

(19)



Europäisches Patentamt
European Patent Office
Office européen des brevets



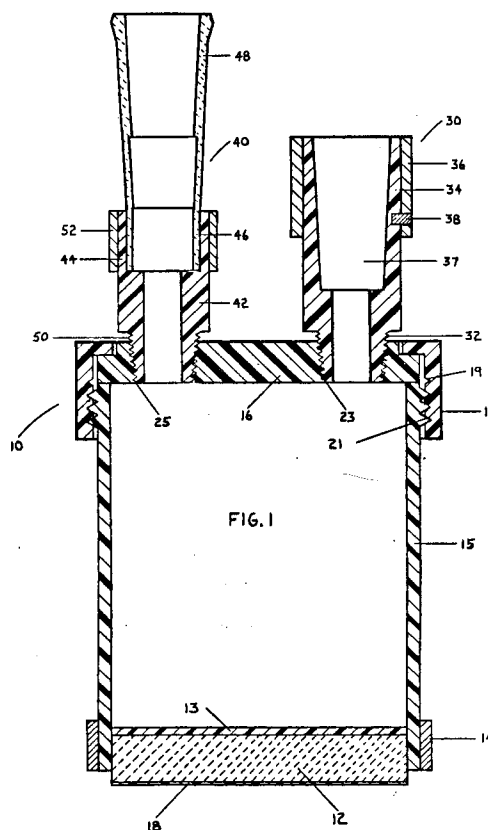
(11) Publication number:

0 464 288 A2

(12)

EUROPEAN PATENT APPLICATION(21) Application number: **90314445.9**(51) Int. Cl.⁵: **B01L 7/00**(22) Date of filing: **31.12.90**(30) Priority: **05.07.90 US 548629**(43) Date of publication of application:
08.01.92 Bulletin 92/02(84) Designated Contracting States:
DE FR GB IT(71) Applicant: **INTERTEC ASSOCIATES, INC.**
165 Panorama Creek Drive
Rochester, New York 14625(US)(72) Inventor: **Conant, Louis A.**
7B Brook Hill Lane**Rochester, New York 14625(US)**Inventor: **Bolton, Wilbur M.****162 Vollmer Parkway****Rochester, New York 14623(US)**Inventor: **Wilson, James E.****22 Main Street****Livonia, New York 14487(US)**(74) Representative: **Ackroyd, Robert et al**
W.P. THOMPSON & CO. Eastcheap House
Central Approach
Letchworth, Hertfordshire SG6 3DS(GB)(54) **Plastic laboratory boiler.**

(57) A plastics boiler 10 has an improved plastics and plastics-glass joint for connecting laboratory ware of different thermal expansion. The plastics joint 30 includes a tubular plastics section 34 having a compression ring 36 secured at its end which receives the labware of lower thermal expansion. The plastics-glass joint alternatively receives a shorter standard tapered glass joint 48. The boiler 10 has a bottom 12 having a chemically-resistant and non-contaminating inner side coating 13 and a chemically-resistant outer side coating 18. A metallic compression ring 14 is heat-shrunk around the bottom of the boiler 10.

**EP 0 464 288 A2**

Field of the Invention:

This invention relates to a heatable plastic boiler that interconnects to conventional glassware systems, useful generally in laboratory, industrial or service applications wherein glass boilers and boiling vessels would generally be used.

BACKGROUND OF THE INVENTION

Glass boilers, boiling vessels, and the like are used in virtually all chemical laboratories because of their excellent chemical resistance and transparency. These glass boilers are generally interconnected to condensers, columns, receivers, and other glassware. Connections are made through standard joints known as interchangeable taper-ground joints, or standard taper joints (S.T.). Spherical joints are used to a lesser extent or can be connected to standard taper joints by means of adapters. Glass boiling vessels are generally the most vulnerable component of the boiler system, being sensitive to scratches, nicks, and other defects which act as stress raisers resulting in catastrophic failure at the slightest impact. Glass vessels generally boil liquids in a non-uniform manner, frequently with superheating and bumping.

A variety of plastic materials, particularly the fluoroplastics, are also highly resistant to most chemicals, even more so than borosilicate glass. Some are transparent or translucent, and resistant to breakage. However, plastic materials have low thermal conductivity, about 1/4 to 1/6 that of glass and, therefore, are poorly suited for making boilers or boiling flasks. However, fluoroplastic (polytetrafluoroethylene) boilers and boiling flasks are available with rounded bottoms suitable for use with heating mantles. Some of the boilers have molded on PTFE joints for connections to PTFE receivers and other PTFE laboratory ware. Such vessels heat very slowly because of the low thermal conductivity of the plastic. These PTFE vessels are opaque.

It is, therefore, apparent that there has existed for a long time a need for an efficient transparent or translucent plastic boiler that brings liquids to a rapid, uniform and smooth boil, free of bumping. One that connects to virtually any glass system, is chemically resistant, a kilowatt saver, and adds a big safety factor - being shatter and impact resistant.

SUMMARY OF THE INVENTION

The present invention adds a truly new boiler system to laboratory ware providing a composite plastic boiler that can be directly heated on a hot plate and that easily interconnects to conventional

glassware systems. A boiler where liquids contact only chemically and biologically resistant surfaces. A boiler that brings liquids to a rapid, uniform and smooth boil, free of superheating and bumping. One that adds a big safety factor, being shatter and impact resistant, that is a time and kilowatt saver. Normally glass and plastic, with their widely divergent thermal expansions cannot be effectively interconnected with all-plastic, or all-glass joints for use at elevated temperatures. However, the unique composite joints of the plastic boiler system of this invention make this interconnection very functional. Thus, glass boiling vessels can be replaced by the more effective and safe composite plastic boiler system significantly increasing the efficiency and performance of glass systems for evaporations distillations, refluxing, extractions, purifications, recovery, and other processes.

The composite plastic boiler comprises:

- a plastic vessel having a heatable bottom;
- a closure secured to the top of the vessel having at least one composite plastic and/or plastic/glass joint secured to said closure providing a passageway through said closure for connection with the interior of said vessel for connection to a piece of labware being made of a material having a thermal expansion less than said joint, said joint comprising a generally tubular plastic section and a compression ring of a lower thermal expansion material attached to its upper end.

BRIEF DESCRIPTION OF THE DRAWING

An embodiment of the invention will now be described by way of example with reference to the drawing in which Figure 1 is a cross-sectional view of a composite laboratory boiler with two types of composite plastic joints.

DETAILED DESCRIPTION OF THE INVENTION

Referring to Figure 1, there is illustrated a composite plastic laboratory boiler system made in accordance with one embodiment of the present invention. The boiler comprises a vessel 10 having a plastic sidewall with a graphitic or metallic heatable bottom 12 having a chemically resistant and non-contaminating coating or laminate 13 on its inner surface and a chemically resistant coating 18 on its outer surface, said coatings having sufficient thickness so as to provide minimal resistance to heat transfer but of sufficient thickness to resist liquid penetration into the heatable bottom. A metallic corrosion resistant compression ring 14 is heat shrunk around the bottom 12 annular sidewall 15 of the vessel 10 and firmly seals and secures the heatable bottom 12 to plastic sidewall 15. A Mason jar-type closure assembly is provided so as

to seal vessel 10 which comprises a peripheral plastic threaded annular ring 17 and disc 16. The ring 17 has internal threads 19 that engage external threads 21 disposed on the upper end of sidewall 15 and effectively seals top disc 16 to sidewall 15 of vessel 10. Disc 16 is provided with threaded ports 23, 25 for connecting threaded stem end 32 of composite tubular plastic joint 30 and threaded stem end 42 of composite tubular plastic-glass joint 40 to disc 16 of vessel 10.

Joint 30 comprises a tubular plastic section 34 with an internal passage 37 of standard taper geometry. Joint 30 connects to standard taper glassware (not shown). Joint 30 includes a loose fitting metal or reinforced plastic peripheral compression ring 36 which constrains the upper end of tubular plastic section 34 from expanding away from the inserted inner standard taper glass joint (not shown) when heated, because of the lower thermal expansion of said metal or reinforced plastic ring 36, the tubular plastic section 34 is strongly compressed around the inserted inner joint of the glassware by the constraining action of the peripheral metal or reinforced plastic ring 36, preventing it (the glass joint) from sinking too low in the tapered passageway 37, which would otherwise be expanding much more than the glass joint at elevated temperatures without the ring 36. This would result in dimensional changes, distortions of the plastic, a poorly sealed joint, and strong sticking action between the parts. The metal, or reinforced plastic pin 38, keeps the ring 36 from slipping down tubular plastic section 34 at room temperature where it would have a loose fit.

The joint 40, based on the same principle of the compression ring 36 as joint 30, allows the chemist to have a glass to glass connection, which some chemists may prefer, and as in joint 30, has a plastic to plastic connection to disc 16. In joint 40, the tubular plastic section 42 has an upper end 44 into which is secured the stem end 46 of a standard taper outer glass joint 48, for connecting to standard taper glassware, and a cover stem end 50, externally threaded for fastening to the threaded port 25 of disc 16. The shortened lower stem end 46 of the outer glass joint 48 is tightly sealed to the upper end 44 of tubular plastic section 42 with a metal, or reinforced plastic compression ring 52 that effectively eliminates the problem of the widely divergent thermal expansions between glass and plastic, allowing for the interconnection of glassware and the plastic boiler.

The boiler system of the present invention provides a number of favorable characteristics and properties not found in prior art laboratory boiler system to the best of our knowledge. A boiler according to the present invention has a highly thermally conductive bottom that allows direct heat-

ing on a hot plate, and closure assembly with top ports that connect to composite plastic joints for direct interconnection to virtually any glassware system. The vessel brings liquids to a rapid, uniform and smooth boil, free of bumping at lower hot plate temperatures. This is a time and kilowatt saver for many types of evaporations, distillations, extractions and other processes. The vessel is preferably made of a translucent fluoroplastic (PFA) with a PTFE closure and joints, or other chemically resistant plastics, and has a graphitic or metallic heatable bottom with a chemically resistant, non-contaminating coating on its inner side, and a chemically resistant coating on its outer side. The boiler system offers greater safety, being shatter, thermal shock and impact resistant. This is particularly important when used under vacuum, as the boiler vessel is usually the most vulnerable part of a glassware system. The plastic boiler system increases the efficiency and performance of glass systems for evaporations, distillations, refluxing, extractions, purifications, recovery, and others. For example, comparative water heating and evaporation tests with borosilicate glass vessels, of a comparative size, showed a 1.5 to 2-fold superiority of the composite plastic boiler vessels in boiling and evaporation rates over the glass boiling vessels.

The boiler vessel itself is made by injection molding a thermoplastic, fluoroplastic resin such as PFA, FEP, or others. (It should be noted that although PTFE is classified as a thermoplastic, it is much too viscous for commercial type injection molding.) A bottom heatable insert disc can be included during injection molding. Another commercial method starts with a plain plastic injection molded vessel, having top external threads. In this case, the bottom is machined out and a coated or laminated heatable bottom disc inserted, and sealed by shrink fitting a metallic compression ring. A Mason jar-type top closure assembly is used, having an internally threaded ring that seals the flat top cover. The top cover has threaded ports for connection to the composite plastic joints, thermometer holder, feed funnel, or other accessories. Other methods of connecting joints and accessories to the top cover can be used, such as clamping, taper fits, and others. Other type closures can be used including internally fitting and sealed tops.

The composite joints 30, 40 of the invention are unique in that they provide a means for interconnecting the boiler vessel to virtually any glassware system. Either all-plastic or glass joints would not be suitable because of the very wide difference in thermal expansions between plastics and glass. Thus, the linear coefficient of expansion for polytetrafluoroethylene (PTFE) is $12.1 \times 10^{-5}/\text{in/in}/^{\circ}\text{F}$ between 77 and 572 $^{\circ}\text{F}$ (25 and 300 $^{\circ}\text{C}$), whereas standard laboratory borosilicate glass has a linear

coefficient of expansion of $1.8 \times 10^{-6}/\text{in}/\text{in}/^{\circ}\text{F}$ between 32 and 572 $^{\circ}\text{F}$ (25 and 300 $^{\circ}\text{C}$). A PTFE outer joint would therefore expand sixty-seven times more than a matching glass inner joint at elevated temperatures. It is, therefore, clear that an inner S.T. joint on a glass condenser or other glass joint inserted into a PTFE outer S.T. joint on the boiler closure, and supported in the vertical refluxing position, would fit poorly, and leak badly under vacuum. If the condenser was not well supported, as frequently is the case, so that all or part of its weight rested on the plastic joint, the inner glass joint would tend to sink into the expanded outer plastic joint, at elevated temperatures, causing a gradual elongation of the joint depending on the load (stress), temperature, and time. Upon cooling, the inner glass joint would be strongly wedged into the plastic joint, and would require heating to remove.

If a composite joint 30, having a metal or reinforced plastic compression ring was used, in Figure 1, the tubular plastic section 34 would be constrained by the ring 36, and expand very little. In this case the glass inner joint of the condenser would be held tightly by the plastic, under the constraint of the compression ring 36. The fit would therefore be good, and little or no sticking would occur. In the case of the composite plastic glass joint 40 of Figure 1 the inner S.T. glass outer joint of the condenser would form a perfect thermal expansion match with the glass end of the composite S.T. outer joint and the plastic (PTFE) stem end of the joint would have the same thermal expansion as the plastic (PTFE) top of the boiler closure to which it would fasten. The tubular plastic of the composite S.T. joints is preferably made of a fluoroplastic, particularly polytetrafluoroethylene (PTFE) or perfluoroalkoxy (PFA) because of their relatively high use temperatures, 500 to 550 $^{\circ}\text{F}$ (260 to 288 $^{\circ}\text{C}$), and especially their excellent resistance to chemicals, being as good or even better than glass. However, for many applications the polyolefins such as polyethylene and polypropylene are suitable, or other appropriate, chemically resistant, anti-contaminating plastics.

For the composite S.T. joint 40 shown in Figure 1, the upper S.T. outer glass joint is made of a chemically resistant standard laboratory grade borosilicate glass. The stem end of S.T. glass joint is shortened by cutting off about 2 inches (51 mm).

The metal or reinforced plastic compression rings 52 and 36 are made of an aluminum alloy such as 6061 with a good combination of mechanical properties and corrosion resistance. The stainless steels particularly the 300 series are also excellent alloys for the compression rings 52 and 36. Most metals and alloys with good corrosion resistance can be used for the compression rings

52 and 36, or rings with a chemically resistant coating. Reinforced plastics are used in applications where an all plastic boiler without a heatable bottom is heated by microwaves, since metals would not be acceptable. Materials such as continuous filament woven glass fabric grades impregnated with epoxy resin such as Nema G-10 type GEE, or Glass-Epoxy Nema G-11, Type GFB or other comparable materials.

Applicants built and tested the plastic boiler system of this invention. The description and results of such efforts are set forth in the following examples.

EXAMPLE 1

The plastic boiler system was built in accordance with the illustration of Figure 1, and fabricated by machining out the bottom of an injection molded perfluoroalkoxy (PFA) plastic one liter screw cap jar. The screw cap closure was also machined to leave only a Mason jar-type ring to secure and seal a disc of polytetrafluoroethylene (PTFE). The disc 16 was machined from a 1/2 inch (13 mm) thick sheet of PTFE plastic, as the top of the closure assembly of the vessel. Threaded ports 23, 25 were also machined into the top of the closure to accommodate the stem threaded composite joints and other accessories such as a sparging rod, a thermometer holder, plugs and others. The heatable bottom disc 12 was machined from an extruded graphite cylinder having a bulk density of 1.7g cm $^{-3}$ and a fine to medium grain size structure. The disc was laminated with a PFA film layer of about 0.010 inch thick, at a molding temperature of about 600 $^{\circ}\text{F}$ (316 $^{\circ}\text{C}$), and a pressure of 200-300 psi (1.38 to 2.07 MPa) for a time of 5 minutes. The PFA polymer was forced into the pores of the graphite surface forming a strong bond, and being reduced to a 0.007-0.008 inch (0.18 to 0.20 mm) thick film coating. This film layer formed the inner surface 13, of the vessel illustrated in Figure 1. The outer side of bottom disc was coated with a high temperature epoxy resin about 0.002 inch (0.05 mm) thick shown as 18 of Figure 1. The disc 12 was then positioned in the vessel bottom and secured by a shrunk fit aluminum compression ring 14 of Figure 1.

The plastic boiler was evaluated by several testing methods, the first to compare boiling and evaporation rates with those of a standard borosilicate glass flat bottom vessel of the same capacity, in this case a one liter beaker. Normally glass boiling vessels have a round bottom. This would have required a heating mantle whereas the plastic boiler would have been heated on a hot plate, making a one to one comparison difficult. Both vessels containing 450cm 3 of distilled water

were heated on a hot plate at a starting temperature of 560° F (293° C), without a closure. The water in the plastic boiler came to a brisk, uniform boil in 13.5 min. with complete evaporation in 78.0 min. The water in the glass vessel came to a slow irregular boil in 21.0 min. with evaporation in 118.0 min. or a boil ratio of $21/13.5 = 1.6$ advantage of the plastic boiler, and an evaporation ratio $118/78 = 1.5$ advantage over glass. At a hot plate temperature of 700° F (371° C) the borosilicate boiling vessel took about twice as long to come to a slow irregular boil, with an evaporation rate about one third that of the plastic boiler. At a hot plate temperature of 1000° F (538° C) the plastic boiler showed a 2/1 superiority over the glass vessel in boiling rate, and a 1.85 margin over the glass vessel in evaporation rate.

EXAMPLE 2

An empty plastic boiler vessel, as described in Example 1, was subjected to a long time heating test on a hot plate at 550° F (288° C). The continuous test lasted 168 hours after which the hot vessel was quickly removed from the hot plate and plunged into cold water. The boiler was then filled with water (600 cm³) placed on a hot plate at 700° F (371° C) and brought to a brisk boil. No damage to the vessel occurred. The quench test in cold water illustrated the excellent thermal shock resistance of the vessel.

It should be noted that the plastic boiler vessel should not be allowed to heat to dryness at a hot plate temperature over about 550° F (288° C) since the softening and melting point of the PFA plastic is about 590-600° F (310 to 316° C). Liquids with boiling points about 550° F (288° C), such as concentrated sulfuric acid, should not be boiled in the vessel. However, most liquids can be heated to the limit of the hot plate. Glass vessels have a much higher softening and melting point, however, glass vessels are vulnerable to cracking if heated to dryness.

EXAMPLE 3

A plastic boiler vessel described in Example 1 was subjected to the following impact tests. A boiler with the closure removed was filled with 800 cm³ of water, the total weight being 2.96 lbs (1.34 kg). The filled vessel was taken outdoors and dropped on a concrete walk from a measured height of 5 ft (1.5 m). This was repeated 3 times and the vessel examined for damage. This amounted to edge chipping of the graphite disc 12 and denting of the aluminum compression ring 14. The sustained impact was 14.8 ft./lbs.(20.0 Nm). The vessel was then filled with water and heated on a

hot plate at 700° F (371° C) to a brisk boil. The boiler proved to be free of leaks. This severe test demonstrated the impact safety of plastic boiler vessel.

EXAMPLE 4

The composite plastic joint 30 of Figure 1 was fabricated by machining a PTFE 1.25 in. (31.8 mm) diameter rod into a tubular form with its upper end of standard taper (S.T.) geometry 37. An aluminum alloy 6061 tube was machined to give a compression ring 36 of Figure 1, 1.0 in. (25 mm) wide with an I.D. of 0.0625 in. (1.59 mm) and a wall thickness of 0.060 in. (1.5 mm). An aluminum rivet was used as a fastening pin 38, and was inserted into a blind hole in the tubular plastic section 34. The stem end of composite plastic S.T. joint was connected to a threaded port 23 or 25 of disc 16 and the upper S.T. end to a 24/40 inner end of a S.T. glass joint, with the outer 24/40 S.T. end of the adapter connected to the inner joint side of a Friedrich-type refluxing condenser. The adapter was used in the event of a tightly sticking joint that would be difficult to remove if connected directly to the inner condenser joint. When it was determined that no sticking occurred, the condenser was connected directly to the composite joint. Testing consisted of the continuous refluxing of boiling water, or solvent, with intermittent cool-downs for measurement checks and examination of the composite joint. The condenser was vertically positioned by a clamp and support stand. Although, about half the weight of the water filled condenser (load) was supported by the composite joint. The objective was to determine the extent of creep (deformation) that slowly occurs under a continuous load. Creep increases with stress (load) temperature, and time. This was observed with plain PTFE S.T. joints without metal or reinforced compression rings as will be described in this and other examples. A plain PTFE 24/40 S.T. joint was connected to a condenser as described above. The first check, after 5 hours of refluxing, showed the joint too tight for removal from the glass adapter joint without unscrewing the stem end of the plastic joint from the boiler closure. Removal eased with each additional check. After 28 hours of refluxing, the upper Inside Diameter of the PTFE joint had expanded 6.4 percent from the original measurement. After 94.5 hours, testing was terminated when examination and measurement of the joint indicated that the Inside Diameter of the upper end of the joint increased $0.012 \pm .002$ inches (0.30 ± 0.05 mm). This allowed the bottom end of the inner glass adapter joint to touch the bottom of the PTFE joint at the stem section. Thus, the joint no longer formed a seal with the glass adapter joint. A composite S.T. joint with an alu-

minum compression ring, was tested under the same conditions as the plain PTFE joint above, for 226 hours with intermittent cool-downs. An overall elongation of about .009 in. (0.23 mm) occurred, but no appreciable change in the Inside Diameter (0.002 in; 0.05 mm) was observed. Seal integrity was good and the glass adapter joint released easily from the composite joint.

EXAMPLE 5

A new design plain PTFE S.T. joint with an extended taper section was tested for 125.5 hours. The Friedrich refluxing condenser was connected directly to the joint for half the time, and to a glass adapter joint, connected to the condenser, for the balance of the time. After 20 hours and upon cool-down, the joint showed an elongation of 0.085 in. (2.2 mm) and a diameter decrease of 0.007 in (0.18 mm). At the end of the test period of 125.5 hours, the glass S.T. joint of the adapter was tightly wedged in the PTFE outer joint, and had to be removed still attached to the adapter joint, and heated in an oven to separate the two. A second composite S.T. joint with a reinforced plastic compression ring (G11, type GEB, Glass-Epoxy) was tested under the conditions as the plain PTFE joint above for 148 hours, half the time connected directly to the condenser and to the condenser via the glass adapter for the balance of the time. Dimensional changes were minimal with a decrease in the Inside Diameter of 0.002 in. (0.05 mm) and an elongation of 0.006 in. (0.15 mm). Both the glass adapter and condenser joint were easily removed without sticking.

EXAMPLE 6

A composite tubular PTFE plastic-glass standard taper (S.T.) joint of the type 40 shown in Figure 1 was fabricated as follows. The tubular plastic section 42 was machined from a cylindrical rod (1.25 in, 31.8 mm diameter) and the metal compression ring 52 was machine from type 316 stainless steel tubing. The ring 52 was then shrunk fit over the tubular plastic, tightly sealing the tubular plastic section 44 to the shortened stem 46 of the glass joint, and effectively constraining the tubular plastic section from expanding away from the stem of the glass joint. The stem end of the tubular plastic section 50 was previously threaded by machining to fasten to the threaded port 25 of the PTFE disc 16. The joint was tested as described in Example 4 with the inner joint of the Friedrich condenser connected directly to the outer S.T. glass end of the composite joint 40 illustrated in Figure 1. After 250 hours of refluxing boiling water with intermittent cool-downs, no dimensional

changes were noted, and no sticking occurred since the glass to glass connection was a perfect match of thermal expansions. Although glass to glass joints may stick depending on chemicals used and experimental set-up, this can be easily controlled by the use of a thin (.0015-.003 in. (0.04 to 0.08 mm)) PTFE sleeve that fits around the inner tapered glass joint.

EXAMPLE 7

A composite S.T. joint 30 illustrated in Figure 1 was fabricated as described in Example 4 with an aluminum compression ring 36. The composite joint was tested as described in Example 4 for 75 hours by refluxing with boiling tetrachloroethylene (C_2Cl_4 -B.P. $250^\circ F$; $121^\circ C$) with intermittent cool-downs. The composite joint was connected directly to the glass inner joint of the Friedrich-type condenser. No significant dimensional changes were noted and no sticking occurred.

EXAMPLE 8

A plastic boiler was built in accordance with the illustration in Figure 1 and as described in Example 1, with the exception that an aluminum bottom disc 12 was substituted for the graphite bottom disc 12. The aluminum disc 12 was machined from an aluminum alloy 6061, and laminated with a 0.010 in. (0.25 mm) PFA plastic film layer on the inner side of the disc 12. The boiler was set-up for simple distillation of water, under a vacuum, at a pressure of 120 mbar (12.0 kpa). (Normal atmospheric pressure is about 1013 mbar (101.3 kpa.) The hot plate temperature was $340^\circ C$ ($644^\circ F$), water vapor temperature was $55^\circ C$ ($131^\circ F$), the condensation rate was $950\text{ cm}^3/\text{hr}$. This compares favorably with similar size (1 liter) rotary-type evaporators at $860\text{ cm}^3/\text{hr}$., Rotary evaporators generally have evaporation rates 2 to 3 times higher than conventional laboratory glass boiler set-ups.

Claims

1. A boiler that interconnects to conventional labware having a thermal expansion different from said boiler, said boiler comprising:
 - a vessel made substantially of plastics and having a heatable bottom;
 - a closure secured to the top of said vessel; and
 - a joint secured to said closure providing a passageway through said closure for connection with the interior of said vessel for connection to a piece of labware being made of a material having a thermal expansion less than said joint, said joint comprising a generally

tubular plastics section and a compression ring of a lower thermal expansion material attached to its upper end.

2. A boiler according to claim 1 wherein said plastics vessel, closure and tubular plastics section are made of a fluoroplastics, polyolefin, or other chemically resistant non-contaminating plastics. 5
3. A boiler according to claim 2 wherein said vessel, closure and joint are made of a fluoroplastics including perfluoroalkoxy (PFA), polytetrafluorethylene (PTFE), or fluorinated ethylene propylene (FEP) plastics, or other appropriate fluoroplastics. 10
4. A boiler according to any preceding claim, wherein said closure is of a Mason jar-type comprising an annular ring for threaded engagement with said vessel and a disc secured between said ring and vessel, said disc having threaded top ports that connect to a joint, plugs and accessory holders of said fluoroplastics. 15
5. A boiler according to any preceding claim, wherein said heatable bottom comprises a disc made of a graphitic material with a chemically resistant, non-contaminating plastics coating on its inner side, and a chemically resistant coating on its outer side. 20
6. A boiler according to any of claims 1 to 4, wherein said heatable bottom comprises a disc made of a metallic material selected from good thermally conductive materials including aluminium, stainless steels, copper, nickel, cobalt, carbon steels, titanium, tantalum and their alloys. 25
7. A boiler according to claim 6, wherein said disc has a chemically resistant and non-contaminating coating on its inner side and a chemically resistant coating on its outer side. 30
8. A boiler according to claim 5 or 7, wherein said inner-side coating on said disc is of fluoroplastics, polyolefin, or other chemically resistant, non-contaminating coating on its inner side. 35
9. A boiler according to claim 6, wherein said disc has a chemically resistant and non-contaminating glass, or glass-ceramic coating on its inner and outer sides. 40
10. A boiler according to any of claims 5 and 7 to 45

9, wherein said inner-side and/or said outer-side coating has a sufficient thickness so as to provide minimal resistance to heat transfer but of sufficient thickness to resist liquid penetration into said disc.

11. A boiler according to any preceding claim, wherein said upper end of said tubular plastics section has an internal passage of standard taper geometry allowing for interconnection with standard taper glassware, said tubular plastics section having a lower end threaded for connection to said closure. 10
12. A boiler according to any preceding claim, wherein said compression ring of said joint has a lower thermal expansion than said tubular plastics section. 15
13. A boiler according to claim 12, wherein said compression ring is made of aluminium metal or alloys, stainless steels, or other corrosion resistant metals and alloys. 20
14. A boiler according to claim 12, wherein said compression ring of said joint is of a reinforced plastics material. 25
15. A boiler according to claim 14, wherein said compression ring is of a continuous filament woven glass fabric grade impregnated with epoxy resin or other comparable chemically resistant material. 30
16. A boiler according to any preceding claim, wherein said compression ring of said joint is loose fitting at room temperatures being attached to the said tubular plastics with a fastening pin of metal or reinforced plastics. 35
17. A plastics boiler that can be heated directly on a hot plate and that interconnects to conventional glassware, although thermal expansions of plastics and glass are widely divergent, said boiler comprising: 40
 - a vessel of fluoroplastics material having a heatable bottom disc of a graphitic or metallic material with a chemically resistant and non-contaminating coating on its inner side and a chemically resistant coating on its outer side, said bottom disc being securely sealed to said vessel sidewalls by means of a corrosion resistant metallic compression ring, said vessel having a fluoroplastics Mason jar-type closure comprising an annular ring for threaded engagement with said vessel and a disc secured between said ring and said vessel, said disc having at least one threaded top port, and at 45

least one fluoroplastics tubular joint for connection to said threaded top port comprising a fluoroplastics tubular section and a metallic or reinforced plastics compression ring attached to said fluoroplastics tubular section at its upper end.

18. A plastics boiler that can be heated directly on a hot plate and that interconnects to conventional glassware, although thermal expansions of plastics and glass are widely divergent, said boiler comprising:

a vessel of fluoroplastics material having a heatable bottom disc of a graphitic or metallic material with a chemically resistant and non-contaminating coating on its inner side and a chemically resistant coating on its outer side, said bottom disc being securely sealed to said vessel sidewalls by means of a corrosion resistant metallic compression ring, said vessel having a fluoroplastics Mason jar-type closure comprising an annular ring for threaded engagement with said vessel and a disc secured between said ring and said vessel, said disc having at least one threaded top port;

at least one composite tubular fluoroplastics glass joint comprising a tubular fluoroplastics section having its lower end connected to said closure and its upper end secured to the lower stem end of a standard taper glass joint by means of a metallic or reinforced plastics compression ring.

19. A plastics boiler that can be heated directly on a hot plate and that interconnects to conventional glassware, although thermal expansions of plastics and glass are widely divergent, said boiler comprising:

a fluoroplastics vessel having a heatable bottom disc of a graphitic or metallic material with a chemically resistant and non-contaminating coating on its inner side and a chemically resistant coating on its outer side, said bottom disc being securely sealed to said vessel sidewalls by means of a corrosion resistant metallic compression ring, said vessel having a fluoroplastics Mason jar-type closure comprising an annular ring for threaded engagement with said vessel and a disc secured between said ring and said vessel, said disc having at least one threaded top port, at least one fluoroplastics tubular joint for connection to said threaded top port comprising a fluoroplastics tubular section and a compression ring attached to its upper end, and at least one composite tubular fluoroplastics-glass joint comprising a tubular fluoroplastics section having its lower end connected to said closure

and its upper end sealed to the lower stem end of a standard taper glass joint by means of a compression ring.

20. A plastics joint for use in attaching plastics laboratory ware to glass laboratory ware comprising a plastics tubular section and a compression ring of a lower thermal expansion attached to the upper end of said plastics tubular section.

21. A glass-plastics joint for use in attaching plastics laboratory ware to glass laboratory ware comprising a tubular plastics section having its lower end for connection to a plastics vessel and its upper end tightly sealed to the lower stem end of a standard taper glass joint by means of a compression ring having a lower thermal expansion than said tubular plastics section.

