United States Patent [19]

Stejskal

[11] **3,739,617**

[45] **June 19, 1973**

[54] **HIGH TEMPERATURE VACUUM CREEP FORMING FIXTURE**

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[73] Assignee: **The Boeing Company,** Seattle, Wash.

[22] Filed: **Sept. 21, 1970**

[21] Appl. No.: **73,927**

[52] **U.S. Cl.** **72/63**

[51] **Int. Cl.** **B21d 22/12**

[58] **Field of Search** 72/54, 57, 63; 18/DIG. 19; 29/421

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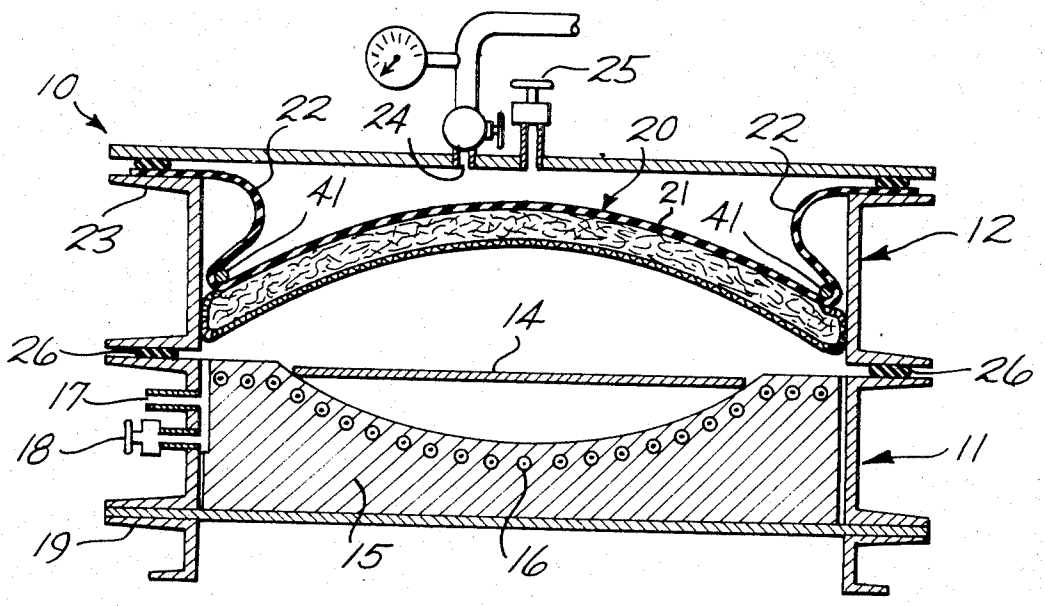
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[57] **ABSTRACT**

A high temperature vacuum creep forming fixture is disclosed comprising a vacuum chamber, a die with heating electrodes therein for receiving a metallic blank, and a high heat resistant forming diaphragm for pressing the metallic blank over said hot die for forming the blank into the desired part, and for raising the diaphragm clear of the die. A new heat resistant diaphragm per se, is disclosed comprising a plurality of interconnected elongated modules of high heat resistant insulating material secured to a plurality of two sheets of heat resistant materials, one sheet being of aluminized asbestos cloth for reflecting the heat back and the other sheet or sheets being of fiberglass reinforced silicone rubber for providing high strength and flexibility in the diaphragm for forming and lifting a highly efficient heat insulating diaphragm. Alternatively, a ring spring may be placed over the diaphragm for urging the periphery thereof outwardly.

4 Claims, 11 Drawing Figures



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SHEET 1 OF 4

Fig. 1.

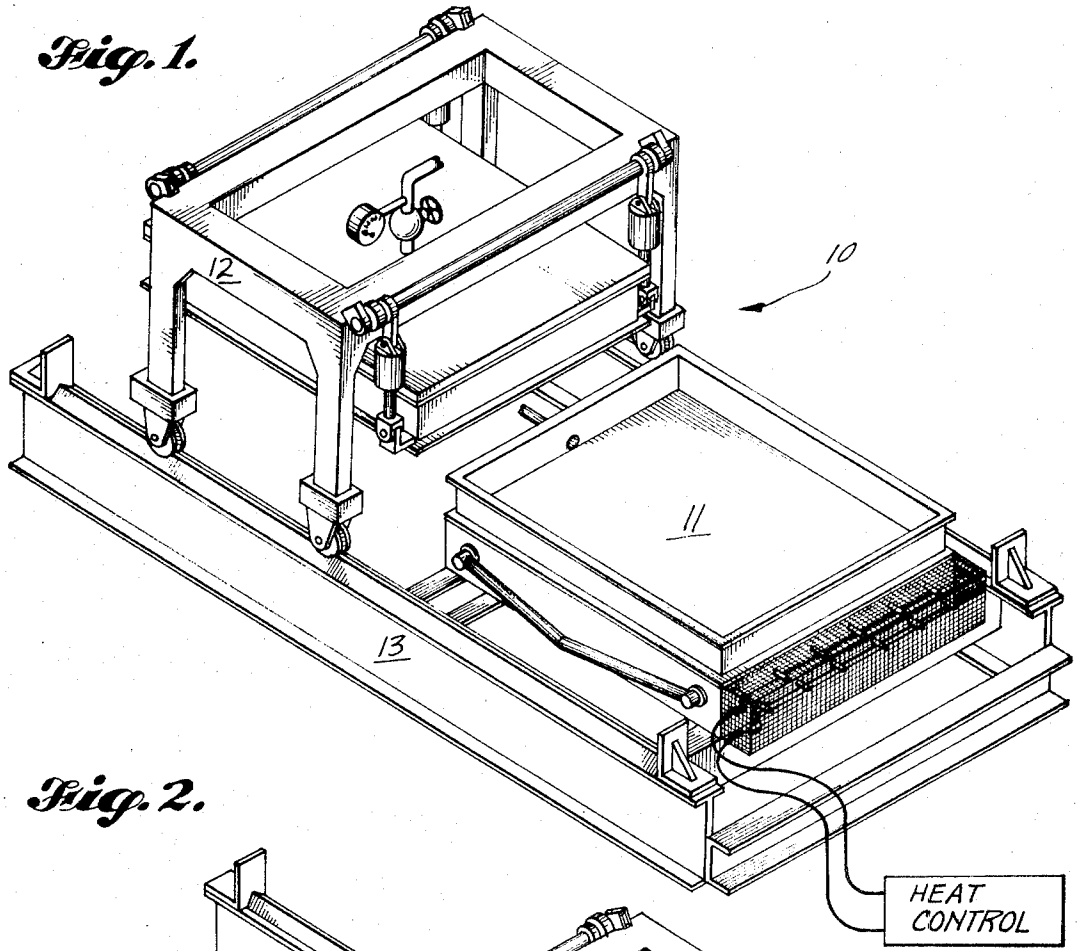
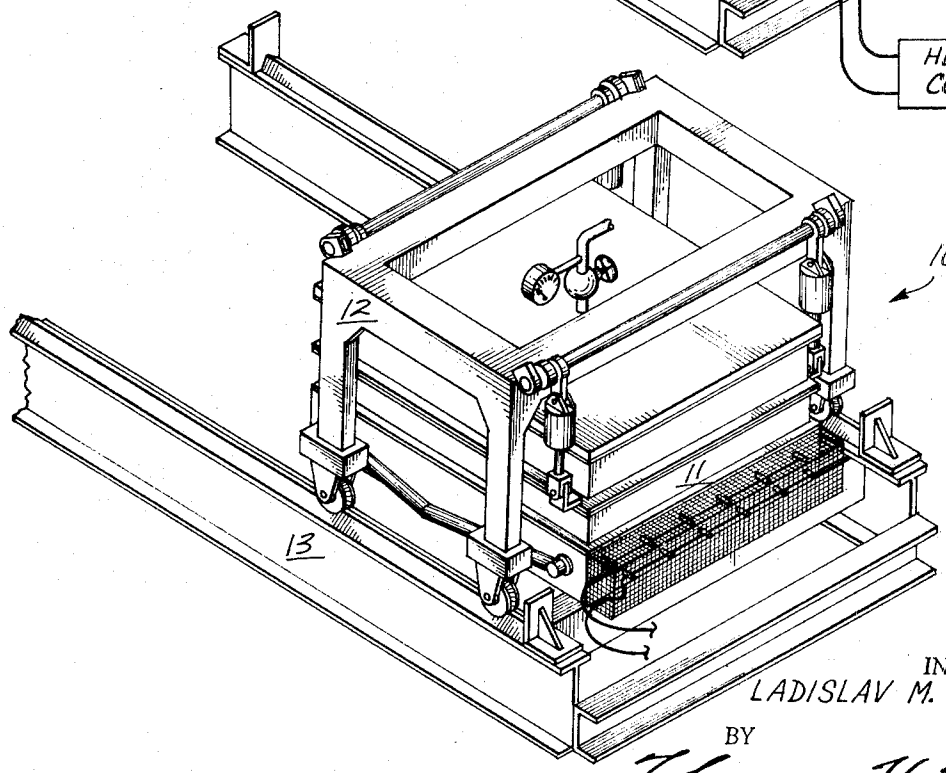


Fig. 2.



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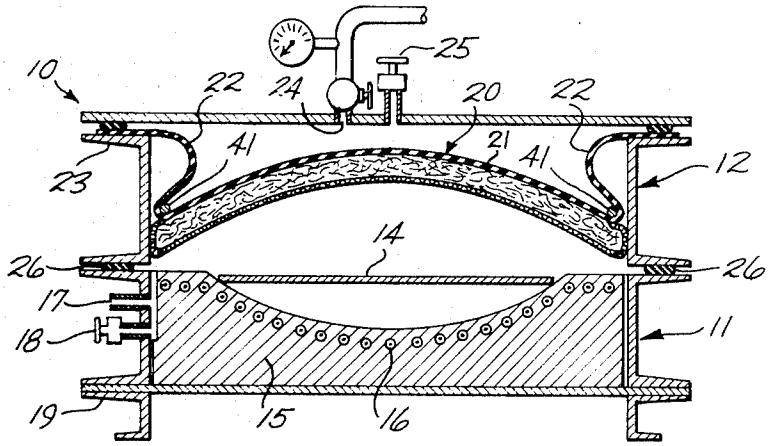


Fig. 3.

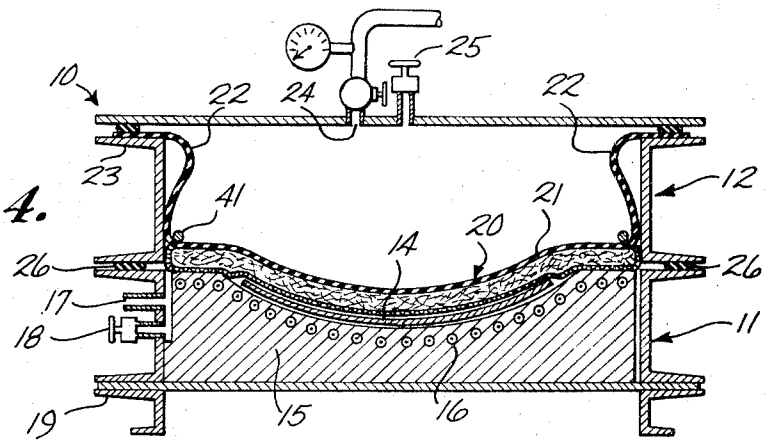
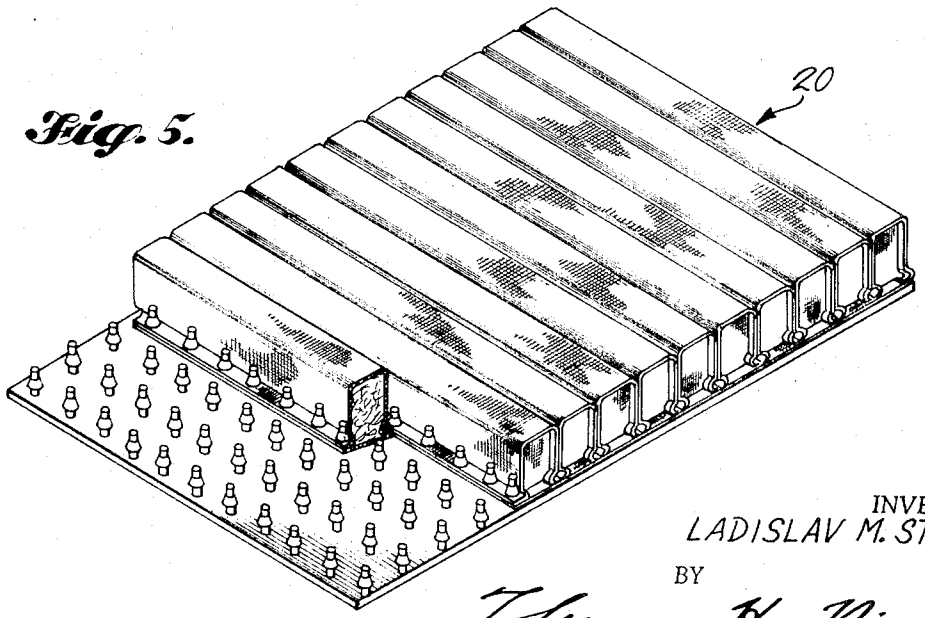


Fig. 4.

Fig. 5.



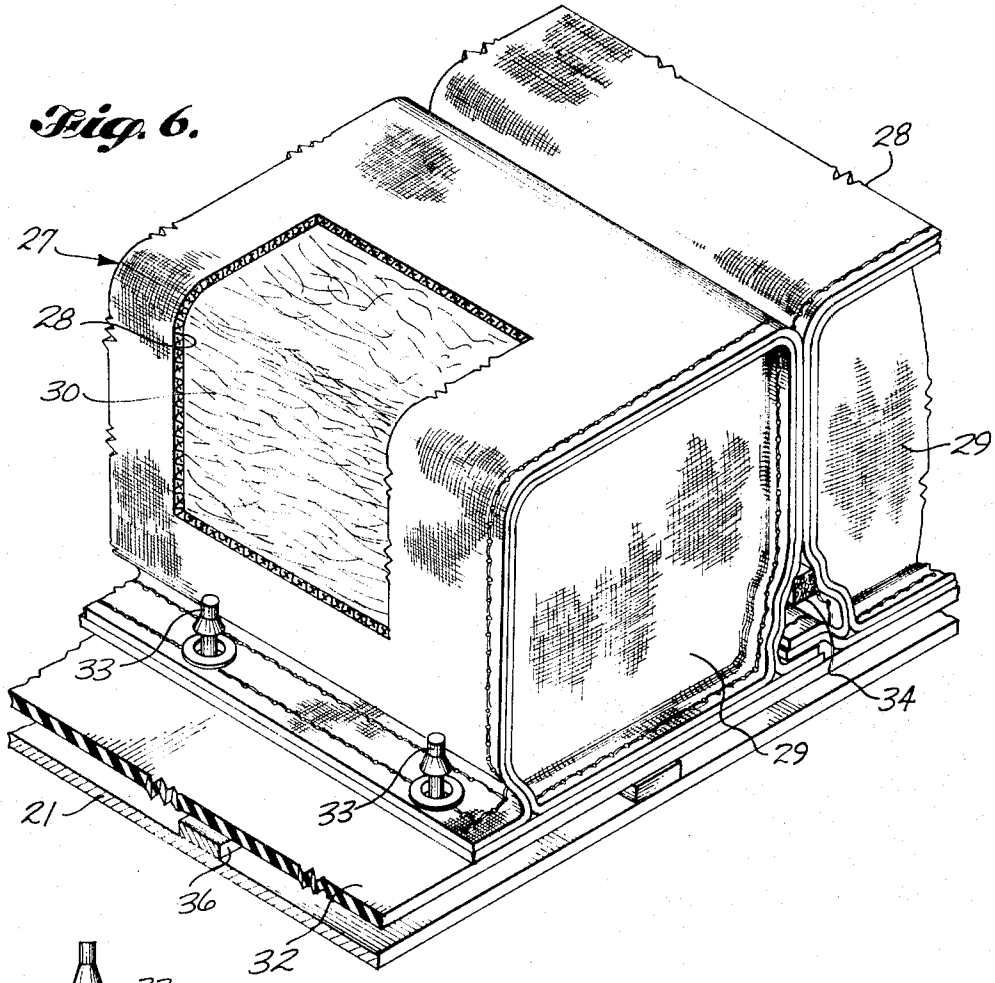
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Fig. 6.



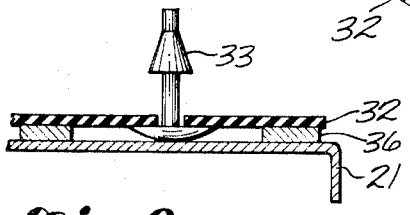


Fig. 9.

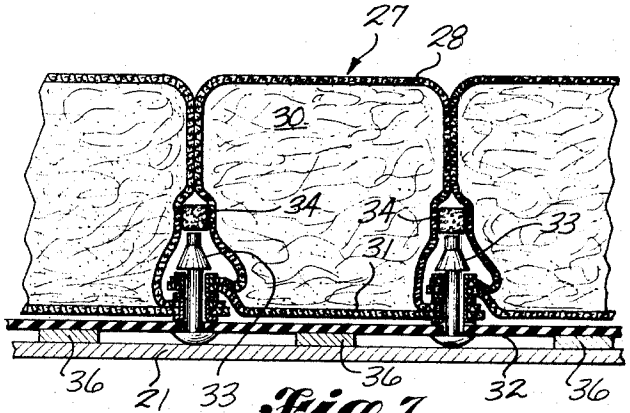


Fig. 7.

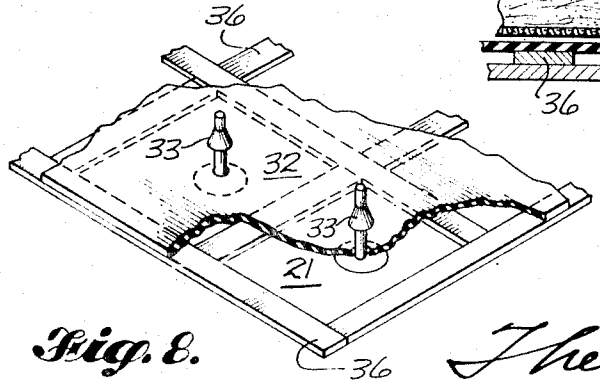


Fig. 8.

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Fig. 10.

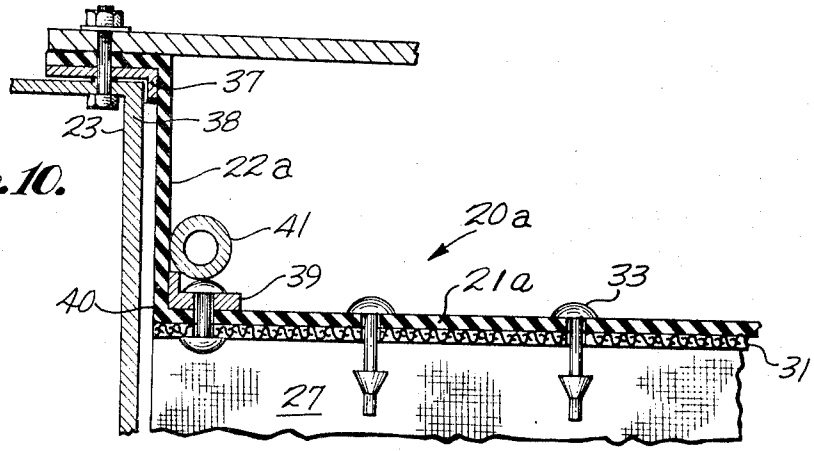
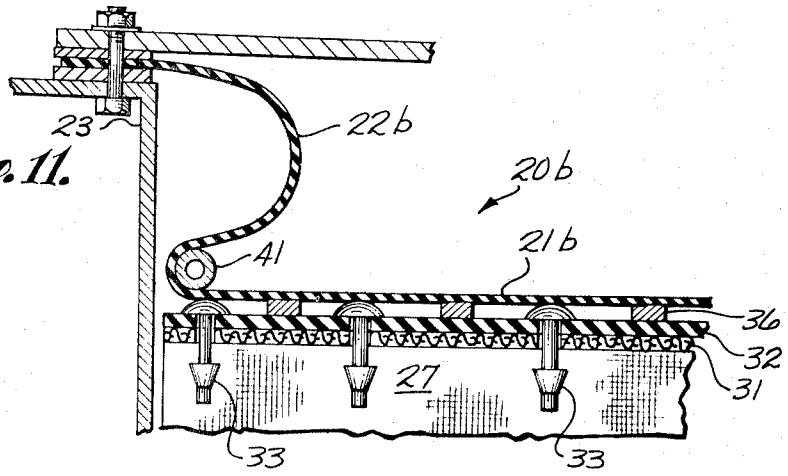


Fig. 11.



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HIGH TEMPERATURE VACUUM CREEP FORMING FIXTURE

SUMMARY OF THE INVENTION

The disclosed invention pertains to a high temperature vacuum creep forming fixture comprising a die forming lower chamber portion and a diaphragm upper chamber portion.

The diaphragm upper chamber portion is illustrated as being mounted on rollers and tracks so that after the diaphragm has been raised subsequent to forming of a part, the diaphragm upper chamber portion is rolled back to provide clearance for removing the formed part and reloading the lower chamber portion with a new blank. Following positioning of the new blank over the die in the lower chamber portion, the diaphragm upper chamber portion is again moved over the lower chamber, lowered until into sealing engagement therewith and then the vacuum pulled from under the lower chamber to press the diaphragm on the blank to form it over the die.

The vacuum in this new vacuum creep forming fixture is controlled by valves in both the lower chamber portion and in the upper chamber portion for either forcing the blank down over the die with the diaphragm and for raising the diaphragm clear of the die for removing the newly formed part and inserting a new blank.

Likewise, a new diaphragm is disclosed for use in high temperature environments, such as but not limited to, for use in the disclosed new vacuum creep forming fixture. It comprises a layer of continuous, interconnected elongated modules made of aluminized asbestos cloth and alumina-silica fibers and cloth mounted on a sheet of fiberglass reinforced silicone rubber for providing strength, flexibility, and an air tight seal.

Two modifications of a diaphragm are disclosed, one utilizing two preformed fiberglass reinforced silicone rubber corners on each side of the diaphragm and the other diaphragm utilizing a flexible silicone rubber sheet on each side for distribution of stresses on the peripheral edges of the diaphragm.

Accordingly, a primary object of this invention is to provide a forming fixture that utilizes vacuum forces for actuating a diaphragm for pressing a blank over a die to the shape thereof in place of utilizing pneumatic, hydraulic, or mechanical actuating forces.

Another object of this invention is to provide a vacuum creep forming fixture that may be rapidly opened and closed even at very high temperatures.

A further object of this invention is to provide a high temperature heat resistant diaphragm.

Still another object of this invention is to provide a high heat resistant diaphragm comprising a layer of interconnected modules of heat resistant material.

A still further object of this invention is to provide a high heat resistant diaphragm comprising a layer of interconnected modules with the addition of two layers of high heat resistant material.

Other objects and various advantages of the disclosed high temperature vacuum creep forming fixture will be apparent from the following detailed description, together with the accompanying drawings, submitted for purposes of illustration only and not intended to define the scope of the invention, reference being made for that purpose to the subjoined claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawings diagrammatically illustrate by way of example, not by way of limitation, two forms of the invention wherein like reference numerals designate corresponding parts in the several views in which:

FIG. **1** is a schematic perspective view of the high temperature vacuum creep forming fixture wherein the diaphragm upper chamber portion is illustrated as being rolled clear of the forming lower chamber portion;

FIG. **2** is a view similar to FIG. **1**, except the upper and lower portions are illustrated as sealed together for forming;

FIG. **3** is a schematic sectional view of the high temperature vacuum creep forming fixture illustrating the diaphragm being lifted by the vacuum;

FIG. **4** is a view similar to FIG. **3**, but with the diaphragm illustrated in forming position;

FIG. **5** is a schematic perspective view of a portion of the diaphragm upside down with parts broken away;

FIG. **6** is a detailed enlarged schematic view of a portion of FIG. **5**;

FIG. **7** is a schematic sectional view of one of the insulating modules and adjacent portions of the membrane, all upside down;

FIG. **8** is a detailed enlarged schematic view of a portion of FIG. **5** with parts cut away;

FIG. **9** is a schematic sectional view of a portion of FIG. **8**;

FIG. **10** is a schematic sectional view of a portion of one embodiment of the diaphragm; and

FIG. **11** is a modification of FIG. **10**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention, the scope of which being defined in the appended claims, is not limited in its application to the details of construction and arrangement of parts shown and described, since the invention is capable of other embodiments and of being practiced or carried out in various other ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

FIG. **1**, a schematic perspective view of the high temperature vacuum creep forming fixture **10**, illustrates the diaphragm upper chamber portion **12** rolled on tracks **13** clear of die forming lower chamber portion **11**. In this position the finished or new formed part may be removed from lower chamber portion **11** and a new blank placed in position over a die (not shown) therein.

FIG. **2** illustrates the diaphragm upper chamber portion **12** sealed over the die forming lower chamber portion **11** for operation of the high temperature vacuum creep forming fixture **10**.

FIG. **3**, a cross section of the high temperature vacuum creep forming fixture **10**, illustrates the lower chamber portion **11** comprising a blank **14** of titanium, for example, positioned over ceramic die **15** having heating elements **16** therein, and vacuum pump pipe outlet and release valve, **17** and **18** respectively, all mounted in die frame **19**. This vacuum creep forming fixture is particularly adapted for forming blanks of titanium and other refractory metals and superalloys, as nickelchrome, stainless steel, etc.

Upper chamber portion **12** includes high heat resistant and high strength diaphragm **20** comprising a high

heat resistant die forming portion **21** and a more flexible, supporting, vacuum membrane portion **22** connecting the peripheral edge of the die forming thick portion **21** to the upper frame **23.** Air outlet **24** to a vacuum pump (not shown) and vacuum releasing valve **25** are coordinated with similar outlet **17** and vacuum release valve **18** to control the vacua being pulled on both sides of the diaphragm alternately. Upper diaphragm frame **23** is pneumatically sealed to lower die frame **19** with annular silicone rubber, or the like, seal **26.**

As shown in FIG. **3,** the vacuum pulled in the upper chamber, as controlled by the appropriate valves, is causing the ambient air pressure to support the diaphragm in the illustrated raised position. Annular steel free-floating frame rod **41** tends to maintain the diaphragm high heat resistant die forming portion **21** stretched out in a generally horizontal attitude.

FIG. **4** illustrates the reversal in vacua with the vacuum being pulled in the lower chamber instead of the top chamber after the ceramic die **15** is heated to forming temperature. The force of the vacuum on the flexible diaphragm then forms the blank to the shape of the die for producing the high temperature vacuum creep formed article.

More details of the high temperature heat resistant diaphragm are revealed in the following detailed drawings.

FIG. **5** illustrates a portion of the diaphragm **20** upside down, i.e., the hot side on top, with parts cut away for clarity of disclosure.

FIG. **6,** an enlarged view of a portion of the diaphragm of FIG. **5,** illustrates details of the modules as module **27** for example. Here, the cover **28** and end cover **29** comprise nickelchrome wire reinforced alumina-silica fiber insulating cloth such as but not limited to "Fiberfrax" manufactured by The Carborundum Company, Niagara Falls, N.Y., for enclosing a filler **30** of alumina-silica fiber.

FIG. **7,** a sectional view of one of the modules **27,** illustrates the insulating cover **28** stretched over the filler **30** and secured to an aluminized asbestos cloth bottom strip **31** of the module and a supporting sheet **32** of fiberglass reinforced silicone rubber with silicone rubber fastening pin **33** inside of grommets. Each row of pins **33** with their attendant grommets, FIG. **7,** fasten the adjacent sides of two modules to the supporting sheet **32** and an insulating rope **34** of nickelchrome wire reinforced alumina-silica fiber insulating material protect the pins from the high heat of metal forming. Thus, a damaged module may be replaced by removing only the fastening pin on each side of the damaged module, the module replaced, and then the pin replaced.

A second supporting sheet **21** is stretchable silicone rubber and is adhesively secured to spacer strips **36** which are, in turn, adhesively secured to the supporting sheet **32.**

FIG. **8,** a detailed view of a part of the diaphragm of FIG. **5,** with the modules cut away, and on this part, a portion of the first supporting sheet **32** is cut away for clarity of disclosure.

FIG. **9,** a cross sectional view of a portion of FIG. **8,** illustrates the two silicone rubber supporting sheets **21** and **32** interconnected with spacer strips **36** and locking the silicone rubber fastening pin **33** thereto. Sheet **32** is also fiberglass reinforced silicone rubber and sheet **21** is stretchable silicone rubber.

FIG. **10** is a schematic sectional view of the preferred embodiment of the diaphragm wherein diaphragm **20***a* has a fiberglass reinforced flexible membrane **22***a* attached to upper frame **23** and integral with flexible, supporting membrane **21***a*. Here, preformed fiberglass reinforced silicone rubber annular angular strip **37** is adhesively secured to the supporting membrane **22***a* so as to overlap and loosely fit on the corner **38** of the upper frame **23.** Likewise, preformed fiberglass reinforced silicone rubber annular angular strip **39** is fastened, as by an adhesive or the like, to the corner **40** of the flexible, supporting membrane **22***a* where it joins the high heat resistant die forming portion **21***a* and where the tension forces of the membrane **22***a* are at right angles to the diaphragm portion **21***a* and which portion **21***a* forms a supporting sheet which is secured adhesively and/or with fastening pins **33** to aluminized asbestos module cloth bottom strip **31.** Thus, with raising and lowering of the diaphragm **20***a* producing the flexing or bending and straightening or pulling of the diaphragm membrane **22***a*, the strip **37** fits loosely over frame corner **38** and the strip **39** reinforces membrane corner **40,** all for increasing the wear life of the diaphragm membrane.

FIG. **11,** a modification of FIG. **10,** illustrates schematically another embodiment **20***b* of the diaphragm comprising a stretchable silicone rubber membrane **21***b* extending from on top of the upper frame **23** inwardly into a loop and back around free-floating frame **41.** Membrane **22***b* is integral with the silicone rubber supporting sheet portion **21***b*. Sheet portion **21***b* is adhesively secured to silicone rubber sheet **32** through interconnecting spacer strips **36.** Sheet **32** is secured to aluminized asbestos bottom cloth **31** of module **27** with silicone rubber fastening pin **33.** Therefore, with raising and lowering of the diaphragm **20***b* which produces flexing and straightening or stretching of the diaphragm membrane **22***b*, the large bend in the membrane merely bends with little, if any, rubbing on upper frame **23.**

Accordingly, it will be seen that the present high temperature vacuum creep forming fixture operates in a manner which meets each of the objects set forth hereinbefore.

While only two embodiments have been disclosed, it will be evident that various other modifications are possible in the arrangement and construction of the disclosed high temperature vacuum creep forming fixture without departing from the scope of the invention, and it is accordingly desired to comprehend within the purview of this invention such modifications as may be considered to fall within the scope of the appended claims.

I claim:

1. A high temperature vacuum creep forming fixture comprising: vacuum chamber means; diaphragm means secured at its outer edges so as to divide the vacuum chamber into an upper and lower chamber; a die enclosed in said lower chamber for receiving and heating a metallic blank; an insulating blanket comprising a plurality of interconnected elongated modules fastened to the lower surface of the diaphragm and extending substantially across the forming surface of the die for providing thermal protection of the diaphragm from the metallic blank; and said diaphragm being responsive to vacuum creating means in said upper chamber

for raising itself and the insulating blanket attached thereto, from contact with the metallic blank.

2. A high temperature vacuum creep forming fixture as recited in claim 1 further including: a heavy metal bar frame positioned over the diaphragm for forcing the diaphragm outwardly to prevent bridging of the plurality of interconnected elongated modules during the vacuum raising of the diaphragm.

3. Apparatus for hot creep forming a sheet material workpiece having a relatively high melting point such as titanium, comprising: a housing having an upper and a lower portion; a die enclosed in the lower portion for receiving and heating the workpiece; a diaphragm secured at its outer edges to the upper portion so as to form an upper lifting vacuum chamber; modular insulators attached in abutment relation to the lower surface of the diaphragm for providing thermal protection to the diaphragm from the workpiece; and said diaphragm being responsive to vacuum creating means in the upper portion for raising itself and the modular insulators attached thereto from contact with the workpiece.

4. Apparatus for hot creep forming a workpiece as recited in claim 3 further including: a frame loosely fitted inside the upper lifting vacuum chamber and positioned for free floating action on the upper surface of the diaphragm to force the diaphragm adjacent the workpiece to move outwardly and prevent bridging of the modular insulators during the lifting operation thereby eliminating the peeling action of the shear forces caused by pulling the diaphragm inwardly.

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