

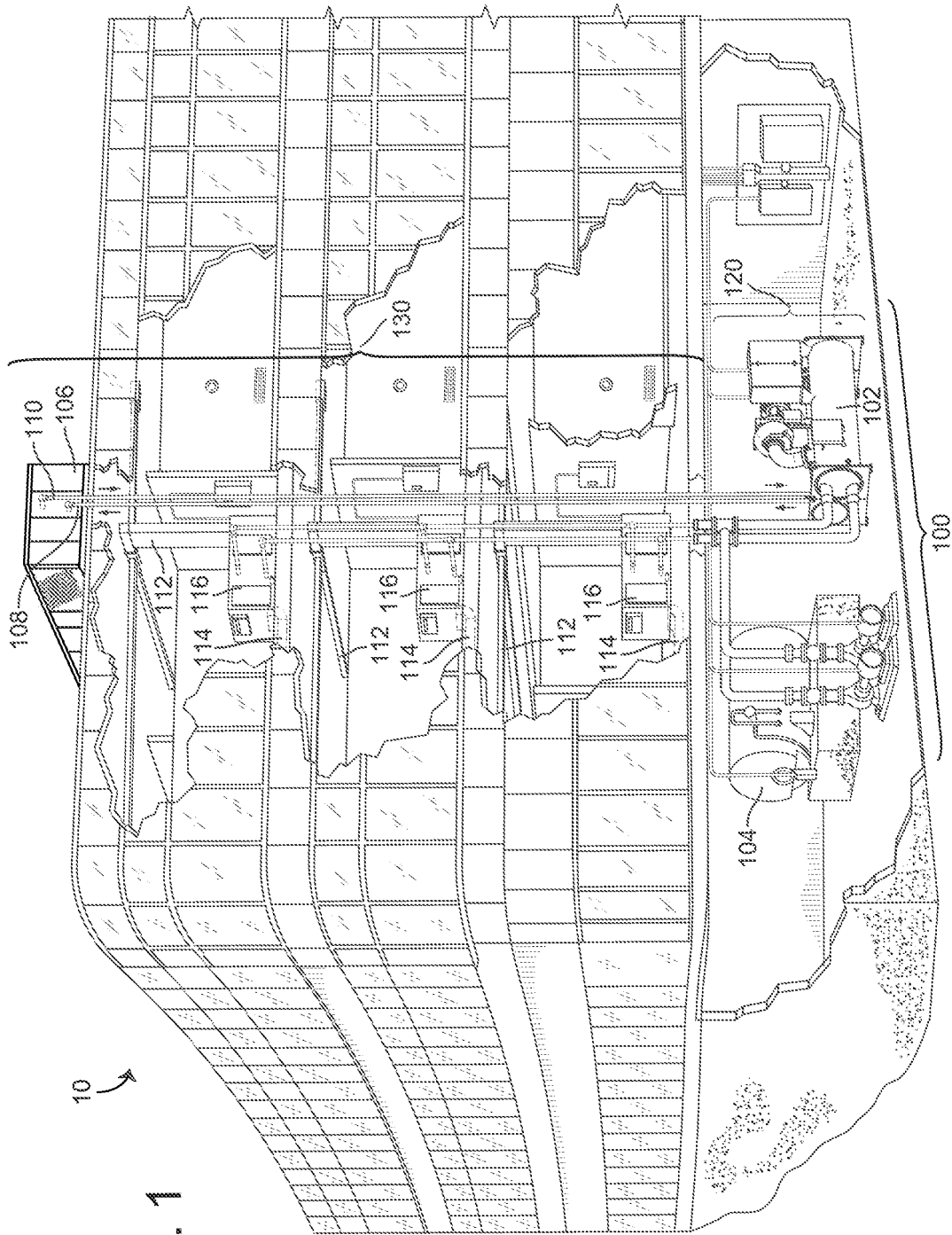


FIG. 1

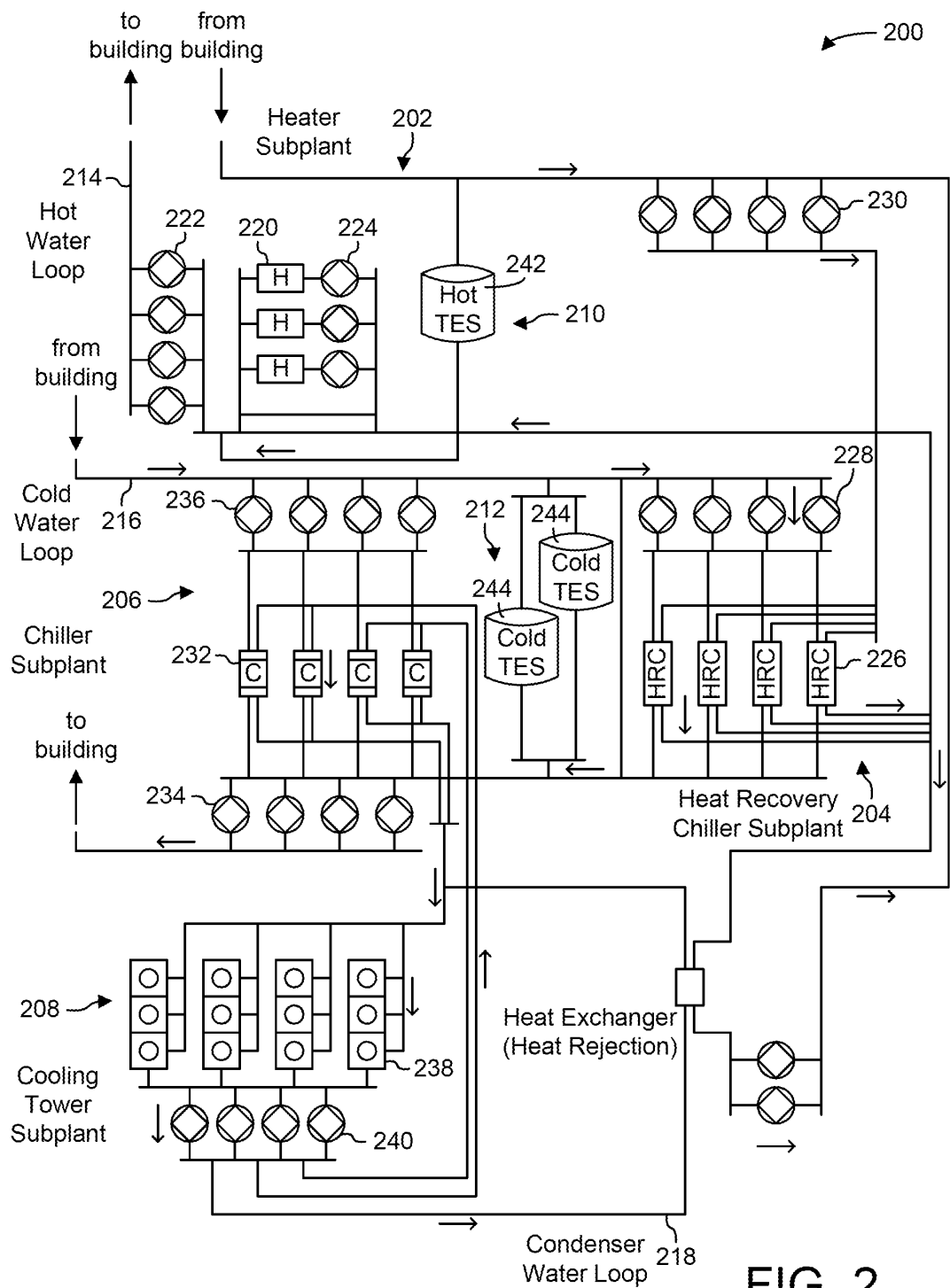
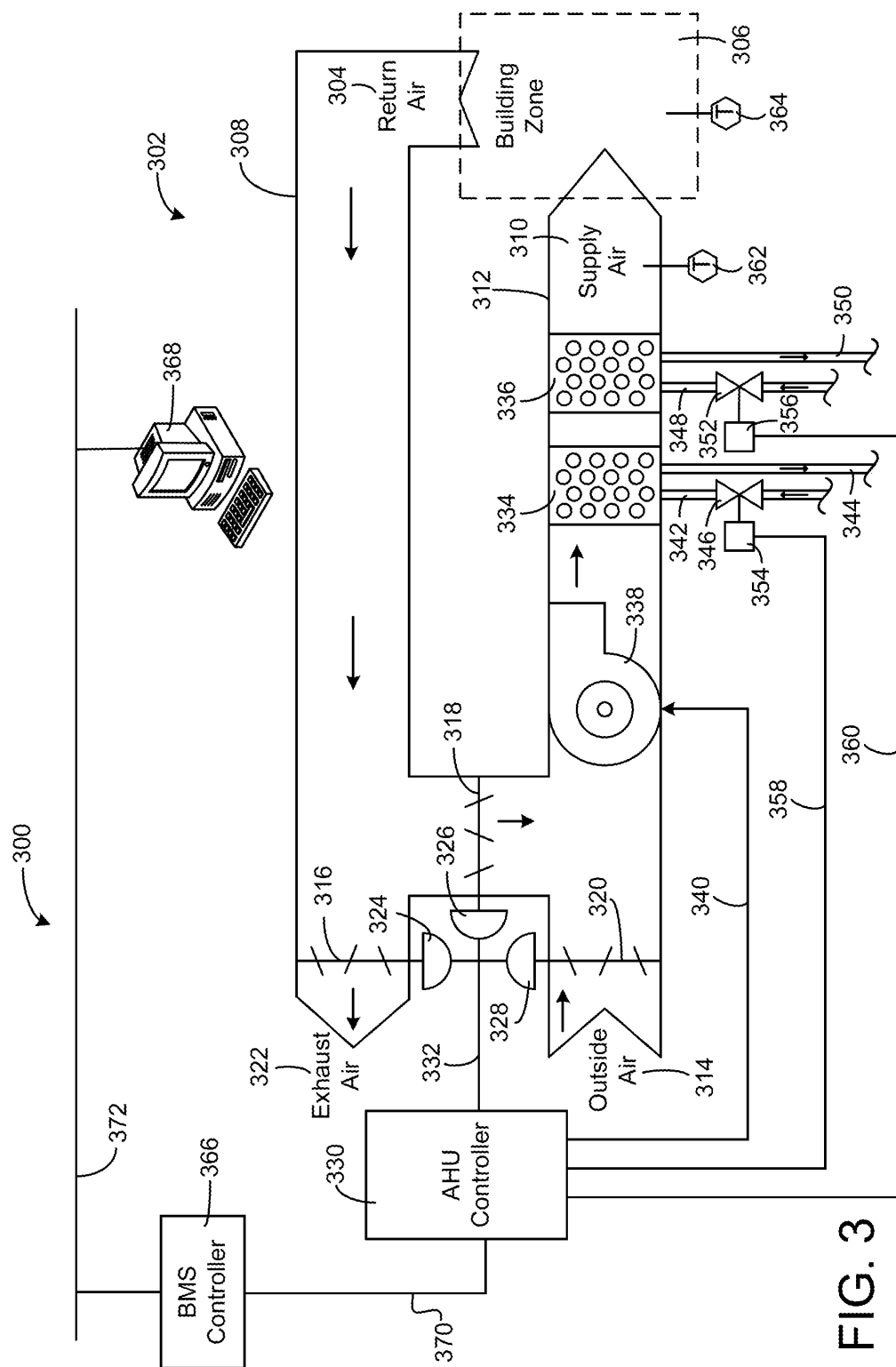


FIG. 2



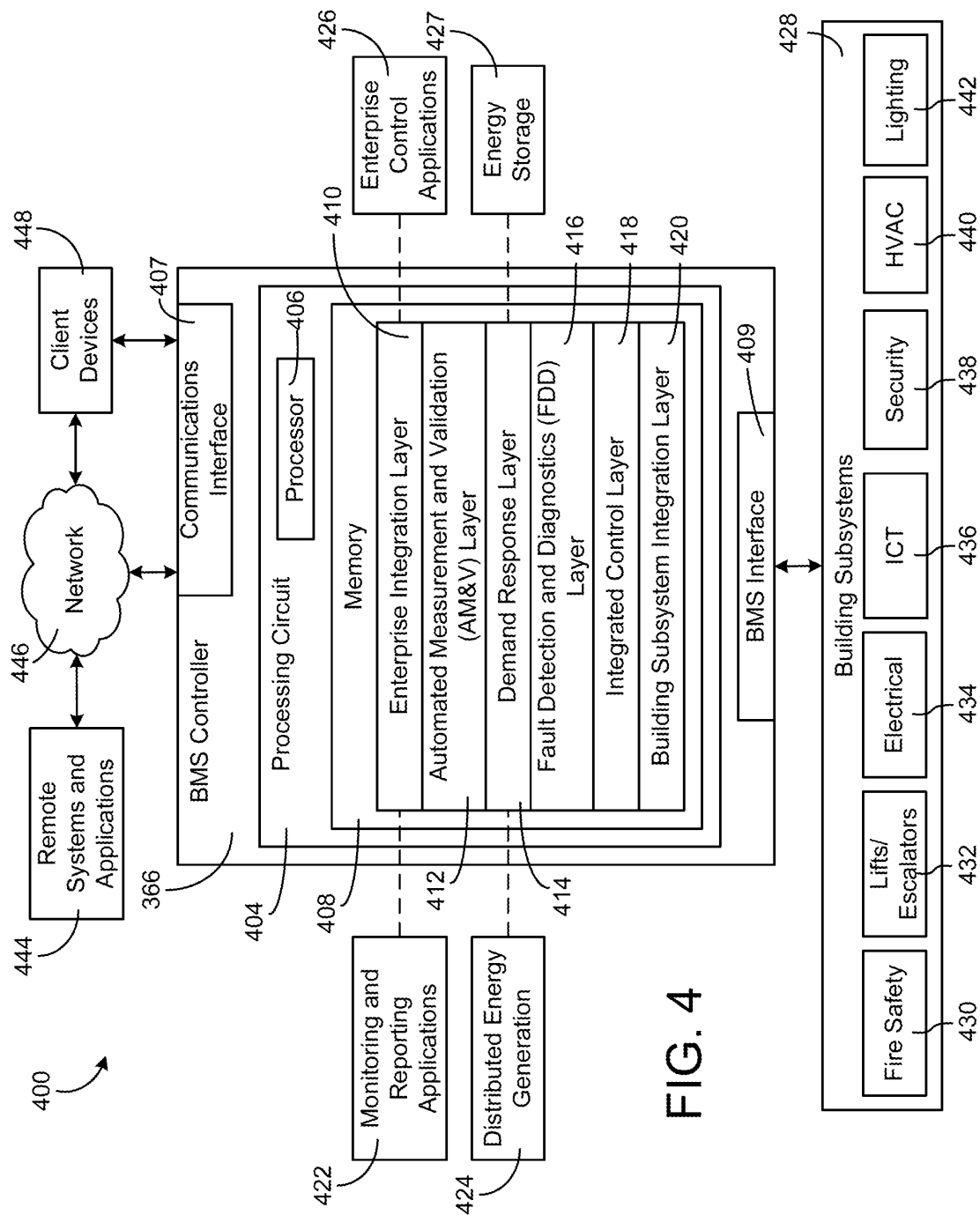


FIG. 4

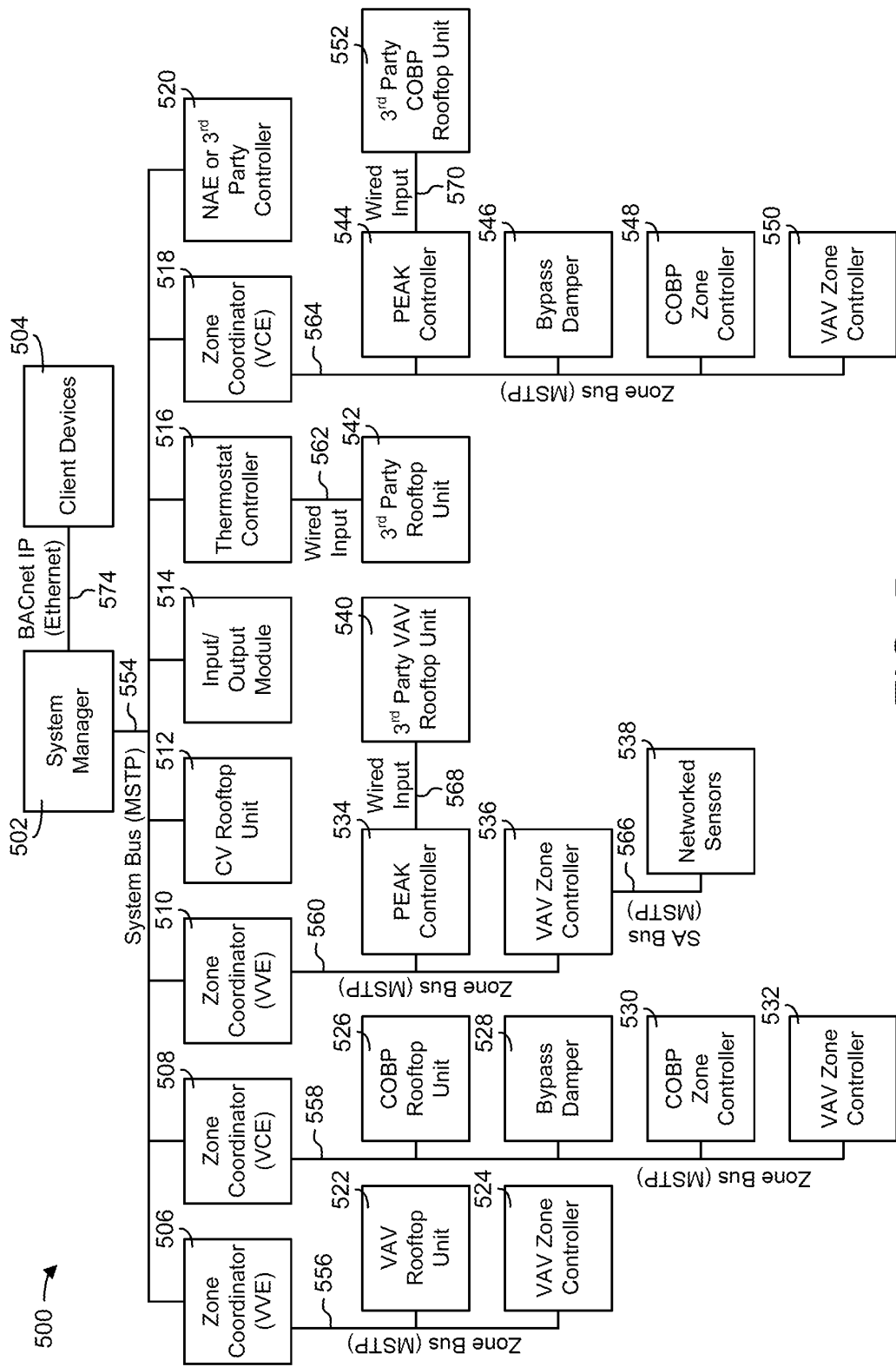


FIG. 5

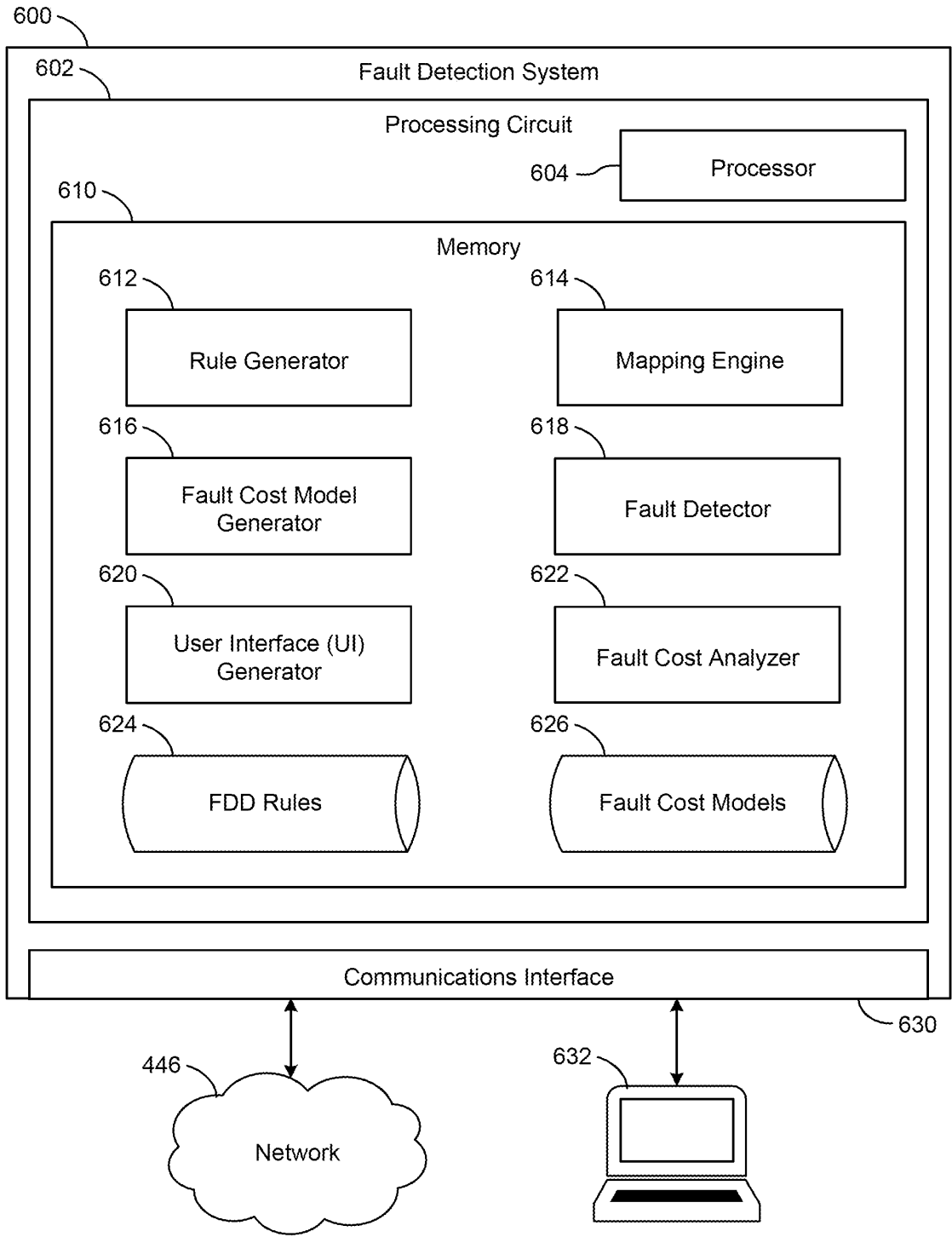


FIG. 6A

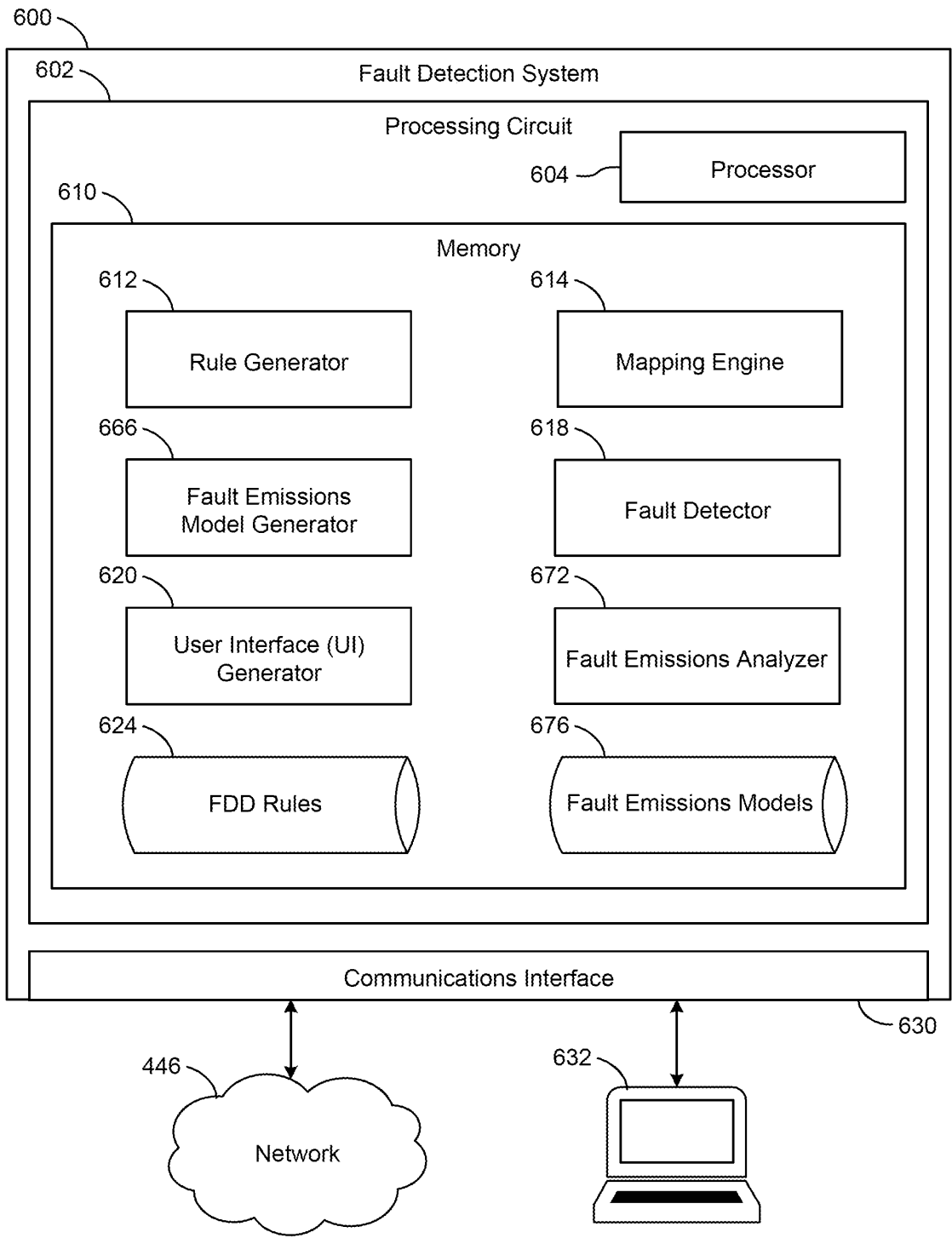


FIG. 6B

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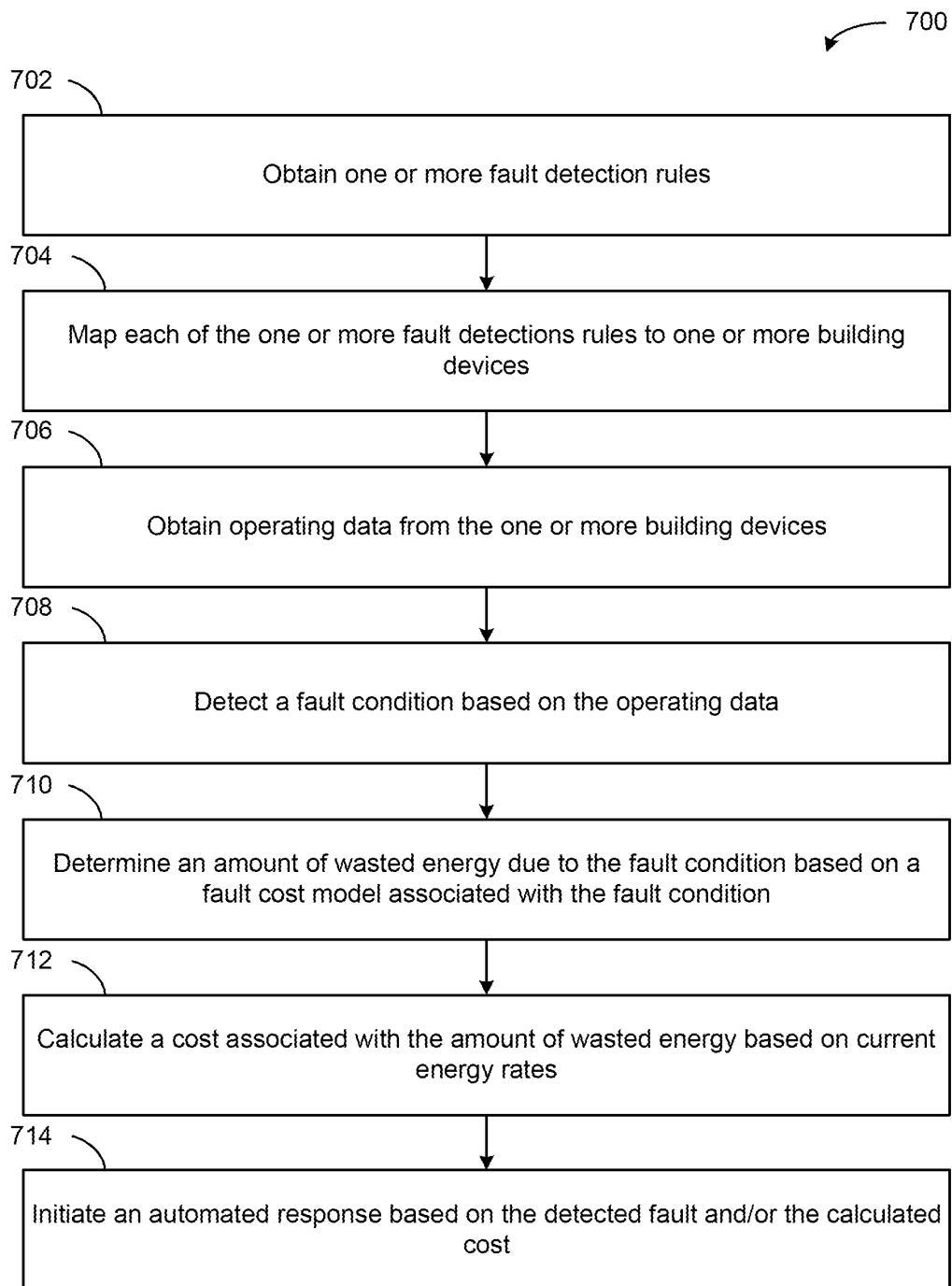


FIG. 7A

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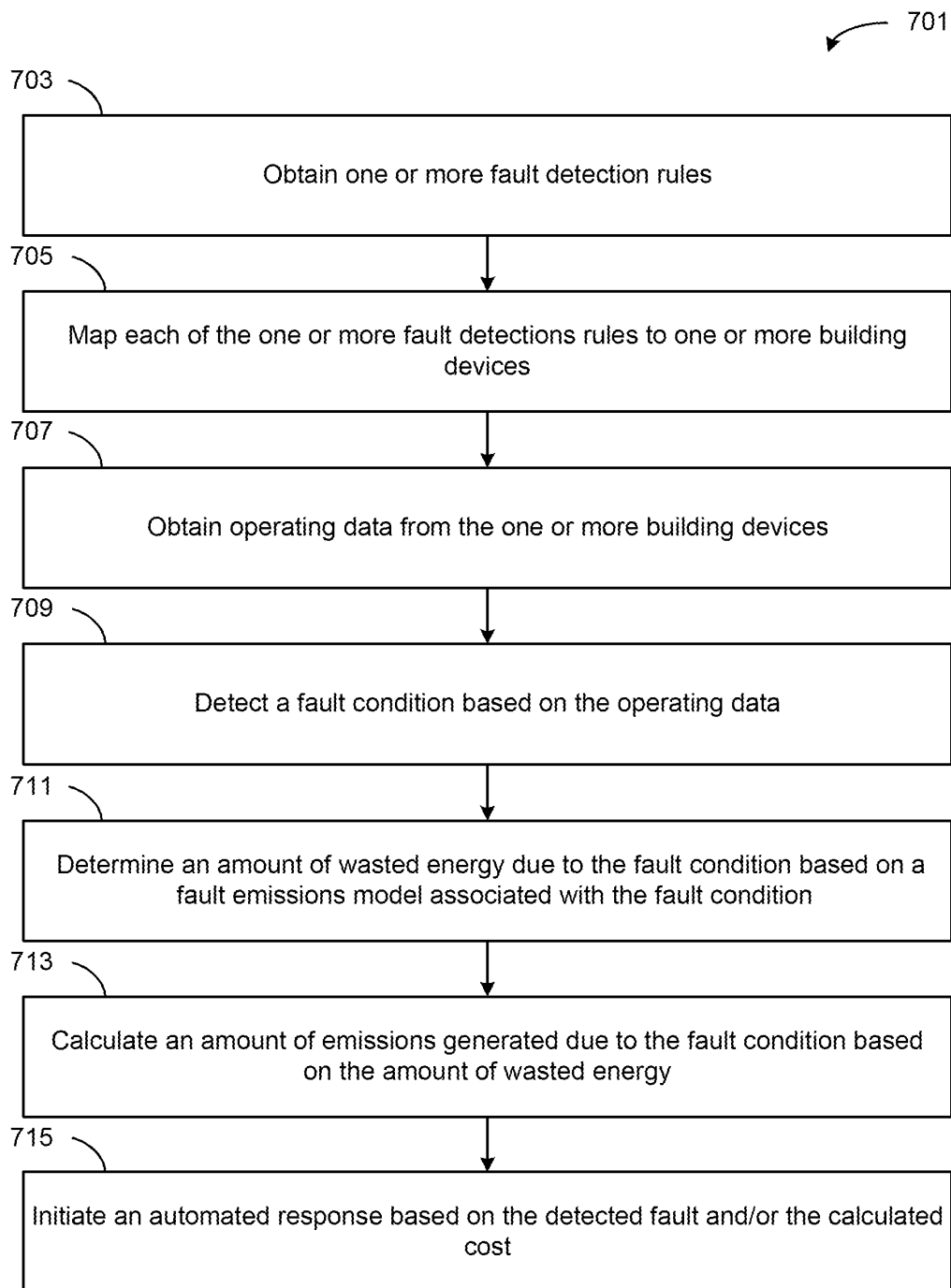


FIG. 7B

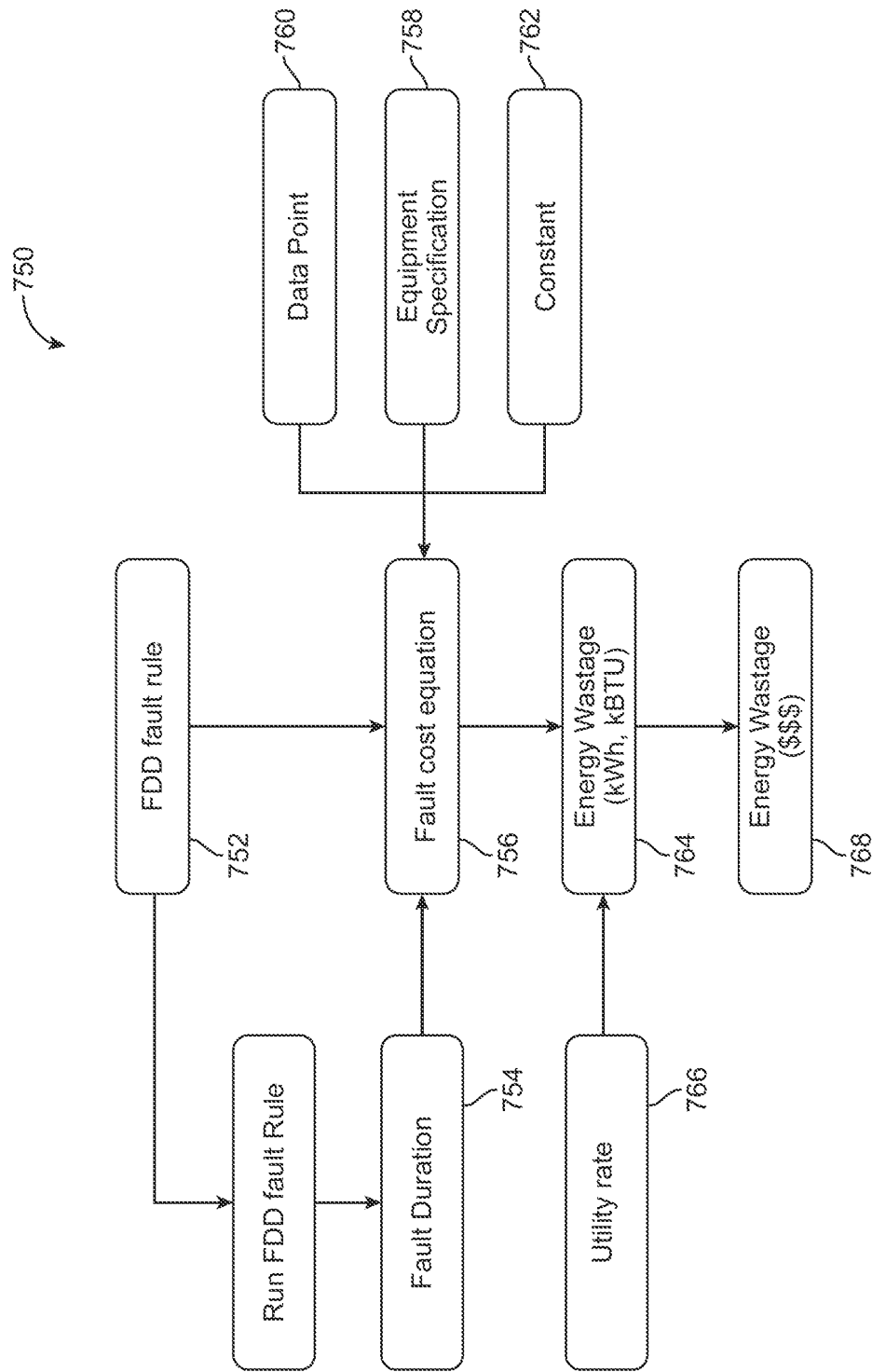


FIG. 7C

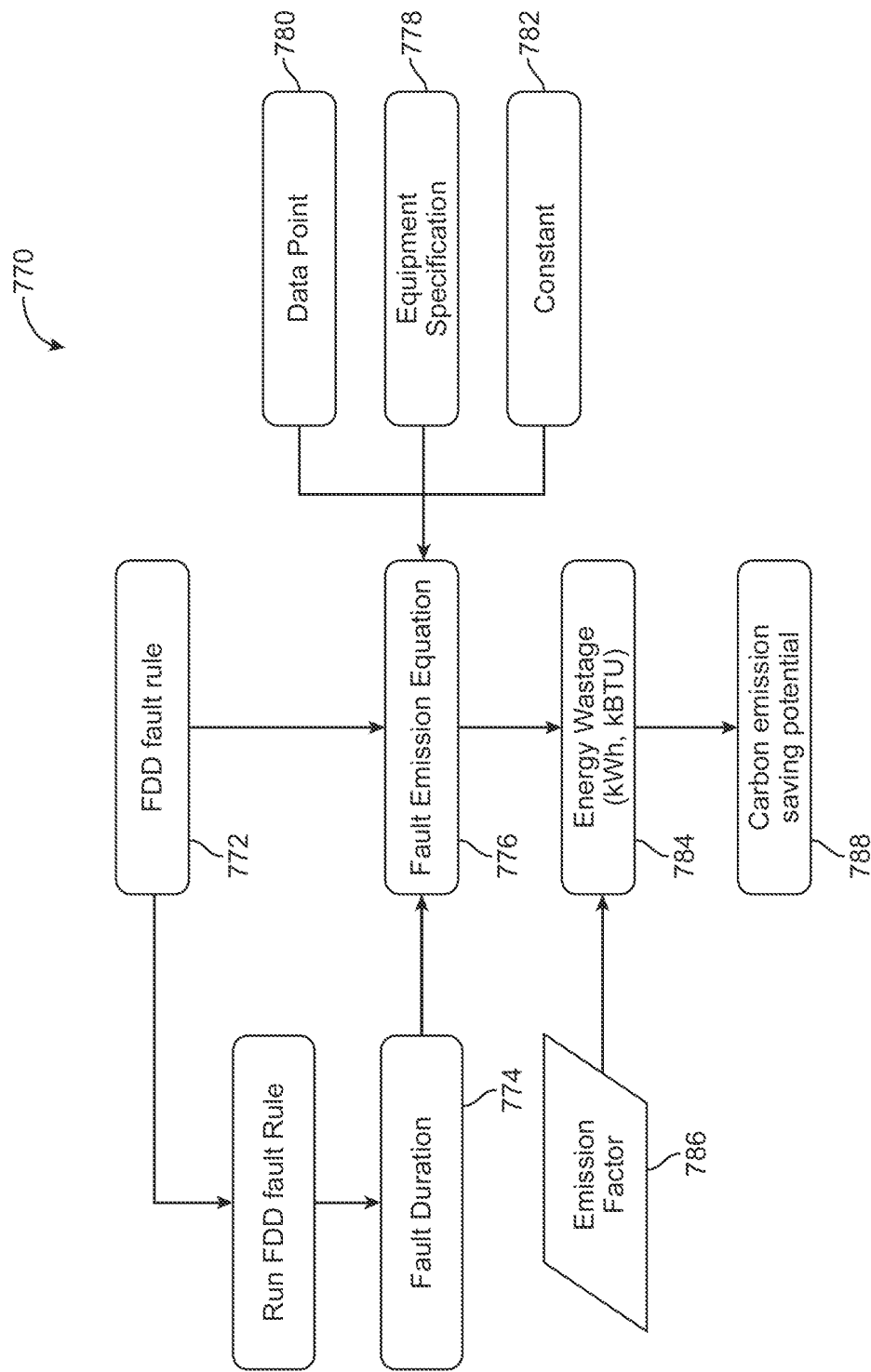


FIG. 7D

12/26

800
802

Constant Template

Sub Rules

Equipment Fault Rules

Threshold

Diagnostics

System Fault Rules

System Diagnostics Rules

Cost Expression

Mixed Faults

Equation Name*
AHU-FD-900-R2-AHU Manual Operation

Equation Description*
R2 AHU Manual Operation

Equipment category*
Air Handling Unit ▼
Equipment type* ▼
Mixed Single Air Duct AHU (MSD) ▼

Fault category*
Operation ▼
Parameter value* ▼
After Hours ▼

Fault detection*
Enable ▼
Tag* ▼
Custom ▼

Version*
Baseline ▼
Rule category* ▼
Energy ▼

Rule function*
Time delay based ▼
Time Delay (in mins)* ▼
10

Fault Priority* ▼
High

Equation statement*
(Supply Air Fan Status == 0)AND(Supply Air Flow == 0)

(

<

>

SORT TX (X)

=

+

*

/

AND

OR

NOT

MIN

MAX

STOP

AVG

ENTER

00:00

ENTER

Constant / Numeric Value

ENTER

Add

Update

Delete

Clear

Delete Equation

Test Fault

Validate Syntax

Map Equipment

Map Diagnostic

Map Cost Expression

Save Rule

804
806

၈၆၆

900

Equipment Category			Space Name			Fault Category			Fault Priority		
All			902			All			All		
Equipment	Space Name	Fault Name	Latest Occurrence Time	Fault Category	Fault Priority	Duration (Hrs)	Electrical Energy Savings Potential (KWh)	Thermal Energy Savings Potential (KWh)	Cost Savings Potential (USD)		
RMU-AB-BL-V03	ATLANTA AIRPORT > Concourse A > Boarding Level > Acon Boarding Level - ASI	VAV-FD-004 VAV Low Supply Air Flow - Reheat	03-04-2020 17:00:11	Comfort	Medium	77.49	-	-	No Cost Mapped		
RMU-AB-BL-V03	ATLANTA AIRPORT > Concourse A > Boarding Level > Acon Boarding Level - ASI	VAV-FD-007 High Zone Temperature - Reheat	03-04-2020 17:00:11	Comfort	High	77.49	-	-	No Cost Mapped		
RMU-AB-BL-V03	ATLANTA AIRPORT > Concourse A > Boarding Level > Acon Boarding Level - ASI	VAV reheat valve passing in occupied period	03-04-2020 17:00:11	Energy	High	77.49	0	2934.94	44.02		
RMU-AB-BL-V03	ATLANTA AIRPORT > Concourse A > Boarding Level > Acon Boarding Level - ASI	E3 Hot water valve leaking or stuck open (VAV)	03-04-2020 17:00:11	Comfort	Medium	75.63	-	-	No Cost Mapped		
RMU-93A-V13	ATLANTA AIRPORT > Concourse A > Boarding Level > Acon Boarding Level - A2	VAV-FD-004 VAV Low Supply Air Flow - Reheat	03-04-2020 17:00:11	Comfort	Medium	71.74	-	-	No Cost Mapped		
RMU-93A-V13	ATLANTA AIRPORT > Concourse A > Boarding Level > Acon Boarding Level - A2	E3 Hot water valve leaking or stuck open (VAV)	03-04-2020 17:00:11	Comfort	Medium	69.63	-	-	No Cost Mapped		
RMU-93A-V13	ATLANTA AIRPORT > Concourse A > Boarding Level > Acon Boarding Level - A2	VAV-FD-007 High Zone Temperature - Reheat	03-04-2020 17:00:11	Comfort	High	68.49	-	-	No Cost Mapped		

FIG. 9

14/26

1000

Work Order

Export work order

1004

Search

1002

1006

Work ord...	Location	Building	Equipment	Equipment	Request description	Work order...	Status	Docum...
137	507 E Mich...	Building 1	Air Handlin...	507-B3PH-AHU-3PI	AHU-FD-013 Supply Air F...	2018-08-02	Open	📄
137	507 E Mich...	Building 1	Variable Air ...	B1F4-VMA-121	CC-7-23-18 Test_VAV-FD...	2018-07-24	Open	
137	507 E Mich...	Building 1	Variable Air ...	5757 VAV-2-13	VAV-FD-007 High Zone T...	2018-07-12	Open	
137	507 E Mich...	Building 1	Variable Air ...	5757 VAV-2-22	VAV-FD-007 High Zone T...	2018-07-12	Open	
137	507 E Mich...	Building 1	Air Handlin...	5757 1-1	AHU-FD-007 Economy d...	2018-05-31	Open	
137	507 E Mich...	Building 1	Air Handlin...	507-B7F2-AHU-442	AHU-FD-02 High Static P...	2018-05-18	Open	
137	507 E Mich...	Building 1	Air Handlin...	5180-B1FO-AHU-B-2	AHU-FD-025 High Supply...	2018-05-17	Open	
137	507 E Mich...	Building 1	Variable Air ...	B1F4-VMA-121	VAV-FD-007 High Zone T...	2018-12-26	Open	📄
9	507 E Mich...	Building 1	Variable Air ...	5757 VAV-1-10	VAV-FD-007 High Zone T...	2018-09-28	Open	
8	5757 N Gr...	Building 1	Variable Air ...	5757 VAV-1-7	VAV-FD-004 VAV Low Sta...	2018-09-28	Open	

Page Size 10 | 1 | 2 |

Total items: 15

Details

Location

123 Main Street, USA

Building

Building 1 - Corporate Center

Floor

Floor 1

Wing

Room

Equipment category

Air Handling Unit

Equipment

5757 1-1

Request description

AHU-FD-001 High Return Air humidity

Task details

1. EC Fan running at 100% ; check air balancing

Add task details

Select document

Browse

FIG. 10

1100

Point configuration		x
FQR / Point path	ADX-1:507-B3PH-NAE01/BACnet IP B3F4 VMAs.507-B3F4-VAV-01.DA-VP	
Name *	1102 507-B3F4-VAV-01.DA-VP	1108 15 minute
Unit type *	1104 Pressure	1110 Inches of water
Point role *	1106 Pressure	Instantaneous
Min value *	-1000000	1000000
		0
		Max value *
		Update Cancel

FIG. 11

1200

Setup - Custom rules

Space

Meter configuration

Equipment configuration

Global rules

Custom rules

Users

Schedule

Global points

Baseline

Auto configuration

Work order

Mapped points

Degree days

Tariff

Finance

App integration

1210

1214

1212

1208

1206

1204

1202

Fault Name	Fault Description	Fault priority	Tag	Edit Map	Search fault
Abnormal zone temperature setpoint	Zone setpoint is above 78.8F or below 66.2F	High	Custom	☒	☒
ACPH - OR	Maintained Air Changes/Hour	High	Custom	☒	☒
AHU Economizer Not Enabled - Test	Test	High	Custom	☒	☒
AHU Insufficient Cooling Capacity	Can't meet cooling demand	High	Custom	☒	☒
AHU Insufficient Cooling Capacity 2	Cooling Capacity insufficient	High	Custom	☒	☒
AHU is running beyond building occupancy schedule	AHU running in unoccupied mode - Outside admin schedule	High	Custom	☒	☒
AHU Speed over 50% for 8 hrs	Test	Medium	Custom	☒	☒
Chiller 1 Hospital TEST FAULT	high temp chiller fault - TEST FAULT	High	Custom	☒	☒
Chiller Energy Inefficiency - kW/Ton	Energy Waste (kW/Ton)	High	Custom	☒	☒
Fault Index 5 - System using excessive RA with mechanical cooling	System using excessive RA with mechanical cooling - additional free cooling available	High	Custom	☒	☒

FIG. 12

1300

Required

Constant template

Sub rules

Equipment fault rules

Thresholds

Diagnostics

Reason

System fault rules

System diagnostic rules

Cost Expression

Create fault

Enter equation name

Equation name*

Brief equation description*

Equipment category*

Fault detection*

Version*

Select Unit*

Equation statement*

Boiler

Select fault detection

Select version

Kbitu

Equipment type*

Tag*

Rule Type*

Hot Water System: General

Custom

Thermal

AND

MIN

AVG

Constant / Numeric Value

Editor Help

<

>

<=

>=

+

-

OR

NOT

MAX

STD D

ENTER

SORT

TX (X)

ENTER (000)

ENTER

Add

Update

Delete

Clear

Delete equation

Test fault

Validate syntax

Attribute

Constants

Sub rules

Specifications

Boiler Rotation

Domestic Hot Water Pump Disable Setpoint

Domestic Hot Water Pump Enable Setpoint

Heating Hot Water Sys Enable

HHW Outside Air Temp Lockout Flag

Hot Water Header Return Flow

Hot Water Header Return Temp

Hot Water Header Supply Flow

Attribute

Value

FIG. 13

18/26

1402 1400

Faults													
Priority	Category	Equipment Name	Fault Name	First Occurrence	Latest Occurrence	Count	Duration (Hrs)	Est. Cost Impact	Est. Electrical Saving (kWh)	Est. Thermal Saving (kBtu)	Est. Carbon Saving (MT CO2e)	Work Order Status	Notes
☐	Critical	Comfort	Sun Valley Mail AHU Low Zone Temperature	10/20/2021	11/04/2021	50	180.02	523.23	5,675	120	40	Open	View
☐	Critical	Energy	Mountain View High Static Pressure	10/23/2021	10/31/2021	12	63.06	515.53	4,7669	89	30	In Progress	View
☐	Critical	Energy	Sun Valley Mail AHU insufficient Cooling Capacity	10/08/2021	10/19/2021	42	130.02	145.00	348	10	5	New	View
☐	High	Comfort	Sun Valley Mail High Zone Temperature	09/30/2021	10/18/2021	14	19.0	98.88	688	0	1	In Progress	View
☐	High	Maintenance	Mountain View VAV Unexpected Value: Zone Temp	10/15/2021	11/01/2021	87	37.62	98.88	670	0	1	Open	View
☐	High	Comfort	Garden Suites VAV Air Supply Less Than Set Value	10/29/2021	10/30/2021	34	64.99	32.99	300	0	0.5	New	View
☐	High	Comfort	Sun Valley Mail Low Zone Temperature	10/08/2021	12/19/2021	43	15.97	523.23	5,675	120	40	In Progress	View
☐	High	Maintenance	Sun Valley Mail Cooling Valve Stuck	10/30/2021	11/02/2021	23	12.25	65.55	569	20	10	New	View
☐	High	Energy	Mountain View High Oil Temp with Chiller Shutdown	10/07/2021	10/26/2021	54	120.25	6.77	60	-	0.005	In Progress	View
☐	High	Maintenance	Garden Suites VAV Unexpected Value: Zone Temp	09/12/2021	10/21/2021	32	23.75	83.48	870	-	2	In Progress	View
☐	High	Energy	Sun Valley Mail Low Static Pressure	10/20/2021	10/25/2021	25	59.43	32.99	298	-	0.5	Open	View

FIG. 14

19/26

1500

#	Equipment Category	Parent Fault Name	Priority	Electrical Cost Rule (kWh) for Ventilation & Cooling Energy	Remark	Thermal Cost Rule (kBtu) for Heating Energy	Remark
1	Air Handling Unit	AHU-FD-002 High Static Pressure	Critical	$\text{MAX}(0, (((\text{Supply Air Flow} * (\text{Supply Air Static Pressure} - \text{Supply Air Pressure Setpoint})) / (6356 * 0.75)) * 0.746)))$	Fan Efficiency - 0.75 0.746 - HP to kW Flow unit = CFM Pressure unit = Inches of water	$\text{MAX}(0, ((0.3 * 1.08 * (\text{Heating Output} / 100) * \text{Supply Air Flow} * (\text{Supply Air Temperature} - \text{Mixed-Air Temperature}) / 1000)))$	Considering 30 % wastage in heating due to high static pressure Flow unit = CFM Output unit = % Temperature unit = Degree F
2	Air Handling Unit	AHU-FD-021 Economy cycle not running	Medium	$\text{MAX}(0, (((4.5 * \text{Outside Air Flow} * \text{Outside Air Enthalpy}) / 12000) * 0.85)))$	Flow unit = CFM Enthalpy unit = KJ/KG	N/A	
3	Air Handling Unit	AHU-FD-028 VFD permanently at full load	Medium	$\text{MAX}(0, (((\text{Supply Air Flow} * (\text{Supply Air Static Pressure} - \text{Supply Air Pressure Setpoint})) / (6356 * 0.75)) * 0.746) * ((\text{Supply Air Flow} / 400) * 0.03 * 0.85)))$	Chiller plant efficiency - 0.85 kW/TR Flow unit = CFM Pressure unit = Inches of water	$\text{MAX}(0, ((0.3 * 1.08 * (\text{Heating Output} / 100) * \text{Supply Air Flow} * (\text{Supply Air Temperature} - \text{Mixed-Air Temperature}) / 1000)))$	Considering 30 % wastage in heating due to high static pressure Flow unit = CFM Output unit = % Temperature unit = Degree F
4	Air Handling Unit	AHU-FD-030 Low Zone Temperature	High	$\text{MAX}(0, (((1.08 * \text{Supply Air Flow} * (\text{Space Temperature} - \text{MASD} - \text{Space Temperature} - \text{MASD})) / 12000) * 0.85) * (\text{Cooling Output} / \text{Cooling Output})))$	Chiller plant efficiency - 0.85 kW/TR 1.5 % improvement per Deg F Flow unit = CFM Output unit = % Temperature unit = Degree F	N/A	

FIG. 15A

20/26

1500

#	Equipment Category	Parent Fault Name	Priority	Electrical Cost Rule (kWh) for Ventilation & Cooling Energy	Remark	Thermal Cost Rule (kBtu) for Heating Energy	Remark
5	Air Handling Unit	AHU-FD-031 Simultaneous heating and cooling operation.	High	$\text{MAX}(0, ((\text{Supply Air Flow}/400) * (\text{Cooling Output}/100 * 0.85 * 0.8)))$	Chiller plant efficiency -0.85 kW/Ton, 400 cfm = 1 Ton, 80% confidence factor Flow unit = CFM Output unit = %	$\text{MAX}(0, (((\text{Heating Output}/100) * \text{Const}((\text{Heating Capacity}/\text{MBH}))) * 0.85 * 0.8)))$	Boiler Efficiency-85% Confidence factor-80% Output unit = % Heating capacity unit = MBH
6	Air Handling Unit	AHU-FD-053 CO2 level is too low	Medium	$\text{MAX}(0, ((1.08 * (\text{Supply Air Flow} * ((\text{Outdoor Air Damper output} - 20) / 100)) * (\text{Outside Air Temperature} - \text{Supply Air Temperature}) / 12000) * 0.85)))$	20% minimum Outside air damper position and calculation uses sensible heat saving only. Flow unit = CFM Output unit = % Temperature unit = Degree F	$\text{MAX}(0, ((1.08 * (\text{Supply Air Flow} * (\text{Outdoor Air Damper output} - 20)) * (\text{Supply Air Temperature} - \text{Outside Air Temperature}) / 1000)))$	20% minimum Outside air damper position Flow unit = CFM Output unit = % Temperature unit = Degree F
7	Fan Coil Unit	FCU-FD-002 Low Zone Temperature	High	$(\text{MAX}(0, (((1.08 * \text{Const}(\text{FCUDESIGNFLOW}) * (\text{Zone Temperature Setpoint} - \text{Zone Temperature})) / 12000) * 0.85) * (\text{Cooling Output} / \text{Cooling Output}))))$	Chiller plant efficiency -0.85 kW/TR FCUDESIGNFLOW unit = CFM Output unit = % Temperature unit = Degree F	N/A	

FIG. 15B

21/26

1500

#	Equipment Category	Parent Fault Name	Priority	Electrical Cost Rule (kWh) for Ventilation & Cooling Energy	Remark	Thermal Cost Rule (kBtu) for Heating Energy	Remark
8	Roof Top Unit	RTU-FD-021 Outside and return air dampers both open high	Low	$\text{MAX}(0, (((1.08 * \text{Supply Air Flow} * (\text{Outdoor Air Damper Output} - 20)) * (\text{Outdoor Air Temperature} - \text{Supply Air Temperature})) / 12000) * 0.85))$	20% minimum outside air damper position and calculation uses sensible heat saving only. Flow unit = CFM Output unit = % Temperature unit = Degree F	$\text{MAX}(0, (((1.08 * (\text{Supply Air Flow} * (\text{Outdoor Air Damper Output} - 20)) * (\text{Supply Air Temperature} - \text{Outdoor Air Temperature})) / 1000))$	20% minimum Outside air damper position Flow unit = CFM Output unit = % Temperature unit = Degree F
9	Roof Top Unit	RTU-FD-028 Low Zone Temperature	High	$\text{MAX}(0, (((1.08 * \text{Supply Air Flow} * (\text{Zone Average Temperature Set point} - \text{Zone Average Temperature})) / 12000) * 1.2))$	RTU efficiency considered = 1.2 kW/TR Upto 25 TR York RTU has design efficiency of 1.09 kW/TR 1.5% improvement per Deg F Flow unit = CFM Output unit = % Temperature unit = Degree F	N/A	
10	Chilled Water Pumps	CHW-PP-FD-002 Pump Operation at High Speed	High	$(\text{MAX}(0, (\text{Primary Chilled water Pump VSD Power}) - (\text{Primary Chilled water Pump VSD Power} / ((\text{Primary Chilled Water Pump Speed Drive Output} / \text{Const}(\text{High Speed Threshold} - \text{CHWP})) * (\text{Primary Chilled Water Pump Speed Drive Output} / \text{Const}(\text{High Speed Threshold} - \text{CHWP})))) * (\text{Primary Chilled Water Pump Speed Drive Output} / \text{Const}(\text{High Speed Threshold} - \text{CHWP}))))$	Power unit = kW Output unit = %	NA	

FIG. 15C

1500

#	Equipment Category	Parent Fault Name	Priority	Electrical Cost Rule (kWh) for Ventilation & Cooling Energy	Remark	Thermal Cost Rule (kBtu) for Heating Energy	Remark
11	Chiller	Poor Plant Efficiency	High	$\text{MAX}(0, (\text{MIN}(500, ((\text{Total Plant Room System Efficiency} - \text{Const}(\text{CHW Plant SYS Efficiency} - \text{Design}) * \text{Const}(\text{Design Efficiency Multiplier}))) * \text{Total Chiller Load}))))$	Total Plant Room System Efficiency = kW/TR Total Chiller Load = TR	NA	
12	Chiller	High Condenser Water Header Supply Temperature	High	$\text{MAX}(0, (\text{MIN}(500, ((\text{Condenser Water Header Supply Temperature} - 29.5) * 0.03 * \text{Total Chiller Power}))))$	Condenser Water Header Supply Temperature = Deg F Total Chiller Power = kW	NA	
13	Air Handling Unit	AHU Return Air Temperature is too Cold	High	$\text{MAX}(0, (\text{MIN}(40, (0.0002 * (\text{Const}(\text{RAT LowLimit}) - \text{Return Air Temperature}) * (40/50) * \text{Const}(\text{AHU Design Airflow}))))))$	Return Air Temperature = Deg F AHU Design Airflow = cfm	NA	

FIG. 15D

1600

Commodity units & Currency selection

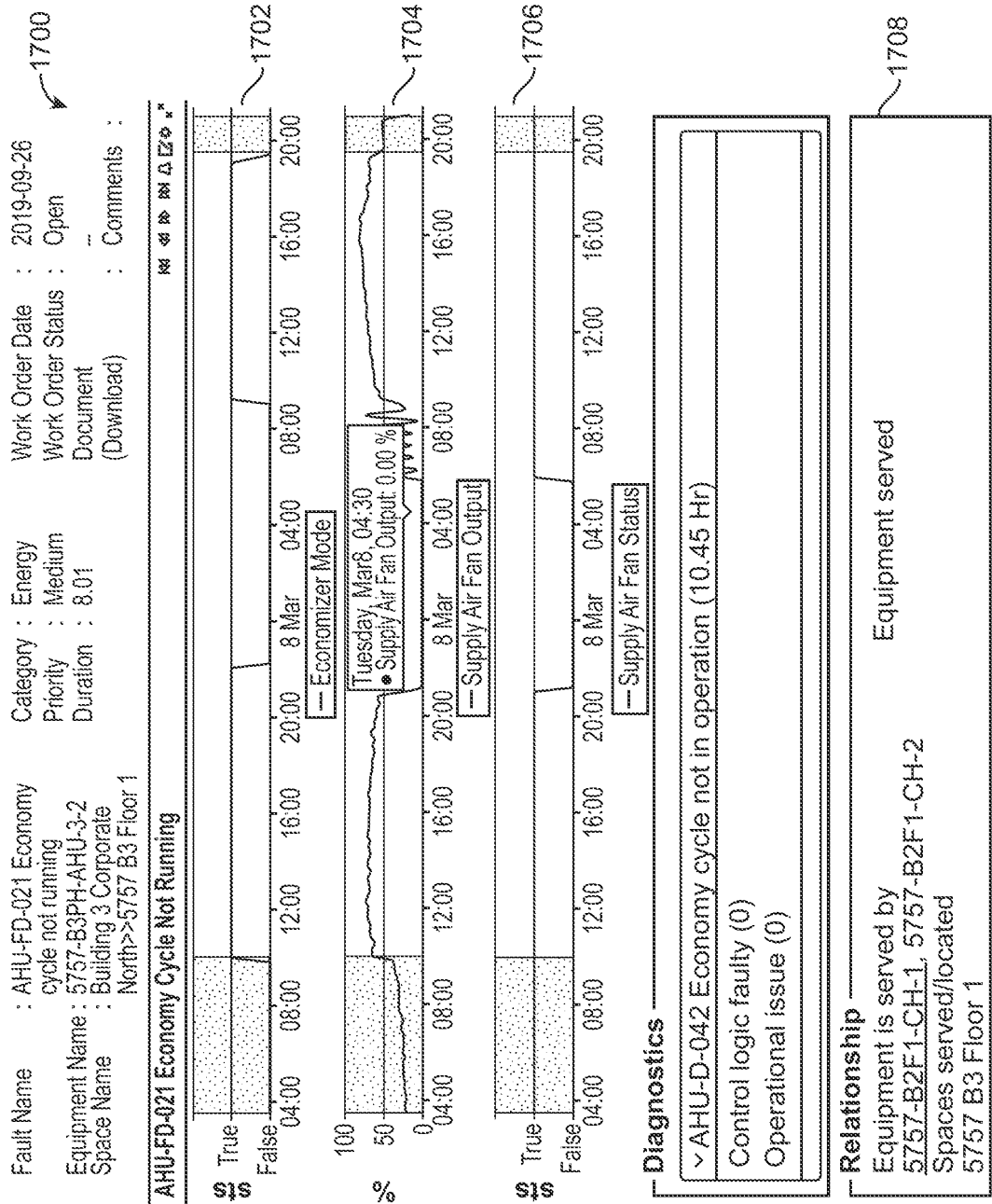
Fuel oil	▼	US Dollar Per KL	1	▼
Fuel oil	▼	US Dollar Per KL	0	▼
Propane	▼	US Dollar Per KL	0	▼
Diesel	▼	US Dollar Per KL	0	▼
Sewage	▼	US Dollar Per Gal	0	▼
Coal	▼	US Dollar Per kBtu	0	▼
Thermal Overall *	▼	US Dollar Per kBtu	0.015	▼
Carbon emission factor for electricity(kilowatt-hours)	▼	tons of CO2 emissions	0.00069	▼
Building Load *	▼	Efficiency *	TR	▼

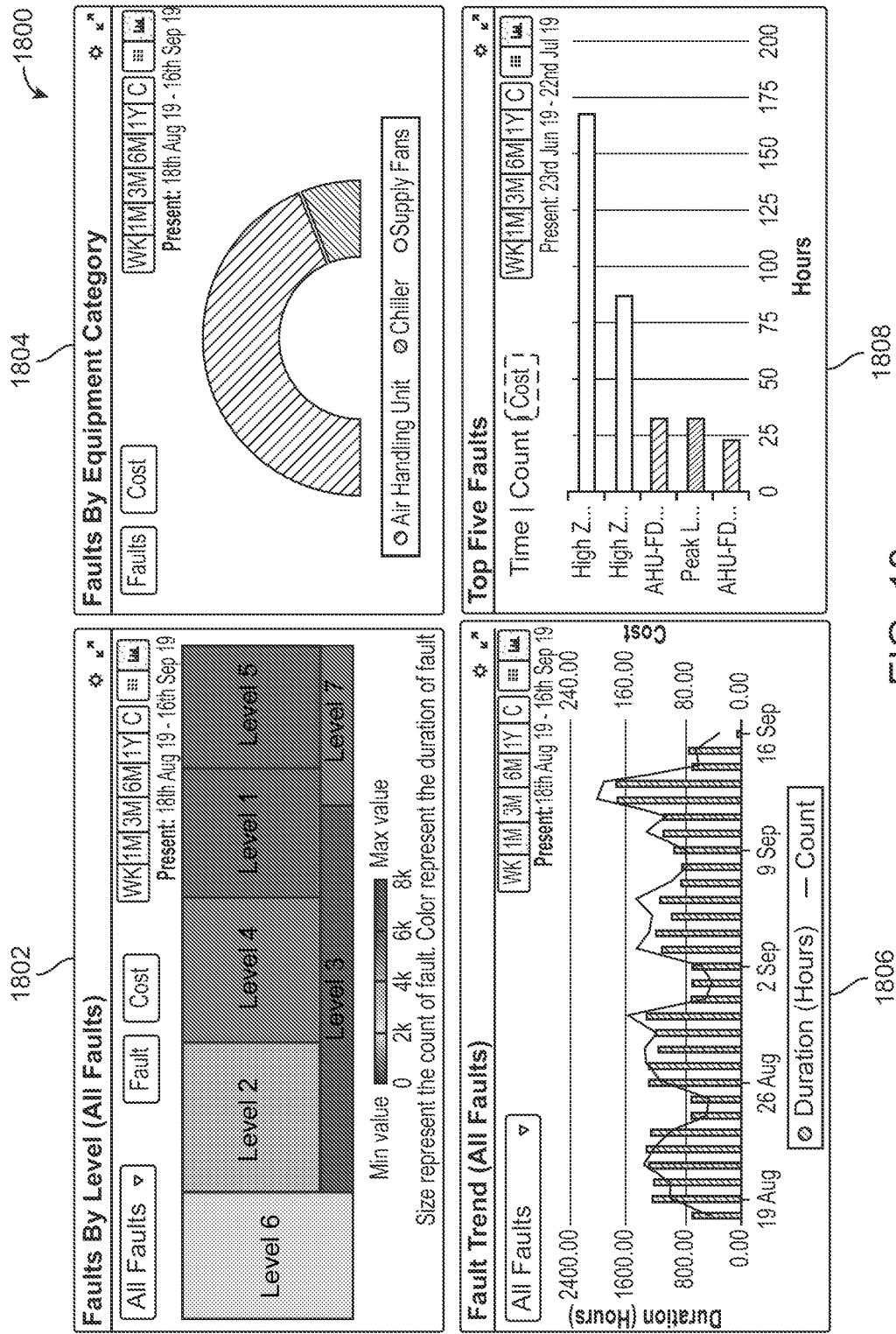
Submit

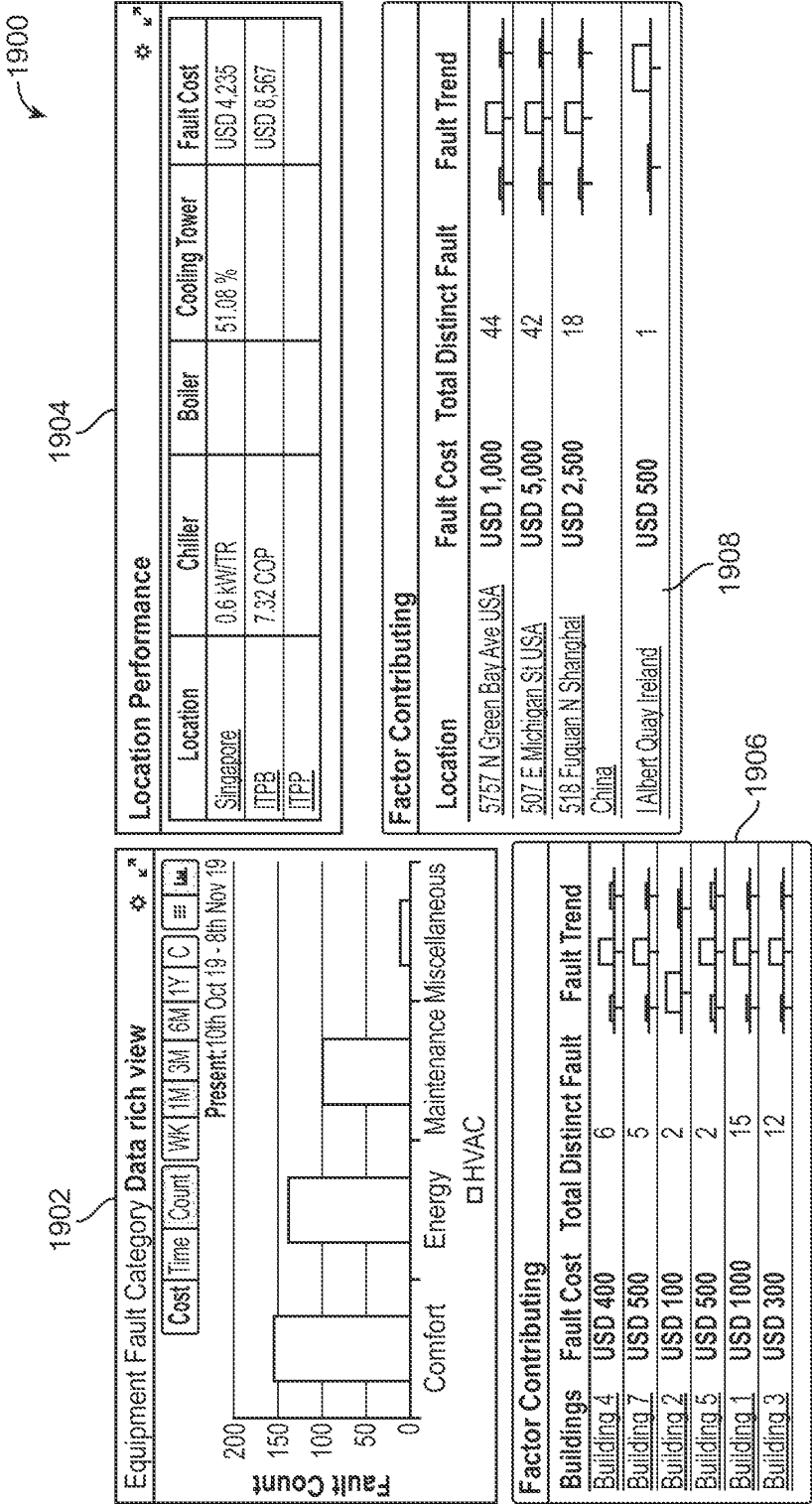
Cancel

Clear

FIG. 16







1906

Factor Contributing

Location

Fault Cost

Total Distinct Fault

Fault Trend

5757 N Green Bay Ave USA

USD 1,000

44

507 E Michigan St USA

USD 5,000

42

518 Fuguan N Shanghai China

USD 2,500

18

1 Albert Quay Ireland

USD 500

1

1908

Factor Contributing

Buildings

Fault Cost

Total Distinct Fault

Fault Trend

Building 4

USD 400

6

Building 7

USD 500

5

Building 2

USD 100

2

Building 5

USD 500

2

Building 1

USD 1000

15

Building 3

USD 300

12

FIG. 19