

Fig. 1 – System Block Diagram showing reagent reservoirs, 21-pump rack, injection ring, PAT spool / process line, and controller flow.

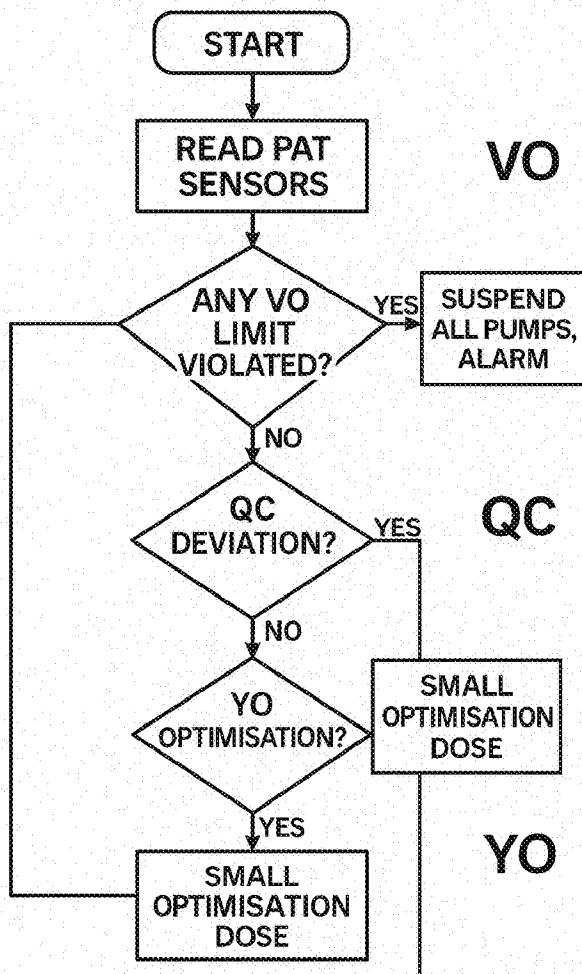


FIG. 2 Control-Logic Flowchart – Three-tier hierarchy (Vital-Override → Quality-Critical → Yield-Optimiser) with decision diamonds and pump-dose actions.

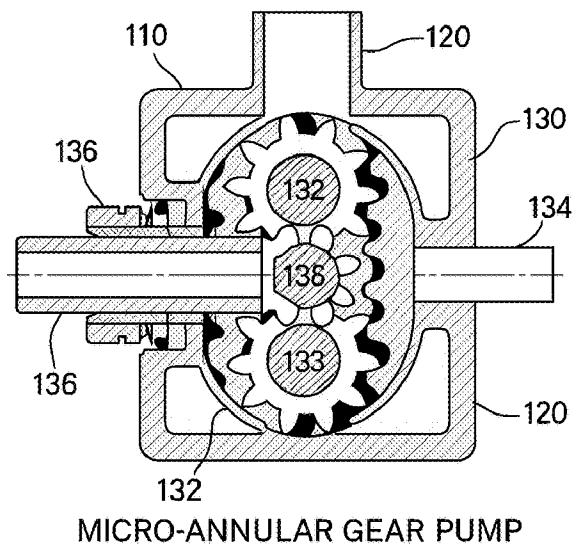
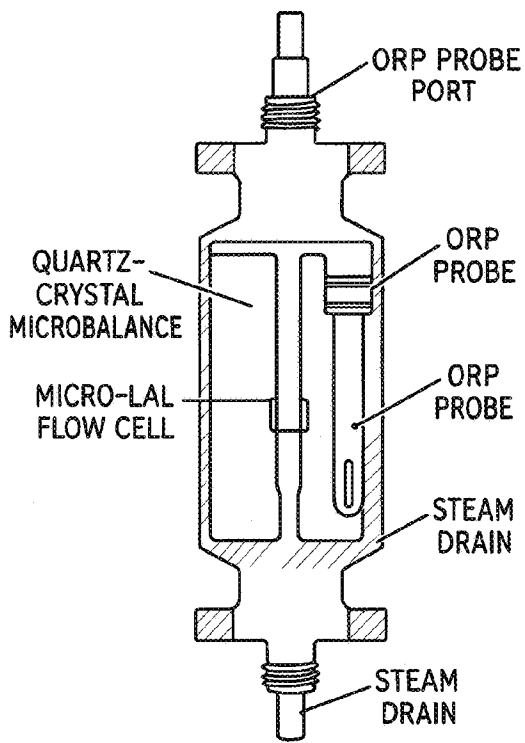


FIG. 3 Micro-Annular Gear Pump Cross-Section – Shows annular gear (132), spur gear (133), housing (120), magnetic coupling and shaft seals (136).

FIG. 4 Injection-Ring Cross-Section – Perspective cut-away of 316 L ring with radial quill (212) and CIP jumper loop.



PAT spool

FIG 5 – PAT Spool Cross-Section is now ready, showing the quartz-crystal microbalance, micro-LAL flow cell, ORP probe port, and steam drain in a cut-away view.

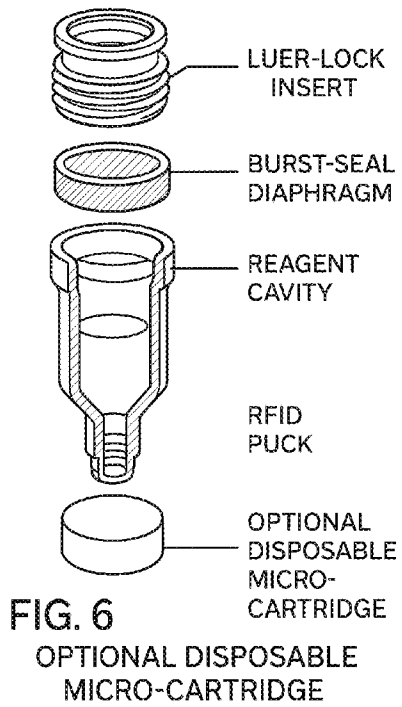


Figure 6 – Optional Disposable Micro-Cartridge (exploded view) is complete, showing the luer-lock insert, burst-seal diaphragm, reagent cavity, and RFID puck.

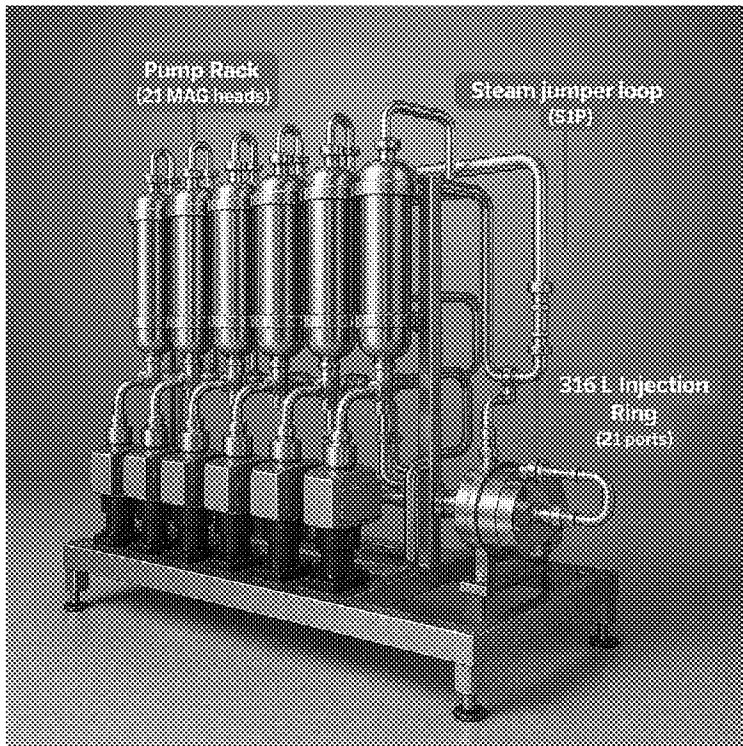


Figure 7A - Exploded Isometric of 21-Pump Rack & Injection Ring – Overall assembly with numbered reference parts, steam jumper loop, and EtherCAT drive bay.

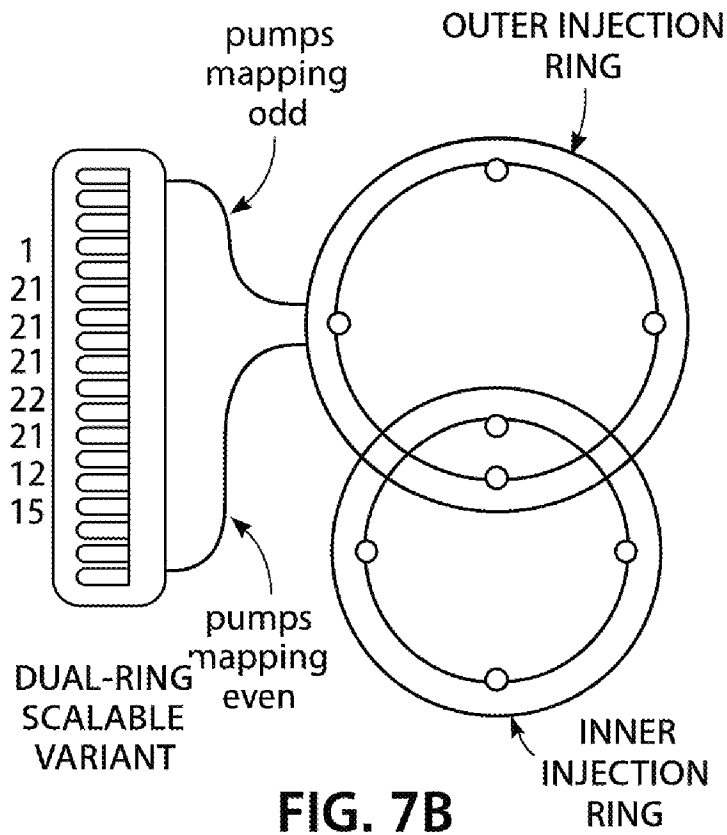


Figure 7B – Dual-Ring Scalable Variant illustrates odd-numbered pumps feeding an outer injection ring and even-numbered pumps feeding an inner ring, enabling simultaneous solvent and aqueous micro-dosing.

