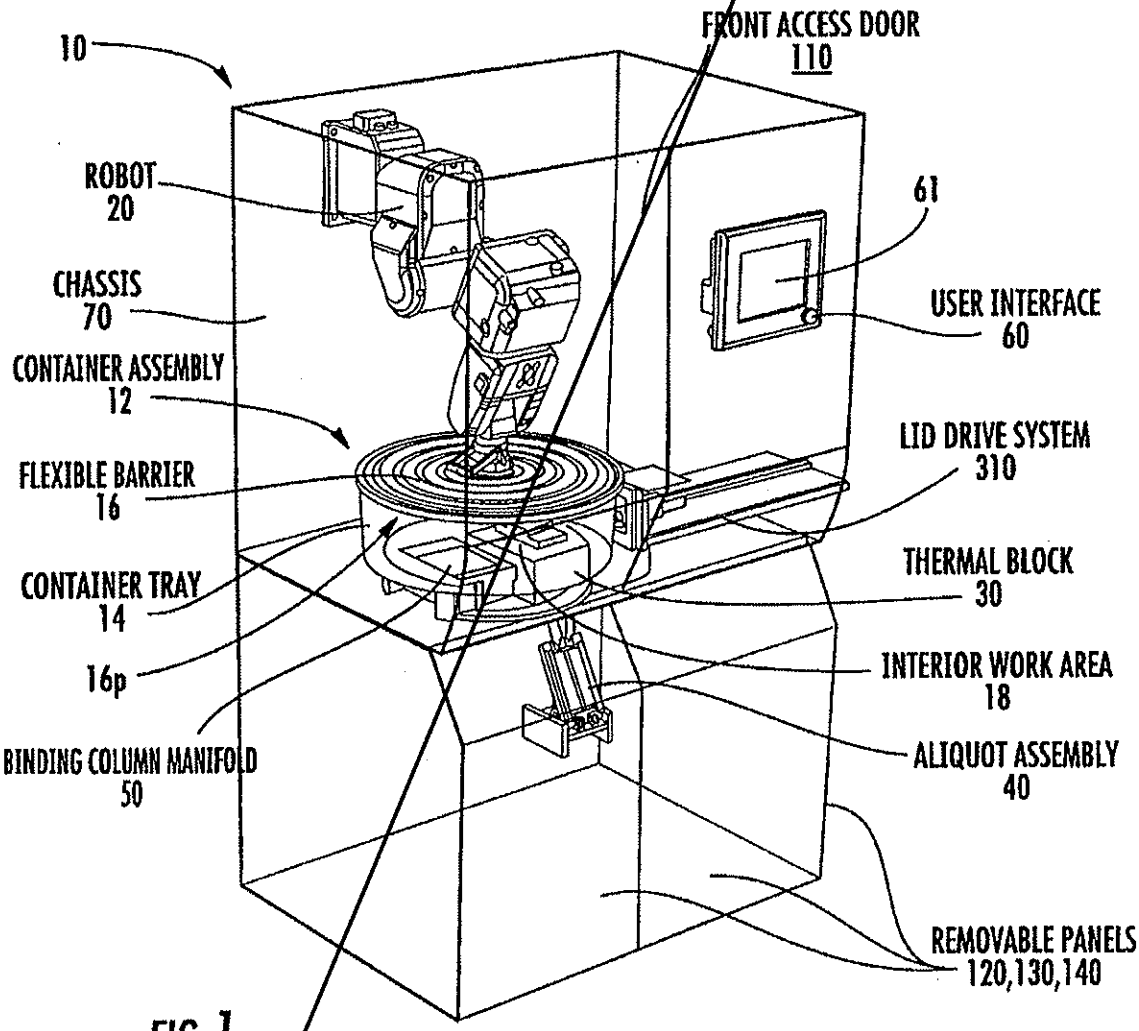

10
FRONT ACCESS DOOR
110
ROBOT
20
61
CHASSIS
70
USER INTERFACE
60
CONTAINER ASSEMBLY
12
LID DRIVE SYSTEM
310
FLEXIBLE BARRIER
16
THERMAL BLOCK
30
CONTAINER TRAY
14
INTERIOR WORK AREA
18
16p
ALIQUOT ASSEMBLY
40
BINDING COLUMN MANIFOLD
50
REMOVABLE PANELS
120,130,140

FIG. 1

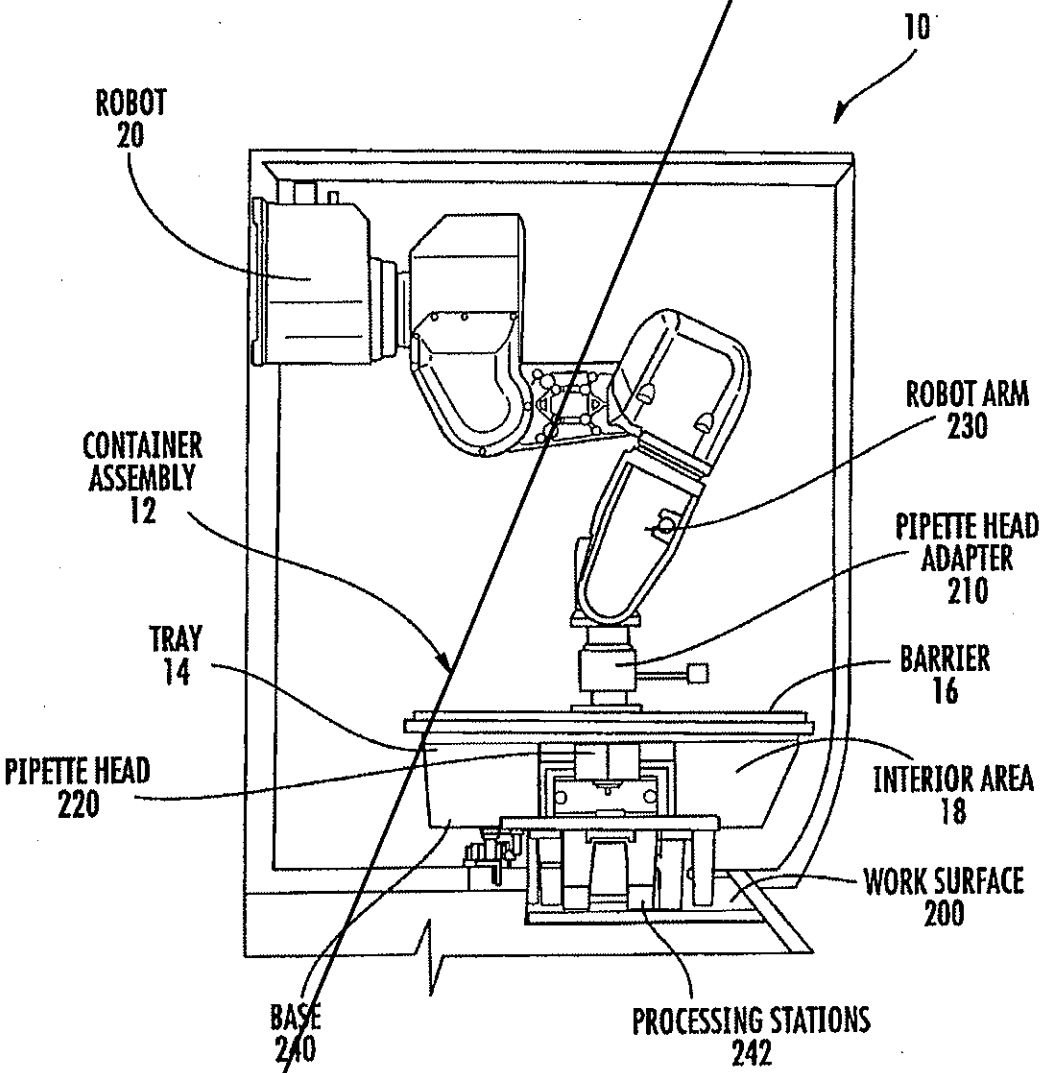

10
ROBOT
20
ROBOT ARM
230
CONTAINER
ASSEMBLY
12
PIPETTE HEAD
ADAPTER
210
TRAY
14
BARRIER
16
PIPETTE HEAD
220
INTERIOR AREA
18
WORK SURFACE
200
BASE
240
PROCESSING STATIONS
242

FIG. 2

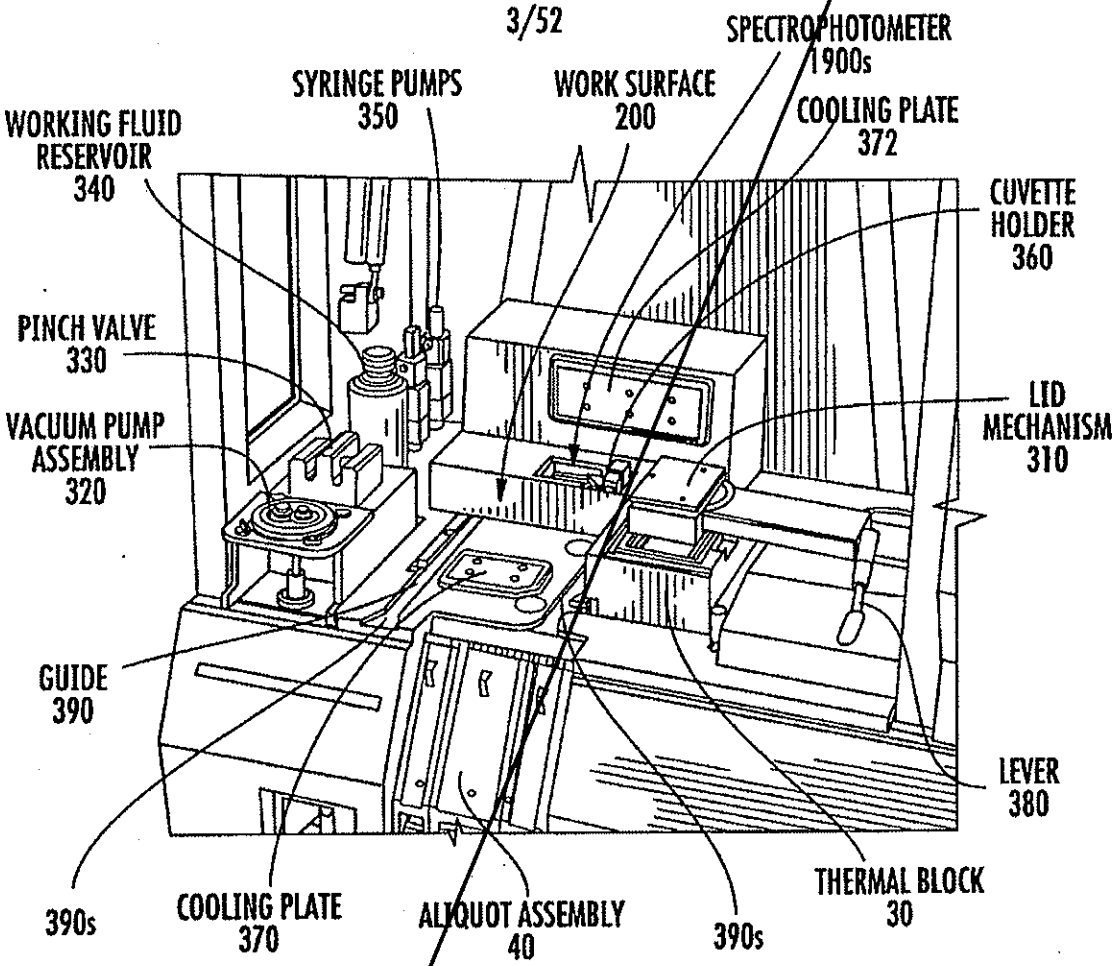

SPECTROPHOTOMETER
1900s
SYRINGE PUMPS
350
WORK SURFACE
200
COOLING PLATE
372
WORKING FLUID
RESERVOIR
340
CUVETTE
HOLDER
360
PINCH VALVE
330
LID
MECHANISM
310
VACUUM PUMP
ASSEMBLY
320
GUIDE
390
LEVER
380
390s
COOLING PLATE
370
ALIQUOT ASSEMBLY
40
390s
THERMAL BLOCK
30

FIG. 3

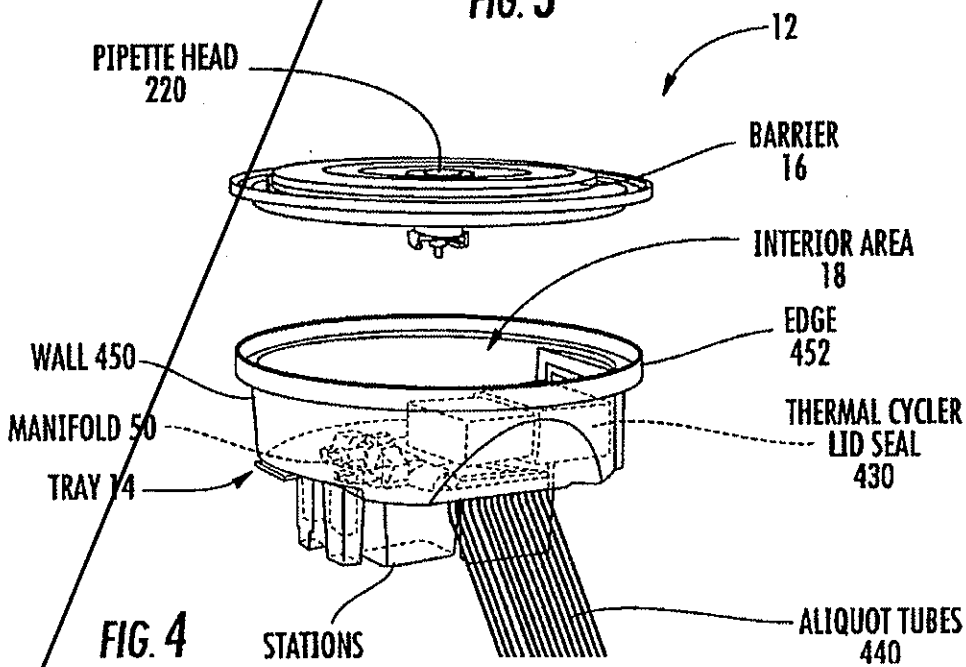

12
PIPETTE HEAD
220
BARRIER
16
INTERIOR AREA
18
EDGE
452
WALL 450
MANIFOLD 50
THERMAL CYCLER
LID SEAL
430
TRAY 14
STATIONS
ALIQUOT TUBES
440

FIG. 4

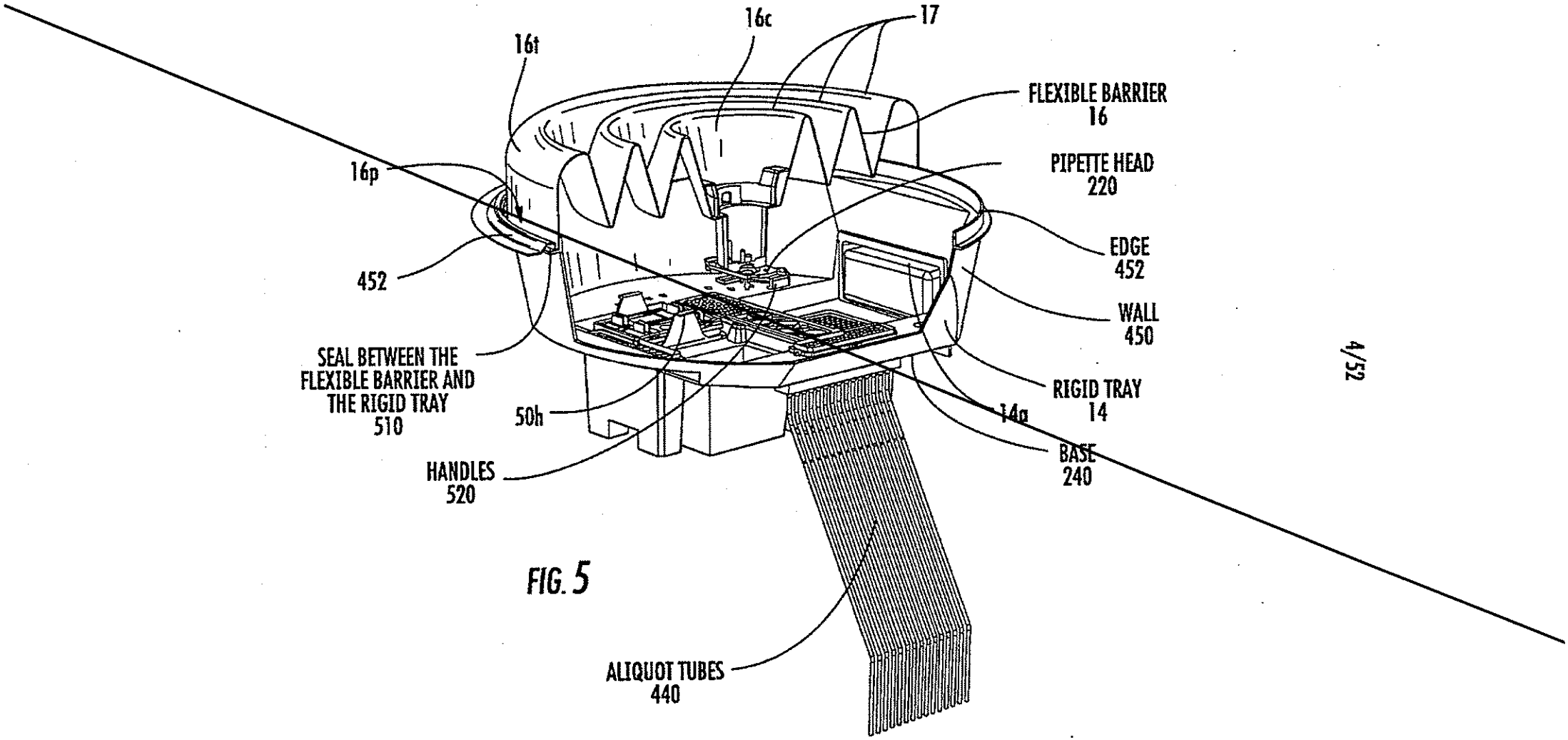

16t
16c
17
FLEXIBLE BARRIER
16
16p
PIPETTE HEAD
220
452
EDGE
452
WALL
450
SEAL BETWEEN THE
FLEXIBLE BARRIER AND
THE RIGID TRAY
510
50h
RIGID TRAY
14
14a
HANDLES
520
BASE
240
ALIQUOT TUBES
440

FIG. 5

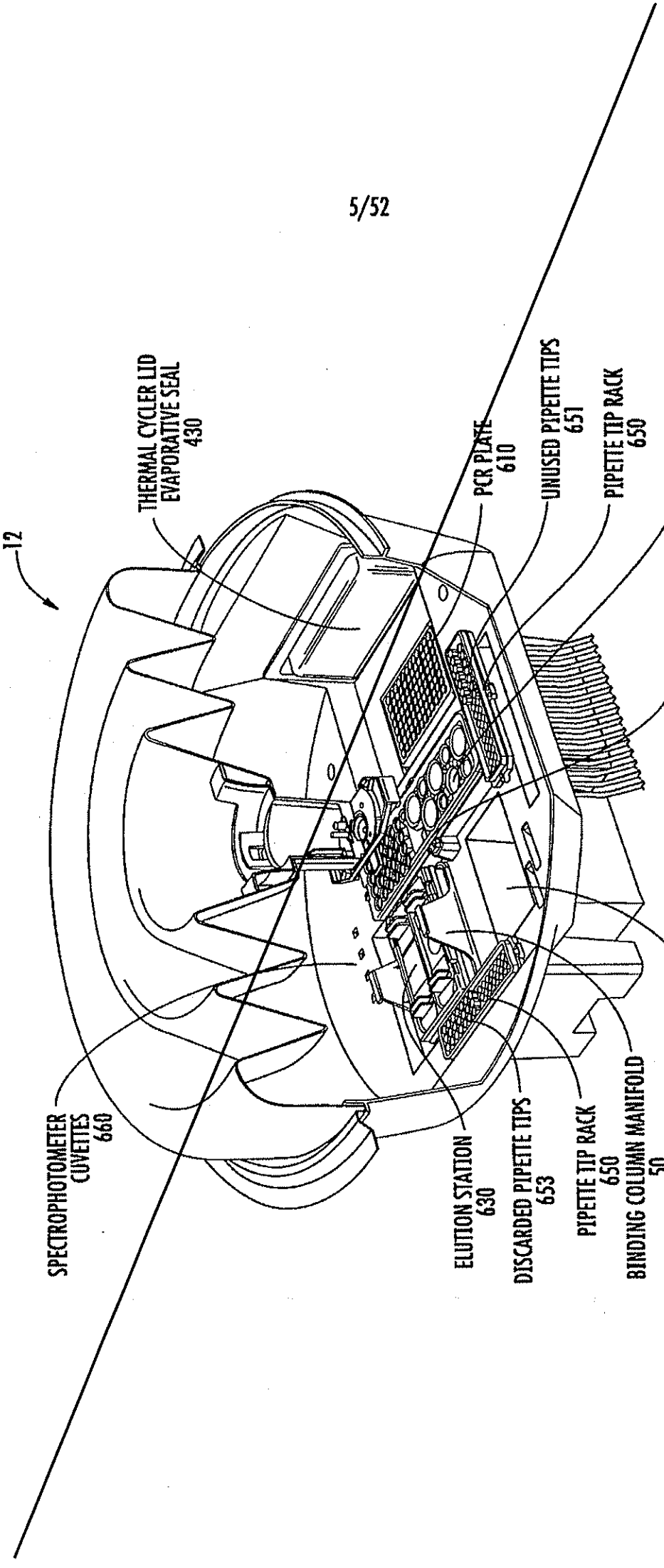

12
THERMAL CYCLER LID EVAPORATIVE SEAL 430
PCR PLATE 610
UNUSED PIPETTE TIPS 651
PIPETTE TIP RACK 650
REAGENT VESSELS 622
REAGENT TRAY 620
SPECTROPHOTOMETER CUVETTES 660
ELUTION STATION 630
DISCARDED PIPETTE TIPS 653
PIPETTE TIP RACK 650
BINDING COLUMN MANIFOLD 50
WASTE STATION 632

FIG. 6

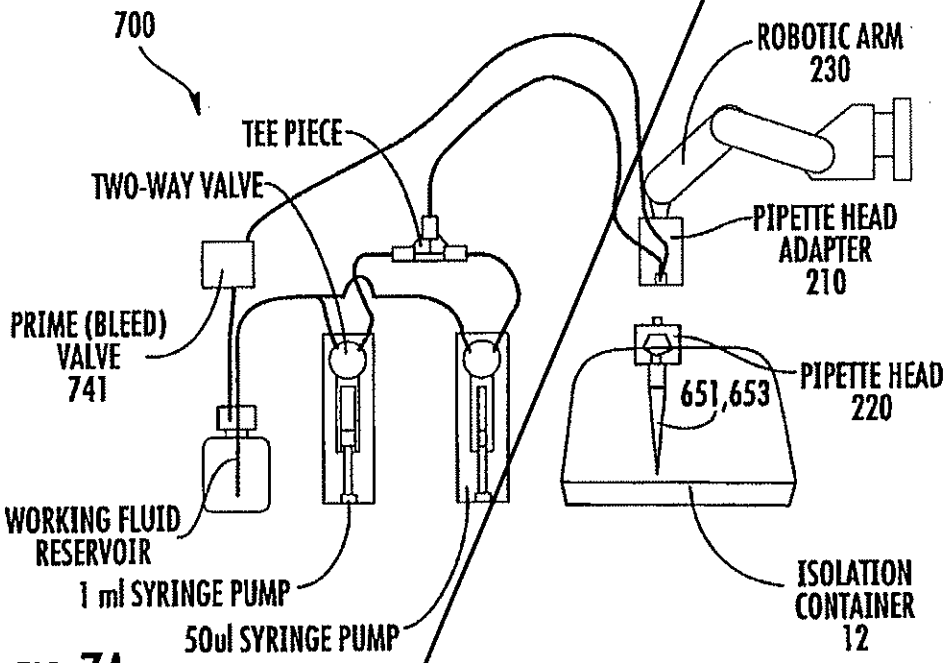

700
ROBOTIC ARM
230
TEE PIECE
TWO-WAY VALVE
PIPETTE HEAD
ADAPTER
210
PRIME (BLEED)
VALVE
741
651,653
PIPETTE HEAD
220
WORKING FLUID
RESERVOIR
1 ml SYRINGE PUMP
50ul SYRINGE PUMP
ISOLATION
CONTAINER
12

FIG. 7A

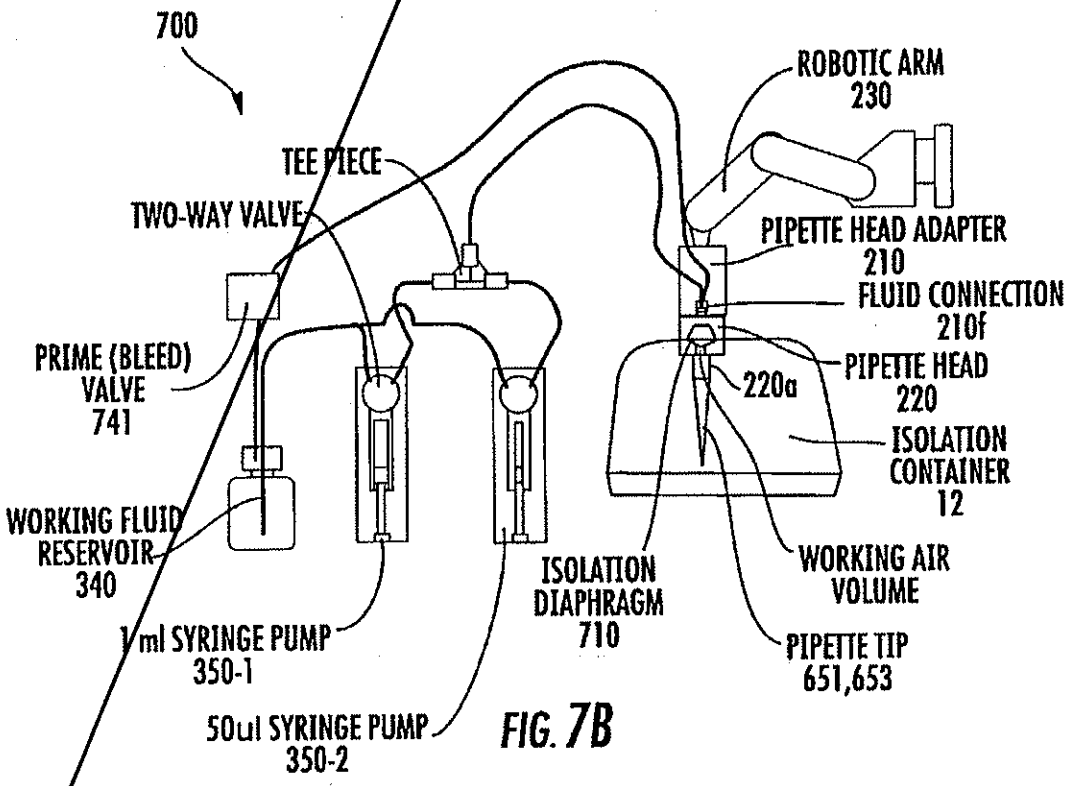

700
ROBOTIC ARM
230
TEE PIECE
TWO-WAY VALVE
PIPETTE HEAD ADAPTER
210
FLUID CONNECTION
210f
PRIME (BLEED)
VALVE
741
220a
PIPETTE HEAD
220
ISOLATION
CONTAINER
12
WORKING FLUID
RESERVOIR
340
ISOLATION
DIAPHRAGM
710
WORKING AIR
VOLUME
1 ml SYRINGE PUMP
350-1
PIPETTE TIP
651,653
50ul SYRINGE PUMP
350-2

FIG. 7B

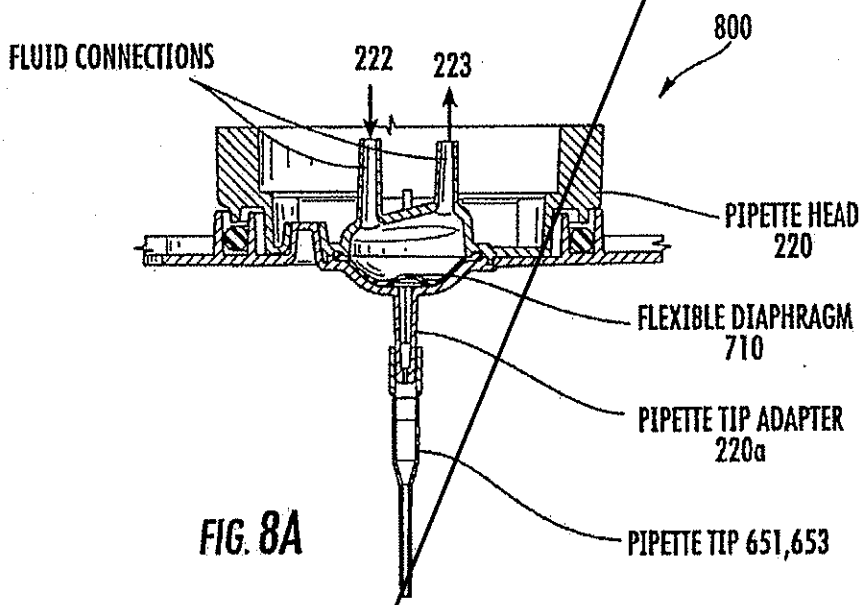

FLUID CONNECTIONS
222
223
800
PIPETTE HEAD
220
FLEXIBLE DIAPHRAGM
710
PIPETTE TIP ADAPTER
220a
PIPETTE TIP 651,653

FIG. 8A

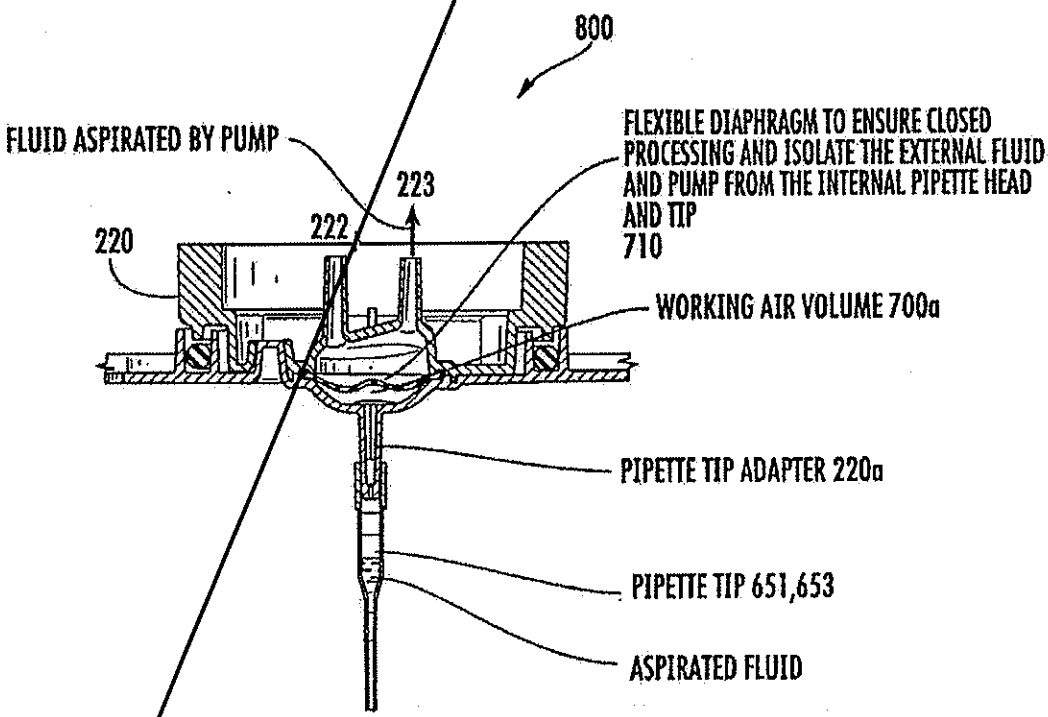

800
FLUID ASPIRATED BY PUMP
223
222
220
FLEXIBLE DIAPHRAGM TO ENSURE CLOSED PROCESSING AND ISOLATE THE EXTERNAL FLUID AND PUMP FROM THE INTERNAL PIPETTE HEAD AND TIP
710
WORKING AIR VOLUME 700a
PIPETTE TIP ADAPTER 220a
PIPETTE TIP 651,653
ASPIRATED FLUID

FIG. 8B

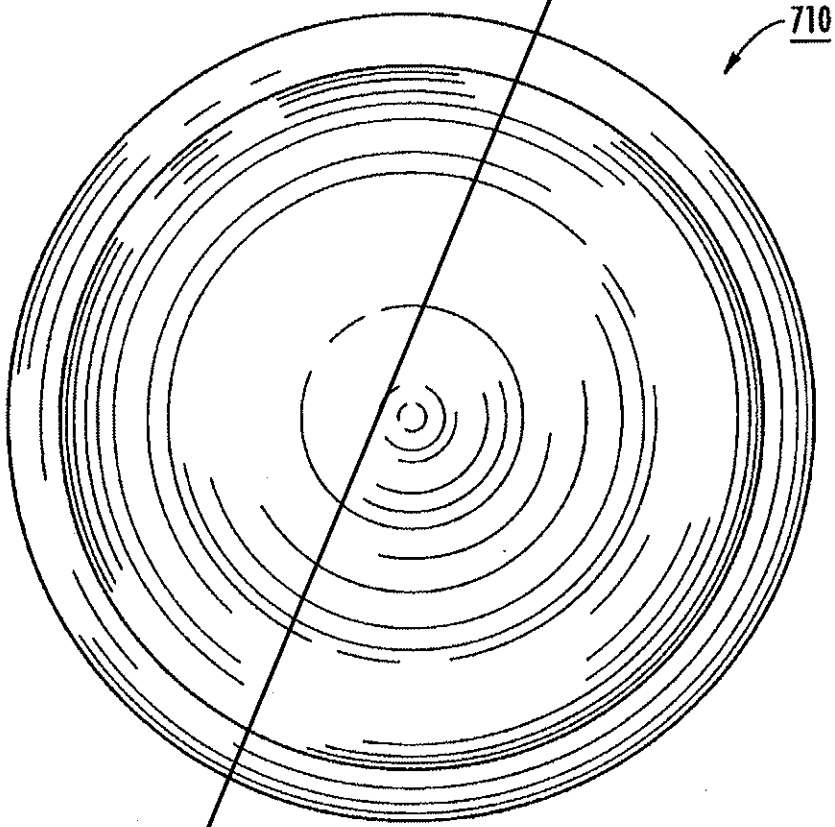


FIG. 8C

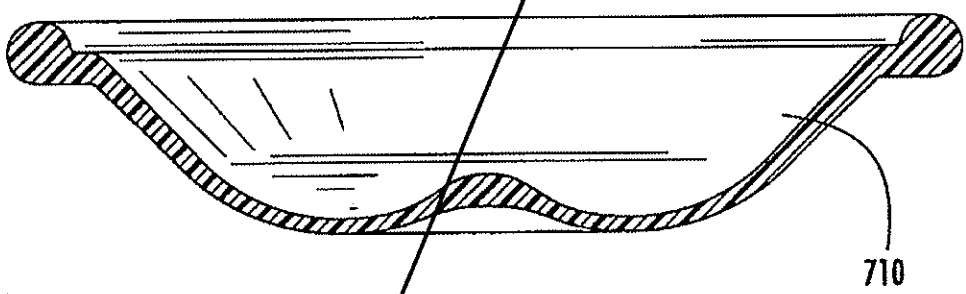


FIG. 8D

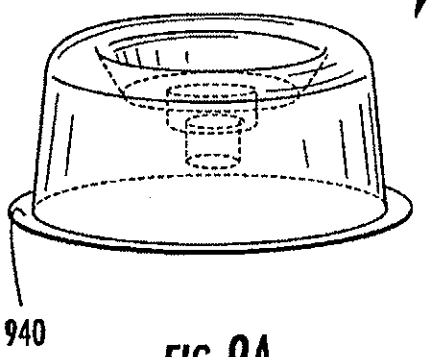


FIG. 9A

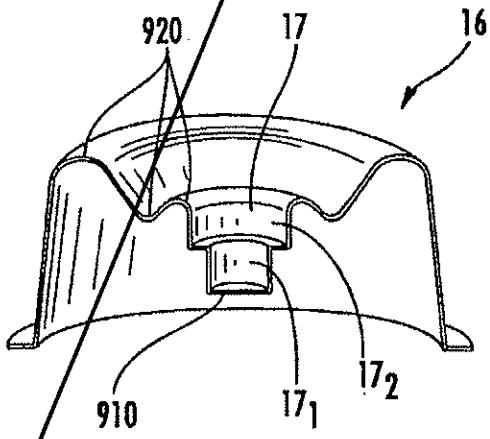


FIG. 9B

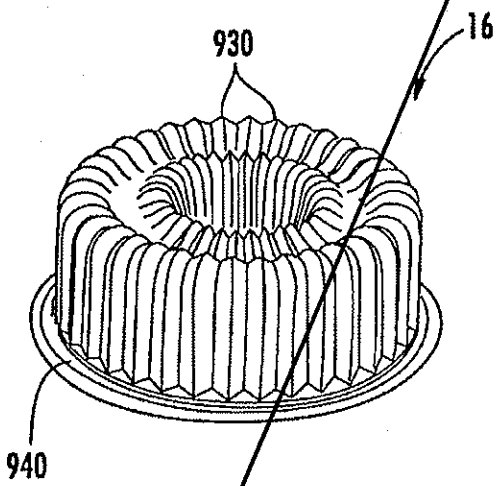


FIG. 9C

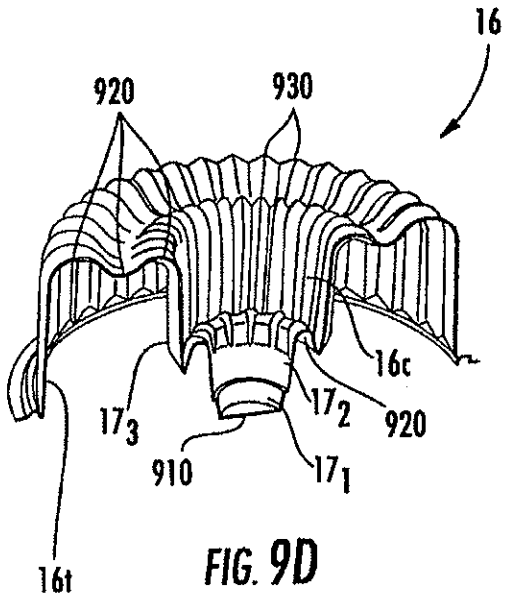


FIG. 9D

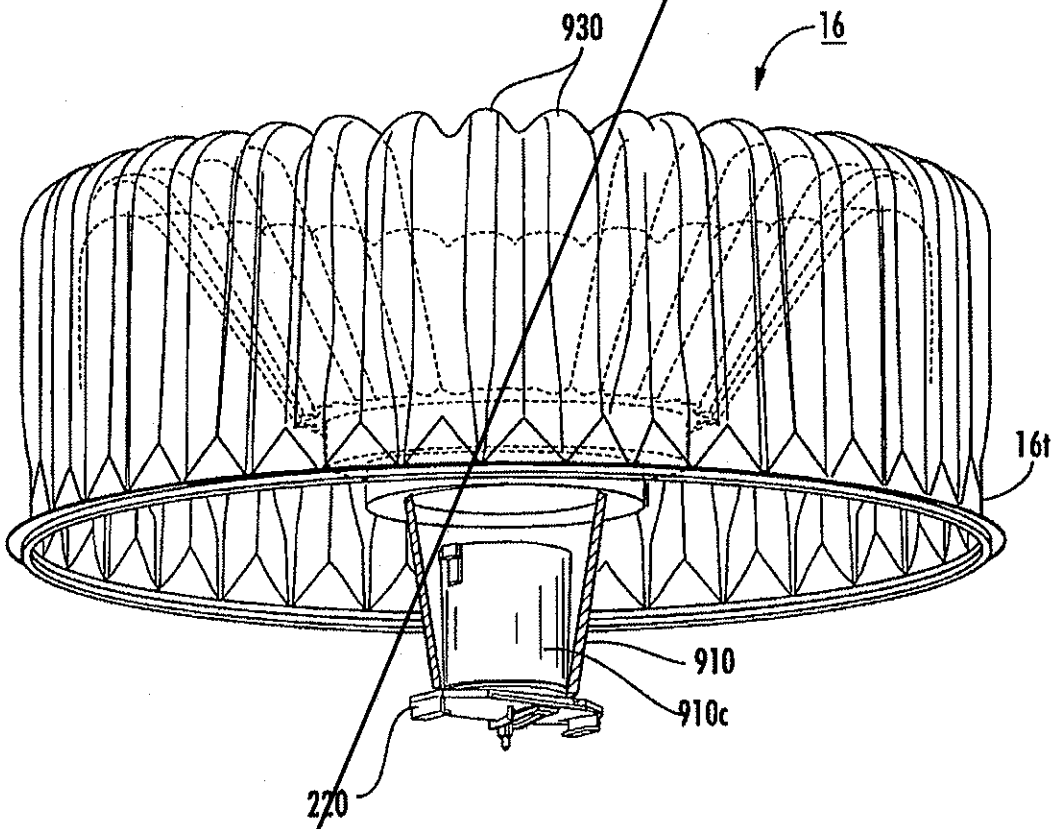


FIG. 9E

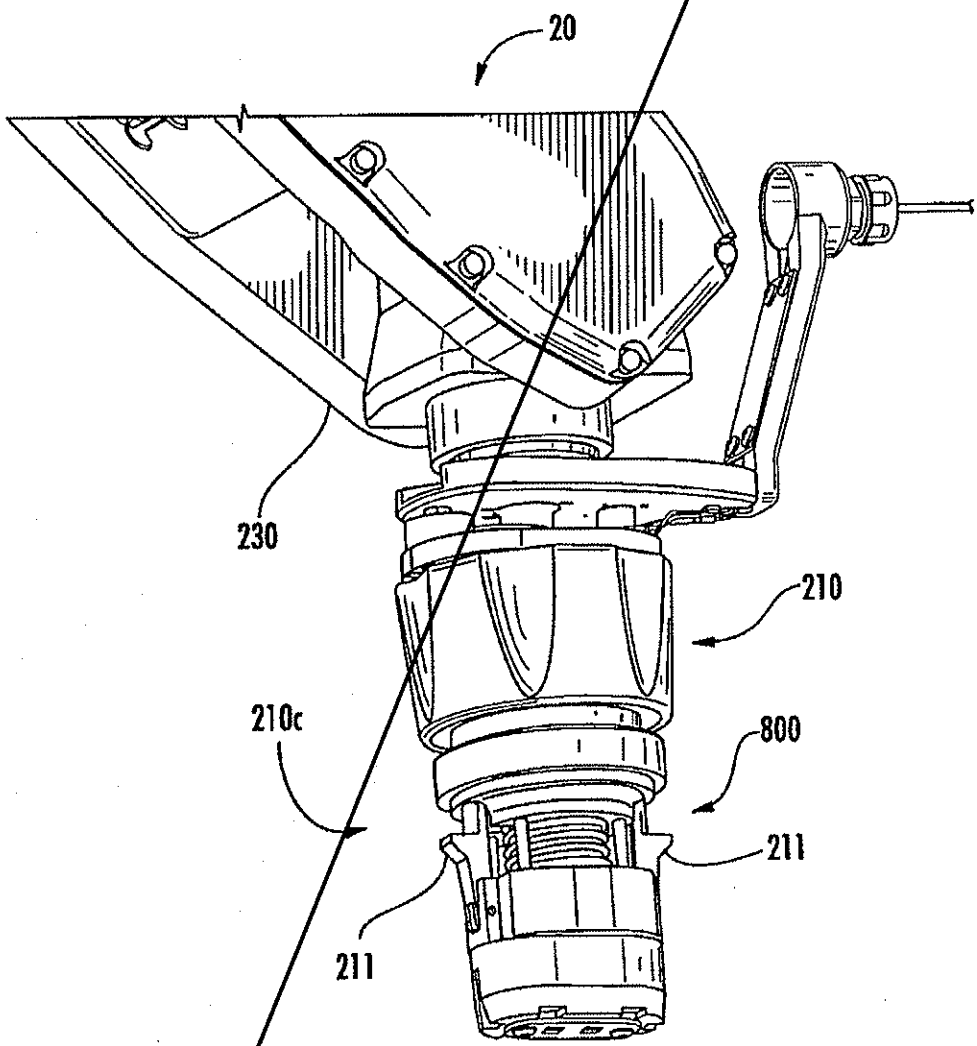


FIG. 9F

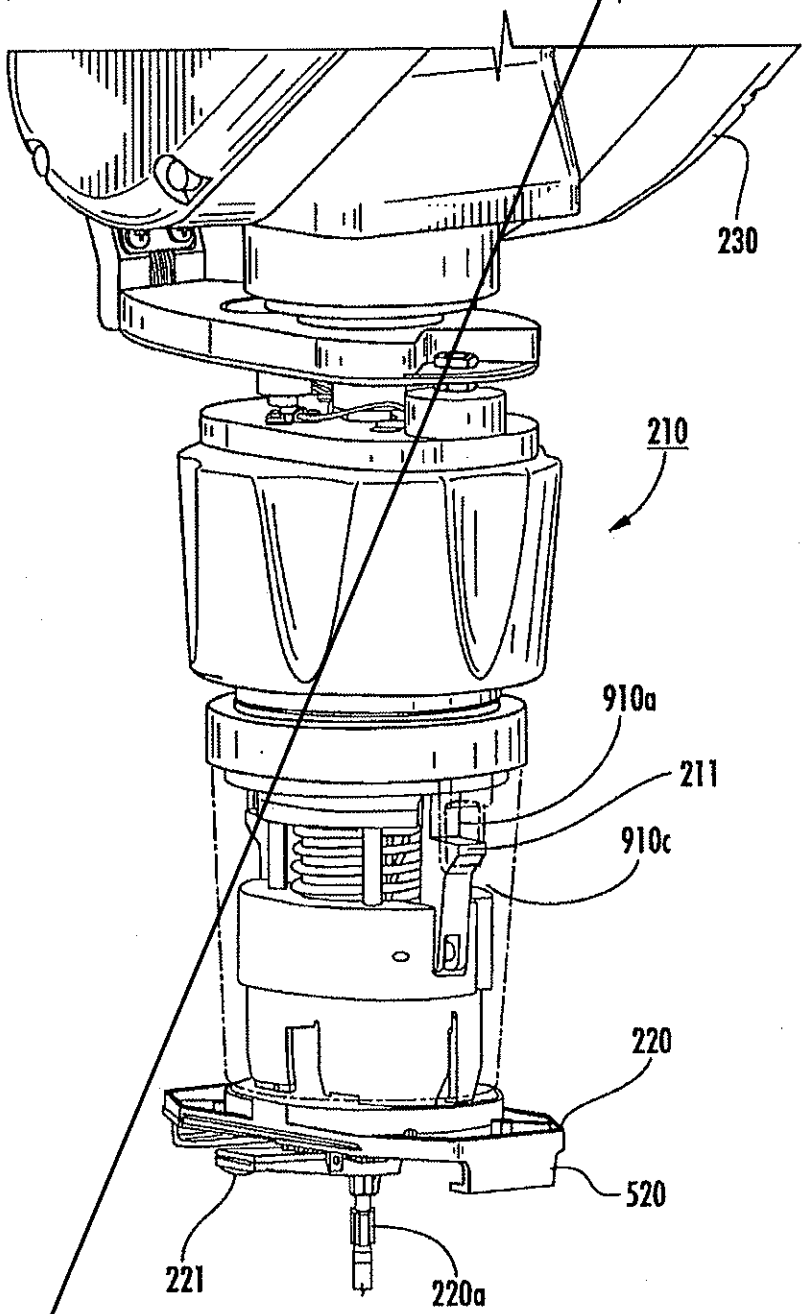


FIG. 9G

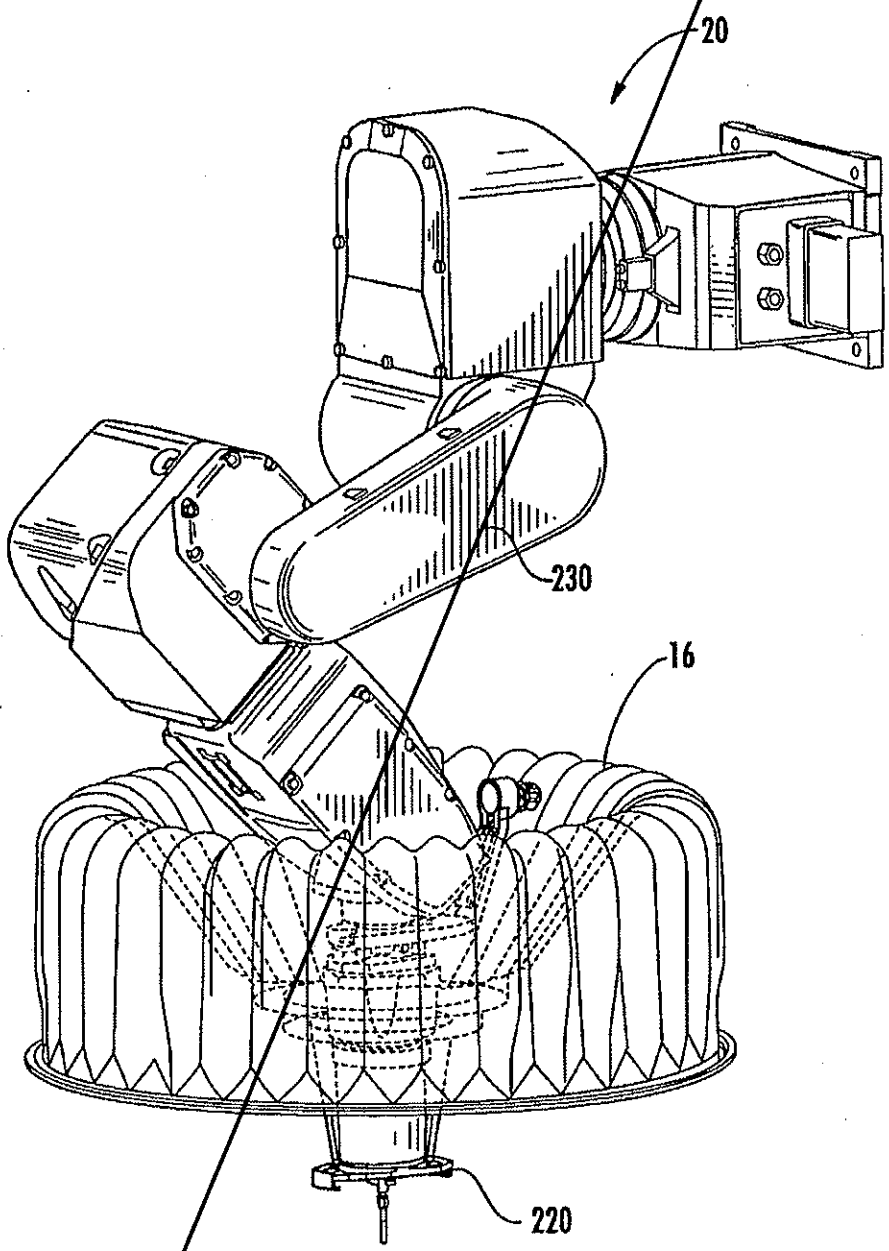


FIG. 9H

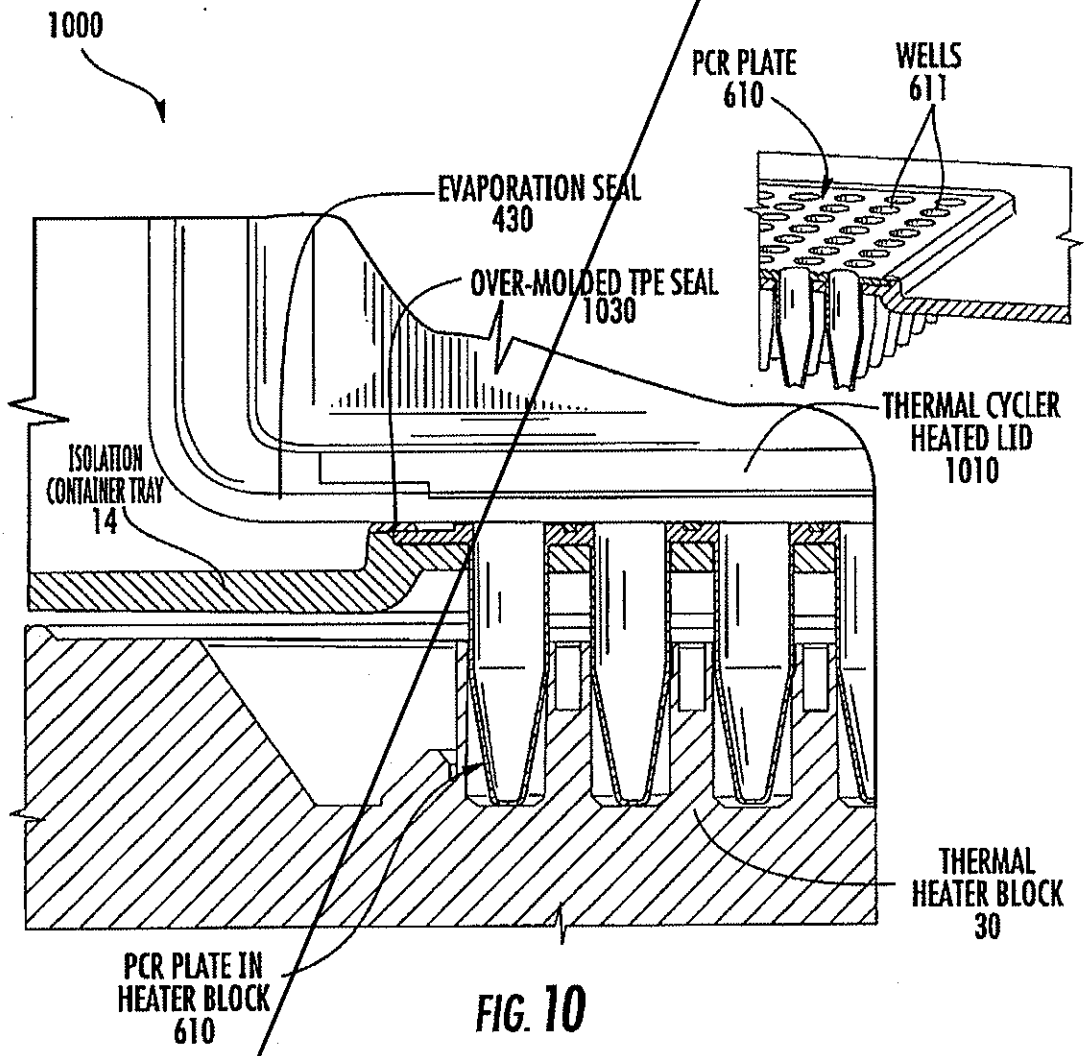

1000
PCR PLATE
610
WELLS
611
EVAPORATION SEAL
430
OVER-MOLDED TPE SEAL
1030
THERMAL CYCLER
HEATED LID
1010
ISOLATION
CONTAINER TRAY
14
THERMAL
HEATER BLOCK
30
PCR PLATE IN
HEATER BLOCK
610

FIG. 10

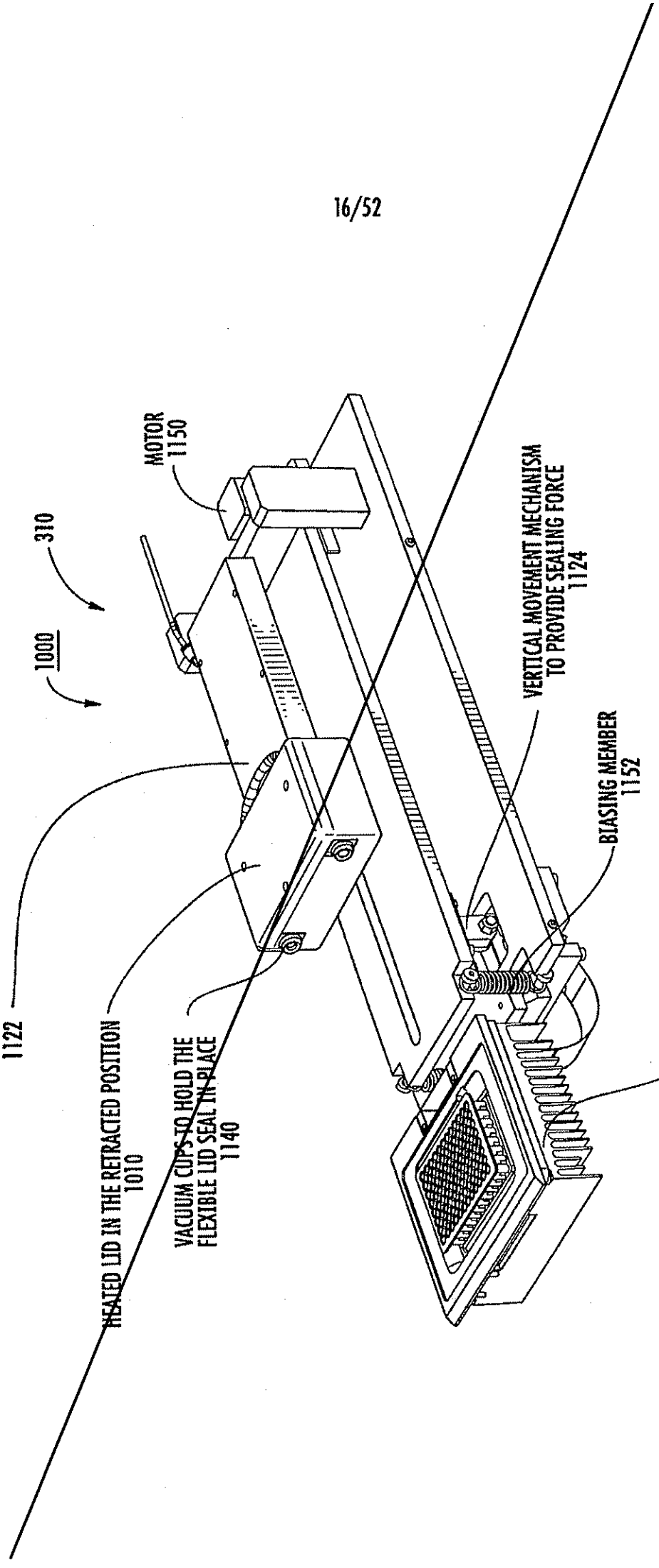

1000
310
MOTOR
1150
VERTICAL MOVEMENT MECHANISM
TO PROVIDE SEALING FORCE
1124
BIASING MEMBER
1152
THERMAL HEATER BLOCK
30
1122
HEATED LID IN THE RETRACTED POSITION
1010
VACUUM CUPS TO HOLD THE
FLEXIBLE LID SEAL IN PLACE
1140

FIG. 11

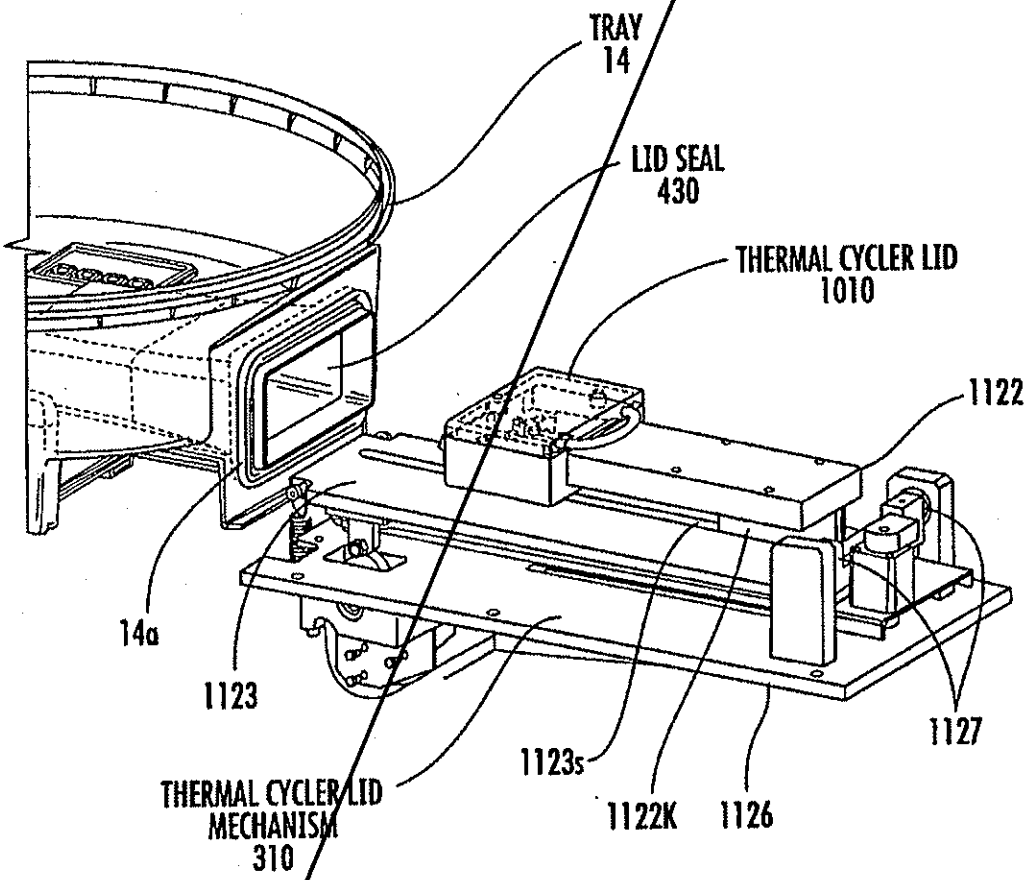

TRAY
14
LID SEAL
430
THERMAL CYCLER LID
1010
1122
14a
1123
1123s
1127
THERMAL CYCLER LID
MECHANISM
310
1122K
1126

FIG. 12

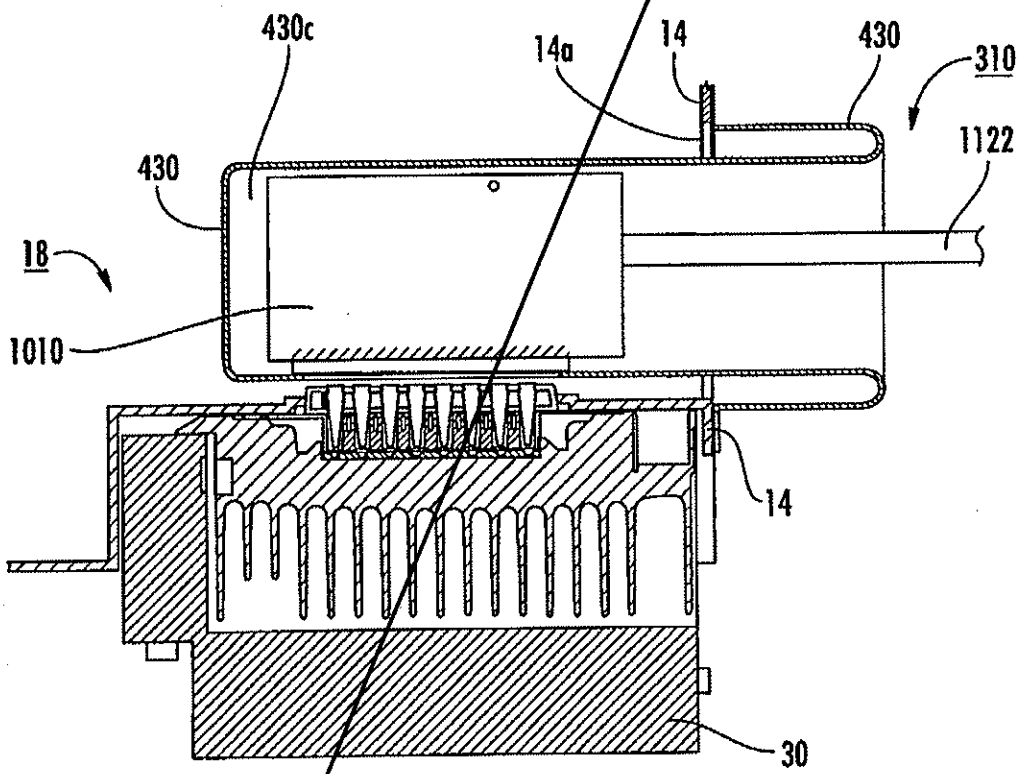


FIG. 13A

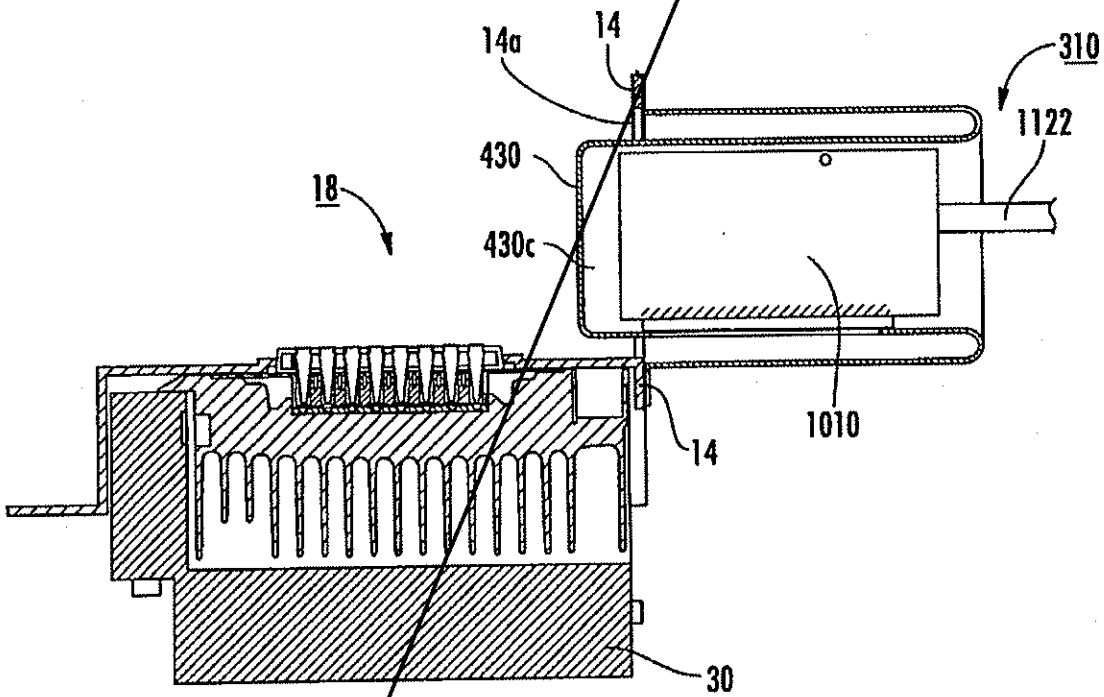


FIG. 13B

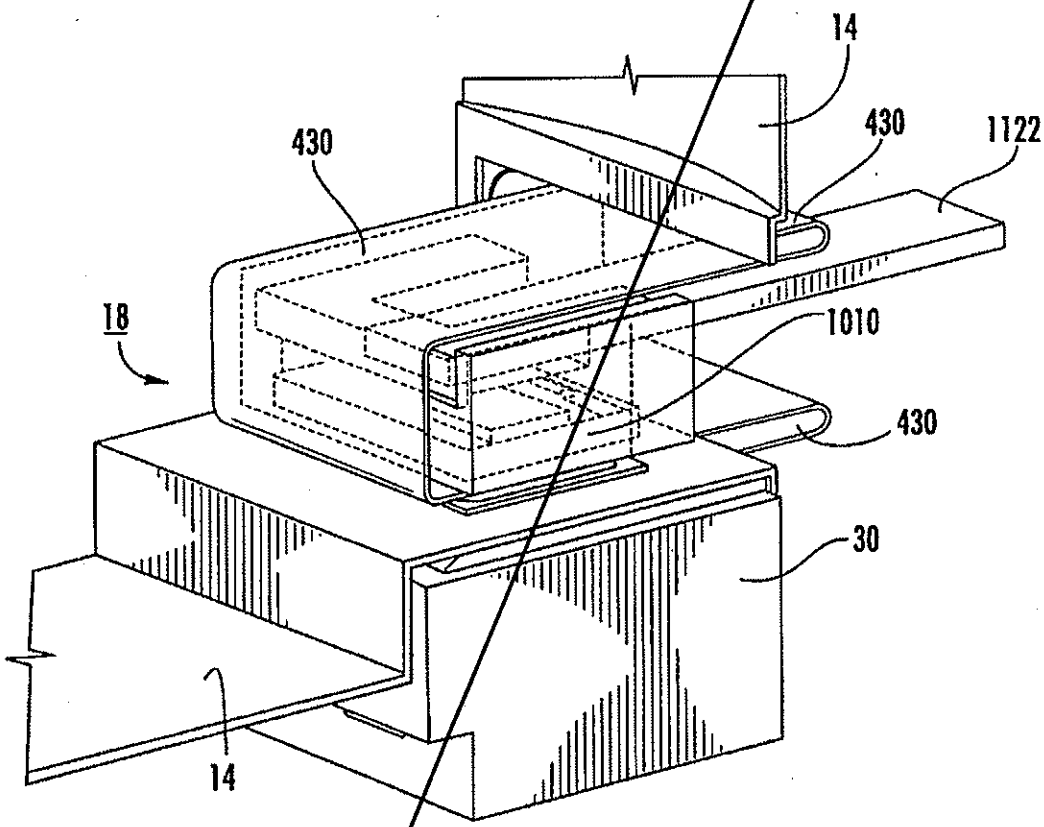


FIG. 13C

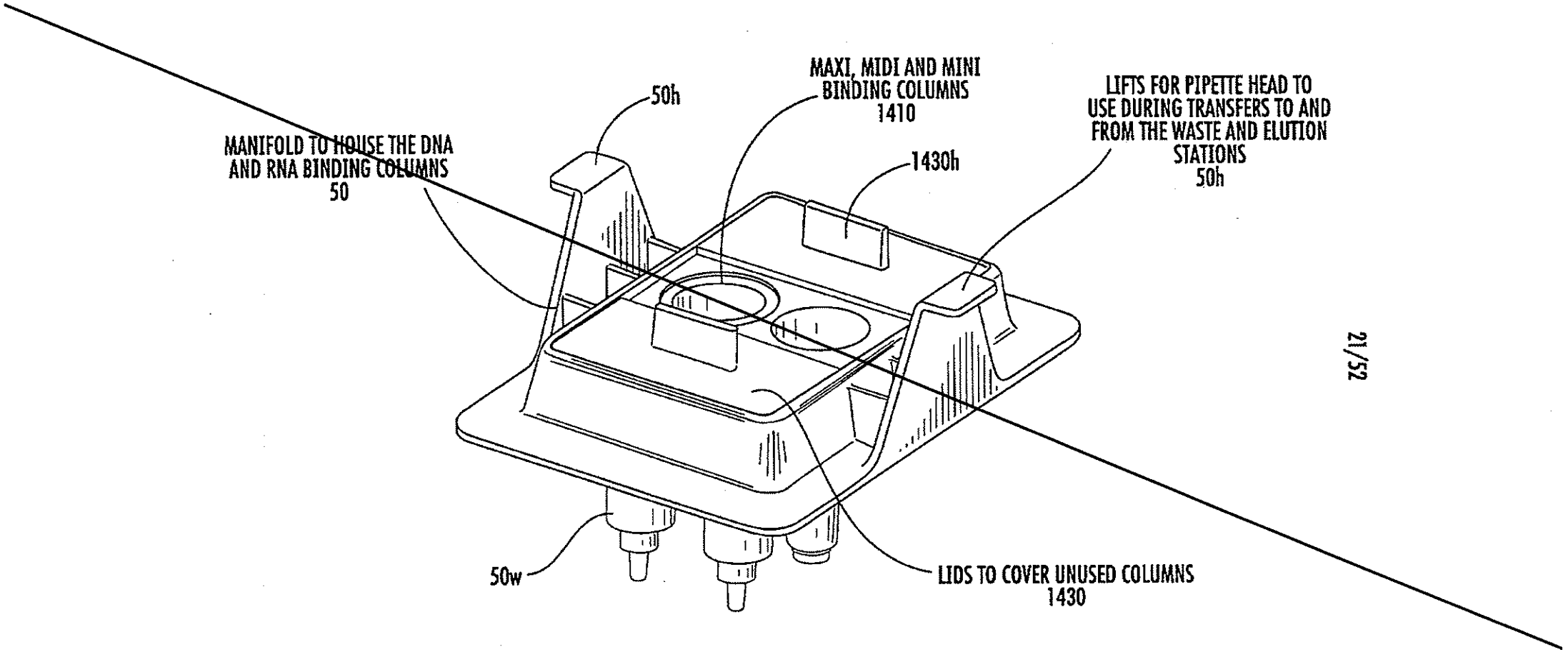

MANIFOLD TO HOUSE THE DNA AND RNA BINDING COLUMNS 50
50h
MAXI, MIDI AND MINI BINDING COLUMNS 1410
1430h
LIFTS FOR PIPETTE HEAD TO USE DURING TRANSFERS TO AND FROM THE WASTE AND ELUTION STATIONS 50h
50w
LIDS TO COVER UNUSED COLUMNS 1430

FIG. 14

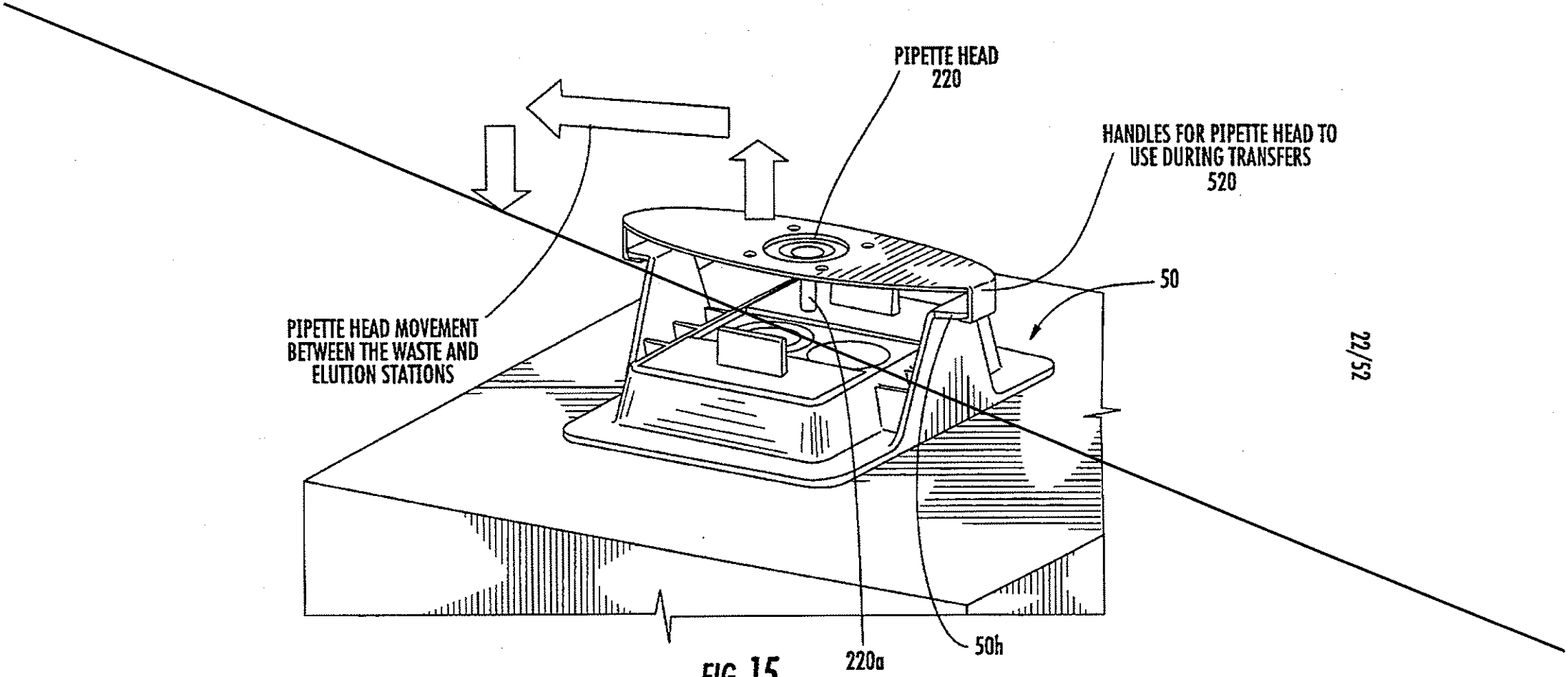

PIPETTE HEAD
220
HANDLES FOR PIPETTE HEAD TO
USE DURING TRANSFERS
520
50
PIPETTE HEAD MOVEMENT
BETWEEN THE WASTE AND
ELUTION STATIONS
220a
50h

FIG. 15

SEALED ISOLATION CONTAINER PRIOR TO PROCESSING

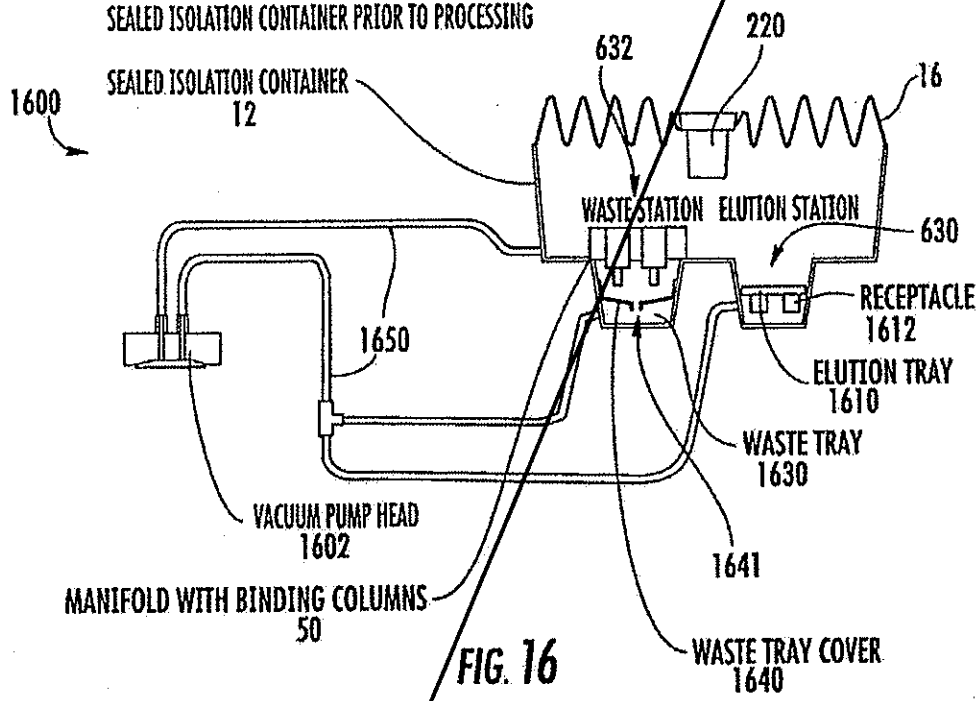


FIG. 16

SEALED ISOLATION CONTAINER CONNECTED FOR PROCESSING

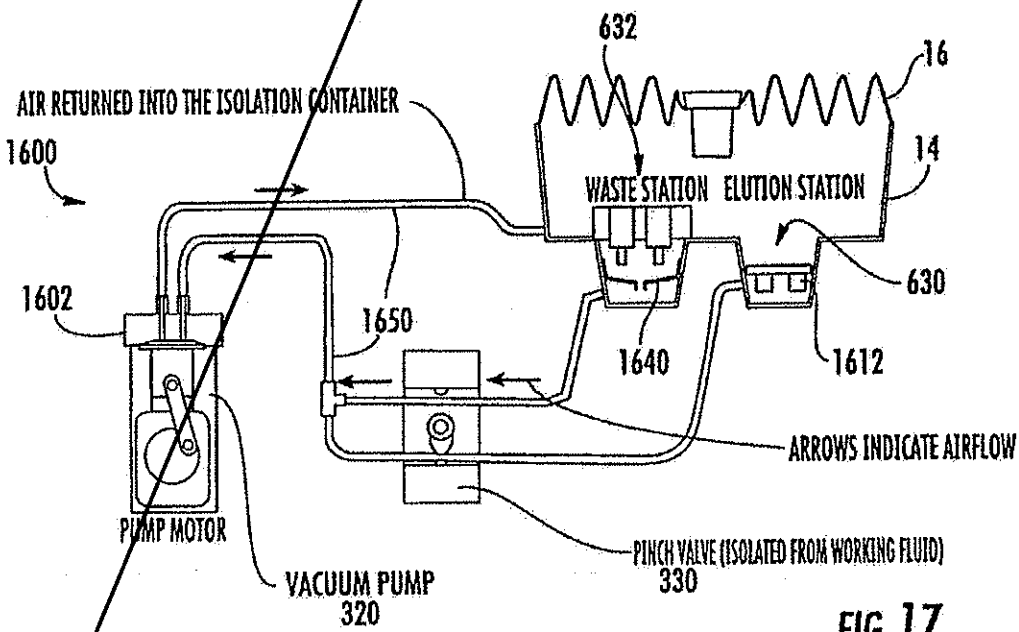


FIG. 17

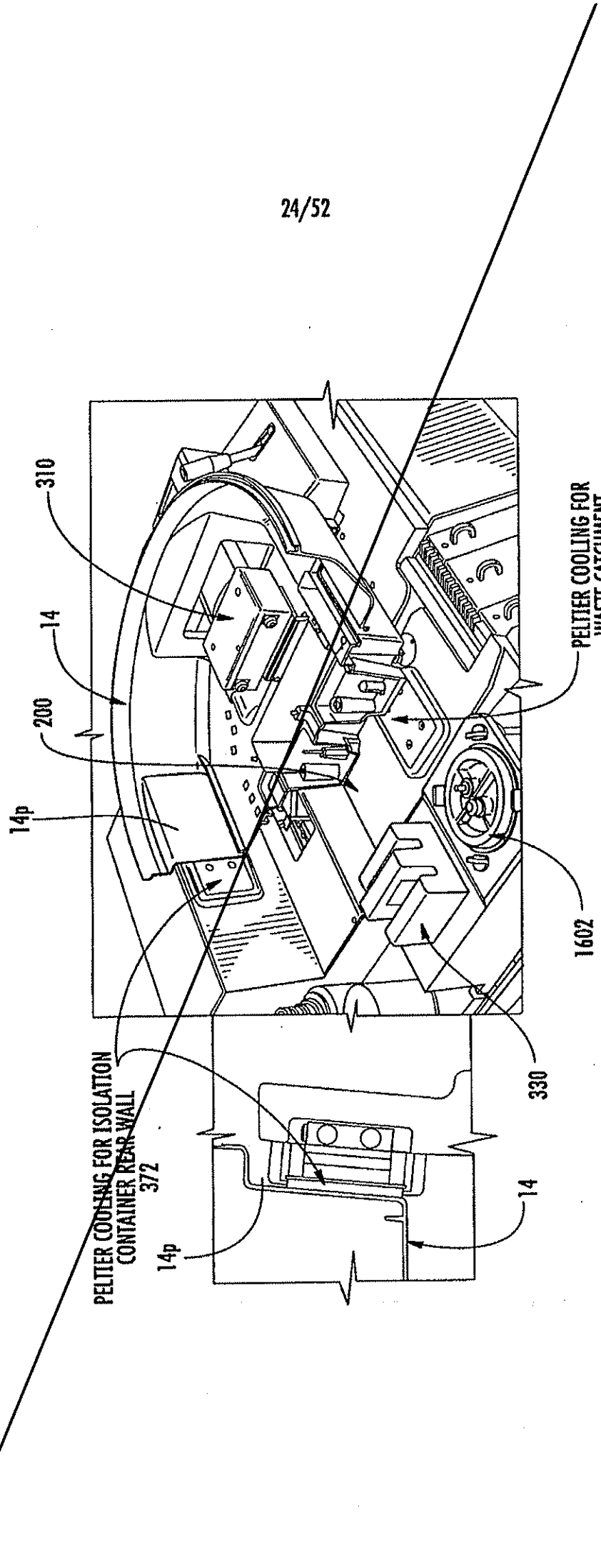

310
14
200
14p
PELTIER COOLING FOR WASTE CATCHMENT 370
1602
330
PELTIER COOLING FOR ISOLATION CONTAINER REAR WALL 372
14p
14

FIG. 18

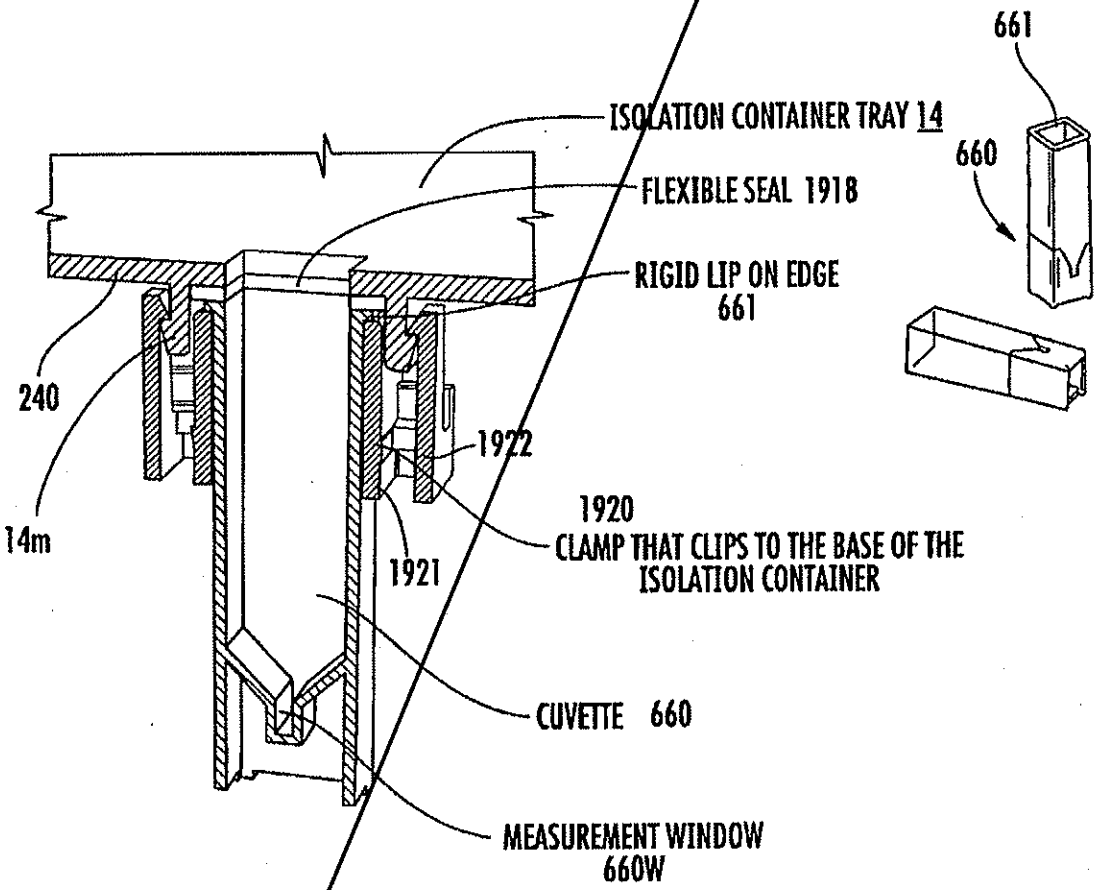

661
ISOLATION CONTAINER TRAY 14
660
FLEXIBLE SEAL 1918
RIGID LIP ON EDGE
661
240
1922
14m
1920
1921
CLAMP THAT CLIPS TO THE BASE OF THE
ISOLATION CONTAINER
CUVETTE 660
MEASUREMENT WINDOW
660W

FIG. 19A

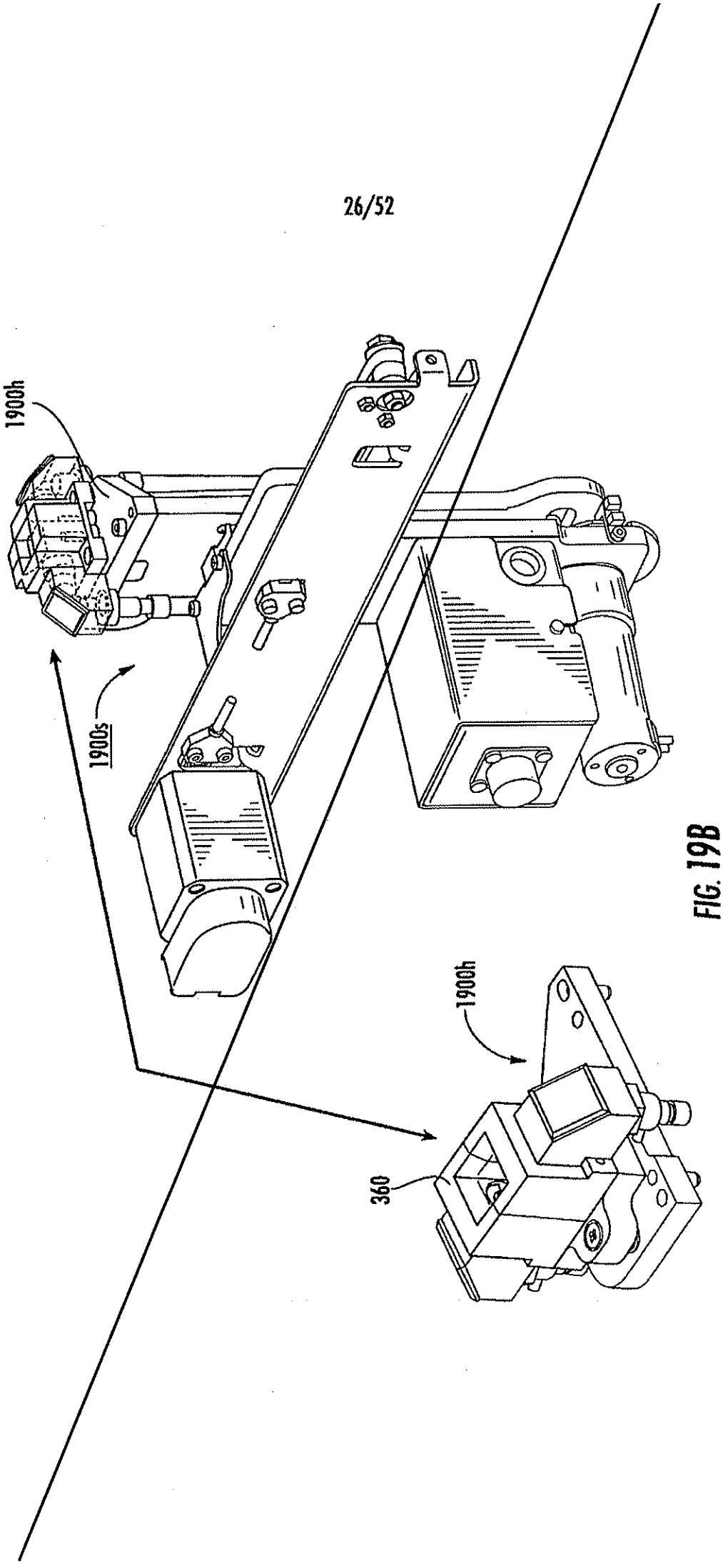


FIG. 19B

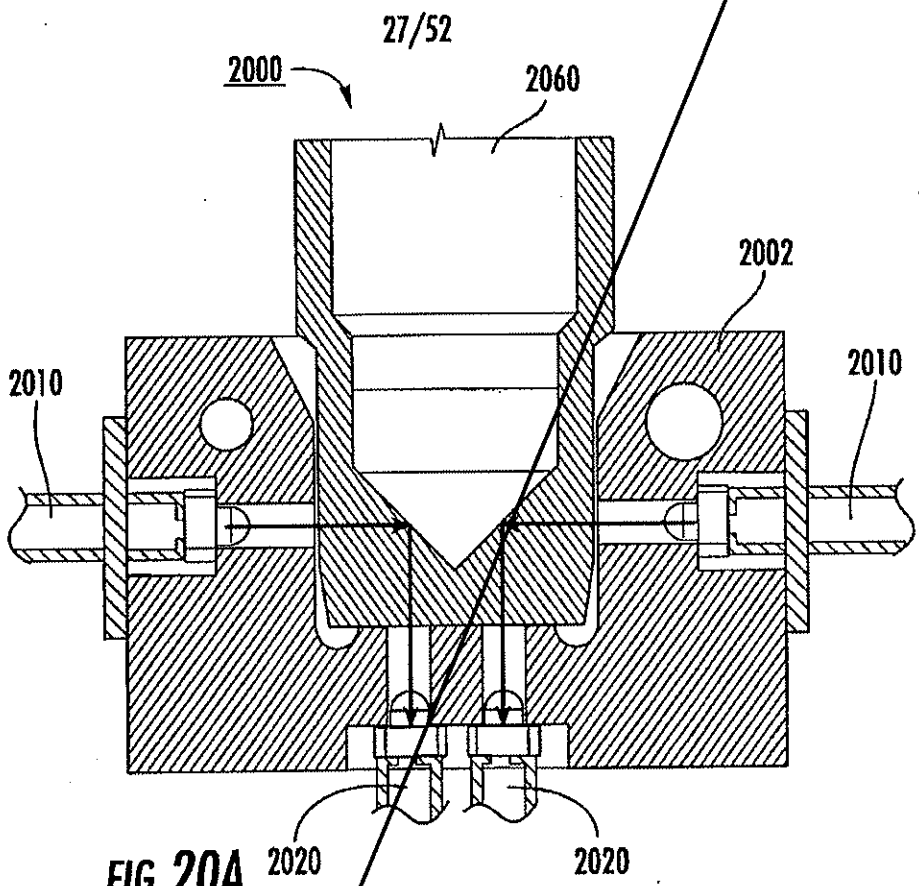


FIG. 20A

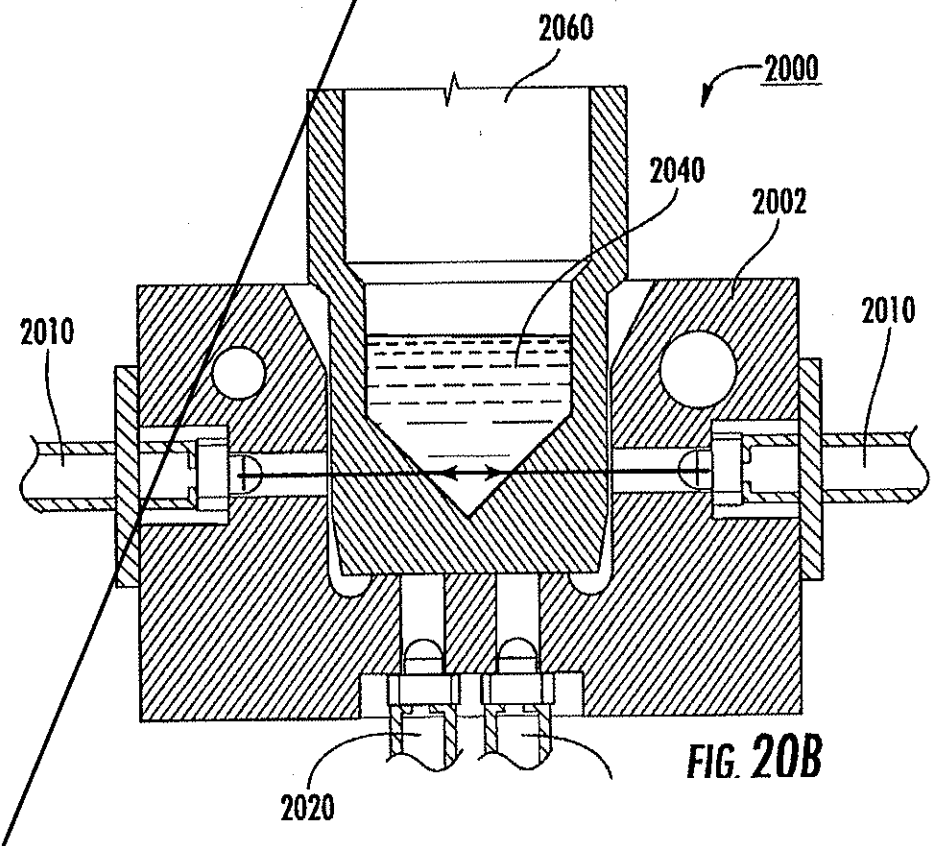


FIG. 20B

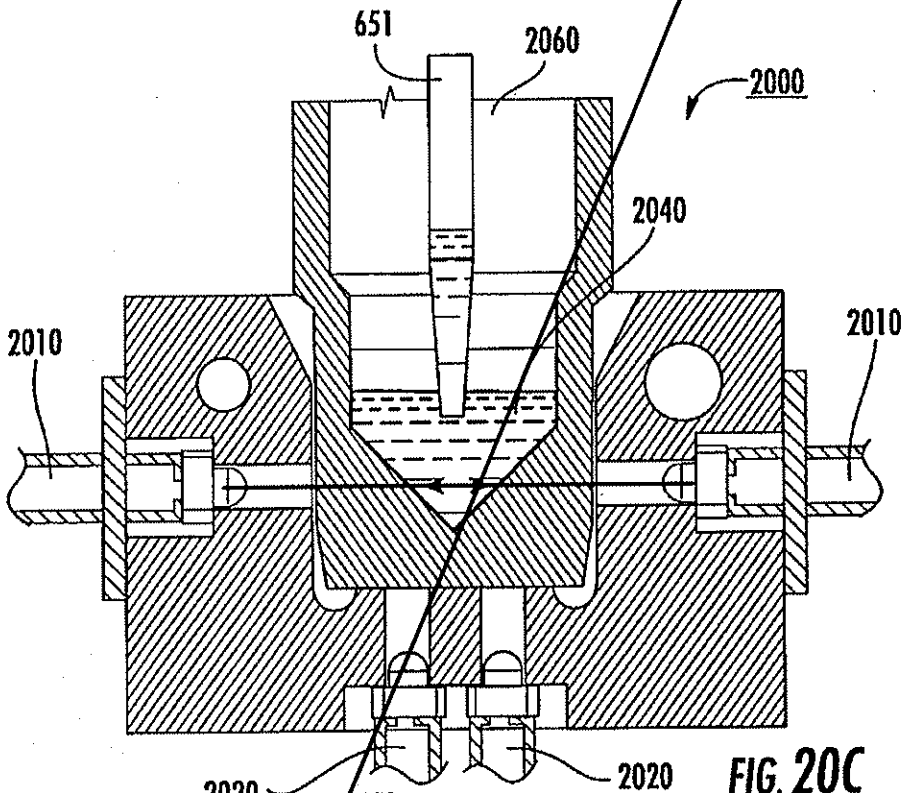


FIG. 20C

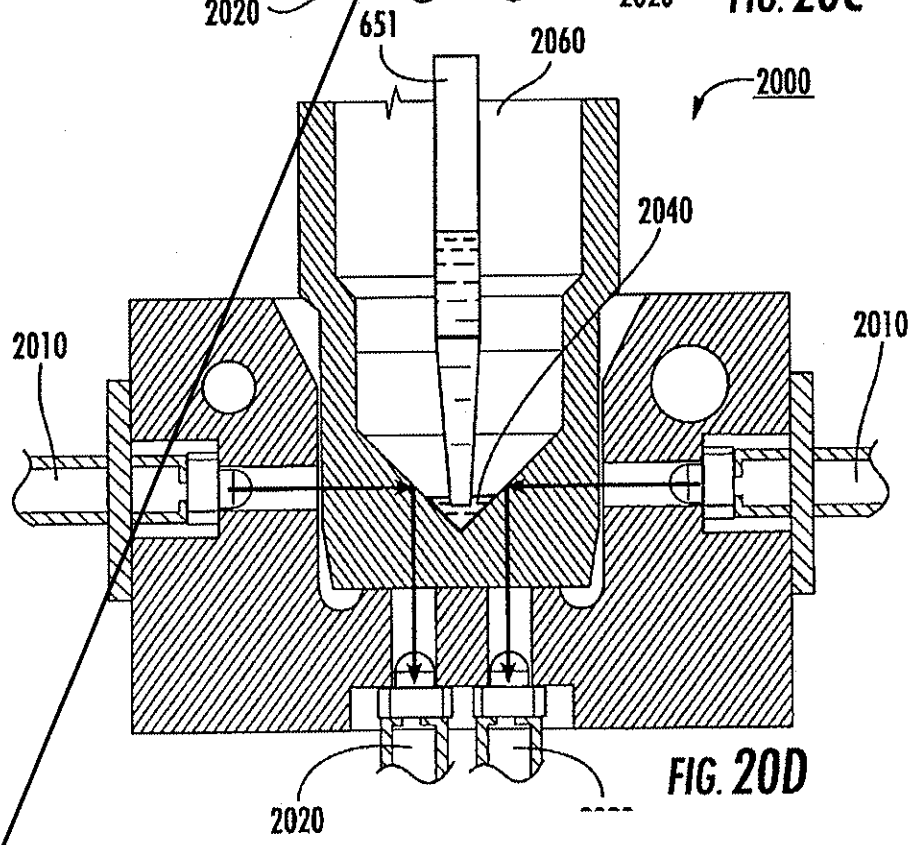


FIG. 20D

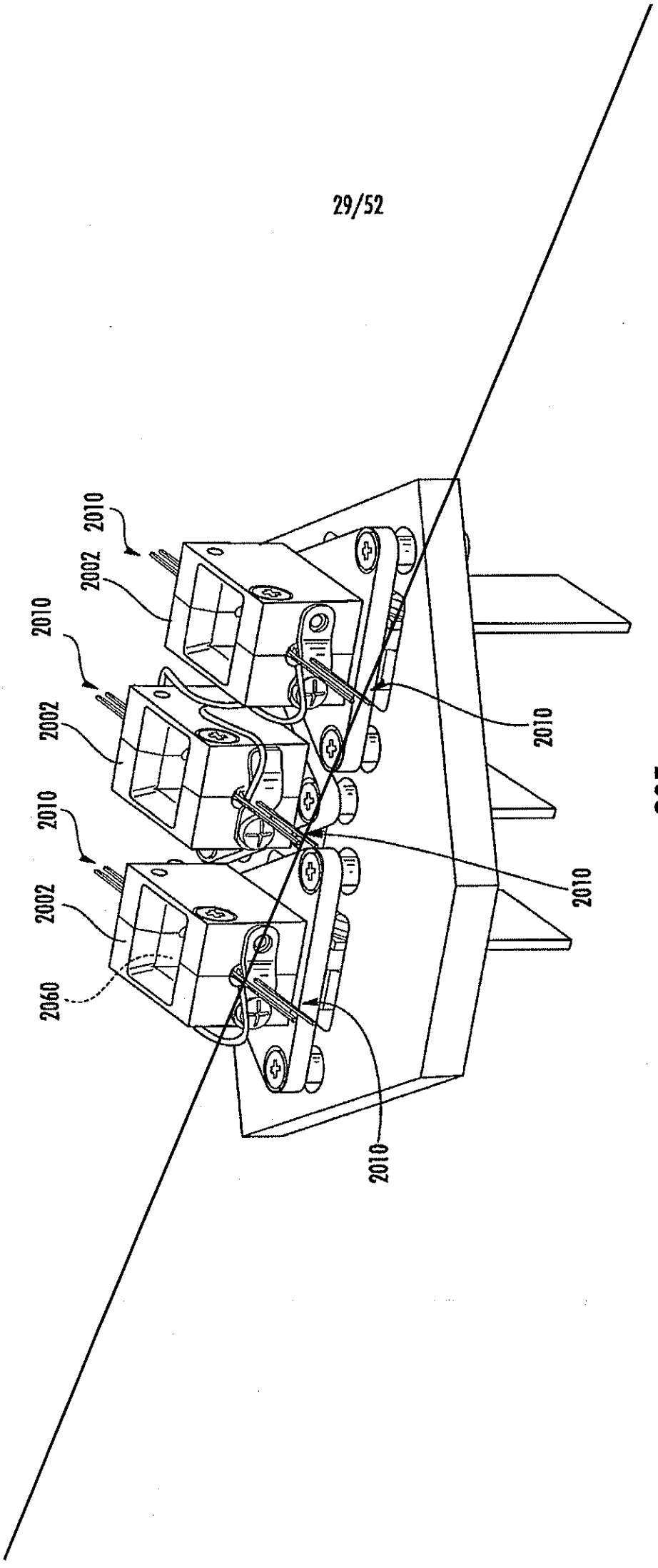


FIG. 20E

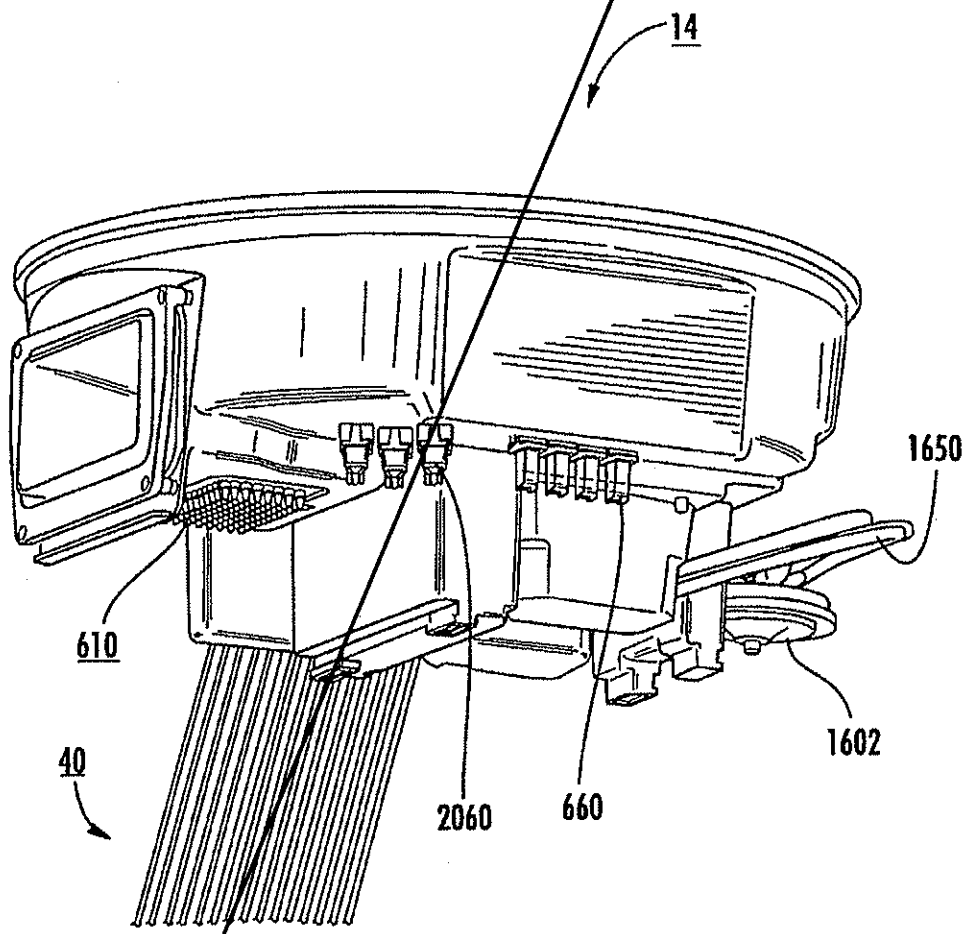


FIG. 20F

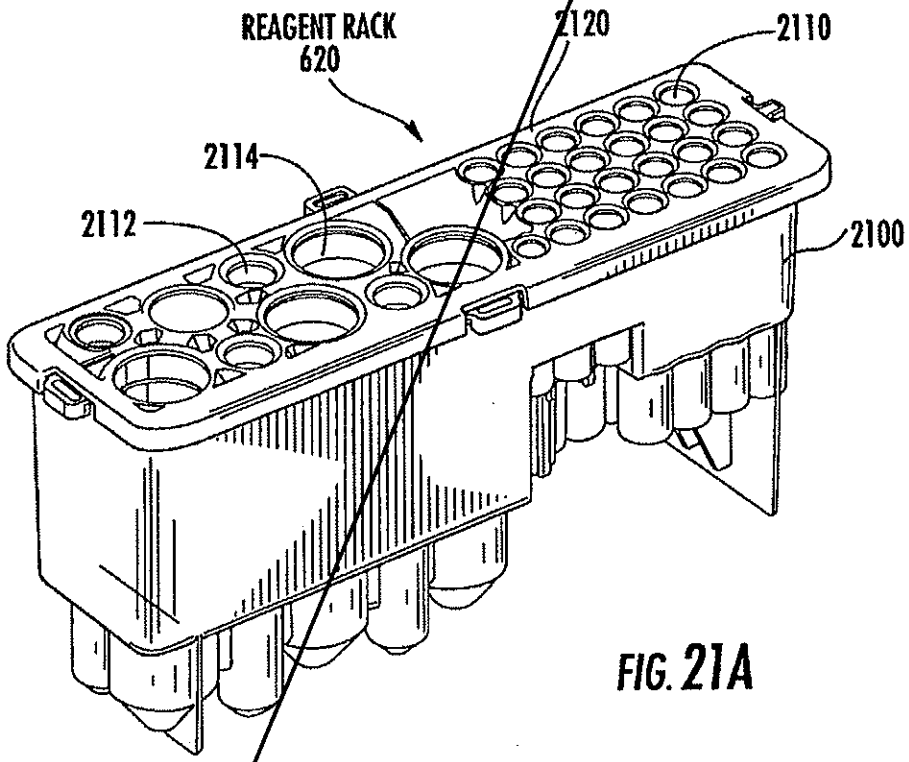


FIG. 21A

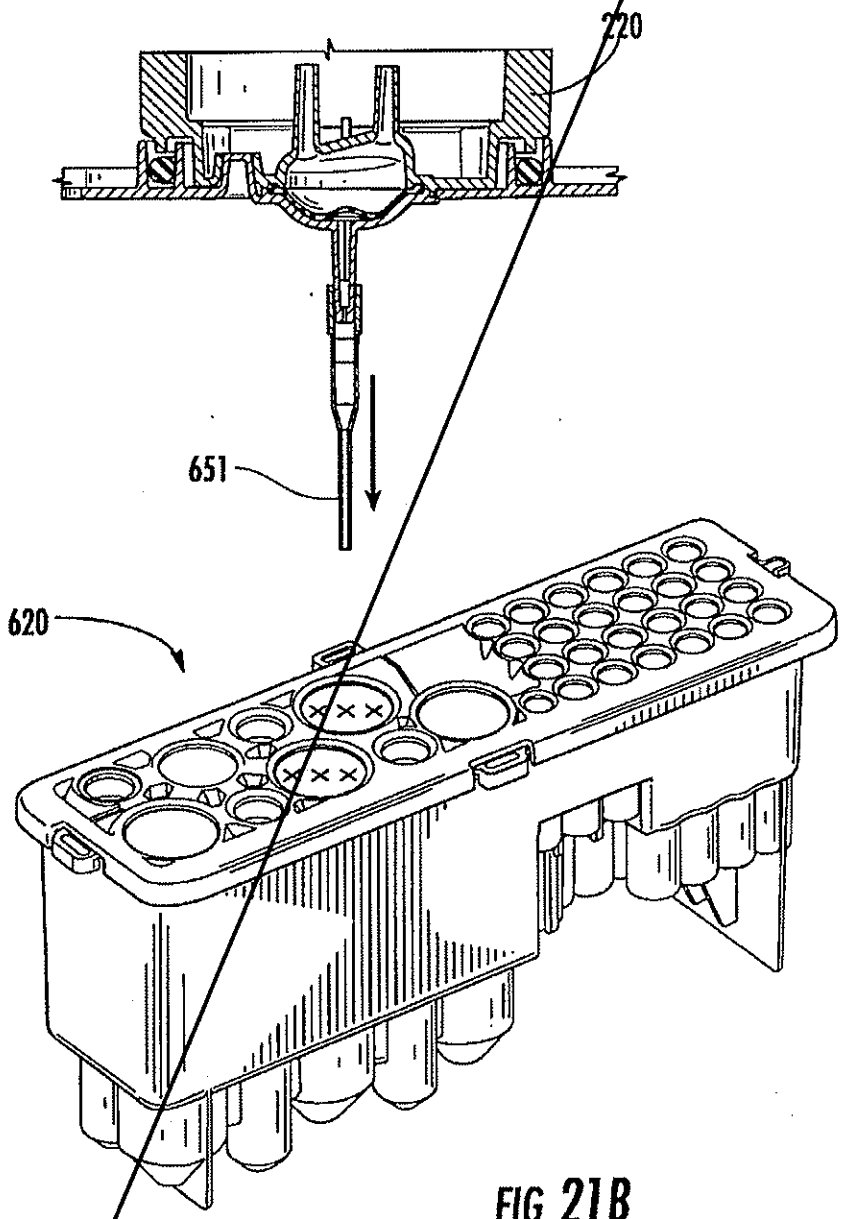


FIG. 21B

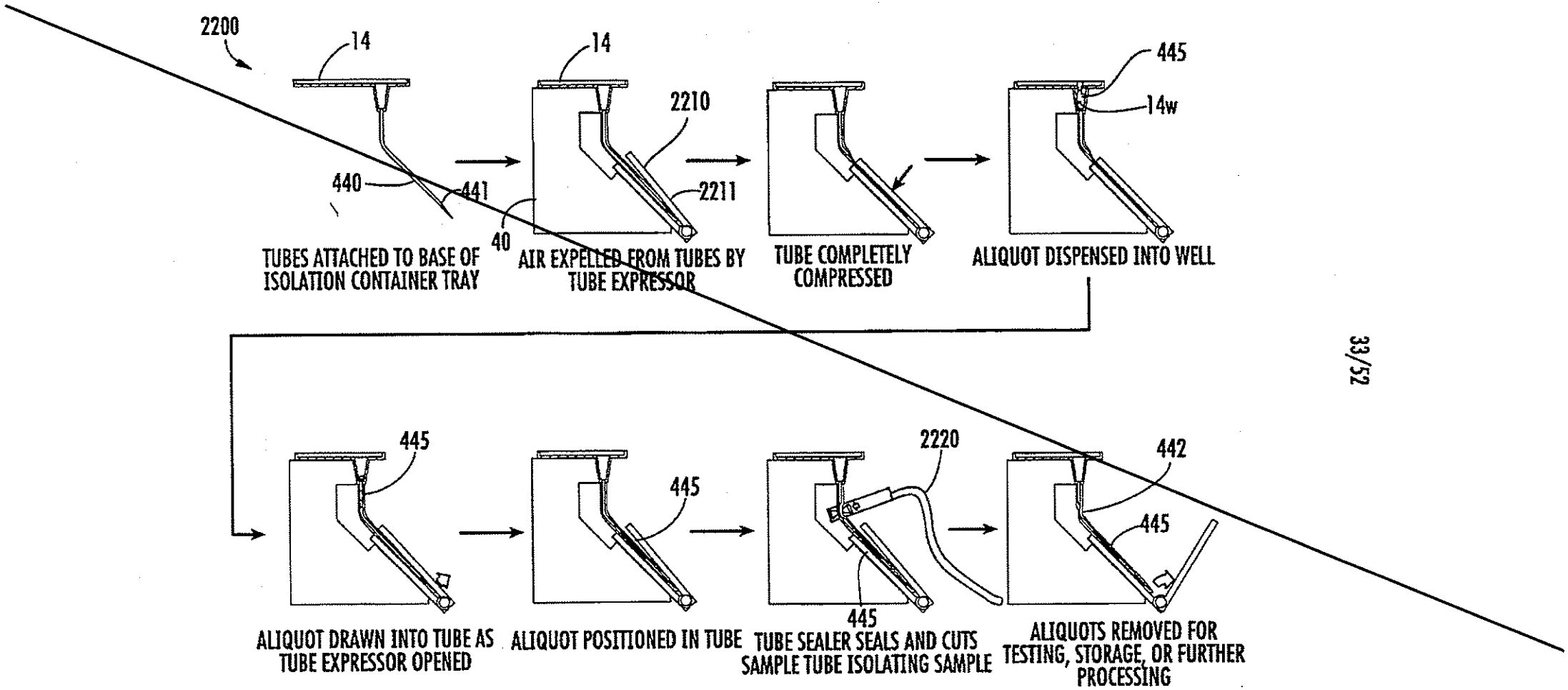

2200
14
440
441
40
TUBES ATTACHED TO BASE OF ISOLATION CONTAINER TRAY
14
2210
2211
AIR EXPELLED FROM TUBES BY TUBE EXPRESSOR
TUBE COMPLETELY COMPRESSED
445
14w
ALIQUOT DISPENSED INTO WELL
445
ALIQUOT DRAWN INTO TUBE AS TUBE EXPRESSOR OPENED
445
ALIQUOT POSITIONED IN TUBE
2220
445
TUBE SEALER SEALS AND CUTS SAMPLE TUBE ISOLATING SAMPLE
442
445
ALIQUOTS REMOVED FOR TESTING, STORAGE, OR FURTHER PROCESSING

FIG. 22

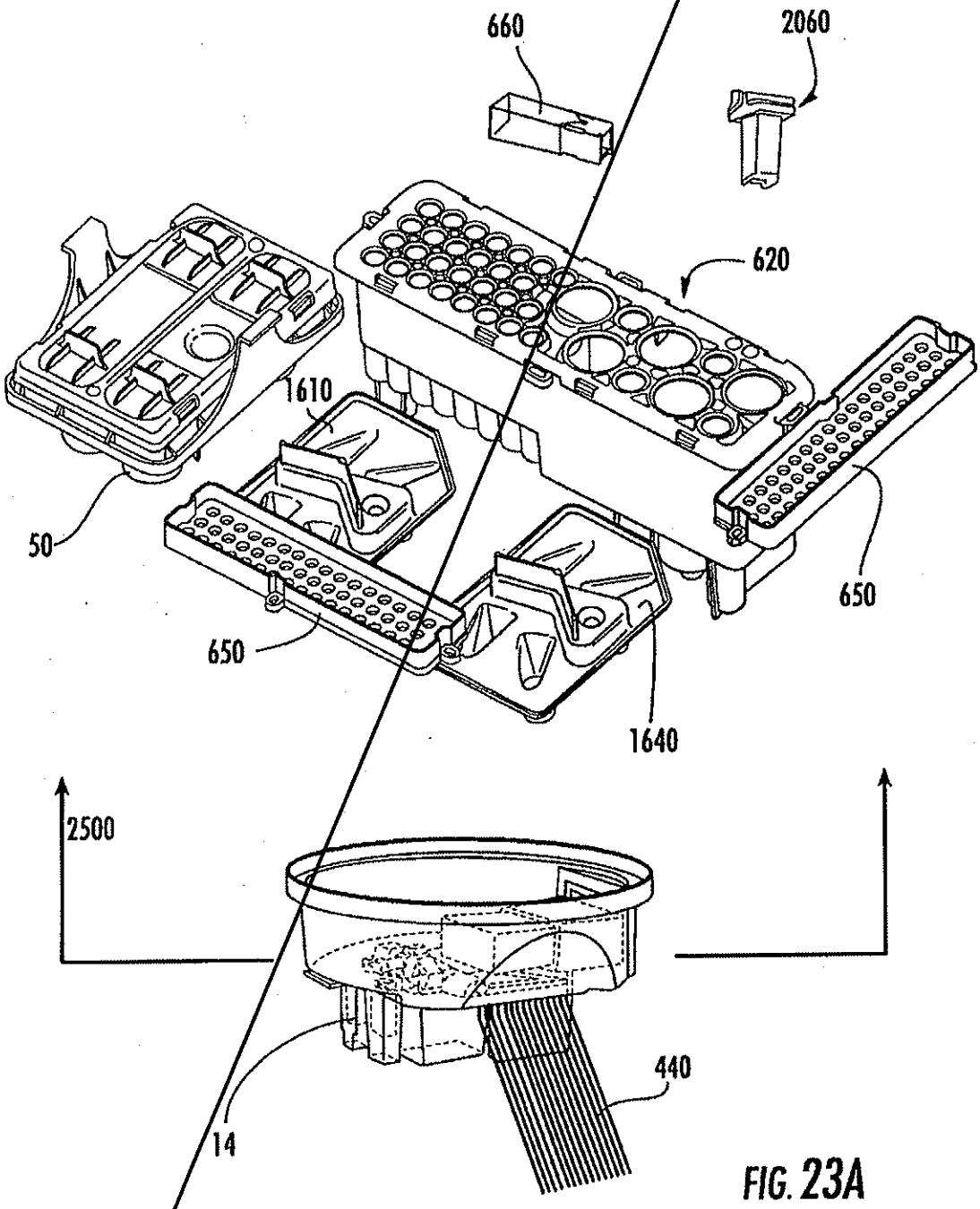


FIG. 23A

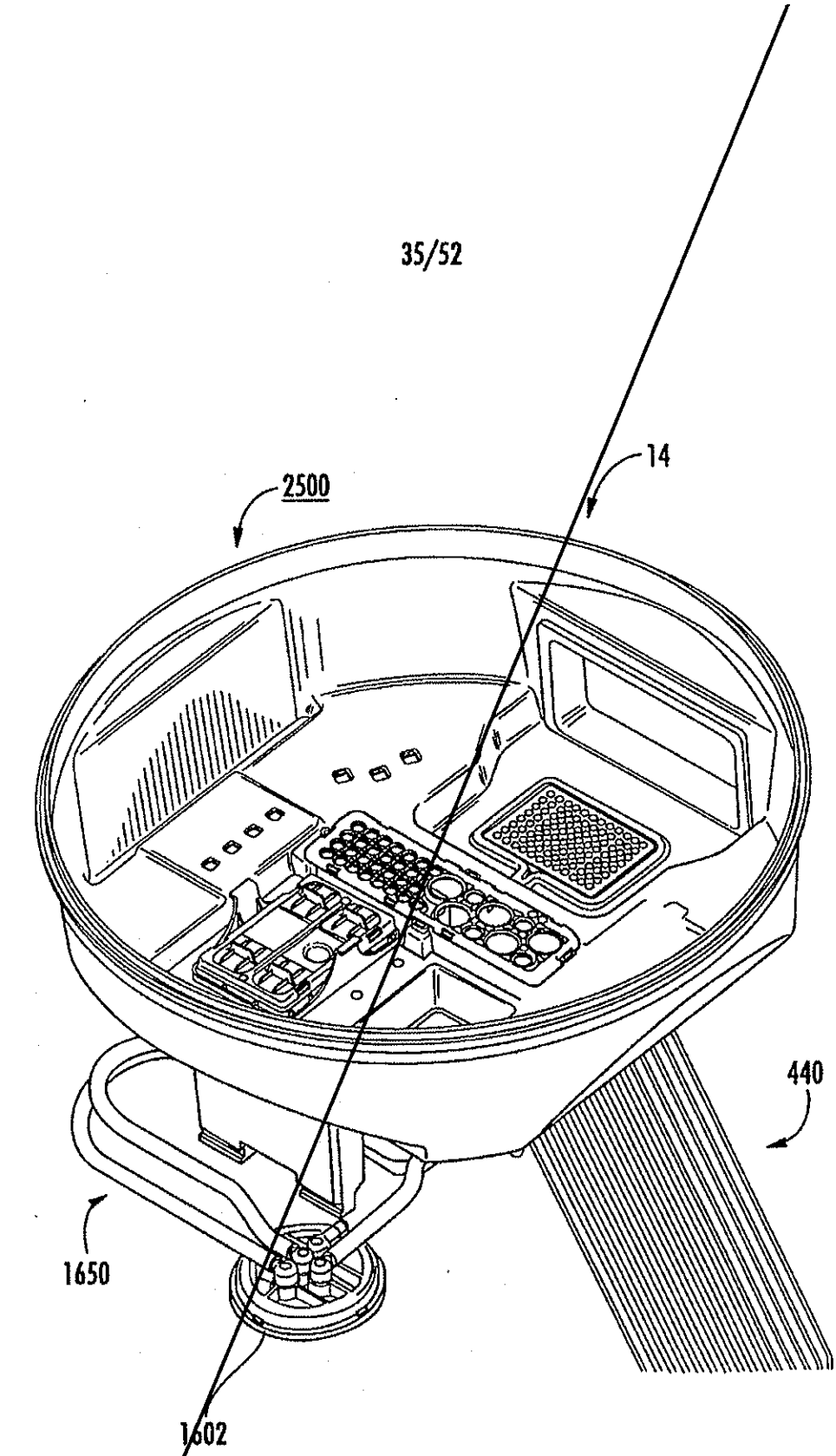


FIG. 23B

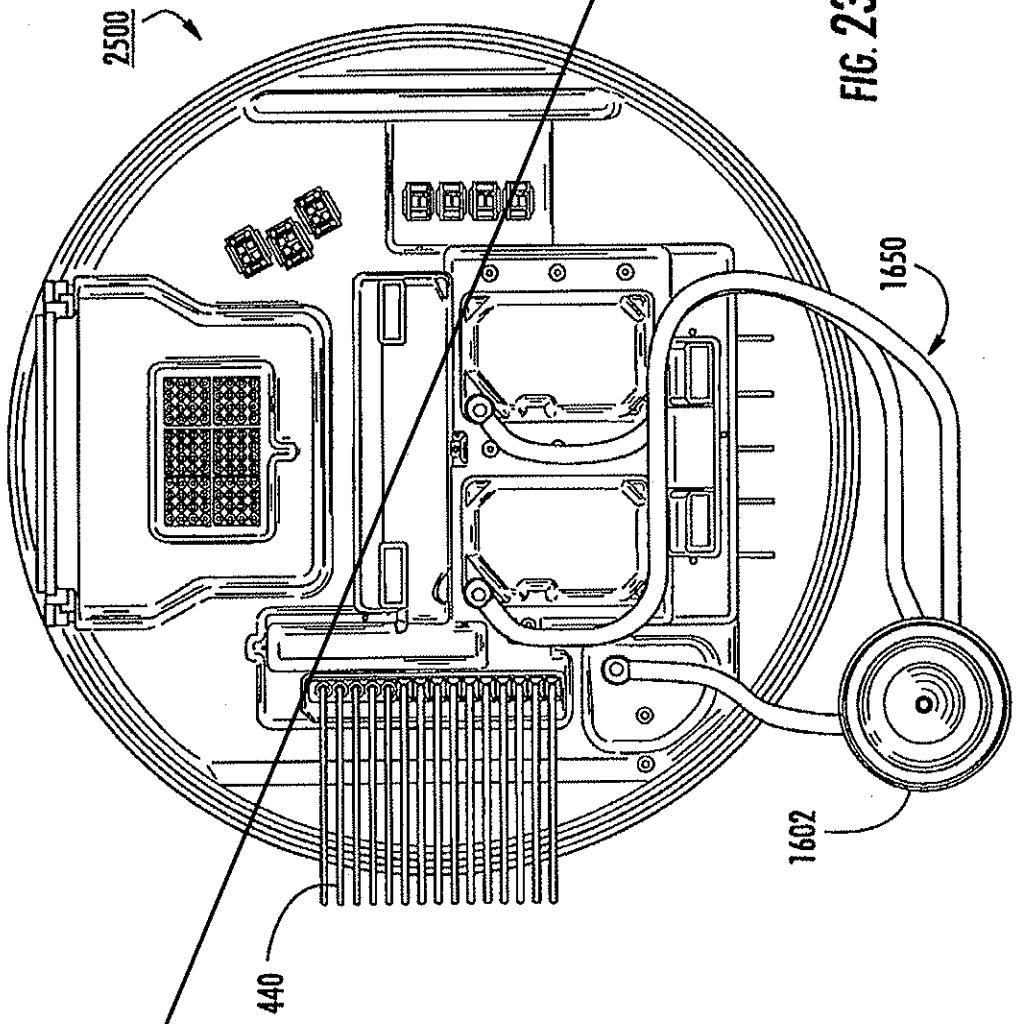


FIG. 23C

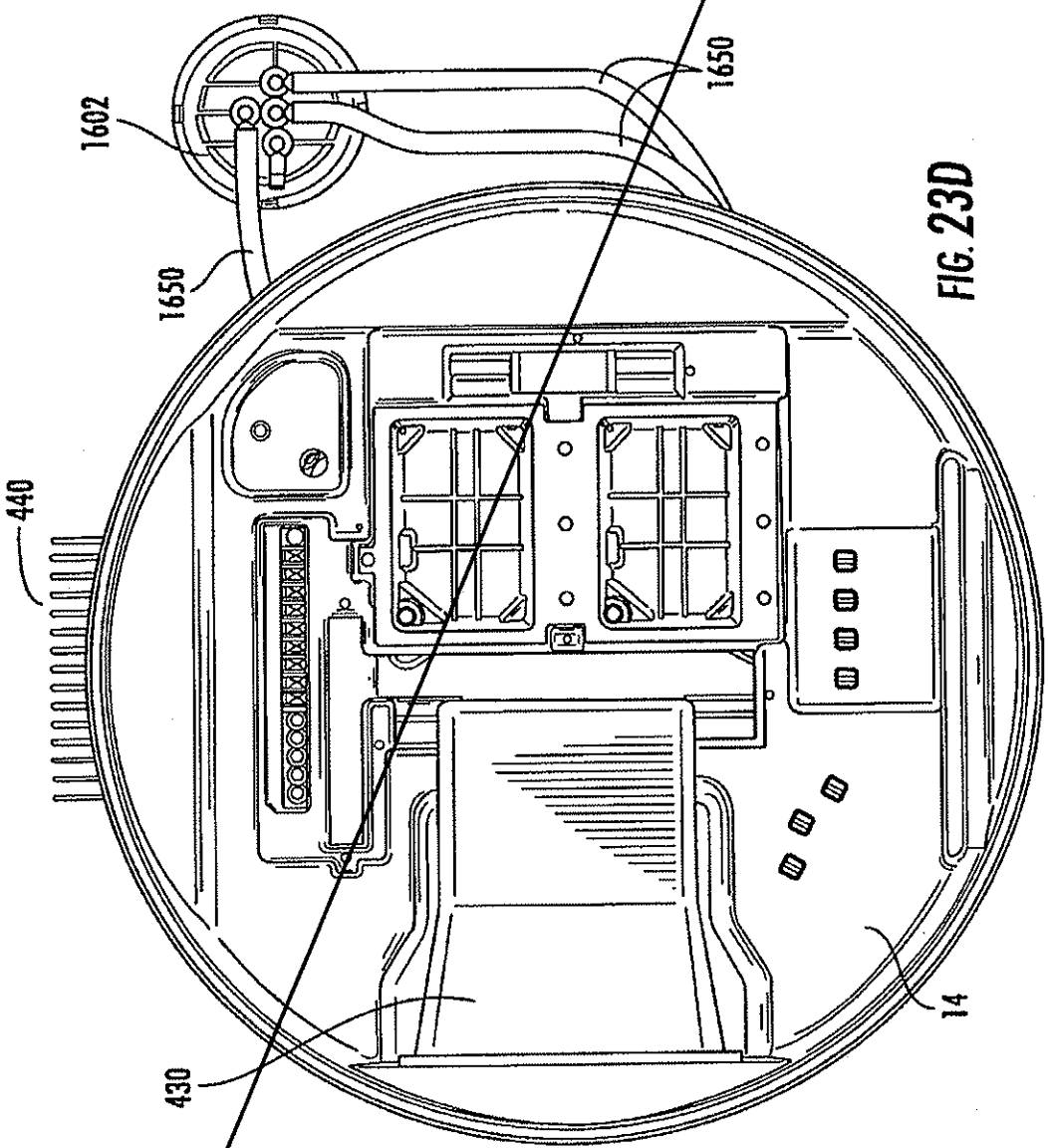


FIG. 23D

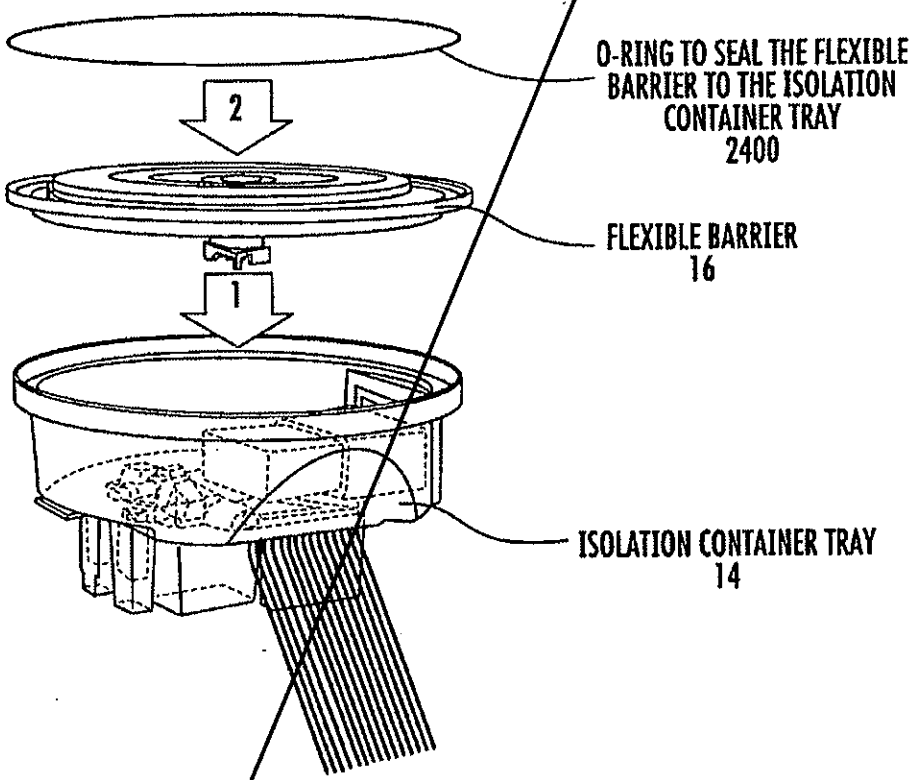

2
1
O-RING TO SEAL THE FLEXIBLE BARRIER TO THE ISOLATION CONTAINER TRAY 2400
FLEXIBLE BARRIER 16
ISOLATION CONTAINER TRAY 14

FIG. 24

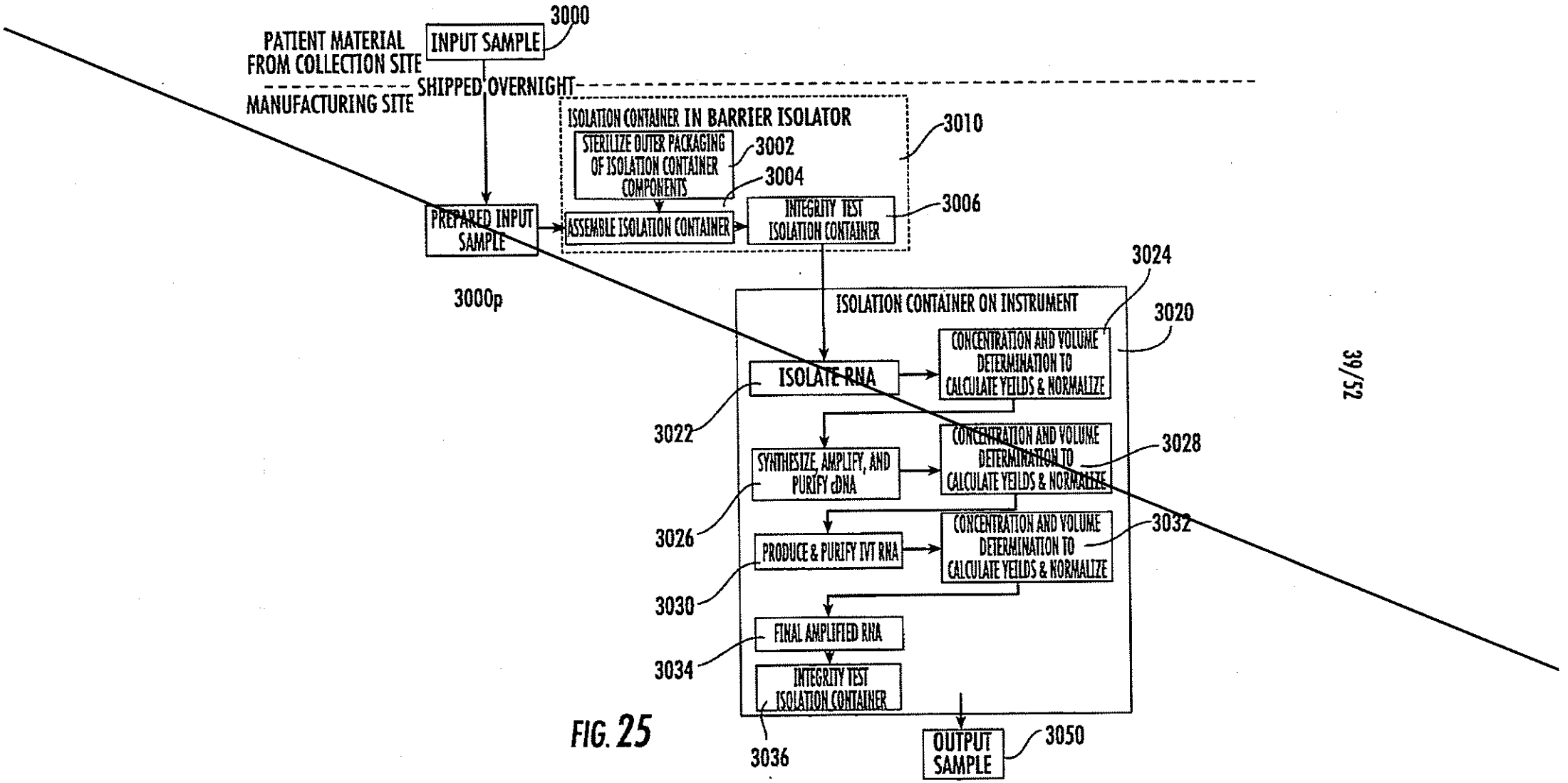

PATIENT MATERIAL FROM COLLECTION SITE
INPUT SAMPLE
3000
SHIPPED OVERNIGHT
MANUFACTURING SITE
ISOLATION CONTAINER IN BARRIER ISOLATOR
3010
STERILIZE OUTER PACKAGING OF ISOLATION CONTAINER COMPONENTS
3002
3004
PREPARED INPUT SAMPLE
ASSEMBLE ISOLATION CONTAINER
INTEGRITY TEST ISOLATION CONTAINER
3006
3000p
ISOLATION CONTAINER ON INSTRUMENT
3024
3020
CONCENTRATION AND VOLUME DETERMINATION TO CALCULATE YEILDS & NORMALIZE
ISOLATE RNA
3022
SYNTHESIZE, AMPLIFY, AND PURIFY cDNA
CONCENTRATION AND VOLUME DETERMINATION TO CALCULATE YEILDS & NORMALIZE
3028
3026
PRODUCE & PURIFY IVT RNA
CONCENTRATION AND VOLUME DETERMINATION TO CALCULATE YEILDS & NORMALIZE
3032
3030
FINAL AMPLIFIED RNA
3034
INTEGRITY TEST ISOLATION CONTAINER
3036
OUTPUT SAMPLE
3050

FIG. 25

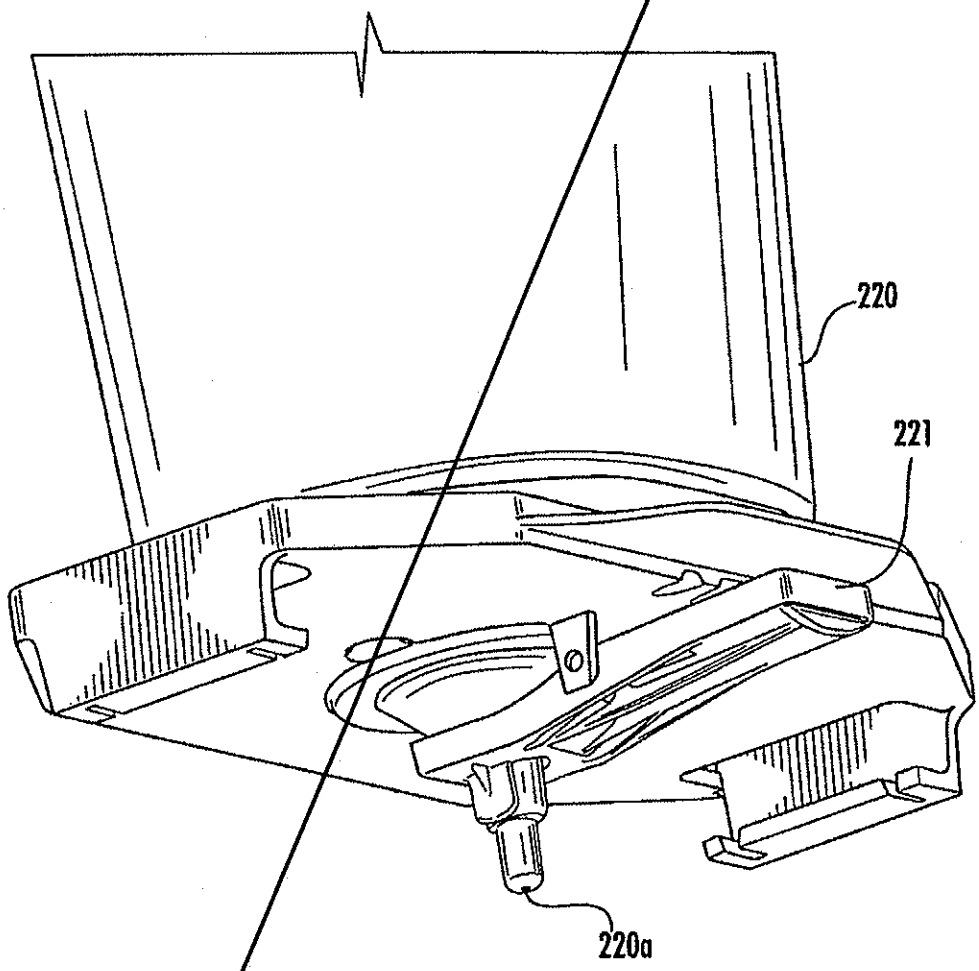


FIG. 26A

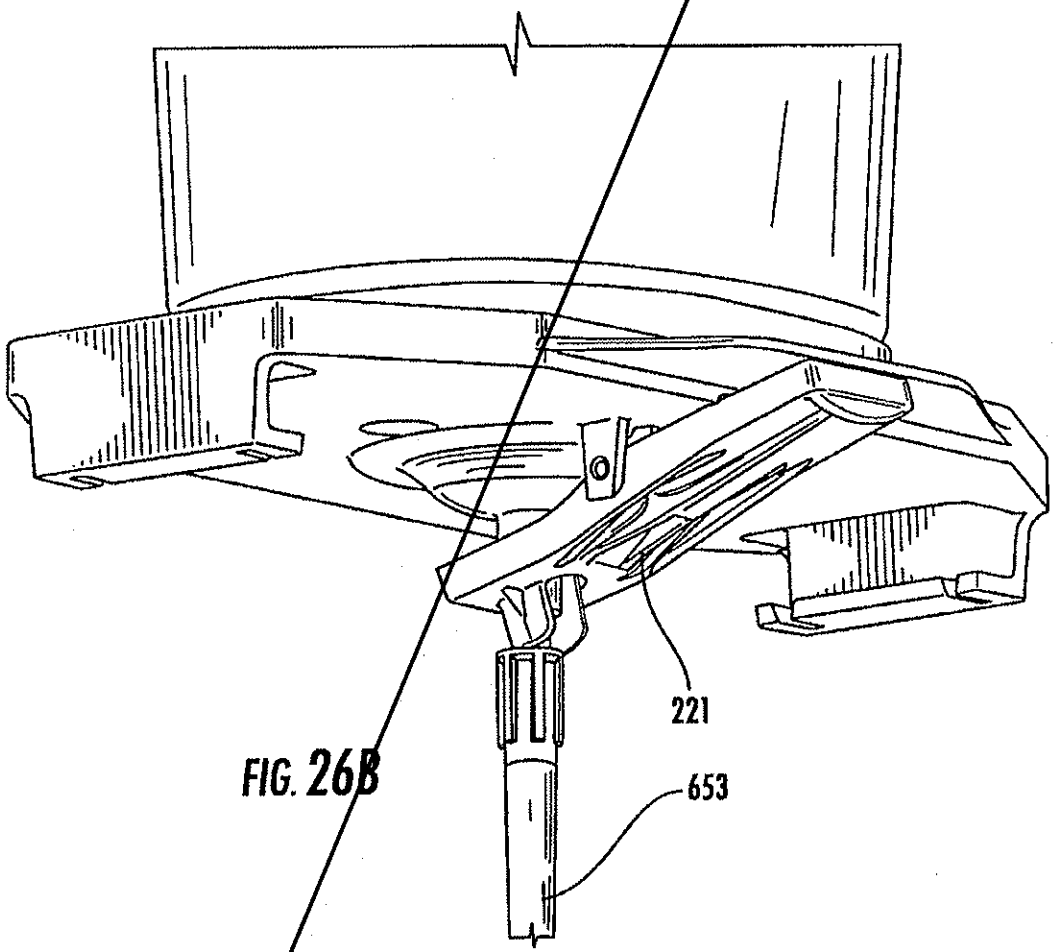


FIG. 26B

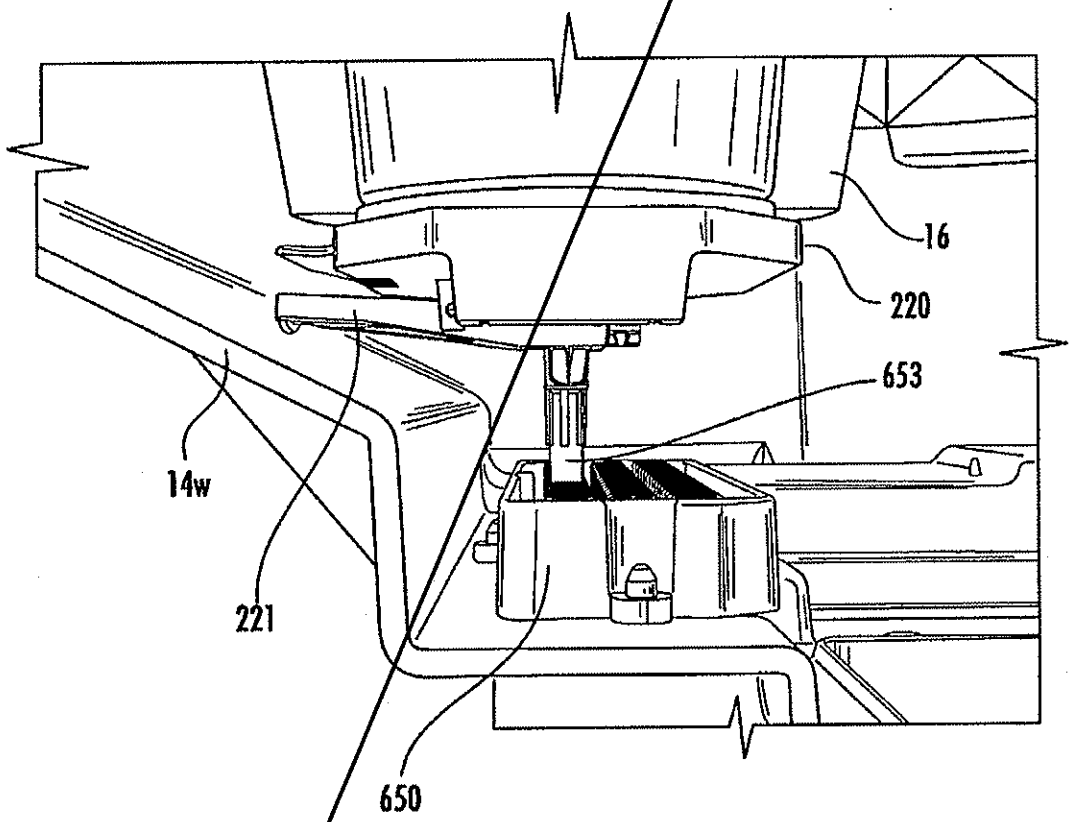


FIG. 26C

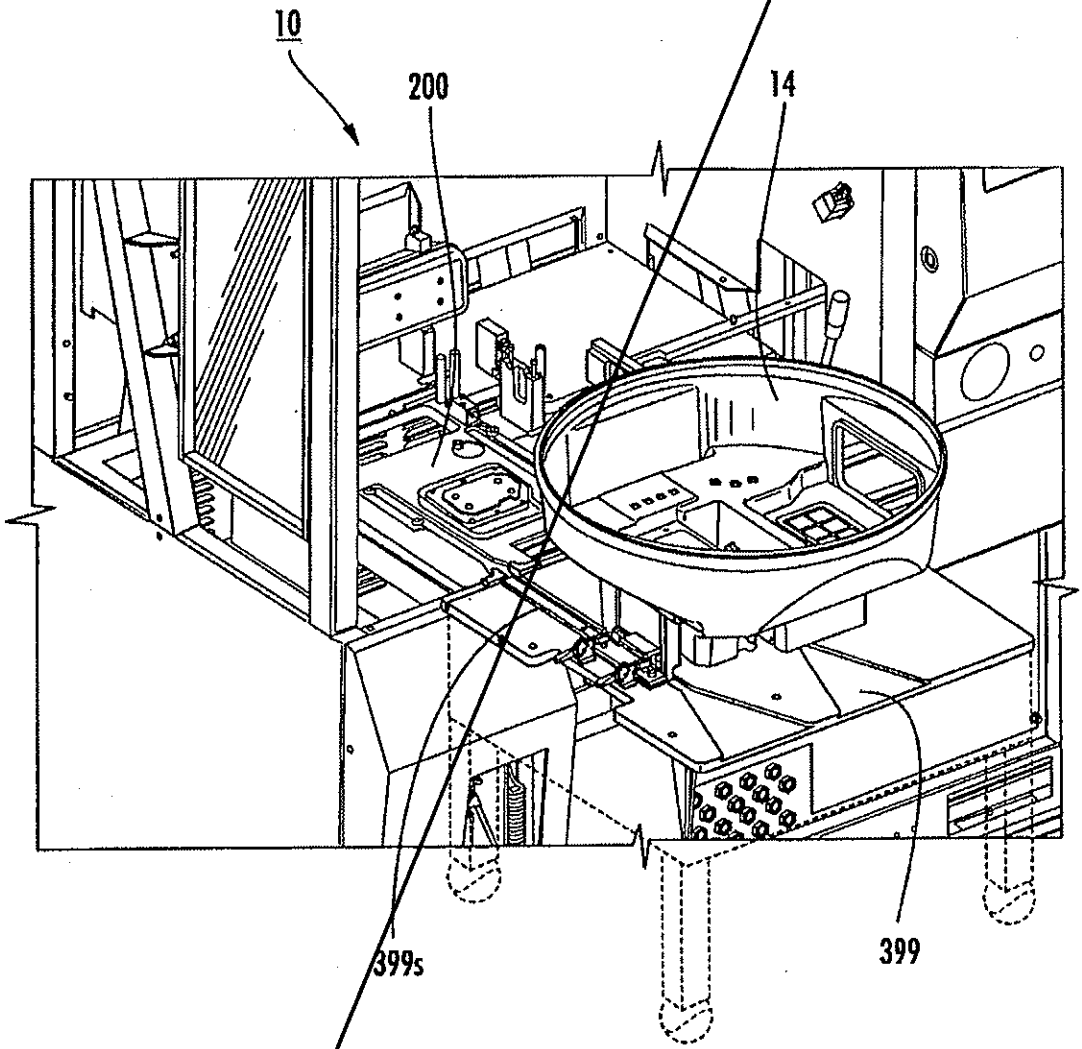


FIG. 27

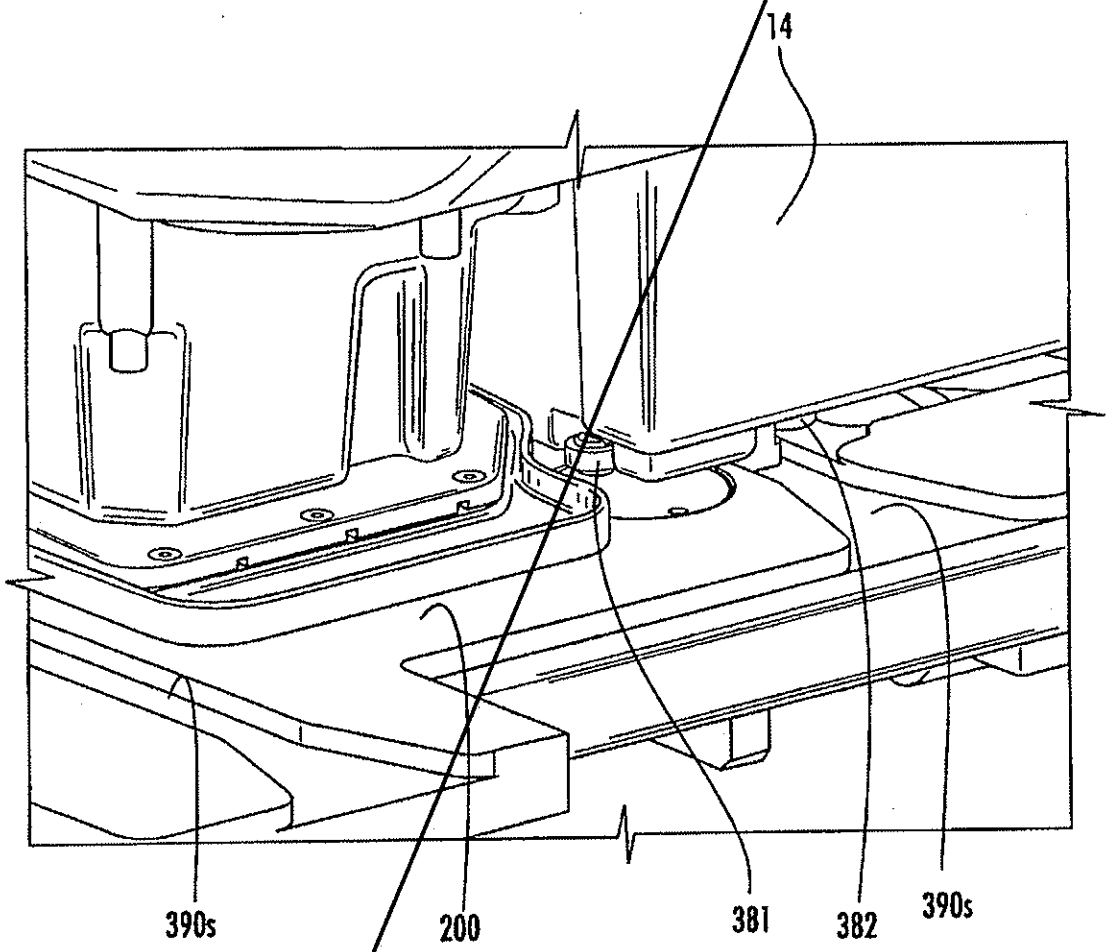


FIG. 28A

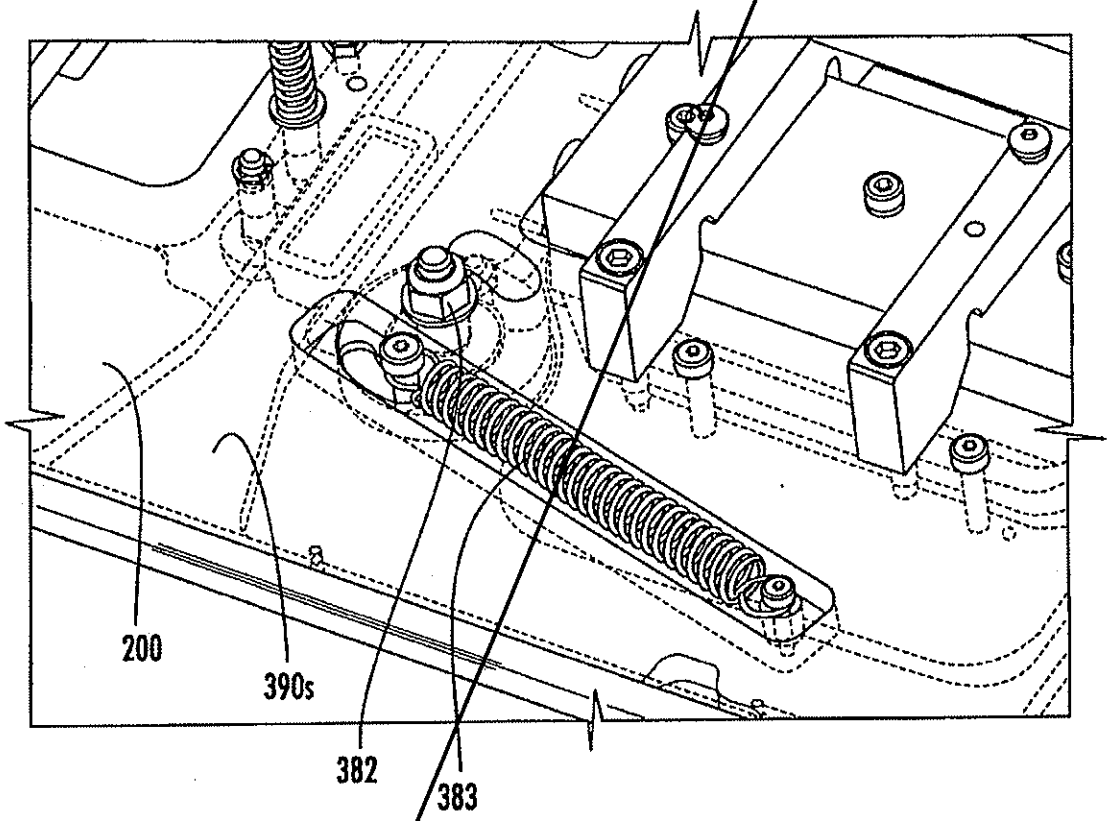


FIG. 28B

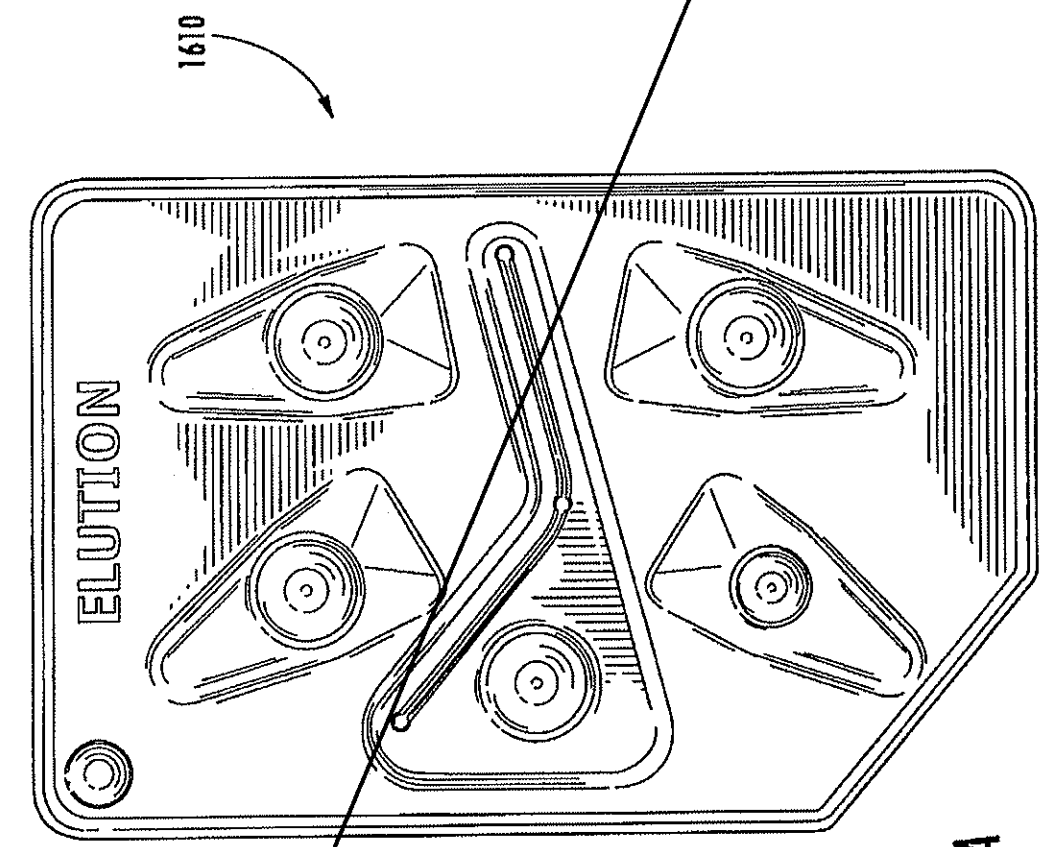


FIG. 29A

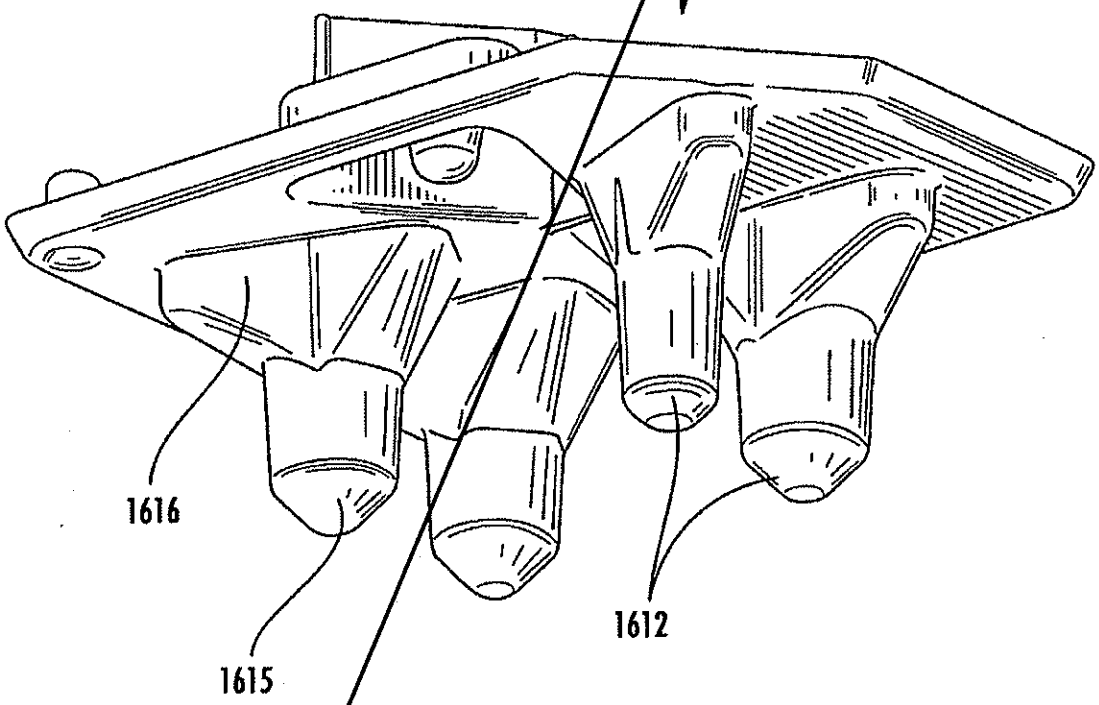


FIG. 29B

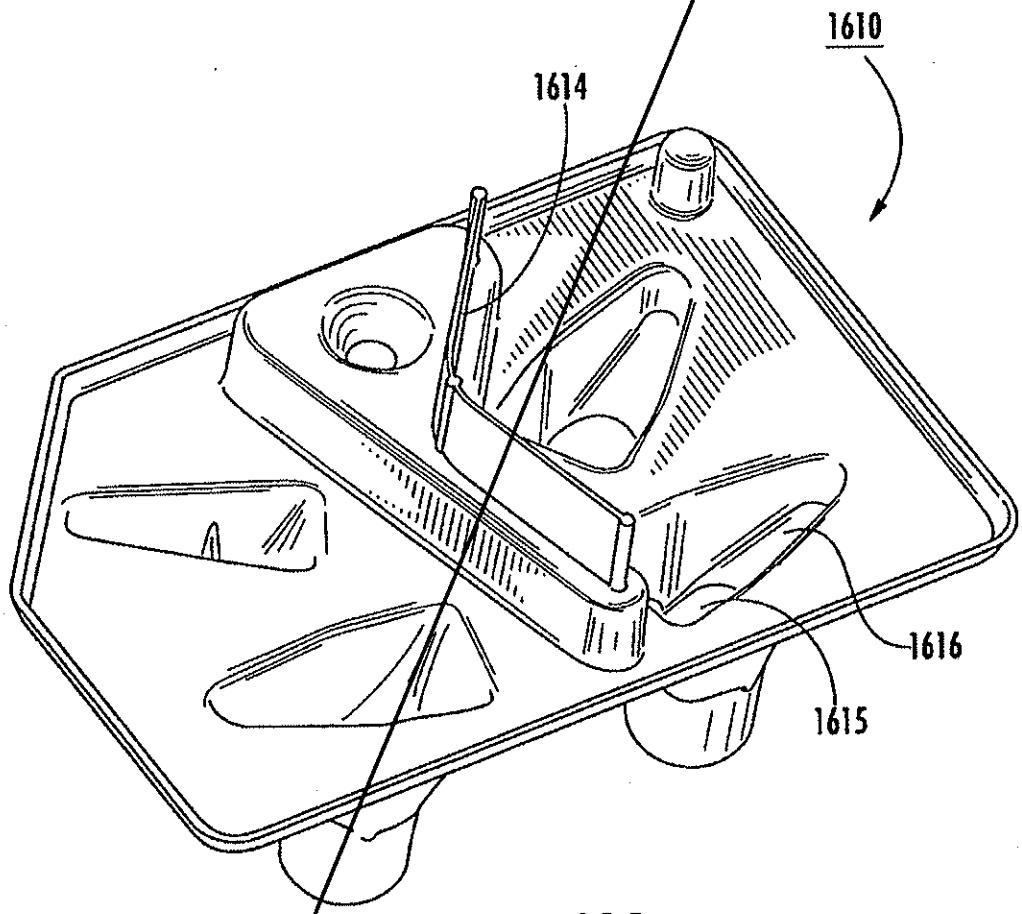


FIG. 29C

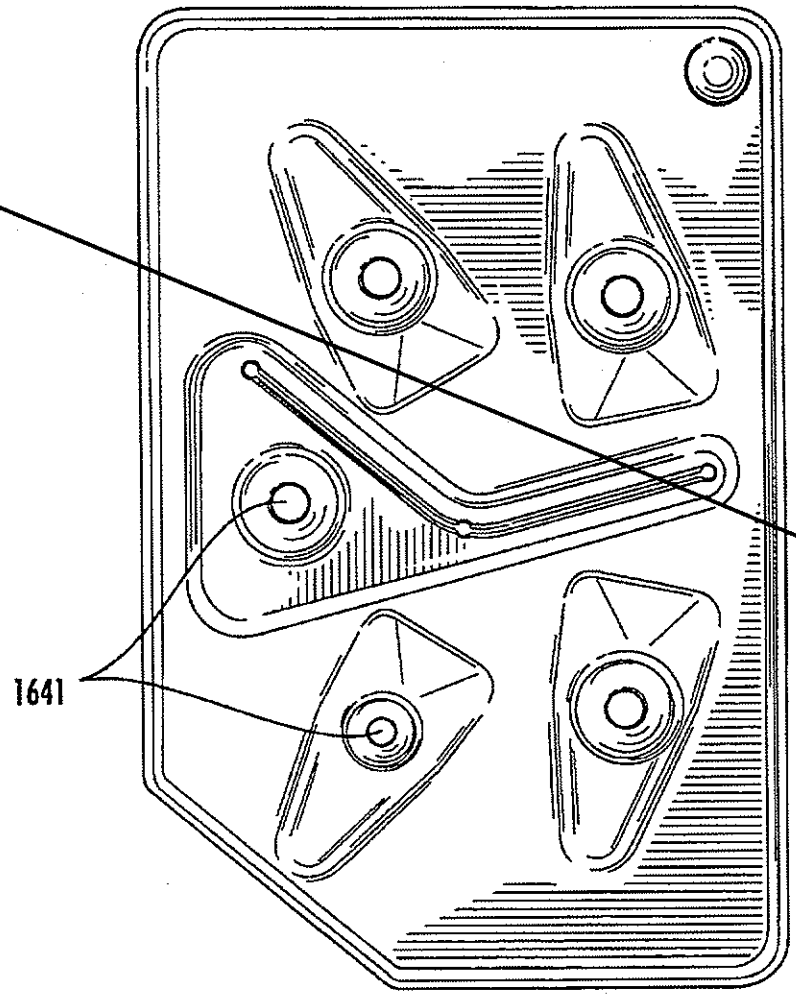


FIG. 30A

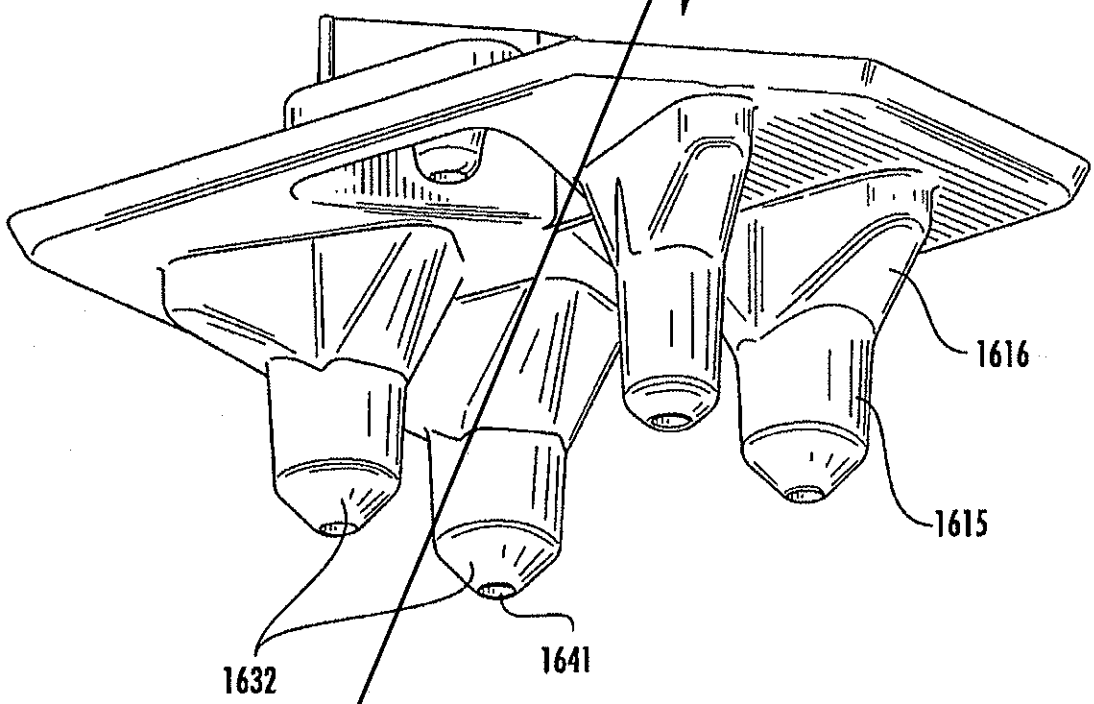


FIG. 30B

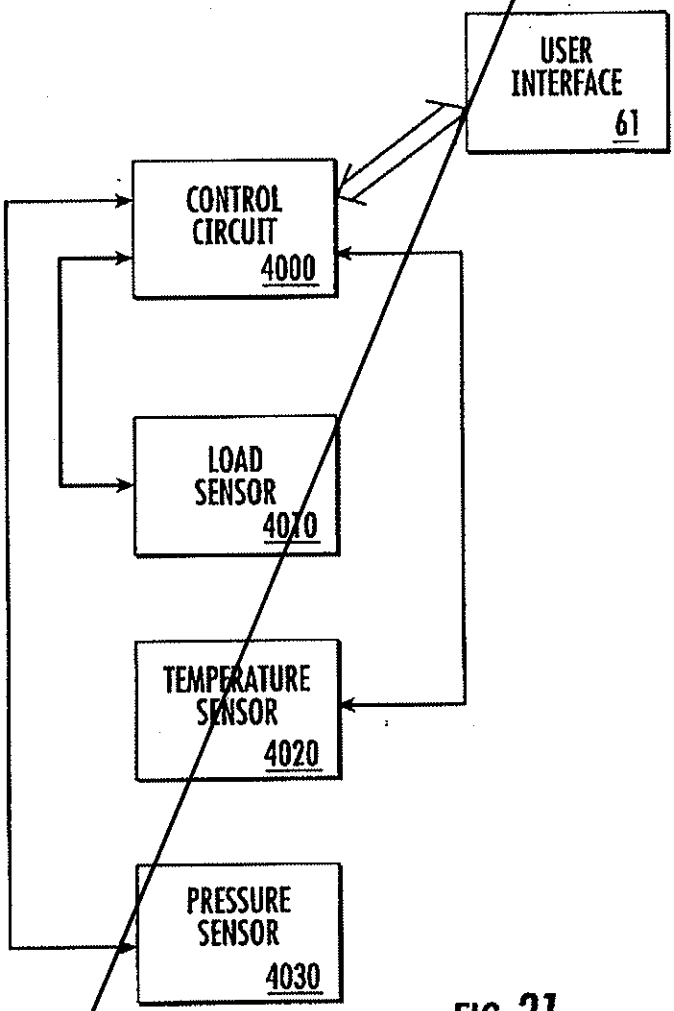

USER INTERFACE
61
CONTROL CIRCUIT
4000
LOAD SENSOR
4010
TEMPERATURE SENSOR
4020
PRESSURE SENSOR
4030

FIG. 31

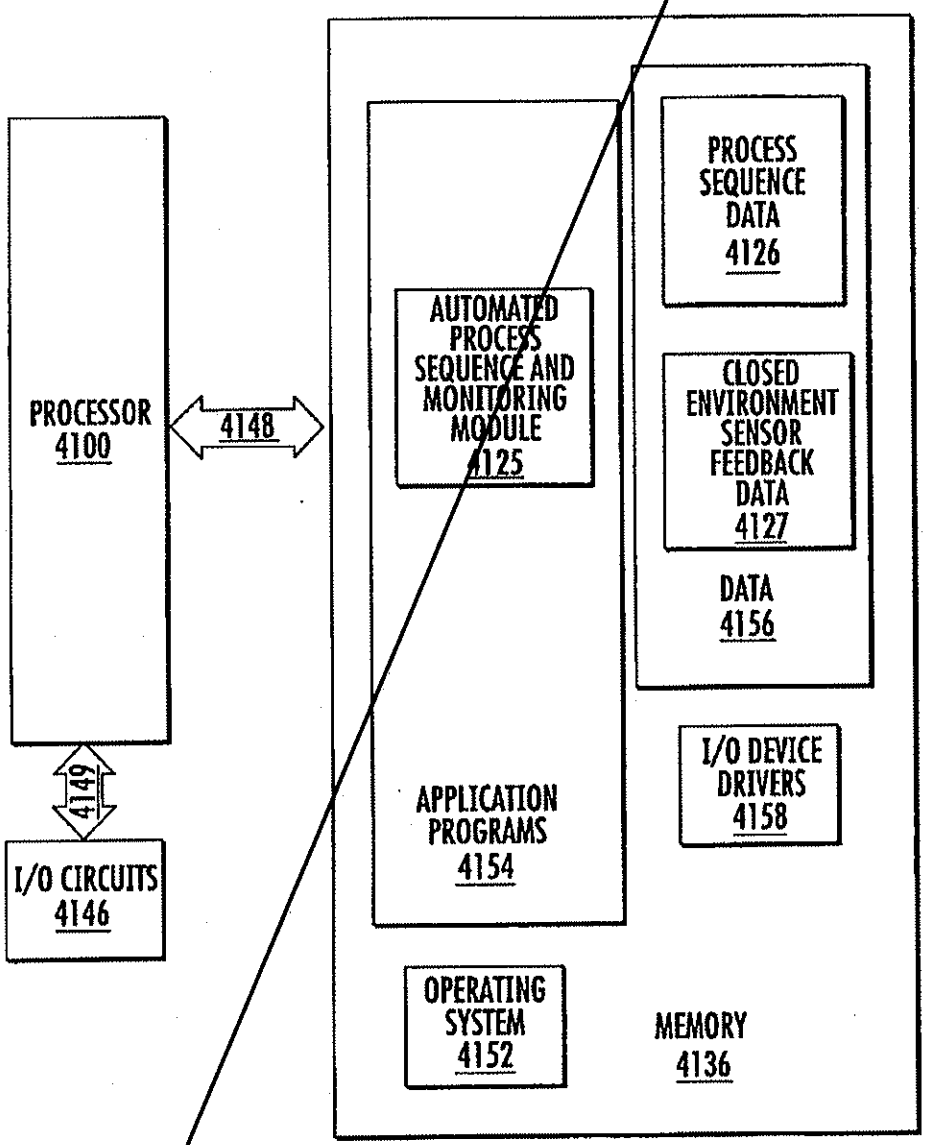

4116
PROCESSOR
4100
4148
4149
I/O CIRCUITS
4146
AUTOMATED PROCESS SEQUENCE AND MONITORING MODULE
4125
PROCESS SEQUENCE DATA
4126
CLOSED ENVIRONMENT SENSOR FEEDBACK DATA
4127
DATA
4156
I/O DEVICE DRIVERS
4158
APPLICATION PROGRAMS
4154
OPERATING SYSTEM
4152
MEMORY
4136

FIG. 32

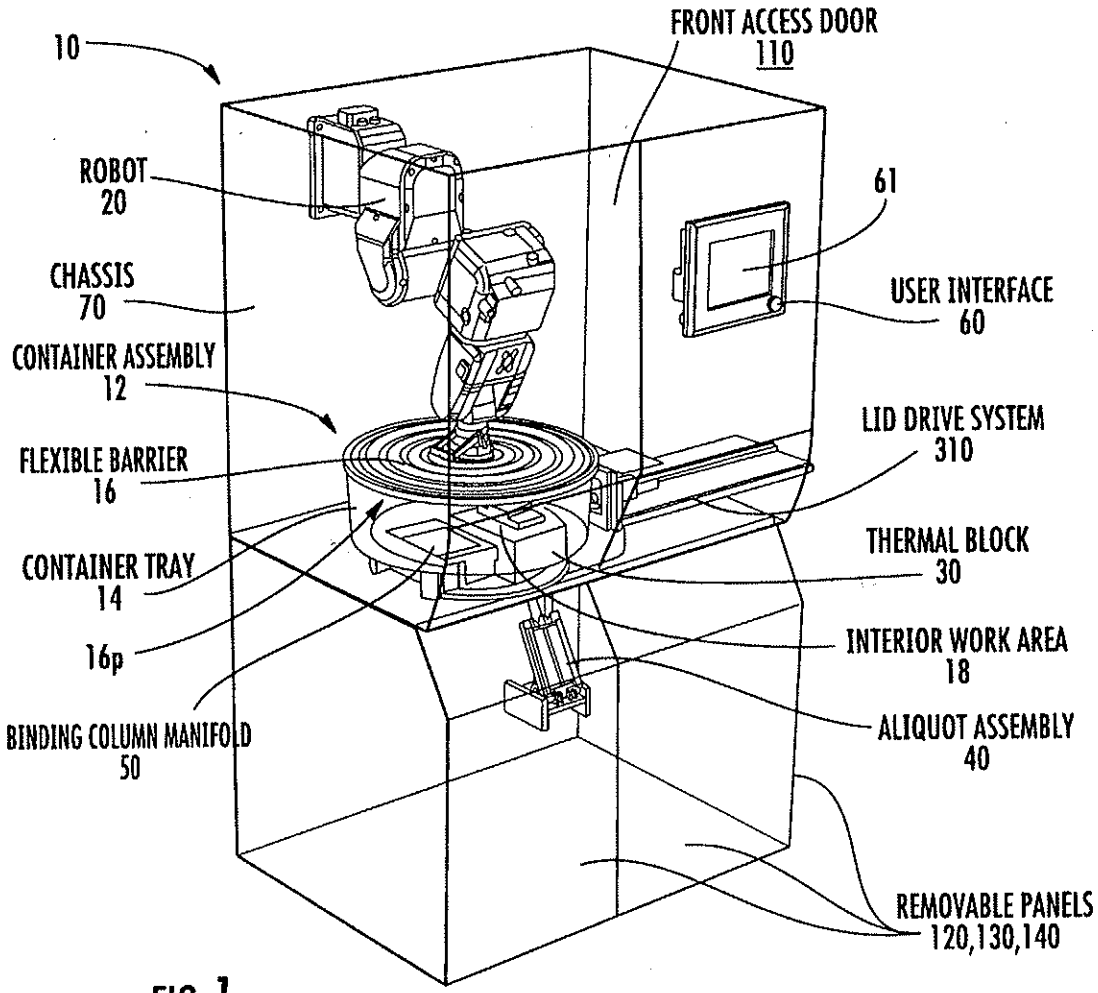

10
FRONT ACCESS DOOR
110
ROBOT
20
61
CHASSIS
70
USER INTERFACE
60
CONTAINER ASSEMBLY
12
LID DRIVE SYSTEM
310
FLEXIBLE BARRIER
16
THERMAL BLOCK
30
CONTAINER TRAY
14
INTERIOR WORK AREA
18
16p
ALIQUOT ASSEMBLY
40
BINDING COLUMN MANIFOLD
50
REMOVABLE PANELS
120,130,140

FIG. 1

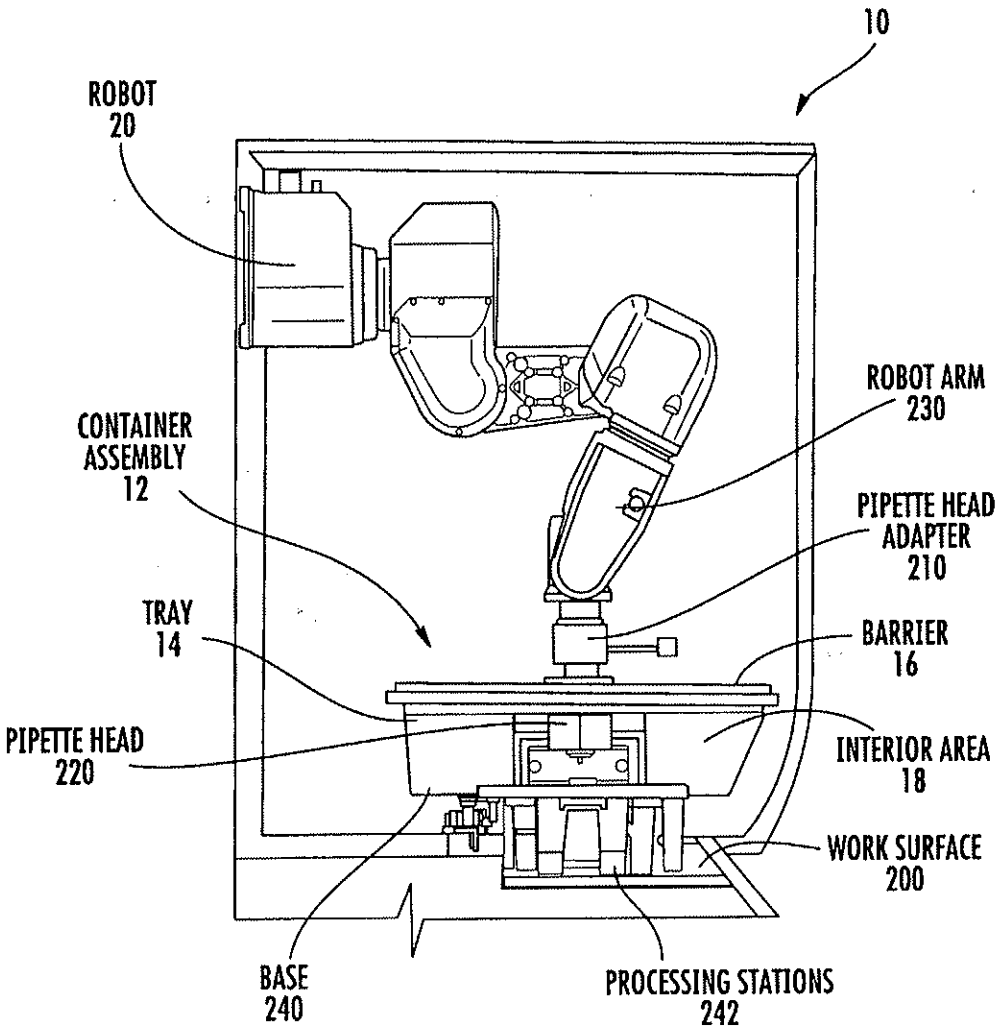

10
ROBOT
20
ROBOT ARM
230
CONTAINER
ASSEMBLY
12
PIPETTE HEAD
ADAPTER
210
TRAY
14
BARRIER
16
PIPETTE HEAD
220
INTERIOR AREA
18
WORK SURFACE
200
BASE
240
PROCESSING STATIONS
242

FIG. 2

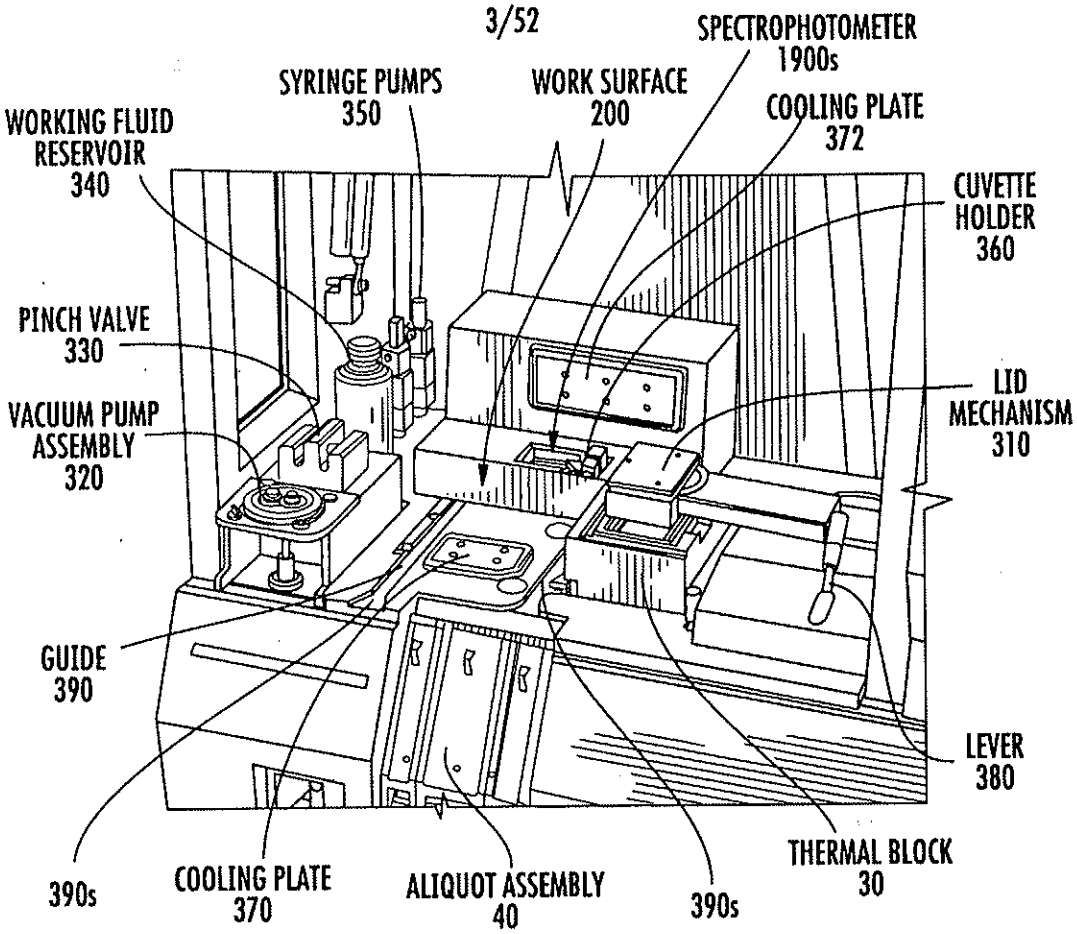

SPECTROPHOTOMETER
1900s
SYRINGE PUMPS
350
WORK SURFACE
200
COOLING PLATE
372
WORKING FLUID
RESERVOIR
340
CUVETTE
HOLDER
360
PINCH VALVE
330
LID
MECHANISM
310
VACUUM PUMP
ASSEMBLY
320
GUIDE
390
LEVER
380
390s
COOLING PLATE
370
ALIQUOT ASSEMBLY
40
390s
THERMAL BLOCK
30

FIG. 3

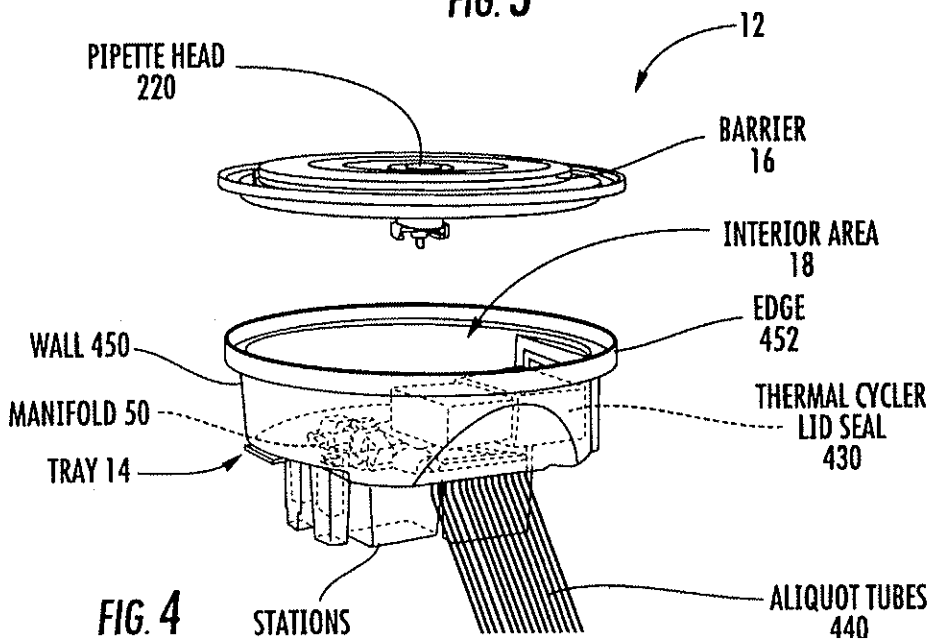

12
PIPETTE HEAD
220
BARRIER
16
INTERIOR AREA
18
EDGE
452
WALL 450
MANIFOLD 50
THERMAL CYCLER
LID SEAL
430
TRAY 14
STATIONS
ALIQUOT TUBES
440

FIG. 4

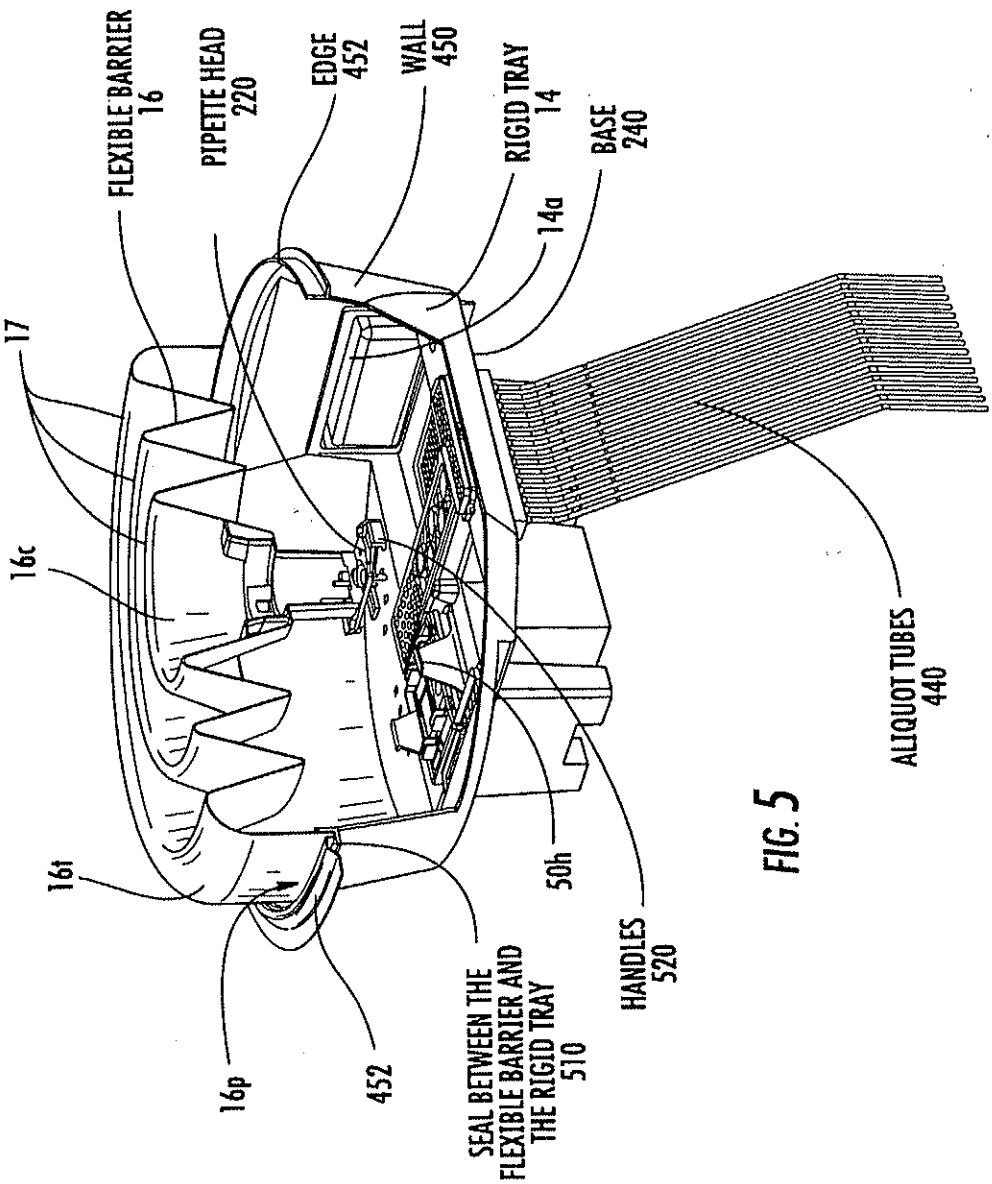

FLEXIBLE BARRIER
16
PIPETTE HEAD
220
EDGE
452
WALL
450
RIGID TRAY
14
BASE
240
14a
17
16c
16t
16p
452
SEAL BETWEEN THE
FLEXIBLE BARRIER AND
THE RIGID TRAY
510
50h
HANDLES
520
ALIQUOT TUBES
440

FIG. 5

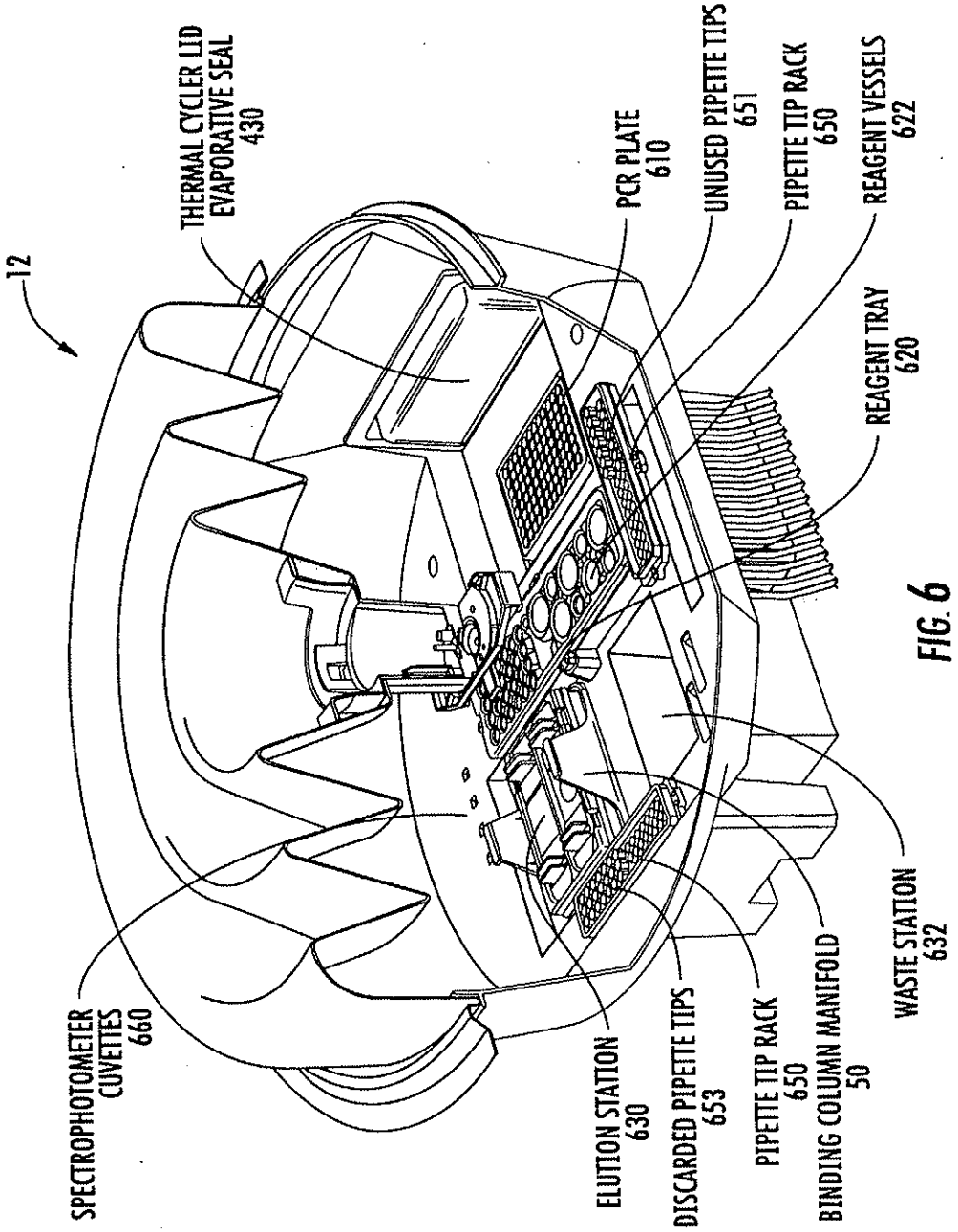

12
THERMAL CYCLER LID EVAPORATIVE SEAL 430
PCR PLATE 610
UNUSED PIPETTE TIPS 651
PIPETTE TIP RACK 650
REAGENT VESSELS 622
REAGENT TRAY 620
SPECTROPHOTOMETER CUVETTES 660
ELUTION STATION 630
DISCARDED PIPETTE TIPS 653
PIPETTE TIP RACK 650
BINDING COLUMN MANIFOLD 50
WASTE STATION 632

FIG. 6

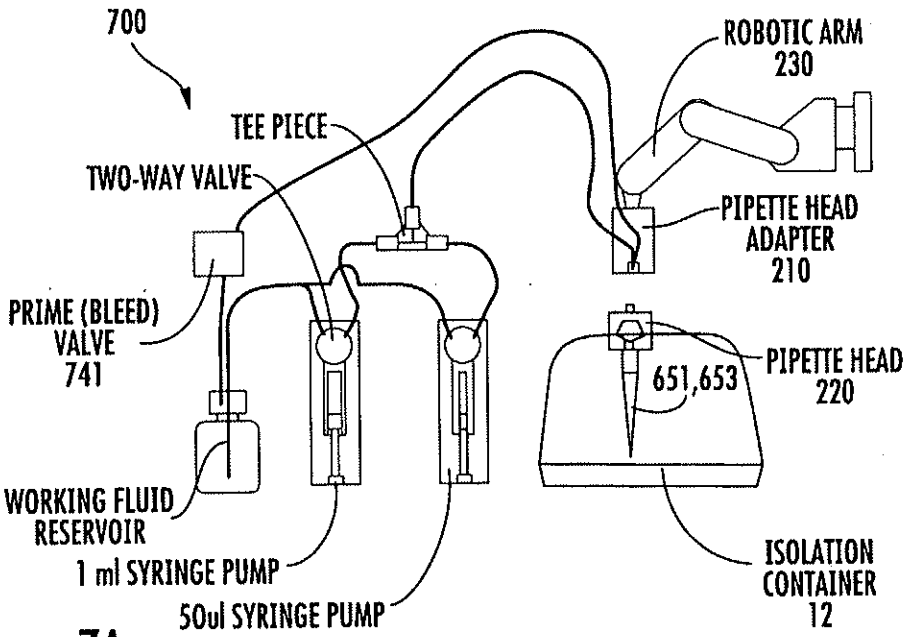

700
ROBOTIC ARM
230
TEE PIECE
TWO-WAY VALVE
PIPETTE HEAD
ADAPTER
210
PRIME (BLEED)
VALVE
741
651,653
PIPETTE HEAD
220
WORKING FLUID
RESERVOIR
1 ml SYRINGE PUMP
50ul SYRINGE PUMP
ISOLATION
CONTAINER
12

FIG. 7A

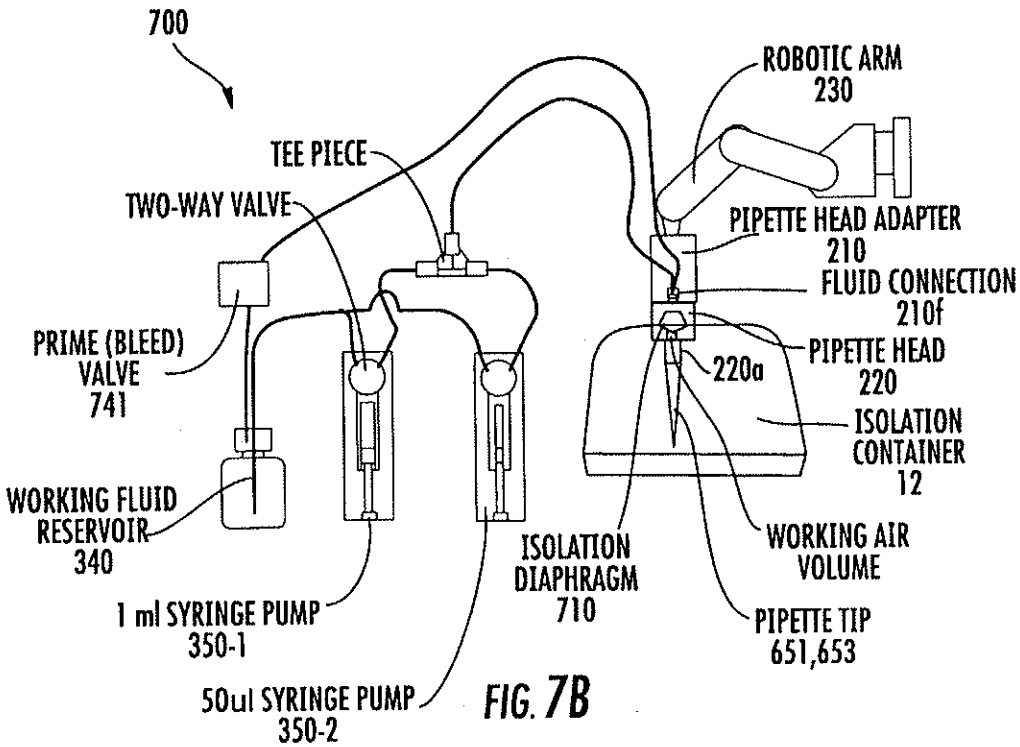

700
ROBOTIC ARM
230
TEE PIECE
TWO-WAY VALVE
PIPETTE HEAD ADAPTER
210
FLUID CONNECTION
210f
PRIME (BLEED)
VALVE
741
220a
PIPETTE HEAD
220
ISOLATION
CONTAINER
12
WORKING FLUID
RESERVOIR
340
WORKING AIR
VOLUME
ISOLATION
DIAPHRAGM
710
1 ml SYRINGE PUMP
350-1
PIPETTE TIP
651,653
50ul SYRINGE PUMP
350-2

FIG. 7B

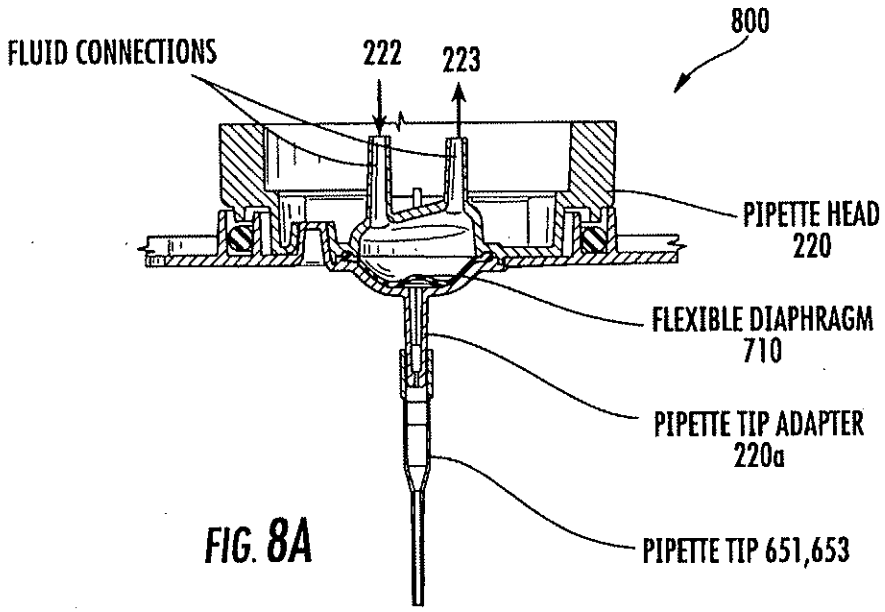

800
FLUID CONNECTIONS
222
223
PIPETTE HEAD
220
FLEXIBLE DIAPHRAGM
710
PIPETTE TIP ADAPTER
220a
PIPETTE TIP 651,653

FIG. 8A

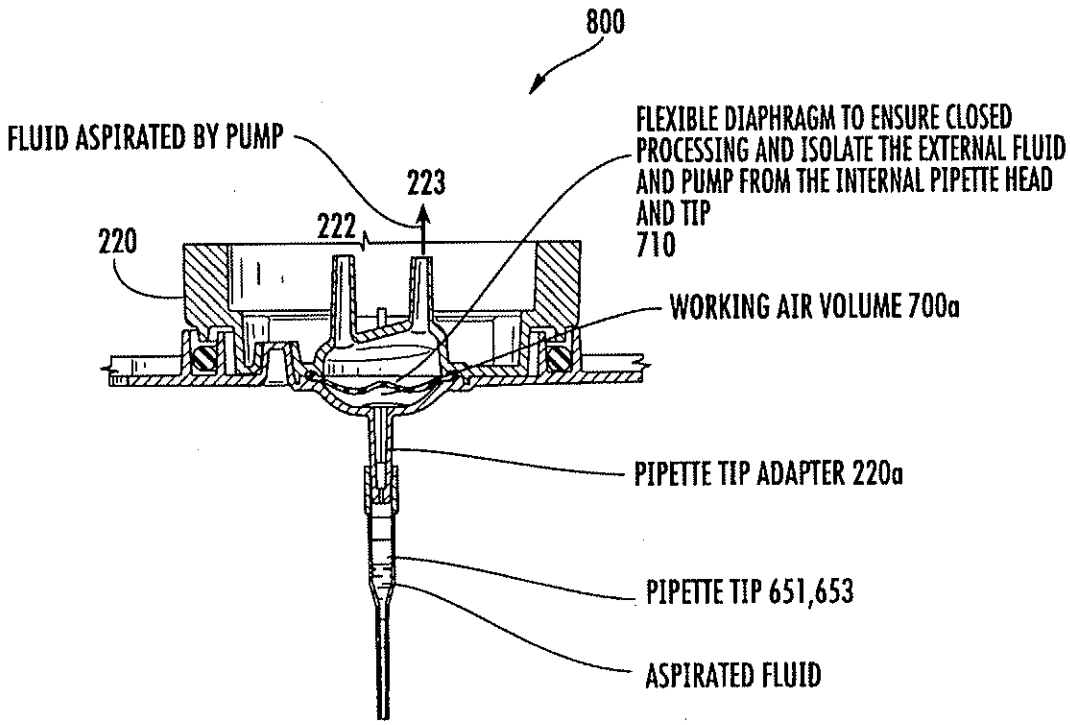

800
FLUID ASPIRATED BY PUMP
223
222
220
FLEXIBLE DIAPHRAGM TO ENSURE CLOSED PROCESSING AND ISOLATE THE EXTERNAL FLUID AND PUMP FROM THE INTERNAL PIPETTE HEAD AND TIP
710
WORKING AIR VOLUME 700a
PIPETTE TIP ADAPTER 220a
PIPETTE TIP 651,653
ASPIRATED FLUID

FIG. 8B

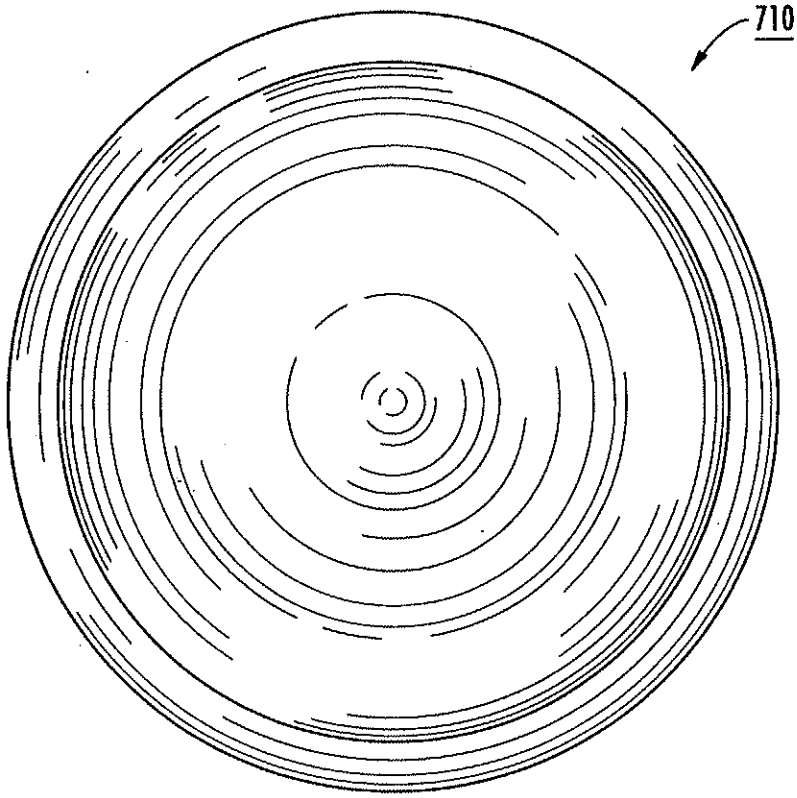


FIG. 8C

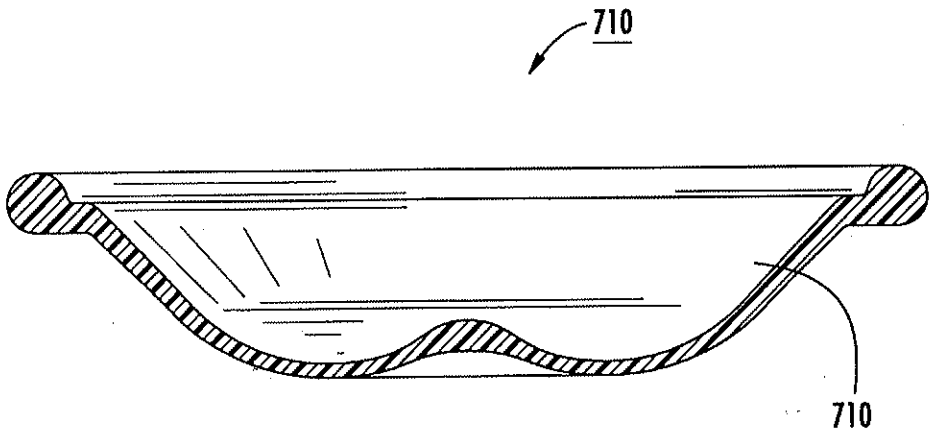


FIG. 8D

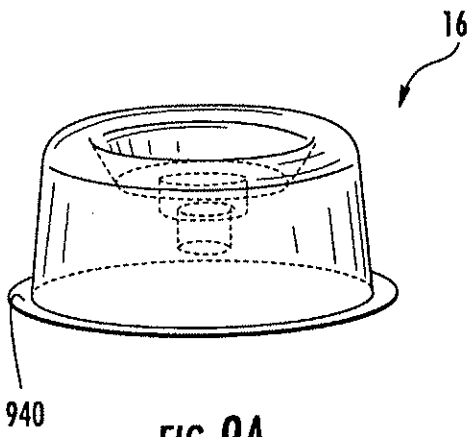


FIG. 9A

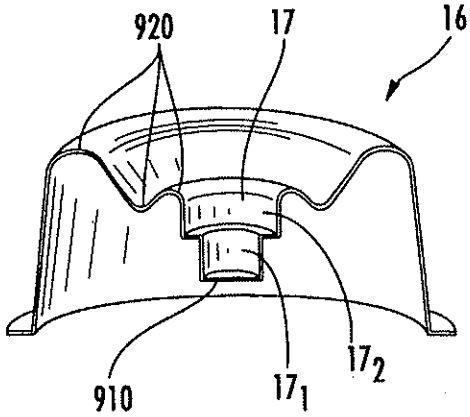


FIG. 9B

910

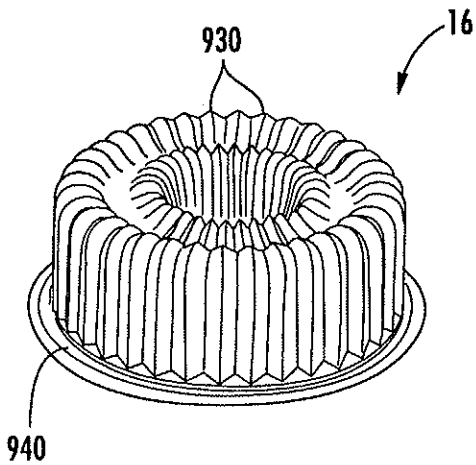


FIG. 9C

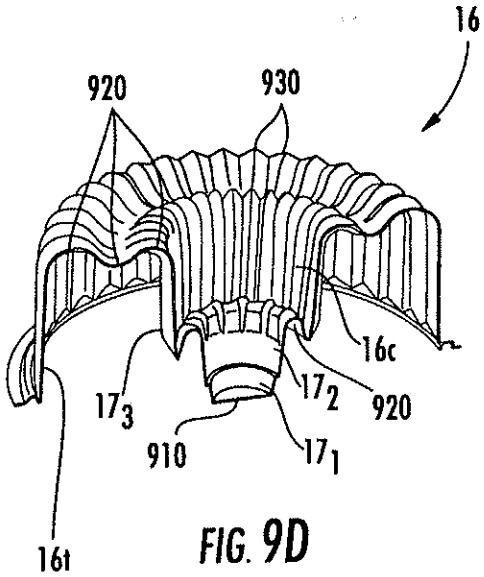


FIG. 9D

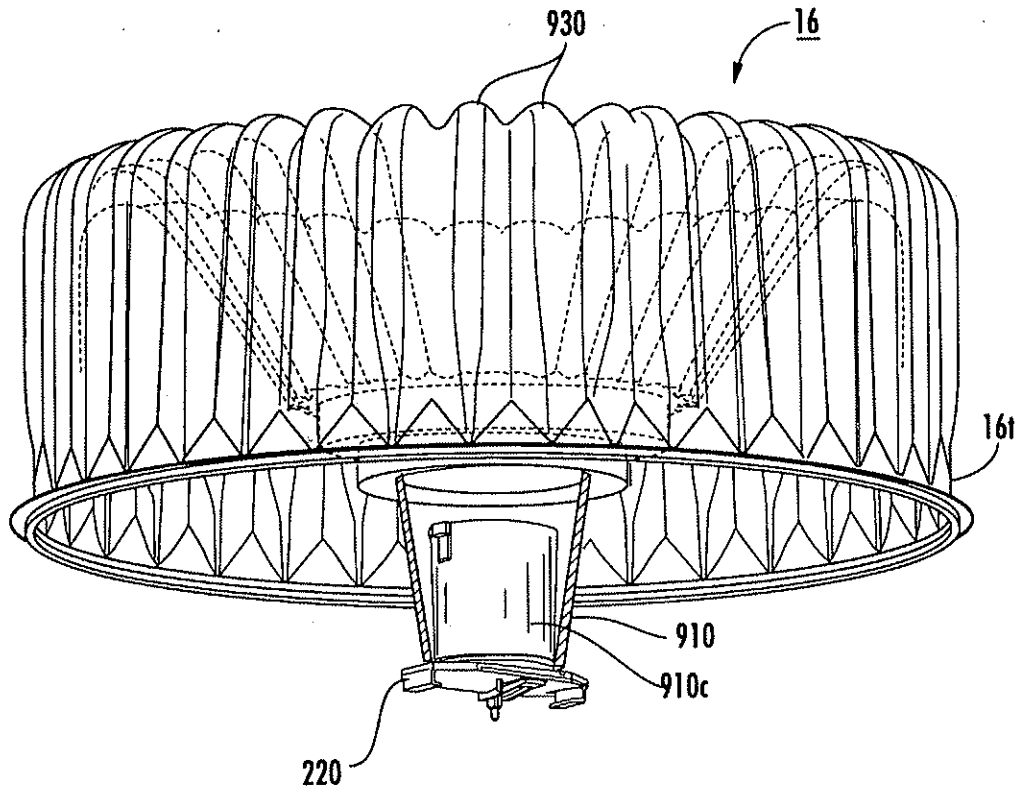


FIG. 9E

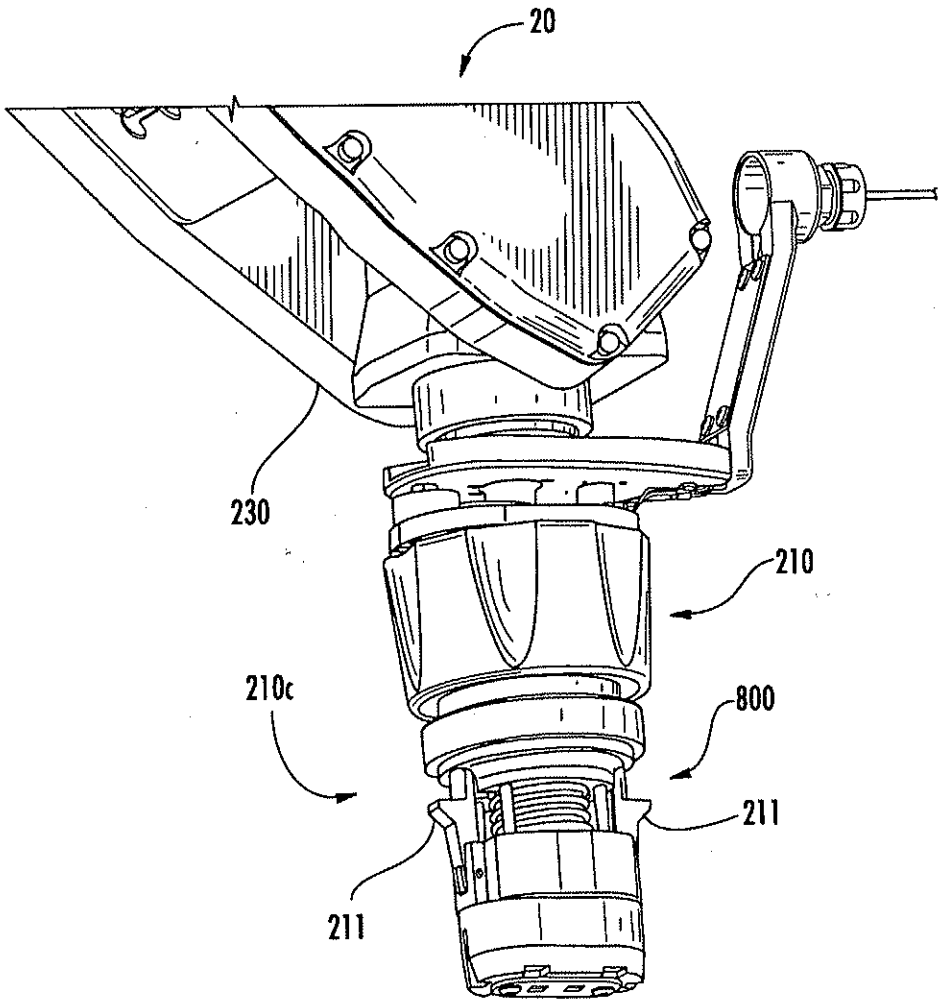


FIG. 9F

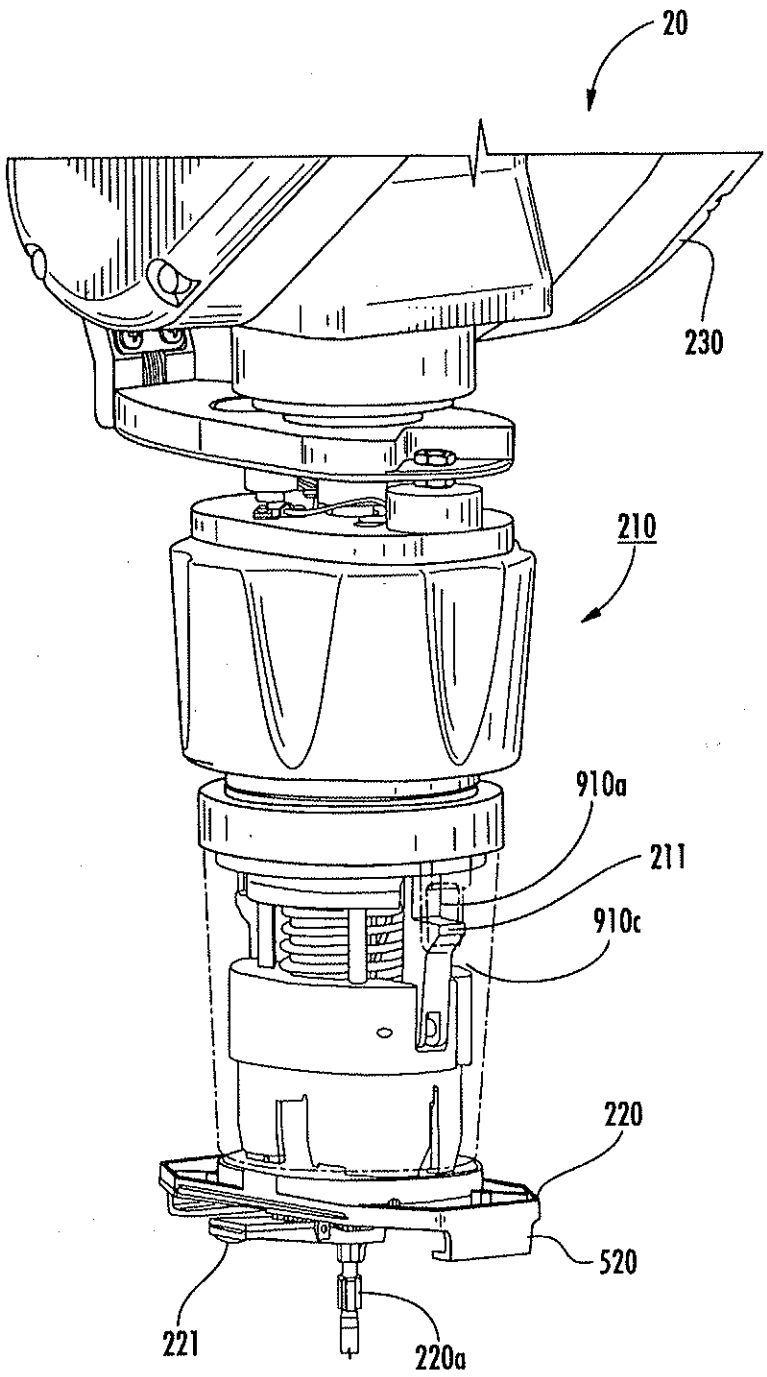


FIG. 9G

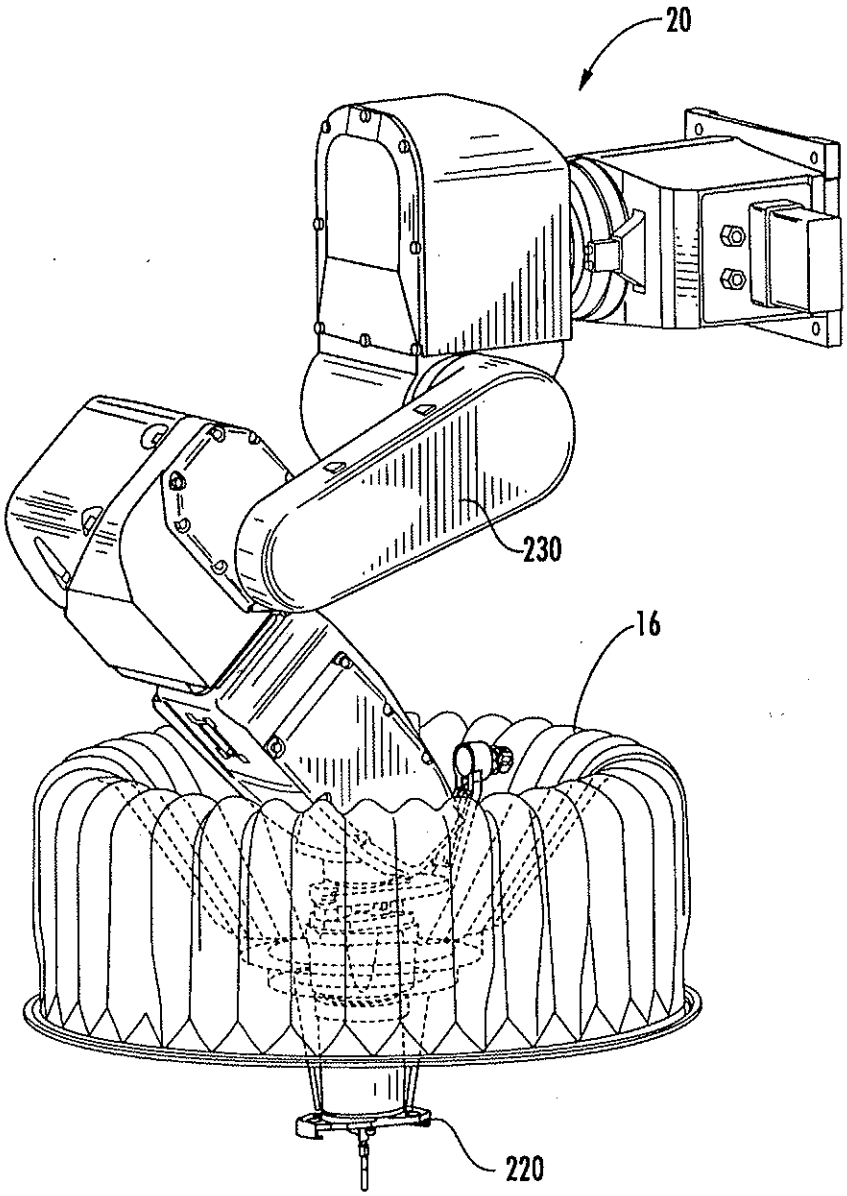


FIG. 9H

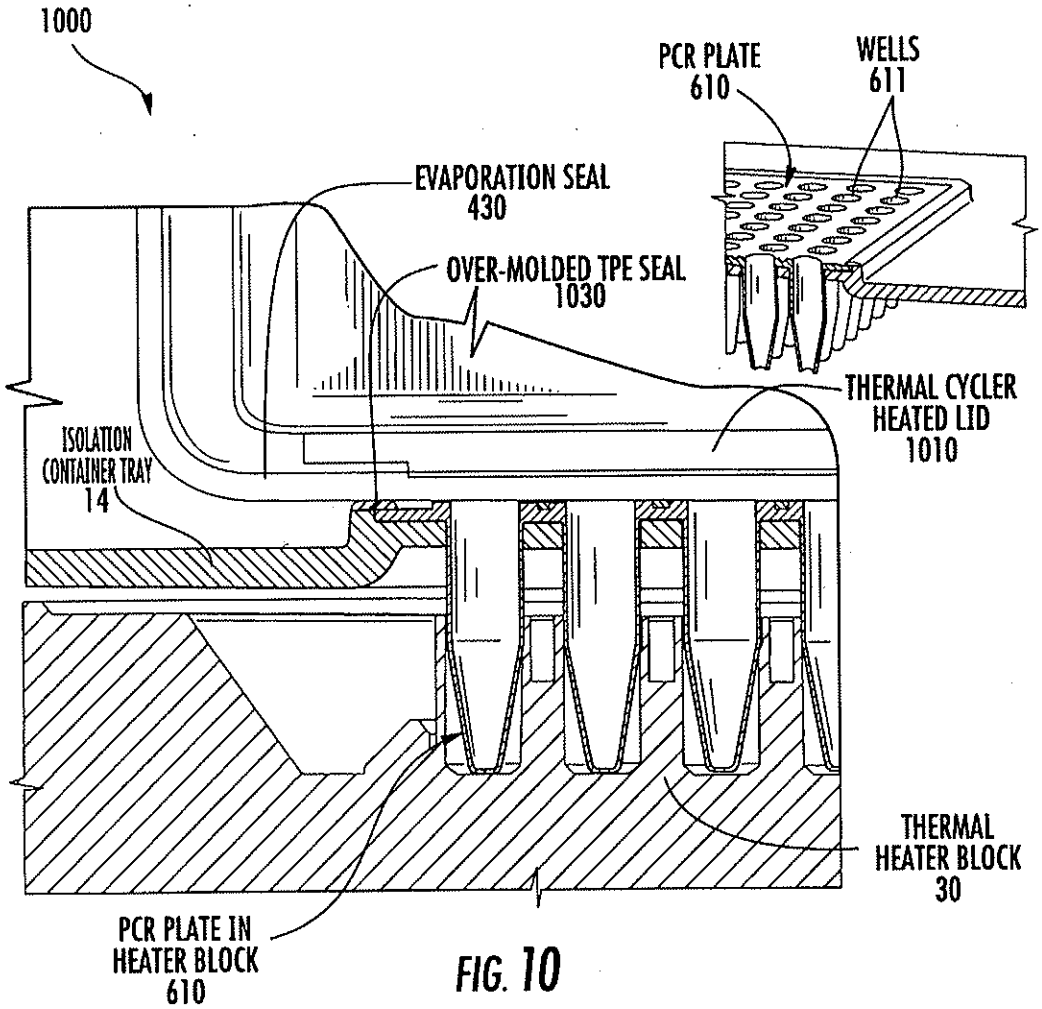

1000
PCR PLATE
610
WELLS
611
EVAPORATION SEAL
430
OVER-MOLDED TPE SEAL
1030
THERMAL CYCLER
HEATED LID
1010
ISOLATION
CONTAINER TRAY
14
THERMAL
HEATER BLOCK
30
PCR PLATE IN
HEATER BLOCK
610

FIG. 10

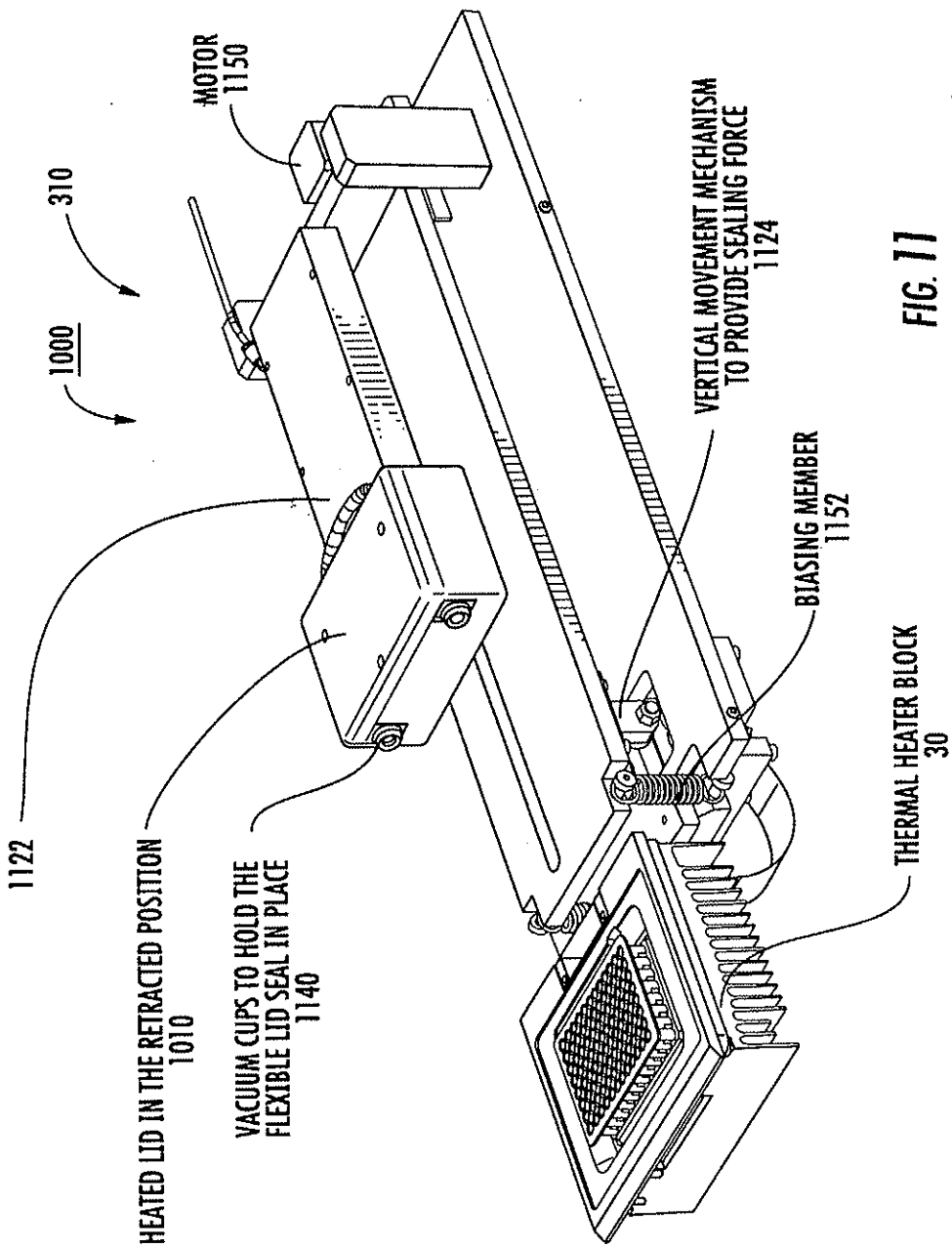

1000
310
MOTOR
1150
VERTICAL MOVEMENT MECHANISM
TO PROVIDE SEALING FORCE
1124
BIASING MEMBER
1152
THERMAL HEATER BLOCK
30
1122
HEATED LID IN THE RETRACTED POSITION
1010
VACUUM CUPS TO HOLD THE
FLEXIBLE LID SEAL IN PLACE
1140

FIG. 11

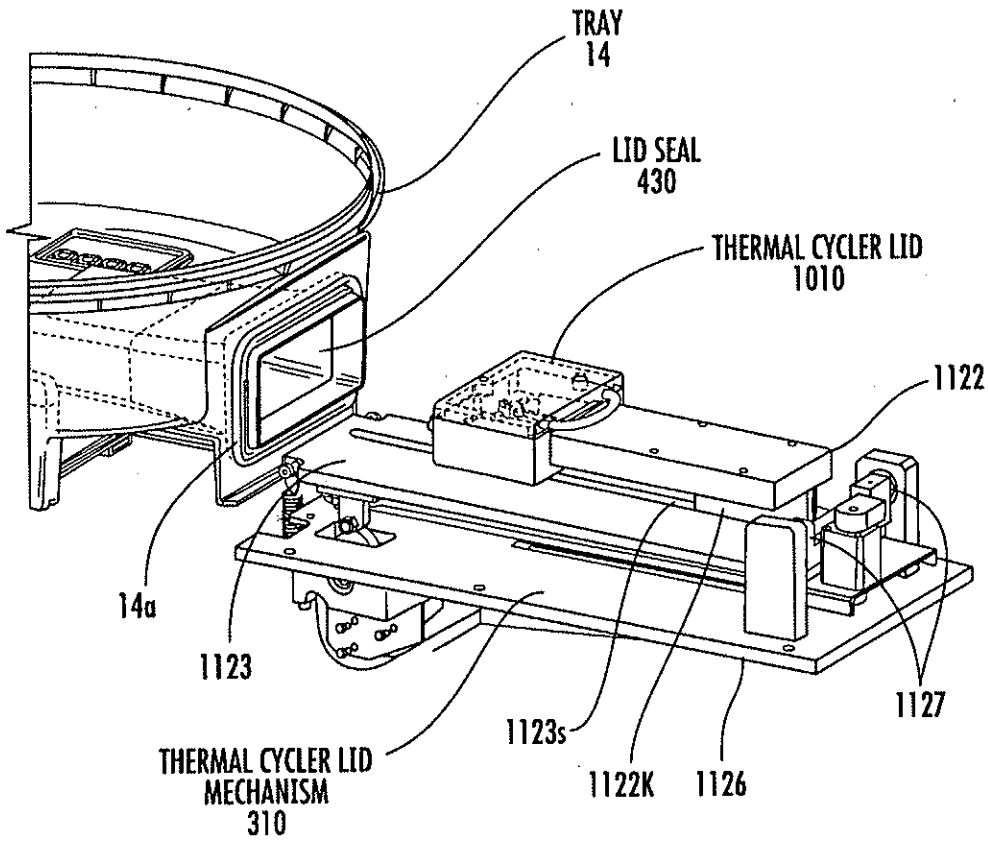

TRAY
14
LID SEAL
430
THERMAL CYCLER LID
1010
1122
14a
1123
1123s
1127
THERMAL CYCLER LID
MECHANISM
310
1122K
1126

FIG. 12

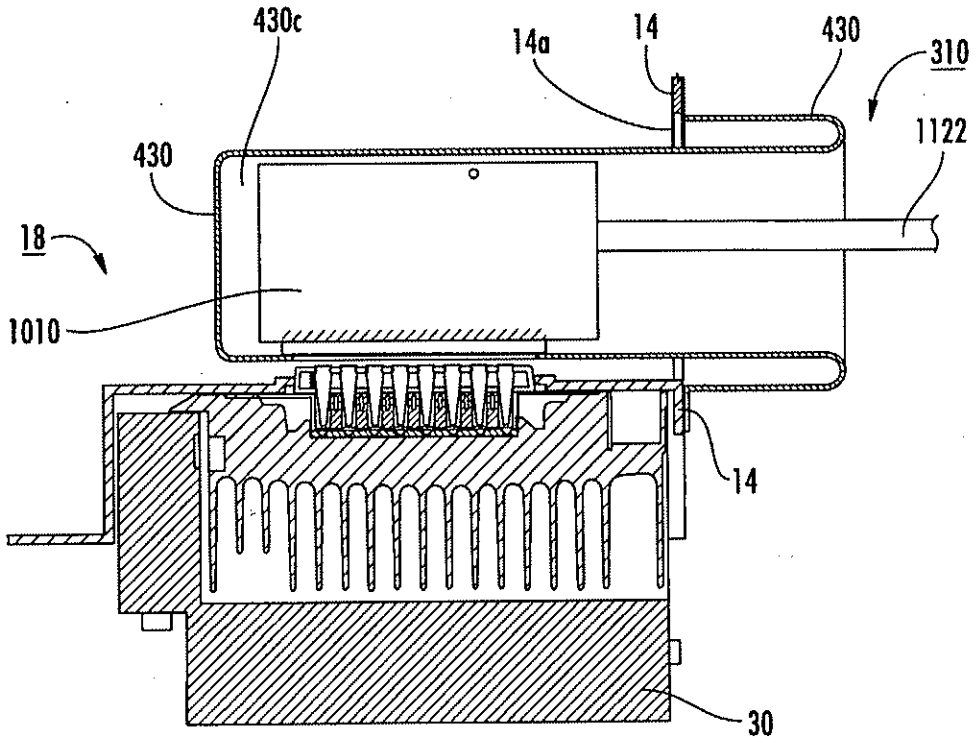


FIG. 13A

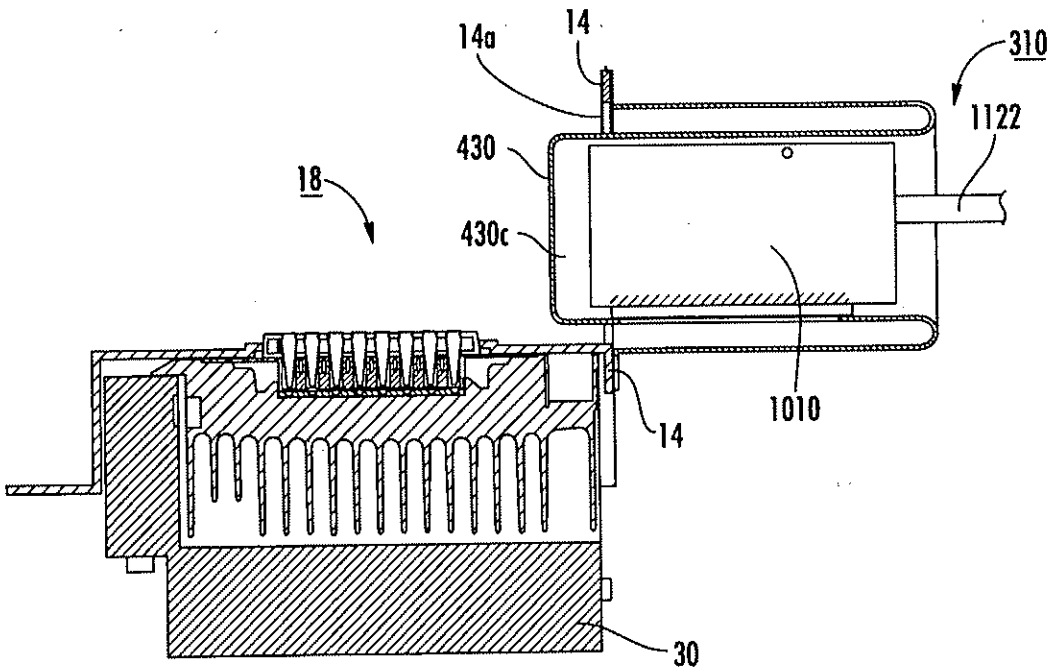


FIG. 13B

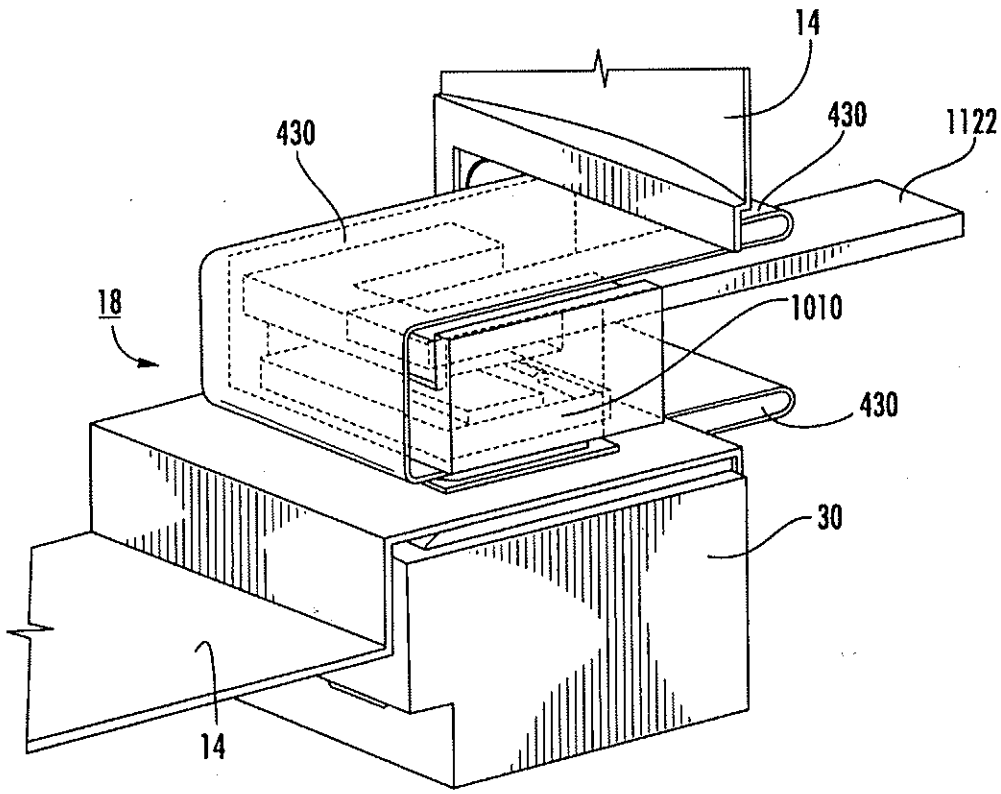


FIG. 13C

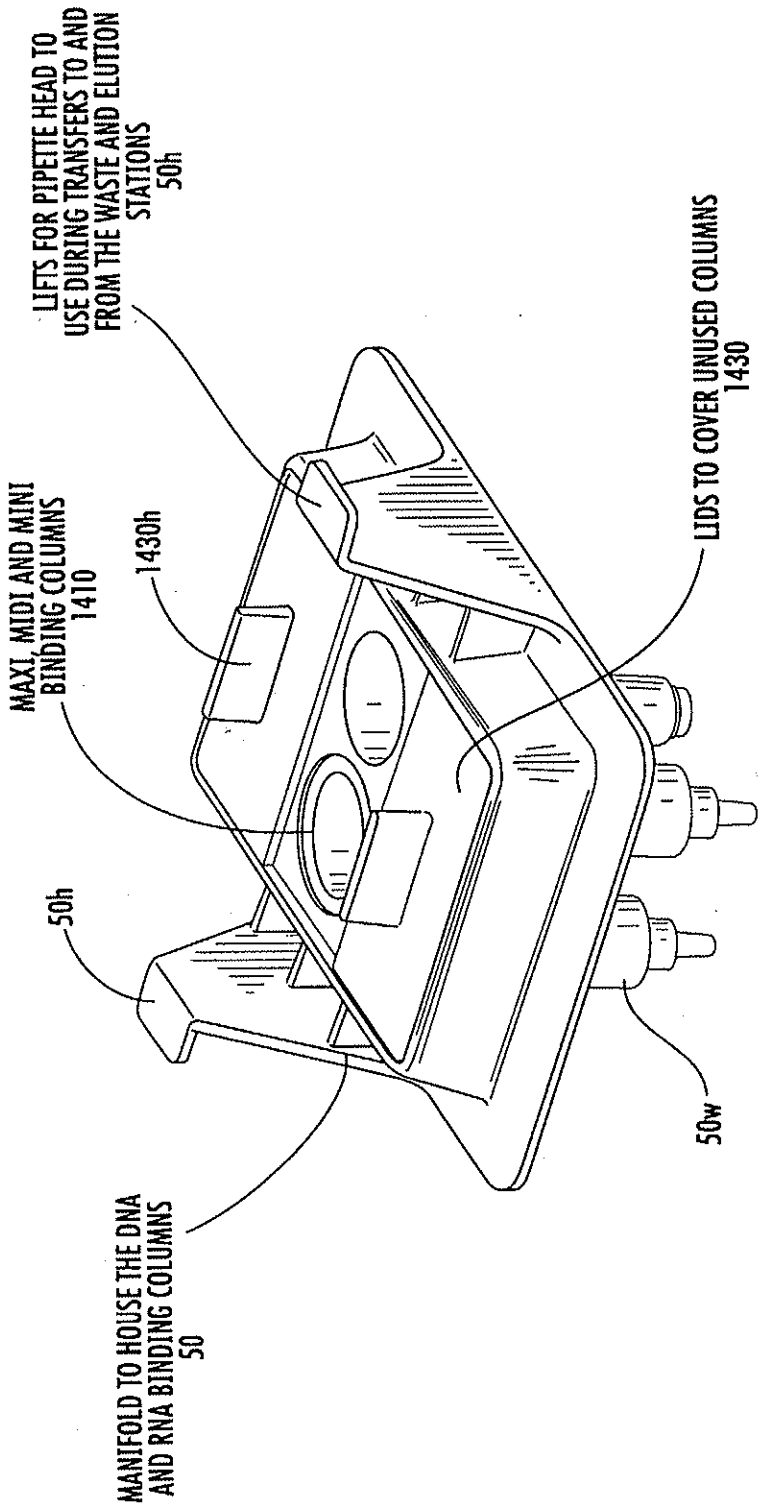

LIFTS FOR PIPETTE HEAD TO USE DURING TRANSFERS TO AND FROM THE WASTE AND ELUTION STATIONS 50h
MAXI, MIDI AND MINI BINDING COLUMNS 1410
1430h
LIDS TO COVER UNUSED COLUMNS 1430
50h
50w
MANIFOLD TO HOUSE THE DNA AND RNA BINDING COLUMNS 50

FIG. 14

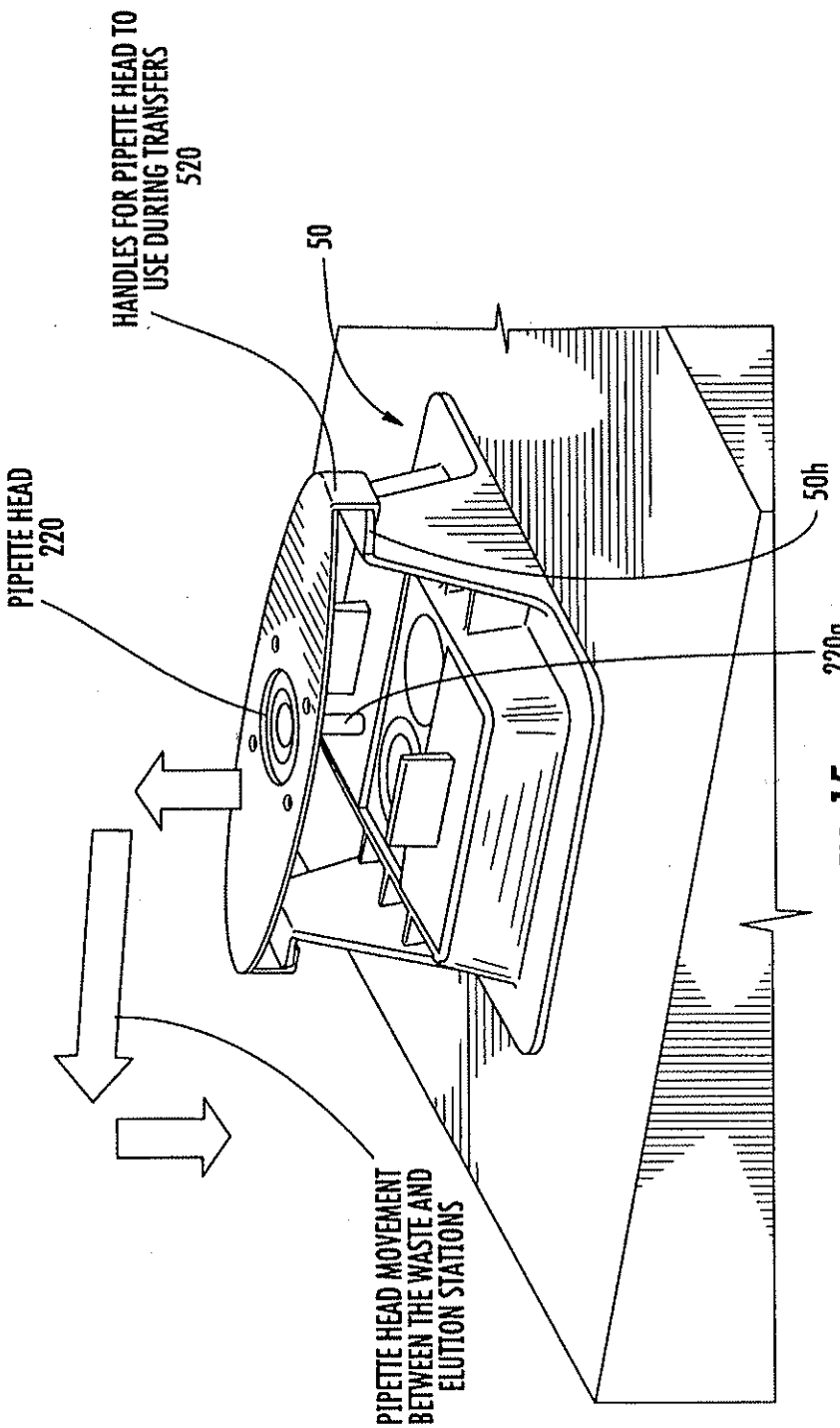

HANDLES FOR PIPETTE HEAD TO USE DURING TRANSFERS
520
50
PIPETTE HEAD
220
50h
220a
PIPETTE HEAD MOVEMENT BETWEEN THE WASTE AND ELUTION STATIONS

FIG. 15

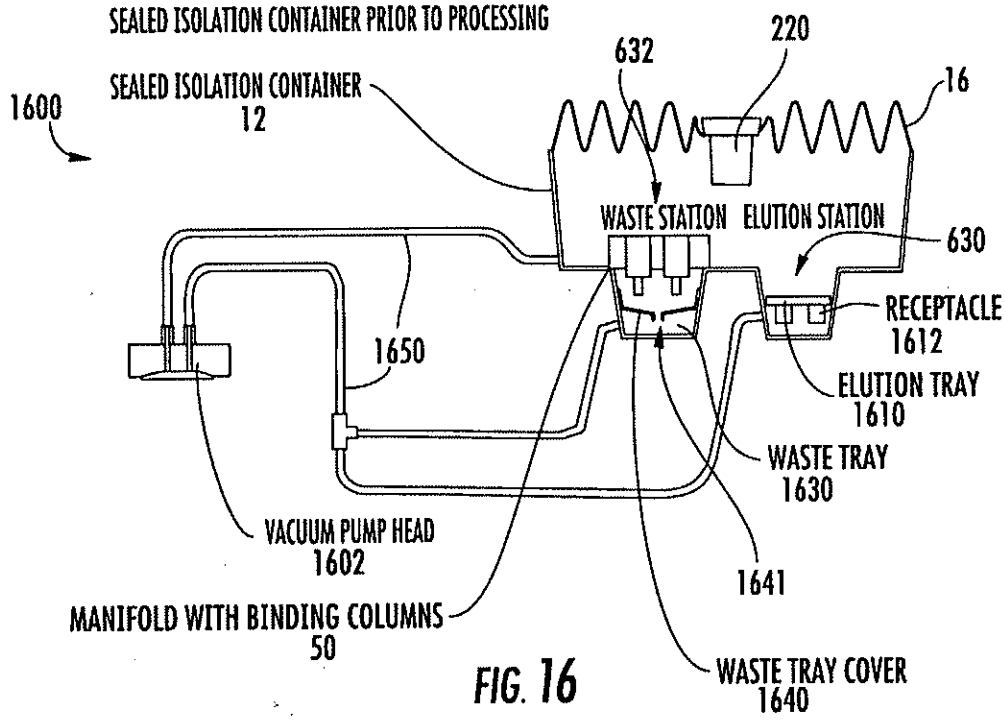

SEALED ISOLATION CONTAINER PRIOR TO PROCESSING
SEALED ISOLATION CONTAINER
12
1600
632
220
16
WASTE STATION
ELUTION STATION
630
RECEPTACLE
1612
ELUTION TRAY
1610
1650
WASTE TRAY
1630
VACUUM PUMP HEAD
1602
1641
MANIFOLD WITH BINDING COLUMNS
50
WASTE TRAY COVER
1640

FIG. 16

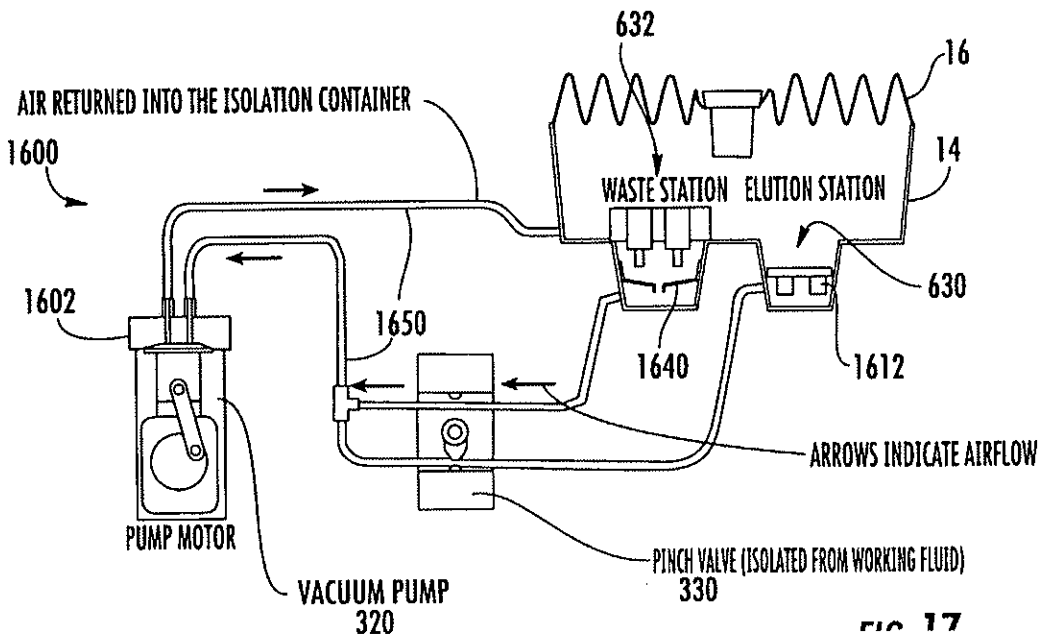

SEALED ISOLATION CONTAINER CONNECTED FOR PROCESSING
632
16
AIR RETURNED INTO THE ISOLATION CONTAINER
1600
14
WASTE STATION
ELUTION STATION
630
1602
1650
1640
1612
ARROWS INDICATE AIRFLOW
PUMP MOTOR
PINCH VALVE (ISOLATED FROM WORKING FLUID)
330
VACUUM PUMP
320

FIG. 17

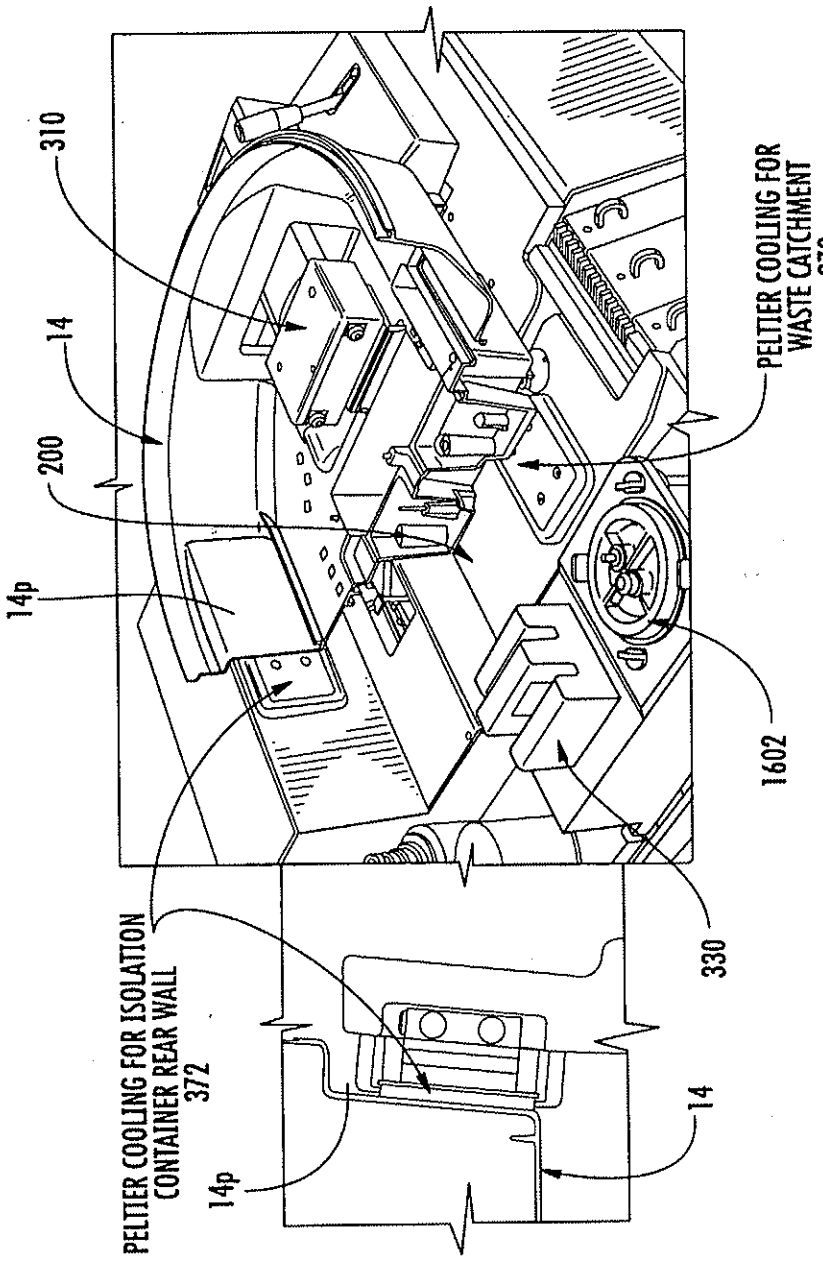

310
14
200
14p
PELTIER COOLING FOR WASTE CATCHMENT 370
1602
330
PELTIER COOLING FOR ISOLATION CONTAINER REAR WALL 372
14p
14

FIG. 18

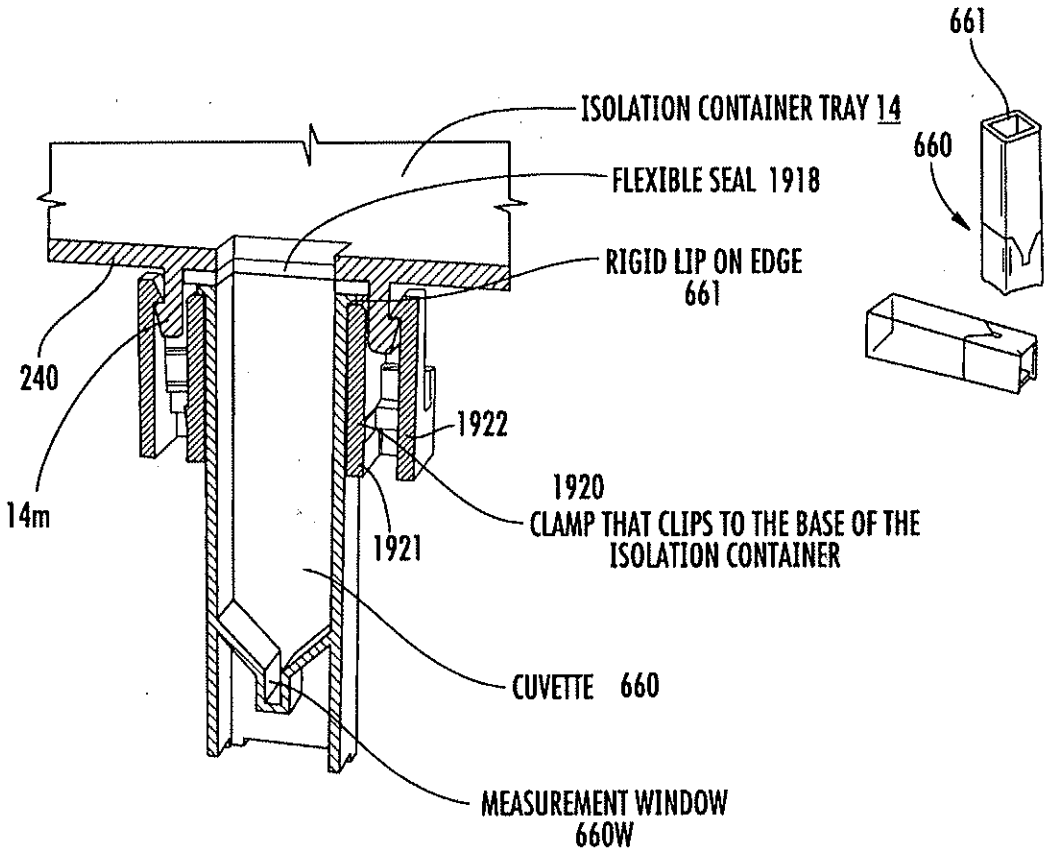

661
ISOLATION CONTAINER TRAY 14
660
FLEXIBLE SEAL 1918
RIGID LIP ON EDGE
661
240
1922
14m
1920
CLAMP THAT CLIPS TO THE BASE OF THE
ISOLATION CONTAINER
1921
CUVETTE 660
MEASUREMENT WINDOW
660W

FIG. 19A

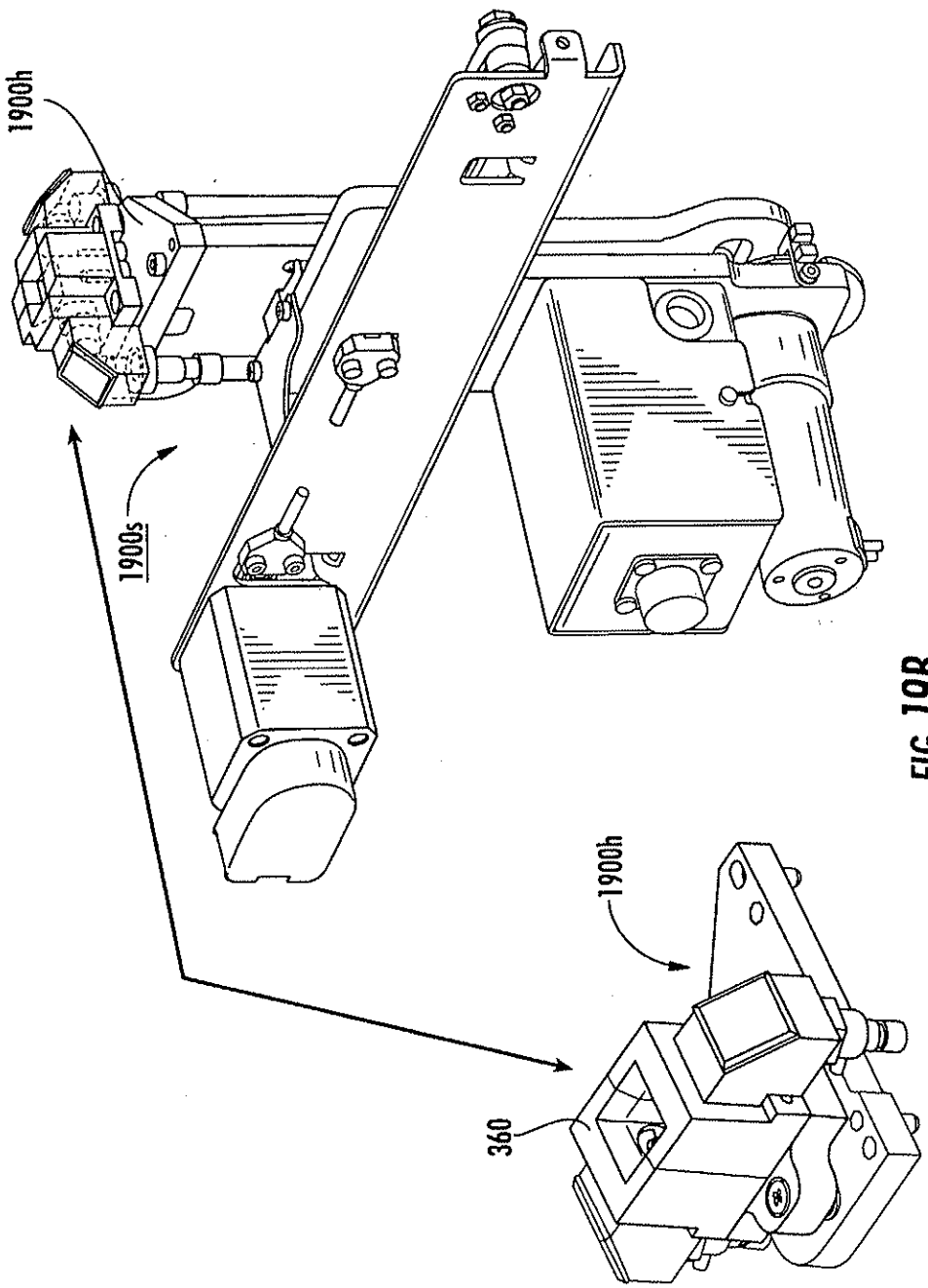


FIG. 19B

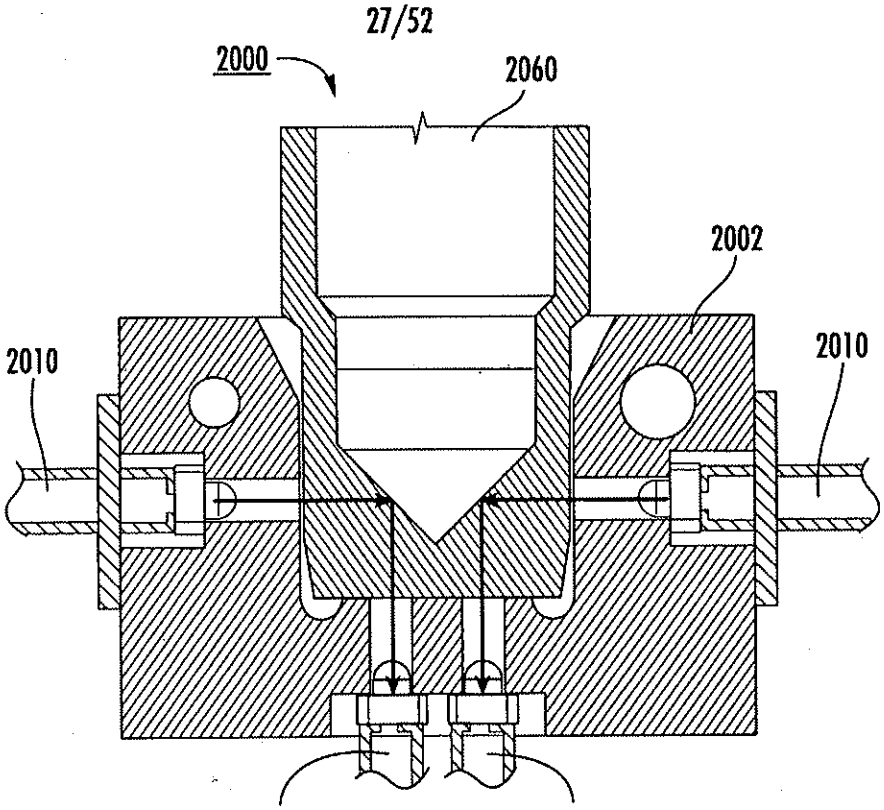


FIG. 20A

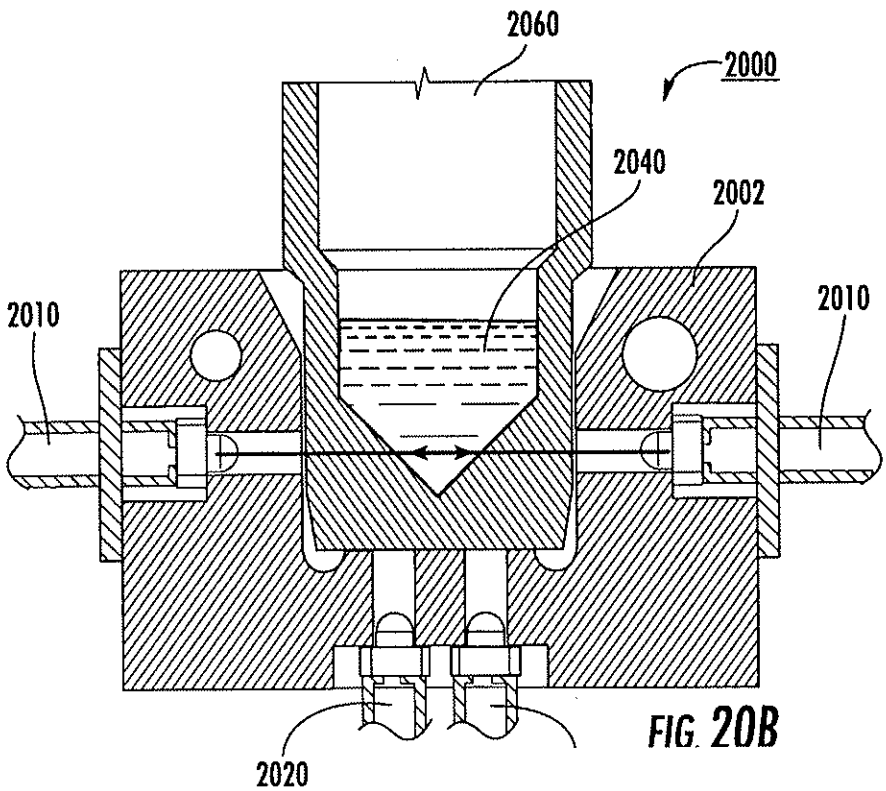


FIG. 20B

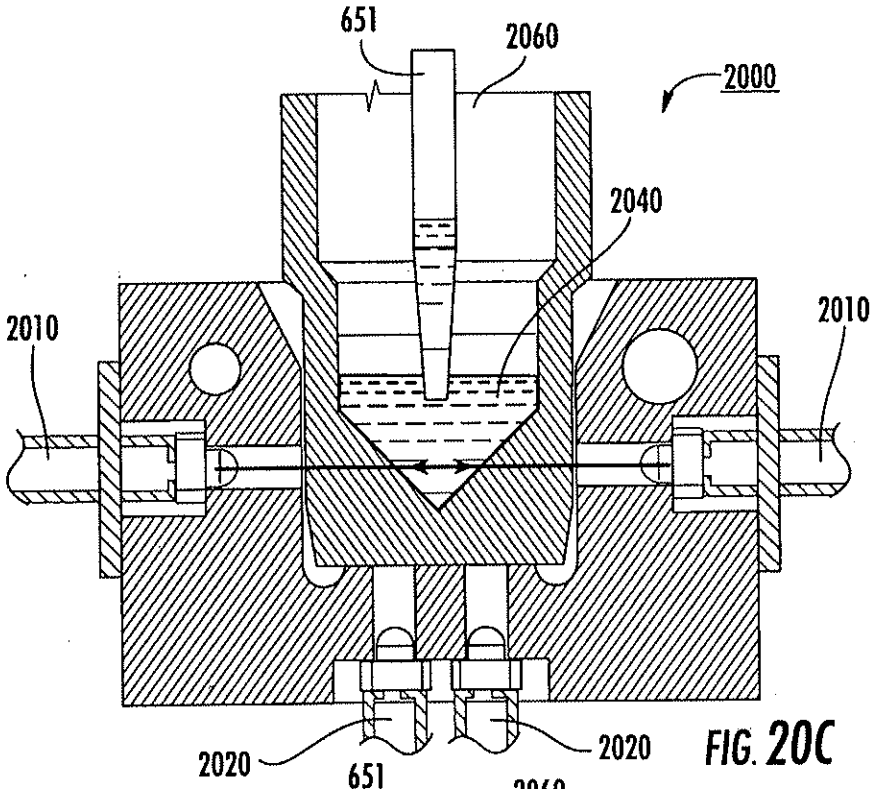


FIG. 20C

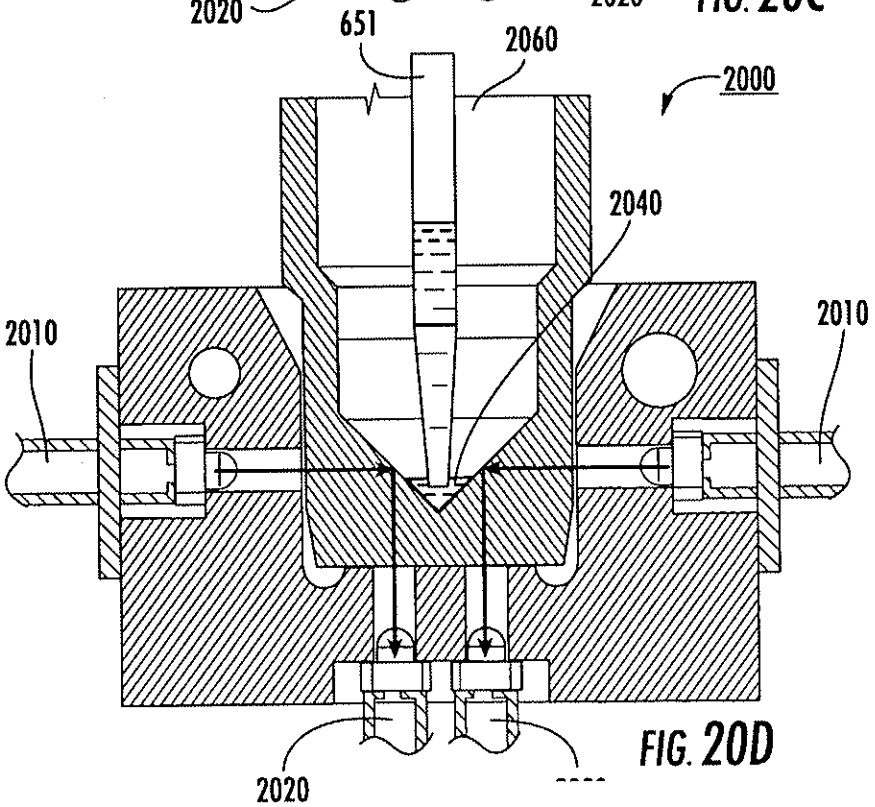


FIG. 20D

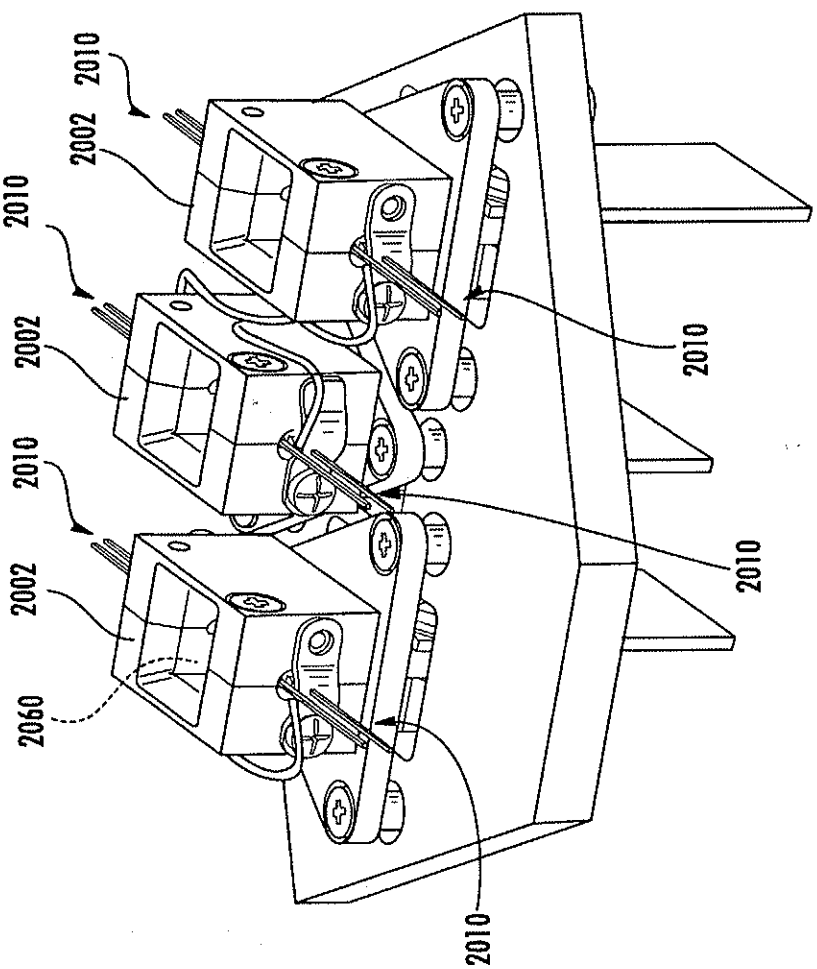


FIG. 20E

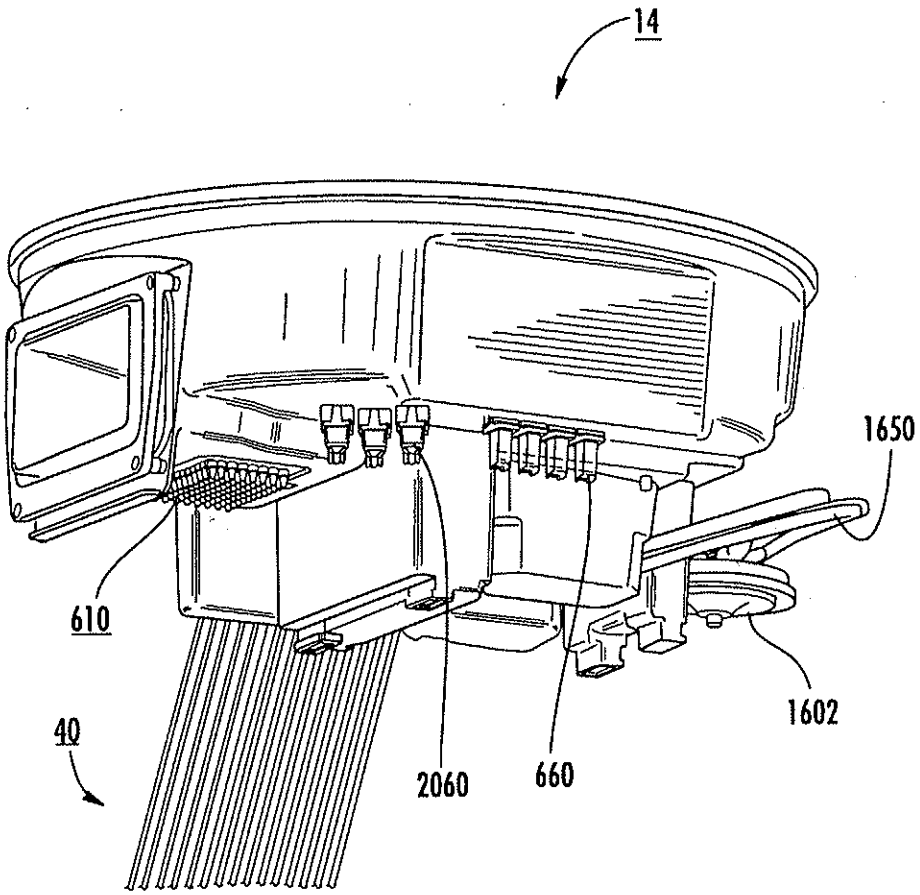


FIG. 20F

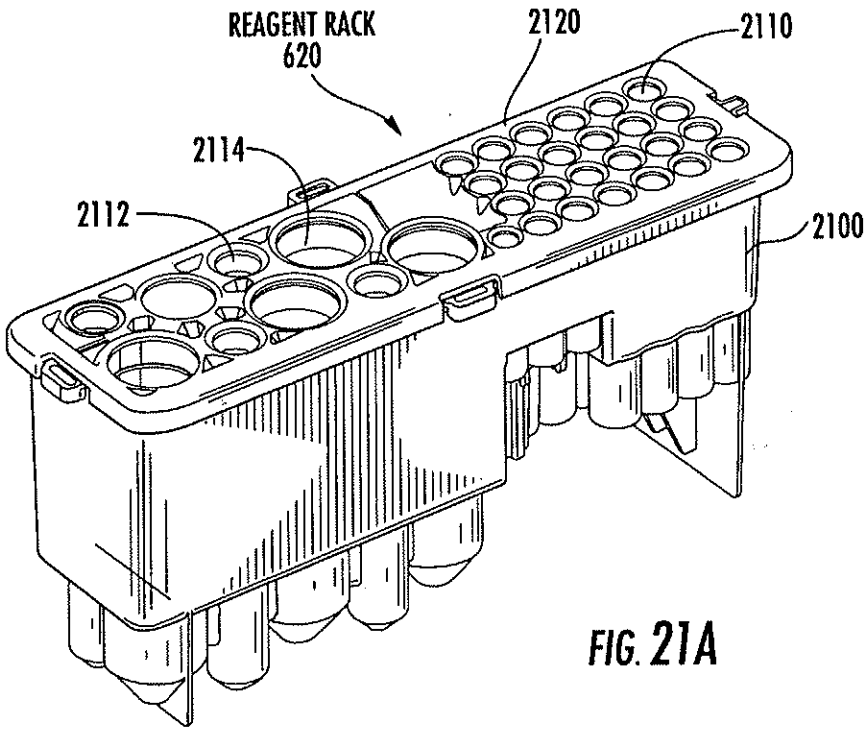


FIG. 21A

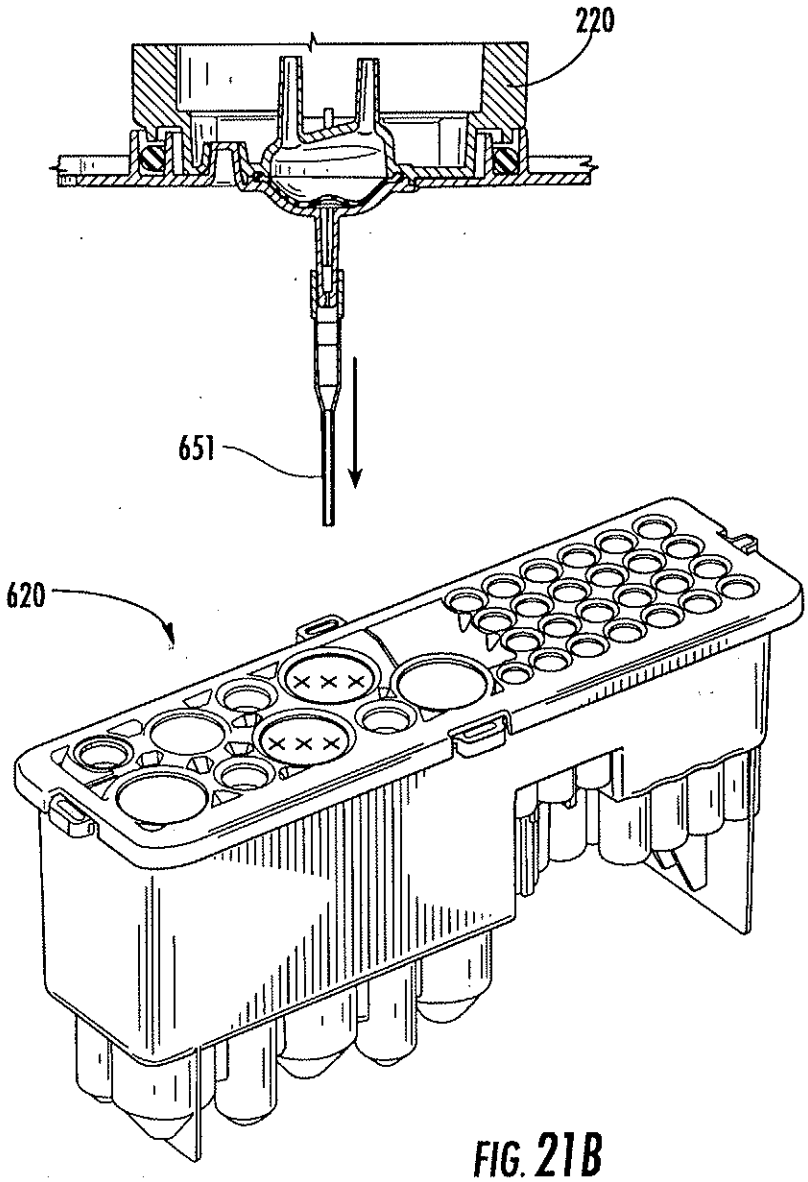


FIG. 21B

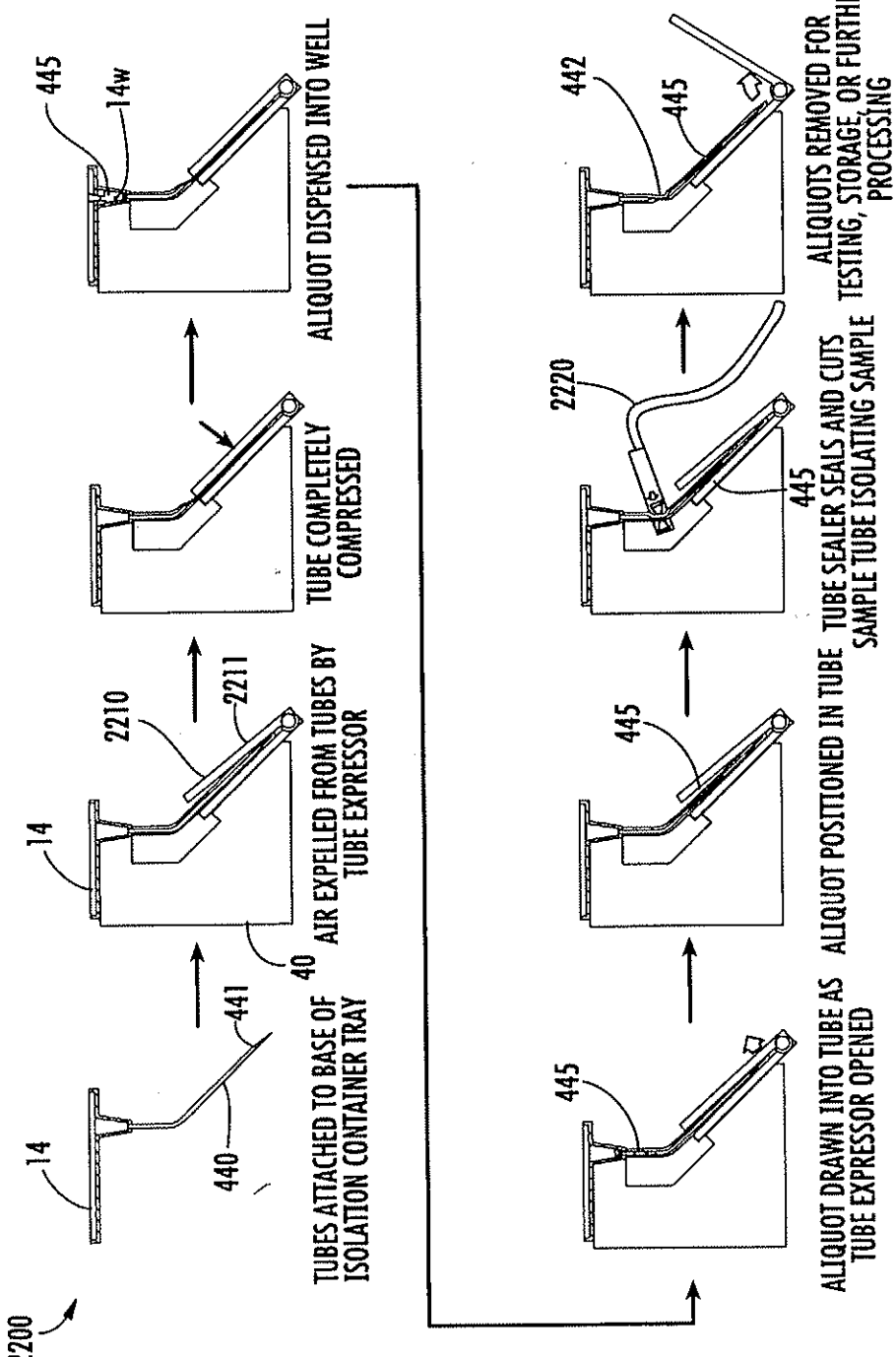

2200
14
440
441
TUBES ATTACHED TO BASE OF ISOLATION CONTAINER TRAY
14
2210
2211
40
AIR EXPELLED FROM TUBES BY TUBE EXPRESSOR
TUBE COMPLETELY COMPRESSED
445
14w
ALIQUOT DISPENSED INTO WELL
445
ALIQUOT DRAWN INTO TUBE AS TUBE EXPRESSOR OPENED
445
ALIQUOT POSITIONED IN TUBE
2220
445
TUBE SEALER SEALS AND CUTS SAMPLE TUBE ISOLATING SAMPLE
442
445
ALIQUOTS REMOVED FOR TESTING, STORAGE, OR FURTHER PROCESSING

FIG. 22

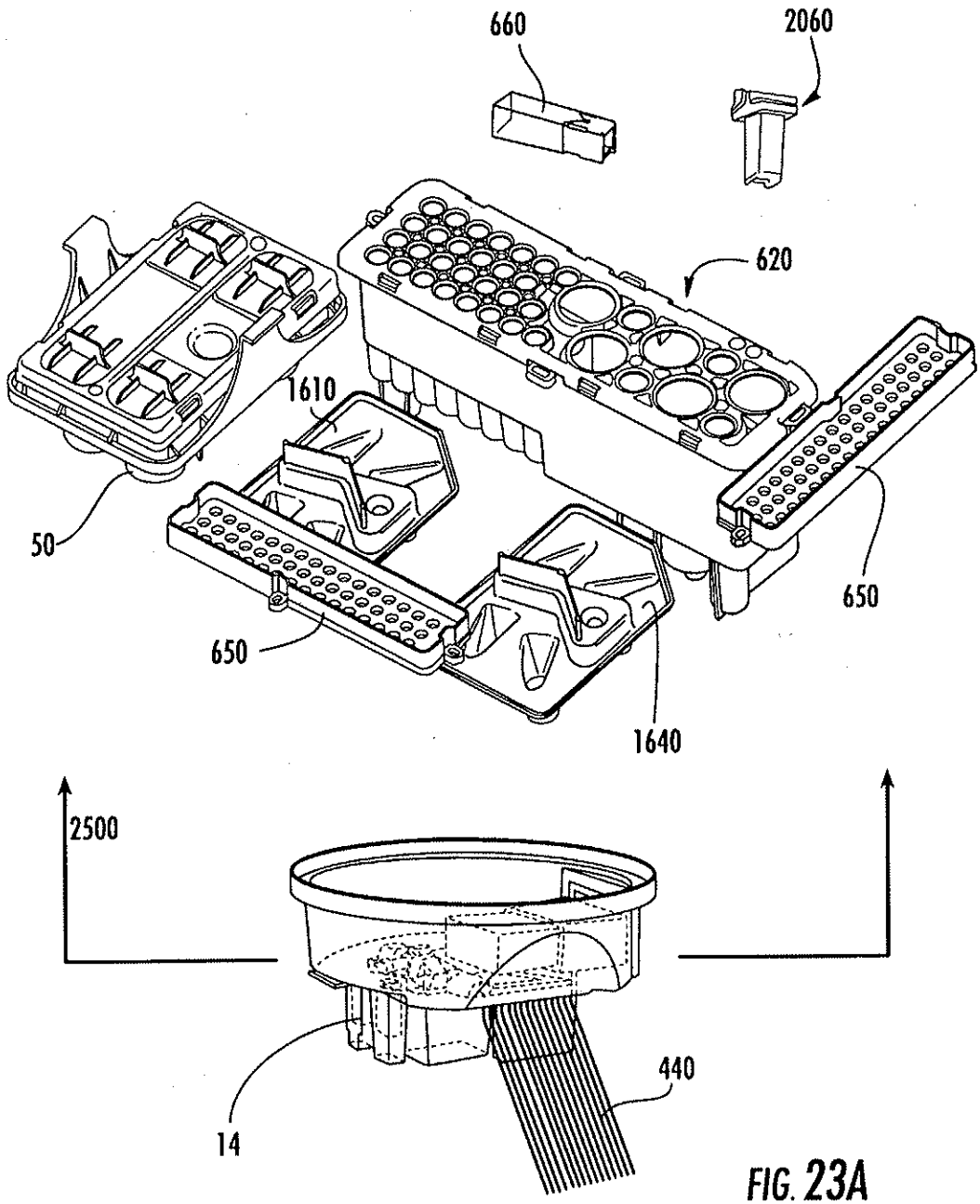


FIG. 23A

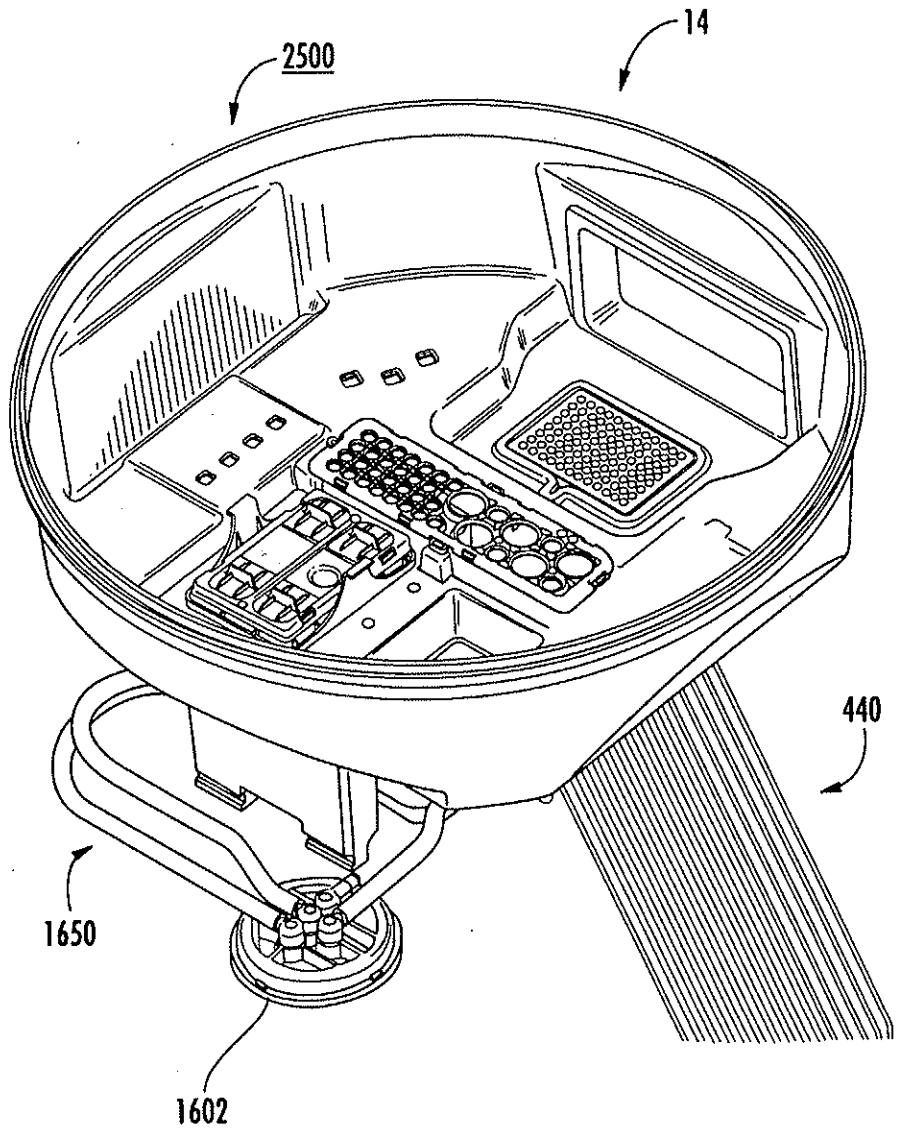


FIG. 23B

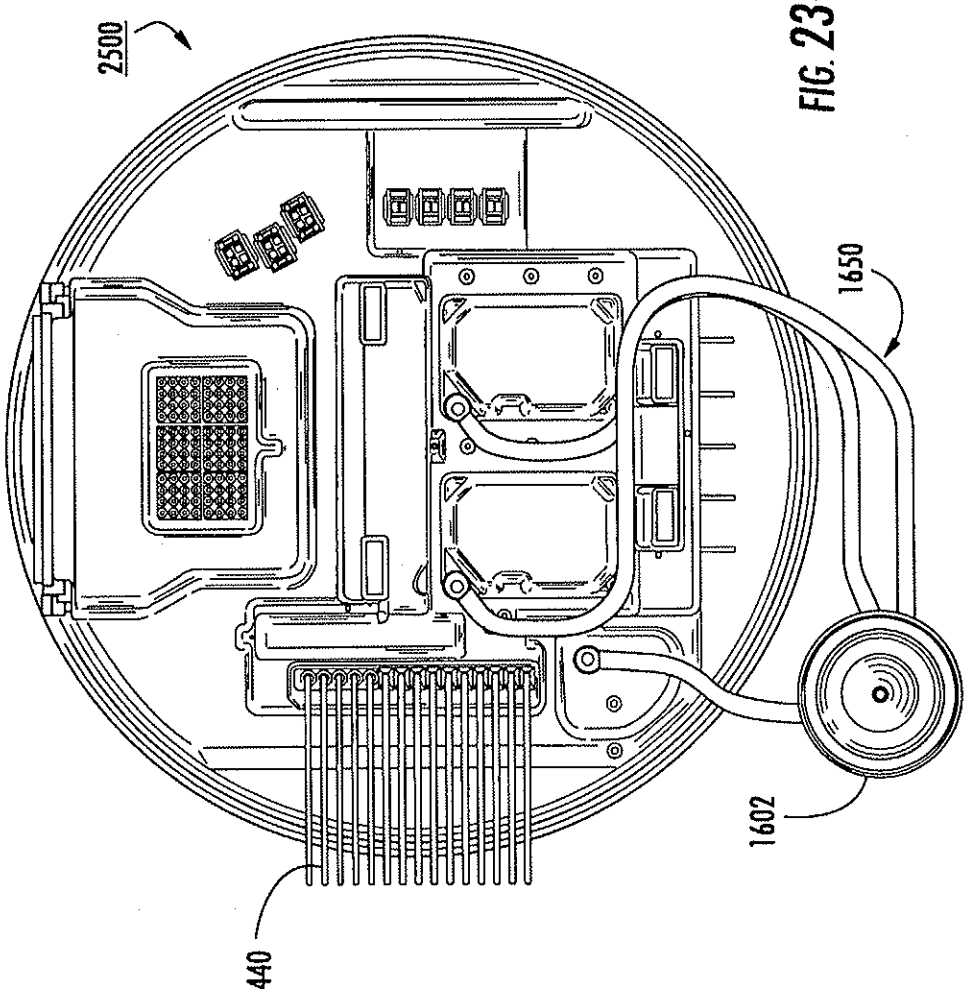


FIG. 23C

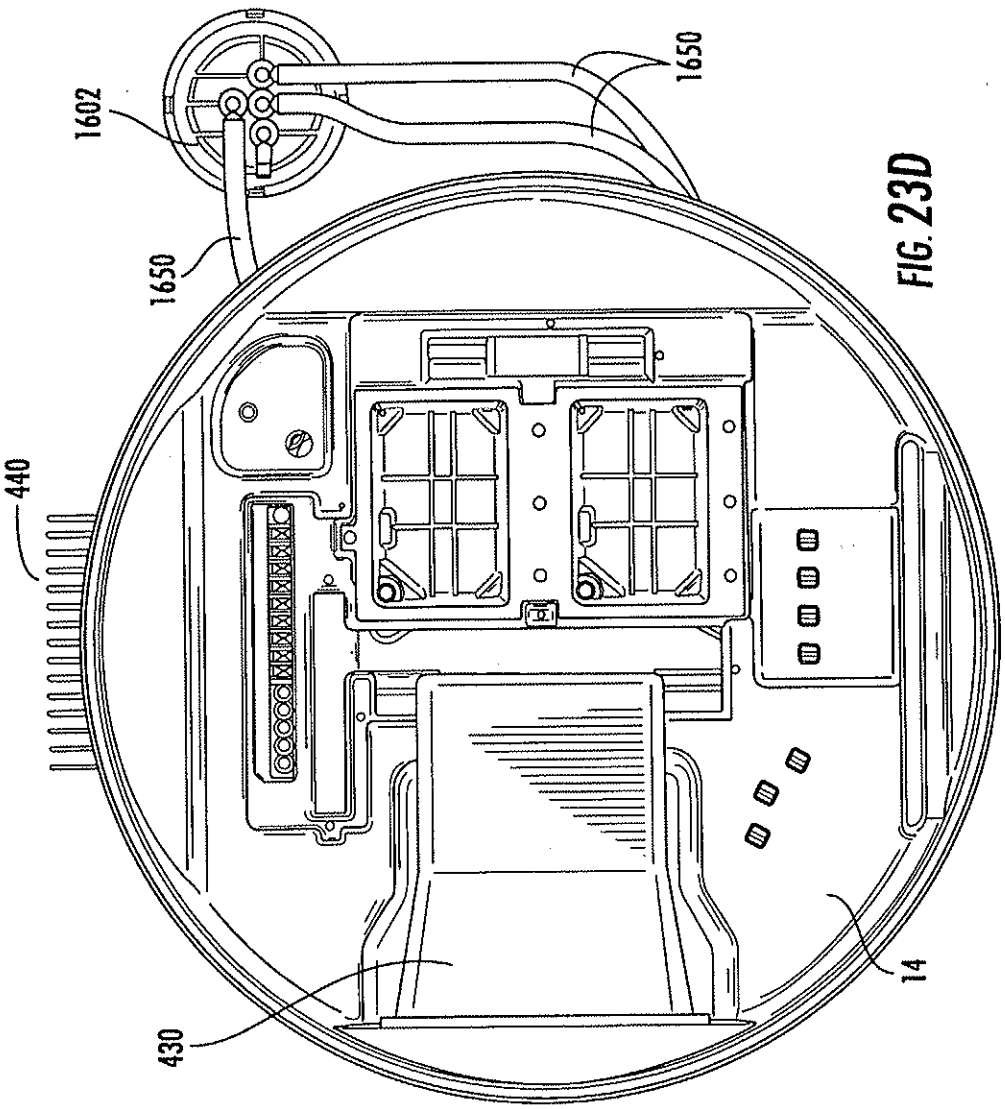


FIG. 23D

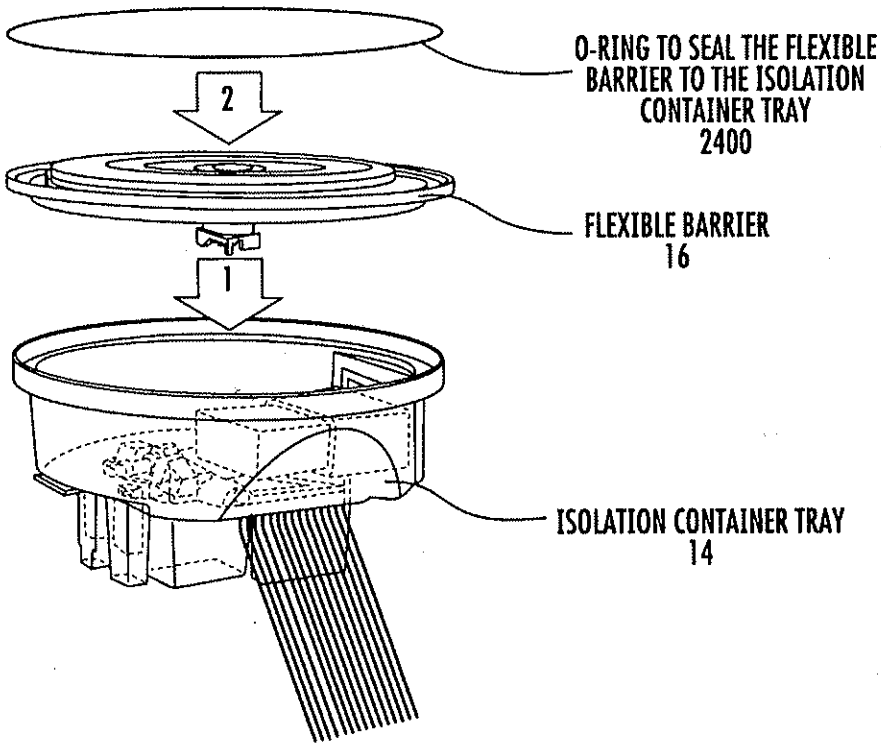

O-RING TO SEAL THE FLEXIBLE BARRIER TO THE ISOLATION CONTAINER TRAY
2400
2
FLEXIBLE BARRIER
16
1
ISOLATION CONTAINER TRAY
14

FIG. 24

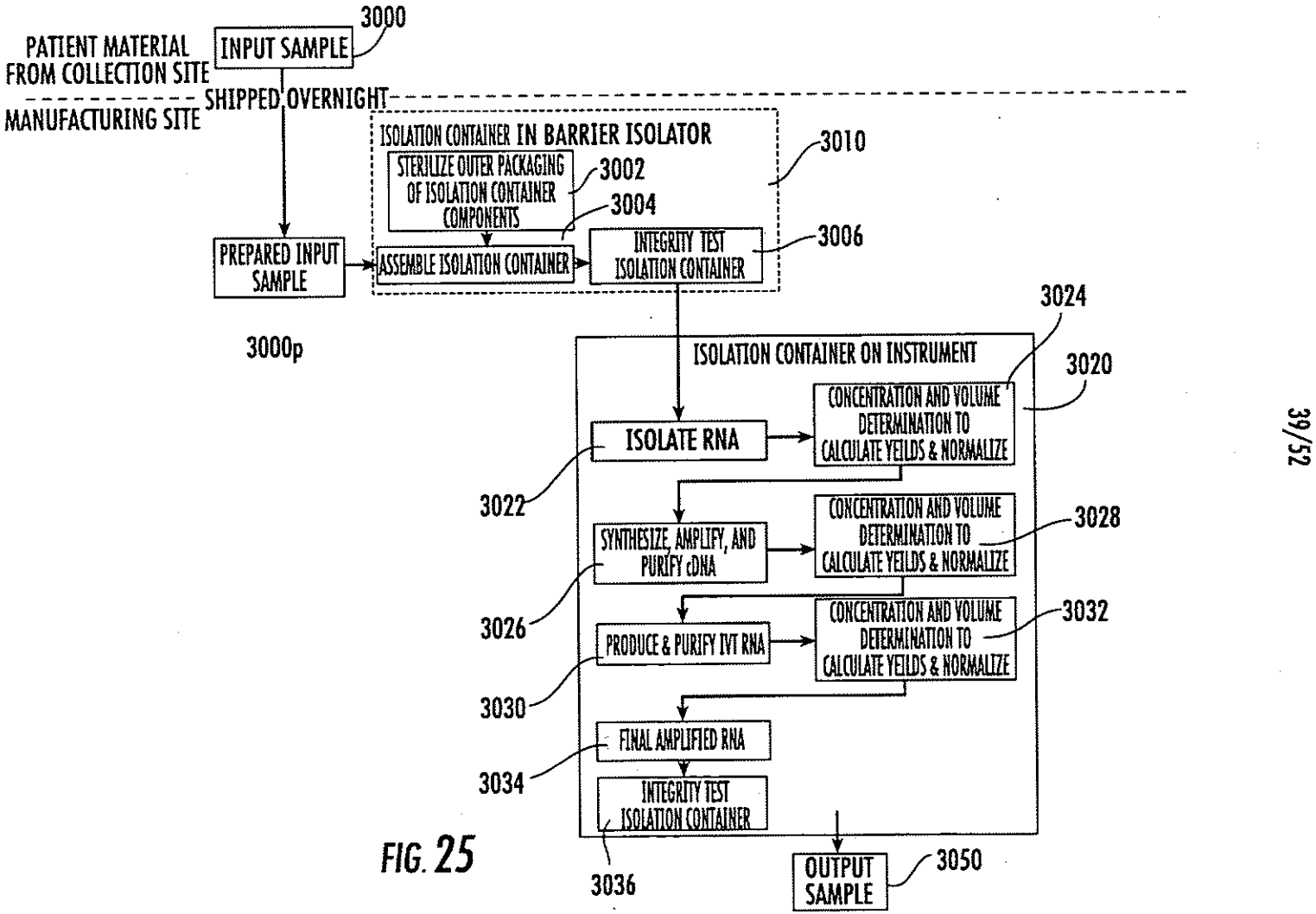

PATIENT MATERIAL FROM COLLECTION SITE
INPUT SAMPLE
3000
SHIPPED OVERNIGHT
MANUFACTURING SITE
ISOLATION CONTAINER IN BARRIER ISOLATOR
3010
STERILIZE OUTER PACKAGING OF ISOLATION CONTAINER COMPONENTS
3002
3004
PREPARED INPUT SAMPLE
ASSEMBLE ISOLATION CONTAINER
INTEGRITY TEST ISOLATION CONTAINER
3006
3000p
3024
ISOLATION CONTAINER ON INSTRUMENT
3020
CONCENTRATION AND VOLUME DETERMINATION TO CALCULATE YEILDS & NORMALIZE
ISOLATE RNA
3022
SYNTHESIZE, AMPLIFY, AND PURIFY cDNA
CONCENTRATION AND VOLUME DETERMINATION TO CALCULATE YEILDS & NORMALIZE
3028
3026
PRODUCE & PURIFY IVT RNA
CONCENTRATION AND VOLUME DETERMINATION TO CALCULATE YEILDS & NORMALIZE
3032
3030
FINAL AMPLIFIED RNA
3034
INTEGRITY TEST ISOLATION CONTAINER
3036
OUTPUT SAMPLE
3050

FIG. 25

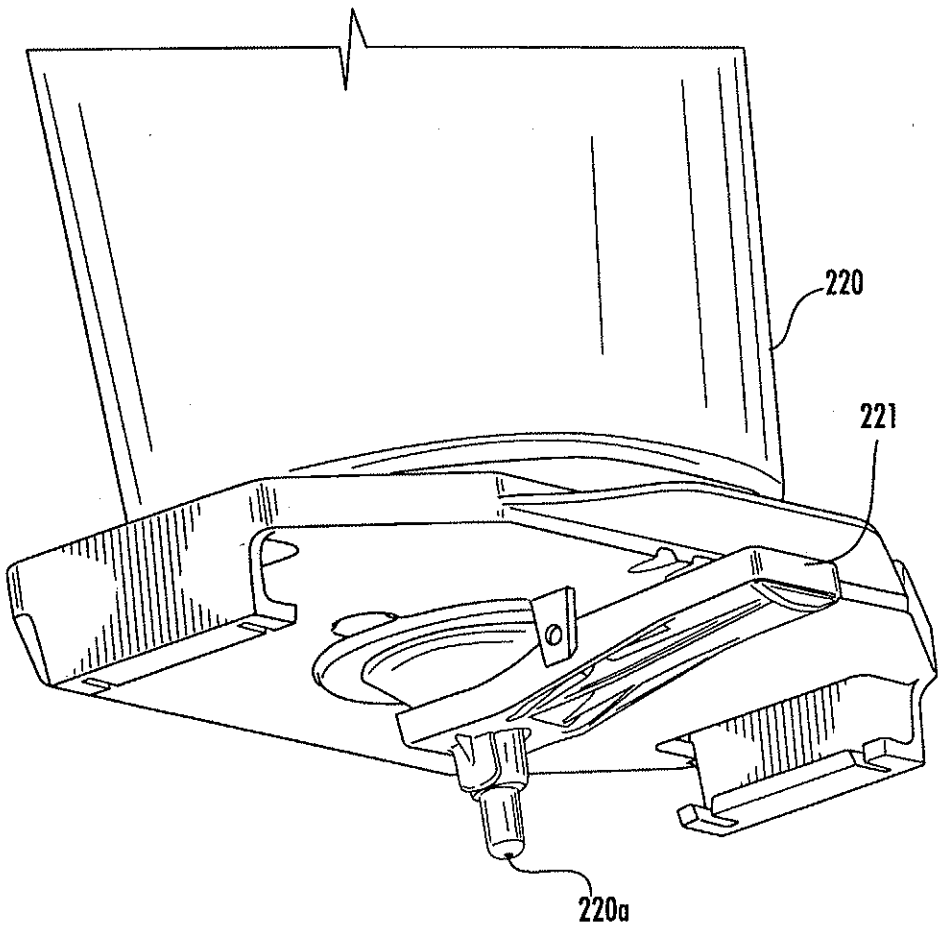


FIG. 26A

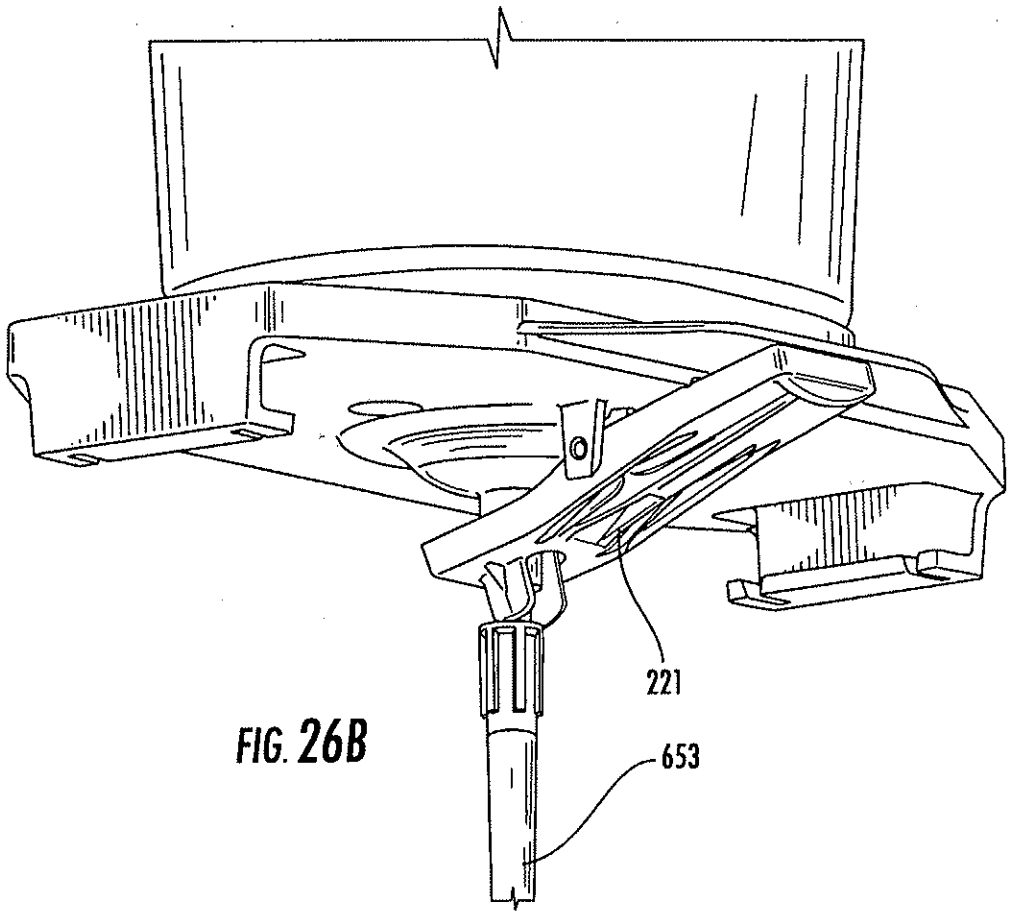


FIG. 26B

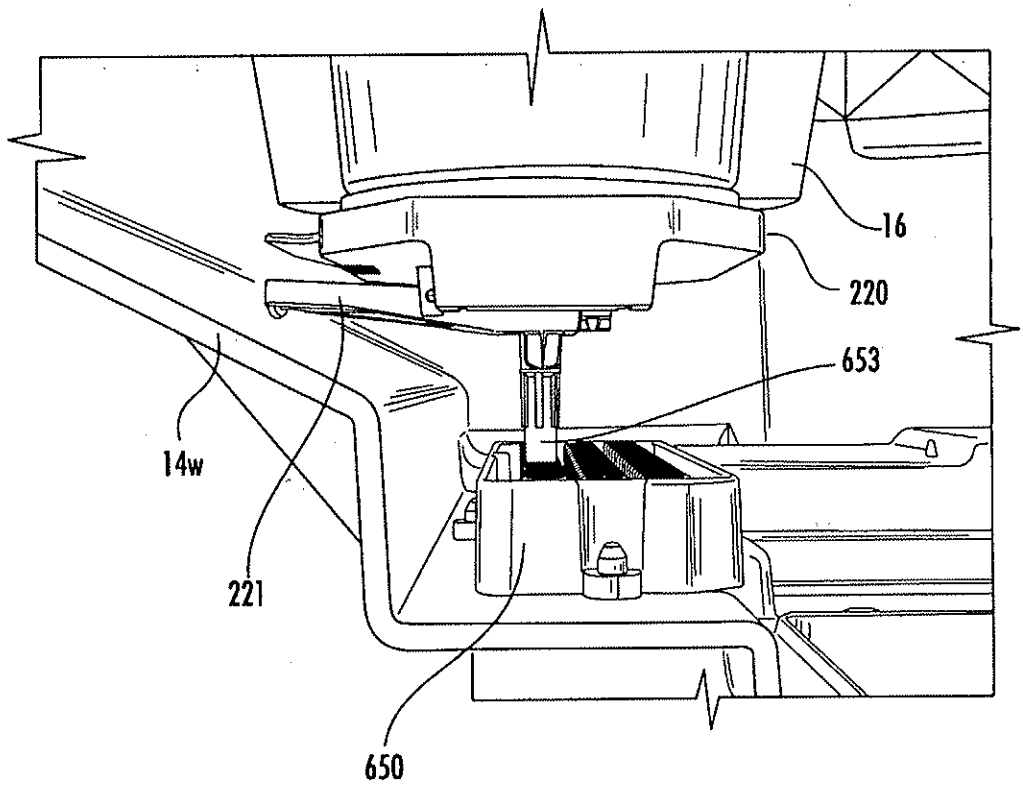


FIG. 26C

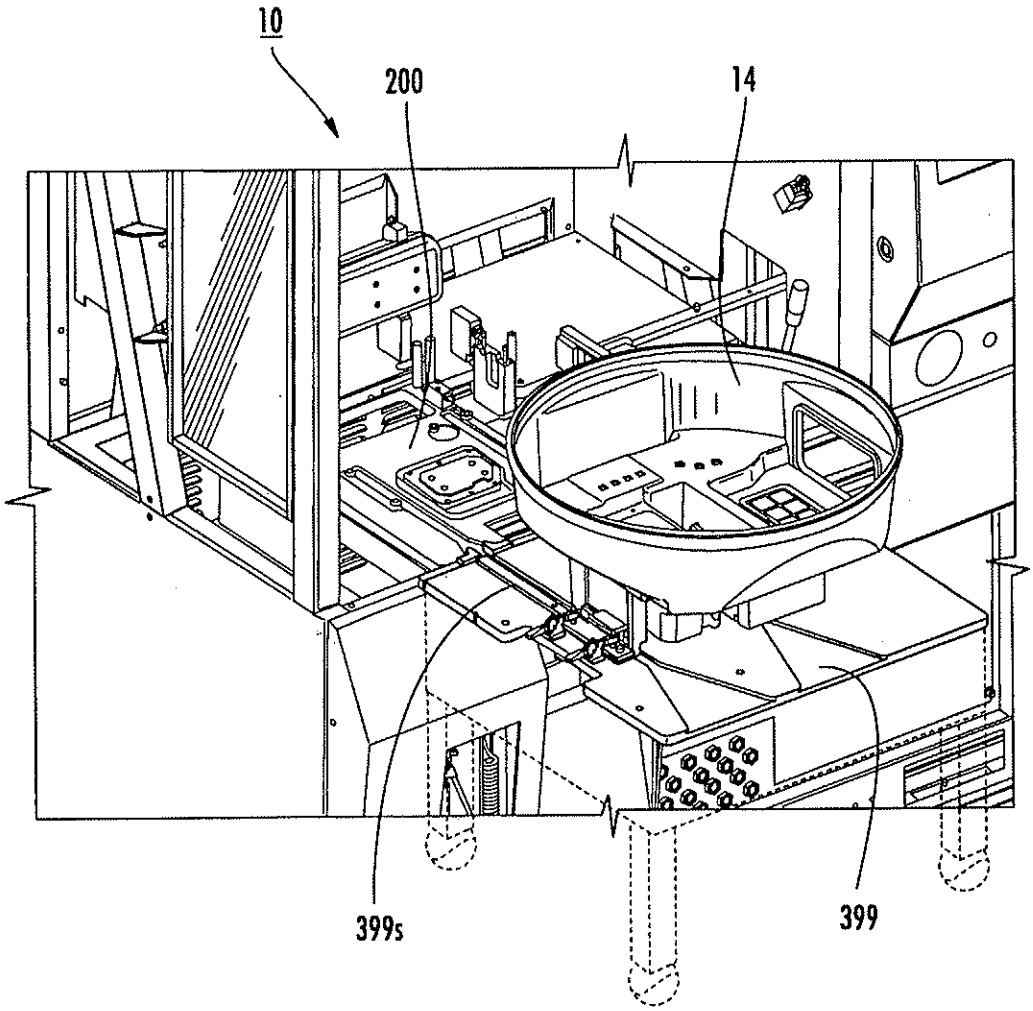


FIG. 27

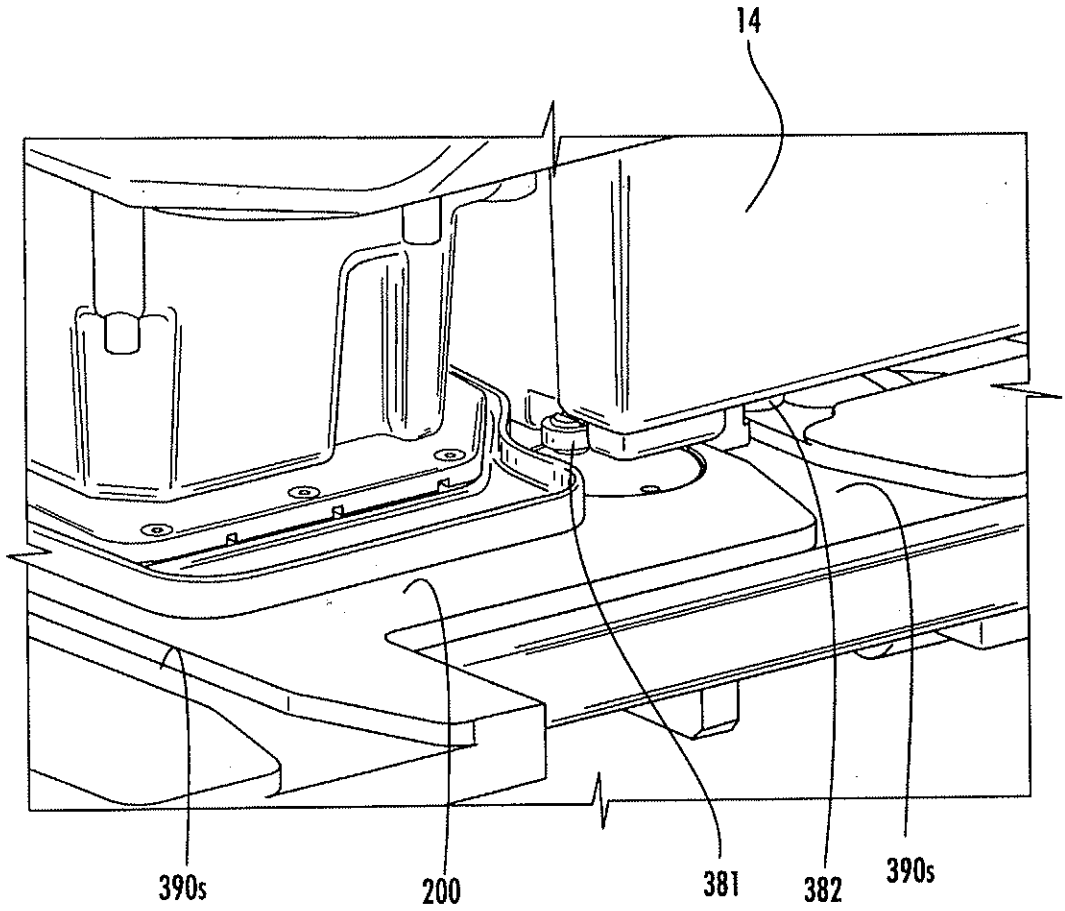


FIG. 28A

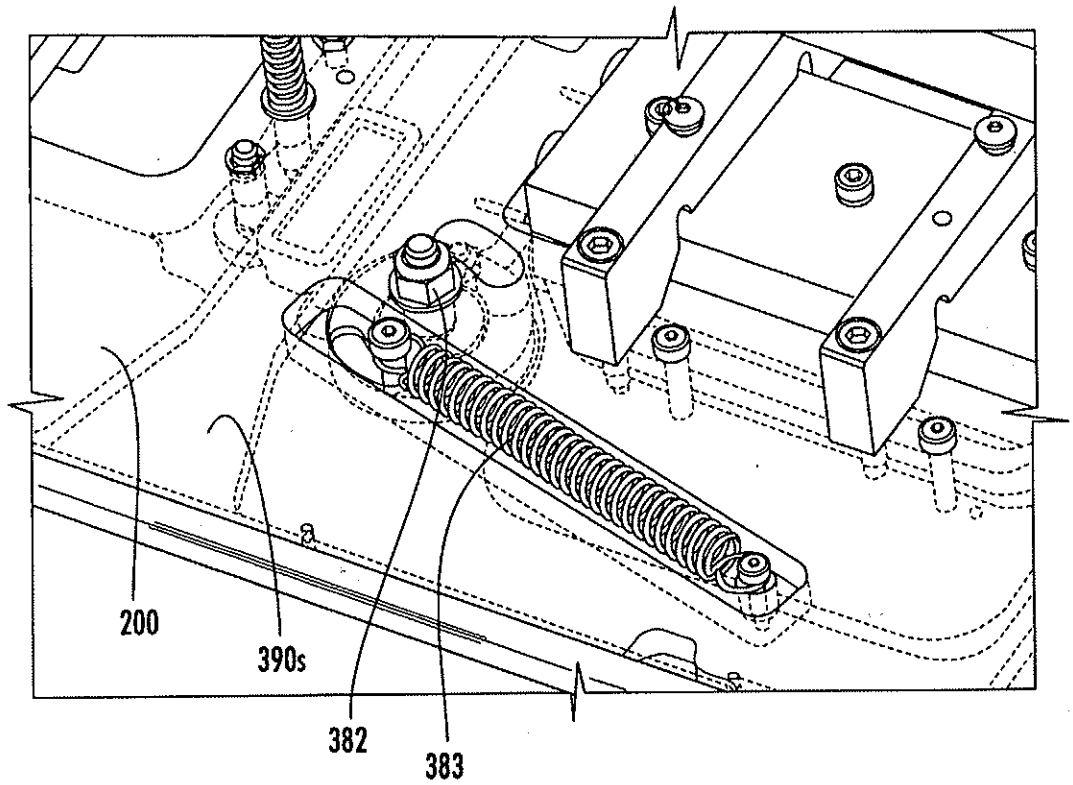


FIG. 28B

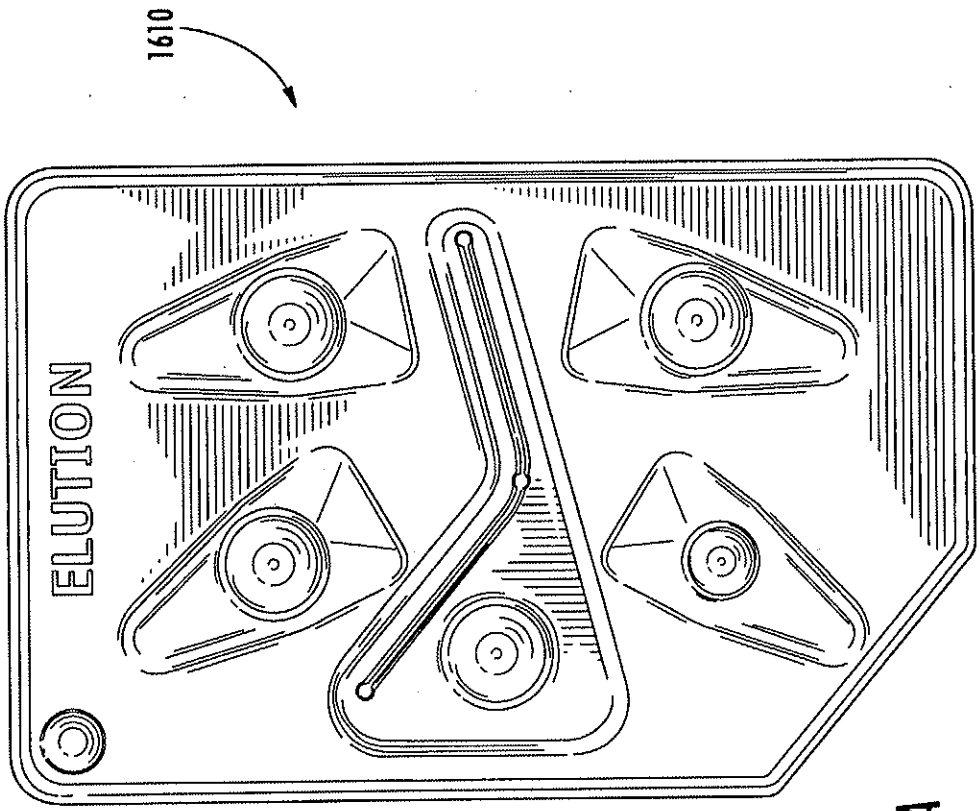


FIG. 29A

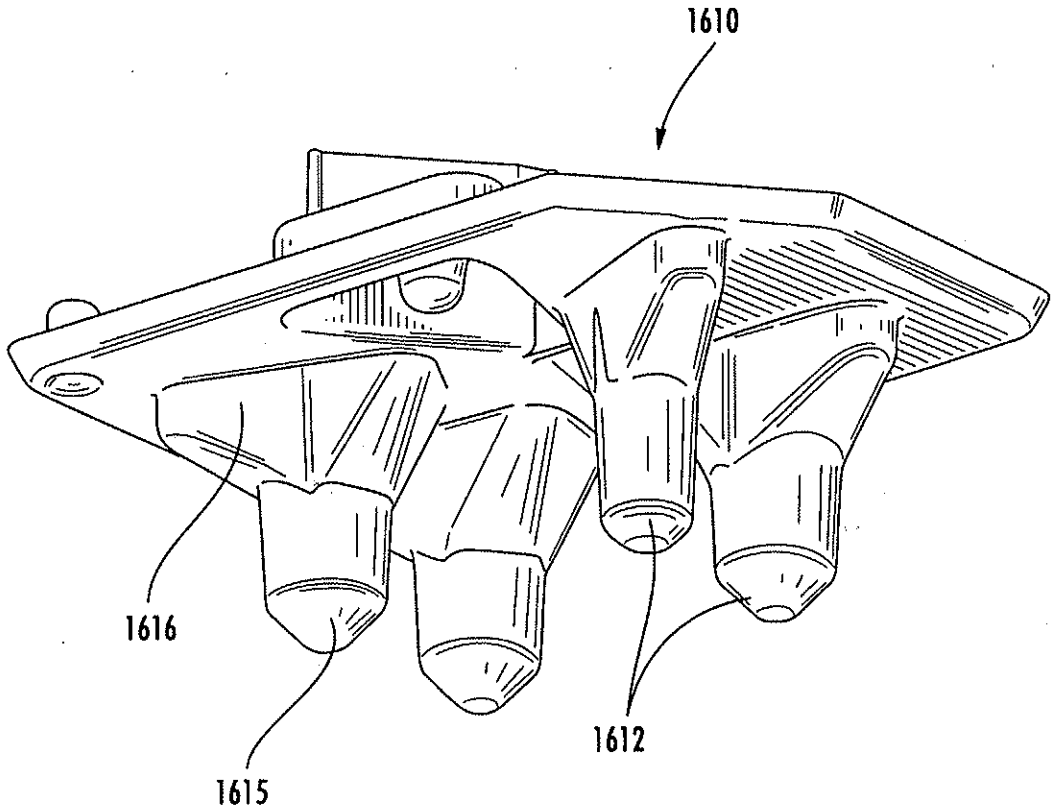


FIG. 29B

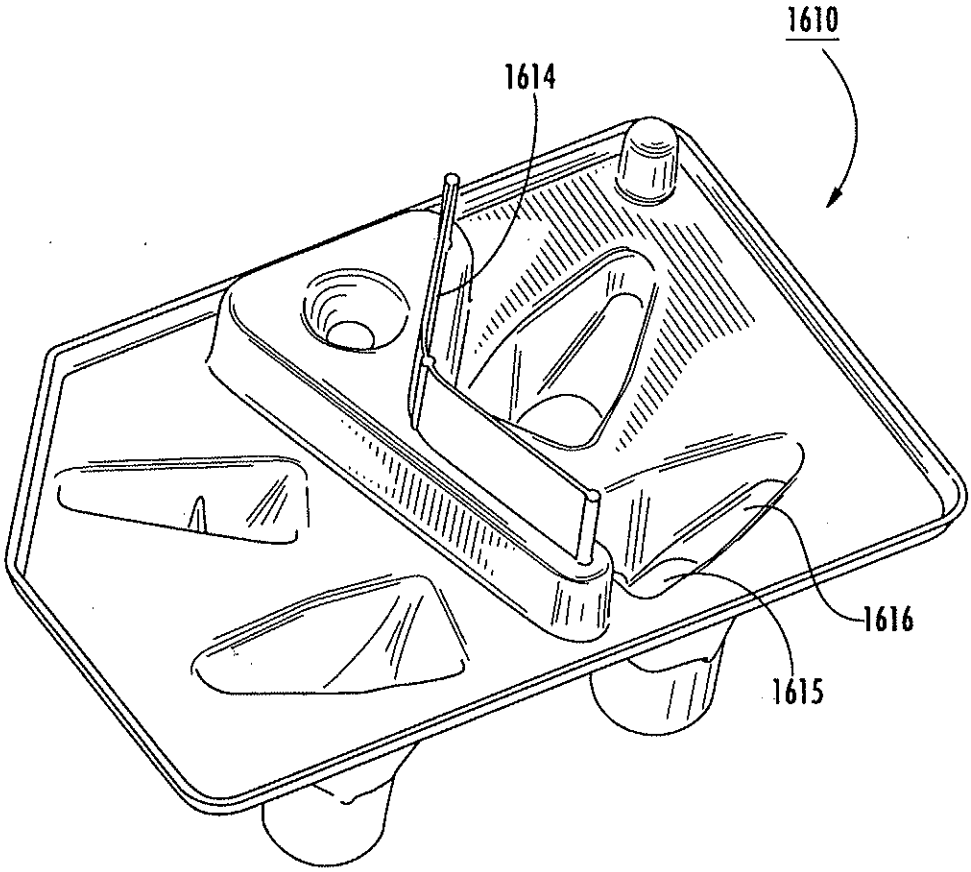
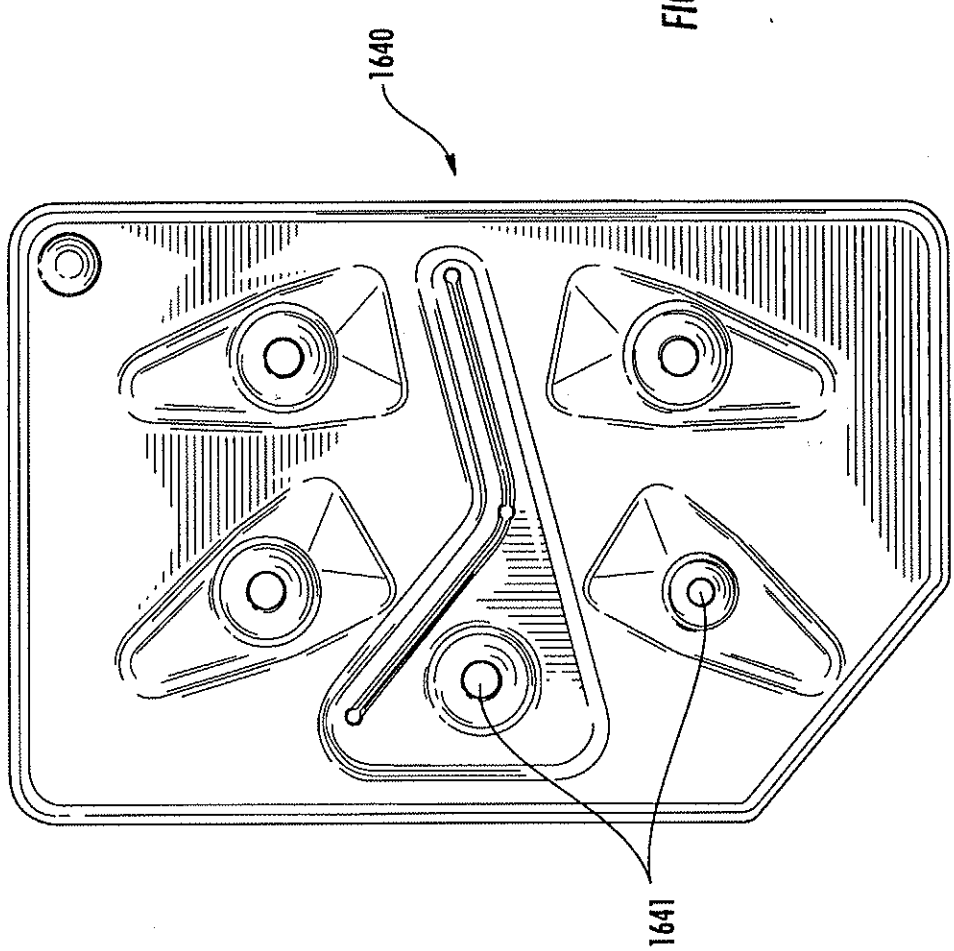


FIG. 29C

FIG. 30A



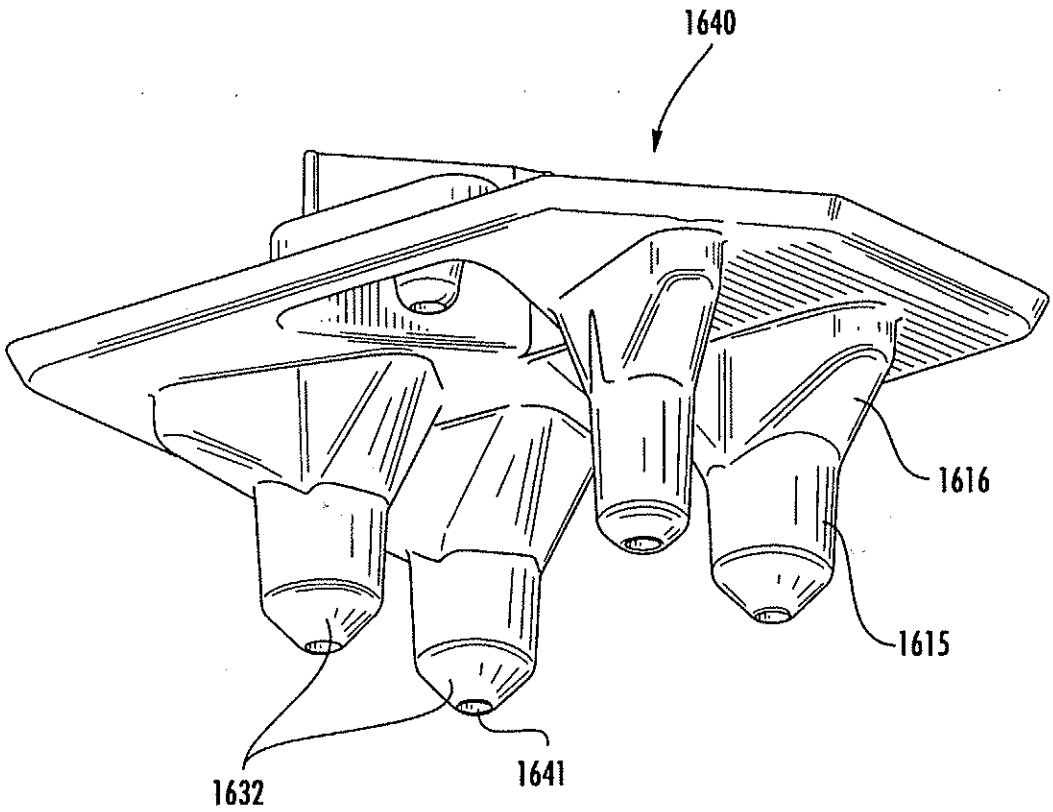


FIG. 30B

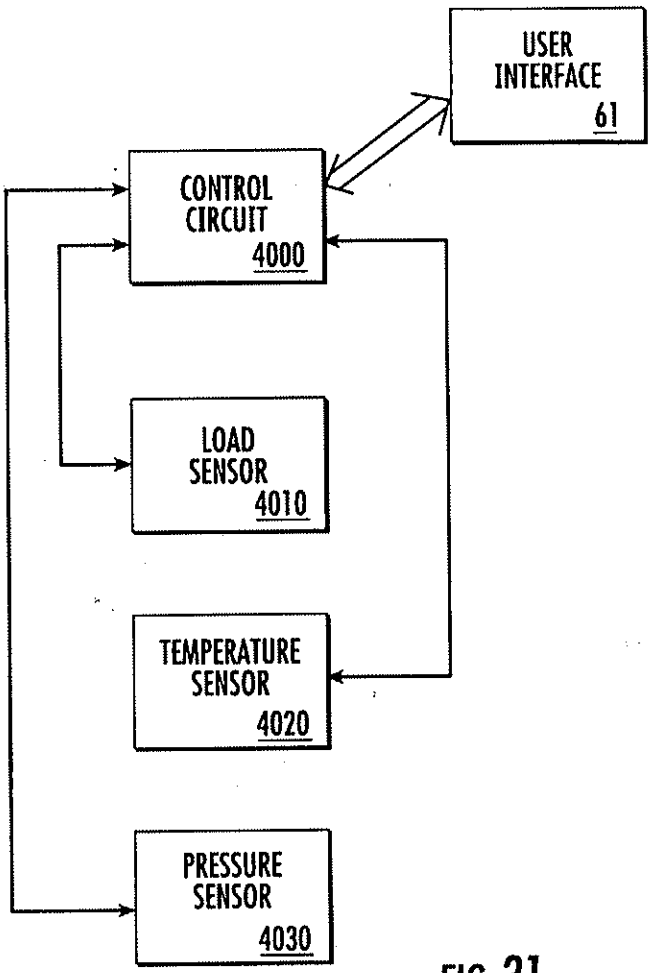

USER
INTERFACE
61
CONTROL
CIRCUIT
4000
LOAD
SENSOR
4010
TEMPERATURE
SENSOR
4020
PRESSURE
SENSOR
4030

FIG. 31

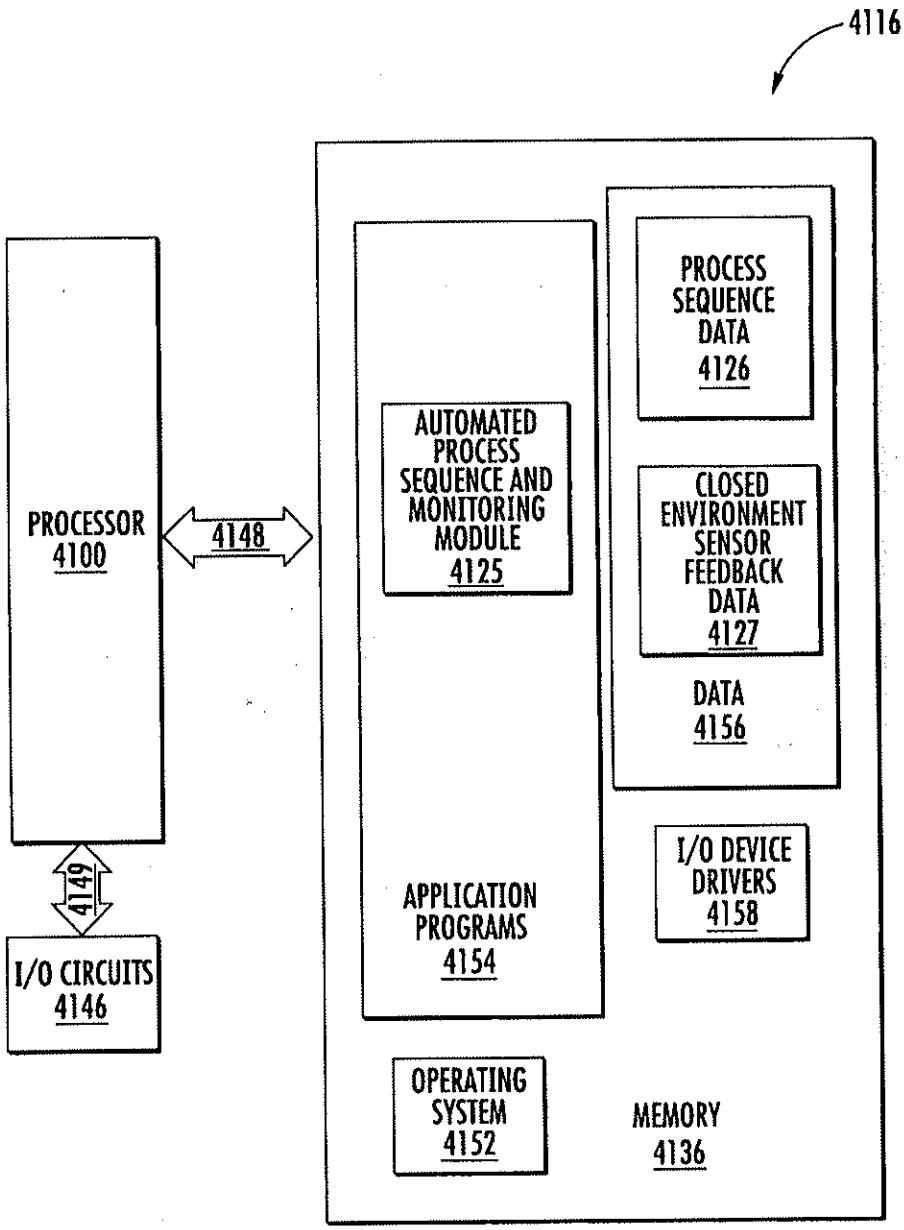

4116
PROCESSOR
4100
4148
4149
I/O CIRCUITS
4146
AUTOMATED
PROCESS
SEQUENCE AND
MONITORING
MODULE
4125
APPLICATION
PROGRAMS
4154
OPERATING
SYSTEM
4152
PROCESS
SEQUENCE
DATA
4126
CLOSED
ENVIRONMENT
SENSOR
FEEDBACK
DATA
4127
DATA
4156
I/O DEVICE
DRIVERS
4158
MEMORY
4136

FIG. 32