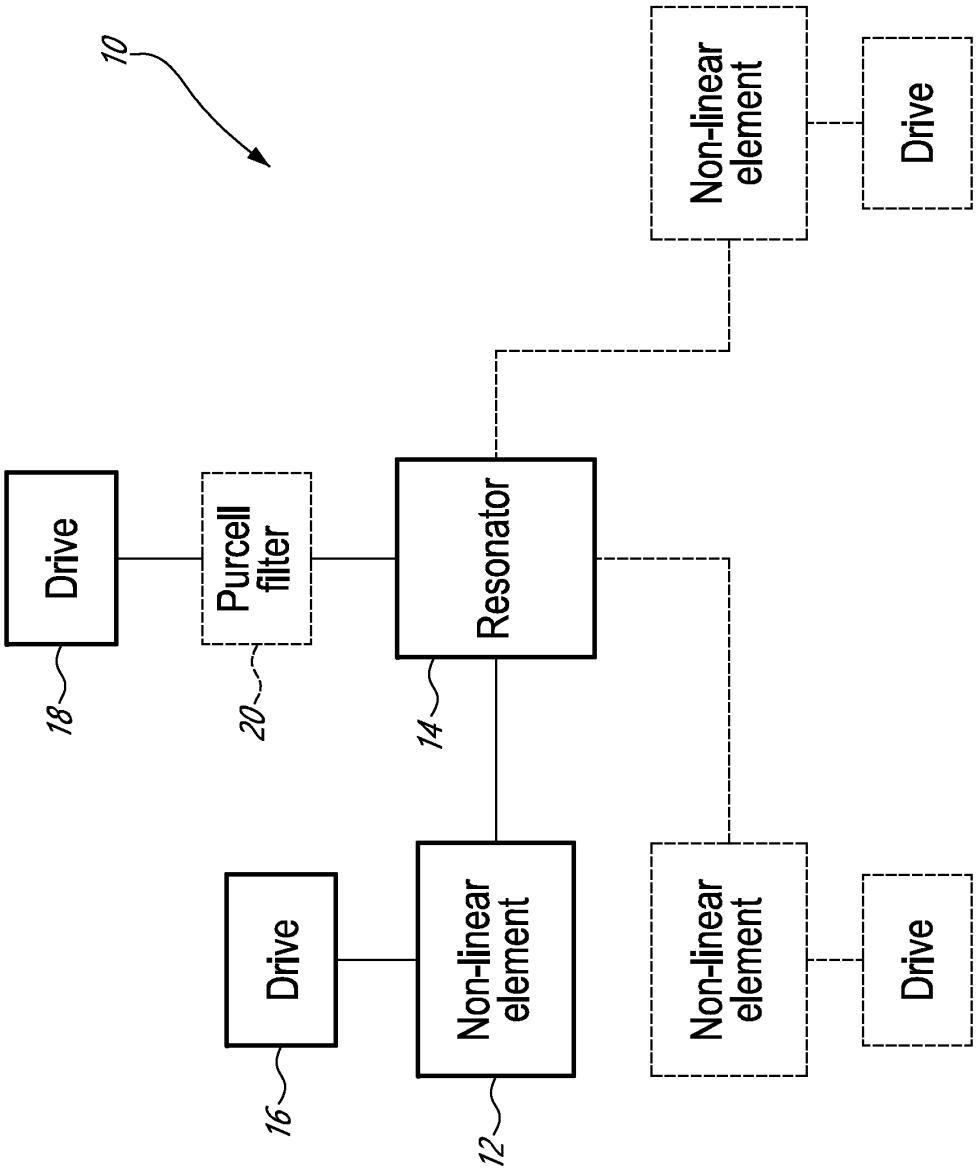

10
Non-linear element
Drive
Drive
Purcell filter
Resonator
18
20
14
Drive
Non-linear element
Non-linear element
Drive
16
12

Fig. 1

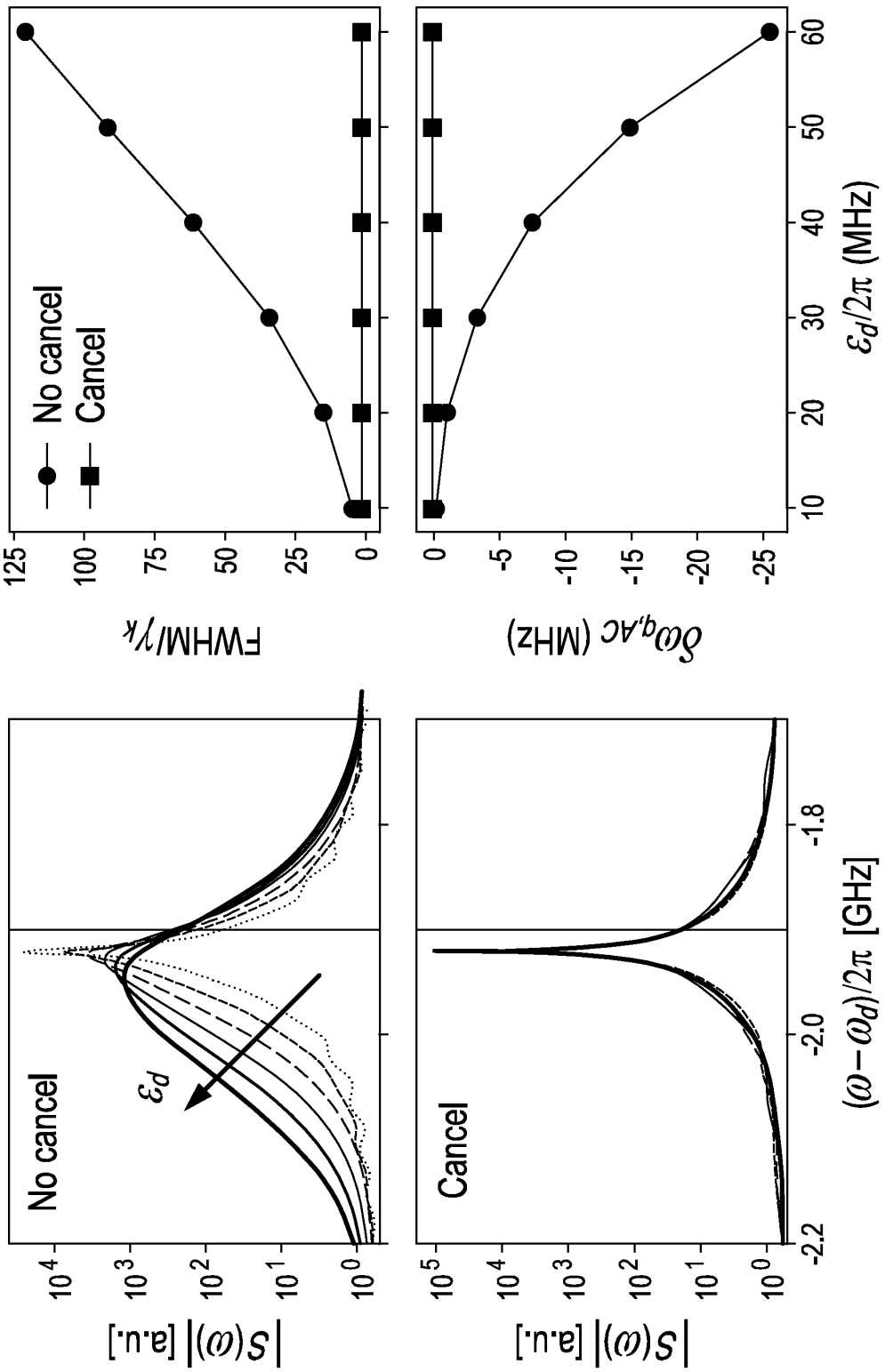

No cancel
Cancel
FWHM/γ_k
$\delta\omega_{q,AC}$ (MHz)
$\varepsilon_d/2\pi$ (MHz)
No cancel
ε_d
Cancel
$|S(\omega)|$ [a.u.]
$(\omega-\omega_d)/2\pi$ [GHz]

Fig. 2

18
ϵ_d
resonator
14
12
non-linear element
16
$\epsilon_q = r_a e^{i\varphi} f(\epsilon_d)$
FIG. 3A
$|\Gamma_{AC} + i\omega_{AC}|/2\pi$ (kHz)
10^2
10^1
10^0
-0.4
-0.2
0.0
0.2
0.4
$\phi/2\pi$
FIG. 3B
$|\Gamma_{AC} + i\omega_{AC}|/2\pi$ (kHz)
120
100
80
60
40
20
0
ϵ_q off
ϵ_q on
0.0
0.2
0.4
0.6
0.8
$(\epsilon_d/2\pi)^2$ (MHz^2)
FIG. 3D
$|\Gamma_{AC} + i\omega_{AC}|/2\pi$ (kHz)
10
8
6
4
2
0
0.6
0.8
1.0
1.2
1.4
r_a
FIG. 3C

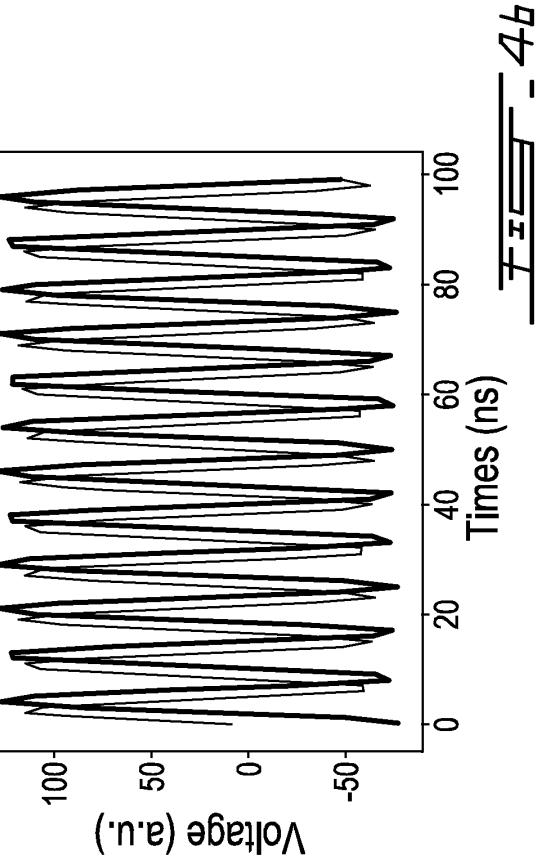


Fig - 4b

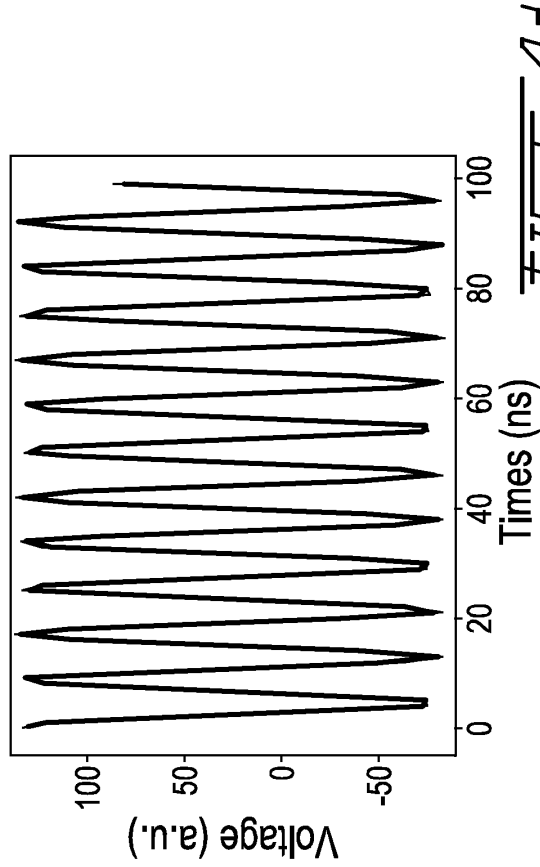


Fig - 4d

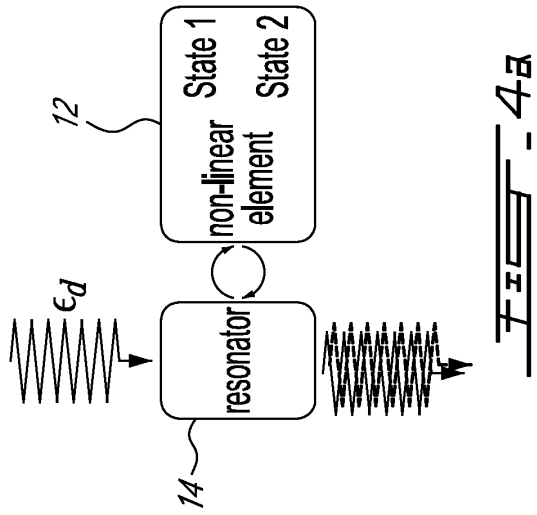


Fig - 4a

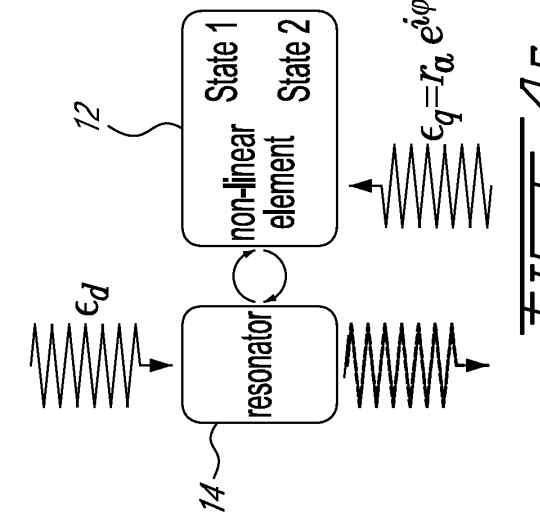


Fig - 4c

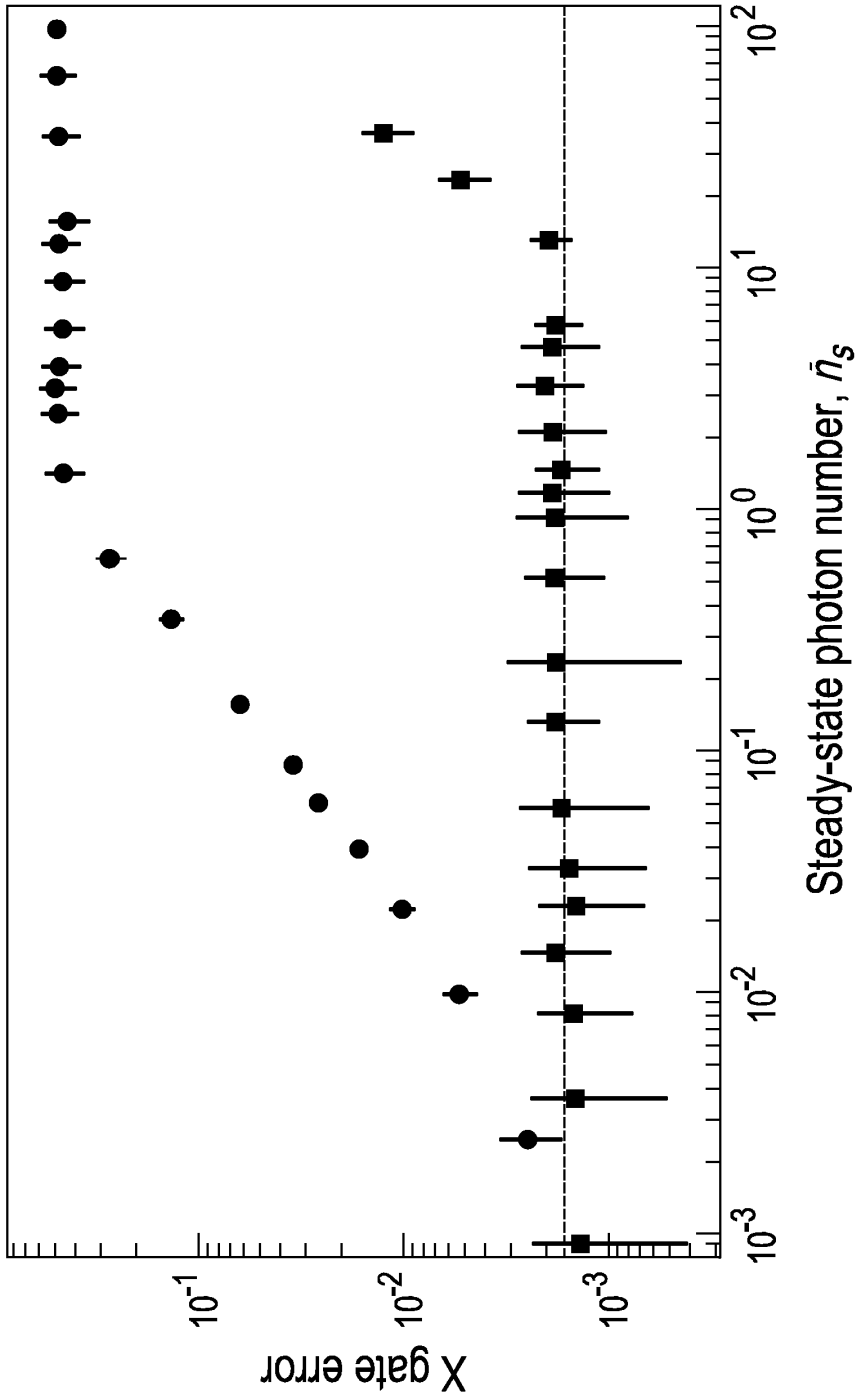
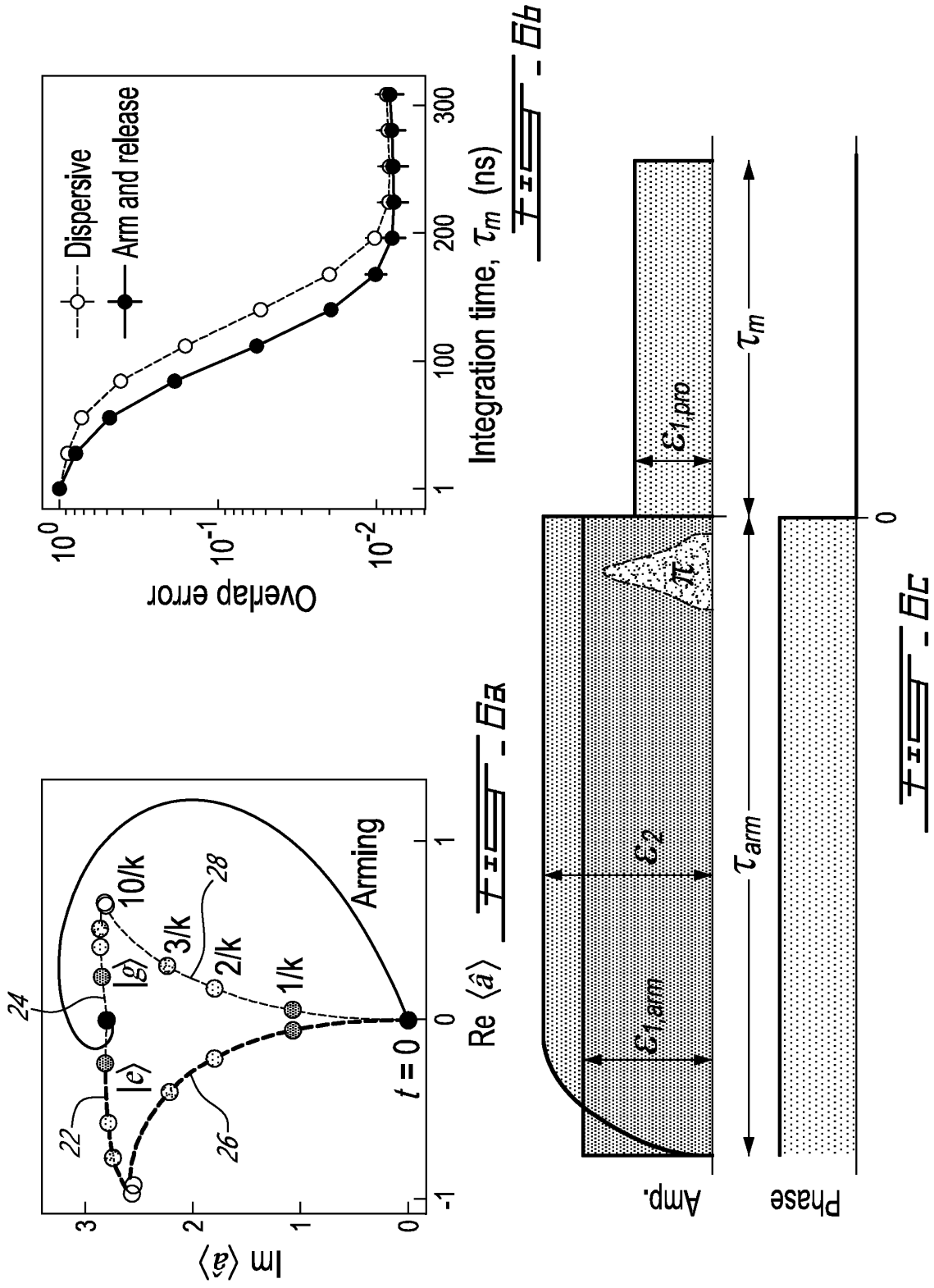

X gate error
10^{-1}
10^{-2}
10^{-3}
Steady-state photon number, $\bar{n}_s$
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}

Fig. 5


Overlap error
Dispersive
Arm and release
Integration time, τ_m (ns)
Fig. 6b
Im $\langle \hat{a} \rangle$
Re $\langle \hat{a} \rangle$
Arming
$t = 0$
$|g\rangle$
$|e\rangle$
10/k
3/k
2/k
1/k
22
24
26
28
Fig. 6a
Amp.
Phase
$\varepsilon_{1,arm}$
ε_2
$\varepsilon_{1,pro}$
τ_{arm}
τ_m
0
Fig. 6c

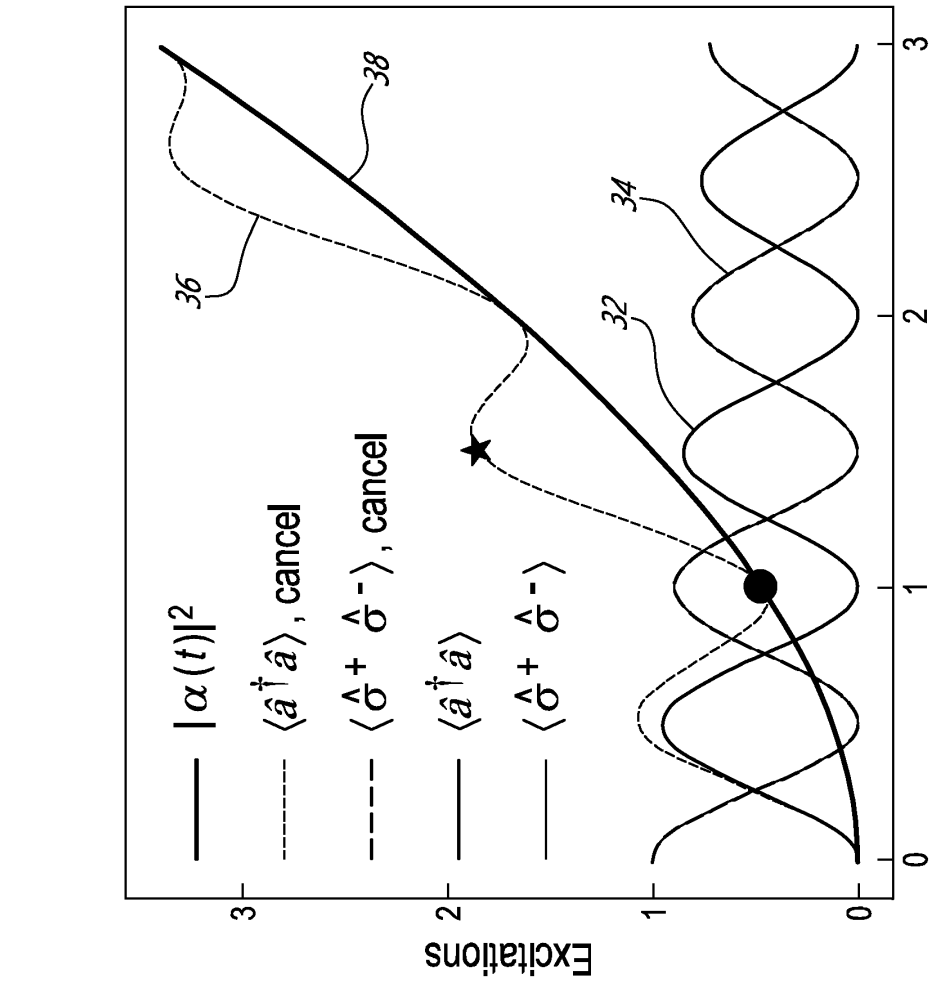

Excitations
Rabi periods, $(2\pi/2g)$
$|\alpha(t)|^2$
$\langle \hat{a}^\dagger \hat{a} \rangle$, cancel
$\langle \hat{\sigma}^+ \hat{\sigma}^- \rangle$, cancel
$\langle \hat{a}^\dagger \hat{a} \rangle$
$\langle \hat{\sigma}^+ \hat{\sigma}^- \rangle$
36
38
32
34

Fig. 7a

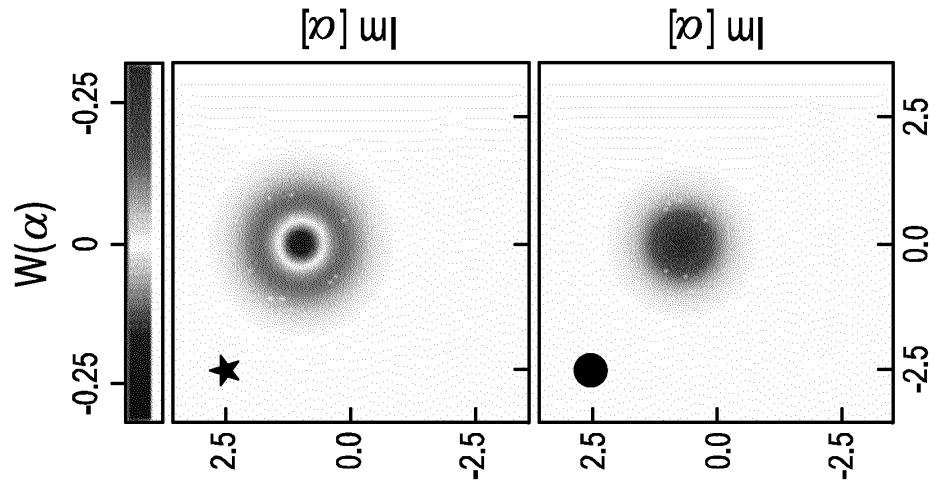

W(α)
Im [α]
Re [α]

Fig. 7b

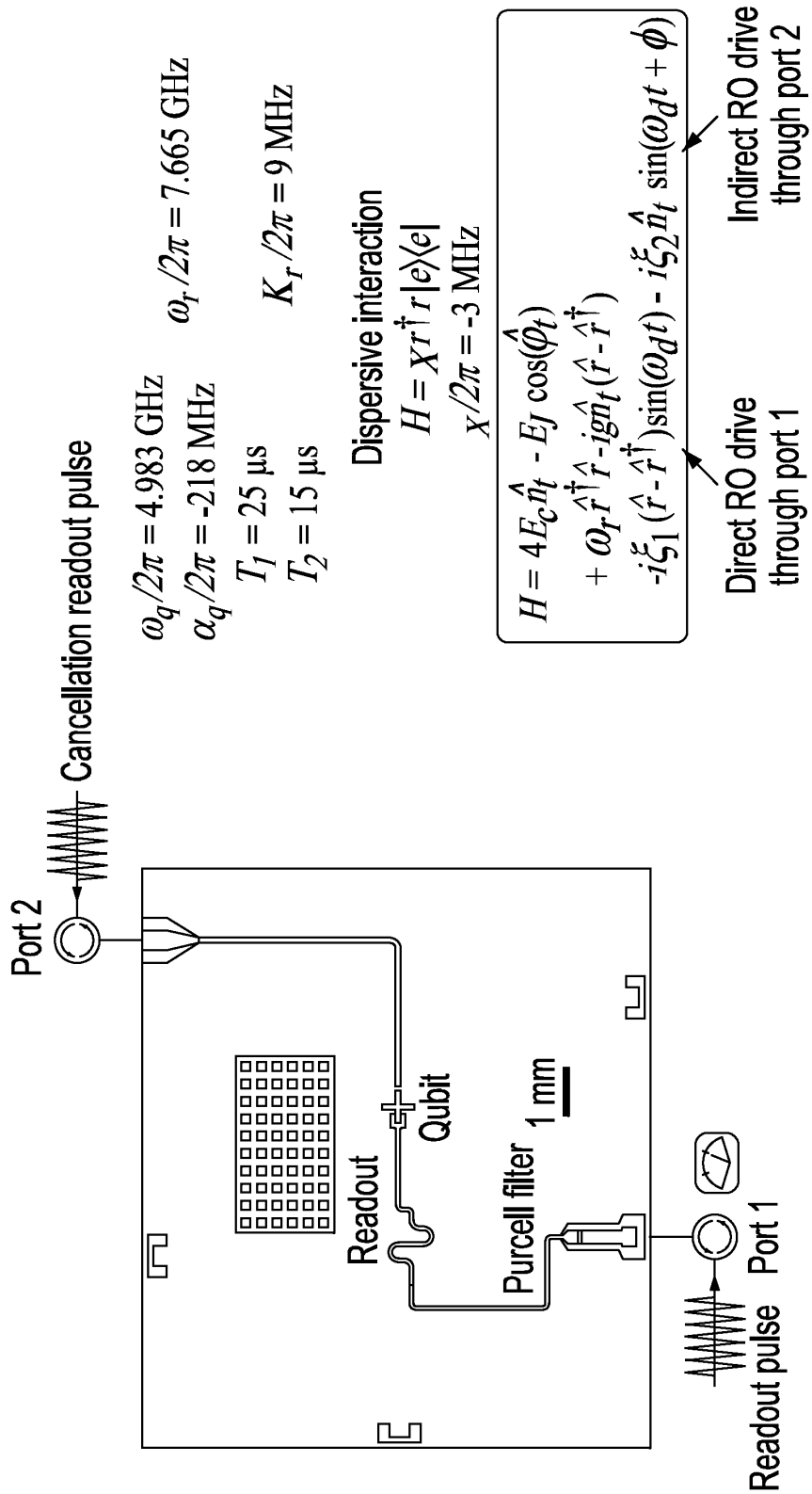
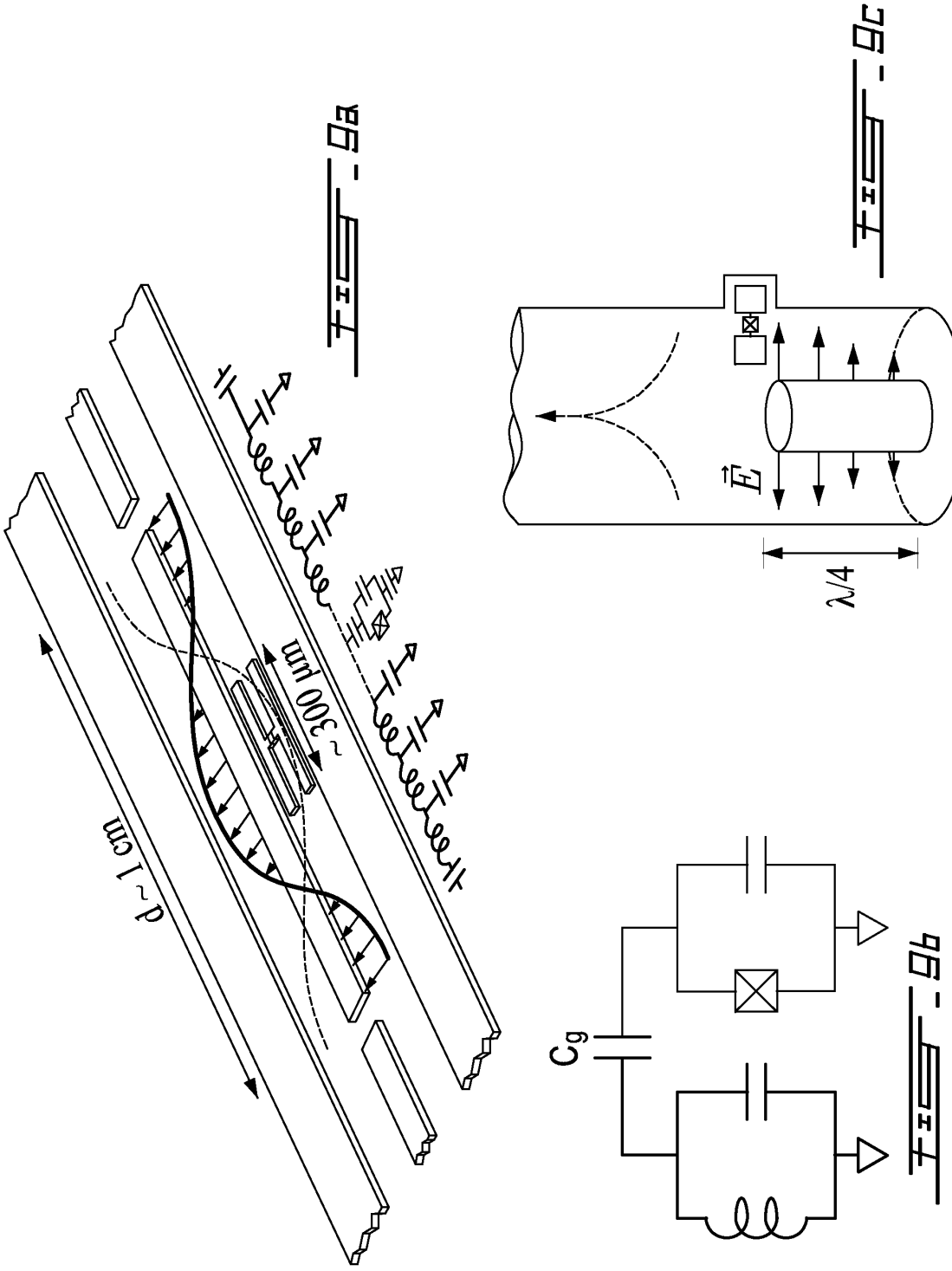

Port 2
Cancellation readout pulse
$\omega_q/2\pi = 4.983$ GHz
$\alpha_q/2\pi = -218$ MHz
$T_1 = 25$ µs
$T_2 = 15$ µs
$\omega_r/2\pi = 7.665$ GHz
$K_r/2\pi = 9$ MHz
Dispersive interaction
$H = \chi r^\dagger r |e\rangle\langle e|$
$\chi/2\pi = -3$ MHz
$H = 4E_c\hat{n}_t^2 - E_J\cos(\hat{\varphi}_t)$
$+ \omega_r \hat{r}^\dagger \hat{r} - ig\hat{n}_t(\hat{r} - \hat{r}^\dagger)$
$-i\xi_1(\hat{r} - \hat{r}^\dagger)\sin(\omega_d t) - i\xi_2\hat{n}_t \sin(\omega_d t + \phi)$
Direct RO drive through port 1
Indirect RO drive through port 2
Readout
Qubit
Purcell filter
1 mm
Readout pulse
Port 1

Fig. 8


λ/4
$\vec{E}$
C_g
d ~ 1 cm
~ 300 µm

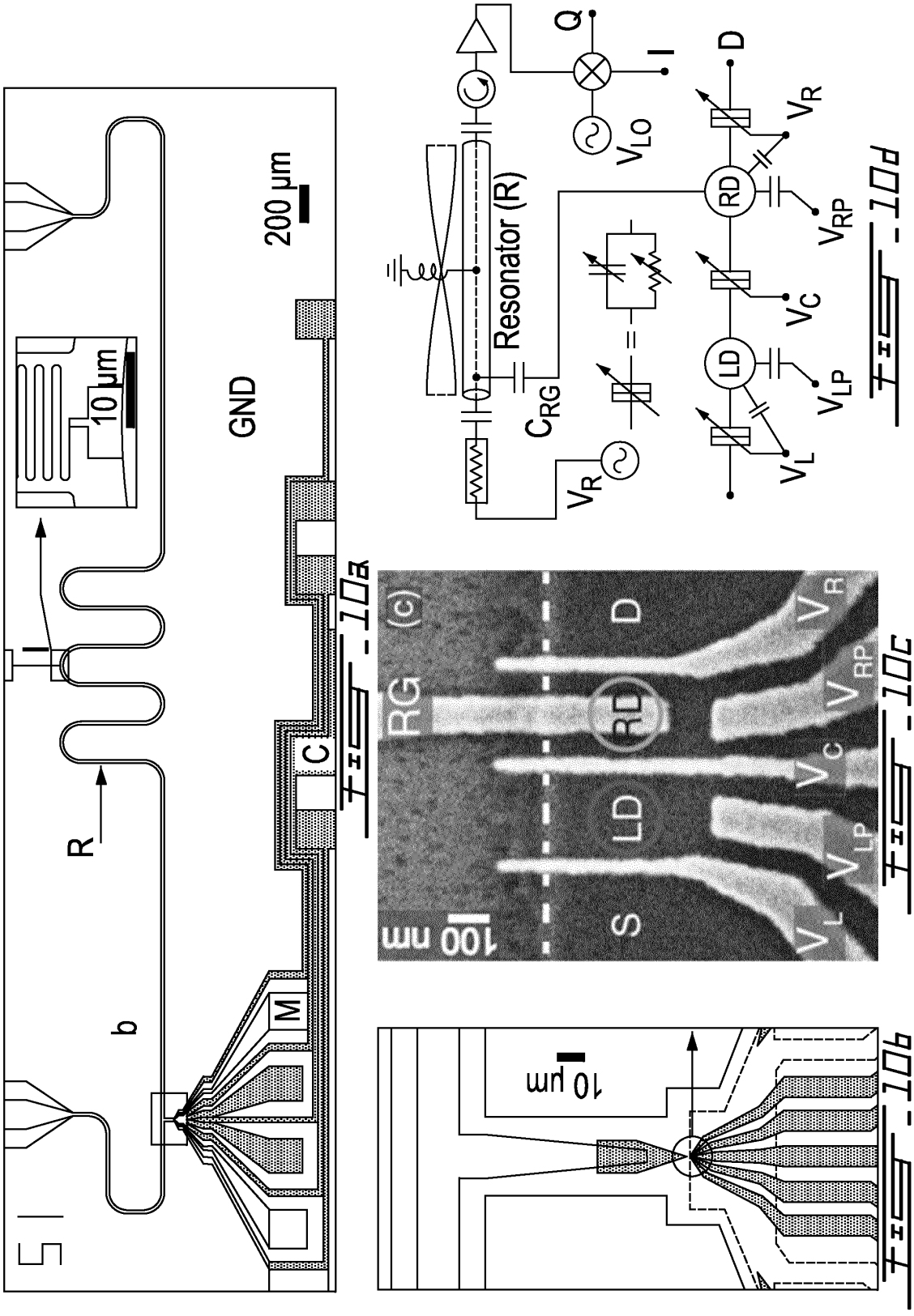


Fig. 10a Fig. 10d Fig. 10c Fig. 10b

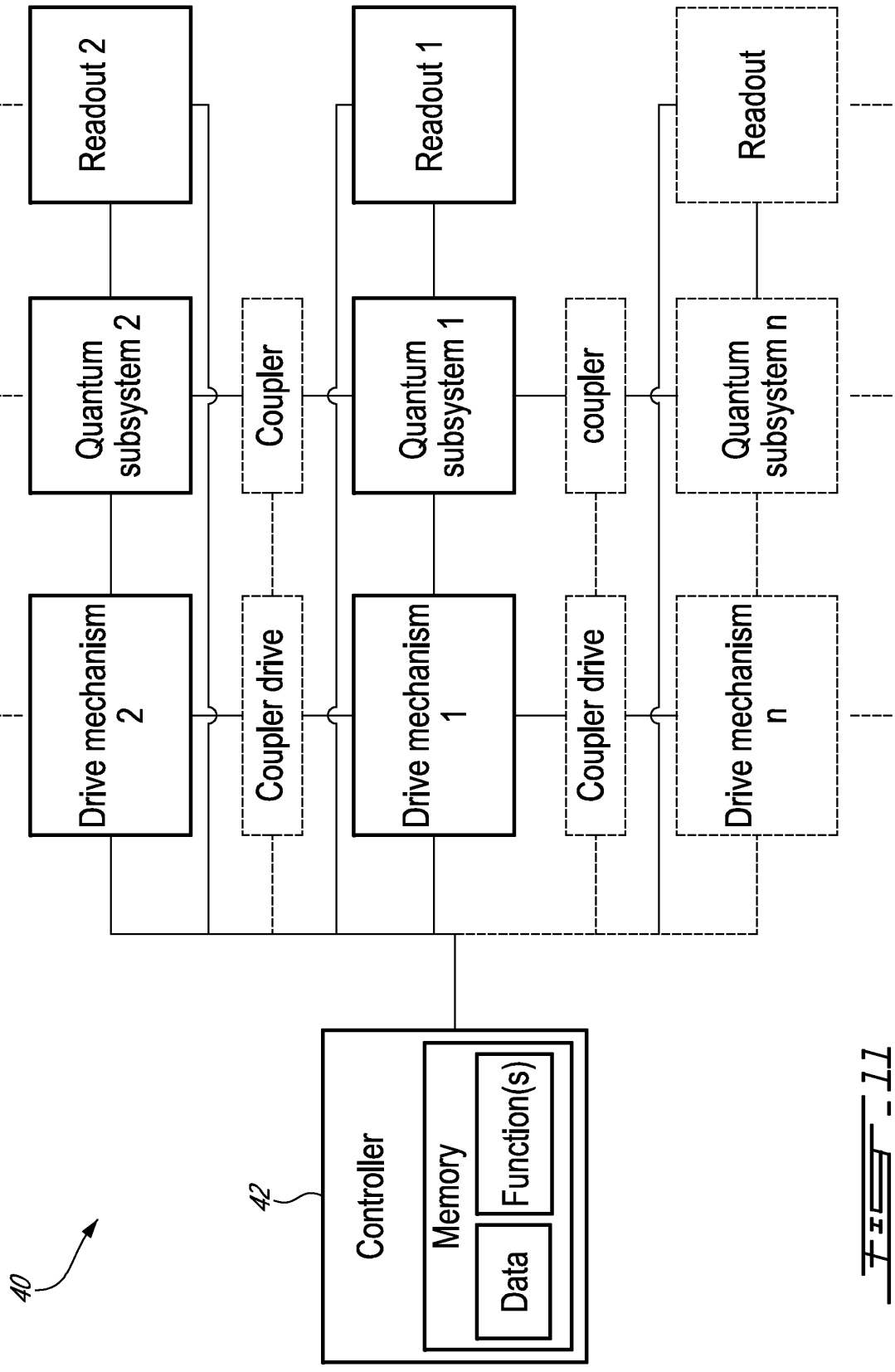

Readout 2
Readout 1
Readout
Quantum subsystem 2
Coupler
Quantum subsystem 1
coupler
Quantum subsystem n
Drive mechanism 2
Coupler drive
Drive mechanism 1
Coupler drive
Drive mechanism n
Controller
Memory
Function(s)
Data
42
40

Fig. 11