June 2, 1959 G. H. VON FUCHS 2,889,069

PRESSURE VESSELS

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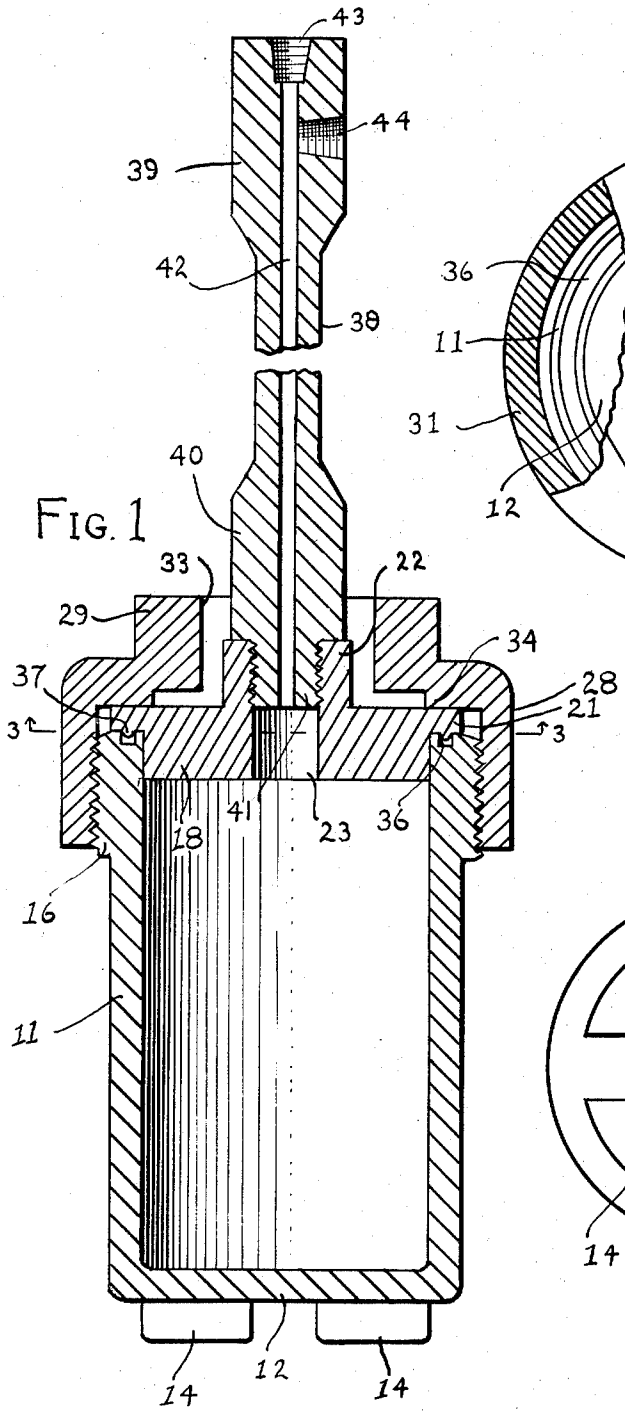


FIG. 1

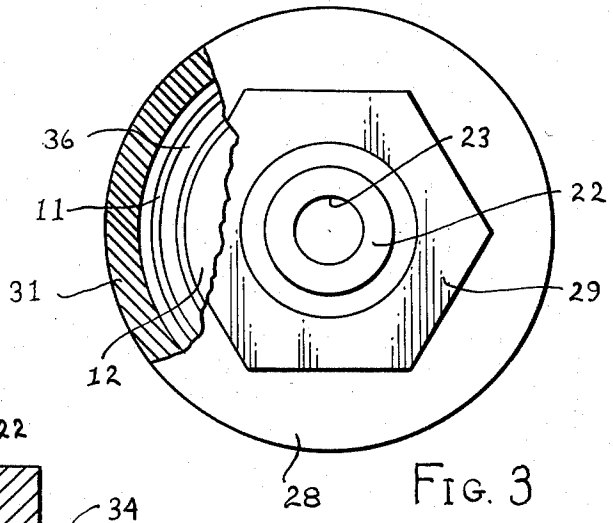
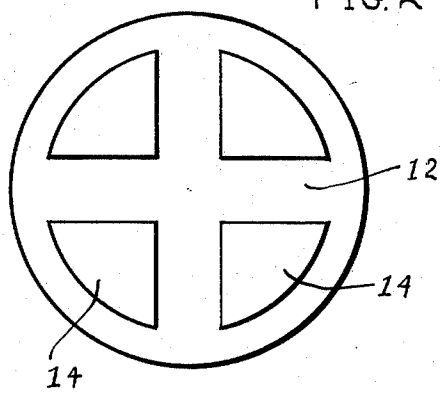


FIG. 3

FIG. 2



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PRESSURE VESSELS

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10 Claims. (Cl. 220—39)

The invention of this application relates to pressure vessels and is particularly concerned with small pressure vessels or bombs used at elevated temperatures.

It is an object of the invention to provide a bomb or pressure vessel of the character described which may be utilized in carrying out chemical reactions and tests of various types at elevated temperatures and pressures.

Another object of the present invention is to provide a bomb of the character described which is resistant to attack by substances contained therein.

Another object of the invention is to provide a bomb of the character described which has a high thermal conductivity.

A further object of the invention is to provide a bomb of the character described which is of simple, durable construction.

Still another object of the invention is to provide a bomb of the character described which may be readily assembled and taken apart and which may be easily and effectively sealed.

Other objects and advantages of the present invention will be apparent from the following description taken in conjunction with the drawings in which:

Figure 1 is a vertical sectional view of one embodiment of the present invention;

Figure 2 is a bottom view of the bomb shown in Figure 1; and

Figure 3 is a top plan view of the assembled bomb without the stem and with a portion of the cover or cap and the retainer therefor broken away.

Referring to Figure 1, the bomb comprises a hollow body portion 11, preferably cylindrical, which is preferably formed by casting or by machining from a forged or cast metal block, although it may be produced by drawing or extrusion. The block 11 has an integral bottom 12 and adjacent its upper end is provided with external threads which are preferably formed on a thickened portion 16 of the cylindrical wall, thereby avoiding weakening of the wall.

A cap 18 in the form of a disc is provided for the body 11. The lower portion of the cap 18 is reduced in diameter to permit it to extend into the top of the body 11. The periphery of the top portion of the cap therefore provides an annular flange 21 which is of approximately the same external diameter as the external diameter of the body 11 at its top. Centrally of the top face of the cap 18 there is provided a short, upwardly projecting boss 22. Extending axially through the boss 22 and the cap 18 is a passage 23, the upper portion of which is internally threaded.

The cap 18 is held in place on the body 11 by a tubular retainer 28, the upper end of which is preferably formed externally as a hexagonal nut 29. The lower end 31 of the retainer, of larger diameter, is provided with internal threads adapted to engage the threads formed on the thickened portion 16 adjacent the upper end of the body 11. The bore 33 provided in the nut portion 29 of the

retainer 28 is of sufficient diameter to receive and permit access to the boss 22 of the cap 18.

As will be seen from Figure 1, the interior, annular shoulder 34 in the lower end of the retainer 28 engages the flange 21 of the cap 18 when the retainer is threaded onto the body. To permit tight sealing of the bomb, the outer end of the body 11 is provided with an annular groove 36, preferably rectangular in cross-section and the lower surface of the flange 21 on the cap 18 is formed with a registering annular rib or bead 37. The latter may be, as shown, of rectangular cross section or may be convex. Complete sealing is obtained by inserting a suitable gasket (not shown) within the groove 36, the gasket being compressed by the bead 37 when the retainer 28 is tightened. Only the annular shoulder 34 of the retainer engages the cap 18 when the bomb is closed. The relatively small surface areas in contact make it easier to seal the bomb as excessive friction is avoided and greater force is exerted on the flange 21.

The threaded portion of the passage 23 is adapted to receive a tubular stem or connector 38, an axial nipple 41 on the lower end 40 of the stem being externally threaded for engagement therein. At its outer end the stem 38 may be enlarged as shown at 39 and the bore 42 therein provided with internal threads 43. A threaded radial passage 44 may also be provided in the enlarged end 39 if desired. Preferably the lower end 40 of the stem 38 is provided with a hexagonal or other desired non-circular exterior for such a distance from the nipple 41 as to extend substantially above the retainer 28, thereby permitting convenient engagement of a wrench on the stem.

In using a bomb of the type described, one or more solid or liquid reacting materials is placed in the body 11, a suitable gasket is inserted in the groove 36 and the cap 18 is put in place. The threads of the retainer 28 are then engaged with the external threads on the body and the retainer is turned down until the shoulder 34 engages the flange 21 of the cap and the vessel is sealed by the gasket. The stem 38 may then be connected to the cap and a desired gaseous reactant may be admitted through the bore 42 in the stem and the communicating bore 23 in the cap. If desired, the bomb may be evacuated prior to filling with gas or it may be flushed out by repeatedly filling it with the desired gas under pressure and releasing the pressure. A pressure gage (not shown) may, if desired be connected to one of the passages at the outer end 39 of the stem 38.

Heating of the bomb may be accomplished in any desired manner. When, however, as is usually the case, it is necessary to have accurate temperature control, heating by immersion in an oil bath or the like is preferred. In the event agitation of the contents of the bomb is desired, it may be easily obtained by inclining the bomb in the oil bath or the like and rotating it. For convenience, in securing rotation the bottom 12 of the bomb body 11 is provided with spaced projections 14 which may be engaged by a suitable driving element (not shown) beneath the surface of the bath. The degree of agitation may be increased by including in the bomb charge one or more inert objects of substantial size which will tumble about as the bomb is rotated.

Bombs of the type with which the present invention is concerned are adapted for a wide variety of uses involving temperatures and pressures above normal. For example, they may be used in carrying out various catalytic reactions such as hydrogenation, for chlorination or oxidation of organic materials, and for other reactions in which a closed system is desired or pressure is necessary.

The materials from which bombs constructed in accordance with the present invention are formed are of great importance. While attack of the bomb by one

or more of the reacting materals is, of course, to be avoided, it will be realized that other factors are also involved. Thus, since heating of the bomb contents, if heat must be supplied, will usually be by application of heat to the exterior of the bomb, a relatively high heat conductivity is most desirable for the bomb body. Further, operation at superatmospheric pressures necessitates a body having adequate strength. The latter is preferably obtained by the use of metals having relatively high strengths rather than by making the body walls thicker since the amount of heat stored in the body and the consequent lag in heating and cooling will thus be less.

Ordinary low carbon steels, i.e. mild steels, have adequate strength for bombs of the present general type and have a rather good thermal conductivity. Such steels are, moreover, relatively inexpensive and easy to machine. However, iron is strongly catalytic for many reactions and may interfere with the carrying out of a particular desired reaction. Furthermore, steel is not resistant to corrosion by many of the materials which may be used or formed in a bomb. On the other hand, materials which have a high resistance to corrosion such as tantalum, stainless steel, titanium and the like are either prohibitively expensive or, like stainless steel, have very low thermal conductivities, thus preventing rapid heating and cooling.

It has now been found that, by providing a thin coating of a suitable metal on the interior surfaces of a bomb formed from mild steel, there may be obtained a relatively inexpensive bomb having the necessary strength, a desirable thermal conductivity, and lack of reaction with the bomb contents. For many purposes thin platings of nickel or chromium will be satisfactory. Obviously, however, where special conditions require it, coatings of other metals may be employed.

Mild steels have thermal conductivities from room temperature up to about 300° C. greater than .100 as contrasted with those of stainless steels which may be as low as .045 at 300° C. It will be understood that there are other metals and alloys having good thermal conductivities which, when used for the construction of a bomb in accordance with the present invention, will in many cases have adequate strength. Thus, for example, aluminum and many aluminum alloys have thermal conductivities at 300° C. at least as high as .200. Certain of such alloys are quite strong. Magnesium alloys, brass, phosphor bronze and even cast iron are further examples of metals having thermal conductivities above .100 at elevated temperatures which are suitable for bombs for certain reactions when provided with an interior coating of metal inert with respect to the desired bomb contents. When using certain metals for coating the interior surfaces of a bomb according to the present invention the coating must be applied or may be more conveniently applied by electrodeposition, in some cases over metal undercoats. In appropriate cases the metal coating may be applied molten or in spray form. Obviously, the metal coating, however applied, should when finished be non-porous and smooth to facilitate cleaning of the bomb. The heat conductivity of the bomb is not materially reduced by the metal coating of its interior surfaces, even when the metal used for the coating has a very low thermal conductivity, since the coating employed may frequently be less than .003 in. In some special cases such as for certain catalytic reactions the metal coating for the interior surfaces of the bomb may be active rather than inert. Thus, for example, copper being an excellent catalyst for oxidation of many hydrocarbons may be employed as a coating for the interior of a bomb used in carrying out such reactions. Other similar possibilities will be apparent to those skilled in the art.

Preferably, the cap **18** is formed of the same metal as the body **11** of the bomb although this is not essential. Obviously, the surfaces of the cap which may come into contact with the bomb contents should be provided with a suitable metal coating which is desirably the same as that on the interior of the bomb body. The retainer **28** does not come into contact with the bomb contents. Hence, no protective coating thereon is required. Care should, however, be taken to avoid the use of a metal having a thermal expansion greatly exceeding that of the bomb body in order to prevent loosening of the retainer when the bomb is heated. It is also preferred to form the stem **39** of some metal different from the metal of the body **11** and having a low thermal conductivity. For the purpose, stainless steel, Inconel, or other similar alloy is desirable. Such metals have, from about 300° C. down to room temperature, thermal conductivities of .065 or less. Consequently, the heat lost to the air by radiation from the stem will be less and less heat will be conducted to the gage and gas connections provided at the outer end of the stem. Gaskets for bombs according to the present invention may be of various materials, but should, of course, be inert with respect to the bomb contents. In some cases, a soft metal such as lead may be used. In other instances, gaskets of neoprene, polyethylene, silicone rubber or similar plastic materials may be used.

The thermal conductivities set forth above and in the appended claims are expressed as calories per cm.^{2} per second per ° C. per cm.

I claim:

1. A bomb of the character described for use at elevated temperatures and pressures comprising a hollow, cylindrical body open at one end, a cap for said open end, a retainer for said cap detachably secured to said body, and a tubular stem carried by said cap extending through said retainer and providing communication with the interior of said body, said body and cap being formed of a metal having a relatively high thermal conductivity and said stem being formed of another metal having a relatively low thermal conductivity.

2. A bomb of the character described for use at elevated temperatures and pressures as set forth in claim 1 in which the interior surfaces of said bomb are provided with a metal coating resistant to chemical attack.

3. A bomb of the character described for use at elevated temperatures and pressures as set forth in claim 1 in which the metal from which said body is formed has a thermal conductivity between room temperature and about 300° C. of at least .100 and the metal of which said stem is formed has a thermal conductivity between room temperature and about 300° C. of less than about .065.

4. A bomb of the character described for use at elevated temperatures and pressures comprising a hollow, cylindrical body open at one end, a cap for said open end, a retainer for said cap detachably secured to said body, and a tubular stem carried by said cap extending through said retainer and providing communication with the interior of said body, said body and said cap being formed of metal having a thermal conductivity between room temperature and about 300° C. of at least .100 and said stem being formed of a metal having a thermal conductivity between room temperature and about 300° C. of less than about .065, and the interior surfaces of said bomb being provided with a metal coating resistant to chemical action.

5. A bomb of the character described for use at elevated temperatures and pressures as set forth in claim 4 in which said body and said cap are formed of mild steel and said stem is formed of stainless steel.

6. A bomb of the character described for use at elevated temperatures and pressures as set forth in claim 4 in which said metal coating is chromium.

7. A bomb of the character described for use at elevated temperatures and pressures comprising a hollow, cylindrical body open at one end, a cap for said open

end, a retainer for said cap detachably secured to said body, and a tubular stem carried by said cap extending through said retainer and providing communication with the interior of said body, said body and cap being formed of a metal having a relatively high thermal conductivity and the interior thereof being provided with a catalytic metal surface coating, and said stem being formed of another metal having a relatively low thermal conductivity.

8. A bomb of the character described for use at elevated temperatures and pressures comprising a hollow, cylindrical body open at one end, a cap for said open end, a retainer for said cap threadedly secured to said body, and a tubular stem carried by said cap extending through said retainer and providing communication with the interior of said body, said body and said cap being formed of metal having a thermal conductivity between room temperature and about 300° C. of at least .100 and said stem being formed of a metal having a thermal conductivity between room temperature and about 300° C. of less than about .065, said cap being unthreaded and having a portion extending into said body, said body having means integral therewith for engagement in rotating said bomb, and the interior surfaces of said bomb being provided with a metal coating resistant to chemical action.

9. A bomb of the character described as set forth in claim 1 in which the interior of said body is provided with a catalytic metal surface coating.

10. A bomb of the character described for use at elevated temperatures and pressures comprising a hollow,

cylindrical body open at one end, a cap for said open end, a tubular retainer for said cap threadedly engaged on the exterior of said body and a tubular stem detachably carried by said cap and providing communication with the interior of said body, said stem extending through and being annularly spaced from said retainer, said body and cap being formed of metal having a thermal conductivity between room temperature and about 300° C. of at least .100 and said stem being formed of metal having a thermal conductivity between room temperature and about 300° C. of less than about .065.

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