United States Patent [19]

Boyer et al.

[11] **3,741,718**

[45] **June 26, 1973**

[54] **APPARATUS FOR LOADING A HIGH-PRESSURE FURNACE**

[75] Inventors: **Charles B. Boyer**, Columbus; **Franklin D. Orcutt**, Galloway; **Robert L. Shaw**, Columbus; **Galen C. Gregg**, West Jefferson, all of Ohio

[73] Assignee: **Battelle Memorial Institute**, Columbus, Ohio

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[21] Appl. No.: **186,607**

[52] **U.S. Cl.** **432/253**, 432/261, 432/162, 13/25, 13/31, 13/33, 432/5

[51] **Int. Cl.** **F27b 14/00**, F27d 3/00

[58] **Field of Search** 263/6, 52, 41, 47, 263/48; 13/33, 25, 31; 432/162, 253, 5, 261, 262

[56] **References Cited**

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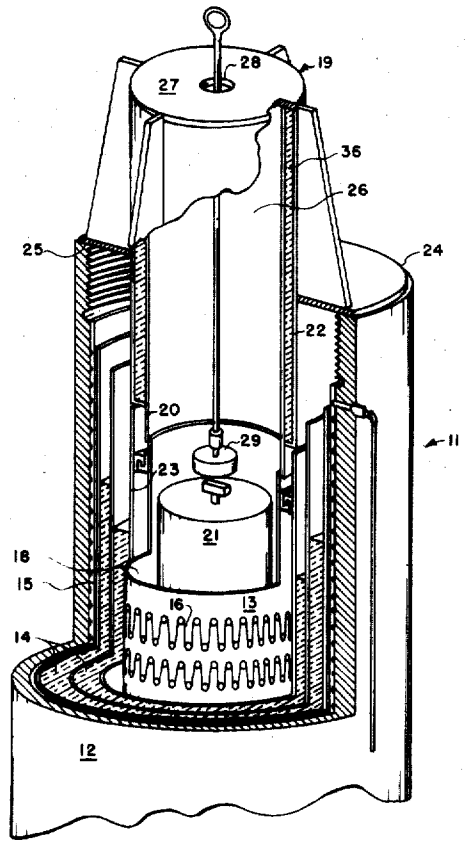
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Primary Examiner—John J. Camby
Assistant Examiner—Henry C. Yuen
Attorney—John L. Gray, Philip M. Dunson et al.

[57] **ABSTRACT**

A method and apparatus that decrease the time normally used in a high-pressure, high-temperature furnace for heating a material to be treated to a desired temperature prior to treatment and cooling that material to low temperatures after the treatment. The material is heated prior to insertion into the furnace and held within a thermally insulated container having a means of communicating with the hot zone of the furnace until insertion is desired and the normal treatment carried out. Subsequent to the treatment the material is again placed within the container and allowed to cool or possibly subjected to further thermal treatments within the container. The use of this holding apparatus allows greater utilization of the high-pressure, high-temperature furnace by freeing it from the function of routine heating and cooling of the treated materials.

5 Claims, 4 Drawing Figures



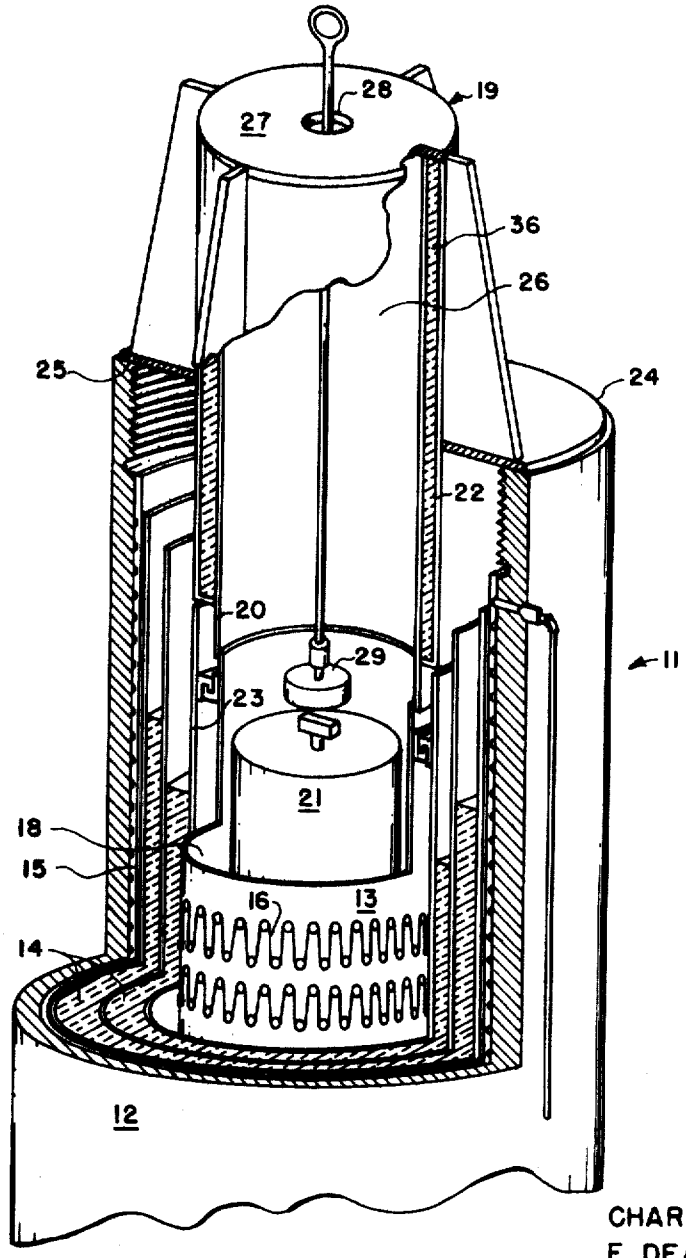


Fig. 1

CHARLES B. BOYER
F. DEAN ORCUTT
ROBERT L. SHAW
GALEN C. GREGG
INVENTORS

BY

Gray, Mase & Dunson
ATTORNEYS

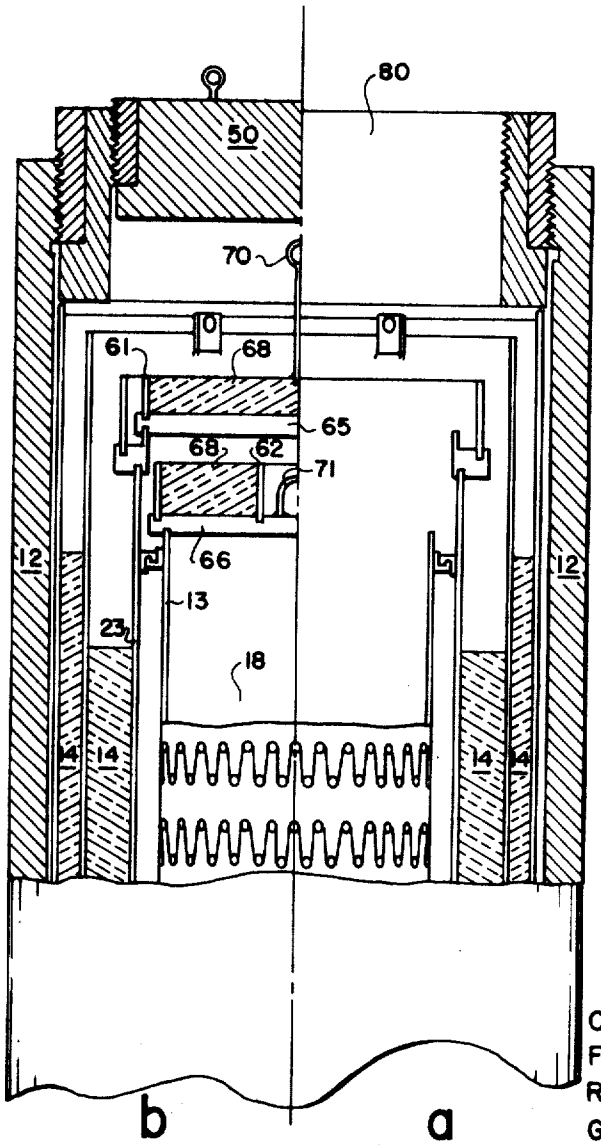


Fig. 2

CHARLES B. BOYER
F. DEAN ORCUTT
ROBERT L. SHAW
GALEN C. GREGG
INVENTORS

BY

Gray, Mase & Dunson
ATTORNEYS

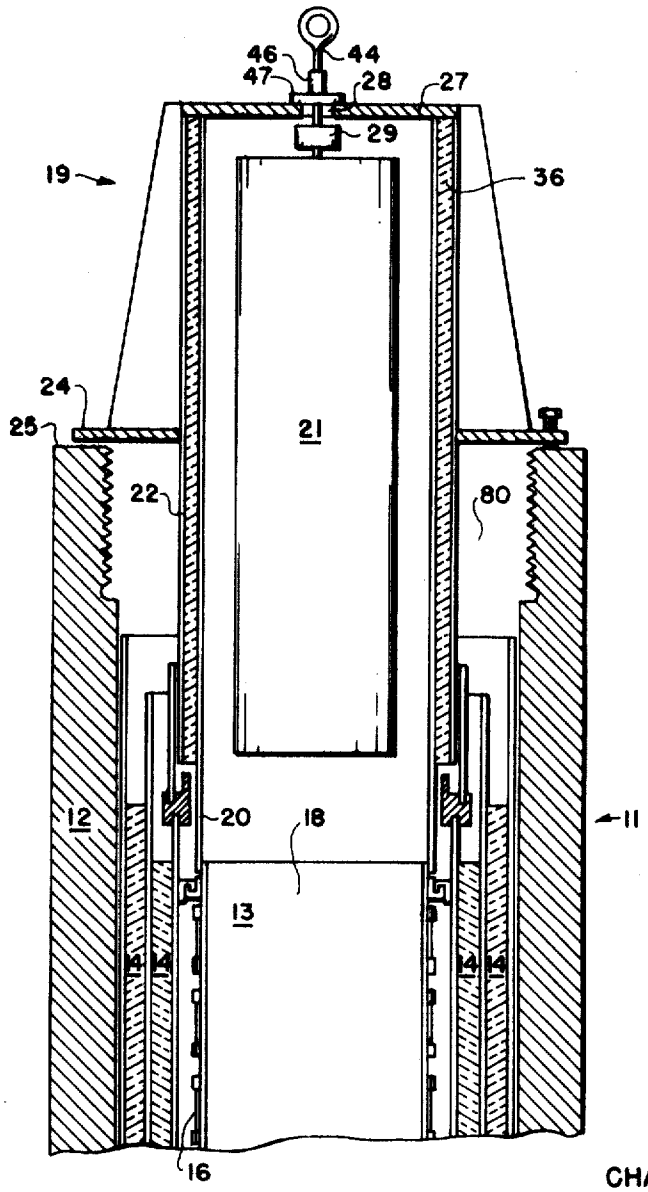


Fig. 3

CHARLES B. BOYER
F. DEAN ORCUTT
ROBERT L. SHAW
GALEN C. GREGG
INVENTORS

BY

Gray, Mase & Dunson
ATTORNEYS

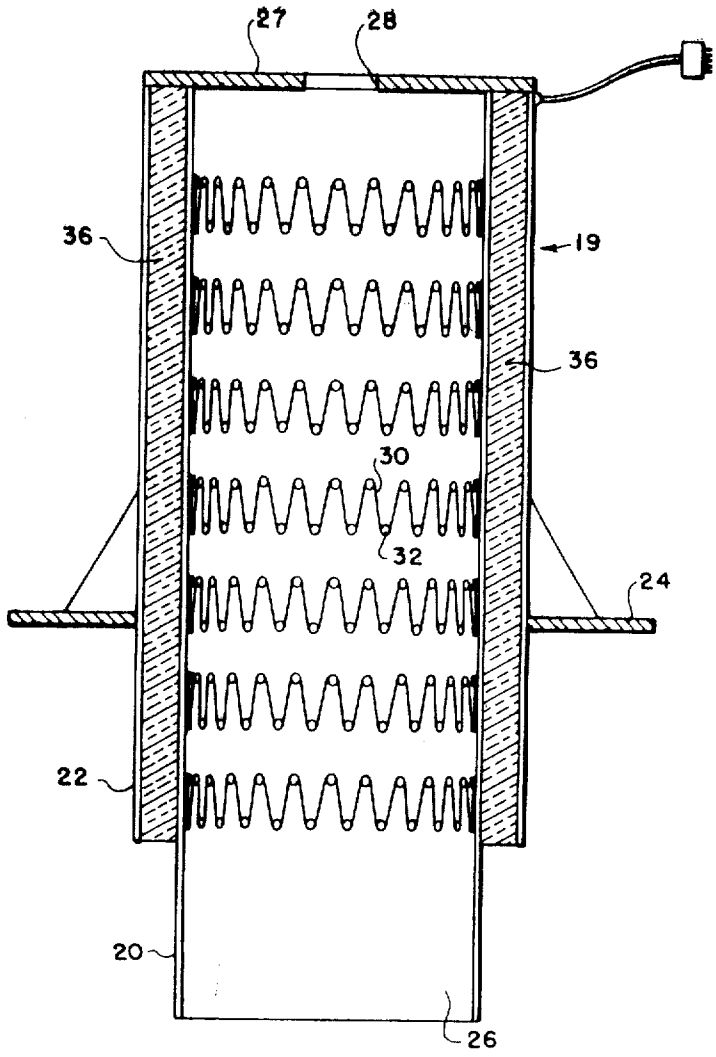


Fig. 4

CHARLES B. BOYER
F. DEAN ORCUTT
ROBERT L. SHAW
GALEN C. GREGG
INVENTORS

BY

Gray, Mase & Dunson
ATTORNEYS

APPARATUS FOR LOADING A HIGH-PRESSURE FURNACE

BACKGROUND OF THE INVENTION

This invention relates generally to an apparatus for loading and unloading a workpiece from a furnace and more particularly to apparatus for loading and unloading a high-pressure, high-temperature furnace such as disclosed in U.S. Pat. No. 3,427,011, Boyer et al.

The invention is particularly adapted to use with high-pressure furnaces used for gas-pressure bonding and hot isostatic compaction of particulate materials. Briefly, the gas-pressure bonding process utilizes isostatic gas pressure and elevated temperatures to form a solid-state bond between metal or ceramic parts. The process of hot isostatic compaction uses high-temperature gas and high pressures to compact and bond particulate metal or ceramic materials into a fully dense component. While the feasibility of bonding and densifying various materials with a high-temperature, high-pressure process has been successfully demonstrated, several inherent shortcomings of the batch-type process have precluded commercial acceptance of this technique.

As this technique is now used, the cold workpiece to be treated is placed in the cold furnace cavity, insulation is packed above the furnace, the sealing head for the vessel is replaced, and the furnace is brought to temperature, while applying the gas pressure. After a specified time at high temperature and pressure, the pressure is released and the furnace is allowed to cool permitting the treated workpiece to be removed. A process of this type can consume 12 hours which can severely limit the availability of the equipment and therefore the cost efficiency of the process.

The present invention seeks to alleviate the inefficient use of the high-pressure furnace by providing a means to load and unload the workpiece while it is hot.

SUMMARY OF THE INVENTION

The present invention consists of a means of hot loading and unloading a furnace with a device consisting of two coaxial metal shells separated by a layer of thermal insulation with the device partially inserted into the furnace chamber through the main head opening. A workpiece is suspended inside the device and may be preheated either by a previous treatment or process or by heating coils within the device. The workpiece can be inserted into the preheated furnace while hot, thereby eliminating a time consuming heat-up cycle. The device may be provided with seals to prevent excessive heat escape during the loading process. The same device is also used for removal of the workpiece subsequent to the pressure cycle. Upon removal of the workpiece from the furnace into the device, the device and workpiece can be removed from the high-pressure furnace and further cooled thereby freeing the high-pressure furnace for reloading. The use of the present invention may reduce cycle times of the process 75 percent and thereby enhance the commercial feasibility of gas-pressure bonding and isostatic compaction.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an isometric view of a high-pressure furnace with the present invention in place and the workpiece within the furnace;

FIG. 2 is a cross-sectional view of a high-pressure furnace with the closure head and internal heat shields in place in view *a* and removed in view *b*;

FIG. 3 is a cross-sectional view of the high-pressure furnace having the present invention inserted into the furnace opening with the workpiece contained within the device; and

FIG. 4 is a cross-sectional view of the device separate from the furnace showing the possible use of internal heating elements to preheat the workpiece.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, the high-pressure furnace **11** is comprised of an open-ended cylindrical steel pressure vessel **12** containing a cylindrical heating element support **13** with layers of thermal insulation **14** between the pressure vessel wall **15** and the heating elements **16**. The pressure vessel **12** is not heated to significant temperatures since cooling water is circulated adjacent the inner wall **15** of the vessel. Access to the hot zone **18** is provided by the removal of the closure head **50** and the internal heat shields **61** and **62** shown in FIG. **2** but not shown in FIG. **1**. The removal of these components allows the loading device **19** to be inserted into the high-pressure furnace **11**.

The inner shell **20** of the device **19** has approximately the same inside diameter as the hot zone **18** and upon insertion abuts the heating element support **13**. This provides a smooth inner surface from the loading device **19** to the hot zone **18** preventing the workpiece **21** from catching on any protrusions while being lowered or raised. The inner shell **20** of the device **19** is separated from a second, shorter coaxial shell **22** by thermal insulation **36**. This second shell **22** abuts the heat shield **23** immediately adjacent to the heating elements **16** thus preventing excessive heat loss while the device **19** is in place. While these portions of the device **19** abut portions of the furnace **11**, the weight of the device **19** and the workpiece **21** when contained and fastened within it is carried by a support flange **24** that bears on the flat upper surface **25** of the high-pressure furnace **11** created when the closure head **50** is removed. The interior cavity **26** of the device **19** is closed at the end opposite the hot zone **18** by a member **27** having enough strength to support the weight of the workpiece **21** and transmit it to the support flange **24** when the workpiece **21** is retracted up into the interior cavity **26** and fastened to the device **19** prior to removal of both the device **19** and the workpiece **21**. A central opening **28** in the member **27** allows a coupling **29** to be lowered through the device **19** to attach to the workpiece **21**. This opening **28** may contain a thermal insulating seal, not shown, to prevent heat loss out of the device **19**.

FIG. **2** shows the two configurations of the high-pressure furnace with view *a* showing it ready to accept the loading device through an access port **80**, and view *b* showing it loaded and completely closed ready to pressurize. The members **61** and **62** are thermally insulated baffles that both reduce the heat conduction toward the closure head **50** and prevent the formation of convextion currents of hot gases within the high-pressure furnace during operation. The baffles consist of metal plates **65** and **66** with insulating material **68** on top of each plate. The metal plates **65** and **66** are supported by the coaxial shells within the furnace **65** by

the heating element support 13 and 66 by the adjacent shell 23. The baffles are removed by attaching a hook to an eye 70 and 71 on the plates 65 and 66 and simply lifting them out of the access port 80.

FIG. 3 shows the loading device 19 inserted in the access port 80 of the high-pressure furnace 11 with the workpiece 21 suspended within the device 19. This configuration illustrates the manner with which the workpiece 21 and the loading device 19 are attached before loading. The workpiece 21 is suspended from a detachable coupling 29 that also forms a heat baffle restricting heat flow out of the opening 28 in the top plate 27 of the device 19. The coupling 29 is suspended on a shaft 44 having a means such as an eye to attach a lifting device. On this shaft 44 is a projection 46 that rests on a removable plate 47 with the plate 47 preventing the projection 46 from passing through the opening 28 and thereby suspending the workpiece 21 from the top plate 27 of the device 19. The workpiece 21 is lowered into the furnace hot zone 18 by lifting the workpiece 21 slightly to facilitate removal of the plate 47 and then lowering the workpiece 21 down into the hot zone 18 by a lifting device passed through the opening 28. When the workpiece 21 comes to rest on the bottom of the furnace hot zone 18, the coupling 28 is removed from the workpiece attachment and raised to the lower surface of the top plate 27 where the removable plate 47 is again inserted. The device 19 can then be removed from the furnace 11 allowing the high-pressure furnace 11 to be prepared for pressurization.

Referring now to FIG. 4 where the device 19 has the added capability of heating the workpiece 21 before or after the high-pressure treatment through the use of self-contained heating elements 30. These heating elements may consist of conventional resistance heating elements or those similar to the pressure furnace. As disclosed, the means for heating the workpiece 21 consist of heating elements 30 of the same type as the furnace 11 being a cylindrical metal shell 20 with a series of cylindrical insulators 32 mounted thereon. The heating elements 30 are wound in a serpentine manner around the insulators 32. The elements 30 may be arranged in zones in the same manner as the heater 16 of the furnace 11 as to provide accurate temperature control of the workpiece 21 while it is contained within the device 19.

To carry out the complete process utilizing the subject invention, the furnace 11 should be at an elevated temperature below that temperature where the heating element would be damaged by exposure to the atmosphere. This preheating of the furnace can be the result of a previous cycle or the preparation for the next cycle. The closure head 50 and the internal heat baffles 61 and 62 must be removed as shown in FIG. 2. The workpiece 21 is now contained in the loading device 19 where it can be preheated either by an external heat source, a previous pressure-temperature cycle, or from the internal heater 30 as shown in FIG. 4. When the furnace 11 and the workpiece 21 are at the proper temperature, any temporary insulation in place in the access-port of the furnace 11 is removed and the device 19 with the workpiece 21 container is inserted into the access port 80 as shown in FIG. 3. The workpiece 21 is then lowered into the hot zone 18 of the furnace 11 as shown in FIG. 1 and the device 19 is removed. The internal heat baffles and the closure head are replaced and the furnace 11 is filled with pressurized inert gas. When the atmosphere in the hot zone 18 is sufficiently pure, the temperature and pressure are raised to the desired values for the bonding or compaction process.

When the high-pressure, high-temperature process is completed, the pressure and temperature are reduced to a point of atmosphere pressure and the temperature at which the furnace was loaded. The closure head and the internal heat baffles are removed and the device 19 is inserted into the furnace 11. The workpiece 21 is drawn up into the device 19 as shown in FIG. 3 by means of a coupling 29 and the entire assembly of the device 19 plus the workpiece 21 is removed from the furnace 11. The furnace 11 is now in readiness for the insertion of another workpiece 21.

After the previously treated workpiece 21 has been removed from the furnace 11, it can be allowed to cool slowly inside the device 19, removed, and allowed to cool rapidly or the device 19 equipped with an internal heater 30 can control the cooling rate or even perform additional thermal treatments.

The device 19 is also applicable to high-temperature, high-pressure furnaces that have removable heating assemblies 13 as disclosed by U. S. Pat. No. 3,427,011, Boyer et al. In that concept the heating assembly 13 is provided with convenient electrical connections and the workpiece 21 and the heater assembly 13 are moved as a unit. The device 19 would then accommodate this unit with no need for internal heaters 30 provided in the device 19.

It is to be understood that the description of the embodiments of the invention in no way limits the scope of the invention with many possible modifications and variations remaining within the scope and spirit of the invention as herein disclosed and claimed.

We claim:

1. An apparatus for loading and unloading a furnace with said apparatus consisting of:
   a. a first cylindrical shell having an inside diameter substantially the same as the hot zone of said furnace;
   b. a layer of thermal insulation surrounding said first shell disposed to prevent escape of heat from the cavity within said first shell;
   c. a second shell surrounding said insulation and said first shell;
   d. a closure at one end of both shells provided with an access port to said cavity within the shells; and
   e. a radial protrusion from said shells at the end opposite said closure with said protrusion disposed to support said apparatus when said apparatus is in place over an opening having a diameter greater than that of either of said shells.

2. The apparatus of claim 1 where said first shell projects below the extremity of said second shell at the end of said second shell opposite said closure and where said radial protrusion emanates from said extremity of said second shell.

3. The apparatus of claim 1 where said cavity contains heating elements disposed to heat material placed within said cavity.

4. The apparatus of claim 1 where said closure includes thermal insulation.

5. The apparatus of claim 4 where said thermal insulation includes a means of preventing heat loss through said access port from said cavity.

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