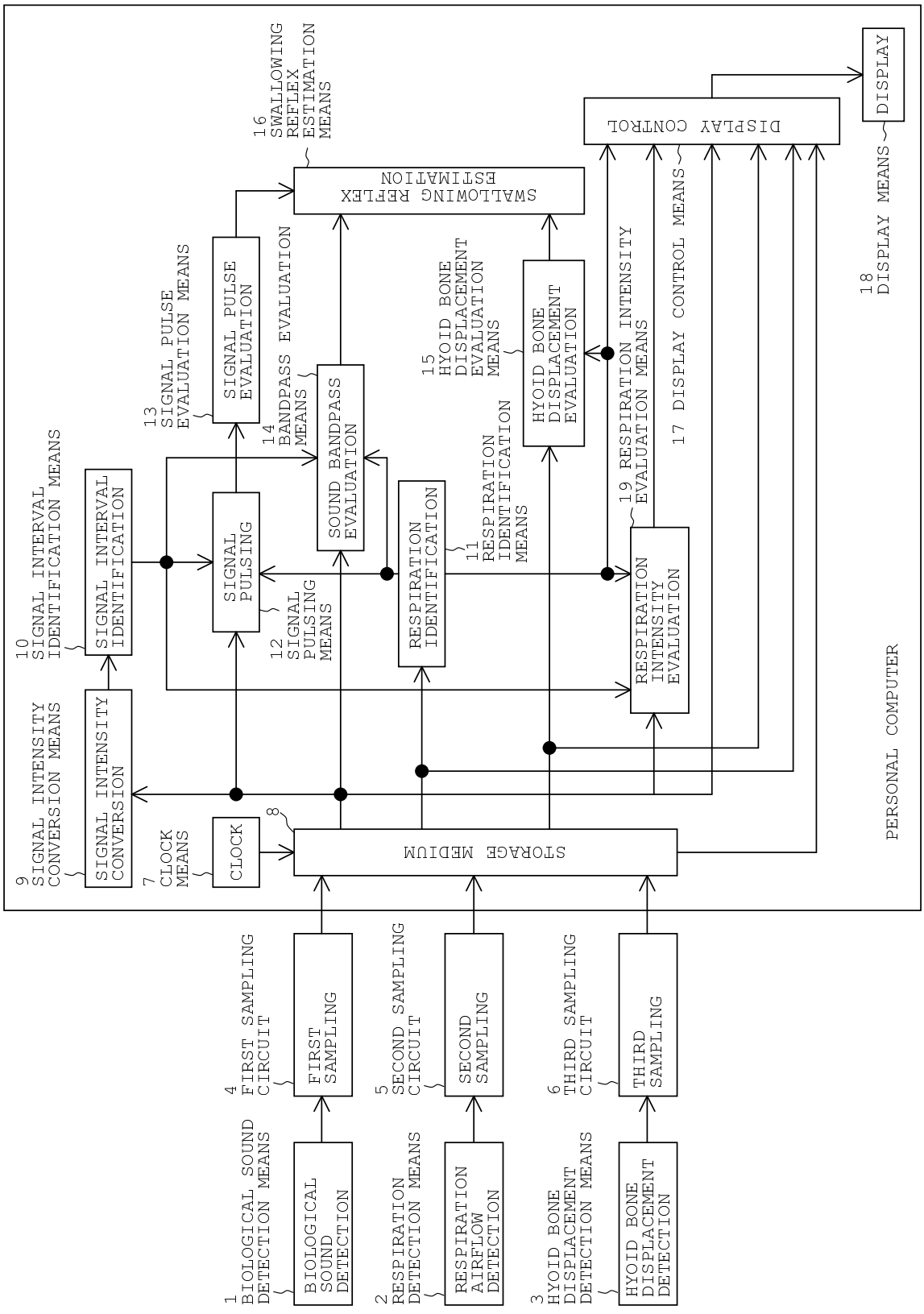
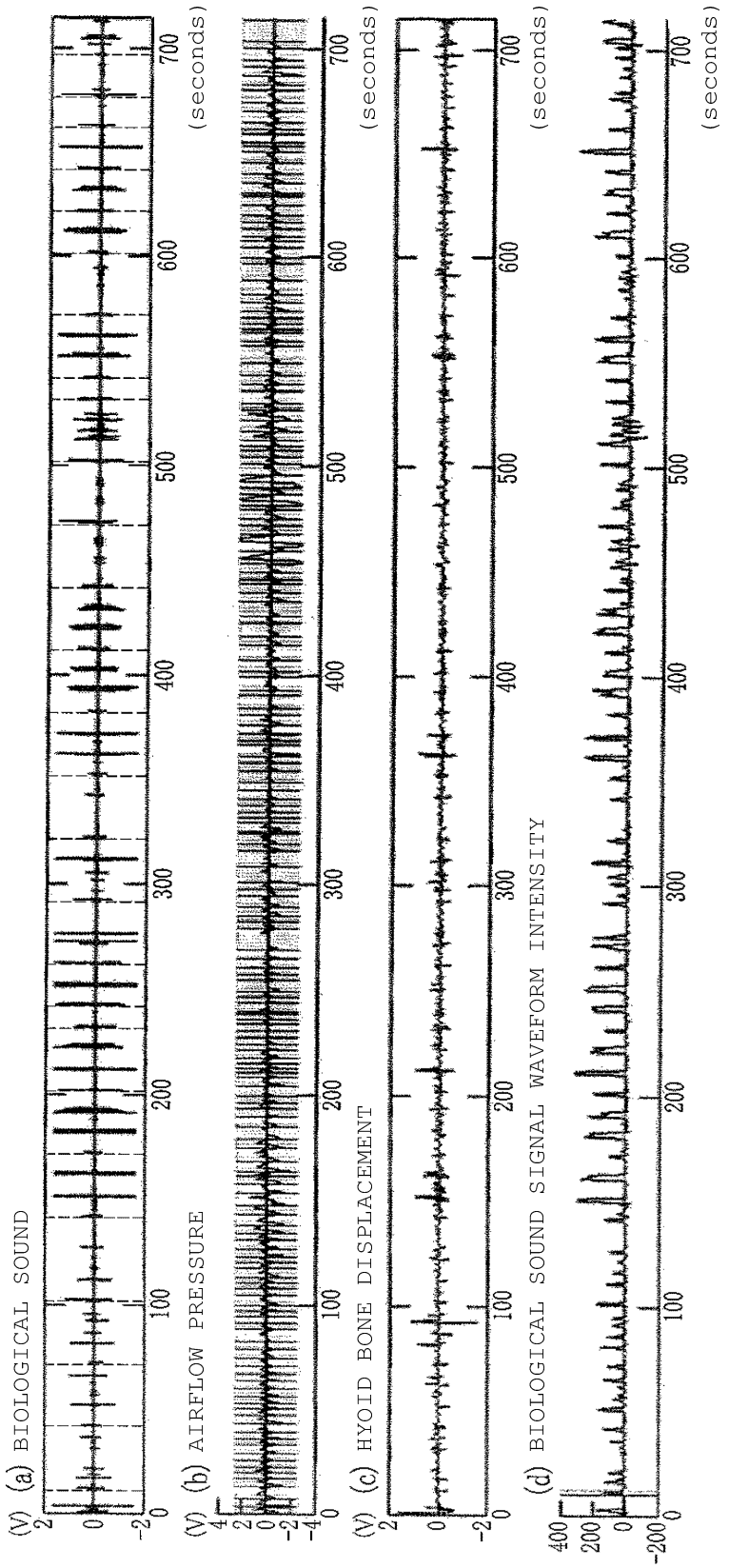
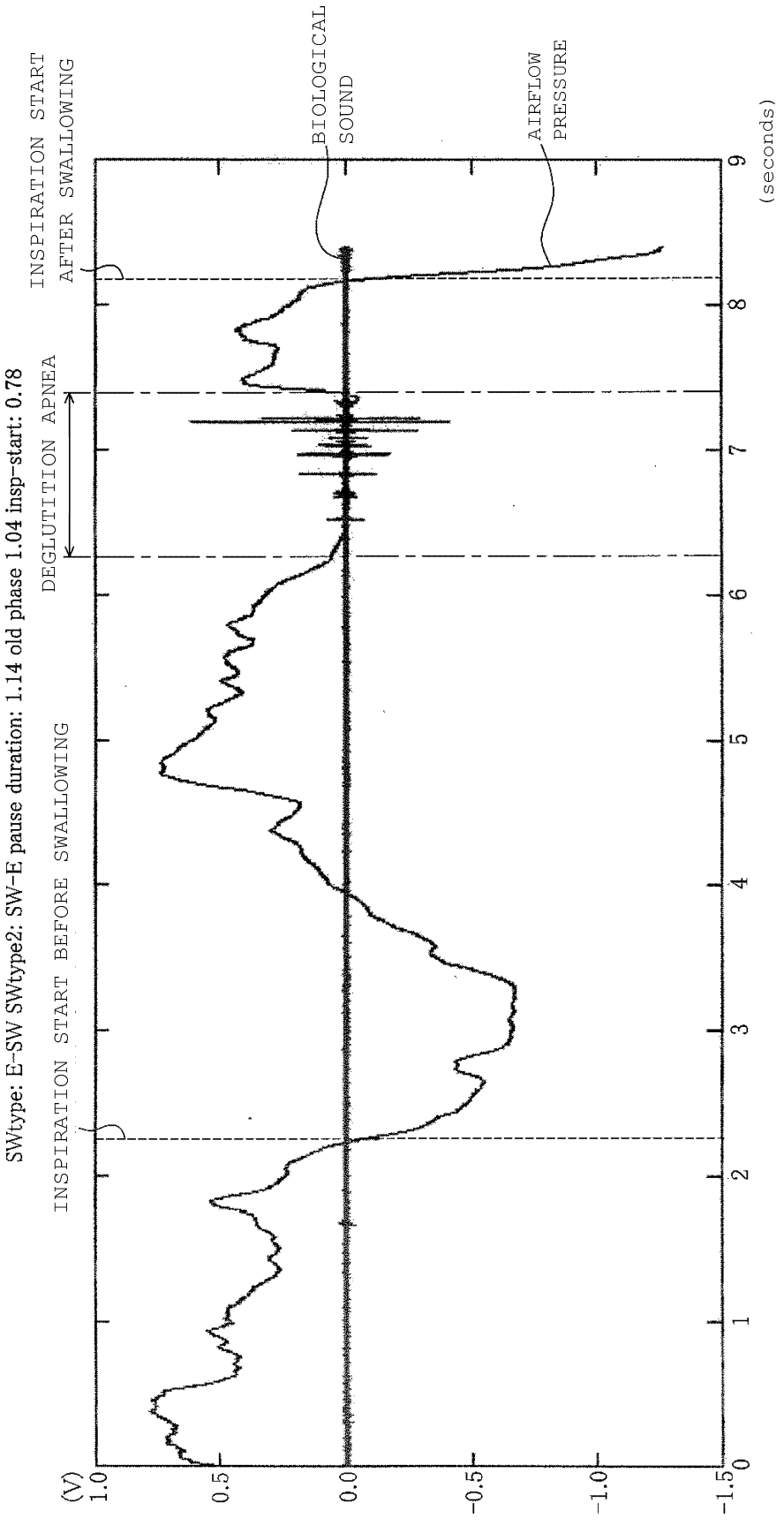
[FIG.1]


1
BIOLOGICAL SOUND DETECTION MEANS
BIOLOGICAL SOUND DETECTION
2
RESPIRATION DETECTION MEANS
RESPIRATION AIRFLOW DETECTION
3
HYOID BONE DISPLACEMENT DETECTION MEANS
HYOID BONE DISPLACEMENT DETECTION
4
FIRST SAMPLING CIRCUIT
FIRST SAMPLING
5
SECOND SAMPLING CIRCUIT
SECOND SAMPLING
6
THIRD SAMPLING CIRCUIT
THIRD SAMPLING
7
CLOCK MEANS
CLOCK
8
STORAGE MEDIUM
9
SIGNAL INTENSITY CONVERSION MEANS
SIGNAL INTENSITY CONVERSION
10
SIGNAL INTERVAL IDENTIFICATION MEANS
SIGNAL INTERVAL IDENTIFICATION
12
SIGNAL PULSING MEANS
SIGNAL PULSING
11
RESPIRATION IDENTIFICATION MEANS
RESPIRATION IDENTIFICATION
13
SIGNAL PULSE EVALUATION MEANS
SIGNAL PULSE EVALUATION
14
BANDPASS EVALUATION MEANS
SOUND BANDPASS EVALUATION
15
HYOID BONE DISPLACEMENT EVALUATION MEANS
HYOID BONE DISPLACEMENT EVALUATION
16
SWALLOWING REFLEX ESTIMATION MEANS
SWALLOWING REFLEX ESTIMATION
19 RESPIRATION INTENSITY EVALUATION MEANS
RESPIRATION INTENSITY EVALUATION
17 DISPLAY CONTROL MEANS
DISPLAY CONTROL
18
DISPLAY MEANS
DISPLAY
PERSONAL COMPUTER

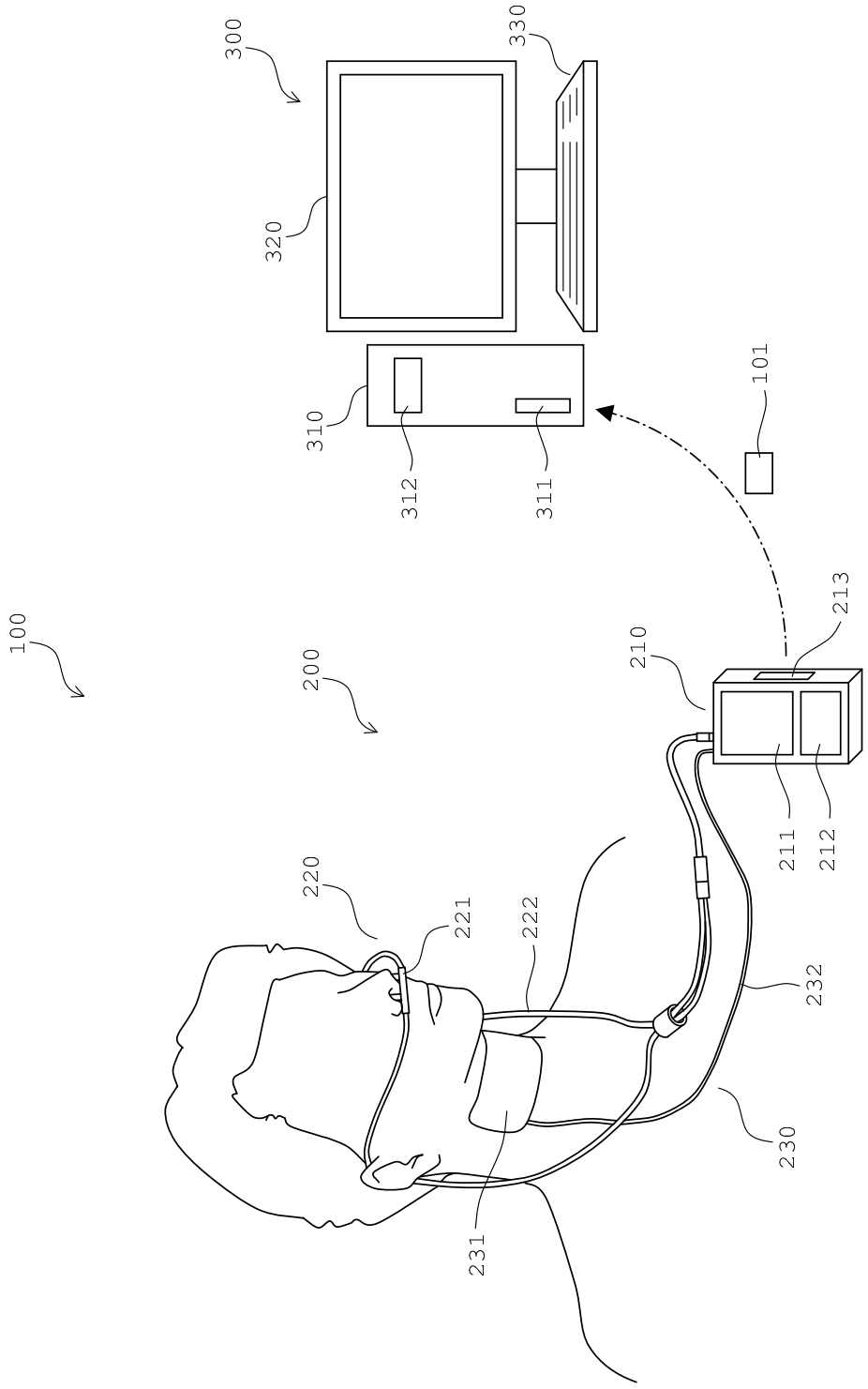
[FIG.2]


(a) BIOLOGICAL SOUND
(V)
(b) AIRFLOW PRESSURE
(V)
(c) HYOID BONE DISPLACEMENT
(V)
(d) BIOLOGICAL SOUND SIGNAL WAVEFORM INTENSITY
(seconds)

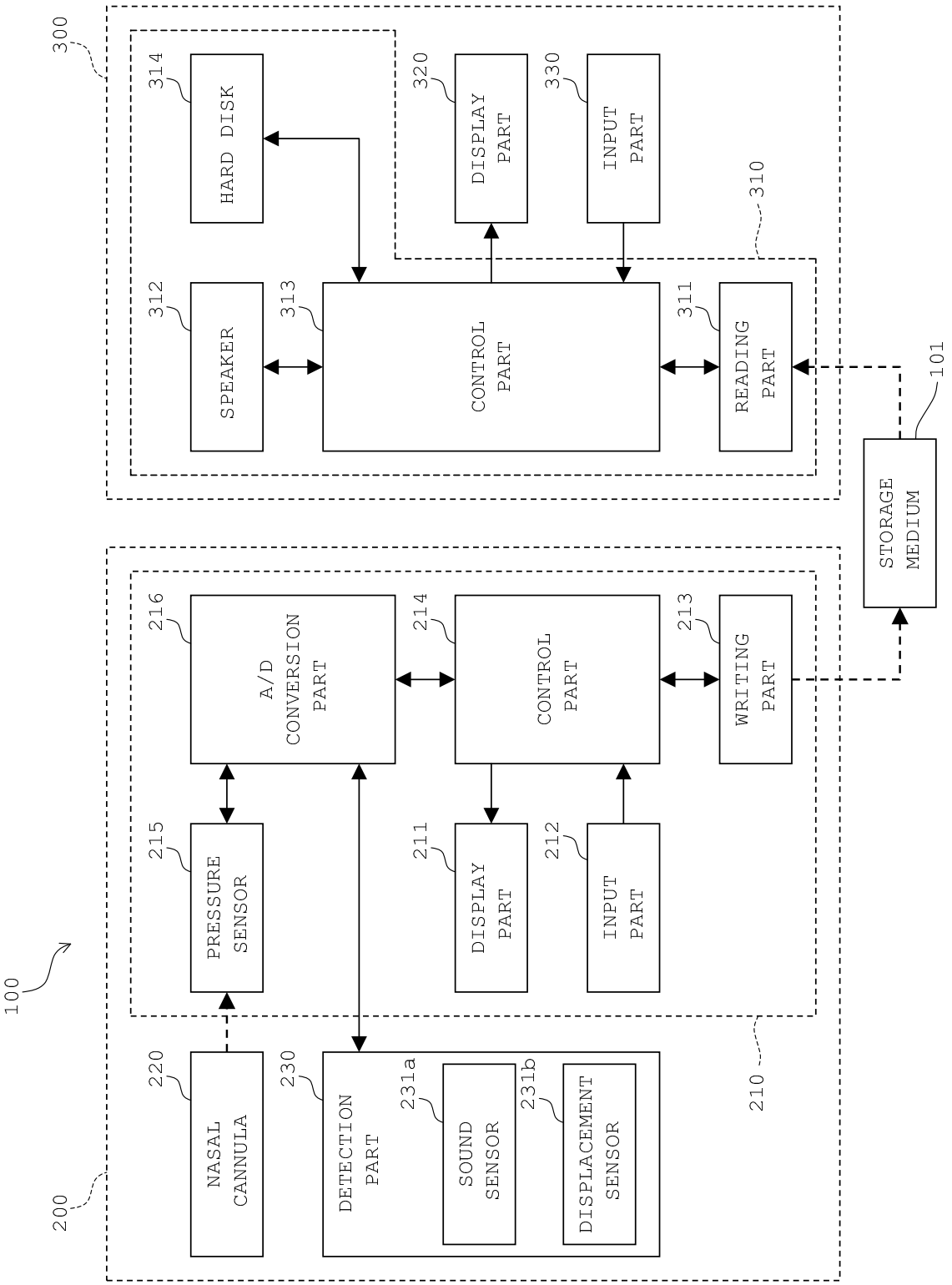
[FIG.3]


SWtype: E-SW SWtype2: SW-E pause duration: 1.14 old phase 1.04 insp-start: 0.78
INSPIRATION START BEFORE SWALLOWING
DEGLUTITION APNEA
INSPIRATION START AFTER SWALLOWING
BIOLOGICAL SOUND
AIRFLOW PRESSURE
(V)
1.0
0.5
0.0
-0.5
-1.0
-1.5
0
1
2
3
4
5
6
7
8
9
(seconds)

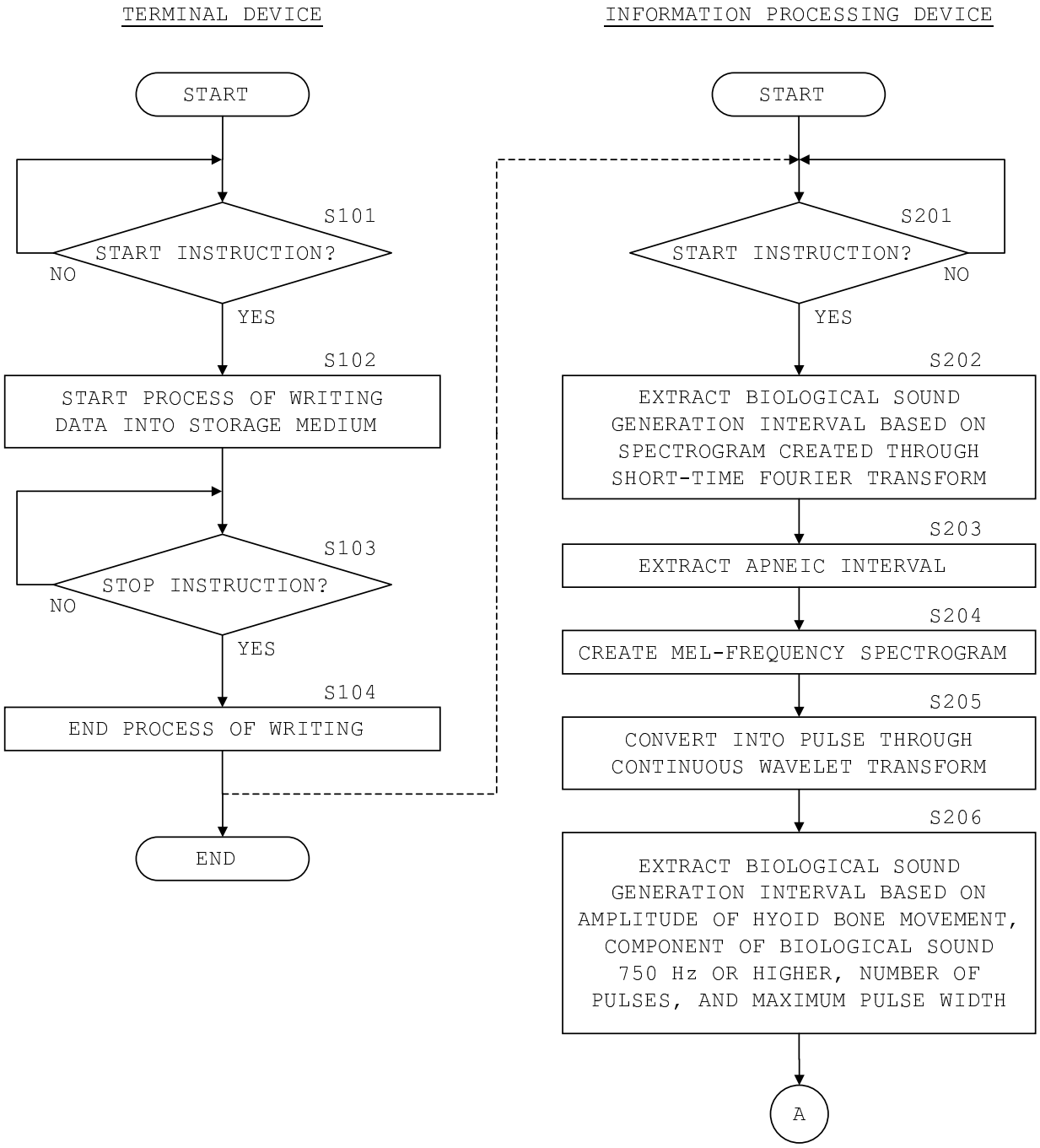
[FIG.4]


100
200
300
310
311
312
320
330
101
210
211
212
213
220
221
222
230
231
232

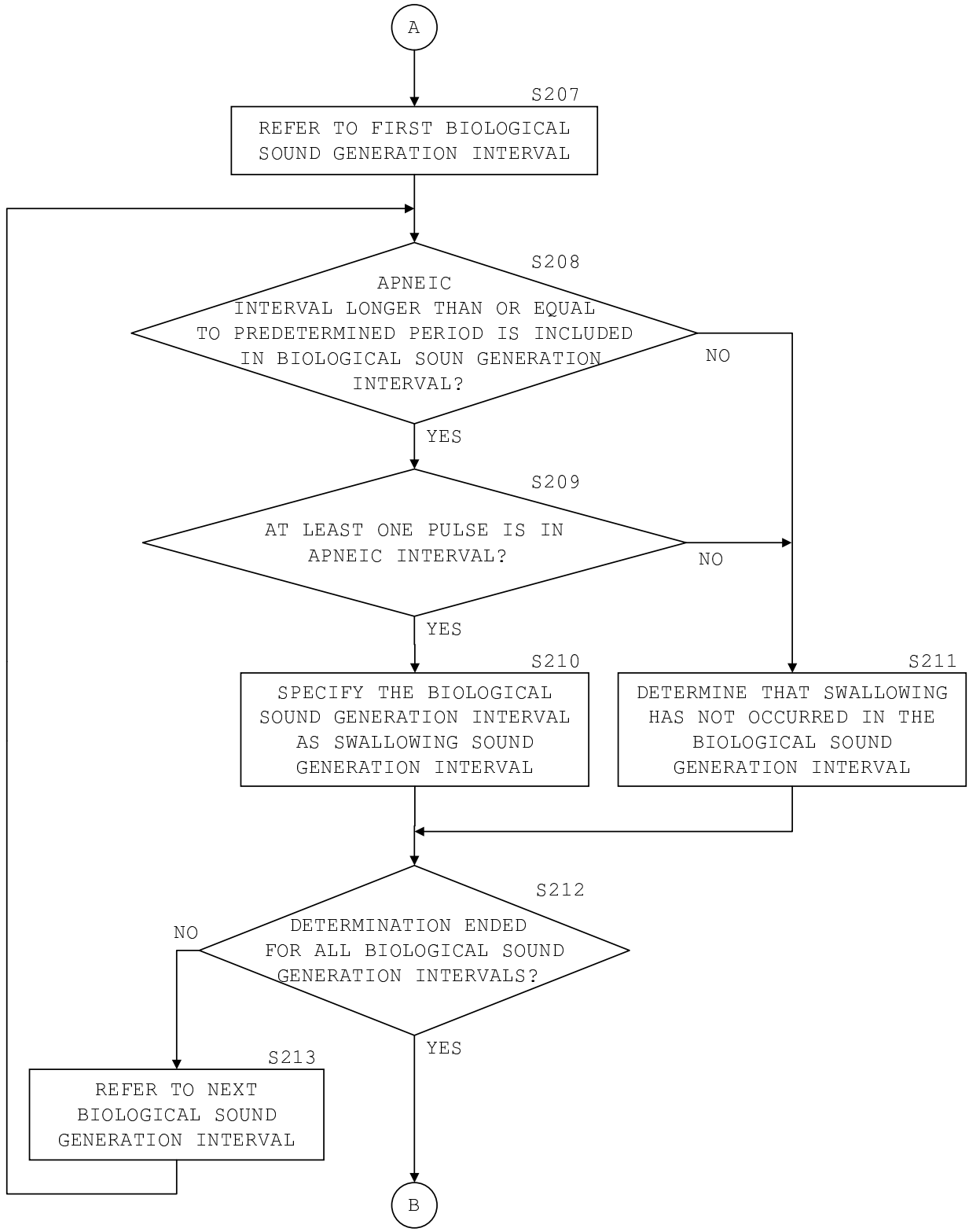
[FIG.5]


100
200
210
300
310
314
HARD DISK
320
DISPLAY PART
330
INPUT PART
312
SPEAKER
313
CONTROL PART
311
READING PART
101
STORAGE MEDIUM
216
A/D CONVERSION PART
214
CONTROL PART
213
WRITING PART
215
PRESSURE SENSOR
211
DISPLAY PART
212
INPUT PART
220
NASAL CANNULA
230
DETECTION PART
231a
SOUND SENSOR
231b
DISPLACEMENT SENSOR

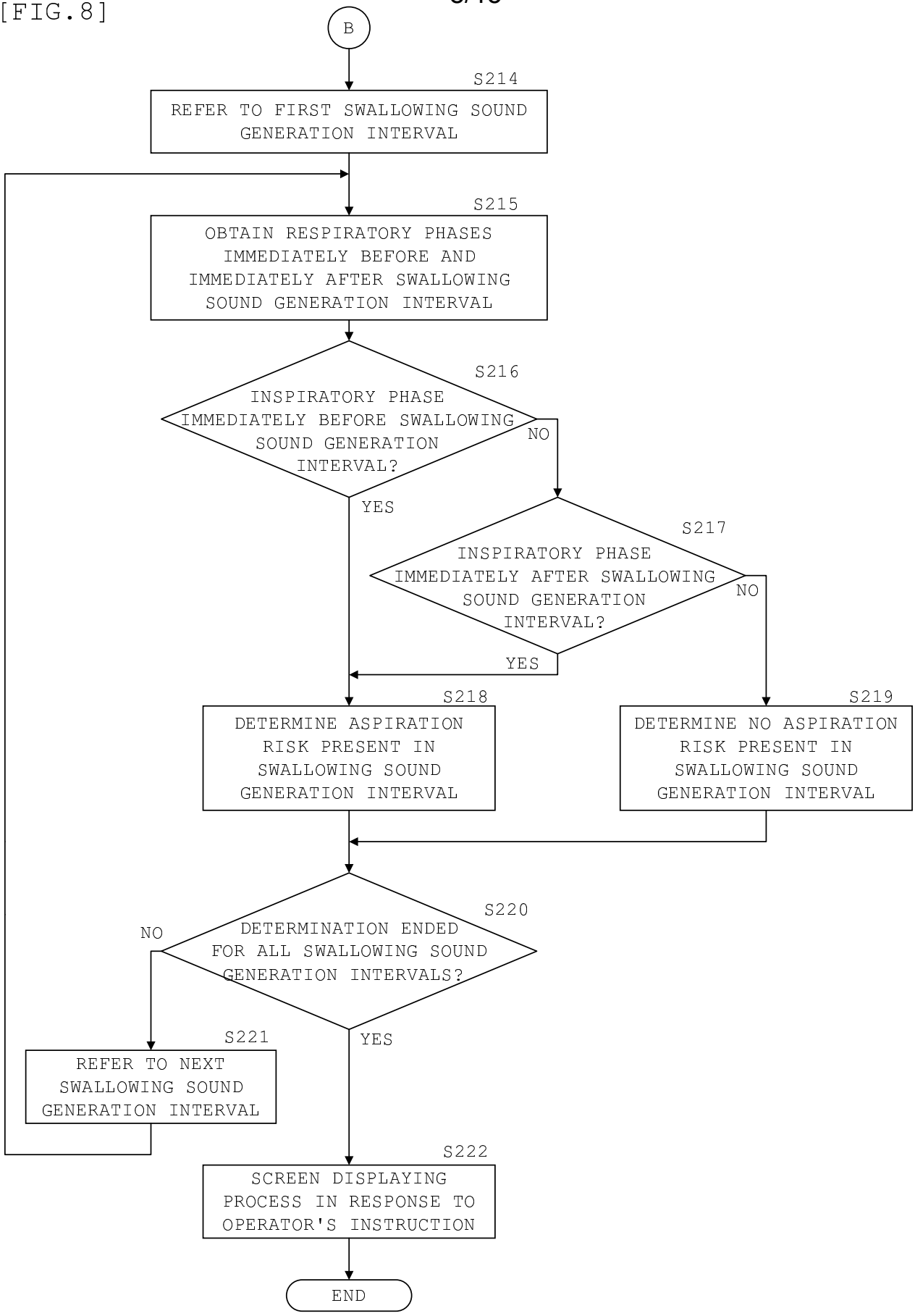
[FIG.6]


TERMINAL DEVICE
INFORMATION PROCESSING DEVICE
START
S101
START INSTRUCTION?
NO
YES
S102
START PROCESS OF WRITING DATA INTO STORAGE MEDIUM
S103
STOP INSTRUCTION?
NO
YES
S104
END PROCESS OF WRITING
END
START
S201
START INSTRUCTION?
NO
YES
S202
EXTRACT BIOLOGICAL SOUND GENERATION INTERVAL BASED ON SPECTROGRAM CREATED THROUGH SHORT-TIME FOURIER TRANSFORM
S203
EXTRACT APNEIC INTERVAL
S204
CREATE MEL-FREQUENCY SPECTROGRAM
S205
CONVERT INTO PULSE THROUGH CONTINUOUS WAVELET TRANSFORM
S206
EXTRACT BIOLOGICAL SOUND GENERATION INTERVAL BASED ON AMPLITUDE OF HYOID BONE MOVEMENT, COMPONENT OF BIOLOGICAL SOUND 750 Hz OR HIGHER, NUMBER OF PULSES, AND MAXIMUM PULSE WIDTH
A

[FIG.7]

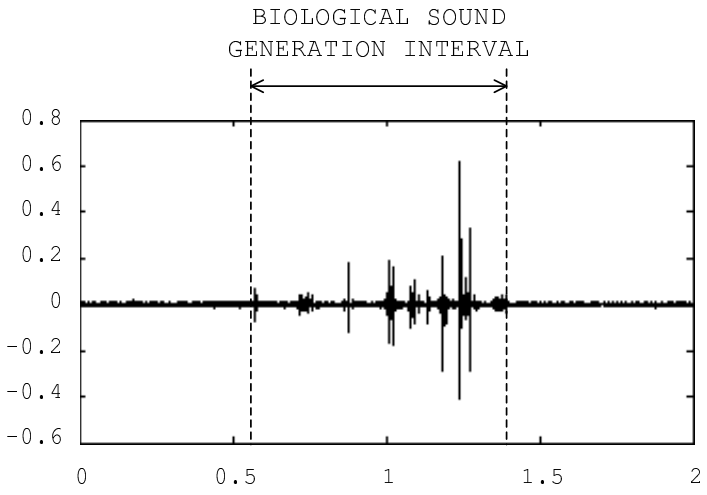

A
S207
REFER TO FIRST BIOLOGICAL SOUND GENERATION INTERVAL
S208
APNEIC INTERVAL LONGER THAN OR EQUAL TO PREDETERMINED PERIOD IS INCLUDED IN BIOLOGICAL SOUN GENERATION INTERVAL?
NO
YES
S209
AT LEAST ONE PULSE IS IN APNEIC INTERVAL?
NO
YES
S210
SPECIFY THE BIOLOGICAL SOUND GENERATION INTERVAL AS SWALLOWING SOUND GENERATION INTERVAL
S211
DETERMINE THAT SWALLOWING HAS NOT OCCURRED IN THE BIOLOGICAL SOUND GENERATION INTERVAL
S212
DETERMINATION ENDED FOR ALL BIOLOGICAL SOUND GENERATION INTERVALS?
NO
YES
S213
REFER TO NEXT BIOLOGICAL SOUND GENERATION INTERVAL
B

[FIG.8]

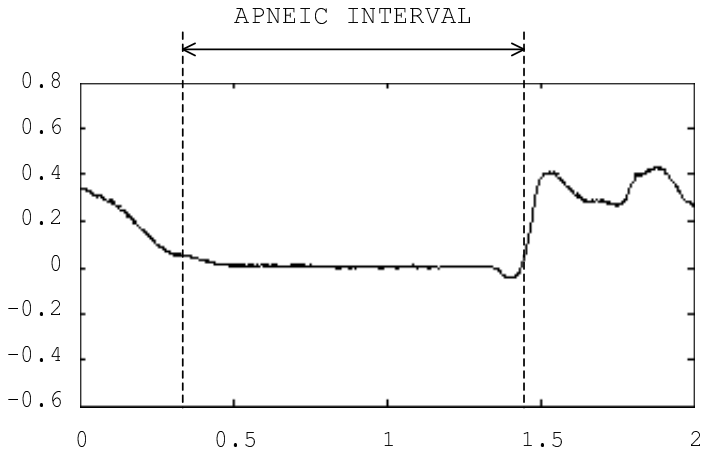

B
S214
REFER TO FIRST SWALLOWING SOUND GENERATION INTERVAL
S215
OBTAIN RESPIRATORY PHASES IMMEDIATELY BEFORE AND IMMEDIATELY AFTER SWALLOWING SOUND GENERATION INTERVAL
S216
INSPIRATORY PHASE IMMEDIATELY BEFORE SWALLOWING SOUND GENERATION INTERVAL?
NO
YES
S217
INSPIRATORY PHASE IMMEDIATELY AFTER SWALLOWING SOUND GENERATION INTERVAL?
NO
YES
S218
DETERMINE ASPIRATION RISK PRESENT IN SWALLOWING SOUND GENERATION INTERVAL
S219
DETERMINE NO ASPIRATION RISK PRESENT IN SWALLOWING SOUND GENERATION INTERVAL
S220
DETERMINATION ENDED FOR ALL SWALLOWING SOUND GENERATION INTERVALS?
NO
YES
S221
REFER TO NEXT SWALLOWING SOUND GENERATION INTERVAL
S222
SCREEN DISPLAYING PROCESS IN RESPONSE TO OPERATOR'S INSTRUCTION
END

[FIG.9]

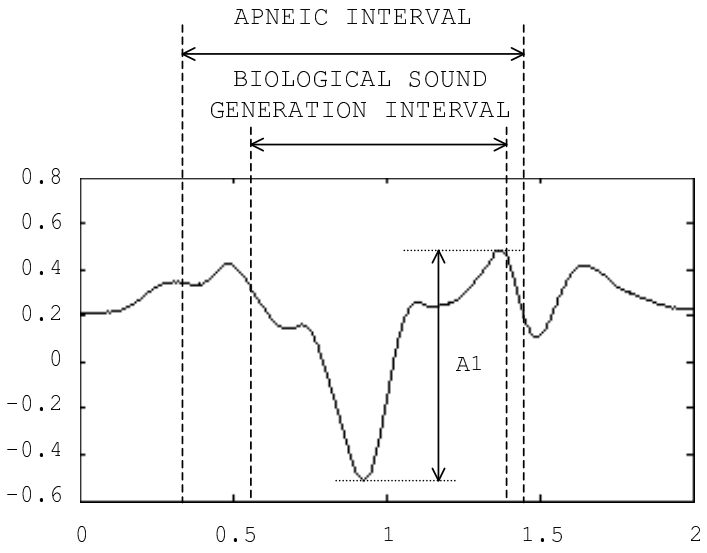
(a) BIOLOGICAL SOUND DATA



(b) AIRFLOW PRESSURE DATA

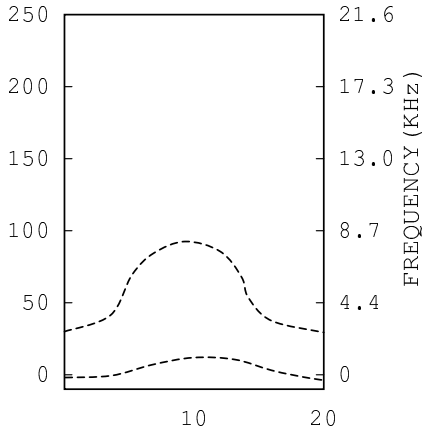


(c) HYOID BONE DISPLACEMENT DATA

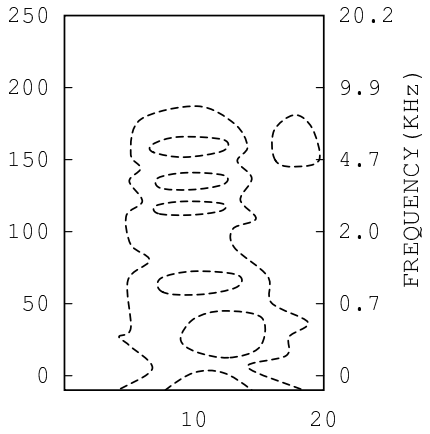


[FIG.10]

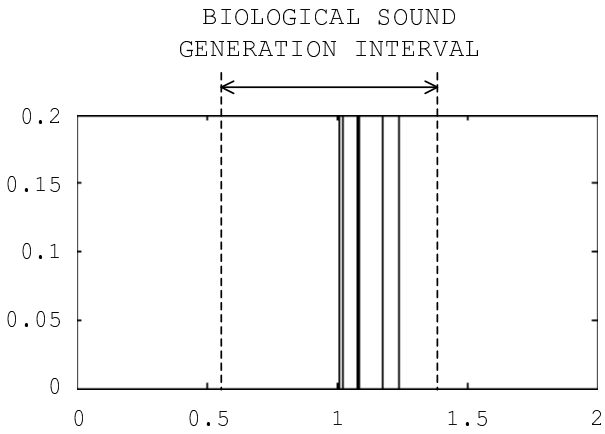
(a)


250
200
150
100
50
0
21.6
17.3
13.0
8.7
4.4
0
FREQUENCY(KHz)
10
20

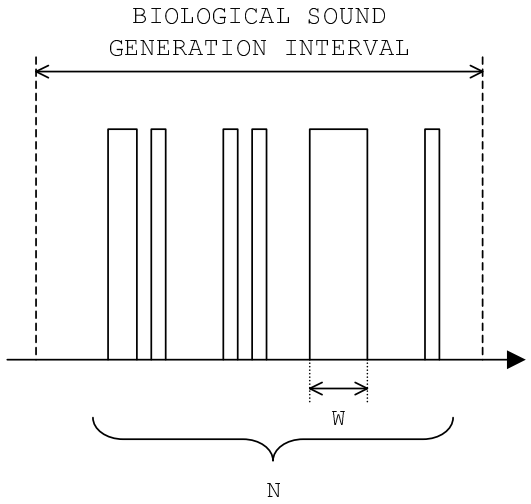
(b)


250
200
150
100
50
0
20.2
9.9
4.7
2.0
0.7
0
FREQUENCY(KHz)
10
20

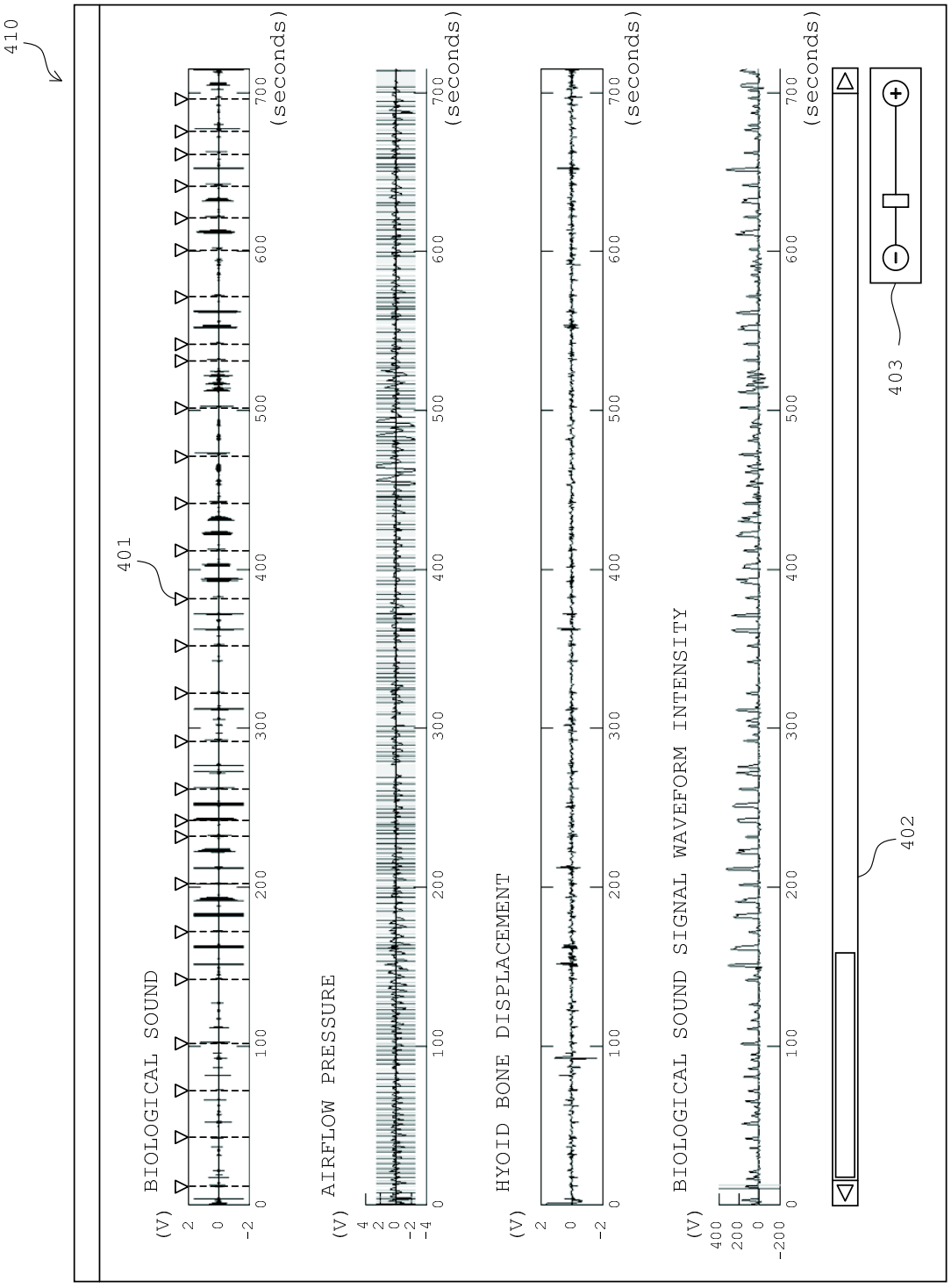
(c)


BIOLOGICAL SOUND
GENERATION INTERVAL
0.2
0.15
0.1
0.05
0
0
0.5
1
1.5
2

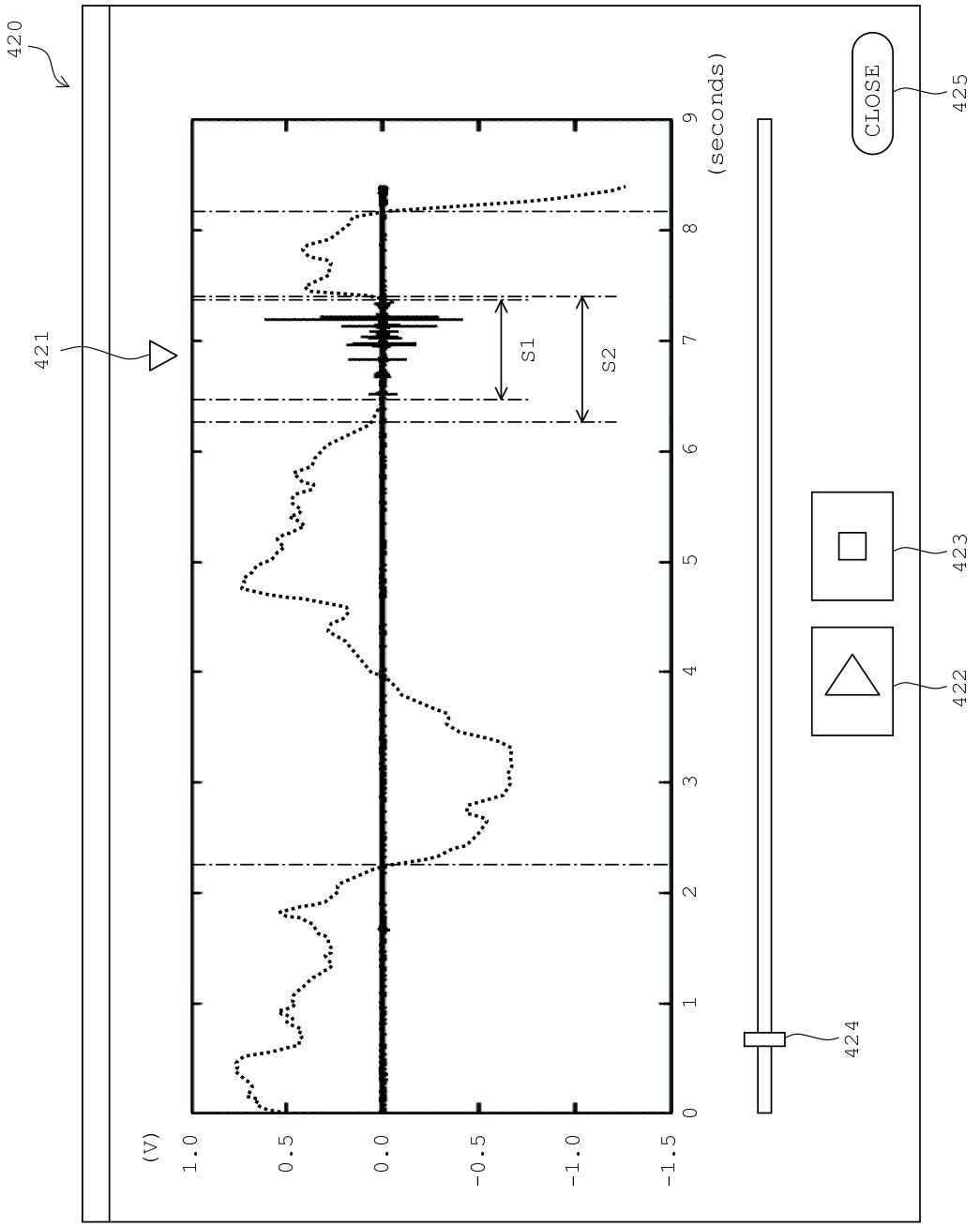
(d)


BIOLOGICAL SOUND
GENERATION INTERVAL
W
N

[FIG.11]

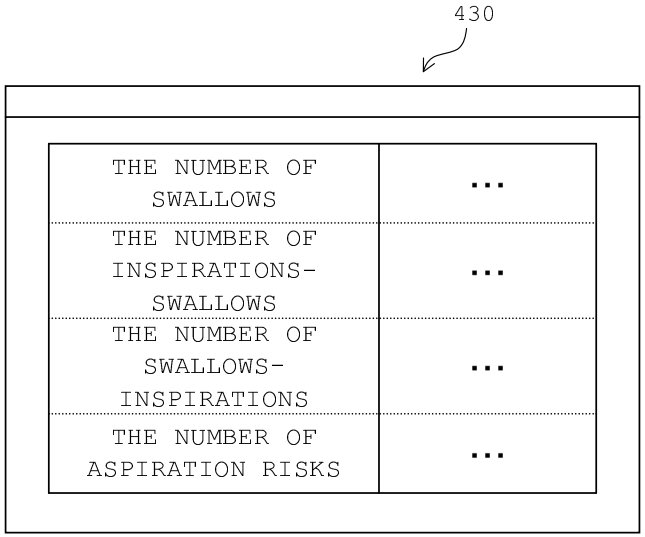

410
401
BIOLOGICAL SOUND
(V)
2
0
-2
0
100
200
300
400
500
600
700
(seconds)
AIRFLOW PRESSURE
(V)
4
2
0
-2
-4
HYOID BONE DISPLACEMENT
BIOLOGICAL SOUND SIGNAL WAVEFORM INTENSITY
400
200
-200
402
403
+
-

[FIG.12]

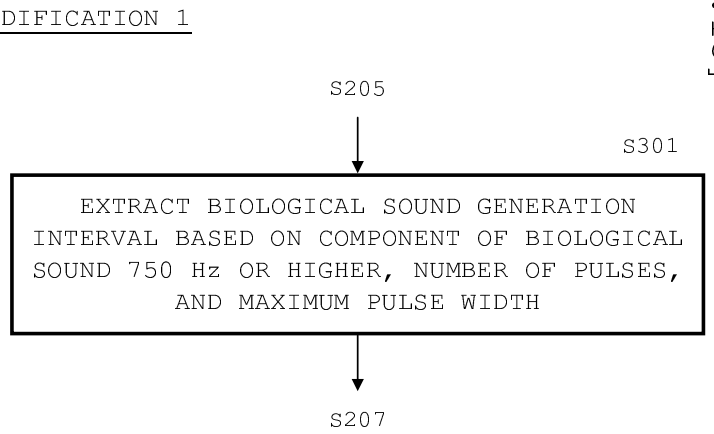

420
421
S1
S2
(seconds)
0
1
2
3
4
5
6
7
8
9
(V)
1.0
0.5
0.0
-0.5
-1.0
-1.5
CLOSE
425
423
422
424

[FIG.13]

(a)



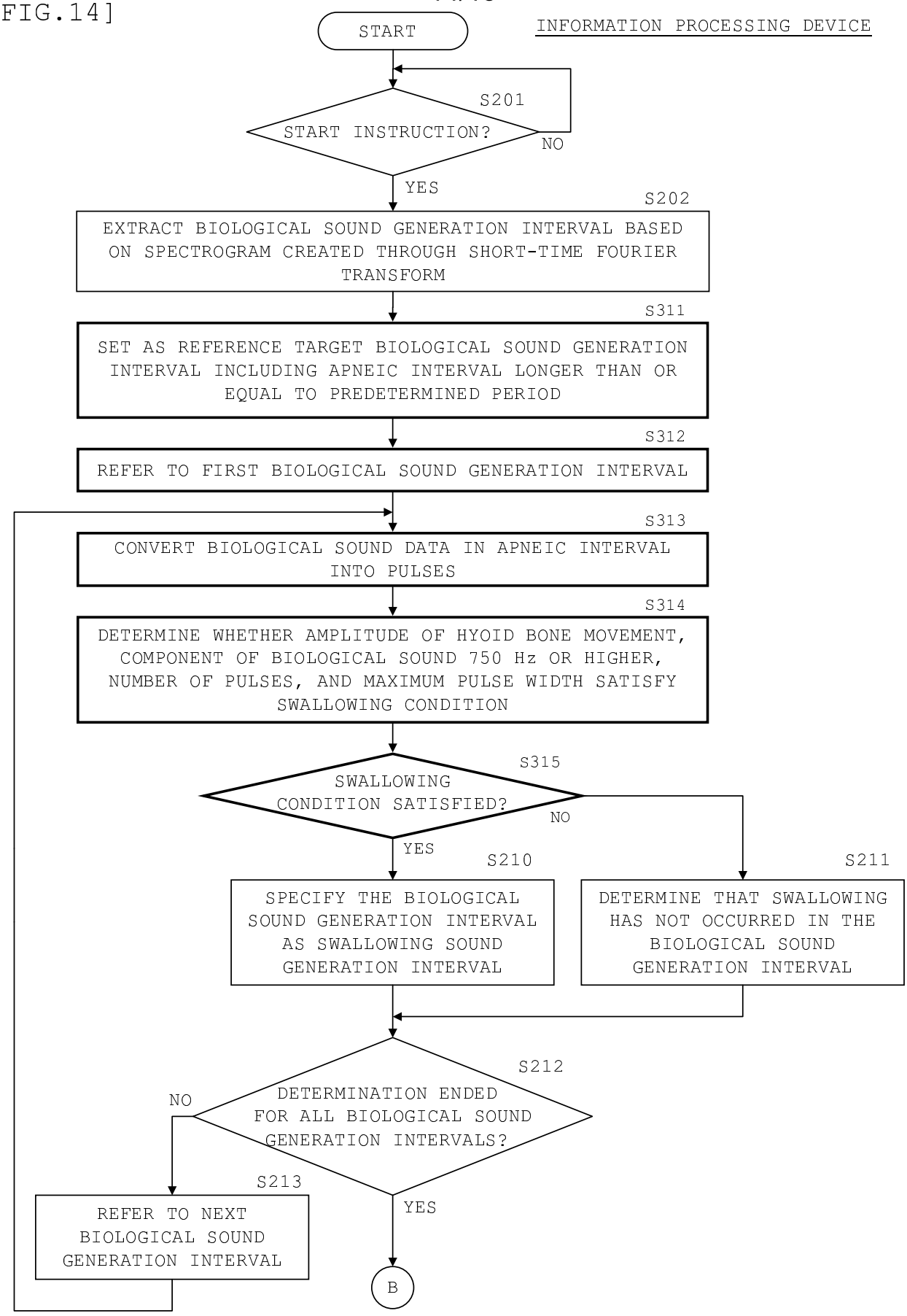
(b)



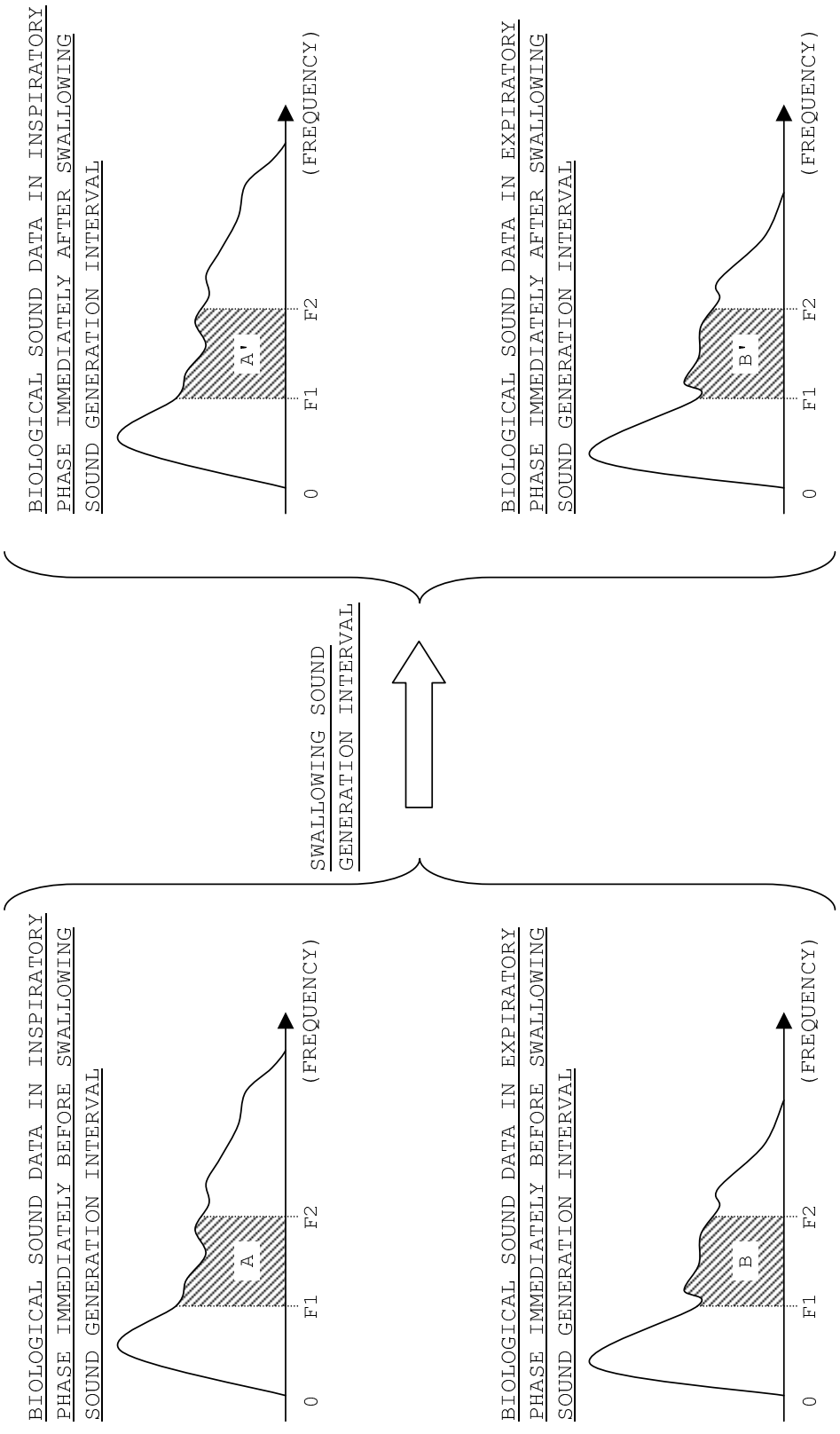
(c)

	3 ELEMENTS (EMBODIMENT 2)	WITHOUT SOUND (COMPARATIVE EXAMPLE 1))	WITHOUT RESPIRATION (COMPARATIVE EXAMPLE 2))	WITHOUT HYOID BONE (MODIFICATION 1)
THE NUMBER OF EXTRACTED SWALLOWS	27	27	27	27
NON-EXTRACTIONS	0	0	0	0
ERRONEOUS EXTRACTIONS	7	19	36	18
TOTAL	34	46	63	45

[FIG.14]


INFORMATION PROCESSING DEVICE
START
S201
START INSTRUCTION?
NO
YES
S202
EXTRACT BIOLOGICAL SOUND GENERATION INTERVAL BASED ON SPECTROGRAM CREATED THROUGH SHORT-TIME FOURIER TRANSFORM
S311
SET AS REFERENCE TARGET BIOLOGICAL SOUND GENERATION INTERVAL INCLUDING APNEIC INTERVAL LONGER THAN OR EQUAL TO PREDETERMINED PERIOD
S312
REFER TO FIRST BIOLOGICAL SOUND GENERATION INTERVAL
S313
CONVERT BIOLOGICAL SOUND DATA IN APNEIC INTERVAL INTO PULSES
S314
DETERMINE WHETHER AMPLITUDE OF HYOID BONE MOVEMENT, COMPONENT OF BIOLOGICAL SOUND 750 Hz OR HIGHER, NUMBER OF PULSES, AND MAXIMUM PULSE WIDTH SATISFY SWALLOWING CONDITION
S315
SWALLOWING CONDITION SATISFIED?
NO
YES
S210
SPECIFY THE BIOLOGICAL SOUND GENERATION INTERVAL AS SWALLOWING SOUND GENERATION INTERVAL
S211
DETERMINE THAT SWALLOWING HAS NOT OCCURRED IN THE BIOLOGICAL SOUND GENERATION INTERVAL
S212
DETERMINATION ENDED FOR ALL BIOLOGICAL SOUND GENERATION INTERVALS?
NO
YES
S213
REFER TO NEXT BIOLOGICAL SOUND GENERATION INTERVAL
B

[FIG.15]


BIOLOGICAL SOUND DATA IN INSPIRATORY PHASE IMMEDIATELY BEFORE SWALLOWING SOUND GENERATION INTERVAL
A
0
F1
F2
(FREQUENCY)
BIOLOGICAL SOUND DATA IN EXPIRATORY PHASE IMMEDIATELY BEFORE SWALLOWING SOUND GENERATION INTERVAL
B
0
F1
F2
(FREQUENCY)
SWALLOWING SOUND GENERATION INTERVAL
BIOLOGICAL SOUND DATA IN INSPIRATORY PHASE IMMEDIATELY AFTER SWALLOWING SOUND GENERATION INTERVAL
A'
0
F1
F2
(FREQUENCY)
BIOLOGICAL SOUND DATA IN EXPIRATORY PHASE IMMEDIATELY AFTER SWALLOWING SOUND GENERATION INTERVAL
B'
0
F1
F2
(FREQUENCY)