surfaces are formed on the outer surface and are positioned adjacent to one another on the outer surface. The first and second ramp surfaces are contiguous along a first apex extending parallel to the axis and projecting outwardly from the outer surface. The first and second ramp surfaces are angularly oriented with respect to a first line extending radially from the axis to the first apex.

An example embodiment further comprises third and fourth ramp surfaces positioned adjacent to one another on the outer surface. The third and fourth ramp surfaces are contiguous along a second apex projecting outwardly from the outer surface. The third and fourth ramp surfaces are angularly oriented with respect to a second line extending radially from the axis to the second apex. In an example embodiment the first and second apexes are diametrically opposite to one another. An example embodiment further comprises a lobe extending circumferentially around a first side of the outer ring. The lobe has an outer surface facing away from the axis and a sealing surface facing toward the axis. An example embodiment further comprises fifth and sixth ramp surfaces positioned adjacent to one another on the outer surface of the lobe. The fifth and sixth ramp surfaces are contiguous along a third apex projecting from the outer surface of the lobe. The fifth and sixth ramp surfaces are angularly oriented with respect to a third line extending radially from the axis to the third apex. In a specific example embodiment the first and third apexes are aligned with one another.

An example embodiment further comprises seventh and eighth ramp surfaces positioned adjacent to one another on the outer surface of the lobe. The seventh and eighth ramp surfaces are contiguous along a fourth apex projecting from the outer surface of the lobe. The seventh and eighth ramp surfaces are angularly oriented with respect to a fourth line extending radially from the axis to the fourth apex. In a specific example embodiment the second and fourth apexes are aligned with one another.

An example, embodiment further comprises a rim extending circumferentially around a side of the outer ring opposite the lobe. The rim has an outer surface facing away from the axis and offset from the outer surface of the outer ring. Ninth and tenth ramp surfaces are positioned adjacent to one another on the outer surface of the rim. The ninth and tenth ramp surfaces are contiguous along a fifth apex projecting from the outer

surface of the rim. The ninth and tenth ramp surfaces are angularly oriented with respect to a fifth line extending radially from the axis to the fifth apex.

A further example embodiment comprises eleventh and twelfth ramp surfaces positioned adjacent to one another on the outer surface of the rim. The eleventh and twelfth ramp surfaces are contiguous along a sixth apex projecting from the outer surface of the rim. The eleventh and twelfth ramp surfaces are angularly oriented with respect to a sixth line extending radially from the axis to the sixth apex. In a specific example embodiment the fifth and sixth apexes are diametrically opposite one another. In a particular example embodiment the fifth apex is aligned with the first apex and the sixth apex is aligned with the second apex.

Another example embodiment comprises an inner ring positioned between the outer ring and the axis. The inner ring is attached between the outer ring and the lobe and defining oppositely facing surfaces oriented perpendicular to the axis. An example embodiment further comprises an inner ring positioned between the outer ring and the axis. The inner ring is attached to the lobe and defines oppositely facing surfaces oriented perpendicular to the axis.

The invention also encompasses a seal, comprising an outer ring surrounding an axis oriented coaxially with the outer ring. The outer ring has an outer surface facing away from the axis. First and second ramp surfaces are formed on the outer surface and are positioned adjacent to one another on the outer surface. The first and second ramp surfaces are contiguous along a first apex extending parallel to the axis and projecting outwardly from the outer surface. The first and second ramp surfaces are angularly oriented with respect to a first line extending radially from the axis to the first apex. Third and fourth ramp surfaces are positioned adjacent to one another on the outer surface. The third and fourth ramp surfaces are contiguous along a second apex projecting outwardly from the outer surface. The third and fourth ramp surfaces are angularly oriented with respect to a second line extending radially from the axis to the second apex. The first and second apexes are diametrically opposite to one another in a specific example embodiment.

A further example embodiment comprises an inner ring positioned between the outer ring and the axis. The inner ring is attached between the outer ring and the lobe and defining oppositely facing surfaces oriented perpendicular to the axis. An example embodiment further comprises an inner ring positioned between the outer ring and the axis. The inner ring is attached to the lobe and defining oppositely facing surfaces oriented perpendicular to the axis.

The invention further encompasses, in combination, a seal and a coupling for joining pipe elements. In one example embodiment the seal comprises an outer ring surrounding an axis oriented coaxially with the outer ring. The outer ring has an outer surface facing away from the axis. First and second ramp surfaces are formed on the outer surface and are positioned adjacent to one another on the outer surface. The first and second ramp surfaces are contiguous along a first apex extending parallel to the axis and projecting outwardly from the outer surface. The first and second ramp surfaces are angularly oriented with respect to a first line extending radially from the axis to the first apex. Third and fourth ramp surfaces are positioned adjacent to one another on the outer surface. The third and fourth ramp surfaces are contiguous along a second apex projecting outwardly from the outer surface. The third and fourth ramp surfaces are angularly oriented with respect to a second line extending radially from the axis to the second apex. The first and second apexes are diametrically opposite to one another in an example embodiment. In an example embodiment the coupling comprises a plurality of segments attached to one another end to end surrounding the seal. Each segment has attachment members located at opposite ends. Each the segment has arcuate surfaces positioned on opposite sides thereof for engagement with the pipe elements.

In a specific example embodiment the attachment members comprise lugs extending outwardly from opposite ends of each the segment. Each lug defines a hole for receiving a fastener. By way of example the arcuate surfaces project from the segments radially toward the axis.

In an example embodiment the combination further comprises a lobe extending circumferentially around a first side of the outer ring. The lobe has an outer surface

CLAIMS

What is claimed is:

1. A seal, comprising:

an outer ring surrounding an axis oriented coaxially with said outer ring, said outer ring having an outer surface facing away from said axis;

first and second ramp surfaces formed on said outer surface and positioned adjacent to one another on said outer surface, said first and second ramp surfaces being contiguous along a first apex extending parallel to said axis and projecting outwardly from said outer surface, said first and second ramp surfaces being angularly oriented with respect to a first line extending radially from said axis to said first apex.

2. The seal according to claim 1, further comprising third and fourth ramp surfaces positioned adjacent to one another on said outer surface, said third and fourth ramp surfaces being contiguous along a second apex extending parallel to said axis and projecting outwardly from said outer surface, said third and fourth ramp surfaces being angularly oriented with respect to a second line extending radially from said axis to said second apex.

3. The seal according to claim 2, wherein said first and second apexes are diametrically opposite to one another.

4. The seal according to claim 3, further comprising:

a lobe extending circumferentially around a first side of said outer ring, said lobe having an outer surface facing away from said axis and a sealing surface facing toward said axis.

5. The seal according to claim 4, further comprising fifth and sixth ramp surfaces positioned adjacent to one another on said outer surface of said lobe, said fifth and sixth ramp surfaces being contiguous along a third apex projecting from said outer surface of said lobe, said fifth and sixth ramp surfaces being angularly oriented with respect to a third line extending radially from said axis to said third apex.

6. The seal according to claim 5, wherein said first and third apexes are aligned with one another.

7. The seal according to claim 5, further comprising seventh and eighth ramp surfaces positioned adjacent to one another on said outer surface of said lobe, said seventh and eighth ramp surfaces being contiguous along a fourth apex extending parallel to said axis and projecting from said outer surface of said lobe, said seventh and eighth ramp surfaces being angularly oriented with respect to a fourth line extending radially from said axis to said fourth apex.

8. The seal according to claim 7, wherein said second and fourth apexes are aligned with one another.

9. The seal according to claim 7, further comprising:

a rim extending circumferentially around a side of said outer ring opposite said lobe, said rim having an outer surface facing away from said axis and offset from said outer surface of said outer ring;

ninth and tenth ramp surfaces positioned adjacent to one another on said outer surface of said rim, said ninth and tenth ramp surfaces being contiguous along a fifth apex projecting from said outer surface of said rim, said ninth and tenth ramp surfaces being angularly oriented with respect to a fifth line extending radially from said axis to said fifth apex.

10. The seal according to claim 9, further comprising eleventh and twelfth ramp surfaces positioned adjacent to one another on said outer surface of said rim, said eleventh and twelfth ramp surfaces being contiguous along a sixth apex projecting from said outer surface of said rim, said eleventh and twelfth ramp surfaces being angularly oriented with respect to a sixth line extending radially from said axis to said sixth apex.

11. The seal according to claim 10, wherein said fifth and sixth apexes are diametrically opposite one another.

12. The seal according to claim 11, wherein said fifth apex is aligned with said first apex and said sixth apex is aligned with said second apex.

13. The seal according to claim 4, further comprising an inner ring positioned between said outer ring and said axis, said inner ring being attached between said outer ring and said lobe and defining oppositely facing surfaces oriented perpendicular to said axis.

14. The seal according to claim 4, further comprising an inner ring positioned between said outer ring and said axis, said inner ring being attached to said lobe and defining oppositely facing surfaces oriented perpendicular to said axis.

15. A seal, comprising:

an outer ring surrounding an axis oriented coaxially with said outer ring, said outer ring having an outer surface facing away from said axis;

first and second ramp surfaces formed on said outer surface and positioned adjacent to one another on said outer surface, said first and second ramp surfaces being contiguous along a first apex extending parallel to said axis and projecting outwardly from said outer surface, said first and second ramp surfaces being angularly oriented with respect to a first line extending radially from said axis to said first apex;

third and fourth ramp surfaces positioned adjacent to one another on said outer surface, said third and fourth ramp surfaces being contiguous along a second apex projecting outwardly from said outer surface, said third and fourth ramp surfaces being angularly oriented with respect to a second line extending radially from said axis to said second apex; and

wherein said first and second apexes are diametrically opposite to one another.

16. The seal according to claim 15, further comprising:

a lobe extending circumferentially around a first side of said outer ring, said lobe having an outer surface facing away from said axis and a sealing surface facing toward said axis;

fifth and sixth ramp surfaces positioned adjacent to one another on said outer surface of said lobe, said fifth and sixth ramp surfaces being contiguous along a third apex projecting from said outer surface of said lobe, said fifth and sixth ramp surfaces being angularly oriented with respect to a third line extending radially from said axis to said third apex; and

seventh and eighth ramp surfaces positioned adjacent to one another on said outer surface of said lobe, said seventh and eighth ramp surfaces being contiguous along a fourth apex projecting from said outer surface of said lobe, said seventh and eighth ramp surfaces being angularly oriented with respect to a fourth line extending radially from said axis to said fourth apex.

17. The seal according to claim 16, wherein said first and third apexes are aligned with one another and said second and fourth apexes are aligned with one another.

18. The seal according to claim 16, further comprising:

a rim extending circumferentially around a side of said outer ring opposite said lobe, said rim having an outer surface facing away from said axis and offset from said outer surface of said outer ring;

ninth and tenth ramp surfaces positioned adjacent to one another on said outer surface of said rim, said ninth and tenth ramp surfaces being contiguous along a fifth apex projecting from said outer surface of said rim, said ninth and tenth ramp surfaces being angularly oriented with respect to a fifth line extending radially from said axis to said fifth apex; eleventh and twelfth ramp surfaces positioned adjacent to one another on said outer surface of said rim, said eleventh and twelfth ramp surfaces being contiguous along a sixth

apex projecting from said outer surface of said rim, said eleventh and twelfth ramp surfaces being angularly oriented with respect to a sixth line extending radially from said axis to said sixth apex; wherein

said fifth and sixth apexes are diametrically opposite one another.

19. The seal according to claim 18, wherein said third and fifth apexes are aligned with said first apex and said fourth and sixth apexes are aligned with said second apex.

20. The seal according to claim 16, further comprising an inner ring positioned between said outer ring and said axis, said inner ring being attached between said outer ring and said lobe and defining oppositely facing surfaces oriented perpendicular to said axis.

21. The seal according to claim 16, further comprising an inner ring positioned between said outer ring and said axis, said inner ring being attached to said lobe and defining oppositely facing surfaces oriented perpendicular to said axis.

22. In combination, a seal and a coupling for joining pipe elements, said seal comprising:

an outer ring surrounding an axis oriented coaxially with said outer ring, said outer ring having an outer surface facing away from said axis;

first and second ramp surfaces formed on said outer surface and positioned adjacent to one another on said outer surface, said first and second ramp surfaces being contiguous along a first apex extending parallel to said axis and projecting outwardly from said outer surface, said first and second ramp surfaces being angularly oriented with respect to a first line extending radially from said axis to said first apex;

third and fourth ramp surfaces positioned adjacent to one another on said outer surface, said third and fourth ramp surfaces being contiguous along a second apex projecting outwardly from said outer surface, said third and fourth ramp surfaces being angularly oriented with respect to a second line extending radially from said axis to said second apex, said first and second apexes being diametrically opposite to one another; and

said coupling comprising:

a plurality of segments attached to one another end to end surrounding said seal, each said segment having attachment members located at opposite ends, each said segment having arcuate surfaces positioned on opposite sides thereof for engagement with said pipe elements.

23. The combination according to claim 22, wherein said attachment members comprise lugs extending outwardly from opposite ends of each said segment, each said lug defining a hole for receiving a fastener.

24. The combination according to claim 22, wherein said arcuate surfaces project from said segments radially toward said axis.

25. The combination according to claim 22, further comprising:

a lobe extending circumferentially around a first side of said outer ring, said lobe having an outer surface facing away from said axis and a sealing surface facing toward said axis for engagement with one of said pipe elements;

fifth and sixth ramp surfaces positioned adjacent to one another on said outer surface of said lobe, said fifth and sixth ramp surfaces being contiguous along a third apex projecting from said outer surface of said lobe, said fifth and sixth ramp surfaces being angularly oriented with respect to a third line extending radially from said axis to said third apex; and

seventh and eighth ramp surfaces positioned adjacent to one another on said outer surface of said lobe, said seventh and eighth ramp surfaces being contiguous along a fourth apex projecting from said outer surface of said lobe, said seventh and eighth ramp surfaces being angularly oriented with respect to a fourth line extending radially from said axis to said fourth apex.

26. The combination according to claim 25, wherein said first and third apexes are aligned with one another and said second and fourth apexes are aligned with one another.

27. The combination according to claim 25, further comprising:

a rim extending circumferentially around a side of said outer ring opposite said lobe, said rim having an outer surface facing away from said axis and offset from said outer surface of said outer ring;

ninth and tenth ramp surfaces positioned adjacent to one another on said outer surface of said rim, said ninth and tenth ramp surfaces being contiguous along a fifth apex projecting from said outer surface of said rim, said ninth and tenth ramp surfaces being angularly oriented with respect to a fifth line extending radially from said axis to said fifth apex; eleventh and twelfth ramp surfaces positioned adjacent to one another on said outer surface of said rim, said eleventh and twelfth ramp surfaces being contiguous along a sixth apex projecting from said outer surface of said rim, said eleventh and twelfth ramp surfaces being angularly oriented with respect to a sixth line extending radially from said axis to said sixth apex; wherein

said fifth and sixth apexes are diametrically opposite one another.

28. The combination according to claim 27, wherein said third and fifth apexes are aligned with said first apex and said fourth and sixth apexes are aligned with said second apex.

29. The combination according to claim 27, further comprising:

a valve body positioned between said ring and said axis;

a valve closing member positioned within said valve body, said valve closing member being movable between a closed position and an open position; and

a valve stem attached to said valve closing member and extending through one of said segments.

30. The combination according to claim 29, further comprising an inner ring positioned between said outer ring and said axis, said inner ring being attached between said outer ring and said lobe and defining oppositely facing surfaces oriented perpendicular to said axis, one of said oppositely facing surfaces being engageable with an end of one of said pipe elements, the other of said oppositely facing surfaces being engageable with said valve body.

31. The combination according to claim 29, further comprising an inner ring positioned between said outer ring and said axis, said inner ring being attached to said lobe and defining oppositely facing surfaces oriented perpendicular to said axis, one of said oppositely facing surfaces being engageable with an end of one of said pipe elements, the other of said oppositely facing surfaces being engageable with said valve body.

32. The combination according to claim 22, wherein said plurality of segments comprises no more than two said segments, each of said segments comprising:

a back wall extending between said opposite ends, said back wall having an inner surface facing said axis;

first and second angularly oriented surfaces positioned on said inner surface of said back wall at opposite ends of said segments.