CLAIMS

1. A gas cylinder sealing arrangement for a gas cylinder having a neck with a side surface and a top surface including a gas outlet, the sealing arrangement comprising:

a cap having a lower portion arranged to engage with a neck of a gas cylinder to retain the cap on the gas cylinder, and an upper portion arranged to extend above a top surface of the gas cylinder and define an inner space, the upper portion having an upper opening to receive a piercing element into the upper opening; and

a gasket sized to fit in the inner space defined by the upper portion of the cap, the gasket having an upper surface, a region of the upper surface being exposed at the upper opening of the cap and arranged to contact a piercing element received in the upper opening of the cap to pierce a gas outlet of the cylinder, and a lower surface arranged to form a seal with the top surface of the cylinder;

wherein the upper portion of the cap is arranged to radially contain the gasket such that radial expansion of the gasket in response to forming a seal with the piercing element moved into the upper opening and toward the gasket is restrained and causes deformation of the gasket, and

wherein the cap and gasket are unattached to any piercing element arranged to pierce the gas outlet of a gas cylinder.

2. The sealing arrangement of claim 1, wherein voids are present at upper and lower radially outer regions of the inner space with the gasket located in the inner space and in an undeformed state, and wherein the gasket is arranged to at least partially fill the upper and lower radially outer void regions in response to forming a seal with the piercing element moved into the upper opening and with the top surface of the cylinder.

3. The sealing arrangement of claim 1, wherein the upper portion of the cap includes a sidewall and an upper wall having an annular shape that extends radially inwardly from the sidewall and includes a radially inner part that defines the upper opening.

4. The sealing arrangement of claim 3, wherein the gasket has an uppermost part of the upper surface located radially inward of the radially inner part of the upper wall.

5. The sealing arrangement of claim 4, wherein the uppermost part of the upper surface of the gasket extends into the upper opening.

6. The sealing arrangement of claim 3, wherein the inner space has a cylindrical shape and the gasket has a torus shape.

7. The sealing arrangement of claim 1, wherein the lower portion of the cap includes an internal thread arranged to engage with an external thread on a cylinder neck.

8. The sealing arrangement of claim 1, wherein the gasket has a torus shape.

9. The sealing arrangement of claim 1, further comprising a piercing element separate from the cap and gasket, the piercing element including a lance arranged to pierce a gas outlet of a gas cylinder and a gasket-contacting surface arranged to contact and form a seal with the upper surface of the gasket.

10. The sealing arrangement of claim 9, wherein the gasket-contacting surface includes a horizontal annular surface around a conical or cylindrical surface that are both arranged to contact the upper surface of the gasket and urge the gasket toward the top surface of the cylinder.

11. The sealing arrangement of claim 9, wherein the cap and the piercing element are arranged such that with the piercing element introduced into the upper opening, the cap and piercing element define the inner space to have a shape and a volume that is different than a shape and volume of the gasket.

12. The sealing arrangement of claim 11, wherein contact of the piercing element with the gasket causes the gasket to change shape and to at least partially conform to the shape of the inner space defined by the cap and the piercing element.

13. The sealing arrangement of claim 9, wherein the piercing element has an outer surface adjacent the gasket-contacting surface that is sized and shaped to fit closely within the upper opening of the cap.

14. The sealing arrangement of claim 1, further comprising the gas cylinder, and wherein the cap is attached to the neck of the cylinder.

15. The sealing arrangement of claim 1, wherein the cap includes one or more vent holes in a sidewall of the cap.

16. The sealing arrangement of claim 1, wherein the cap includes a stop to position the lower portion of the cap relative to the cylinder.

17. The sealing arrangement of claim 1, wherein the cap includes a stop to contact the neck of the cylinder and define a volume for the inner space as bounded by the upper portion of the cap and the top surface of the cylinder.

18. The sealing arrangement in claim 1, wherein the upper portion of the cap at least partially covers the upper surface of the gasket.

19. The sealing arrangement in claim 1, wherein the upper opening in the cap is operable to engage a piercing element and prevent rotation of the cylinder relative to the piercing element.

20. A method for establishing a seal with a gas cylinder, comprising:

providing a gas cylinder having a neck with a side surface and a top surface including a gas outlet, and a sealing arrangement including a cap and a gasket, the cap having a lower portion engaged with the neck of a gas cylinder, and an upper portion defining an inner space and having an upper opening, the gasket being located in the inner space defined by the upper portion of the cap and having a region of an upper surface of the cap exposed at the upper opening of the cap;

introducing the cap into a receiving opening of a gas delivery device;

receiving a piercing element into the upper opening of the cap;

moving the piercing element relative to the gas outlet such that the piercing element contacts the exposed region of the gasket and opens the gas outlet to release gas from the gas cylinder; and

forming a seal between the piercing element and the gasket and between the top surface of the cylinder and the gasket by moving the cylinder and the piercing element toward each other.

21. The method of claim 20, wherein the step of forming a seal includes deforming the gasket to at least partially fill voids in the inner space.

22. The method of claim 21, wherein the step of forming a seal includes radially restraining the gasket.

23. The method of claim 20, wherein the step of forming a seal includes forming seals between the gasket and the piercing element and between the gasket and the top surface prior to the piercing element opening the gas outlet.