CLAIMS

What is claimed is:

1. An electric submersible pump (ESP) comprising a plurality of stages, at least one stage comprising:

a rotating impeller rotationally fixed to a shaft of the ESP, the impeller comprising a balance ring;

a stationary diffuser rotationally fixed to a housing of the ESP;

an upthrust washer disposed axially between a portion of the impeller and a portion of the diffuser, the upthrust washer disposed radially outside of the balance ring; and

a bearing assembly disposed radially between the shaft and the diffuser, wherein an axial gap between the portion of the impeller and the portion of the diffuser is smaller than an axial gap between the bearing assembly and an upwardly facing surface of the impeller disposed radially between a central hub of the impeller and the balance ring of the impeller.

2. The ESP of Claim 1, further comprising a second upthrust washer disposed adjacent a leading edge shoulder of the diffuser.

3. The ESP of Claim 2, wherein the second upthrust washer comprises one or more lubrication grooves.

4. The ESP of Claim 1, wherein the balance ring of the impeller comprises one or more lubrication grooves.

5. The ESP of Claim 1, wherein the diffuser comprises one or more lubrication grooves.

6. The ESP of Claim 5, wherein a central hub of the diffuser comprises one or more lubrication grooves in a leading or upstream edge of the central hub.

7. The ESP of Claim 5, wherein a ring surrounding a central hub of the diffuser comprises one or more lubrication grooves in a leading edge shoulder of the ring.

8. The ESP of Claim 1, wherein the upthrust washer comprises phenolic material, tungsten carbide, or silicon carbide.

9. The ESP of Claim 1, wherein an axial gap between the portion of the impeller and the portion of the diffuser is smaller than an axial gap between a downstream edge of the balance ring of the impeller and the diffuser.

10. The ESP of Claim 1, wherein an axial gap between the portion of the impeller and the portion of the diffuser is smaller than an axial gap between the diffuser and an upwardly

facing surface of the impeller disposed radially between a central hub of the impeller and a balance ring of the impeller.

11. An electric submersible pump (ESP) comprising:

a plurality of centrifugal stages, each stage comprising a rotating impeller coupled to a rotating shaft and a stationary diffuser disposed about the rotating impeller; and

an upthrust bearing assembly disposed radially between the shaft and the diffuser, wherein an axial gap between a portion of the impeller and a portion of the diffuser is smaller than an axial gap between the upthrust bearing assembly and an upwardly facing surface of the impeller disposed radially between a central hub of the impeller and a balance ring of the impeller and comprising:

a bearing sleeve disposed about the shaft and rotationally keyed to the shaft;

a stationary bushing disposed about the bearing sleeve, the bushing having a generally T-shaped longitudinal cross-section shape and a bore extending longitudinally therethrough, the bushing having a base portion and a thrust pad at an upstream end of the base portion; and

an upthrust bearing runner disposed about the shaft upstream of the bushing, the upthrust bearing runner configured to move toward an upthrust surface of the thrust pad of the bushing when the ESP operates in an upthrust condition.

12. The ESP of Claim 11, wherein the upthrust bearing assembly is disposed proximate a top or downstream end of the plurality of centrifugal stages.

13. The ESP of Claim 11, wherein the upthrust bearing assembly is disposed in a pump head section.

14. The ESP of Claim 11, wherein the upthrust surface comprises one or more grooves configured to allow fluid flow.

15. The ESP of Claim 11, wherein a compliance is introduced between the upthrust bearing and head to prevent or inhibit impact loading onto the bearing system.

16. The ESP of Claim 11, the bushing comprising an anti-rotation feature configured to rotationally fix the bushing.

17. The ESP of Claim 16, wherein the anti-rotation feature comprises notches in a downstream end of the base portion and/or a downstream surface of the thrust pad.

18. The ESP of Claim 16, wherein the anti-rotation feature comprises a groove in an outer surface of the base portion extending axially along at least a portion of a length of the base portion.