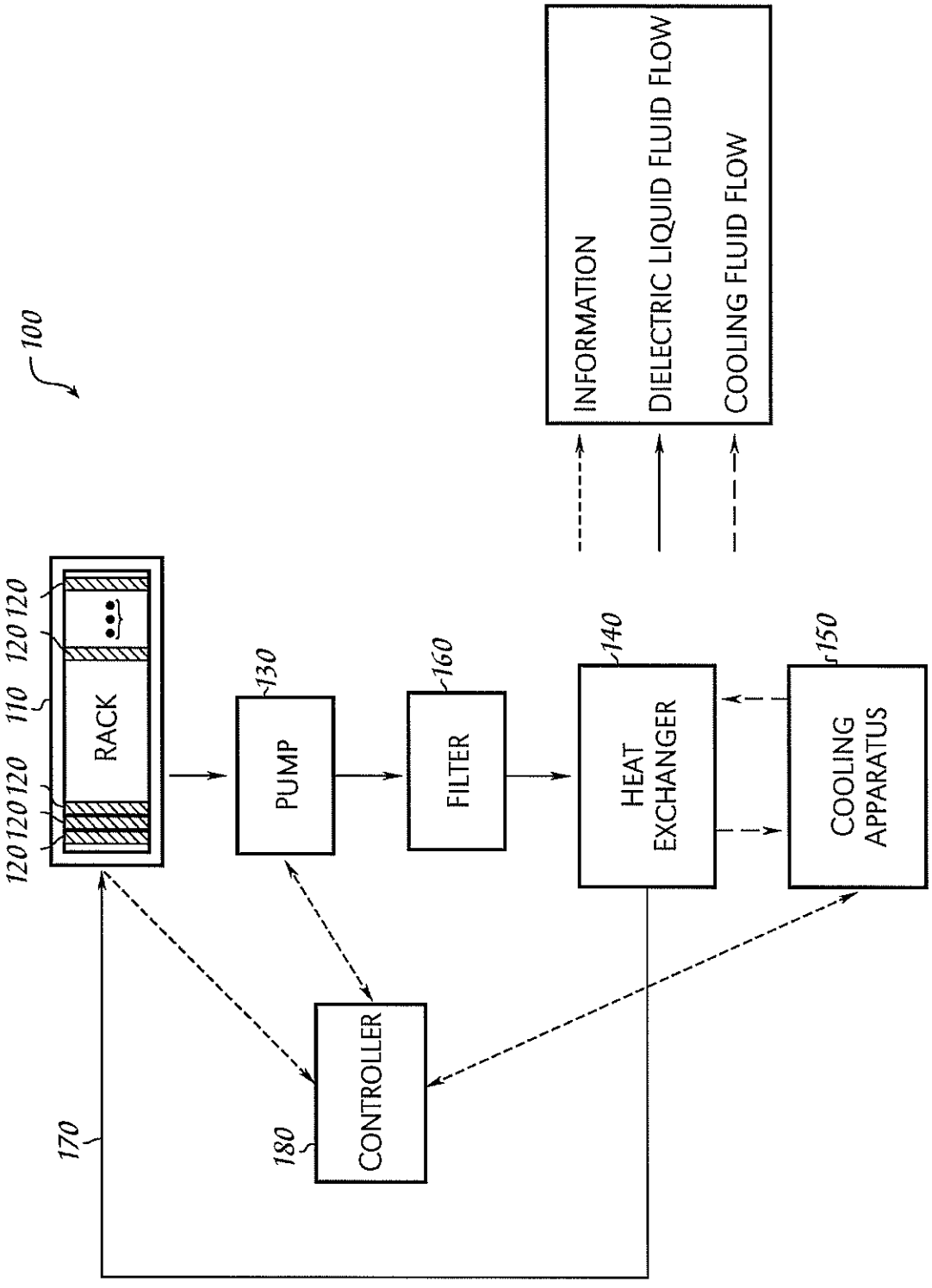

100
INFORMATION
DIELECTRIC LIQUID FLOW
COOLING FLUID FLOW
120 120 120 110 120 120 120
RACK
130
PUMP
160
FILTER
140
HEAT EXCHANGER
150
COOLING APPARATUS
170
180
CONTROLLER

Fig. 1A

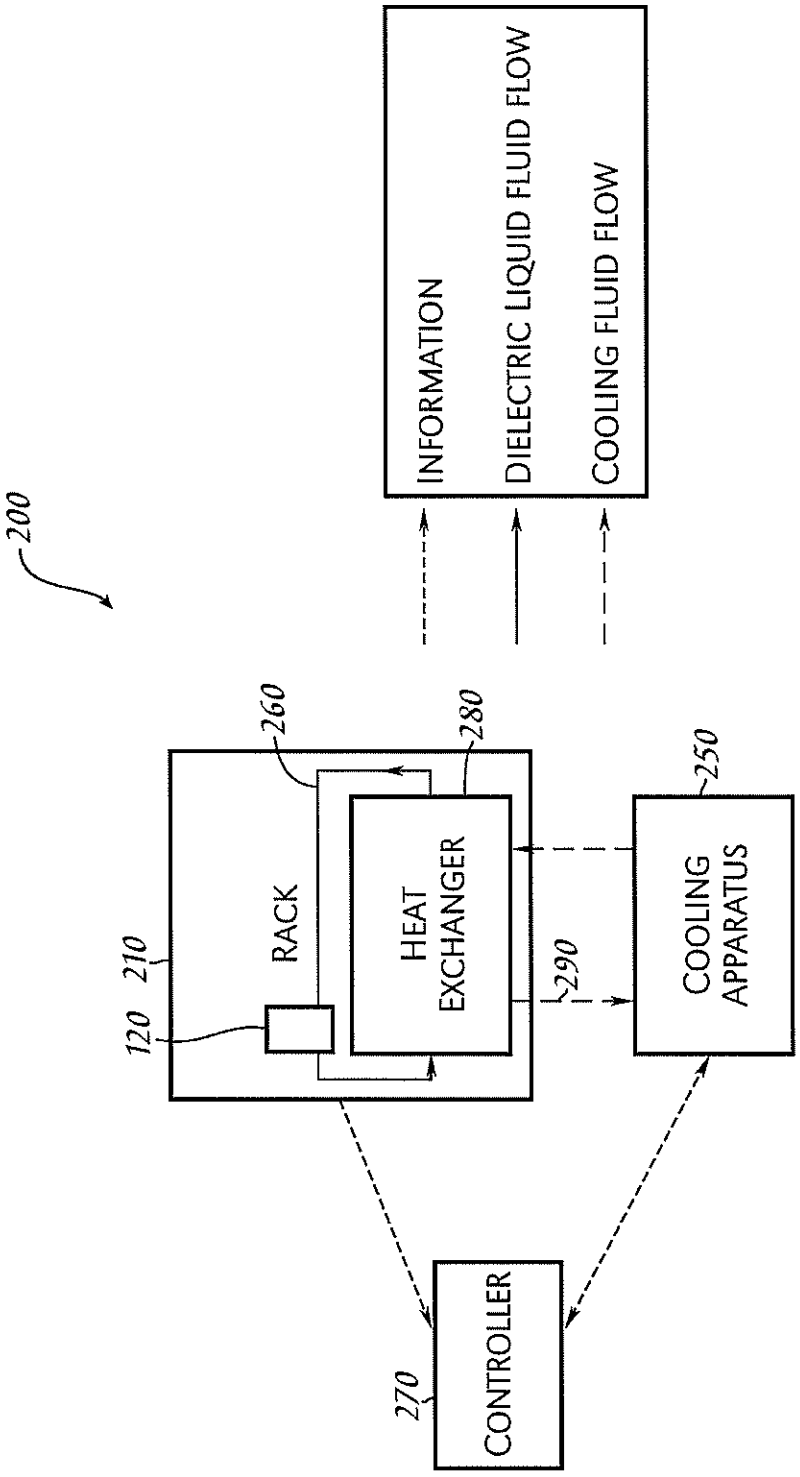

200
INFORMATION
DIELECTRIC LIQUID FLUID FLOW
COOLING FLUID FLOW
260
280
250
210
120
RACK
HEAT EXCHANGER
290
COOLING APPARATUS
270
CONTROLLER

Fig. 1B

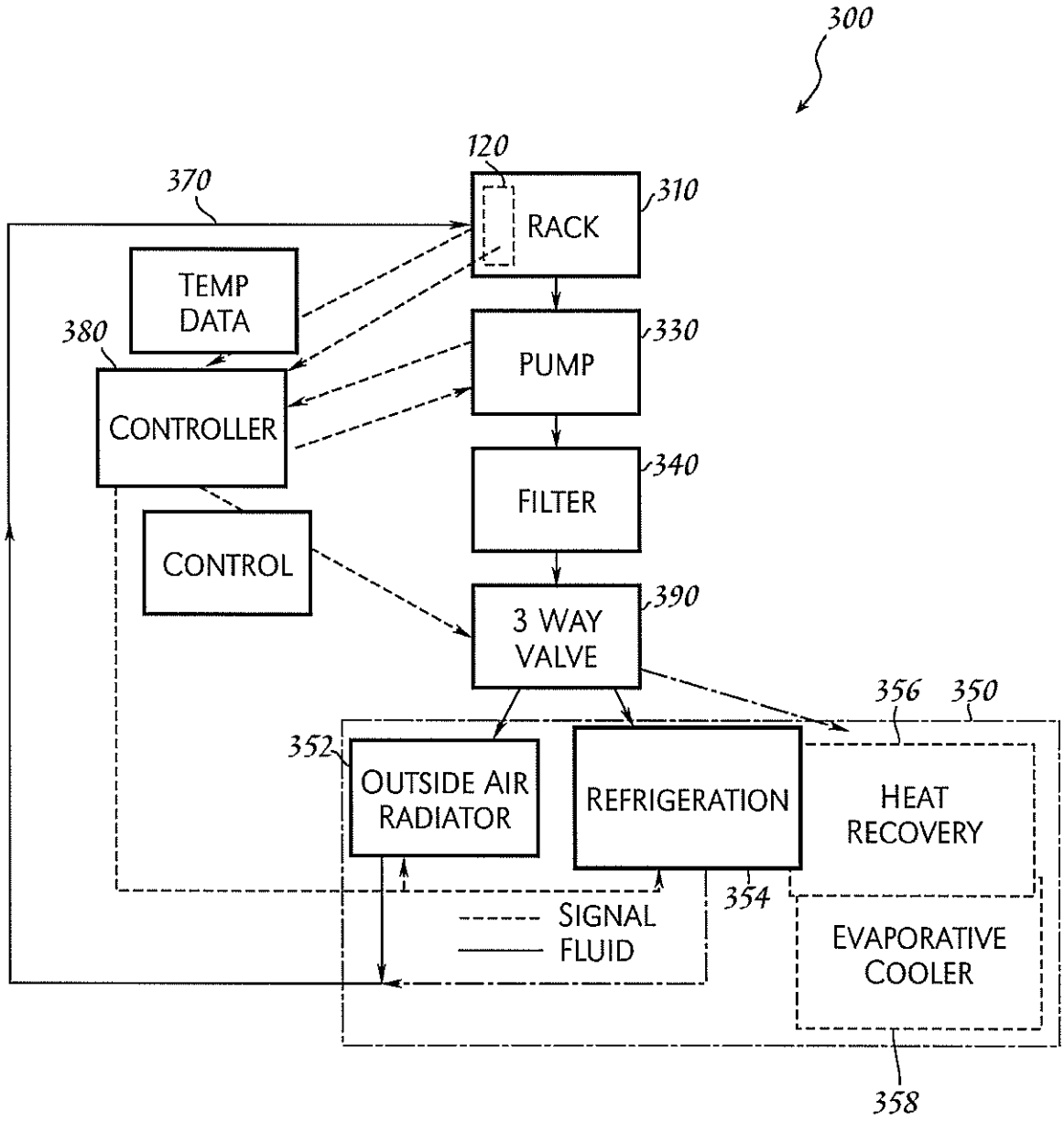

300
120
370
310
RACK
TEMP DATA
380
330
PUMP
CONTROLLER
340
FILTER
CONTROL
390
3 WAY VALVE
356
350
352
OUTSIDE AIR RADIATOR
REFRIGERATION
HEAT RECOVERY
354
SIGNAL
FLUID
EVAPORATIVE COOLER
358

Fig. 2

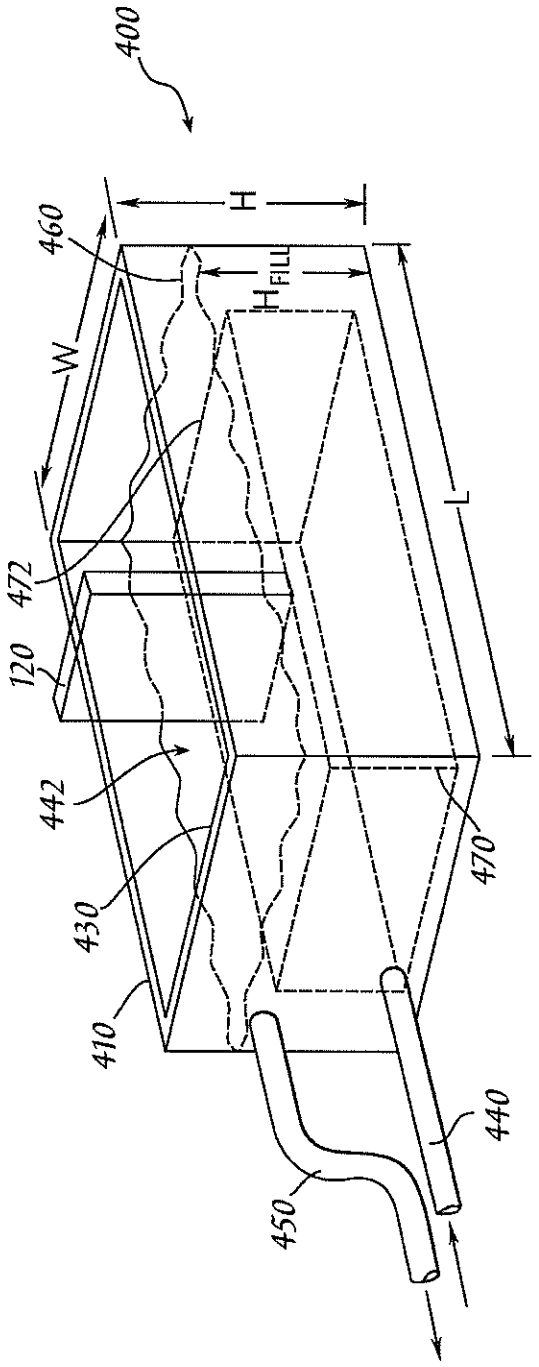

400
H
460
W
H_{FILL}
L
472
120
442
430
410
470
440
450

Fig. 3

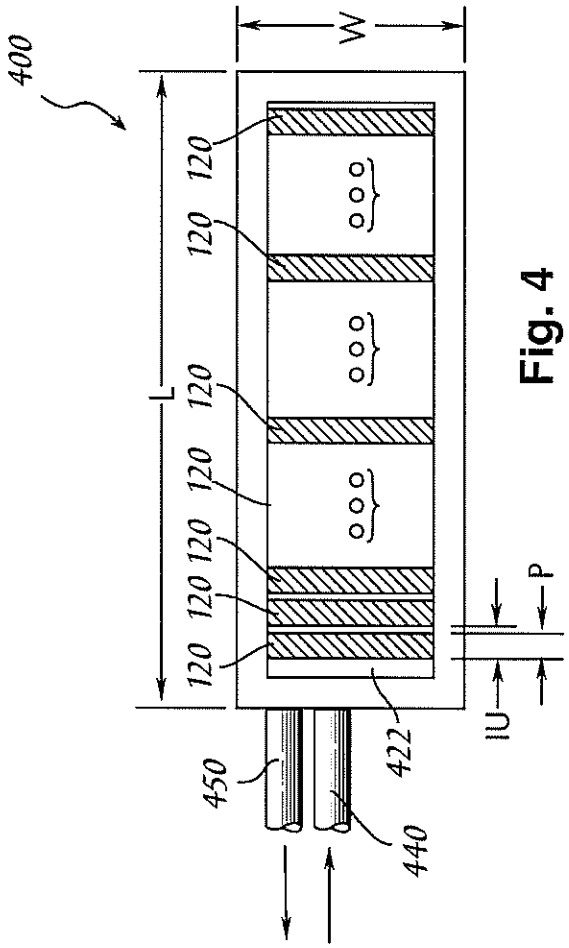

400
W
L
120
120
120
120
120
120
120
P
IU
450
422
440

Fig. 4

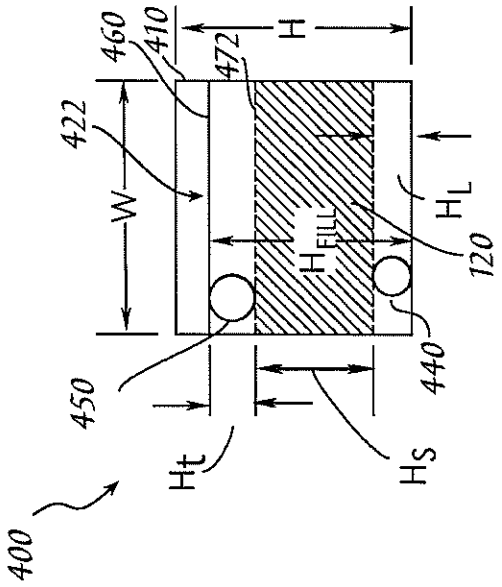

400
450
Ht
Hs
440
120
HL
HFILL
W
422
460
410
472
H

Fig. 5

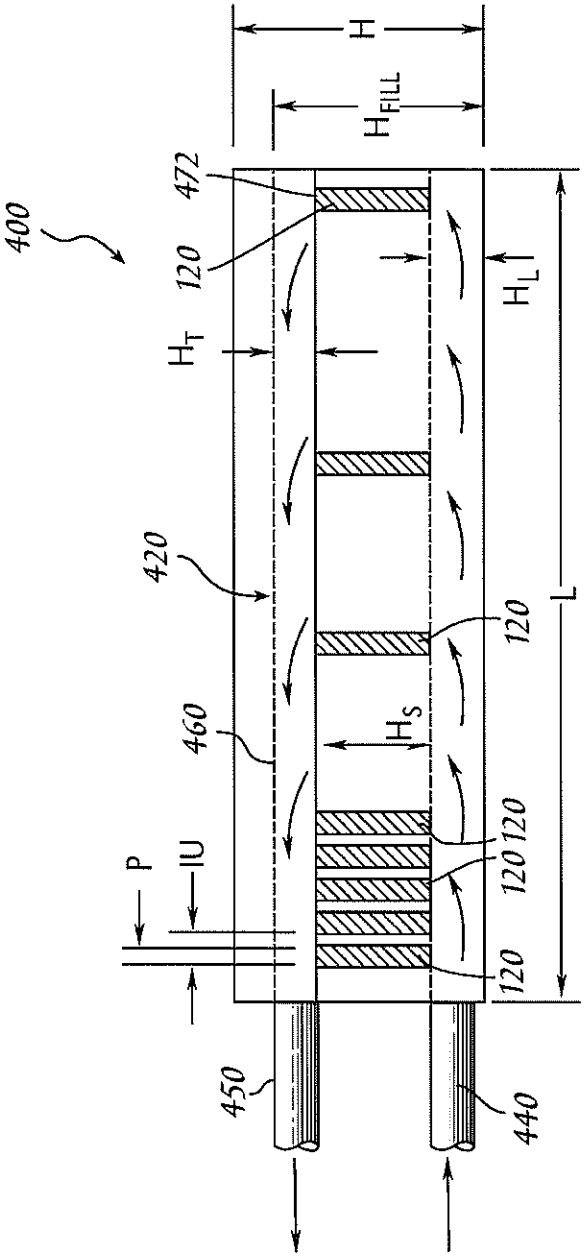

400
H
HFILL
472
120
HT
HL
420
460
Hs
120
L
P
IU
120
120
120
450
440

Fig. 6

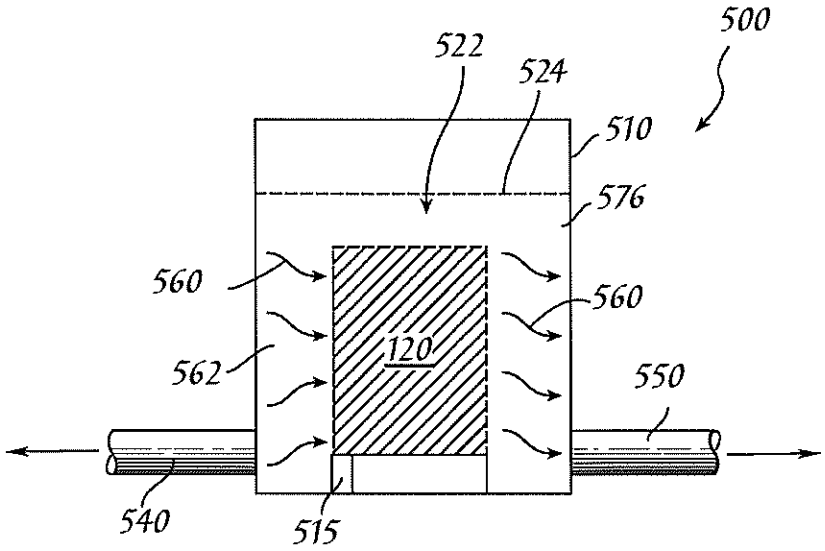

500
522
524
510
576
560
560
562
120
550
540
515

Fig. 7

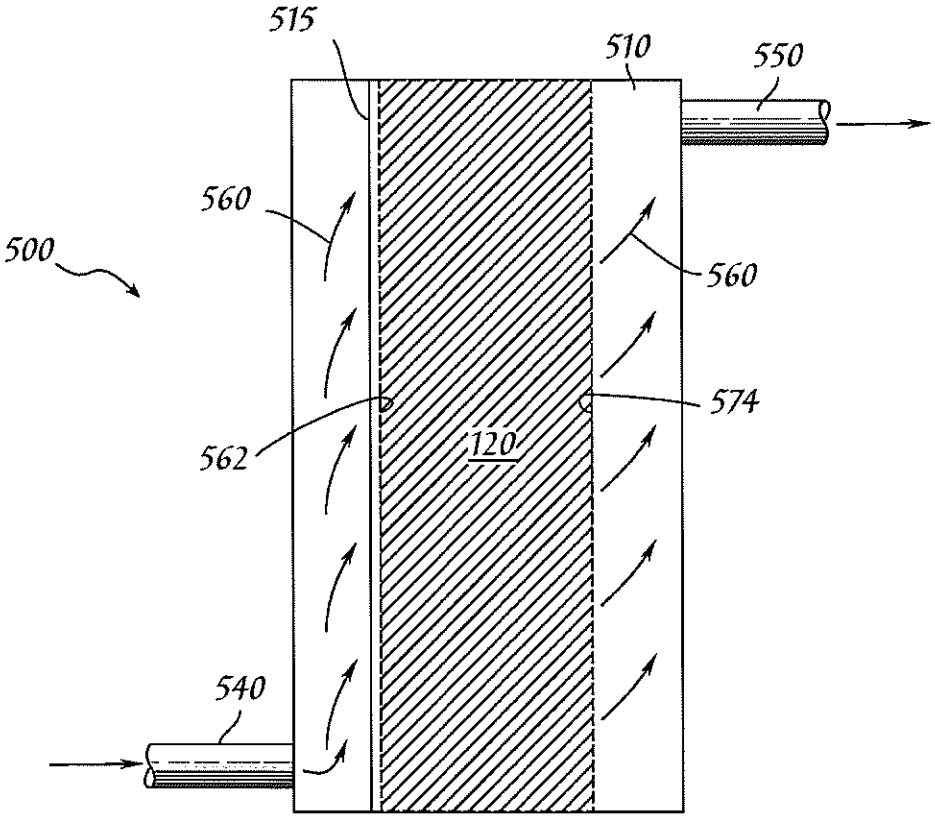

515
510
550
560
500
560
574
562
120
540

Fig. 8

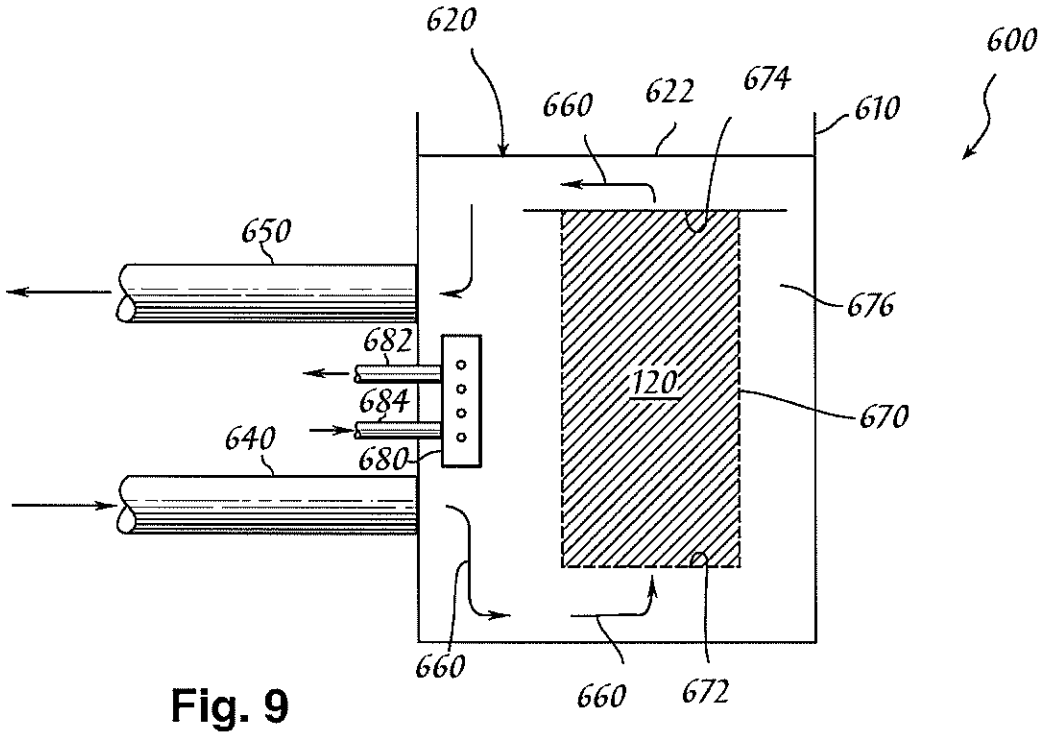

620
600
660
622
674
610
650
676
682
120
684
670
640
680
660
660
672

Fig. 9

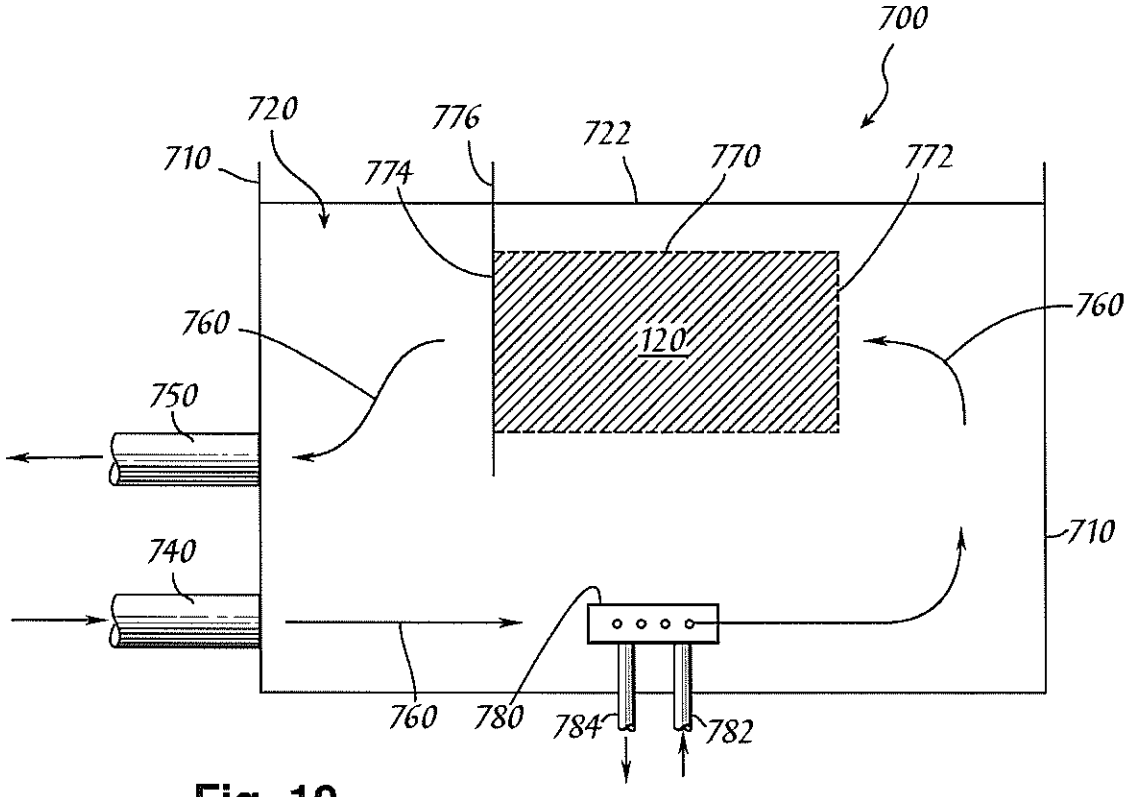

700
720
776
722
710
774
770
772
760
120
760
750
710
740
760
780
784
782

Fig. 10

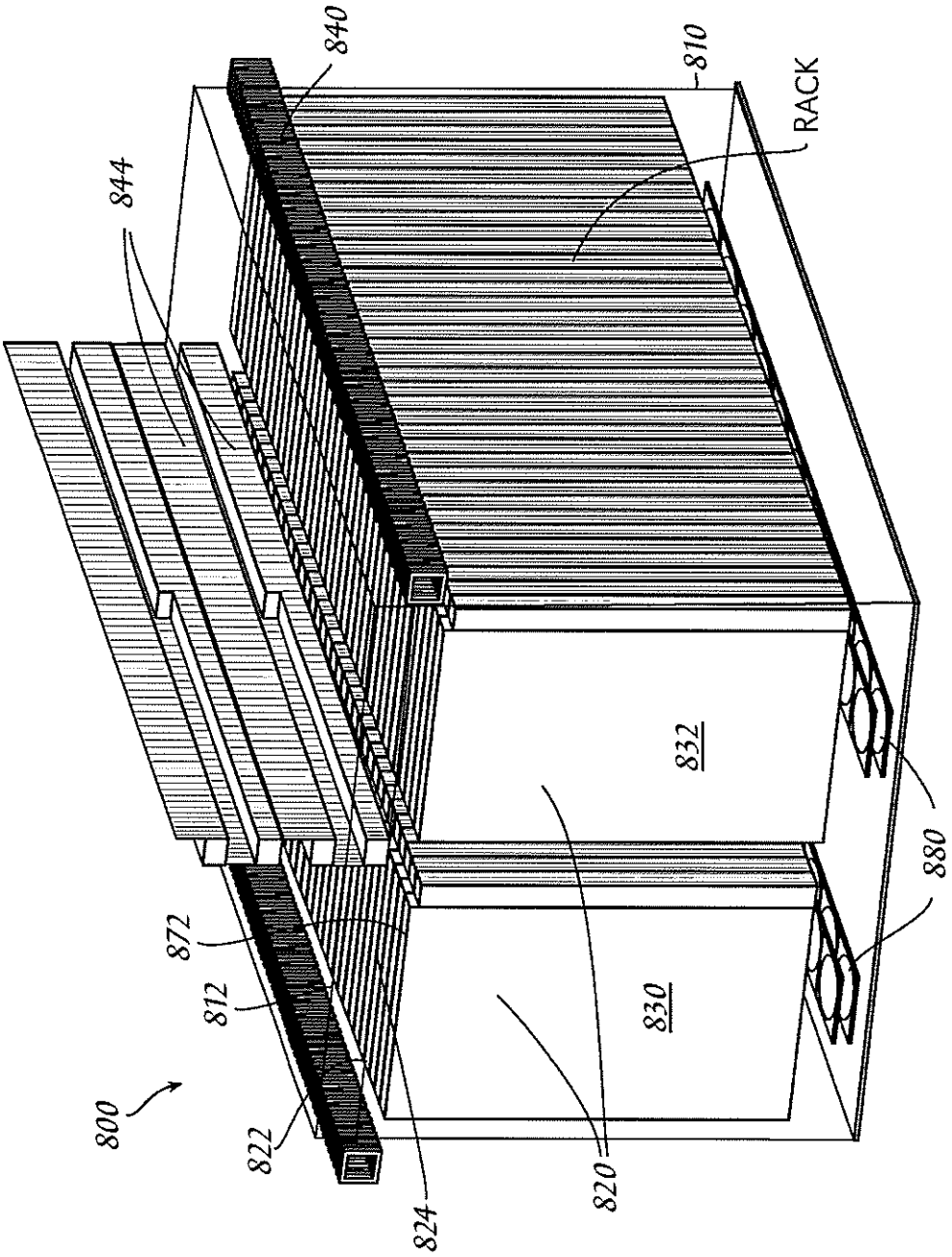


Fig. 11

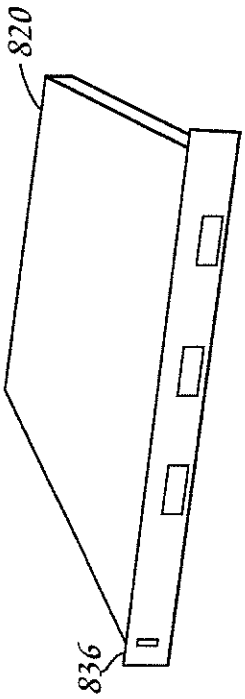


Fig. 12A

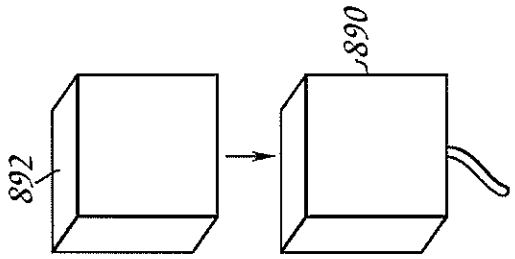


Fig. 12B

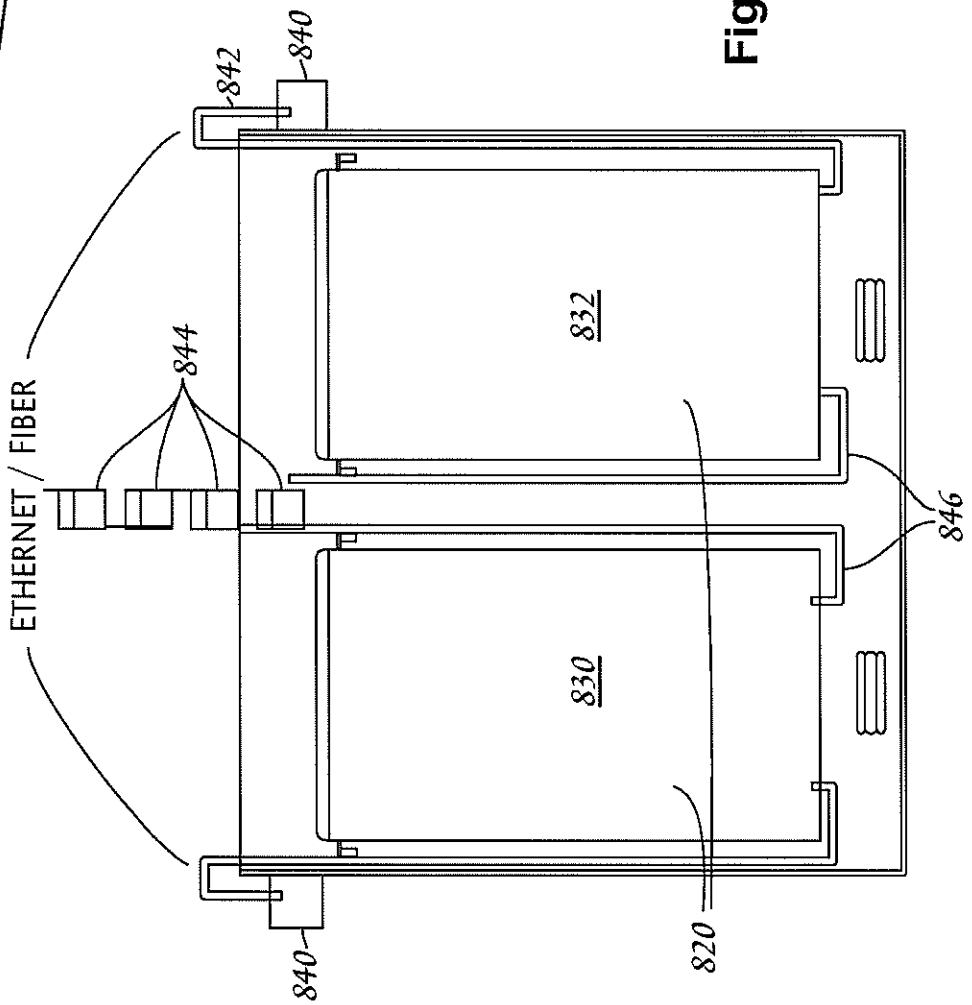


Fig. 13

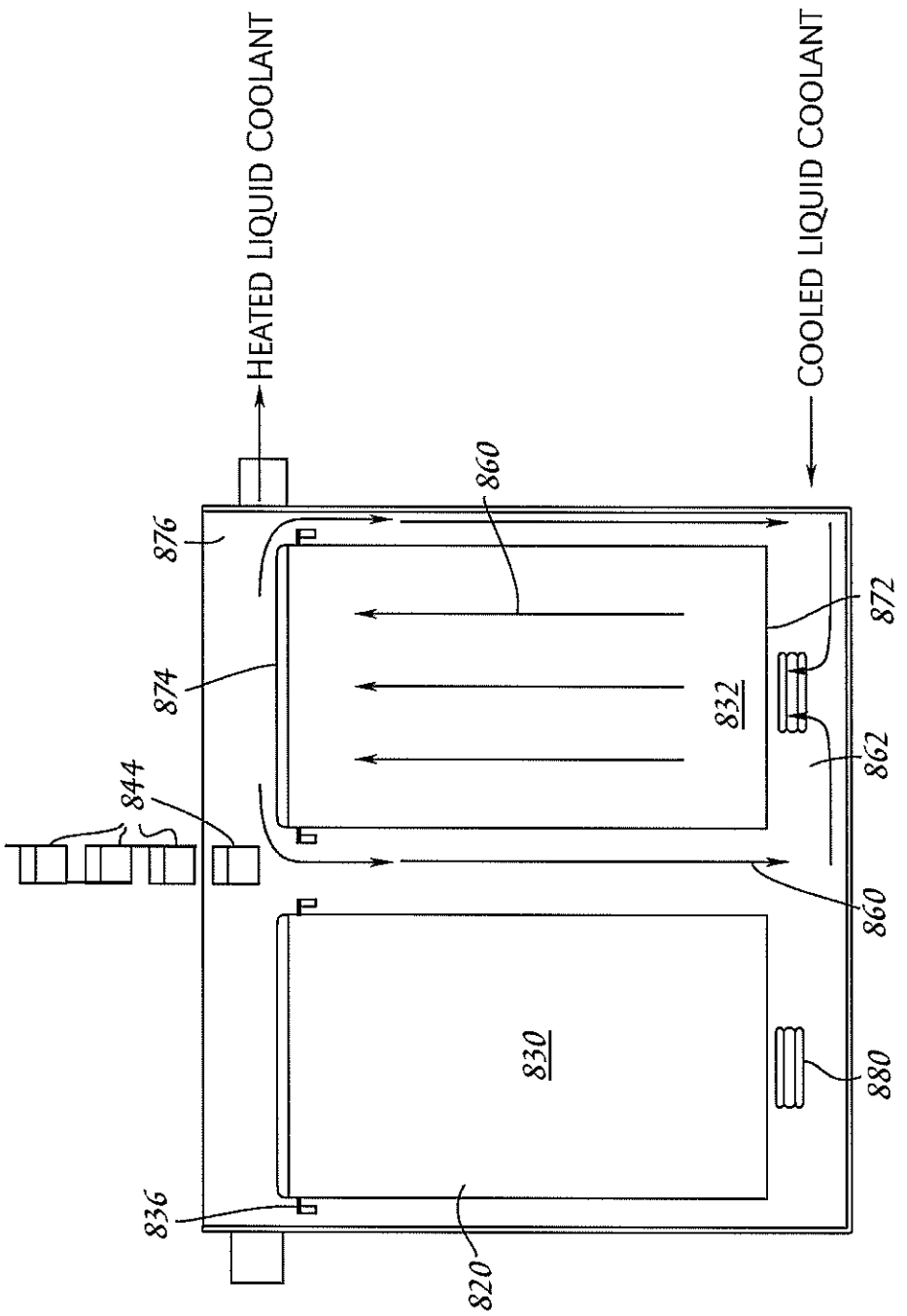

HEATED LIQUID COOLANT
COOLED LIQUID COOLANT
860
876
872
874
832
862
844
860
830
880
836
820

Fig. 14

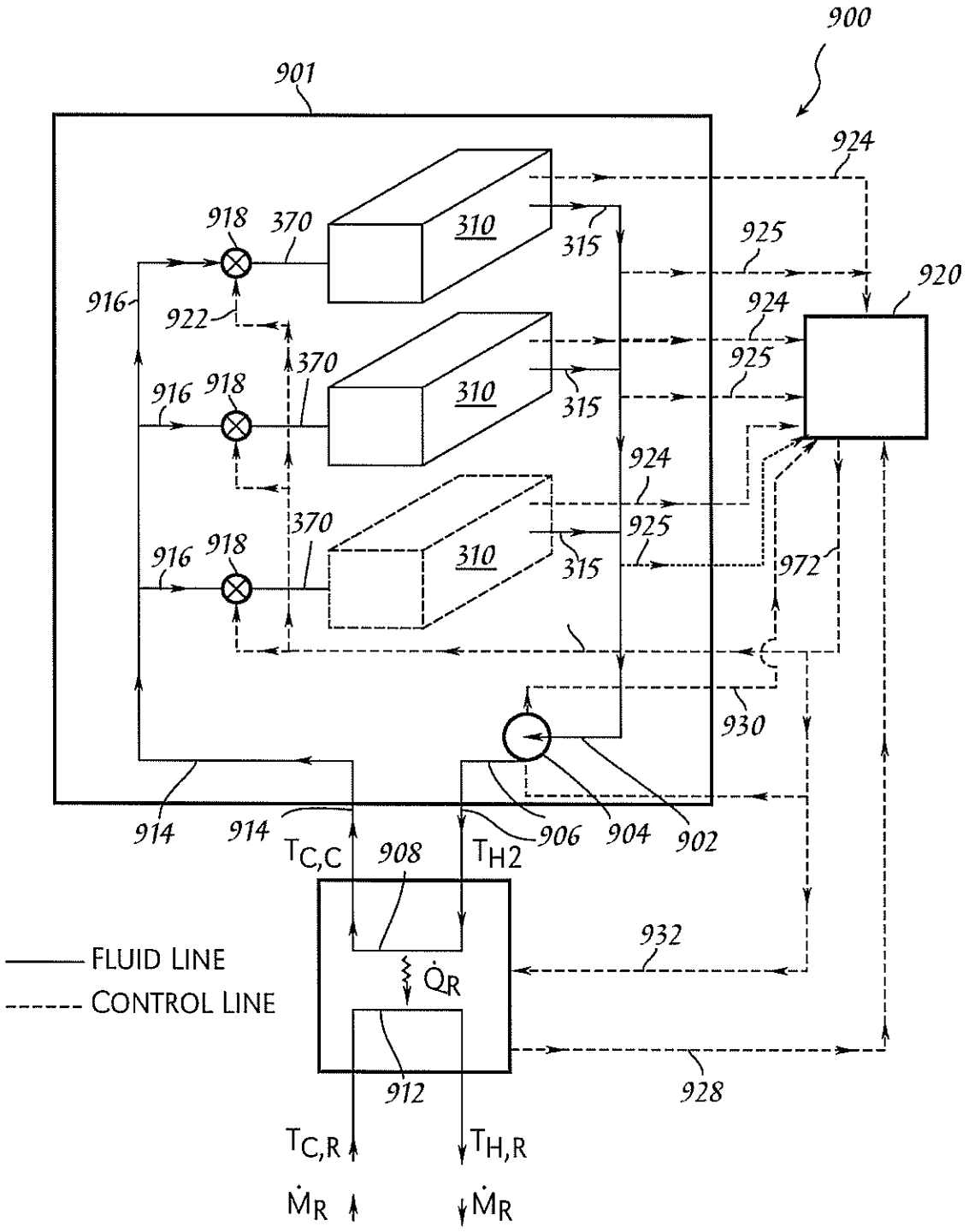

900
901
924
918
370
310
315
925
920
916
922
924
370
925
916
918
310
315
924
370
925
916
918
310
315
972
930
914
914
$T_{C,C}$
908
T_{H2}
906
904
902
932
FLUID LINE
CONTROL LINE
$\dot{Q}_R$
912
928
$T_{C,R}$
$T_{H,R}$
$\dot{M}_R$
$\dot{M}_R$

Fig. 15

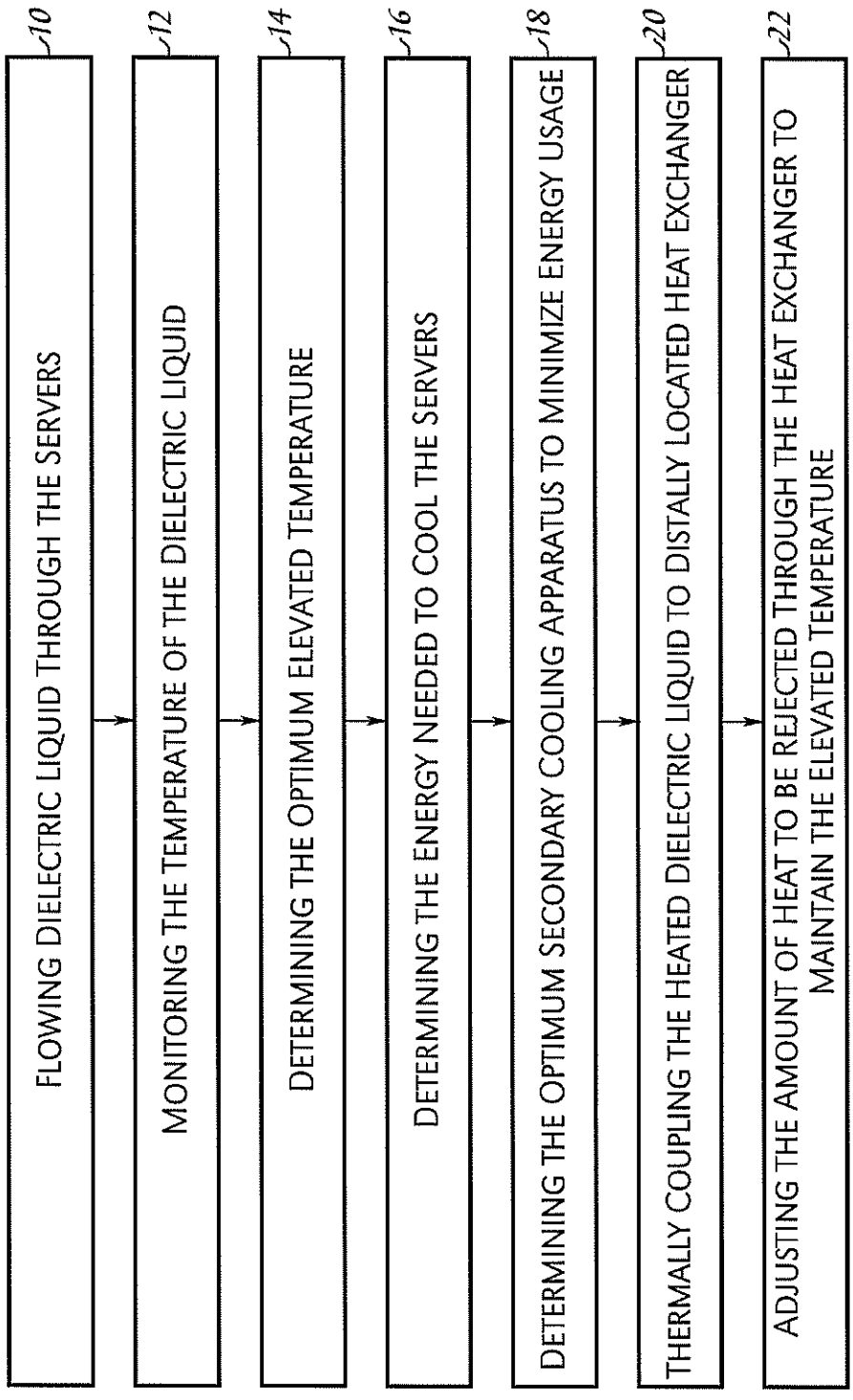

10
FLOWING DIELECTRIC LIQUID THROUGH THE SERVERS
12
MONITORING THE TEMPERATURE OF THE DIELECTRIC LIQUID
14
DETERMINING THE OPTIMUM ELEVATED TEMPERATURE
16
DETERMINING THE ENERGY NEEDED TO COOL THE SERVERS
18
DETERMINING THE OPTIMUM SECONDARY COOLING APPARATUS TO MINIMIZE ENERGY USAGE
20
THERMALLY COUPLING THE HEATED DIELECTRIC LIQUID TO DISTALLY LOCATED HEAT EXCHANGER
22
ADJUSTING THE AMOUNT OF HEAT TO BE REJECTED THROUGH THE HEAT EXCHANGER TO MAINTAIN THE ELEVATED TEMPERATURE

Fig. 16

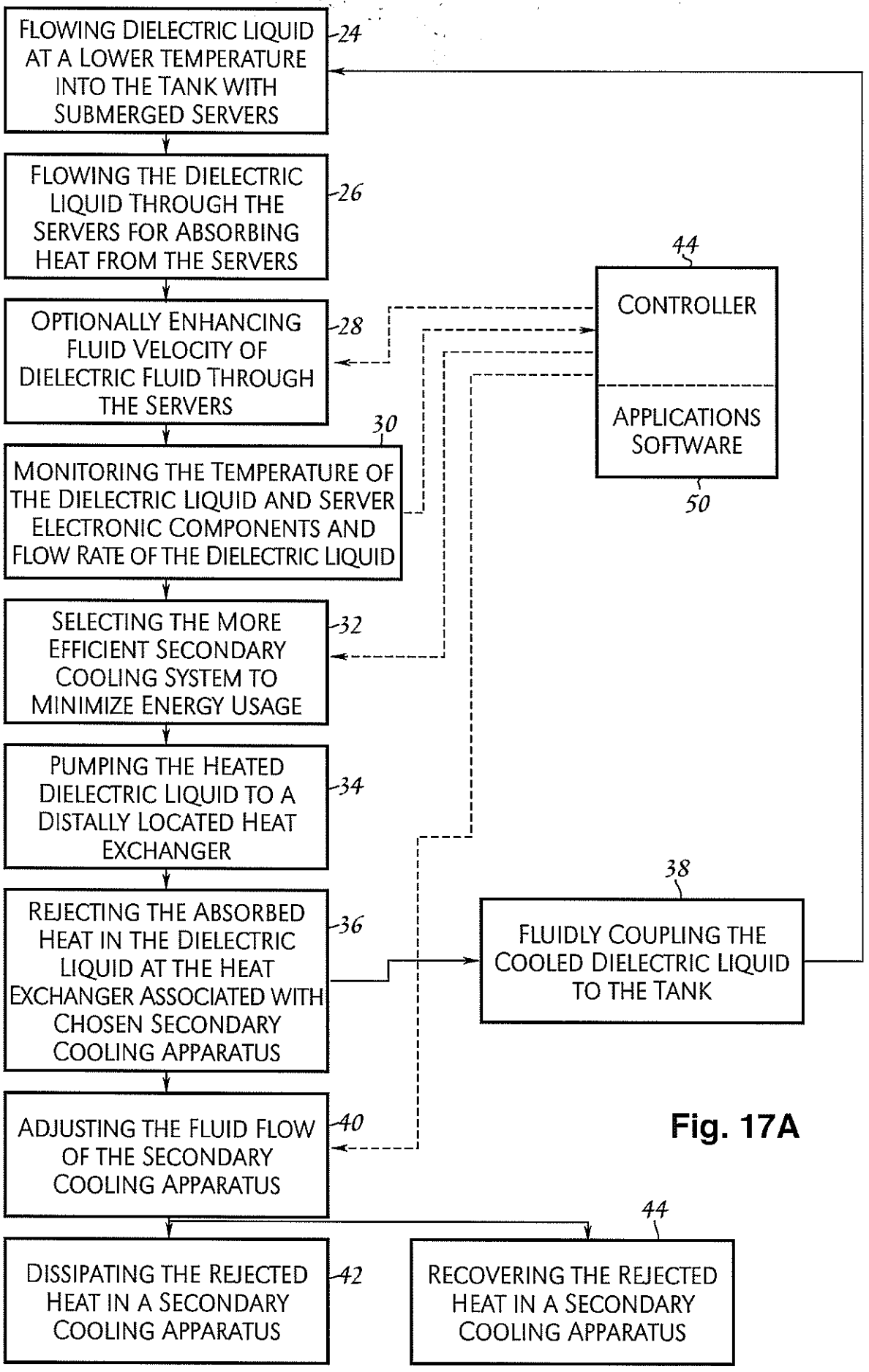

FLOWING DIELECTRIC LIQUID AT A LOWER TEMPERATURE INTO THE TANK WITH SUBMERGED SERVERS
24
FLOWING THE DIELECTRIC LIQUID THROUGH THE SERVERS FOR ABSORBING HEAT FROM THE SERVERS
26
OPTIONALLY ENHANCING FLUID VELOCITY OF DIELECTRIC FLUID THROUGH THE SERVERS
28
MONITORING THE TEMPERATURE OF THE DIELECTRIC LIQUID AND SERVER ELECTRONIC COMPONENTS AND FLOW RATE OF THE DIELECTRIC LIQUID
30
SELECTING THE MORE EFFICIENT SECONDARY COOLING SYSTEM TO MINIMIZE ENERGY USAGE
32
PUMPING THE HEATED DIELECTRIC LIQUID TO A DISTALLY LOCATED HEAT EXCHANGER
34
REJECTING THE ABSORBED HEAT IN THE DIELECTRIC LIQUID AT THE HEAT EXCHANGER ASSOCIATED WITH CHOSEN SECONDARY COOLING APPARATUS
36
ADJUSTING THE FLUID FLOW OF THE SECONDARY COOLING APPARATUS
40
DISSIPATING THE REJECTED HEAT IN A SECONDARY COOLING APPARATUS
42
44
CONTROLLER
APPLICATIONS SOFTWARE
50
38
FLUIDLY COUPLING THE COOLED DIELECTRIC LIQUID TO THE TANK
44
RECOVERING THE REJECTED HEAT IN A SECONDARY COOLING APPARATUS

Fig. 17A

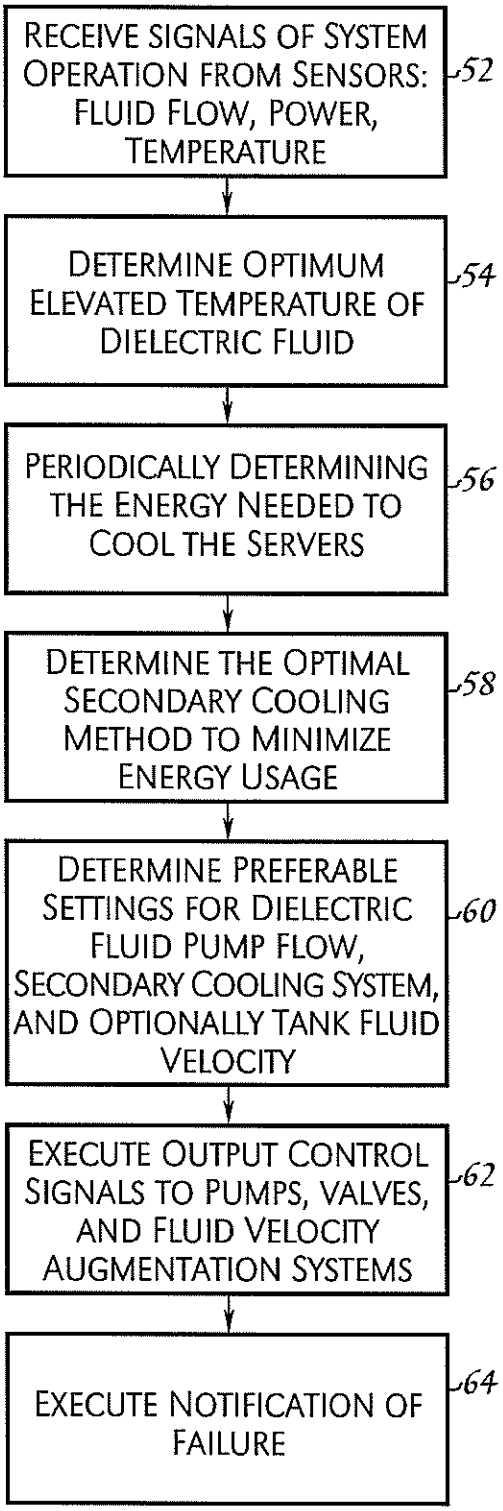

RECEIVE SIGNALS OF SYSTEM OPERATION FROM SENSORS: FLUID FLOW, POWER, TEMPERATURE
52
DETERMINE OPTIMUM ELEVATED TEMPERATURE OF DIELECTRIC FLUID
54
PERIODICALLY DETERMINING THE ENERGY NEEDED TO COOL THE SERVERS
56
DETERMINE THE OPTIMAL SECONDARY COOLING METHOD TO MINIMIZE ENERGY USAGE
58
DETERMINE PREFERABLE SETTINGS FOR DIELECTRIC FLUID PUMP FLOW, SECONDARY COOLING SYSTEM, AND OPTIONALLY TANK FLUID VELOCITY
60
EXECUTE OUTPUT CONTROL SIGNALS TO PUMPS, VALVES, AND FLUID VELOCITY AUGMENTATION SYSTEMS
62
EXECUTE NOTIFICATION OF FAILURE
64

Fig. 17B