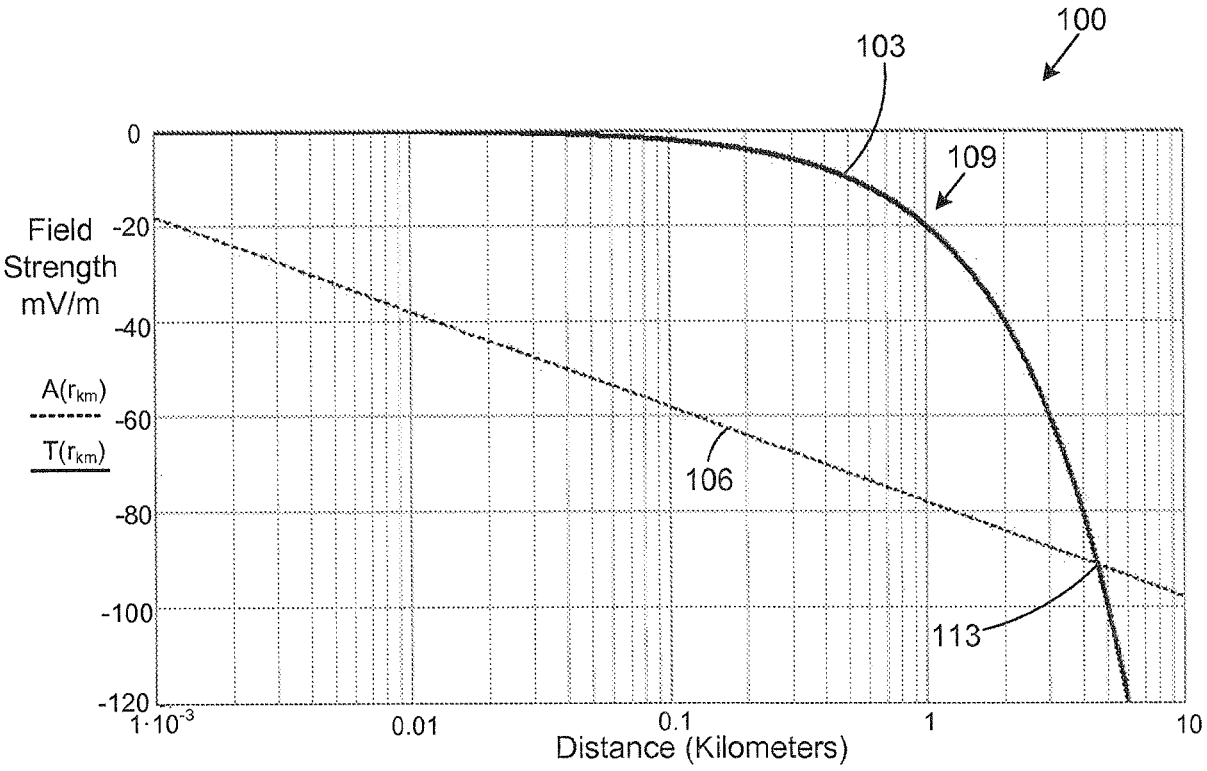

100
103
109
106
113
0
-20
-40
-60
-80
-100
-120
Field Strength mV/m
A(r_km)
T(r_km)
1·10^-3
0.01
0.1
1
10
Distance (Kilometers)

FIG. 1

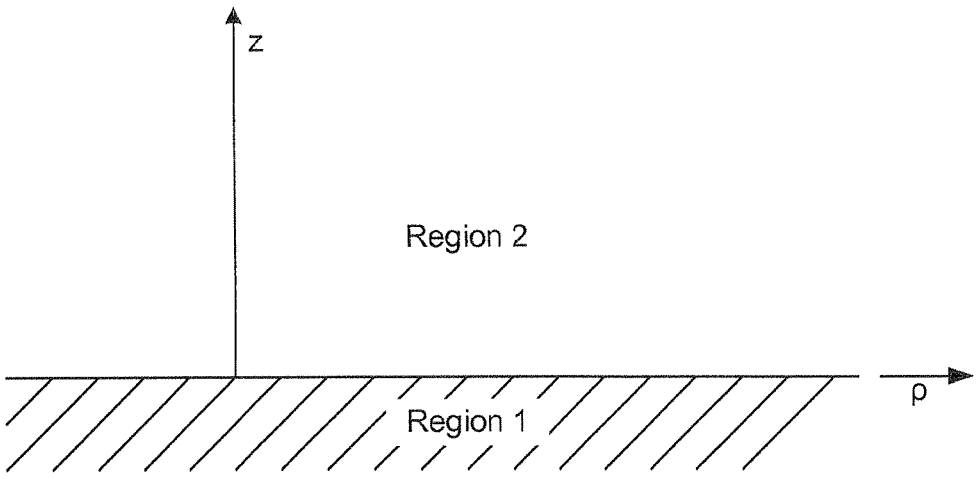

z
Region 2
Region 1
ρ

FIG. 2

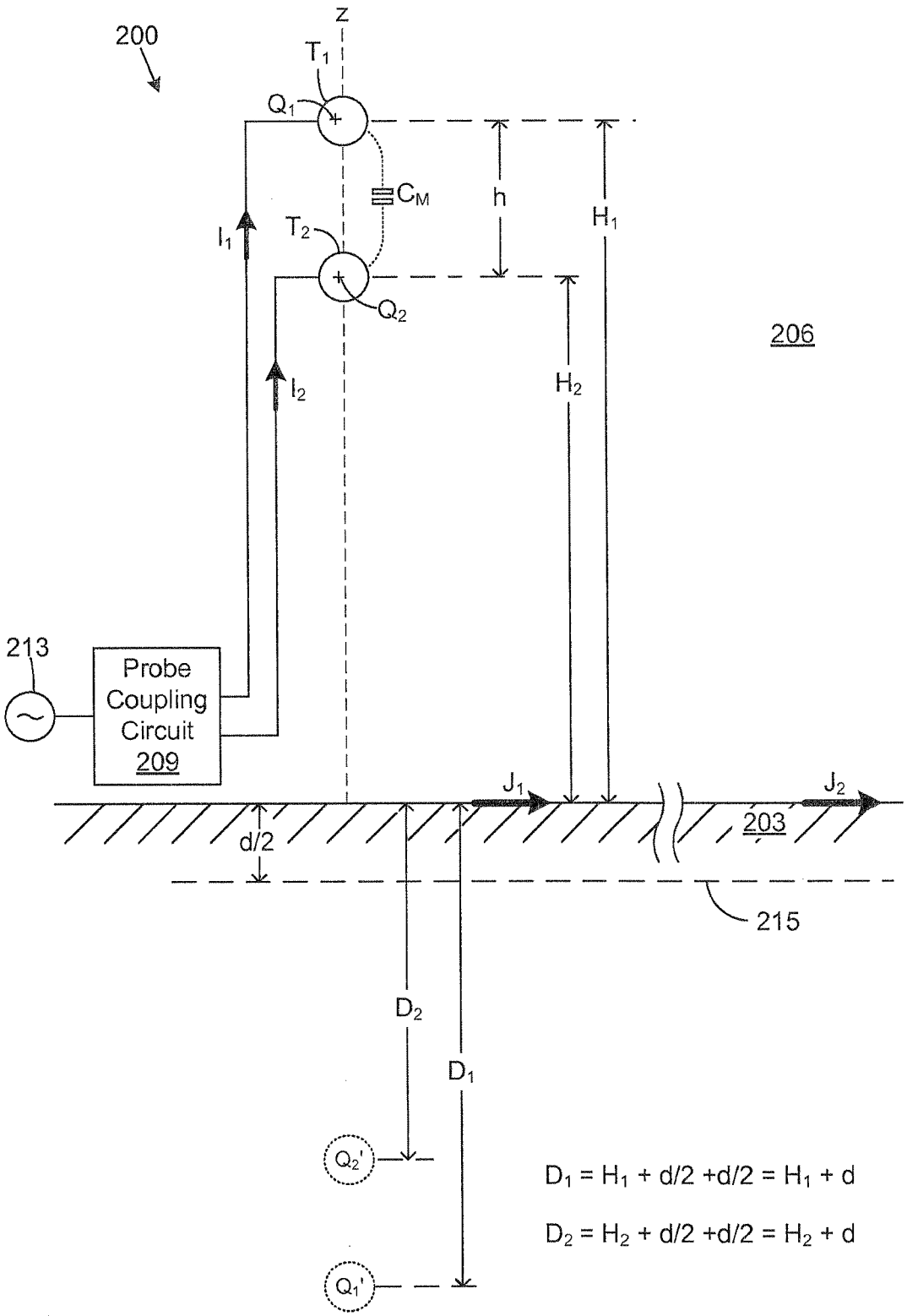
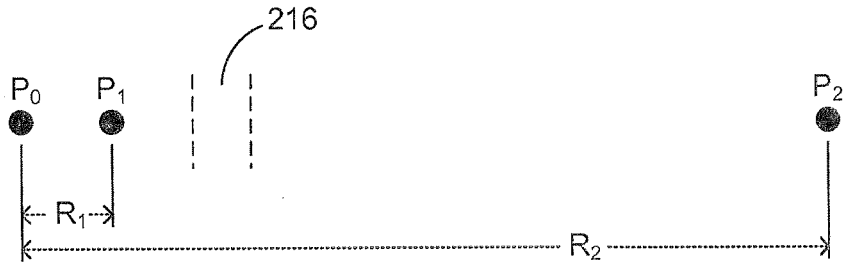

200
z
T1
Q1
CM
h
H1
I1
T2
Q2
206
I2
H2
213
Probe
Coupling
Circuit
209
J1
J2
203
d/2
215
D2
D1
Q2'
Q1'
D1 = H1 + d/2 +d/2 = H1 + d
D2 = H2 + d/2 +d/2 = H2 + d

FIG. 3

P_0: $\left|J_{P_0}\right| \angle \varphi_0$

P_1: $\left|J_{P_1}\right| \angle \varphi_0 - \beta R_1$

P_2: $\left|J_{P_2}\right| \angle \varphi_0 - \beta R_2 + \varphi_\Delta$



$$\varphi_\Delta = \arg\left(\sqrt{\gamma}\right) \approx \frac{\pi}{4}$$

FIG. 4

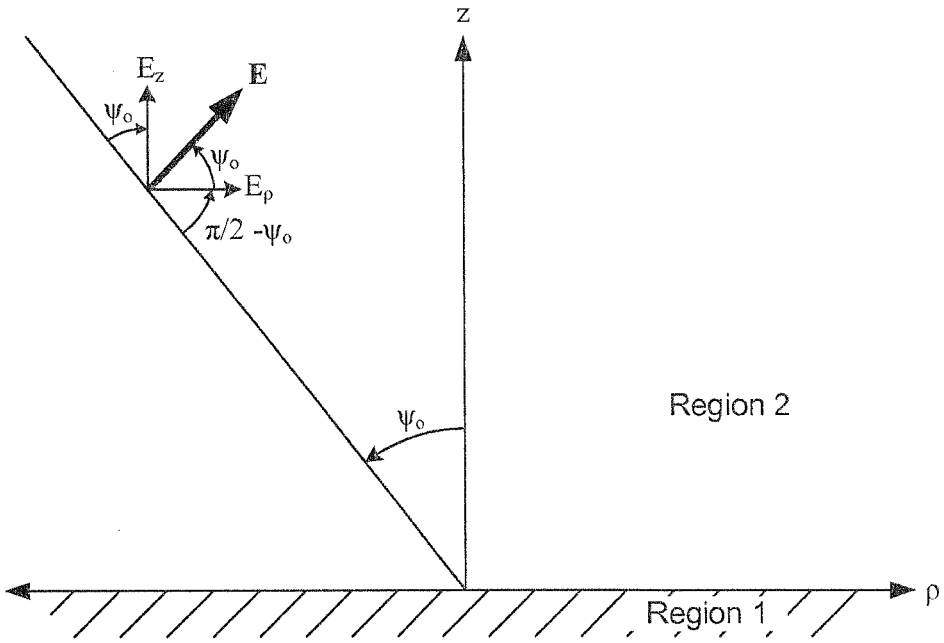


FIG. 5

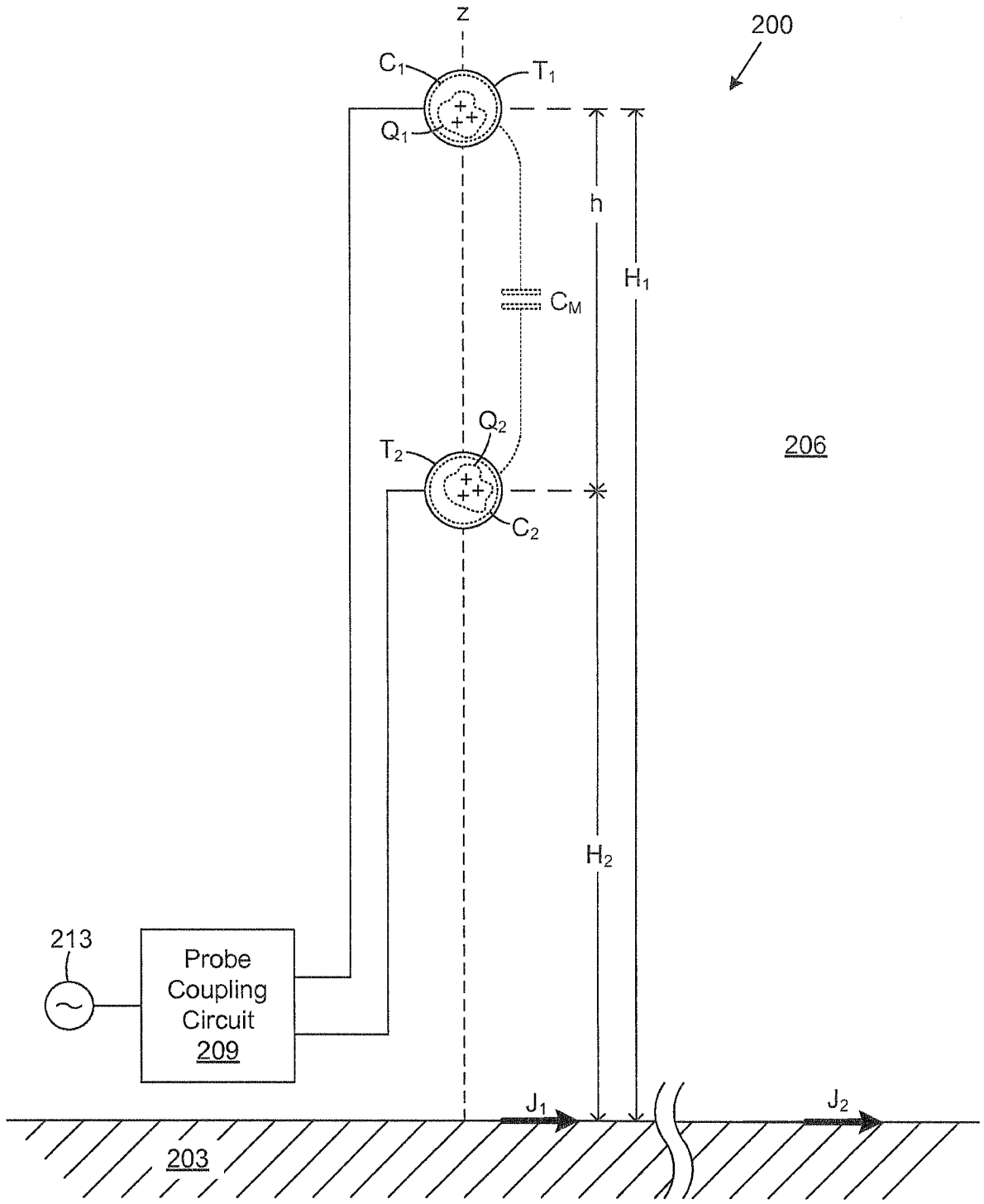

z
200
C1
T1
Q1
h
H1
CM
Q2
T2
206
C2
H2
213
Probe
Coupling
Circuit
209
J1
J2
203

FIG. 6

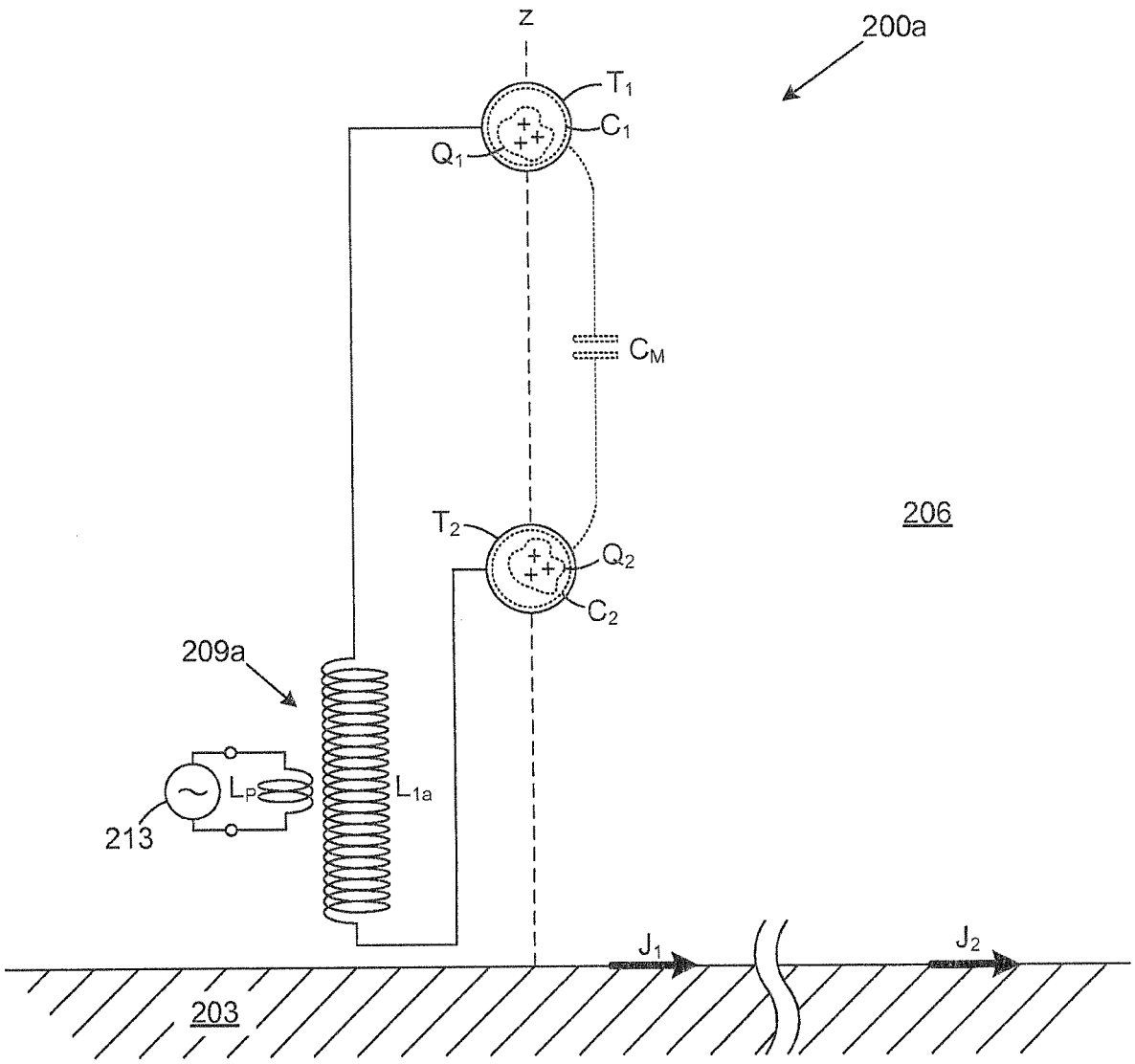


FIG. 7A

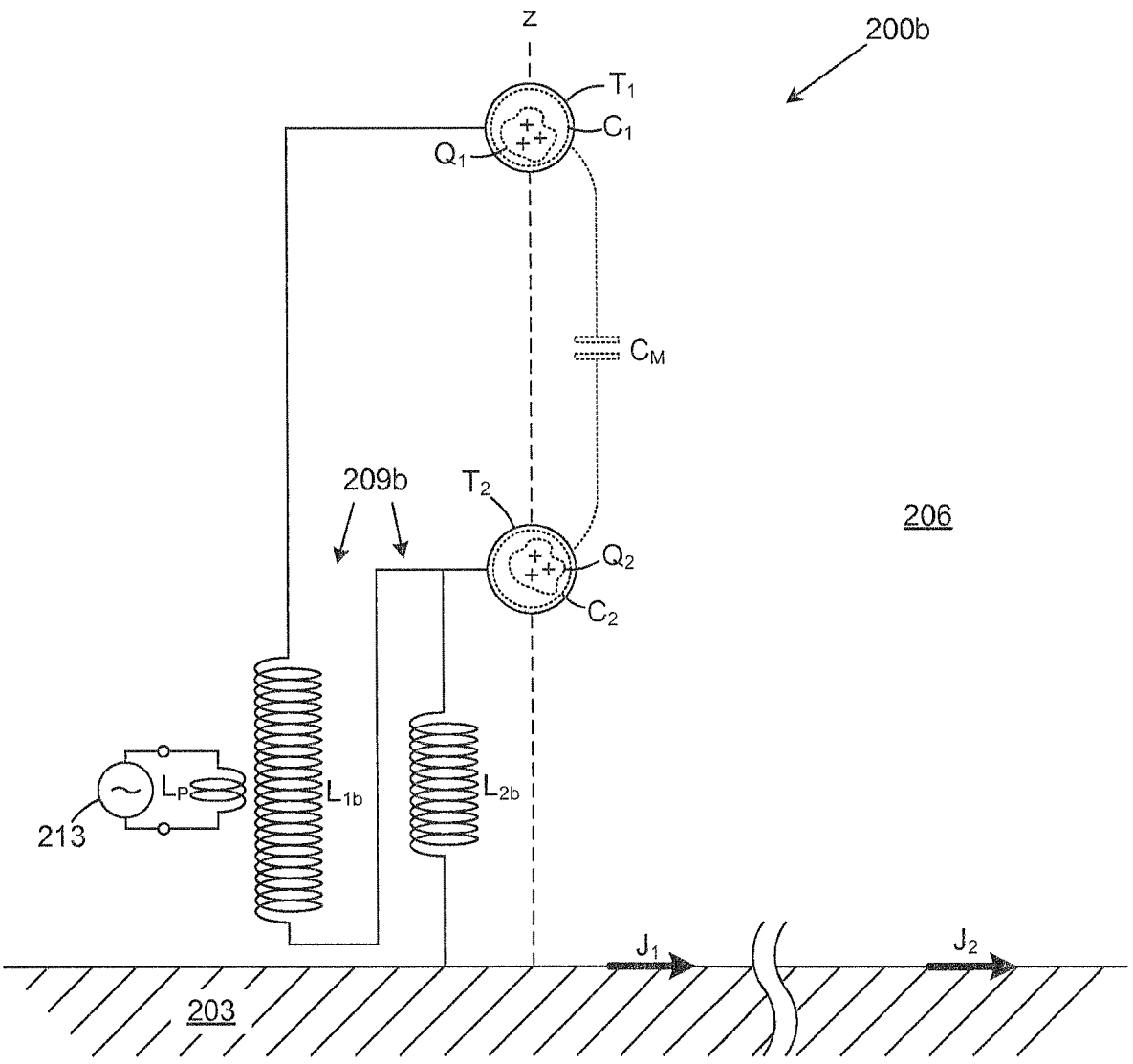


FIG. 7B

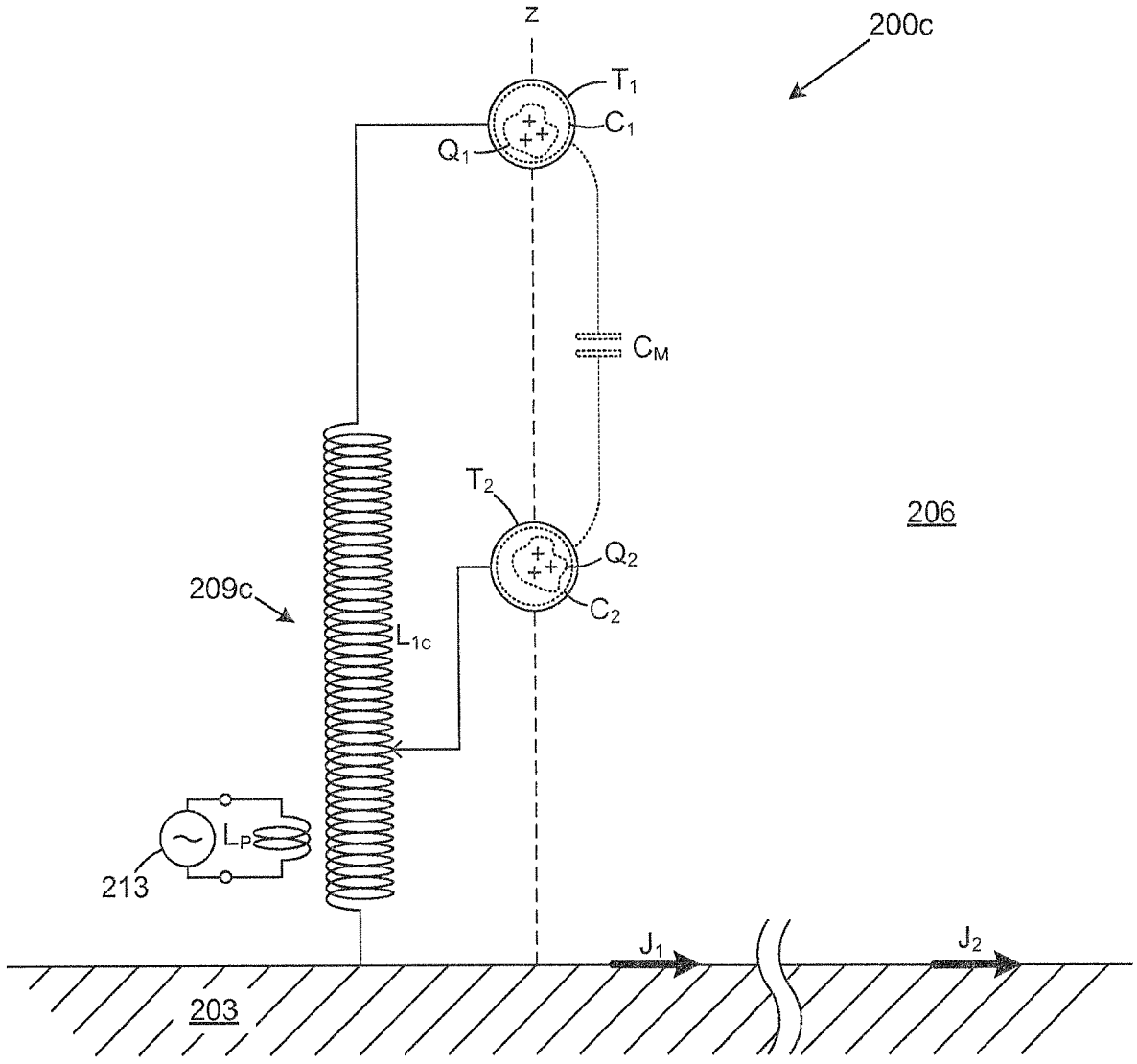


FIG. 7C

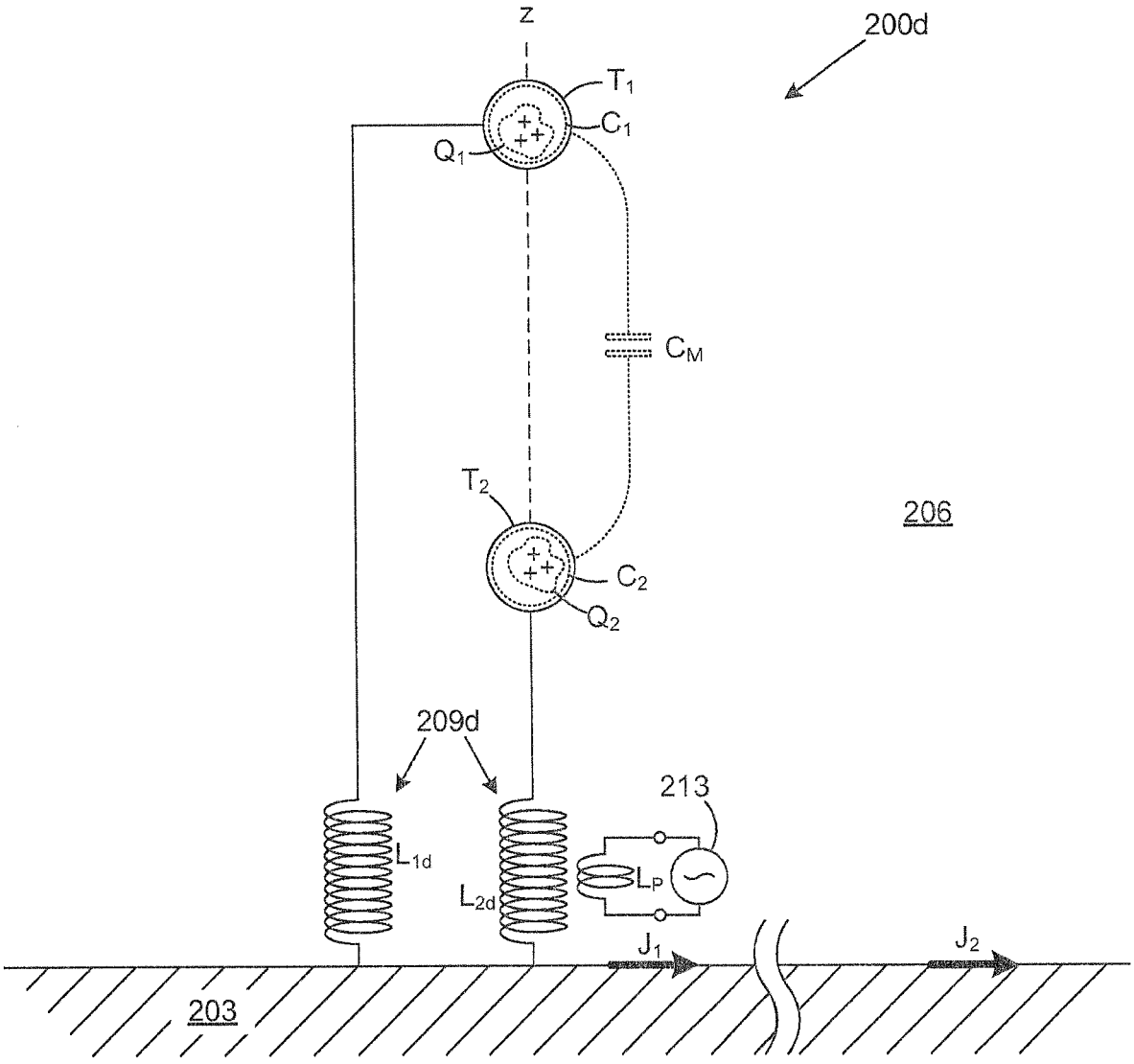


FIG. 7D

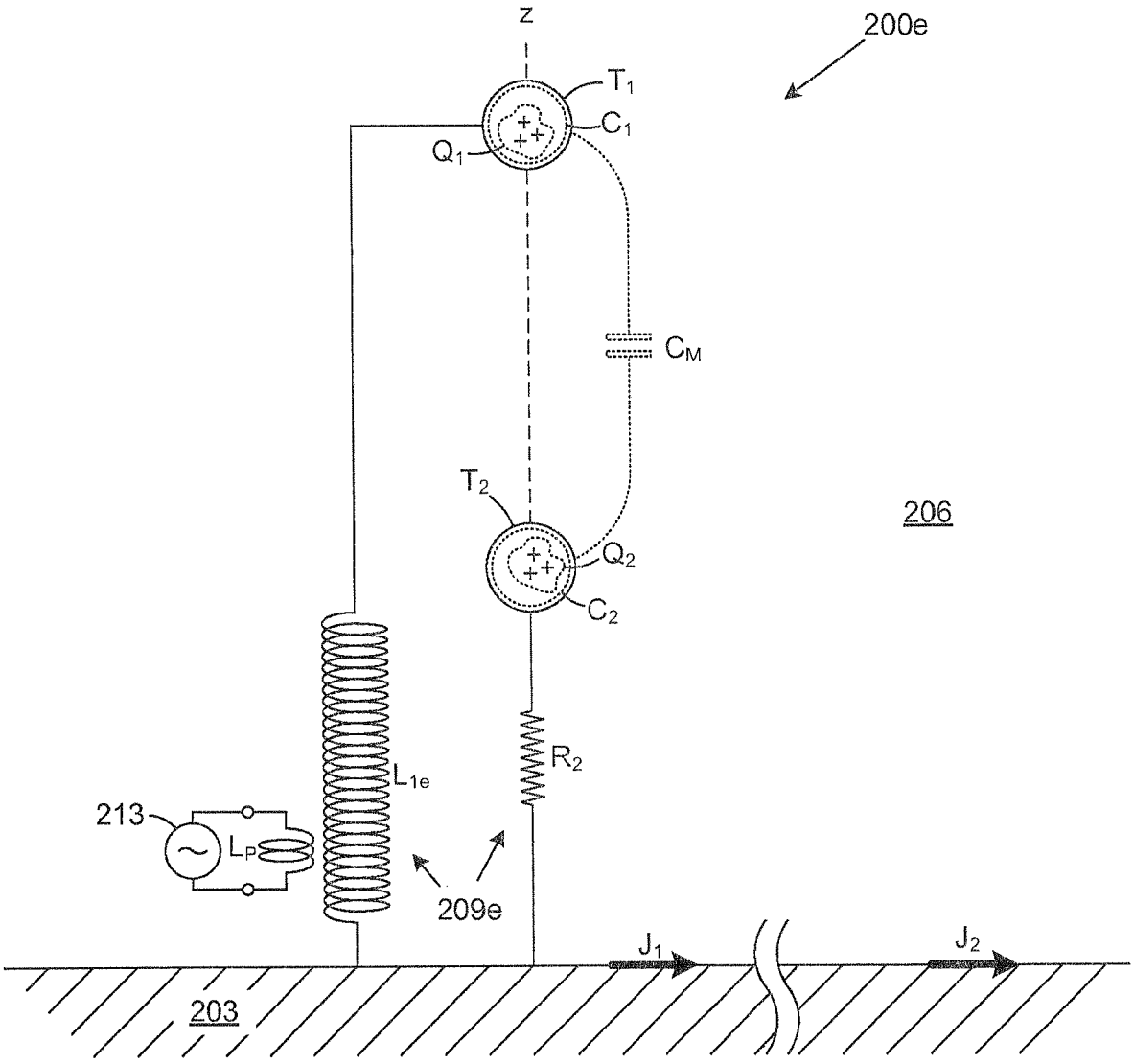


FIG. 7E

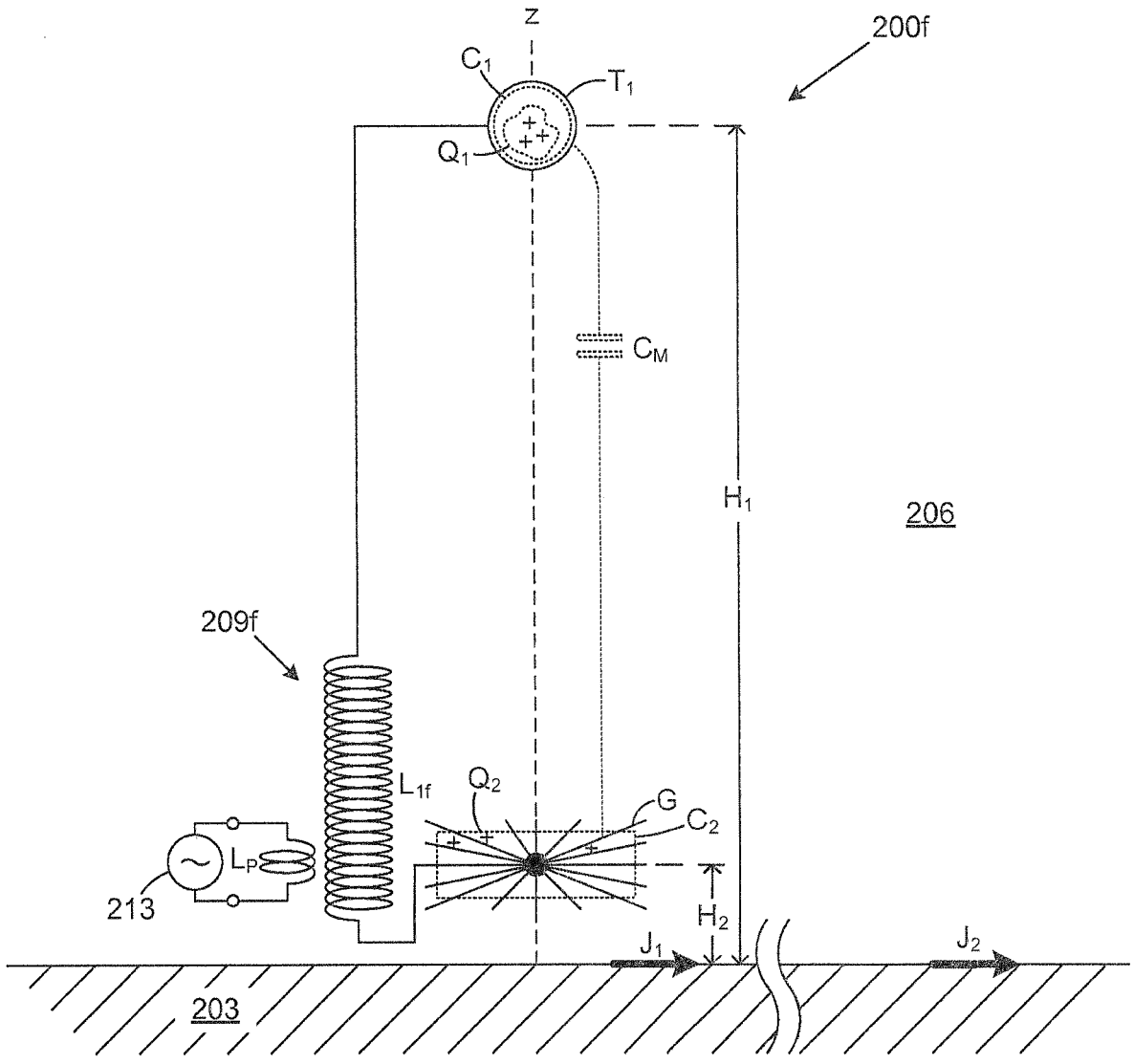


FIG. 7F

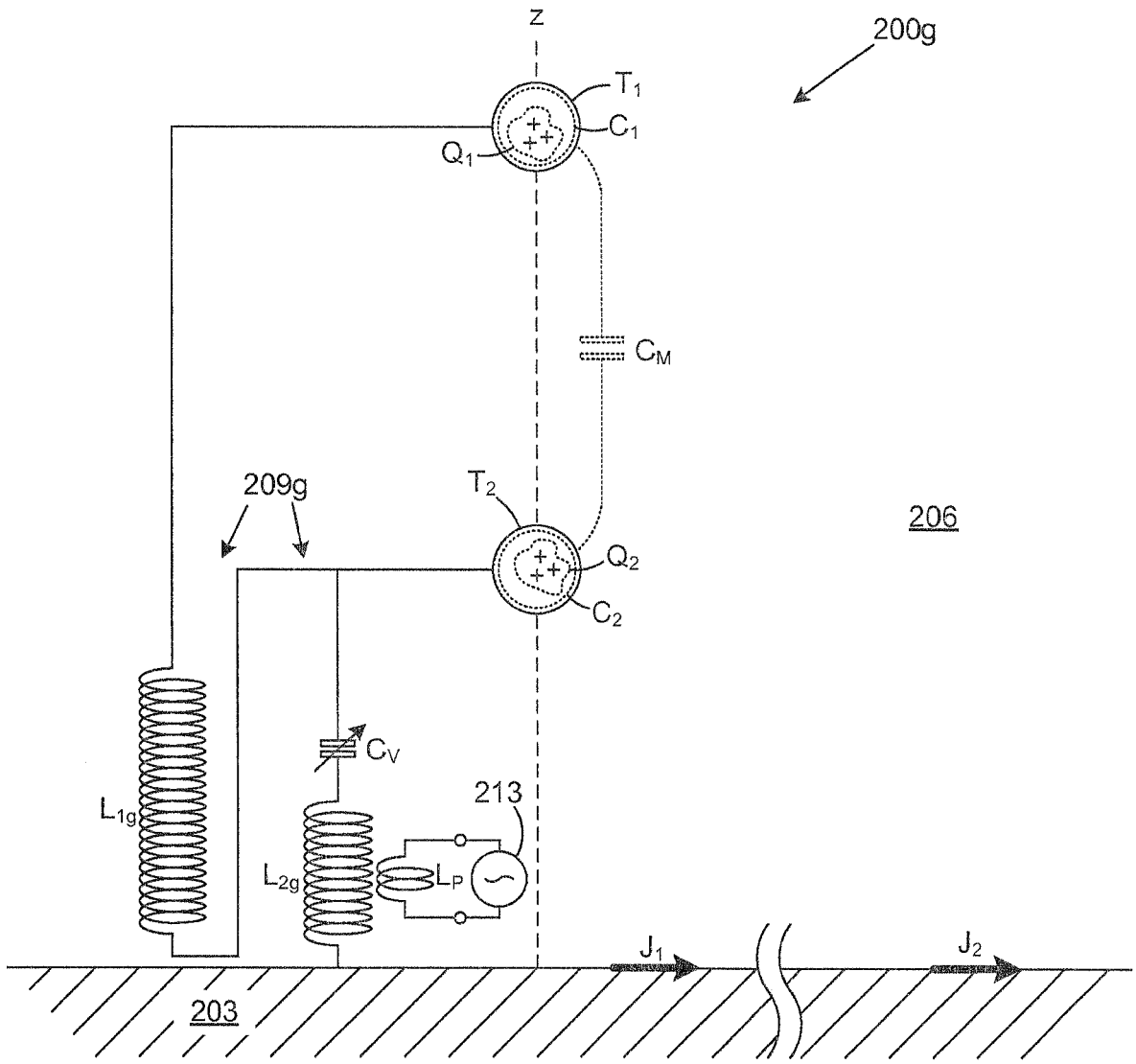


FIG. 7G

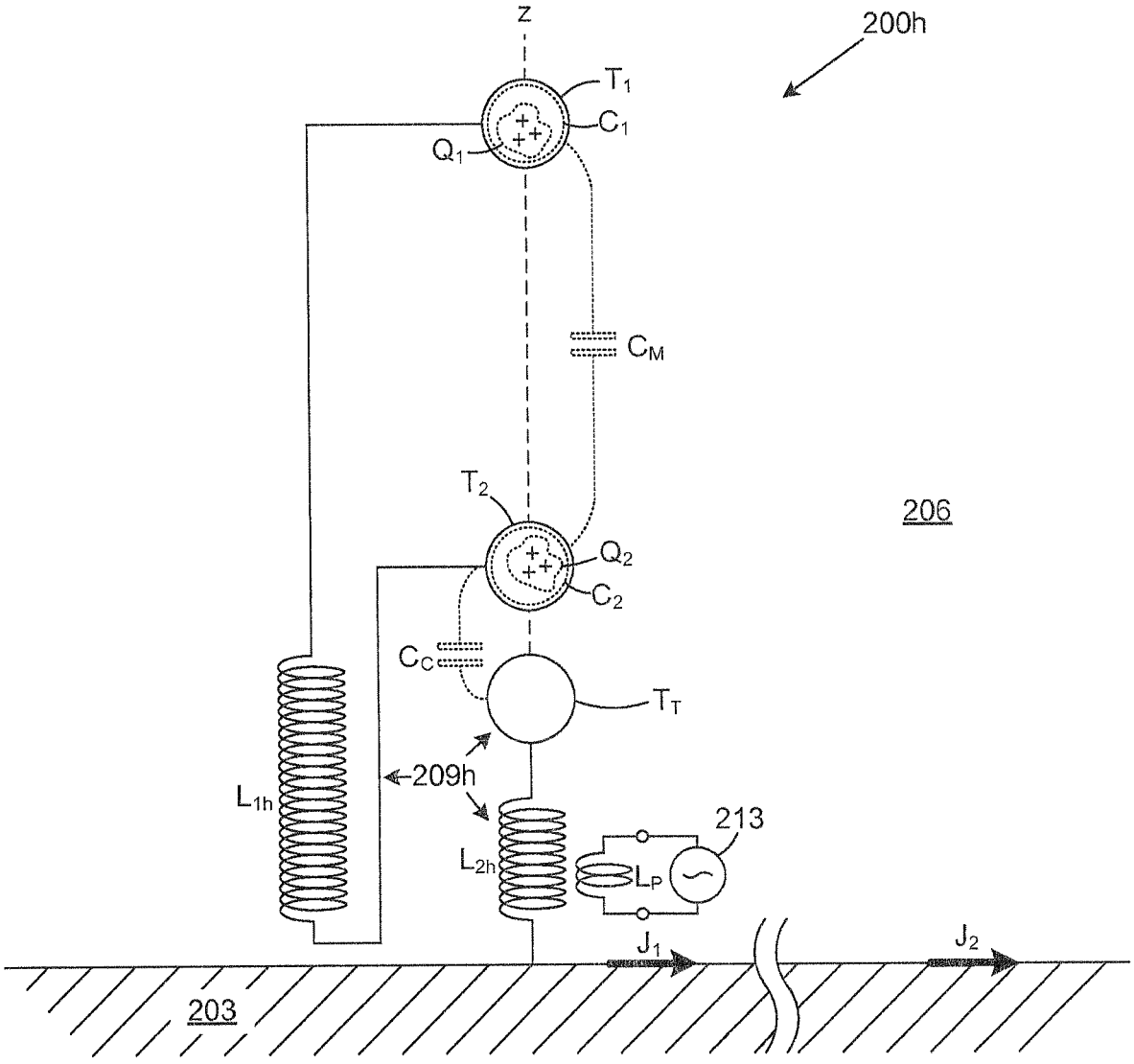


FIG. 7H

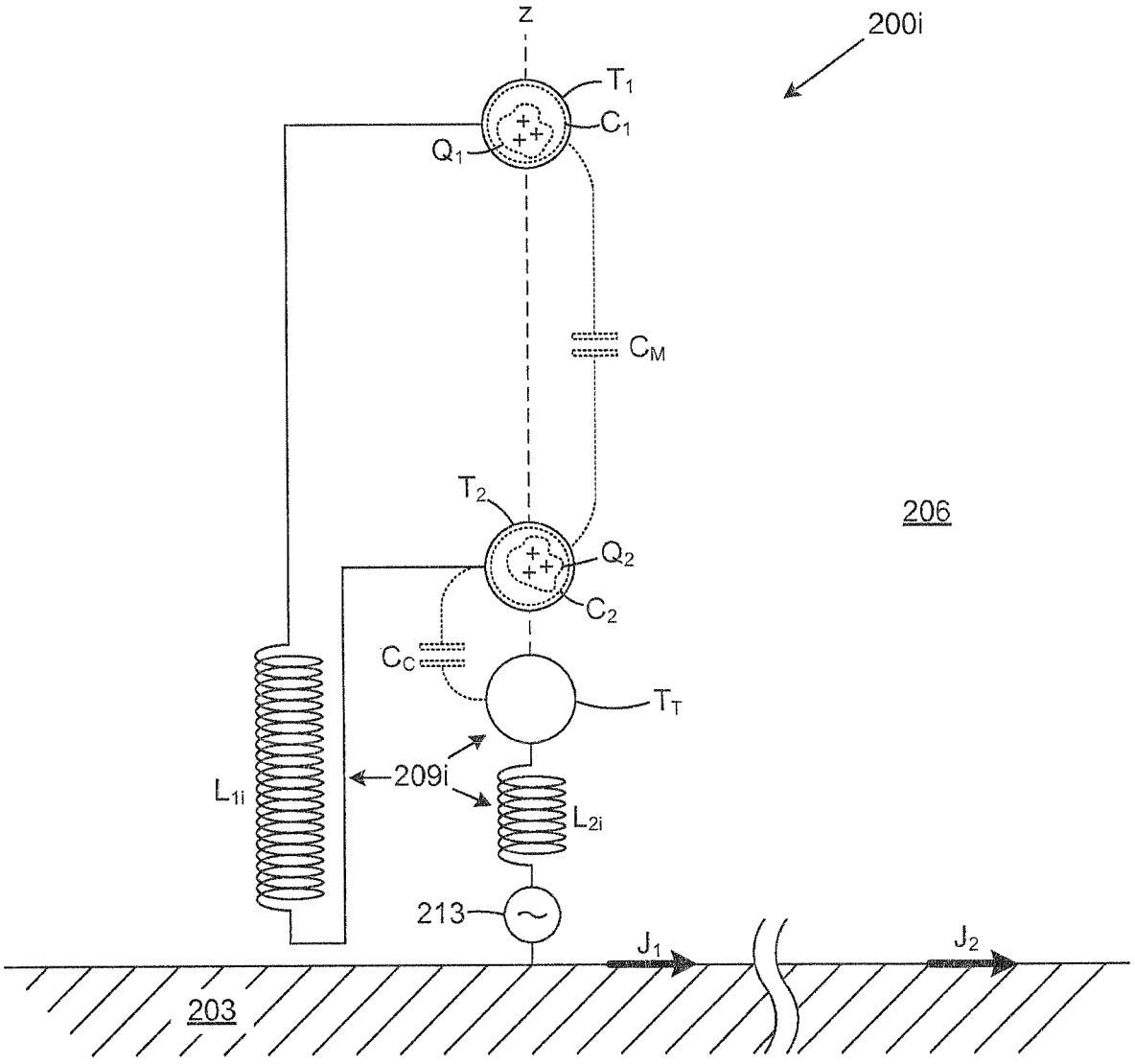


FIG. 7I

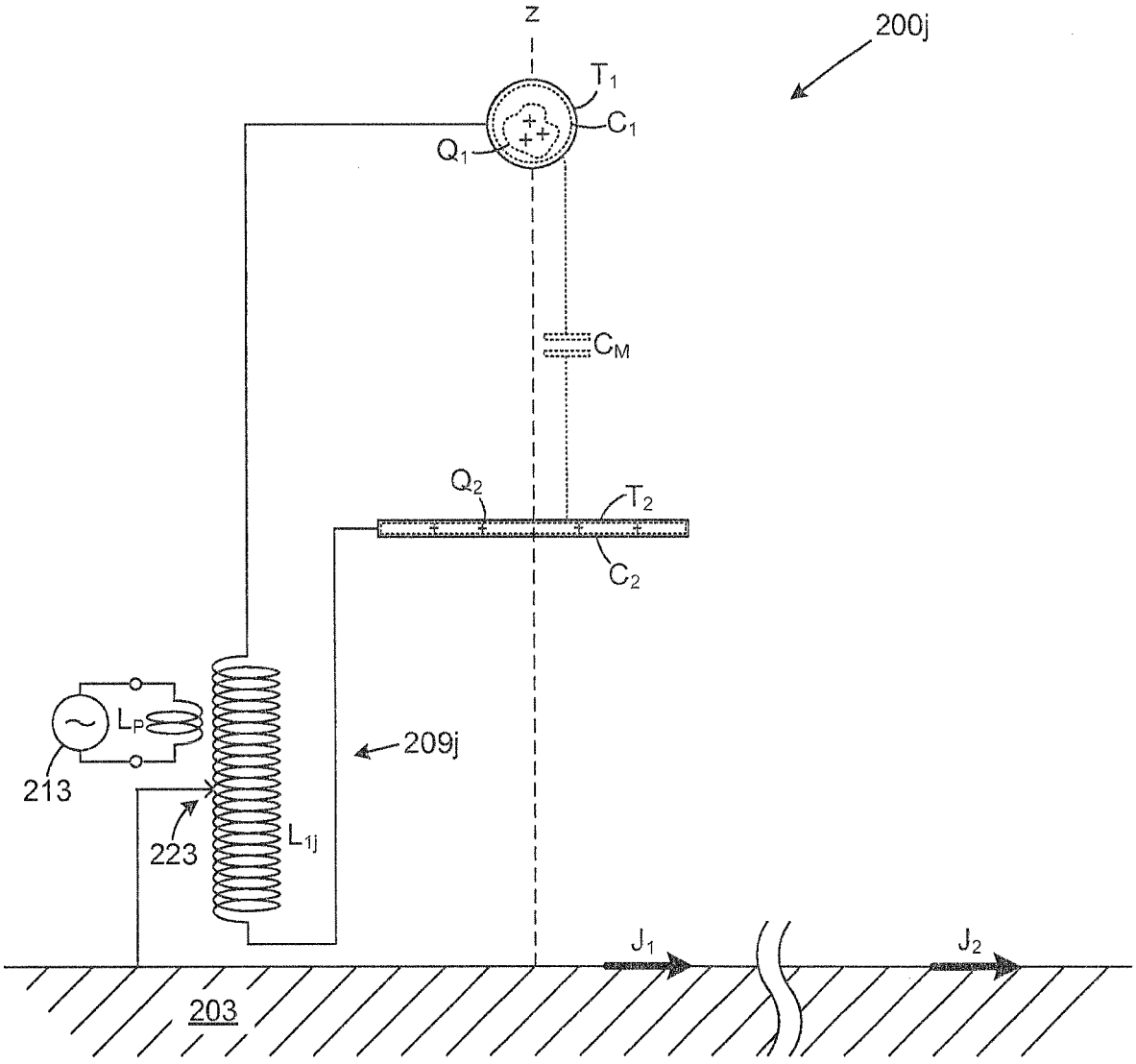


FIG. 7J

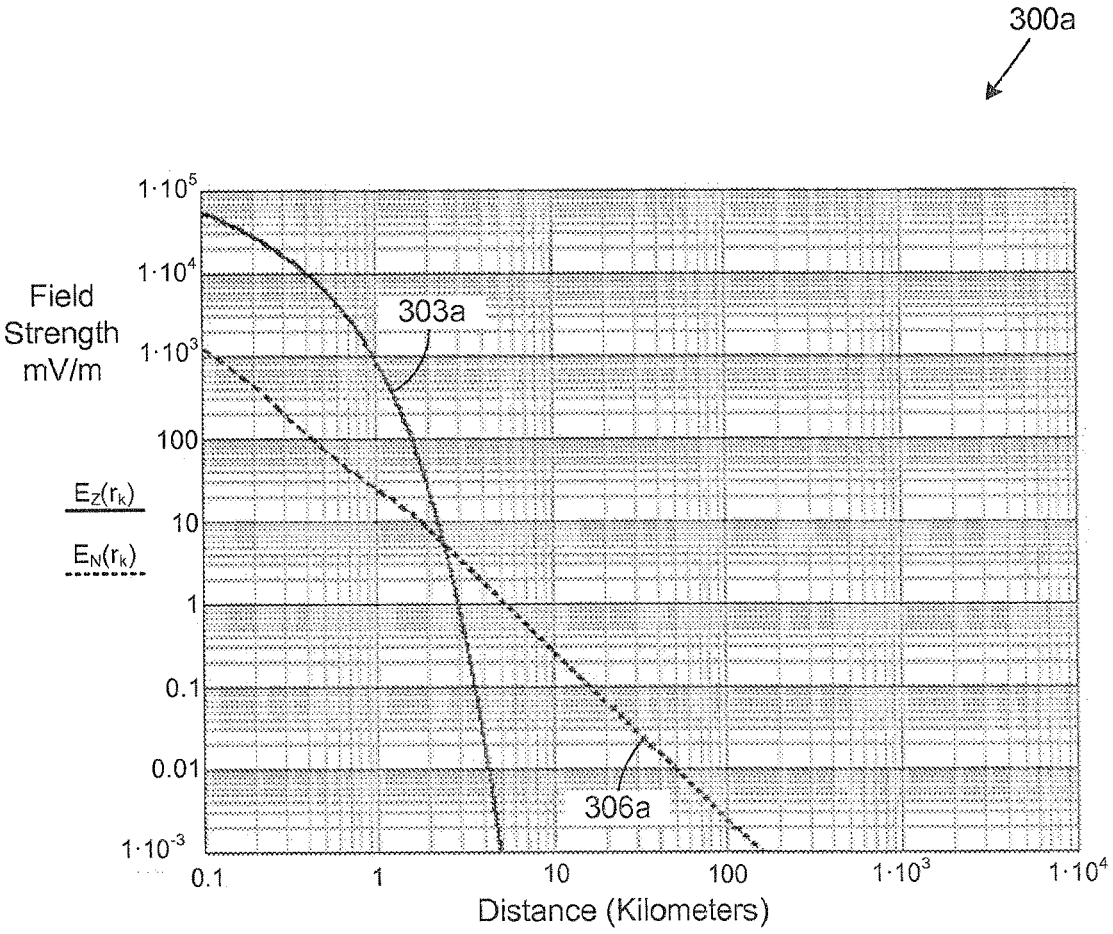

300a
Field Strength mV/m
$1\cdot10^5$
$1\cdot10^4$
$1\cdot10^3$
100
10
1
0.1
0.01
$1\cdot10^{-3}$
$E_Z(r_k)$
$E_N(r_k)$
303a
306a
0.1
1
10
100
$1\cdot10^3$
$1\cdot10^4$
Distance (Kilometers)

FIG. 8A

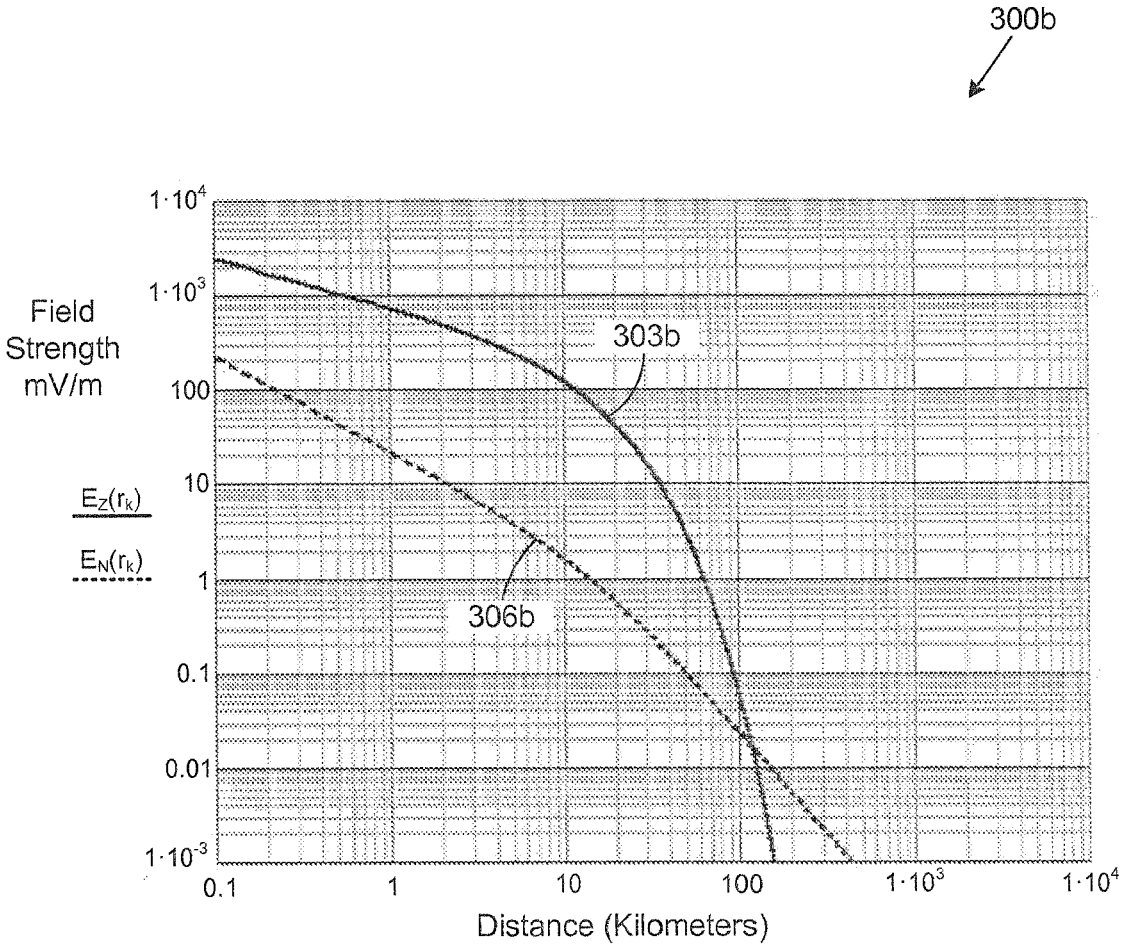

300b
Field Strength mV/m
$1 \cdot 10^4$
$1 \cdot 10^3$
100
10
1
0.1
0.01
$1 \cdot 10^{-3}$
$E_Z(r_k)$
$E_N(r_k)$
303b
306b
0.1
1
10
100
$1 \cdot 10^3$
$1 \cdot 10^4$
Distance (Kilometers)

FIG. 8B

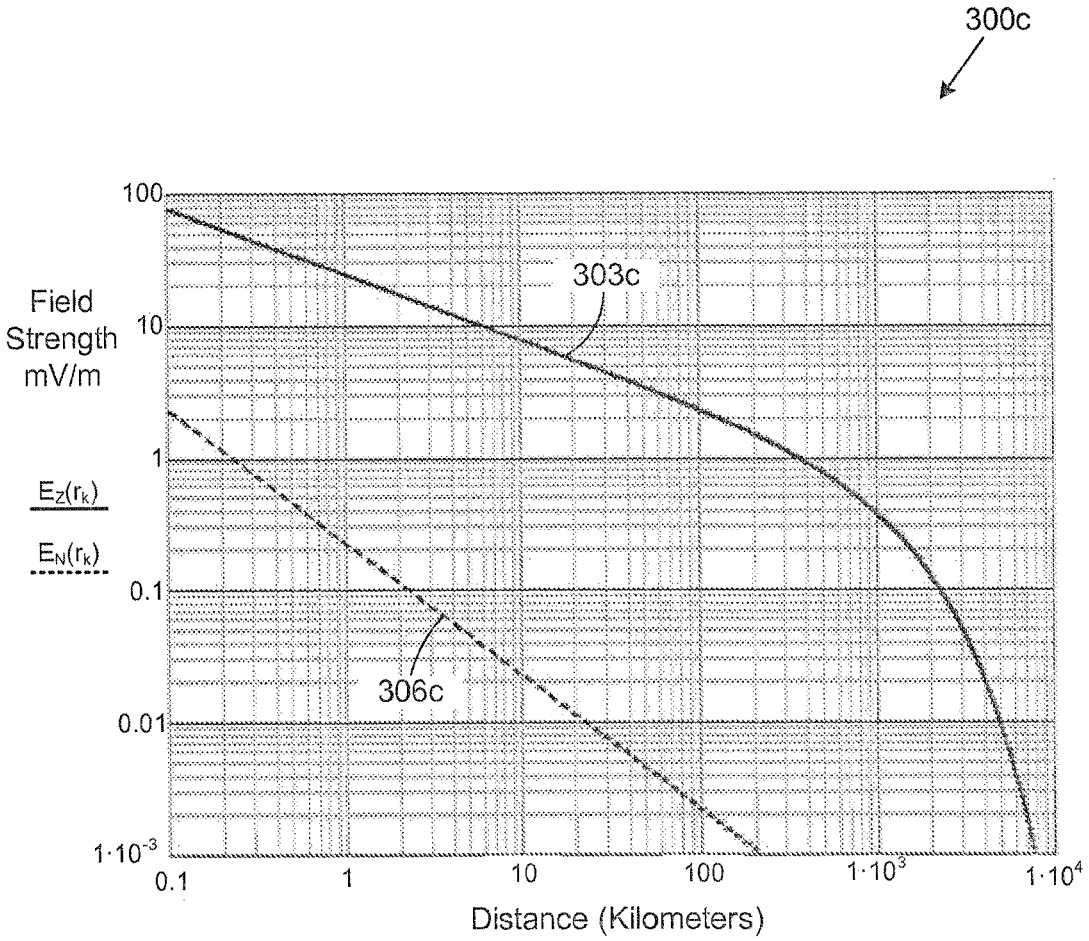

300c
100
10
1
0.1
0.01
$1 \cdot 10^{-3}$
Field Strength mV/m
$E_Z(r_k)$
$E_N(r_k)$
303c
306c
0.1
1
10
100
$1 \cdot 10^3$
$1 \cdot 10^4$
Distance (Kilometers)

FIG. 8C

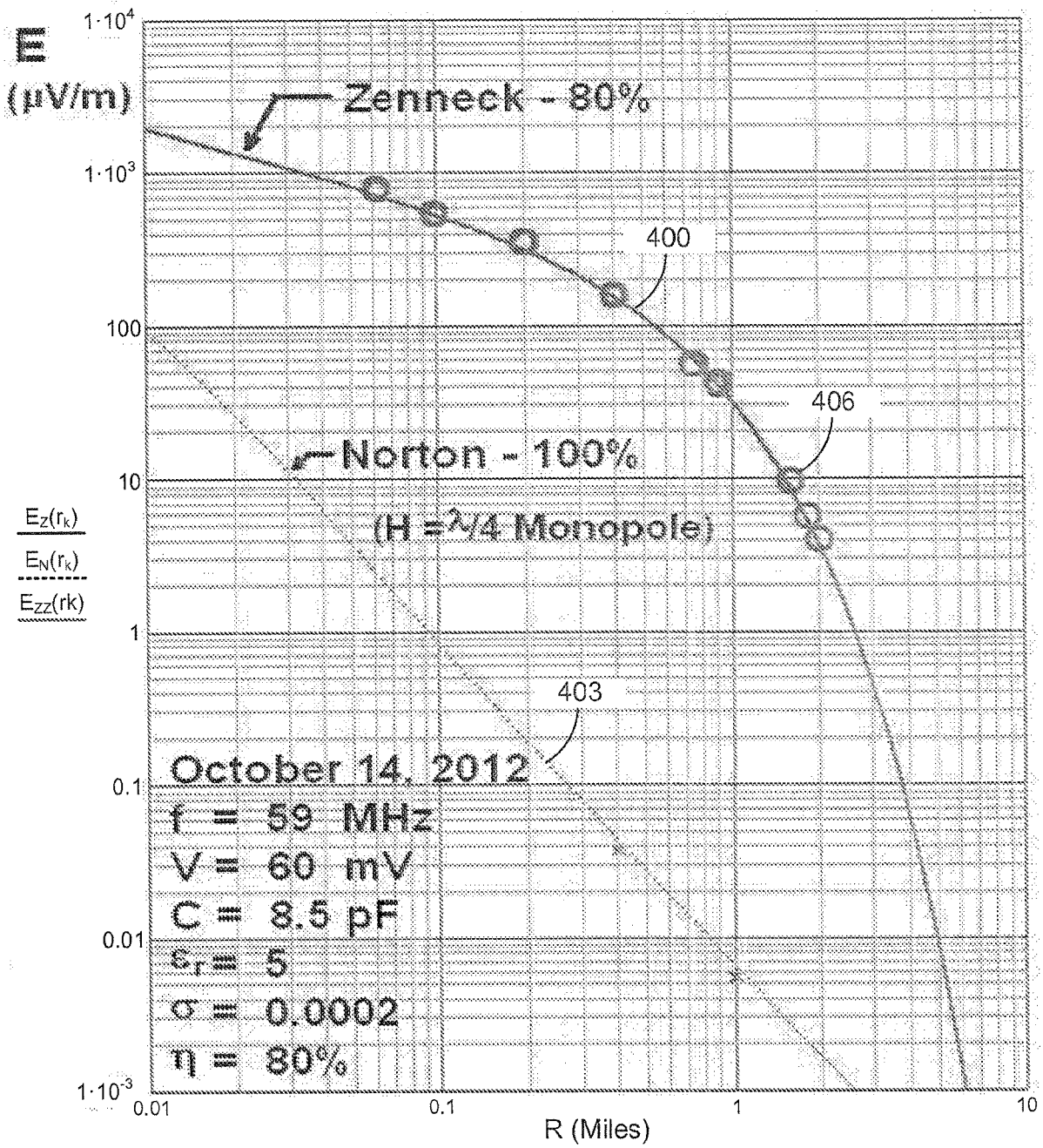

E
(μV/m)
1·10^4
1·10^3
100
10
1
0.1
0.01
1·10^-3
Zenneck - 80%
Norton - 100%
(H = λ/4 Monopole)
400
406
403
October 14, 2012
f = 59 MHz
V = 60 mV
C = 8.5 pF
εr = 5
σ = 0.0002
η = 80%
Ez(rk)
EN(rk)
Ezz(rk)
0.01
0.1
1
10
R (Miles)

FIG. 9

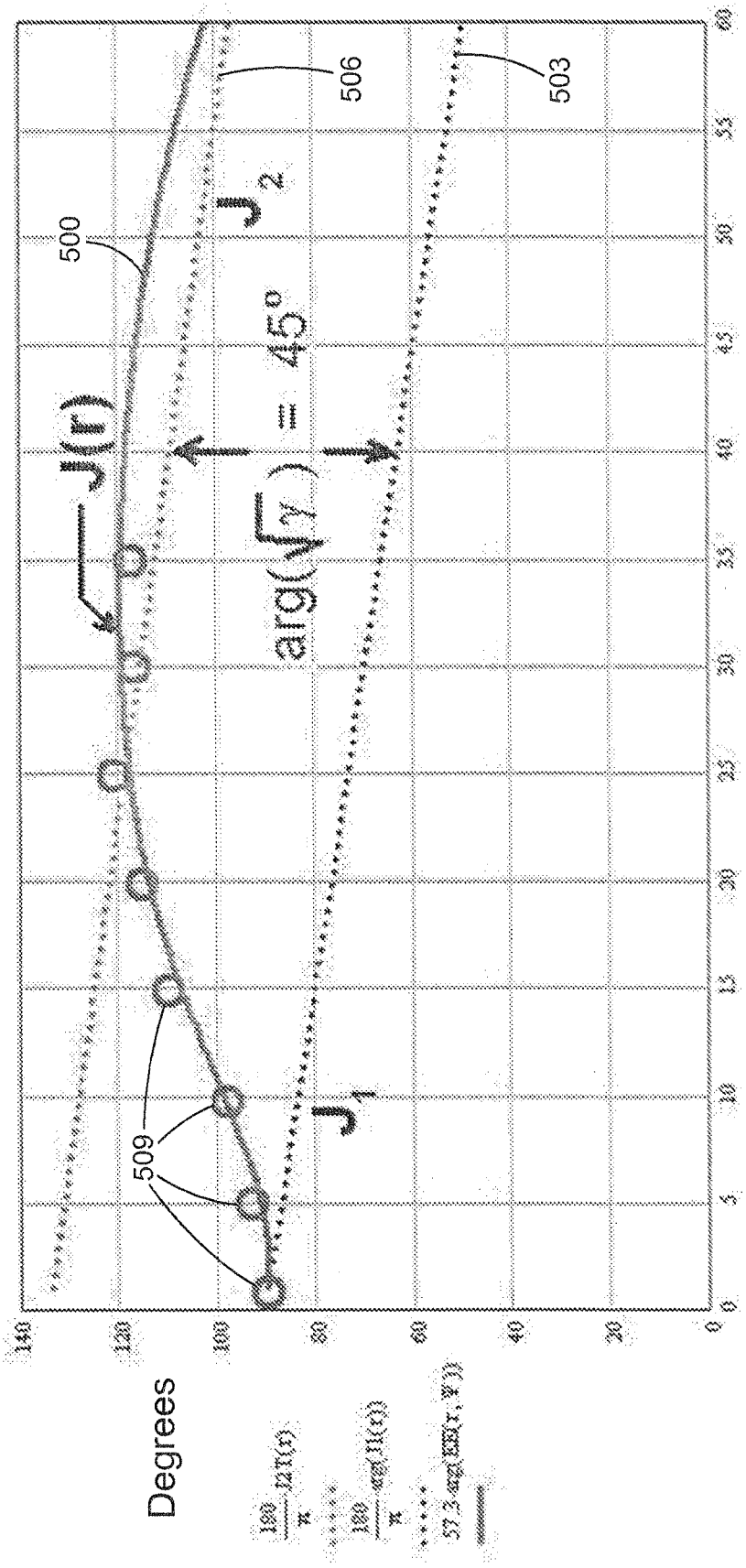


FIG. 10

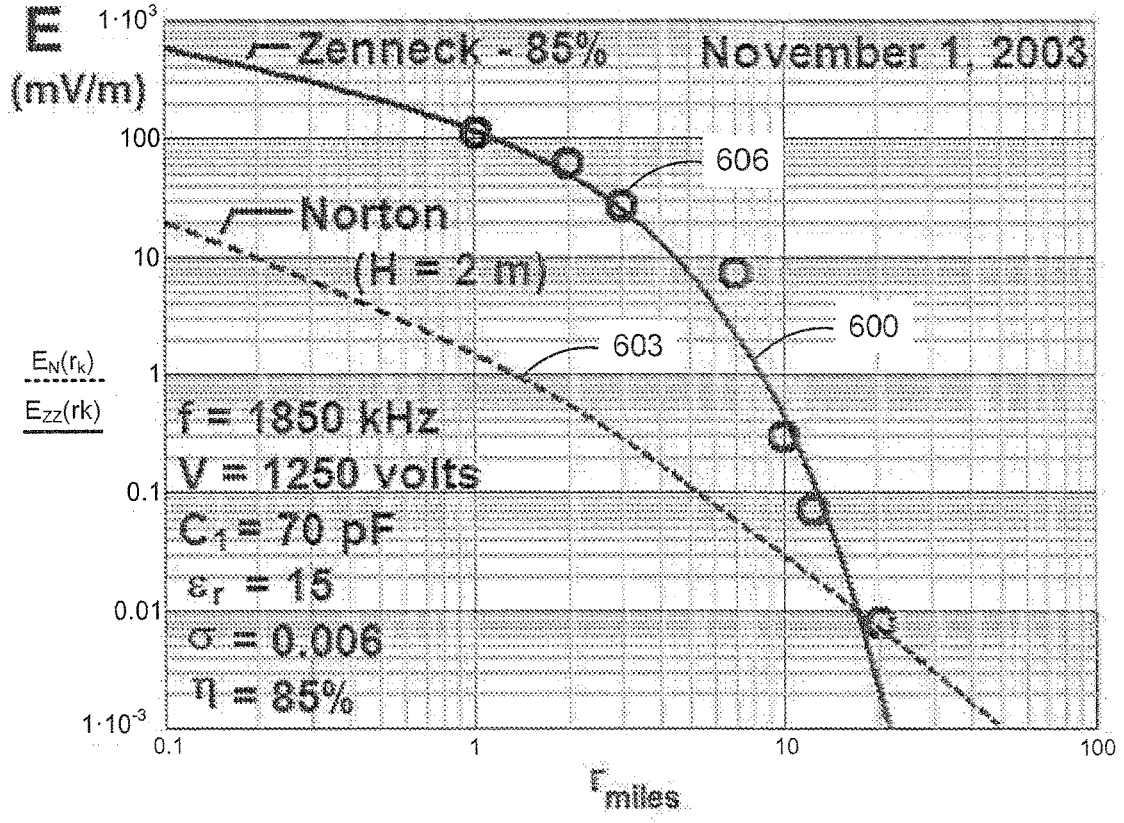

E
(mV/m)
1·10³
100
10
1
0.1
0.01
1·10⁻³
Zenneck - 85%
November 1, 2003
606
Norton
(H = 2 m)
603
600
E_N(r_k)
E_ZZ(rk)
f = 1850 kHz
V = 1250 volts
C1 = 70 pF
εr = 15
σ = 0.006
η = 85%
0.1
1
10
100
r miles

FIG. 11

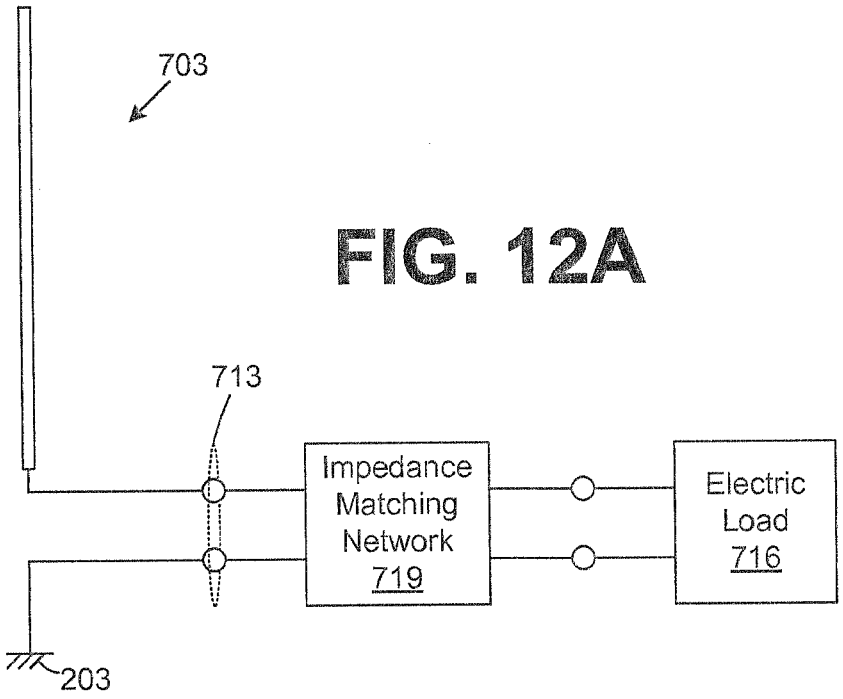


FIG. 12A

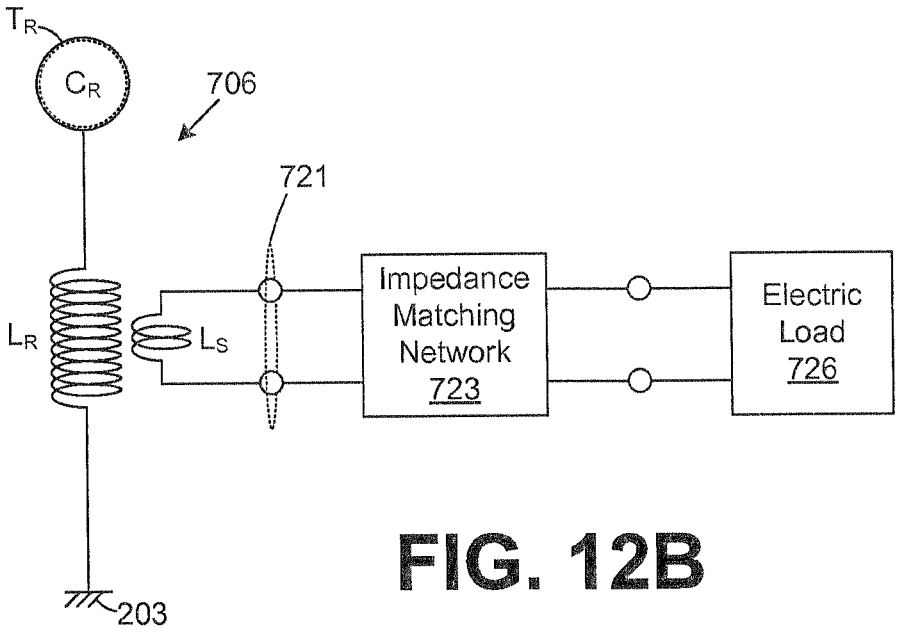


FIG. 12B

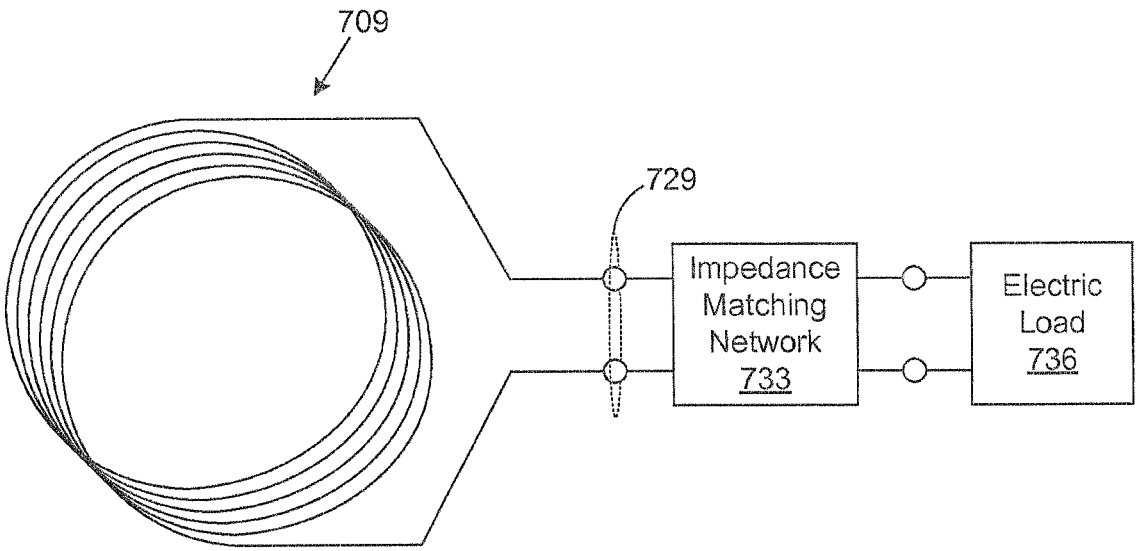


FIG. 13

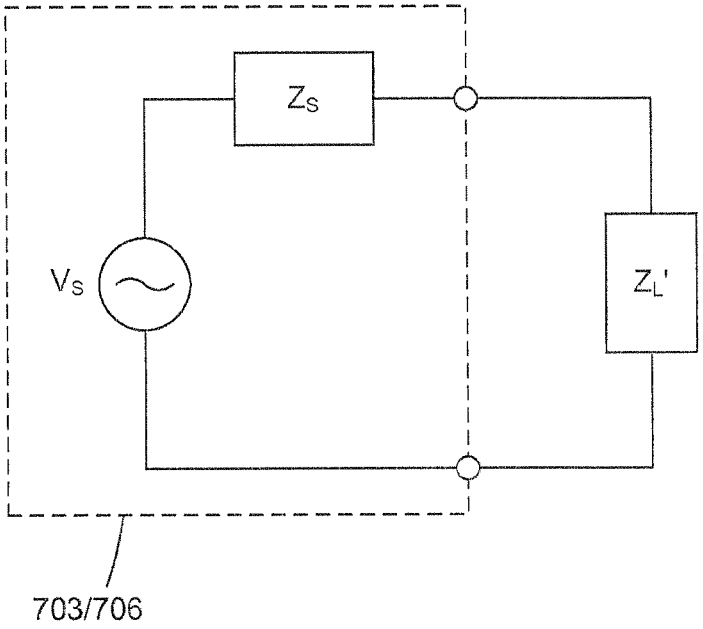


FIG. 14A

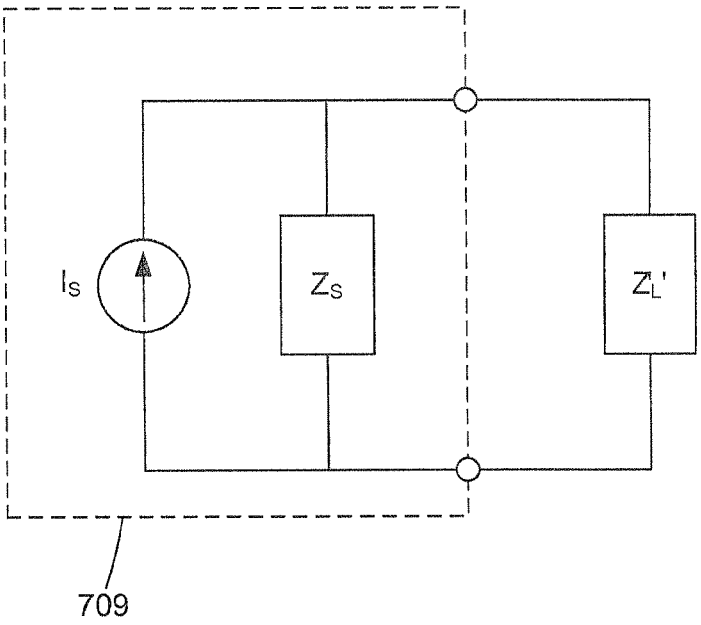


FIG. 14B