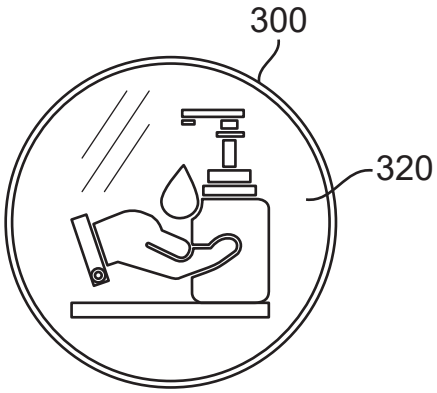

FIG. 1A

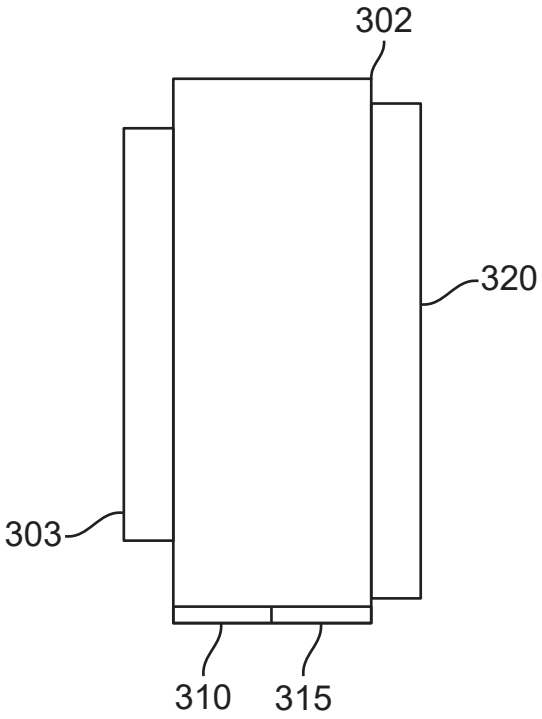

FIG. 1B

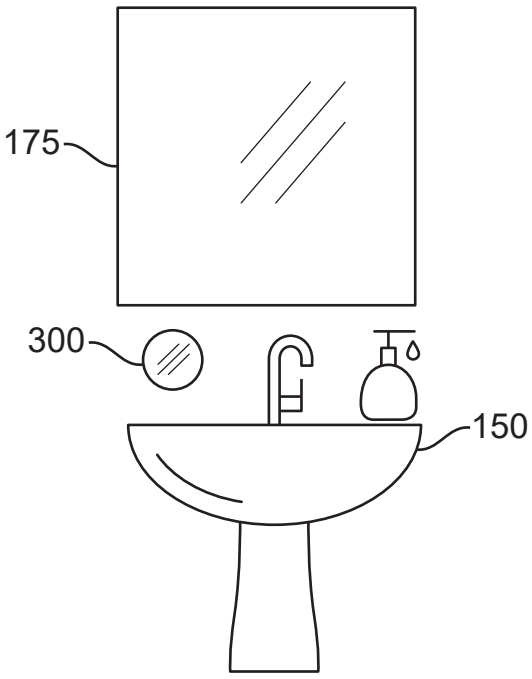

FIG. 1C

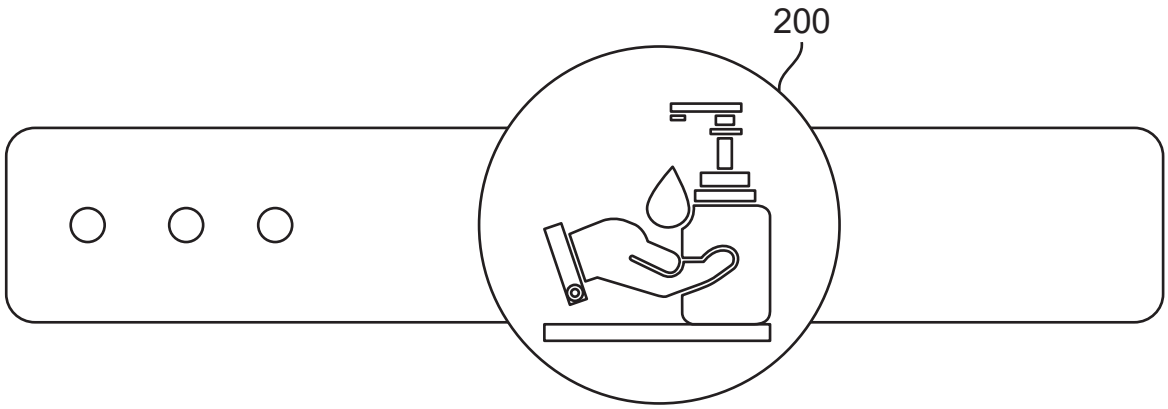

FIG. 2

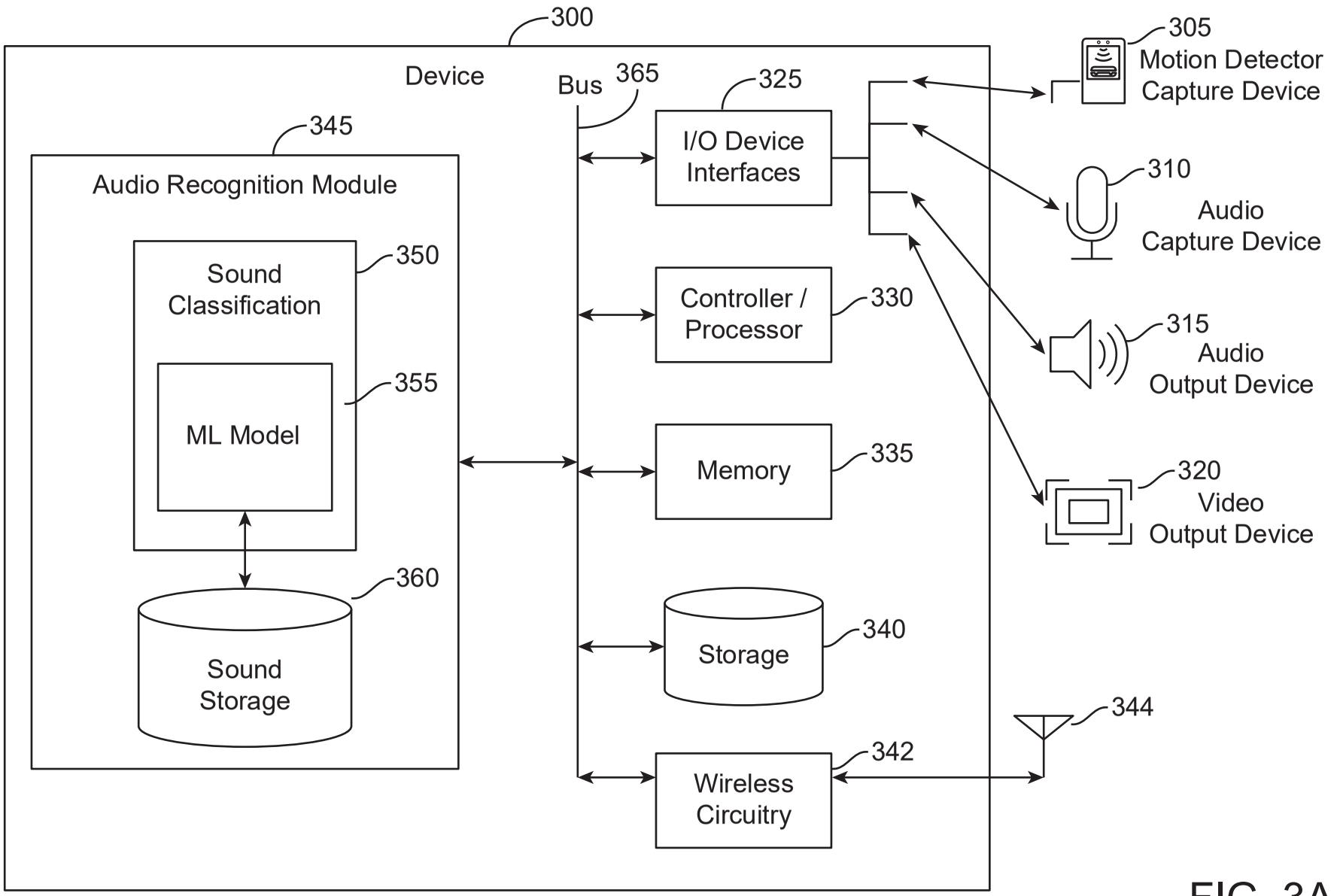
300
Device
Bus
365
325
I/O Device Interfaces
345
Audio Recognition Module
Sound Classification
350
ML Model
355
Controller / Processor
330
Memory
335
360
Sound Storage
Storage
340
342
Wireless Circuitry
344
305
Motion Detector Capture Device
310
Audio Capture Device
315
Audio Output Device
320
Video Output Device

FIG. 3A

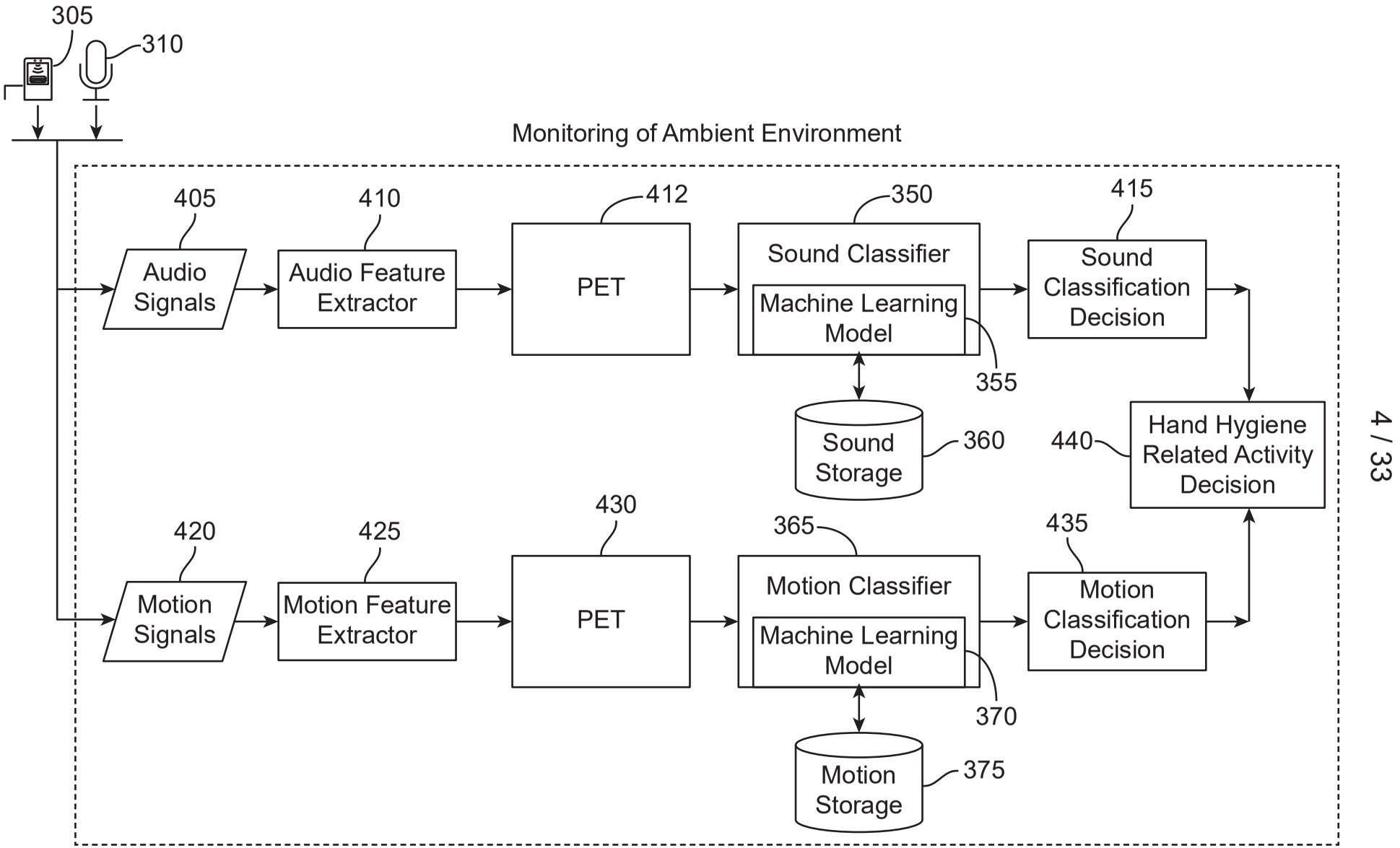
305
310
Monitoring of Ambient Environment
405
Audio Signals
410
Audio Feature Extractor
412
PET
350
Sound Classifier
Machine Learning Model
355
415
Sound Classification Decision
Sound Storage
360
440
Hand Hygiene Related Activity Decision
420
Motion Signals
425
Motion Feature Extractor
430
PET
365
Motion Classifier
Machine Learning Model
370
435
Motion Classification Decision
Motion Storage
375

FIG. 3B

Exemplary Trigger Sounds	Exemplary Trigger Motions
Water faucet handles opening and/or closing	Water faucet open or closed
Water flowing from the faucet	Water flowing from faucet
Soap dispenser being used	Soap dispenser in operation
Lathering of hands with soap	Lathering of hands with soap
Rinsing hands with water	Rinsing hands with water
Drying hands with towels	Drying hands with towels
Drying hands with air dryer	Drying hands with air dryer
Doors opening and/or closing	Doors opening and/or closing
Urinal use	User walking to urinal or toilet area
Urinal flush	User walking from urinal or toilet area
Toilet flush	User approaching sink
Footsteps of a user walking towards sink	User walking away from sink
Footsteps of a user walking away from sink	User exiting washroom
User exiting washroom	User entering washroom
User entering washroom	
Shower usage	
Bathtub usage	
Fan usage	

FIG. 4A

User Deviation	Device Response
User ignores handwashing altogether after using washroom facilities	Audio alert and/or visual message to return to the recommended handwashing protocol - example: "Please wash your hands to help reduce the spread of disease."
The user walks away before completing all steps of recommended handwashing	Audio alert and/or visual message to return to the recommended handwashing protocol - example: "Almost done! A few more important steps for clean hands." Optionally, signal sent to janitorial staff to disinfect door handles.
The user stops scrubbing hands with soap prematurely	Audio alert and/or visual message to return to the recommended handwashing protocol - example: "Keep scrubbing! Only 5 seconds more to go!"
The user does not apply soap to hands	Audio alert and/or visual message to return to the recommended handwashing protocol - example: "Keep scrubbing! Only 5 seconds more to go!"
The user does not rinse hands with water	Audio alert and/or visual message to return to the recommended handwashing protocol - example: "Don't forget to rinse your hands with water!"
The user does not dry their hands	Audio alert and/or visual message to return to the recommended handwashing protocol - example: "Don't forget to dry your hands!"

FIG. 4B

Voice Recognition for Washroom Related Issues
No soap
No paper towels
The towel dispenser is broken
The soap dispenser is broken
The washroom is dirty/ washroom needs cleaning
The sink is dirty/Sink needs cleaning

FIG. 4C

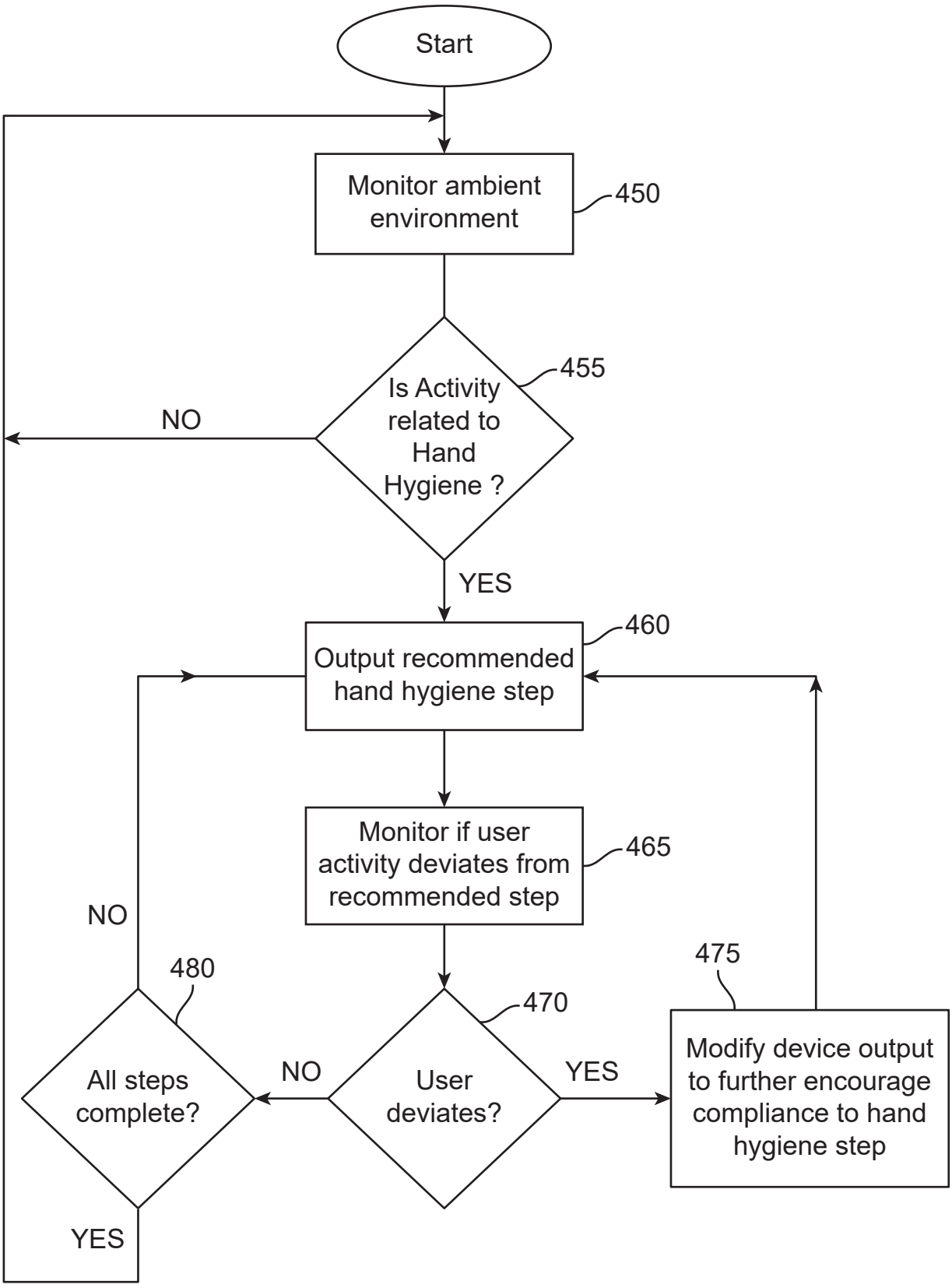
Start
Monitor ambient environment
450
Is Activity related to Hand Hygiene ?
455
NO
YES
Output recommended hand hygiene step
460
Monitor if user activity deviates from recommended step
465
NO
480
All steps complete?
NO
User deviates?
470
YES
475
Modify device output to further encourage compliance to hand hygiene step
YES

FIG. 5A

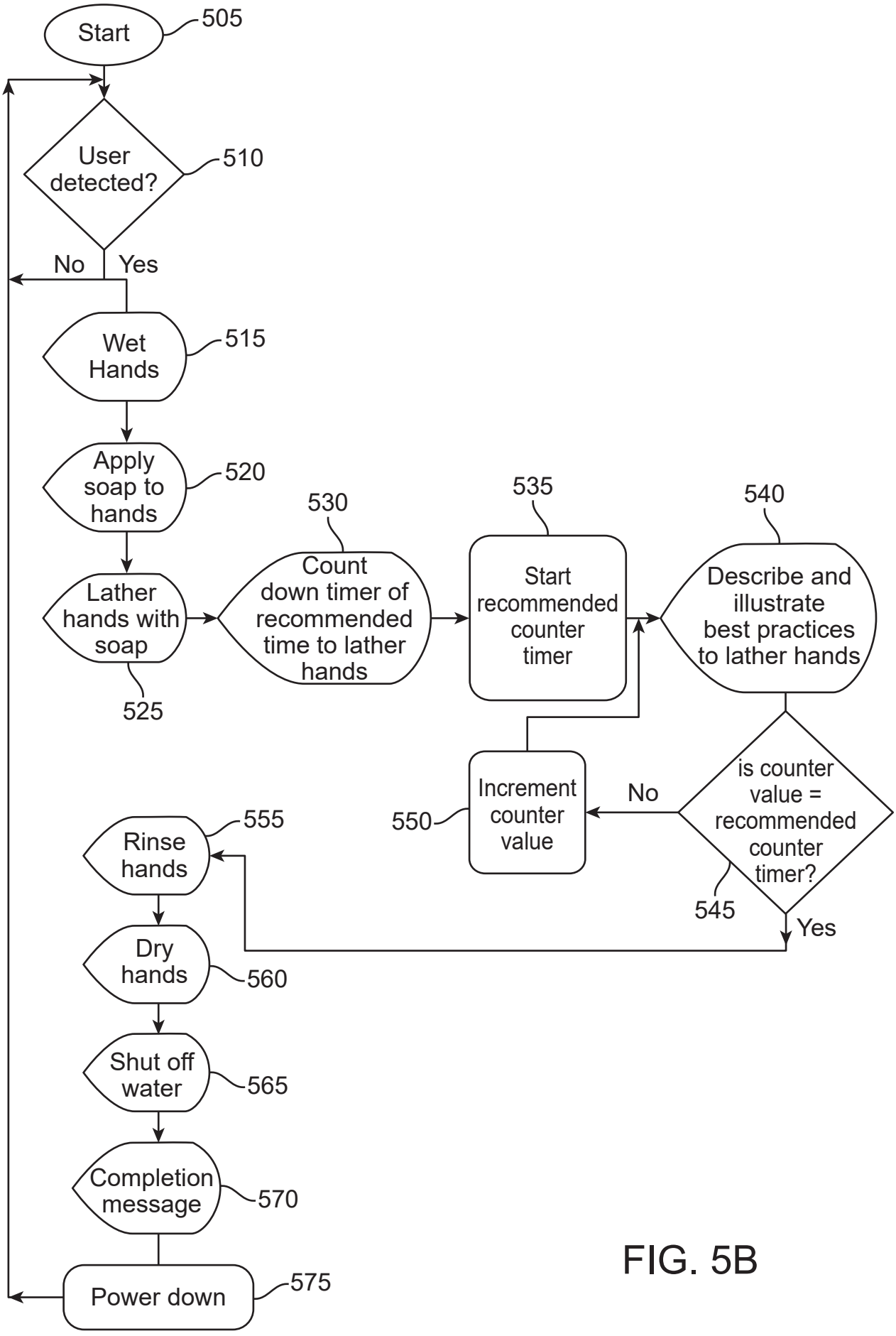
Start
505
User detected?
510
No
Yes
Wet Hands
515
Apply soap to hands
520
Lather hands with soap
525
530
Count down timer of recommended time to lather hands
535
Start recommended counter timer
540
Describe and illustrate best practices to lather hands
is counter value = recommended counter timer?
545
No
Yes
Increment counter value
550
Rinse hands
555
Dry hands
560
Shut off water
565
Completion message
570
Power down
575

FIG. 5B

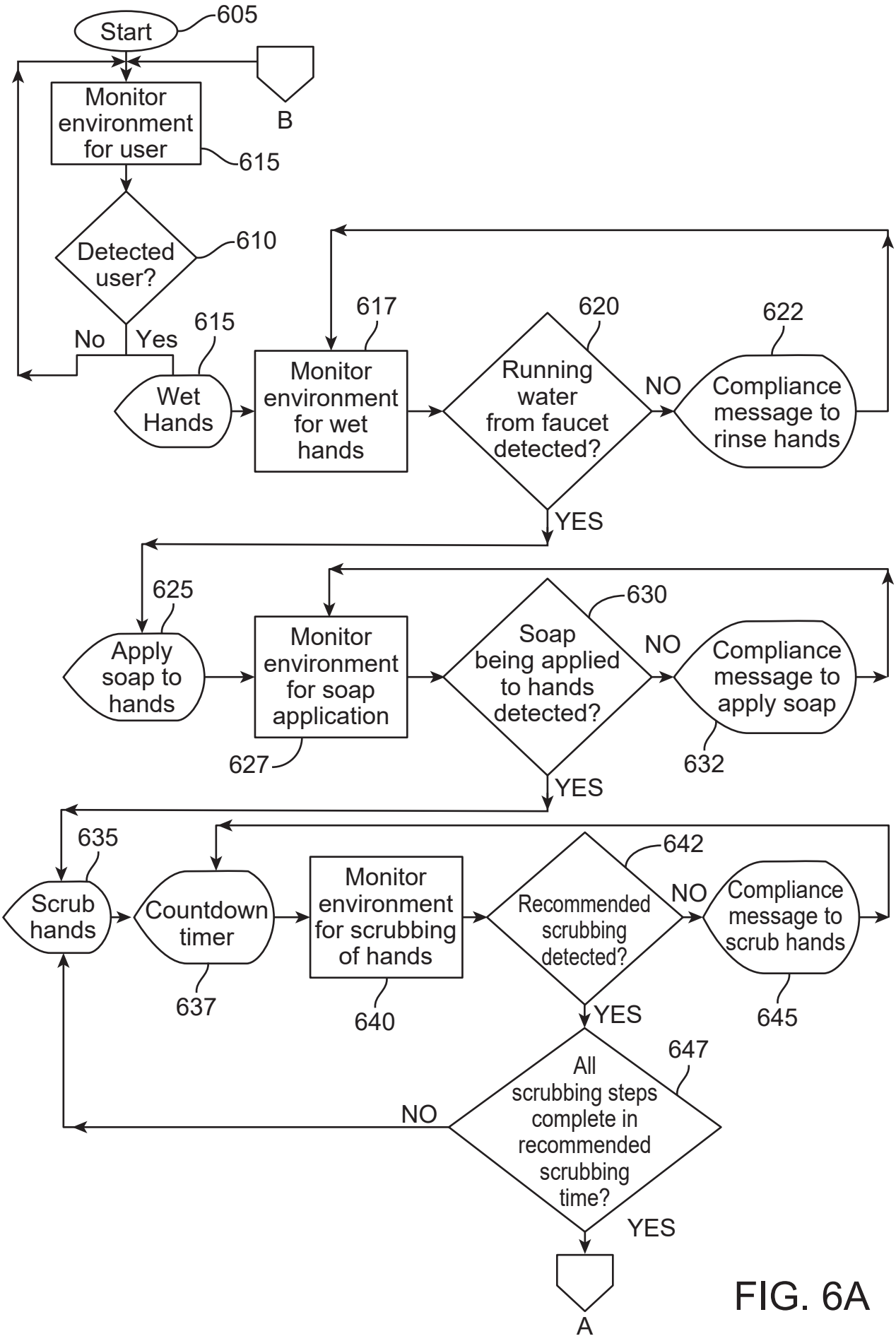
Start
605
B
Monitor environment for user
615
Detected user?
610
No
Yes
615
Wet Hands
617
Monitor environment for wet hands
620
Running water from faucet detected?
NO
622
Compliance message to rinse hands
YES
625
Apply soap to hands
Monitor environment for soap application
627
630
Soap being applied to hands detected?
NO
Compliance message to apply soap
632
YES
635
Scrub hands
Countdown timer
637
Monitor environment for scrubbing of hands
640
642
Recommended scrubbing detected?
NO
Compliance message to scrub hands
645
YES
647
All scrubbing steps complete in recommended scrubbing time?
NO
YES
A

FIG. 6A

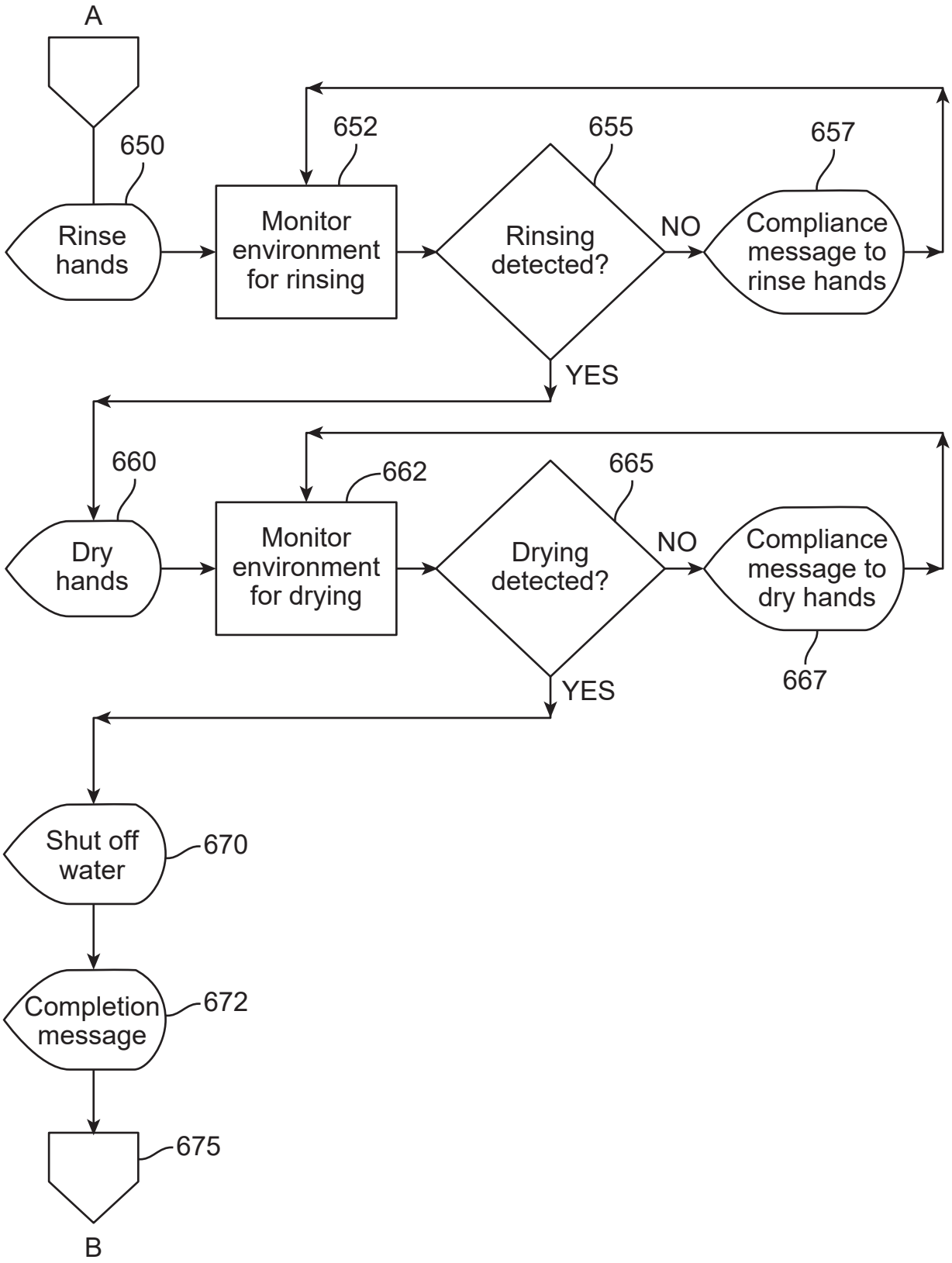
A
650
Rinse hands
652
Monitor environment for rinsing
655
Rinsing detected?
NO
657
Compliance message to rinse hands
YES
660
Dry hands
662
Monitor environment for drying
665
Drying detected?
NO
Compliance message to dry hands
667
YES
Shut off water
670
Completion message
672
675
B

FIG. 6B

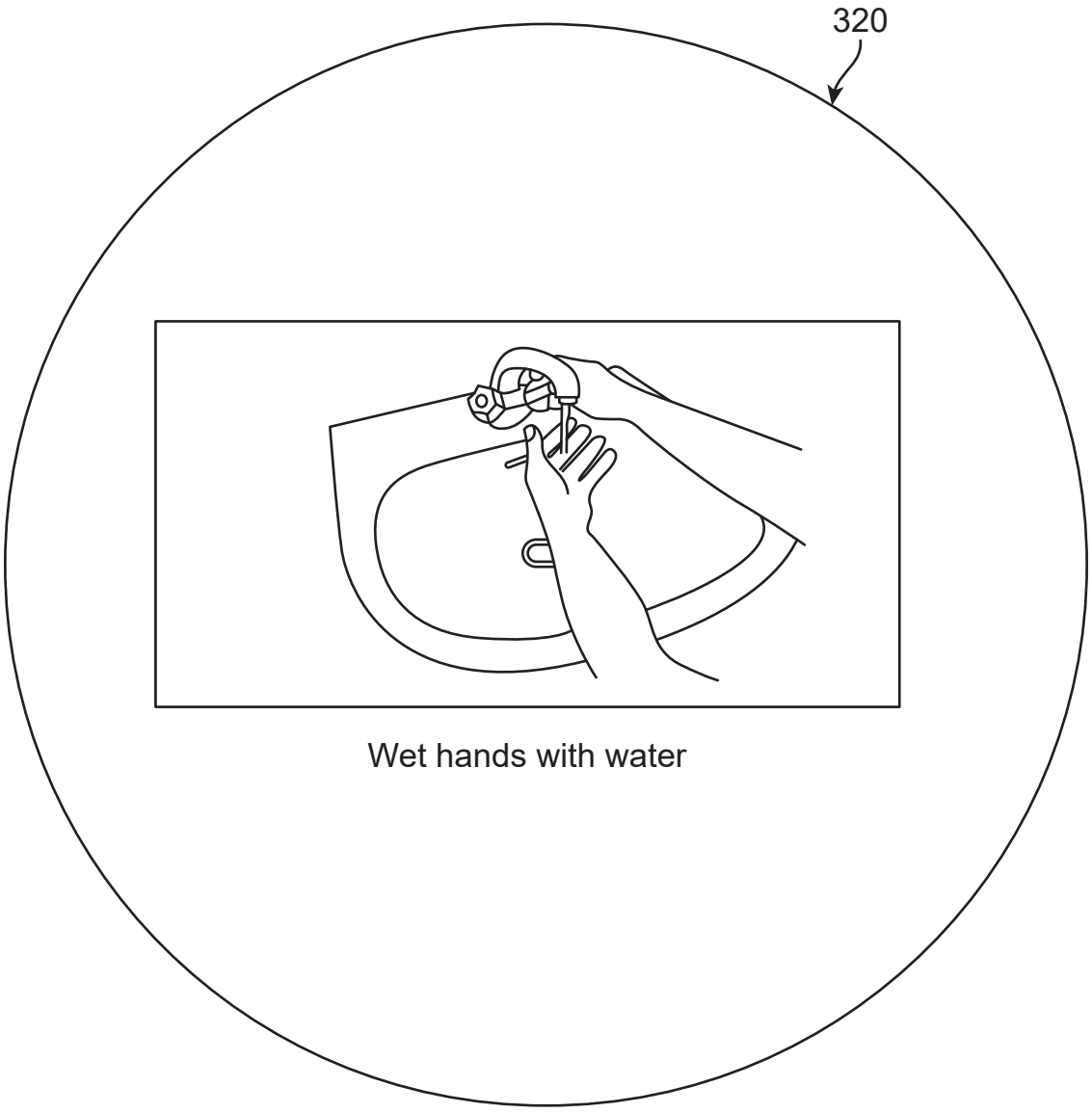

FIG. 7A

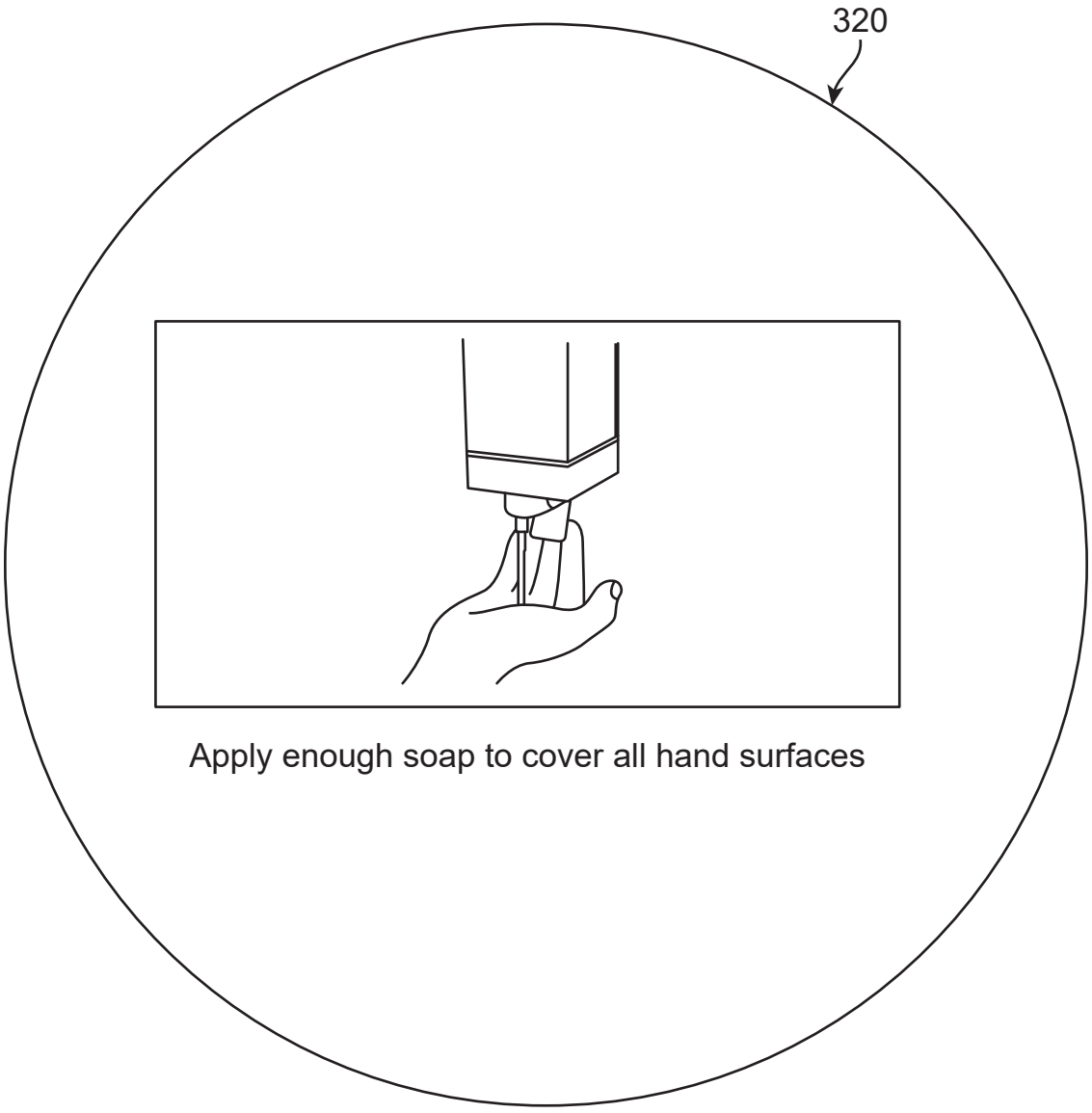

FIG. 7B

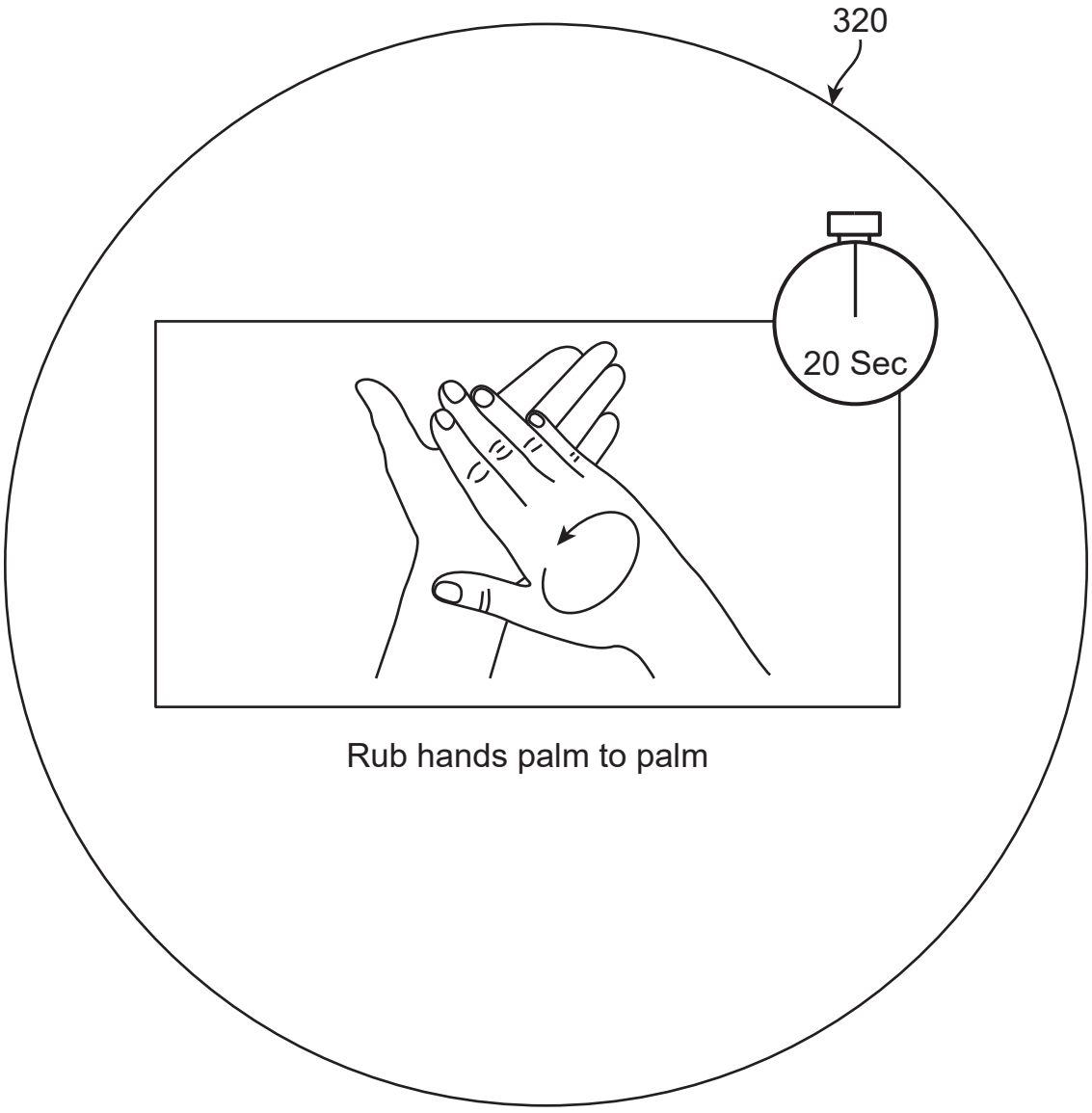

FIG. 7C

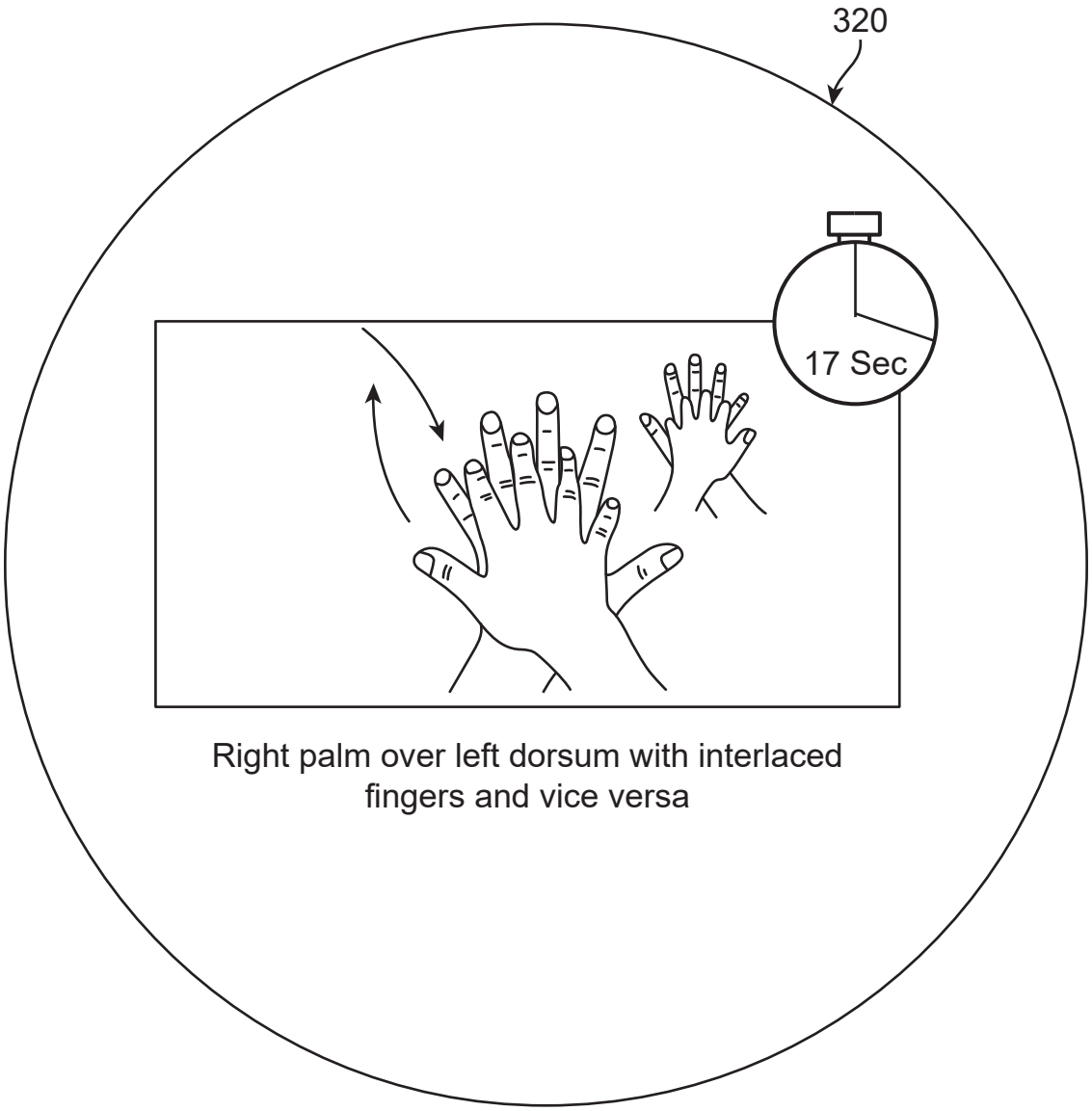
320
17 Sec
Right palm over left dorsum with interlaced fingers and vice versa

FIG. 7D

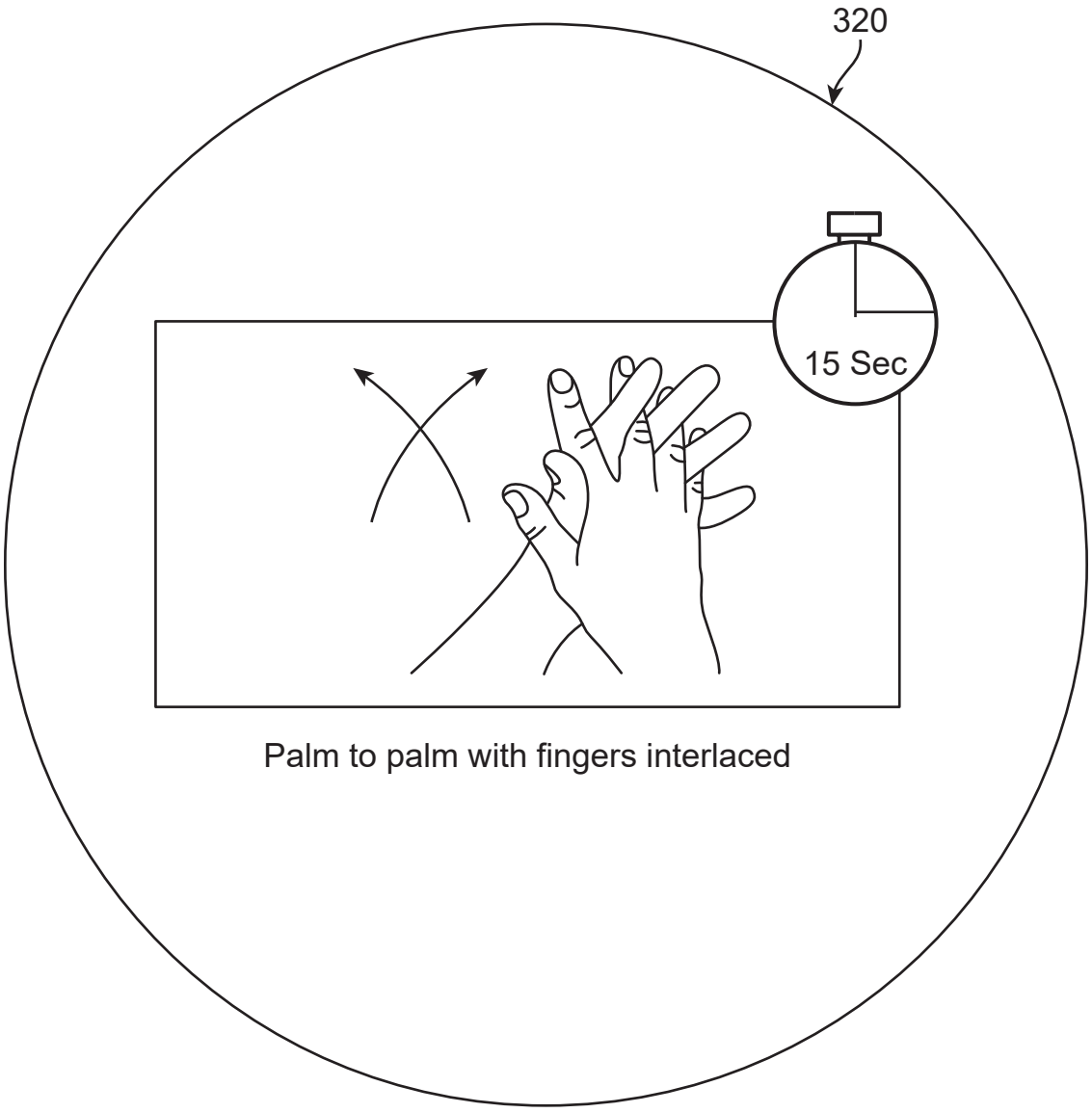

FIG. 7E

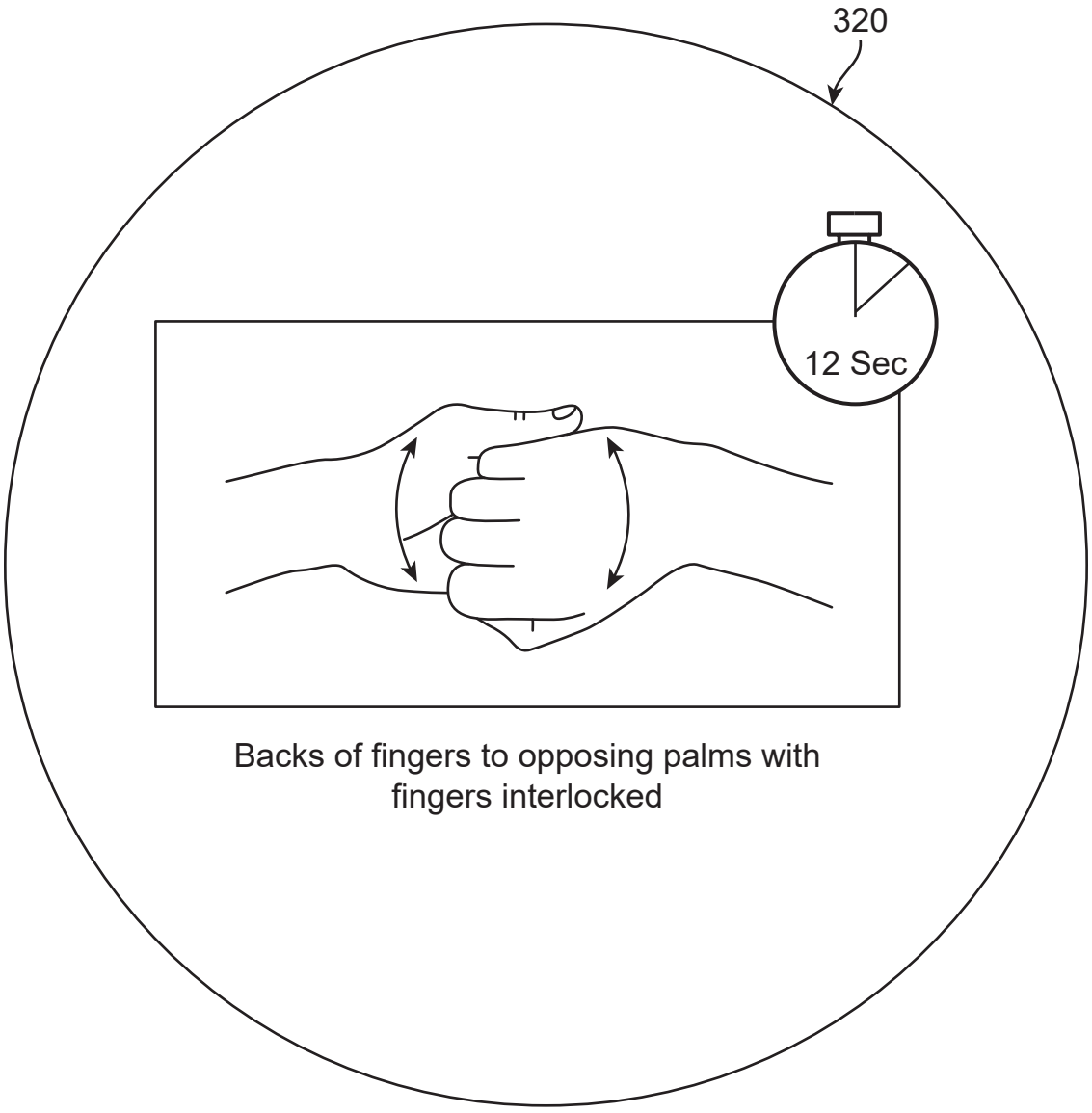
320
12 Sec
Backs of fingers to opposing palms with fingers interlocked

FIG. 7F

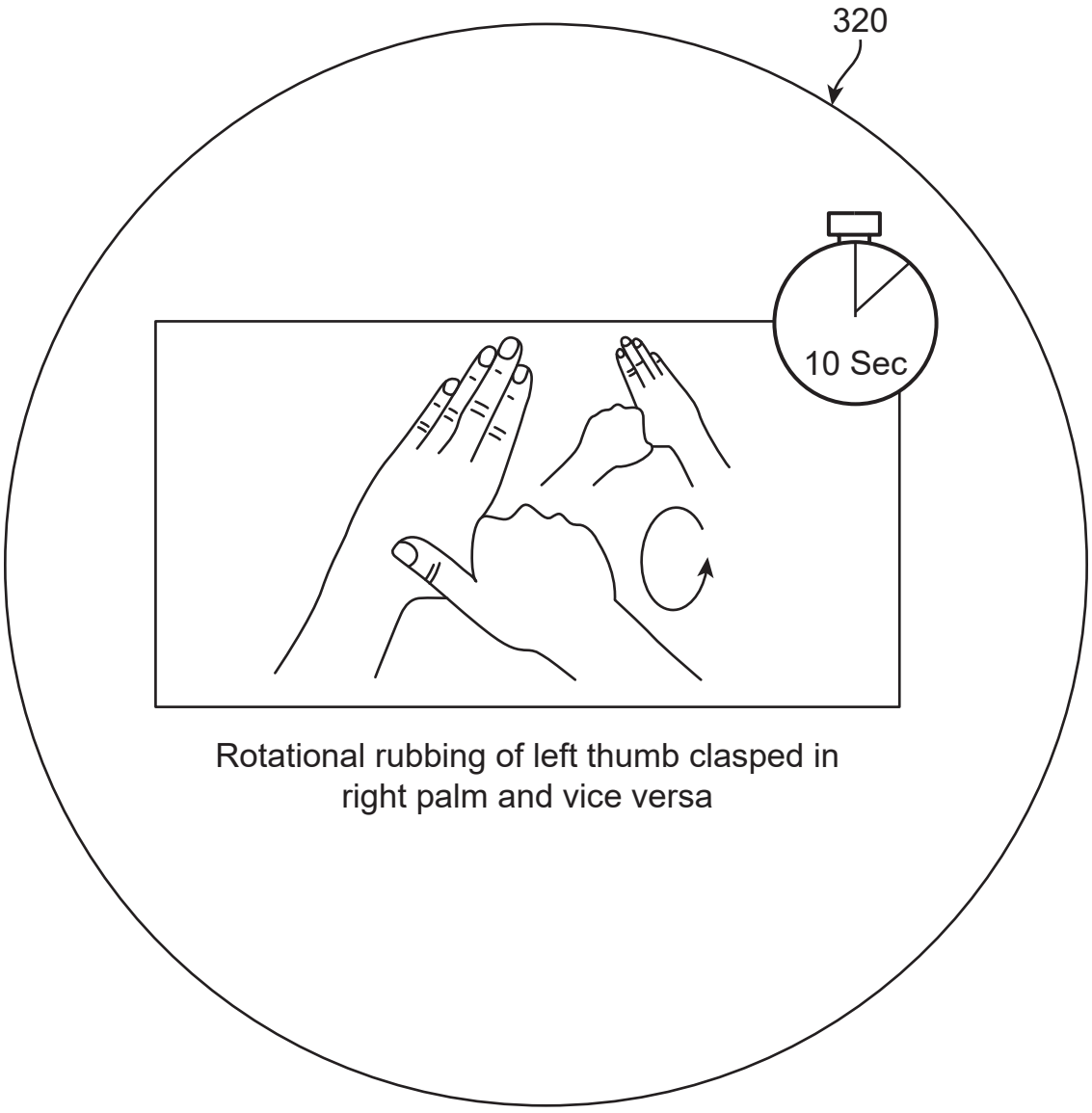
320
10 Sec
Rotational rubbing of left thumb clasped in right palm and vice versa

FIG. 7G

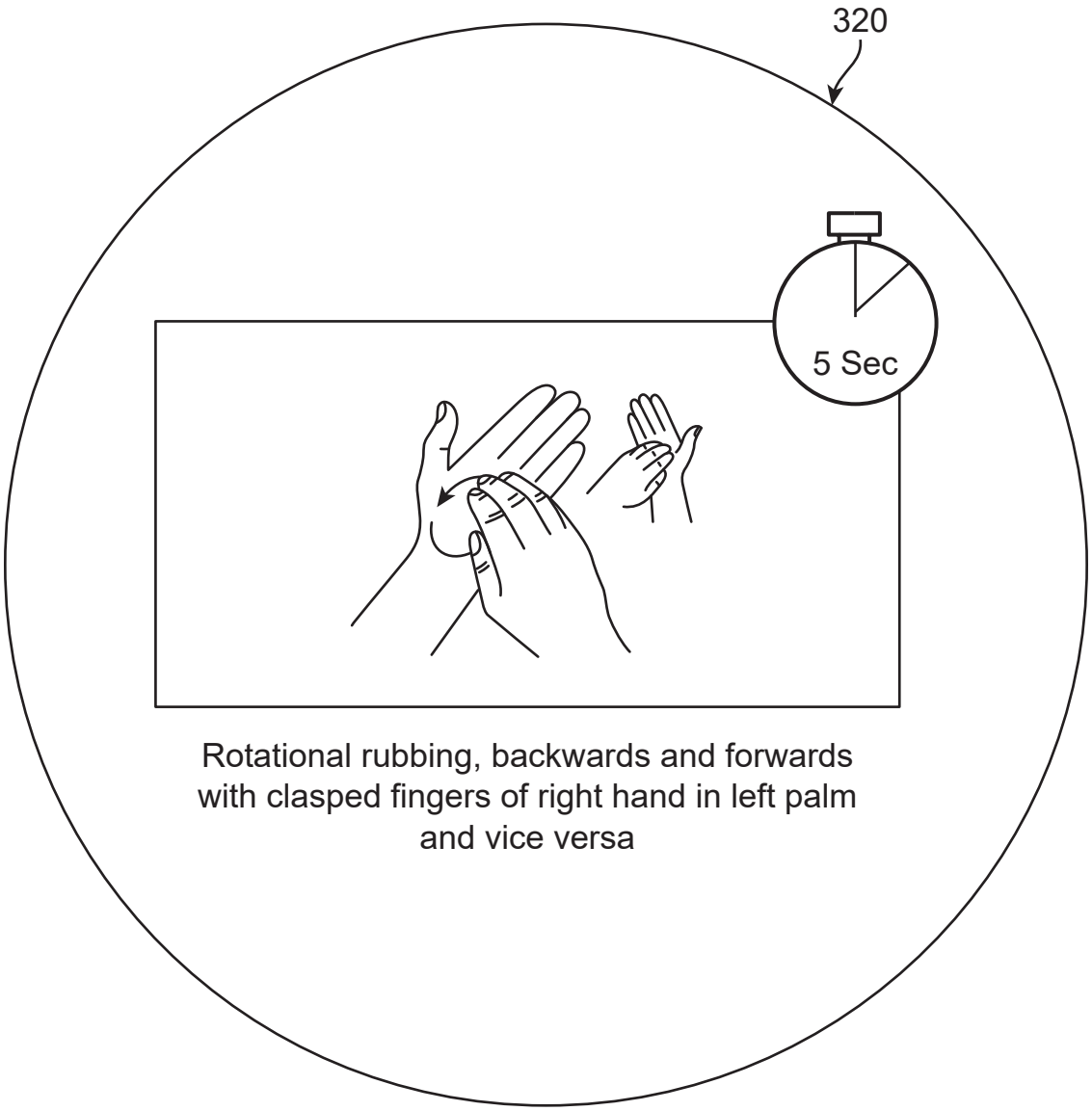
320
5 Sec
Rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa

FIG. 7H

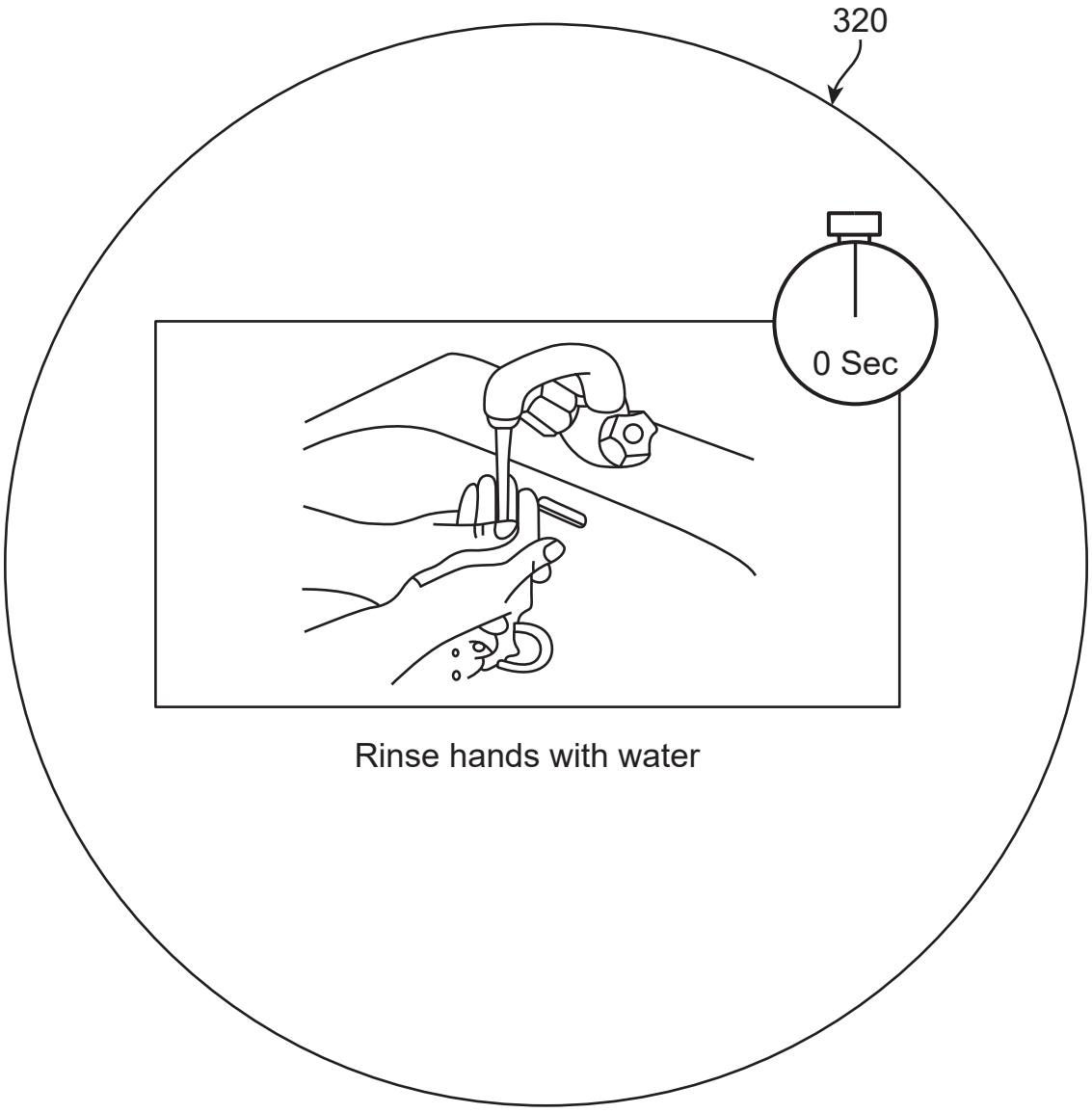

FIG. 7I

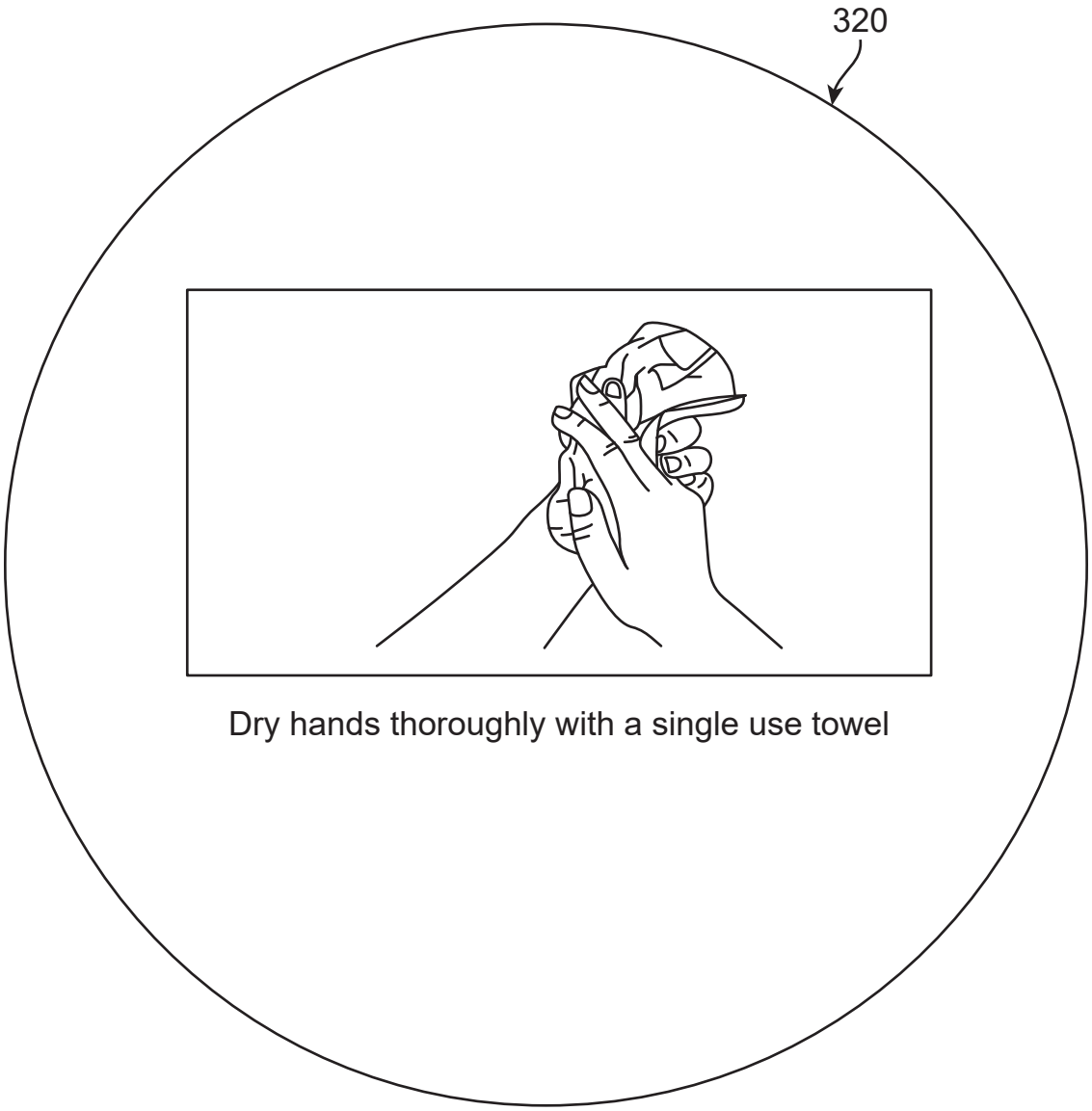

FIG. 7J

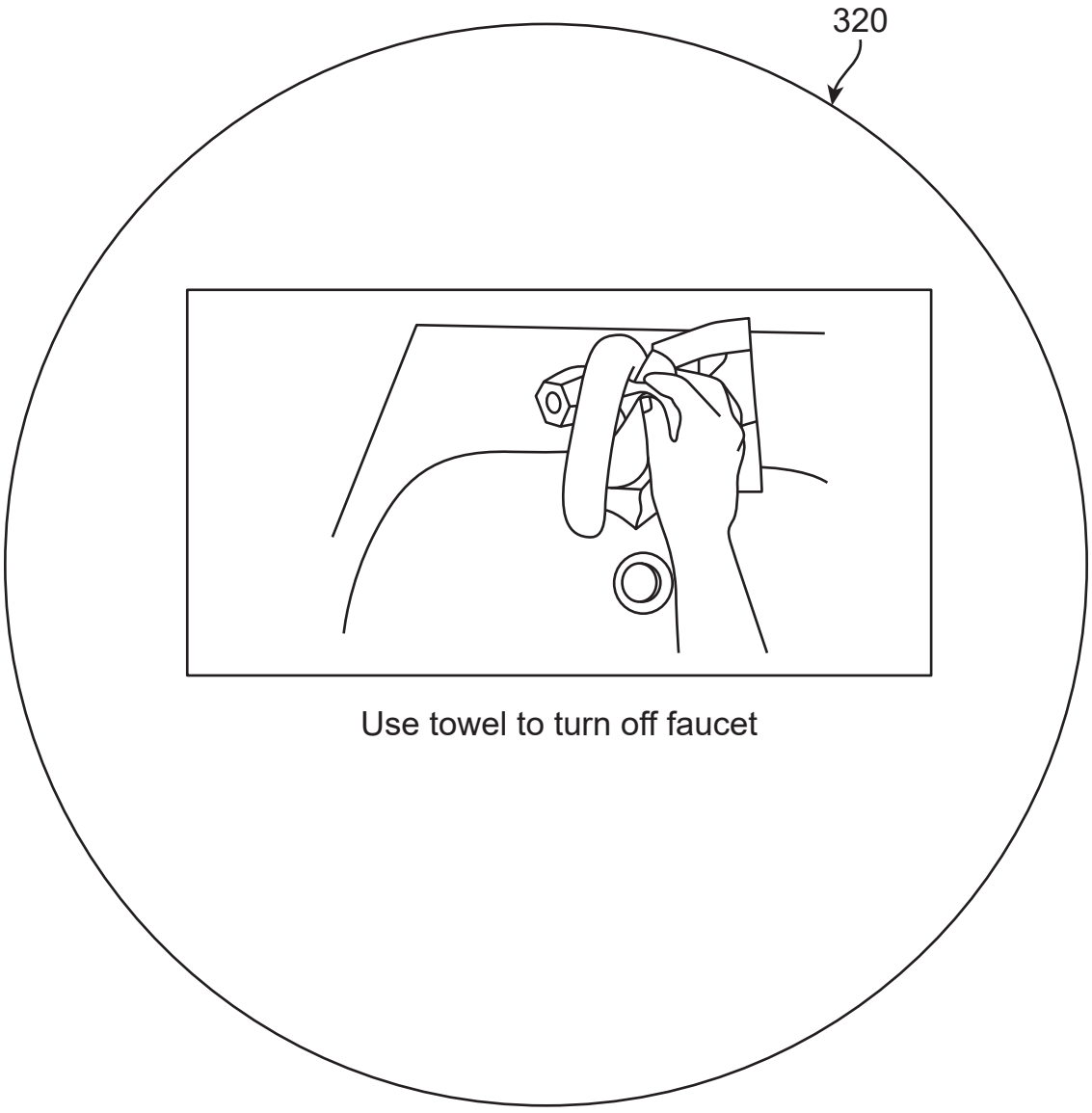

FIG. 7K

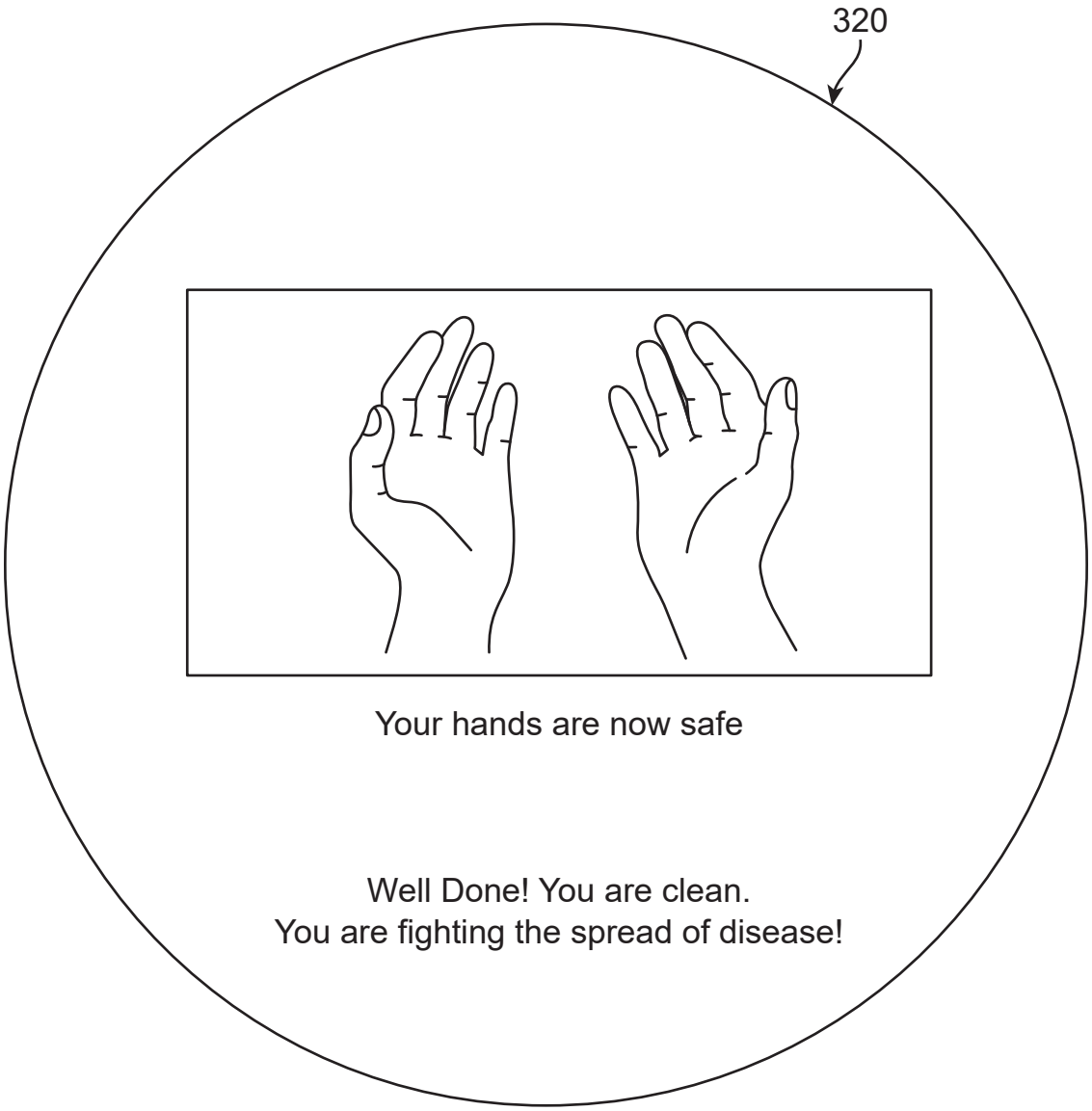
320
Your hands are now safe
Well Done! You are clean.
You are fighting the spread of disease!

FIG. 7L

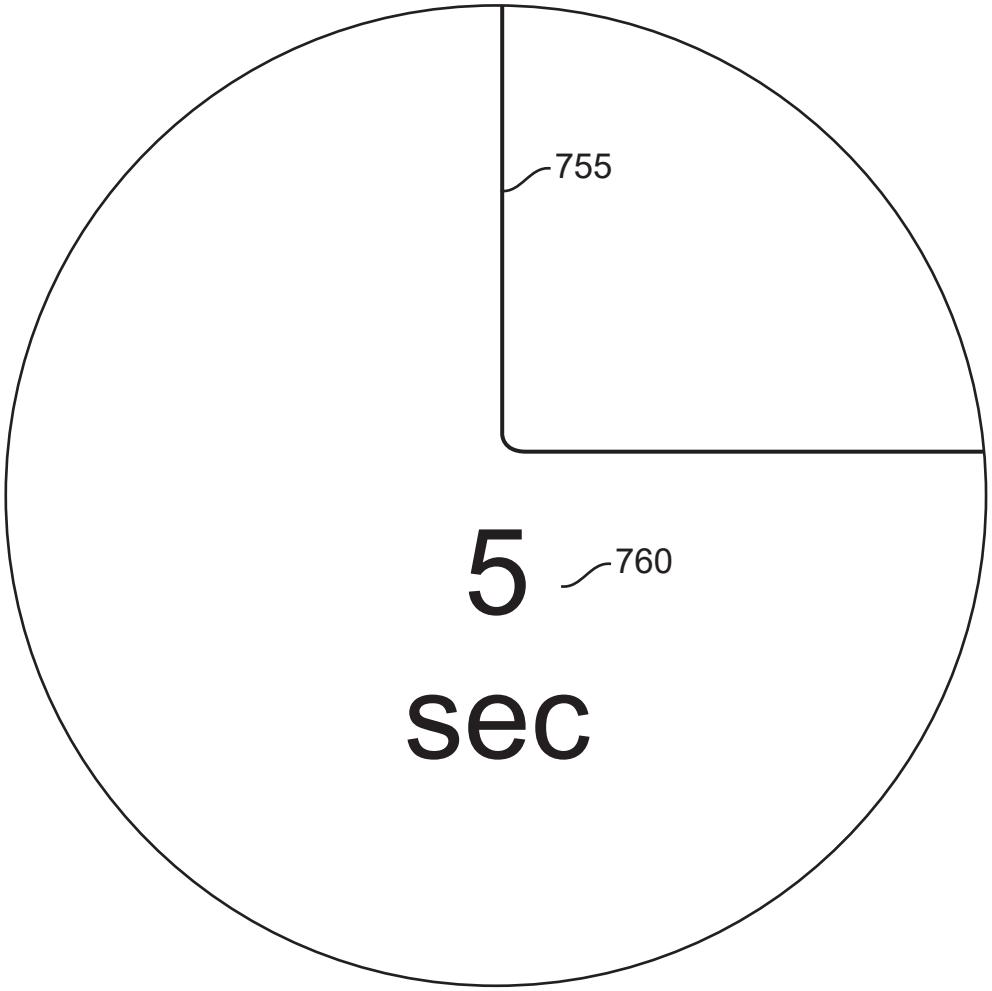

FIG. 7M

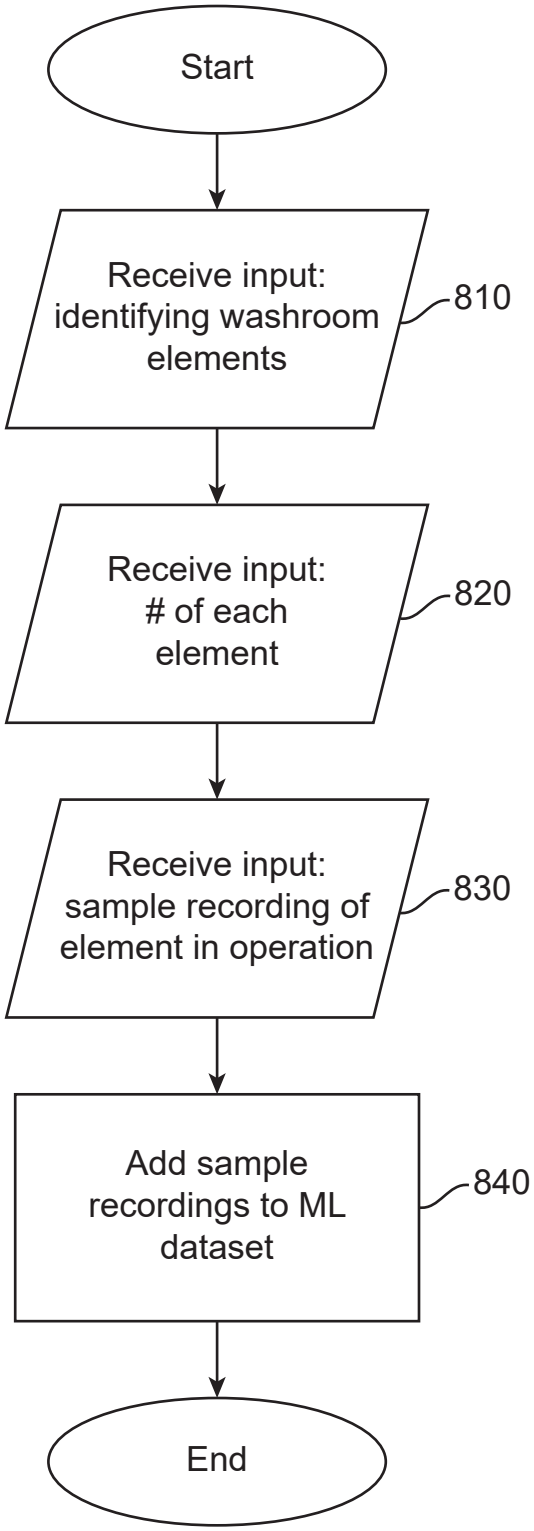
Start
Receive input: identifying washroom elements
810
Receive input: # of each element
820
Receive input: sample recording of element in operation
830
Add sample recordings to ML dataset
840
End

FIG. 8

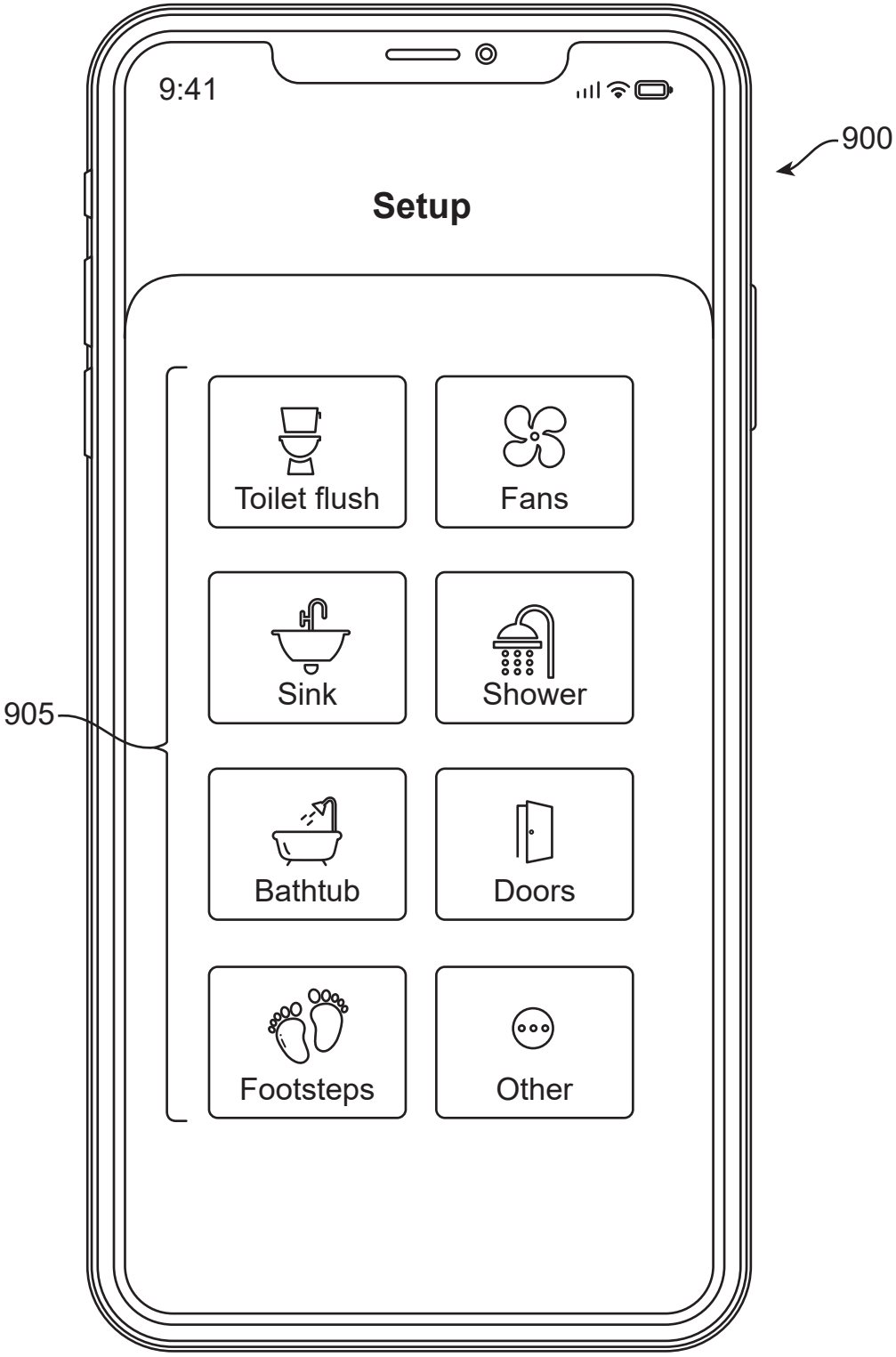
9:41
900
Setup
905
Toilet flush
Fans
Sink
Shower
Bathtub
Doors
Footsteps
Other

FIG. 9A

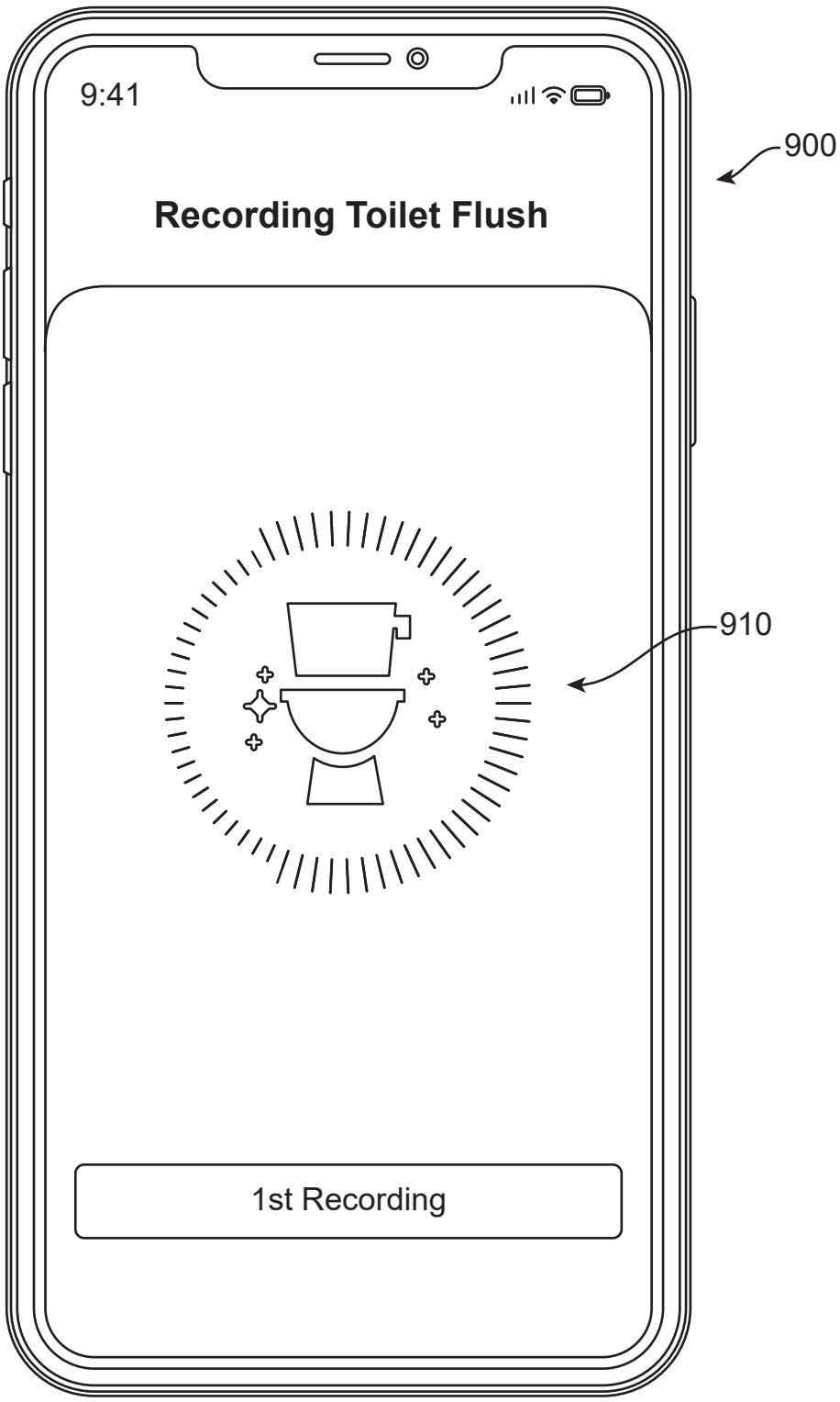

FIG. 9B

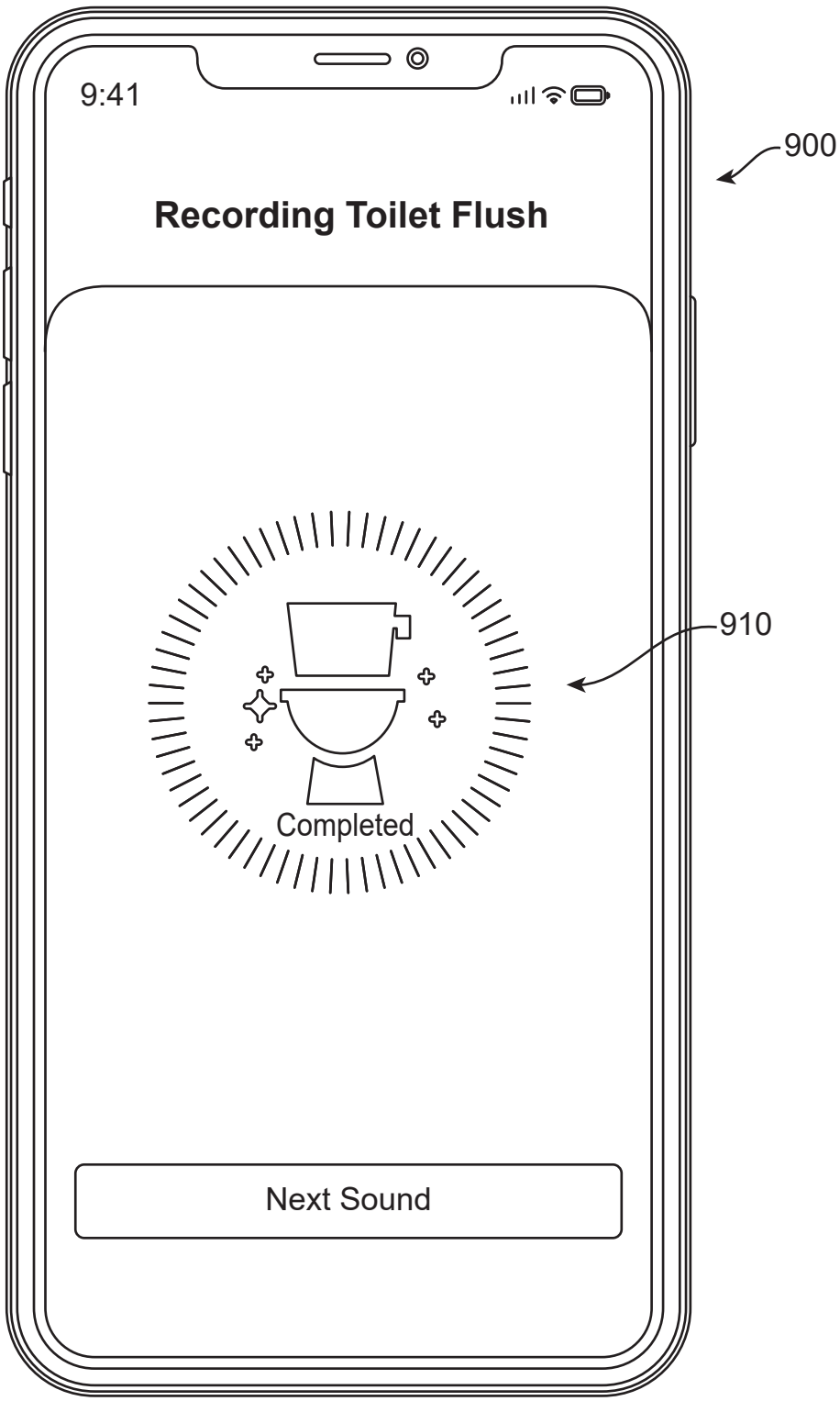

FIG. 9C

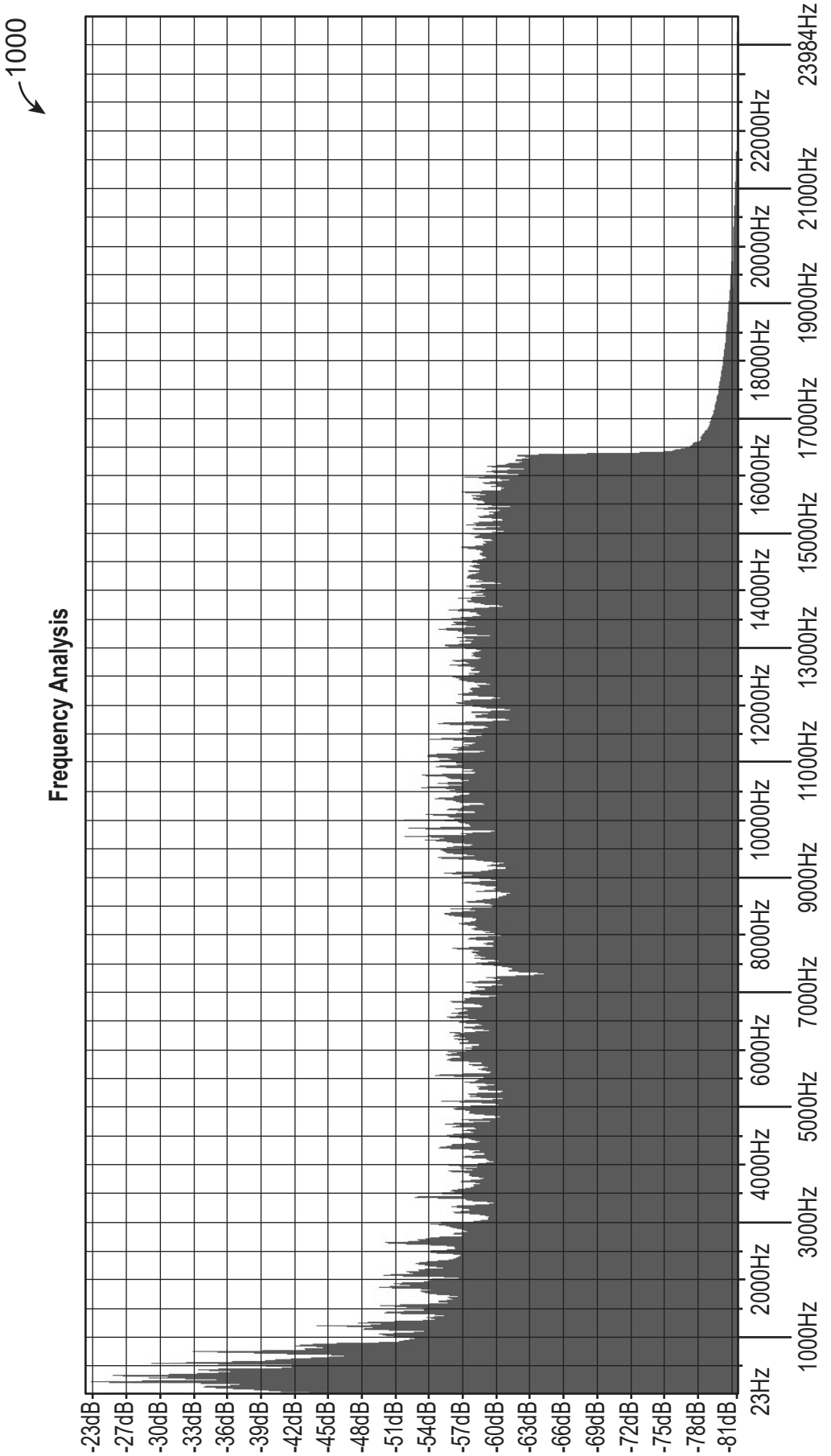
1000
Frequency Analysis
-23dB
-27dB
-30dB
-33dB
-36dB
-39dB
-42dB
-45dB
-48dB
-51dB
-54dB
-57dB
-60dB
-63dB
-66dB
-69dB
-72dB
-75dB
-78dB
-81dB
23Hz
1000Hz
2000Hz
3000Hz
4000Hz
5000Hz
6000Hz
7000Hz
8000Hz
9000Hz
10000Hz
11000Hz
12000Hz
13000Hz
14000Hz
15000Hz
16000Hz
17000Hz
18000Hz
19000Hz
20000Hz
21000Hz
22000Hz
23984Hz

FIG. 10A

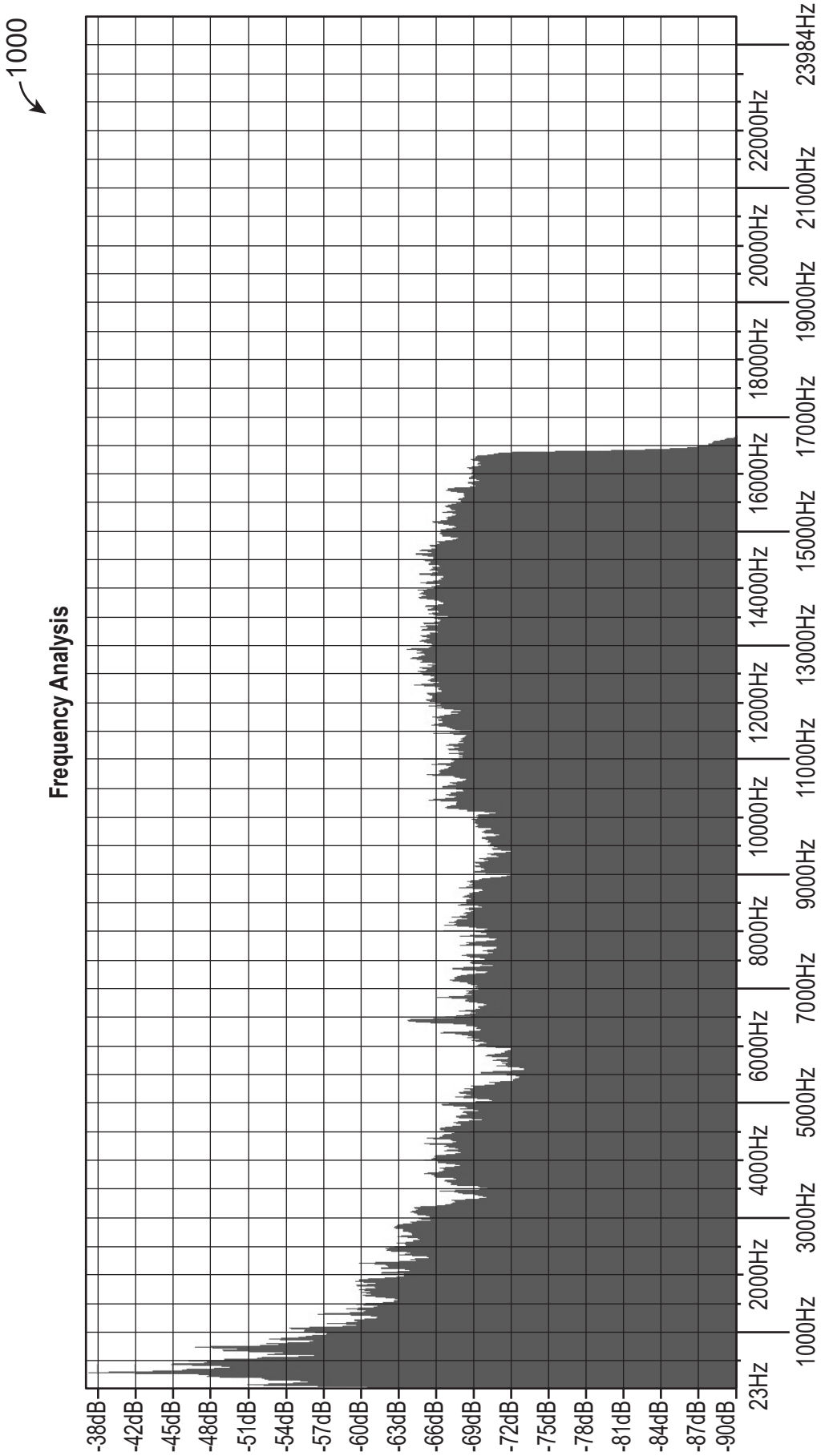
1000
Frequency Analysis
-38dB
-42dB
-45dB
-48dB
-51dB
-54dB
-57dB
-60dB
-63dB
-66dB
-69dB
-72dB
-75dB
-78dB
-81dB
-84dB
-87dB
-90dB
23Hz
1000Hz
2000Hz
3000Hz
4000Hz
5000Hz
6000Hz
7000Hz
8000Hz
9000Hz
10000Hz
11000Hz
12000Hz
13000Hz
14000Hz
15000Hz
16000Hz
17000Hz
18000Hz
19000Hz
20000Hz
21000Hz
22000Hz
23984Hz

FIG. 10B

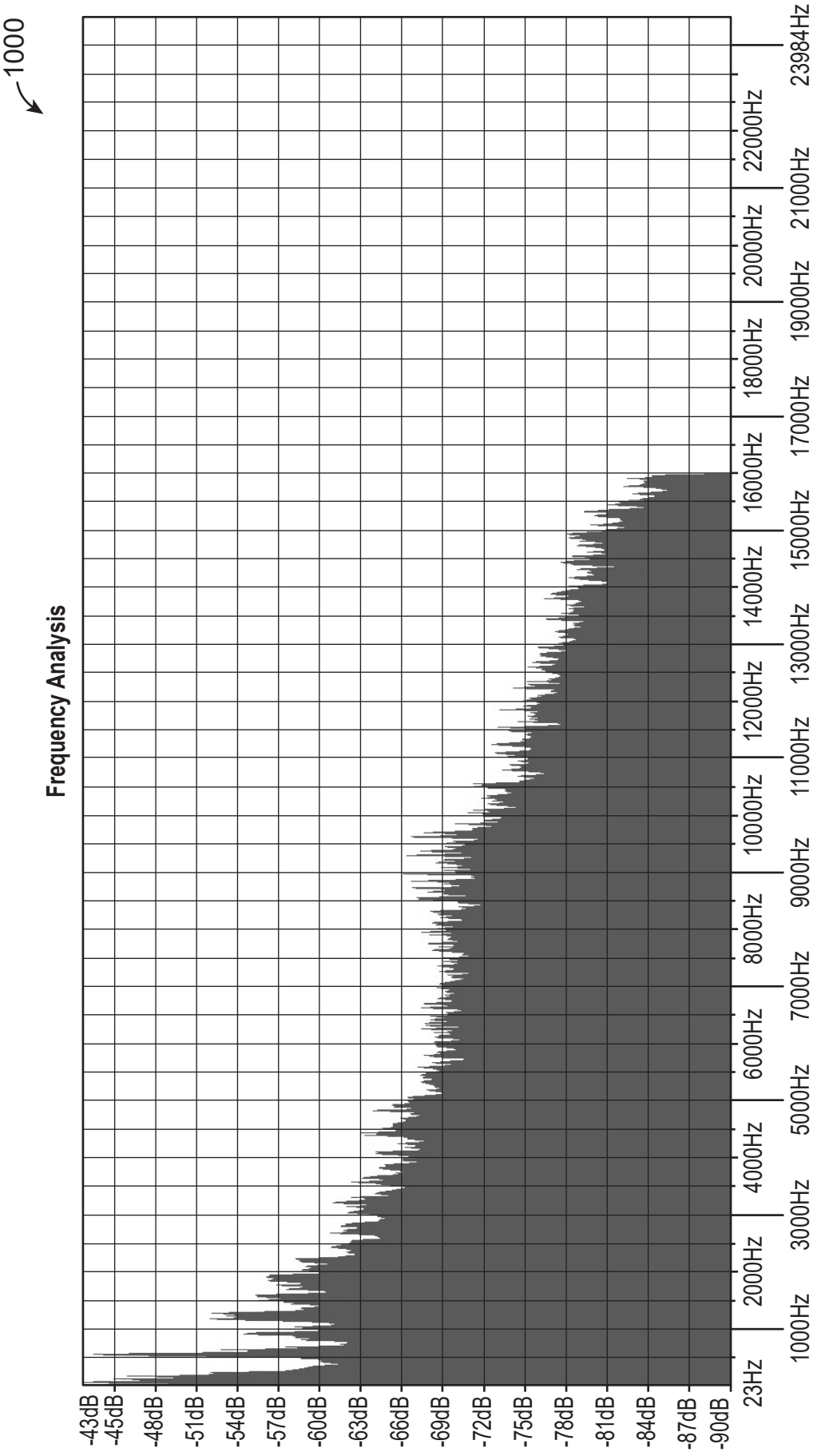
1000
Frequency Analysis
-43dB
-45dB
-48dB
-51dB
-54dB
-57dB
-60dB
-63dB
-66dB
-69dB
-72dB
-75dB
-78dB
-81dB
-84dB
-87dB
-90dB
23Hz
1000Hz
2000Hz
3000Hz
4000Hz
5000Hz
6000Hz
7000Hz
8000Hz
9000Hz
10000Hz
11000Hz
12000Hz
13000Hz
14000Hz
15000Hz
16000Hz
17000Hz
18000Hz
19000Hz
20000Hz
21000Hz
22000Hz
23984Hz

FIG. 10C

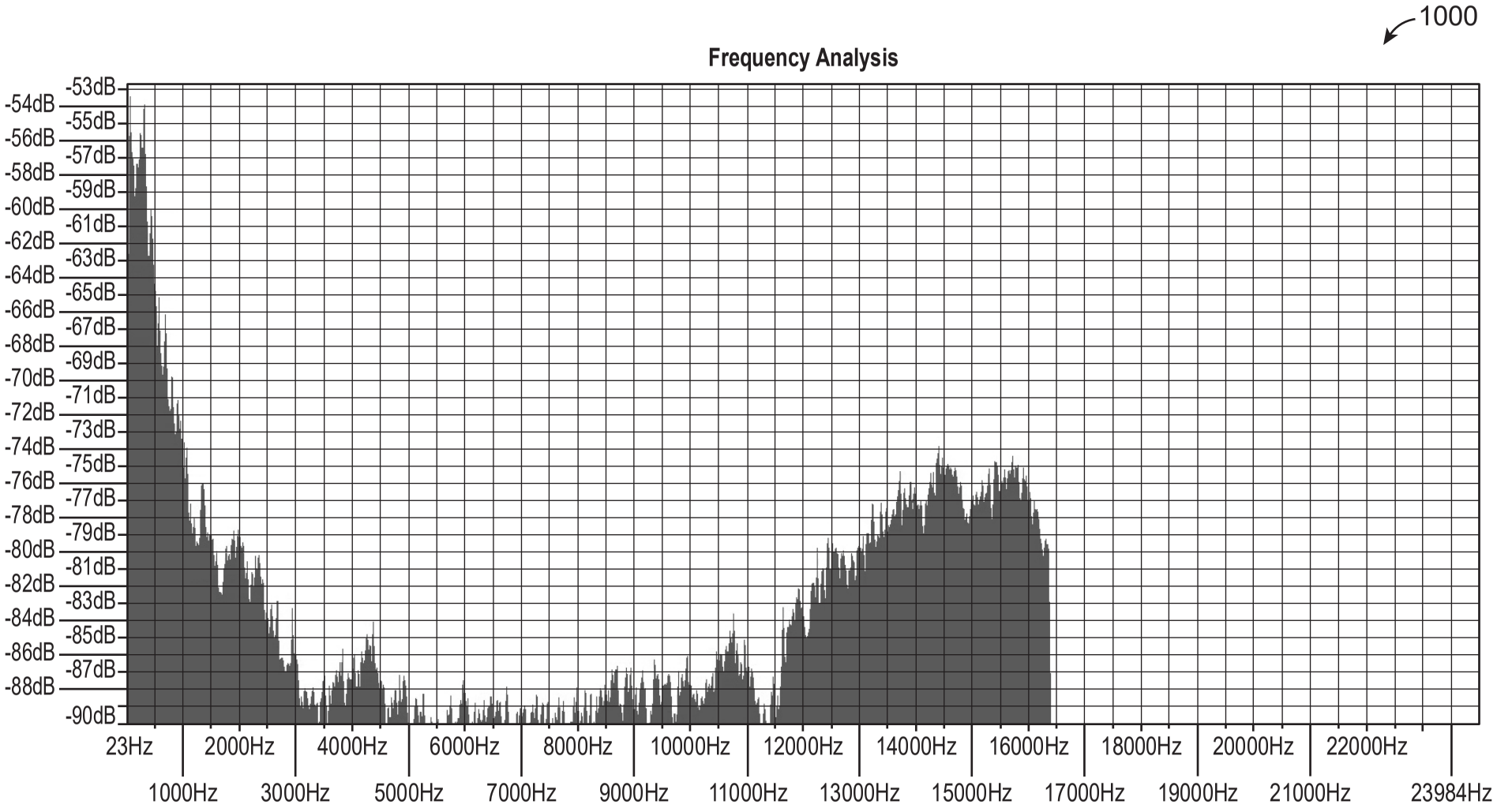
1000
Frequency Analysis
-53dB
-54dB
-55dB
-56dB
-57dB
-58dB
-59dB
-60dB
-61dB
-62dB
-63dB
-64dB
-65dB
-66dB
-67dB
-68dB
-69dB
-70dB
-71dB
-72dB
-73dB
-74dB
-75dB
-76dB
-77dB
-78dB
-79dB
-80dB
-81dB
-82dB
-83dB
-84dB
-85dB
-86dB
-87dB
-88dB
-90dB
23Hz
1000Hz
2000Hz
3000Hz
4000Hz
5000Hz
6000Hz
7000Hz
8000Hz
9000Hz
10000Hz
11000Hz
12000Hz
13000Hz
14000Hz
15000Hz
16000Hz
17000Hz
18000Hz
19000Hz
20000Hz
21000Hz
22000Hz
23984Hz

FIG. 10D

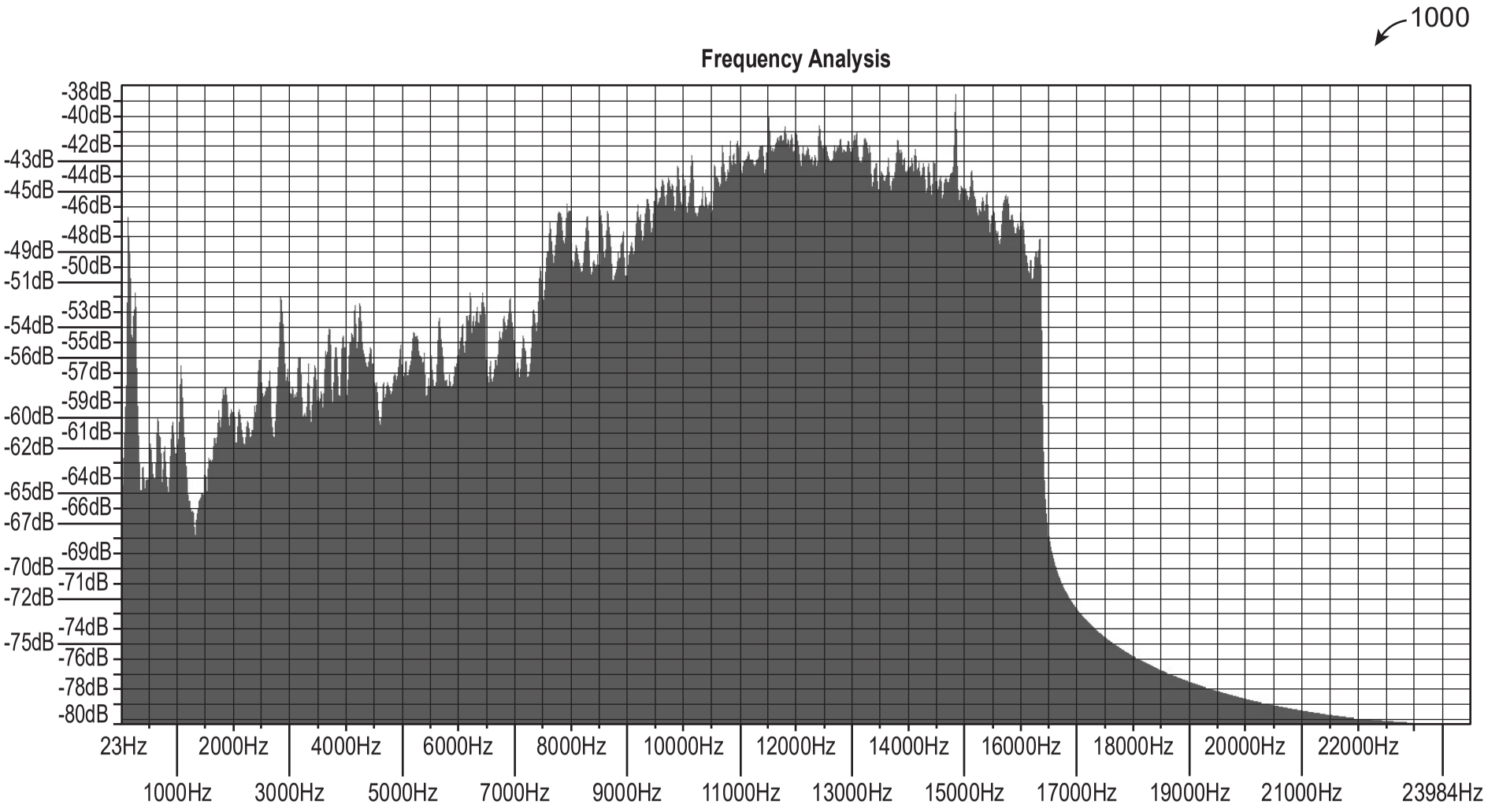
1000
Frequency Analysis
-38dB
-40dB
-42dB
-43dB
-44dB
-45dB
-46dB
-48dB
-49dB
-50dB
-51dB
-53dB
-54dB
-55dB
-56dB
-57dB
-59dB
-60dB
-61dB
-62dB
-64dB
-65dB
-66dB
-67dB
-69dB
-70dB
-71dB
-72dB
-74dB
-75dB
-76dB
-78dB
-80dB
23Hz
1000Hz
2000Hz
3000Hz
4000Hz
5000Hz
6000Hz
7000Hz
8000Hz
9000Hz
10000Hz
11000Hz
12000Hz
13000Hz
14000Hz
15000Hz
16000Hz
17000Hz
18000Hz
19000Hz
20000Hz
21000Hz
22000Hz
23984Hz

FIG. 10E