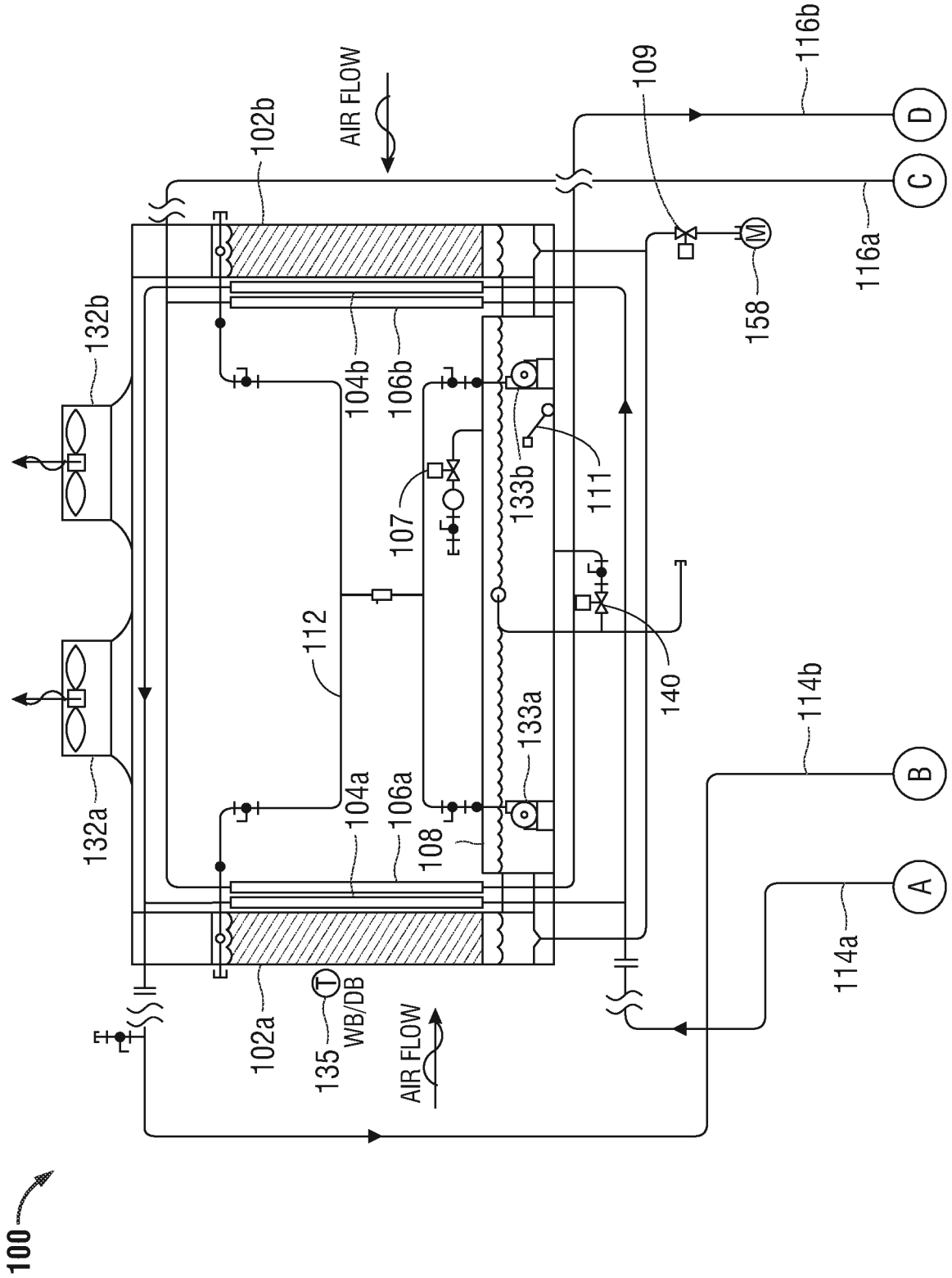

100
102a
102b
104a
104b
106a
106b
107
108
109
111
112
114a
114b
116a
116b
132a
132b
133a
133b
135
140
158
AIR FLOW
AIR FLOW
WB/DB
A
B
C
D
M
T

FIG. 1A

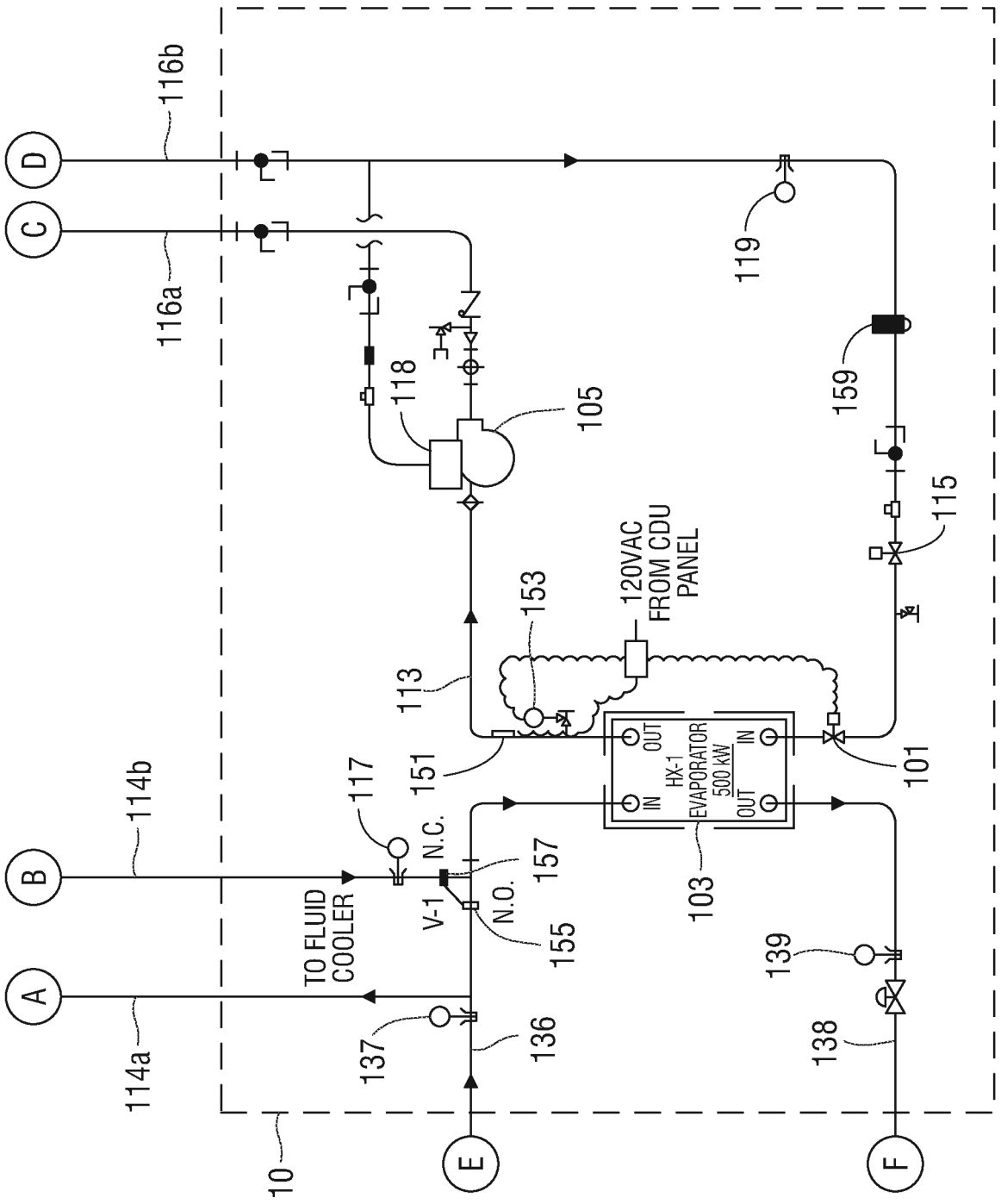

A
B
C
D
E
F
110
114a
114b
116a
116b
TO FLUID COOLER
137
136
V-1
N.C.
N.O.
117
157
155
151
113
153
118
105
120VAC FROM CDU PANEL
HX-1 EVAPORATOR 500 kW
IN
OUT
IN
OUT
103
101
119
159
115
139
138

FIG. 1B

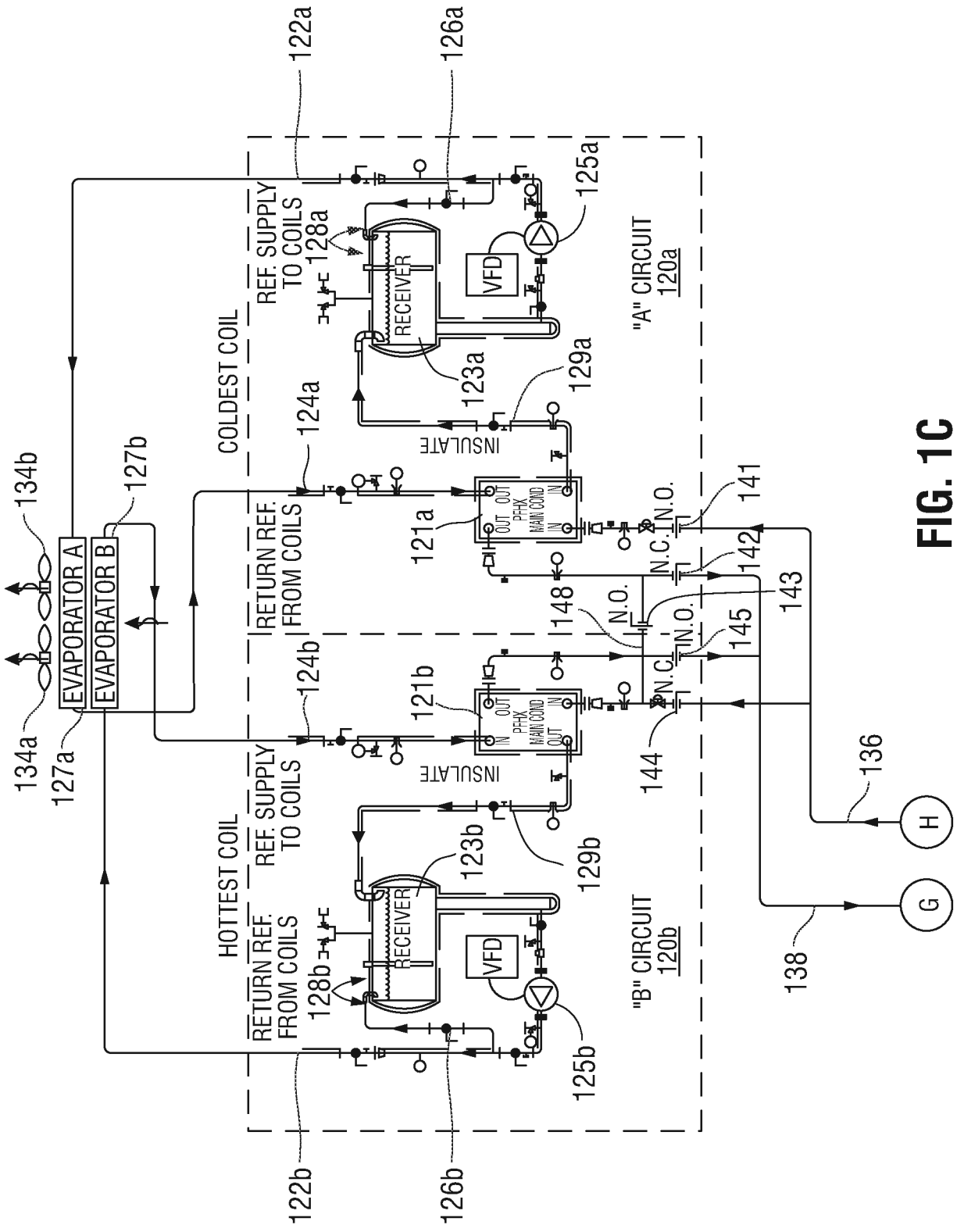

EVAPORATOR A
EVAPORATOR B
134a
134b
127a
127b
122a
122b
126a
126b
COLDEST COIL
HOTTEST COIL
REF. SUPPLY TO COILS
RETURN REF. FROM COILS
RECEIVER
VFD
INSULATE
PHX MAIN COND
"A" CIRCUIT 120a
"B" CIRCUIT 120b
N.C.
N.O.
124a
124b
121a
121b
123a
123b
125a
125b
128a
128b
129a
129b
141
142
143
144
145
148
136
138
G
H

FIG. 1C

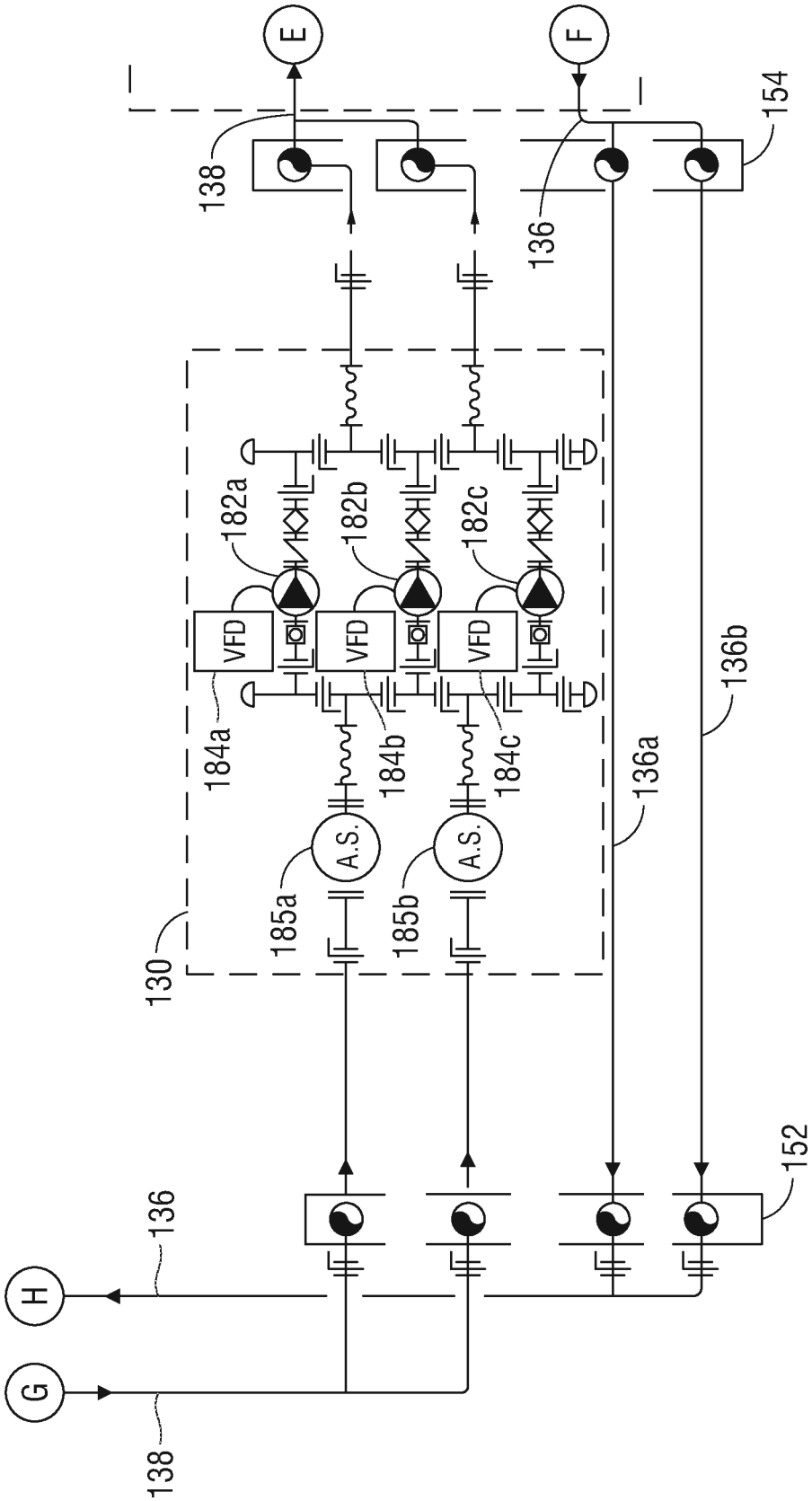

E
F
138
136
154
182a
182b
182c
VFD
VFD
VFD
184a
184b
184c
A.S.
A.S.
185a
185b
130
136a
136b
152
136
H
G
138

FIG. 1D

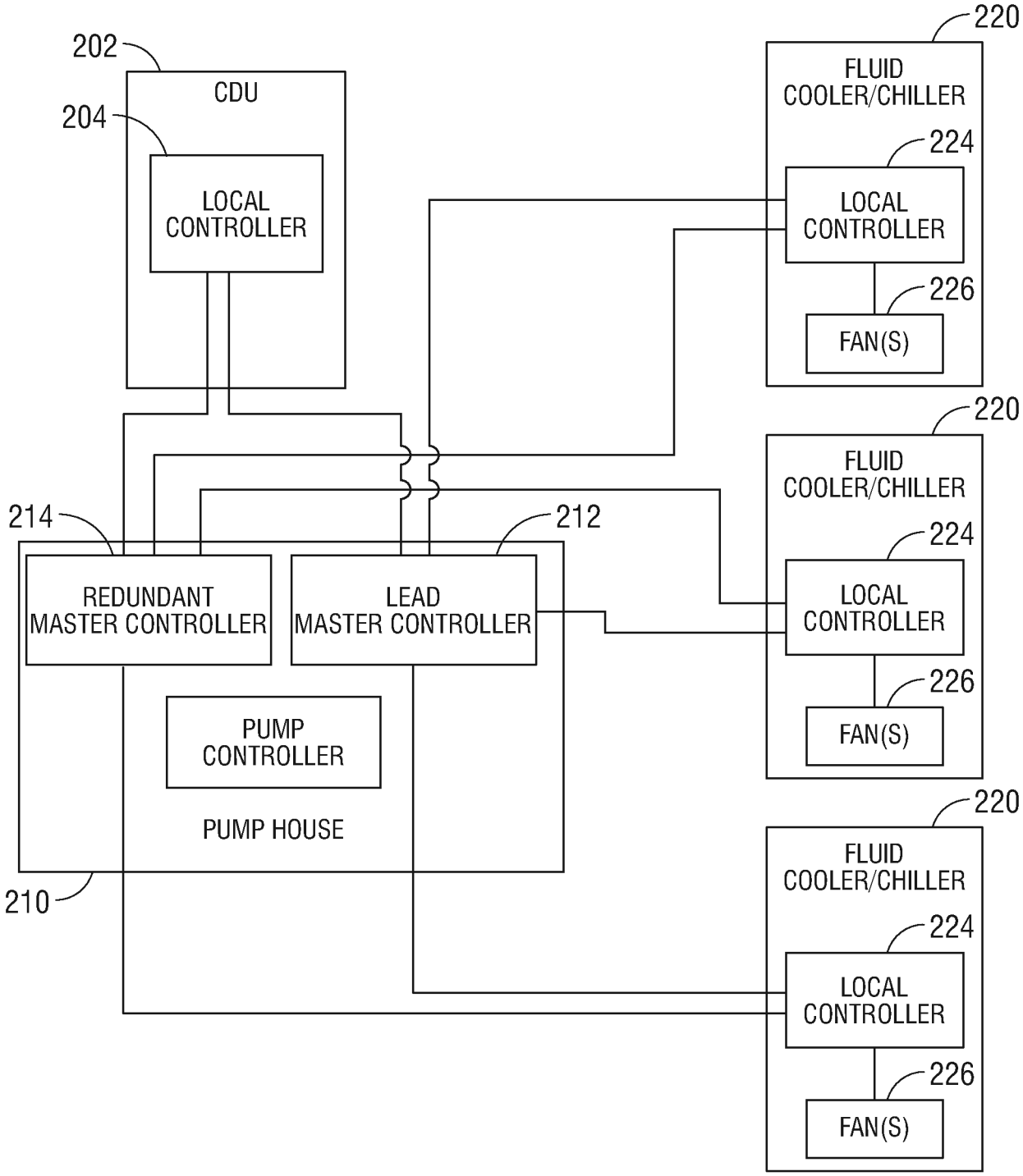

202
CDU
204
LOCAL CONTROLLER
220
FLUID COOLER/CHILLER
224
LOCAL CONTROLLER
226
FAN(S)
220
FLUID COOLER/CHILLER
224
LOCAL CONTROLLER
226
FAN(S)
214
212
REDUNDANT MASTER CONTROLLER
LEAD MASTER CONTROLLER
PUMP CONTROLLER
PUMP HOUSE
210
220
FLUID COOLER/CHILLER
224
LOCAL CONTROLLER
226
FAN(S)

FIG. 2

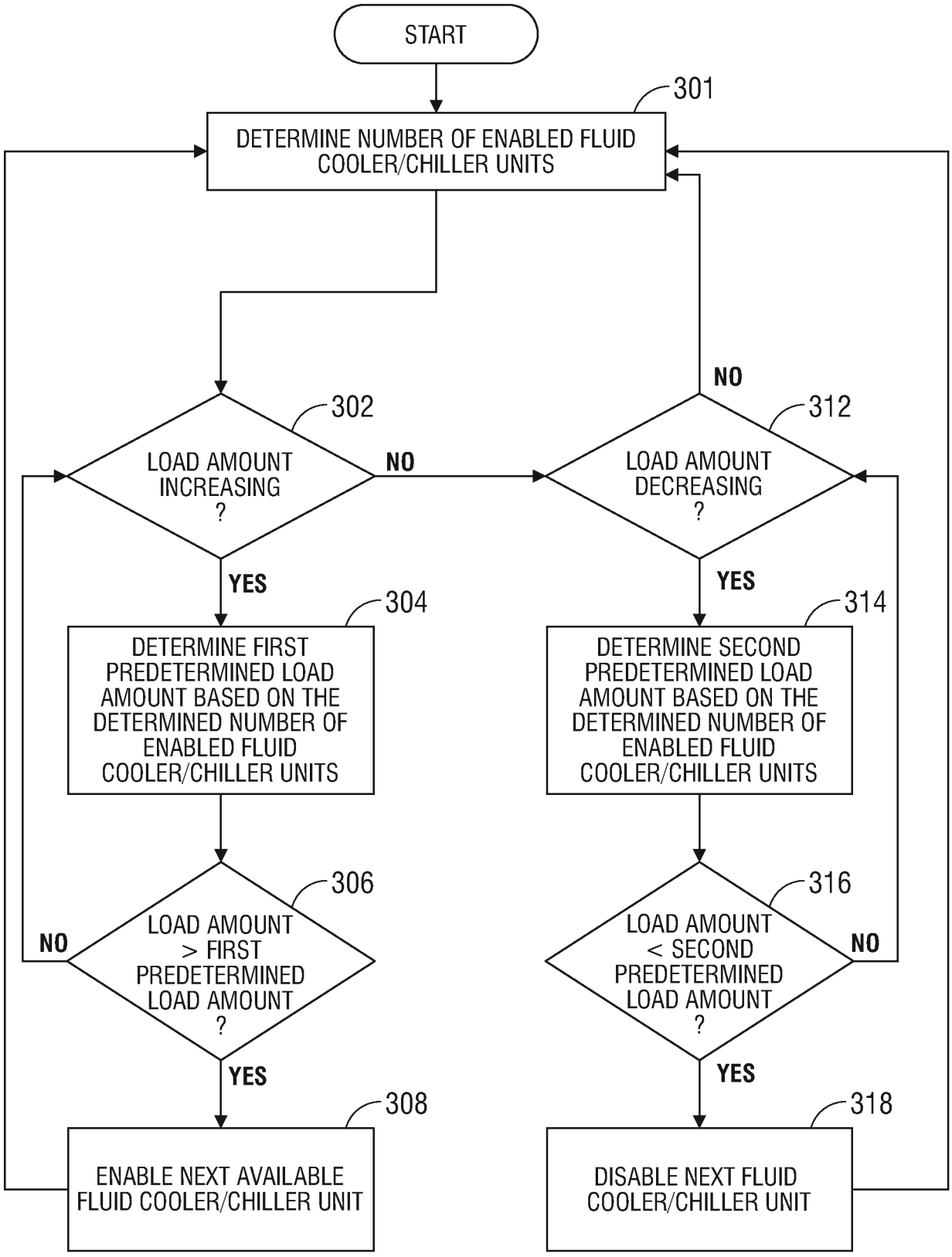

START
301
DETERMINE NUMBER OF ENABLED FLUID COOLER/CHILLER UNITS
302
LOAD AMOUNT INCREASING ?
NO
312
LOAD AMOUNT DECREASING ?
NO
YES
YES
304
DETERMINE FIRST PREDETERMINED LOAD AMOUNT BASED ON THE DETERMINED NUMBER OF ENABLED FLUID COOLER/CHILLER UNITS
314
DETERMINE SECOND PREDETERMINED LOAD AMOUNT BASED ON THE DETERMINED NUMBER OF ENABLED FLUID COOLER/CHILLER UNITS
306
LOAD AMOUNT > FIRST PREDETERMINED LOAD AMOUNT ?
NO
316
LOAD AMOUNT < SECOND PREDETERMINED LOAD AMOUNT ?
NO
YES
YES
308
ENABLE NEXT AVAILABLE FLUID COOLER/CHILLER UNIT
318
DISABLE NEXT FLUID COOLER/CHILLER UNIT

FIG. 3

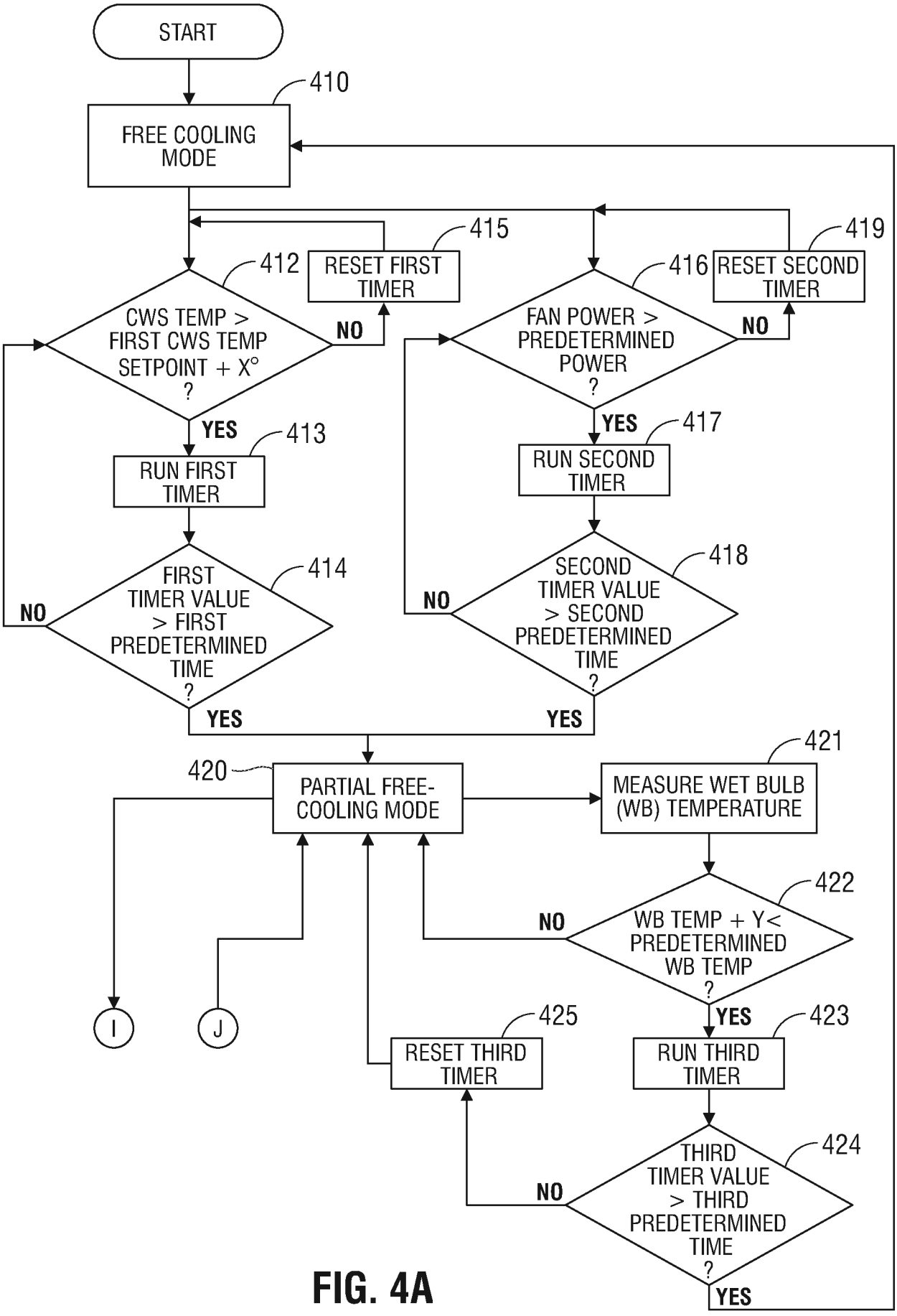

START
410
FREE COOLING MODE
412
CWS TEMP > FIRST CWS TEMP SETPOINT + X° ?
NO
415
RESET FIRST TIMER
YES
413
RUN FIRST TIMER
414
FIRST TIMER VALUE > FIRST PREDETERMINED TIME ?
NO
YES
416
FAN POWER > PREDETERMINED POWER ?
NO
419
RESET SECOND TIMER
YES
417
RUN SECOND TIMER
418
SECOND TIMER VALUE > SECOND PREDETERMINED TIME ?
NO
YES
420
PARTIAL FREE-COOLING MODE
421
MEASURE WET BULB (WB) TEMPERATURE
422
WB TEMP + Y< PREDETERMINED WB TEMP ?
NO
YES
423
RUN THIRD TIMER
424
THIRD TIMER VALUE > THIRD PREDETERMINED TIME ?
NO
YES
425
RESET THIRD TIMER
I
J

FIG. 4A

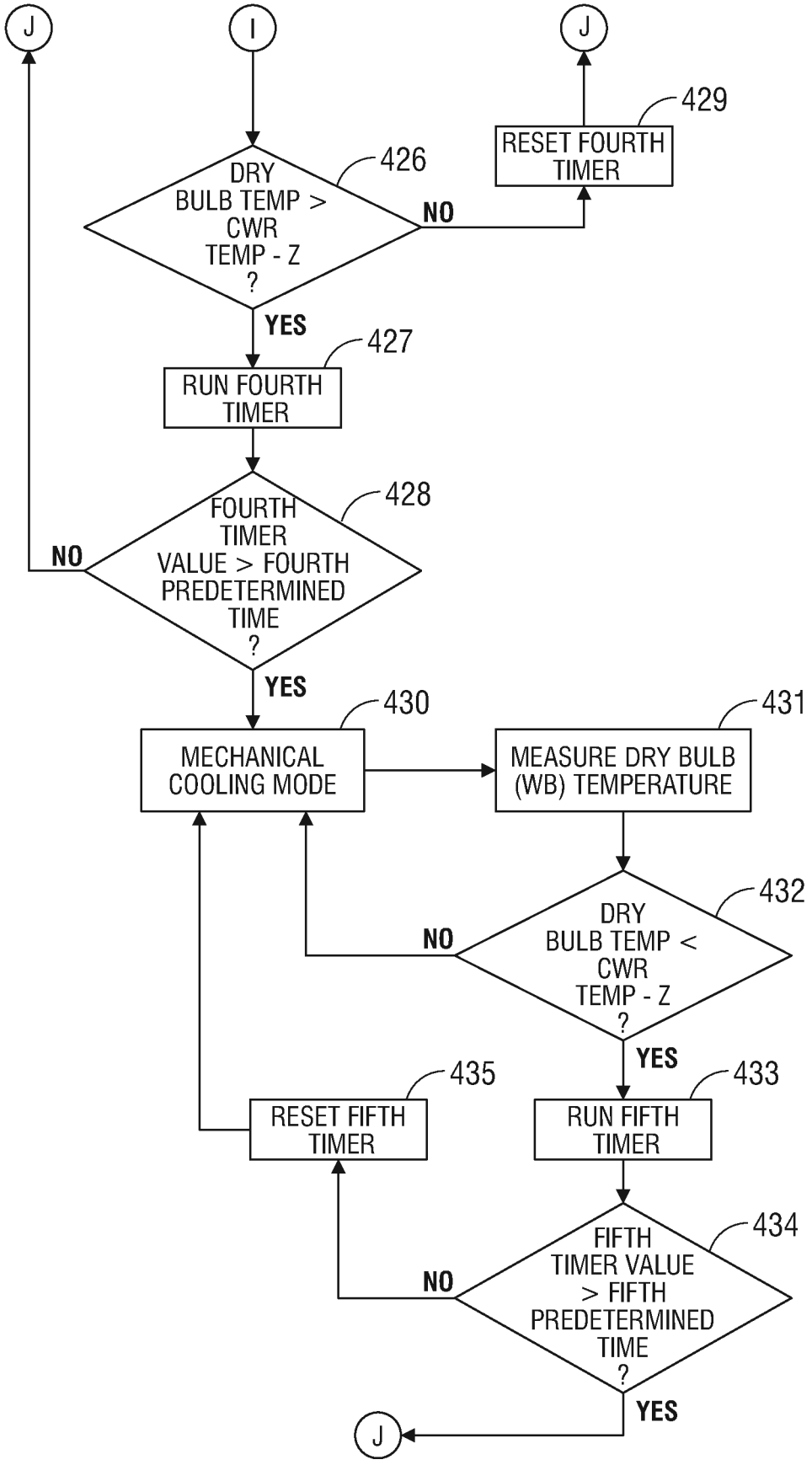

J
I
J
429
RESET FOURTH TIMER
426
DRY BULB TEMP > CWR TEMP - Z ?
NO
YES
427
RUN FOURTH TIMER
428
FOURTH TIMER VALUE > FOURTH PREDETERMINED TIME ?
NO
YES
430
MECHANICAL COOLING MODE
431
MEASURE DRY BULB (WB) TEMPERATURE
432
DRY BULB TEMP < CWR TEMP - Z ?
NO
YES
435
RESET FIFTH TIMER
433
RUN FIFTH TIMER
434
FIFTH TIMER VALUE > FIFTH PREDETERMINED TIME ?
NO
YES
J

FIG. 4B

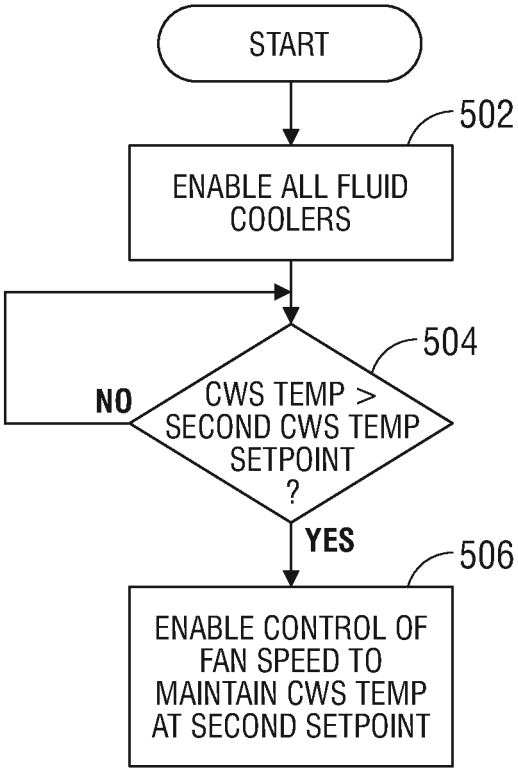

START
502
ENABLE ALL FLUID COOLERS
504
CWS TEMP > SECOND CWS TEMP SETPOINT ?
NO
YES
506
ENABLE CONTROL OF FAN SPEED TO MAINTAIN CWS TEMP AT SECOND SETPOINT

FIG. 5

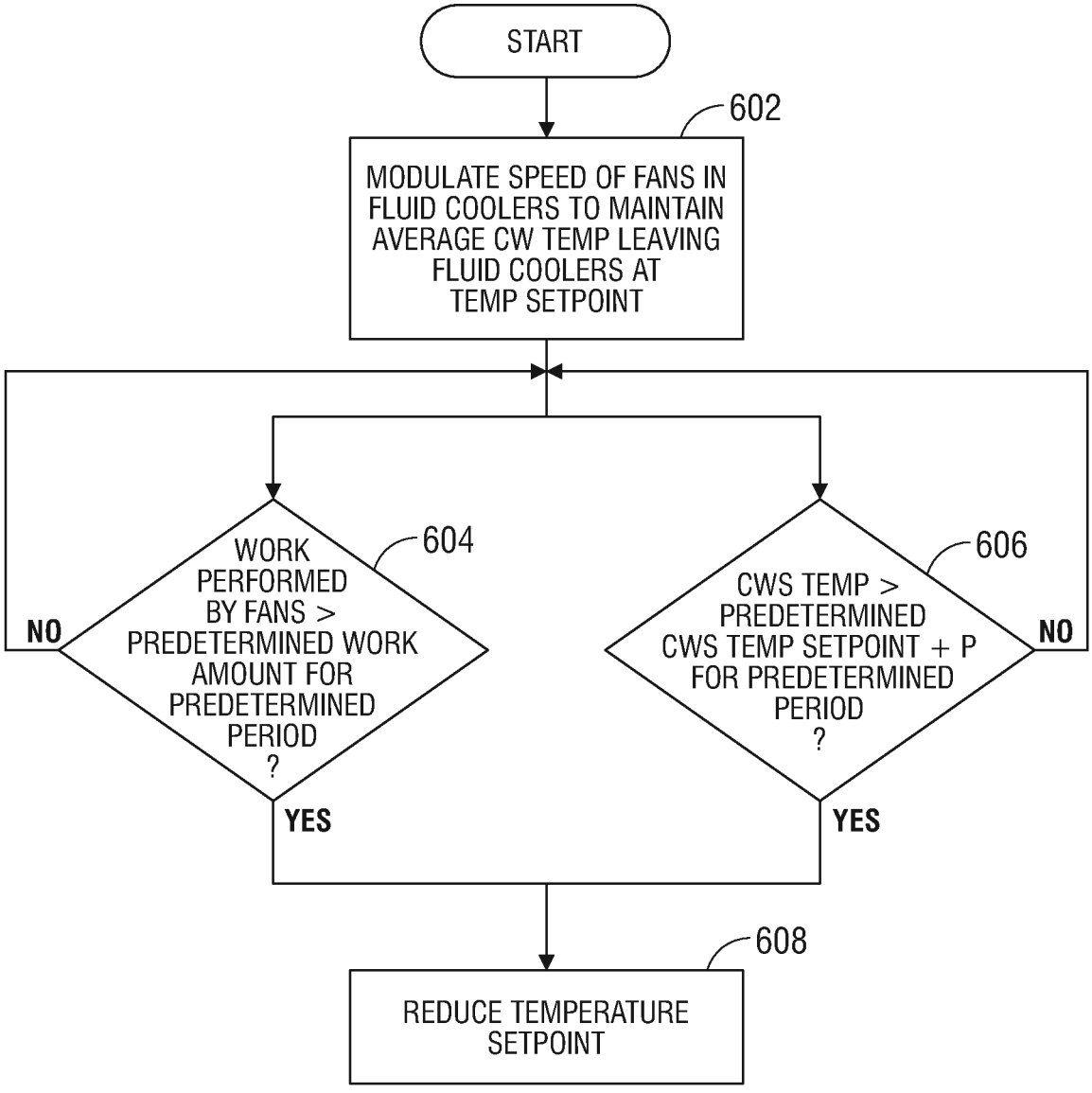

START
602
MODULATE SPEED OF FANS IN FLUID COOLERS TO MAINTAIN AVERAGE CW TEMP LEAVING FLUID COOLERS AT TEMP SETPOINT
604
WORK PERFORMED BY FANS > PREDETERMINED WORK AMOUNT FOR PREDETERMINED PERIOD ?
NO
YES
606
CWS TEMP > PREDETERMINED CWS TEMP SETPOINT + P FOR PREDETERMINED PERIOD ?
NO
YES
608
REDUCE TEMPERATURE SETPOINT

FIG. 6

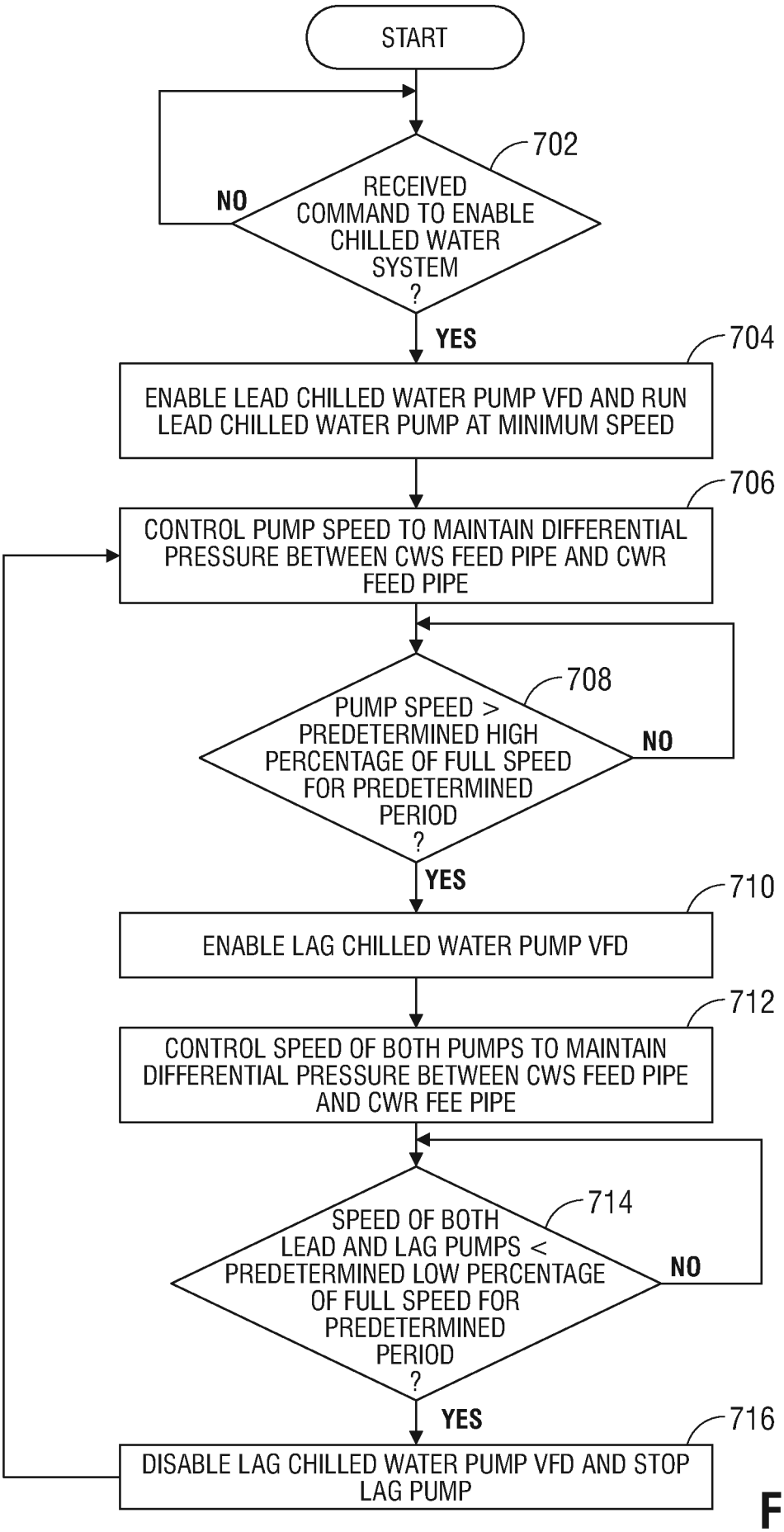

START
702
RECEIVED COMMAND TO ENABLE CHILLED WATER SYSTEM ?
NO
YES
704
ENABLE LEAD CHILLED WATER PUMP VFD AND RUN LEAD CHILLED WATER PUMP AT MINIMUM SPEED
706
CONTROL PUMP SPEED TO MAINTAIN DIFFERENTIAL PRESSURE BETWEEN CWS FEED PIPE AND CWR FEED PIPE
708
PUMP SPEED > PREDETERMINED HIGH PERCENTAGE OF FULL SPEED FOR PREDETERMINED PERIOD ?
NO
YES
710
ENABLE LAG CHILLED WATER PUMP VFD
712
CONTROL SPEED OF BOTH PUMPS TO MAINTAIN DIFFERENTIAL PRESSURE BETWEEN CWS FEED PIPE AND CWR FEE PIPE
714
SPEED OF BOTH LEAD AND LAG PUMPS < PREDETERMINED LOW PERCENTAGE OF FULL SPEED FOR PREDETERMINED PERIOD ?
NO
YES
716
DISABLE LAG CHILLED WATER PUMP VFD AND STOP LAG PUMP

FIG. 7

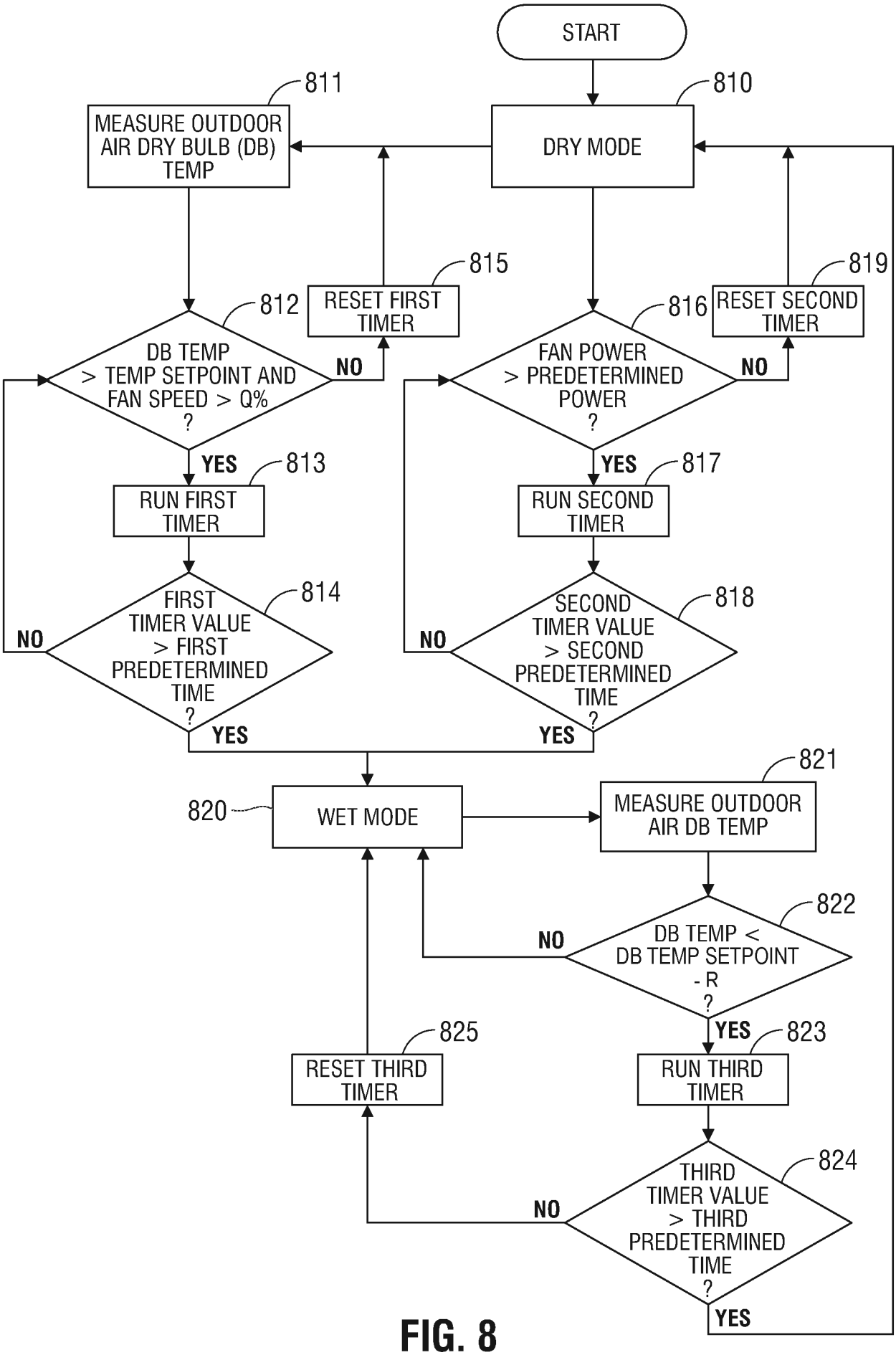

START
810
DRY MODE
811
MEASURE OUTDOOR AIR DRY BULB (DB) TEMP
812
DB TEMP > TEMP SETPOINT AND FAN SPEED > Q% ?
NO
YES
813
RUN FIRST TIMER
814
FIRST TIMER VALUE > FIRST PREDETERMINED TIME ?
NO
YES
815
RESET FIRST TIMER
816
FAN POWER > PREDETERMINED POWER ?
NO
YES
817
RUN SECOND TIMER
818
SECOND TIMER VALUE > SECOND PREDETERMINED TIME ?
NO
YES
819
RESET SECOND TIMER
820
WET MODE
821
MEASURE OUTDOOR AIR DB TEMP
822
DB TEMP < DB TEMP SETPOINT - R ?
NO
YES
823
RUN THIRD TIMER
824
THIRD TIMER VALUE > THIRD PREDETERMINED TIME ?
NO
YES
825
RESET THIRD TIMER

FIG. 8

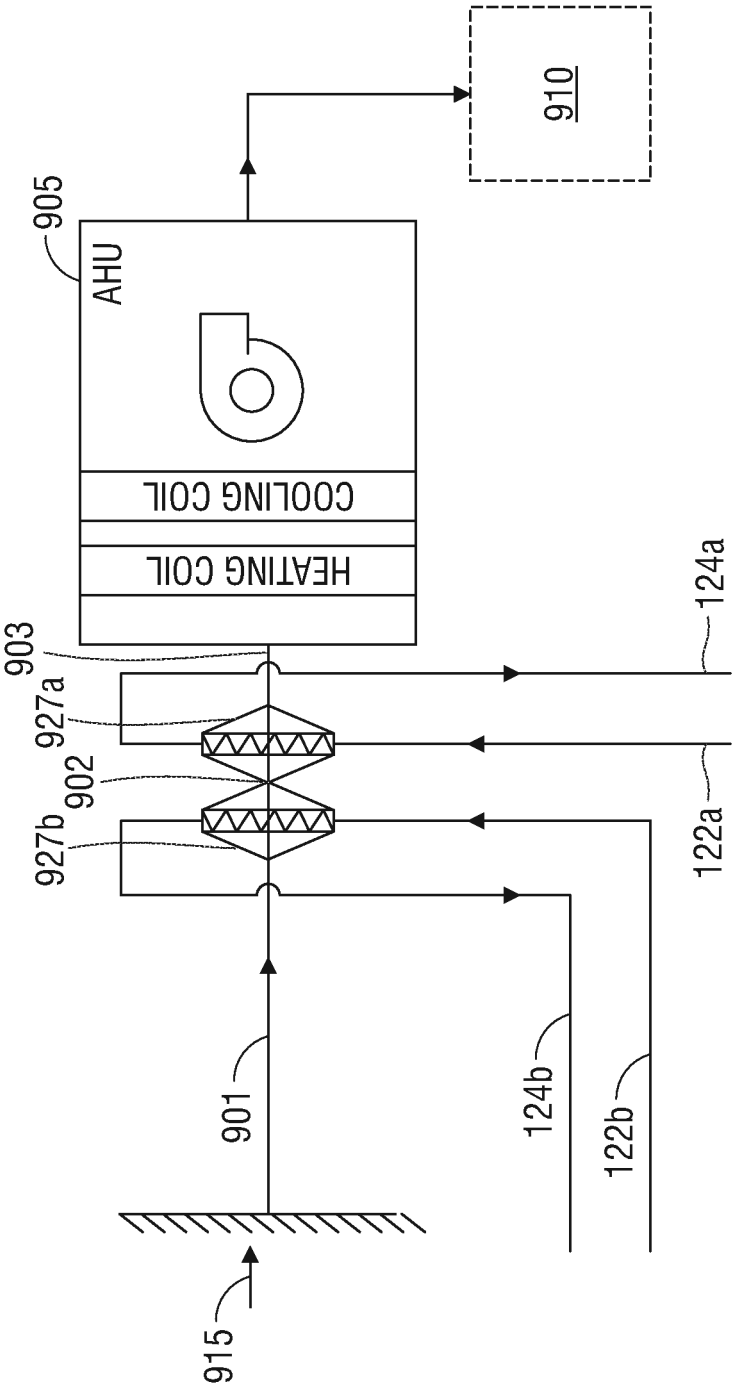

910
905
AHU
COOLING COIL
HEATING COIL
903
927a
902
927b
124a
122a
901
124b
122b
915

FIG. 9

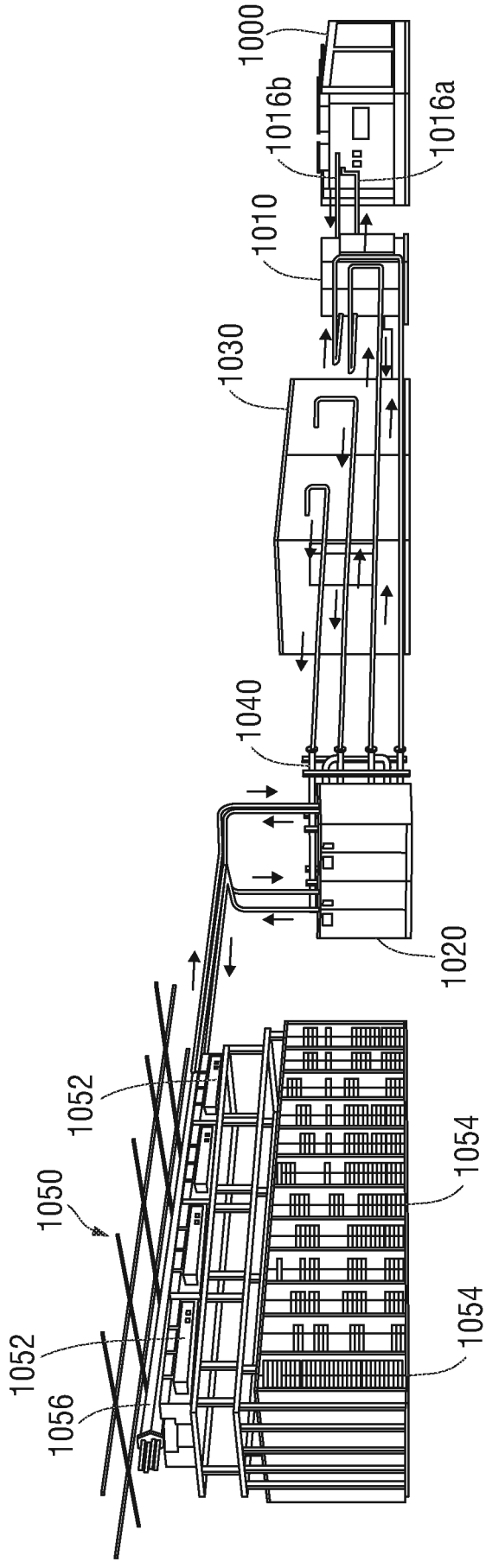

1000
1016b
1016a
1010
1030
1040
1020
1052
1050
1054
1052
1056
1054

FIG. 10

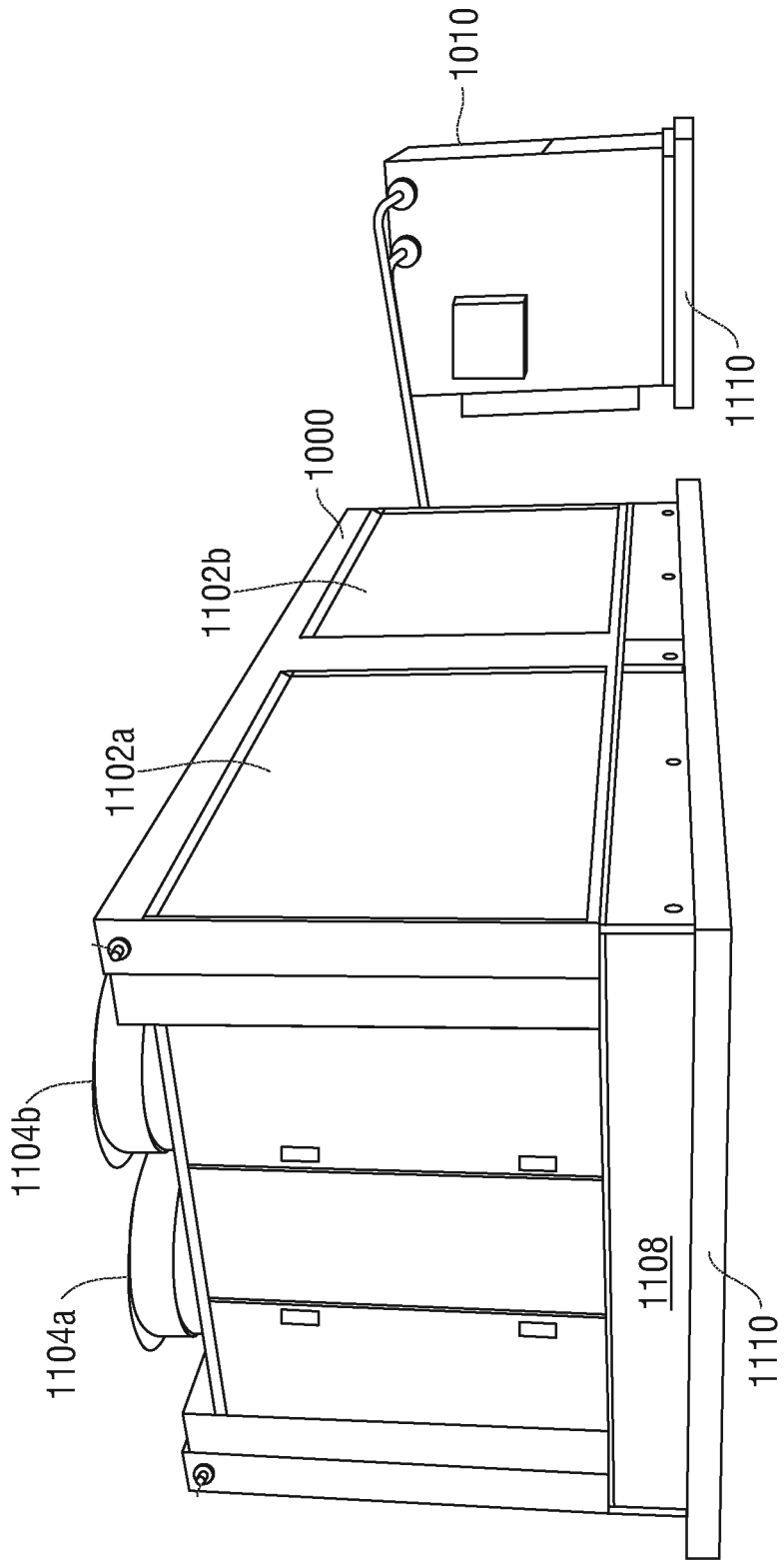



FIG. 11

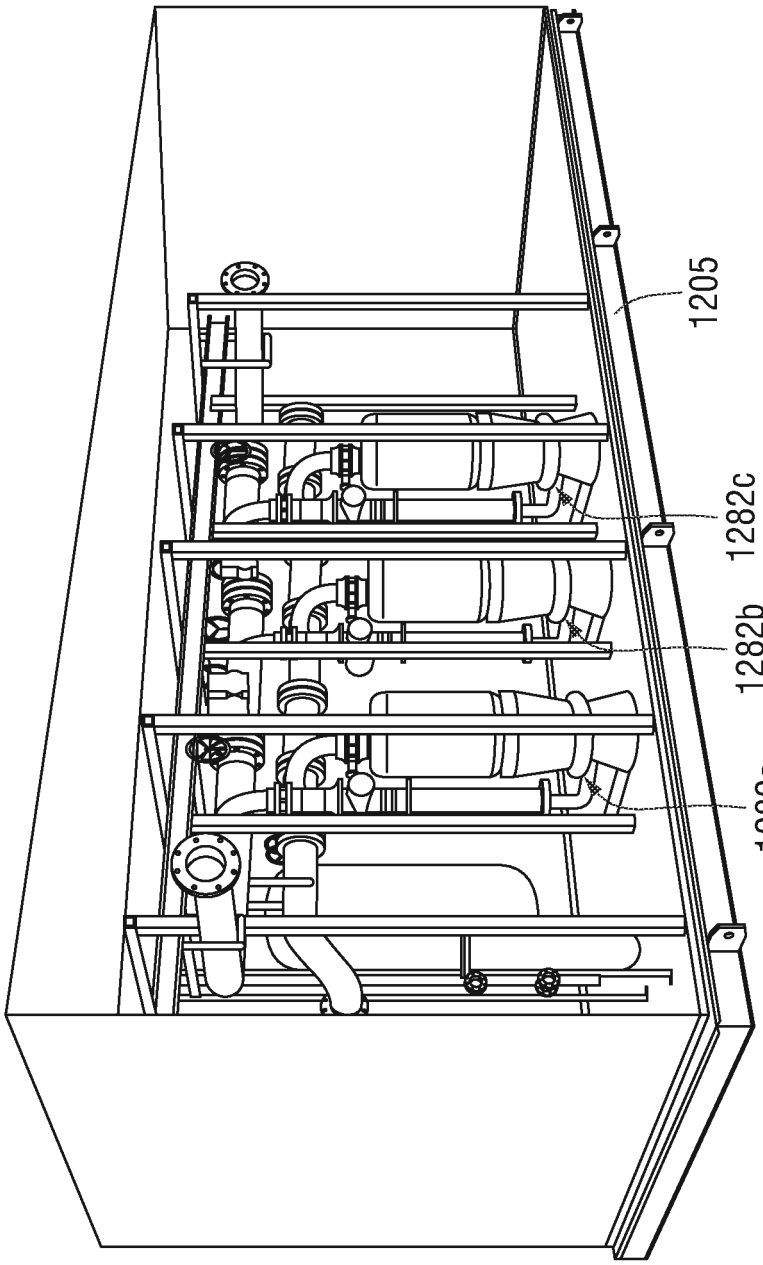



FIG. 12

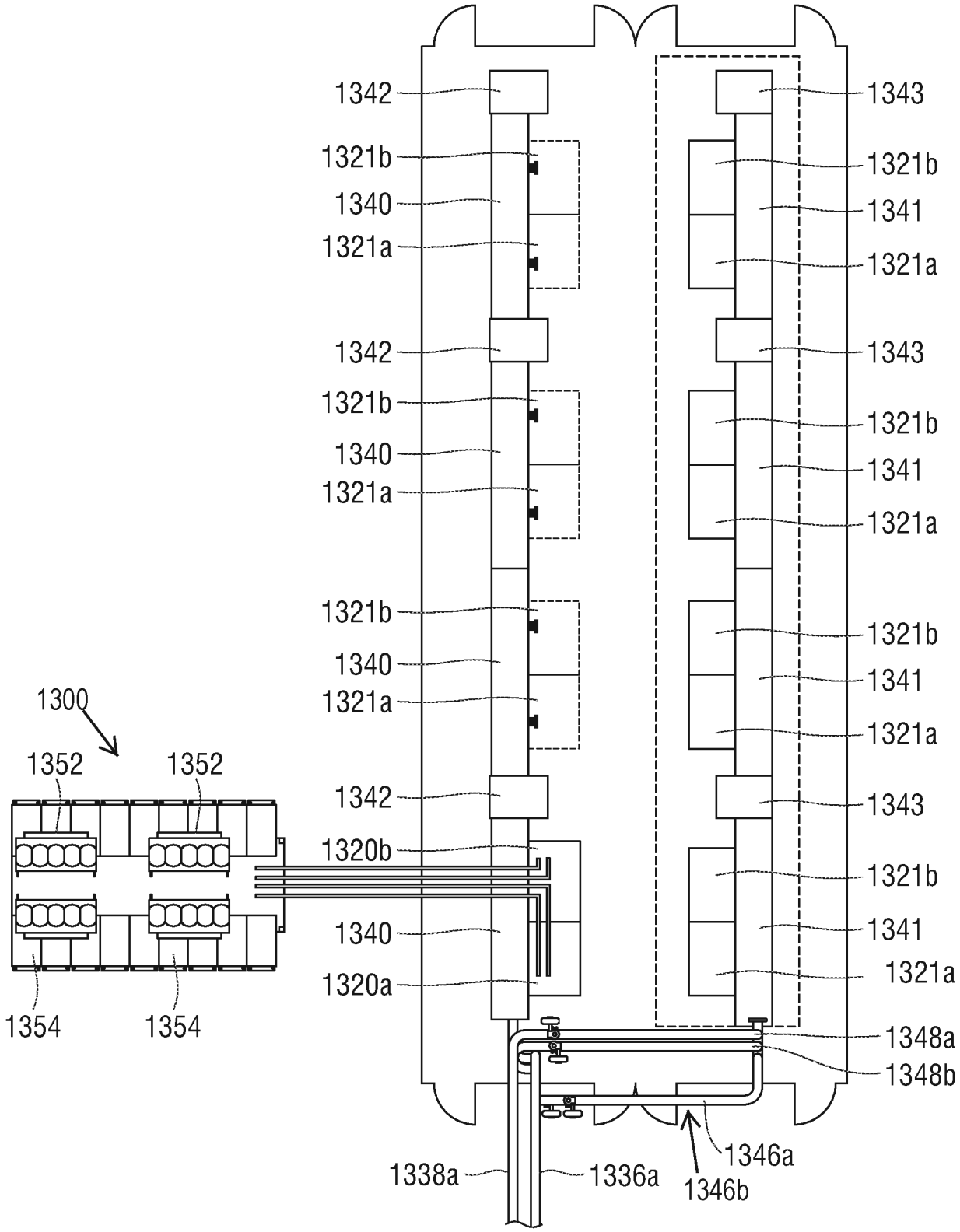

1342
1321b
1340
1321a
1342
1321b
1340
1321a
1321b
1340
1321a
1342
1320b
1340
1320a
1343
1321b
1341
1321a
1343
1321b
1341
1321a
1321b
1341
1321a
1343
1321b
1341
1321a
1348a
1348b
1346a
1346b
1338a
1336a
1300
1352
1352
1354
1354

FIG. 13A

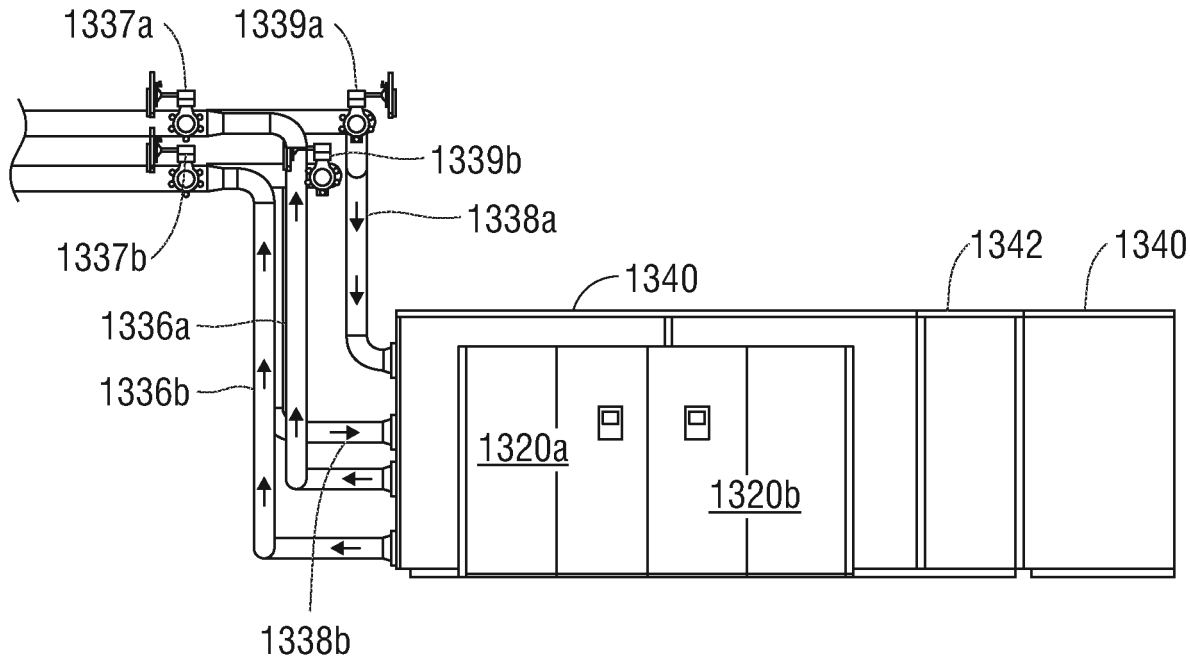



FIG. 13B

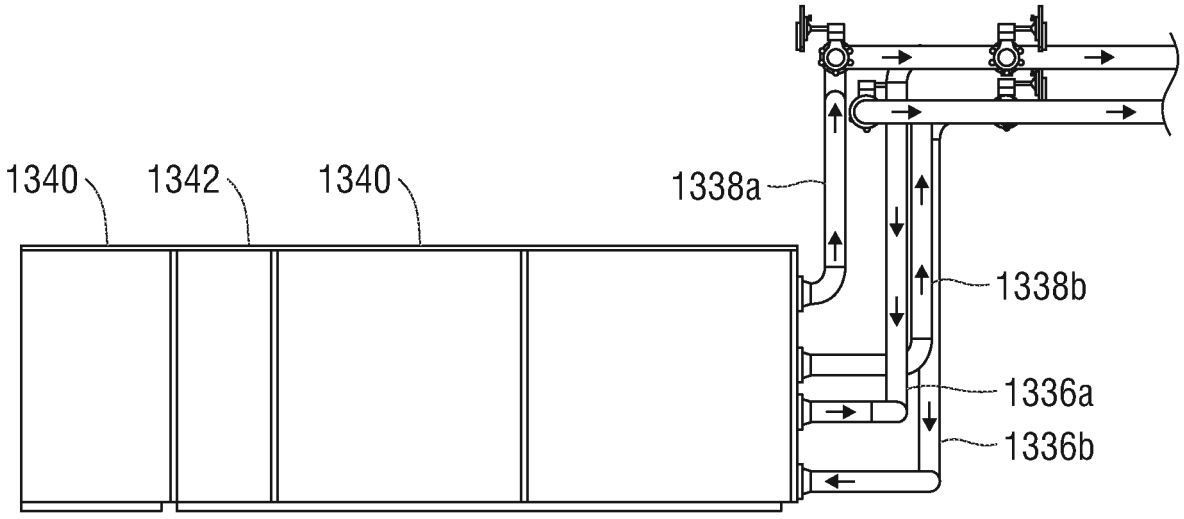



FIG. 13C

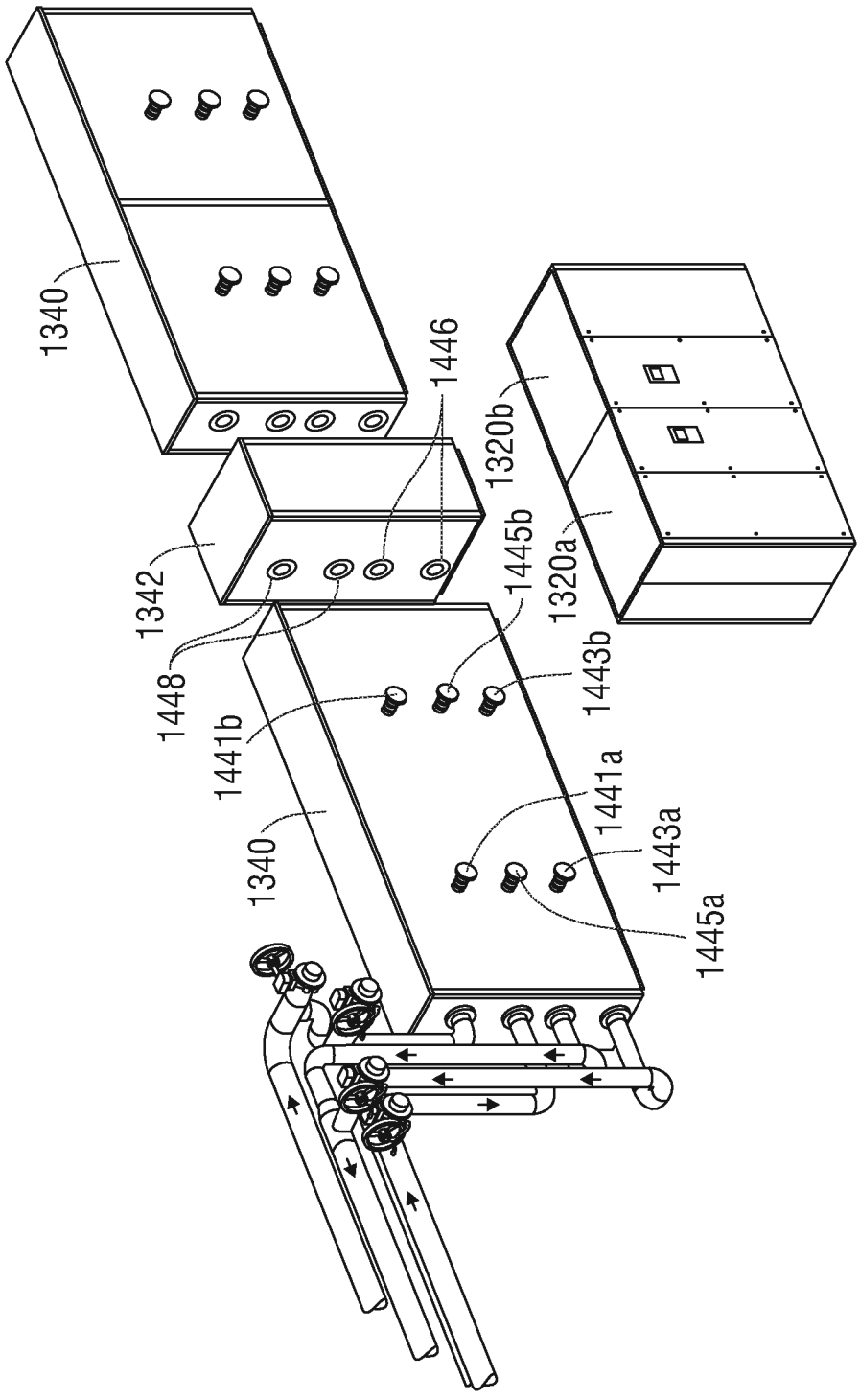

1340
1446
1320b
1342
1445b
1320a
1448
1443b
1441b
1441a
1340
1443a
1445a

FIG. 14

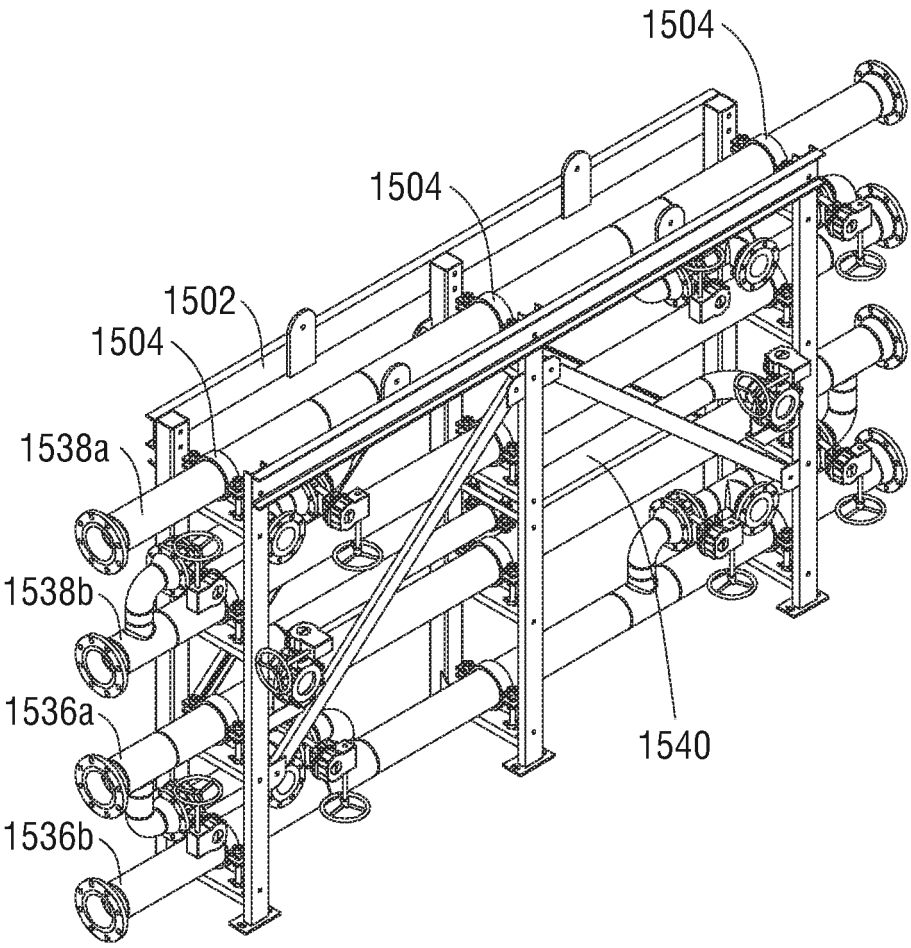



FIG. 15A

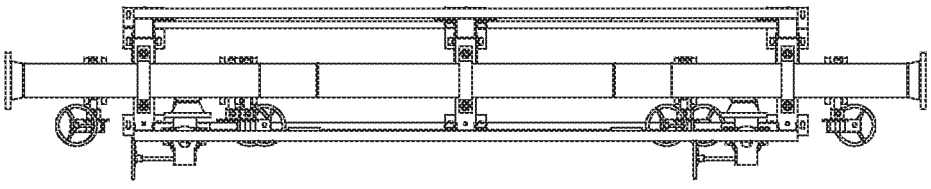


FIG. 15B

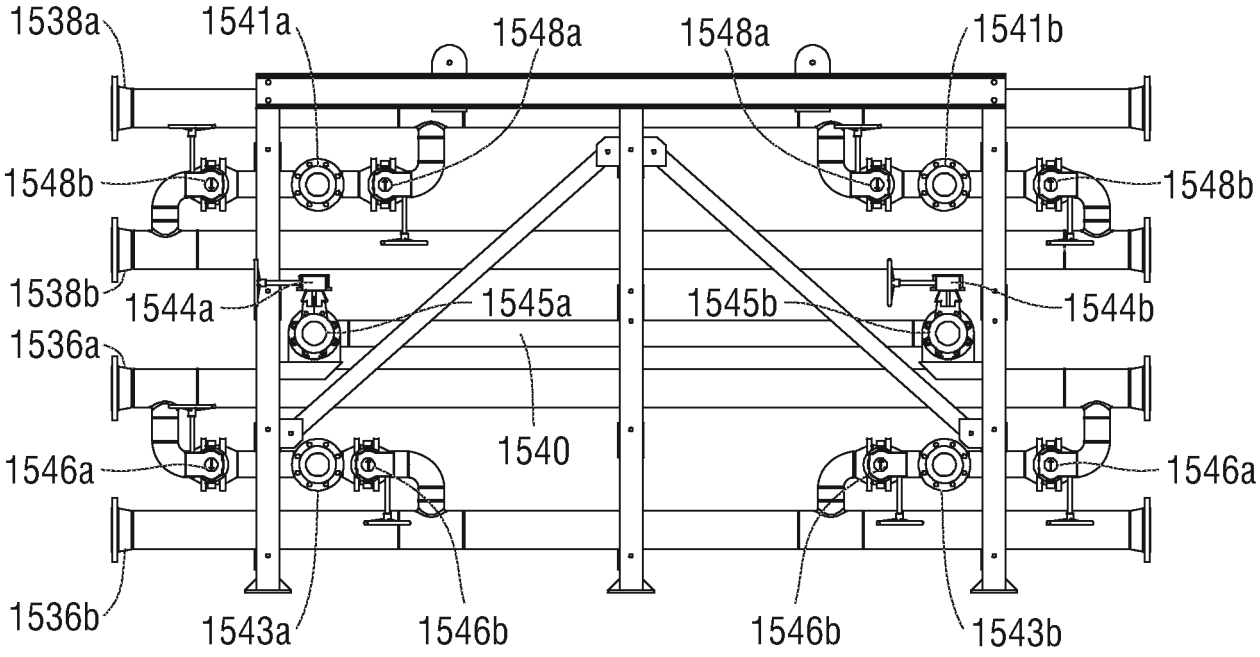



FIG. 15C

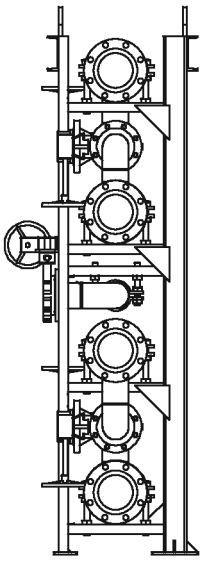


FIG. 15D

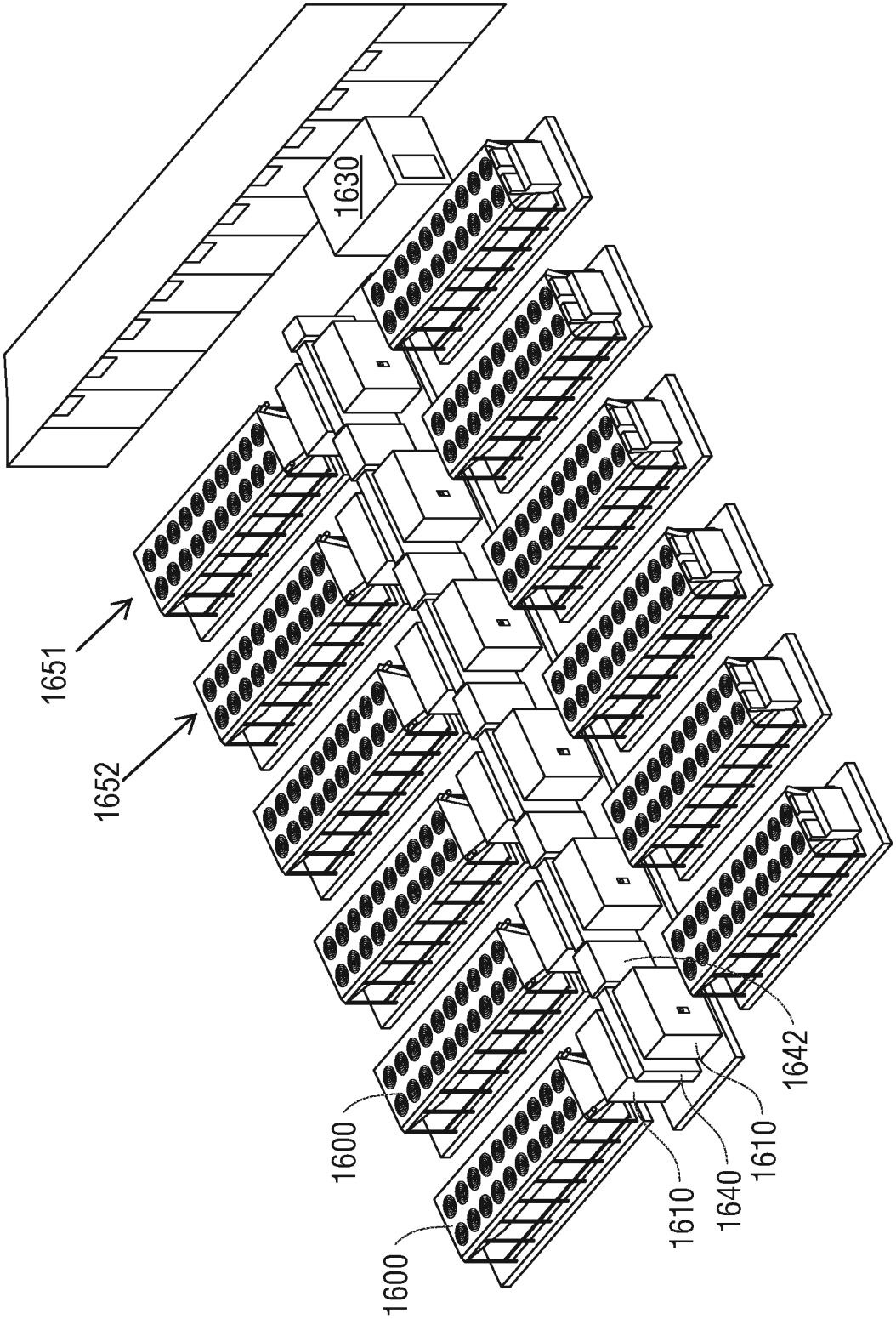



FIG. 16A

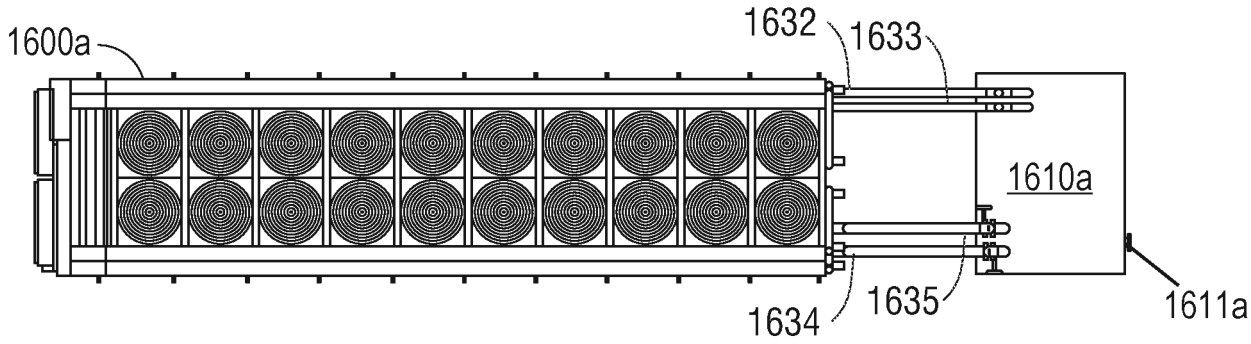



FIG. 16B

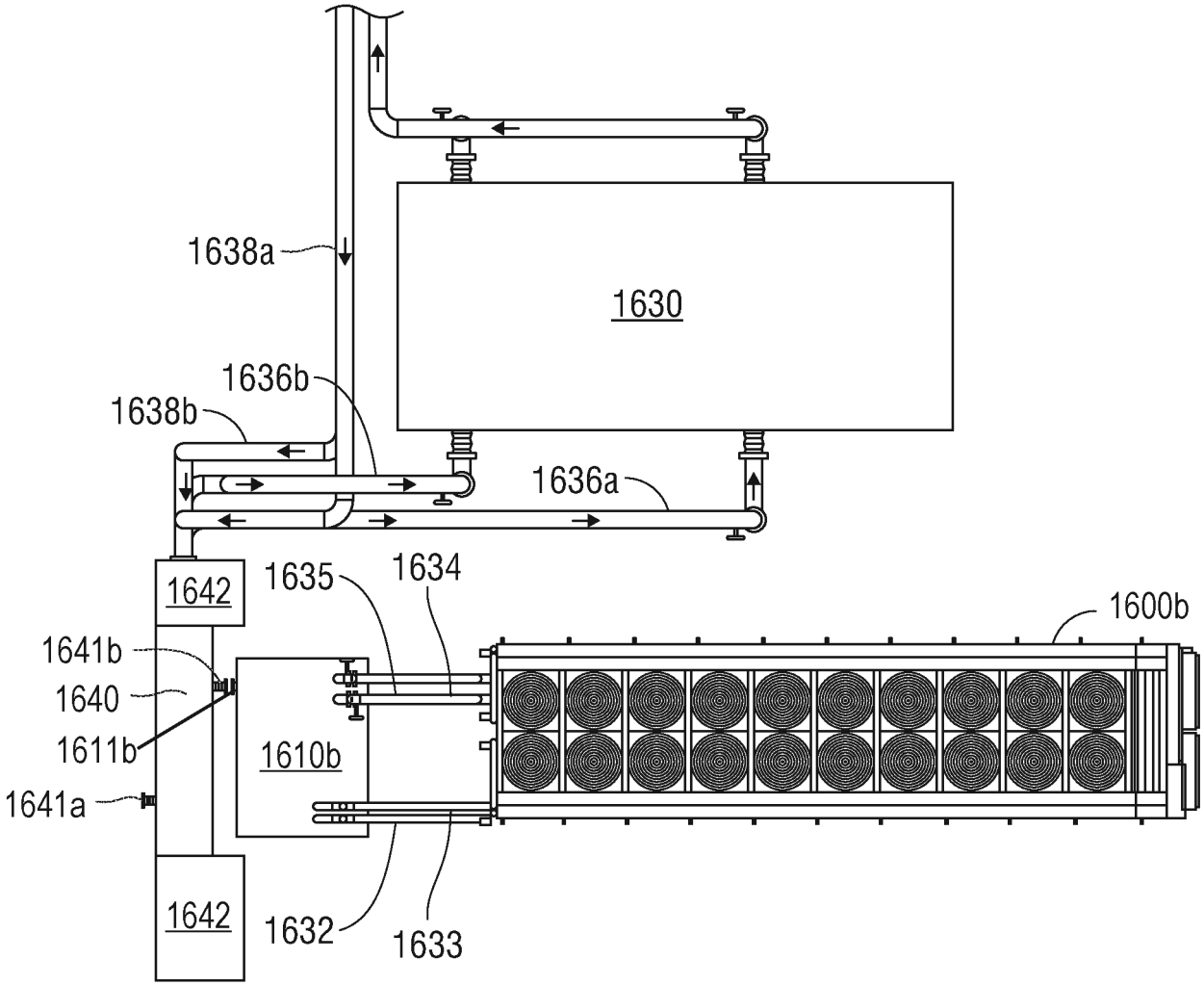

1638a
1630
1636b
1638b
1636a
1642
1635
1634
1600b
1641b
1640
1611b
1610b
1641a
1642
1632
1633

FIG. 16C

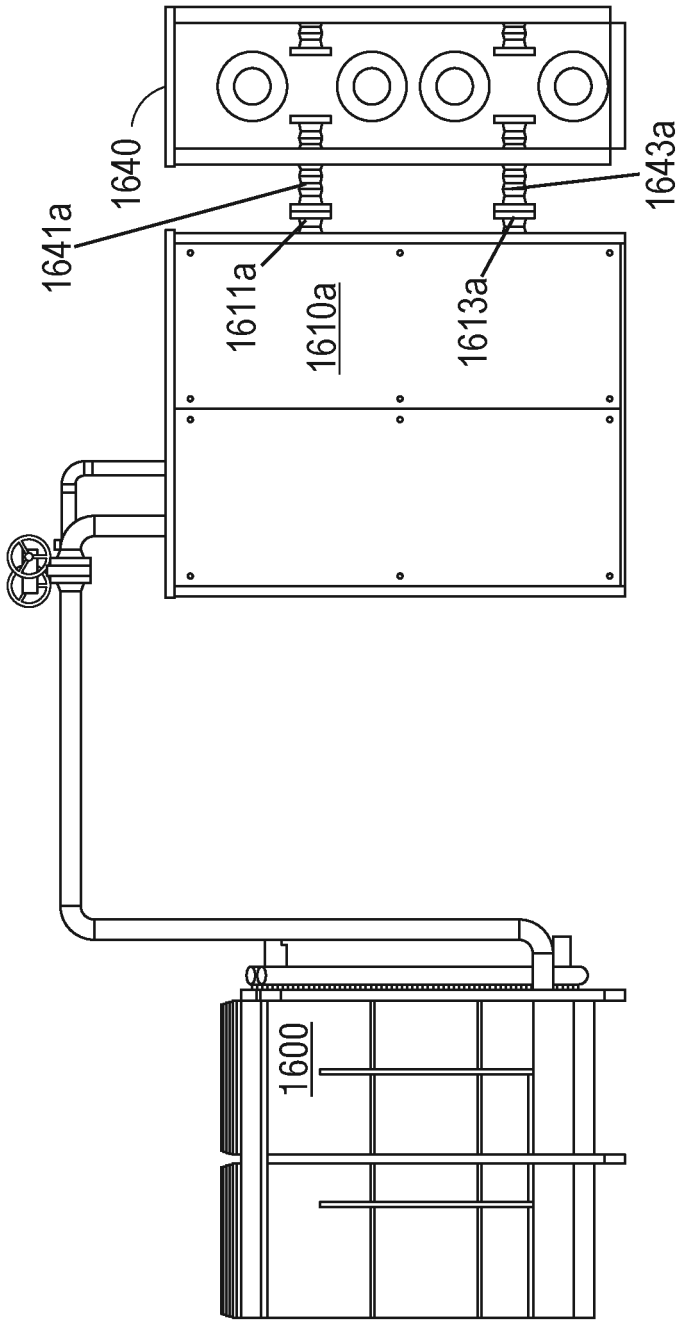



FIG. 16D

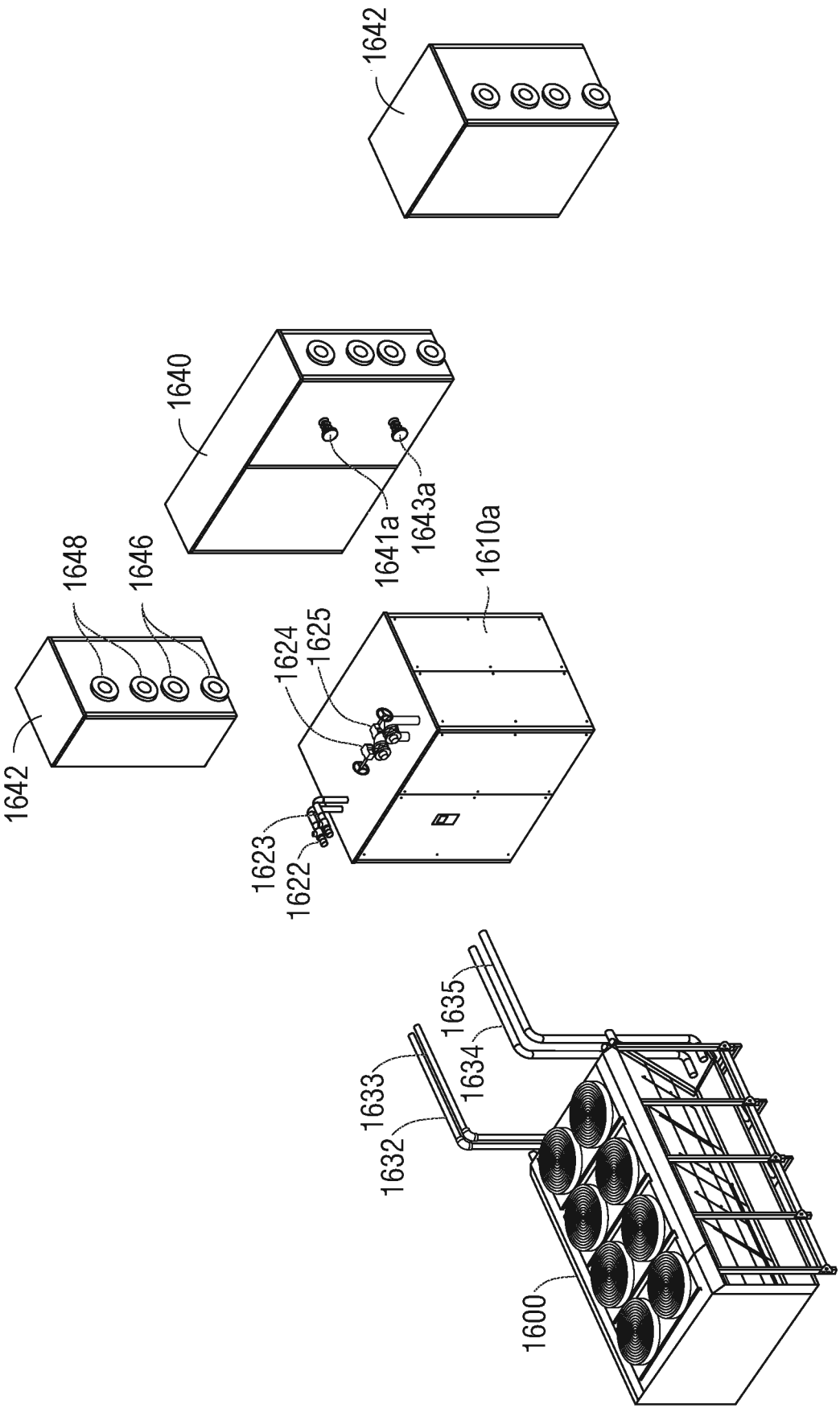

1642
1640
1643a
1641a
1610a
1648
1646
1624
1625
1642
1623
1622
1635
1634
1633
1632
1600

FIG. 16E