

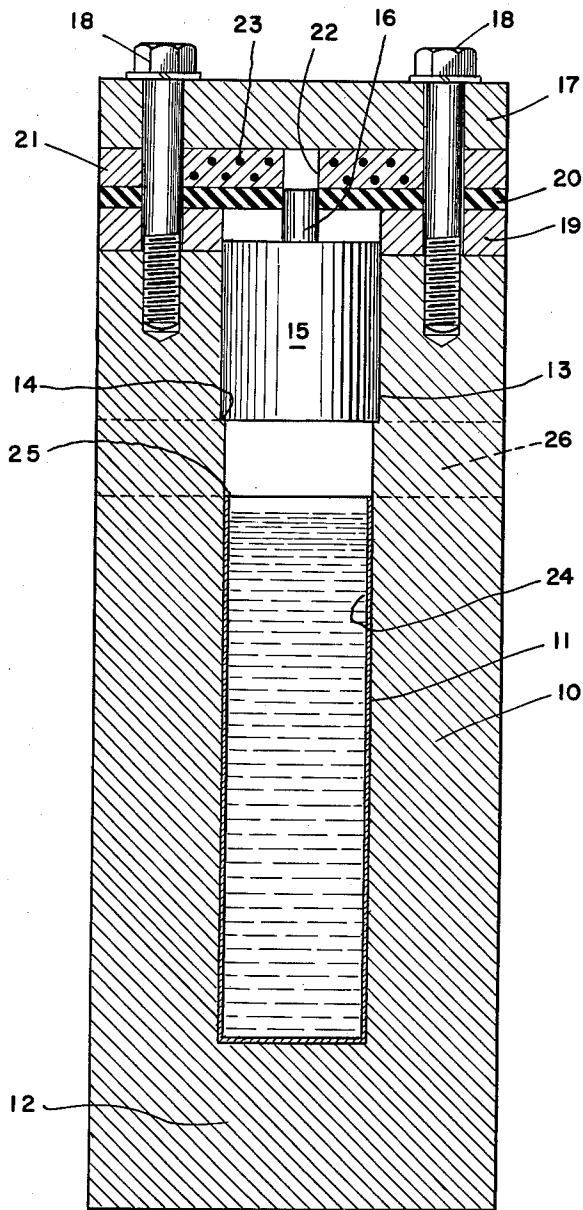
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METHOD OF APPLYING HIGH PRESSURE TO A BODY

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METHOD OF APPLYING HIGH PRESSURE TO A BODY

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This invention relates to a method of applying high pressures to a body, and more particularly concerns a method of applying high pressures to various forms of solid matter to effect a change of state or form therein.

It has been proposed to exert high pressures on confined bodies by various means including hydraulic rams and the like; such procedures usually being accompanied by the application of heat at elevated temperatures. However, the apparatus involved is complex, particularly in respect to the hydraulic pressure portion thereof, and entails expensive installations.

Accordingly, an object of this invention is to provide an improved method of applying high pressures to a confined body, which involves relatively simple and inexpensive apparatus.

A further object of this invention is to provide an improved method of the character described which achieves very substantial unit pressures for application to powders, sheet and other forms of solid material in a confined state.

Another object of this invention is to provide an improved, economical procedure for transforming amorphous carbon to a crystalline form having a hardness substantially equal to that of the diamond.

Still another object of this invention is to provide an improved procedure for rapidly and simply converting metals into refractory carbides.

Yet another object of this invention is to provide an improved procedure for applying high pressures to forming dies whereby various solid materials in sheet or other form, may have their original shape varied to suit a particular purpose.

Other objects of this invention will in part be obvious and in part hereinafter pointed out.

In the drawing, the figure is a longitudinal sectional view of a device useful in practicing the process of the instant invention.

It has been found that freezable, expansible liquid, such as water or the like, may be used in association with a body of material, in an elongated chamber which confines both liquid and body, to exert very high unit pressures on the body, upon subjecting the chamber to temperatures which will freeze and expand the liquid. Thus, there may be achieved a change of state or form in the body of the material so enclosed. It has been found that carbon in amorphous form, such as furnace black, graphite and the like, may be readily converted into a crystalline form having a hardness of about 9.8+.

Also, refractory metal such as titanium, tungsten, boron and the like, may be admixed with carbon and converted into their respective carbides. Furthermore, forming dies may be arranged to have transmitted thereto, very high pressures in a unique manner, whereby such dies may be used to vary the shape or form of various solid materials in sheet or other physical form.

The process in accordance with the instant invention is suitably carried out in an enclosed chamber, such as shown in the figure. Thus, such chamber may take the form of a tubular member 10 formed of hard alloy steel and having a longitudinal bore 11 which is closed at the end 12 by a wall of substantial thickness. The bore 11 at the upper end of said member, includes a slightly enlarged bore portion 13 providing an annular shoulder 14, for the purpose hereinafter appearing.

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A piston 15 is disposed in bore portion 13, seating on shoulder 14. The piston 15 includes at its upper end a ram portion 16. A cap 17 also of suitably formed alloy steel is removably secured to the open end of tubular member 10 to close the same, by bolts 18. Interposed between the upper end of member 10 and cap 17 is a clearance ring 19 having an opening which will pass the piston 15.

An asbestos ring 20 is seated on clearance ring 19 and its central opening will pass ram portion 16 of piston 15. A charge ring 21 is disposed between cap 17 and asbestos ring 20. Charge ring 21 has a central charge chamber 22, together with electrical resistance elements 23 surrounding chamber 22 for raising the temperature thereof. The charge chamber 22 has a diameter substantially equal to the diameter of ram portion 16 of piston 15.

The piston 15 is adapted to be moved by substantial pressures generated in bore 11 in order to exert very high unit pressures on the contents of charge chamber 22 by way of ram 16 as the same enters charge chamber 22.

To this end, a tubular envelope 24 closed at the lower end and open at its upper end 25 is adapted to be filled with water or other freezable, expansible liquid. The envelope 24, which if formed of thin flexible metal, is adapted to be located in the bore 11 of tubular member 10 in an upright position thereof, the walls of said bore having been previously coated with a thin layer of silicone grease or other low temperature type of lubricant.

An additional quantity of water or other expansible liquid is added to the bore 11 to bring the level thereof up to shoulder 14. The piston 15 is then seated on shoulder 14 within bore portion 13. The clearance ring 19, the asbestos ring 20, the charge ring 21 and cap 17 are thereafter assembled in place on member 10 and retained therein by bolts 18. It is understood that charge ring 21 has the chamber 22 thereof filled with the specific material which is to be treated.

The process involved includes the initial step of applying freezing temperatures to a zone of the tubular member 10 indicated at 26, thereby freezing a portion of the liquid in bore 11 which is immediately below piston 15. This may be readily accomplished by wrapping freezing coils, not shown, about zone 26. Such frozen slug of liquid forms a seal between piston 15 and the remainder of the freezable liquid within envelope 24. The entire tubular member 10 is now inverted and progressively inserted into a suitable freezing bath whereby the contents of envelope 24 are progressively frozen. Such freezing bath may comprise any of the well known freezing media including methylene chloride, frozen carbon dioxide admixed with isopropyl alcohol or acetone, liquid carbon dioxide or the like.

It will be apparent that the freezable expansible liquid within envelope 24 as it is progressively frozen will expand longitudinally to exert very substantial pressures against piston 15. The resultant pressures are effective to move piston 15 and its ram portion 16 into the charge chamber 22 of charge ring 21, thereby exerting very high pressure on the contents of said chamber. If desired, the heating elements 23 may be energized by a current, through electrical connections not shown, to increase the temperature of the contents of chamber 22, to selected values concomitantly with the application of pressure. It has been found that with the very high pressures available in the apparatus disclosed herein, the contents of chamber 22 may be quickly and readily converted into various forms in accordance with the nature of the original charge.

Thus, it has been found that upon filling chamber 22 with carbon black, lampblack or other suitable form of amorphous carbon, there is produced a shiny, crystalline body which has upon test, a hardness of 9.8+.

Alternatively, charges have been prepared for chamber

22, which consist of an admixture of carbon and refractory metals such as tungsten, titanium, boron or the like in stoichiometric proportions. In such cases, the resultant charge upon being subjected to the pressures developed within tubular member 10, have been converted to the respective refractory carbides.

It has been found that upon varying the length of the tubular member 10 and thereby varying the extent of the column of freezable liquid contained within bore 11, the ultimate pressures developed and applied to piston 15 may be adjusted to desired values.

It is further understood that the charge ring 21 may be the configuration of chamber 22 varied so as to accommodate other solid materials which are to be altered as to shape or form. Accordingly, the piston 15 will have its ram portion 16 modified as to configuration so as to be complementary to the chamber 22 in charge ring 21. Thus, dies may be used for varying the shape and form of metals and the like.

Envelope 24 provides a convenient means for holding the liquid which is to be frozen while the same is in bore 11 of member 10. However, the envelope 24 may be omitted, in which case, the water is directly placed within said bore 11. The lubricant on the walls of bore 11 prevents adhesion of the freezing liquid to the walls of bore 11.

The asbestos ring 20 tends to insulate the charge ring 21 from the body of tubular member 10, and is particularly effective when heating elements 23 are energized to raise the temperature of the charge in chamber 22 while pressure is being applied by piston 15.

It has been found that the initial formation of the frozen seal at zone 26 in bore 11 is highly effective in preventing leakage of liquid to piston 15 during the freezing operation. Despite the pressures developed, such seal shows no cold flow, thereby allowing for optimum operation of the piston 15.

In order to achieve any desired pressure, adjustments may be made by varying the extent in reduction of temperature of the freezable, expansible liquid in bore 11. It is understood that with an increase in resistance offered by the charge in chamber 22, the temperature at which the liquid freezes, is lowered. In addition, the length of the bore 11 may be varied to adjust the extent of linear expansion of the liquid as the same freezes.

By varying the temperature of the freezing medium to which the device 10 is subjected, or by changing the length of the bore 10; or by a combination thereof, desired pressures may be attained. Thus, the pressures achieved bear a substantially inverse relation to the freezing temperatures applicable to device 10.

Once the temperature of the liquid within bore 11 has been lowered to a desired value by the freezing bath or other freezing medium used, the effect of the developed high pressures on the contents of chamber 22 is almost instantaneous. The device 10 may then be readily disassembled, by removing cap 17 therefrom; to allow recovery of the converted or modified charge in chamber 22.

As various changes might be made in the embodiments of the invention disclosed herein without departing from the spirit thereof, it is understood that all matter herein disclosed is deemed illustrative and not limiting except as set forth in the appended claims.

Having thus disclosed my invention, I claim as new and desire to protect by Letters Patent:

1. The method of applying high pressure to a body comprising associating said body with a pressure applying means and a quantity of freezable expansible liquid in pressure transmitting relation to each other, interposing a freezable liquid seal between said pressure applying means and said liquid, confining said body, pressure apply-

ing means, liquid and liquid seal, freezing said liquid seal and subjecting said confined body and liquid to reduced temperature to freeze said liquid.

2. The method of applying high pressure to a body comprising locating said body within a chamber open at one end thereof, disposing a quantity of expansible, freezable liquid within said chamber in pressure transmitting relation to said body, interposing longitudinally movable pressure applying means between said body and liquid, initially freezing a portion of said liquid in a zone adjacent said pressure applying means, thereafter freezing the remainder of said liquid and subjecting said body to pressure developed by the expansion of said liquid and the consequent longitudinal movement of said pressure applying means.

3. The method of applying high pressure to a body comprising disposing said body within the bore of a tubular member, disposing a column of freezable liquid within said bore, interposing a movable pressure applying means between said body and liquid within said bore, freezing a portion of said liquid at one end of the column adjacent said pressure applying means, thereafter progressively freezing the remainder of said column of freezable liquid between the said one end thereof and the other end thereof.

4. The method of applying high pressures to a body to effect a change of state therein comprising associating said body and a quantity of freezable, expansible liquid in pressure transmitting relation to each other, interposing a pressure applying means between said body and said liquid, confining said body, liquid and pressure transmitting means in a chamber having cold conductive walls, subjecting a portion of said chamber to sub-freezing temperatures to freeze a portion of said liquid immediately adjacent said pressure transmitting means, and thereafter freezing the remainder of said liquid whereby to exert a longitudinally directed pressure upon said pressure transmitting means.

5. The method of applying predetermined pressures to a body comprising longitudinally relating said body with a column of freezable, expansible liquid, interposing a movable pressure applying means between said body and said liquid column, confining said body, liquid column and pressure applying means, subjecting a portion of said liquid column adjacent said pressure applying means to a temperature for freezing said liquid column portion to form a seal, and thereafter lowering the temperature of the remainder of said liquid column to a freezing condition whereby to exert longitudinally directed pressure relative to said pressure applying means, said last mentioned pressure being substantially inversely related to said predetermined pressures.

6. The method of applying pressure to a body comprising providing an elongated confining chamber, disposing a column of freezable, expansible liquid within said chamber, locating said body within said chamber in longitudinal relation to said liquid column, disposing pressure applying means between said liquid column and said body, subjecting a limited zone of said chamber to temperatures for freezing a portion of said liquid column adjacent said pressure applying means, and thereafter subjecting the remainder of said chamber to temperatures for freezing the remainder of said liquid column.

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