BRIEF SUMMARY OF THE INVENTION

[0008] The present invention in one embodiment applies pre-compressive forces in pump bodies, or selected portion(s) thereof, to inhibit initiation of fatigue cracks in the fluid end of a multiplex pump.

[0009] According to a first aspect of the present invention, there is provided~~In one embodiment,~~ a method comprising~~es~~: expanding a displacement plug in a cavity to pre-compress a portion of a pump body comprising a piston bore, an inlet bore and an outlet bore spaced from said cavity; and connecting the pre-compressed pump body in a pump assembly~~. In an embodiment,~~; wherein the pre-compressed pump body portion is adjacent an intersection of the piston bore, inlet bore and outlet bore.

[0010] In an embodiment, the method comprises drilling the pump body to form the cavity as a bore. In an embodiment, the displacement plug comprises an interference fit pin having an outside diameter larger than an inside diameter of the cavity, and in a further embodiment, the displacement plug comprises an air relief port. In an embodiment, the displacement plug comprises a sleeve with a tapered inside diameter, wherein the sleeve is expanded by driving a similarly tapered pin into the sleeve. In another embodiment, the displacement plug comprises a pin with one or more cams to provide directional displacement at a surface of the cavity.

[0011] In an embodiment, the method further comprises forming raised surfaces on opposite exterior side surfaces of the pump body to apply a pre-compressive force at the raised surfaces upon the connection in the pump assembly.

[0012] In an embodiment, the method further comprises assembling a plurality of the pre-compressed pump bodies side by side between opposing end plates with a plurality of fasteners to form the pump assembly, wherein the fasteners are tightened to compress the pump bodies between the end plates. In an embodiment, the pre-compressed pump bodies further comprise raised surfaces on opposite exterior side surfaces thereof, wherein the raised surfaces engage with an adjacent end plate or an adjacent pump body; whereby the

tightening of the fasteners applies a pre-compressive force at the raised surfaces on each of the pump bodies.

[0013] In an embodiment, the method further comprises autofrettaging the pump body. In an embodiment, the method further comprises placing a sleeve in the piston bore, inlet bore, outlet bore or a combination thereof and expanding the sleeve in place for use as a cylinder liner.

[0014] In an embodiment, the method further comprises operating the pump assembly to reciprocate a piston in the piston bore and cycle between relatively high and low fluid pressures in the inlet and outlet bores, wherein the pre-compressed pump body portion inhibits initiation of fatigue cracks. In an embodiment, the method further comprises disassembling the fluid pump assembly to remove the pump body when it exhibits fatigue crack initiation, and reassembling the fluid pump assembly with a replacement pump body.

[0015] According to a second aspect of the present invention, there is provided~~In another embodiment,~~ a fluid pump assembly comprising~~es~~: a plurality of pump bodies connected side by side between opposing end plates with a plurality of fasteners tightened to compress the pump bodies between the end plates; wherein each pump body comprises a piston bore, an inlet bore, an outlet bore and an expanded displacement plug in a cavity; and wherein the expanded displacement plugs apply a pre-compressive force at the respective cavities on each of the pump bodies; wherein the cavities are adjacent an intersection of the piston bore, the inlet bore, and the outlet bore. In an embodiment, the pump bodies are autofrettaged.

[0016] In an embodiment, raised surfaces are provided on opposite exterior side surfaces of the pump bodies, wherein the raised surfaces engage with an adjacent end plate or the raised surface of an adjacent pump body, whereby the tightening of the fasteners applies a pre-compressive force at the raised surfaces on each of the pump bodies.

[0017] ~~In an embodiment, the cavities are adjacent an intersection of the piston bore, the inlet bore, and the outlet bore.~~ In an embodiment, the pre-compressive force extends the operational life of the assembly by reducing stress adjacent an intersection of the piston bore, the inlet bore, and the outlet bore. In an embodiment, a piston is reciprocatably disposed in the piston bore to

wherein the expanded displacement plug applies a pre-compressive force at the cavity on each of the pump bodies; wherein the cavities are adjacent an intersection of the piston bore, the inlet bore, and the outlet bore.

15. The fluid pump assembly of claim 14, wherein the cavity comprises a bore drilled in the pump body and the displacement plug comprises an interference fit pin having an outside diameter larger than an inside diameter of the cavity.

16. The fluid pump assembly of claim 14, wherein the cavity comprises a bore drilled in the pump body and the displacement plug comprises a sleeve with a tapered inside diameter, wherein the sleeve is expanded by driving a similarly tapered pin into the sleeve.

17. The fluid pump assembly of claim 14, wherein the cavity comprises a bore drilled in the pump body and the displacement plug comprises a pin with one or more cams to provide directional displacement at a surface of the cavity.

18. The fluid pump assembly of claim 14, 15, 16 or 17, wherein the pump bodies are autofrettaged.

19. The fluid pump assembly of claim 14, 15, 16 or 17, further comprising raised surfaces on opposite exterior side surfaces of the pump bodies, wherein the raised surfaces engage with an adjacent end plate or the raised surface of an adjacent pump body, whereby the tightening of the fasteners applies a pre-compressive force at the raised surfaces on each of the pump bodies.

~~20. The fluid pump assembly of claim 18, wherein the cavities are adjacent an intersection of the piston bore, the inlet bore, and the outlet bore.~~

~~21. The fluid pump assembly of claim 19, wherein the cavities are adjacent an intersection of the piston bore, the inlet bore, and the outlet bore.~~

20~~22~~. The fluid pump assembly of claim 14, 15, 16 or 17, wherein the pre-compressive force extends the operational life of the assembly by reducing

stress adjacent an intersection of the piston bore, the inlet bore, and the outlet bore.

2123. The fluid pump assembly of claim 14, 15, 16 or 17, wherein the pre-compressive force extends the operational life of the assembly by reducing stress adjacent an intersection of the piston bore, the inlet bore, and the outlet bore.

2224. The fluid pump assembly of claim 1820, wherein the pre-compressive force extends the operational life of the assembly by reducing stress adjacent an intersection of the piston bore, the inlet bore, and the outlet bore.

2325. The fluid pump assembly of claim 1921, wherein the pre-compressive force extends the operational life of the assembly by reducing stress adjacent an intersection of the piston bore, the inlet bore, and the outlet bore.

2426. The fluid pump assembly of claim 14, 15, 16 or 17, further comprising a piston reciprocatably disposed in the piston bore to cycle between relatively high and low fluid pressures in the inlet and outlet bores, wherein the pre-compressive force inhibits initiation of fatigue cracks.

2527. A method to inhibit fatigue cracks in a fluid pump assembly comprising a plurality of pump bodies comprising a piston bore, an inlet bore and an outlet bore, comprising:

drilling bores on opposite exterior side surfaces of the plurality of pump bodies adjacent an intersection of the piston bore, inlet bore and outlet bore;

driving displacement plugs into the bores, wherein the displacement plugs are selected from the group consisting of interference fit pins, sleeves with tapered inside diameters, pins with one or more cams, and combinations thereof;

expanding the displacement plugs in the bores to apply a pre- compressive force adjacent the intersection;

forming the pump assembly by connecting the plurality of the pre- compressed pump bodies side by side between opposing end plates with a plurality of fasteners; and

tightening the fasteners to compress the plurality of pump bodies between the end plates.

2628. The method of claim 257, further comprising autofrettaging the pump bodies.

2729. The method of claim 2527 or 2628, further comprising providing raised surfaces on opposite exterior side surfaces of the plurality of pump bodies, wherein the raised surfaces engage with an adjacent end plate or an adjacent pump body, whereby the tightening of the fasteners applies a pre-compressive force at the raised surfaces on each of the pump bodies.

2830. The method of claim 2527 or 2628, further comprising disassembling the fluid pump assembly to remove one of the pump bodies exhibiting fatigue crack initiation, and reassembling the fluid pump assembly with a replacement pump body without fatigue cracks.

2931. The method of claim 2729, further comprising disassembling the fluid pump assembly to remove one of the pump bodies exhibiting fatigue crack initiation, and reassembling the fluid pump assembly with a replacement pump body without fatigue cracks.