Dec. 29, 1936. H. L. PARR 2,065,870

OXYGEN BOMB

Filed May 14, 1934 2 Sheets-Sheet 1

Fig. 1

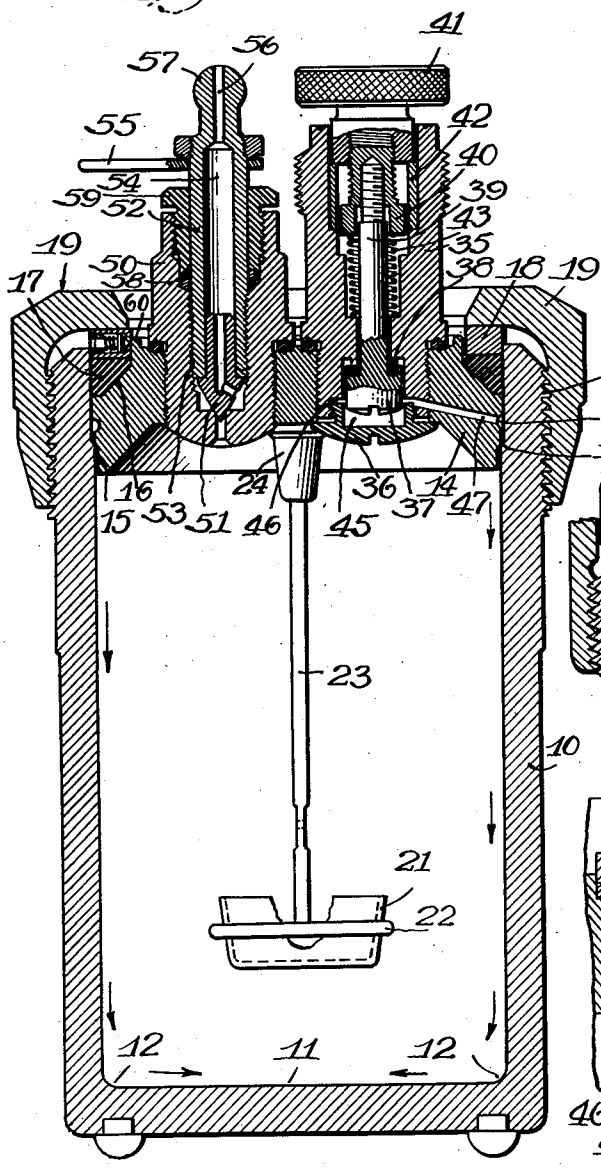
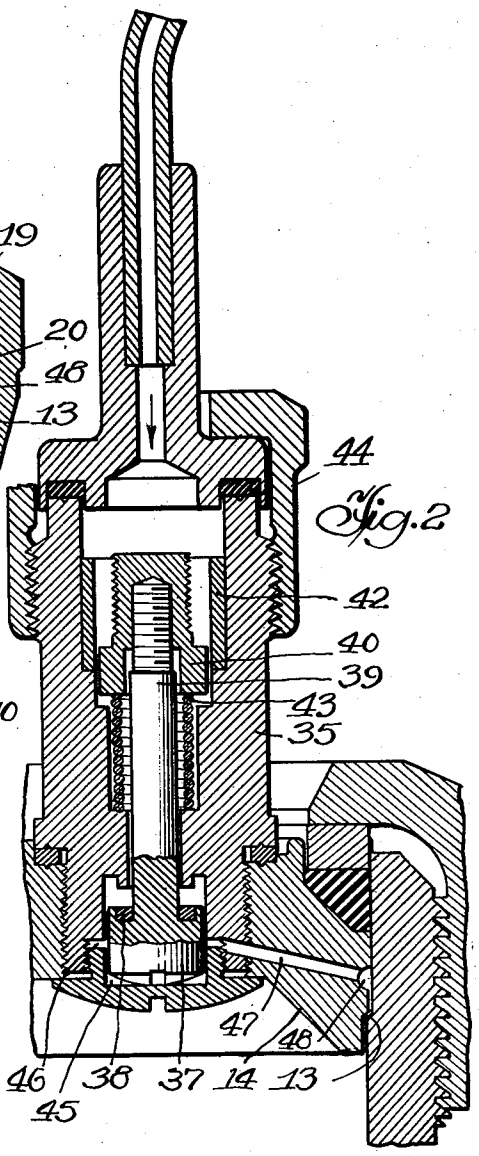


Fig. 2



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Fig. 3

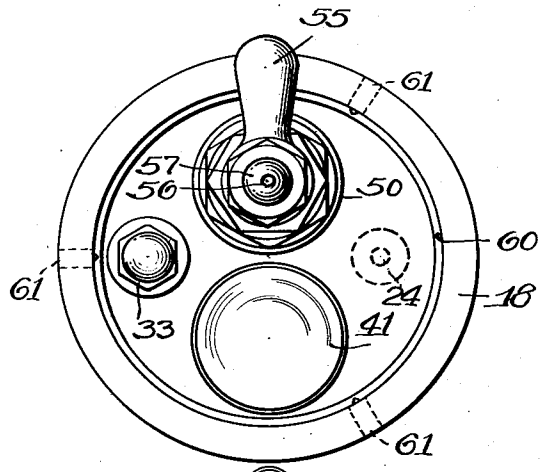
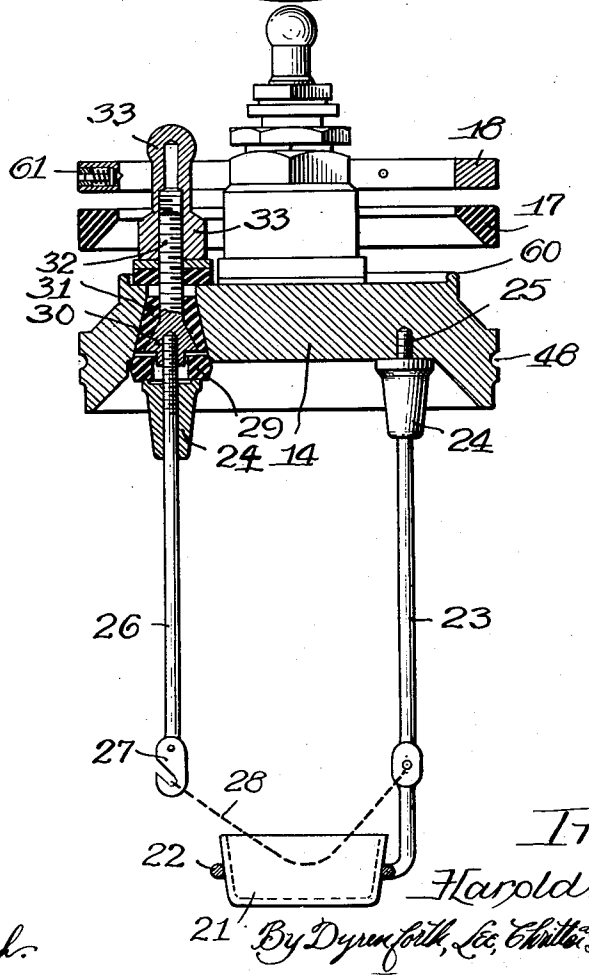


Fig. 4



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UNITED STATES PATENT OFFICE

2,065,870

OXYGEN BOMB

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Application May 14, 1934, Serial No. 725,589

10 Claims. (Cl. 73—191)

My invention relates to improvements in oxygen bombs such as comprise the main part of calorimeters used for the determination of heat units available in solid and liquid fuels and for the determination of sulfur in fuel oils.

Apparatus of this character must withstand enormous internal pressures, normally one thousand pounds per square inch and occasionally as high as four thousand pounds per square inch. This pressure necessitates not only a bomb of great strength but one with specially designed cover joints and seals, to prevent leakage or blowing out of the gaskets.

In many cases it has been the practice to hold the bomb in a special vise and use a long handled box wrench so as to give great leverage in screwing down the cover against a gasket. After the oxygen has been admitted to the bomb, however, the effectiveness of this seal decreases as the internal pressure increases, resulting in the occasional blowing out of the gasket with serious damage to the apparatus.

One object of the invention is to provide an effective seal, in the form of a compressible ring, such as soft rubber, having such cross section as to fit in a correspondingly shaped annular groove between the wall of the bomb or container and a wall on the closure or plug which fits within the open end of said container. Thus the outward pressure of the oxygen against said plug increases the engagement of the parts and increases the effectiveness of the seal. Also, the screw threaded ring or cap, which confines the ring in its groove, may be screwed down by hand initially without requiring wrenches or special tools.

Another object is to provide improved means for admitting the high pressure oxygen to the bomb whereby its pressure and velocity as it flows through the admission valve are so reduced that the valve gasket is not damaged.

A further object is to provide means for delivering the gas downwardly along the inner cylindrical wall of the bomb to a smoothly curved portion at the bottom which directs it radially inwardly, thereby avoiding displacement of the sample of fuel in the cup suspended above the bottom.

Another object is to protect both the closure gasket and the inlet valve gasket from deterioration by contact with hot gases or hot metal.

An additional object is to provide an improved outlet valve, separate from the inlet valve, and in the form of a needle valve which may be easily operated to release the gases as slowly as may be desired.

Further objects relate to improvements in the electrical insulation, to preventing flames and hot gases from contacting directly with such insulation, to improvements in the ignition circuit and to convenient and rapid handling and operation.

In the accompanying drawings I have illustrated a commercial embodiment of the invention:

Fig. 1 is a central sectional elevation of the bomb;

Fig. 2 is an enlarged sectional elevation of the inlet valve, in its open position;

Fig. 3 is a top plan view of the closure and certain associated parts shown also in Fig. 4; and

Fig. 4 is a sectional elevation of the same on a plane at right angles to that of Fig. 1.

The bomb is shown in the form of a cylindrical container 10, preferably turned from a solid casting of the nickel-chromium alloy "illium". This material has extremely high resistance to corrosion, a high elastic limit and ultimate strength and very dense structure. The bottom of the container 11 joins the cylindrical side wall in a smooth curve 12, for a purpose hereinafter described. Near the top of the container the bore is enlarged slightly, providing a shoulder 13.

A closure 14 in the form of a stepped cylindrical plug is provided, having preferably three different diameters and having a circumferential groove therein, the purpose of which is explained later. Said plug is made preferably from the nickel-chromium alloy referred to. The cylindrical surface of the plug, above said groove, is machined to a close sliding fit in the cylinder providing a clearance of only a few thousandths of an inch. The cylindrical surface below said groove, as shown more particularly in Fig. 2, is of slightly reduced diameter providing a clearance or annular port between itself and the wall of the container. The lowermost or third cylindrical surface is further reduced in diameter as shown at 15 and provides a second annular port between itself and the cylindrical wall below the shoulder 13. This second port communicates with the first port, as shown in Fig. 2, and the shoulder between the stepped portions is adapted to rest on the shoulder 13 and limit the inward movement of said closure.

The top of said plug may have, in effect, a beveled edge or inclined wall 16, which, with the adjacent cylindrical wall of the container, forms a wedge shaped recess in the particular structure selected for illustration. In this recess is located a gasket of compressible material, preferably a soft rubber ring 17 of substantially wedge shaped

cross section corresponding to that of the recess. A metal ring 18 rests on said rubber ring and is confined by an annular ring or open-center cap 19 which overlies said ring 18 and which has a depending screw threaded flange engaging corresponding screw threads around the top of the container. The buttress form of thread 20 is used on the cylinder and screw cap.

In assembling the device the cap 19 is screwed down with the fingers until a slight pressure is exerted on the soft rubber ring 17 by means of the overlying metal ring 18. This slight pressure causes said ring to expand laterally and engage the vertical cylindrical wall of the container and the inclined wall 16 and adjacent portions of the closure. As no wrench is required in tightening the screw cap the threads 20 are not subjected to any substantial frictional wear. When oxygen is admitted to the bomb through the inlet valve hereinafter described, the resulting increase in internal pressure forces the closure upwardly against the soft rubber ring causing an increased frictional engagement of the parts, thereby assuring a very effective, gas tight joint, regardless of the magnitude of the internal pressure.

Before the parts are assembled, however, the sample of fuel is placed in the tapering receptacle or cup 21 which fits within an incomplete ring 22 on the end of the depending rod 23 of conducting material, which is provided with a lock nut 24 at its upper end and is screwed into the closure 14 at 25. The other depending conductor 26 has a hook shaped contact member 27 at its lower end to which the usual resistance wire 28 is connected, the upper end of said rod having a similar lock nut 24 engaging a washer of flame resisting material 29, such for example as soapstone, porcelain or other hard refractory material. The upper part of said washer is tapered to fit the tapering recess in said plug and it is pressed lightly into said opening. The upper end of said rod has screw threaded engagement with a cone shaped conducting bushing 30 which fits within a bushing 31 of hard insulating material such as that manufactured under the trade-mark "Bakelite" comprising a phenol condensation product. This cone shaped bushing has an outer taper less than the taper of the central opening through it. Thus when the upper screw threaded stem 32 is engaged by the cap nut 33, the cone shaped conducting member 30 is drawn up into said bushing and compresses the same, the compressive stress being greater than the expansive stress exerted by the cone 30. The result is that splitting of the said bushing is avoided and it is possible to use a hard material for said bushing. Thus, with the increase of gaseous pressure within the bomb, the cone member and the bushing are driven more tightly into the conical recess with an increased sealing effect. Therefore, as bushing 31 works upwardly under the influence of gaseous pressure, washer 29 also works upwardly without manual readjustment and without losing its effectiveness as a flame-arrester. In fact, the cap nut 33 may become loose or be removed entirely and yet no leakage will develop, due to the self sealing effect of the tapering parts.

The check valve used for admitting oxygen to the bomb prior to the ignition of the sample will now be described. It consists, as shown in Fig. 2, of a tubular valve housing 35 the lower end of which is screwed into an opening in the closure 14 and is closed at the lower end by a cover 36 screwed into place. The valve head 37 has an annular groove therein which receives a suitable gasket 38 made preferably of rubber. The valve stem 39 extends upwardly and screws into a slidable piston 40. The upper part of said piston has an upward screw threaded extension over which a removable cap 41 is screwed. The chamber in the upper part of the valve housing 35 is provided with a liner 42, a clearance being provided between said liner and the piston 40, providing an annular port through which oxygen is admitted when the valve housing is connected to a suitable source of supply. The valve is normally maintained in uppermost position by a coiled spring 43 which holds the rubber gasket 38 against its seat.

To admit oxygen to the bomb, the cap 41 is unscrewed and the oxygen supply line is connected to the inlet valve by means of a coupling 44 which screws over the upper end of the valve housing. The pressure of oxygen in the supply system may range from four hundred and fifty to two thousand pounds per square inch. The cross section of the valve stem is of such area as compared with the annular orifice surrounding it, immediately above the rubber gasket, and the compressive strength of the spring is such, that a gas pressure of fifteen pounds per inch above the valve will barely cause it to open. If said pressure is increased slightly the valve head 37 will move downwardly until obstructed by the cap 36. As long as the pressure above the valve is more than thirty pounds greater than the pressure within the bomb, with the parts designed as herein described, said valve head will remain in lowermost position. The incoming oxygen flows through the annular port surrounding the piston 40, through the chamber in which the coiled spring is located and through the annular port surrounding the valve stem below said chamber, and into the valve chamber 45. In this position the valve gasket 38 is sufficiently removed from the annular port above it so that the oxygen in entering said chamber is greatly dispersed and so reduced both in pressure and velocity before striking said gasket that no damage results, regardless of the magnitude of the pressure in the upper part of the valve housing. In certain commercial bombs as used heretofore the same valve served both as the inlet and the outlet valve and the valve head was so disposed as to receive the full force of the entering oxygen with the result that there was a tendency for the valve gasket to be torn from its seat.

From the valve chamber 45, and from the annular groove 46, the oxygen in this improved apparatus flows through the tubular duct 47 to an annular groove 48 in the closure and thence downwardly through the clearance space between said closure and the inner wall of the bomb. The oxygen is thus discharged downwardly all around the inner wall of the container, striking the smoothly curved wall 12 at the bottom and being deflected radially inwardly. Its velocity is relatively low due to dispersion in the groove 48 and when deflected inwardly and upwardly under the fuel container 21, it is prevented from impinging directly upon the top or sides of the fuel cup and thus the charge is not dissipated. In this manner the possibility of displacing the sample by careless charging is eliminated.

Before the charge is fired, the cap 41 is replaced and screwed down tightly. This puts additional tension on the valve stem 39 since the latter tends to be drawn upwardly as said cap is screwed downwardly against the liner 42. As a

result, the gasket 38 is subjected to preliminary compression in excess of that due to the spring 43 and to the gaseous pressure on the valve head or piston 37. Thus the effectiveness of the joint is greatly increased. The cap 41 is not removed until the coupling 44 is to be attached again.

When the charge is fired it will be noted that the combustion gases in order to reach the valve gasket 38 must pass through the same annular clearance or orifice below the annular groove 48 through which the oxygen flowed on being admitted, and said gases continuing their outward flow must travel through the duct 47 an annular orifice 46 to the valve chamber, thus expanding in the annular groove 48 and said valve chamber, with a cooling effect. Thus said rubber valve gasket is not damaged by direct contact with these gases and it is further protected from injury by heat conducted through the intervening metal walls by virtue of the thickness of said walls. Furthermore, the flame cannot impinge directly upon the valve head 37 as it is covered by the cap 36. The closure gasket 17 is also protected in like manner from direct contact with the hot gases as said gases are considerably cooled by expansion and otherwise before being forced through the small annular clearance space above the groove 48, and their velocity in said groove is reduced to a rate which will not sustain flame propagation. Damage to the rubber gasket 17 by thermal conductivity is avoided by the provision of a heavy metal barrier. It will be noted that the plug or closure has a thick inclined wall around its outer portion, the slope of the under part of said wall, which is directly exposed to the flame, being about the same as the slope of the inclined wall 16. It will be understood, of course, that the bomb is submerged in cold water during combustion, and, therefore, the temperature gradient is toward the fittings on top of the bomb closure and away from said rubber gasket. Thus conducted heat is dissipated before a serious rise in the temperature of the metal can occur adjacent to said gasket.

The means for blowing off or exhausting the bomb after combustion is completed, will now be described. It has the form of a needle valve, the housing 50 of which is screwed into an opening in the closure or plug 14. As previously stated, it is separate and distinct from the inlet valve. In the closed position of the needle valve as shown in Fig. 1, the needle 51 is pressed firmly against its seat by the hollow stem 52, which latter has been screwed down by a clockwise movement into the screw threads 53 in the lower part of the valve housing. It will be noted that the cylindrical extension on the needle is received loosely in a cylindrical opening or bore 54 in the stem 52, thus allowing said needle to align itself with its seat regardless of any eccentricity in the threads 53, whereby a perfect metallic seal is insured.

To exhaust the bomb the handle 55 affixed to to the upper end of the stem 52 is turned counterclockwise. This raises the stem slightly allowing the needle valve to rise a few thousandths of an inch off its seat, this lifting being occasioned by the internal pressure in the bomb. The released gas flows around the needle and through the bore 54 into the open air. If it is desired to collect the gaseous products of combustion, a rubber tube may be fitted over the hose nipple 57 at the upper end of the stem. Thus the gases may be released very slowly due to the fineness of adjustment of the needle valve and can be passed as bubbles directly through an absorption drain, eliminating the use of an intermediate container.

Where the gases are thus collected, it is important to prevent leakage of the same past the screw threads 53 and for this purpose packing 58 is provided in the stuffing box closed by the gland 59. By virtue of this slow rate of exhaustion, loss of acid vapor within the bomb is eliminated. This is very important in that all the aqueous acid products should be retained within the bomb as a correction for acid formation is made after each combustion operation. Further advantages are the elimination of trouble arising out of the use of the rubber gasket valve heretofore employed, the provision for the collection of combustion products for analysis and the provision of a perfect metallic seal.

The ignition bomb circuit for heating the resistance wire to incandescence in contact with the fuel sample, will now be described. The current flows from the binding post 33 through the stem 32, cone 30 and rod or electrode 26 to fuse wire 28, electrode 23 and closure 14. If said closure were in good mechanical and electrical contact with the side walls or cap of the bomb the circuit would be closed to ground therethrough as said container is immersed in water and the tank grounded. However, the closure 14 has a sliding fit within the open end of the cylindrical container and "floats" on the rubber ring 17 due to the upward thrust occasioned by the internal pressure, i. e. there is no positive metallic contact between said closure and the cylinder after the former has been lifted off of the shoulder 13 by the internal pressure.

In order to complete the circuit said closure is provided with an annular rib 60 which is surrounded by the metal ring 18, the latter being provided with a plurality of spring plungers 61 (see Fig. 3), three being a convenient number, which plungers engage said rib 60 and thus conduct current from the closure through the ring 17 to the screw cap 19 and thus to the cylindrical container and the water bath to ground.

The use of a separate metal ring as distinguished from an integral ring on the screw cap 19 is advantageous as it makes it easier to cut the inside threads on the depending flange without this obstruction. Also, by making said ring as a loose part it can be fitted closely to the bore of the open upper end of the container and it can also be fitted closely around the rib 60 on the closure, without danger of jamming due to any slight error in the concentricity of the buttress threads.

The operation of the equipment will be understood from the foregoing description. The cover joint is self-sealing, no force being required in screwing it into position. After completion of combustion, the bomb is opened with the same ease. Thus routine work is considerably accelerated by elimination of the manual exertion heretofore necessitated. The rubber-seated check valve through which the oxygen is supplied, requires no attention during the charging or exhausting operations and it is readily accessible for inspection. The rubber seat may be replaced without the use of cement or any tools other than a screw driver.

In charging the bomb no caution need be exercised to avoid blowing the sample out of the cup and therefore the bomb may be filled quite rapidly.

The handle by which the exhaust valve is

operated is an integral part of the cover assembly and is not removed during operation. The packing around the valve stem requires no attention as it is not subjected to high pressure and the needle may be replaced without dismantling the cover assembly.

The gases escaping through the needle valve are brought in contact with hard metallic surfaces only and therefore damage in the nature of erosion or "wire-drawing" is eliminated. The needle point is freely pivoted in the valve stem, is self-aligning and is readily replaceable.

The bomb is suitable not only for the determination of thermal values but is also especially adapted to the determination of sulfur and the analysis of combustion products. The needle valve may be opened to such a small degree that a period as long as thirty minutes may elapse during exhaustion to atmospheric pressure. Thus the loss of sulfur in the form of acid vapor may be limited to an immaterial amount. The bomb may be kept connected to the oxygen supply system during exhaustion for the purpose of flushing out the last traces of combustion gas.

The cover joint gasket while advantageously made of wedge shaped section, need not have such section to provide a perfect seal. A rubber ring of square or rectangular section is also satisfactory. The wedge section permits a greater thickness of metal between the ring and the correspondingly inclined inner surface of the closure.

I claim:

1. An oxygen bomb comprising a cylindrical container, a closure having a cylindrical portion closely fitting within one end thereof leaving a projecting wall, and having a beveled edge joining said cylindrical portion whereby an outwardly flaring annular recess is provided, a rubber gasket of a section to fit said recess, a ring against the outer surface of said gasket and a cap secured to said container to limit the outward displacement of said ring and to maintain said gasket normally under slight compression only, the development of a high internal pressure, due to combustion in said container, serving to greatly increase said compression and thereby assure a very effective gas tight joint, said closure having a valve chamber therein, there being a circumferential groove around said cylindrical portion, there being a duct connecting said chamber and said groove, whereby certain portions of the products of combustion, escaping through said groove and duct to said valve chamber are cooled by expansion, and other portions are impeded in reaching said gasket by the small clearance between said cylindrical portion and the container wall, the beveled edge portion of said closure serving as a metal barrier to retard the heat conducted to said gasket.

2. An oxygen bomb comprising a cylindrical container having buttress threads on the outside thereof near the top, the bore of said cylinder being enlarged slightly near the top to form a shoulder, a cylindrical closure having a sliding fit within said enlarged portion and normally resting on said shoulder, the upper part of said closure being of reduced diameter to form an annular groove between itself and the adjacent cylindrical wall, a soft compressible packing fitting within said groove, a metal ring resting on said packing and a screw cap above said ring having a depending flange with internal threads engaging said first threads to retain said ring, packing and cylindrical closure in said container against high pressure developed therein, said packing expanding laterally under compression axially to form a tight seal, said cylindrical closure having a circumferential recess and a portion of reduced diameter beneath the same to provide an annular inlet port for discharging incoming gas directly down and around the inner cylindrical wall of said container.

3. An oxygen bomb comprising a cylindrical container, a cylindrical plug fitting in one end thereof below the top, means providing a positive stop against outward movement of said plug, a container for the fuel suspended from said plug within said container, a smooth rounded wall joining the cylindrical side wall and bottom of said container and an annular port between the lower part of said plug and the inner cylindrical wall to admit oxygen to said container and direct the same downwardly to said rounded wall and thence radially inwardly to avoid blowing said charge out of its container.

4. An oxygen bomb comprising a cylindrical container having an enlarged diameter near the open end providing an annular seat, a cylindrical closure having a peripheral portion with a close sliding fit in said enlarged diameter portion and limited in its inward movement by said seat, and having also a peripheral portion of reduced diameter to provide an appreciable clearance between itself and the smaller diameter portion of said container, an inlet valve housing in said closure, there being a passageway from said valve housing to said clearance space, said cylindrical closure having a beveled edge adjacent the enlarged diameter portion of said cylinder whereby an outwardly flaring annular recess is provided, a rubber gasket of a section to fit said recess, and a cap secured to said container to limit the outward displacement of said closure, whereby the development of a high internal pressure in said container compresses said gasket and assures an effective gas-tight joint, said gasket being protected from the high temperature within said container by the metal barrier afforded by said closure and protected further from direct contact with heated gases by the small dimensions of the sliding fit clearance.

5. A device of the class described comprising a cylindrical container, a closure having a cylindrical portion fitting within one end thereof leaving an upwardly projecting wall, the under side of said closure, which is exposed directly to products of combustion, sloping downwardly at its margin and the upper side thereof having a beveled margin comparable in slope to said under side whereby an outwardly flaring annular recess above said beveled margin is provided, a rubber gasket of a section to fit said recess, the portion between said margins forming an inclined heat barrier of substantially uniform thickness between said gasket and the interior of said container, a ring against the upper surface of said gasket and a cap secured to said container to limit the outward displacement of said ring and to maintain said gasket normally under slight compression only, the development of a high internal pressure, due to combustion in said container, serving to greatly increase said compression and thereby assure a very effective gas tight joint.

6. A device of the class described comprising a cylindrical container, a cylindrical closure therefor having three stepped portions of different diameters, the largest portion having a close sliding fit in said container, the intermediate portion having a circumferential groove

therein and providing both an annular port and an expansion chamber, between itself and the wall of said container, the latter being of reduced internal diameter below said intermediate portion to form a limiting shoulder, and the smallest of said stepped portions providing a further annular port between itself and the container wall and providing a shoulder between itself and said intermediate portion, said shoulder being adapted to engage said first shoulder and limit inward movement of said closure.

7. A device of the class described comprising a cylindrical container, a cylindrical closure therefor having three stepped portions of different diameters, the largest portion having a close sliding fit in said container, the intermediate portion having a circumferential groove therein and providing both an annular port and an expansion chamber, between itself and the wall of said container, the latter being of reduced internal diameter below said intermediate portion to form a limiting shoulder, and the smallest of said stepped portions providing a further annular port between itself and the container wall and providing a shoulder between itself and said intermediate portion, said shoulder being adapted to engage said first shoulder and limit inward movement of said closure, there being a chamber in said closure and a duct connecting said chamber with said groove to permit expansion and consequent cooling of hot gases escaping through said annular ports, the latter serving also as inlet ports for charging gas admitted through said chamber.

8. A device of the class described comprising a cylindrical container, a stepped cylindrical closure, the upper portion of which has a close sliding fit within one end of said container, there being a circumferential groove below said portion, the diameter of said closure below said groove being reduced to provide an annular port, there being a valve chamber in said closure having a passageway communicating with said groove, whereby gas entering through said valve chamber is directed downwardly around the inner wall of said container, and whereby the hot products of combustion may pass outwardly through said annular port and expand in said annular groove and passageway while flowing toward said valve chamber.

9. A device of the class described comprising a cylindrical container, a stepped cylindrical closure, the upper portion of which has a close sliding fit within one end of said container, there being a circumferential groove in said closure below said portion, the diameter of said closure below said groove being reduced to provide an annular port, there being a valve chamber in said closure having a passageway communicating with said groove, whereby gas entering through said valve chamber is directed downwardly around the inner wall of said container, and whereby the hot products of combustion may pass outwardly through said annular port and expand in said annular groove and passageway while flowing toward said valve chamber, the outer margin of said closure being inclined downwardly, providing an upper annular recess for a gasket, such products of combustion as reach said gasket through said groove and the sliding fit clearance, being cooled therein, and said marginal portion serving as a heat barrier for the further protection of said gasket.

10. A device of the class described comprising a cylindrical container, a closure having a cylindrical portion fitting within one end thereof leaving an upwardly projecting wall, the under side of said closure, which is exposed directly to products of combustion, sloping downwardly at its margin and the upper side thereof having a beveled margin comparable in slope to said under side whereby an outwardly flaring annular recess above said beveled margin is provided, and a rubber gasket of a section to fit said recess, the portion between said margins forming an inclined heat barrier of substantially uniform thickness between said gasket and the interior of said container.

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