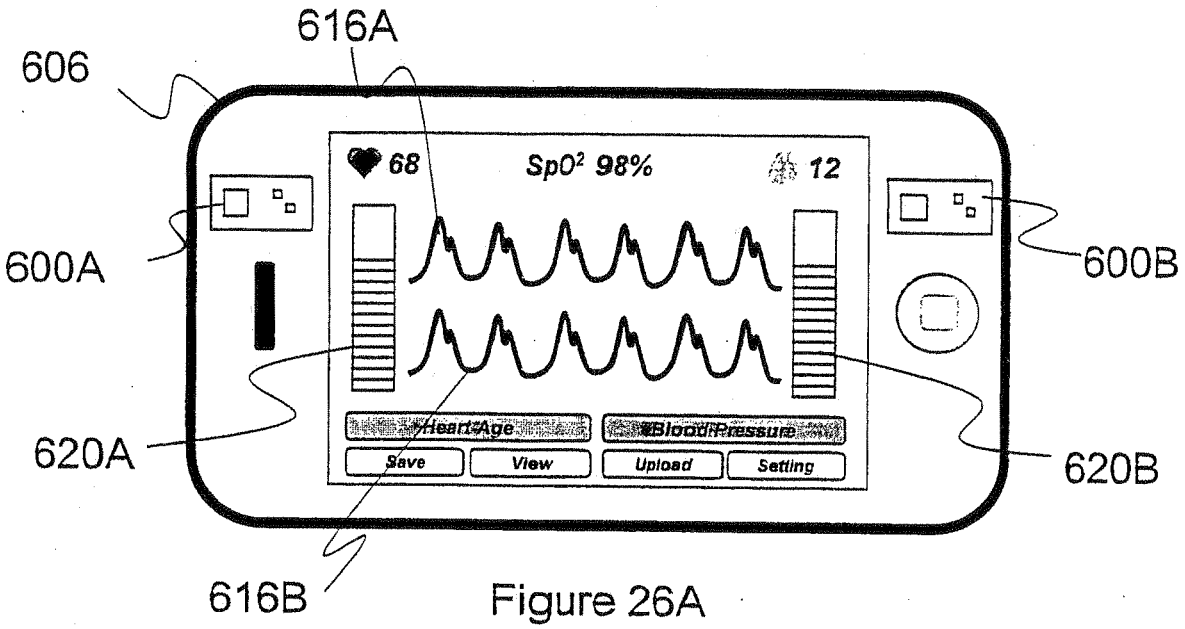


Figure 26A

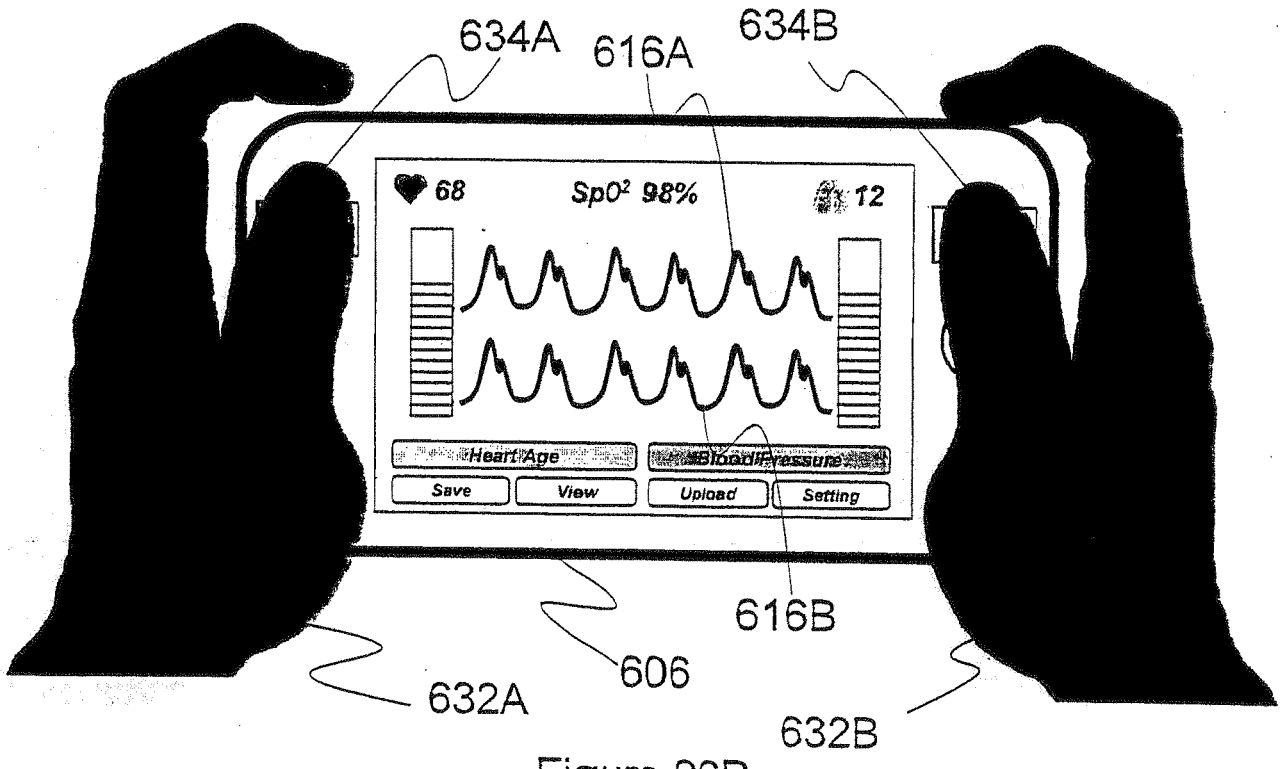


Figure 26B

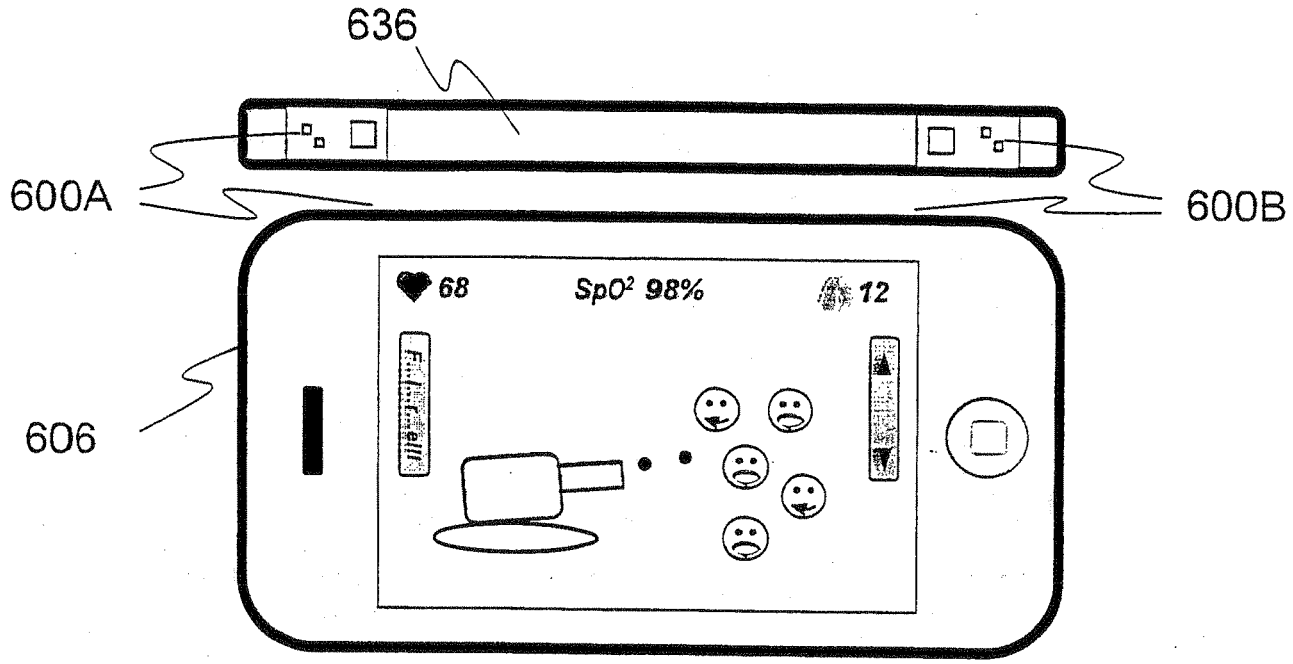


Figure 27A

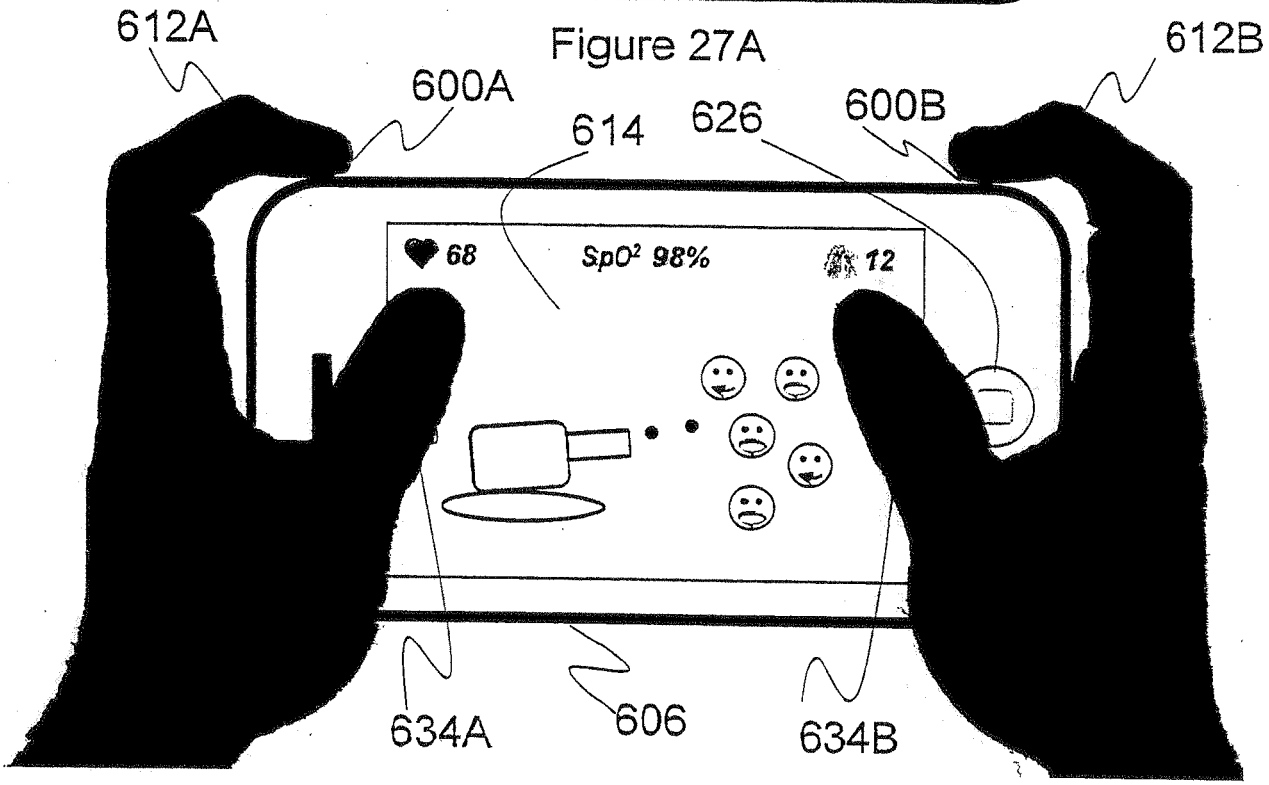


Figure 27B

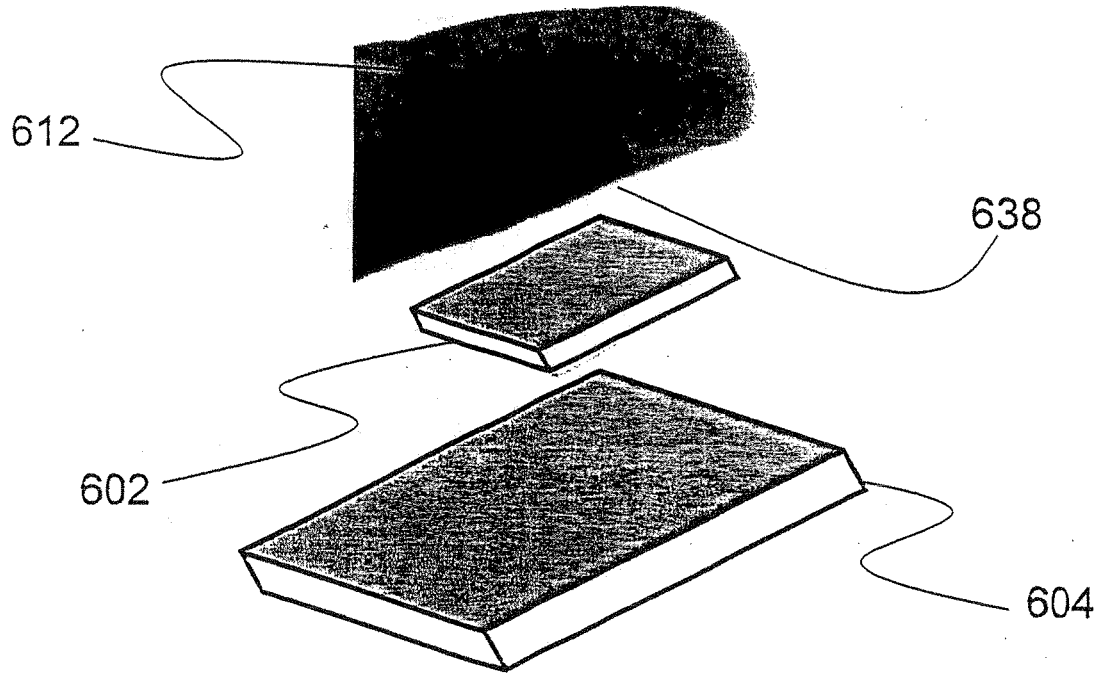


Figure 28A

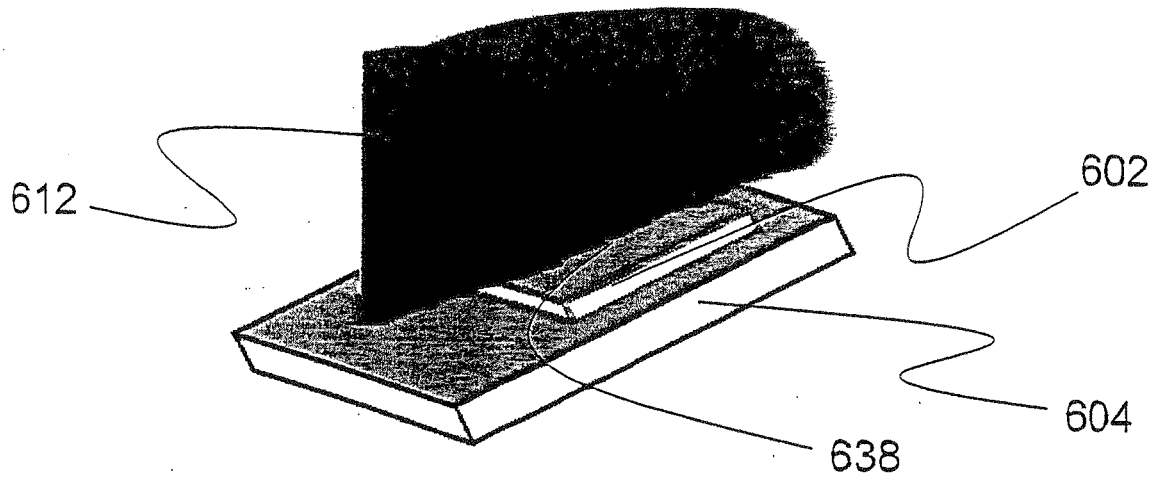


Figure 28B

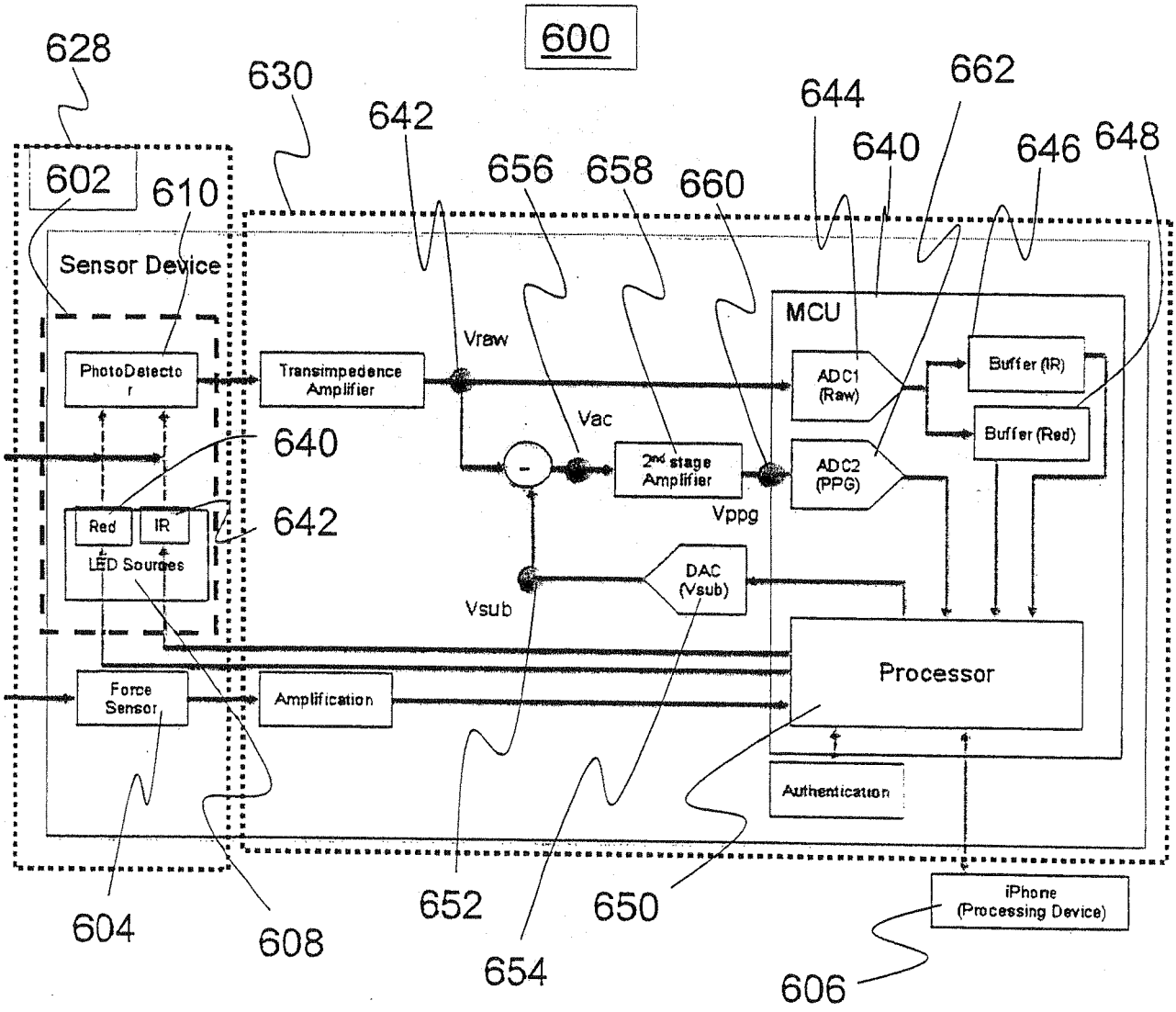

600
628
630
642
644
662
602
610
656
658
660
640
646
648
Sensor Device
MCU
PhotoDetecto r
Transimpedence Amplifier
Vraw
ADC1 (Raw)
Buffer (IR)
Vac
640
Buffer (Red)
2nd stage Amplifier
ADC2 (PPG)
Red
IR
642
Vppg
LED Sources
DAC (Vsub)
Vsub
Processor
Force Sensor
Amplification
Authentication
iPhone (Processing Device)
604
608
652
650
654
606

Figure 29

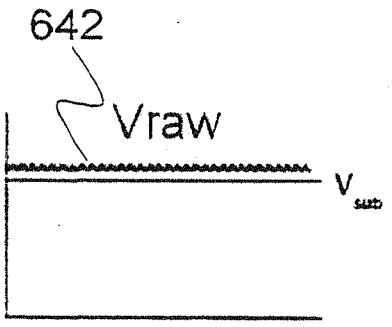


Figure 30A

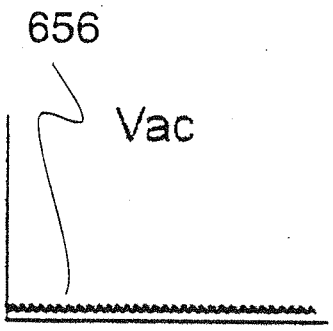


Figure 30B

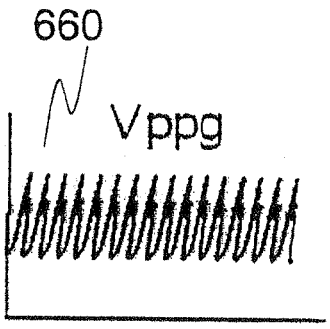


Figure 30C

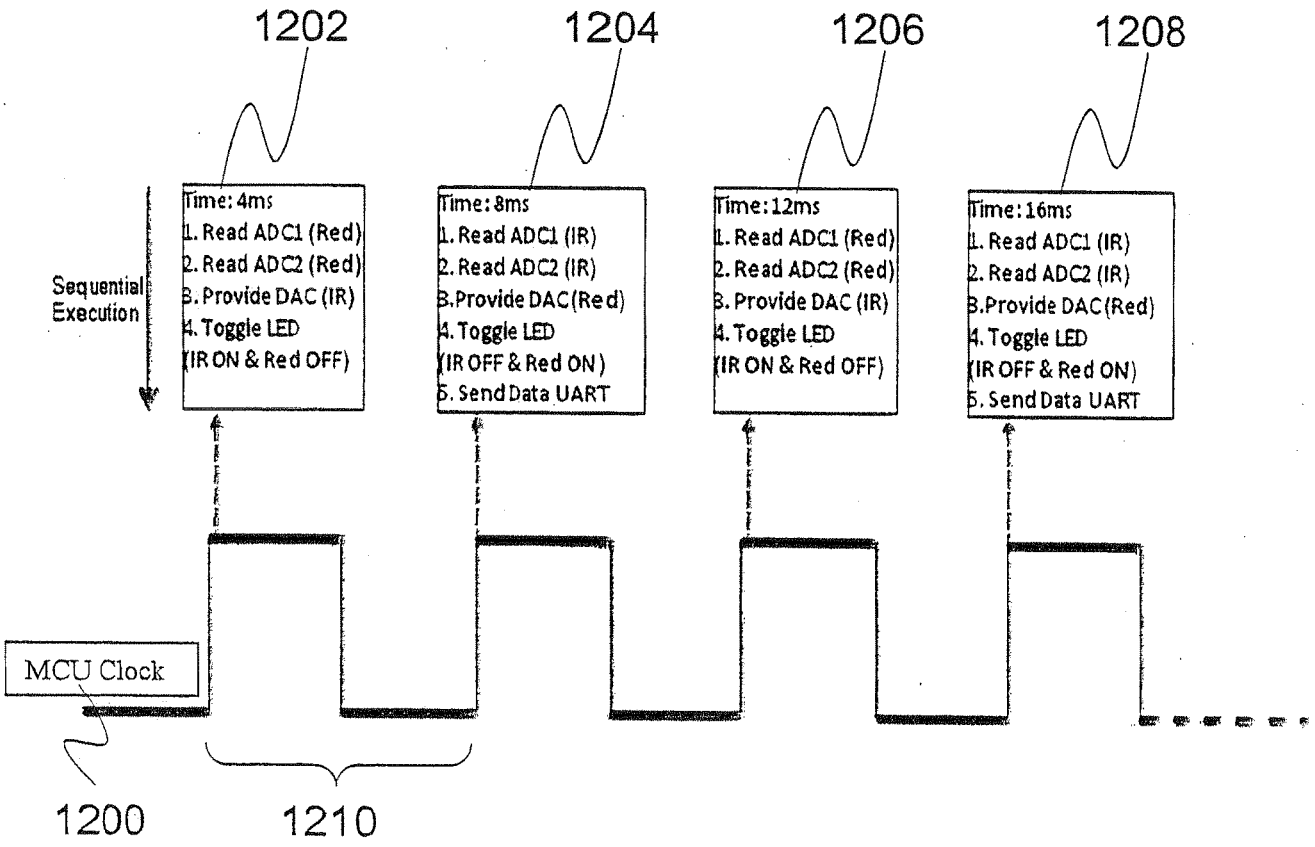

1202
1204
1206
1208
Time: 4ms
1. Read ADC1 (Red)
2. Read ADC2 (Red)
3. Provide DAC (IR)
4. Toggle LED
(IR ON & Red OFF)
Time: 8ms
1. Read ADC1 (IR)
2. Read ADC2 (IR)
3.Provide DAC(Red)
4. Toggle LED
(IR OFF & Red ON)
5. Send Data UART
Time: 12ms
1. Read ADC1 (Red)
2. Read ADC2 (Red)
3. Provide DAC (IR)
4. Toggle LED
(IR ON & Red OFF)
Time: 16ms
1. Read ADC1 (IR)
2. Read ADC2 (IR)
3.Provide DAC(Red)
4. Toggle LED
(IR OFF & Red ON)
5. Send Data UART
Sequential Execution
MCU Clock
1200
1210

Figure 31

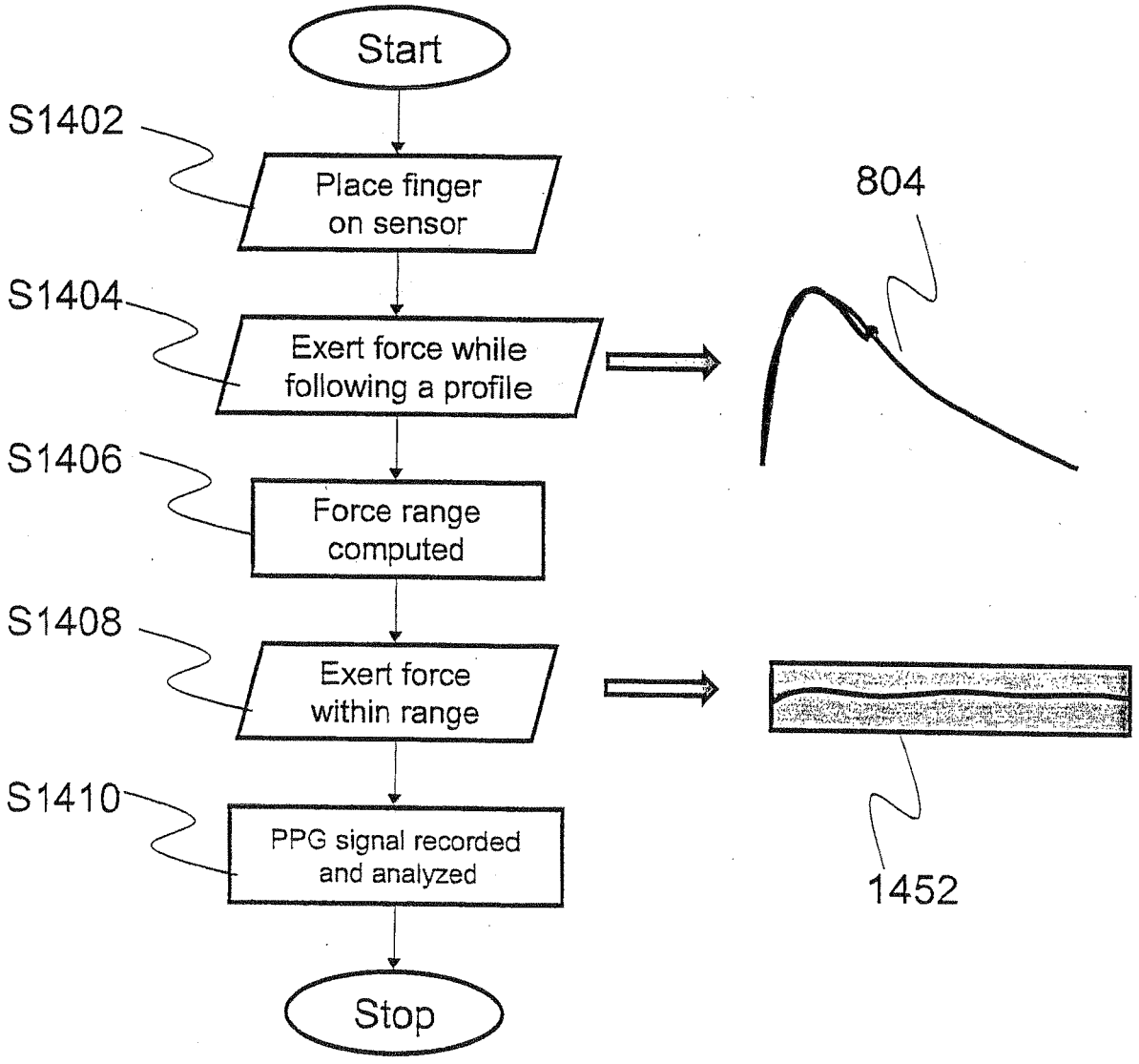

Start
S1402
Place finger on sensor
S1404
Exert force while following a profile
S1406
Force range computed
S1408
Exert force within range
S1410
PPG signal recorded and analyzed
Stop
804
1452

Figure 32

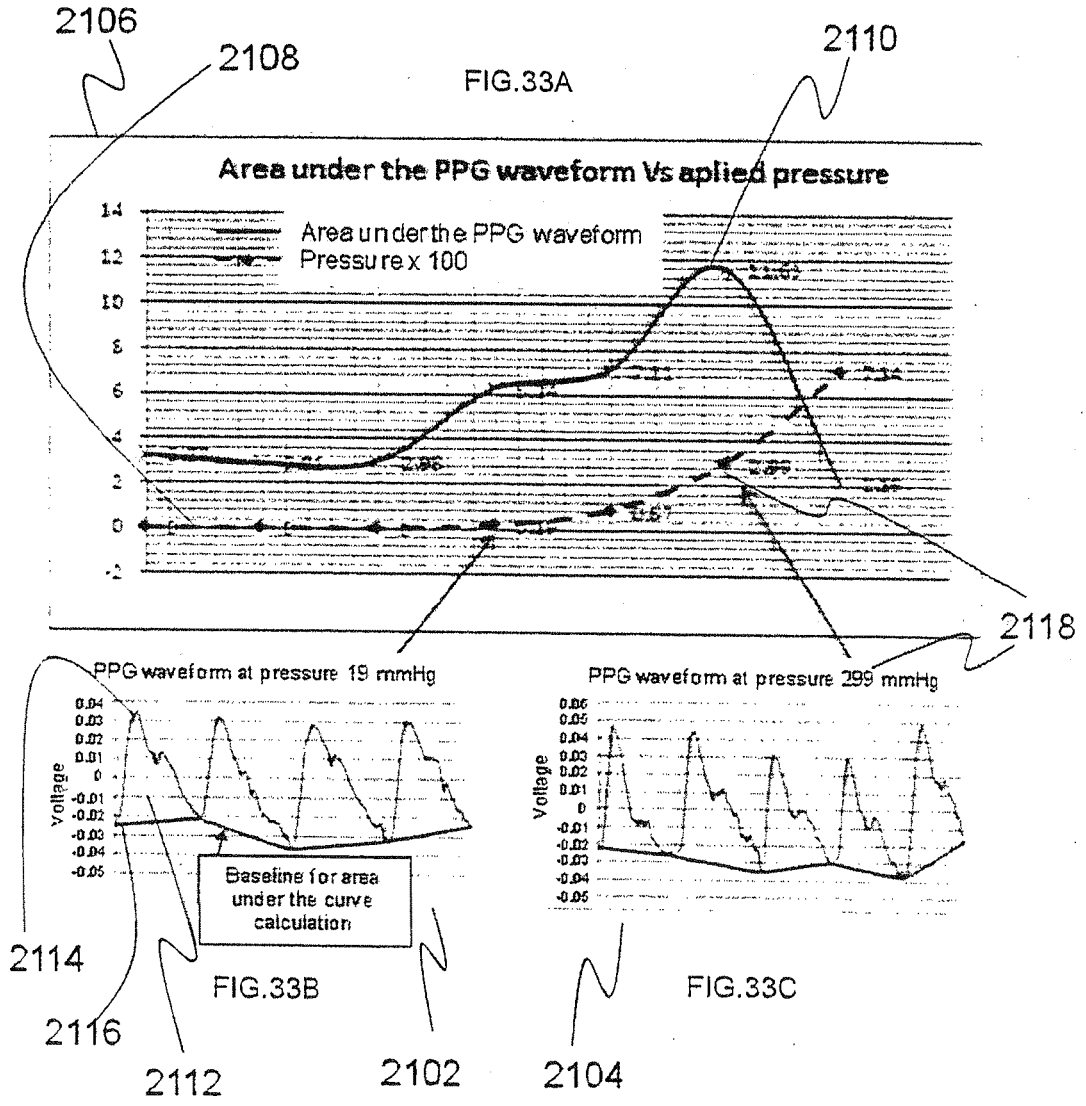


FIG.33A

FIG.33B

FIG.33C

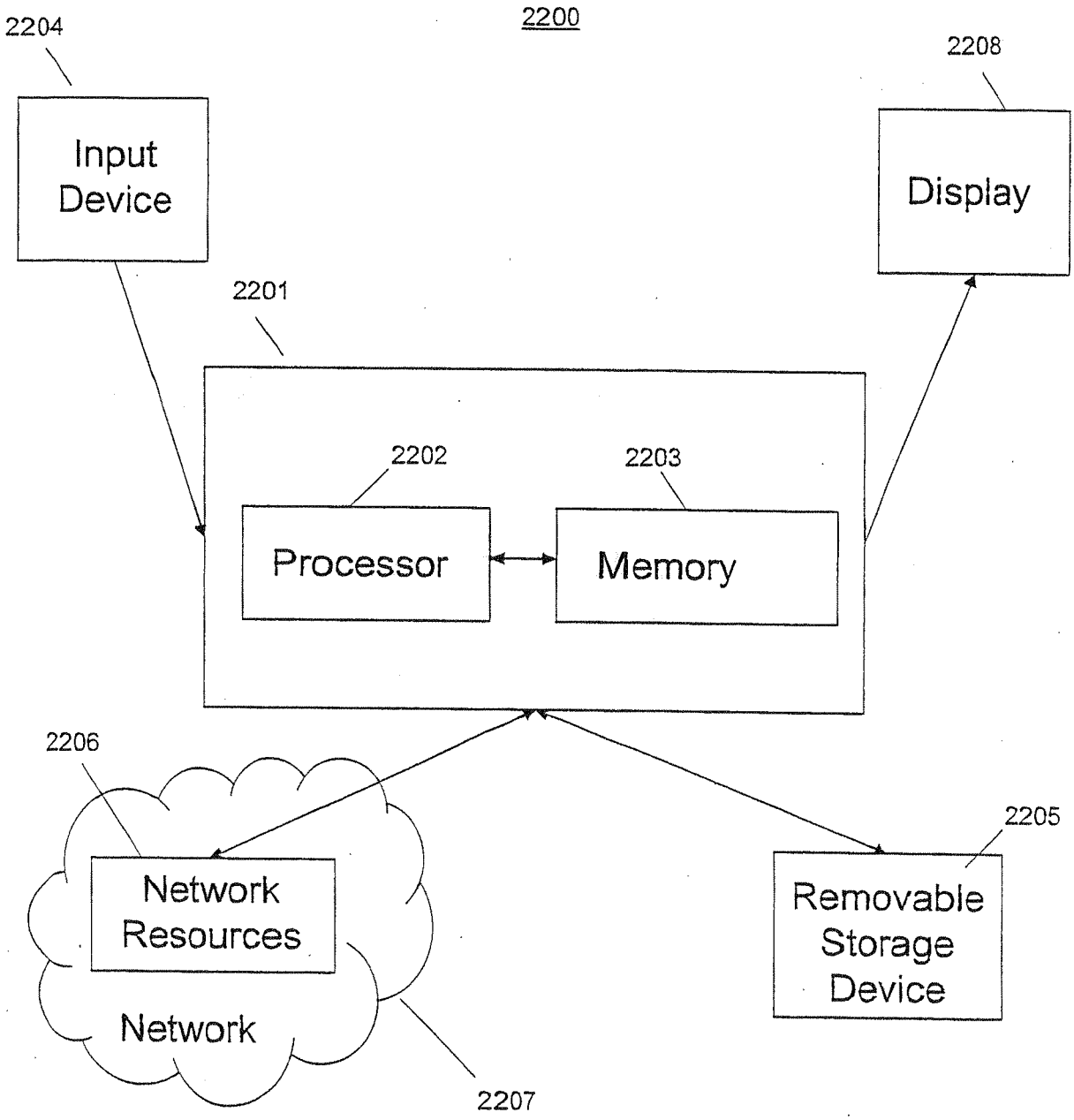

2200
2204
Input Device
2208
Display
2201
2202
Processor
2203
Memory
2206
Network Resources
Network
2207
2205
Removable Storage Device

Figure 34

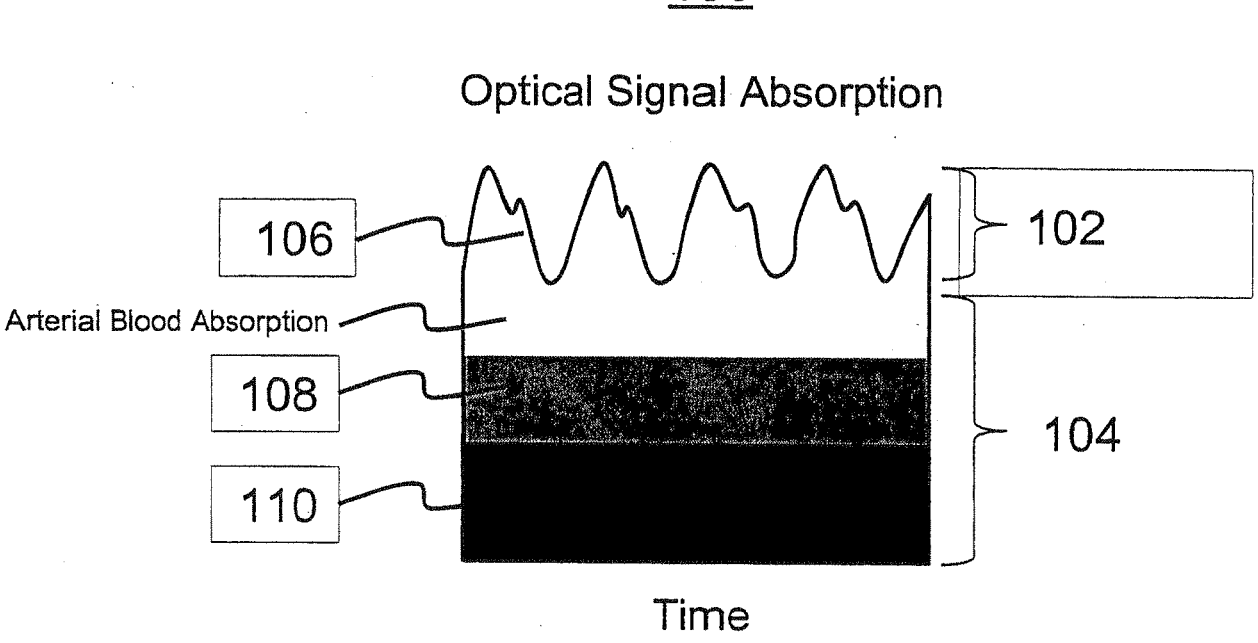

100
Optical Signal Absorption
106
102
Arterial Blood Absorption
108
104
110
Time

Figure 35

Respiratory rate (bpm)	Category / Band
≤5 or ≥25	Group I
21 to 24	Group II
15 to 20	Group III
10 to 14	Group IV
6 to 9	Group V

Figure 36

SpO2 (%)	Category / Band
≤90	Group I
91-94	Group II
95-96	Group III
97-98	Group IV
99-100	Group V

Figure 37

Age	18-25	26-35	36-45	46-55	56-65	65+	
	≤59	≤59	≤60	≤60	≤61	≤61	Group VIIb
	60-68	60-68	61-69	61-69	62-70	61-69	Group VIIa
Athletes	69-75	69-74	70-76	70-77	71-76	70-75	Group VII
Excellent	76-81	75-81	77-82	78-83	77-81	76-81	Group VI
Good	82-85	82-85	83-86	84-87	82-87	82-85	Group V
Abv avg	86-89	86-90	87-90	88-91	88-91	86-89	Group IV
Avg	90-93	91-94	91-95	92-96	92-95	90-93	Group III
Blw avg	94-101	95-101	96-102	97-103	96-101	94-99	Group II
Poor	102+	102+	103+	104+	102+	100+	Group I

Figure 38a: Normal heart rate values for male subject

Age	18-25	26-35	36-45	46-55	56-65	65+	
	≤64	≤64	≤64	≤64	≤64	≤64	Group VIIb
	65-73	65-73	65-73	65-73	65-73	65-73	Group VIIa
Athletes	74-80	74-79	74-79	74-80	74-79	74-79	Group VII
Excellent	81-85	80-84	80-84	81-85	80-84	80-84	Group VI
Good	86-89	85-88	85-89	86-89	85-88	85-88	Group V
Abv avg	90-93	89-92	90-93	90-93	89-93	89-92	Group IV
Avg	94-98	93-96	94-98	94-97	94-97	93-96	Group III
Blw avg	99-104	97-102	99-104	98-103	98-103	97-104	Group II
Poor	105+	103+	105+	104+	104+	104+	Group I

Figure 38b: Normal heart rate values for female subject

Figure 38

	1	2	3	4	5	6	
RR	≤5 & ≥25	21 to 24	15 to 20	10 to 14	6 to 9		
SpO2	≤90	91 to 94	95 to 96	97 to 98	99 to 100		
HR	Groups 1 & 2	Group 3	Group 4	Group 5	Group 6	Group 7	
						Sub-group 7a	Sub-group 7b

Figure 39

	1	2		3	4	5	6	
RR	≤5 & ≥25	21 to 24	6 to 9	15 to 20	10 to 14			
SpO2	≤90	91 to 94		95 to 96	97 to 98	99 to 100		
HR	Groups 1 & 2	Group 3		Group 4	Group 5	Group 6	Group 7	
							Sub-group 7a	Sub-group 7b

Figure 40

RR	SpO2	HR	Interpretation	Score	Band
≤5, ≥25	95-96	1&2	a'	44	7
6-9	99-100	5	ϕ	92	2
15-20	95-96	1&2	ϕ'	58	6
21-24	91-94	3	γ	56	6

3900

Figure 41 – 3-axis table (exemplary extracts only)

Score ranges	Band	Title
96 to 100	1	Extremely healthy
90 to 95	2	Very healthy
80 to 89	3	Healthy
70 to 79	4	Average health
60 to 69	5	Room for improvement
50 to 59	6	Need to improve
40 to 49	7	Very unhealthy
0 to 39	8	Critically unhealthy

Figure 42

Imp	Due to the unusual combination of your levels of SpO2, RR and HR, we are unable to provide you with an appropriate interpretation. You may want to retake your measurements.
N/C	Your HR is faster due to an increase in your RR. Slowing down your RR should help in returning your HR to normal.
N/C'	Your HR is faster due to a decrease in your SpO2.
a	Your RR seems to be controlled voluntarily. Please try to breathe normally.
a'	Due to voluntary control of your RR, your HR is higher to compensate for the low SpO2. Please resume normal breathing to avoid any dangerous effects.
a''	Due to voluntary control of your RR, your SpO2 is lower than usual.
d	Both your HR and RR are faster to compensate for your low SpO2.
d'	Your body cannot cope with your low SpO2. If you are at a location of high altitude, you may want to descend to lower altitudes. Deep breathing may also help.
γ	Both your HR and RR are slightly faster to compensate for your low SpO2.
φ	Normal health condition. May also be due to your calmness or if you are in sleeping conditions.
φ'	Normal health condition, but with lack of exercise. HR can be improved with regular exercise.
z	The voluntary lowering of your RR lowers your HR, and will subsequently cause the lowering of your SpO2 as well. WARNING: this can be extremely dangerous. Please resume normal breathing immediately.

Figure 43

	RR	HR	SpO2	Band
Impossible	10-20	4, 5, 6, 7	< 95	Imp
	≤ 5 , ≥ 25	3, 4	≤ 90	Imp
	21 - 24	7	≤ 90	Imp
		6, 7	91 – 100	Imp
Atypical	≤ 5 , ≥ 25	5, 6, 7	95 – 100	5
	21 - 24	6	≤ 90	6
		3	95 – 98	6
	15 - 20	3	91 – 96	6
			97 – 100	5
	10 – 14	1&2, 3	95 – 100	5
	6 – 9	6, 7	≤ 90	8
			91 – 94	7
		6	95 – 96	2
		3	95 – 96	6
			99 – 100	5

Figure 44

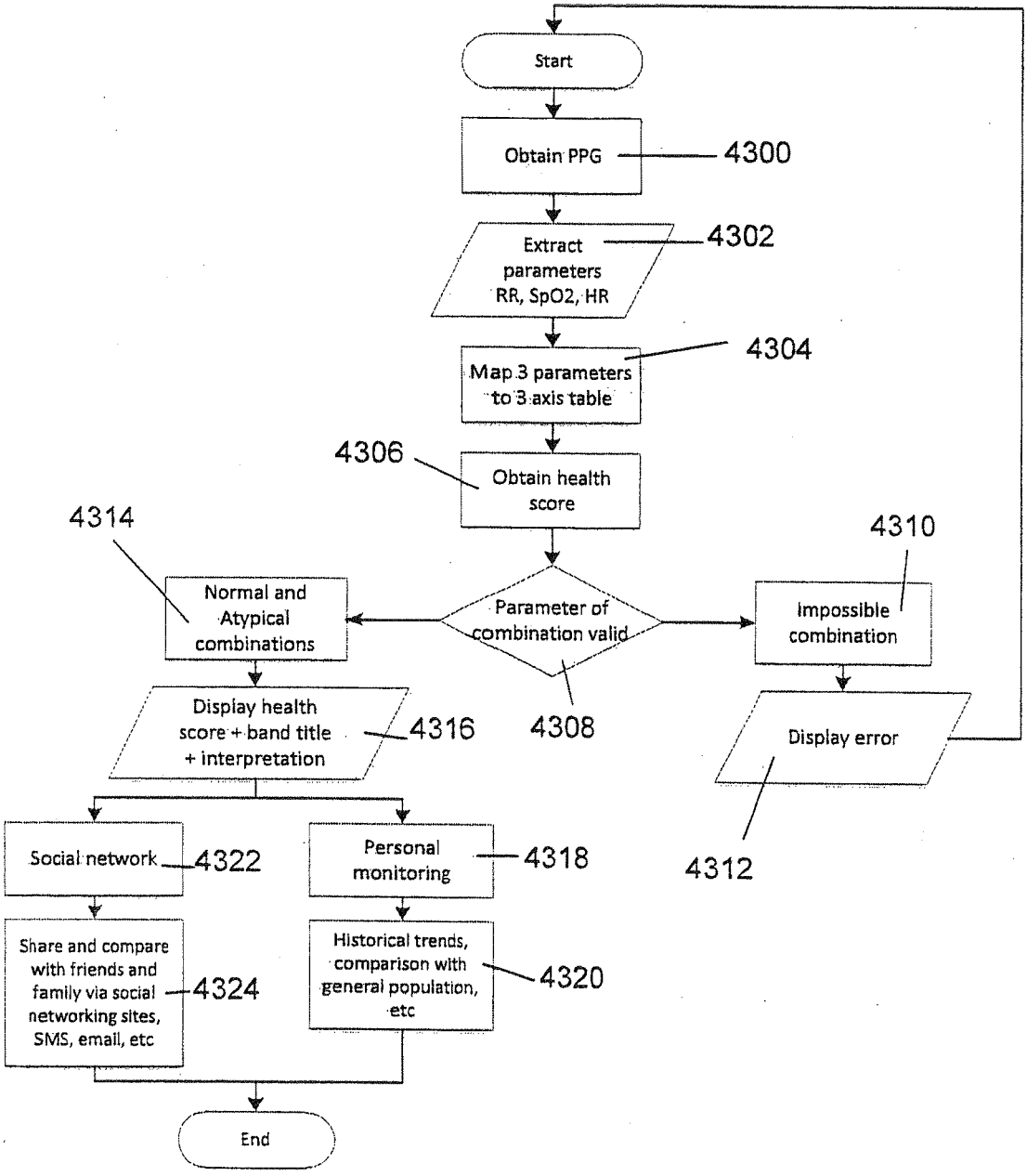

Start
Obtain PPG
4300
Extract parameters RR, SpO2, HR
4302
Map 3 parameters to 3 axis table
4304
4306
Obtain health score
4314
4310
Normal and Atypical combinations
Parameter of combination valid
Impossible combination
Display health score + band title + interpretation
4316
4308
Display error
4312
Social network
4322
Personal monitoring
4318
Share and compare with friends and family via social networking sites, SMS, email, etc
4324
Historical trends, comparison with general population, etc
4320
End

Figure 45

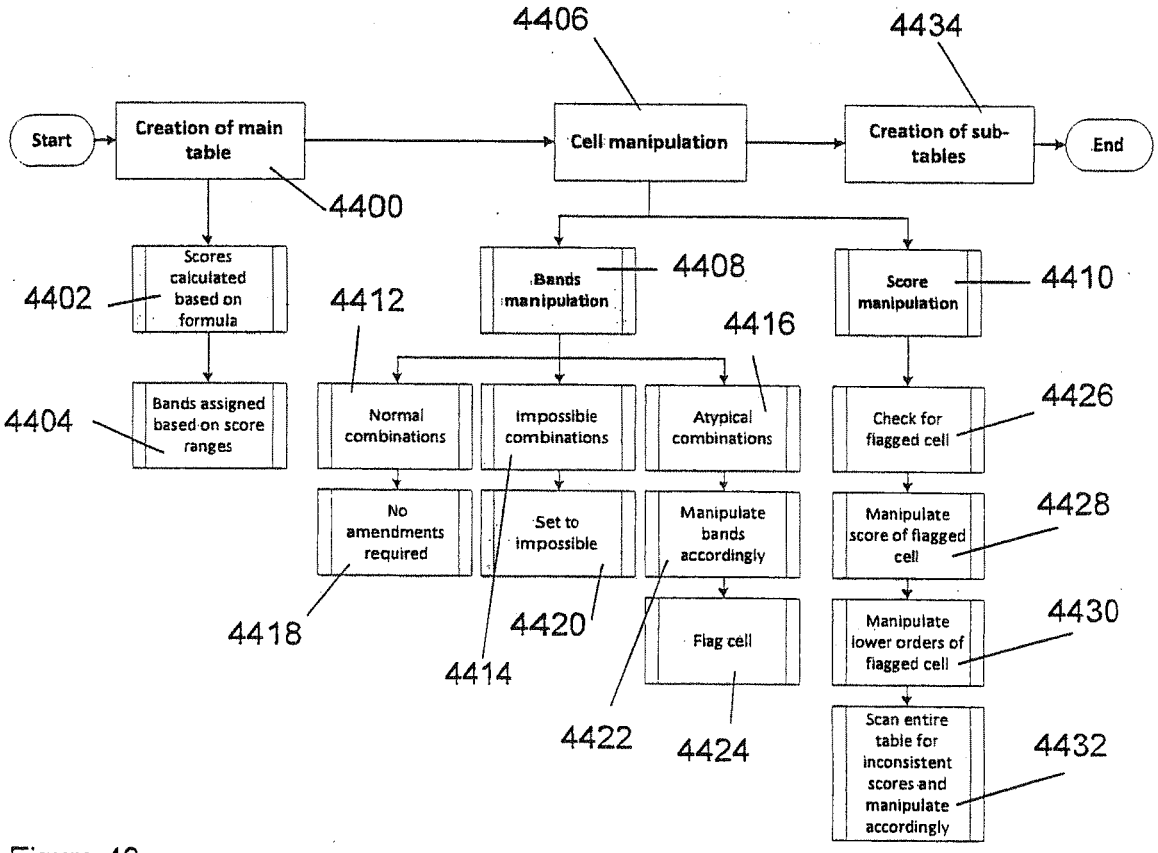

4406
4434
Start
Creation of main table
Cell manipulation
Creation of sub-tables
End
4400
Scores calculated based on formula
4402
Bands manipulation
4408
Score manipulation
4410
4412
4416
Bands assigned based on score ranges
4404
Normal combinations
Impossible combinations
Atypical combinations
Check for flagged cell
4426
No amendments required
Set to impossible
Manipulate bands accordingly
Manipulate score of flagged cell
4428
4418
4420
4414
Flag cell
Manipulate lower orders of flagged cell
4430
4422
4424
Scan entire table for inconsistent scores and manipulate accordingly
4432

Figure 46

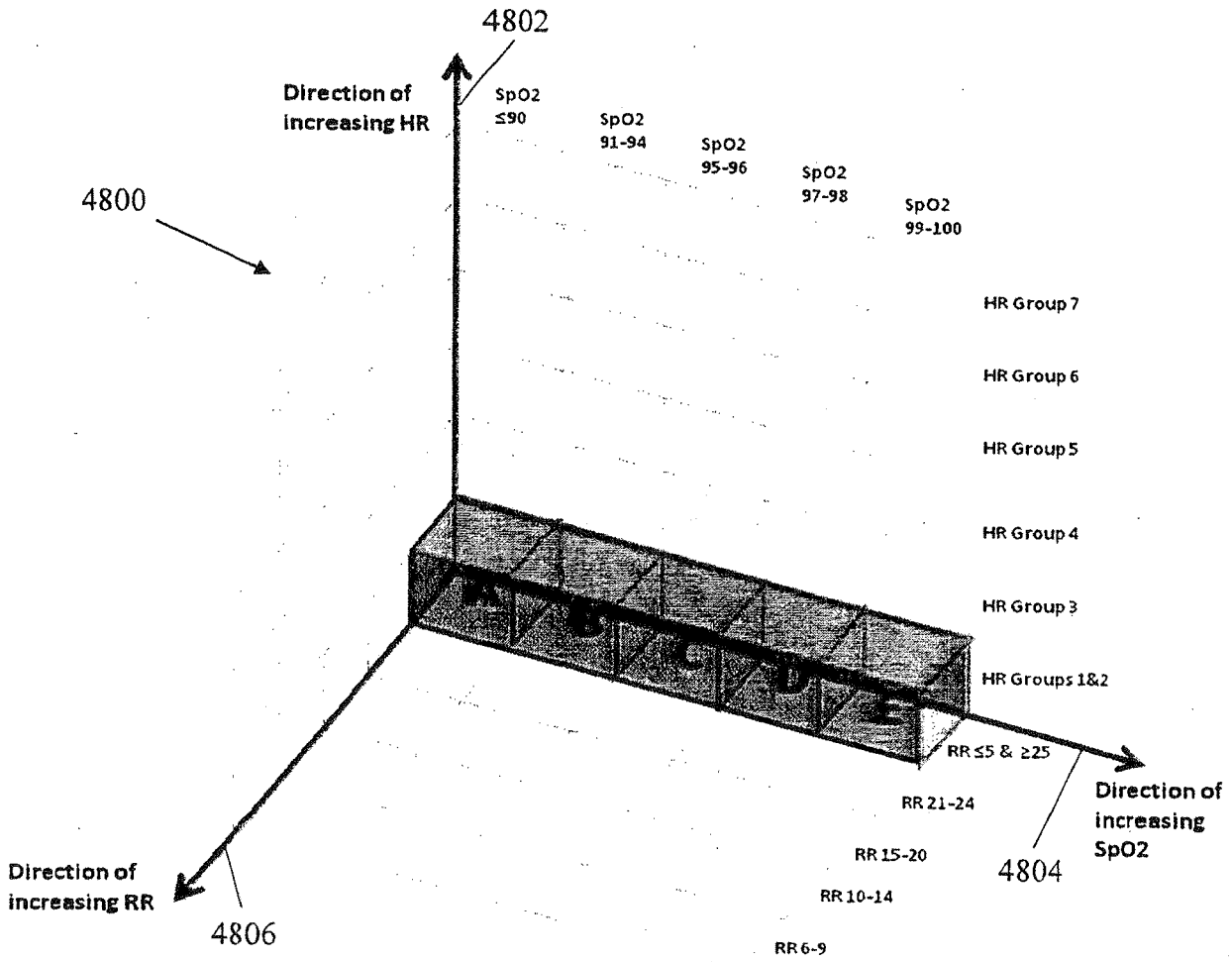

4802
Direction of increasing HR
SpO2 ≤90
SpO2 91-94
SpO2 95-96
SpO2 97-98
SpO2 99-100
4800
HR Group 7
HR Group 6
HR Group 5
HR Group 4
HR Group 3
HR Groups 1&2
A
B
C
D
E
RR ≤5 & ≥25
RR 21-24
RR 15-20
RR 10-14
RR 6-9
Direction of increasing SpO2
4804
Direction of increasing RR
4806

Figure 47a

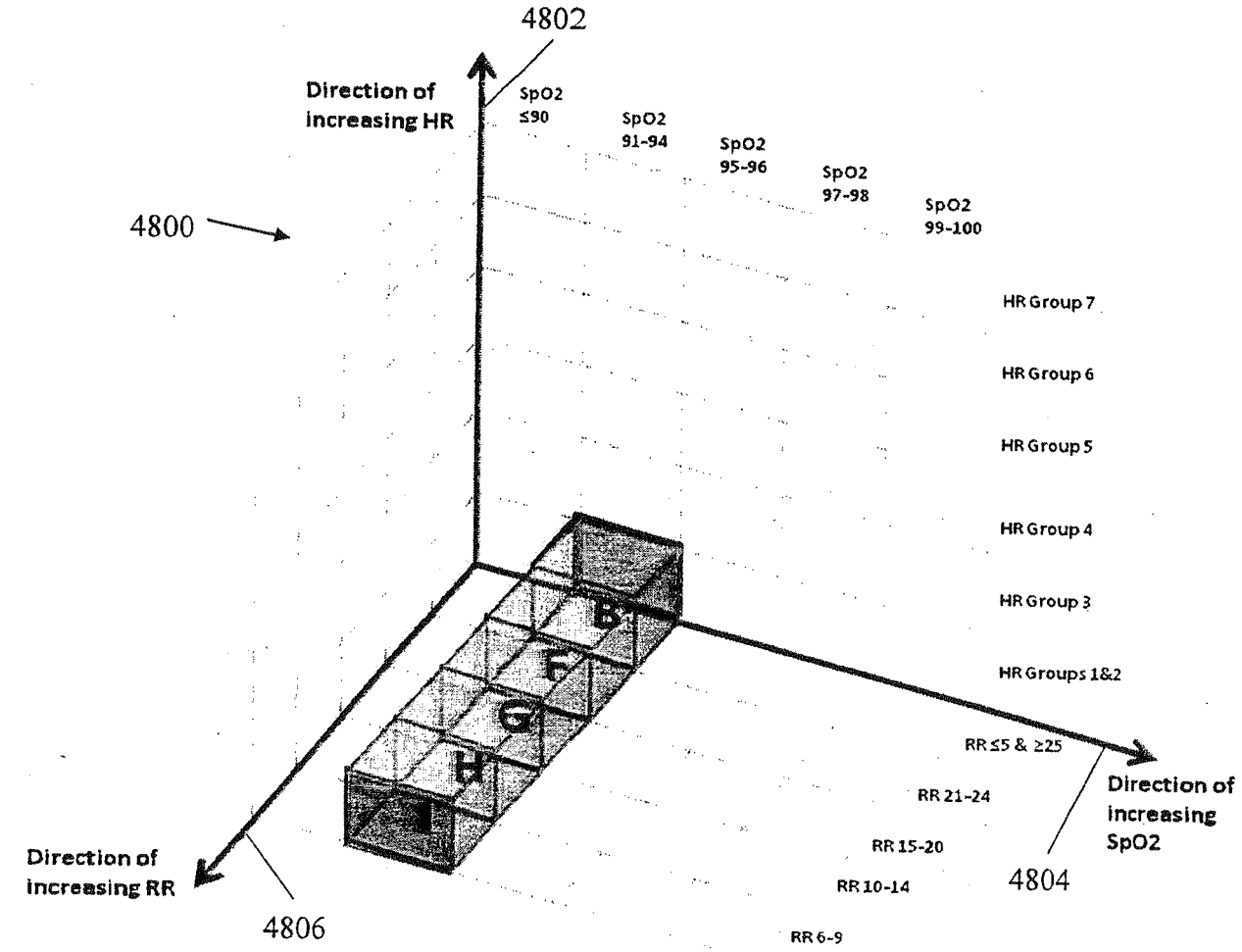

4802
Direction of increasing HR
SpO2 ≤90
SpO2 91-94
SpO2 95-96
SpO2 97-98
SpO2 99-100
4800
HR Group 7
HR Group 6
HR Group 5
HR Group 4
HR Group 3
HR Groups 1&2
B
F
G
H
RR ≤5 & ≥25
RR 21-24
RR 15-20
RR 10-14
RR 6-9
Direction of increasing SpO2
4804
Direction of increasing RR
4806

Figure 47b

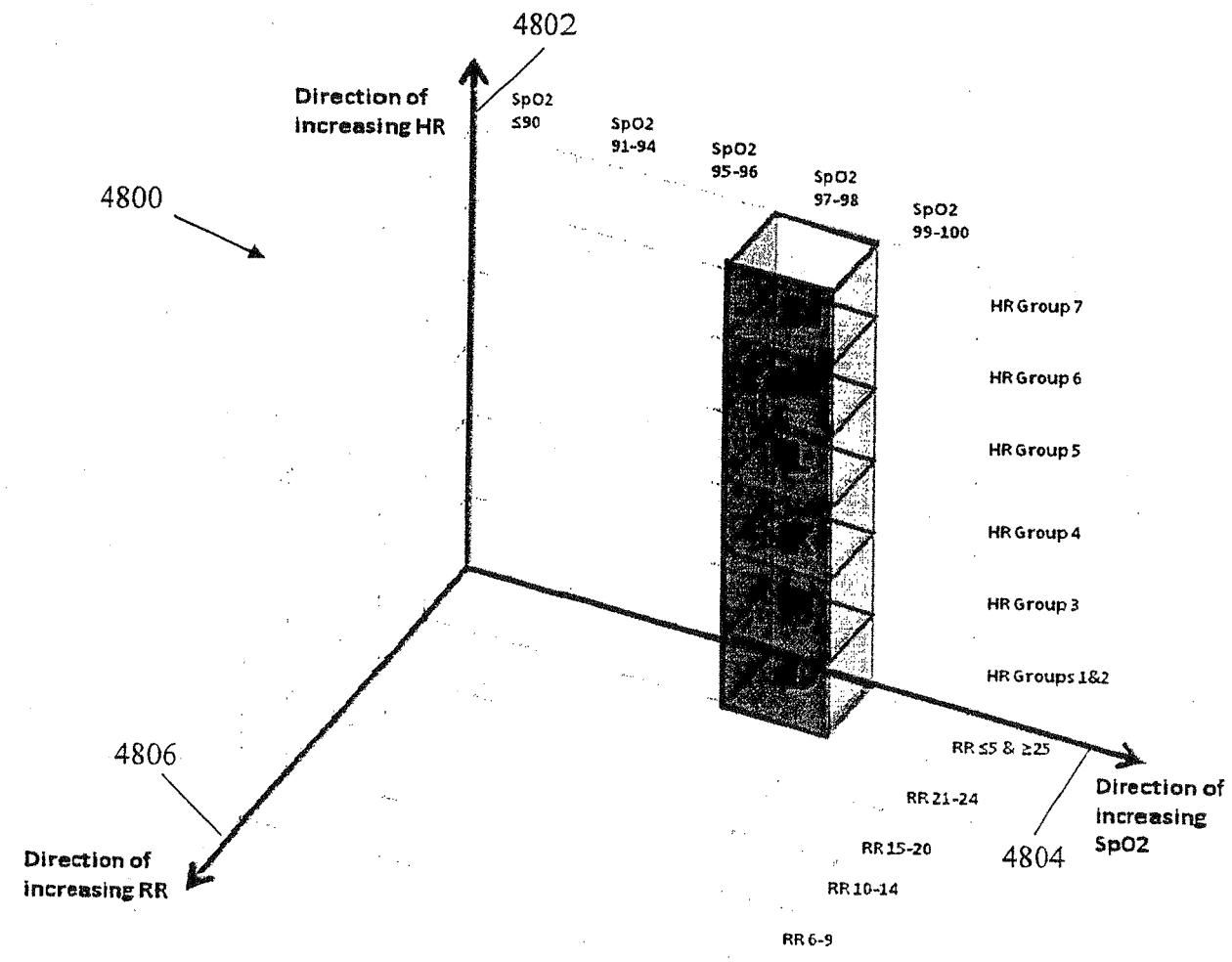

4802
Direction of increasing HR
SpO2 ≤90
SpO2 91-94
SpO2 95-96
SpO2 97-98
SpO2 99-100
4800
HR Group 7
HR Group 6
HR Group 5
HR Group 4
HR Group 3
HR Groups 1&2
4806
RR ≤5 & ≥25
RR 21-24
RR 15-20
RR 10-14
RR 6-9
Direction of increasing RR
Direction of increasing SpO2
4804

Figure 47c