CLAIMS

1. A metallic ring seal comprising:

an annular body defining an axial hole therethrough for fluid passage in an axial direction, the annular body having a radial plane perpendicular to the axial direction and having: a radial outer face with a generally C-shaped cross section groove, a plurality of bores disposed therein, or both the generally C-shaped cross section groove and the plurality of bores;

a first sealing side on a first axial end of the annular body, the first sealing side including:

a first deformable annular protrusion extending from the annular body in the axial direction to a first apex, the first deformable annular protrusion configured to deform upon engagement with a first planar sealing surface,

a second deformable annular protrusion extending from the annular body in the axial direction to a second apex, the second deformable annular protrusion configured to deform upon engagement with the first planar sealing surface,

a first trough defined between the first deformable annular protrusion and the second deformable annular protrusion, the first trough extending annularly around the first sealing side, the first trough including an annular trough base, a first outer rising surface, and a first inner rising surface, the first outer rising surface extending radially outward from the trough base to one of the first apex and the second apex, the first inner rising surface extending radially inward from the trough base to the other of the first apex and the second apex, and the first trough configured to engage with a first annular rounded sealing protrusion;

wherein the first inner rising surface and the first outer rising surface are curved in cross section;

wherein a distance between the first apex and the second apex is between 0.06 cm (0.023 inches) and 0.11 cm (0.043 inches), and

wherein the first trough has a maximum depth below the first deformable annular protrusion of between 0.008 cm (0.003 inches) and 0.02 cm (0.008 inches).

2. The ring seal of claim 1, further comprising:

a second sealing side on a second axial end of the annular body opposite the first axial end, the second sealing side including:

a third deformable annular protrusion extending from the annular body in the axial direction to a third apex, the third deformable annular protrusion configured to deform upon engagement with a second planar sealing surface,

a fourth deformable annular protrusion extending from the annular body in the axial direction to a fourth apex, the second deformable annular protrusion configured to deform upon engagement with the second planar sealing surface,

a second trough defined between the third deformable annular protrusion and the fourth deformable annular protrusion, the second trough extending around the second sealing side and configured to engage with a second annular rounded sealing ring.

3. The ring seal of claim 2, wherein the second sealing side is a mirror image of the first sealing side reflected over the radial plane of the annular body perpendicular to the axial direction.

4. The ring seal of claim 1, wherein the first deformable annular protrusion and the second deformable annular protrusion are configured to deform to form a C-seal upon engagement with the first planar sealing surface.

5. The ring seal of claim 1, wherein the first trough is configured to engage the first annular rounded sealing ring to form a W-seal.

6. The ring seal of claim 1, wherein:

the first apex transitions to an outer extension surface extending radially away from the axial hole and the first outer rising surface extending radially towards the axial hole;

a first angle defined by the first outer rising surface adjacent to the first apex and the axial direction is between 20-60 degrees; and

a second angle defined by the outer extension surface adjacent to the first apex and the axial direction is between 20-60 degrees.

7. The ring seal of claim 1, wherein the second deformable annular protrusion borders the axial hole such that an inner diameter surface defining a portion of the axial hole forms one side of the second deformable annular protrusion.

8. The ring seal of claim 1, wherein the first apex extends in the axial direction farther than the second apex.

9. The ring seal of claim 8, wherein the first apex extends in the axial direction farther than the second apex by about 0.005 cm (0.002 inches) to 0.01 cm (0.004 inches).

10. The ring seal of claim 1, wherein the first trough has a diameter as measured from a point equidistant between the first apex and the second apex between 0.55 cm (0.216 inches) and 0.59 cm (0.234 inches).

11. The ring seal of claim 1, wherein the first outer rising surface is curved from the trough base to the first apex, wherein the first inner rising surface is curved from the trough base to the second apex.

12. The ring seal of claim 1, wherein the first apex is radially outward of the second apex, wherein the first apex extends in the axial direction farther than the second apex.

13. A metallic ring seal comprising:

an annular body defining an axial hole therethrough for fluid passage in an axial direction, the annular body having a radial plane perpendicular to the axial direction and having: a radial outer face with a generally C-shaped cross section groove, a plurality of bores disposed therein, or both the generally C-shaped cross section groove and the plurality of bores;

a first sealing side on a first axial end of the annular body, the first sealing side including: a first deformable annular protrusion extending from the annular body in the axial direction to a first apex, the first deformable annular protrusion configured to deform upon engagement with a first planar sealing surface,

a second deformable annular protrusion extending from the annular body in the axial direction to a second apex, the second deformable annular protrusion configured to deform upon engagement with the first planar sealing surface,

a first trough defined between the first deformable annular protrusion and the second deformable annular protrusion, the first trough extending around the first sealing side and configured to engage with a first annular rounded sealing protrusion, the first trough including an annular trough base, a first outer rising surface, and a first inner rising surface, the first outer rising surface extending radially outward from the trough base to one of the first apex and the second apex, the first inner rising surface extending radially inward from the trough base to the other of the first apex and the second apex, wherein the first inner rising surface and the first outer rising surface are curved in cross section,

wherein a distance between the first apex and the second apex is substantially larger than a maximum depth of the first trough below the first deformable annular protrusion, the distance between the first apex and the second apex and the depth of the first trough permitting the first annular rounded sealing protrusion to be received between the first apex and the second apex and against the trough to deform the trough against the first annular rounded sealing protrusion to form a fluid tight seal with the first annular rounded sealing protrusion.

14. The ring seal of claim 13, wherein the first apex extends in the axial direction farther than the second apex by about 0.005 cm (0.002 inches) to 0.01 cm (0.004 inches).

15. The ring seal of claim 13, further comprising:

a second sealing side on a second axial end of the annular body opposite the first axial end, the second sealing side including:

a third deformable annular protrusion extending from the annular body in the axial direction to a third apex, the third deformable annular protrusion configured to deform upon engagement with a second planar sealing surface,

a fourth deformable annular protrusion extending from the annular body in the axial direction to a fourth apex, the second deformable annular protrusion configured to deform upon engagement with the second planar sealing surface,

a second trough defined between the third deformable annular protrusion and the fourth deformable annular protrusion, the second trough extending around the second sealing side and configured to engage with a second annular rounded sealing ring.

16. The ring seal of claim 15, wherein the second sealing side is a mirror image of the first sealing side reflected over the radial plane of the annular body perpendicular to the axial direction.

17. The ring seal of claim 13, wherein the first deformable annular protrusion and the second deformable annular protrusion are configured to deform to form a C-seal upon engagement with the first planar sealing surface.

18. The ring seal of claim 13, wherein the first trough is configured to engage the first annular rounded sealing ring to form a W-seal.

19. The ring seal of claim 13, wherein:

the first apex transitions to an outer extension surface extending radially away from the axial hole and the first outer rising surface extending radially towards the axial hole;

a first angle defined by the first outer rising surface adjacent to the first apex and the axial direction is between 20-60 degrees; and

a second angle defined by the outer extension surface adjacent to the first apex and the axial direction is between 20-60 degrees.

20. The ring seal of claim 13, wherein the second deformable annular protrusion borders the axial hole such that an inner diameter surface defining a portion of the axial hole forms one side of the second deformable annular protrusion.