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⑤④ **Method and assembly for hot consolidating materials.**

⑤⑦ A quantity of material (10), which is at less than a predetermined density, is disposed within a sealed container (12) which is, in turn, disposed in a first thermal jacket (32) to retain the heat within the material (10) to be consolidated. The first thermal jacket (32) is placed within a second thermal jacket (34) which is, in turn, disposed in a cavity defined by two elastomeric components (22, 24) retained between a ram (16) and pot die (14) of a press whereby upon closure of the press, the ram (16) enters the cavity (26) of the pot die (14) to apply external pressure to the entire exterior of the elastomeric components (22, 24). A seal (36) of material harder than the elastomeric material (22, 24) is disposed within the cavity (26) of the pot die (14) for preventing the elastomeric medium (22, 24) from leaking between the sliding surfaces of the ram (16) and the pot die (14).

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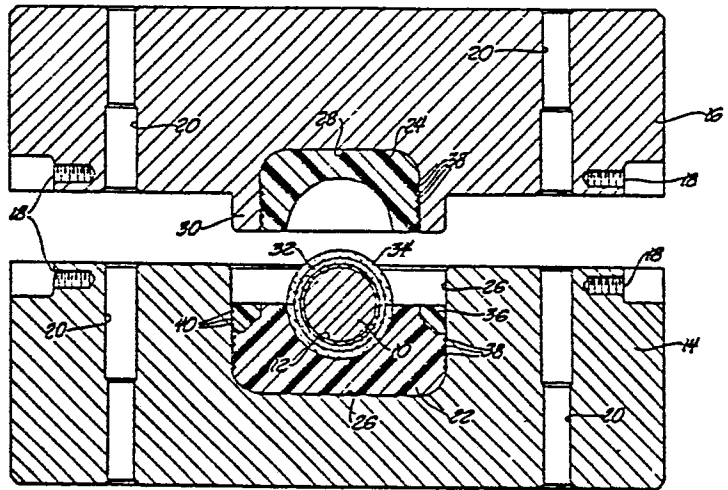


Fig. 1

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TITLE

A method and assembly for hot consolidating materials.

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TECHNICAL FIELD

The subject invention is used for consolidating material of metallic and nonmetallic powder compositions and combinations thereof to form a predetermined densified compact. Consolidation is usually accomplished by evacu-
10 ating a container and filling the container with a powder to be consolidated and thereafter hermetically sealing the container. Pressure is then applied to the filled and sealed container to subject the powder to pressure. Typically, heat is also applied to heat the powder to a
15 compaction temperature. The combination of heat and pressure facilitates consolidation of the powder.

BACKGROUND ART

It is well-known to place a hermetically sealed
20 container with the powder therein in an autoclave or hot isostatic press where it is subjected to heat and gas pressure.

Because of the expense and limitations of an autoclave or hot isostatic press, there have been

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significant developments made wherein the powder to be compacted is encapsulated in a substantially fully dense and incompressible container providing a pressure-transmitting medium which maintains its configurational integrity while being handled both at ambient temperatures and at the elevated compaction temperatures, yet becomes fluidic and capable of plastic flow when pressure is applied to the entire exterior surface thereof to hydrostatically compact the powder. Typically, the powder is hermetically encapsulated within the pressure-transmitting medium which is thereafter heated to a temperature sufficient for compaction and densification of the powder. After being sufficiently heated, the pressure-transmitting medium with the powder therein may be placed between two dies of a press which are rapidly closed to apply pressure to the entire exterior of the pressure-transmitting medium. The pressure-transmitting medium, at least immediately prior to a selected predetermined densification, must be fully dense and incompressible and capable of flow so that the pressure transmitted to the powder is hydrostatic and, therefore, from all directions, i.e., omnidirectional. After the material is densified to the desired degree, the pressure-transmitting medium defining the container must be removed from the compacted material and in so doing the integrity of the pressure-transmitting medium is lost whereby either the pressure-transmitting medium is no longer usable or must be completely recycled to fabricate a new container.

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SUMMARY OF THE INVENTION AND ADVANTAGES

The subject invention is for consolidating material of metallic and nonmetallic compositions and combinations thereof to form a densified compact of a predetermined density wherein a quantity of such material which is less dense than the predetermined density is heated and disposed in a cavity in a pressure-transmitting medium to

which external pressure is applied to the entire exterior of the medium to cause a predetermined densification of the material by hydrostatic pressure applied by the medium in response to the medium being substantially fully dense and incompressible and capable of elastic flow at least just prior to the predetermined densification. The invention is characterized by utilizing an elastomeric pressure-transmitting medium and encapsulating the material in a thermal insulating barrier means disposed within the cavity of the elastomeric medium to establish a thermal barrier between the material to be compacted and the elastomeric medium prior to applying pressure to the medium to limit heat transfer between the material and the elastomeric medium.

15 In order to effect compaction hydrostatically through a substantially fully dense and incompressible medium in a press, the press must provide sufficient force to cause plastic flow of the medium. Typically, the material to be compacted is placed within a pressure-transmitting medium which is, in turn, placed in a press where it is subjected to forces rendering it fluid and capable of transmitting forces hydrostatically to the material to be compacted and in so doing the pressure-transmitting medium changes shape. Additionally, the pressure-transmitting medium totally encapsulates the material being compacted and loses its integrity upon being removed from the compacted material. Because the pressure-transmitting medium changes shape during the compaction and has its integrity destroyed by being removed from the compacted material, it either cannot be reused or must undergo significant processing for reuse. An advantage of the subject invention is that the pressure-transmitting medium comprises an elastomeric medium which becomes fully dense and incompressible and capable of elastic flow just prior to the predetermined densification of the compact, yet is sufficiently elastic to return to its initial configuration

for continued and repetitive reuse and compaction. This may be accomplished in accordance with the instant invention by utilizing a thermal insulating barrier means between the elastomeric medium and the heated material to be compacted so that the integrity of the elastomeric medium is not degraded by the heat and may be used repetitively.

BRIEF DESCRIPTION OF THE DRAWINGS

10 Other advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

15 FIGURE 1 is a cross-sectional view of an assembly utilized in accordance with the subject invention disposed in the open position;

FIGURE 2 is a cross-sectional view similar to FIGURE 1 showing the assembly in a closed position;

20 FIGURE 3 is a fragmentary cross-sectional view taken along line 3-3 of FIGURE 2; and

FIGURE 4 is a fragmentary view of a portion of the exterior surface of a seal utilized in the assembly of the subject invention.

25 DESCRIPTION OF THE INVENTION

The subject invention may be utilized for consolidating various metallic powders and nonmetallic powders, as well as combinations thereof, to form a densified compact. In accordance with the invention, the degree of density of the powder is increased to a pre-determined or desired density which may be full density or densification or less than full density or densification.

The invention relates to a method for consolidating material of metallic and nonmetallic compositions and combinations thereof to form a densified compact of a pre-determined density wherein a quantity of such material

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which is less dense than the predetermined final density is encapsulated in a pressure-transmitting medium to which external pressure is applied to the entire exterior of the medium to cause a predetermined densification of the encapsulated material by hydrostatic pressure applied by the medium in response to the medium being substantially fully dense and incompressible and capable of elastic flow, i.e., fluidic, at least just prior to the predetermined densification. In other words, the medium transmits pressure hydrostatically like a liquid omnidirectionally about the material for compaction thereof.

As the invention is illustrated, a quantity of less than fully dense powder 10 fills and is encapsulated within a container 12. The container 12 is evacuated as by a vacuum through a tube (not shown) and then is filled with the powder 10 under vacuum through the tube. After filling, the tube is sealed to hermetically seal the container 12 with the powder 10 under a vacuum therein. The container 10 is a thin-walled and preferably of a sheet metal material. The container 12 may be filled and sealed in accordance with the teachings of United States Patent 4,229,872 granted October 28, 1980 and assigned to the assignee of the subject invention.

The container 12 is circular in cross section to define a cylinder and has a fill tube (not shown) extending from one end thereof. It will be understood, however, that the configuration of the container 12 will depend upon the desired configuration of the end part or compact.

As illustrated, an assembly for implementing the subject invention includes a pot die 14 and a ram 16 which include attachment points 18 for attaching alignment keys for aligning the pot die 14 and ram 16. The pot die 14 and the ram 16 also include bores 20 for receiving attaching bolts or pins to attach the pot die 14 and ram 16 to a press which may be one of any of a number of well-known types. The ram 16 and pit die 14 are aligned

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during the opening and closing of the press between the open position shown in Figure 1 and the closed position shown in FIGURE 2.

A pressure-transmitting medium, comprising first and second elastomeric components 22 and 24, defines a cavity for encapsulating the material to be consolidated. The pot die 14 is made of an incompressible material such as steel and includes a pot die cavity 26. In a similar fashion, the ram 16 is made of an incompressible material such as steel and includes a ram-cavity 28 therein. The ram 16 includes a raised flange or ridge 30 surrounding the ram-cavity 28. The pot-die cavity 26 has peripheral surfaces for receiving and sliding engagement with the exterior surfaces of the raised flange 30 of the ram 16. In other words, the interior surfaces of the cavity 26 in the pot die 14 are aligned with the exterior surfaces of the flange 30 of the ram 16 so that they are in close sliding engagement with one another as the pot die 14 and ram 16 are closed. The first component 22 of the elastomeric medium is retained in the pot-die cavity 26 as by being wedged therein or having small amounts of adhesive securing the elastomeric component to the cavity 26. In a similar fashion, the second elastomeric component 24 is retained in the ram-cavity 28. The first and second elastomeric components 22 and 24 define a cylindrical cavity for surrounding the material 10 for compaction thereof. The elastomeric components 22 and 24 may, in addition to natural rubber, consist of elastomers such as neoprene, polysiloxane elastomers, polyurethane, polysulfide rubber, polybutadiene, buna-S, etc. The elastomeric medium making up the components 22 and 24 is elastic in that it may be compressed and yet returns to its original configuration. However, after the elastomeric medium defining the components 22 and 24 is compressed to a certain degree, it becomes substantially incompressible, yet fluidic, i.e., capable of elastic

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flow, so that at the point of compaction and the desired densification of the powder 10, it hydrostatically applies pressure omnidirectionally about the container 12 to compact the powder 10 therein. The container 12 is of a material which is thin-walled and reduces in volume to compact the powder 10.

The powder 10 is heated to an elevated temperature for facilitating densification and compaction of the powder 10. In order to protect the elastomeric medium 10 defining the components 22 and 24, a thermal insulating barrier means establishes a thermal barrier between the powder material 10 and the elastomeric medium 22 and 24 prior to applying pressure to the medium 22 and 24 by the closure of the pot die 14 and ram 16 to limit the heat transfer between the material 10 and the elastomeric medium 22 and 24. The thermal insulating barrier means includes a first thermal insulating jacket 32 completely surrounding the container 12 for limiting the heat loss from the material 10 and a second thermal insulating jacket 34 surrounding the first jacket 32 for protecting the elastomeric components 24 and 22 from heat emanating from the first jacket 32.

In accordance with the subject invention, the jackets 32 and 34 are made of a ceramic material having a very low thermal conductivity. In addition, the material of which the jackets 32 and 34 are made is fluidic or capable of flow at least just prior to the desired compaction of the powder 10 as pressure is applied thereabout hydrostatically through the elastomeric components 22 and 24. By analogy, the material of the jackets 32 and 34 may flow in the manner of quicksand just prior to compaction. In the preferred mode, the container 12 has the first jacket 32 cast thereabout in a mold so that the jacket 32 completely encapsulates the container 12 and is a homogeneous material. The first jacket 32 with the container 12 and the material therein is heated to an

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elevated temperature sufficient for compaction. During this heating, the jacket 32 becomes heated. Thereafter, the jacket 32, with the container 12 and the material 10 therein, is placed within the second jacket 34 within the cavity defined by the elastomeric components 22 and 24. The second jacket 34 is made of two complementary sections which mate together to completely encapsulate and surround the first jacket 32. The second jacket 34 is also fluidic or capable of flow just prior to the desired densification of the powder 10. Once the heated material 10 within the container 12 which is, in turn, encapsulated in the first jacket 32 is placed within the second jacket 34 as illustrated in FIGURE 1, the press closes to close the pot die 14 and ram 16 whereby the flange 30 of the ram 16 enters the cavity 26 of the pot die 14. It is important to note that the flange 30 enters the cavity 26 of the pot die 14 before the elastomeric components 22 and 24 contact one another and are compressed to create hydrostatic pressure as they become incompressible and fluidic for transmitting hydrostatic pressure omnidirectionally against the second jacket 34 which, in turn, transmits the hydrostatic pressure through the jacket 32 and the container 12 to compact and densify the powdered metal 10. To compensate for differences in coefficients of thermal expansion, either or both of the jackets 32 and 34 may be made of a ceramic having reinforcing fibers therein which allow some contraction or expansion of the basic materials making up the jackets 32 or 34. In other words, either one of the jackets 32 and 34 may have fibers dispersed therein for reinforcement. Further, the jackets 32 and 34 may be made of a crumbling material which may be crushed to become incompressible, but yet fluidic enough to transmit the pressure hydrostatically from the elastomeric components 22 and 24 to the container 12 and, thus, to the powdered metal 10.

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It is important that the flange 30 of the ram 16 enter the cavity 26 of the pot die 14 prior to the elastomeric components 22 and 24 engaging one another to control the movement of the elastomeric components 22 and 24. Further to this end, a seal 36 of a harder material than the elastomeric medium defining the components 22 and 24 is disposed within and below the upper extremity of the cavity 26 of the pot die 14 so that after the flange 30 of the ram 16 enters the pot die 14 and applies pressure to the elastomeric components 22 and 24, the seal 36 is forced into sealing engagement with the interior surfaces of the cavity 26 in the pot die 14 at the juncture thereof with the exterior surface of the flange 30 of the ram 16 to prevent leakage of the elastomeric components 22 and 24 between the ram 16 and the pot die 14. The seal 36 is of a higher durometer than the elastomeric components 22 and 24 and, therefore, is less capable of plastic flow albeit the seal material 36 is capable of plastic flow.

Once the flange 30 of the ram 16 enters the cavity 26 of the pot die 14, the elastomeric components 22 and 24 engage one another and begin to compress to a point at which they become incompressible and convey pressure hydrostatically in an omnidirectional fashion to compact the powdered metal 10. During the initial compression of the elastomeric components 22 and 24, they move or slide relative to the surfaces of the cavities in which they are disposed in the pot die 14 and ram 16, respectively. Accordingly, the components 22 and 24, as well as the seal 36, include a plurality of lubrication grooves 38 and 40, respectively, in the exterior surfaces thereof to facilitate movement relative to the adjacent supporting surface of the cavities in which they are disposed. Preferably, a lubricant is disposed within the grooves 38 and 40 to allow the material to compress and slide relative to the adjacent surfaces. As illustrated in FIGURE 2, upon full compression of the components, the grooves are diminished

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in size so as to be imperceivable, yet the grooves exist to trap incompressible lubricant therein during full compression.

In accordance with the invention, the powdered metal 5 10 fills a thin-walled container 12 which is, in turn, encapsulated within a first thermal insulating jacket 32 as by having the jacket 32 cast thereabout, after which they are heated to an elevated temperature sufficient for compaction of the powder 10. Thereafter, a lower section 10 of the second jacket 34 may be disposed within a cavity in the elastomeric component 22 of the pot die 14 and the first jacket 32 with the powder therein disposed within the lower section 34 of the outer jacket. The upper half or section of the second jacket 34 is then disposed over 15 the heated inner or first jacket 32 and the ram and pot die are moved together to the position shown in FIGURE 2 to densify and compact the powder into a densified compact 10'. The elastomeric medium defining the components 22 and 24 may initially be compressible, but upon reaching a 20 certain point of applied pressure becomes incompressible so as to hydrostatically transmit pressure in an omnidirectional fashion entirely about the jackets 32 and 34 to the powder 10 to compact and densify the powder into the compact 10' of the desired densification. The pot die 25 14 and ram 16 may be opened to allow the elastomeric components 22 and 24 to return to their precompressed shape and to remove the compact 10' so that thereafter the container 10 and the jackets 32 and 34 may be removed to expose the compact 10'. Normally, the jackets 32 and 34 30 will be disposable and new jackets would be utilized on successive opening and closing of the pot die 14 and ram 16 for successively forming compacts 10'.

It will be appreciated that in many circumstances only one thermal insulating jacket may be utilized between 35 the heated powdered material 10 and the elastomeric components 22 and 24. Additionally, the thicknesses of the

thermal insulating barrier means may vary depending on the sizes, configurations, masses, etc. of the powder 10 to be compacted and densified.

The invention has been described in an illustrative 5 manner, and it is to be understood that the terminology which has been used is intended to be in the nature of words of description rather than of limitation.

Obviously, many modifications and variations of the present invention are possible in light of the above 10 teachings. It is, therefore, to be understood that within the scope of the appended claims wherein reference numerals are merely for convenience and are not to be in any way limiting, the invention may be practiced otherwise than as specifically described.

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CLAIMS

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

- 5 1. A method for hot consolidating material (10) of metallic and nonmetallic compositions and combinations thereof to form a densified compact (10') of a predetermined density wherein a quantity of such material (10) which is less dense than the predetermined density is
10 heated and disposed in a cavity in a pressure-transmitting medium (22, 24) to which external pressure is applied to the entire exterior of the medium (22, 24) to cause a predetermined densification of the material by hydrostatic pressure applied by the medium (22, 24) in response to the
15 medium being substantially fully dense and incompressible and capable of elastic flow at least just prior to the predetermined densification, characterized by utilizing an elastomeric medium and encapsulating the material (10) in a thermal insulating barrier means (32, 34) within the
20 cavity to establish a thermal barrier between the material (10) and the elastomeric medium (22, 24) prior to applying pressure to the medium (22, 24) to limit heat transfer between the material (10) and the elastomeric medium (22, 24).

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2. A method as set forth in claim 1 further characterized by encapsulating the material (10) in a thermal insulating barrier means including a first thermal insulating jacket (32) for limiting heat loss from the material (10) and a second thermal insulating jacket (34) surrounding the first jacket (32) for protecting the elastomeric medium (22, 24) from heat from the first jacket (32).

3. A method as set forth in claim 2 further characterized by heating and encapsulating the material (10) in the first jacket (32) prior to disposing the first jacket (32) and material (10) within the second jacket (34) within the medium (22, 24).

4. A method as set forth in claim 3 further characterized by encapsulating the material (10) in a sealed container (12) and thereafter disposing the container (12) with the material (10) therein within the first jacket (32).

5. A method as set forth in claim 4 further characterized by casting the first jacket (32) about the container (12) so that the first jacket (32) is a monolithic material.

6. A method as set forth in claim 5 further characterized by disposing the first jacket (32) in the second jacket (34) of a plurality of sections mated together to surround the first jacket (32).

7. A method as set forth in any one of claims 1 through 6 further characterized by utilizing a thermal barrier means (32, 34) which is at least in part fluidic and capable of flow just prior to the predetermined densification.

8. A method as set forth in any one of claims 1 through 6 further characterized by utilizing a thermal barrier means (32, 34) which is at least in part reinforced with fibers dispersed therein.

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9. A method as set forth in any one of claims 1 through 6 further characterized by applying pressure to the elastomeric medium (22, 24) by disposing the elastomeric medium (22, 24) between a ram (16) and pot die (14) 5 of a press.

10. A method as set forth in any one of claims 1 through 6 further characterized by applying pressure to the elastomeric medium (22, 24) by attaching a first component (22) of the elastomeric medium within a pot die 10 cavity (26) and attaching a second component (24) of the elastomeric medium to a ram (16) movable into and out of the pot die cavity (26) in close sliding engagement therewith and positioning the first (22) and second (24) elastomeric components so that the ram (16) enters the 15 cavity (26) of the pot die (14) prior to the first (22) and second (24) elastomeric components engaging one another to surround the thermal barrier means (32, 34) within the cavity defined by the first (22) and second (24) components of elastomeric medium so that the first 20 and second components of elastomeric medium may be successively opened and closed with the opening and closing of the ram (16) and pot die (14) in a press to successively form a plurality of densified compacts (10').

11. A method as set forth in any one of claims 1 25 through 6 further characterized by applying pressure to the elastomeric medium (22, 24) by attaching a first component (22) of the elastomeric medium within a pot die cavity (26) and attaching a second component (24) of the elastomeric medium to a ram (16) movable into and out of 30 the pot die cavity (26) in close sliding engagement therewith and positioning the first (22) and second (24) elastomeric components so that the ram (16) enters the cavity (26) of the pot die (14) prior to the first (22) and second (24) elastomeric components engaging one 35 another to surround the thermal barrier means (32, 34) within the cavity defined by the first (22) and second

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(24) components of elastomeric medium so that the first (22) and second (24) components of elastomeric medium may be successively opened and closed with the opening and closing of the ram (16) and pot die (14) in a press to 5 successively form a plurality of densified compacts (10'), and providing a plurality of lubrication grooves (38) in the surface of at least one of the components (22, 24) of elastomeric medium to facilitate movement thereof relative to the adjacent supporting surface of the ram (16) or pot 10 die (14).

12. A method as set forth in any one of claims 1 through 6 further characterized by applying pressure to the elastomeric medium by attaching a first component (22) of the elastomeric medium within a pot die cavity (26) and 15 attaching a second component (24) of the elastomeric medium to a ram (16) movable into and out of the pot die cavity (26) in close sliding engagement therewith and positioning the first (22) and second (24) elastomeric components so that the ram (16) enters the cavity (26) of 20 the pot die (14) prior to the first (22) and second (24) elastomeric components engaging one another to surround the thermal barrier means (32, 34) within the cavity defined by the first (22) and second (24) components of elastomeric medium so that the first and second components 25 of elastomeric medium may be successively opened and closed with the opening and closing of the ram (16) and pot die (14) in a press to successively form a plurality of densified compacts (10'), and disposing a seal (36) of a harder material than the elastomeric medium (22) within 30 and below the extremity of the cavity (26) of the pot die (14) so that after the ram (16) enters the pot die (14) and applies pressure to the elastomeric medium the seal (36) is forced into sealing engagement with the cavity (26) of the pot die (14) at the juncture thereof with the 35 ram (16) to prevent leakage of the elastomeric medium (22) between the ram (16) and pot die (14).

13. An assembly for hot consolidating material (10) of metallic and nonmetallic compositions and combinations thereof to form a densified compact (10') of a predetermined density wherein a quantity of such material (10) 5 which is less dense than the predetermined density is heated and disposed in a cavity in a pressure-transmitting medium (22, 24) to which external pressure is applied to the entire exterior of the medium (22, 24) to cause a predetermined densification of the material (10) by 10 hydrostatic pressure applied by the medium (22, 24) in response to the medium being substantially fully dense and incompressible and capable of elastic flow at least just prior to the predetermined densification, characterized by the pressure-transmitting medium being elastomeric and 15 including a thermal insulating barrier means (32, 34) for surrounding the material (10) and disposition within the cavity of the elastomeric medium (22, 24) to establish a thermal barrier between the material (10) and the elastomeric medium (22, 24) prior to applying pressure to 20 the medium (22, 24) to limit heat transfer between the material (10) and the elastomeric medium (22, 24).

14. An assembly as set forth in claim 13 further characterized by said thermal insulating barrier means (32, 34) including a first thermal insulating jacket (32) 25 for limiting heat loss from the material (10) and a second thermal insulating jacket (34) surrounding the first jacket (32) for protecting the elastomeric medium (22, 24) from heat from the first jacket (32).

15. An assembly as set forth in claim 14 further 30 characterized by including a sealed container (12) encapsulating the material (10), said first jacket (32) having an interior cavity corresponding to the exterior configuration of said container (12) for surrounding said container (12).

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16. An assembly as set forth in claim 15 further characterized by said first jacket (32) being a monolithic material surrounding said container (12).

17. An assembly as set forth in claim 16 further 5 characterized by said second jacket (34) including a plurality of sections for mating engagement with one another to surround said first jacket (32).

18. An assembly as set forth in any one of claims 13 through 17 further characterized by said thermal barrier 10 means (32, 32) being at least in part fluidic and capable of flow just prior to the predetermined densification.

19. An assembly as set forth in any one of claims 13 through 17 further characterized by said thermal barrier means (32, 34) including, at least in part, reinforcing 15 fibers dispersed therein.

20. An assembly as set forth in any one of claims 13 through 17 further characterized by including a ram (16) and pot die (14) for applying pressure to said medium (22, 24).

20 21. An assembly as set forth in any one of claims 13 through 17 further characterized by said elastomeric medium (22, 24) being defined by first (22) and second (24) components, said first component (22) of said elastomeric medium being attached within a cavity (26) in said 25 pot die (14), said second component (24) of said elastomeric medium being attached to said ram (16), said ram (16) being movable into and out of said cavity (26) in said pot die (14) in close sliding engagement therewith, said first and second elastomeric components (22, 24) and 30 said ram (16) and pot die (14) being configured so that said ram (16) enters said cavity (26) of said pot die (14) prior to said elastomeric components (22, 24) engaging one another to surround said thermal barrier means (32, 34) within said cavity defined by said first and second 35 elastomeric components (22, 24) so that said first and second elastomeric components (22, 24) may be successively

opened and closed with the opening and closing of said ram (16) and pot die (14) in a press to successively form a plurality of densified compacts (10').

22. An assembly as set forth in any one of claims 13 5 through 17 further characterized by said elastomeric medium being defined by first (22) and second (24) components, said first component (22) of said elastomeric medium being attached within a cavity (26) in said pot die (14), said second component (24) of said elastomeric 10 medium being attached to said ram (16), said ram (16) being movable into and out of said cavity (26) in said pot die (14) in close sliding engagement therewith, said first and second elastomeric components (22, 24) and said ram (16) and pot die (14) being configured so that said ram 15 (16) enters said cavity (26) of said pot die (14) prior to said elastomeric components (22, 24) engaging one another to surround said thermal barrier means (32, 34) within said cavity defined by said first and second elastomeric components (22, 24) so that said first and second elasto- 20 meric components (22, 24) may be successively opened and closed with the opening and closing of said ram (16) and pot die (14) in a press to successively form a plurality of densified compacts (10'), at least one of said elastomeric components (22, 24) having a plurality of 25 lubrication grooves (38) in the surface thereof abutting said ram (16) or pot die (14) for facilitating movement of said elastomeric component relative to the adjacent supporting surface of said ram or pot die.

23. An assembly as set forth in any one of claims 13 30 through 17 further characterized by said elastomeric medium being defined by first (22) and second (24) components, said first component (22) of said elastomeric medium being attached within a cavity (26) in said pot die (14), said second component (24) of said elastomeric 35 medium being attached to said ram (16), said ram (16) being movable into and out of said cavity (26) in said pot

die (14) in close sliding engagement therewith, said first and second elastomeric components (22, 24) and said ram (16) and pot die (14) being configured so that said ram (16) enters said cavity (26) of said pot die (14) prior to 5 said elastomeric components (22, 24) engaging one another to surround said thermal barrier means (32, 34) within said cavity defined by said first and second elastomeric components (22, 24) so that said first and second elastomeric components (22, 24) may be successively opened and 10 closed with the opening and closing of said ram (16) and pot die (14) in a press to successively form a plurality of densified compacts (10'), a seal (36) of harder material than the elastomeric medium (22) disposed within and below the extremity of the cavity (26) of said pot die 15 (14) so that after the ram (16) enters said pot die (14) and applies pressure to said elastomeric medium (22, 24) said seal (36) is forced into sealing engagement with said cavity (26) in said pot die (14) at the juncture thereof with said ram (16) to prevent leakage of the elastomeric 20 medium (22) between said ram (16) and pot die (14).

24. An assembly as set forth in any one of claims 13 through 17 further characterized by said elastomeric medium being defined by first (22) and second (24) components, said first component (22) of said elastomeric 25 medium being attached within a cavity (26) in said pot die (14), said second component (24) of said elastomeric medium being attached to said ram (16), said ram (16) being movable into and out of said cavity (26) in said pot die (14) in close sliding engagement therewith, said first 30 and second elastomeric components (22, 24) and said ram (16) and pot die (14) being configured so that said ram (16) enters said cavity (26) of said pot die (14) prior to said elastomeric components (22, 24) engaging one another to surround said thermal barrier means (32, 34) within 35 said cavity defined by said first and second elastomeric components (22, 24) so that said first and second

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elastomeric components (22, 24) may be successively opened and closed with the opening and closing of said ram (16) and pot die (14) in a press to successively form a plurality of densified compacts (10'), a seal (36) of
5 harder material than the elastomeric medium (22) disposed within and below the extremity of the cavity (26) of said pot die (14) so that after the ram (16) enters said pot die (14) and applies pressure to said elastomeric medium (22, 24) said seal (36) is forced into sealing engagement
10 with said cavity (26) in said pot die (14) at the juncture thereof with said ram (16) to prevent leakage of the elastomeric medium (22, 24) between said ram (16) and pot die (14), said seal having a beveled surface disposed at an acute angle relative to the direction of movement of
15 said ram (16) into said pot die (14) and facing into said cavity (26) of said pot die (14), said seal (36) having grooves (40) in the exterior surface thereof.

25. An assembly for hot consolidating material (10) of metallic and nonmetallic compositions and combinations
20 thereof to form a densified compact (10') comprising; a ram (16) of incompressible material having a ram-cavity (28) therein and a raised flange (30) surrounding said ram-cavity (28), a pot die (14) made of incompressible material having a pot-die cavity (26) therein with
25 peripheral surfaces for receiving and sliding engagement with the exterior surfaces of said raised flange (30) of said ram (16), a first component (22) of elastomeric medium retained in said pot-die cavity (26), a second component (24) of elastomeric medium retained in said
30 ram-cavity of said ram (16), said first and second elastomeric components (22, 24) defining a cavity for surrounding said material so that compacts (10') may be successively formed therein upon successive opening and closing of the ram (16) and pot die (14).

35 26. An assembly as set forth in claim 25 including a thermal insulating barrier means (32, 34) for disposition

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in said cavity of said elastomeric medium (22, 24) to surround the material (10) to be compacted.

27. An assembly as set forth in claim 26 wherein said thermal insulating barrier means (32, 34) includes a first thermal insulating jacket (32) for limiting heat loss from said material (10) therein and a second thermal insulating jacket (34) for surrounding said first jacket (32) for protecting said elastomeric medium (22, 24) from heat from said first jacket (32).

10 28. An assembly as set forth in claim 27 including a sealed container (12) encapsulating the material (10), said first jacket (32) having an interior cavity corresponding to the exterior configuration of said container (12) for surrounding said container (12).

15 29. An assembly as set forth in claim 28 wherein said first jacket (32) comprises a monolithic material surrounding said container (12).

30. An assembly as set forth in claim 29 wherein said second jacket (34) includes a plurality of sections for mating engagement with one another to surround said first jacket (32).

31. An assembly as set forth in claim 30 including a seal (36) of a harder material than said elastomeric medium (22) disposed within and below the extremity of said cavity (26) in said pot die (14) so that after said ram (16) enters said pot die (14) and applies pressure to said elastomeric medium (22, 24) said seal (36) is forced into sealing engagement with said cavity (26) in said pot die (14) at the juncture of said raised flange (30) of said ram (16) and said peripheral surfaces of said pot-die cavity (26) to prevent leakage of said elastomeric medium (22, 24) between said ram (16) and said pot die (14).

32. An assembly as set forth in any one of claims 25, 26 and 30 wherein said elastomeric medium (22, 24) includes lubrication grooves (38) in the exterior surfaces

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thereof facing the surface of at least one of said ram (16) and pot die (14) cavities.

33. An assembly as set forth in any one of claims 26 through 30 wherein said thermal insulating barrier means (32, 34) is at least in part fluidic and capable of flow just prior to the desired densification of the compact (10').

34. An assembly as set forth in any one of claims 26 through 30 wherein said thermal barrier means (32, 34) includes reinforcing fibers dispersed therein.

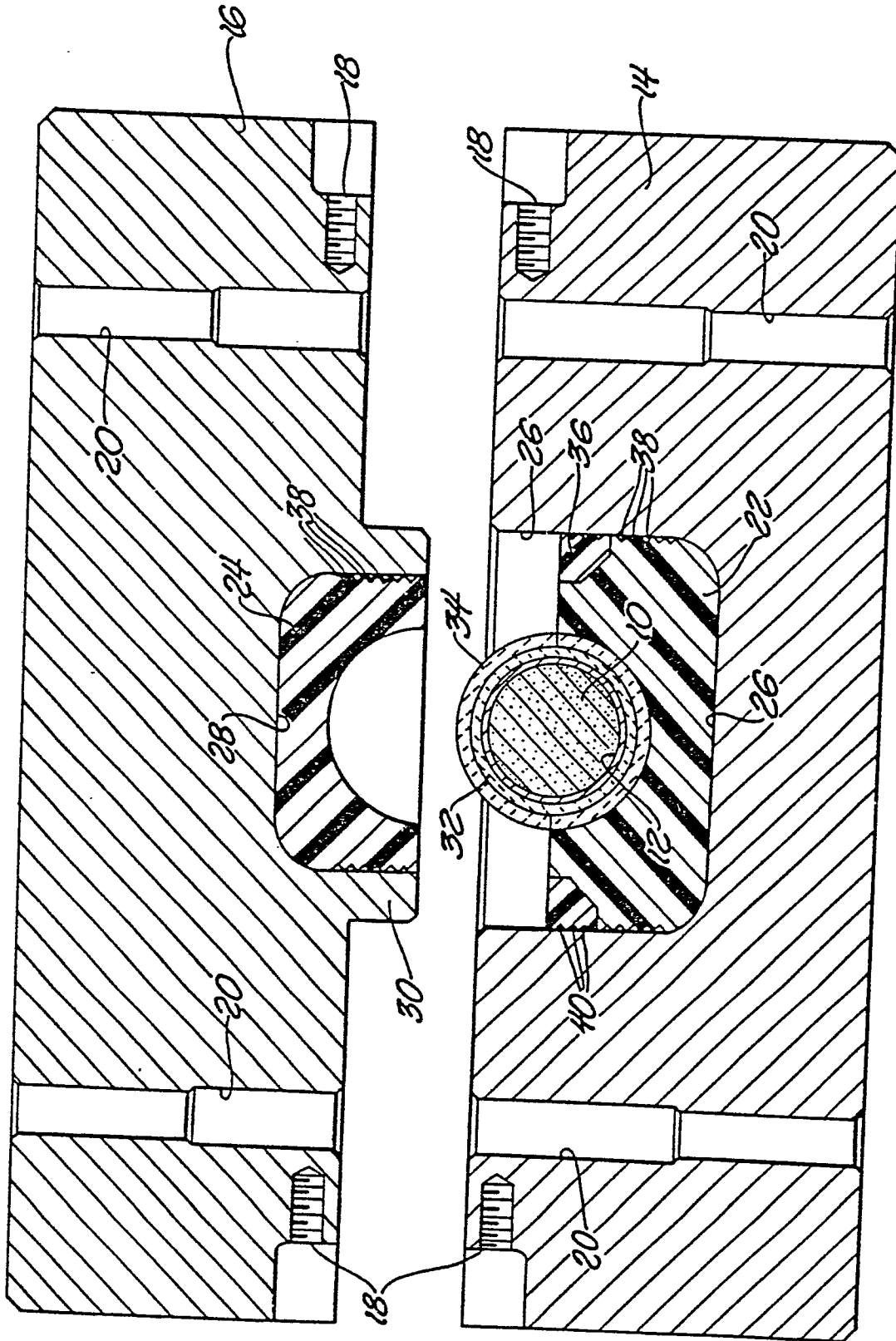


Fig. 1

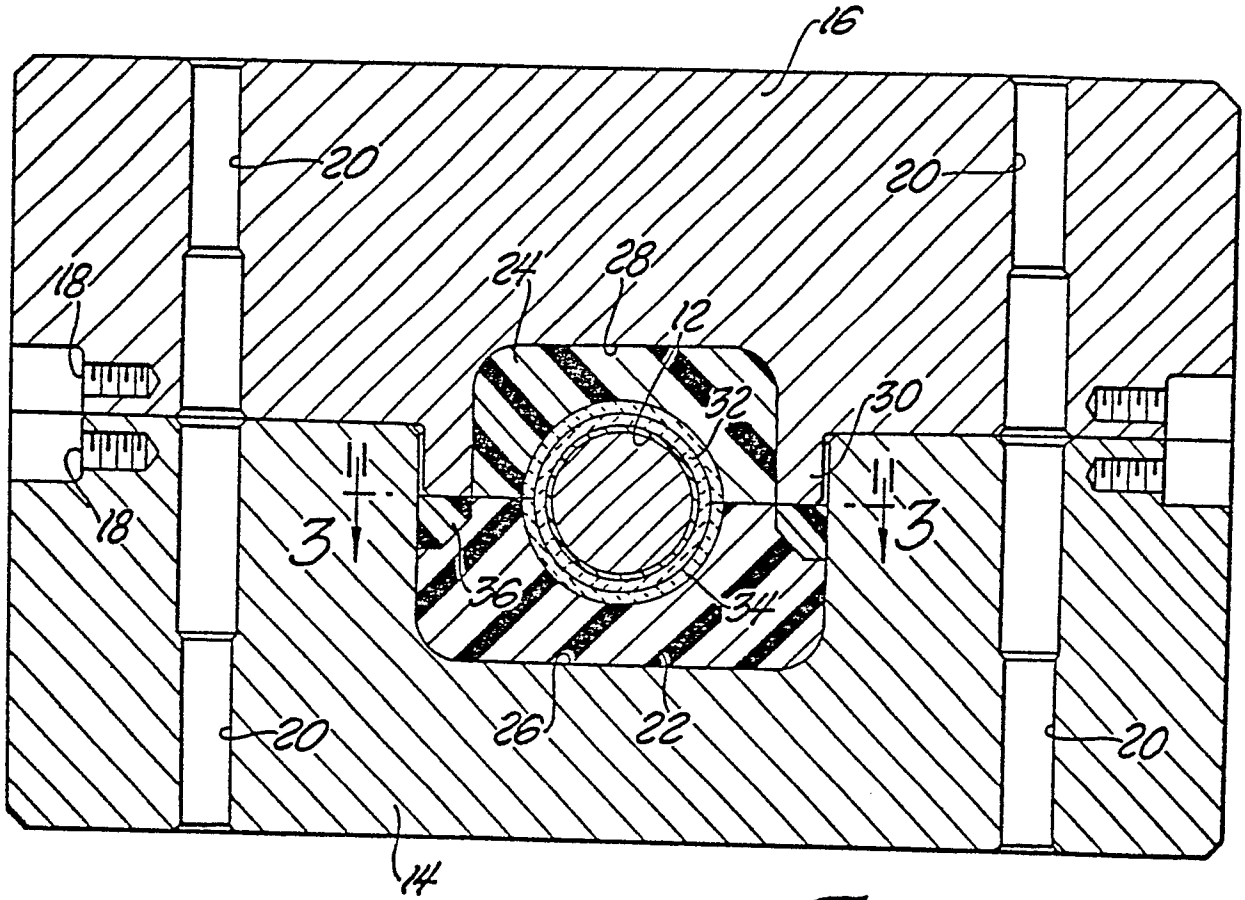


Fig. 2

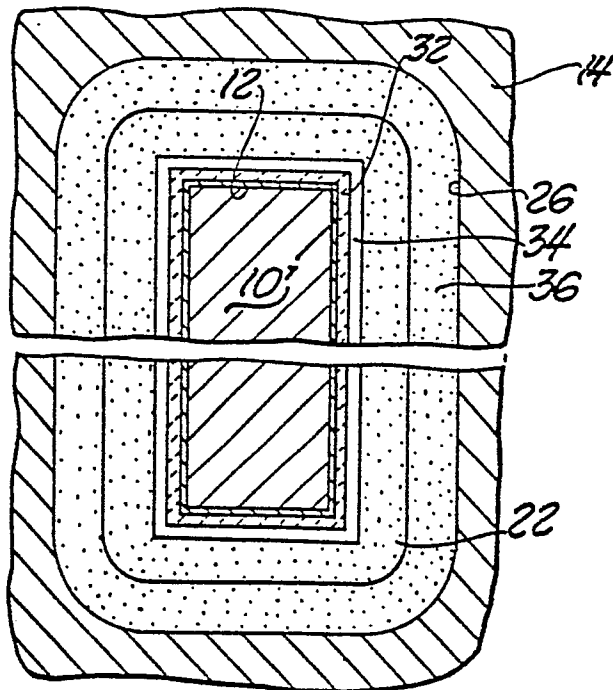


Fig. 3

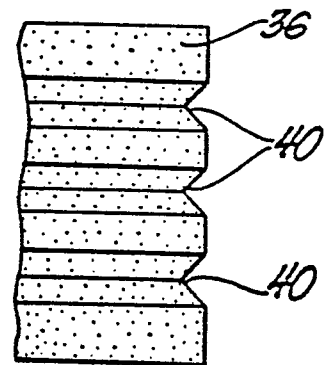


Fig. 4



DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Y	FR-A-2 453 701 (INOUE-JAPAX RESEARCH CORP.) * Page 4, lines 9-30 *	1-31	B 22 F 3/14
Y	FR-A-2 002 433 (TRW INC.) * Claims 1-4 *	2-6, 9 10, 12 14-17 20, 21 23, 25 27-31	
A	FR-A-1 338 493 (L. DESMARQUEST & CIE.)		
A	FR-A-1 420 799 (SUPER-TEMP CORP.)		
A	EP-A-0 039 014 (ASEA)		
A	EP-A-0 014 975 (ASEA)		
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
Place of search THE HAGUE		Date of completion of the search 21-12-1983	Examiner SCHRUERS H. J.
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			