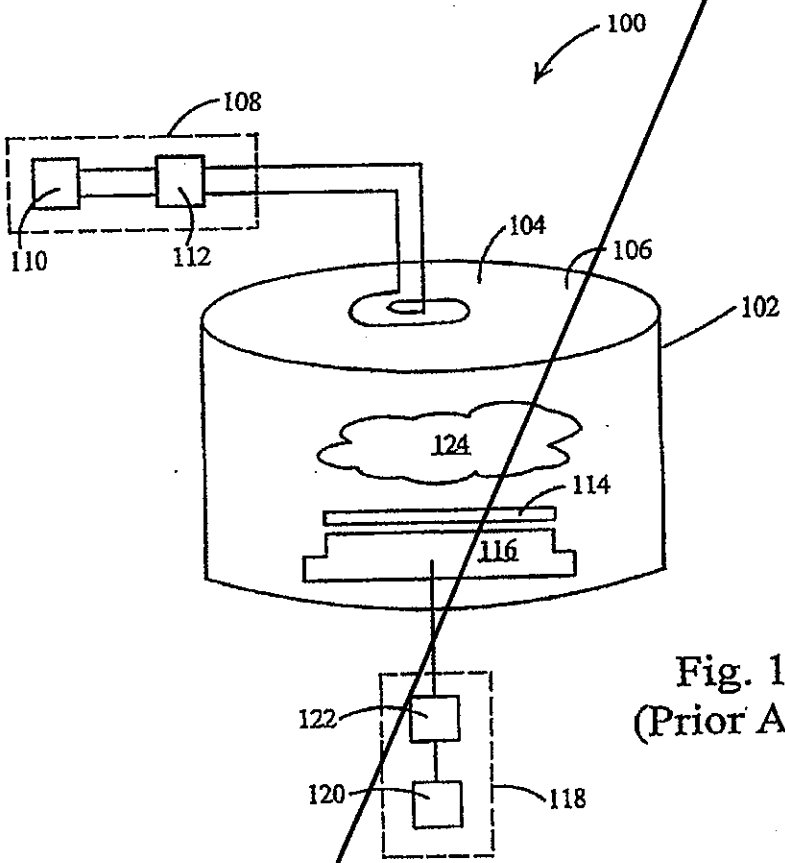



Fig. 1
(Prior Art)

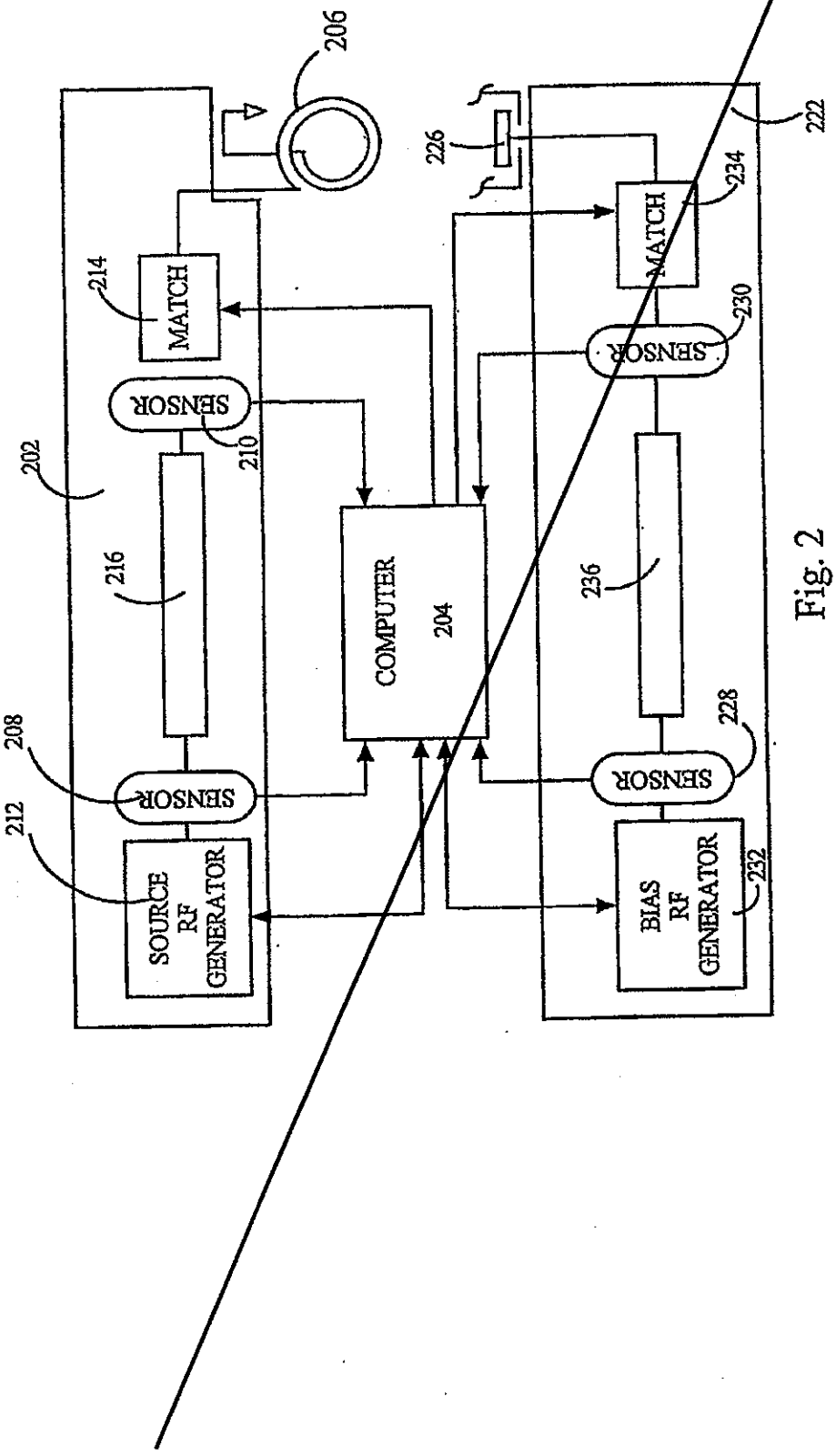

206
214
MATCH
SENSOR
210
202
216
208
SENSOR
212
SOURCE RF GENERATOR
COMPUTER 204
226
222
234
MATCH
230
SENSOR
236
228
SENSOR
BIAS RF GENERATOR
232

Fig. 2

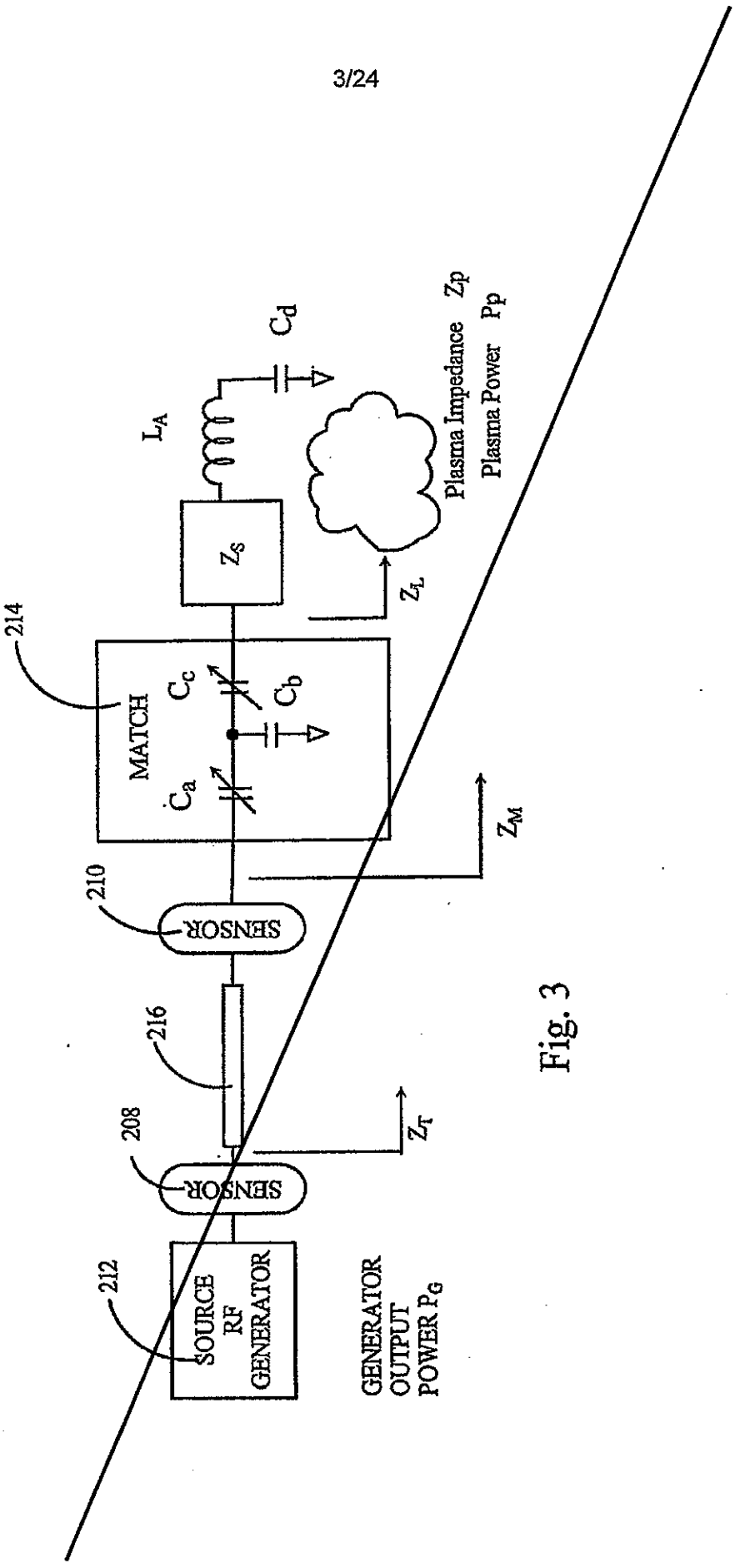
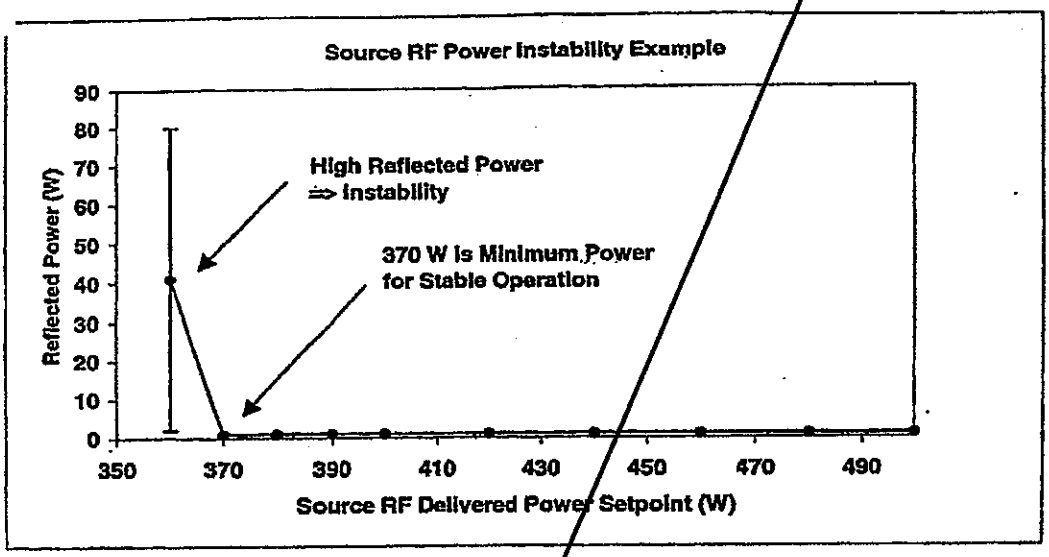

SOURCE RF GENERATOR
212
GENERATOR OUTPUT POWER $P_G$
SENSOR
208
$Z_T$
216
SENSOR
210
MATCH
214
$C_a$
$C_c$
$C_b$
$Z_M$
$Z_s$
$L_A$
$C_d$
$Z_L$
Plasma Impedance Zp
Plasma Power Pp

Fig. 3

Fig. 4A


Source RF Power Instability Example
Reflected Power (W)
90
80
70
60
50
40
30
20
10
0
High Reflected Power
⇒ Instability
370 W is Minimum Power
for Stable Operation
350
370
390
410
430
450
470
490
Source RF Delivered Power Setpoint (W)

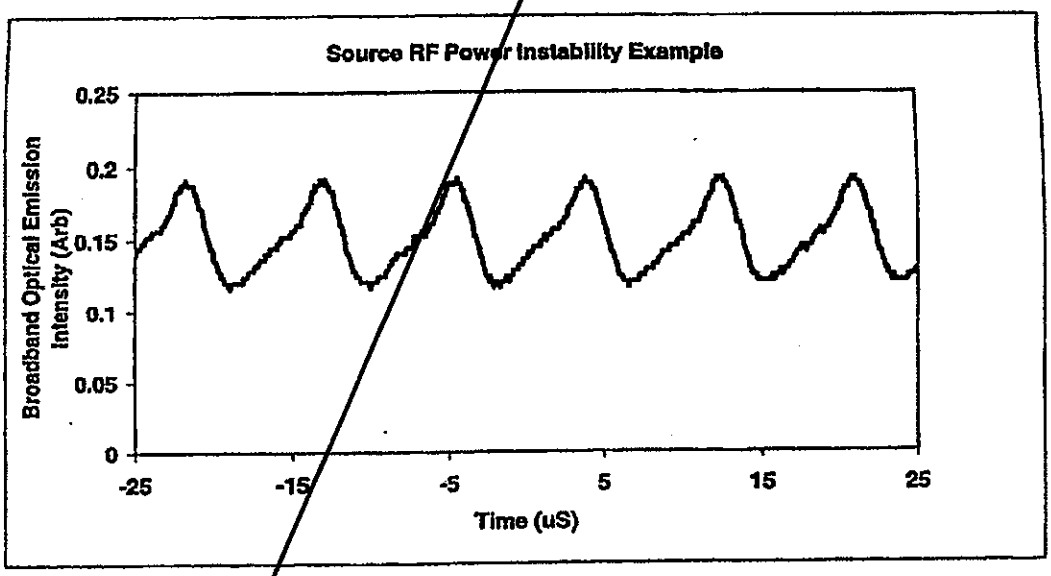

Source RF Power Instability Example
Broadband Optical Emission Intensity (Arb)
0.25
0.2
0.15
0.1
0.05
0
-25
-15
-5
5
15
25
Time (uS)

Fig. 4B

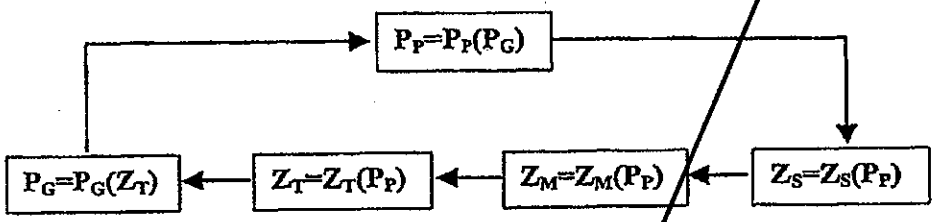



Fig. 5

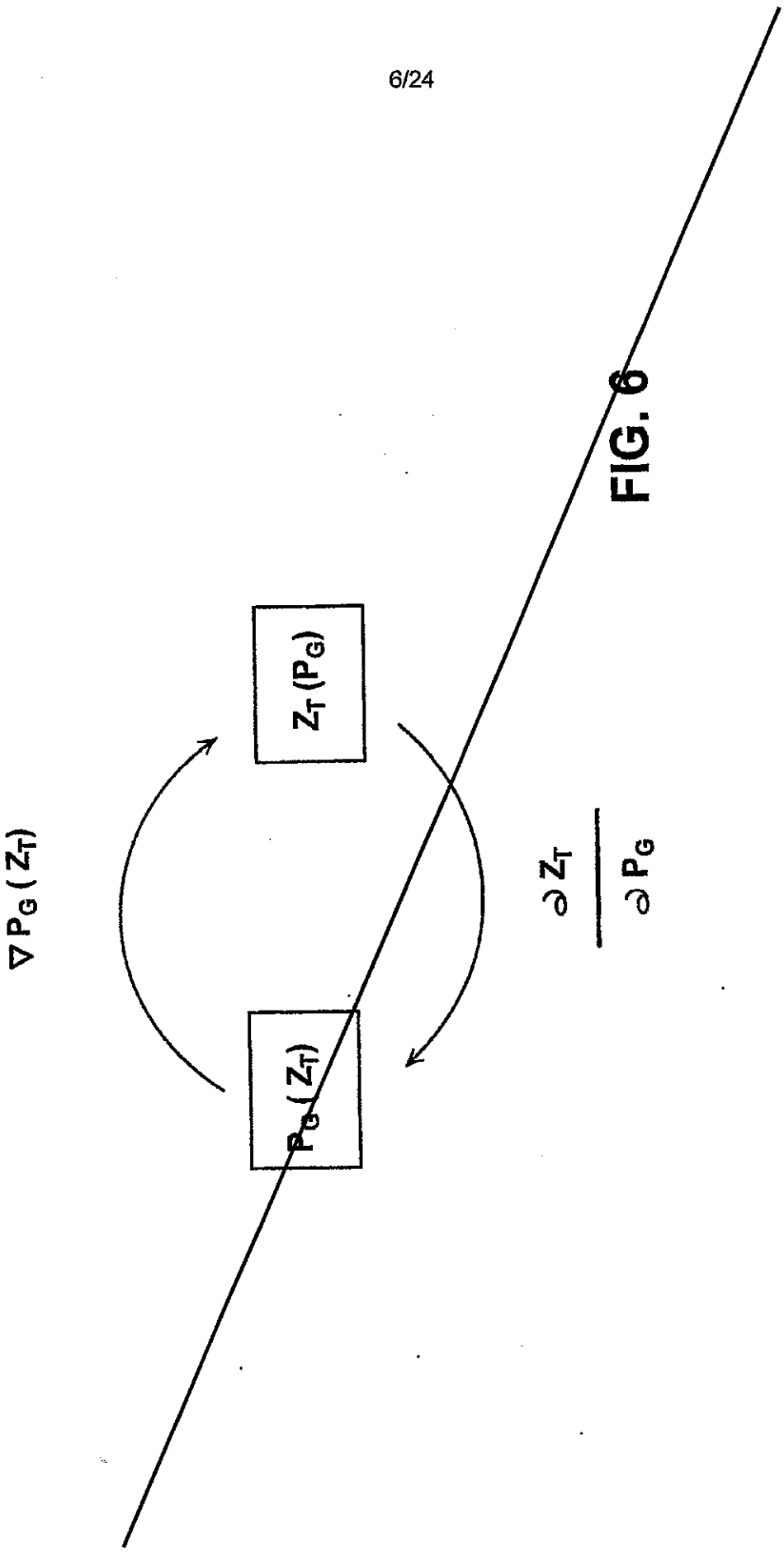



FIG. 6

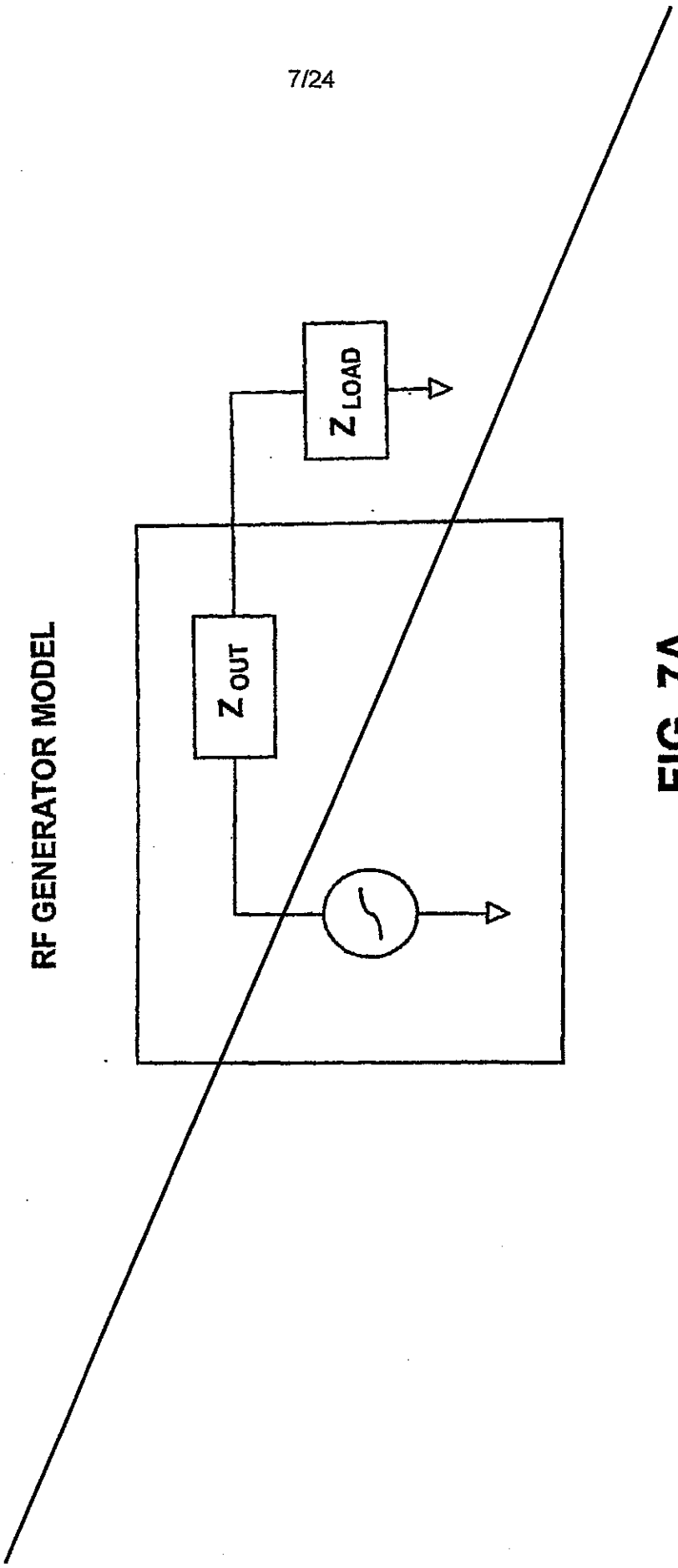



FIG. 7A

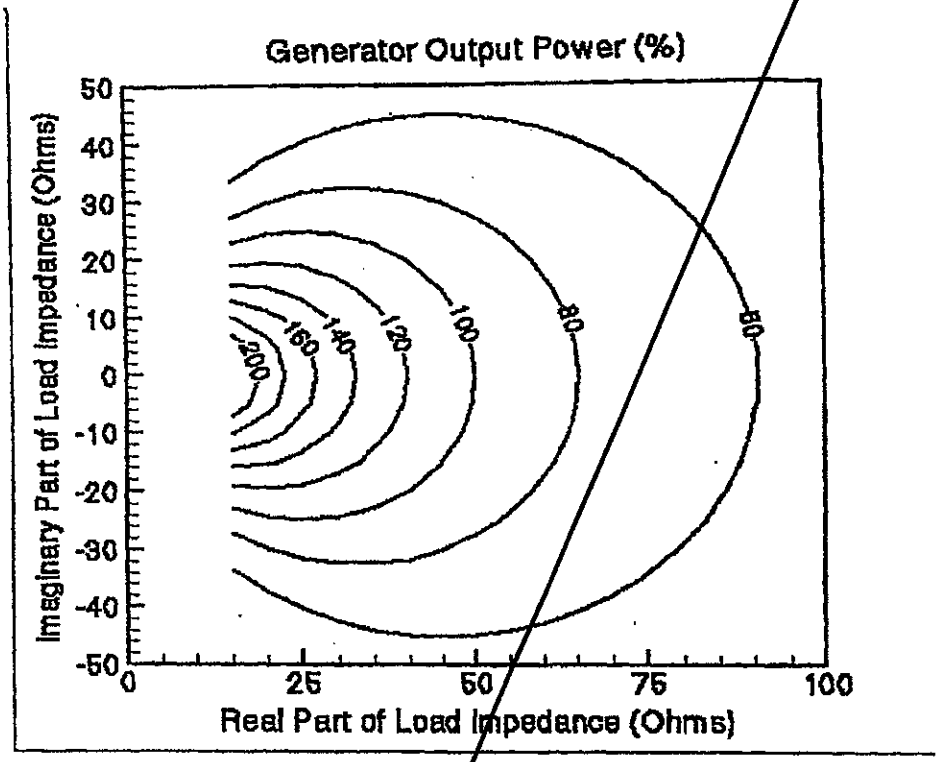

Generator Output Power (%)
Imaginary Part of Load Impedance (Ohms)
50
40
30
20
10
0
-10
-20
-30
-40
-50
0
25
50
75
100
Real Part of Load Impedance (Ohms)
200
160
140
120
100
80
80

Fig. 7B

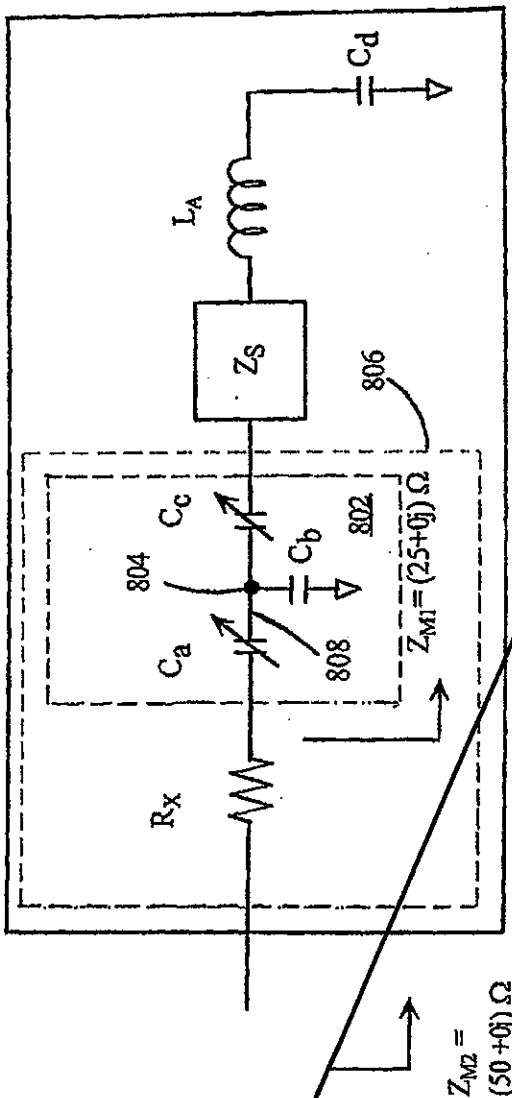

$C_d$
$L_A$
$Z_S$
806
$C_c$
804
$C_b$
802
$C_a$
808
$Z_{M1}=(25+0j)\ \Omega$
$R_x$
$Z_{M2}=$
$(50+0j)\ \Omega$

Fig. 8A

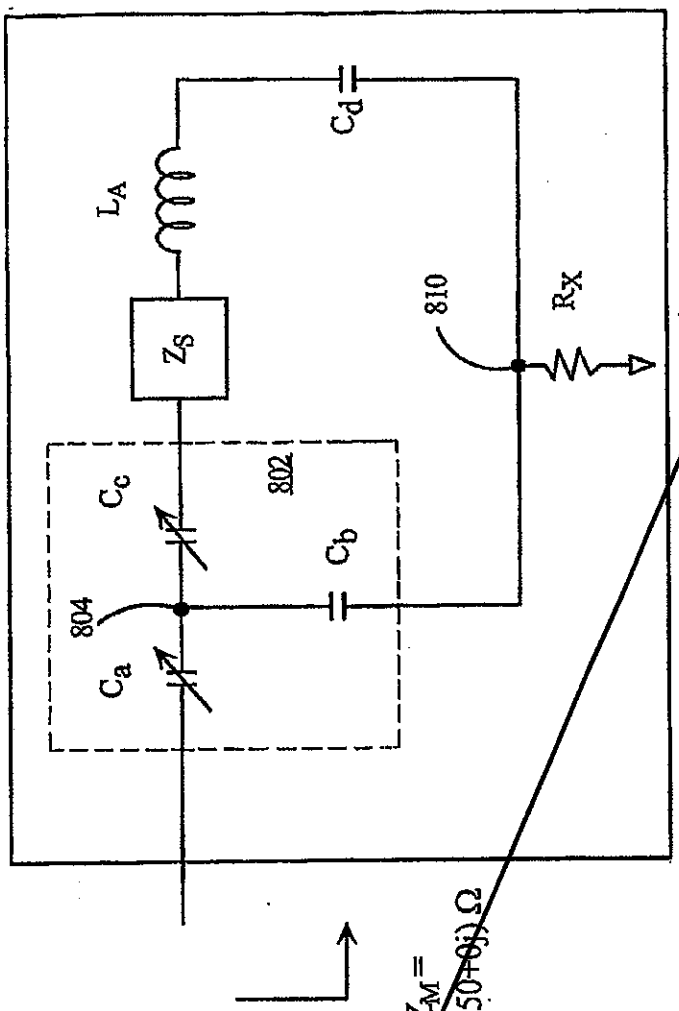



Fig. 8B

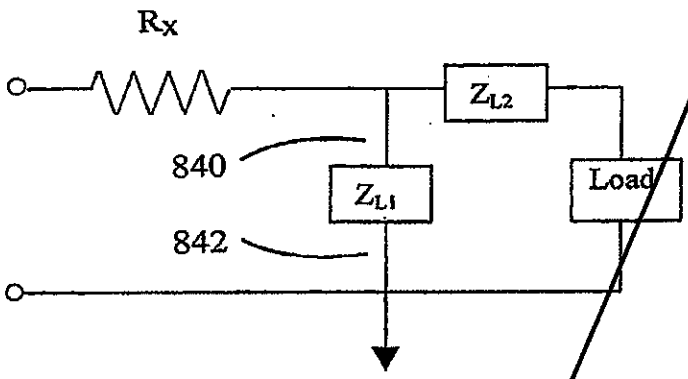



Fig. 8C

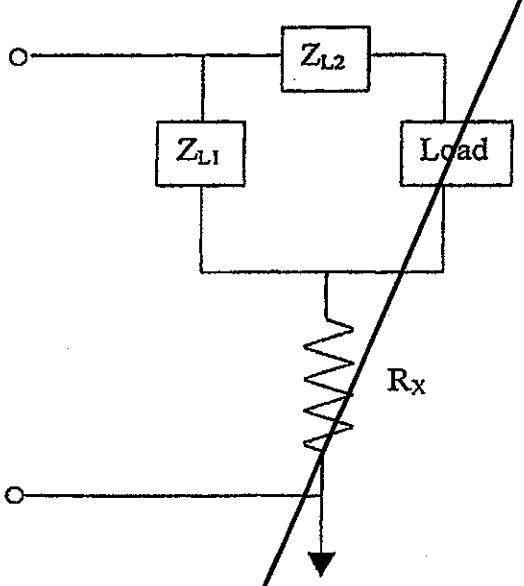



Fig. 8D

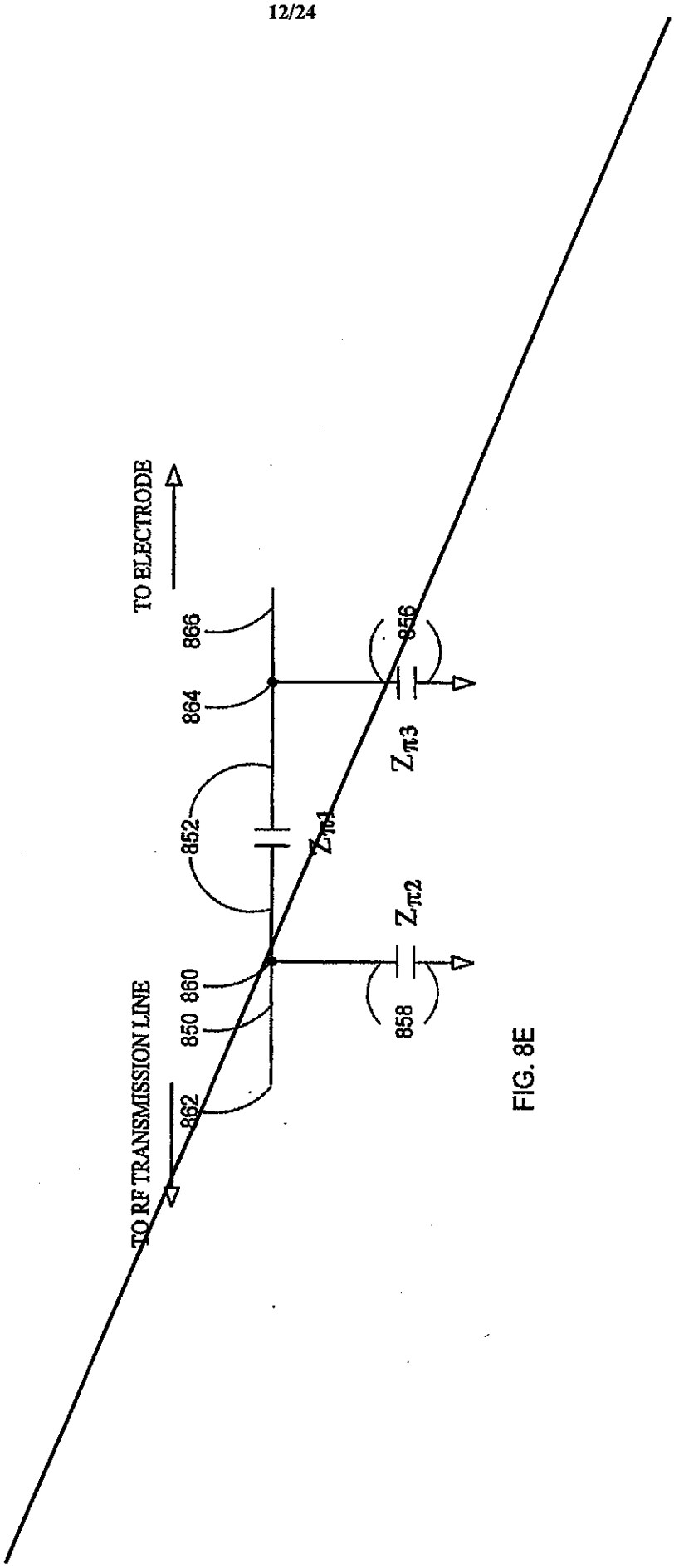

TO ELECTRODE
866
864
852
860
850
862
TO RF TRANSMISSION LINE
856
858
$Z_{\pi 1}$
$Z_{\pi 2}$
$Z_{\pi 3}$

FIG. 8E

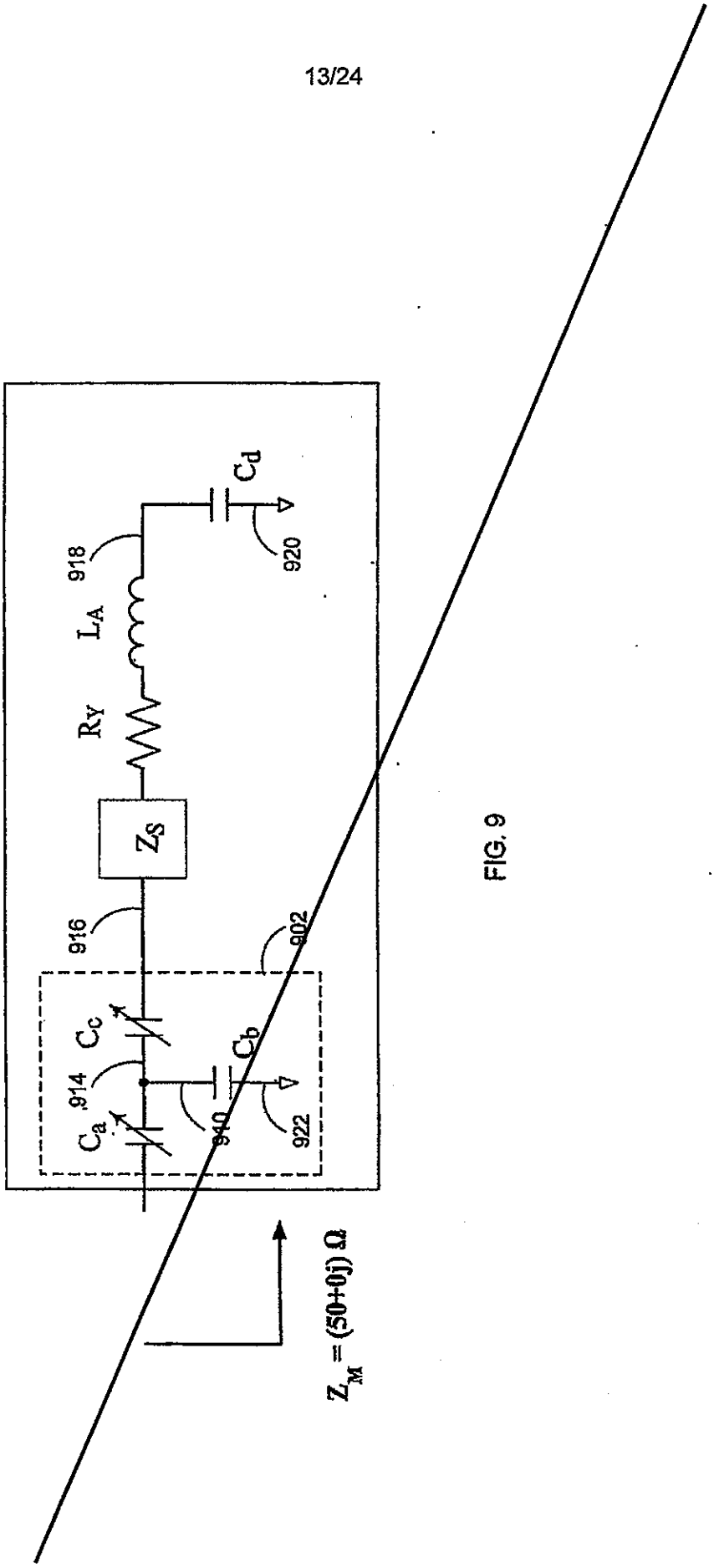



FIG. 9

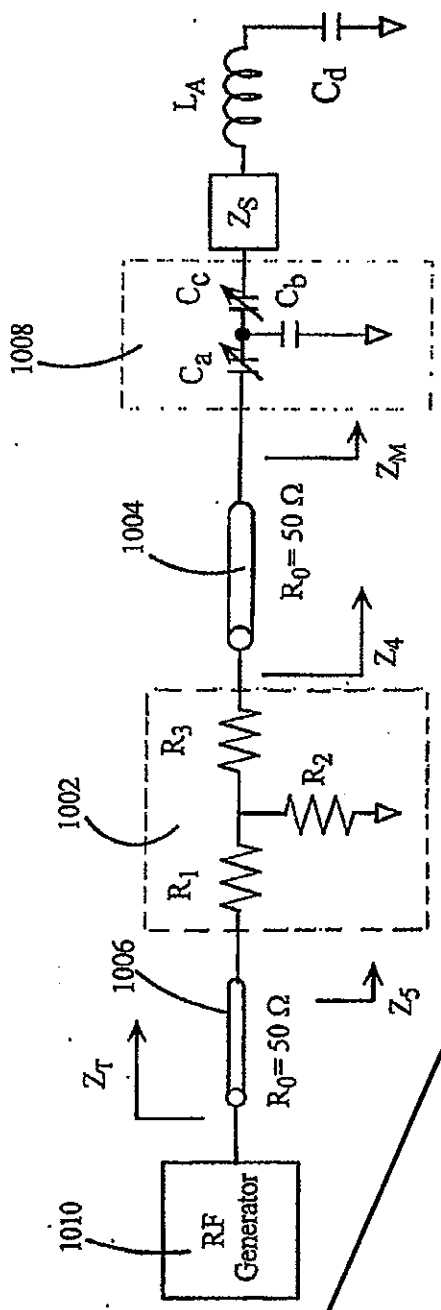



Fig. 10A

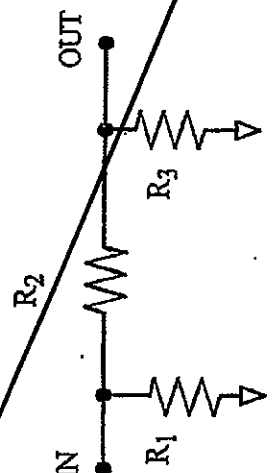



Fig. 10B

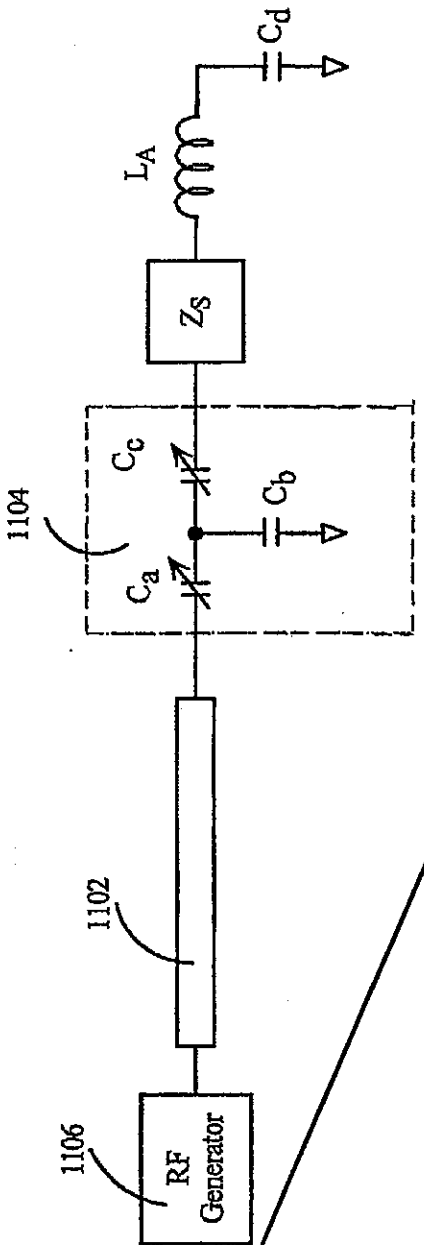



Fig. 11

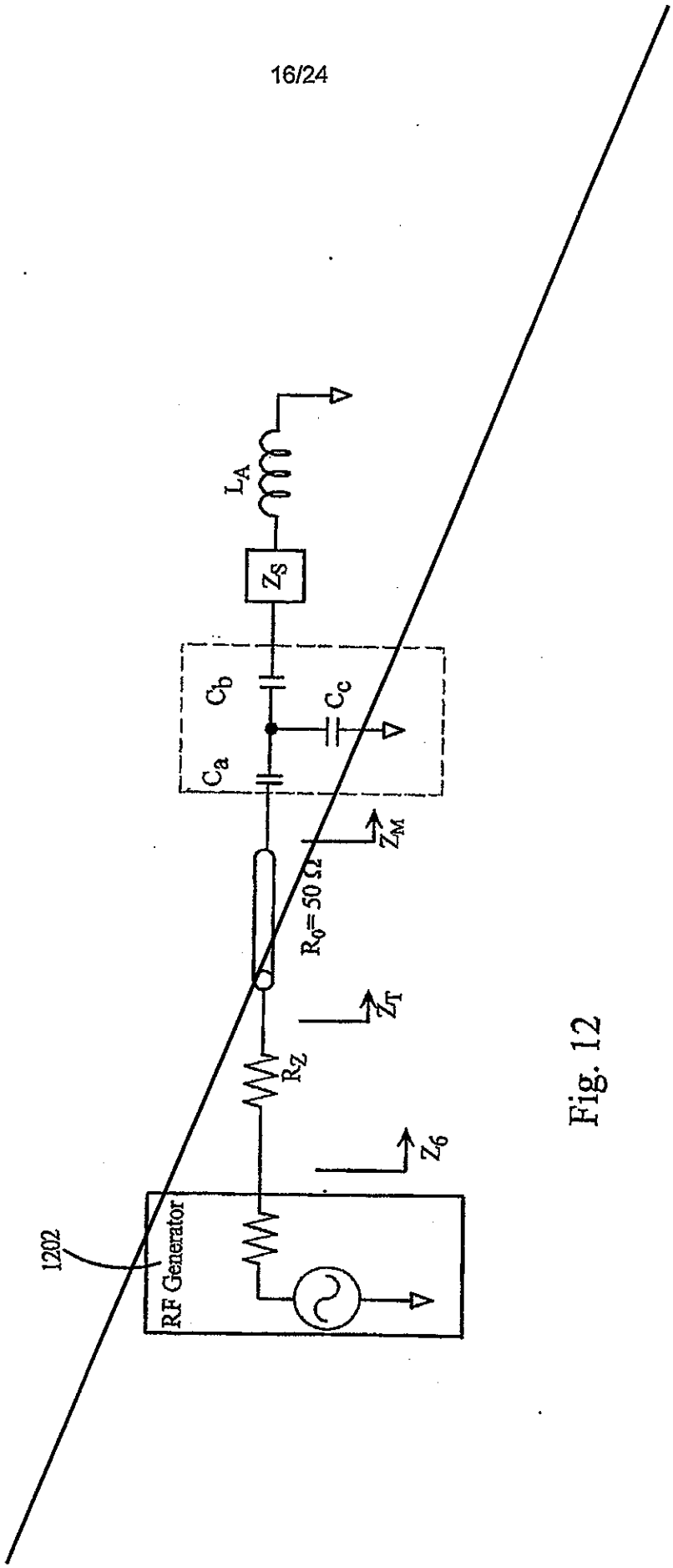
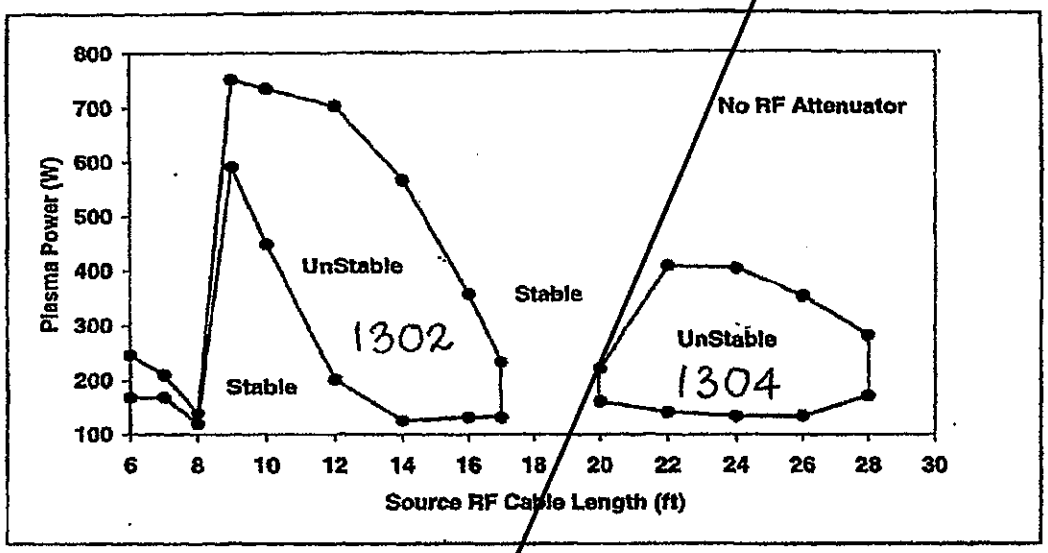



Fig. 12

Fig. 13A



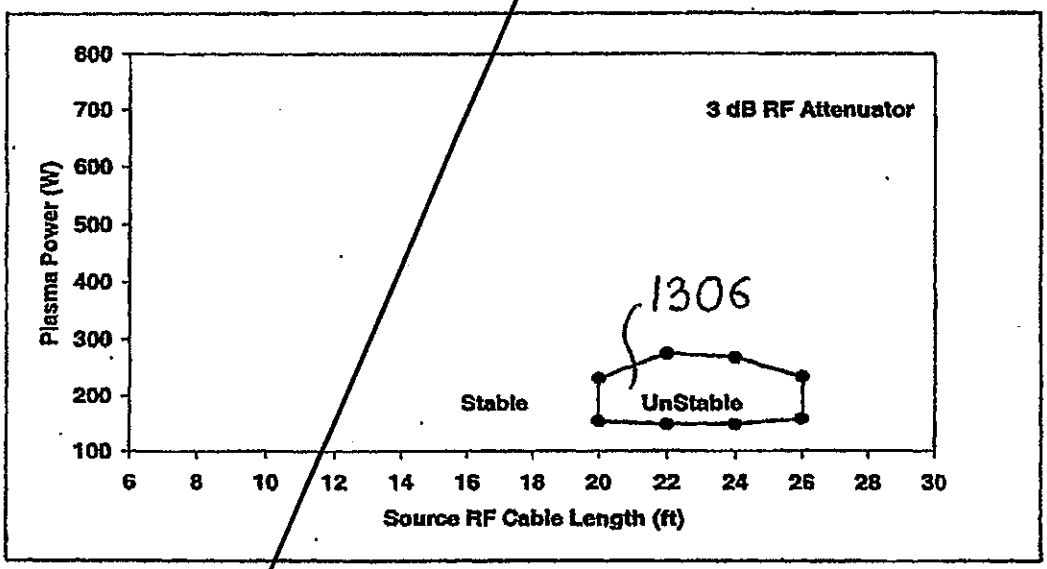




Fig. 13B

Fig 14

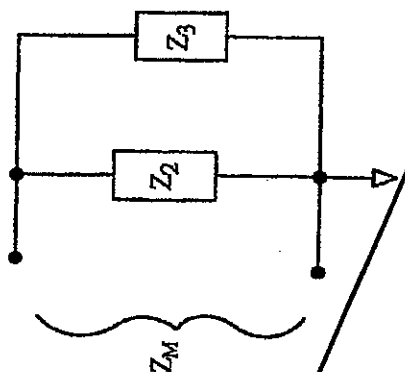
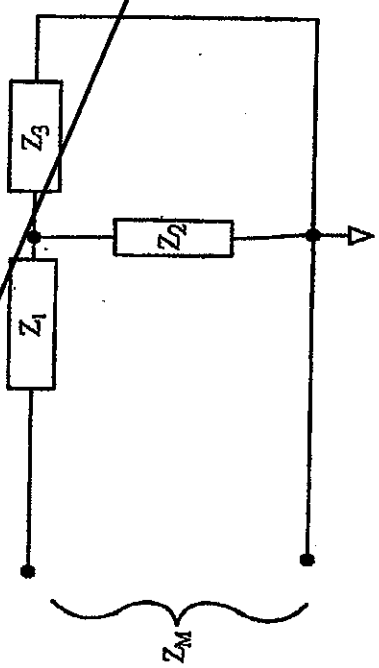



Fig 15



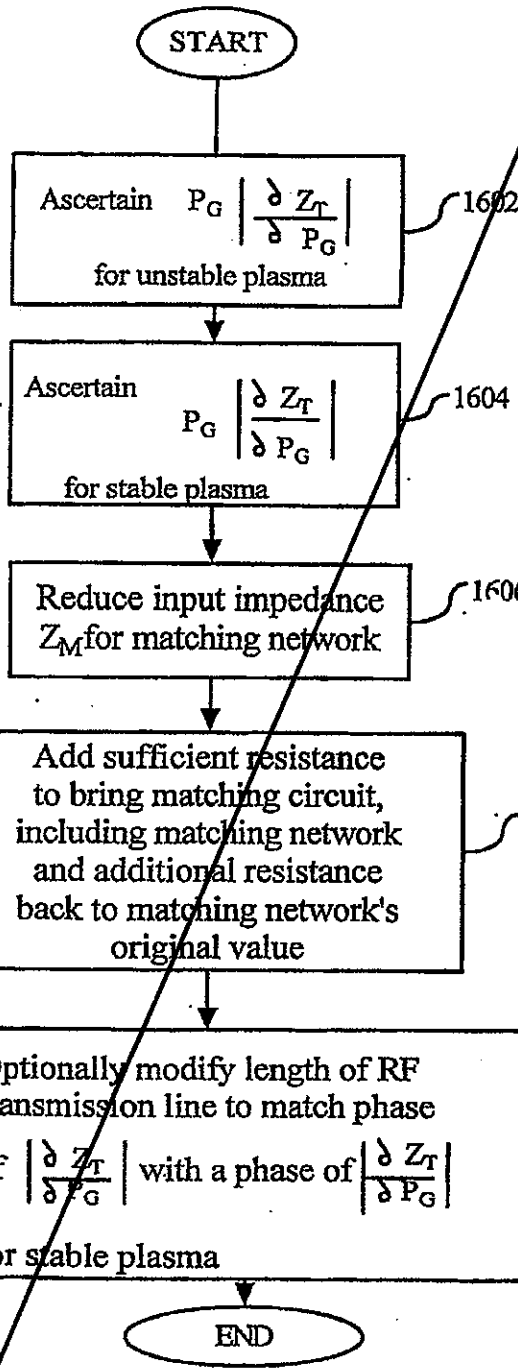

START
Ascertain $P_G \left| \frac{\partial Z_T}{\partial P_G} \right|$ for unstable plasma
1602
Ascertain $P_G \left| \frac{\partial Z_T}{\partial P_G} \right|$ for stable plasma
1604
Reduce input impedance $Z_M$ for matching network
1606
Add sufficient resistance to bring matching circuit, including matching network and additional resistance back to matching network's original value
1608
Optionally modify length of RF transmission line to match phase of $\left| \frac{\partial Z_T}{\partial P_G} \right|$ with a phase of $\left| \frac{\partial Z_T}{\partial P_G} \right|$ for stable plasma
1610
END

Fig 16

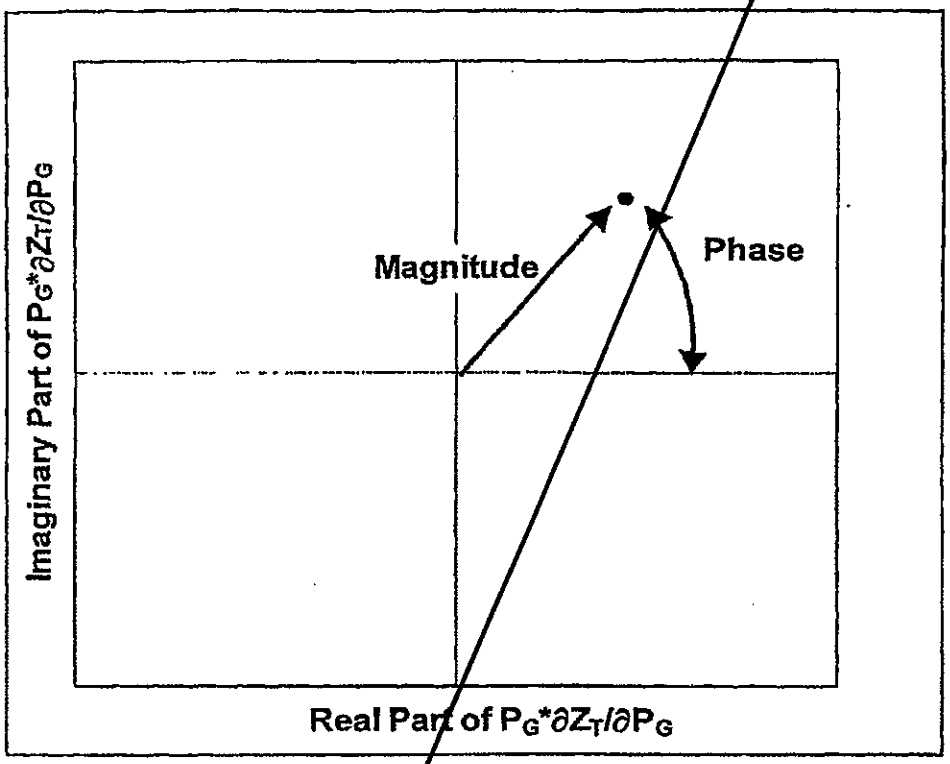

Magnitude
Phase
Imaginary Part of $P_G*\partial Z_T/\partial P_G$
Real Part of $P_G*\partial Z_T/\partial P_G$

Fig. 17A

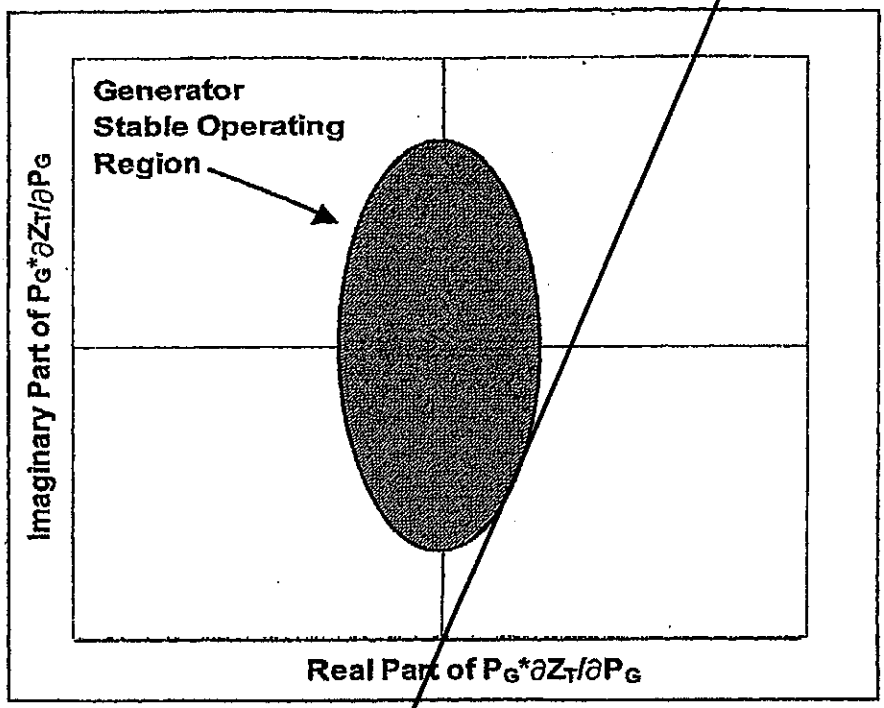

Generator
Stable Operating
Region
Imaginary Part of $P_G^*\partial Z_T/\partial P_G$
Real Part of $P_G^*\partial Z_T/\partial P_G$

Fig. 17B

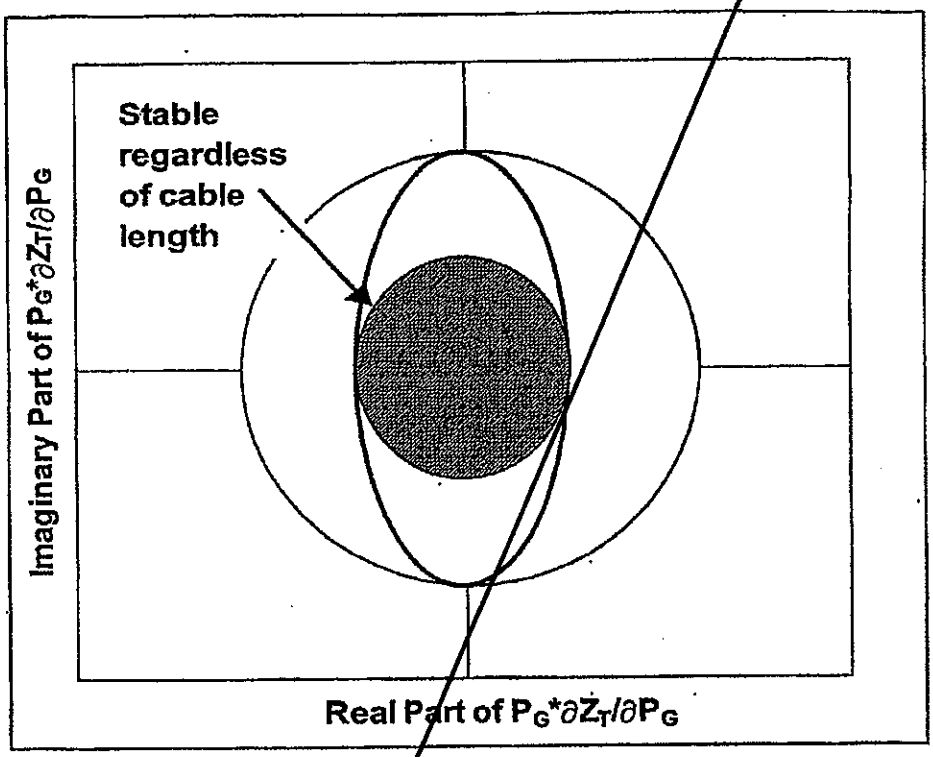

Stable
regardless
of cable
length
Imaginary Part of $P_G^*\partial Z_T/\partial P_G$
Real Part of $P_G^*\partial Z_T/\partial P_G$

Fig. 17C

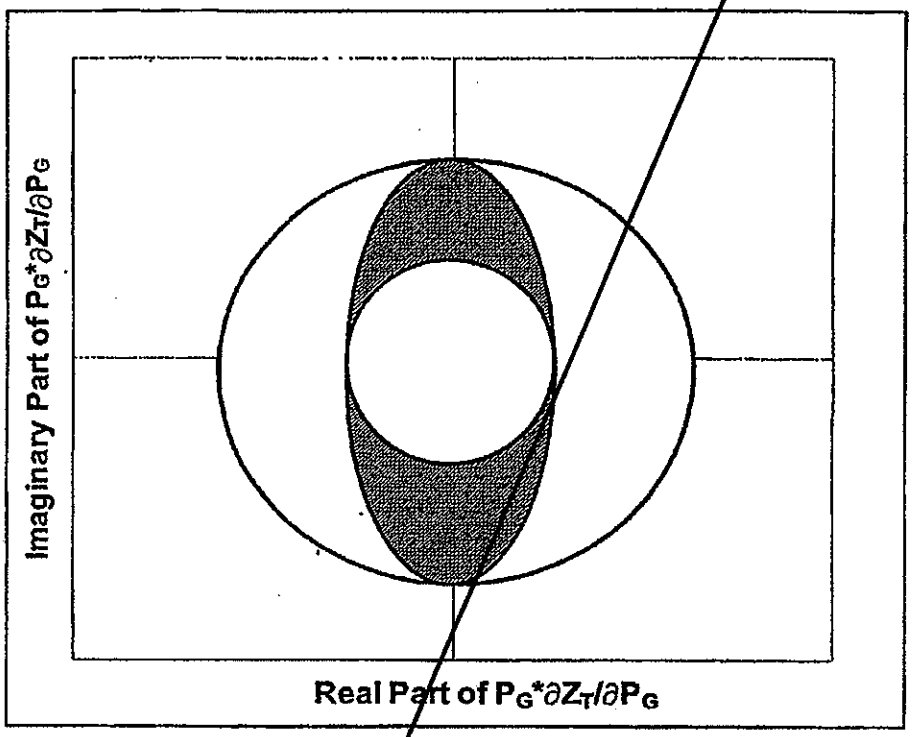

Imaginary Part of $P_G^*\partial Z_T/\partial P_G$
Real Part of $P_G^*\partial Z_T/\partial P_G$

Fig. 17D

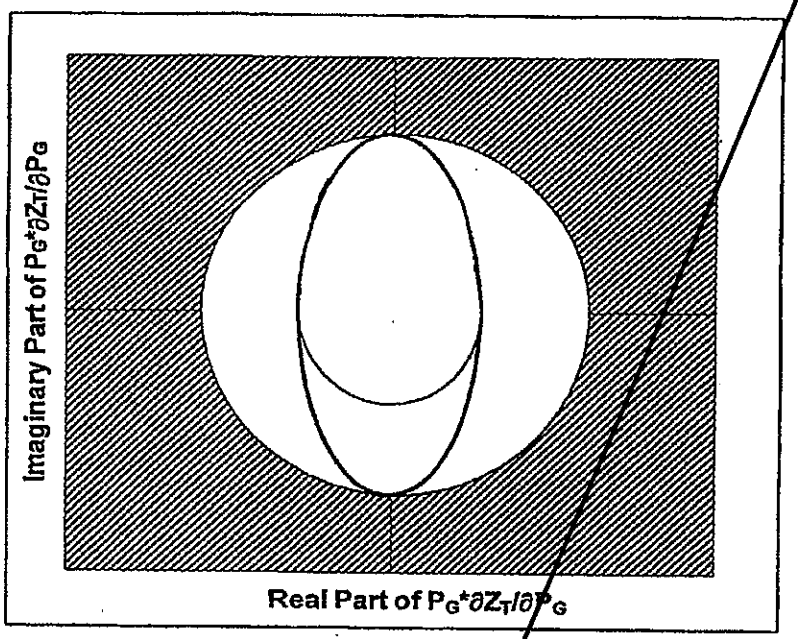

Imaginary Part of $P_G*\partial Z_T/\partial P_G$
Real Part of $P_G*\partial Z_T/\partial P_G$

Fig. 17E

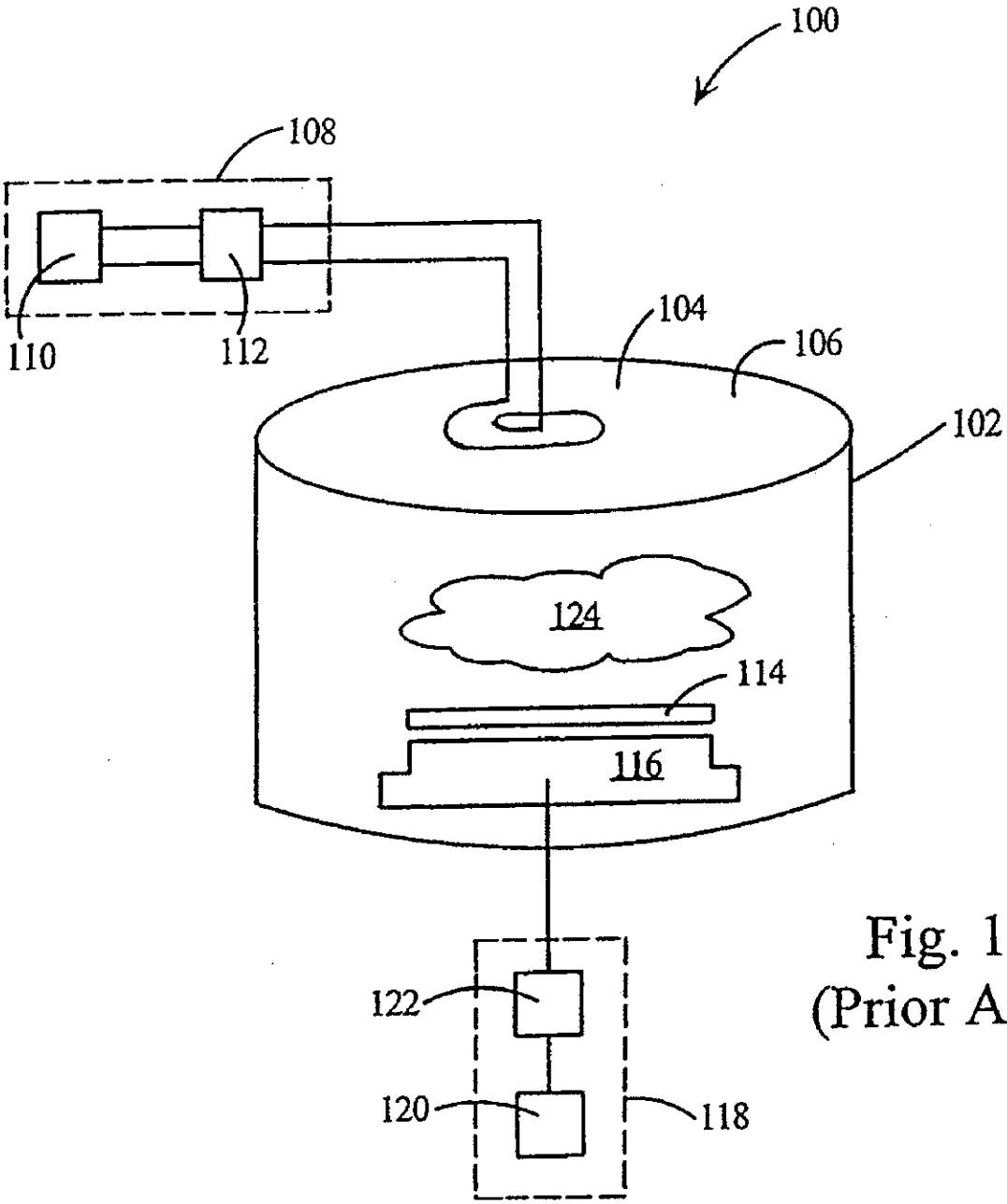



Fig. 1
(Prior Art)

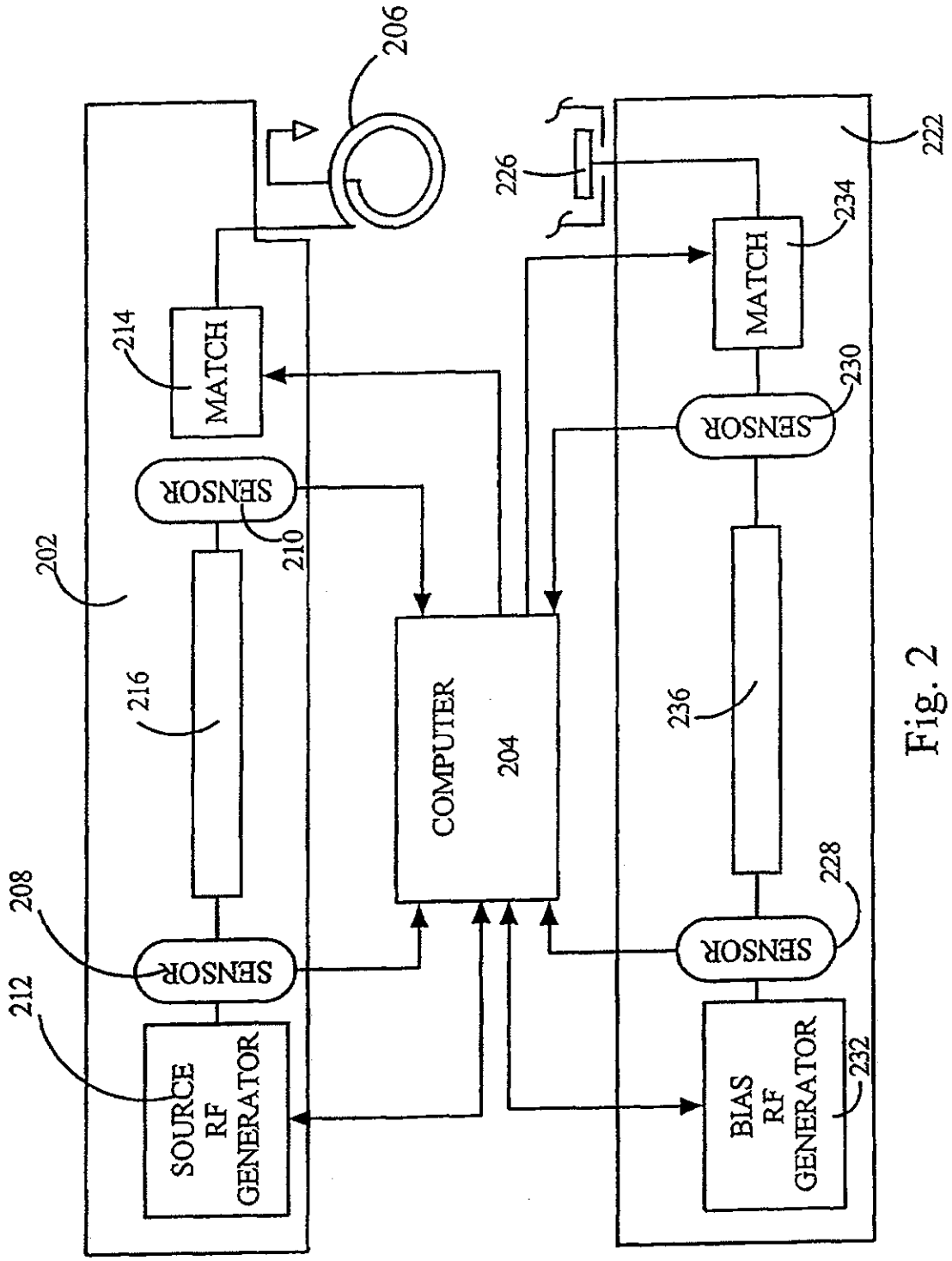

206
222
226
234
MATCH
214
MATCH
230
SENSOR
SENSOR
210
202
216
COMPUTER
204
236
208
228
SENSOR
SENSOR
212
SOURCE
RF
GENERATOR
BIAS
RF
GENERATOR
232

Fig. 2

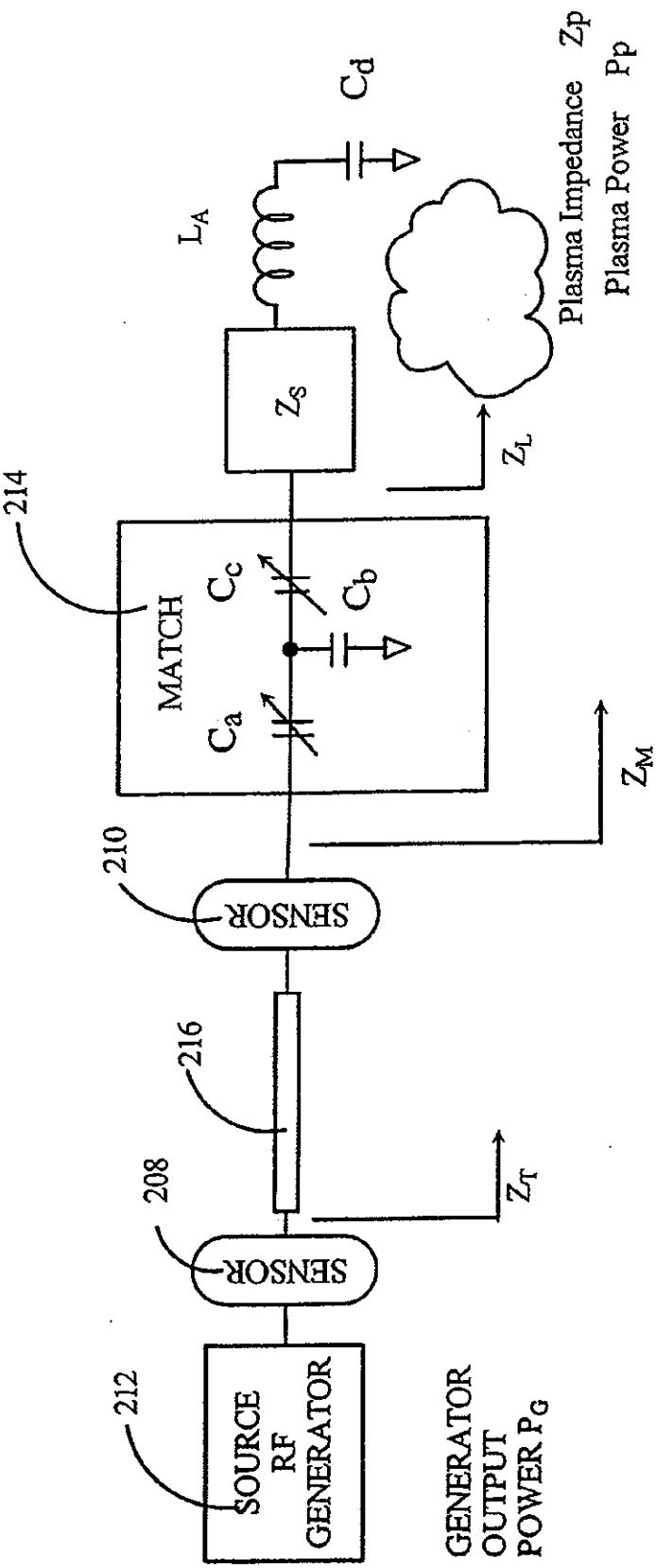
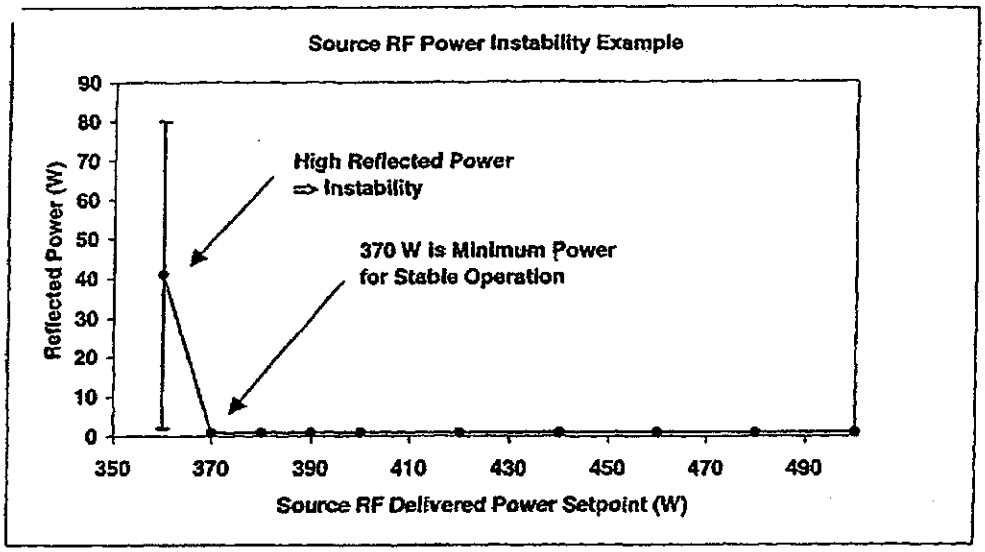

212
SOURCE RF GENERATOR
GENERATOR OUTPUT POWER $P_G$
208
SENSOR
216
$Z_T$
210
SENSOR
214
MATCH
$C_a$
$C_c$
$C_b$
$Z_M$
$Z_S$
$L_A$
$C_d$
$Z_L$
Plasma Impedance $Z_p$
Plasma Power $P_p$

Fig. 3

Fig. 4A


Source RF Power Instability Example
Reflected Power (W)
90
80
70
60
50
40
30
20
10
0
High Reflected Power
⇒ Instability
370 W is Minimum Power
for Stable Operation
350
370
390
410
430
450
470
490
Source RF Delivered Power Setpoint (W)

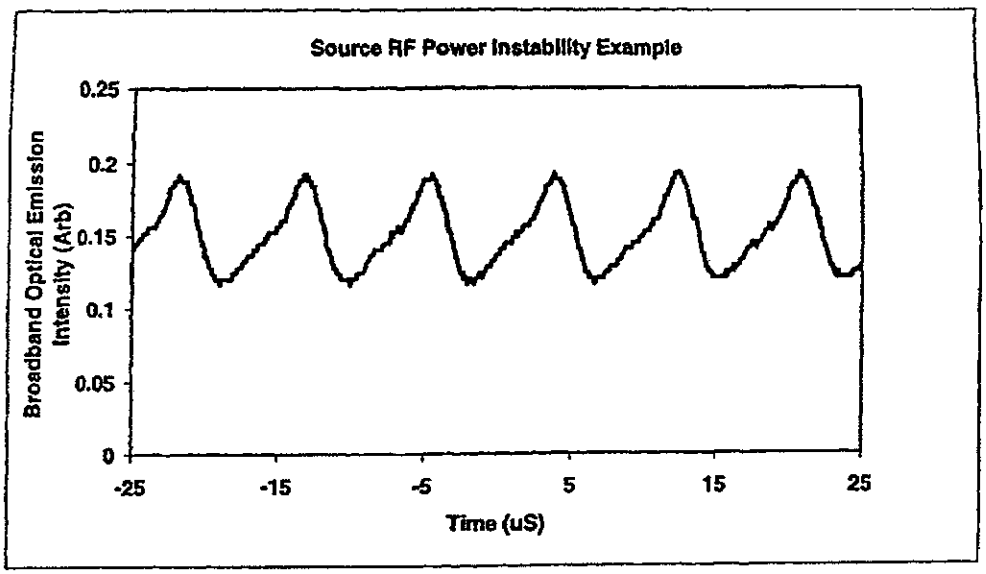

Source RF Power Instability Example
Broadband Optical Emission Intensity (Arb)
0.25
0.2
0.15
0.1
0.05
0
-25
-15
-5
5
15
25
Time (uS)

Fig. 4B

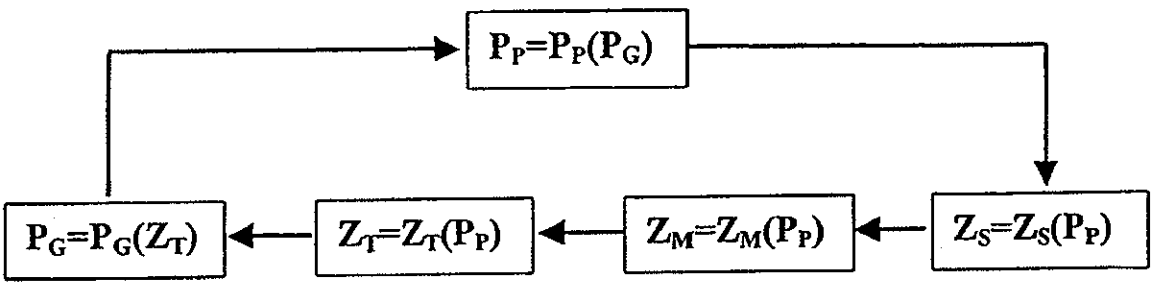



Fig. 5

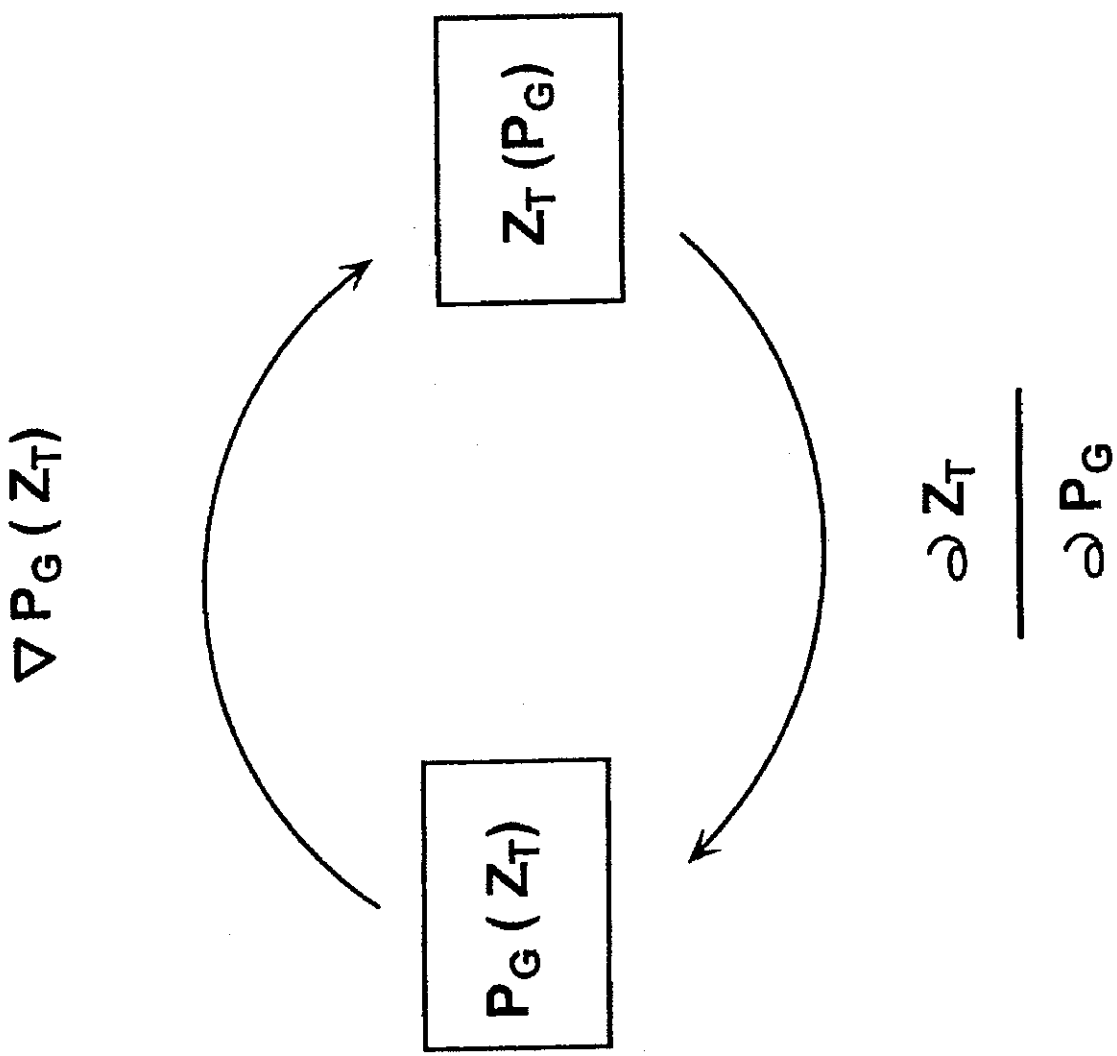



FIG. 6

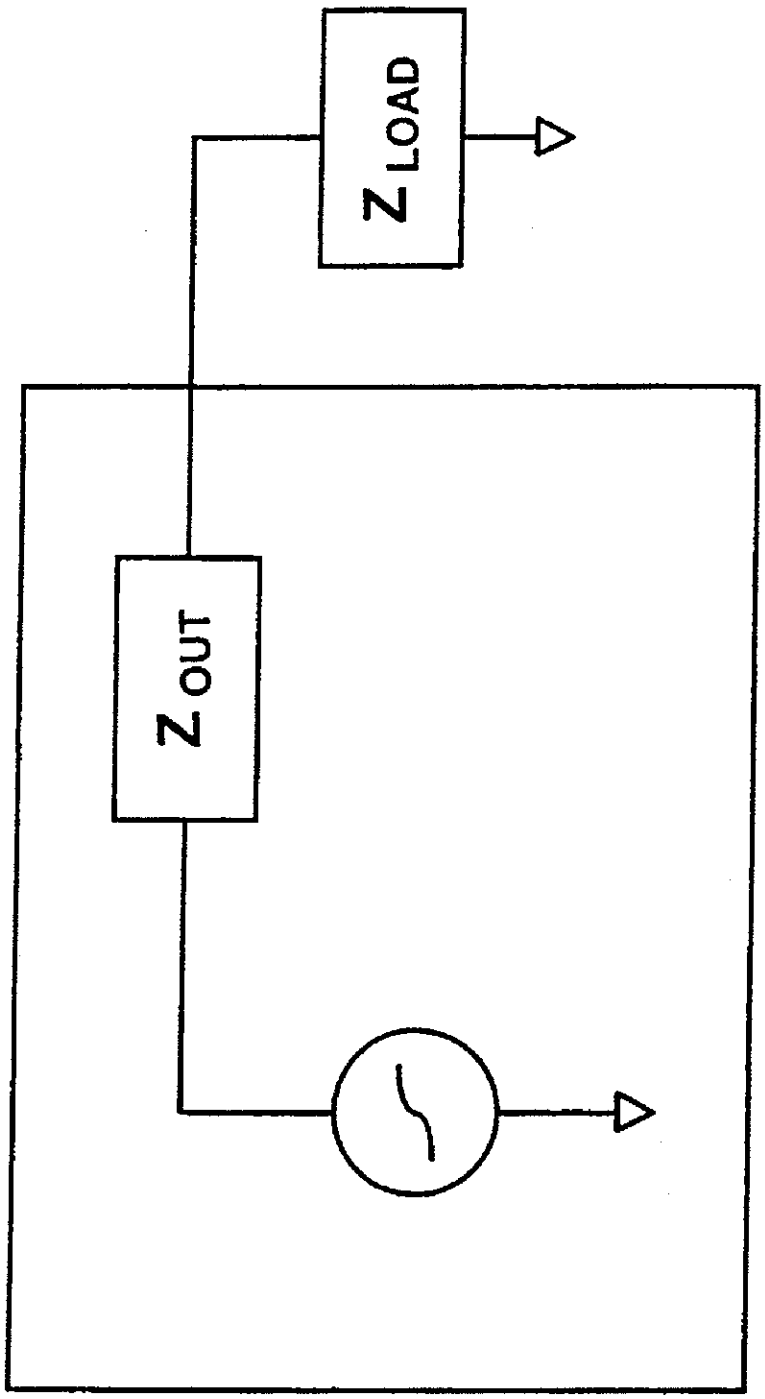



FIG. 7A

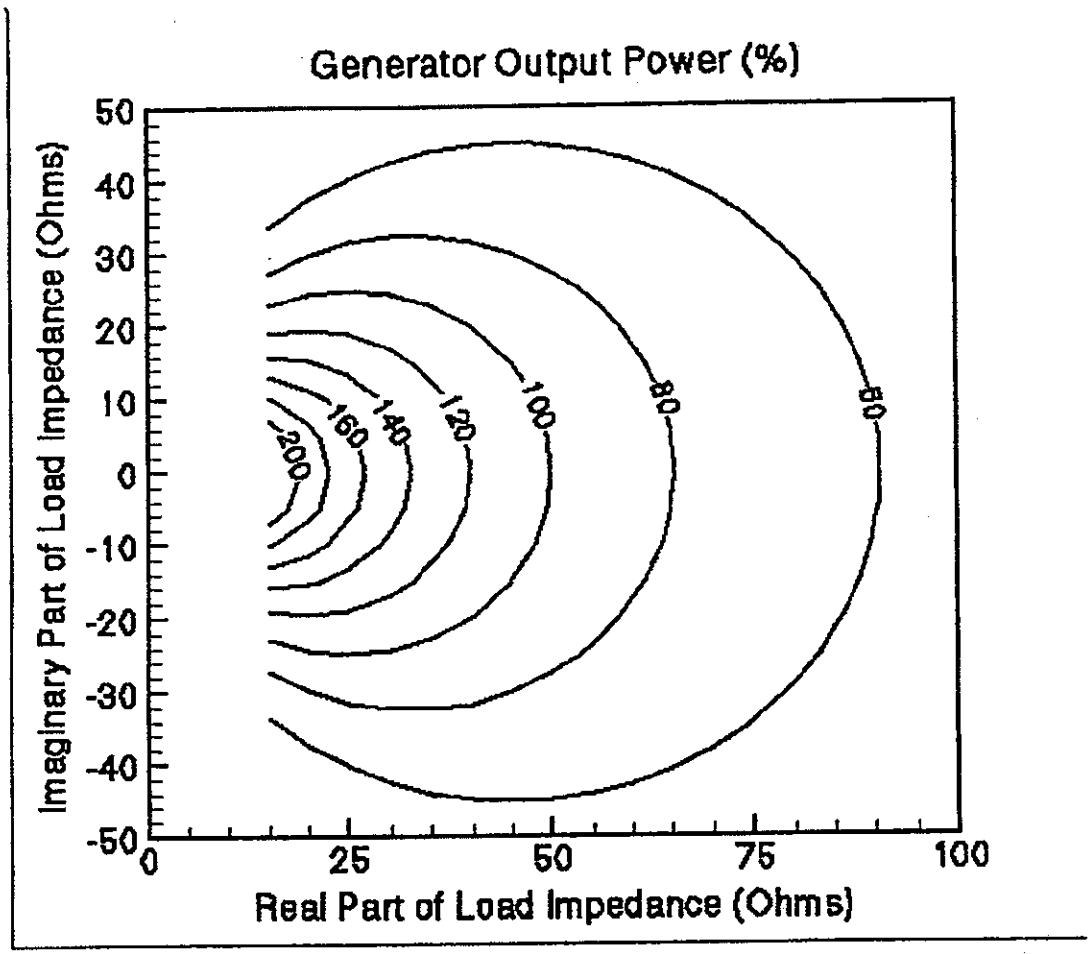

Generator Output Power (%)
Imaginary Part of Load Impedance (Ohms)
50
40
30
20
10
0
-10
-20
-30
-40
-50
0
25
50
75
100
Real Part of Load Impedance (Ohms)
200
160
140
120
100
80
80

Fig. 7B

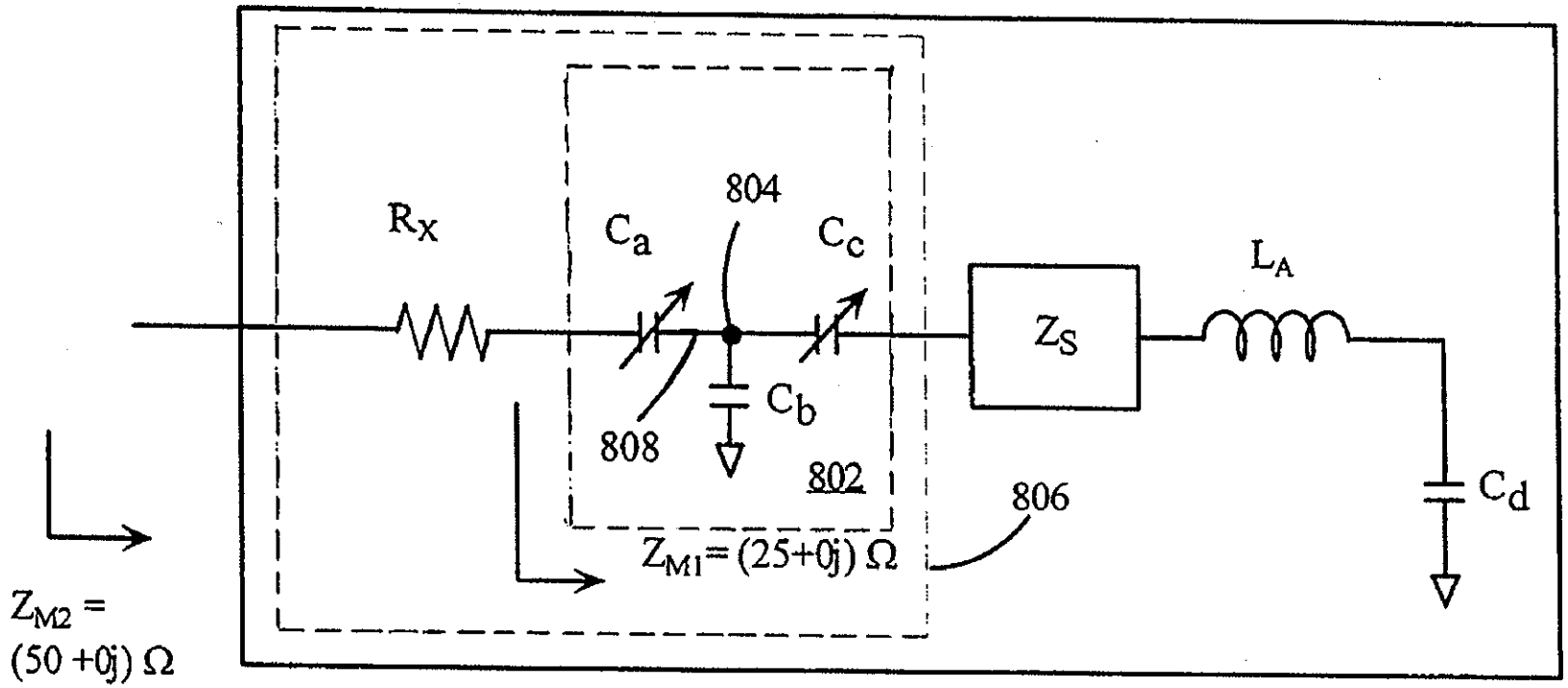

$R_X$
$C_a$
804
$C_c$
$L_A$
$Z_S$
$C_b$
808
802
806
$C_d$
$Z_{M1} = (25+0j)\ \Omega$
$Z_{M2} =$
$(50+0j)\ \Omega$

Fig. 8A

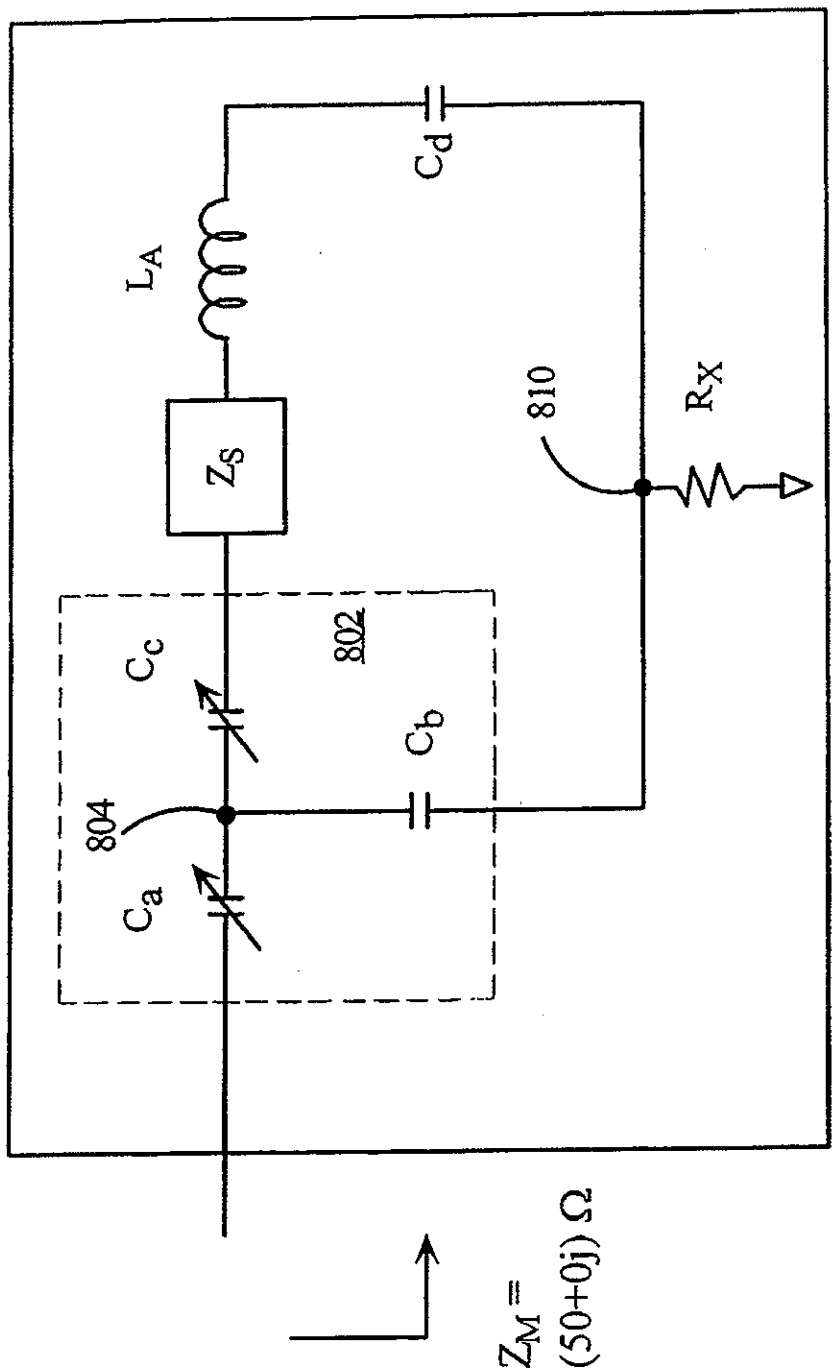



Fig. 8B

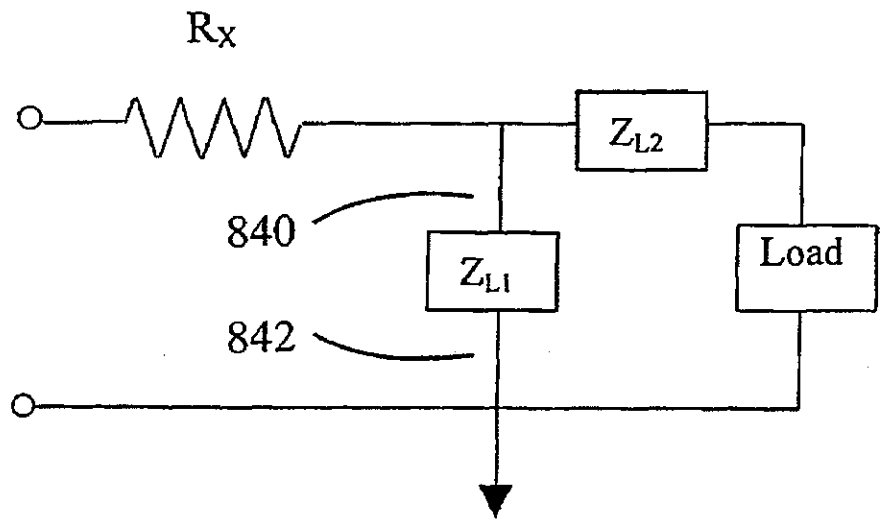



Fig. 8C

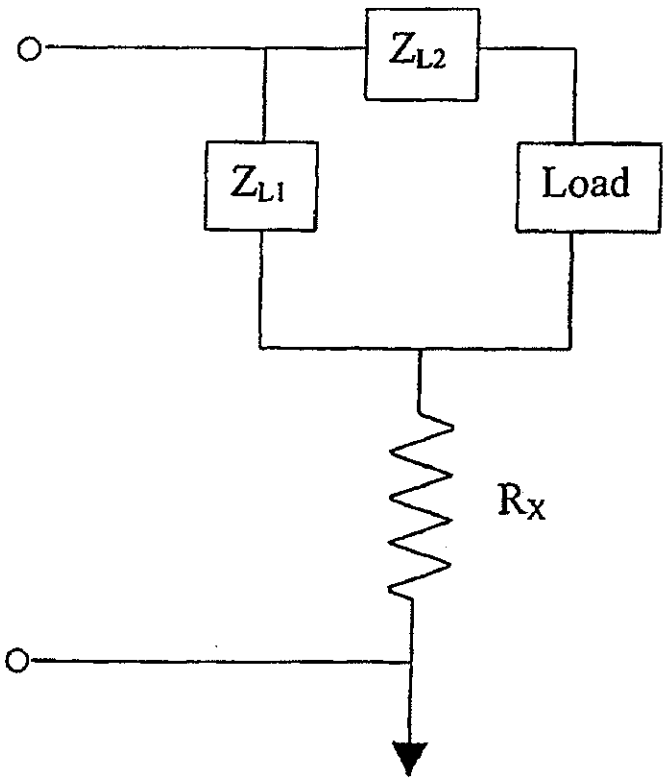



Fig. 8D

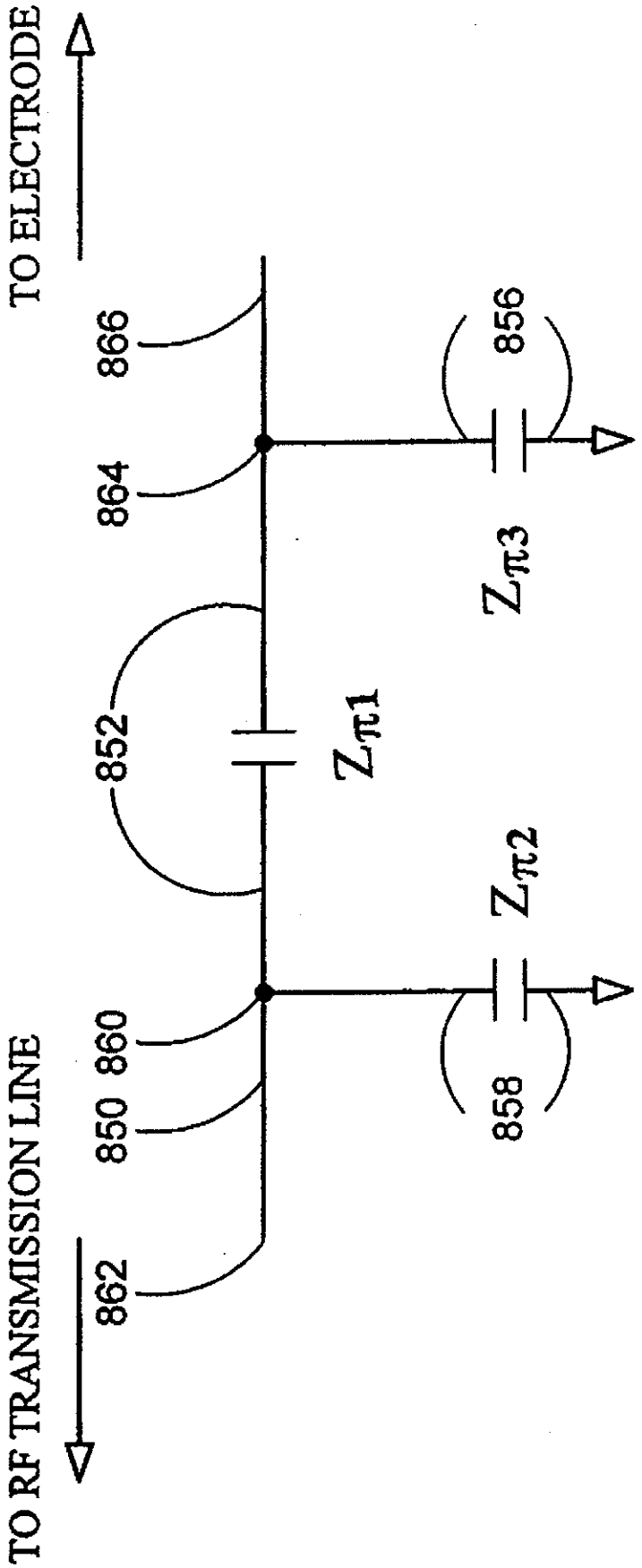

TO ELECTRODE
866
856
864
$Z_{\pi 3}$
852
$Z_{\pi 1}$
$Z_{\pi 2}$
850 860
858
862
TO RF TRANSMISSION LINE

FIG. 8E

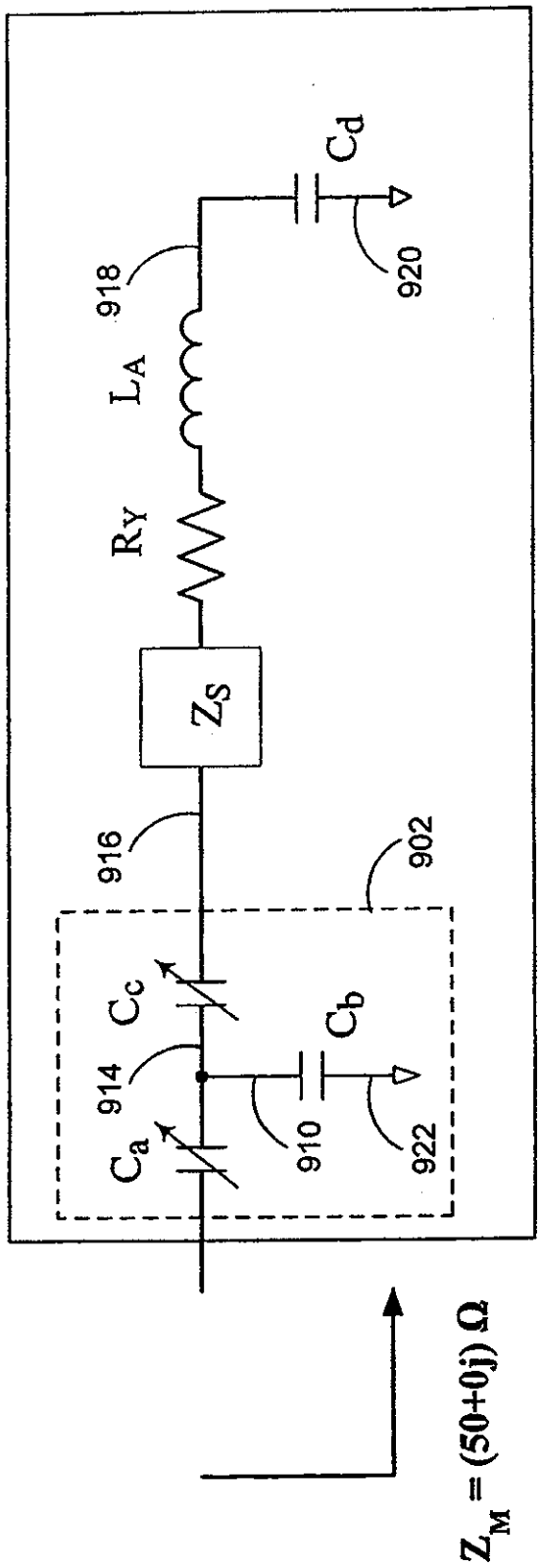



FIG. 9

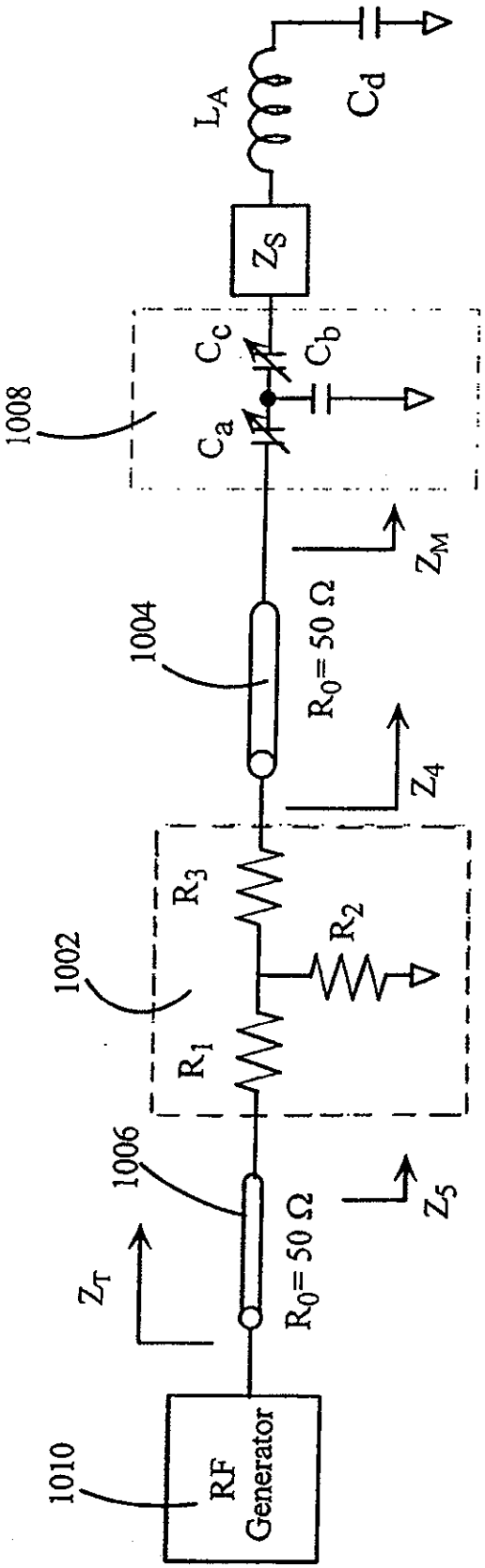



Fig. 10A

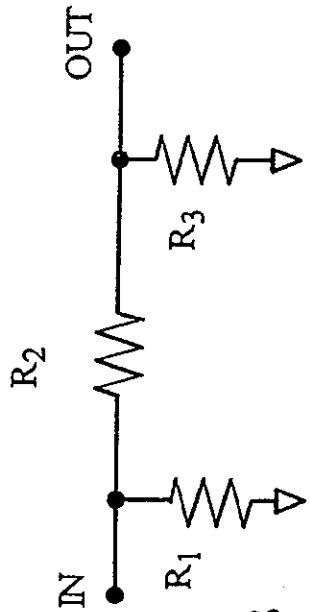



Fig. 10B

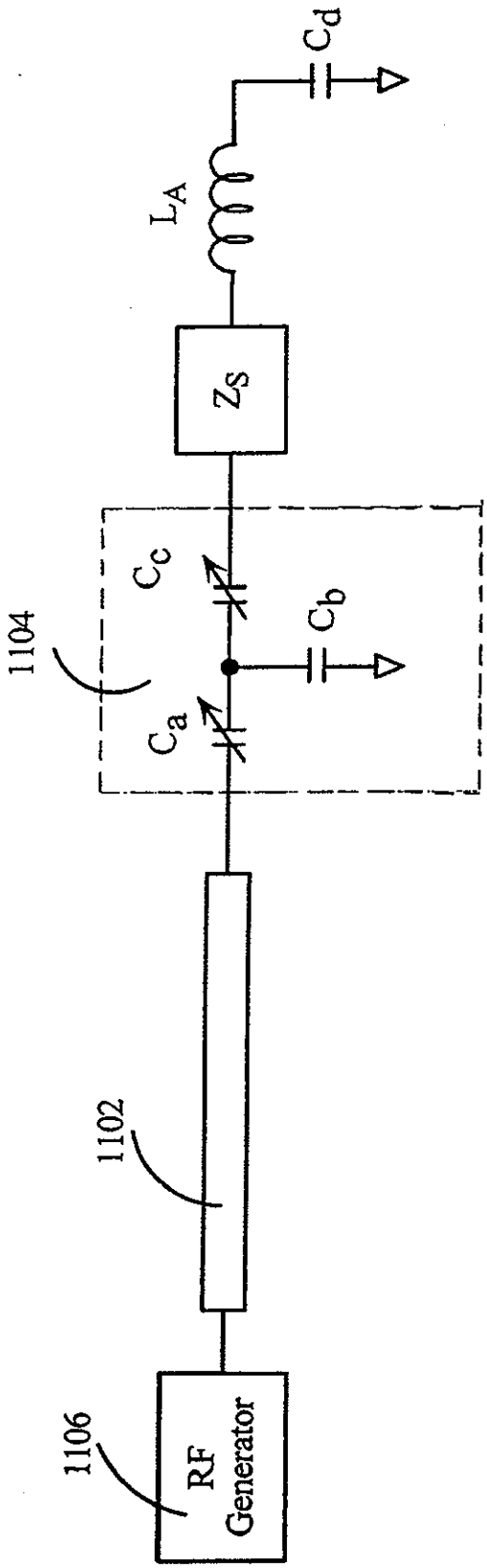



Fig. 11

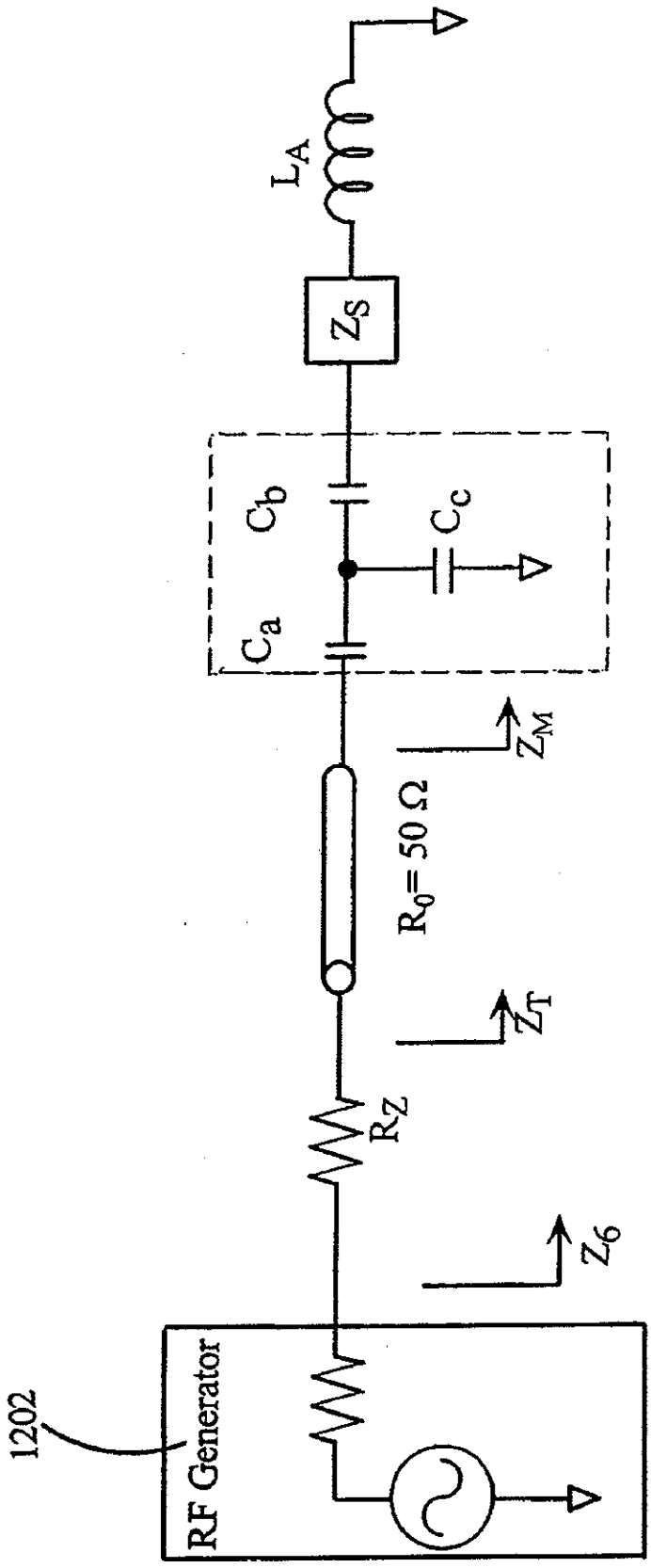
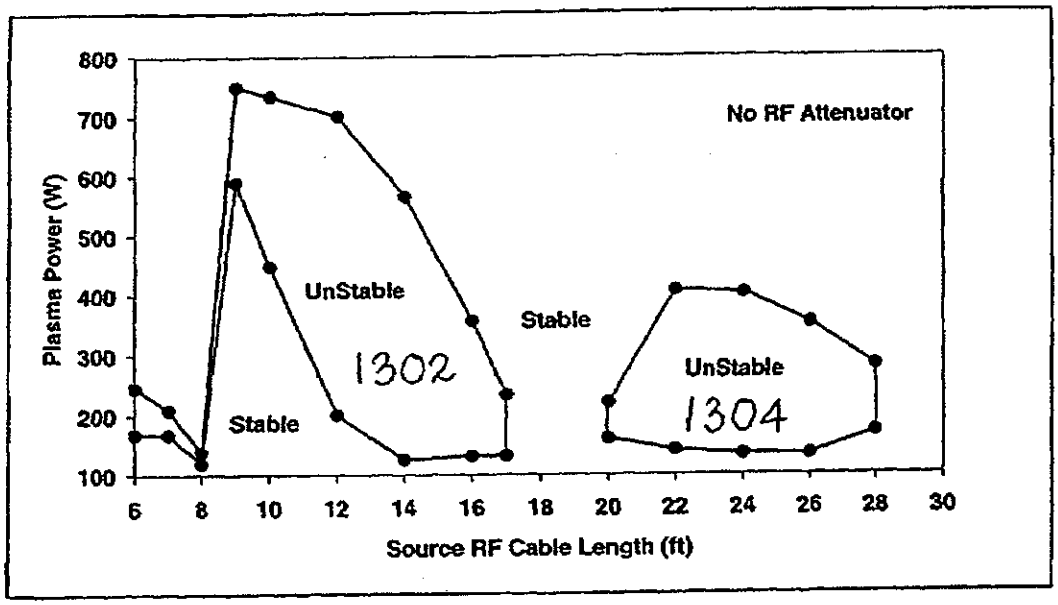



Fig. 12

Fig. 13A



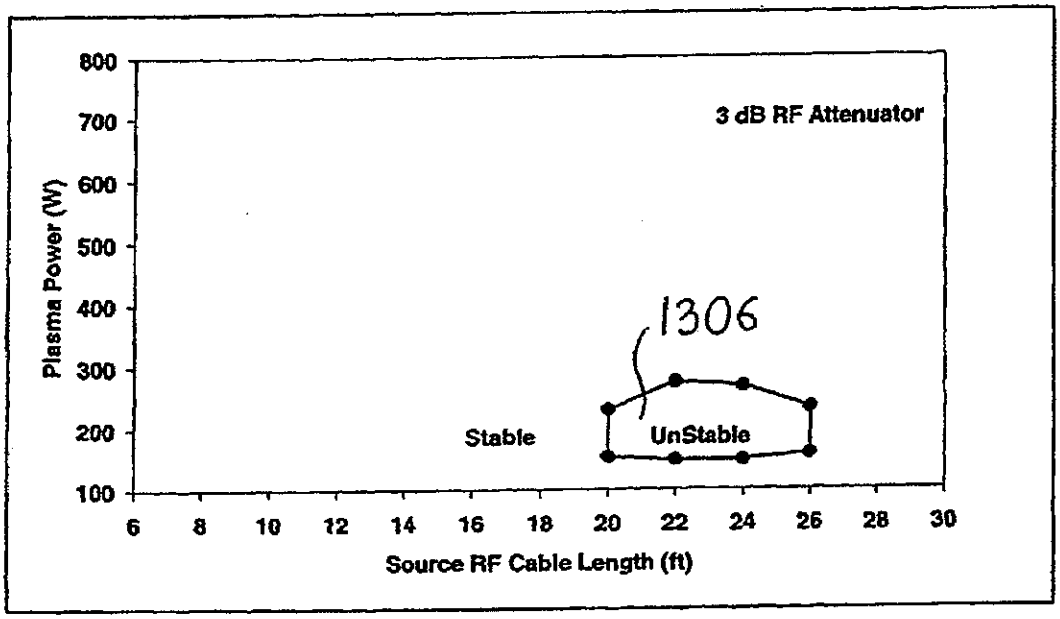




Fig. 13B

Fig 14

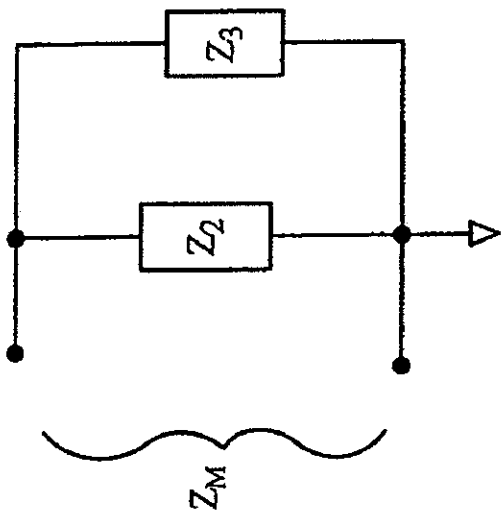
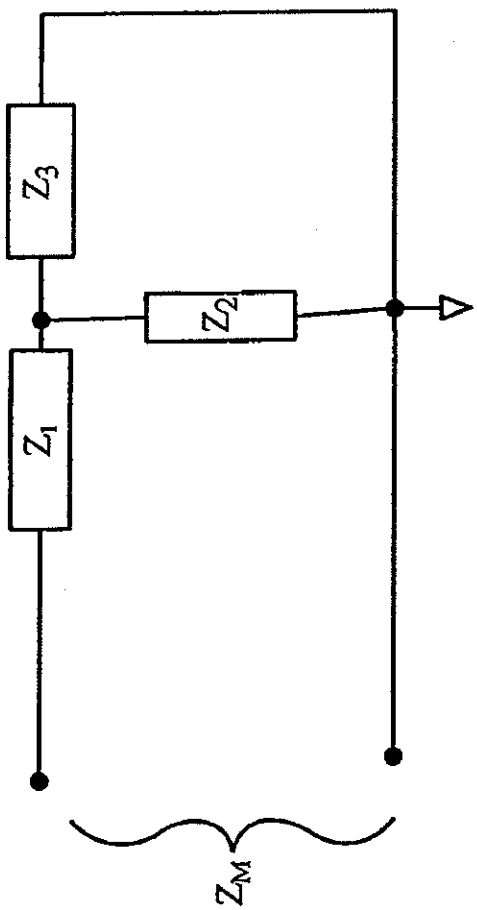



Fig 15



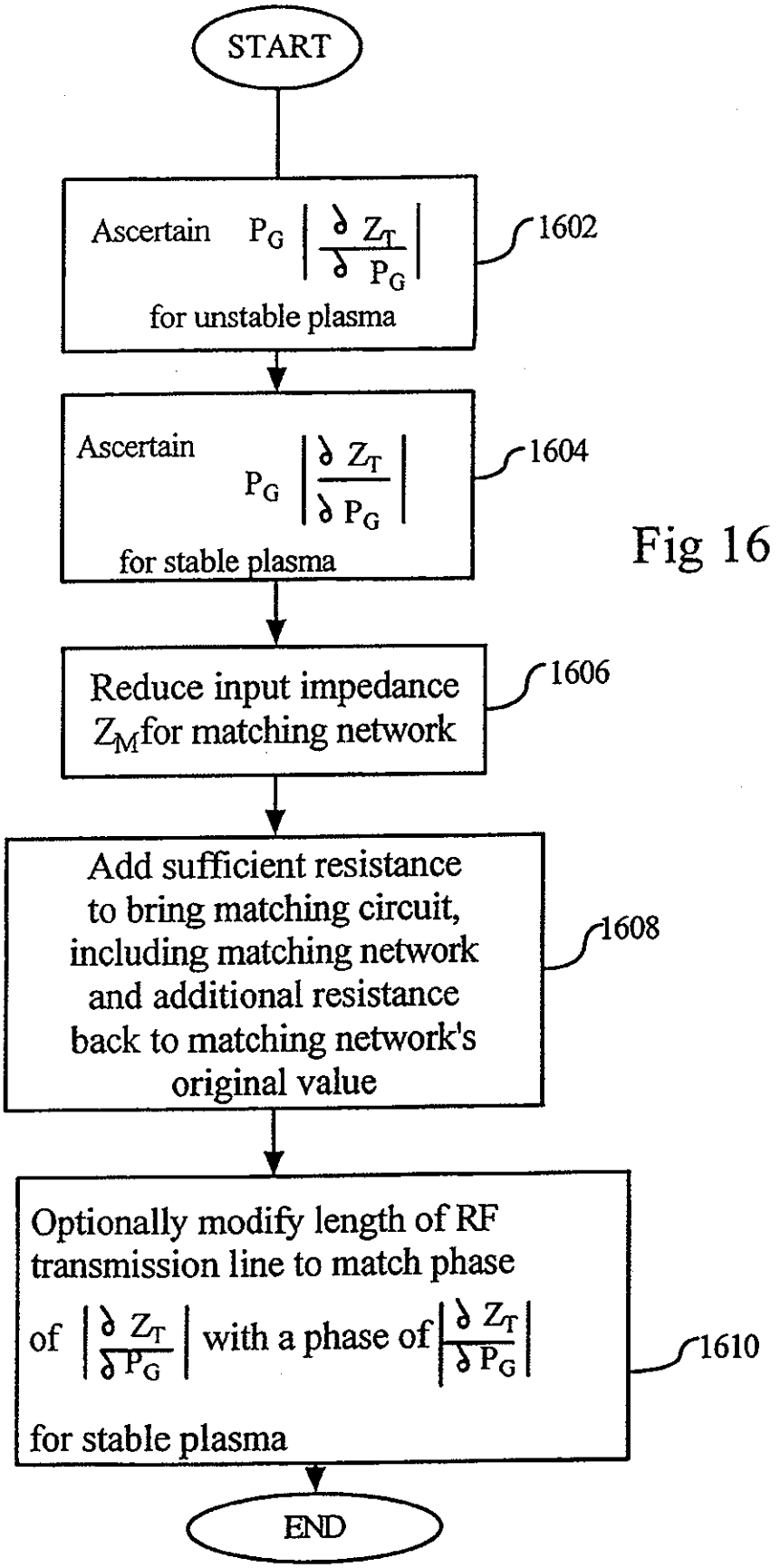

START
Ascertain $P_G \left| \frac{\partial Z_T}{\partial P_G} \right|$ for unstable plasma
1602
Ascertain $P_G \left| \frac{\partial Z_T}{\partial P_G} \right|$ for stable plasma
1604
Reduce input impedance $Z_M$ for matching network
1606
Add sufficient resistance to bring matching circuit, including matching network and additional resistance back to matching network's original value
1608
Optionally modify length of RF transmission line to match phase of $\left| \frac{\partial Z_T}{\partial P_G} \right|$ with a phase of $\left| \frac{\partial Z_T}{\partial P_G} \right|$ for stable plasma
1610
END

Fig 16

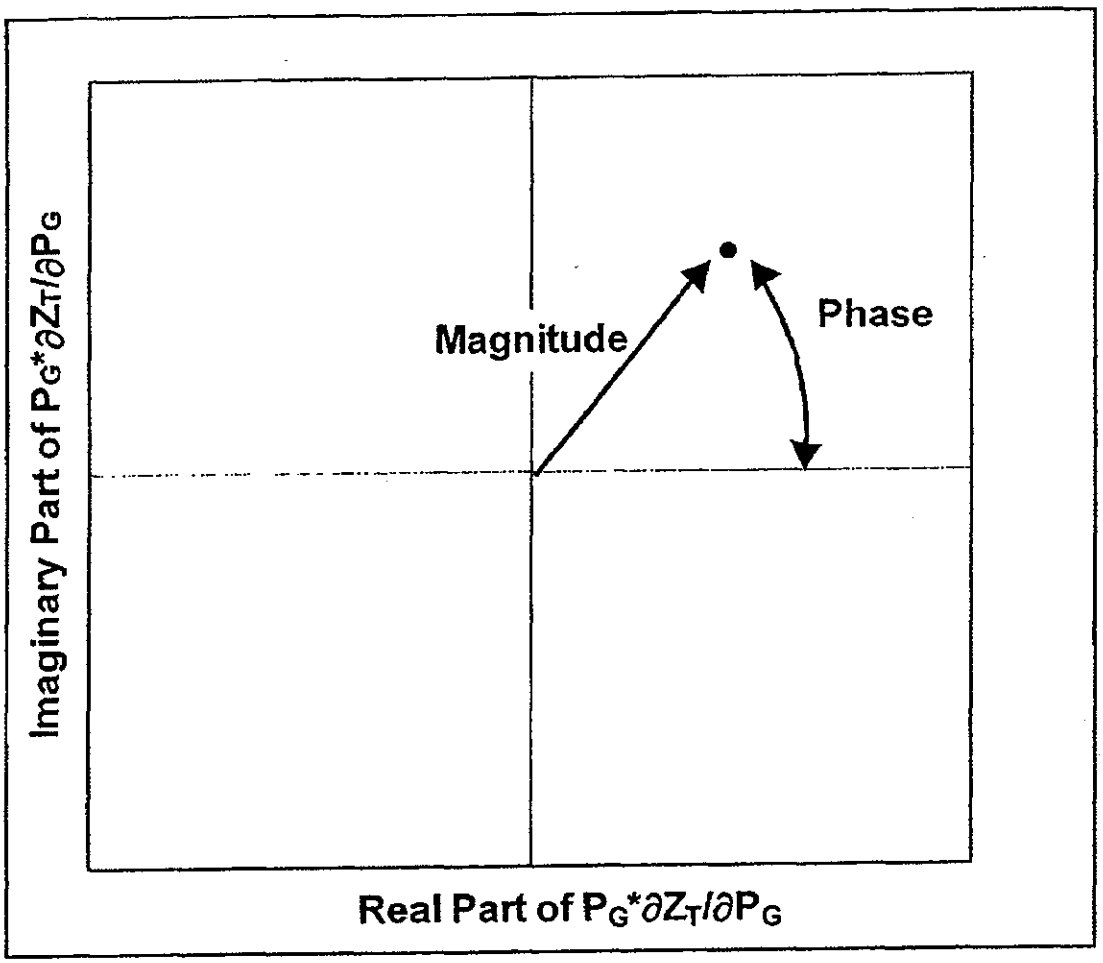

Magnitude
Phase
Imaginary Part of $P_G*\partial Z_T/\partial P_G$
Real Part of $P_G*\partial Z_T/\partial P_G$

Fig. 17A

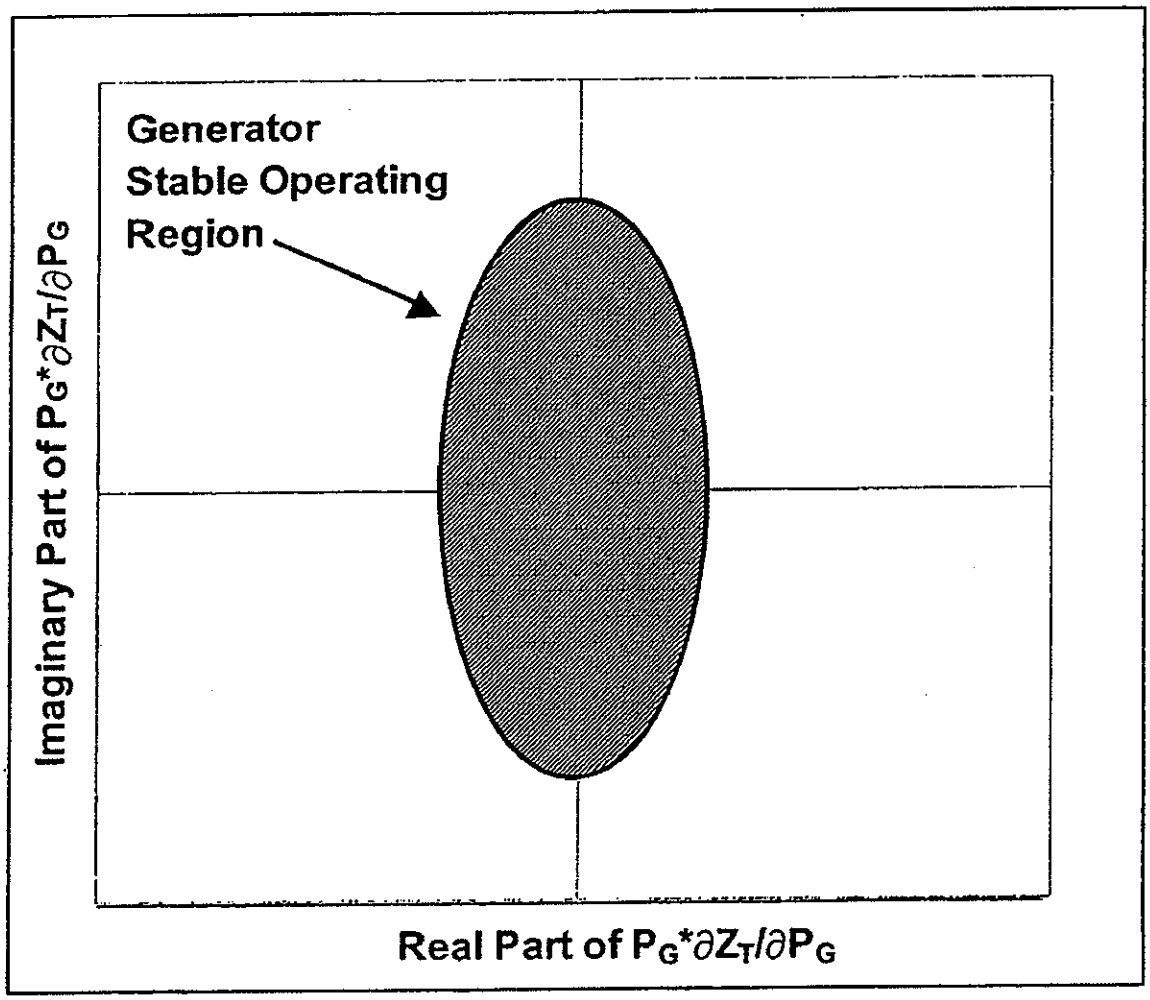

Generator
Stable Operating
Region
Imaginary Part of $P_G*\partial Z_T/\partial P_G$
Real Part of $P_G*\partial Z_T/\partial P_G$

Fig. 17B

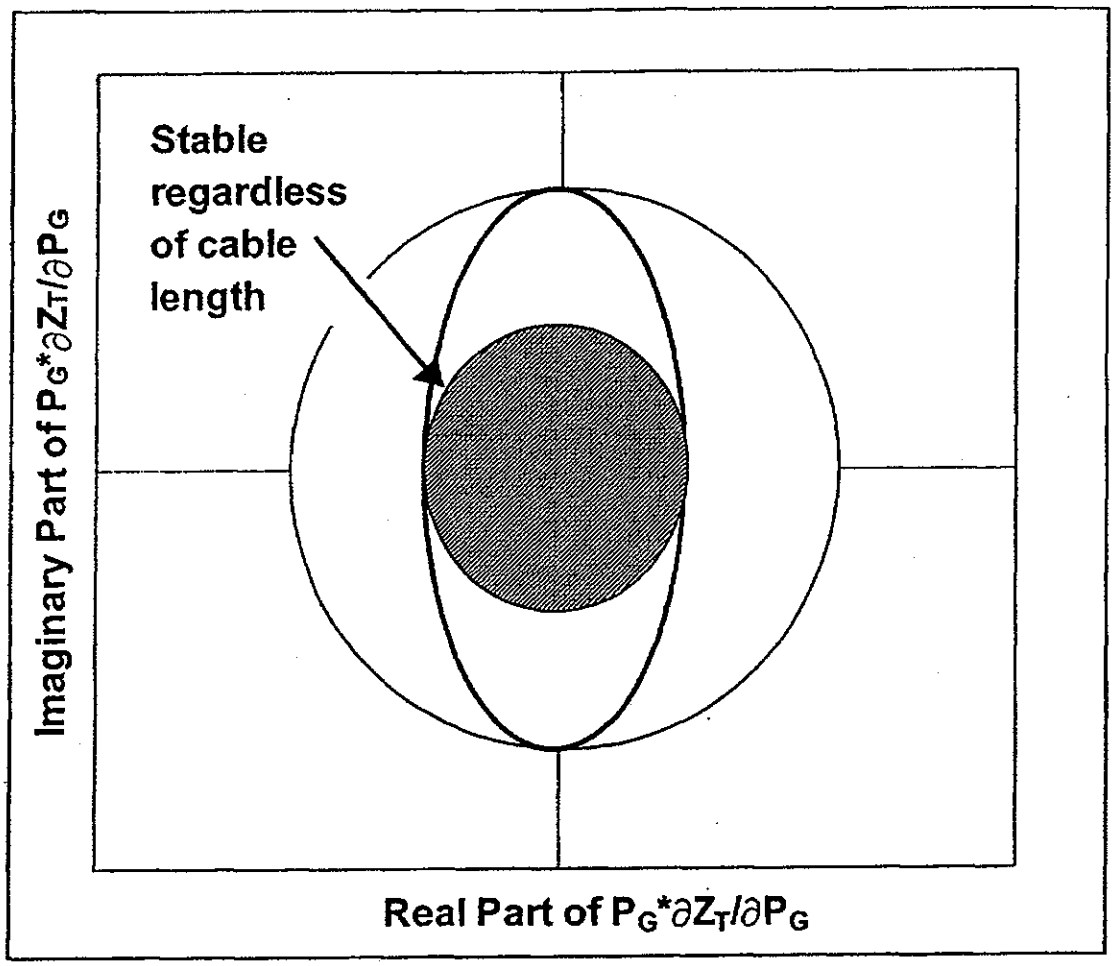

Stable
regardless
of cable
length
Imaginary Part of $P_G^*\partial Z_T/\partial P_G$
Real Part of $P_G^*\partial Z_T/\partial P_G$

Fig. 17C

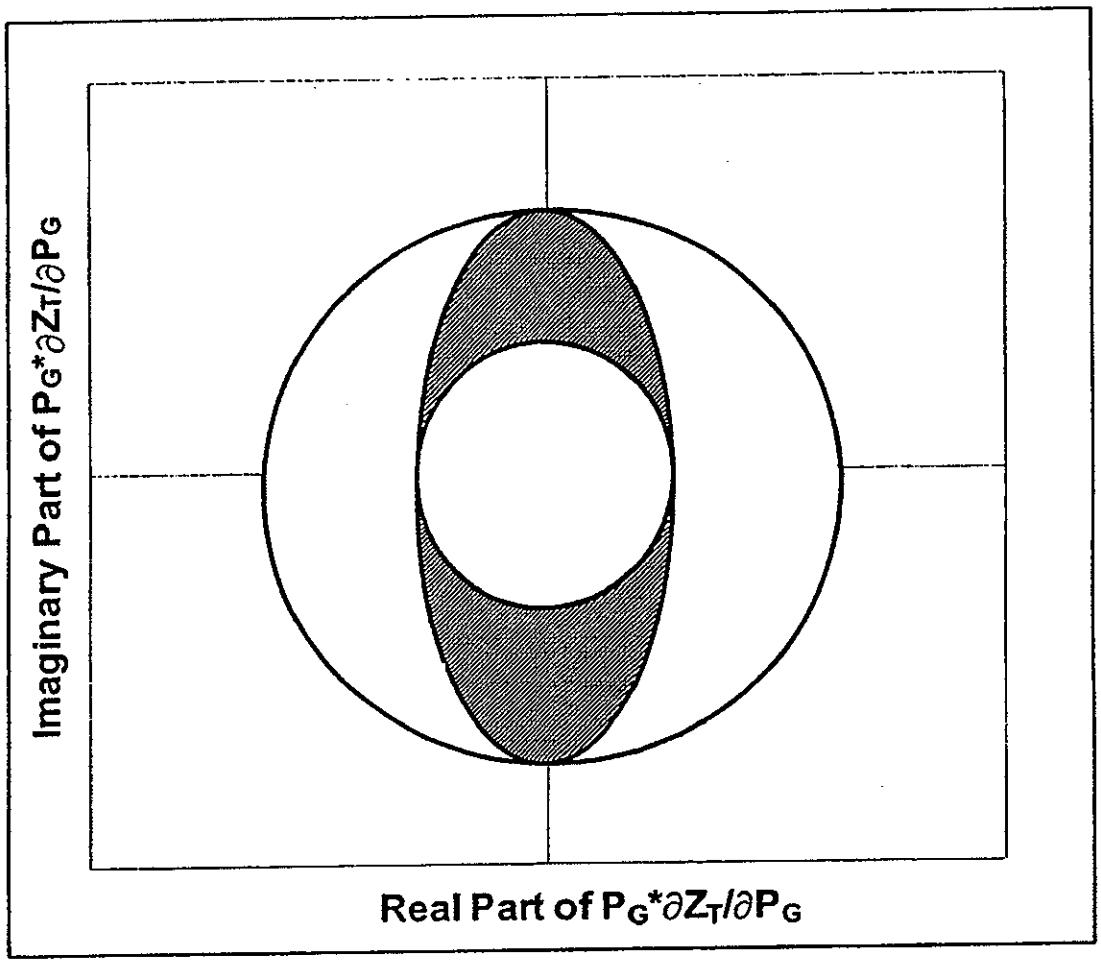

Imaginary Part of $P_G*\partial Z_T/\partial P_G$
Real Part of $P_G*\partial Z_T/\partial P_G$

Fig. 17D

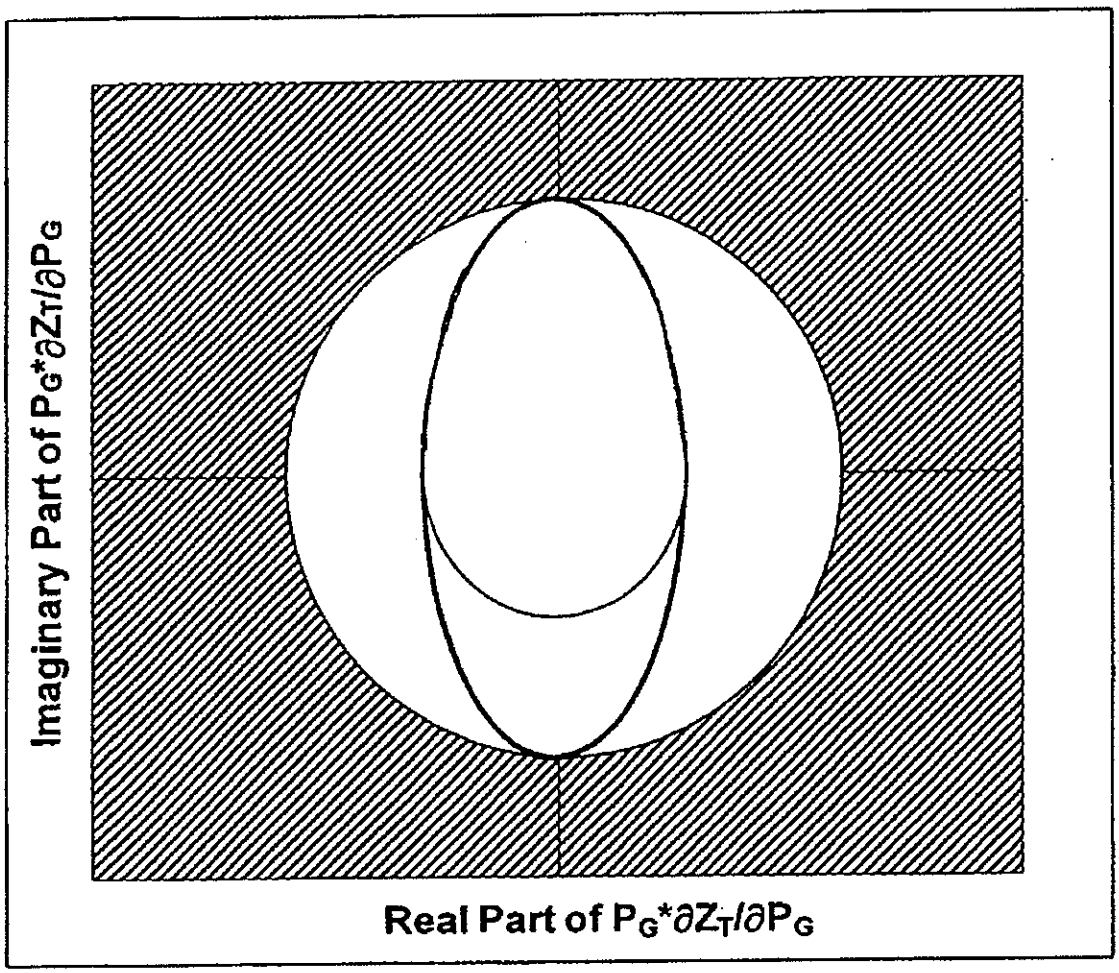

Imaginary Part of $P_G * \partial Z_T / \partial P_G$
Real Part of $P_G * \partial Z_T / \partial P_G$

Fig. 17E