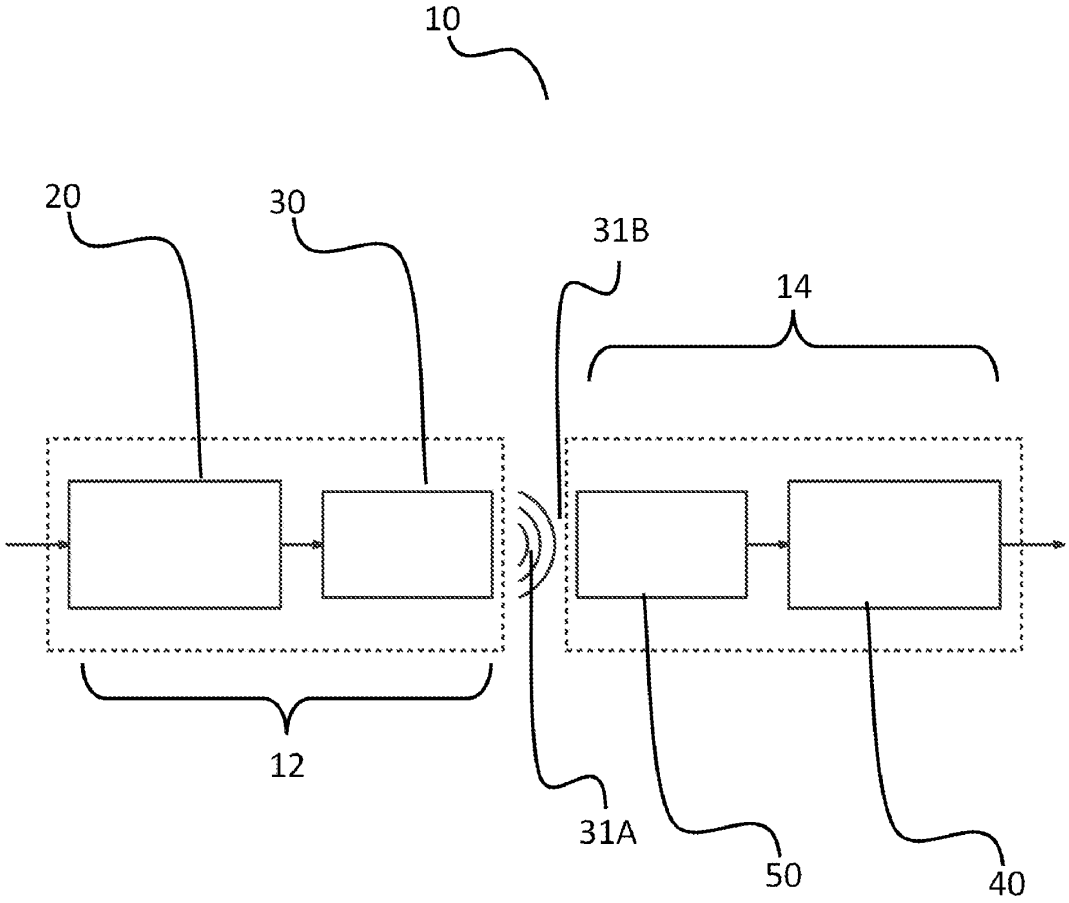


FIG. 1

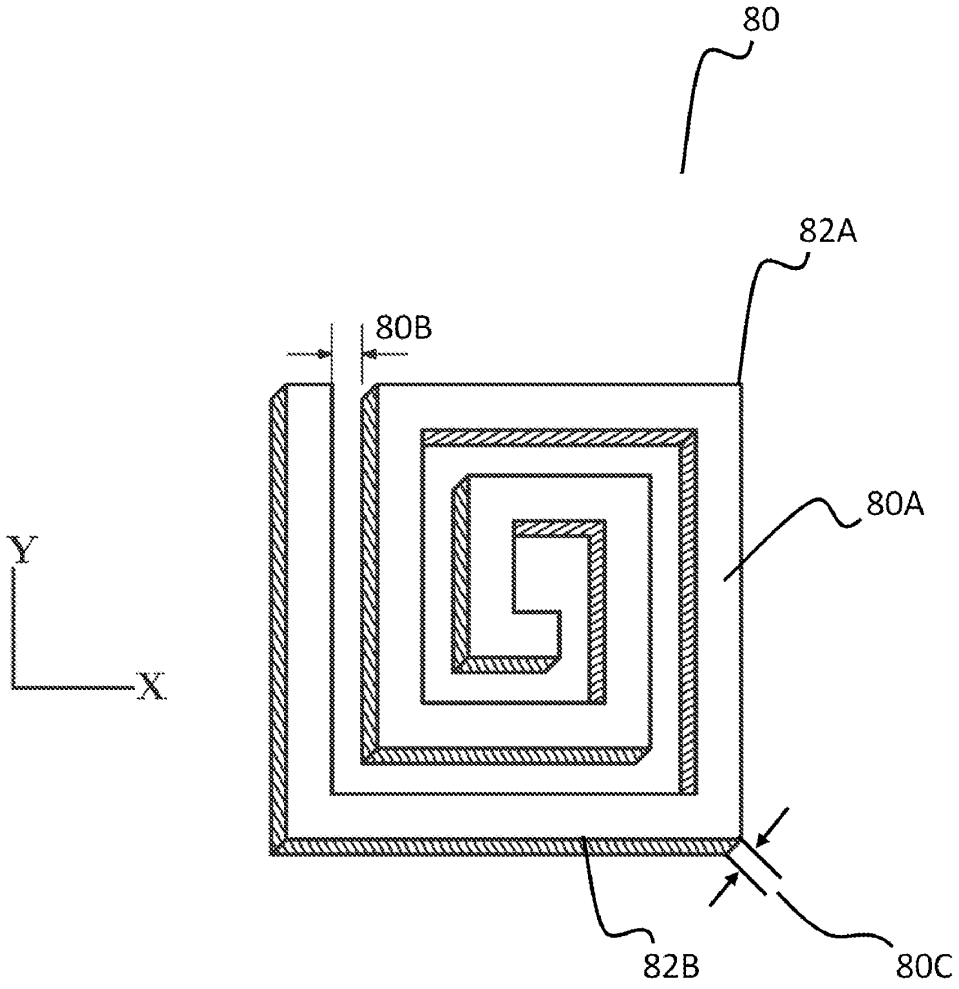


FIG. 2A

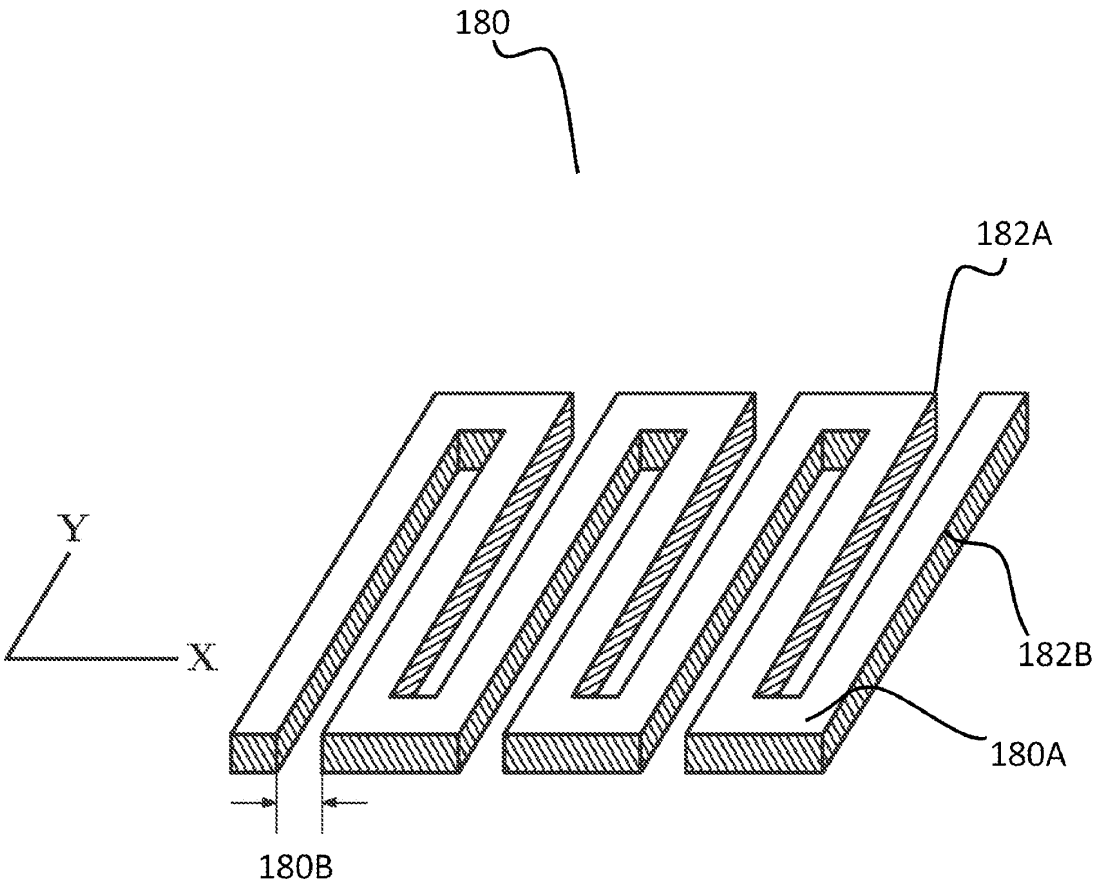


FIG. 2B

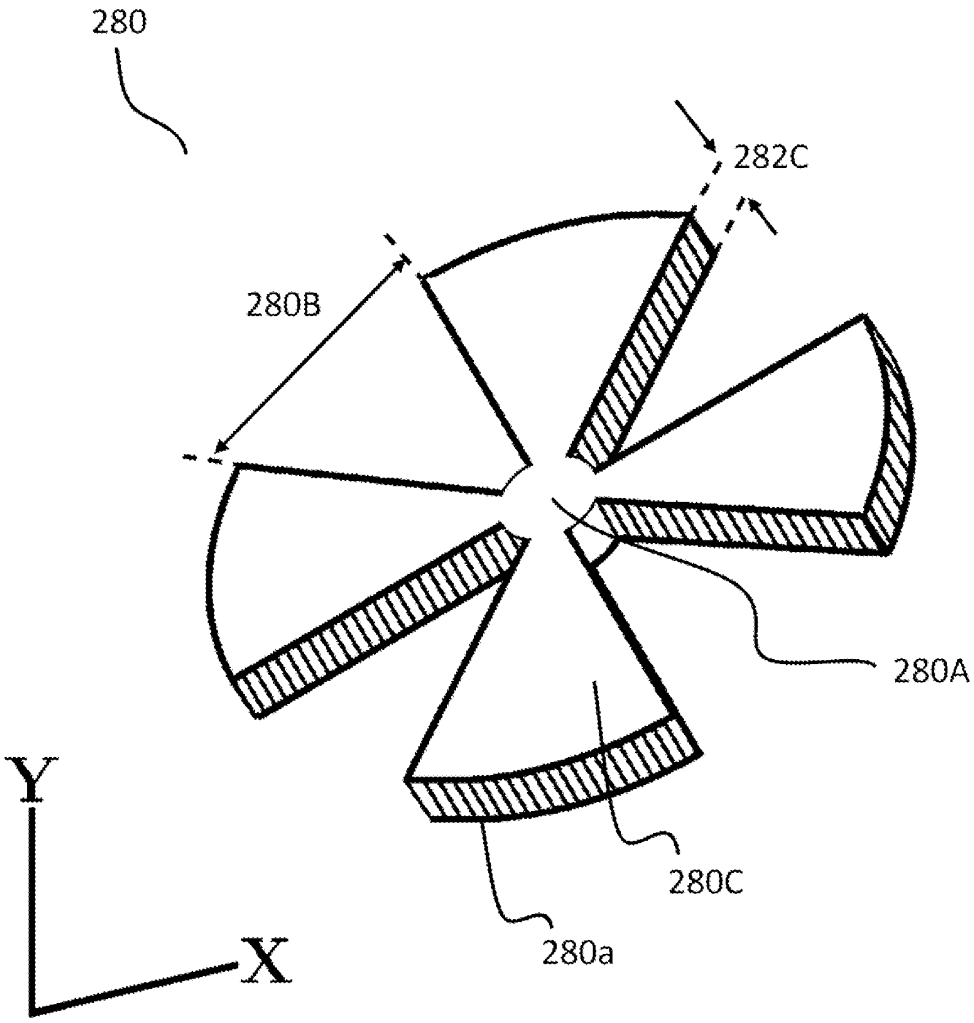


FIG. 2C

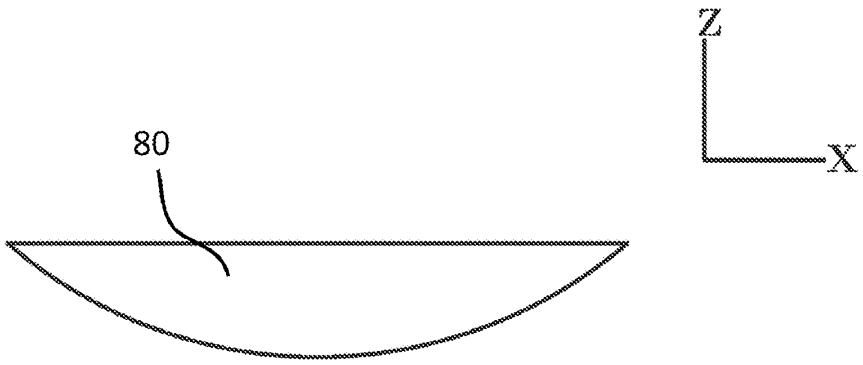


FIG. 3A

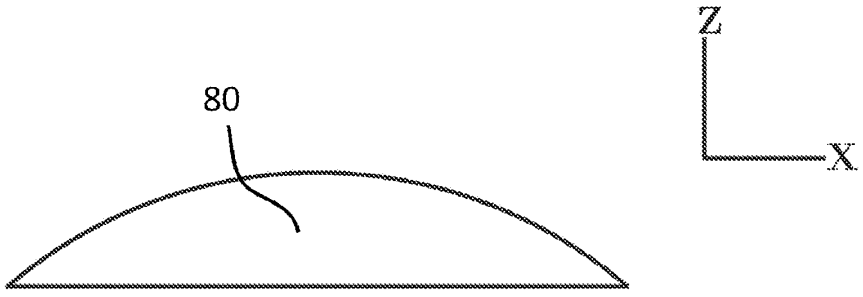


FIG. 3B

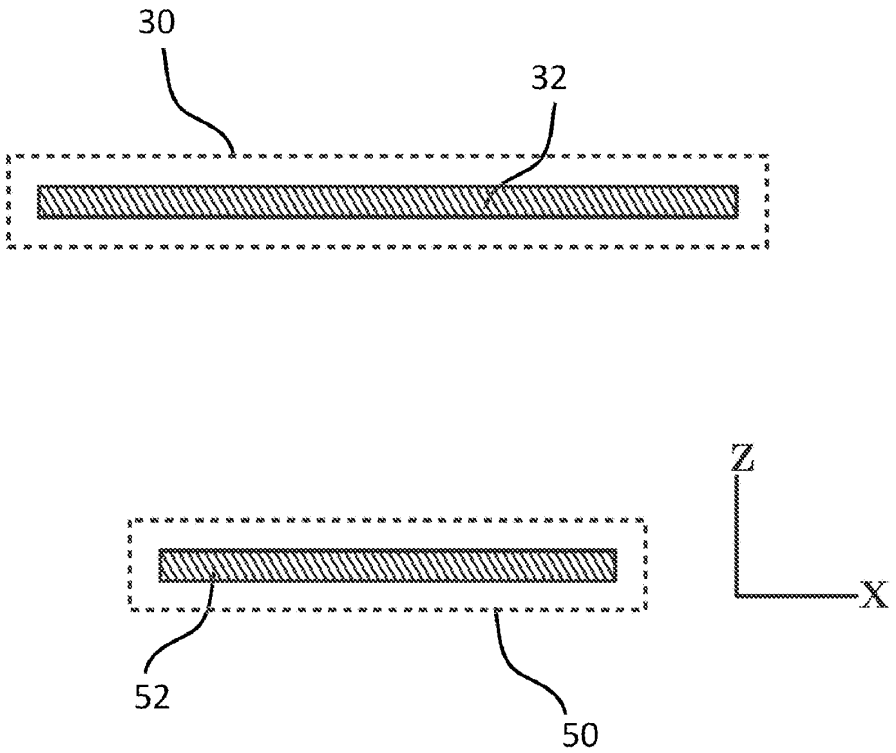


FIG. 4A

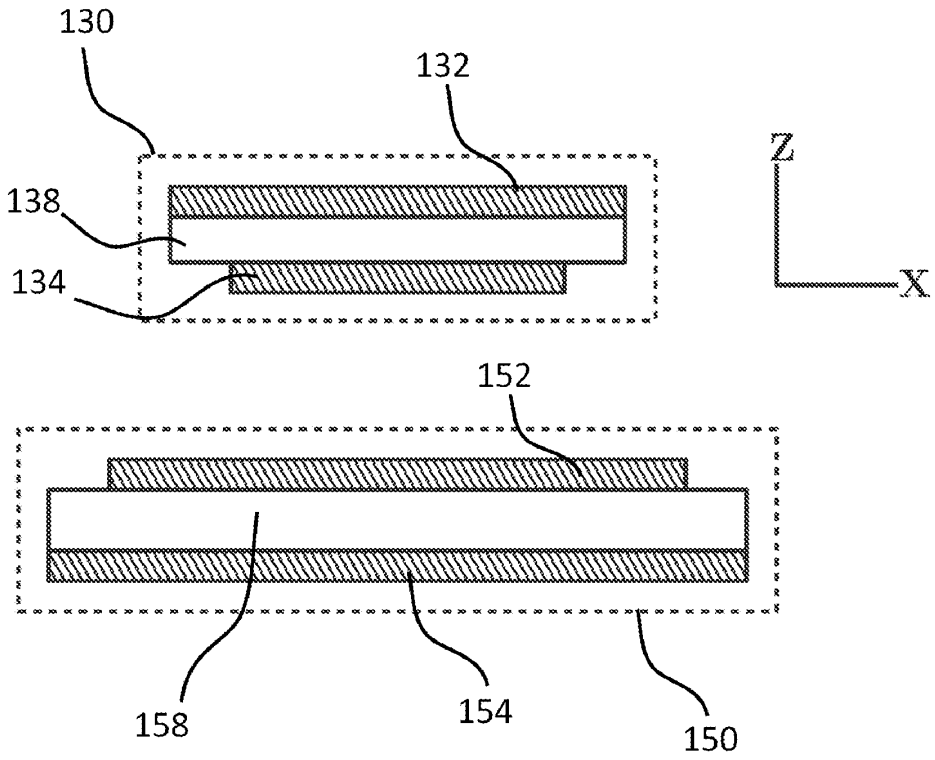


FIG. 4B

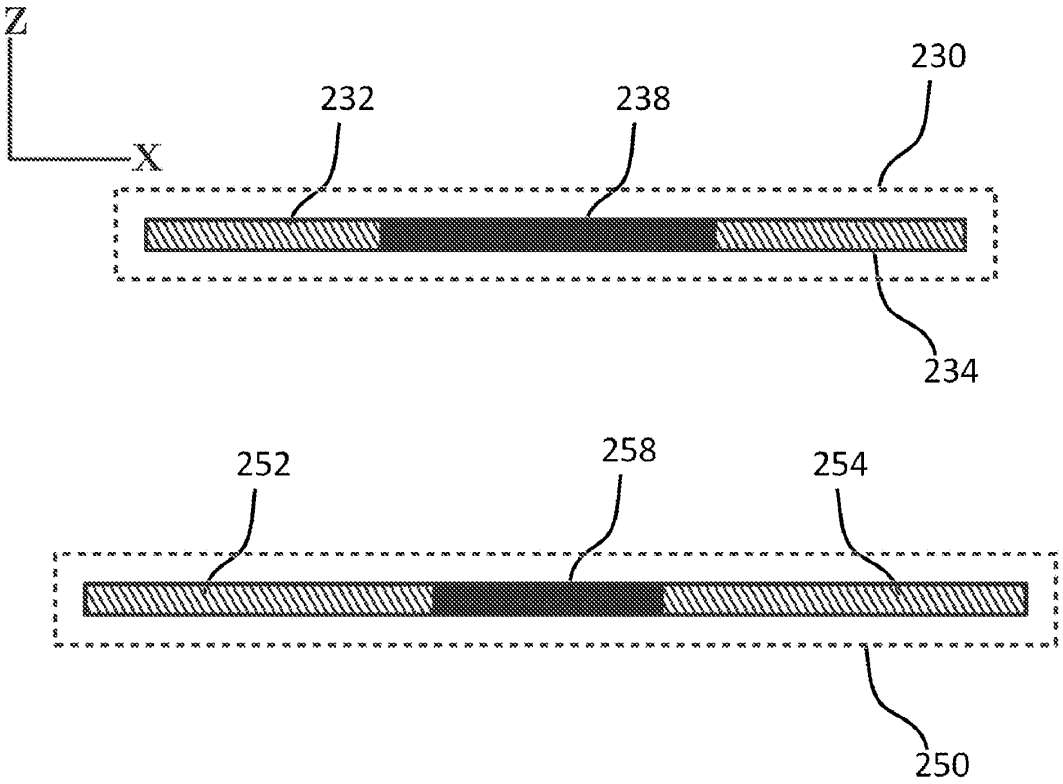


FIG. 4C

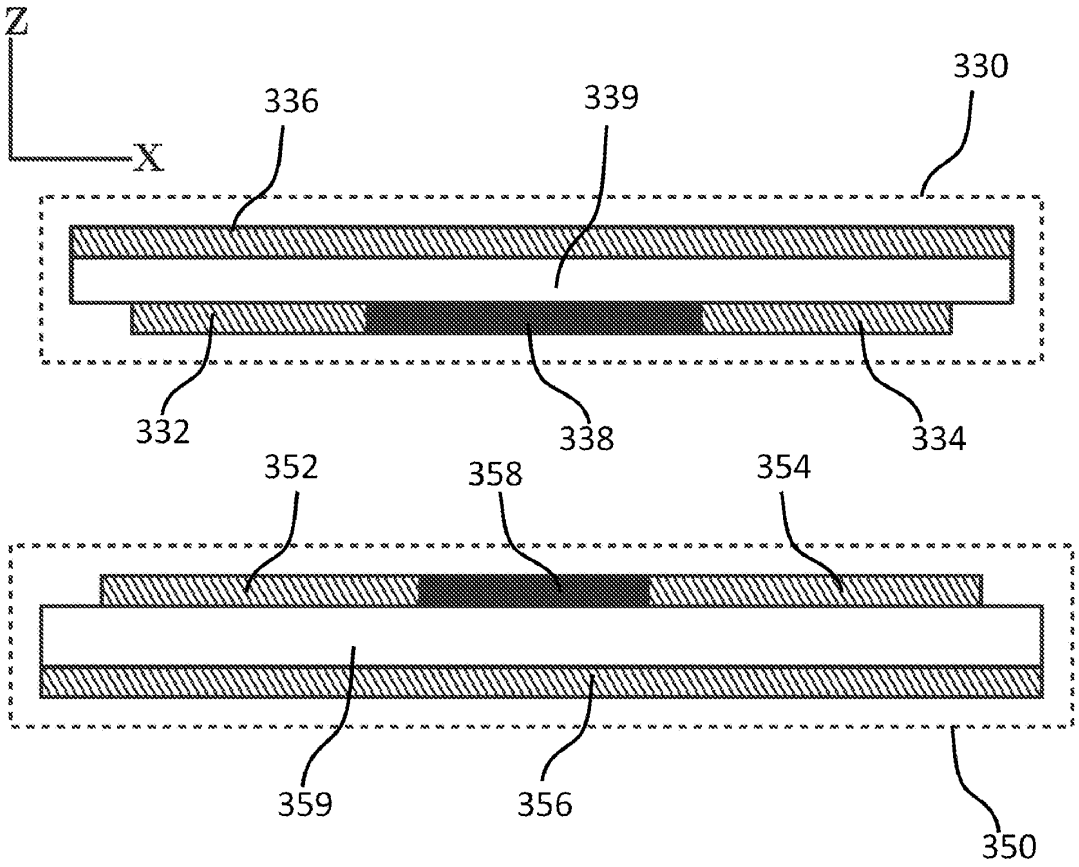


FIG. 4D

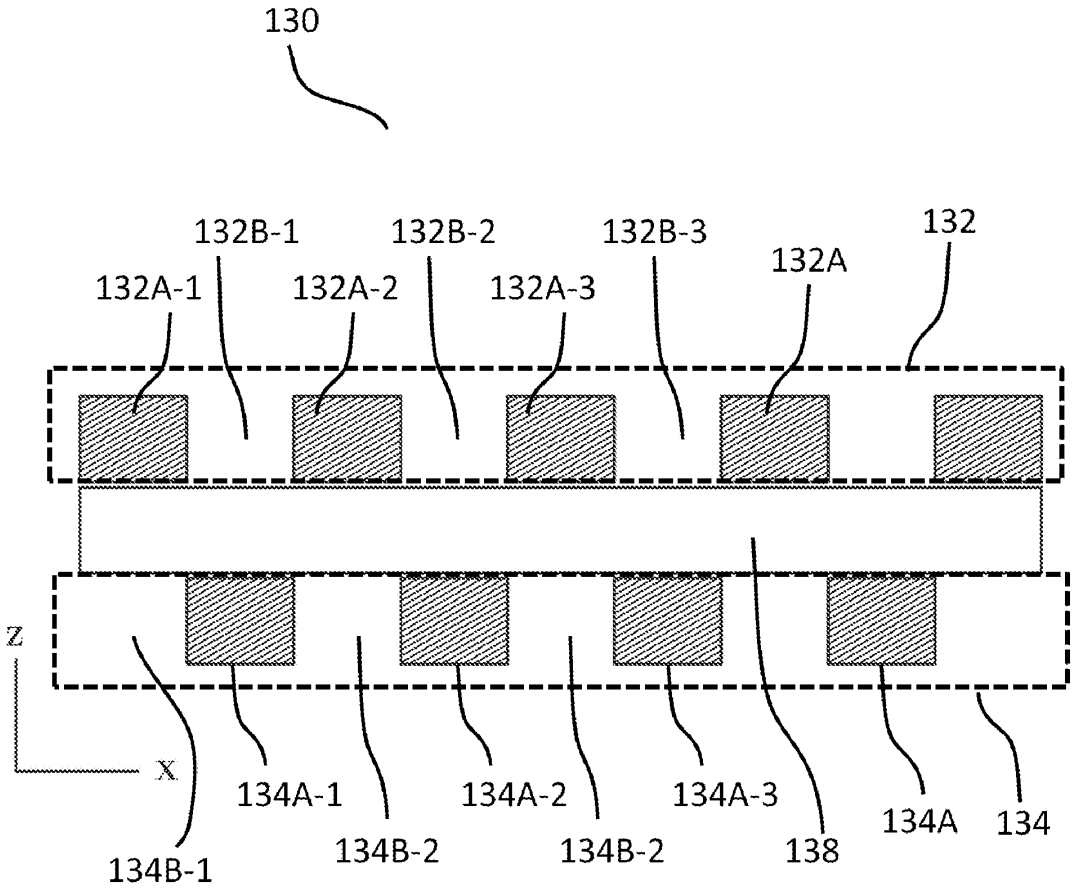

130
132B-1
132B-2
132B-3
132
132A-1
132A-2
132A-3
132A
Z
X
134A-1
134A-2
134A-3
134A
134
134B-1
134B-2
134B-2
138

FIG. 5

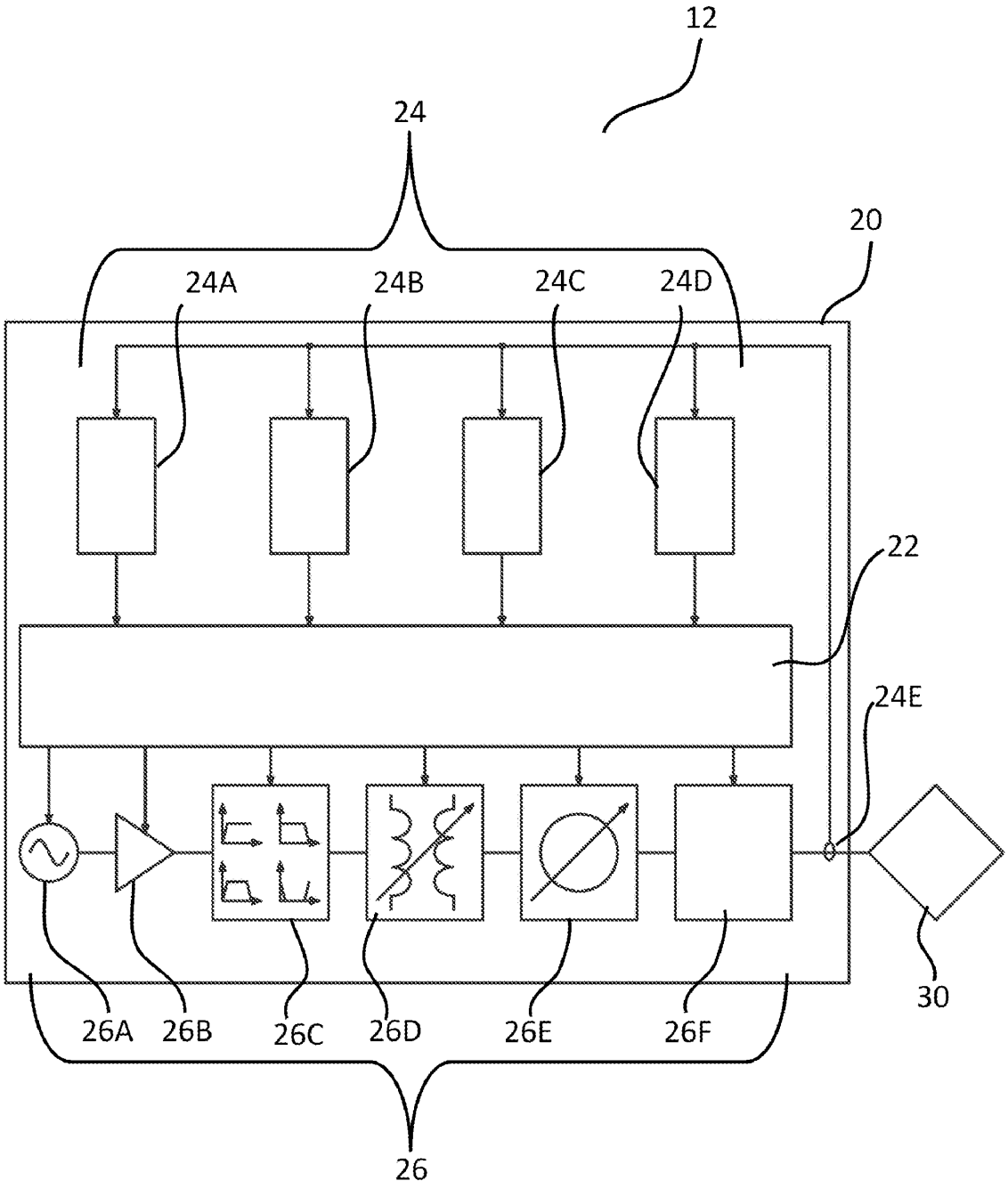


FIG. 6

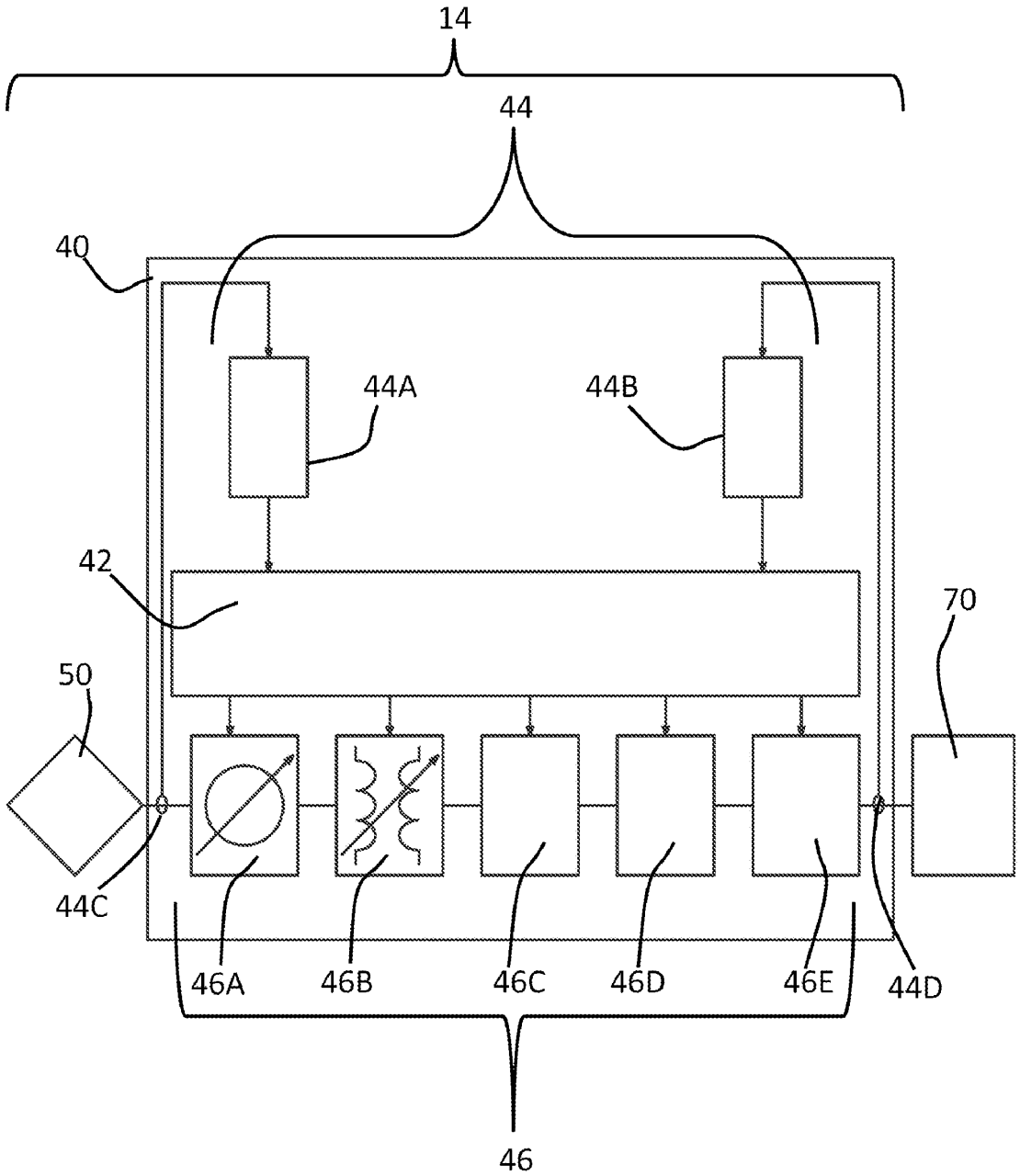


FIG. 7

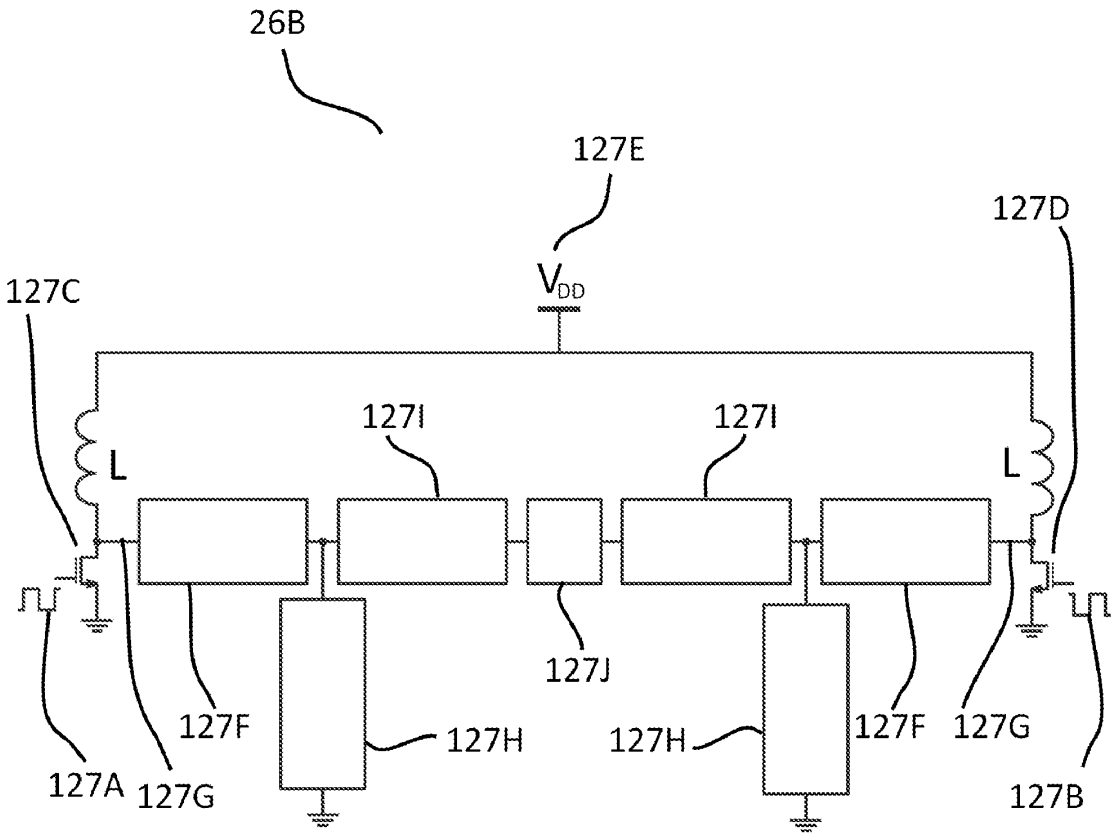

26B
127E
V_{DD}
127D
127C
L
127I
127I
L
127J
127F
127H
127H
127F
127G
127A
127G
127B

FIG. 8

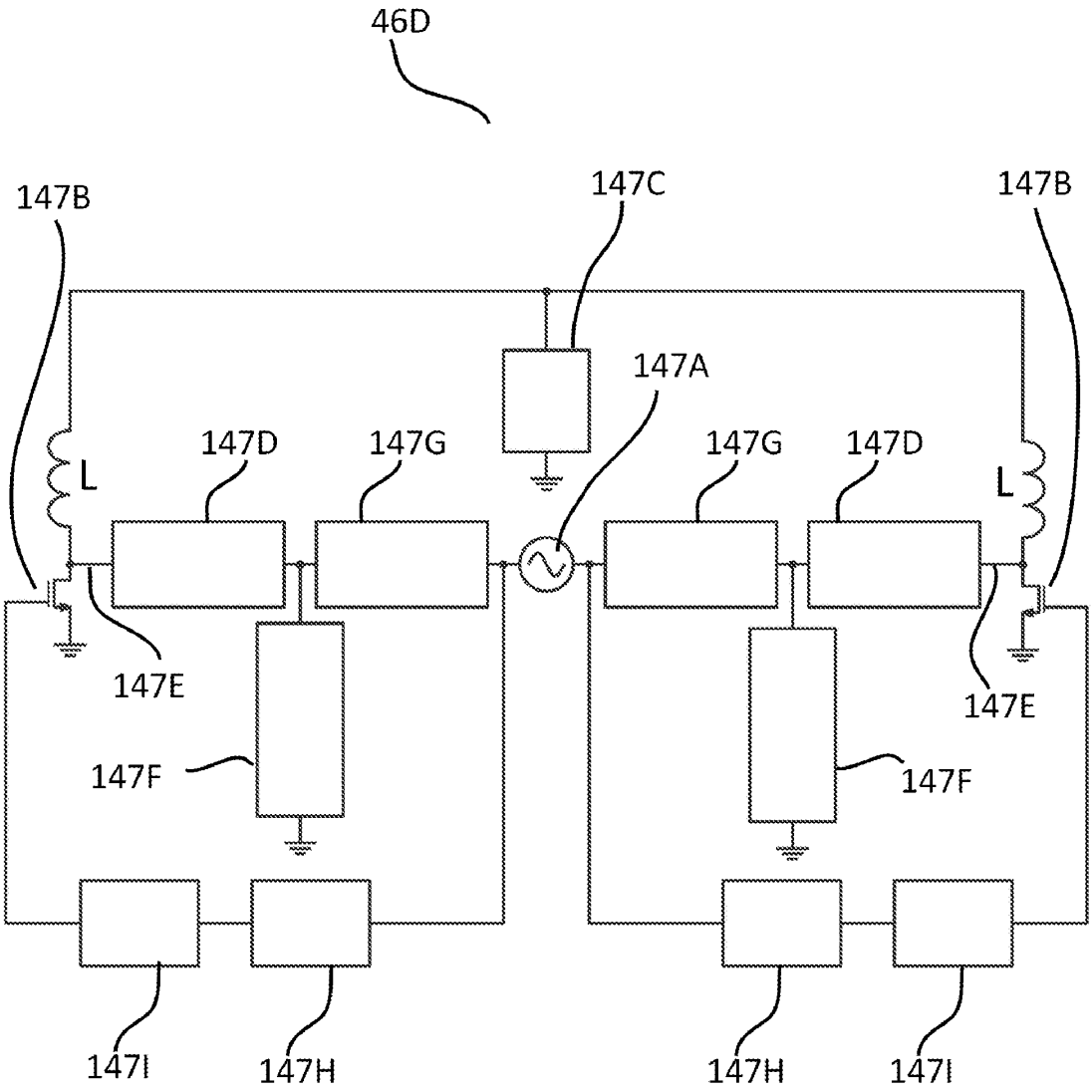

46D
147B
147C
147B
147A
147D
147G
147G
147D
L
L
147E
147E
147F
147F
147I
147H
147H
147I

FIG. 9

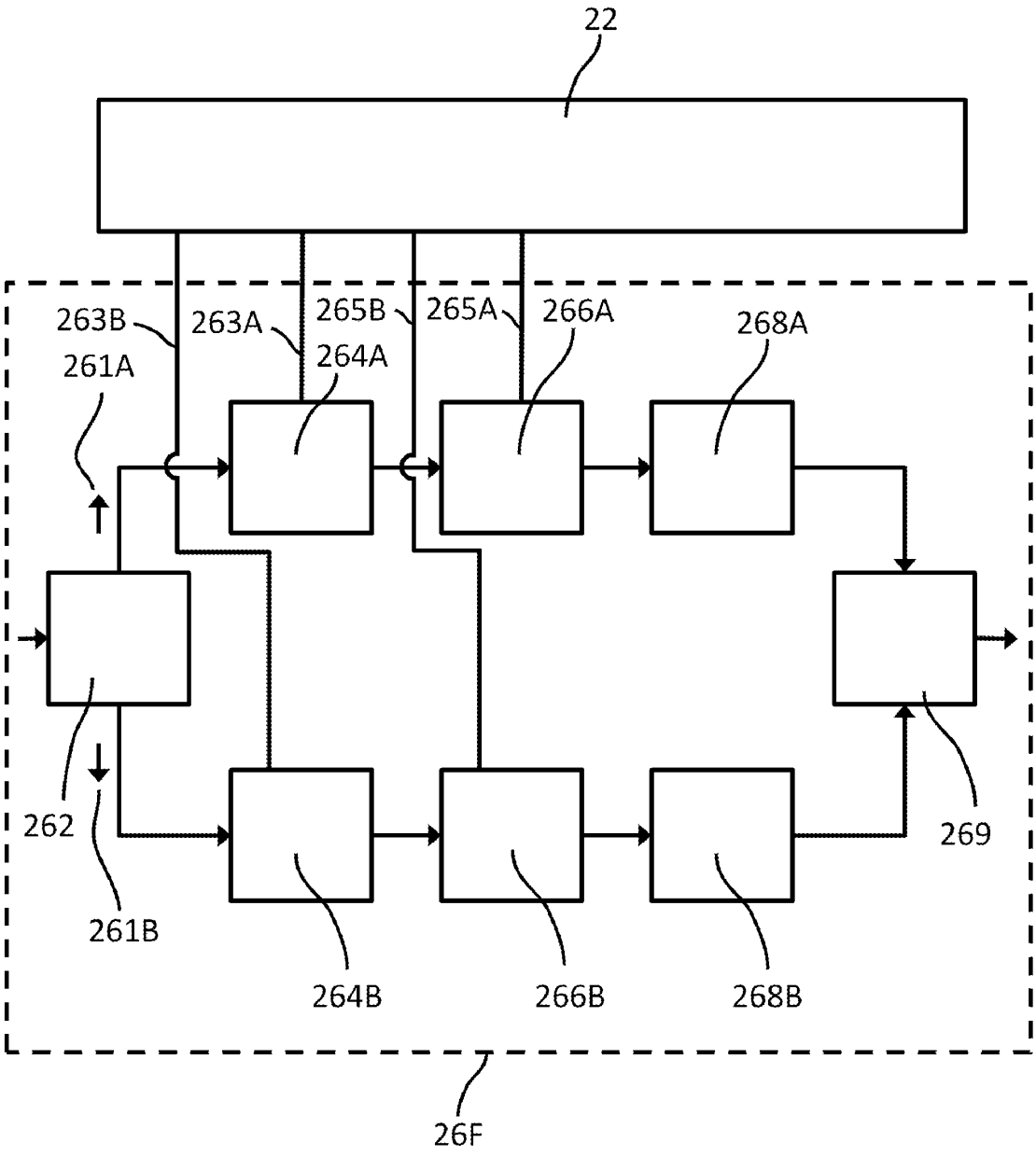

22
263B
263A
265B
265A
266A
268A
261A
264A
262
261B
264B
266B
268B
269
26F

FIG. 10

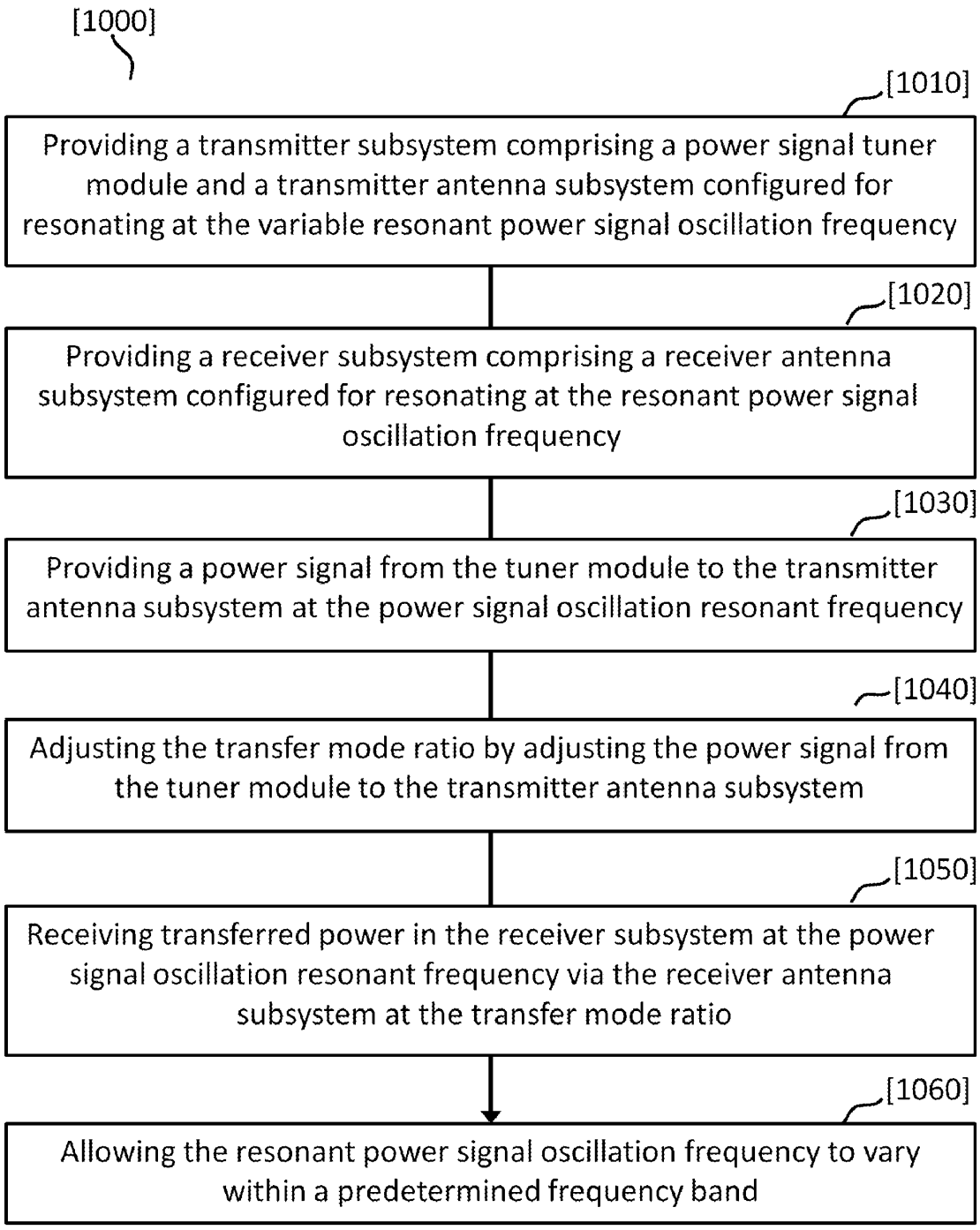

[1000]
[1010]
Providing a transmitter subsystem comprising a power signal tuner module and a transmitter antenna subsystem configured for resonating at the variable resonant power signal oscillation frequency
[1020]
Providing a receiver subsystem comprising a receiver antenna subsystem configured for resonating at the resonant power signal oscillation frequency
[1030]
Providing a power signal from the tuner module to the transmitter antenna subsystem at the power signal oscillation resonant frequency
[1040]
Adjusting the transfer mode ratio by adjusting the power signal from the tuner module to the transmitter antenna subsystem
[1050]
Receiving transferred power in the receiver subsystem at the power signal oscillation resonant frequency via the receiver antenna subsystem at the transfer mode ratio
[1060]
Allowing the resonant power signal oscillation frequency to vary within a predetermined frequency band

FIG. 11

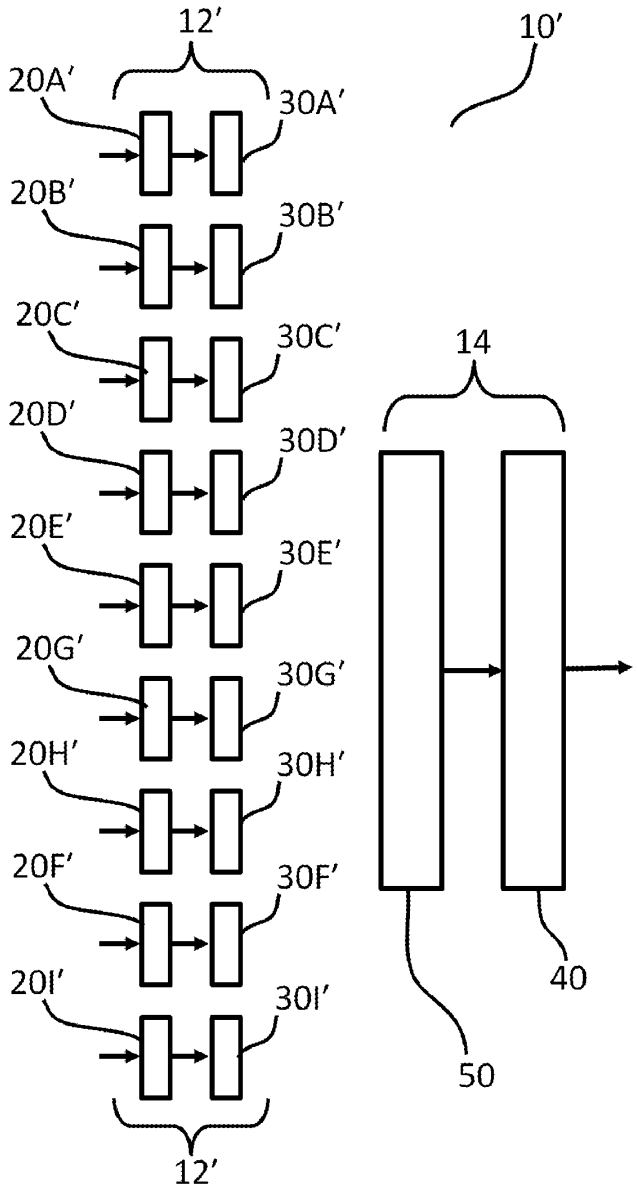

12'
10'
20A'
30A'
20B'
30B'
20C'
30C'
14
20D'
30D'
20E'
30E'
20G'
30G'
20H'
30H'
20F'
30F'
20I'
30I'
40
50
12'

FIG. 12

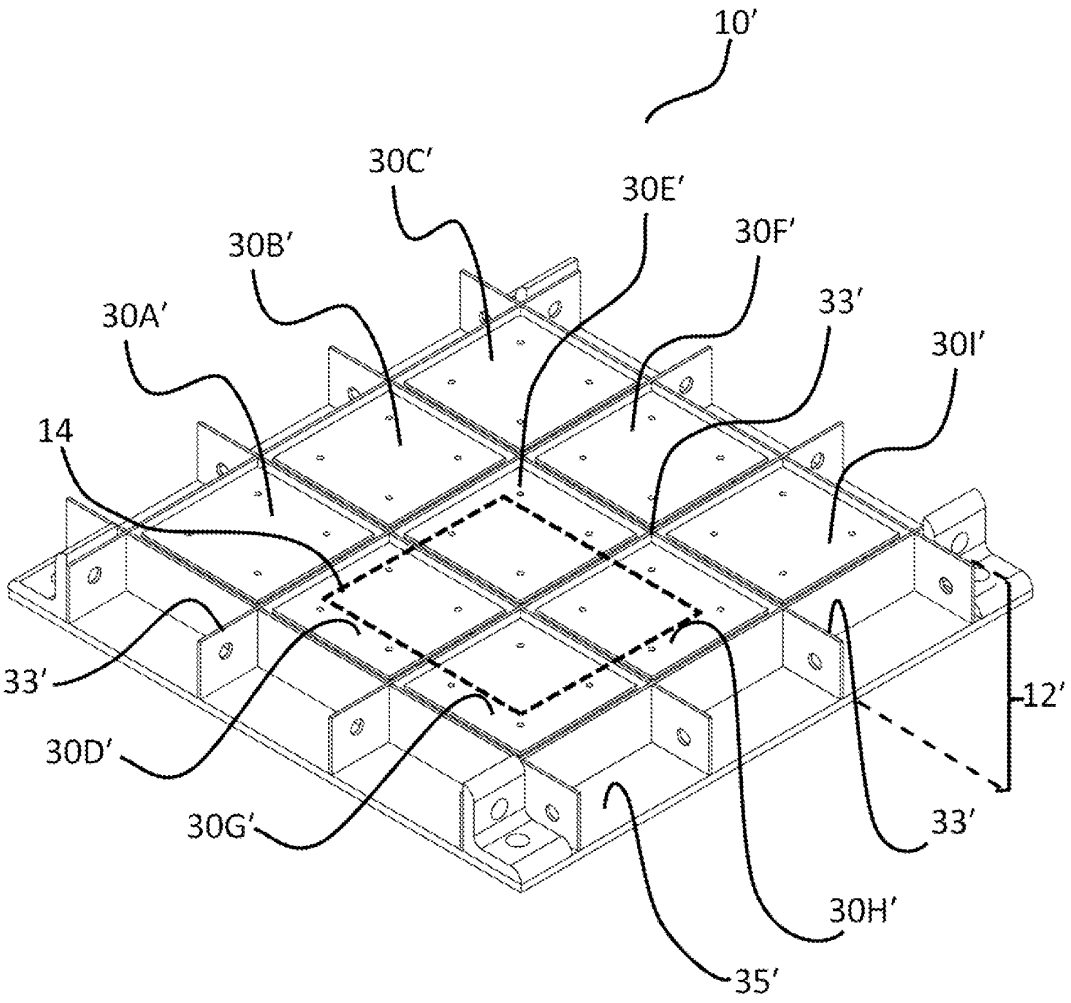


FIG. 13A

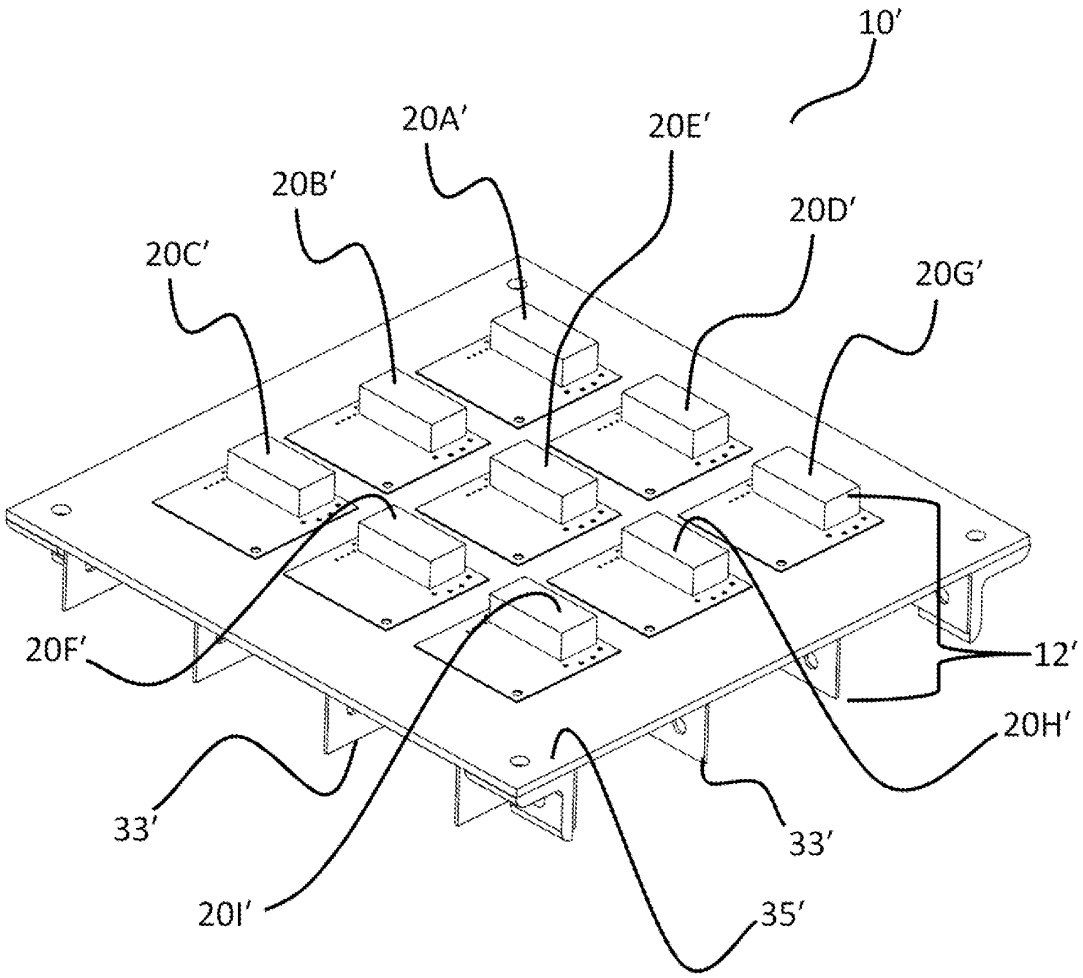


FIG. 13B

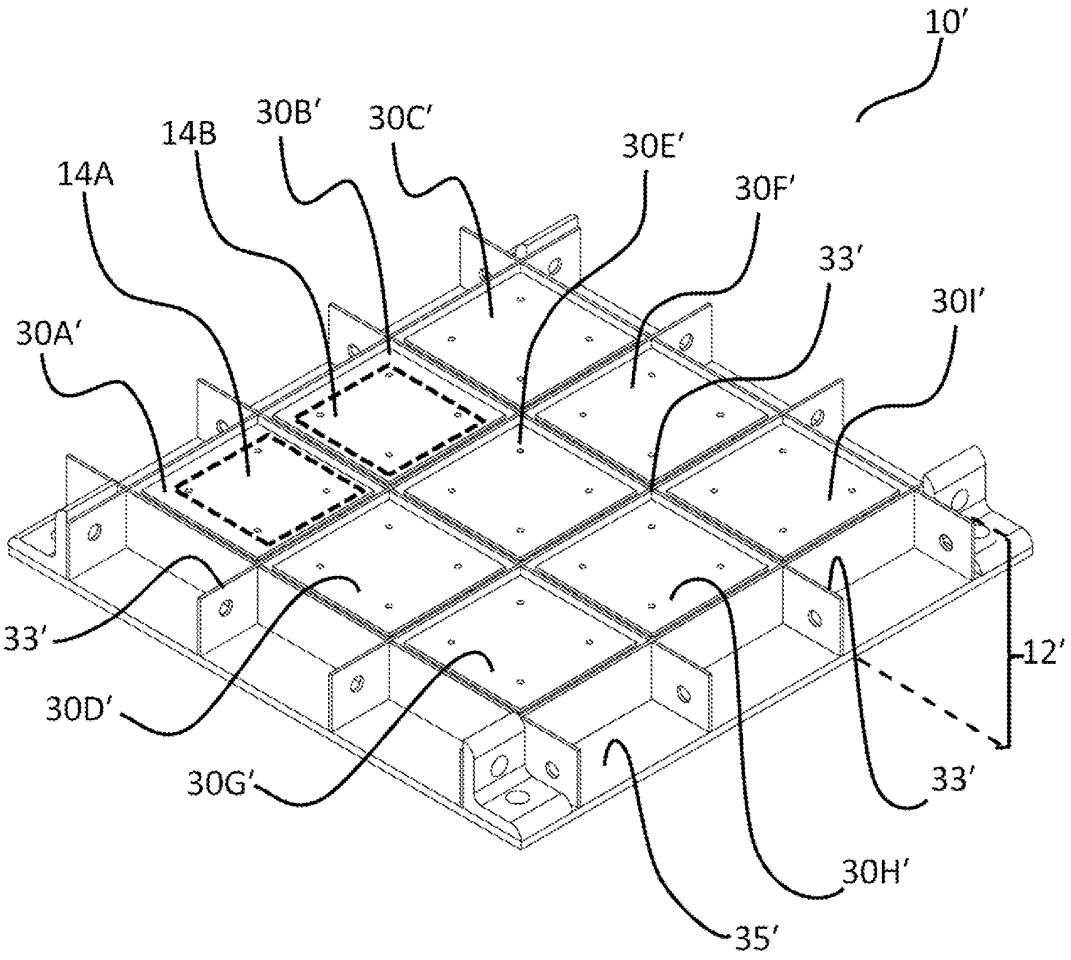


FIG. 14

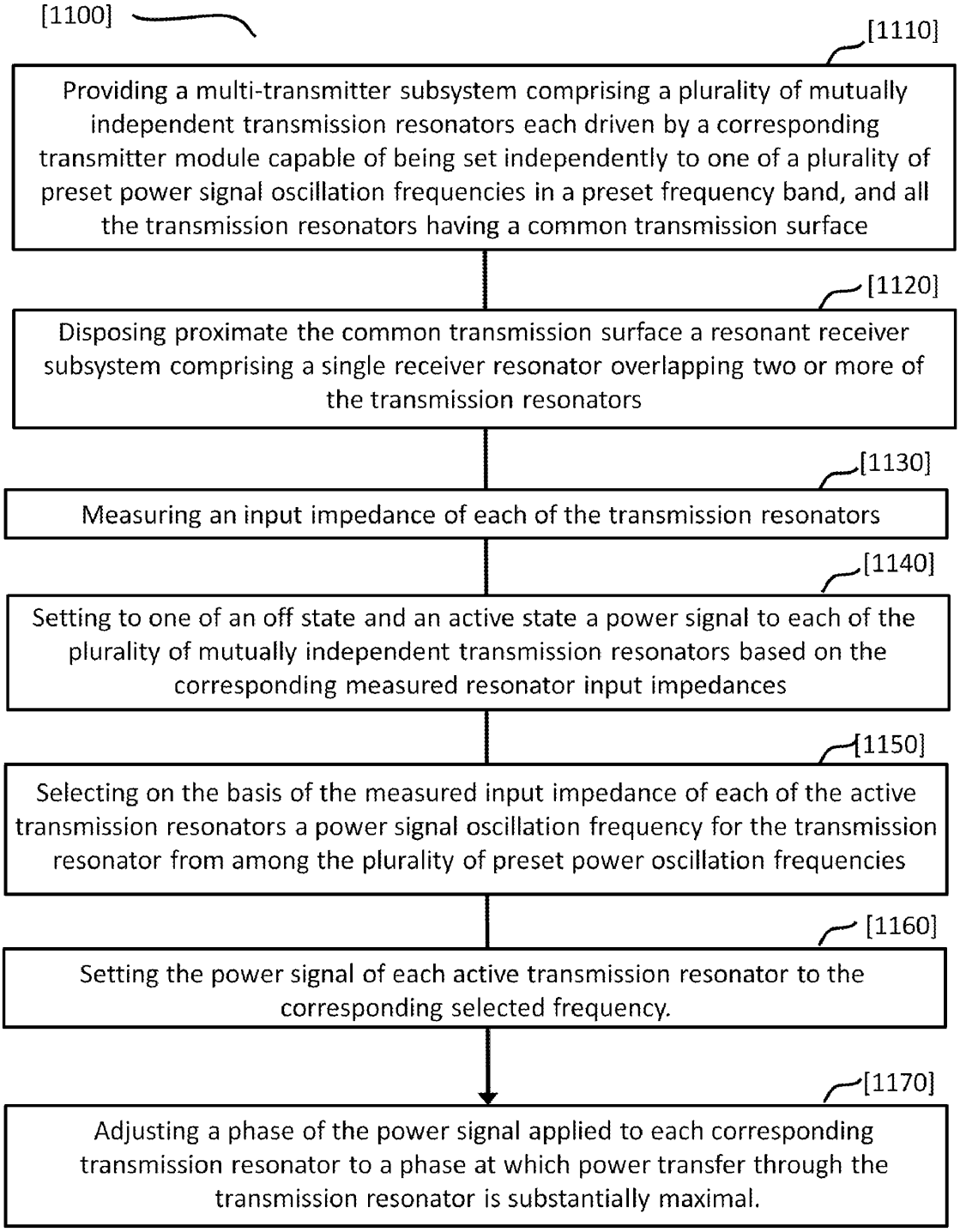

[1100]
[1110]
Providing a multi-transmitter subsystem comprising a plurality of mutually independent transmission resonators each driven by a corresponding transmitter module capable of being set independently to one of a plurality of preset power signal oscillation frequencies in a preset frequency band, and all the transmission resonators having a common transmission surface
[1120]
Disposing proximate the common transmission surface a resonant receiver subsystem comprising a single receiver resonator overlapping two or more of the transmission resonators
[1130]
Measuring an input impedance of each of the transmission resonators
[1140]
Setting to one of an off state and an active state a power signal to each of the plurality of mutually independent transmission resonators based on the corresponding measured resonator input impedances
[1150]
Selecting on the basis of the measured input impedance of each of the active transmission resonators a power signal oscillation frequency for the transmission resonator from among the plurality of preset power oscillation frequencies
[1160]
Setting the power signal of each active transmission resonator to the corresponding selected frequency.
[1170]
Adjusting a phase of the power signal applied to each corresponding transmission resonator to a phase at which power transfer through the transmission resonator is substantially maximal.

FIG. 15

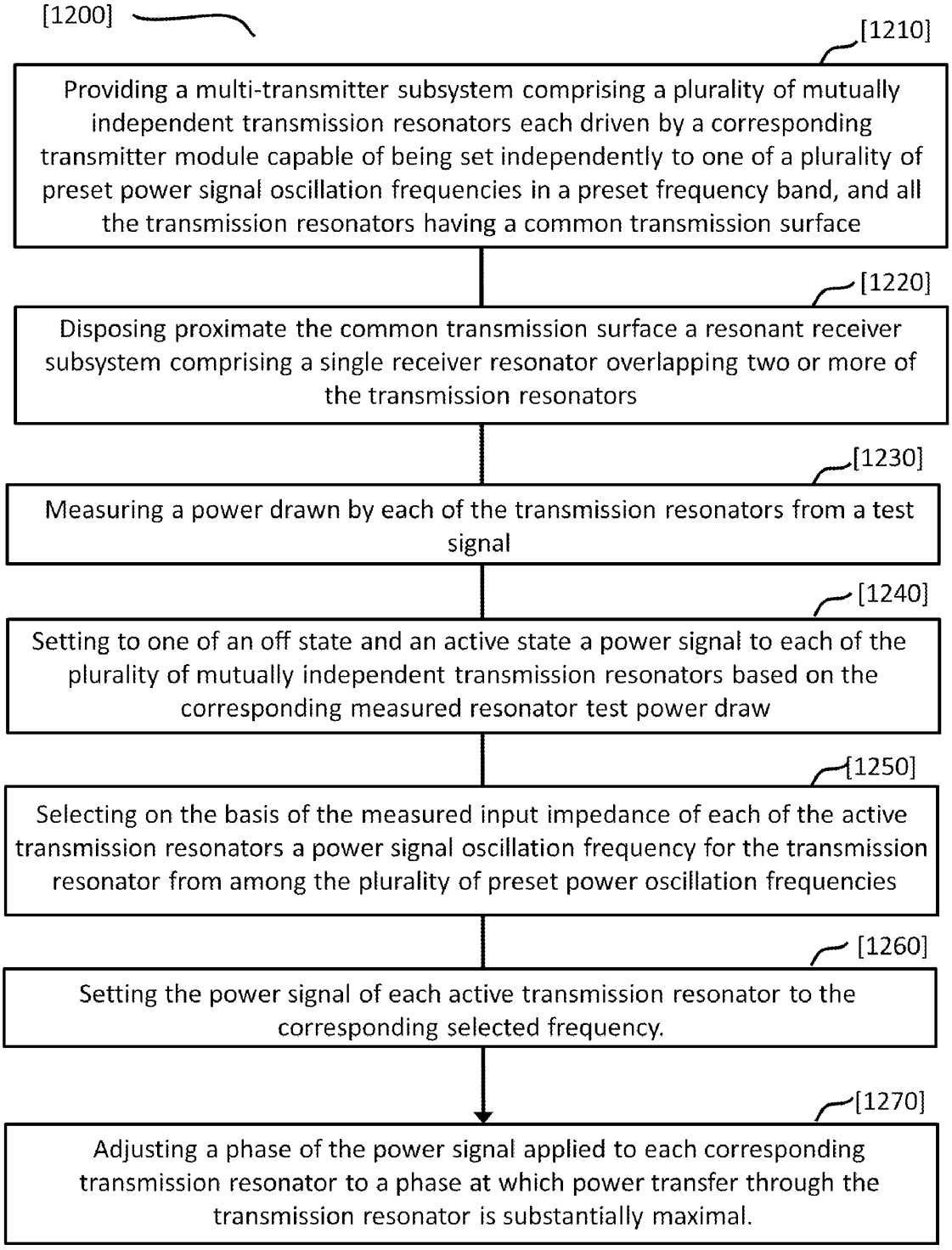

[1200]
[1210]
Providing a multi-transmitter subsystem comprising a plurality of mutually independent transmission resonators each driven by a corresponding transmitter module capable of being set independently to one of a plurality of preset power signal oscillation frequencies in a preset frequency band, and all the transmission resonators having a common transmission surface
[1220]
Disposing proximate the common transmission surface a resonant receiver subsystem comprising a single receiver resonator overlapping two or more of the transmission resonators
[1230]
Measuring a power drawn by each of the transmission resonators from a test signal
[1240]
Setting to one of an off state and an active state a power signal to each of the plurality of mutually independent transmission resonators based on the corresponding measured resonator test power draw
[1250]
Selecting on the basis of the measured input impedance of each of the active transmission resonators a power signal oscillation frequency for the transmission resonator from among the plurality of preset power oscillation frequencies
[1260]
Setting the power signal of each active transmission resonator to the corresponding selected frequency.
[1270]
Adjusting a phase of the power signal applied to each corresponding transmission resonator to a phase at which power transfer through the transmission resonator is substantially maximal.

FIG. 16

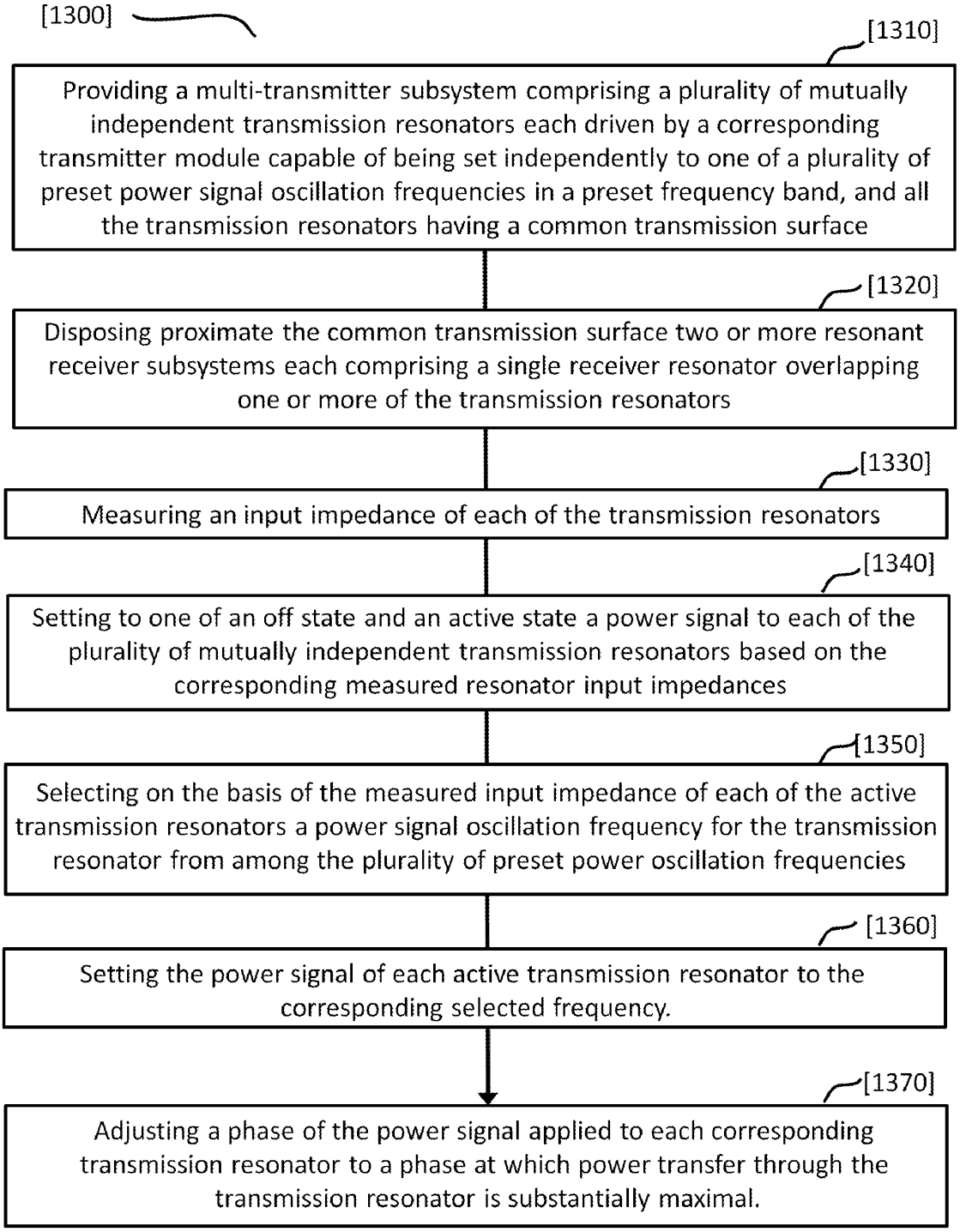

[1300]
[1310]
Providing a multi-transmitter subsystem comprising a plurality of mutually independent transmission resonators each driven by a corresponding transmitter module capable of being set independently to one of a plurality of preset power signal oscillation frequencies in a preset frequency band, and all the transmission resonators having a common transmission surface
[1320]
Disposing proximate the common transmission surface two or more resonant receiver subsystems each comprising a single receiver resonator overlapping one or more of the transmission resonators
[1330]
Measuring an input impedance of each of the transmission resonators
[1340]
Setting to one of an off state and an active state a power signal to each of the plurality of mutually independent transmission resonators based on the corresponding measured resonator input impedances
[1350]
Selecting on the basis of the measured input impedance of each of the active transmission resonators a power signal oscillation frequency for the transmission resonator from among the plurality of preset power oscillation frequencies
[1360]
Setting the power signal of each active transmission resonator to the corresponding selected frequency.
[1370]
Adjusting a phase of the power signal applied to each corresponding transmission resonator to a phase at which power transfer through the transmission resonator is substantially maximal.

FIG. 17

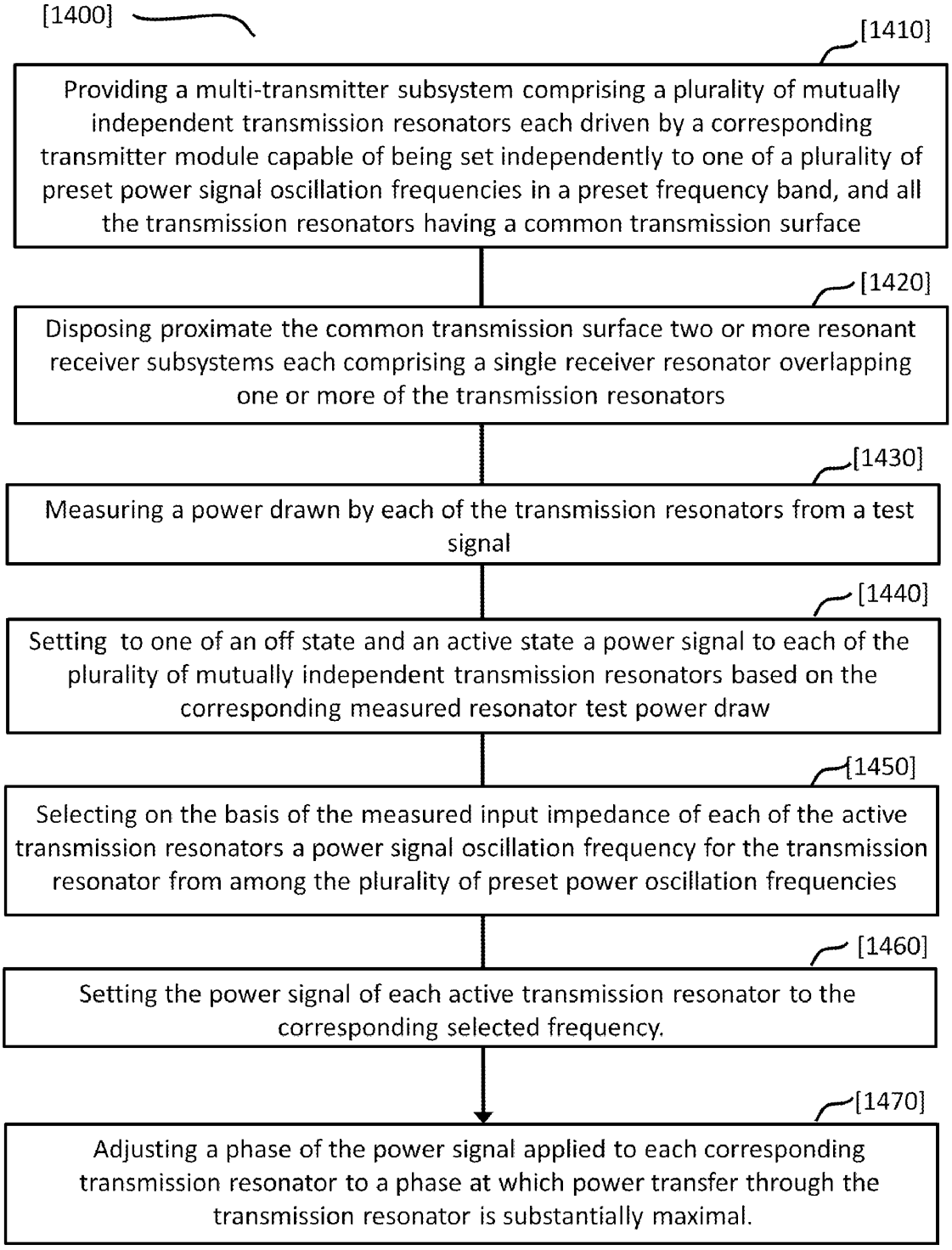

[1400]
[1410]
Providing a multi-transmitter subsystem comprising a plurality of mutually independent transmission resonators each driven by a corresponding transmitter module capable of being set independently to one of a plurality of preset power signal oscillation frequencies in a preset frequency band, and all the transmission resonators having a common transmission surface
[1420]
Disposing proximate the common transmission surface two or more resonant receiver subsystems each comprising a single receiver resonator overlapping one or more of the transmission resonators
[1430]
Measuring a power drawn by each of the transmission resonators from a test signal
[1440]
Setting to one of an off state and an active state a power signal to each of the plurality of mutually independent transmission resonators based on the corresponding measured resonator test power draw
[1450]
Selecting on the basis of the measured input impedance of each of the active transmission resonators a power signal oscillation frequency for the transmission resonator from among the plurality of preset power oscillation frequencies
[1460]
Setting the power signal of each active transmission resonator to the corresponding selected frequency.
[1470]
Adjusting a phase of the power signal applied to each corresponding transmission resonator to a phase at which power transfer through the transmission resonator is substantially maximal.

FIG. 18

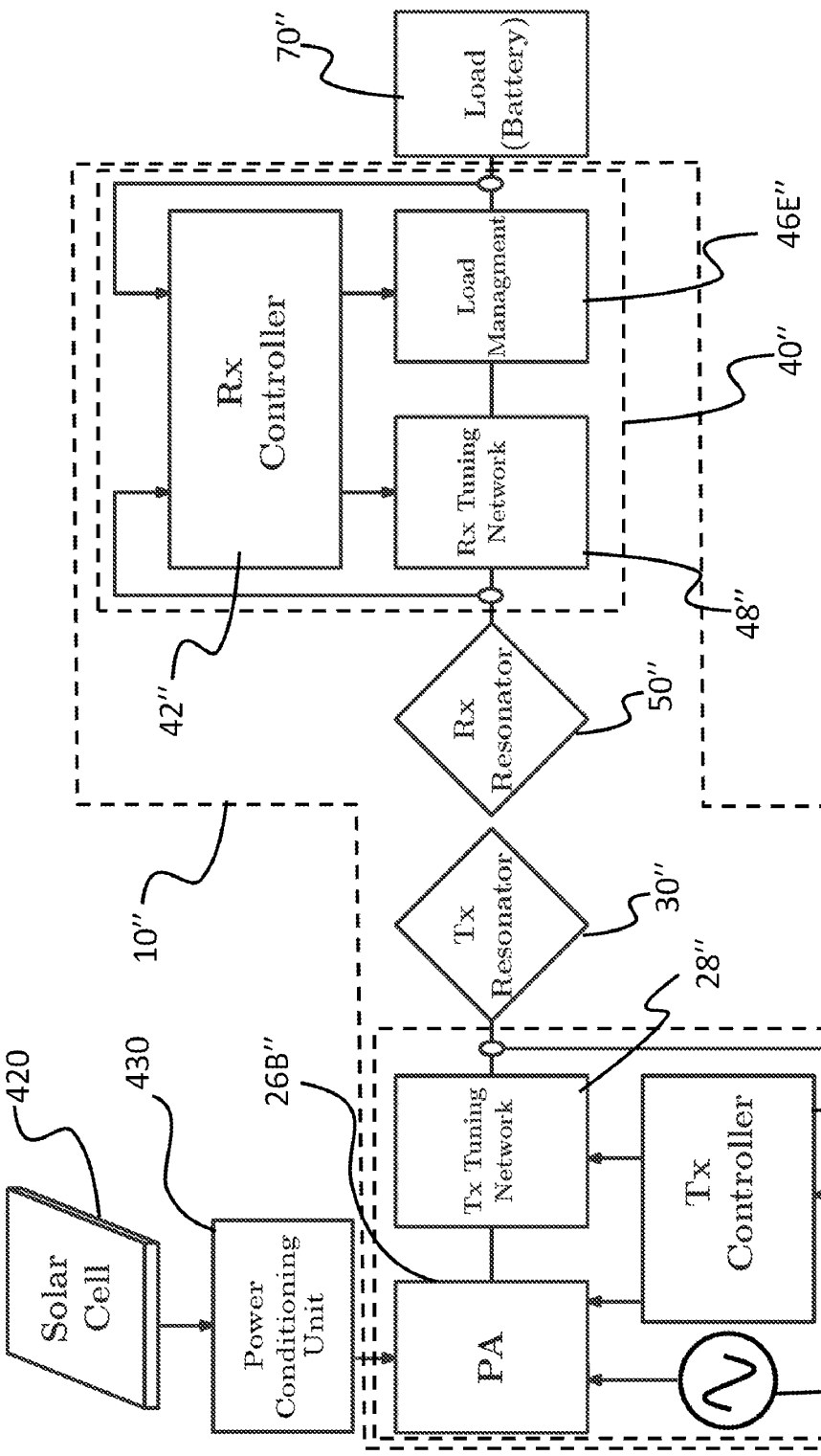

Solar Cell
420
Power Conditioning Unit
430
26B''
PA
Tx Tuning Network
Tx Controller
22''
20''
26A''
28''
Tx Resonator
30''
Rx Resonator
50''
10''
42''
Rx Controller
Rx Tuning Network
48''
Load Managment
40''
46E''
Load (Battery)
70''

FIG. 19A

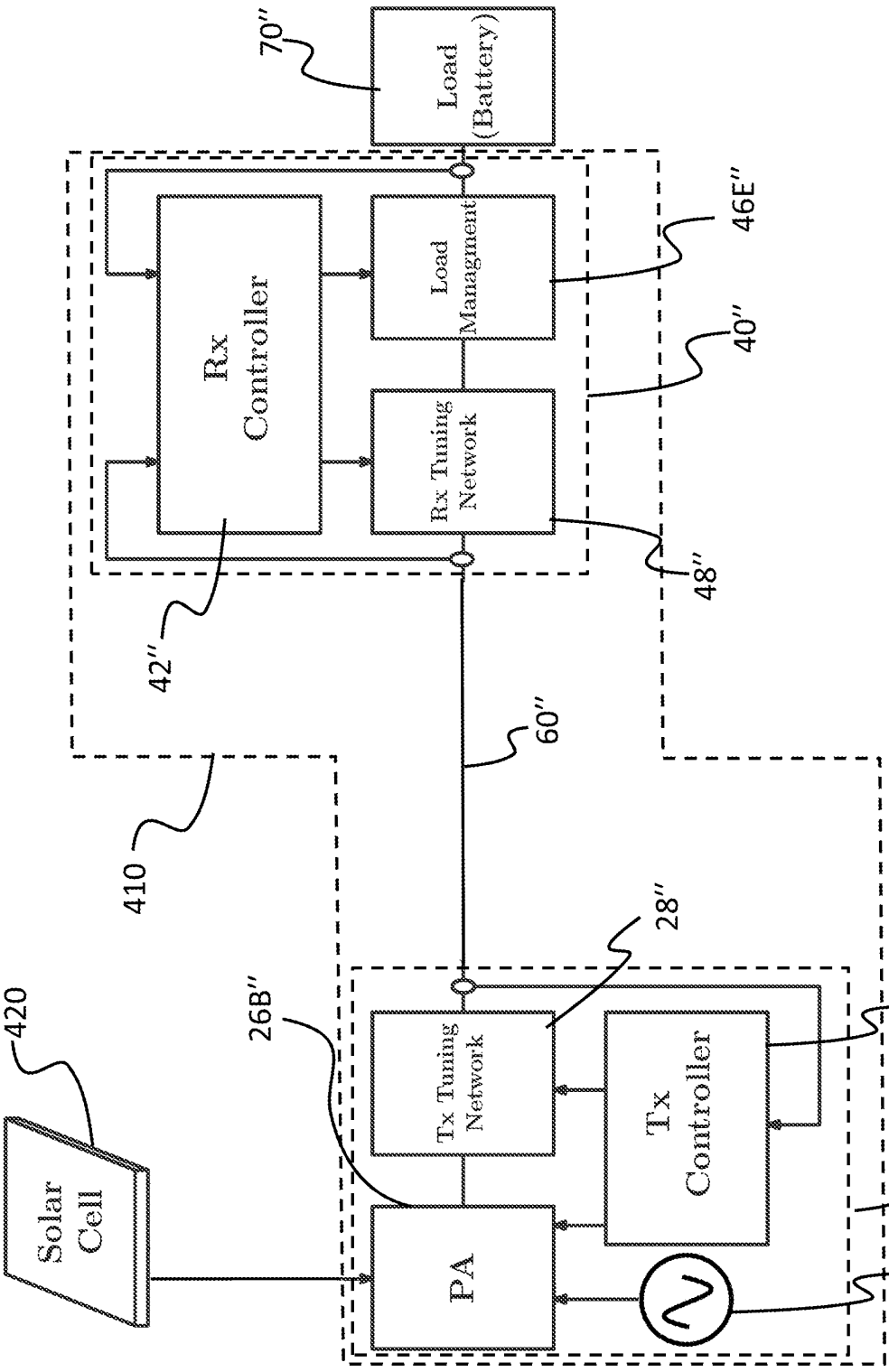

70''
Load (Battery)
46E''
Load Managment
Rx Controller
40''
Rx Tuning Network
48''
42''
60''
410
28''
26B''
420
Tx Tuning Network
Tx Controller
22''
20''
Solar Cell
PA
26A''

FIG. 19B

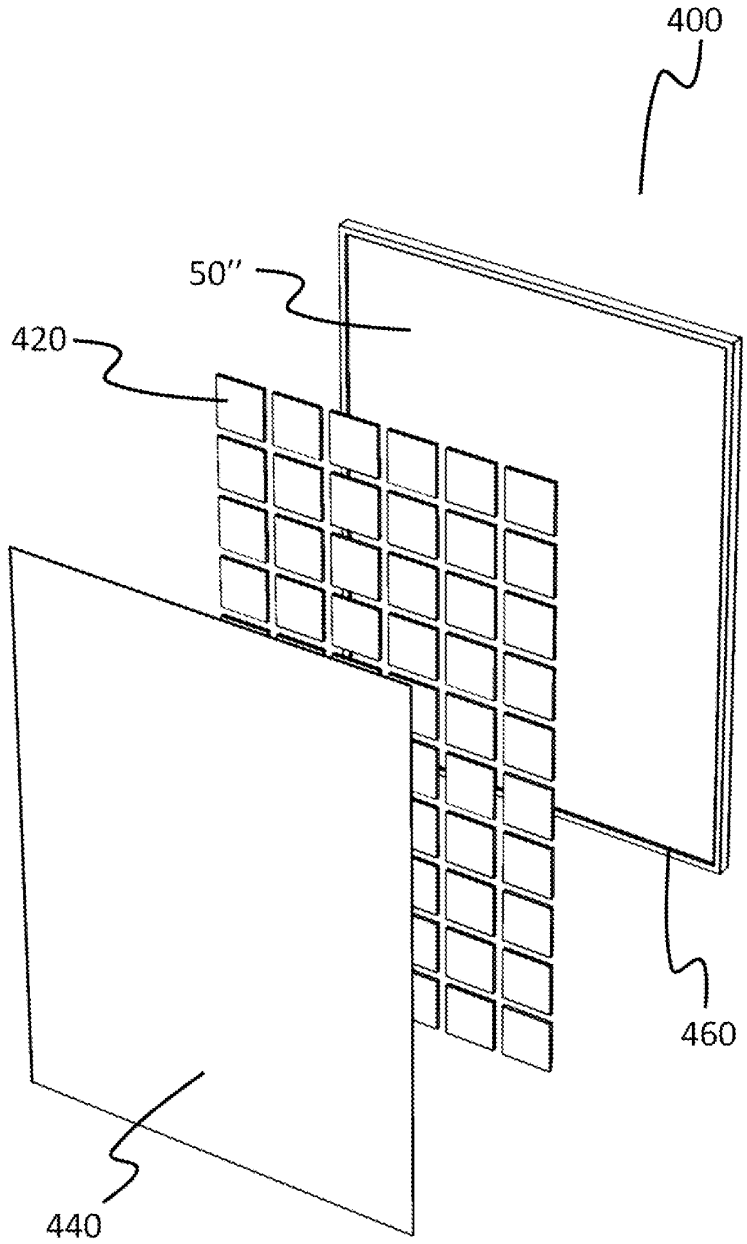


FIG. 20A

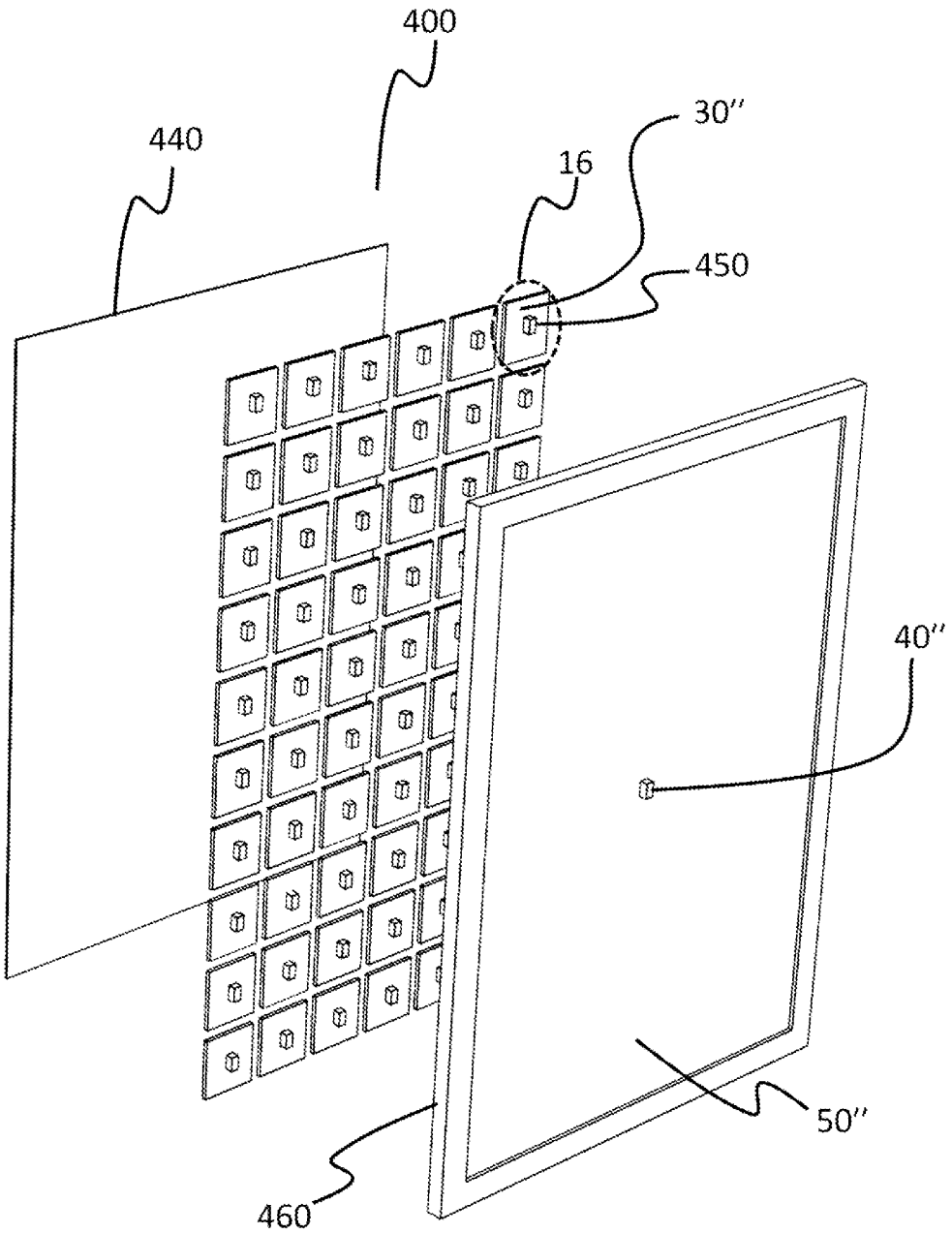


FIG. 20B

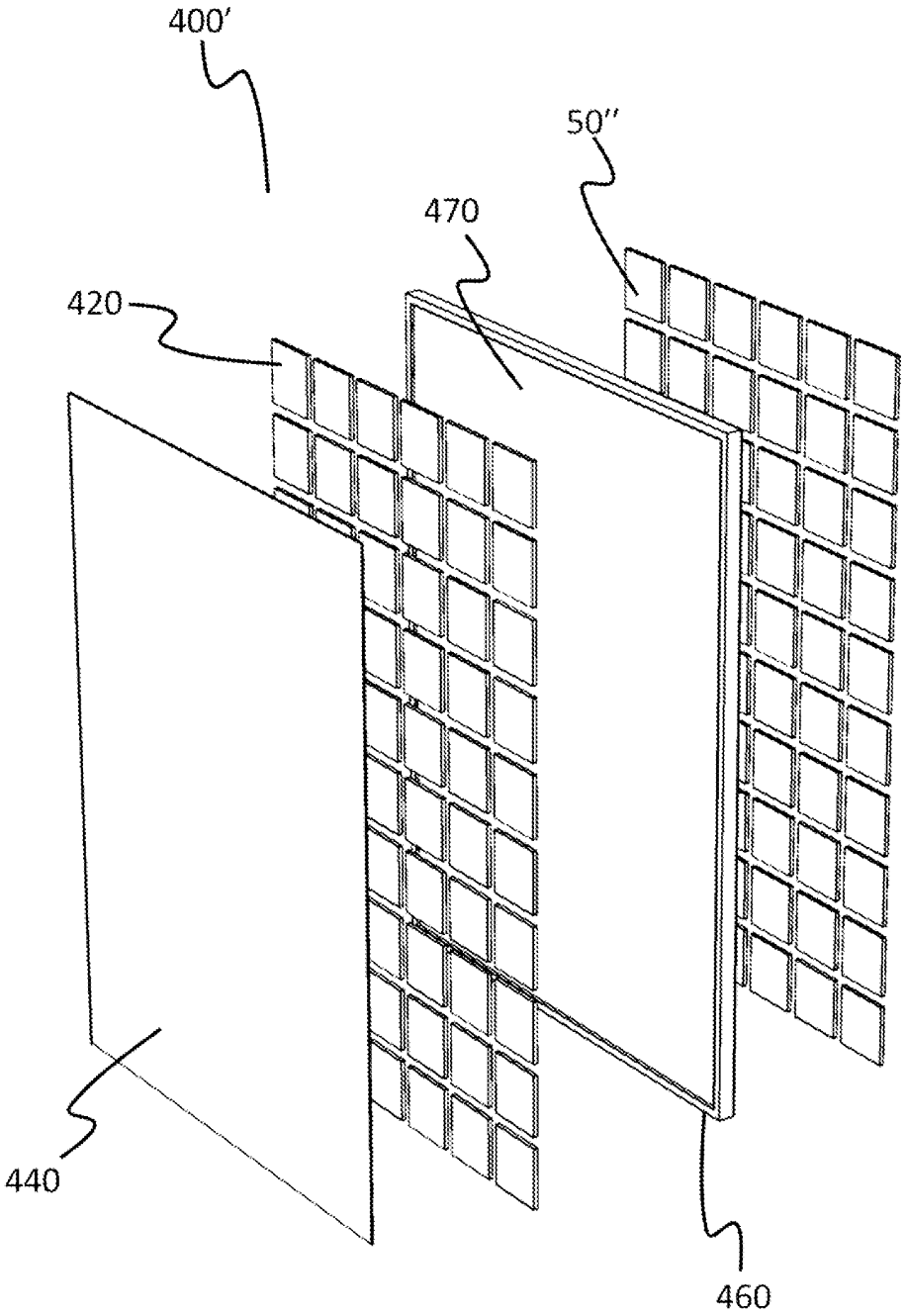


FIG. 21A

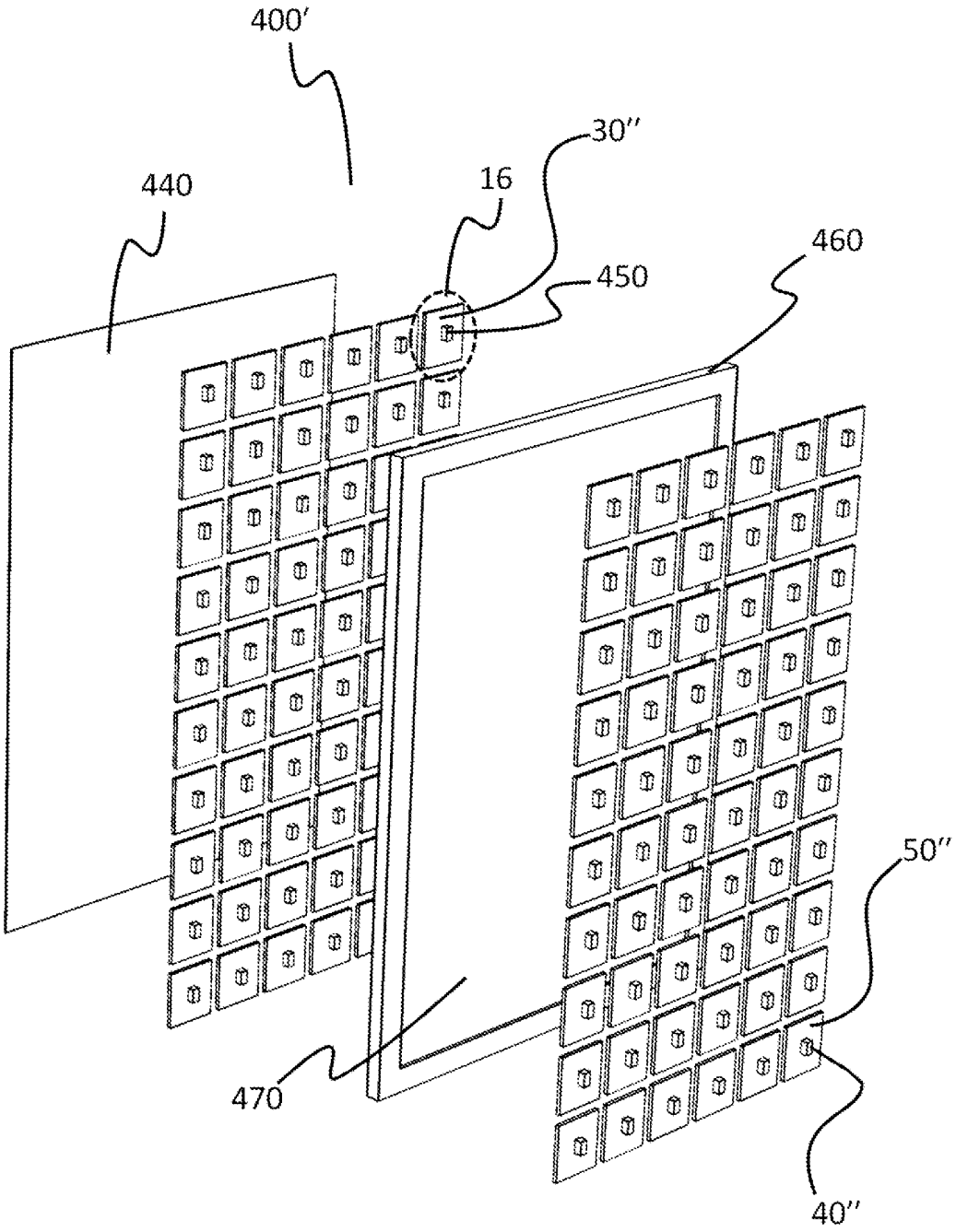


FIG. 21B

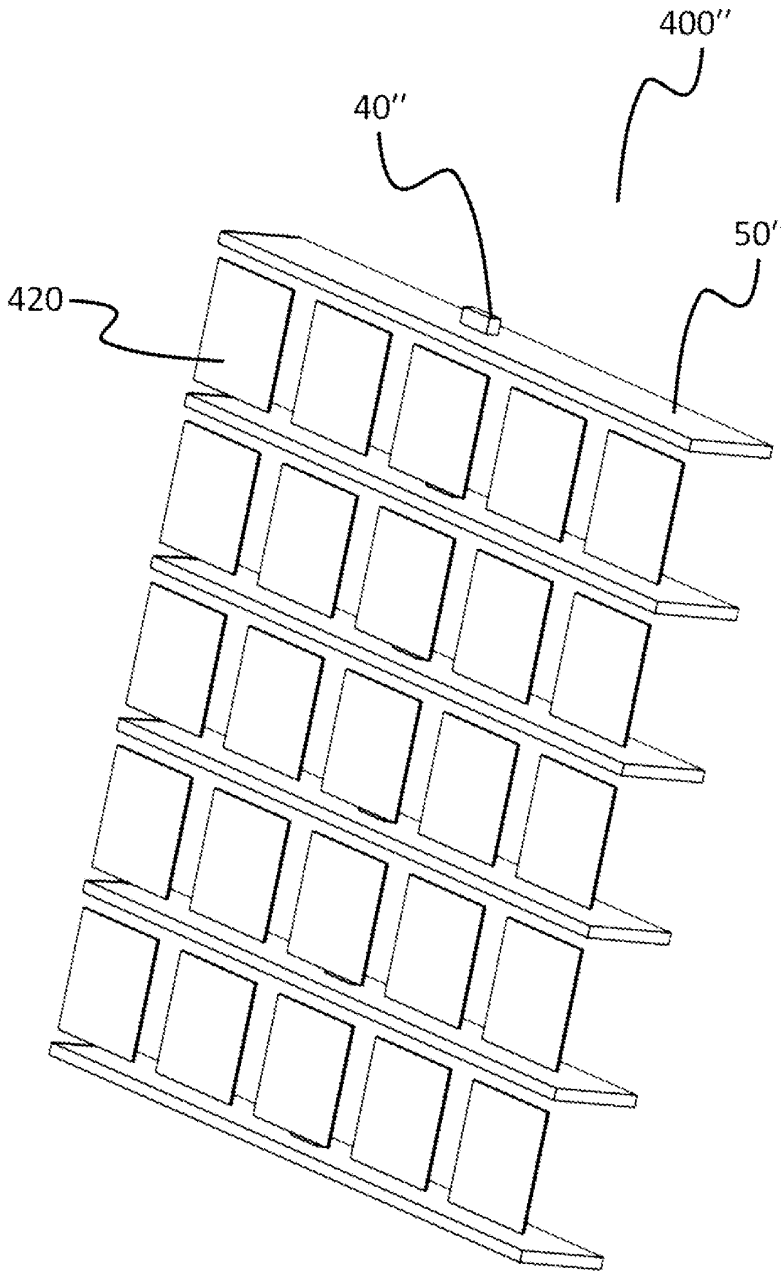


FIG. 22A

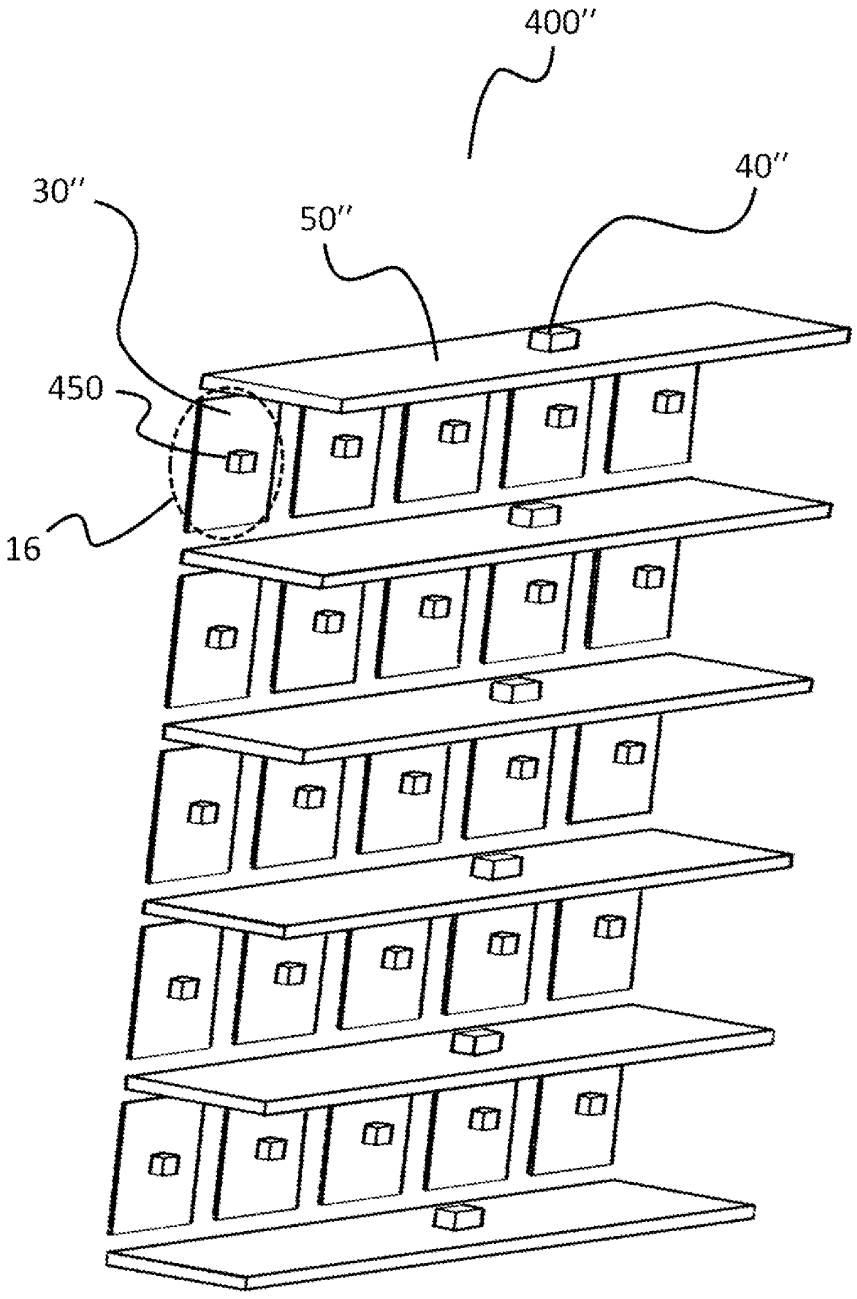


FIG. 22B

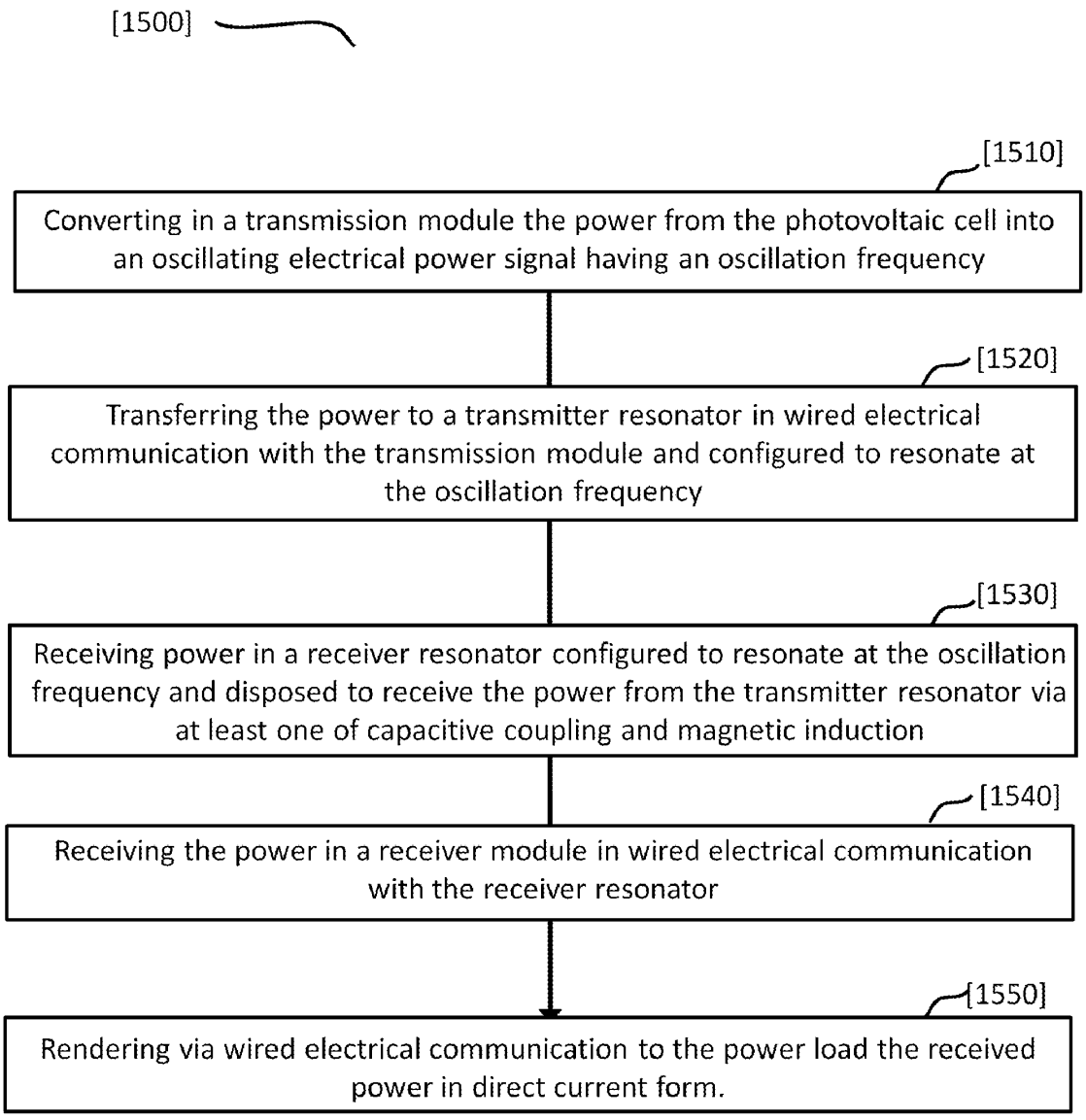

[1500]
[1510]
Converting in a transmission module the power from the photovoltaic cell into an oscillating electrical power signal having an oscillation frequency
[1520]
Transferring the power to a transmitter resonator in wired electrical communication with the transmission module and configured to resonate at the oscillation frequency
[1530]
Receiving power in a receiver resonator configured to resonate at the oscillation frequency and disposed to receive the power from the transmitter resonator via at least one of capacitive coupling and magnetic induction
[1540]
Receiving the power in a receiver module in wired electrical communication with the receiver resonator
[1550]
Rendering via wired electrical communication to the power load the received power in direct current form.

FIG. 23

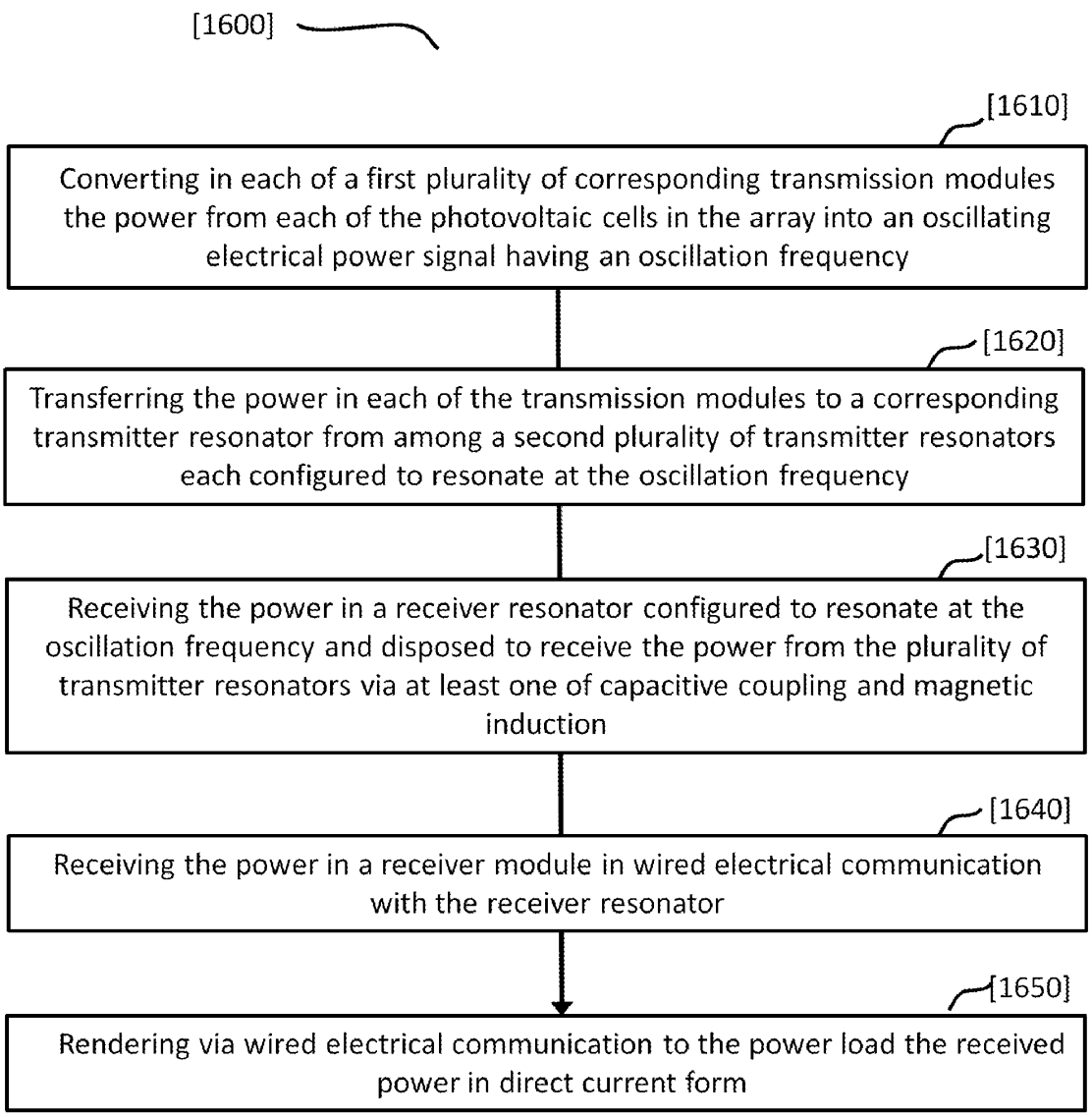

[1600]
[1610]
Converting in each of a first plurality of corresponding transmission modules the power from each of the photovoltaic cells in the array into an oscillating electrical power signal having an oscillation frequency
[1620]
Transferring the power in each of the transmission modules to a corresponding transmitter resonator from among a second plurality of transmitter resonators each configured to resonate at the oscillation frequency
[1630]
Receiving the power in a receiver resonator configured to resonate at the oscillation frequency and disposed to receive the power from the plurality of transmitter resonators via at least one of capacitive coupling and magnetic induction
[1640]
Receiving the power in a receiver module in wired electrical communication with the receiver resonator
[1650]
Rendering via wired electrical communication to the power load the received power in direct current form

FIG. 24

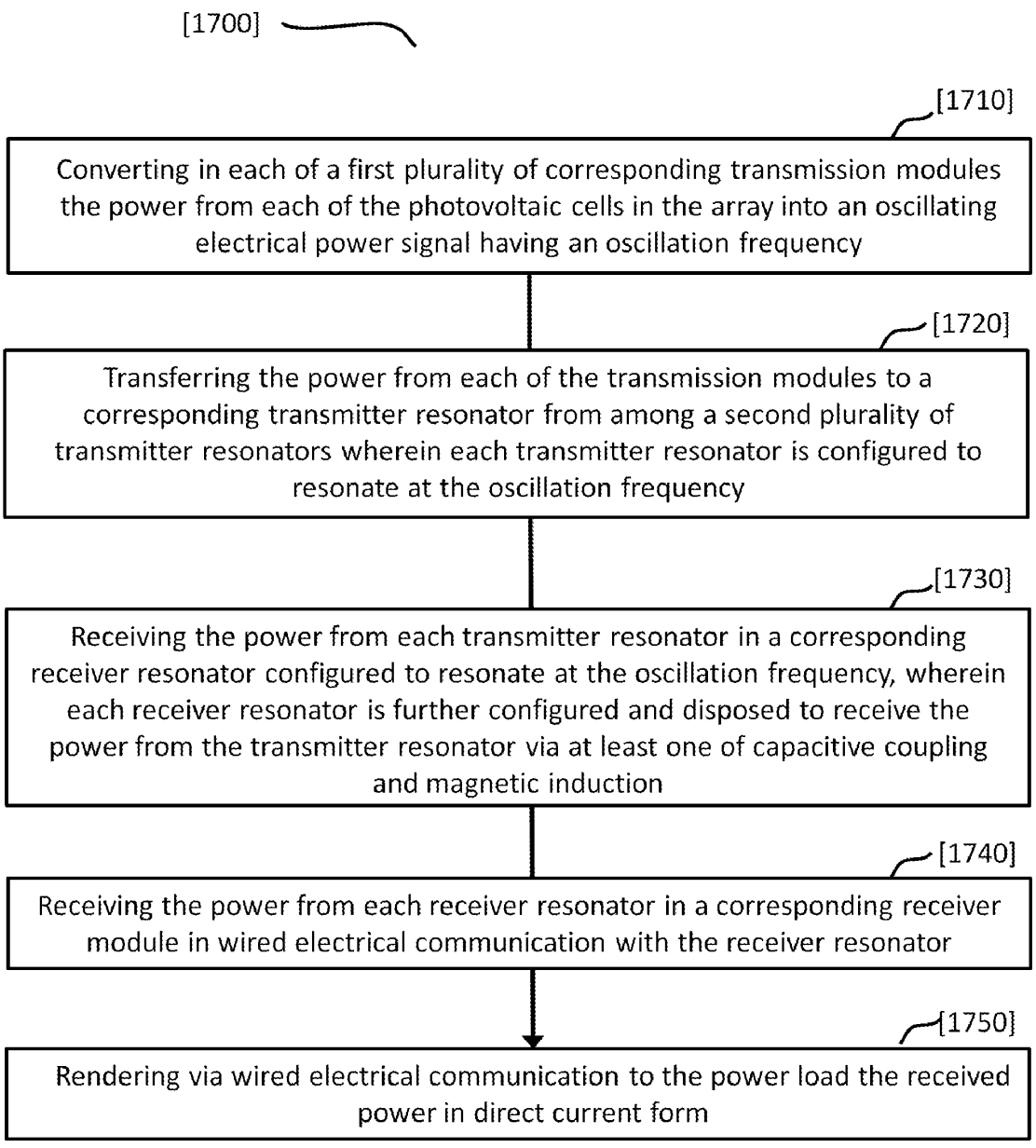

[1700]
[1710]
Converting in each of a first plurality of corresponding transmission modules the power from each of the photovoltaic cells in the array into an oscillating electrical power signal having an oscillation frequency
[1720]
Transferring the power from each of the transmission modules to a corresponding transmitter resonator from among a second plurality of transmitter resonators wherein each transmitter resonator is configured to resonate at the oscillation frequency
[1730]
Receiving the power from each transmitter resonator in a corresponding receiver resonator configured to resonate at the oscillation frequency, wherein each receiver resonator is further configured and disposed to receive the power from the transmitter resonator via at least one of capacitive coupling and magnetic induction
[1740]
Receiving the power from each receiver resonator in a corresponding receiver module in wired electrical communication with the receiver resonator
[1750]
Rendering via wired electrical communication to the power load the received power in direct current form

FIG. 25

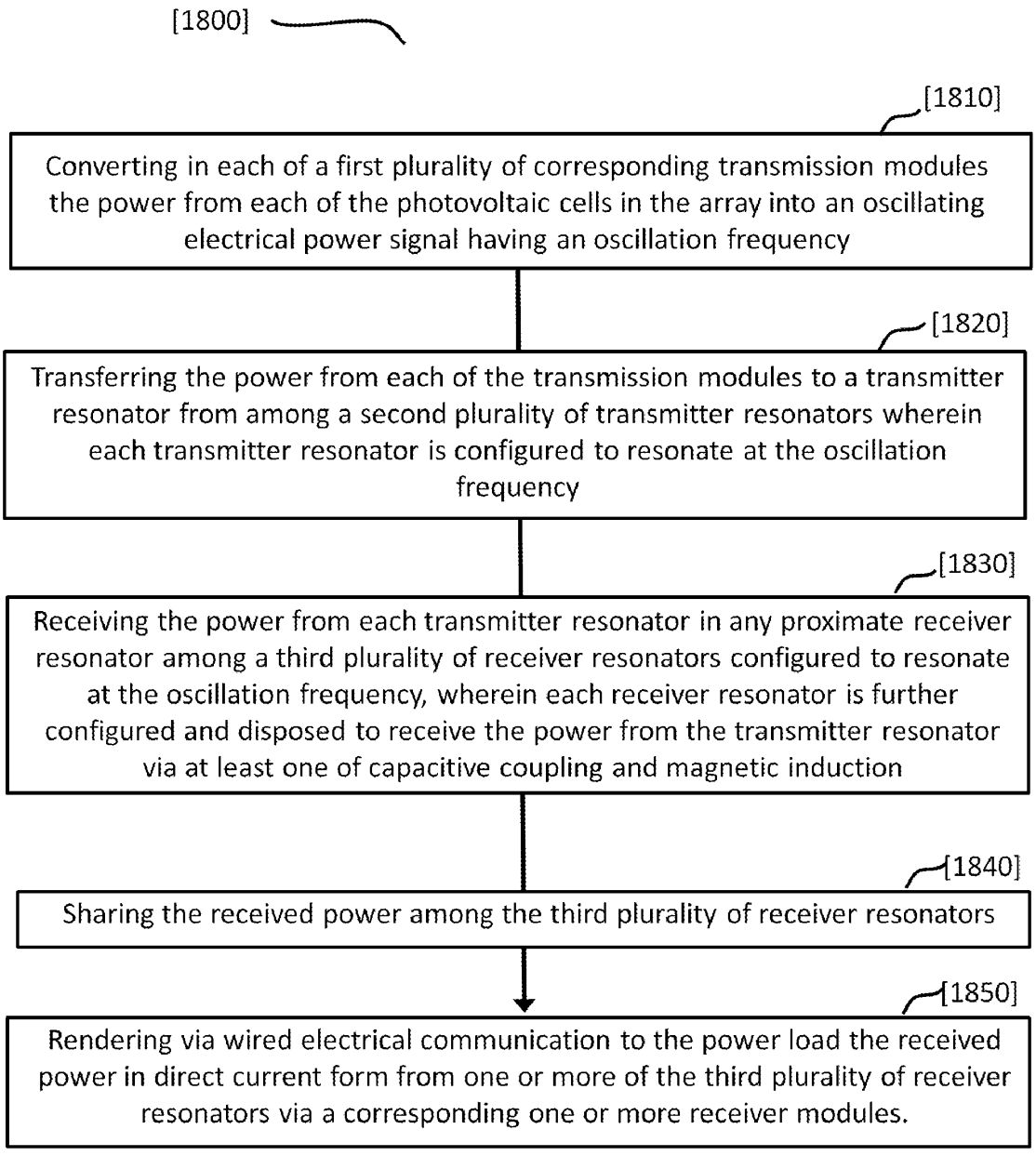

[1800]
[1810]
Converting in each of a first plurality of corresponding transmission modules the power from each of the photovoltaic cells in the array into an oscillating electrical power signal having an oscillation frequency
[1820]
Transferring the power from each of the transmission modules to a transmitter resonator from among a second plurality of transmitter resonators wherein each transmitter resonator is configured to resonate at the oscillation frequency
[1830]
Receiving the power from each transmitter resonator in any proximate receiver resonator among a third plurality of receiver resonators configured to resonate at the oscillation frequency, wherein each receiver resonator is further configured and disposed to receive the power from the transmitter resonator via at least one of capacitive coupling and magnetic induction
[1840]
Sharing the received power among the third plurality of receiver resonators
[1850]
Rendering via wired electrical communication to the power load the received power in direct current form from one or more of the third plurality of receiver resonators via a corresponding one or more receiver modules.

FIG. 26

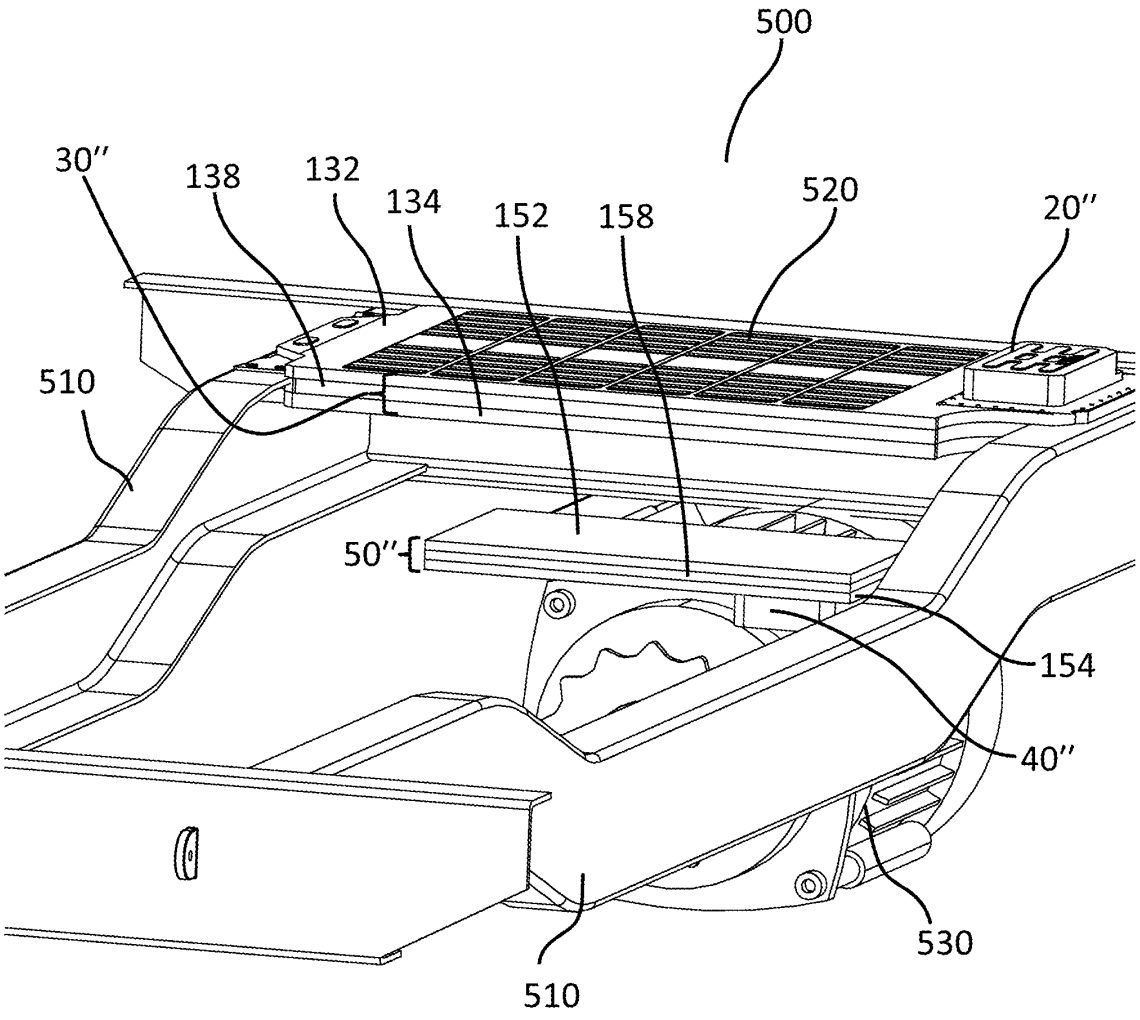


FIG. 27A

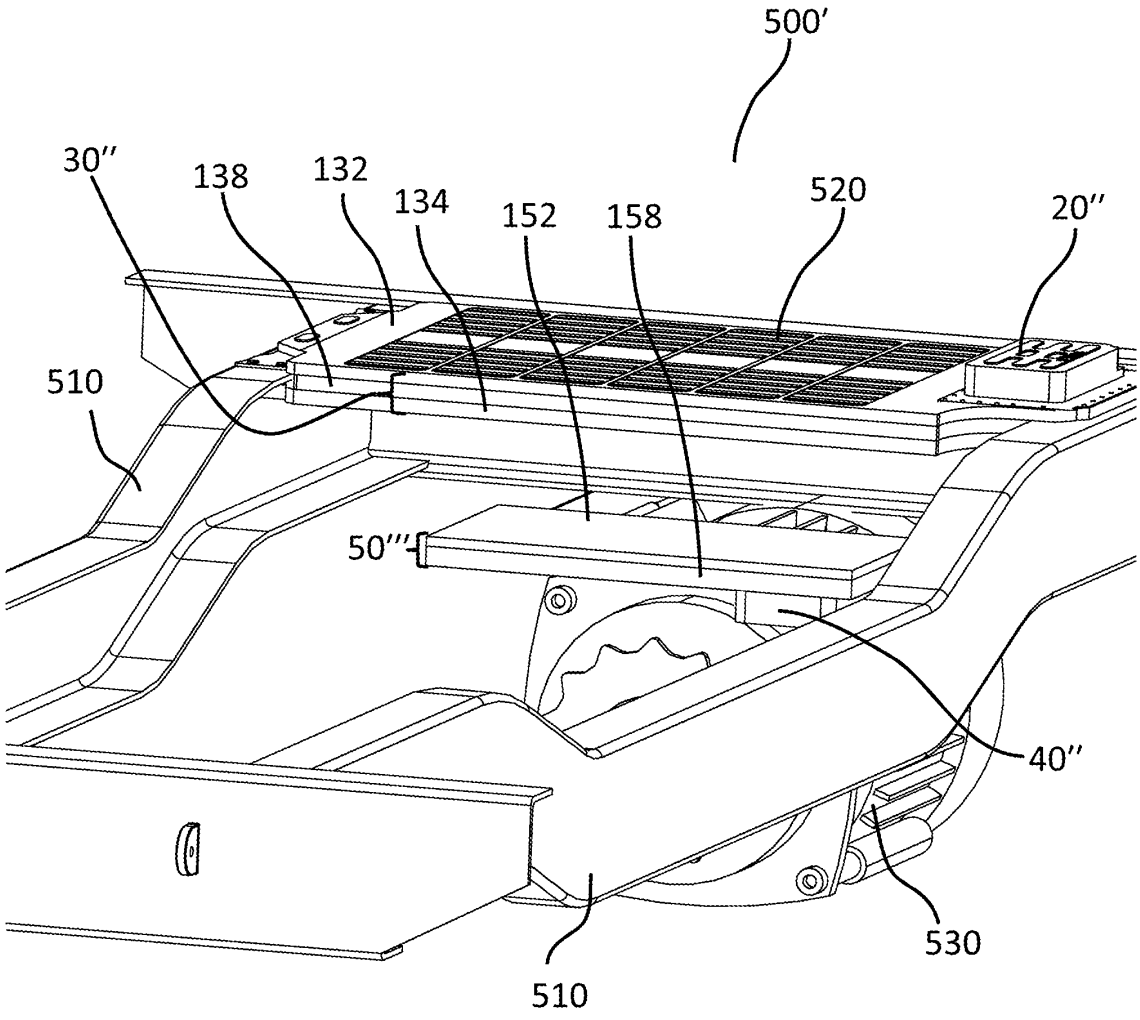


FIG. 27B

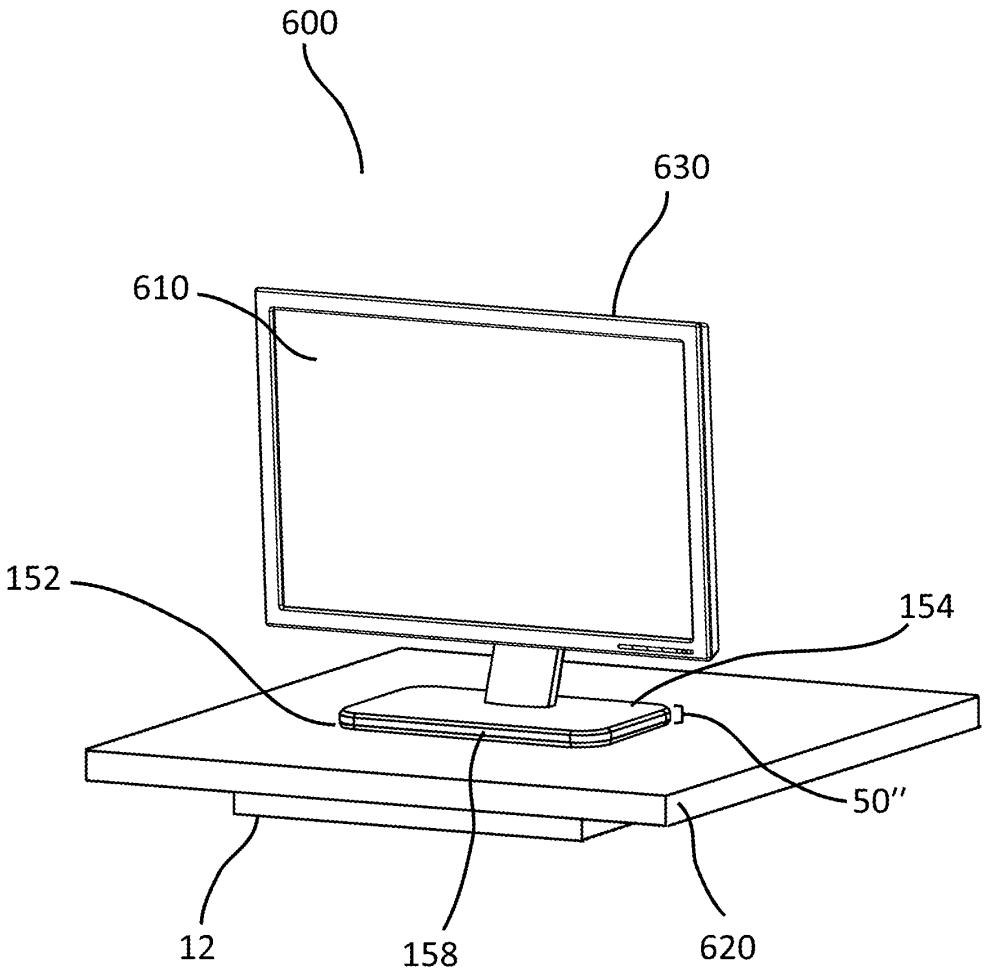


FIG. 28A

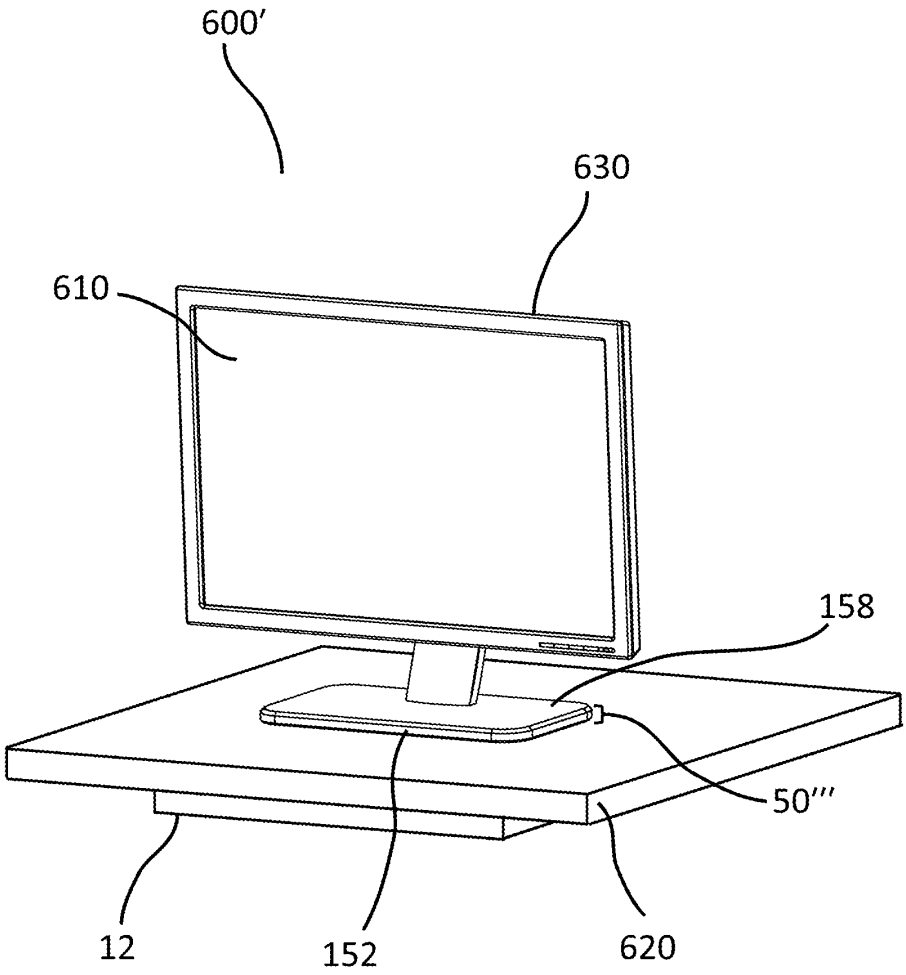


FIG. 28B

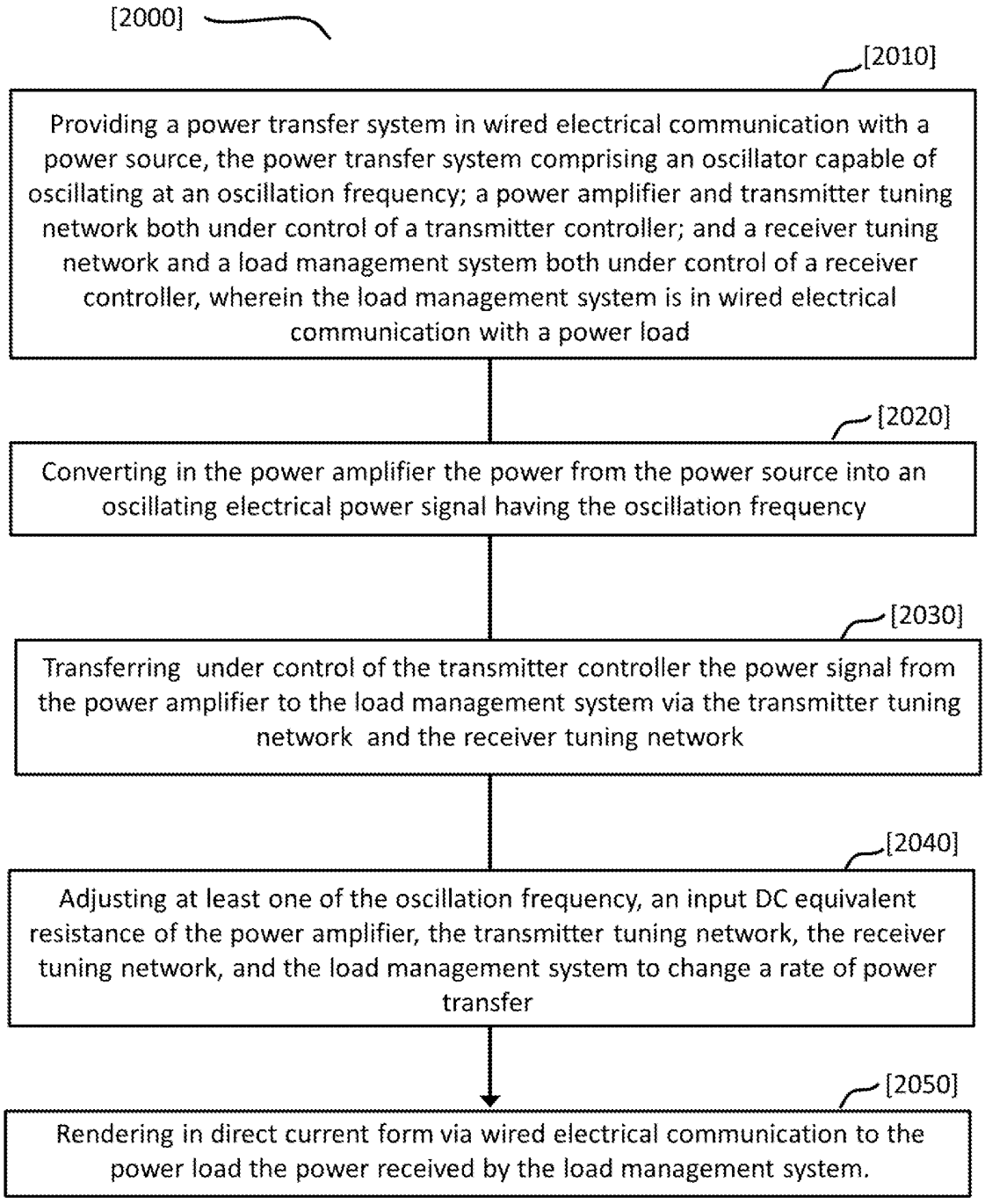

[2000]
[2010]
Providing a power transfer system in wired electrical communication with a power source, the power transfer system comprising an oscillator capable of oscillating at an oscillation frequency; a power amplifier and transmitter tuning network both under control of a transmitter controller; and a receiver tuning network and a load management system both under control of a receiver controller, wherein the load management system is in wired electrical communication with a power load
[2020]
Converting in the power amplifier the power from the power source into an oscillating electrical power signal having the oscillation frequency
[2030]
Transferring under control of the transmitter controller the power signal from the power amplifier to the load management system via the transmitter tuning network and the receiver tuning network
[2040]
Adjusting at least one of the oscillation frequency, an input DC equivalent resistance of the power amplifier, the transmitter tuning network, the receiver tuning network, and the load management system to change a rate of power transfer
[2050]
Rendering in direct current form via wired electrical communication to the power load the power received by the load management system.

FIG. 29

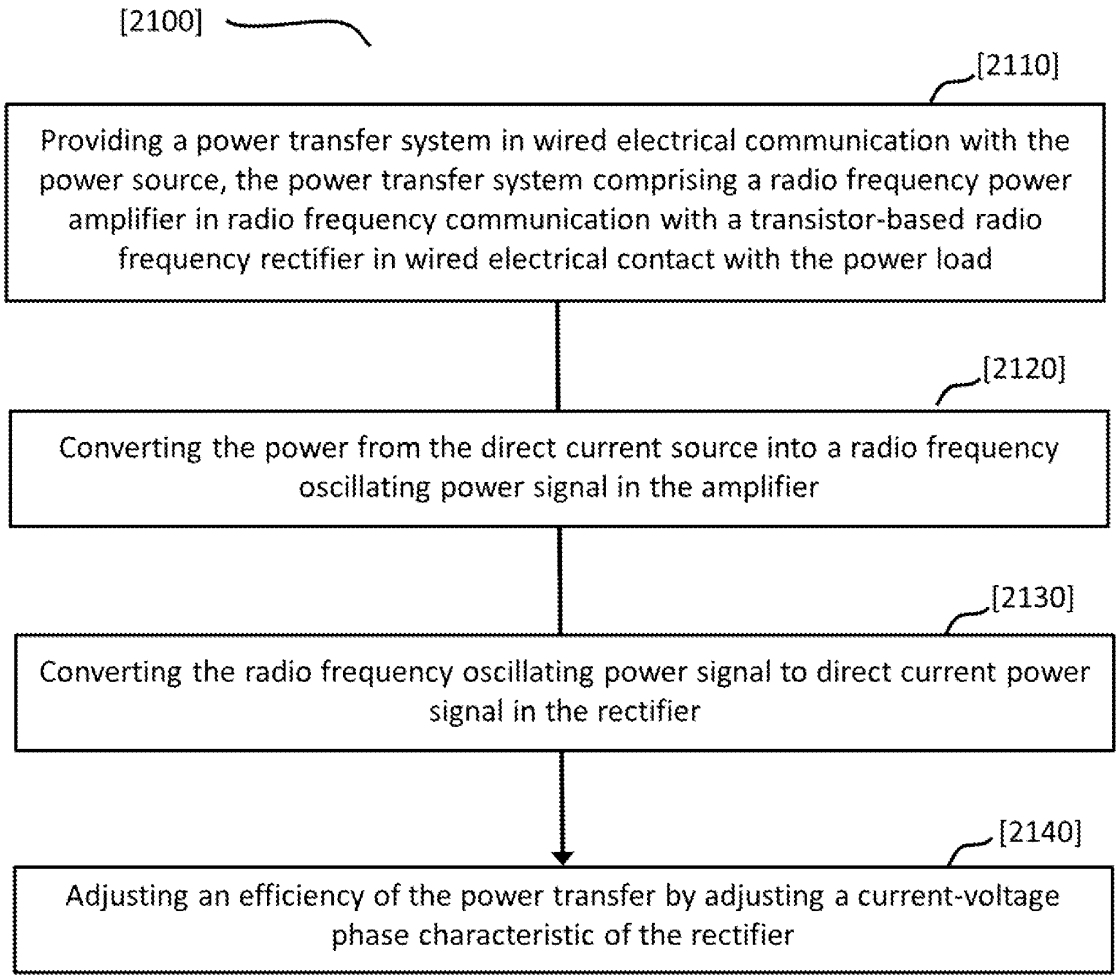

[2100]
[2110]
Providing a power transfer system in wired electrical communication with the power source, the power transfer system comprising a radio frequency power amplifier in radio frequency communication with a transistor-based radio frequency rectifier in wired electrical contact with the power load
[2120]
Converting the power from the direct current source into a radio frequency oscillating power signal in the amplifier
[2130]
Converting the radio frequency oscillating power signal to direct current power signal in the rectifier
[2140]
Adjusting an efficiency of the power transfer by adjusting a current-voltage phase characteristic of the rectifier

FIG. 30