N87-14704

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NASA CASE NO. NPO-16,892-1 CU

PRINT FIG. 1

129.

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(NASA-Case-NPC-16892-1-CU) ACTIVE HOLD-DOWN FOR HEAT TREATING Patent Application (NASA) 12 p
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G3/37 43755

AWARDS ABSTRACT

Contractor: Jet Propulsion Laboratory JPL No. 16892
NASA No. NPO-16892-1-CU

Inventor: Earl R. Collins, Jr. September 16, 1986

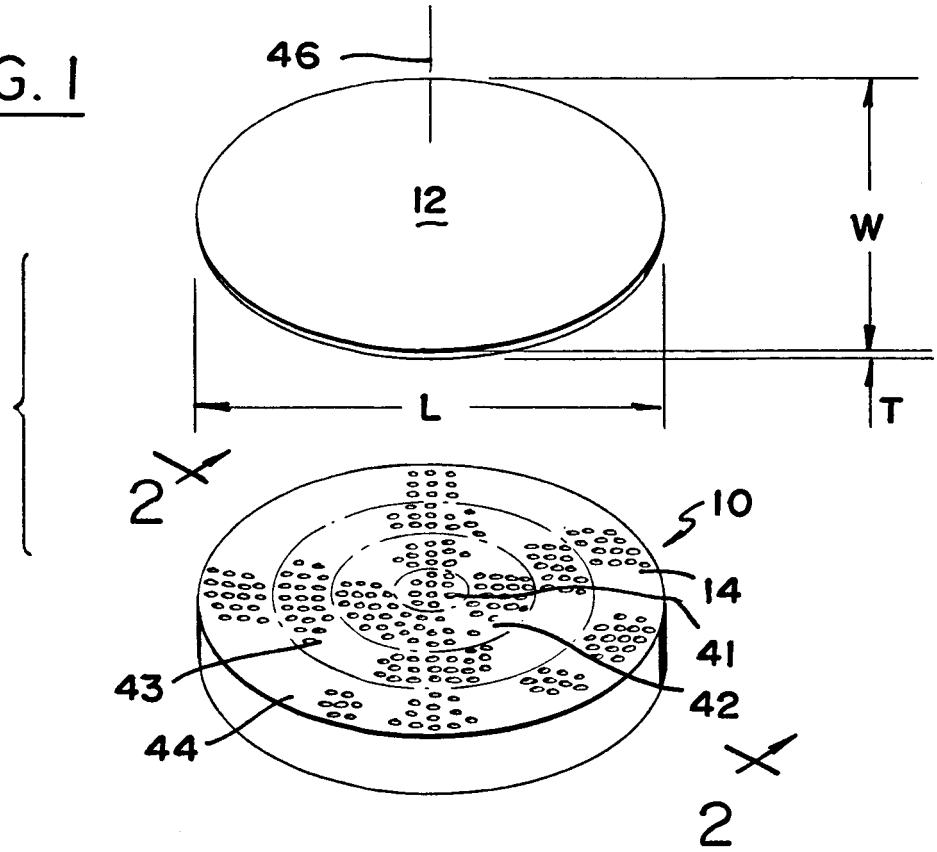
ACTIVE HOLD-DOWN FOR HEAT TREATING

The object of the disclosure is to provide a vacuum hold-down for holding thin sheets to a support surface, which permits the thin sheets to change dimensions as it is held down.

The hold-down includes numerous holes 18 (Fig. 2) in the support surface, through which a vacuum is applied from vacuum source 26. The holes are arranged in zones 41-44. The vacuum is repeatedly interrupted at only one or a few zones (such as 43), while it continues to be applied to other zones, to allow the workpiece to creep along that interrupted zone. The vacuum to different zones is interrupted at different times, as by a slowly turning valve member 52, to allow each zone of the workpiece to creep. A positive pressure may be applied from a pressured air source 59 to a zone when the vacuum is interrupted there, to help lift the corresponding workpiece zone off the surface to aid in creeping. The workpiece may undergo dimensional changes because of heating, cooling, drying, or other procedure.

The major novel feature is interrupting the vacuum to different zones of a support surface at different times, to allow a thin workpiece to change dimensions while it continues to be held down.

FIG. 1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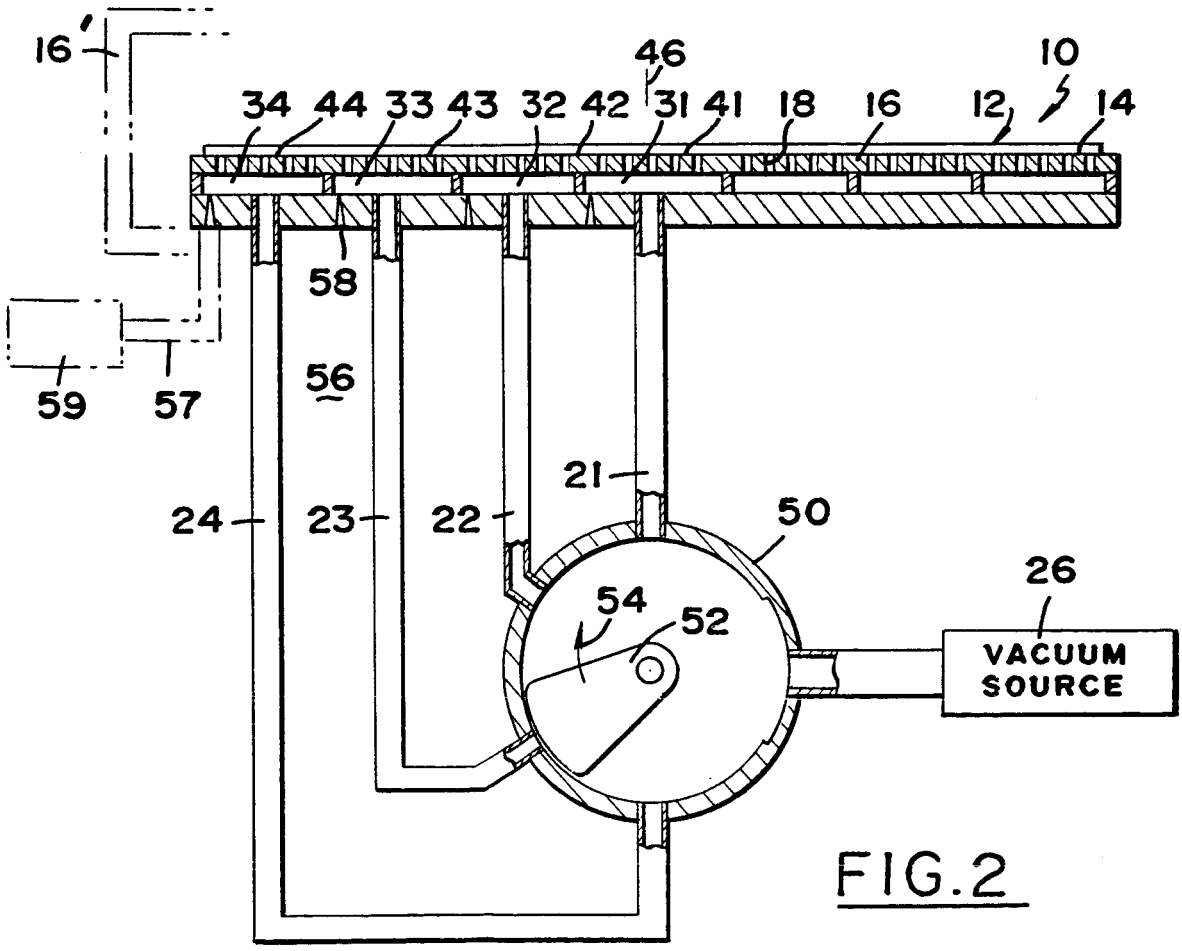
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VACUUM SOURCE

FIG. 2

FIG. 3

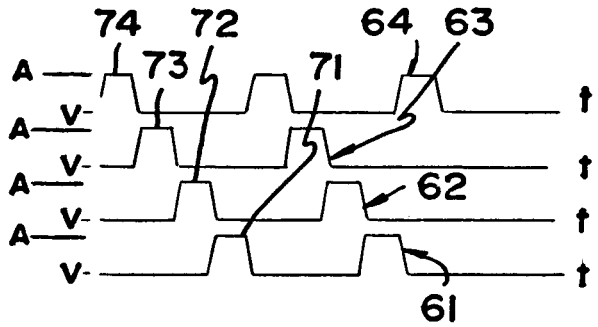
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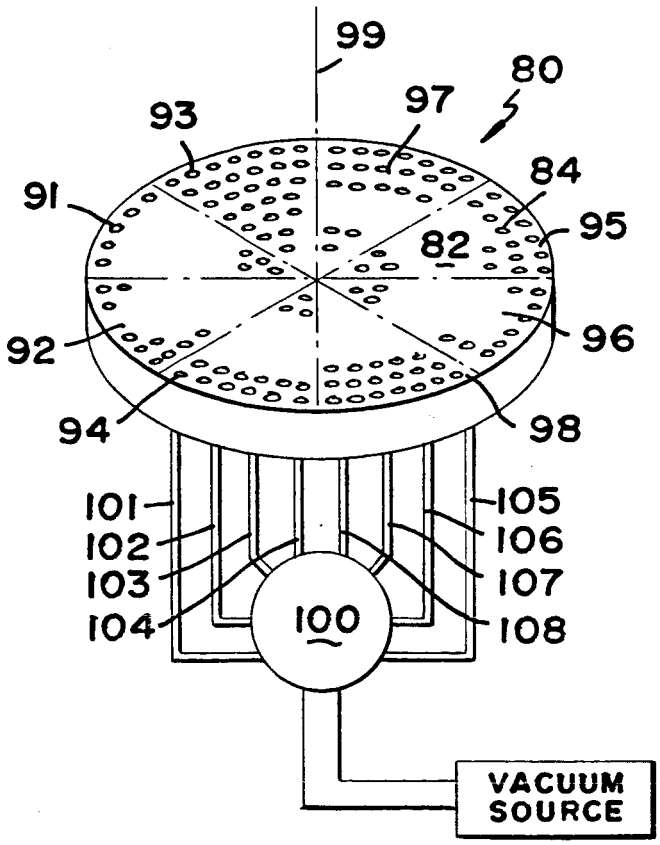
FIG. 4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VACUUM SOURCE

JPL Case No. 16892
NASA Case No. NPO-16892-1-CU

ACTIVE HOLD-DOWN FOR HEAT TREATING

ORIGIN OF INVENTION:

The invention described herein was made in the performance of work under a NASA contract, and is subject to the provisions of Public Law 96-517 (35 USC 202) in which the Contractor has elected not to retain title.

BACKGROUND OF THE INVENTION:

Thin sheets, called tapes, that are used in manufacturing oxygen membranes, capacitors, etc., are formed by squeegeeing a slurry into a thin film, allowing the film to dry to a rubbery condition, and then baking the film in an oven wherein it shrinks and achieves a brittle consistency. During baking, the film must be held down against a flat or other surface to which the final sheet is to conform, to avoid curling of the sheet into a brittle unwanted shape. A vacuum hold-down can be used to hold the sheet while it is baked. However, it is found that the sheet is subject to cracking as it shrinks, due to the vacuum holding all portions of the original sheet in their original positions. A device for holding thin workpieces against a surface, which enabled the workpieces to change dimensions while they continued to be held closely against the surface, would be of value in the forming of the sheets described above as well as other thin workpieces that had to be heat treated.

SUMMARY OF THE INVENTION:

In accordance with one embodiment of the present invention, a hold-down device is provided for

holding a thin workpiece while it undergoes dimensional changes, which permits creep of the workpiece to enable dimensional change thereof without deformity while continuing to hold the workpiece closely against a support surface. The wall which forms the support surface has a mulitiplicity of holes arranged in a plurality of zones. A means for applying vacuum to the holes to hold the workpiece against the surface, is constructed to repeatedly stop applying the vacuum to different of the zones at different times while continuing to apply the vacuum to other zones. At the time the vacuum is interrupted at the zone, the portion of the workpiece at that zone can creep along the support surface, and yet that zone of the workpiece is held substantially to the support surface by the vacuum applied to adjacent zones.

The novel features of the invention are set forth with particularity in the appended claims. The invention will be best understood from the following description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS:

Fig. 1 is a perspective view of a vacuum hold-down constructed in accordance with one embodiment of the present invention.

Fig. 2 is a view taken on the line 2-2 of Fig. 1.

Fig. 3 includes a series of graphs showing the variation of pressure with time at each of the zones of the apparatus of Fig. 2.

Fig. 4 is a perspective view of another hold-down device of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS:

Figs. 1 and 2 illustrate a vacuum hold-down

device 10 which can hold a thin workpiece 12 against a support surface 14 while the workpiece undergoes a change in dimensions. Such change is usually a result of heat treating of the workpiece, as by heating and cooling it within an oven 15. The device includes an upper wall 16 which forms the support surface, and a multiplicity of holes 18 in the upper wall for applying a vacuum to the workpiece resting on the support surface to hold the workpiece tightly against the surface. A group of conduits 21-24 couple a vacuum source 26 to corresponding plenums 31-34 that lead to the holes to apply vacuums to the holes.

In prior art vacuum hold-downs, the vacuum was applied continuously while the workpiece was heat treated. Where the workpiece undergoes a significant change in lateral dimensions L and W (which are perpendicular to the thickness dimension T of the thin workpiece) while its temperature changes or a solvent of the like is driven from the workpiece, damage can occur to the workpiece. If the workpiece contracts, then tears can arise in the workpiece as the different portions draw apart, while if the workpiece expands, localized areas may develop wrinkles.

In one manufacturing operation for producing thin sheets, often referred to as tapes, for use in manufacturing oxygen membranes, dielectrics for capacitors, etc., a slurry is laid in a thin sheet and dried. The dried sheet has the consistency of rubber, and is then placed on a surface where it is heat treated in an oven, where it becomes brittle. During such heat treating, the tape or membrane shrinks. It is necessary to hold down the membrane during heat treating, or else it will curl away from the surface and will not have a flat or predetermined curved shape which is required in a particular application. A vacuum hold-down device is effective in holding the

membrane to a predetermined configuration such as in a flat sheet, but it was found that the sheet would develop tears as it tended to shrink while being firmly held by a vacuum against a support surface.

In accordance with the present invention, creep of the workpiece 12 is permitted while it continues to be held to the support surface 14 by vacuum. The multiplicity of holes 18 in the upper wall 16 of the device is arranged in a plurality of zones. In Figs. 1 and 2, the holes are arranged in four zones 41-44 that are in the form of circles or rings at different spacings from a center or axis 46 of the device. The holes in each zone are coupled to a corresponding one of the plenums 31-34 by a corresponding one of the four conduits 21-24. Each of the conduits is coupled through a valve means or device 50 to the vacuum source 26. The valve device 50 operates to interrupt or relieve the vacuum at the holes in at least some of the zones, so the pressure under the workpiece in each such relieved zone is substantially equal to atomospheric pressure, or ambient pressure where the furnace is at other than atmospheric pressure. Such vacuum relief allows the portion of the workpiece in the relieved zone to creep, either radially inwardly or outwardly.

By alternating the vacuum relieved zones among most or all of the zones, such creeping can progress across substantially the entire area of the thin workpiece, to allow it to change dimensions. The fact that the vacuum continues to be applied to some of the zones while one or more of the others is relieved, results in the workpiece being held down to the surface at a location near the relieved zone, so that the workpiece cannot curl or bend more than a very small distance away from the support surface at the relieved zone. Then, when the vacuum is reapplied to the previously relieved zone, the workpiece is again held

down to the support surface at that zone. By repeatedly altering the relieved zone, creeping can continue throughout heat treating, to produce a workpiece whose shape closely conforms to that of the support surface, but which can be free of tears and wrinkles.

In Fig. 2, the valve 50 includes a blocking member 52 that rotates in a direction 54, to relieve the pressure in conduit 24, then conduit 23, then conduit 22, and finally conduit 21. Thus, the relief zone progresses radially inwardly to permit the workpiece to shrink radially inwardly towards the axis 46. It may be noted that since the centermost zone 41 is at the center, it may not be necessary to repeatedly relieve the vacuum thereat. When the valve member 52 is blocking a particular conduit such as 23, air from the outside 56 is allowed to leak into the plenum 33 through a small leakage hole 58 leading from the environment at the same pressure as the area above the workpiece, into the plenum 33. It is possible to apply a slight positive pressure to the plenum such as 33 when the vacuum applied to the conduit such as 23 is relieved, to help break that zone of the workpiece away from the support surface to facilitate its creeping. This can be accomplished by coupling each bleed hole through a conduit 57 to a source 59 of air at a pressure slightly higher than the ambient pressure above the workpiece.

Fig. 3 includes graphs 61-64 which indicate the variation in pressure with time at each of the groups of holes at each zone 41-44. The pressure in each zone varies between a pressure A equal to ambient pressure, and a pressure V equal to a vacuum pressure. It can be seen that the removal of vacuum as indicated at 71-74 progresses radially inwardly along the zones and then repeats. The period during which the vacuum is

relieved throughout all zones whose vacuum is to be relieved, should occur during a change in dimensions of the unrestrained workpiece of no more than 1%. This is because most materials, other than elastomers, tend to become permanently deformed (and may tear or wrinkle) when their dimensions change more than on the order of 1%. The period during which the vacuum is no longer applied to each zone should be long enough so that the pressure in the plenum under the holes in the zone can fall to substantially ambient pressure (or rise to slightly above ambient pressure where positive pressure is applied). In one device of the type shown in Fig. 2, the valve member 52 makes one rotation about every four seconds, so that during a period of several minutes while the tape is heat treated, there are many vacuum relief cycles during which the workpiece can gradually creep along the support surface as its dimensions change.

Fig. 4 illustrates another vacuum hold-down device 80 which has a wall 82 with holes 84 arranged in eight zones 91-98 that are substantially pie-shaped and which are angularly spaced about the axis 99 of the support surface. A valve 100 connects a vacuum source through each of eight conduits 101-108 to the eight zones. The zone to which ambient or slightly above ambient pressure is applied, rotates around the axis 99. Thus, each pie-shaped area of the workpiece can creep inwardly or outwardly at one time. It is possible to have some holes near the intersection of two zones lie in both zones to facilitate creep.

Thus, the invention provides a vacuum hold-down device which permits a thin workpiece to undergo a dimensional change in its width and/or length, especially as the temperature of the workpiece changes, to avoid tearing or wrinkling of the workpiece. This is accomplished by repeatedly relieving the vacuum at

different zones at different times during the change in dimensions of the workpiece.

Although particular embodiments of the invention have been described and illustrated herein, it is recognized that modifications and variations may readily occur to those skilled in the art, and consequently, it is intended that the claims be interpreted to cover such modifications and equivalents.

ACTIVE HOLD-DOWN FOR HEAT TREATING

ABSTRACT OF THE DISCLOSURE

A vacuum hold-down is described, for holding a thin film workpiece while it undergoes large temperature changes and corresponding dimensional changes, which permits creep of the workpiece to avoid damage thereto while still holding it on a support surface. The support surface has a mulitiplicity of holes arranged in a plurality of zones. The vacuum is repeatedly interrupted at the holes lying at different zones while it continues to be applied at the other zones, to permit creep of the workpiece at a zone when vacuum is not applied thereto.