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Merret et al.

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(54) **REMOTELY ACTUATED LOCALIZED PRESSURE AND HEAT APPARATUS AND METHOD OF USE**

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(52) **U.S. Cl.** **425/501**; 156/580; 156/583.1; 425/394; 425/508; 425/520; 425/405.1

(58) **Field of Search** 425/394, 403, 425/405.1, 501, 508, 520; 156/580, 583.1, 583.3

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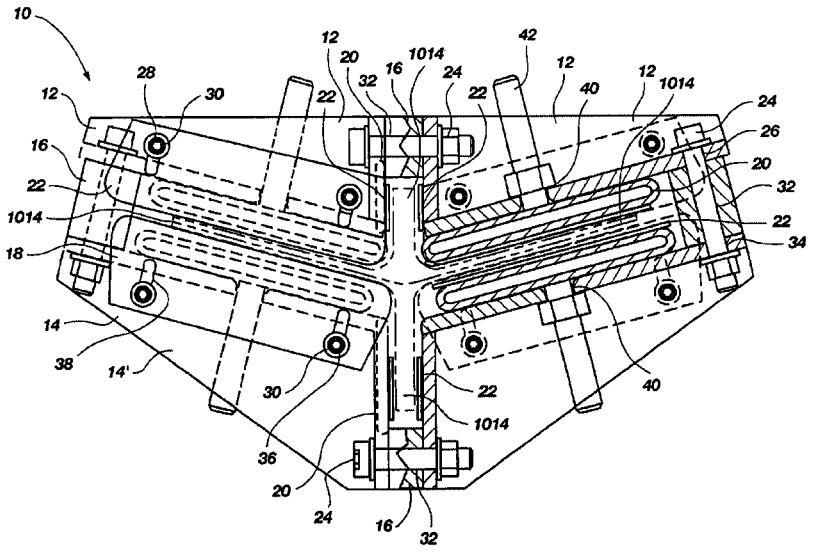
(57) **ABSTRACT**

Apparatus and method for the use of a remotely actuated localized pressure and heat apparatus for the consolidation and curing of fiber elements in, structures. The apparatus includes members for clamping the desired portion of the fiber elements to be joined, pressure members and/or heat members. The method is directed to the application and use of the apparatus.

45 Claims, 11 Drawing Sheets



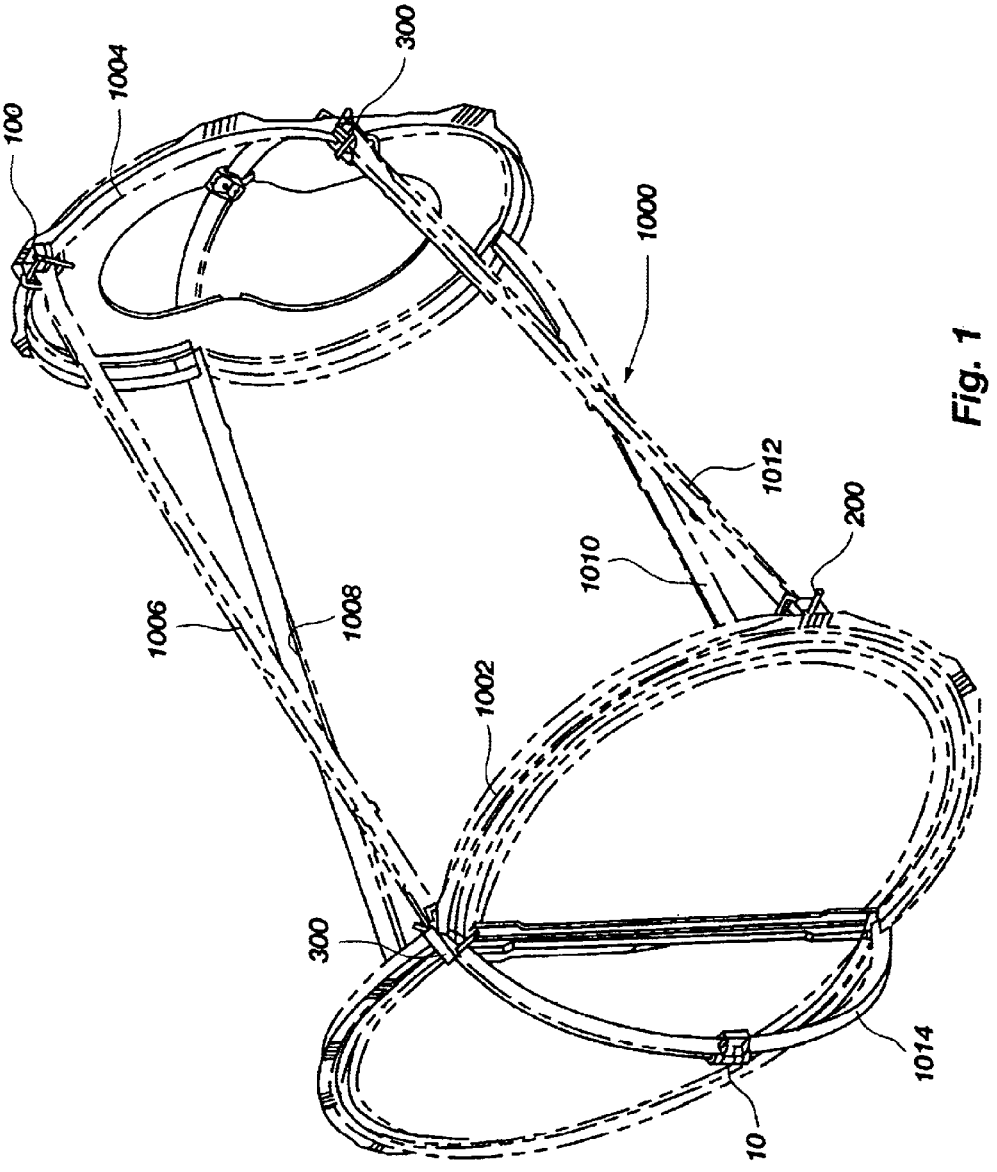
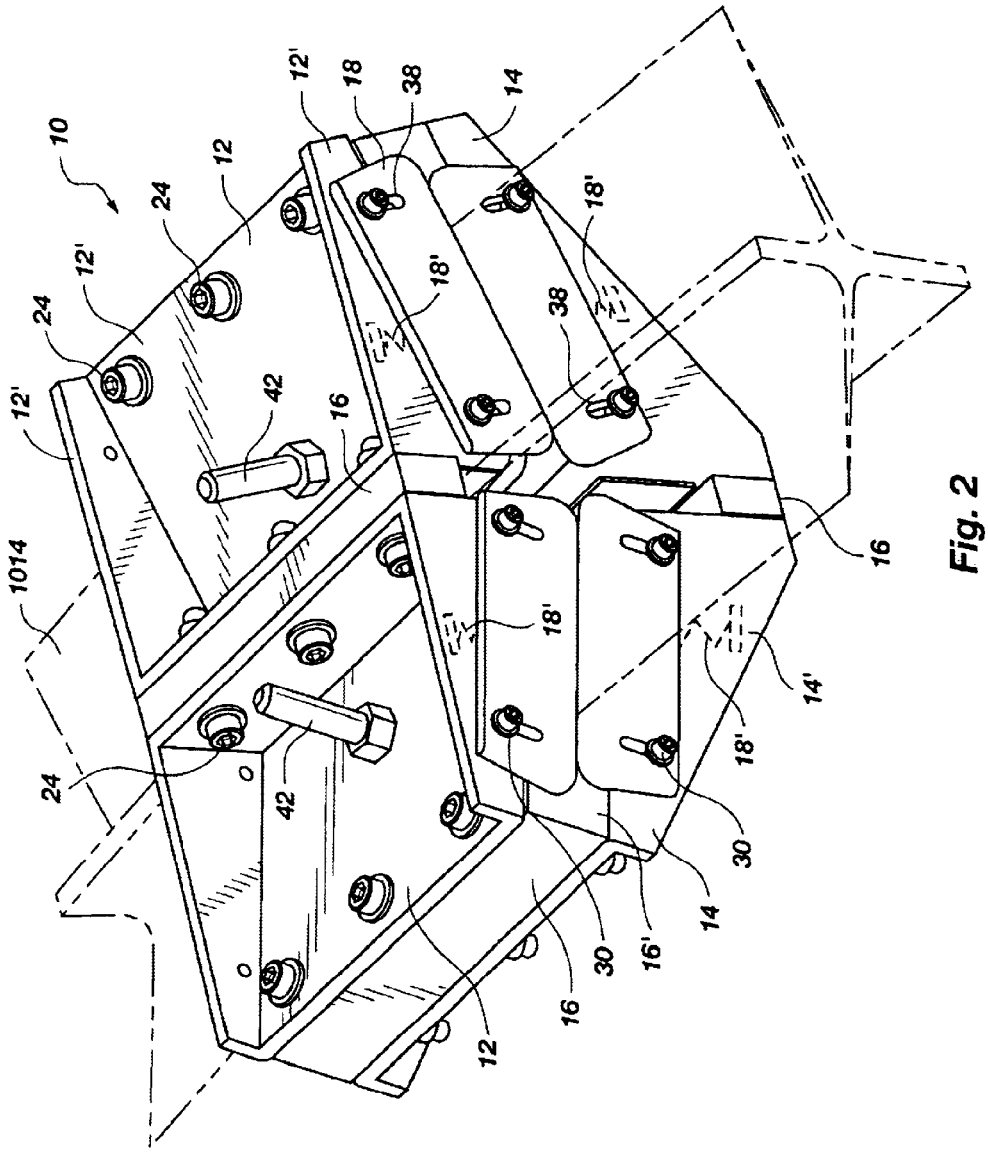


Fig. 1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24
38
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18'
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18'
24
42
30
14
16'
30
16
12

Fig. 2

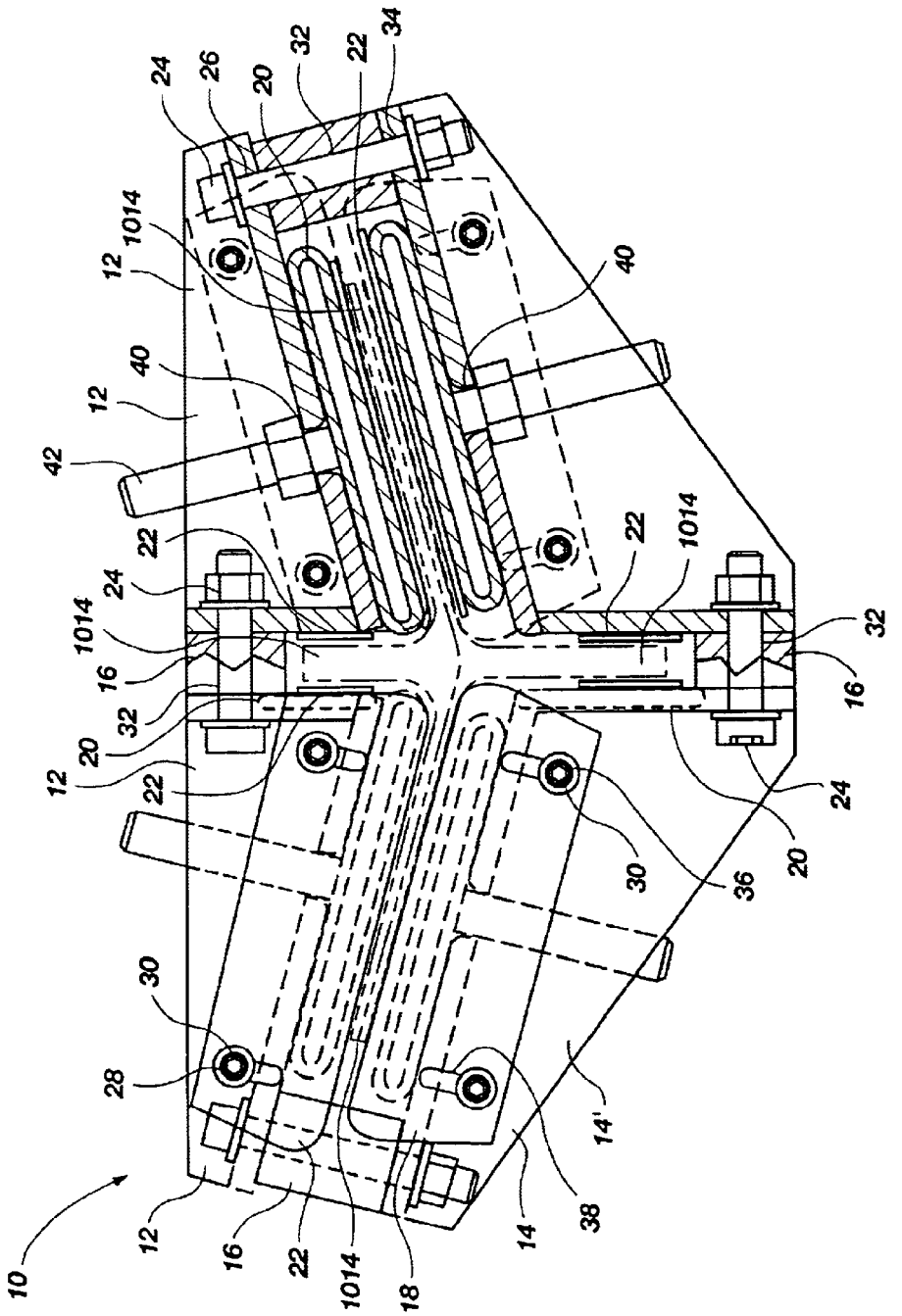
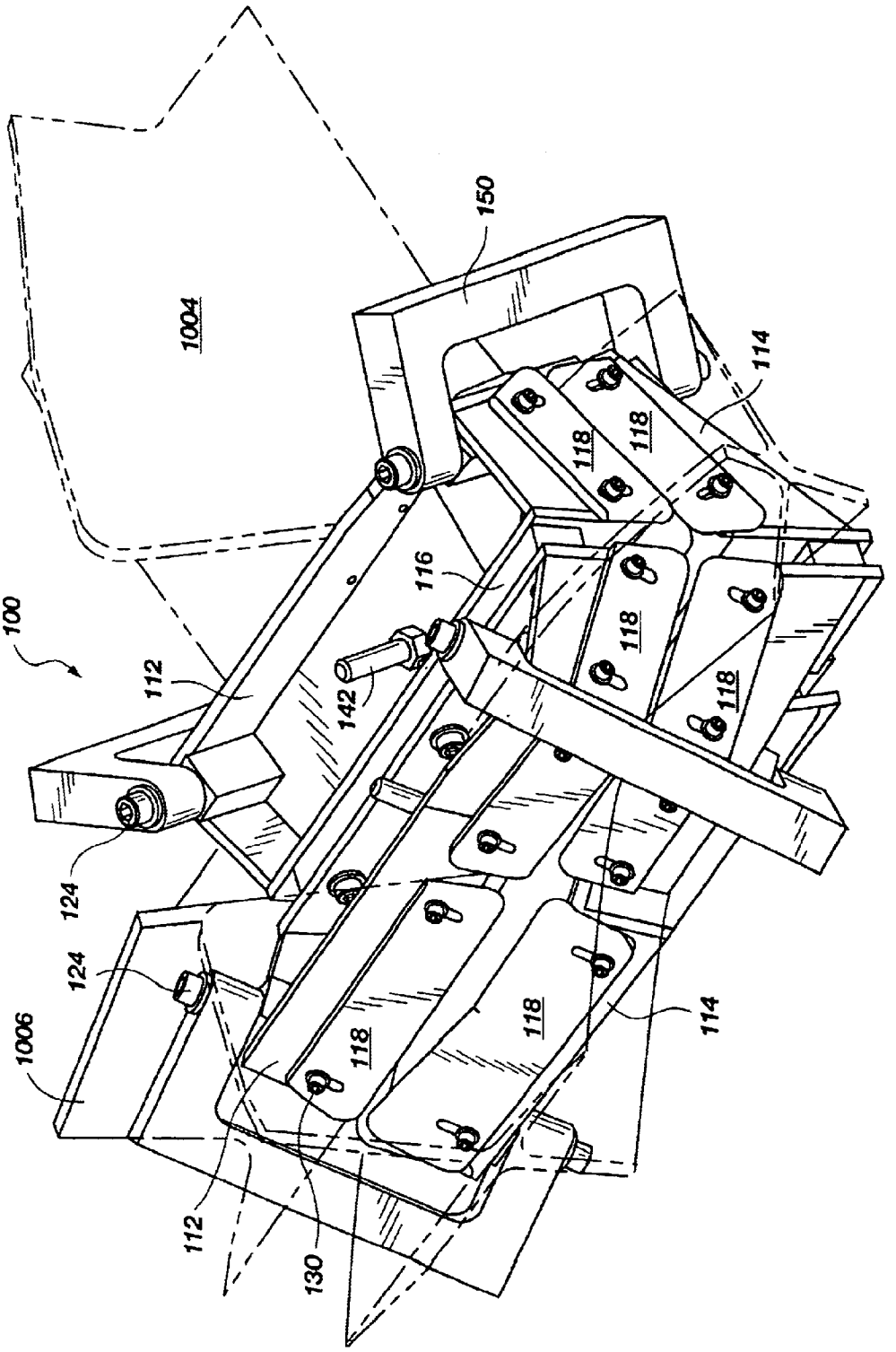


Fig. 3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1004
114
118
118
116
100
118
112
142
118
124
124
1006
118
118
114
112
130

Fig. 4

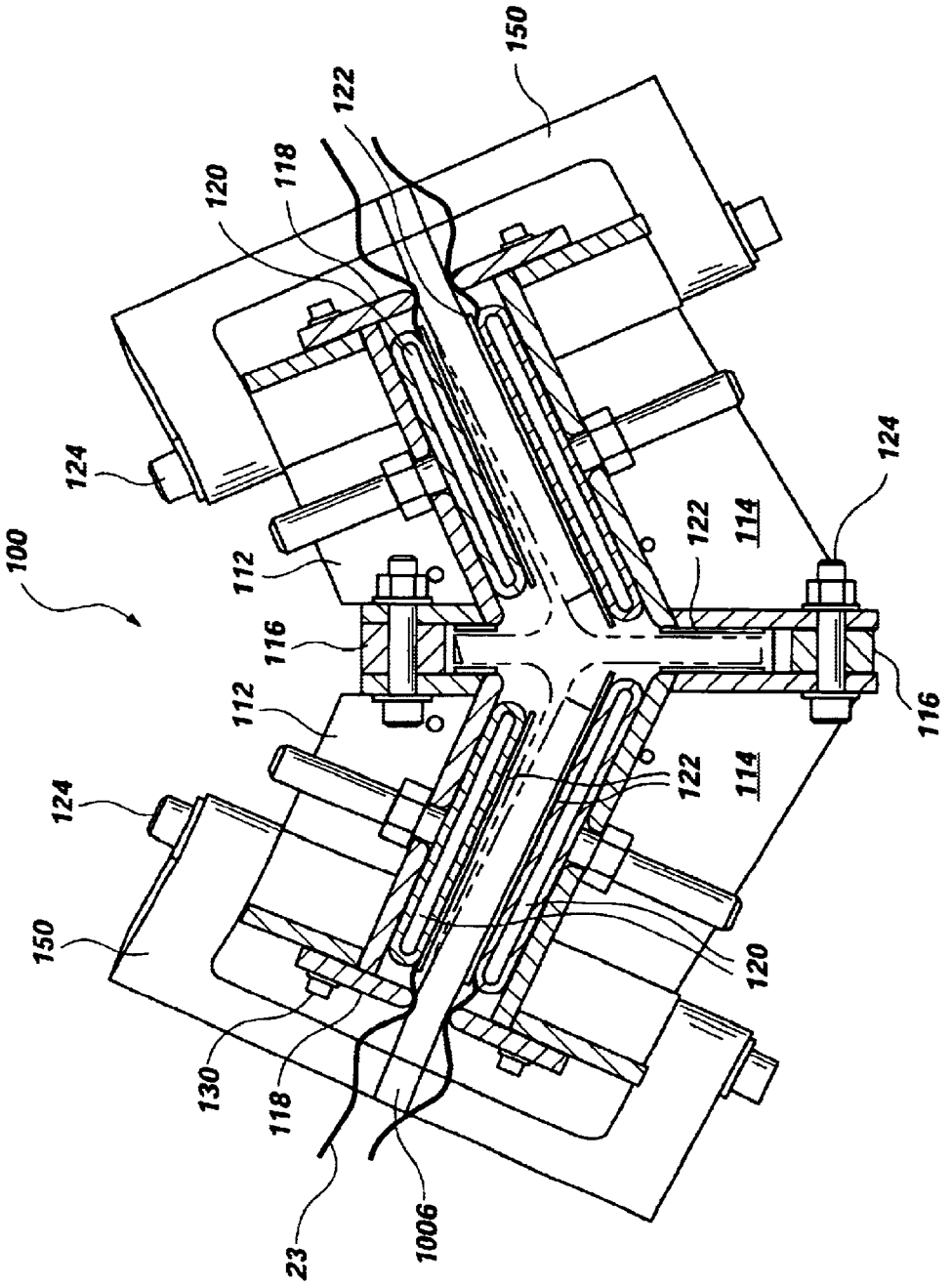
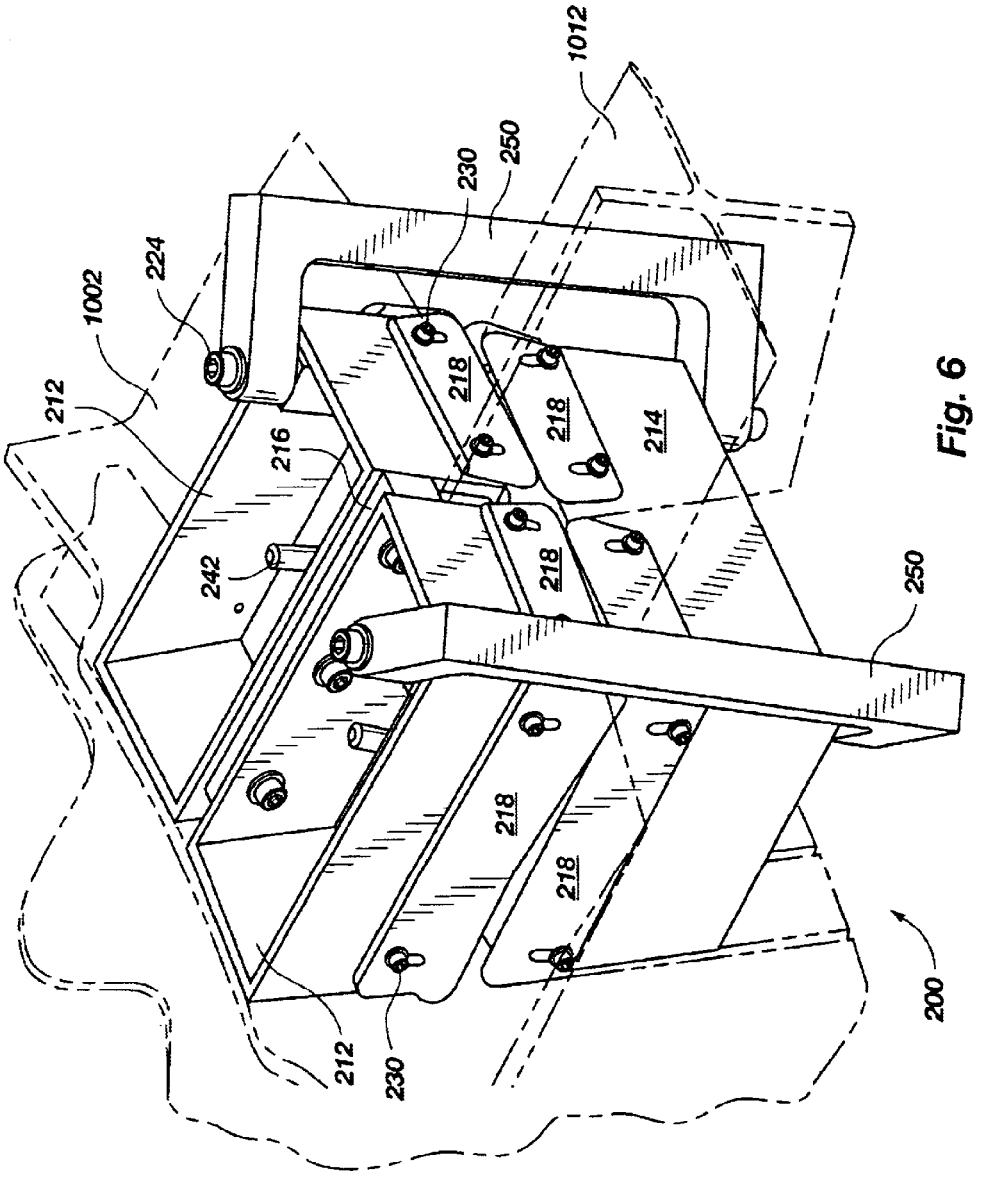


Fig. 5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1002
212
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242
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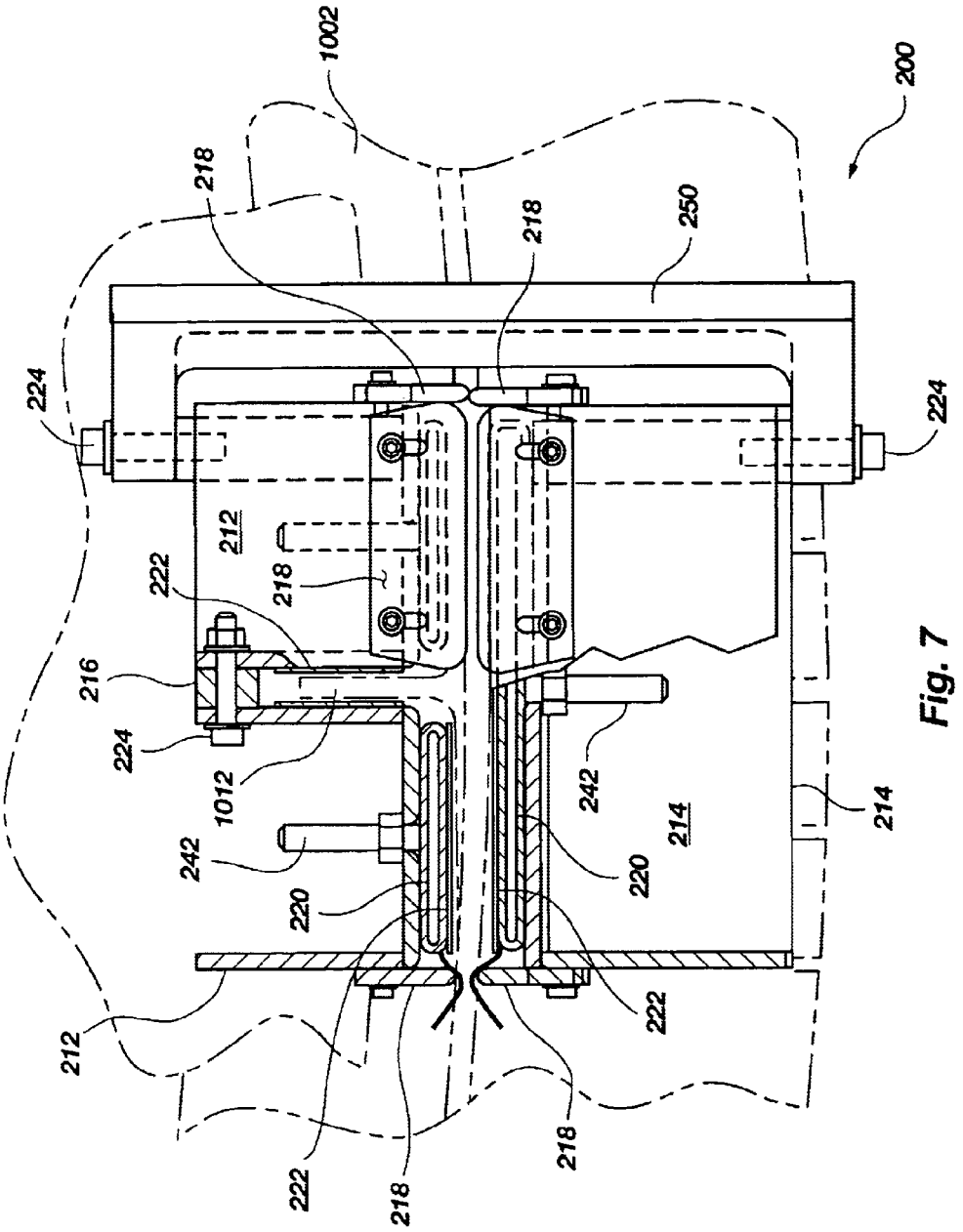
212
230
200

Fig. 6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200
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218
250
224
224
212
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216
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1012
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212
222
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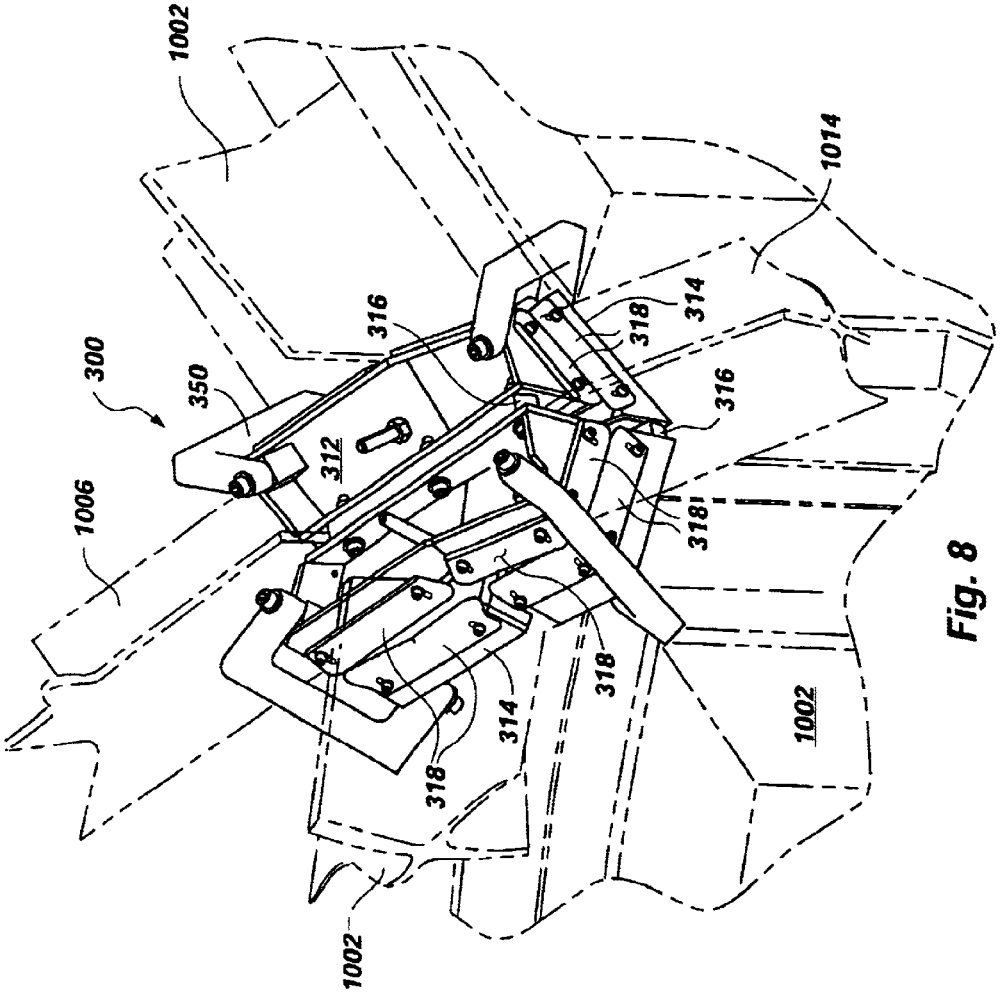
Fig. 7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1014
316
318
314
300
350
316
312
1006
318
318
314
318
1002
1002

Fig. 8

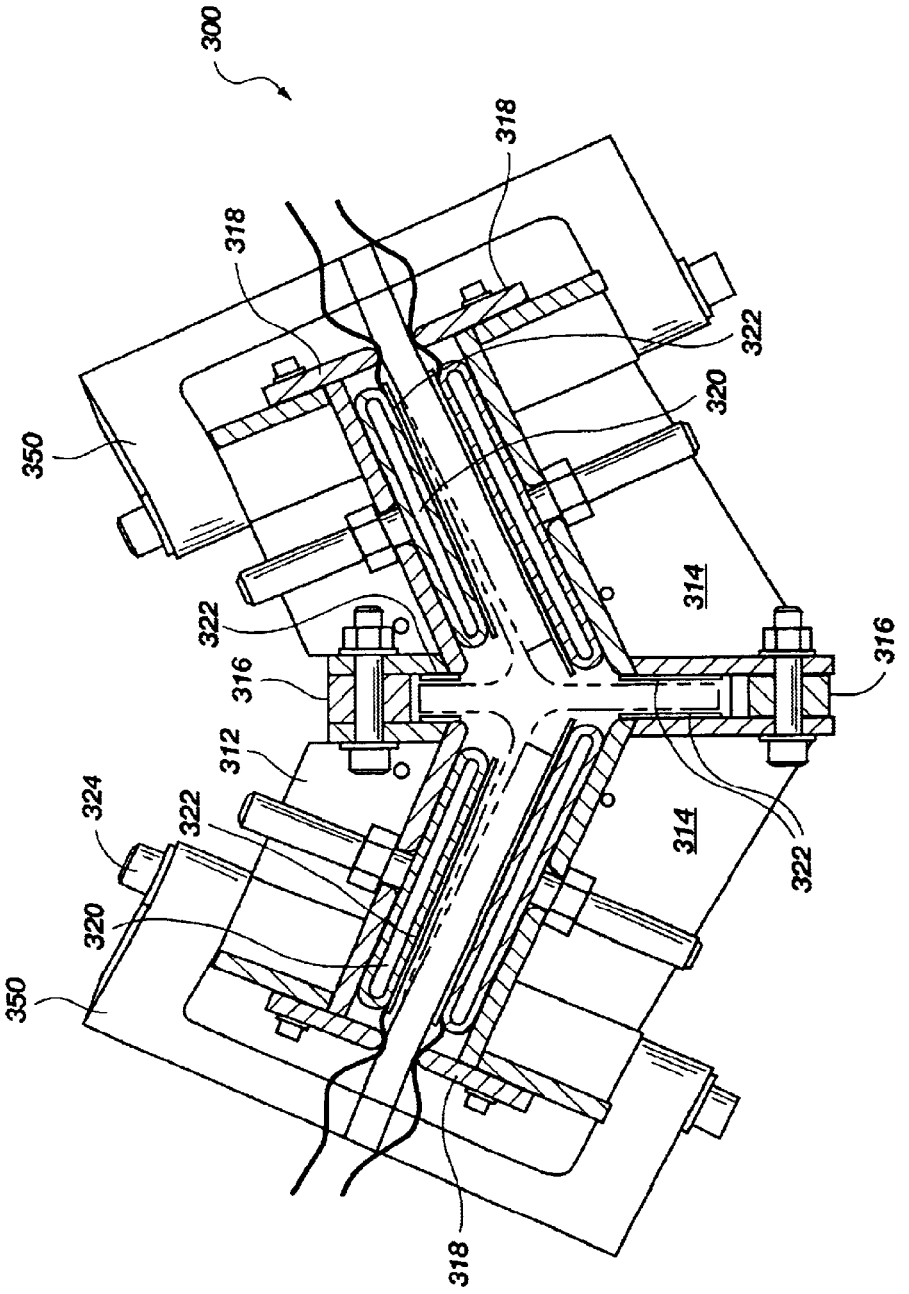
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Fig. 9

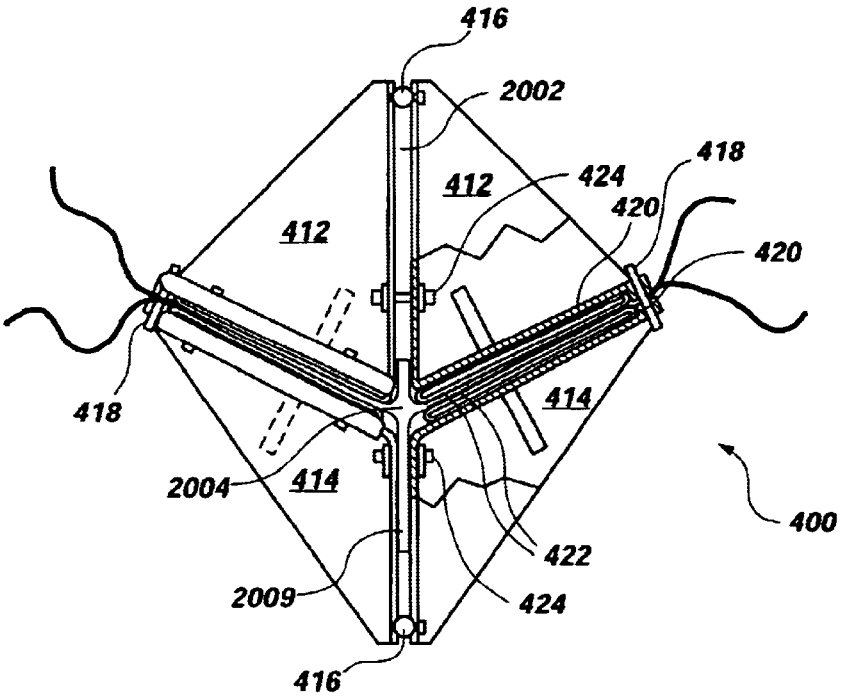
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Fig. 11

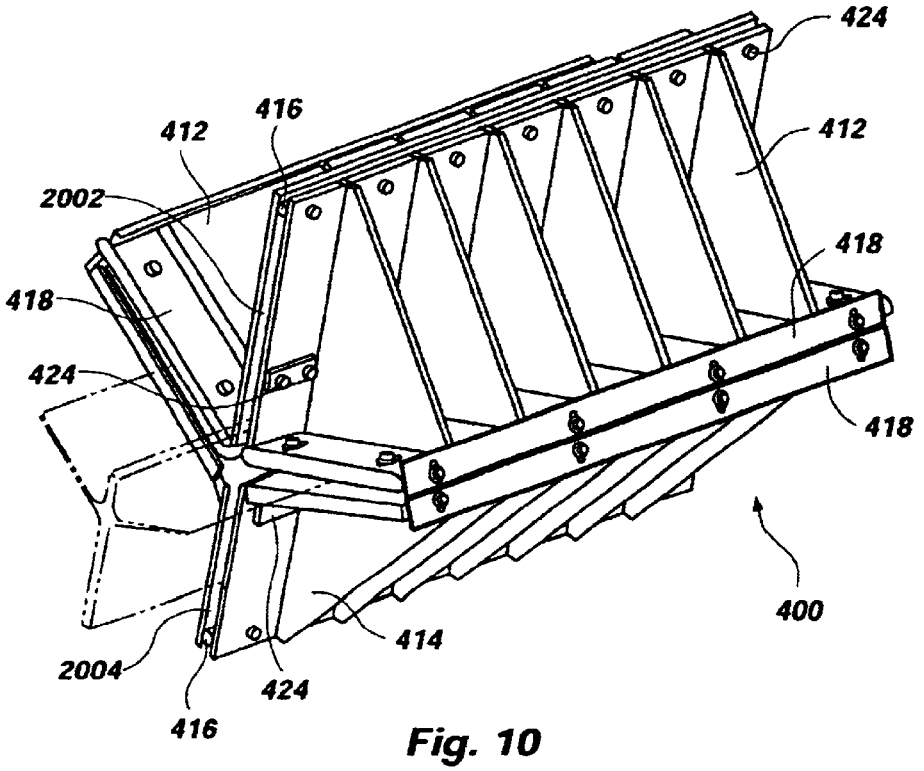
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Fig. 10

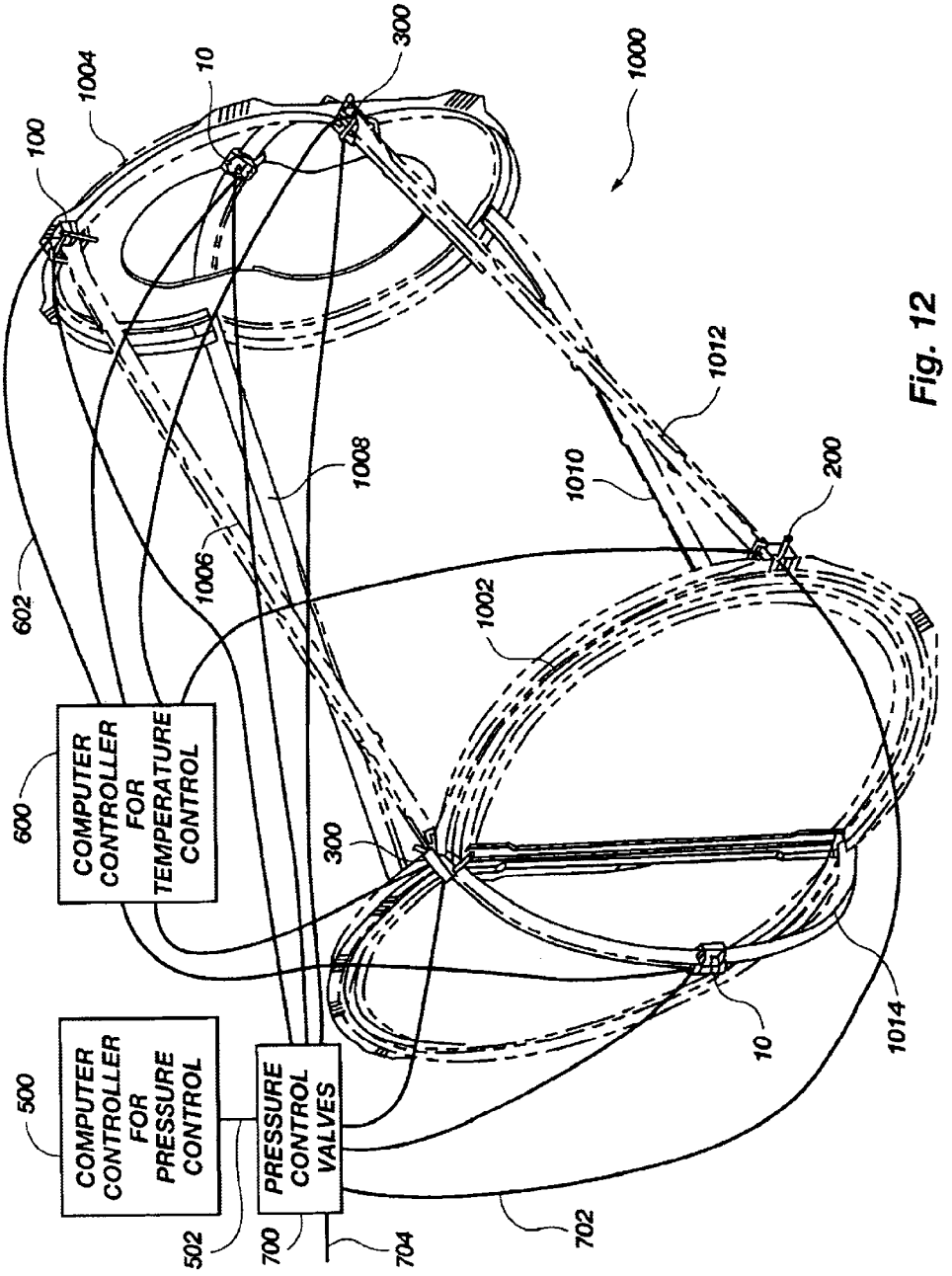
1000
1004
10
300
100
1012
1008
1010
200
1006
602
1002
COMPUTER CONTROLLER FOR TEMPERATURE CONTROL
600
300
10
1014
COMPUTER CONTROLLER FOR PRESSURE CONTROL
500
PRESSURE CONTROL VALVES
502
700
704
702

Fig. 12

REMOTELY ACTUATED LOCALIZED PRESSURE AND HEAT APPARATUS AND METHOD OF USE

GOVERNMENT RIGHTS

This invention is considered to be a subject invention under a subcontract under NASA Cooperative Agreement No. NCC8-115, and the U.S. Government has certain rights in such invention.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an apparatus and method for the manufacture of fiber reinforced structures. More specifically, the present invention relates to an apparatus and method of use of a remotely actuated, localized pressure and heat apparatus for the consolidation, curing and bonding of fiber elements in structures.

2. State of the Art

It is desirable to have inexpensive, strong, lightweight, easily manufactured components in a variety of sizes and geometries for use in aerospace and aircraft applications. Composite reinforced, or "stiffened", structures, such as shells, fuel tanks, fuselage panels, wing skins, etc., provide recognized advantages in aerospace applications over conventional metal assemblies, typically of aluminum, titanium, or combinations thereof, in terms of relatively lower weight, higher strength, and stiffness for the composite structures. The acceptance of all-composite structures has been hampered by the lack of demonstrated, repeatable, and inexpensive fabrication methodology and apparatus, particularly where a large reinforced composite structure is desired, as a suitable autoclave may not be available for the curing of the fiber elements forming the structure. In simple terms, the structure may be too large for any known existing autoclave for curing or may not be capable of transport to a suitable autoclave for curing. Thus, many such structures are Limited to high-performance, military, and/or aerospace applications, as not being cost-competitive in other applications.

A composite shell structure may require discrete internal or external reinforcing elements or stiffeners and bulkheads, hereinafter referred to generally as "ribs" and "bulkheads," adjacent a continuous shell structure, to provide enhanced stiffness to the shell structure in terms of torsional and bending resistance. The larger the composite shell structure and the greater the stresses and the more severe the operating environment, the greater the need for such reinforcement. Reinforcing elements may be discrete and remote from each other, maybe disposed in a mutually parallel relationship, or may be disposed an intersecting relationship to define the reinforcing required for the composite structure. In some instances, the reinforcement ribs and bulkheads for the structure may be formed in segments and subsequently joined at intersection points to form the reinforcement for the composite structure prior to the formation of the continuous shell therewith. Such is particularly advantageous where the composite structure is large, requiring substantial reinforcement ribs and bulkheads and having complex geometric shapes, either for the ribs and bulkheads or the overall structural shape.

The ribs and bulkheads for the reinforcement of the composite structure are typically formed of "composite fiber elements" or "fiber elements" including carbon fiber impregnated or coated with a curable bonding agent. By way of example and not Limitation, composite fibers may include elongated filaments of glass, graphite, boron, or polyarimid (Kevlar™), as specifications indicate.

While components of the ribs and bulkheads may be formed individually, it is necessary to subsequently assemble the rib and bulkhead components into a completed reinforcing structure for the application of the continuous shell of composite material thereto. To assemble and cure the individual rib and bulkhead components to form the completed reinforcing structure, an apparatus and method is required for the clamping and curing of the fiber elements of the rib and bulkhead components locally, particularly at the joints between adjacent ribs and bulkheads.

SUMMARY OF THE INVENTION

The present invention relates to an apparatus and method for the manufacture of fiber reinforced structures. The present invention is directed to an apparatus and method for the use of a remotely actuated localized pressure and heat tool for the consolidation, curing and bonding of portions of fiber elements in composite structures. The apparatus of the present invention comprises an apparatus including members for clamping the desired portion of the fiber elements to be joined, pressure members, and/or heat members. The method of the present invention is directed to the application and use of the clamping apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an isometric view of a typical reinforcing structure formed using the present invention;

FIG. **2** is an isometric view of a first embodiment of the apparatus of the present invention;

FIG. **3** is a partial cross-sectional end view of the first embodiment of the present invention of drawing FIG. **2**;

FIG. **4** is an isometric view of a second embodiment of the apparatus of the present invention;

FIG. **5** is a partial cross-sectional end view of the second embodiment of the present invention of drawing FIG. **4**;

FIG. **6** is an isometric view of a third embodiment of the apparatus of the present invention;

FIG. **7** is a partial cross-sectional front end view of the third embodiment of the apparatus of the present invention;

FIG. **8** is an isometric view of a fourth embodiment of the apparatus of the present invention;

FIG. **9** is a cross-sectional view of the fourth embodiment of the apparatus of the present invention;

FIG. **10** is an isometric view of a fifth embodiment of the apparatus of the present invention;

FIG. **11** is a partial cross-sectional view of the fifth embodiment of the present invention; and

FIG. **12** is an isometric view of the present invention and the control apparatus therefor in relation to a reinforcing structure of ribs and bulkheads.

The present invention will be better understood when the drawings are taken in conjunction with the description of the invention hereafter.

DESCRIPTION OF THE INVENTION

Referring to drawing FIG. **1**, a reinforcing structure **1000** for a tank in an aerospace application is illustrated. The reinforcing structure **1000**, formed of fiber elements, includes first bulkhead **1002**, second bulkhead **1004**, and reinforcing ribs **1006**, **1008**, **1010**, **1012**, and **1014** intercon-

necting the bulkheads **1002** and **1004**. To form the connections between the bulkheads **1002**, **1004** and the ribs **1006**, **1008**, **1010**, **1012**, **1014**, the apparatus **10** of the present invention is used to apply localized pressure and heat to the uncured portions of the reinforcing structure to consolidate and cure the fiber elements forming such structure **1000**. The apparatus **10** of the present invention confines the various portions of the uncured reinforcing structure **1000** during the consolidation and curing of the fiber elements to yield a connection joint having the desired strength and durability.

After the consolidation and curing of fiber elements forming the reinforcing structure **1000**, the apparatus **10** is removed therefrom. The apparatus **10** may be used singly to form a single joint between various members of the reinforcing structure **1000** or a plurality may be used to form a plurality of joints simultaneously of the reinforcing structure. Either before or after the consolidation of the joints of the reinforcing structure **1000**, the apparatus **10** of the present invention may further be used to consolidate and cure remaining portions of the reinforcing structure **1000** which have not been consolidated or cured. A control system for the operation of the apparatus **10** of the present invention may be provided.

Referring to drawing FIG. **2**, the apparatus **10** of the present invention is illustrated in relation to a rib **1014** of the reinforcing structure **1000**. The apparatus **10** of the present invention being is configured for the cross-sectional shape of the joint configuration of the portions of ribs to be connected through the consolidation and curing of the fiber elements forming the ribs. The apparatus **10** of the present invention may be formed of any readily available, suitable material for use in the consolidation and curing of the fiber elements of the reinforcing structure **1000**; however, preferably the apparatus **10** should be of high strength, lightweight material, such as aluminum, titanium, alloys or combinations thereof, to reduce the weight on the structure **1000**. Optionally, the apparatus **10** may require support while installed on the structure **1000**. The apparatus **10** includes upper members **12**, lower members **14**, spacers **16**, end members **18**, pressure members **20** (not shown), heat members **22** (not shown), and fasteners **24**. The upper members **12** may be of any suitable shape and configuration for mating with the rib formed of fiber elements to be consolidated and cured. The upper member **12** may be a fabrication of individual end portions **12** connected by a suitable means, such as welding, threaded fasteners, etc., or may be an integral solid member having a machined configuration. Each upper member **12** is formed having a plurality of apertures **26** therein (not shown) for fasteners **24** to extend therethrough. Individual end portions **12'** of the upper member **12** include a plurality of apertures **28** therein (not shown) for fasteners **30** to retain end members **18** thereon. The upper members **12** may be of any convenient suitable size, shape, and configuration for the consolidation and curing of the fiber elements forming the reinforcing structure **1000**. The upper members **12** are formed having sufficient strength to retain the loads generated by the pressure members **20** at the desired temperature levels generated by the heat members **22** contained and retained therein. The upper members **12** are spaced from lower members **14** by spacers **16** having a plurality of apertures **32** therein (not shown) for the fasteners **24** to extend therethrough. The spacers may be of any convenient suitable size, shape, and configuration for the consolidation and curing of the fiber elements forming the reinforcing structure **1000**, the spacers **16** being sufficiently wide to have a portion on each end **16'** thereof covered by end members **18**. The lower members **14** are formed similarly to the upper members **12**. Each lower member **14** may be a fabrication of individual end portions **14** connected by a suitable means, such as welding, threaded fasteners, etc., or may be an integral solid member having a machined configuration. Each lower member **14** is formed having a plurality of apertures **34** therein (not shown) for fasteners **24** to extend therethrough. Individual end portions **14'** of the lower member **14** include a plurality of apertures **36** therein (not shown) for fasteners **30** to retain end members **18** thereon. The lower members **14** may be of any convenient suitable size, shape, and configuration for the consolidation and curing of the fiber elements forming the reinforcing structure **1000**. The lower members **14** are formed having sufficient strength to retain the loads at the desired temperature levels generated by the pressure members **20** and heat members **22** contained and retained therein. The lower members **14** are spaced from upper members **12** by spacers **16** having a plurality of apertures **32** therein (not shown) for the fasteners **24** to extend therethrough. Each end member **18** is formed having a plurality of slots **38** therein through which fasteners **30** extend, mating with apertures **28** or **36** in upper member **12** or lower member **14**, respectively, to retain the end member **18** thereon to confine the pressure member **20** and heat member **22** within upper member **12** and lower member **14**. The end member **18** is adjusted using fasteners **30** and slots **38** to retain the pressure member **20** (not shown) and heat member **22** (not shown) within the upper member **12** or lower member **14** without the end member **18** contacting the portion of the reinforcing structure **1000** upon which the apparatus **10** is installed during the consolidation and curing of the fiber elements forming the structure **1000**. Typically, a small gap is maintained, although not required, between the end member **18** and the reinforcing structure **1000**. To facilitate the placement of the end members **18** with respect to a portion of the reinforcing member **1000**, a spring **18'** (shown in broken lines) having one end secured to an upper member **12** or lower member **14** and the other end abutting an end member **18** may be used to bias the member **18** in the desired position. Each upper member **12** and lower member **14** further includes an aperture **40** therein (drawing FIG. **3**), which may be threaded, to connect a pressure line **42**, connected to a suitable supply of fluid under pressure to supply fluid under pressure to a pressure member **20** (not shown) contained therein. The geometric shape of each upper member **12**, lower member **14**, spacer **16**, and end member **18** is compatible with the portion of the reinforcement structure **1000** upon which it is to be used. As illustrated in drawing FIG. **1**, the rib **1014** has a T-shaped cross-sectional configuration with the stem of the T-shape extending above the cross-arms to the T-shape with the apparatus **10** surrounding both the stem and the cross-arms of the T-shape in a localized area of the rib **1014**. The end members **18** of the upper member **12** and lower member **14** extend adjacent to, but not in contact with, either the stem portions or the cross-arm portions of the T-shaped rib **1014**. The threaded fasteners **24** and **30** may be of any convenient, suitable size and length well known in the industry for use with the upper members **12**, lower members **14**, and end members **18** in their size, shape, configuration, and loading from pressure members **20** (not shown) and heat members **22** (not shown) for use in consolidation and curing the fiber elements forming rib **1014**. The end members **18** may be of any desired shape and configuration suitable for preventing the pressure member **20** from extending beyond the upper member **12** and lower member **14**. The end members **18** may be placed on the one or more ends and the sides of the upper member **12** and lower member **14**.

Referring to drawing FIG. **3**, the apparatus **10** illustrated in drawing FIG. **2** is shown in a partial cut-away cross-sectional end view. As illustrated, the pressure members **20** are any suitable inflatable pressure member for use in the consolidation and curing of the fiber elements forming the rib **1014**. The pressure members **20** may be any suitable elastomer material or reinforced elastomeric material, such as silicon elastomer, rubber, synthetic rubber, neoprene, and reinforced with nylon, Kevlar™, etc., types of material. The pressure members **20** are preferably thin in construction for the member **20** to be compliant to the shape of the portion of the rib **1014** that it surrounds. Each pressure member **20** is supplied fluid pressure through line **42** connected thereto and extending through apertures **40** in upper member **12** and lower member **14** retained thereby by any suitable manner, such as a threaded connection, welding, etc. The fluid supplied under pressure may be any suitable pressurized fluid which is readily available for use, such as air, nitrogen, etc. It is preferred that the pressure members **20** are used in opposing pairs operating at substantially the same inflation pressure levels to balance the loading on the rib **1014** and the upper member **12** and lower member **14**. The heat members **22** may be any well known, commercially available, electrically powered heat members of suitable size and configuration to be contained within upper members **12** and lower members **14** suitable for use in the consolidation and curing of the fiber elements forming rib **1014** or any portion of structure **1000**. The heat members **22** include members **22** to both heat the cross-arm portions of the T-shaped rib **1014** as well as heat the stem portions of the T-shaped rib **1014**. In this manner, pressure is applied through pressure members **20** while heat is applied through the heat members **22** to consolidate and cure the fiber elements locally. If desired or necessary, pressure members **20** (shown in phantom) may be used to apply additional pressure to the stem portions of the T-shaped rib **1014** during the consolidation and curing process. Illustrated are the apertures **32** in spacer **16** as well as apertures **26** in end members **18**, apertures **28** in upper members **12**, and apertures **34** in lower members **14**. Further illustrated is the relationship between the end members **18** and the cross-arm portions of the T-shaped rib **1014** wherein the end members **18** are located adjacent the cross-arm portions but not in contact therewith during the consolidation and curing process of the fiber elements forming the rib **1014**. As it is preferred to balance the pressure loads on the rib **1014** during consolidation and curing of the fiber elements, it is preferred that the pressure members **20** be actuated substantially simultaneously at substantially the same inflation pressure level and the heat members **22** be actuated substantially simultaneously for uniform loading of the rib **1014** for the application of pressure and heating thereto.

Referring to drawing FIG. **4**, a second embodiment **100** of the apparatus of the present invention is shown. The apparatus **100** is typically used to connect a rib **1006** to a bulkhead **1004**. The apparatus **100** is generally similar to the previously described apparatus **10** including upper members **112**, lower members **114**, spacers **116**, end members **118**, and fasteners **124**, **130**. The apparatus **100** further includes a plurality of C-shaped clamps **150** extending between upper members **112** and lower members **114** to retain the members on the rib **1006** and bulkhead **1004** in position for the consolidation and curing or bonding of the fiber elements. In apparatus **100**, the C-shaped clamps **150** are installed at the outer corners of the upper members **112** and lower members **114** and retained or fastened thereto by fasteners **124**. Each upper member **112** and lower member **114** further includes end members **118** on the front and rear ends thereof and on the outer sides thereof to contain the pressure members **120** (not shown) therein during the consolidation and curing of portions of the fiber elements of the rib **1006** and bulkhead **1004**. The C-shaaped clamp members **150** are used in the place of a plurality of fasteners, such as fasteners **24** in drawing FIGS. **2** and **3**, to retain the upper members **112** and lower members **114** in position on the rib **1006** and bulkhead **1004**. The C-shaped clamps **150** may be of any desired shape and of any desired material having sufficient strength for the loading of the upper members **112** and lower members **114** by the pressure members **120** (not shown) and provide access for the portions of the fiber elements of the ribs and bulkheads of the structure **1000** to be consolidated and cured. However, it is preferred that the apparatus **100** be of strong, lightweight material for ready handling and use.

Referring to drawing FIG. **5**, the apparatus **100** is shown in a partial cut-away cross-sectional view. As shown, the end members **118** are located on the ends and sides of the upper members **112** having inlets **142** thereto and lower members **114** having pressure members **120** and heat members **122** contained therebetween. As illustrated, the heat members **122** contain electrical wiring and connections **23** to supply power thereto for the heating of the members **122**. The apparatus **100** further includes spacers **116** between the individual upper members **112** and the individual lower members **114**, but not between upper members **112** and lower members **114** due to the configuration of the rib **1006** and bulkhead **1004** to be connected.

Referring to drawing FIG. **6**, a third embodiment of the apparatus **200** of the present invention is illustrated. As shown, the apparatus **200** includes upper members **212**, a lower member **214**, a spacer **216**, end members **218** on the one end of upper members **212** and sides thereof and the one end of lower member **214** and the sides thereof for the consolidation and curing of portions of the fiber elements of rib **1012** and bulkhead **1002**, pressure members **220** (not shown) having inlets **242** located between upper members **212** and lower member **214** as described hereinbefore, and heat members **222** (not shown) located between upper members **212** and lower member **214** as described hereinbefore. In apparatus **200** of the present invention, a single lower member **214** is used, rather than a plurality of lower members as described hereinbefore. The use of a single lower member **214** accommodates the differing geometry of the end of the rib **1012** to be joined to the bulkhead. **1002**. As further illustrated, only two C-shaped clamps **250** secured by fasteners **224** are used to retain the upper members **212** to the lower member **214** during the consolidation and curing of the fiber elements of rib **1012** and bulkhead **1002**, the clamps having sufficient strength for the process. As previously described, the end members **218** having fasteners **230** confine the pressure members **220** (not shown) and heat members **222** (not shown) between the upper members **212** and lower member **214**. Only a single spacer **216** is used in the apparatus **200** to separate the upper members **212** from each other for a portion of the rib **1012** to extend therebetween.

Referring to drawing FIG. **7**, the apparatus illustrated in drawing FIG. **6** is shown in a partial cross-sectional view. Illustrated are the upper members **212**, lower member **214**, spacer **216**, end members **218** on the ends and sides of the members **212** and **214**, pressure members **220** having inlets **242**, heat members **222**, and C-shaped clamp **250** secured by fasteners **224** in relation to the rib **1012** and bulkhead **1002**. As shown, the spacer **216** extends between upper members **212** while lower member **214** is connected thereto by C-shaped clamp **250**.

Referring to drawing FIG. **8**, a fourth embodiment **300** of the apparatus of the present invention is illustrated. The apparatus **300** includes upper members **312**, lower members **314**, spacers **316**, end members **318** secured by fasteners **330**, and C-shaped clamps **350** secured by fasteners **324**. The upper members **312** and lower members **314** are clamping and retaining a rib **1006**, rib **1014**, and various portions of bulkhead **1002** during the consolidation and curing of portions of the fiber elements from which such are formed. The upper members **312** and lower members **314** are formed at differing angles to accommodate the ribs **1006**, **1014** and portions of bulkhead **1002** and held in position by the C-shaped clamps **350**.

Referring to drawing FIG. **9**, the apparatus **300** is illustrated in cross-section to show the relationship between the upper members **312**, lower members **314**, spacers **316**, end members **318** on the ends and sides of the members **312**, **314**, pressure members **320**, and heat members **322**. The pressure members **320** and heat members **322** are placed to apply pressure and heat to the fiber elements during the consolidation and curing thereof as illustrated.

Referring to drawing FIG. **10**, a fifth embodiment **400** of the apparatus of the present invention is illustrated. The apparatus **400** includes upper members **412**, lower members **414**, spacers **416**, and end members **418** having fasteners **430**, the upper members being secured together by fasteners **424** and the lower members being secured together by fasteners **424**. The upper members **412** and lower members **414** are additionally secured by fasteners **424** to portions of ribs **2002** and **2004** used as a supporting member for the upper member **412** and lower member **414** during use. In this manner, the upper members **412** are secured to each other and to rib **2002** while the lower members **414** are similarly secured to a portion of rib **2004**. By using portions of the ribs **2002** and **2004** as a support element for the upper members **412** and lower members **414**, it is not necessary that the members **412** and **414**, be secured to each other.

Referring to drawing FIG. **11**, the apparatus **400** is illustrated showing the relationship between the upper members **412** and rib **2002**, lower members **414** and rib **2004**, spacers **416**, end members **418** having fasteners **430** (drawing FIG. **10**) on the ends and sides of members **412**, **414**, pressure members **420** having inlets **442**, and heat members **422**, the apparatus **400** operating in a similar manner to those described hereinbefore except for portions of the ribs **2002** and **2004** being used as support for the apparatus **400**.

Referring to drawing FIG. **12**, a computer controller **500** for the control of pressure to the pressure members of the apparatus of the present invention is illustrated along with a computer controller **600** for the control of the heat members of the apparatus of the present invention. As illustrated, the computer controller **500** is connected via connection **502** to pressure control valves **700** which are, in turn, connected to individual apparatus **10** of the present invention to control the pressure members **20** (not shown) therein. Fluid pressure is supplied to valves **700** via line **704** and is conveyed to each apparatus **10** by lines **702**. The computer controller **600** is connected via lines **602** to the heat members **22** (not shown) of each apparatus **10** to control the heating and cooling thereof during the consolidation and curing of portions of the fiber elements of the ribs and bulkheads. Any desired pressure in any desired schedule of application of pressure may be supplied to the pressure members **20** of the apparatus **10**, such as in the range typically of fifty (50) pounds per square inch to eighty (80) pounds per square inch, although more or less may be used as required. Any desired temperature in any desired schedule of the application of temperature may be used to cure the portions of fiber elements as required by the coating thereon using the heat members **22** in the apparatus **10**. The computer controllers **500** and **600** control the desired application of pressure and temperature. The pressure control valves actuated by the computer controller **500** may be of any suitable, convenient, commercially available type. Similarly, the computer controllers **500** and **600** may be any suitable, convenient, commercially digital computer readily programmed to the desired control function. If desired, only a single computer controller may be used to control both the pressure of the pressure members **20** and heat members **22**. Further, if desired, the apparatus of the present invention may be designed to contain only pressure members **20** therein with the structure **1000** being placed in an autoclave to provide the heat during the consolidation and curing of the portions of the fiber elements forming the structure **1000**, the apparatus and method of the present invention being directed to the consolidation and curing and/or bonding of fiber elements of composite structures.

It will be apparent to those of skill in the art that changes, revisions, additions, and deletions may be made to the present invention, such as having apparatus of differing shapes or configurations, more or less pressure members and heat members, etc. Such are intended to be within the scope of the claimed invention.

What is claimed is:

1. An apparatus and at least a portion of at least one of a first reinforced structure and a second reinforced structure, each of the first reinforced structure and the second reinforced structure having uncured fiber elements therein and cured fiber elements therein, the apparatus and at least a portion of at least one of a portion of the first reinforced structure and a portion of the second reinforced structure comprising:

a structure having an uncured fiber reinforced structure having fiber elements therein and a cured fiber reinforced structure having fiber elements therein;

an upper member having at least a portion thereof contacting at least a portion of the structure consolidating and curing the fiber elements of a portion of an uncured fiber reinforced structure, the upper member including a pressure member and at least one end member providing localized pressure consolidating and curing and bonding of the uncured fiber elements of an uncured fiber reinforced structure; and

a lower member having at least a portion thereof contacting at least a portion of the structure consolidating and curing the fiber elements of a portion of an uncured fiber reinforced structure, the lower member including a pressure member and at least one end member providing localized pressure consolidating and curing and bonding of the uncured fiber elements of an uncured fiber reinforced structure.

2. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **1**, wherein:

the upper member further includes a heat member providing localized heat in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure; and

the lower member further includes a heat member providing localized heat in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

3. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of

claim **1**, wherein the upper member includes a plurality of upper members providing localized pressure in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

4. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **3**, wherein the lower member includes a plurality of lower members providing localized pressure in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

5. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **3**, wherein the upper members of the plurality are spaced from each other by a spacer in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

6. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **4**, wherein the lower members of the plurality are spaced from each other by a spacer in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

7. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **3**, wherein each upper member of the plurality of upper members includes at least one end member thereon providing localized pressure in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

8. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **7**, wherein at least one upper member of the plurality of upper members includes a plurality of end members thereon providing localized pressure in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

9. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **8**, wherein at least one upper member of the plurality of upper members includes an end member on an end thereof and a side thereof.

10. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **4**, wherein each lower member of the plurality of lower members includes at least one end member thereon providing localized pressure in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

11. The apparatus and a portion of an uncured fiber reinforced structure having uncured fiber elements therein of claim **10**, wherein at least one lower member of the plurality of lower members includes a plurality of end members thereon providing localized pressure in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

12. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **11**, wherein at least one lower member of the plurality of lower members includes an end member on an end thereof and a side thereof.

13. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **3**, wherein each upper member of the plurality of upper members includes a pressure member therewith providing localized pressure in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

14. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **4**, wherein each lower member of the plurality of lower members includes a pressure member therewith providing localized pressure in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

15. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **3**, wherein each upper member of the plurality of upper members includes at least one heat member therewith providing localized heat in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

16. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **2**, wherein each upper member of the plurality of upper members includes a plurality of heat members therewith.

17. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **4**, wherein each lower member of the plurality of lower members includes at least one heat member therewith providing localized heat in the consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

18. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **4**, wherein each lower member of the plurality of lower members includes a plurality of heat members therewith.

19. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **1**, wherein a clamp secures the upper member to the lower member.

20. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **1**, wherein a plurality of clamps secures the upper member to the lower member.

21. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **1**, wherein at least one fastener secures the upper member to the lower member in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

22. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **1**, wherein one of the upper member and the lower member is secured to the portion of the uncured fiber reinforced structure.

23. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **1**, wherein the upper member and the lower member are secured to a portion of the portion of the uncured fiber reinforced structure.

24. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **22**, wherein a fastener is used to secure one of the upper member and the lower member to the portion of the uncured fiber reinforced structure.

25. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **1**, wherein the pressure member includes an inflatable member providing localized pressure in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

26. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of

claim **2**, wherein each heat member includes an electrical heat member providing localized heat in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

27. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **1**, wherein the at least one end member of the upper member is movable with respect to the upper member in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

28. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **27**, wherein the at least one end member includes at least one slot therein having a fastener extending therethrough, the fastener having a portion thereof secured to the upper member when consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

29. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **1**, wherein the at least one end member of the upper member is resiliently biased on the upper member in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

30. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **1**, wherein the at least one end member of the lower member is movable with respect to the lower member in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

31. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **30**, wherein the at least one end member includes at least one slot therein having a fastener extending therethrough, the fastener having a portion thereof secured to the lower member in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

32. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **1**, wherein the at least one end member of the lower member is resiliently biased on the upper member in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

33. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **1**, further including:

a pressure control valve for control of pressure to the pressure member of one of the upper member and the lower member in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure; and

computer apparatus for control of the pressure control valve in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

34. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **2**, further including:

computer apparatus for control of temperature of the heat member of one of the upper member and the lower member in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

35. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **2**, further including:

a pressure control valve for control of pressure to a pressure member of one of the upper member and the lower member in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure; and

a computer apparatus to control the pressure control valve of the one of the upper member and the lower member and temperature of one of the heat members in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

36. The apparatus and a portion of the uncured fiber reinforced structure having uncured fiber elements therein of claim **1**, further including:

a pressure control valve for control of pressure to the pressure members of the upper member and the lower member in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure; and

computer apparatus for control of the pressure control valve in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

37. The apparatus and a portion of an uncured fiber reinforced structure having uncured fiber elements therein of claim **2**, further including:

computer apparatus for the control of temperature of the heat members of the upper member and the lower member in consolidating and curing and bonding of the uncured fiber elements of a portion of the uncured fiber reinforced structure.

38. An apparatus and a portion of a reinforced structure having a cured portion and an uncured portion having uncured fiber elements therein, the apparatus locally securing at least one of at least a portion of the reinforced structure, the apparatus and the reinforced structure comprising:

a structure having a portion thereof having an uncured fiber reinforced structure having fiber elements therein and having another portion thereof having cured fiber reinforced structure having fiber elements therein;

an upper member including a pressure member and at least one end member consolidating and curing and bonding the uncured fiber elements of a portion of the uncured fiber reinforced structure; and

a lower member including a pressure member and at least one end member consolidating and curing and bonding the uncured fiber elements of a portion of the uncured fiber reinforced structure.

39. The apparatus and a portion of a fiber reinforced structure having uncured fiber elements therein of claim **38**, wherein:

the upper member further includes a heat member providing localized heat consolidating and curing and bonding the uncured fiber elements of a portion of the uncured fiber reinforced structure; and

the lower member further includes a heat member providing localized heat consolidating and curing and bonding the uncured fiber elements of a portion of the uncured fiber reinforced structure.

40. The apparatus and a portion of a fiber reinforced structure having uncured fiber elements therein of claim **38**,

wherein the upper member includes a plurality of upper members consolidating and curing and bonding the uncured fiber elements of a portion of the uncured fiber reinforced structure.

41. The apparatus and a portion of a fiber reinforced structure having uncured fiber elements therein of claim **40**, wherein the lower member includes a plurality of lower members consolidating and curing and bonding the uncured fiber elements of a portion of the uncured fiber reinforced structure.

42. The apparatus and a portion of a fiber reinforced structure having uncured fiber elements therein of claim **40**, wherein the upper members of the plurality are spaced from each other by a spacer consolidating and curing and bonding the uncured fiber elements of a portion of the uncured fiber reinforced structure.

43. The apparatus and a portion of a fiber reinforced structure having uncured fiber elements therein of claim **41**, wherein the lower member includes a plurality of lower members that are spaced from each other by a spacer consolidating and curing and bonding the uncured fiber elements of a portion of the uncured fiber reinforced structure.

44. The apparatus and a portion of a fiber reinforced structure having uncured fiber elements therein of claim **43**, wherein each lower member of the plurality of upper members and plurality of lower members includes at least one end member thereon consolidating and curing and bonding the uncured fiber elements of a portion of the uncured fiber reinforced structure.

45. The apparatus and a portion of a fiber reinforced structure having uncured fiber elements therein of claim **39**, further including:

computer apparatus for control of temperature of the heat member of the upper member and the heat member of the lower member consolidating and curing and bonding the uncured fiber elements of a portion of the uncured fiber reinforced structure.

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