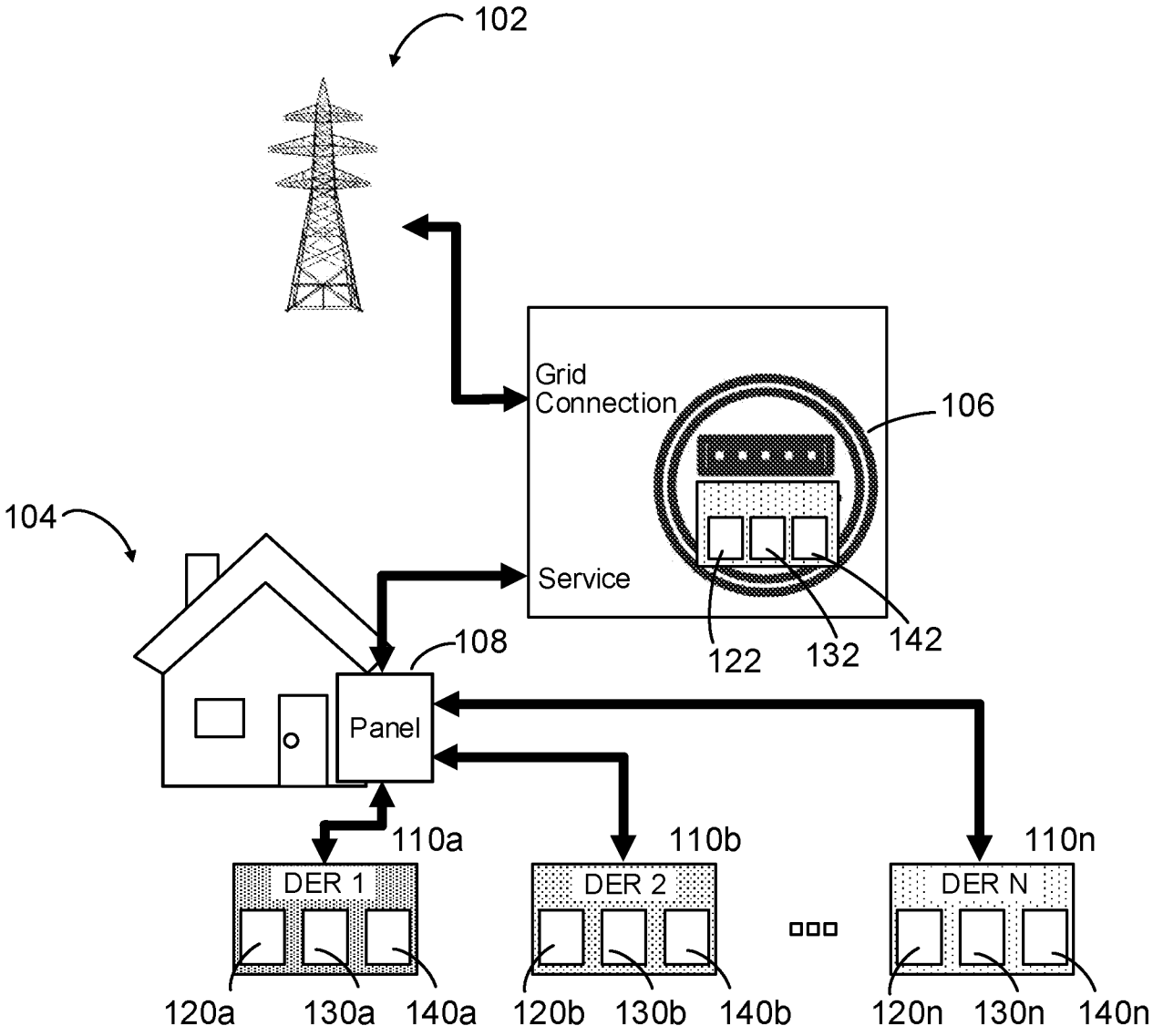
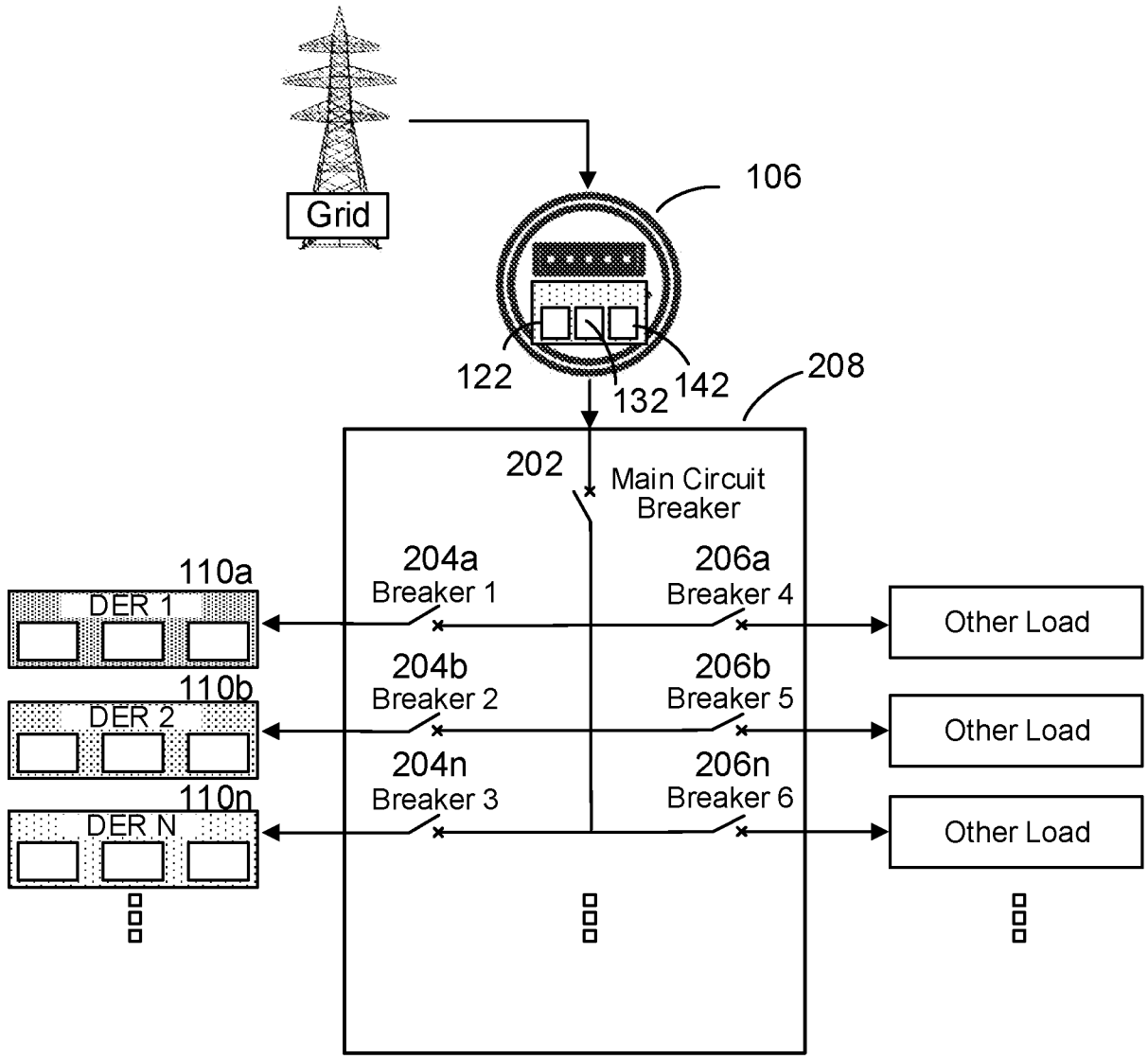

102
Grid
Connection
106
104
Service
108
122
132
142
Panel
110a
110b
110n
DER 1
DER 2
DER N
120a
130a
140a
120b
130b
140b
120n
130n
140n

FIG. 1


Grid
106
122
132
142
208
202
Main Circuit Breaker
110a
DER 1
204a
Breaker 1
206a
Breaker 4
Other Load
110b
DER 2
204b
Breaker 2
206b
Breaker 5
Other Load
110n
DER N
204n
Breaker 3
206n
Breaker 6
Other Load

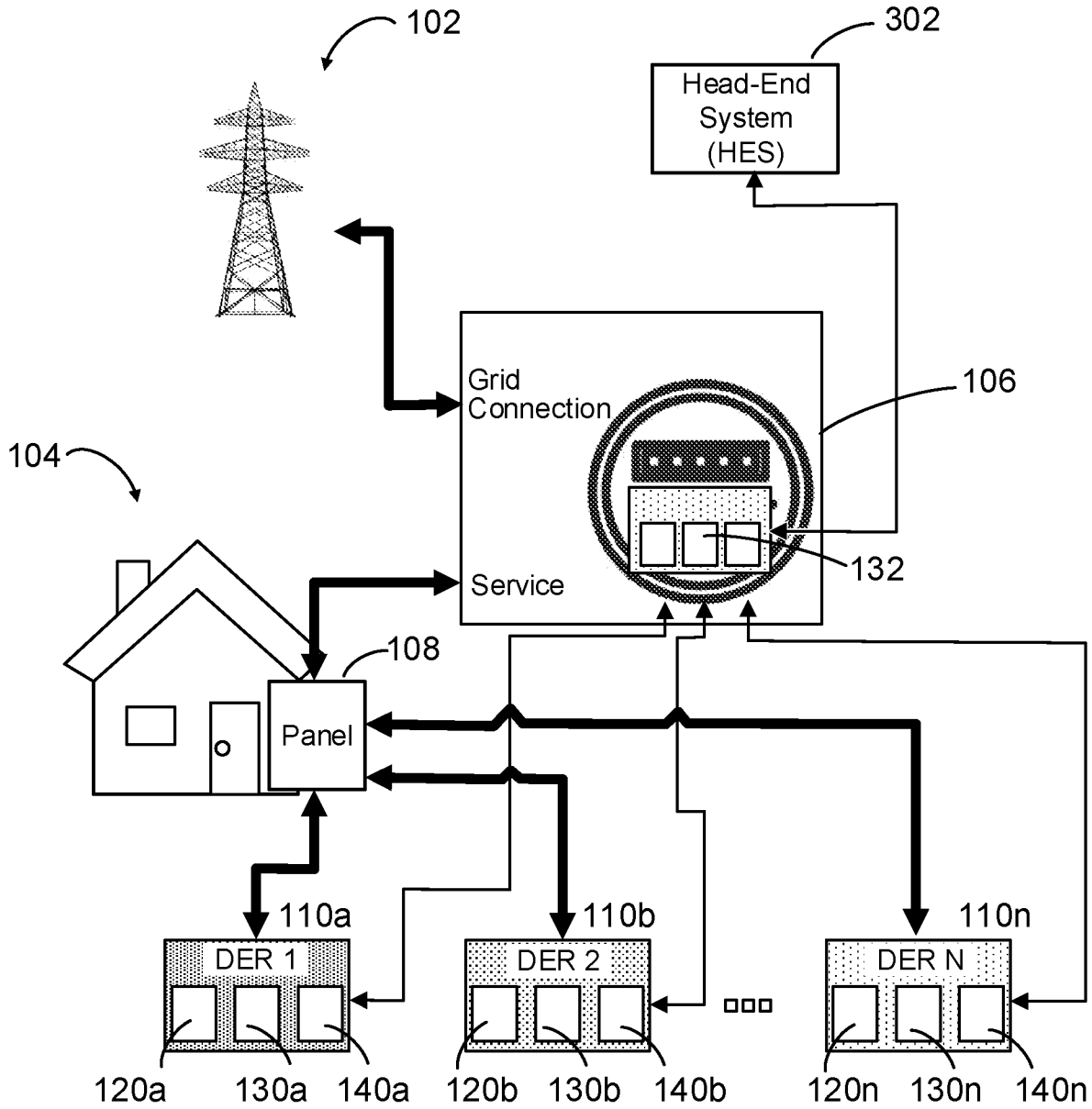

102
302
Head-End System (HES)
Grid Connection
106
104
132
Service
108
Panel
110a
110b
110n
DER 1
DER 2
DER N
120a
130a
140a
120b
130b
140b
120n
130n
140n

FIG. 3

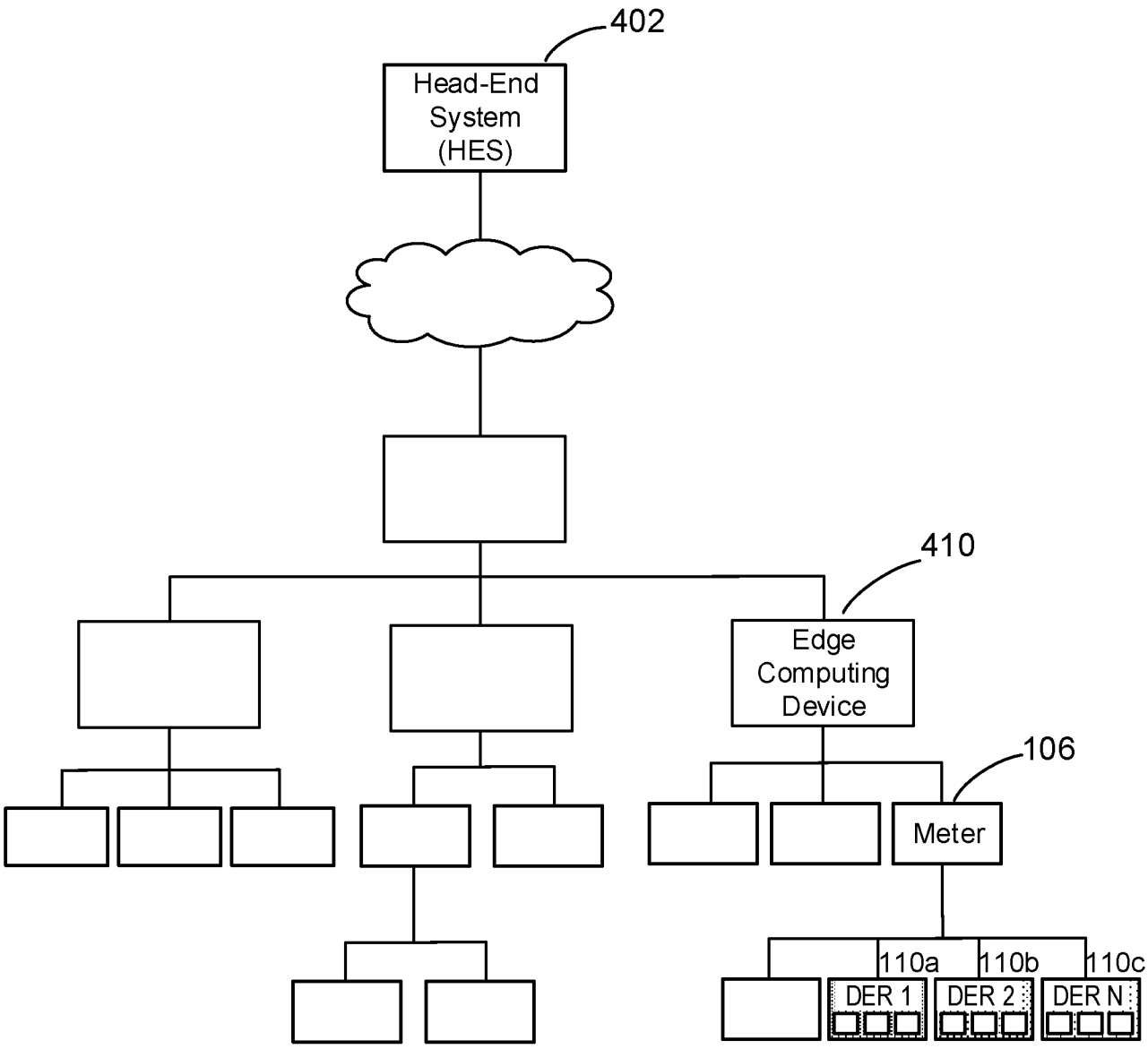

402
Head-End System (HES)
410
Edge Computing Device
106
Meter
110a
110b
110c
DER 1
DER 2
DER N

FIG. 4

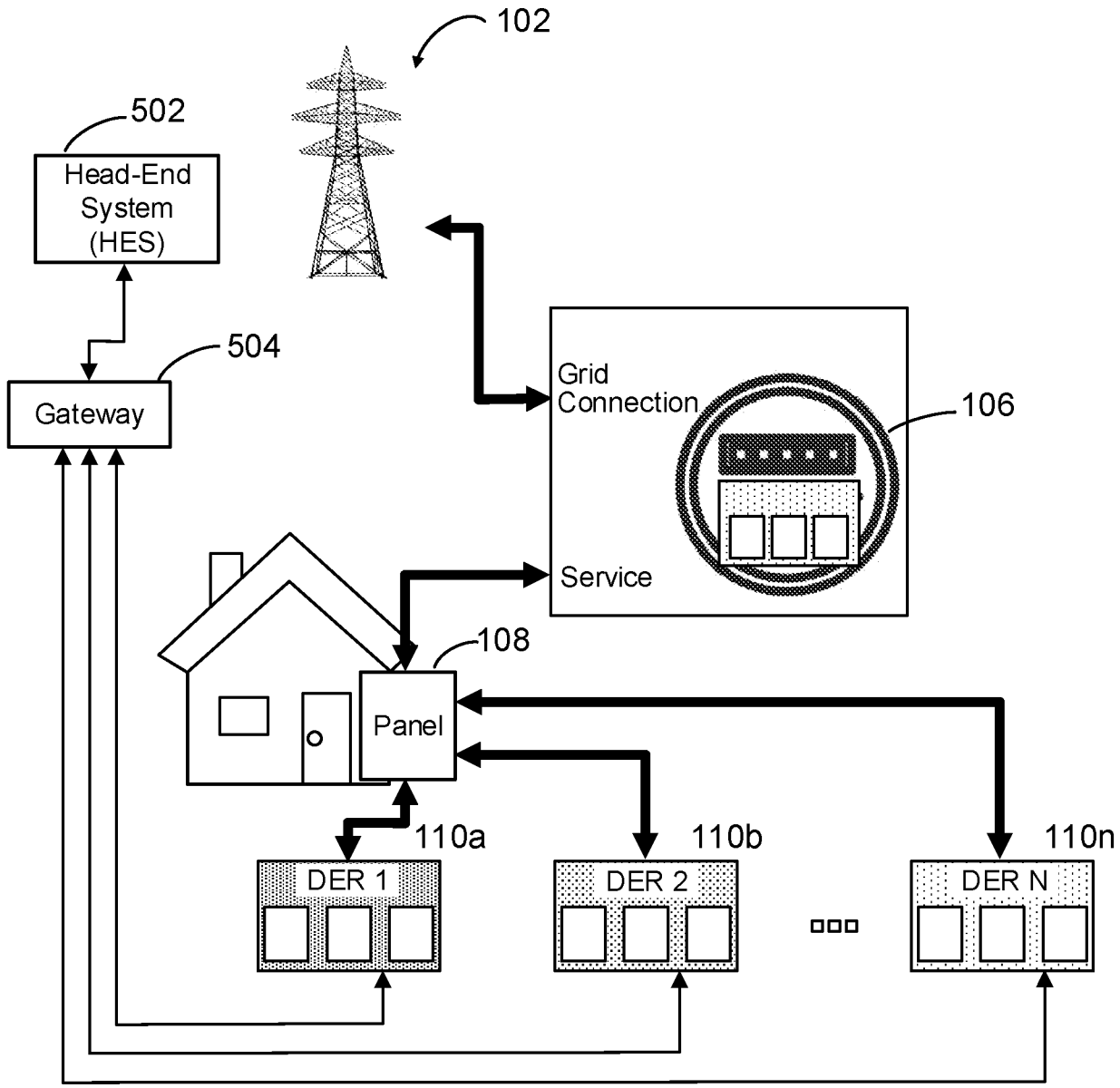

102
502
Head-End System (HES)
504
Gateway
Grid Connection
106
Service
108
Panel
110a
110b
110n
DER 1
DER 2
DER N

FIG. 5

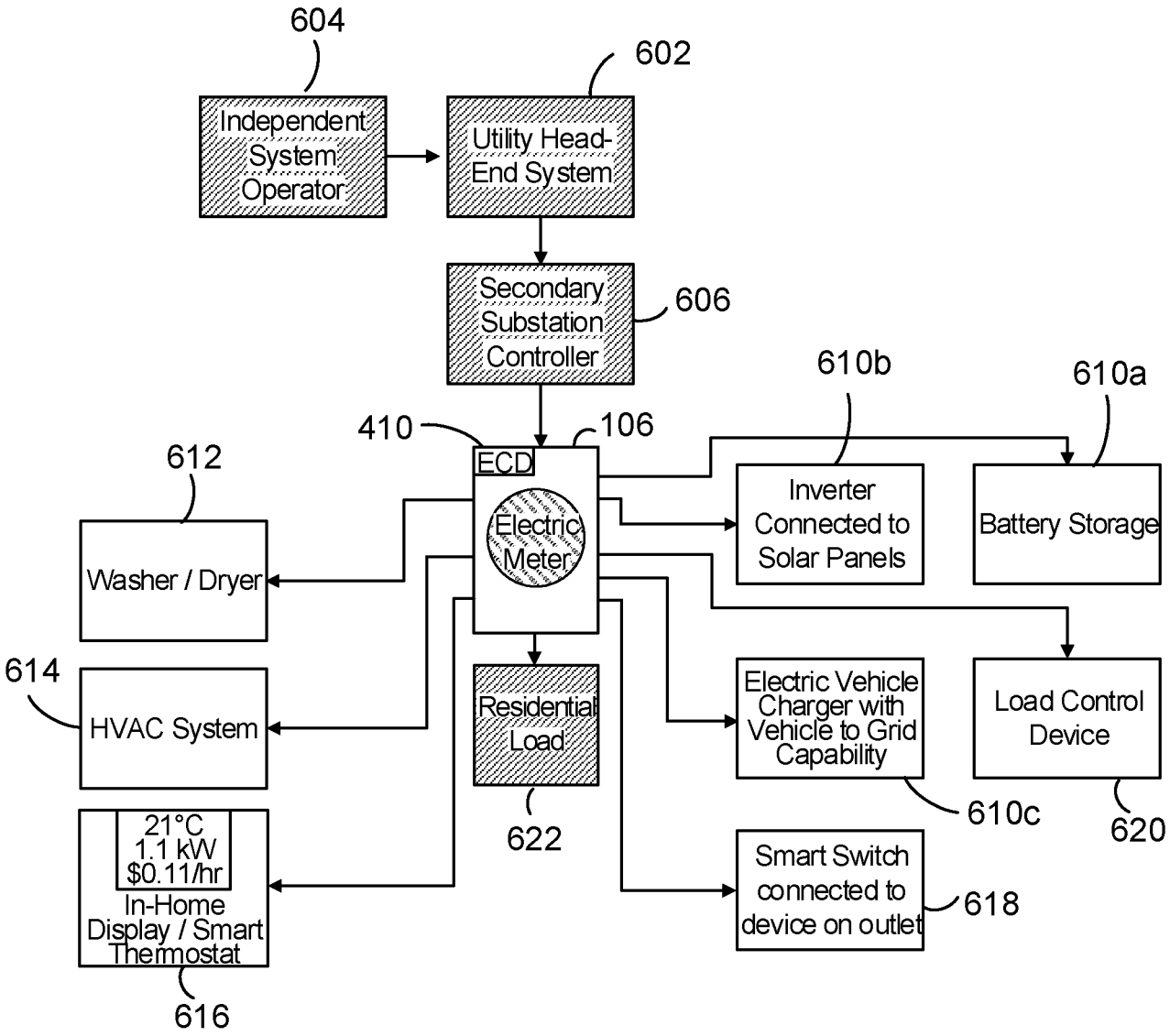

604
602
Independent System Operator
Utility Head-End System
Secondary Substation Controller
606
610b
610a
410
106
612
ECD
Electric Meter
Inverter Connected to Solar Panels
Battery Storage
Washer / Dryer
614
HVAC System
Residential Load
Electric Vehicle Charger with Vehicle to Grid Capability
Load Control Device
610c
620
622
21°C
1.1 kW
$0.11/hr
In-Home Display / Smart Thermostat
Smart Switch connected to device on outlet
618
616

FIG. 6

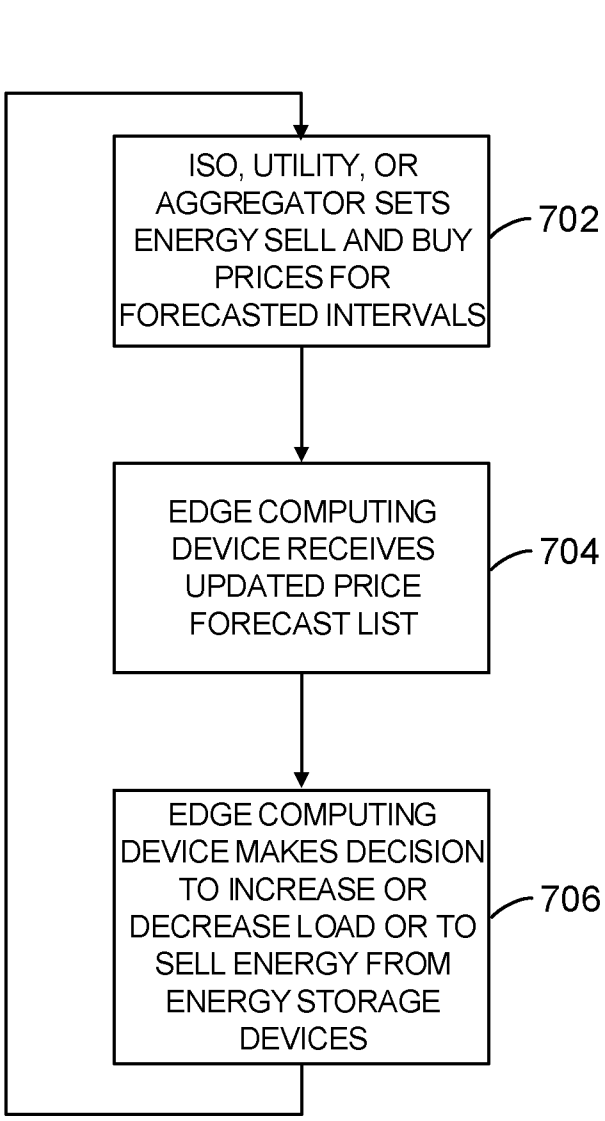

700
ISO, UTILITY, OR AGGREGATOR SETS ENERGY SELL AND BUY PRICES FOR FORECASTED INTERVALS
702
EDGE COMPUTING DEVICE RECEIVES UPDATED PRICE FORECAST LIST
704
EDGE COMPUTING DEVICE MAKES DECISION TO INCREASE OR DECREASE LOAD OR TO SELL ENERGY FROM ENERGY STORAGE DEVICES
706

FIG. 7

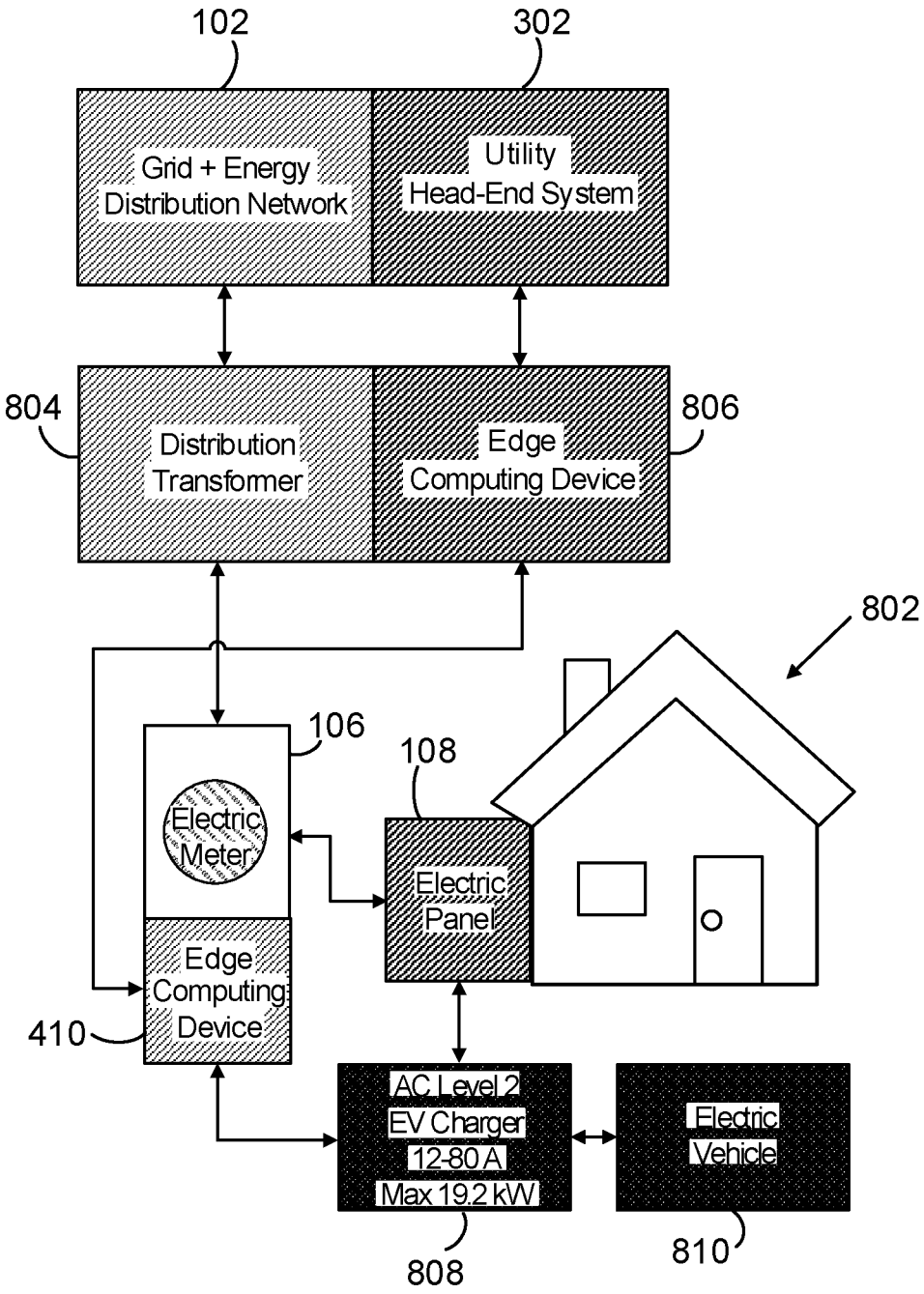

102
302
Grid + Energy Distribution Network
Utility Head-End System
804
Distribution Transformer
Edge Computing Device
806
802
106
108
Electric Meter
Electric Panel
Edge Computing Device
410
AC Level 2 EV Charger 12-80 A Max 19.2 kW
Electric Vehicle
808
810

FIG. 8

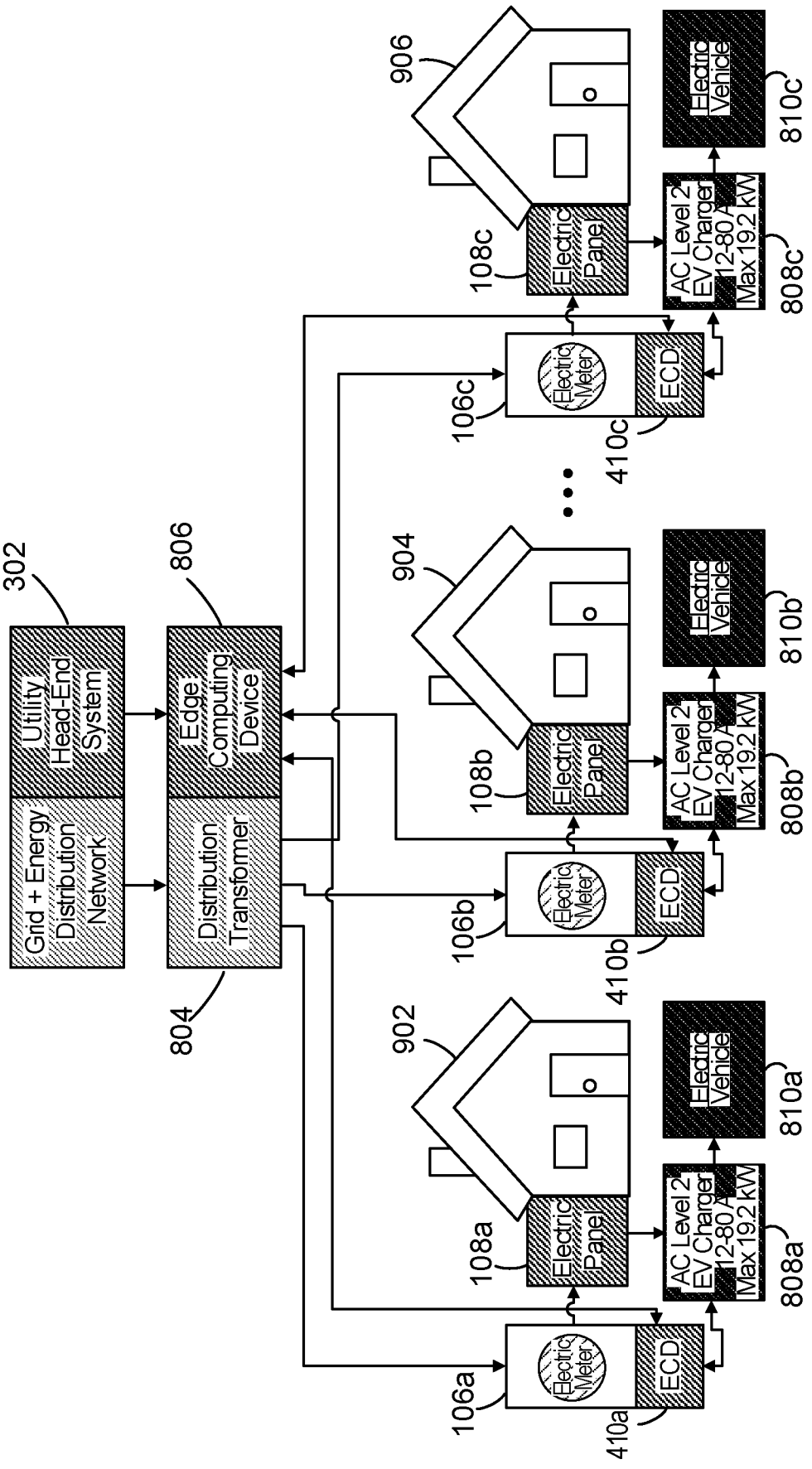

Utility Head-End System
Grid + Energy Distribution Network
Edge Computing Device
Distribution Transformer
302
806
804
902
904
906
108a
108b
108c
Electric Panel
AC Level 2 EV Charger 12-80 A Max 19.2 kW
808a
808b
808c
Electric Vehicle
810a
810b
810c
106a
106b
106c
Electric Meter
ECD
410a
410b
410c

FIG. 9

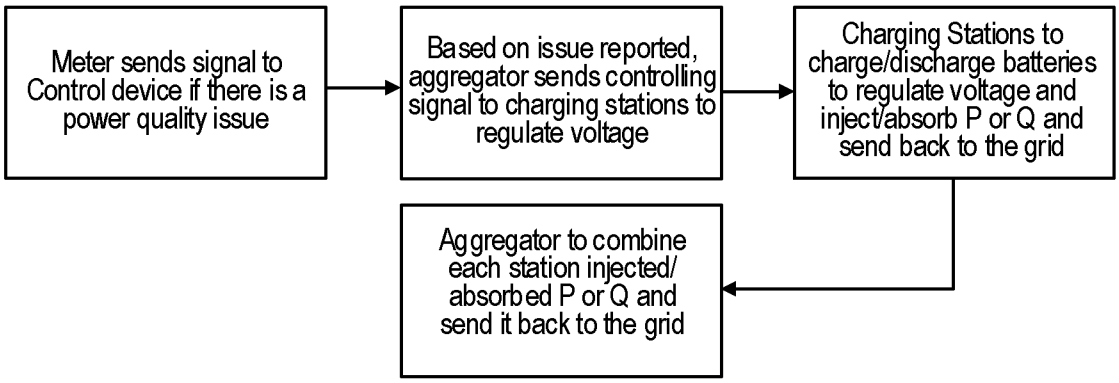


FIG. 10A

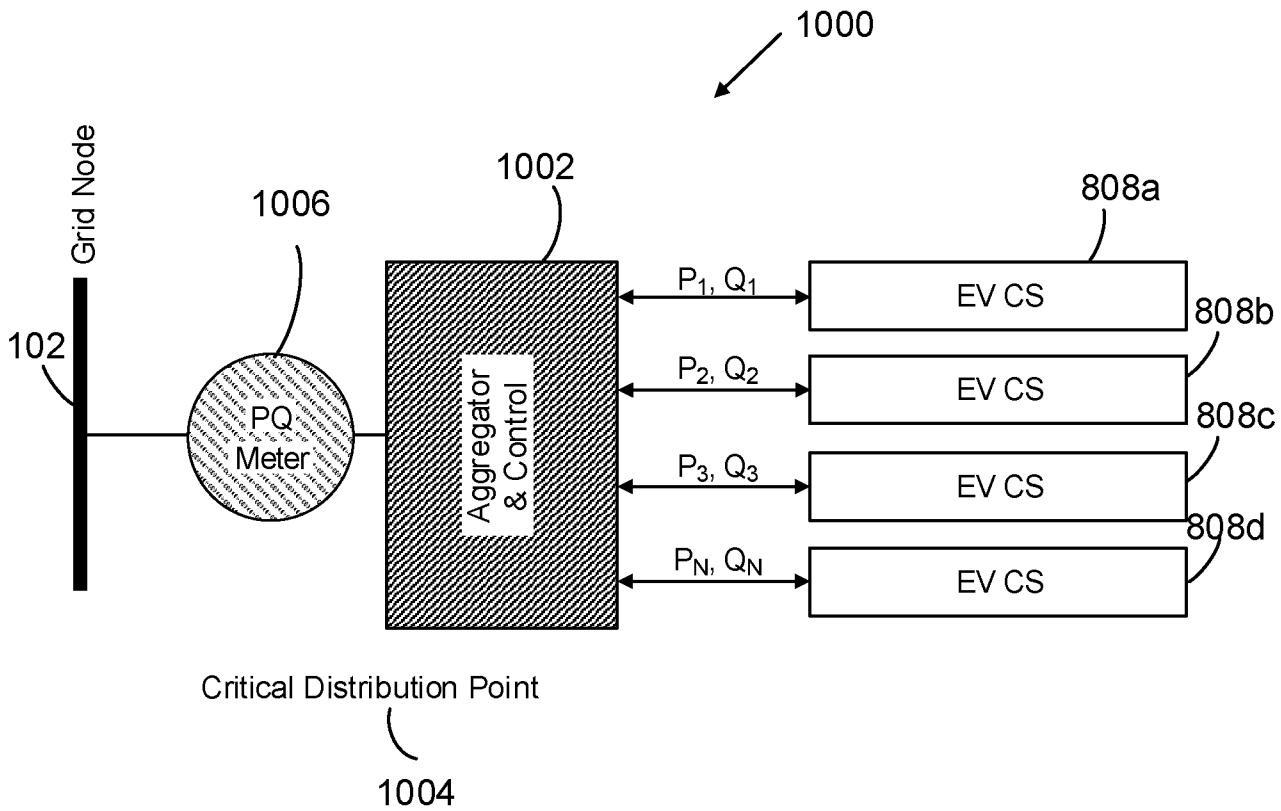


FIG. 10B

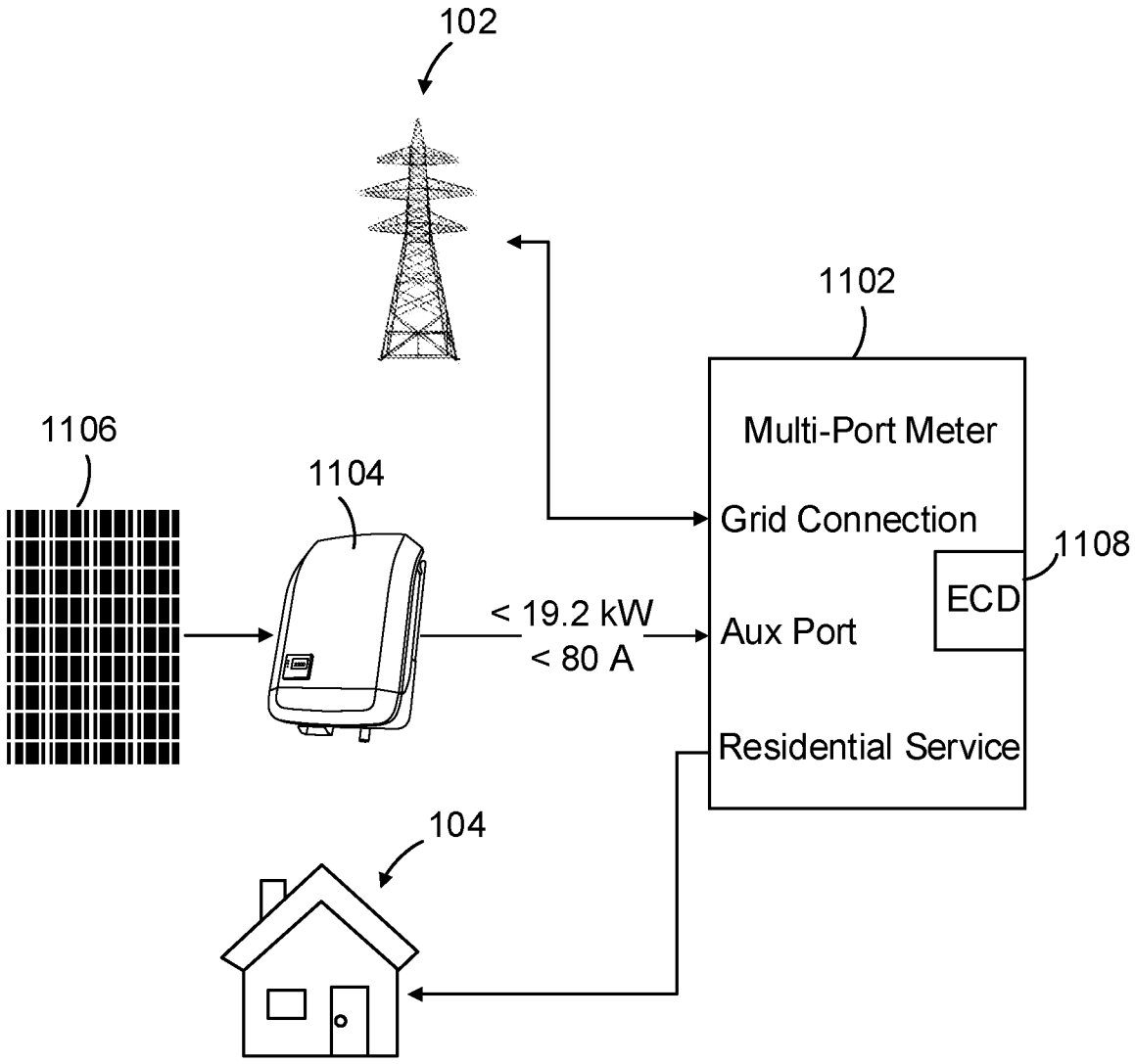

102
1102
Multi-Port Meter
1106
1104
Grid Connection
1108
ECD
< 19.2 kW
< 80 A
Aux Port
Residential Service
104

FIG. 11

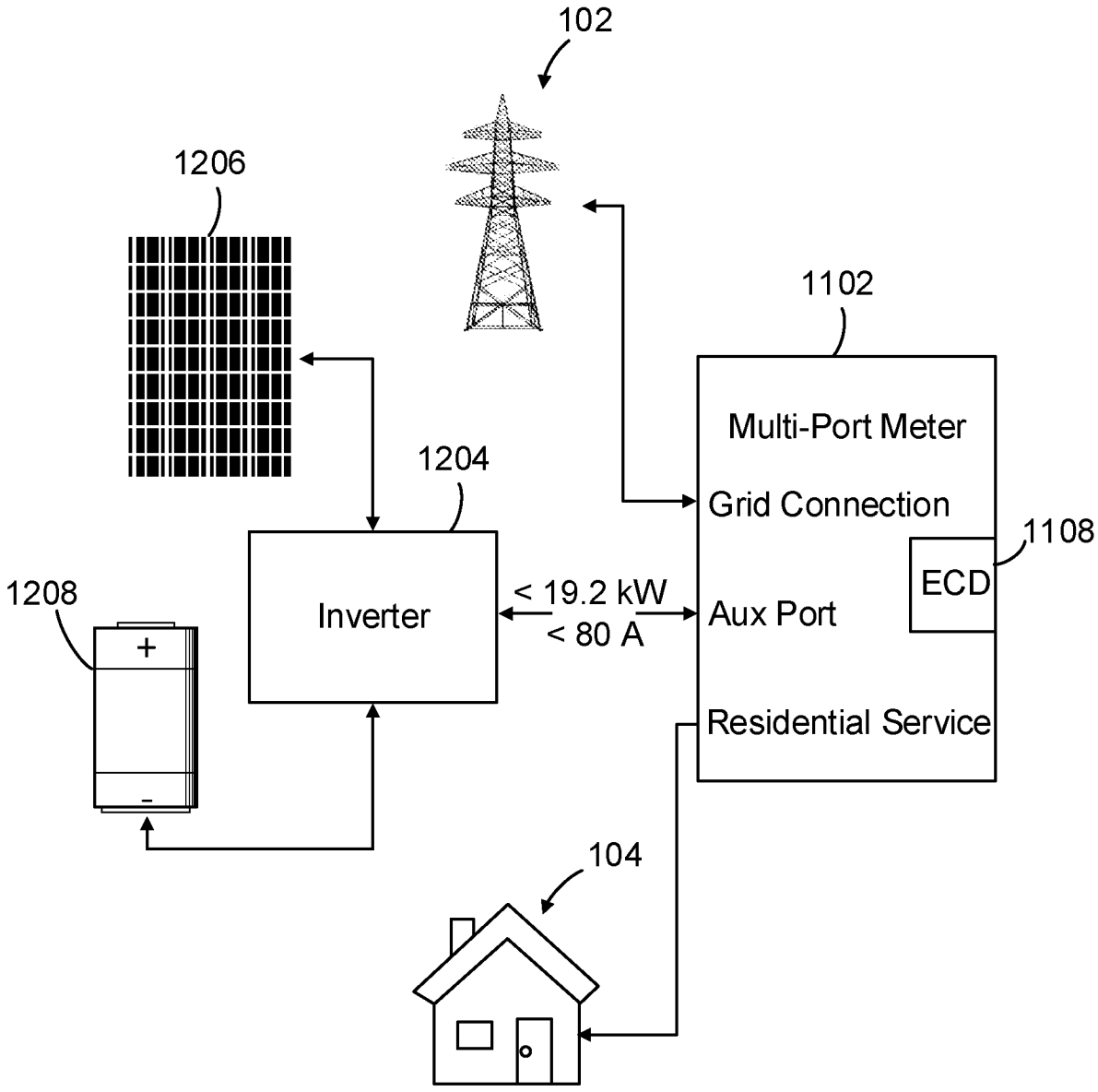

102
1206
1102
Multi-Port Meter
1204
Grid Connection
1108
ECD
1208
Inverter
< 19.2 kW
< 80 A
Aux Port
+
Residential Service
-
104

FIG. 12

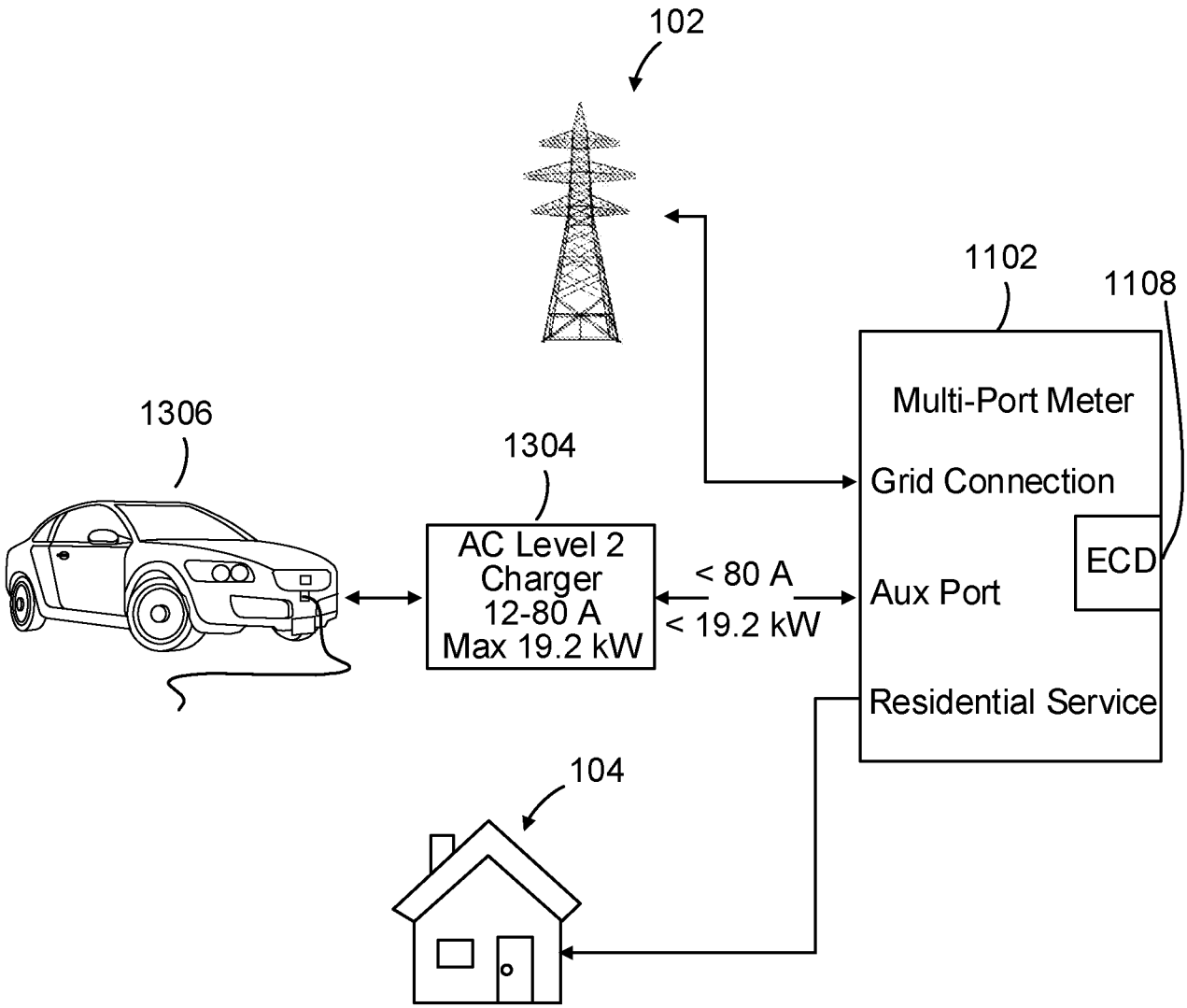

102
1102
1108
Multi-Port Meter
Grid Connection
ECD
Aux Port
Residential Service
1306
1304
AC Level 2
Charger
12-80 A
Max 19.2 kW
< 80 A
< 19.2 kW
104

FIG. 13

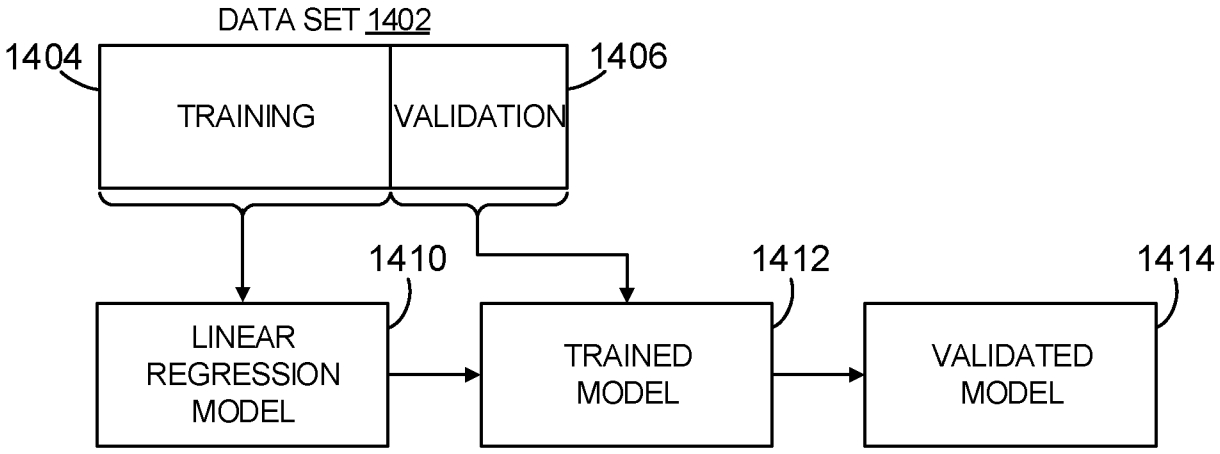

DATA SET 1402
1404
1406
TRAINING
VALIDATION
1410
1412
1414
LINEAR REGRESSION MODEL
TRAINED MODEL
VALIDATED MODEL

FIG. 14