

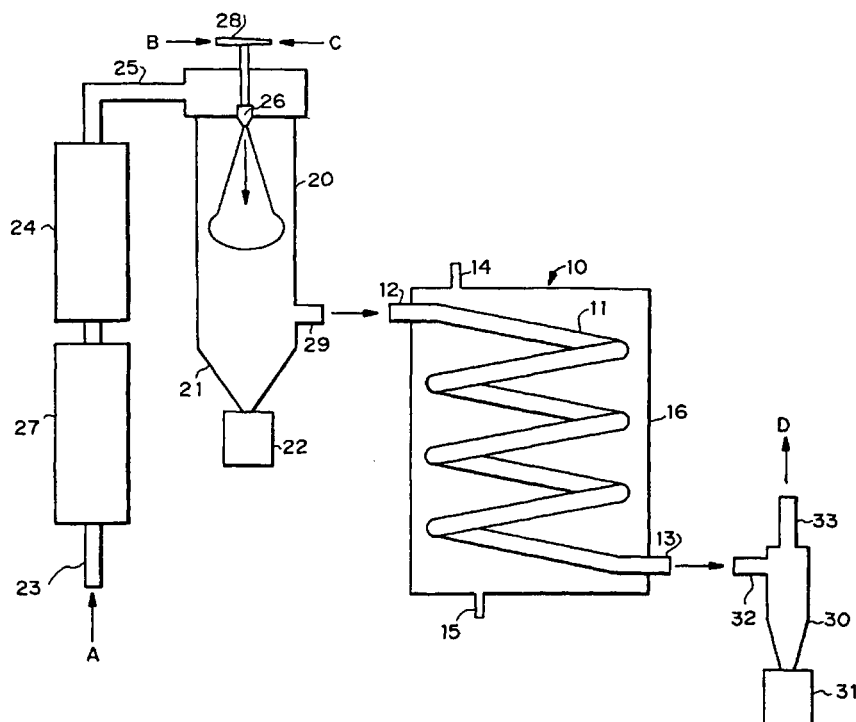


## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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| <b>(21) International Application Number:</b> PCT/US00/11158<br><b>(22) International Filing Date:</b> 26 April 2000 (26.04.00)<br><b>(30) Priority Data:</b><br>09/304,257 3 May 1999 (03.05.99) US<br><b>(71) Applicant:</b> ACUSPHERE, INC. [US/US]; 38 Sidney Street, Cambridge, MA 02139 (US).<br><b>(72) Inventors:</b> CHICKERING, Donald, E.; 3 Holly Way, Framingham, MA 01701 (US). KEEGAN, Mark, J.; 20 Florence Street, Andover, MA 01810 (US). RANDALL, Greg; 100 Ledgewood Drive, Stoneham, MA 02180 (US). BERNSTEIN, Howard; 33A Trowbridge Street, Cambridge, MA (US). STRAUB, Julie; 100 Cambridge Street, Winchester, MA 01890 (US).<br><b>(74) Agents:</b> PABST, Patrea, L. et al.; Arnall Golden & Gregory, LLP, 2800 One Atlantic Center, 1201 West Peachtree Street, Atlanta, GA 30309-3450 (US). | <b>(81) Designated States:</b> AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).<br><br><b>Published</b><br><i>With international search report.</i><br><i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i> |                                                                                                                                            |

**(54) Title:** SPRAY DRYING APPARATUS AND METHODS OF USE**(57) Abstract**

Improved spray drying apparatus, and methods of use thereof, have been developed. The spray drying equipment includes a primary drying chamber (20) and a secondary drying apparatus (10) which includes tubing having a length sufficient to increase the contact time between the drying gas and the droplets/particles to dry the particles to the extent desired, at a drying rate and temperature which would be too low to provide adequate drying without the secondary drying apparatus. The secondary drying apparatus increases the drying efficiency of the spray dryer system without increasing the drying rate, while minimizing loss in yield. The ratio of the length of tubing to the length of the primary drying chamber is at least 2:1. The tubing diameter is substantially smaller than the diameter of the primary drying chamber, such that the particles move at higher velocity through the tubing to minimize product losses. The ratio of the cross-sectional area of the primary drying chamber to the cross-sectional area of the tubing most preferably is about 16:1. The tubing preferably is in a compact coil design, which can more easily be transported and which has minimum space requirements, and may optionally include a jacket to control the temperature of the secondary drying process. A preferred application for the spray drying process and equipment is in the production of microparticles, between about 1 and 200  $\mu\text{m}$  in diameter, which can be used to deliver therapeutic and diagnostic agents.



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