

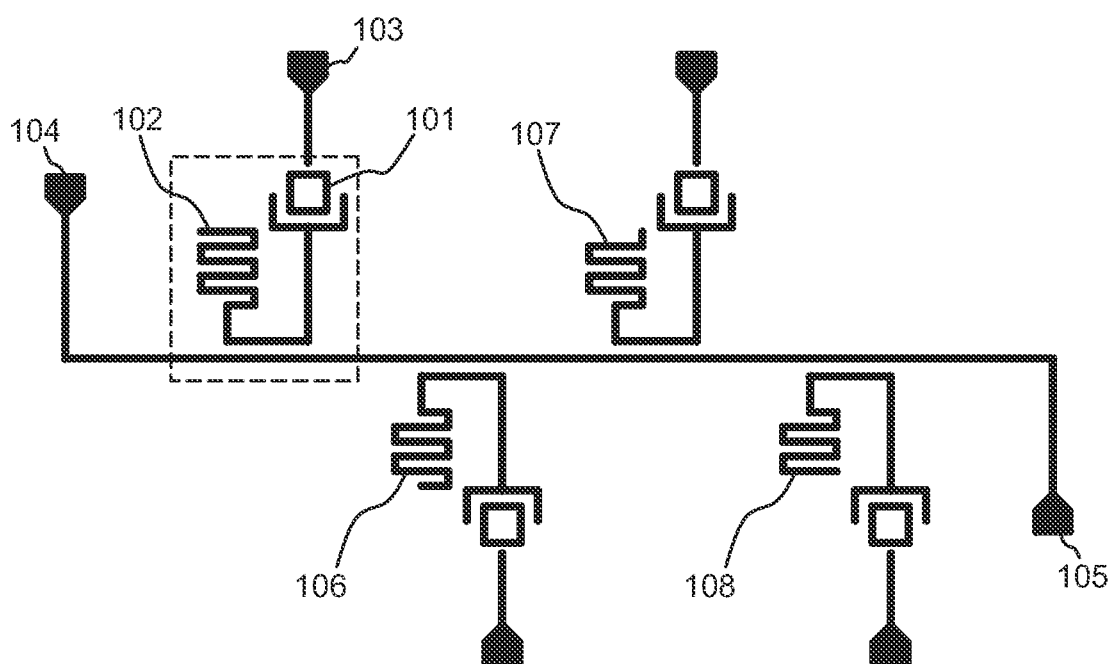


Fig. 1
PRIOR ART

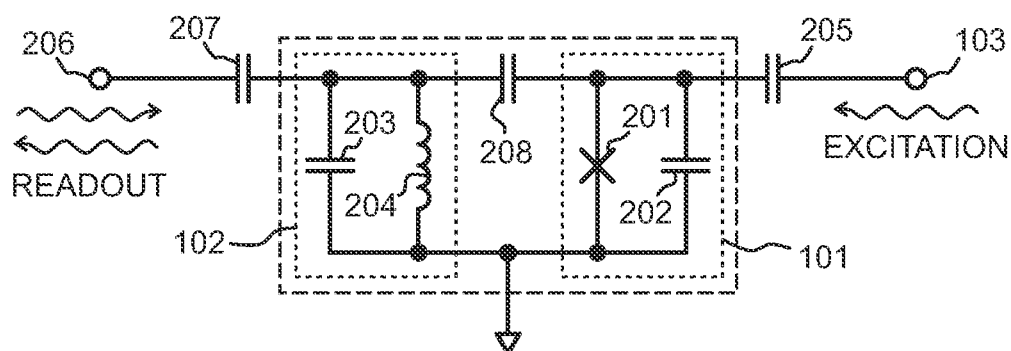


Fig. 2
PRIOR ART

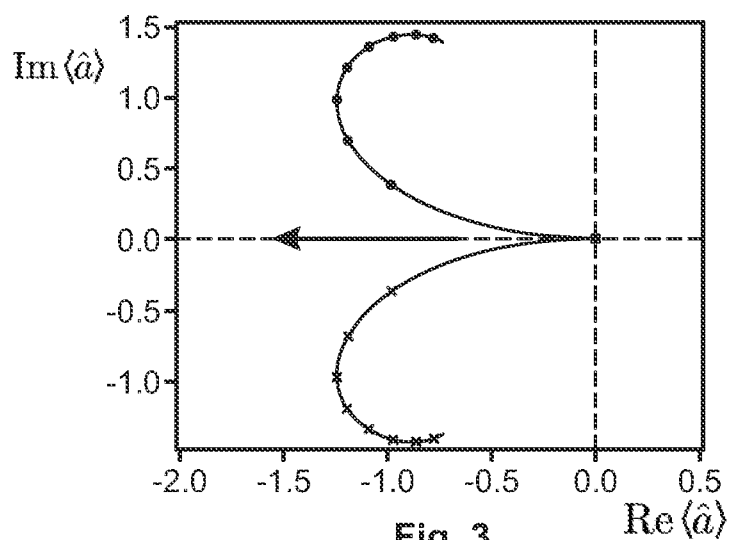


Fig. 3
PRIOR ART

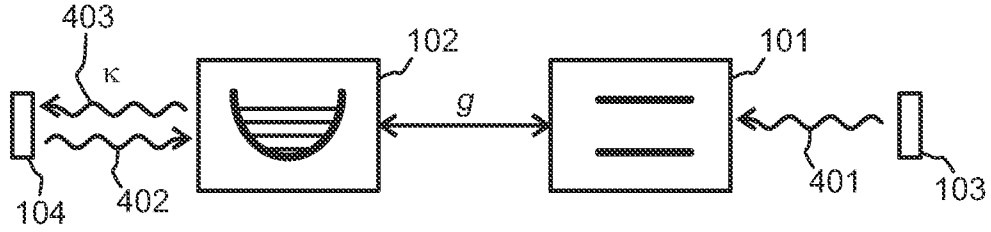


Fig. 4

$$\hat{H}_{\text{total}} = \hat{H}_0 + \hat{H}_{\text{int}} + \hat{H}_{\text{QD}} + \hat{H}_{\text{RD}} \quad (1)$$

$$\hat{H}_0/\hbar = \omega_r \hat{a}^\dagger \hat{a} + \sum_{k=0} \omega_k |k\rangle \langle k| \quad (2)$$

$$\hat{H}_{\text{int}}/\hbar = \sum_{k=0} g_k (\hat{a}^\dagger + \hat{a}) (|k\rangle \langle k+1| + |k+1\rangle \langle k|) \quad (3)$$

$$\hat{H}_{\text{QD}}/\hbar = 2\tilde{\Omega}_{\text{qd}}(t) \sum_{k=0} \lambda_k (|k\rangle \langle k+1| + |k+1\rangle \langle k|) \quad (4)$$

$$\hat{H}_{\text{RD}}/\hbar = 2\tilde{\Omega}_{\text{rd}}(t) (\hat{a}^\dagger + \hat{a}) \quad (5)$$

$$\tilde{\Omega}_{r/q}(t) = \text{Re}(\Omega_{r/q}) \cos(\omega_d t) + \text{Im}(\Omega_{r/q}) \sin(\omega_d t) \quad (6)$$

$$\hat{U}_1 = \exp \left[it \left(\omega_d \hat{a}^\dagger \hat{a} + \sum_k k \omega_d |k\rangle \langle k| \right) \right] = e^{it\omega_d \hat{a}^\dagger \hat{a}} \sum_k e^{it\omega_d k} |k\rangle \langle k| \quad (7)$$

Fig. 5

$$\hat{H}'_0/\hbar = \hat{U}_1 \hat{H}_0 \hat{U}_1^\dagger/\hbar = (\omega_r - \omega_d) \hat{a}^\dagger \hat{a} + \sum_k \tilde{\Delta}_k |k\rangle \langle k| \quad (8)$$

$$\hat{H}'_{\text{int}}/\hbar \approx \sum_k g_k \hat{a}^\dagger |k\rangle \langle k+1| + \text{H.c.} \quad (9)$$

$$\hat{H}'_{\text{QD}}/\hbar \approx \Omega_q \sum_k \lambda_k |k+1\rangle \langle k| + \text{H.c.} \quad (10)$$

$$\hat{H}'_{\text{RD}}/\hbar \approx \Omega_r \hat{a}^\dagger + \text{H.c.} \quad (11)$$

Fig. 6

$$\hat{H}'_{\text{total}} \approx (\omega_{\text{r}} - \omega_{\text{d}}) \hat{a}^\dagger \hat{a} + \sum_k \tilde{\Delta}_k |k\rangle \langle k| + \sum_k \{ [g_k \hat{a}^\dagger + \Omega_{\text{q}} \lambda_k] |k+1\rangle \langle k| + \text{H.c.} \} \quad (12)$$

$$\dot{\rho} = -i[\hat{H}'_{\text{total}}, \rho]/\hbar + \frac{\kappa}{2} \mathcal{L}[\hat{a}] \rho \quad (13)$$

$$\hat{U}_2 = e^{\sum_k \frac{g_k}{\Delta_{k+1} - \Delta_k} (\hat{a}|k+1\rangle \langle k| - \hat{a}^\dagger |k\rangle \langle k+1|)} \quad (14)$$

$$\begin{aligned} \left(\hat{H}_0'' + \hat{H}_{\text{int}}'' \right) / \hbar &\approx \left(\tilde{\Delta}_1 + \chi_0 \right) |e\rangle \langle e| + \left(\tilde{\Delta}_2 + \chi_1 \right) |f\rangle \langle f| \\ &+ [\omega_{\text{r}} - \omega_{\text{d}} - \chi_0 |g\rangle \langle g| + (\chi_0 - \chi_1) |e\rangle \langle e| + \chi_1 |f\rangle \langle f|] \hat{a}^\dagger \hat{a} \end{aligned} \quad (15)$$

$$\begin{aligned} \hat{H}_{\text{QD}}'' / \hbar &\approx \alpha_{\text{vo}} g_0 |e\rangle \langle g| + \alpha_{\text{vo}} g_1 |f\rangle \langle e| \\ &- \alpha_{\text{vo}}^* \chi_0 \hat{a} |g\rangle \langle g| + (\chi_0 - \chi_1) \alpha_{\text{vo}}^* \hat{a} |e\rangle \langle e| + \alpha_{\text{vo}}^* \chi_1 \hat{a} |f\rangle \langle f| + \text{H.c.} \end{aligned} \quad (16)$$

$$\hat{H}_{\text{RD}}'' / \hbar \approx \Omega_{\text{r}} \left(\hat{a}^\dagger + \frac{\chi_0}{g_0} |e\rangle \langle g| + \frac{\chi_1}{g_1} |f\rangle \langle e| \right) + \text{H.c.} \quad (17)$$

Fig. 7

$$\ddot{H}_{total}''/\hbar \approx \chi_0 |\alpha_{vo}|^2 |g\rangle \langle g| + \left[\tilde{\Delta}_1 + \chi_0 - |\alpha_{vo}|^2 (\chi_0 - \chi_1) \right] |e\rangle \langle e| + \left[\tilde{\Delta}_2 + \chi_1 (1 - |\alpha_{vo}|^2) \right] |f\rangle \langle f| \quad (18)$$

$$+ \left[\left(-zg_0 + \Omega_r \frac{\chi_0}{g_0} \right) |e\rangle \langle g| + \left(-zg_1 + \Omega_r \frac{\chi_1}{g_1} \right) |f\rangle \langle e| + \text{H.c.} \right] \quad (19)$$

$$+ [\omega_r - \omega_d - \chi_0 |g\rangle \langle g| + (\chi_0 - \chi_1) |e\rangle \langle e| + \chi_1 |f\rangle \langle f|] \hat{b}^\dagger \hat{b} \quad (20)$$

$$+ [\Omega_r + \alpha_{vo}(\omega_r - \omega_d)] \hat{b}^\dagger + \text{H.c.} \quad (21)$$

Fig. 8

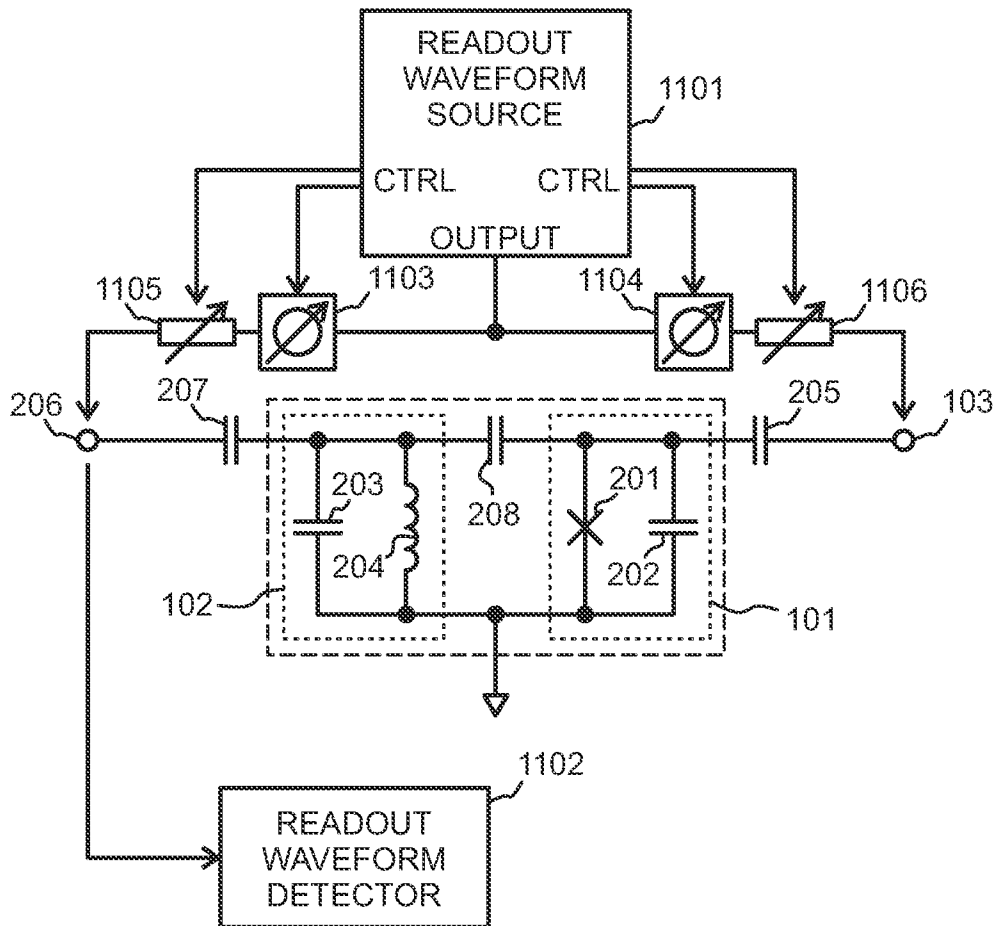
$$\frac{\partial \alpha_{g/e}(t)}{\partial t} = i\Omega_r' \pm i\chi [\alpha_{g/e}(t) - \alpha_{vo}] - \frac{\kappa}{2} \alpha_{g/e}(t) \quad (22)$$

$$\alpha_{g/e}(t) = \frac{-\Omega_r \pm \Omega_r \chi / g}{i\kappa / 2 \mp \chi} (1 - e^{-\frac{\kappa}{2} t \mp i t \chi}) \quad (23)$$

Fig. 9

$$S_{conv}(t) = |\alpha_e(t) - \alpha_g(t)| = \frac{\Omega_{rd}}{4} |\chi_{|e\rangle} - \chi_{|g\rangle}| t^2 + \mathcal{O}(t\chi)^3 \quad (24)$$

$$S_{back}(t) = |\alpha_e(t) - \alpha_g(t)| = \frac{\Omega_{qd}}{2g} t |\chi_{|g\rangle} - \chi_{|e\rangle}| \left(1 - \frac{1}{2}\kappa t\right) + \mathcal{O}(t\chi)^3 \quad (25)$$

Fig. 10**Fig. 11**

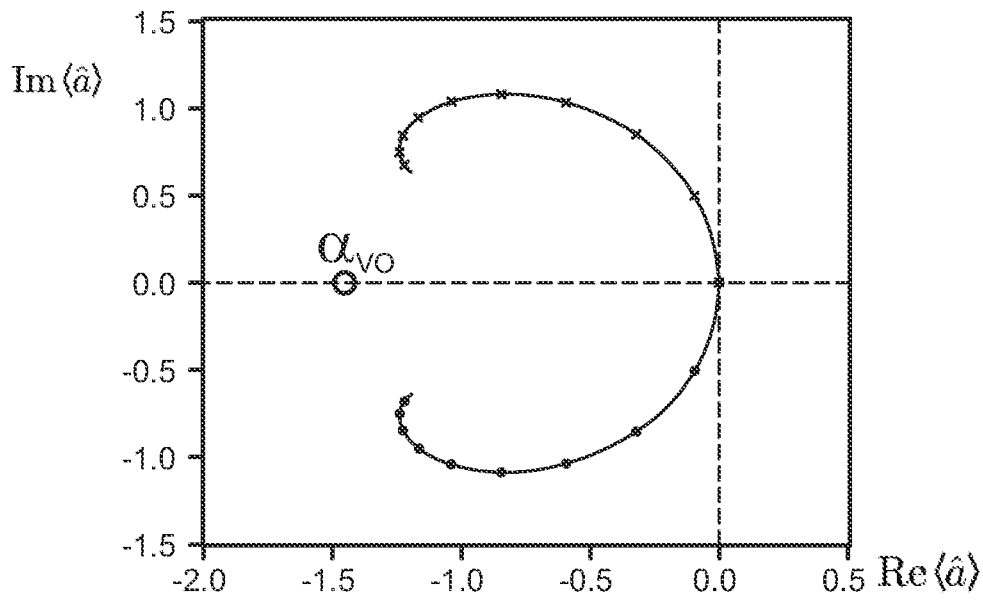


Fig. 12

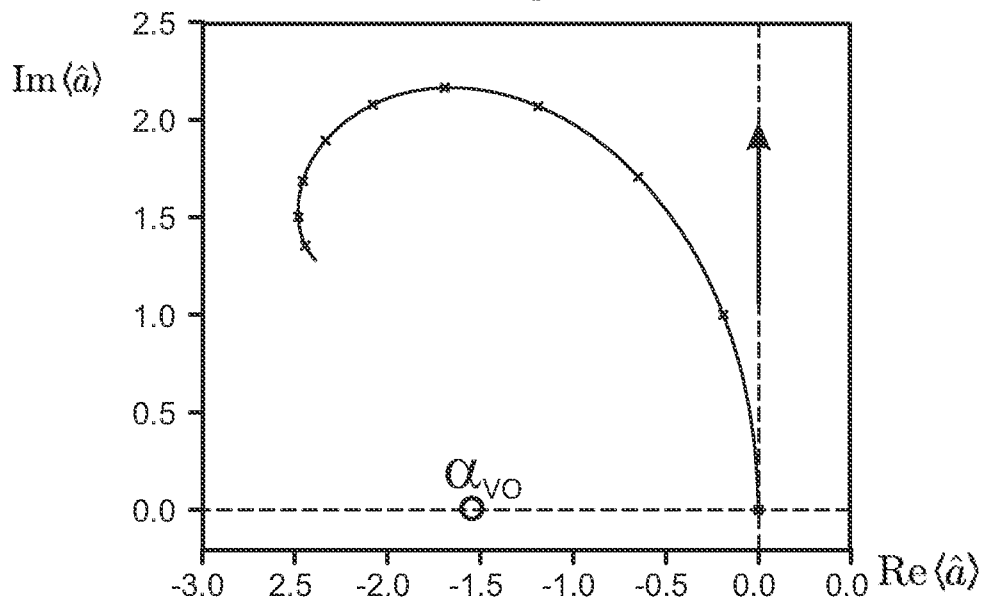


Fig. 13

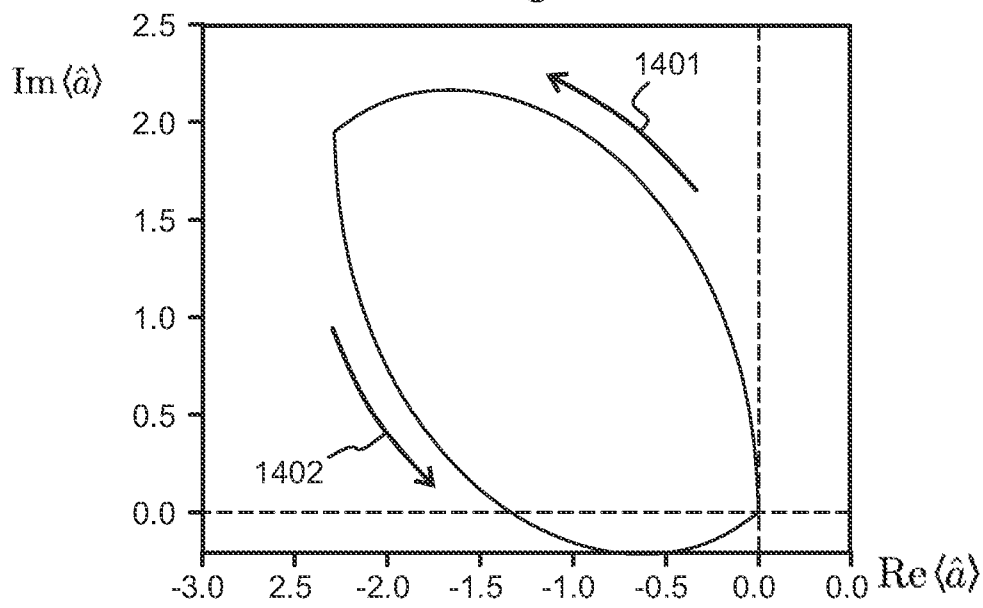


Fig. 14

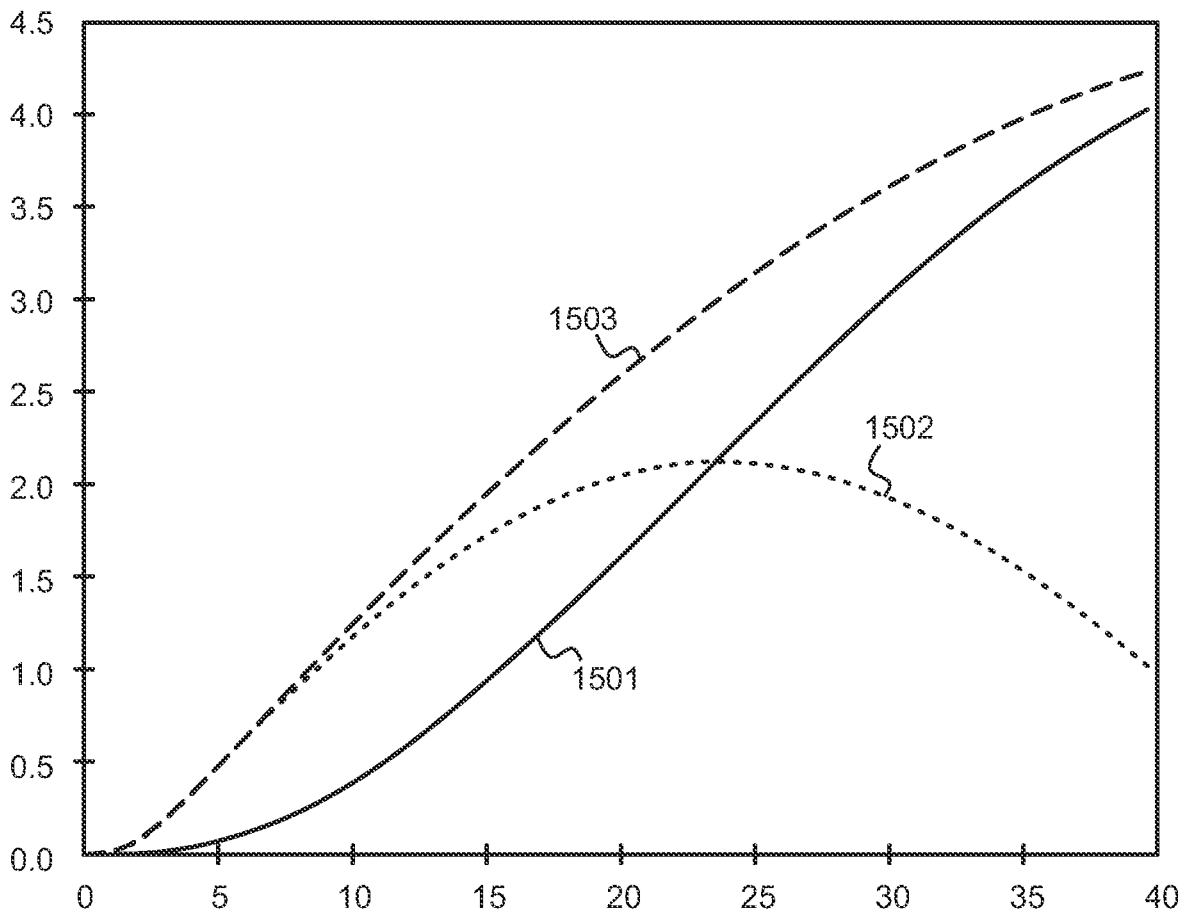


Fig. 15

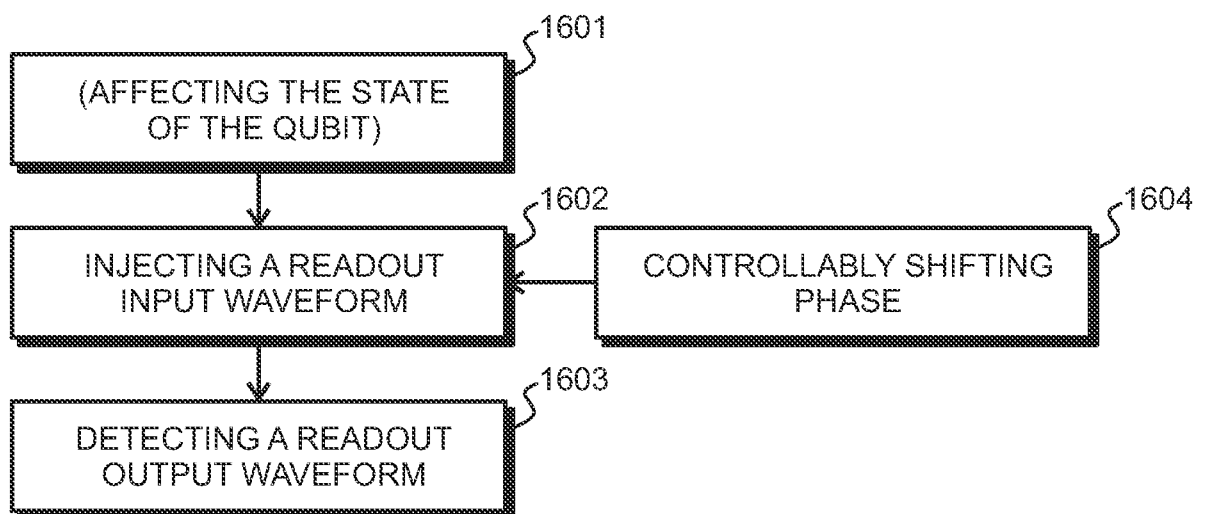


Fig. 16

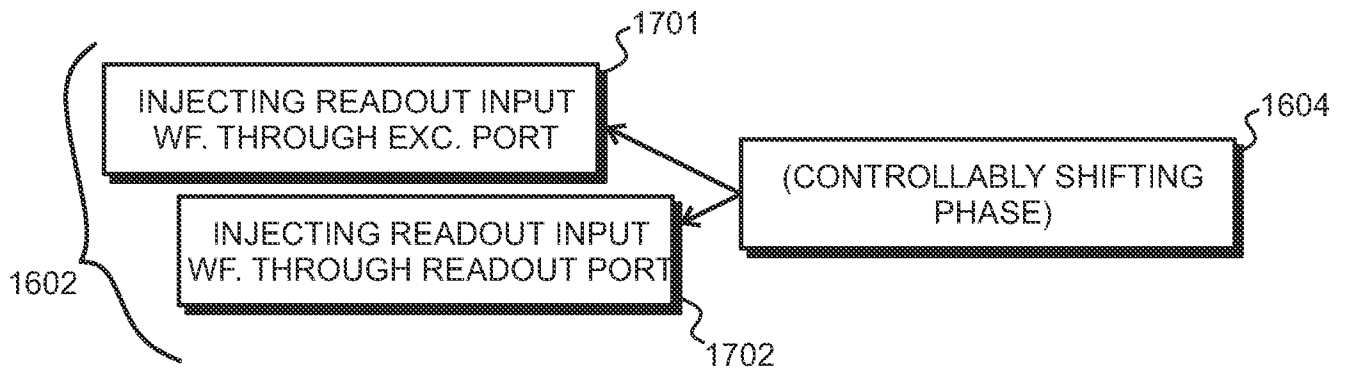


Fig. 17

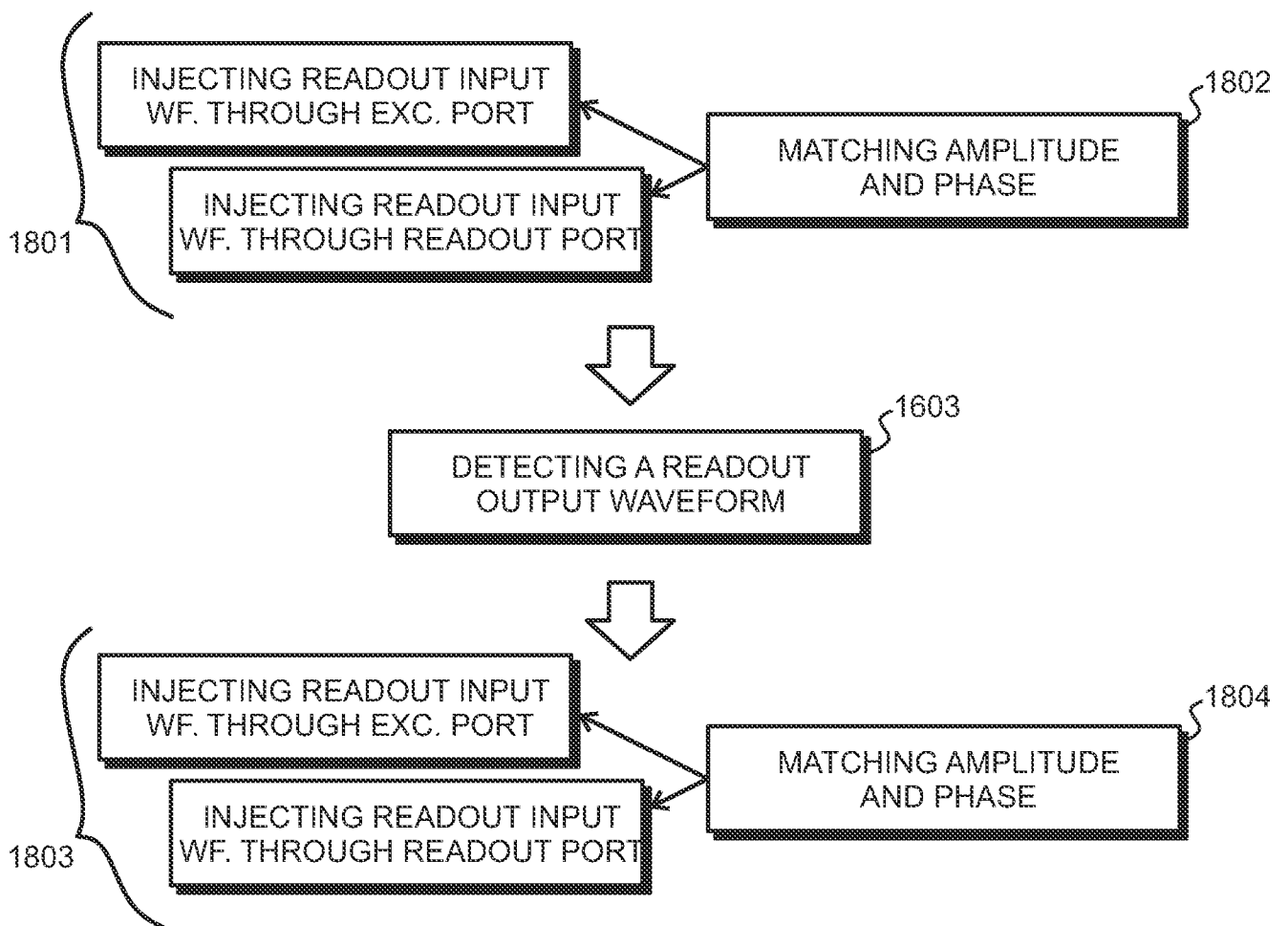


Fig. 18