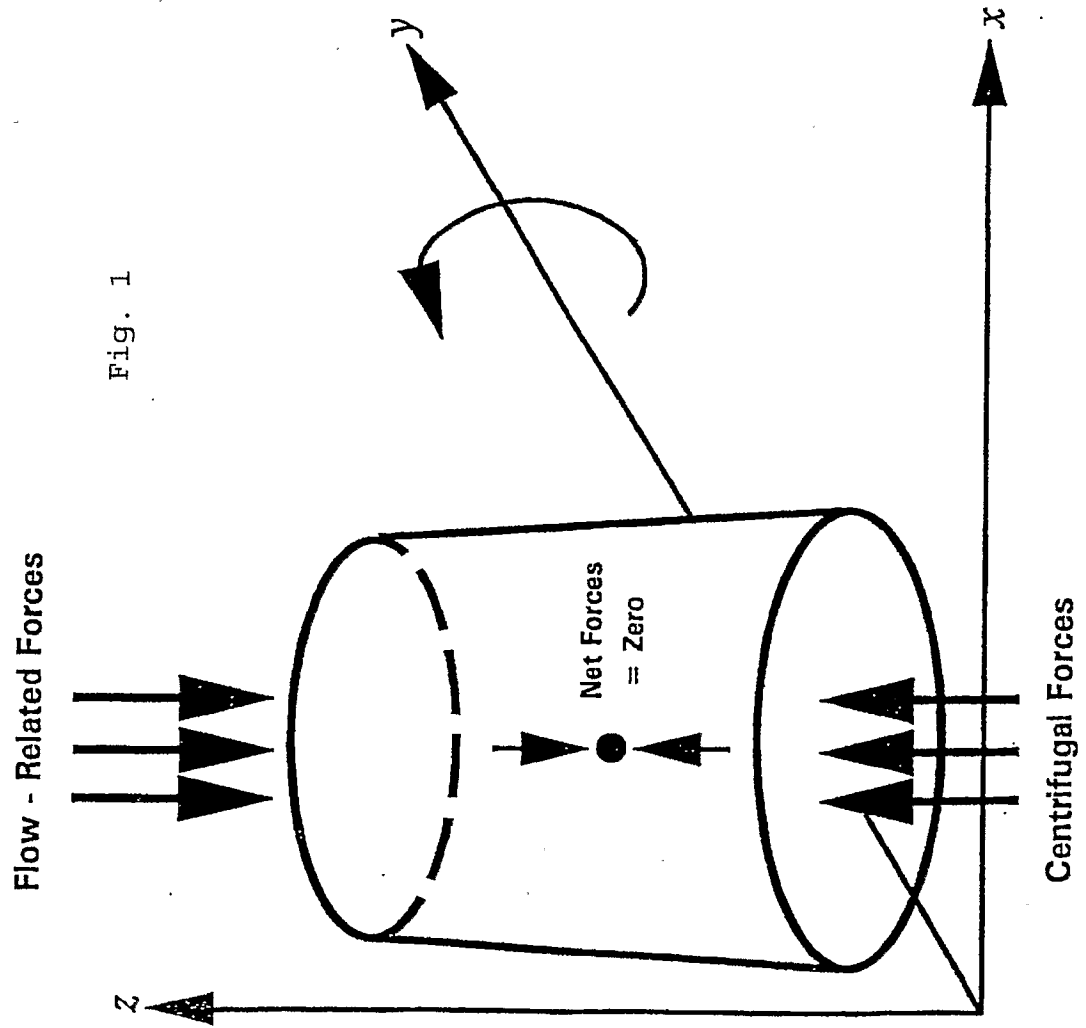
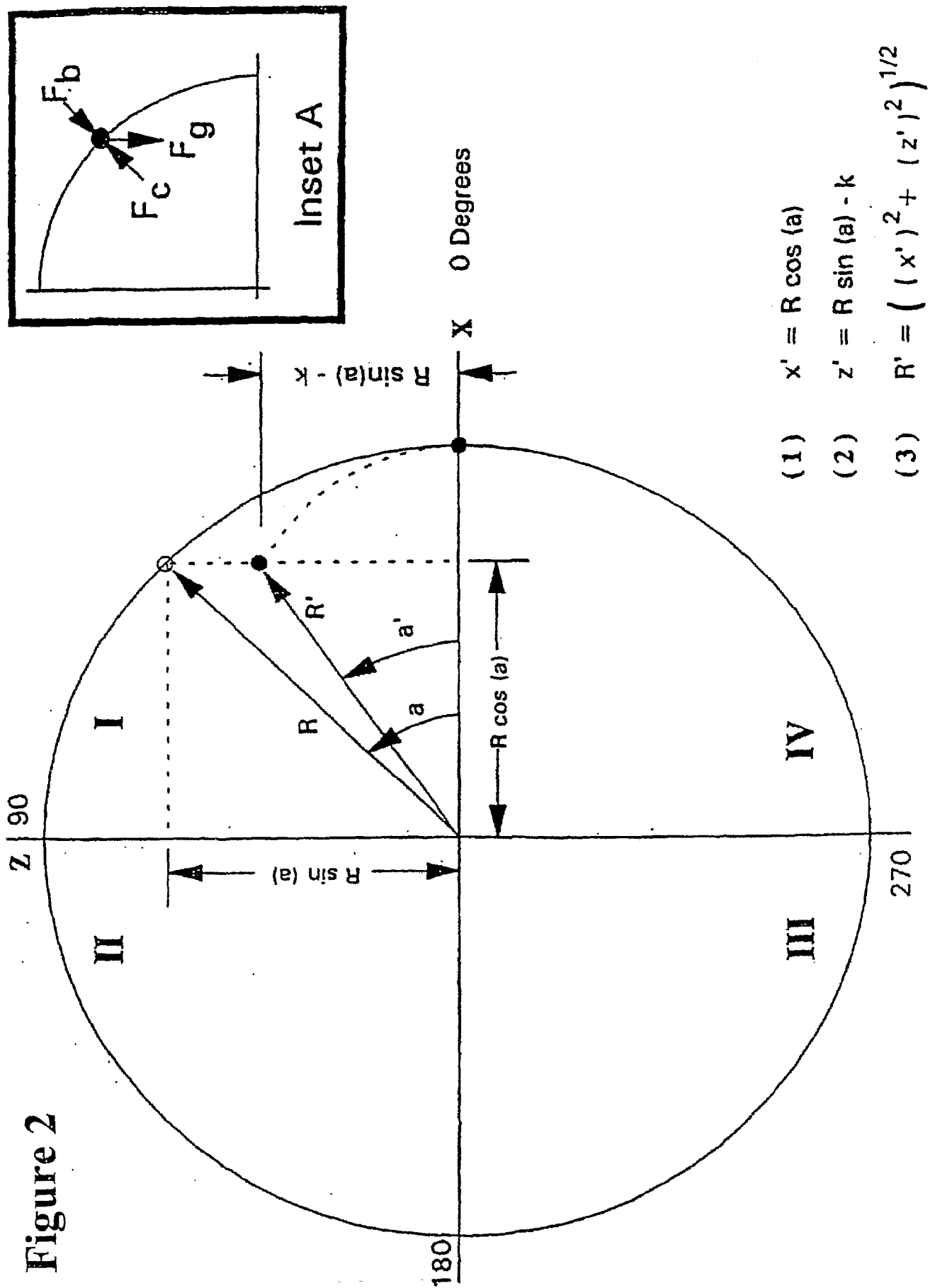






(1) $x' = R \cos(a)$

(2) $z' = R \sin(a) - k$

(3) $R' = \left((x')^2 + (z')^2 \right)^{1/2}$

(4) $a' = \arcsin(z'/R')$

Figure 3

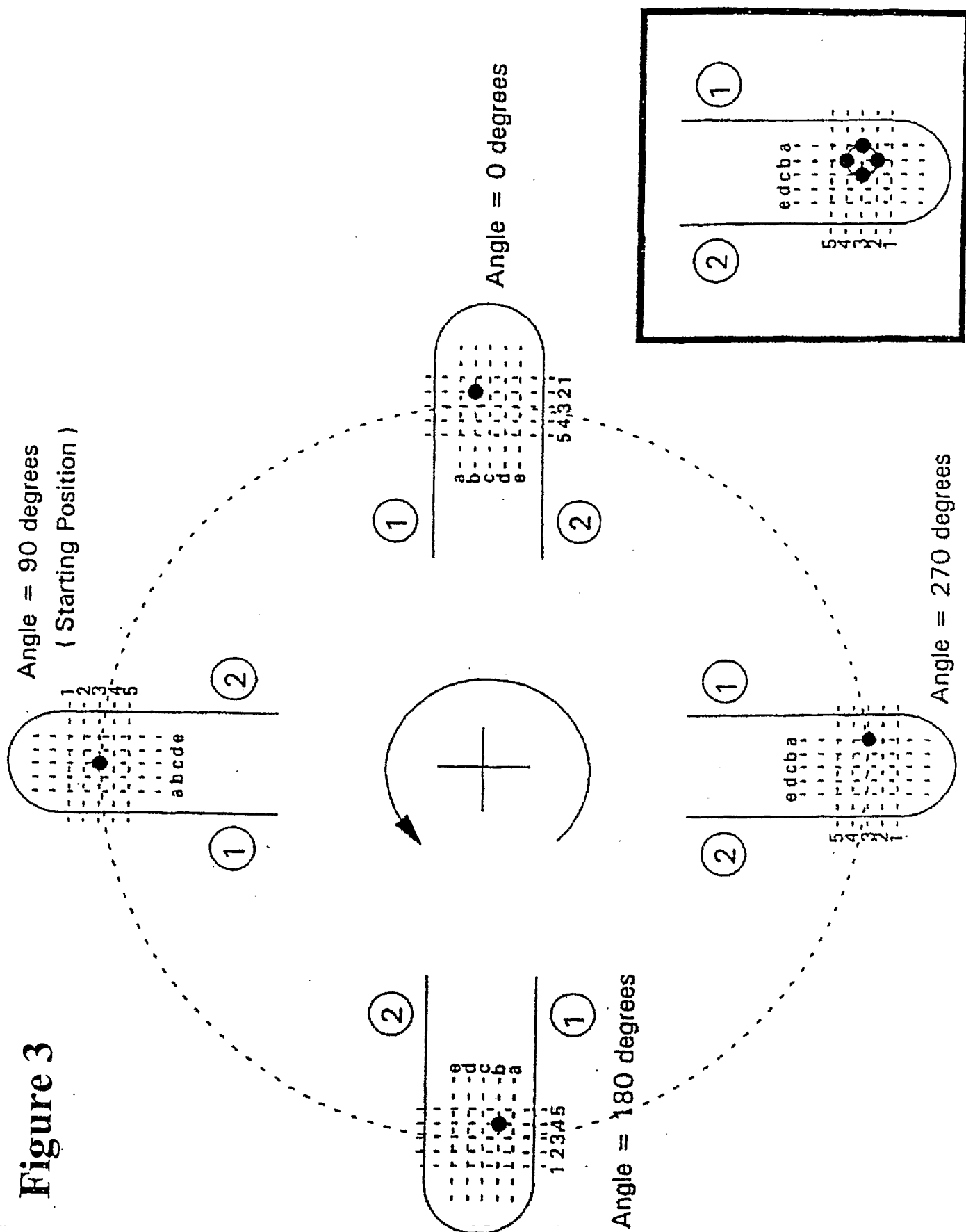
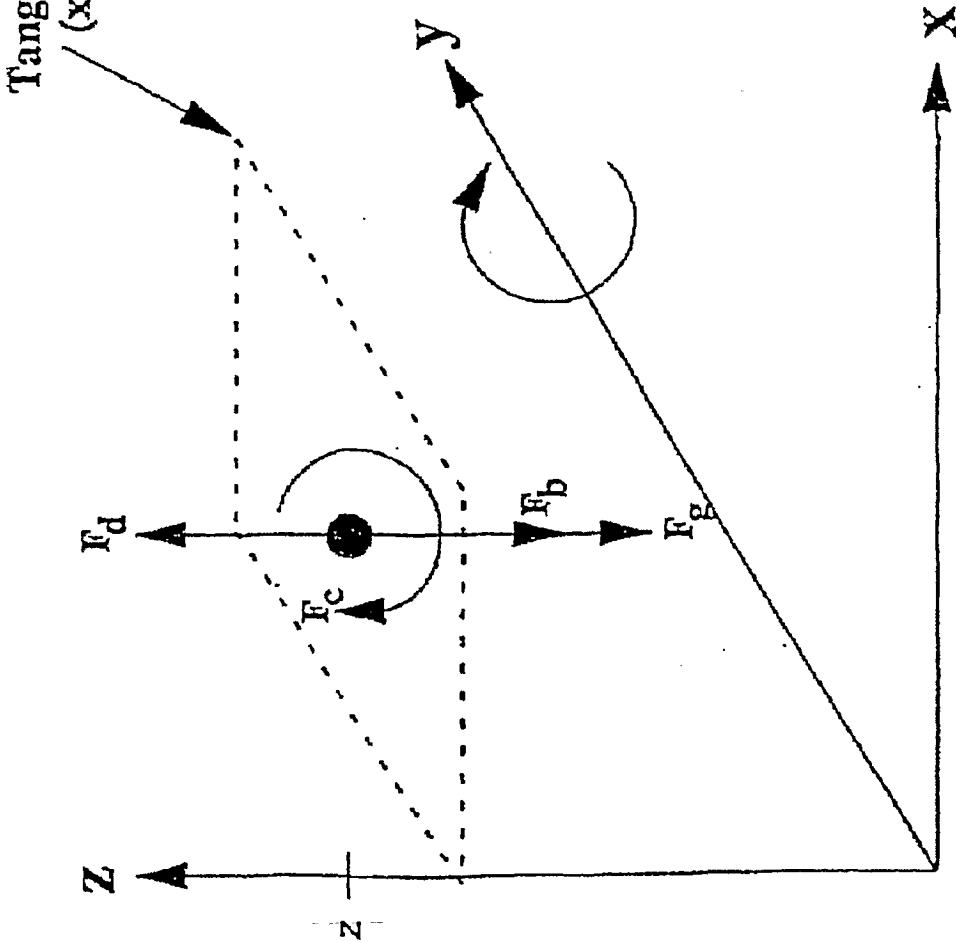


Figure.4

$$SV = \left(\frac{d^2(\rho_p - \rho_m)}{k \eta} \right) (w^2 r) \quad (1)$$

$$SV = C (w^2 r) \quad (2)$$



F_c : Coriolis Force
Acceleration Vector
(in x-y plane)

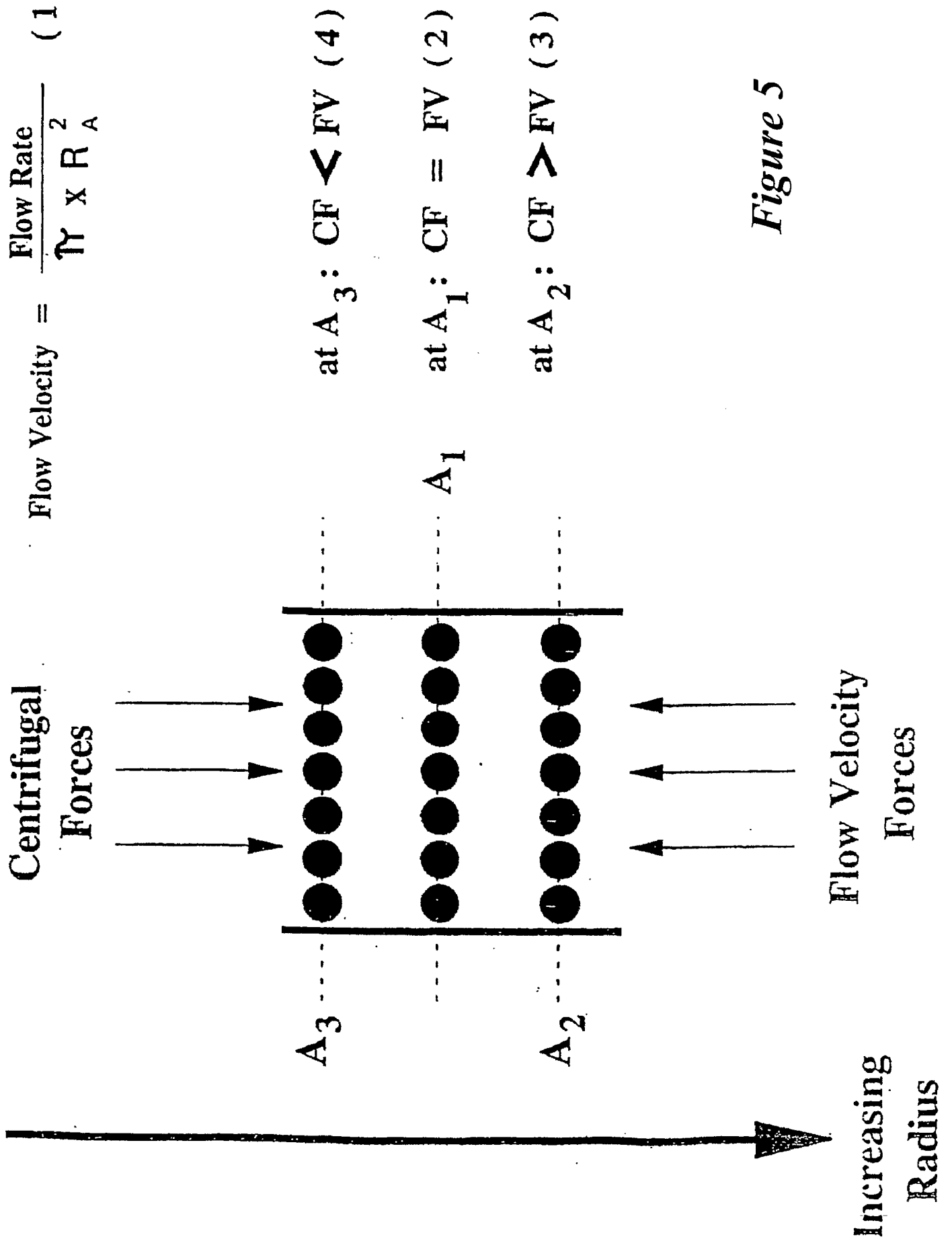
F_b : Buoyant Force
Acceleration Vector
(in x-z plane)

F_d : Centrifugal Force
Acceleration Vector
(in x-z plane)

F_g : Gravitational Force
Acceleration Vector
(in x-z plane)
(net effect = zero)

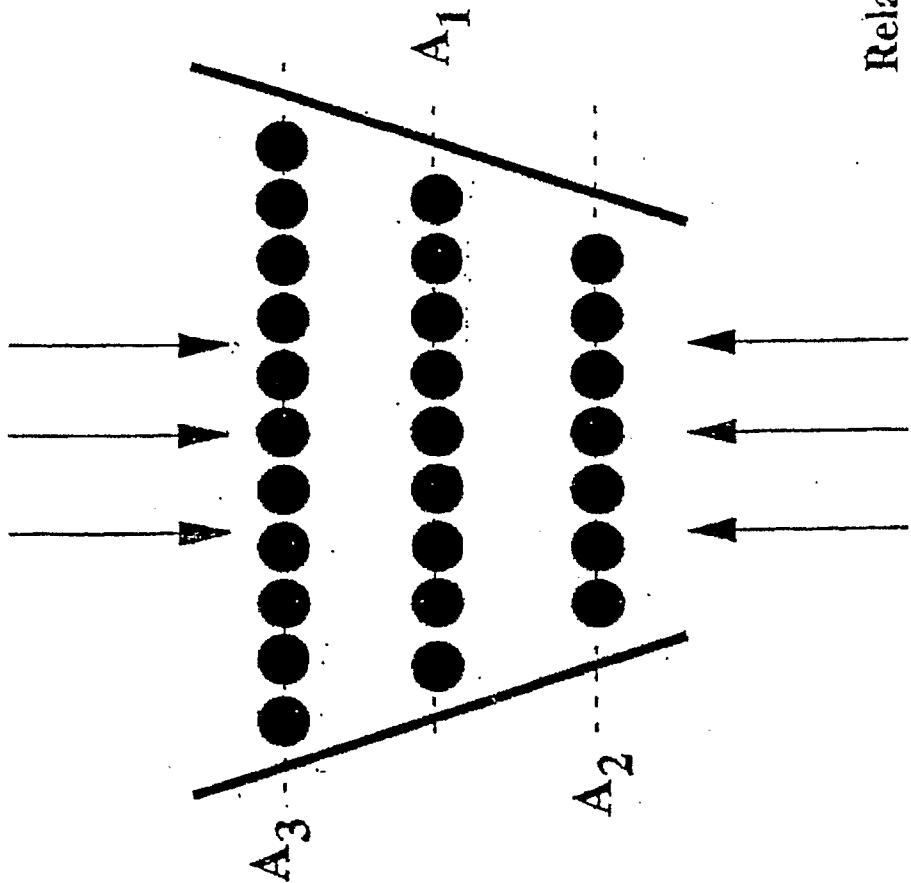
$$r_z = k \eta V_z / (w^2 \rho' d^2) \quad (3)$$

$$FV_z = C (w^2 r_z) \quad (4)$$



Flow Velocity = $\frac{\text{Flow Rate}}{\pi \times R_A^2}$ (1)

Centrifugal
Forces



at A_3 : $CF > FV$ (5)

at A_1 : $CF = FV$ (3)

at A_2 : $CF < FV$ (4)

Relative Centrifugal Force = $w^2 R_c$ (2)

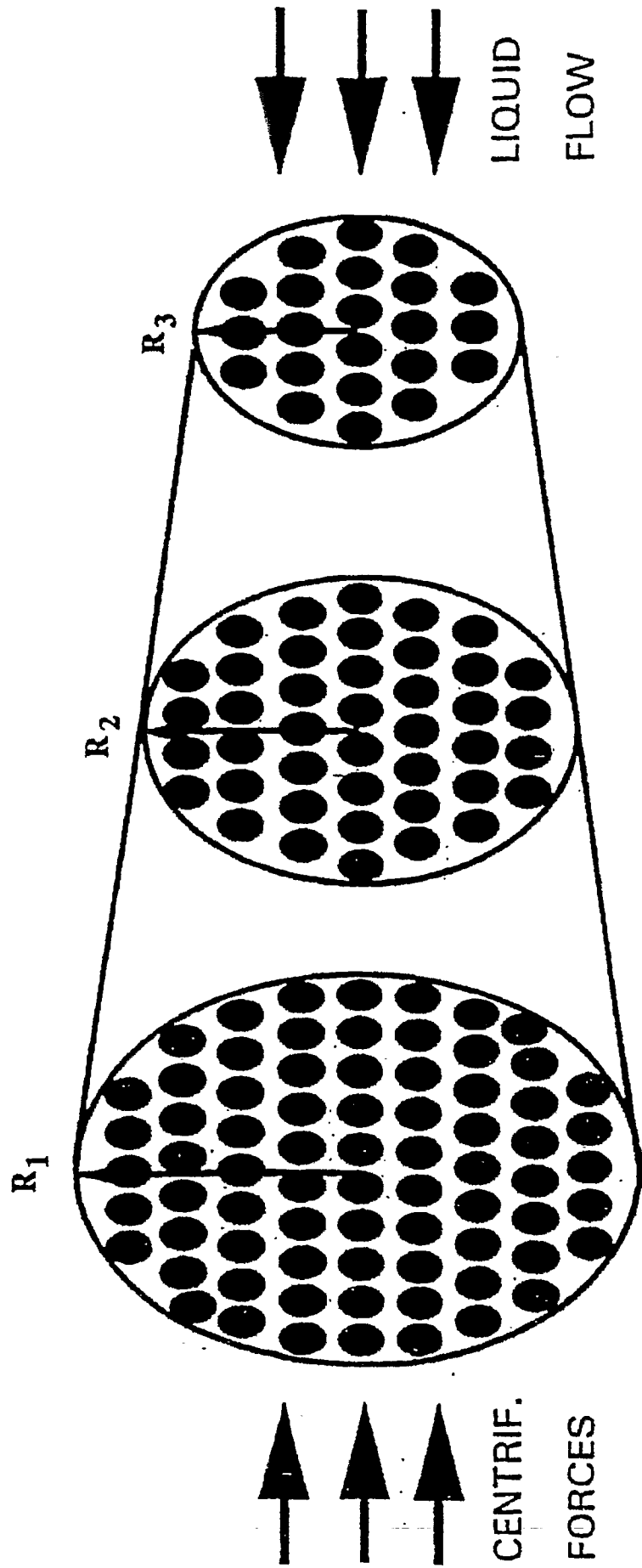
Flow Velocity
Forces

Increasing
Radius
 R_c

Figure 6

Figure 7

$$\text{Flow Velocity} = \frac{\text{Flow Rate}}{\pi \times R_x^2} \quad (1)$$



$$\text{Relative Centrifugal Force} = w^2 R_{C_x} \quad (2)$$

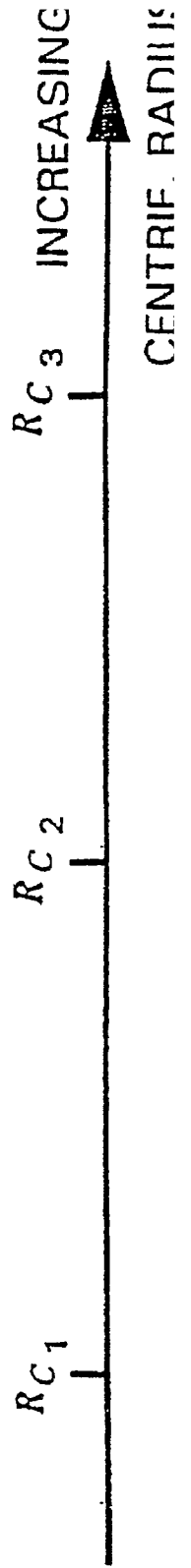
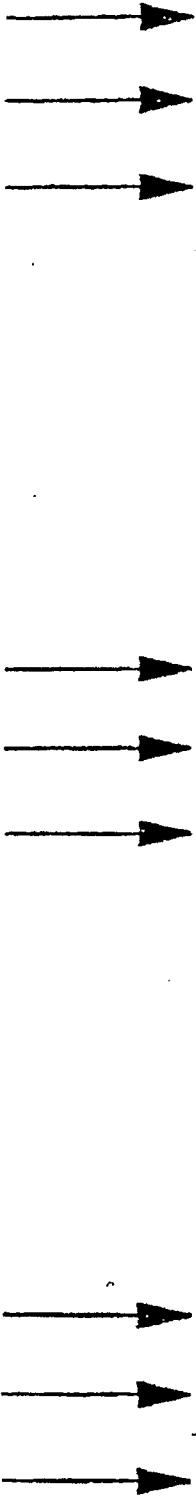
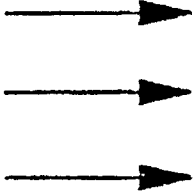


Figure 8

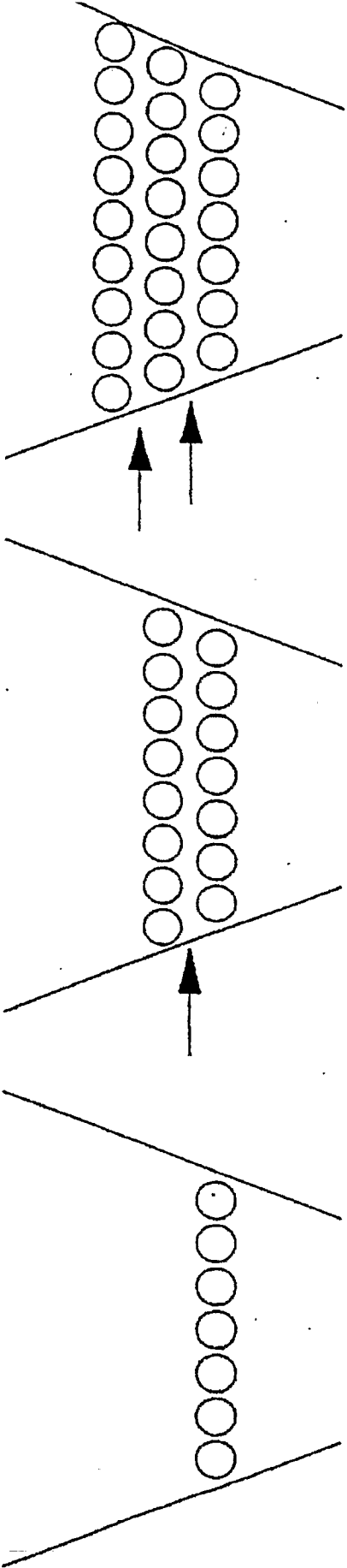
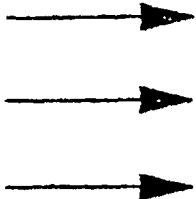
Centrifugal Forces



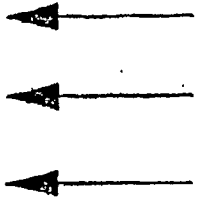
Centrifugal Forces



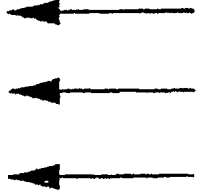
Centrifugal Forces



Flow Velocity Forces



Flow Velocity Forces



Flow Velocity Forces

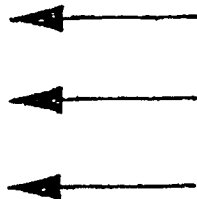
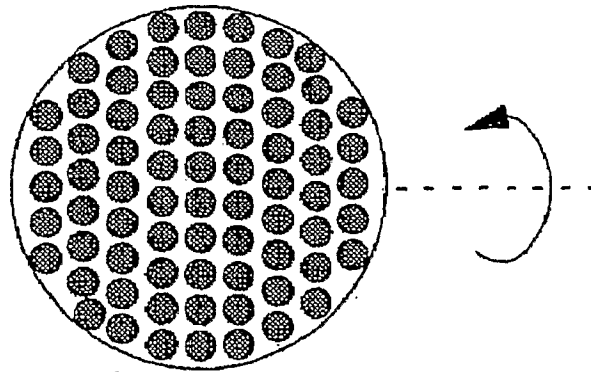
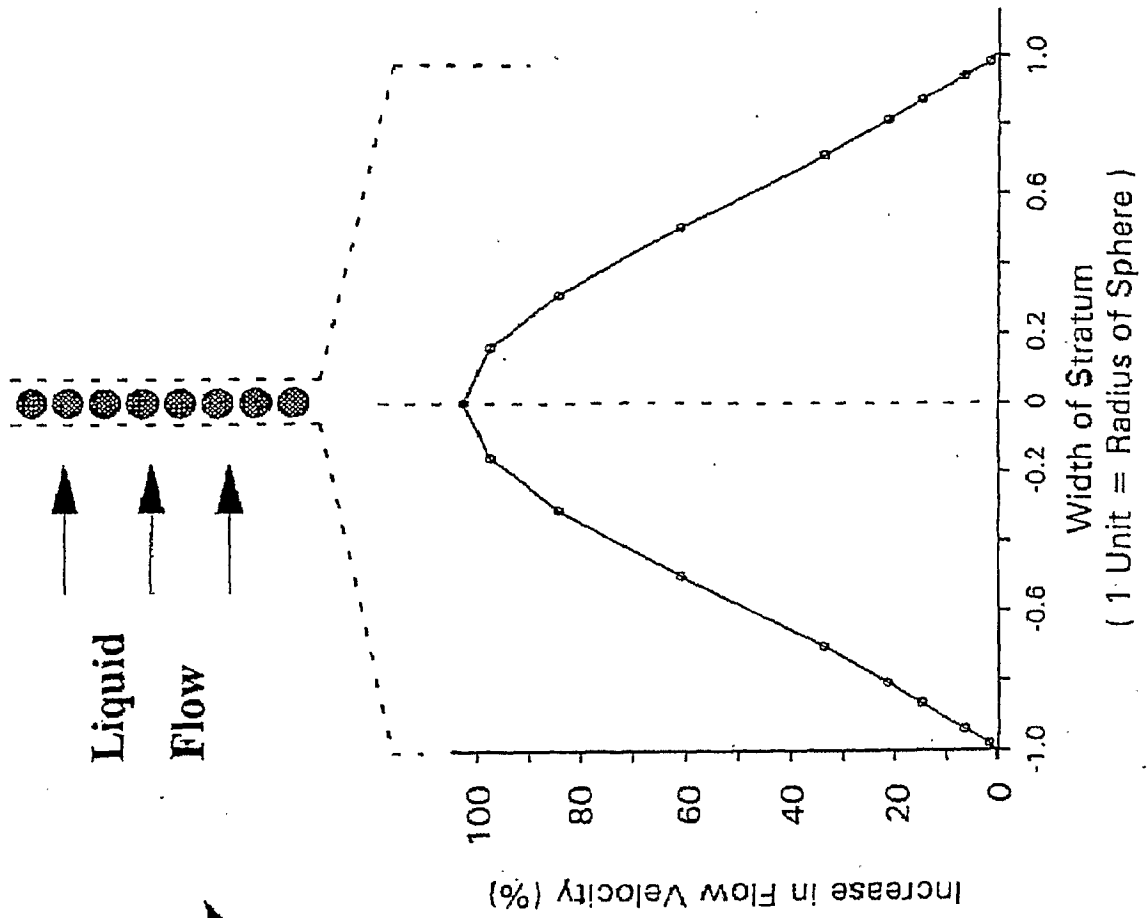


Figure 9

Single Stratum of Cells
at equilibrium
in Centrifugal Bioreactor



$$F.V. = \frac{\text{Flow Rate}}{\text{Cross-Sectional Area}}$$



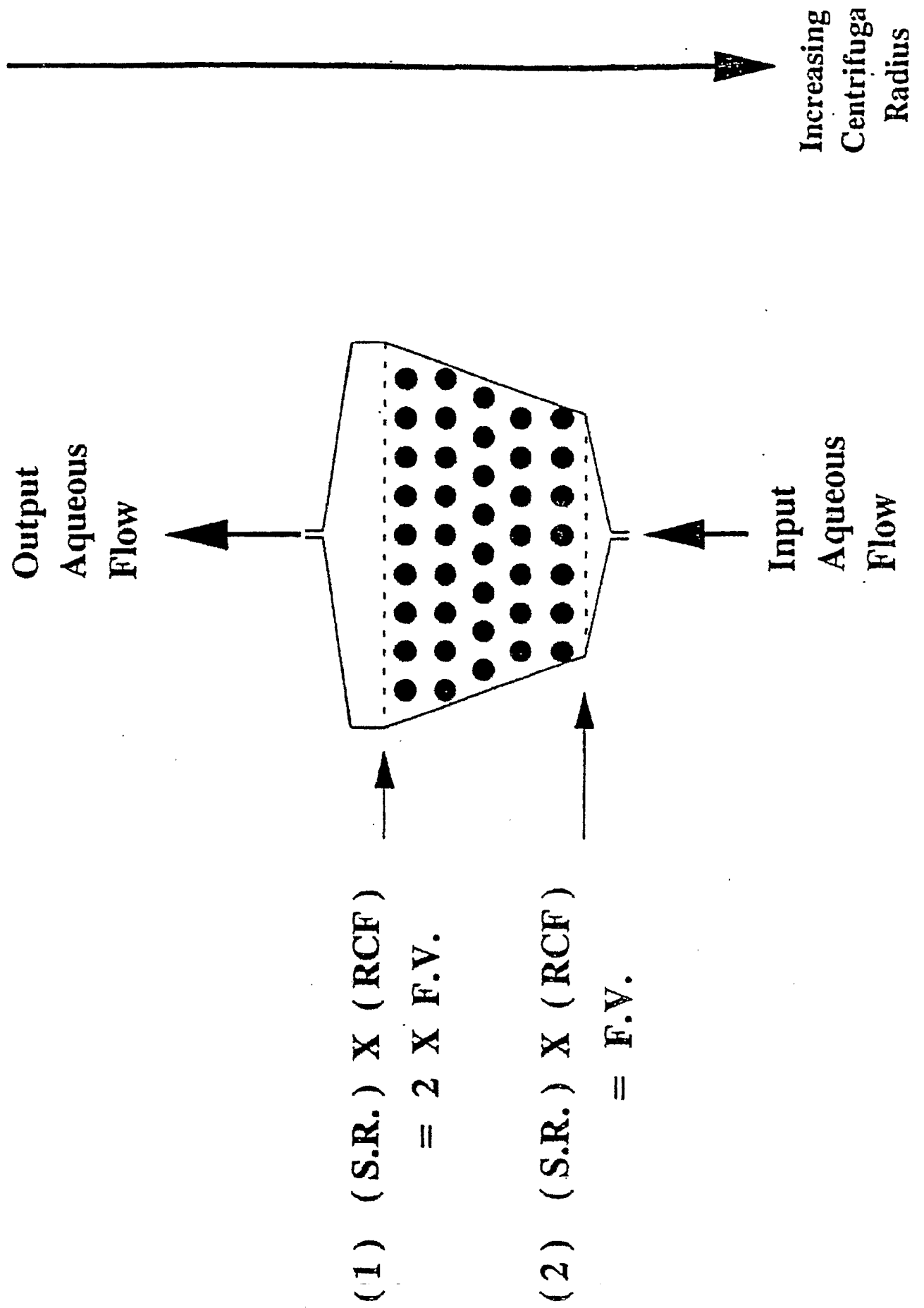


Figure 10

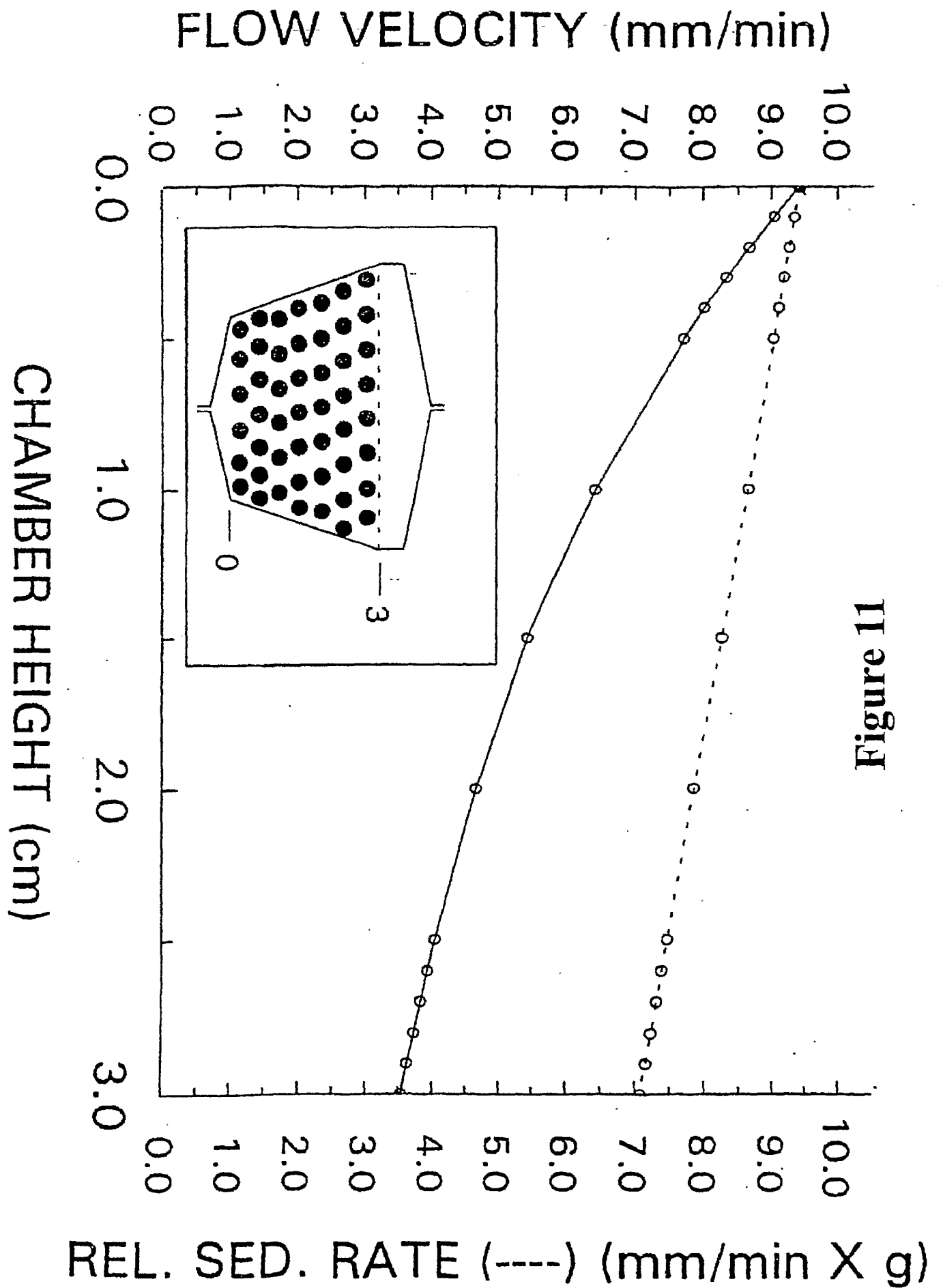
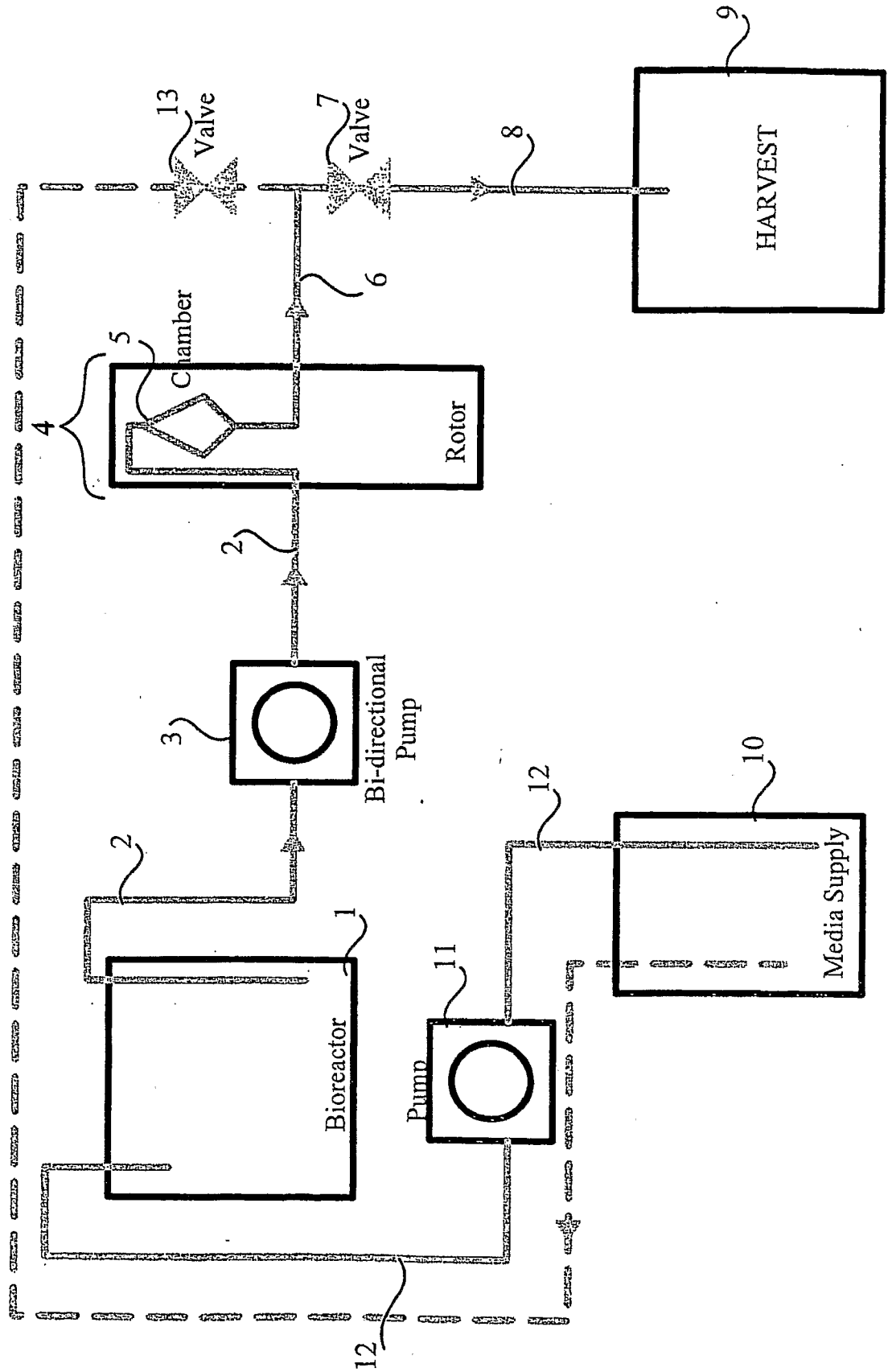


Figure 11

Figure 12
Perfusion Flow Diagram
Cell Capture Mode



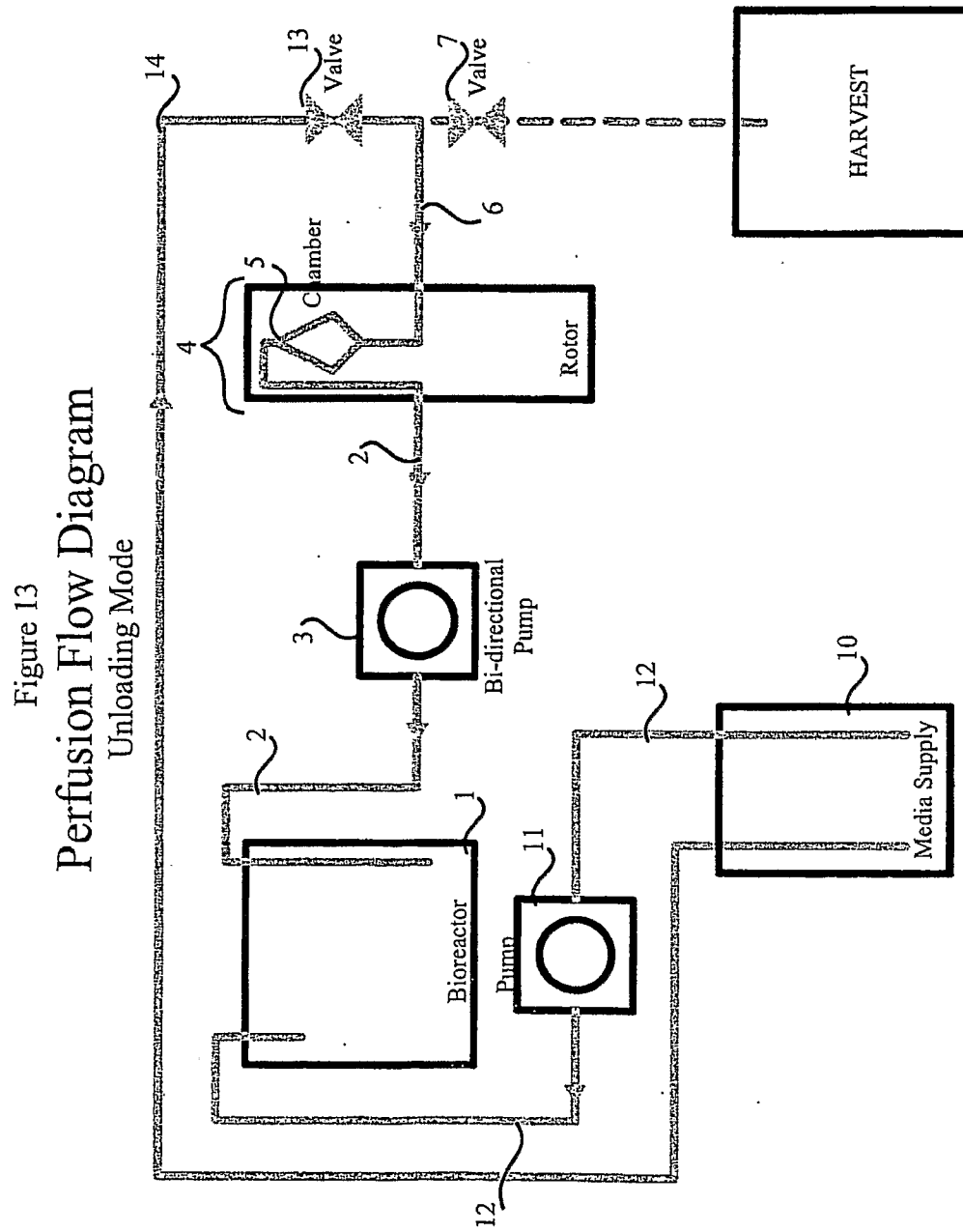


Figure 14

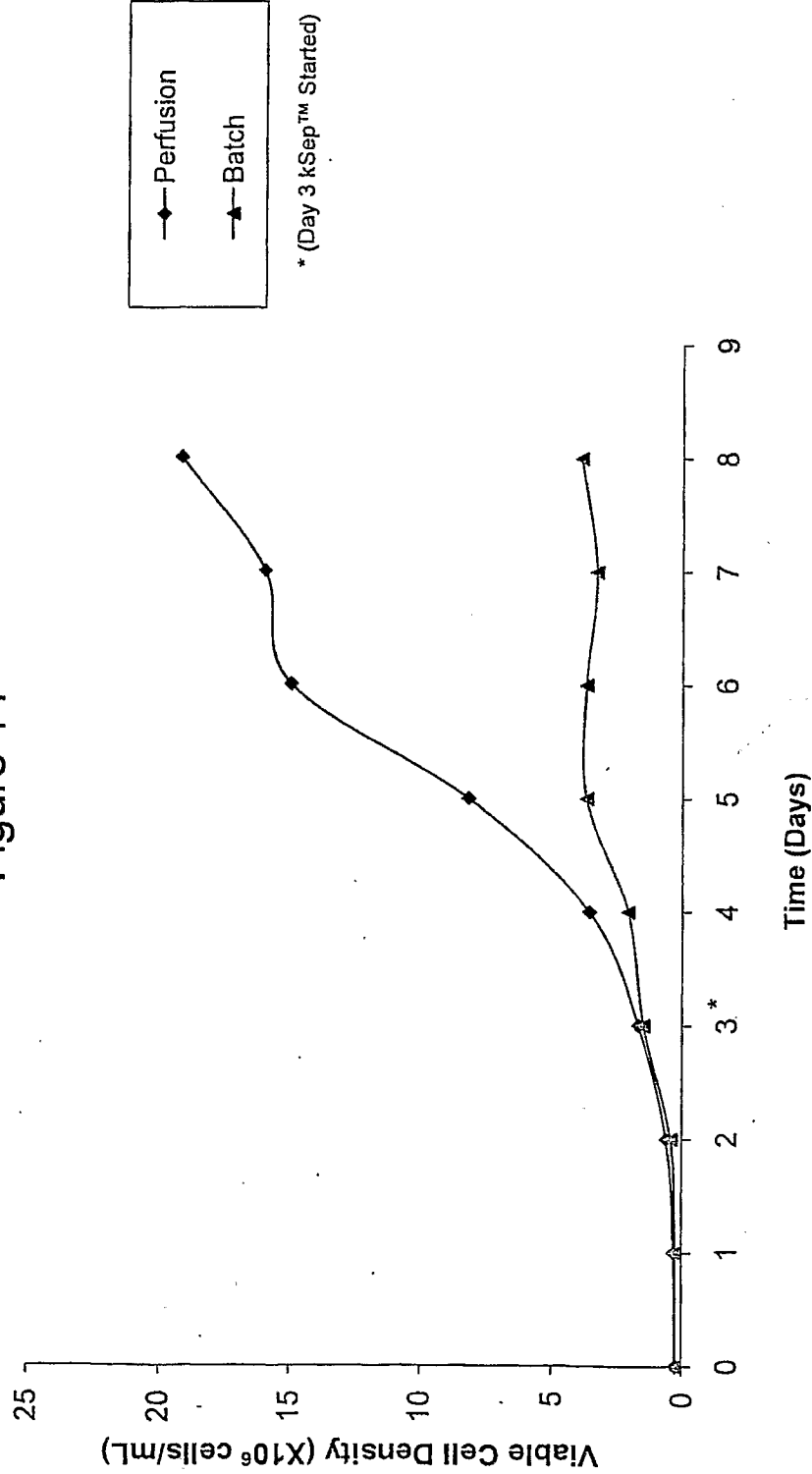


Figure 15

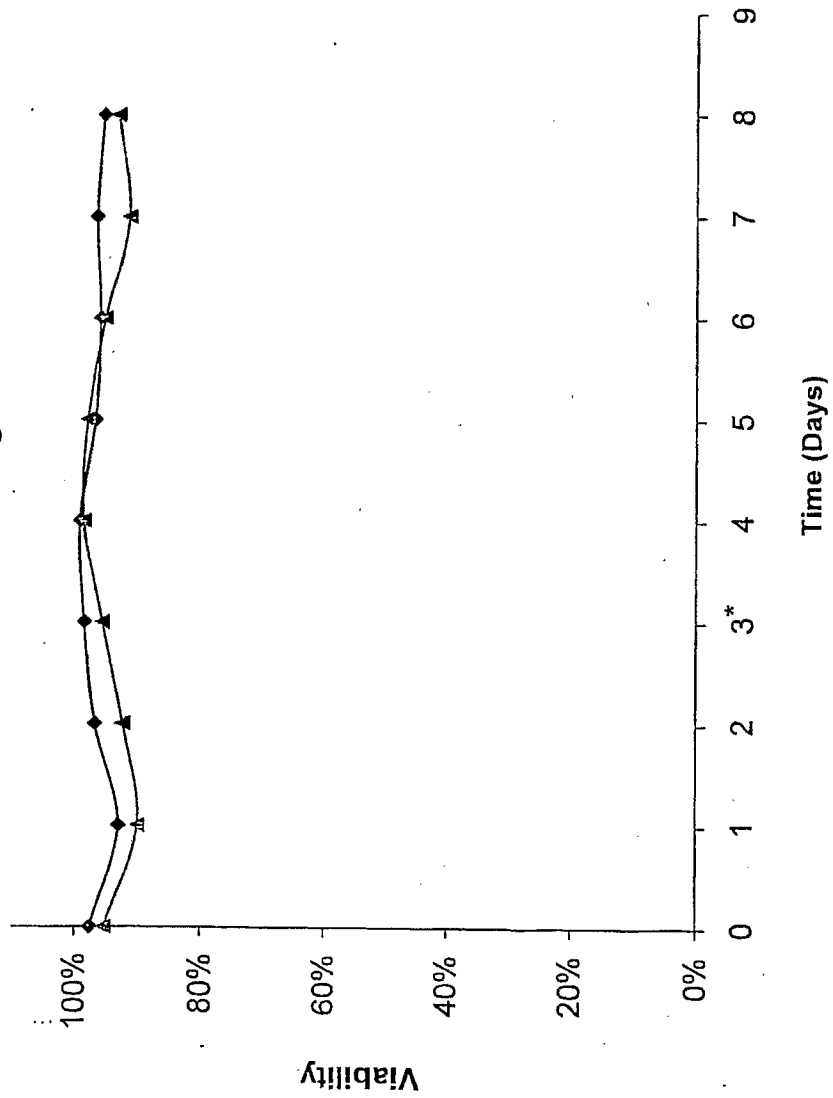


Figure 16
Continuous Flow Centrifuge Flow Diagram

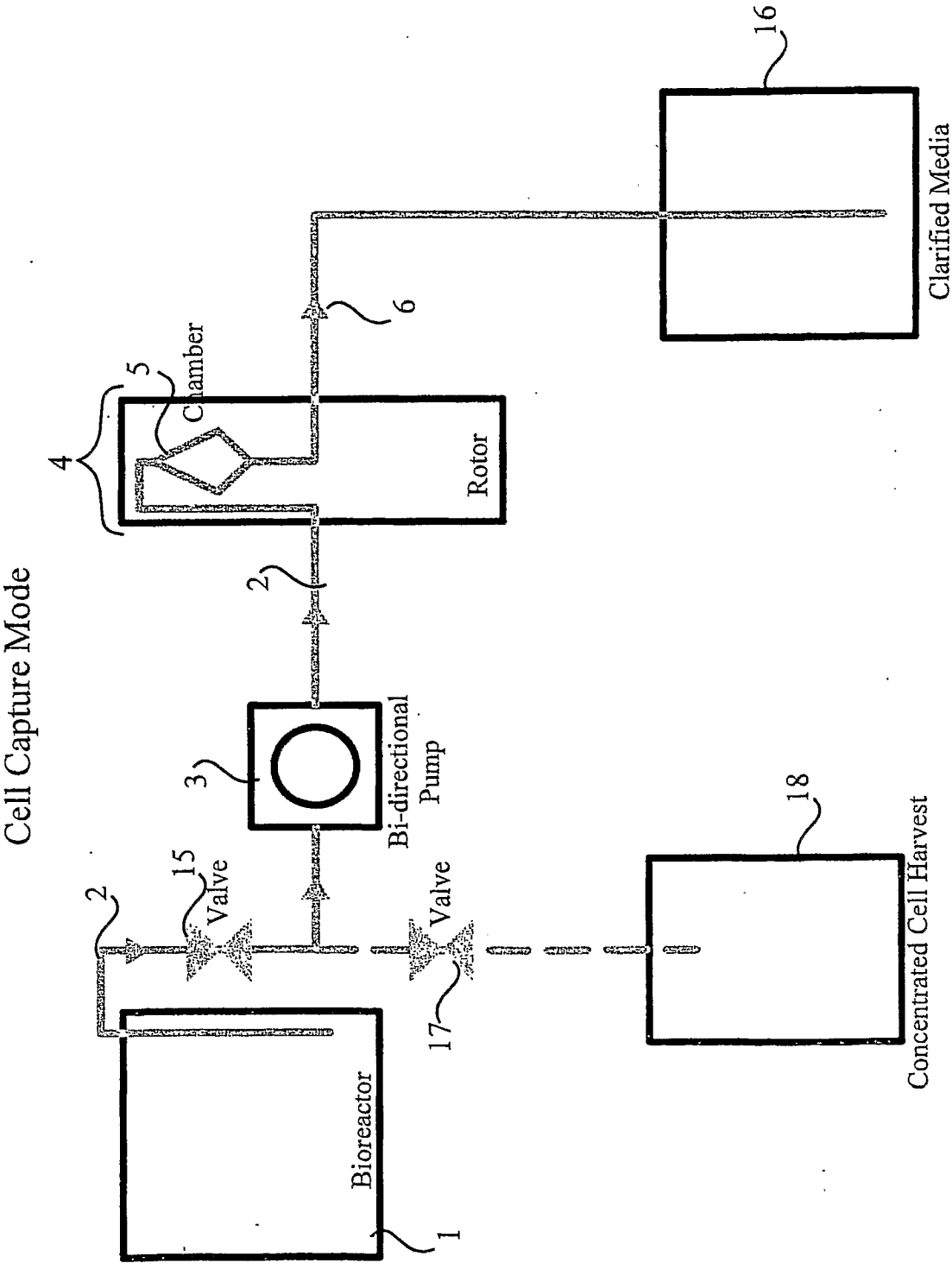


Figure 17
Continuous Flow Centrifuge Flow Diagram

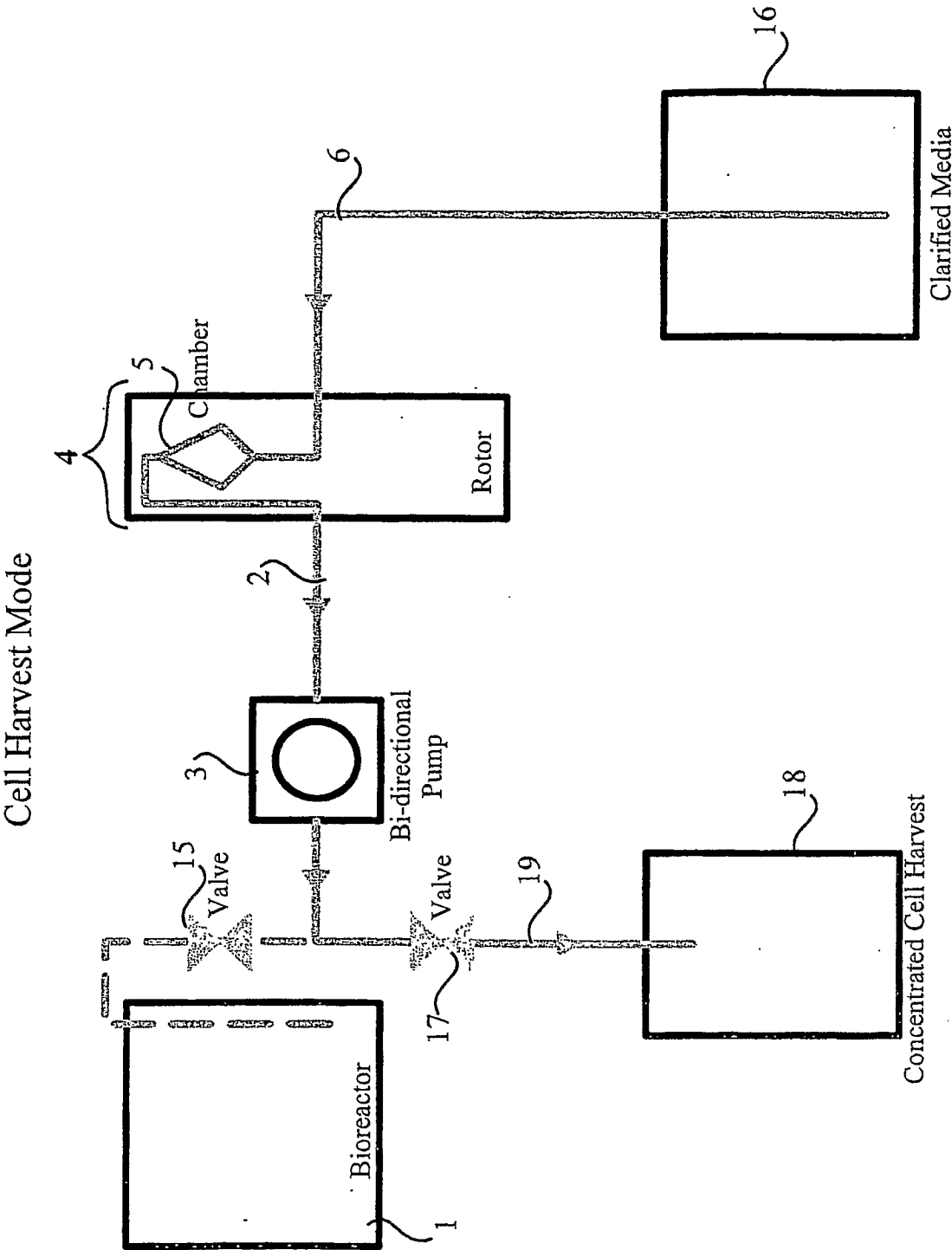


Figure 18
Media / Buffer Exchange Flow Diagram
Cell Separation Mode

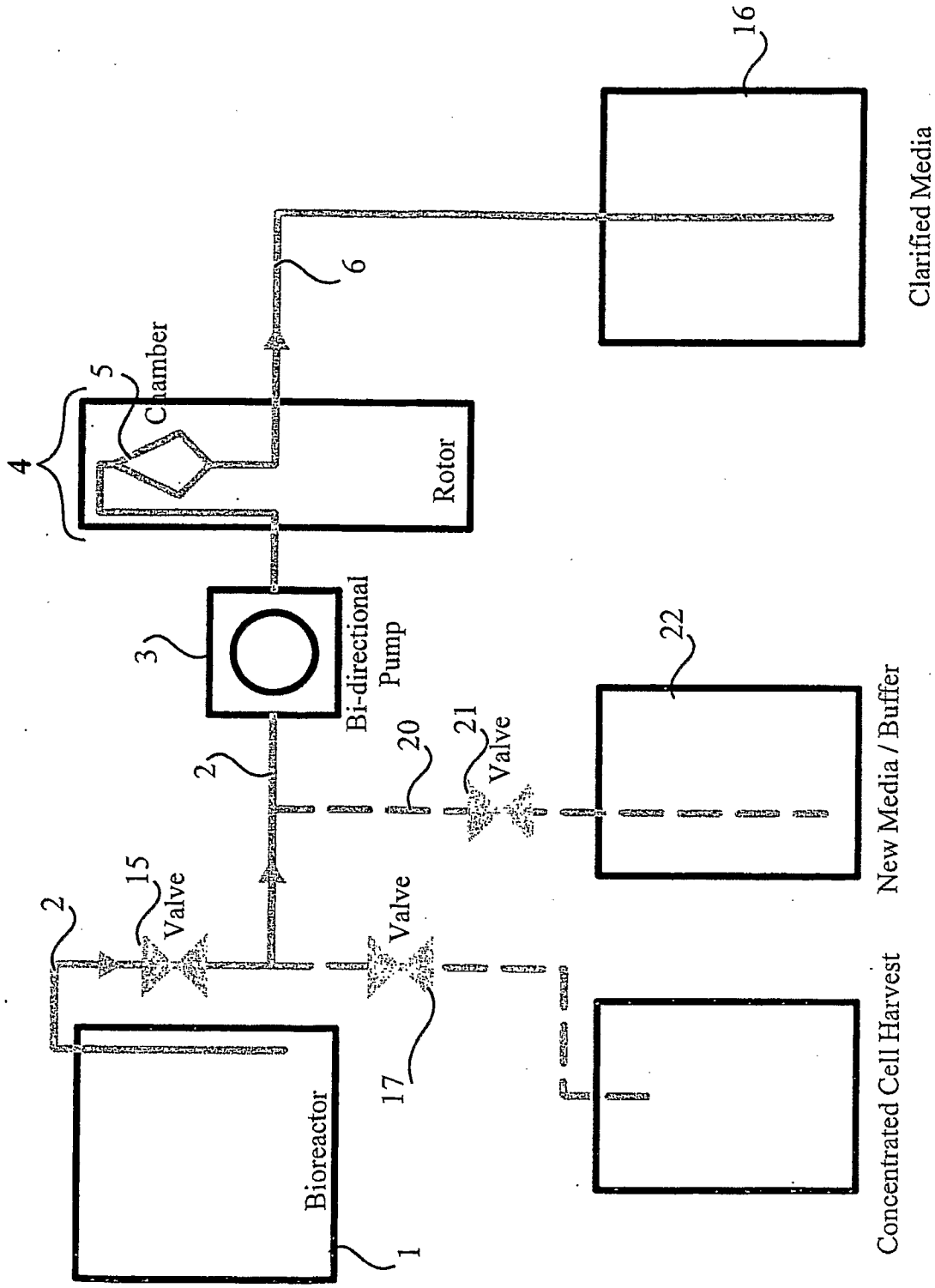


Figure 19
Media / Buffer Exchange Flow Diagram
Media / Buffer Exchange Mode

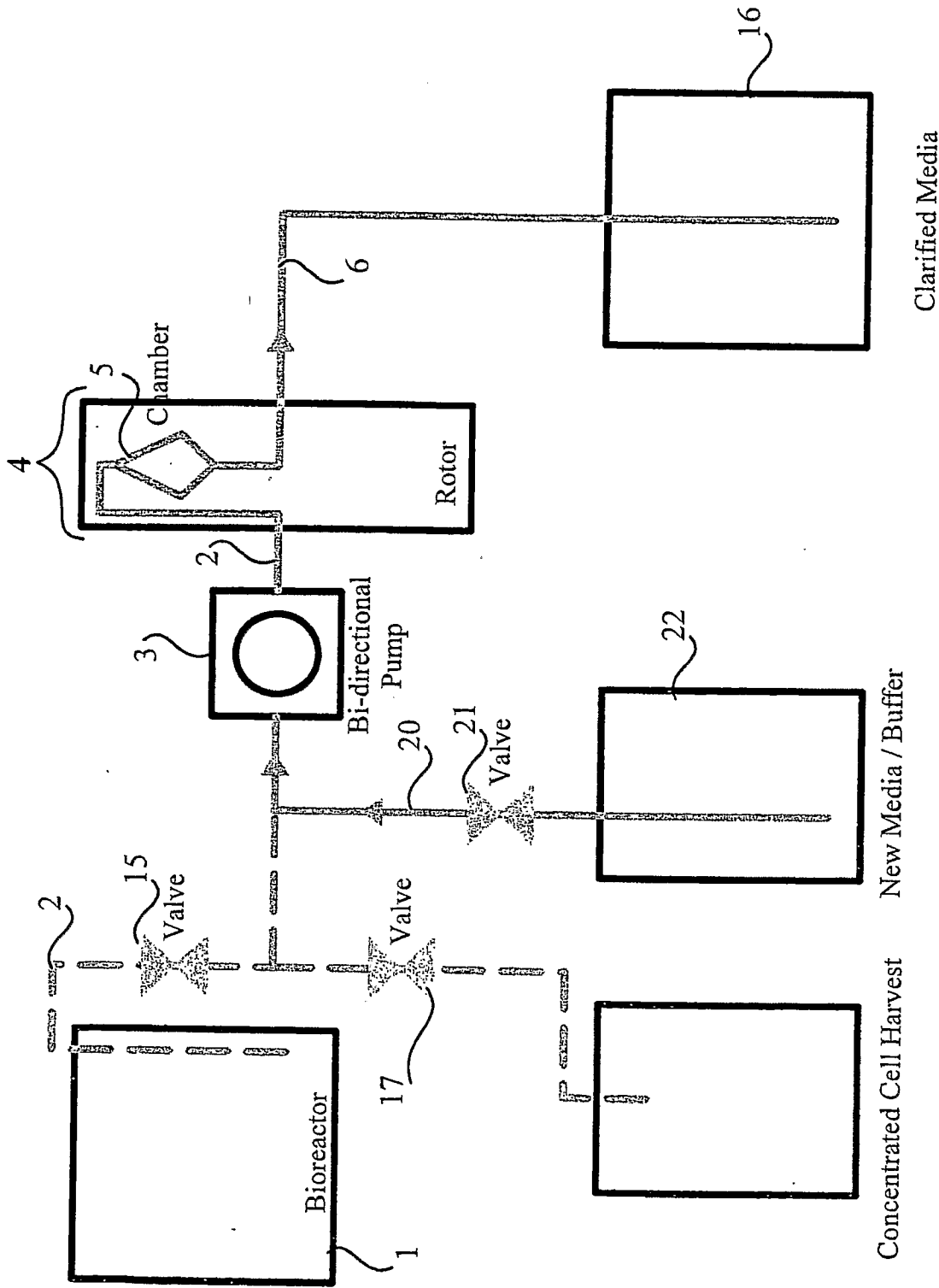


Figure 20
Media / Buffer Exchange Flow Diagram
Cell Harvest Mode

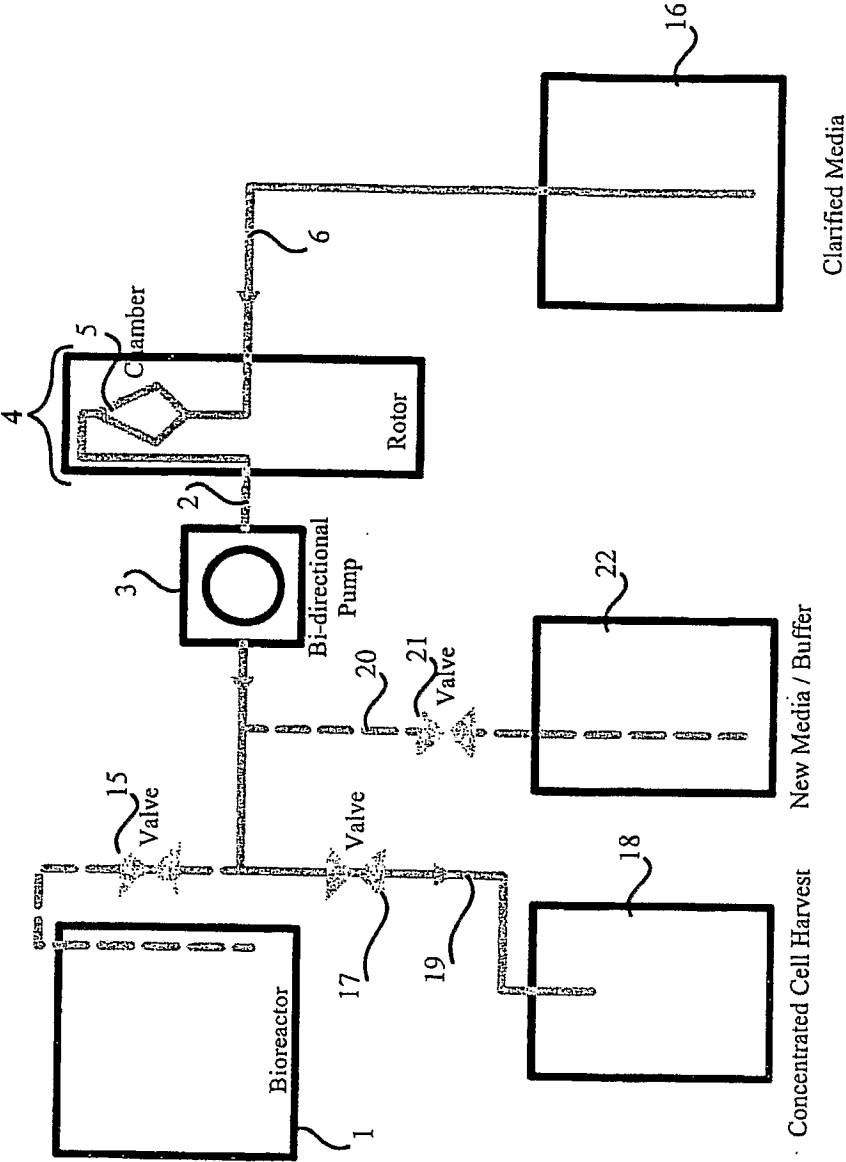


Figure 21
Cell Dispenser Flow Diagram
Cell Capture Mode

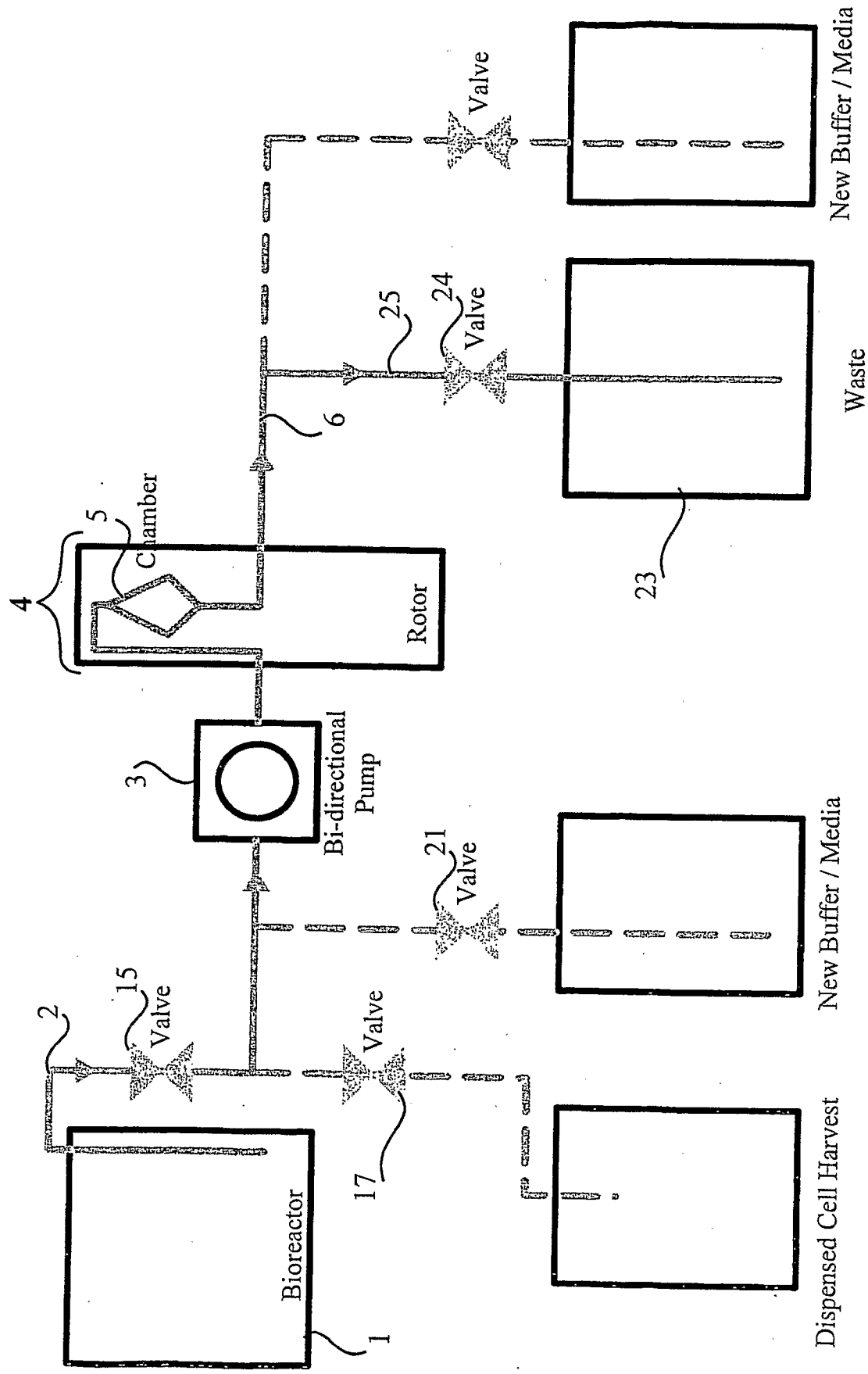


Figure 23
Cell Dispenser Flow Diagram
Dispense Mode

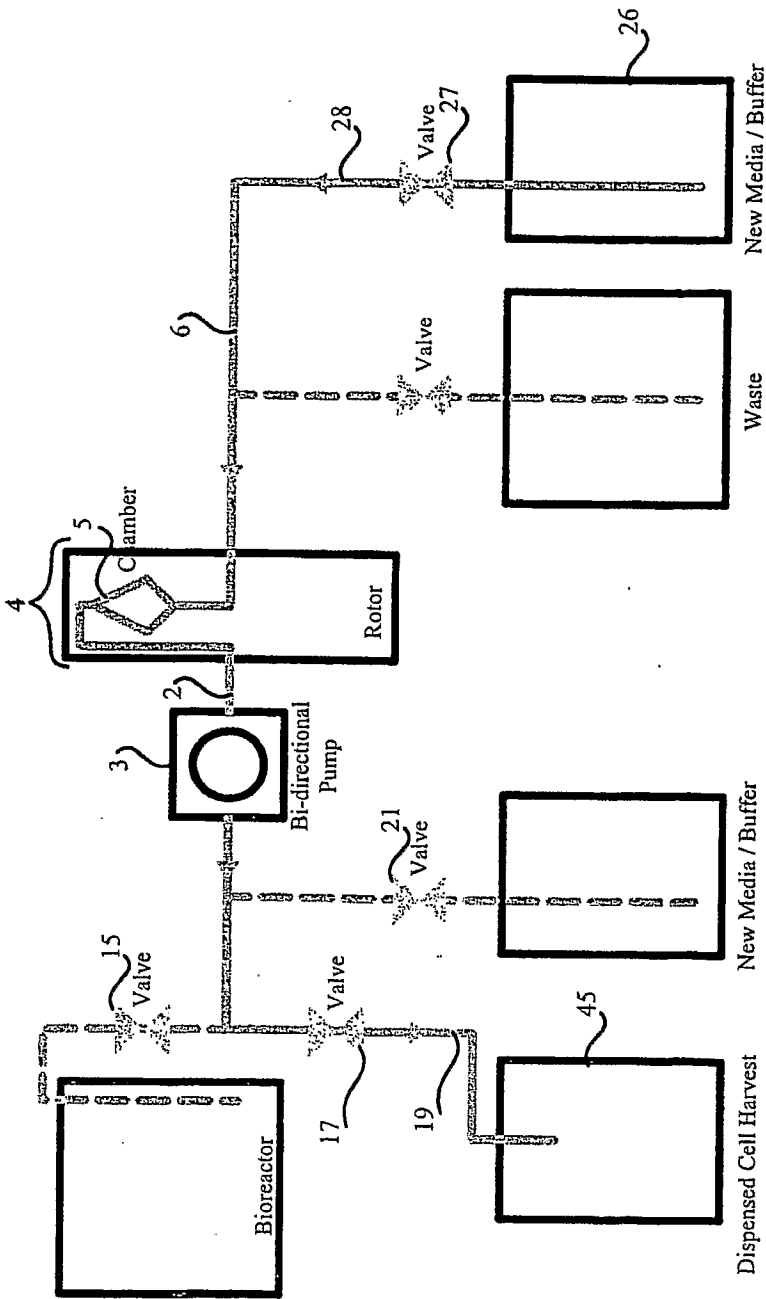


Figure 24
Transfection Flow Diagram
Cell Capture Mode

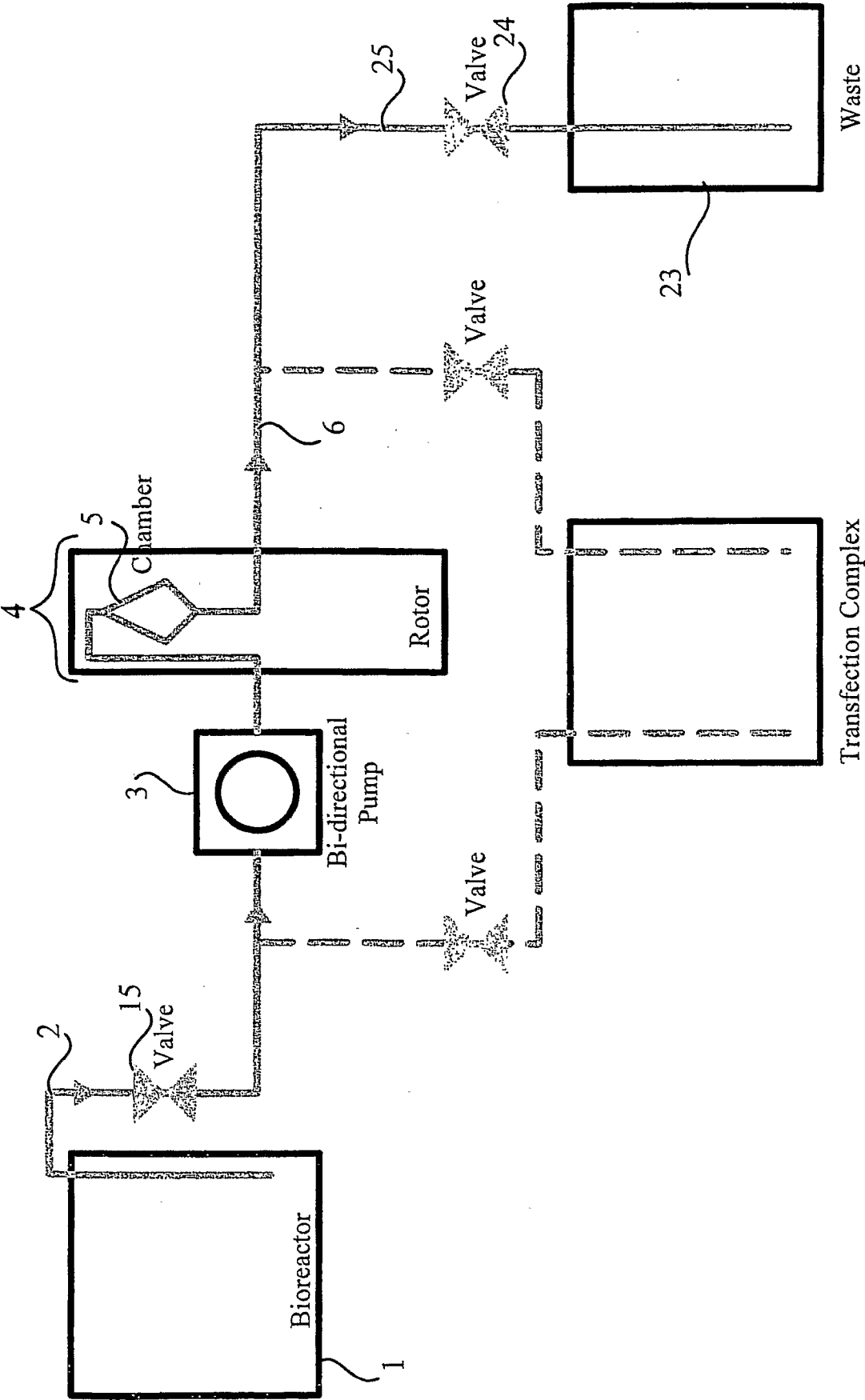


Figure 25
Transfection Mode

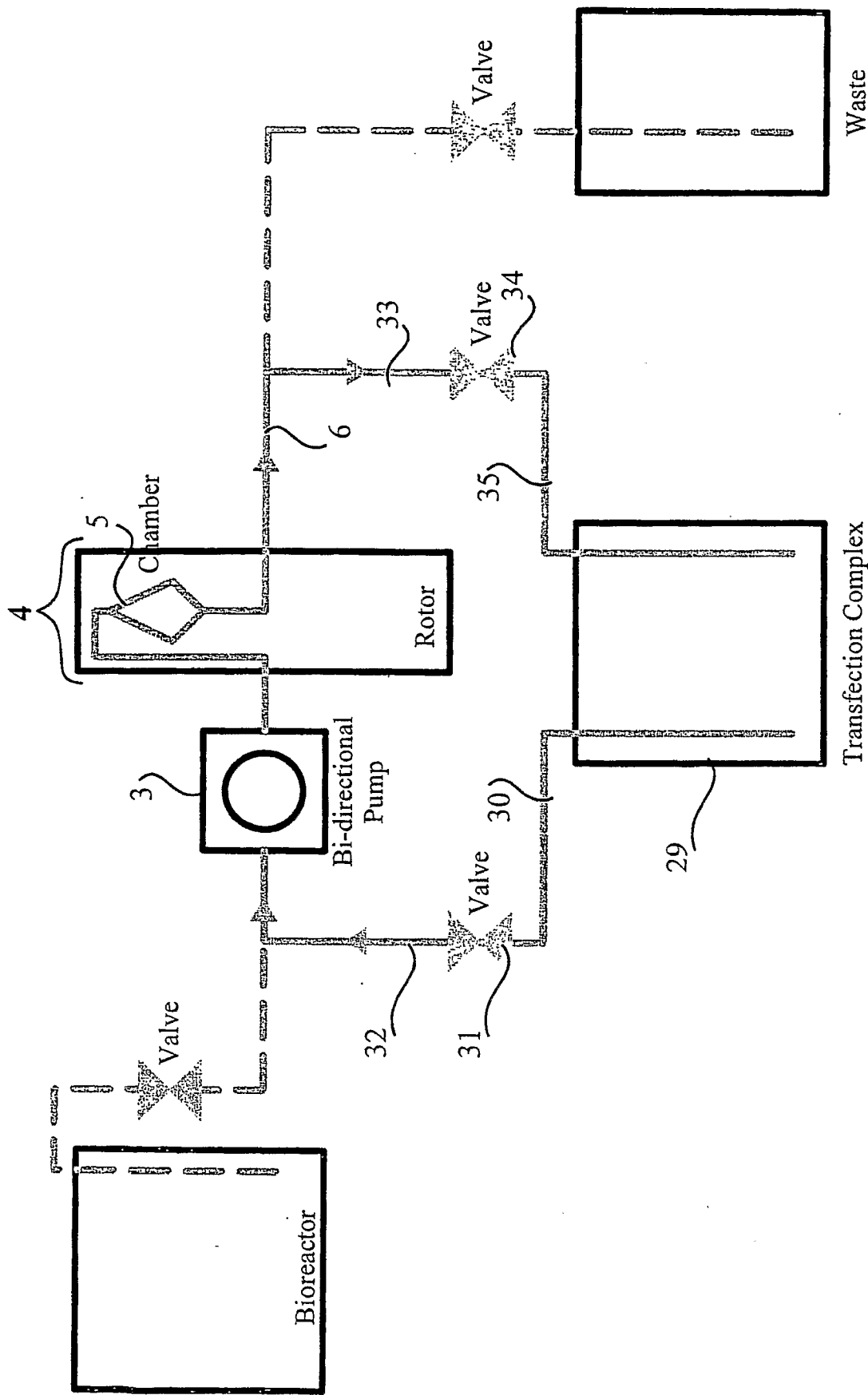


Figure 26
Transfection Flow Diagram
Cell Return Mode

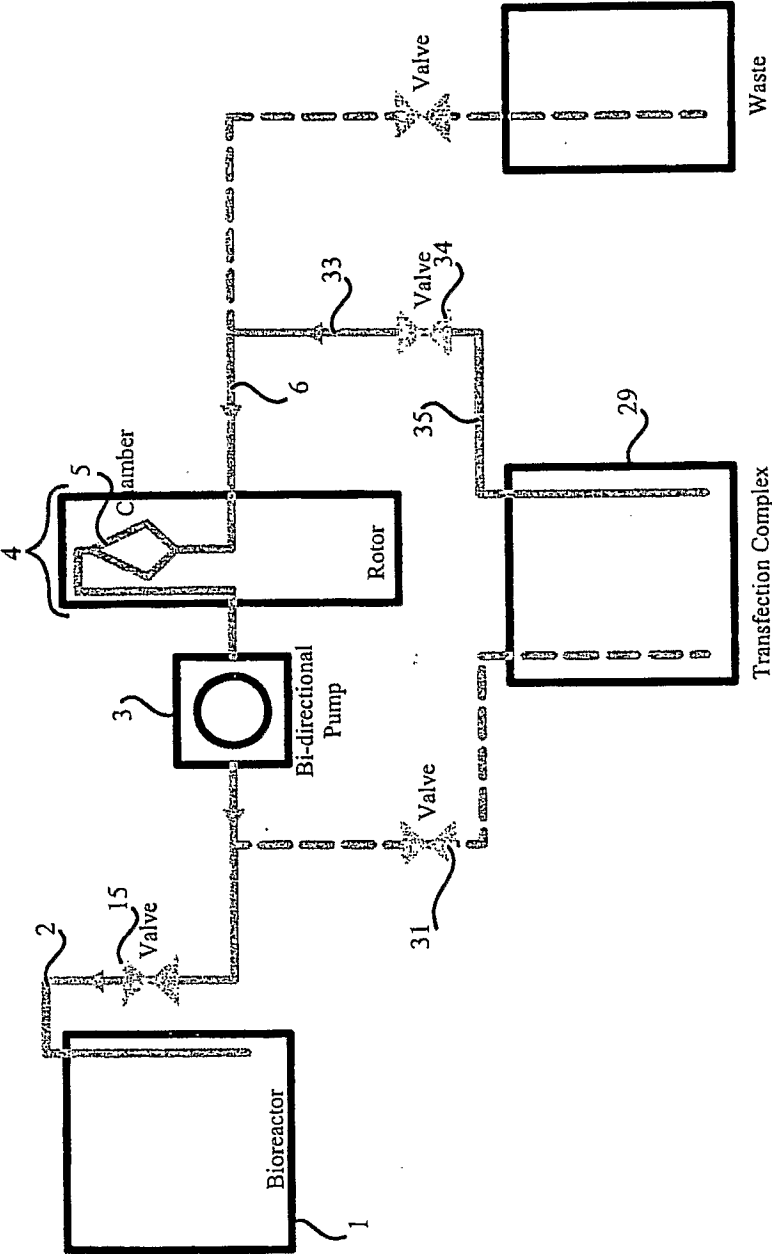


Figure 27
Cell Separator Flow Diagram
Large Cell Capture Mode

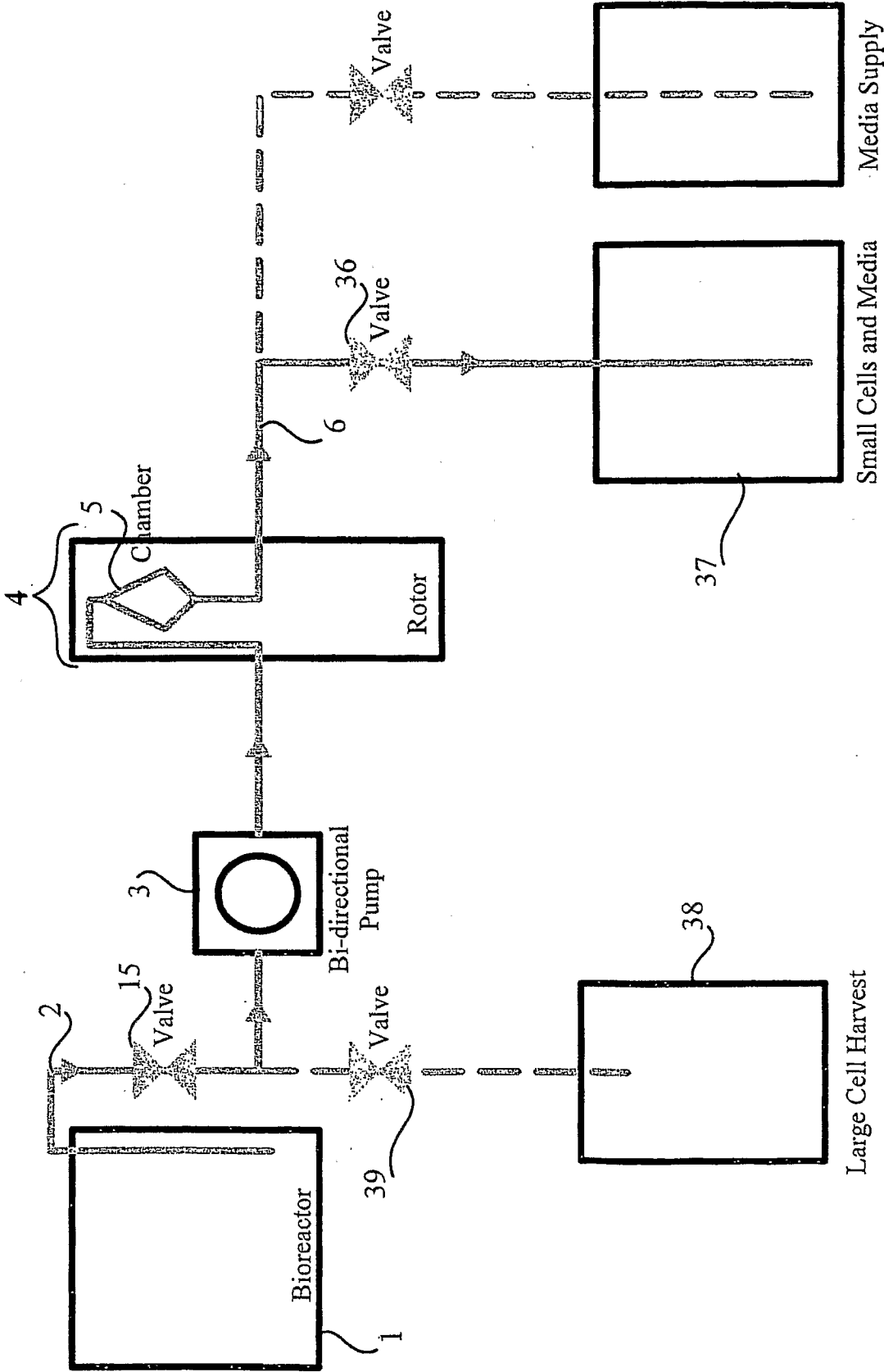


Figure 28
Cell Separator Flow Diagram
Large Cell Harvest Mode

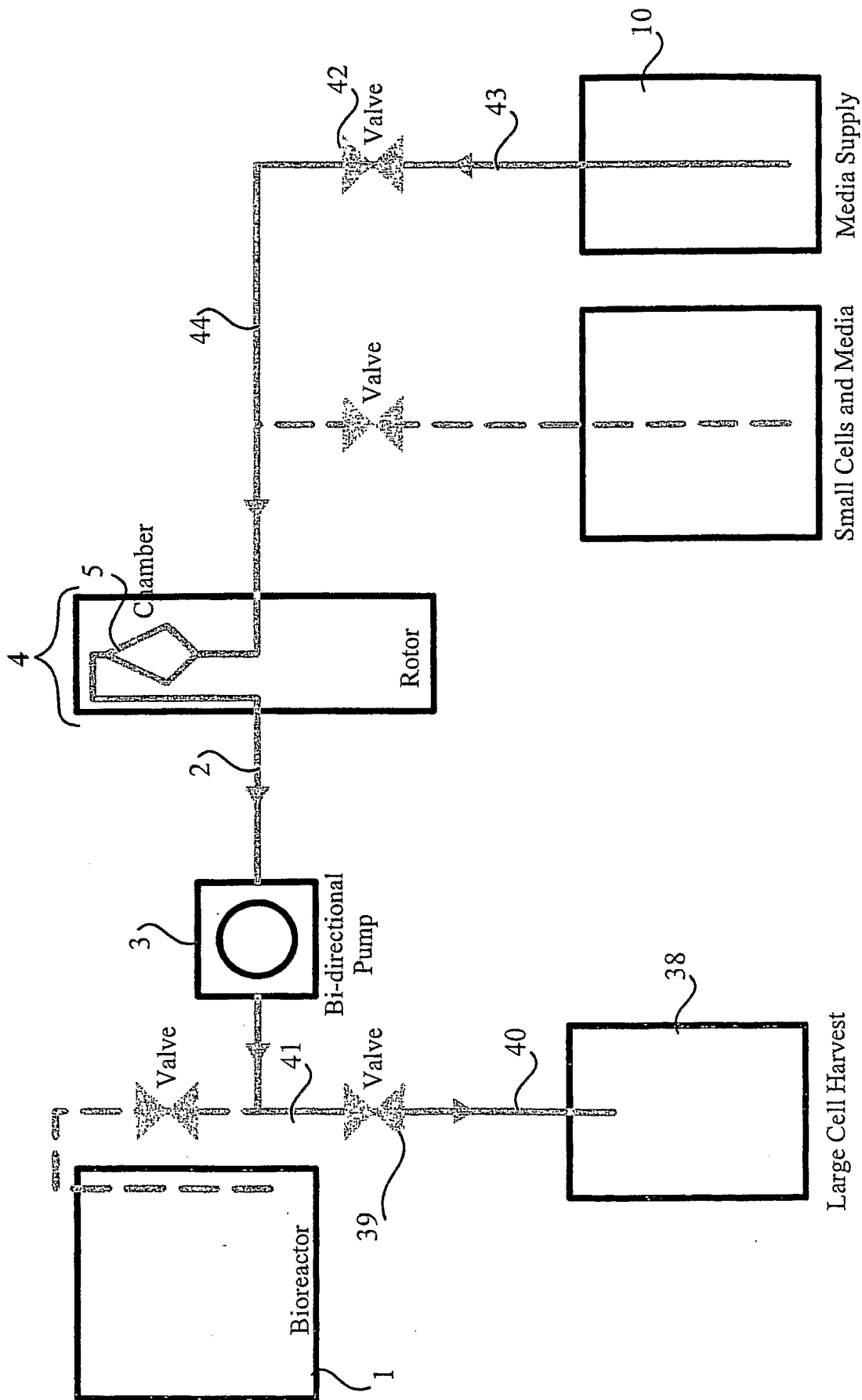


Figure 29

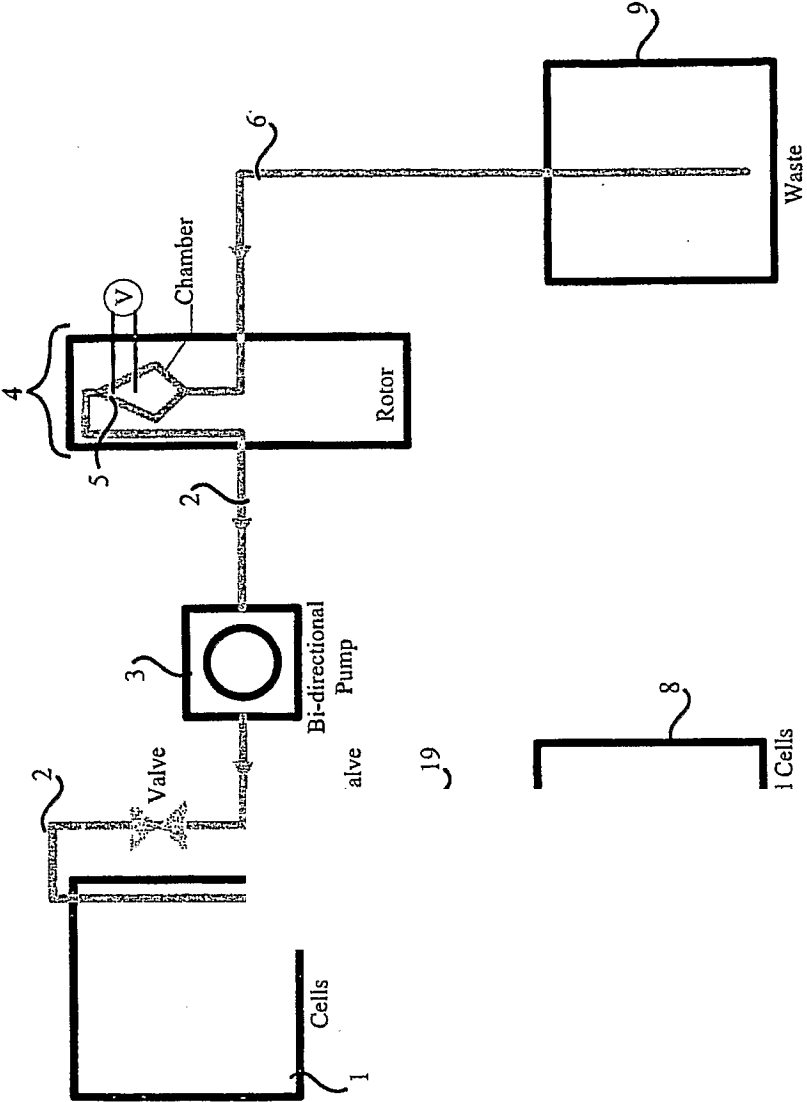


Figure 30

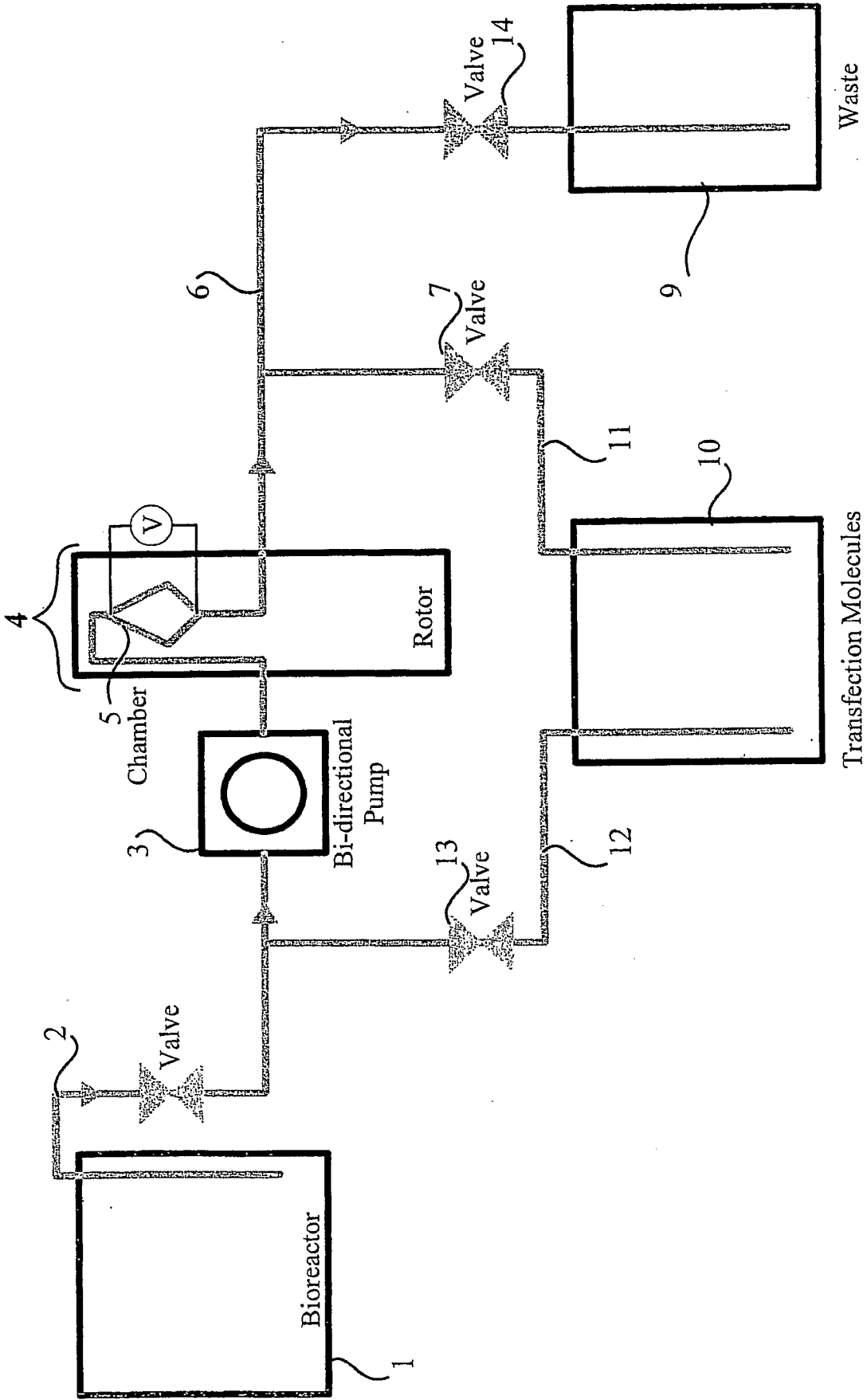


Figure 31

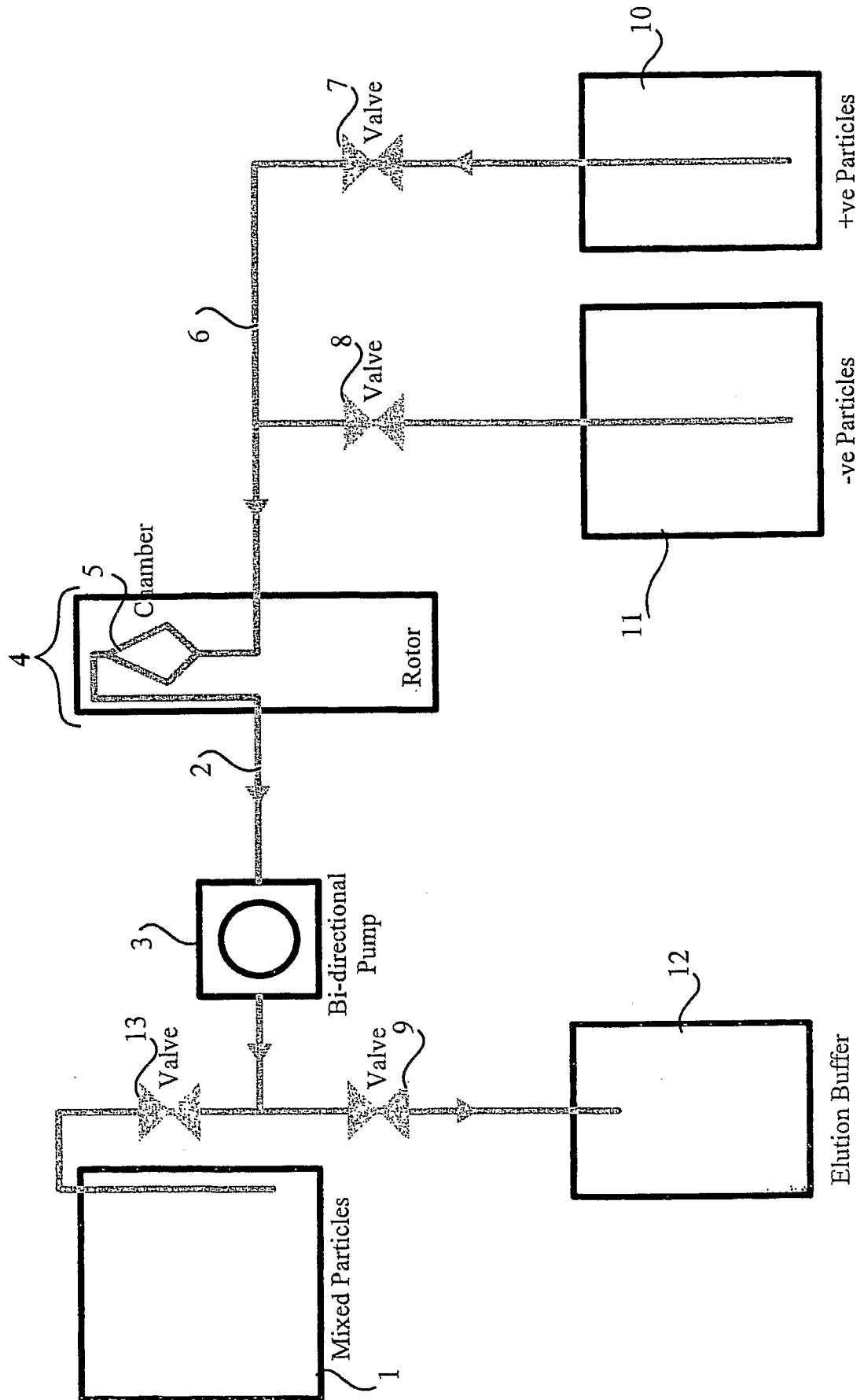


Figure 32

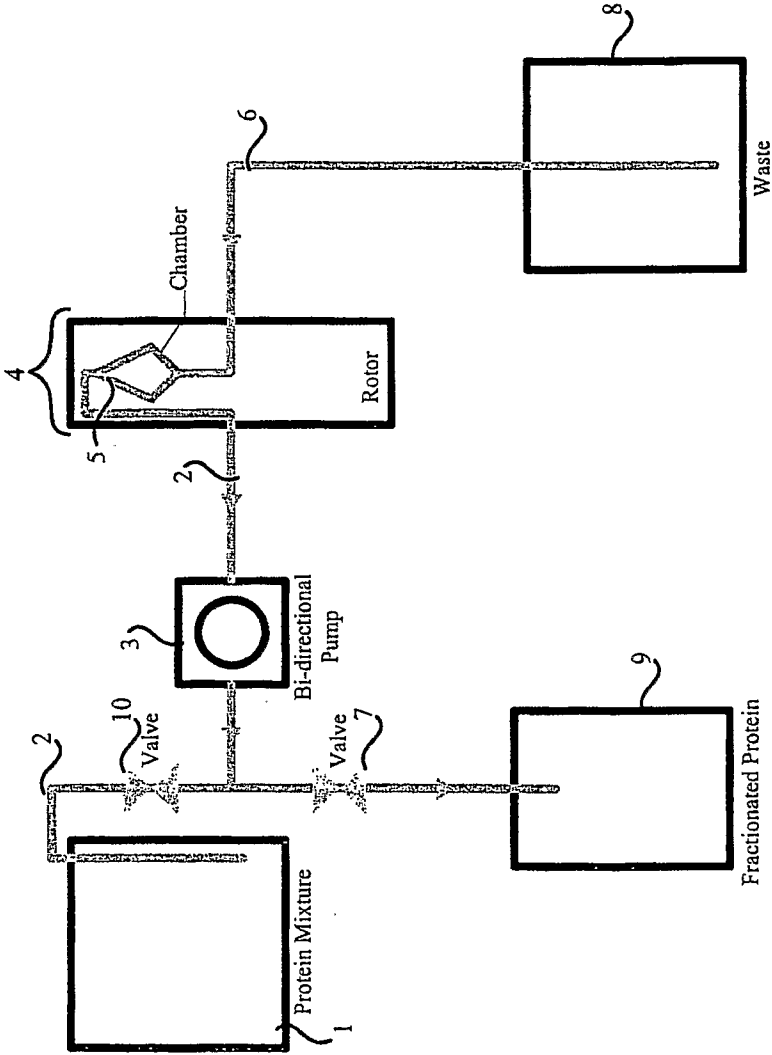


Figure 33

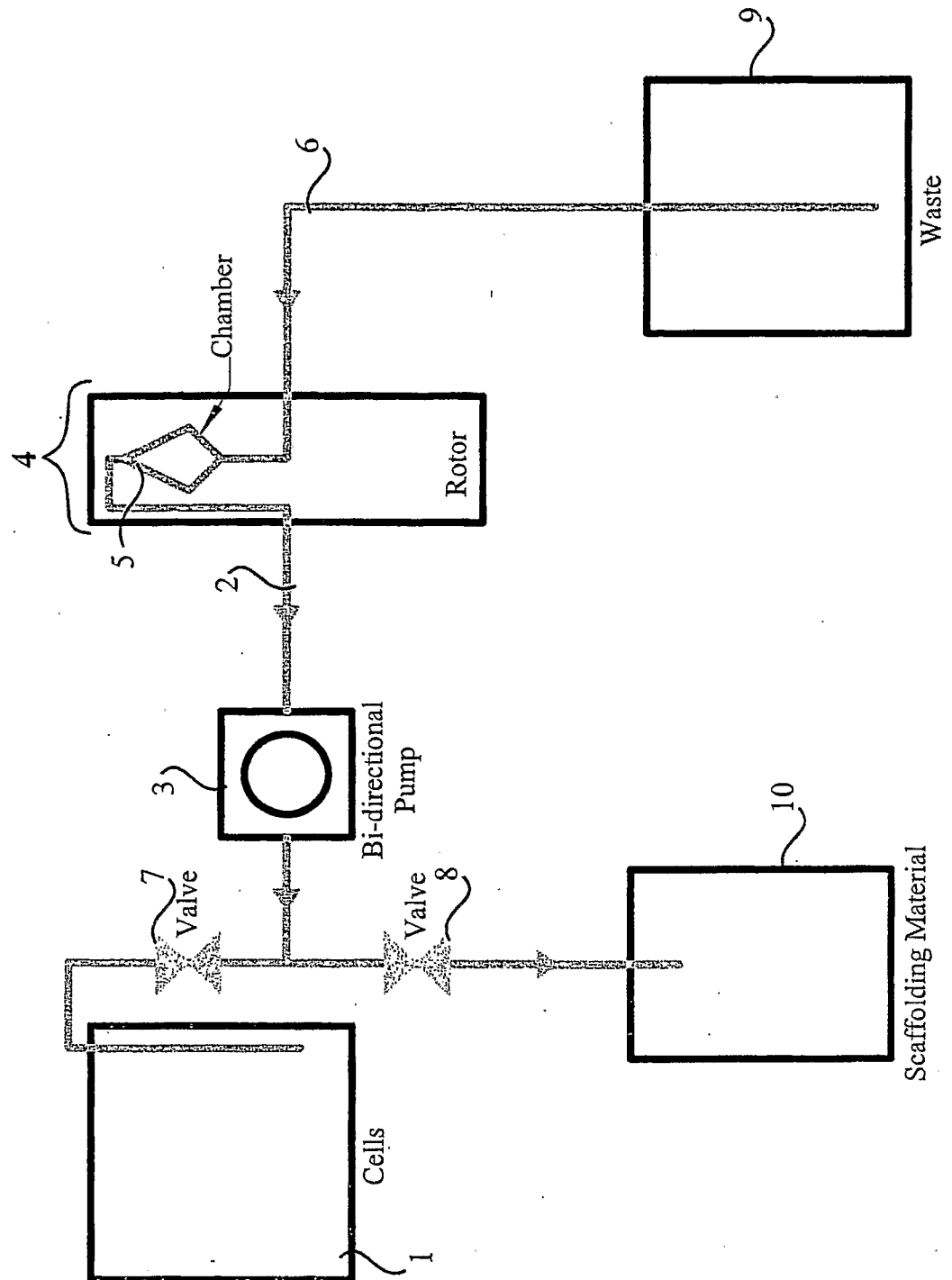


Figure 34

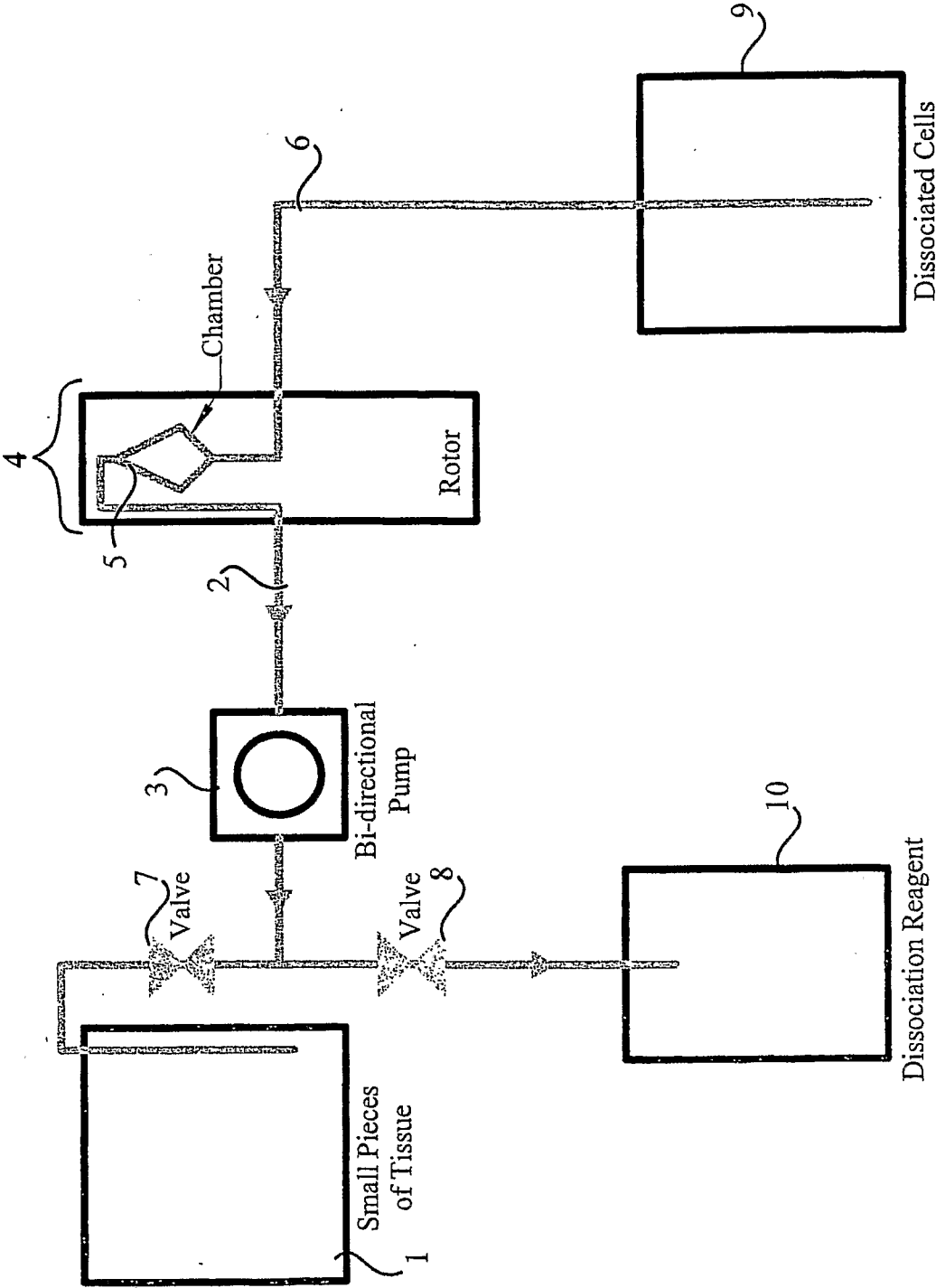


Figure 35

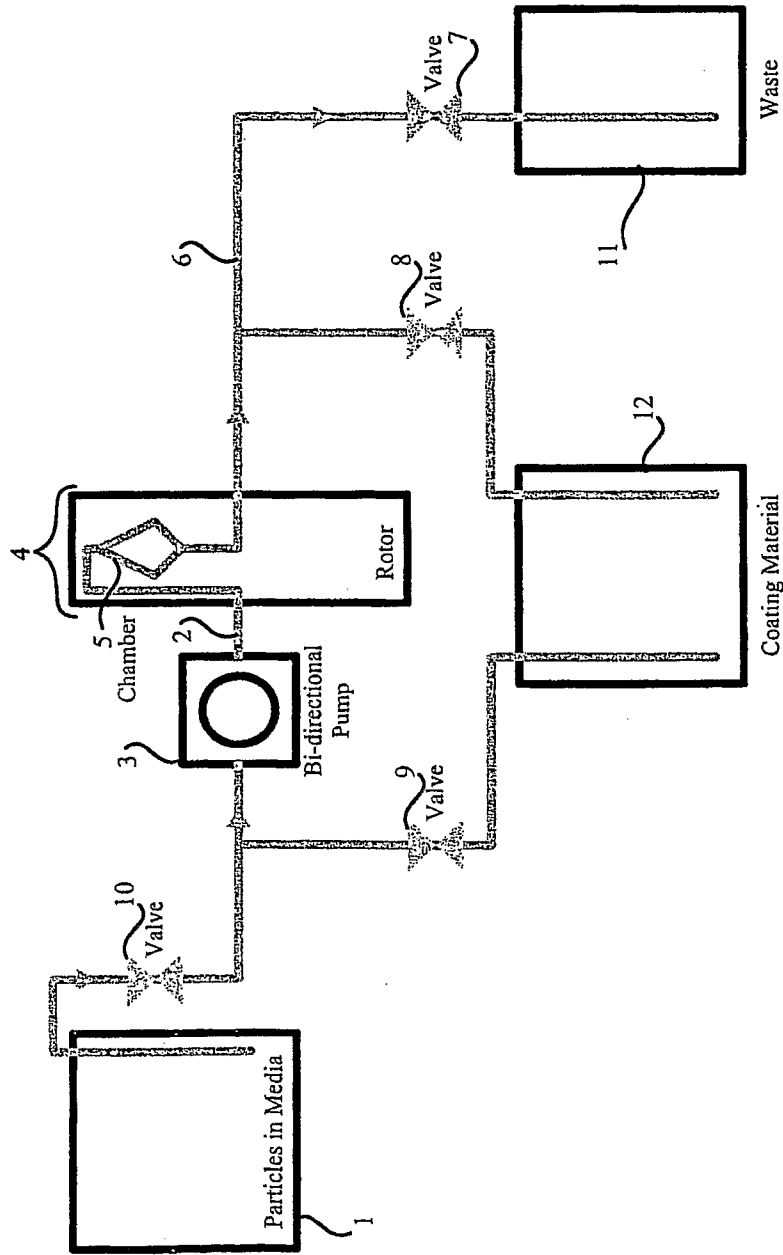


Figure 36

