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REPLY TO ATTN OF: GP

October 21, 1970

TO: USI/Scientific & Technical Information Division
Attention: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General Counsel for Patent Matters

SUBJECT: Announcement of NASA-Owned U. S. Patents in STAR

In accordance with the procedures agreed upon by Code GP and Code USI, the attached NASA-owned U. S. Patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U. S. Patent No.	:	3,465,569
Government or Corporate Employee	:	Government
Supplementary Corporate Source (if applicable)	:	N. A.
NASA Patent Case No.	:	XMF-02964

NOTE - If this patent covers an invention made by a corporate employee of a NASA Contractor, the following is applicable:
Yes ☐ No ☒
Pursuant to Section 305(a) of the National Aeronautics and Space Act, the name of the Administrator of NASA appears on the first page of the patent; however, the name of the actual inventor (author) appears at the heading of Column No. 1 of the Specification, following the words ". . . with respect to an invention of . . ."

Dorothy J. Jackson
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Enclosure
Copy of Patent cited above

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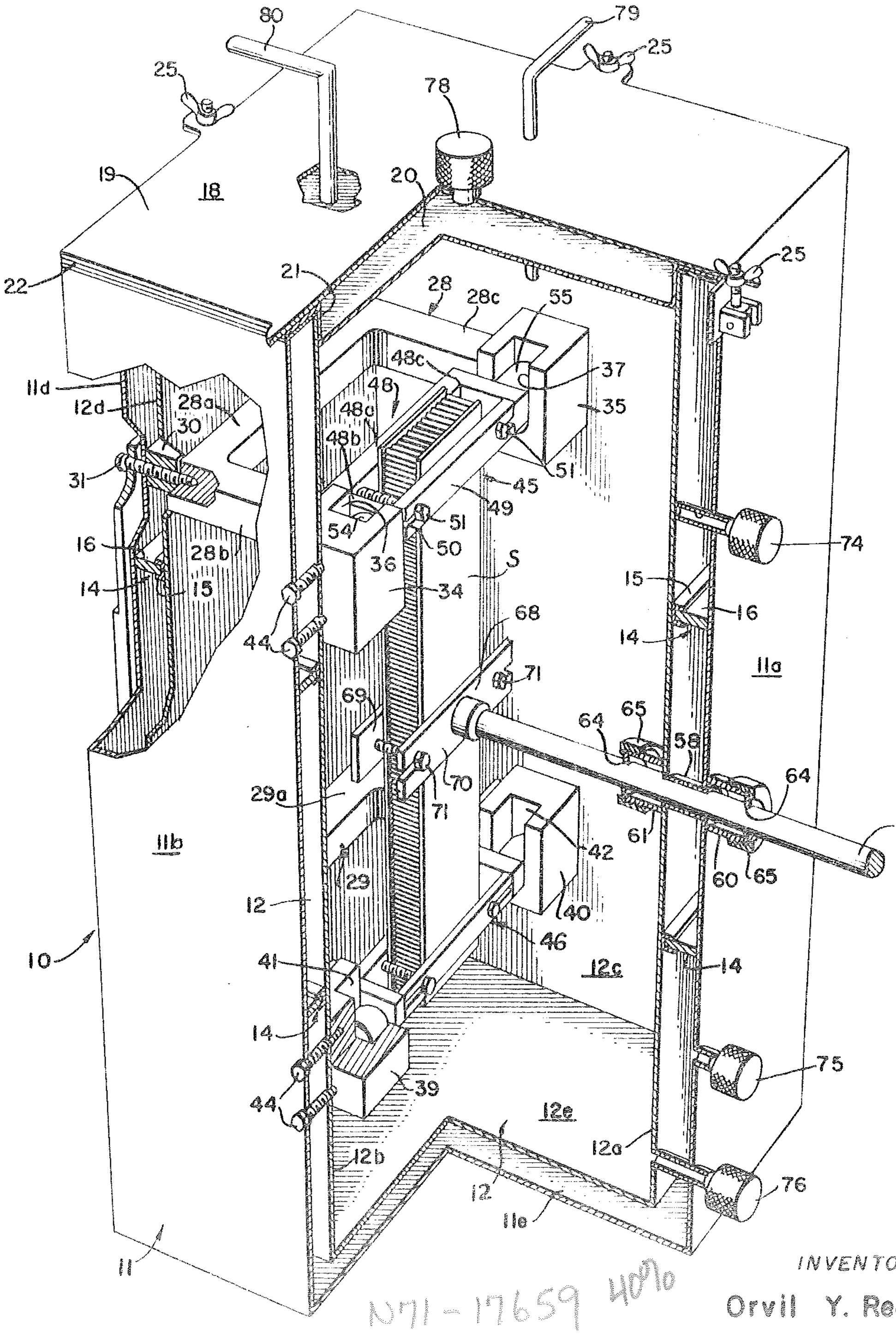
XM7-02964

LOW TEMPERATURE FLEXURE FATIGUE CRYOSTAT

Filed Oct. 7, 1965



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Patented Sept. 9, 1969

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3,465,569
LOW TEMPERATURE FLEXURE FATIGUE CRYOSTAT

Orvil Y. Reece, Huntsville, Ala., assignor to the United States of America as represented by the Administrator of the National Aeronautics and Space Administration

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Int. Cl. G01n *25/02*
U.S. Cl. 73—15.4 1 Claim

ABSTRACT OF THE DISCLOSURE

A flexure fatigue cryostat for testing of materials such as honeycomb panels at cryogenic temperatures. A vertically mounted, top-loading Dewar vessel is provided with upper and lower U-shaped yokes attached to the inner walls of the vessel. The ends of the legs of the yokes have opposed loading slots in which clamps are pivotally mounted. The test specimen is supported vertically at its ends by these clamps in a manner such that lateral movement is prevented, but upward movement and pivoting movement during flexure is allowed. Reciprocating flexure movement is imparted to the specimen intermediate its ends by means of a rod penetrating the front wall of the vessel, the end of the rod being clamped to the specimen.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to a cryostat constructed to test various specimens for flexure fatigue at various temperatures, and at especially low temperatures, including temperatures as low as —425° F.

The interest in strength studies of composite honeycomb structures and solids at very low temperatures has increased in recent years. This interest has been stimulated by the advances made in space travel and exploration at the earth's poles. It has become very desirable to accurately determine strength properties of the various composite materials utilized in equipment carried in these low temperatures well in advance of their use so that the probabilities of survival of human life can be calculated.

Accordingly, this invention comprises a flexure fatigue cryostat constructed to provide a means of flexure fatigue testing of various materials at atmospheric and cryogenic temperatures, such as those which will be encountered during pre-launch, launch, and flight conditions of a space craft. The invention comprises a vertically mounted, top loading Dewar vessel having interior load supports at its upper and lower ends and arranged so that a specimen of material to be tested can be pivotally supported at its ends in the load supports and flexed at a point intermediate its ends at various amplitudes and forces and for various lengths of time.

Accordingly, it is an object of this invention to provide a method of flexure fatigue testing of composite honeycomb and solid structures at various temperatures, including cryogenic temperatures.

It is another object of this invention to provide an apparatus for flexure fatigue testing composite honeycomb and solid materials at various temperatures, including cryogenic temperatures.

Another object of this invention is to provide apparatus for mounting various composite and solid materials within a cryostat whereby the materials can be pivotally supported near their ends and motion can be imparted thereto intermediate their ends.

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Other objects, features and advantages of the instant invention will be apparent from inspection of the following specification, taken in conjunction with the drawing, in which:

The single figure is a perspective view of the low temperature flexure fatigue cryostat, with parts broken away to show the interior components.

Referring now more particularly to the drawing, reference numeral **10** designates a Dewar vessel having spaced apart stainless steel walls or containers **11** and **12**. While a double wall vessel is disclosed, it should be understood that it is within the scope of this invention to utilize a vessel having several walls, the main criterion being that the interior portion of the vessel be insulated from the outer portion of the vessel, as by a vacuum, cryogenic fluid, insulating substance such as polyurethane foam, or any combination of these means. The outer and inner walls comprise, respectively, front portions **11***a*, **12***a*, side portions **11***b*, **12***b* and **12***c*, rear portions **11***d*, **12***d* and bottom portions **11***e* and **12***e*.

The inner and outer walls or containers **11** and **12** are uniformly spaced from each other by the spacers **14** positioned therebetween and spaced along their length. The spacers **14** comprise a U-shaped bracket **15** attached at the base of its U to the inner wall **12**. A material of low heat conductivity, such as Teflon, is inserted in the bracket and extends outwardly of the inner wall **12** to contact the inner surface of the outer wall **11**. Similar spacers (not shown) are positioned between the bottom portions of the inner and outer walls **12***e* and **11***e*, respectively.

The Dewar vessel is closed at its top by a double walled cover **18** of a construction substantially similar to that of the vessel itself. The cover **18** has outer wall **19** and inner wall **20** spaced apart from each other in their central portions, and at their edges the inner wall **20** is folded toward the outer wall **19** at **21** so that the cover exactly fits onto the top of the Dewar vessel **10**. A gasket **22** made from an insulating material, such as Teflon, is inserted between the cover **18** and the vessel **10** to insure that the vessel is sealed when the cover is in place, and to inhibit any heat transfer between the vessel **10** and its cover **18**. The cover **18** is secured to the vessel **10** by a plurality of securing means **25**, of the conventional wing-nut design.

Upper and lower load support yokes **28** and **29**, respectively, of substantially identical configuration are positioned near the upper and lower portions of the Dewar vessel. The yoke **28** has a base portion **28***a* and leg portions **28***b* and **28***c*. The lower yoke **29** is similarly shaped with a base **29***a* and leg portions (not shown). The yokes are dimensioned so that they conform with the interior dimensions with the inner wall **12** in that the bases **28***a* and **29***a* extend entirely across the width of the rear wall portion **12***b* of the inner wall **12** and the legs, such as legs **28***b* and **28***c* of the upper yoke **28**, extend forwardly from the rear wall portion **12***b* along the side wall portions **12***b* and **12***c* of the inner wall **12**, to a point substantially intermediate the front wall portion **12***a* and the rear wall portion **12***b* of the inner wall **12**.

A load support insert **30**, formed of stainless steel or a similar strong metal, is positioned between the outer and inner walls **11** and **12** of the Dewar chamber **10**, and extends substantially parallel to the base **28***a* of the U-shaped yoke **28**, between the rear portions **11***b* and **12***b* of the outer and inner walls, respectively. The yoke **28**, rear portion **12***b* of the inner wall **12**, load support insert **30** and rear portion **11***b* of the outer wall **11** are all apertured so that a cap-screw **31** can be inserted therethrough to firmly position the yoke **28** against the rear portion **12***b* of the inner wall **12**. With this arrangement it can be seen that the load support insert 30 helps to maintain the outer and inner walls 11 and 12 in their predetermined spaced relationship while it allows the cap-screw 31 to be securely threaded into the yoke 28 so that it is tightly pressed against the rear portion 12*b* of the inner wall 12. The lower yoke 29 is attached to the inner wall 12 in a similar manner.

The upper yoke 28 has brackets 34 and 35 positioned and welded to the ends of the legs 28*b* and 28*c* remote from the base 28*a* of the U-shaped bracket 28. The brackets 34 and 35 each have center facing slots 36 and 37 that are diametrically opposed and adapted to be vertical loading slots. The lower yoke 29 has similar brackets 39 and 40, each having diametrically opposed vertical loading slots 41 and 42, similar to those of the upper yoke 28. The brackets 34 and 35 of the upper yoke 28, and the brackets 39 and 40 of the lower yoke 29, are secured to the side walls of the Dewar vessel 10, such as side walls 11*b* and 12*b*, by the screws 44.

End clamps 45 and 46 of the offset bracket type are positioned in the diametrically opposed vertical loading slots of the upper and lower yokes, respectively. The end clamp 45 comprises a bracket 48 of a substantially U-shaped configuration having a base portion 48*a* and leg portions 48*b* and 48*c*. A cover 49, having slots 50 at its ends, is adapted to be secured to the base 48*a* of the clamp 48 by the cap screws 51.

The legs 48*b* and 48*c* of the U-shaped bracket 48 have diametrically opposed needle bearings 54 and 55 arranged to extend into the vertical loading slots 36 and 37 so that the end clamp 45 is pivotal along the axis of its needle bearings 54 and 55, in the loading slots 36 and 37.

The lower end clamp 46 is identical in construction with the upper end clamp 45 and is constructed to be pivotally supported by the vertical loading slots 41 and 42 of the lower yoke 29.

The front wall portions 11*a* and 12*a* of the outer and inner walls 11 and 12, respectively, are apertured at their center portions so that a load rod 56, constructed of a material such as titanium, can extend therethrough. In order to insulate the inner portion of the Dewar vessel from the atmosphere, a sleeve 58 is positioned and welded between the front portions 11*a* and 12*a* of the outer and inner walls 11 and 12, respectively, around the load rod 56 to prevent the vacuum existing in the space between the outer and inner walls from being lost through the apertures. Furthermore, the flanges 60 and 61 are connected to the outer and inner walls, respectively, the flange 60 extending outwardly from the outer wall and the flange 61 extending inward from the inner wall. The flanges 60 and 61 are externally threaded, and washers 64 of an insulating substance such as Teflon are positioned outwardly of each, and the caps 65 are threaded thereon to compress the washers against the flanges. The washers 64 are dimensioned to slideably but tightly fit around the load rod 56 so that the load rod can be reciprocated through the front wall portions 11*a* and 12*a* of the outer and inner walls 11 and 12 with a minimum of heat transfer between the atmosphere and the inner portion of the Dewar vessel 10.

The load rod 56 has a clamp 68 attached to its end projecting inside the Dewar vessel. The clamp 68 has parallel plates 69 and 70 fastened to each other by the bolts 71.

The Dewar vessel 10 has a bonnet valve 74 that is capable of communicating the area intermediate its outer and inner walls 11 and 12 with the atmosphere or with a vacuum pump for evacuating the air from between the walls 11 and 12. The vessel also has the conventional rupture disc 75 and a drain 76 at its lower portion. The cover 18 has a bonnet valve 78 for exerting a vacuum in its intermediate portion between its walls 19 and 20. The cover 18 also has a thermocouple 79 and a cryogen inlet 80 extending therethrough.

OPERATION

In operation of the low temperature flexure fatigue cryostat a sample of composite honeycomb material, such as the sample S shown in the drawing, is clamped at its ends by the clamps 45 and 46 and positioned inside the Dewar vessel 10; the clamps 45 and 46 being mounted in the diametrically opposed vertical loading slots of the upper and lower yokes 28 and 29. The composite honeycomb material S is also clamped in the clamp 68 and the cover 18 is fitted over the vessel 10 and secured thereon by means of the clamping means 25. A cryogenic fluid is admitted through the cryogen inlet 79 until the interior portion of the vessel is brought to the desired temperature, as determined by the thermocouple. When the vessel is at the proper temperature for a predetermined period of time so that the composite honeycomb substance S has attained the temperature desired for its test, the load rod 56 is reciprocated through the front wall portions 11*a* and 12*a* of the outer and inner walls 11 and 12.

The reciprocal movement of the load rod 56 is carefully calculated in amplitude and force exerted and number of reciprocations in order to determine accurately the strength of the material being tested inside the Dewar vessel.

It can be seen that vertical loading slots 36–37 and 41–42 of the upper and lower yokes 28 and 29 support the material being tested so that substantially no lateral movement is encountered at the ends of the material while the center portion of the material is free to be moved by the load rod 56. Also, since the end clamps 45 and 46 are pivotally mounted, substantially no shearing force will be encountered at the ends of the material since the ends of the material will be allowed to pivot along the axis of the needle bearings in their loading shots.

In the event that the length of the tested material changes during the fatigue testing of the material or when the material is initially cooled by the cryogenic fluid, the fact that the slots of the upper and lower yokes are open allows the material to be lengthened or shortened without restriction from the loading slots.

Thus, the resistance offered the loading rod is restricted to the bending or flexing resistance of the tested material plus any resistance from the sliding action of the load rod through the washers 64 of the flanges 60 and 61, which is easily precalculated. Accordingly, a very accurate determination of the tested material's resistance can be made at selected temperatures.

It will be obvious to those skilled in the art that many variations may be made in the embodiments chosen for the purpose of illustrating the present invention without departing from the scope thereof as defined by the appended claim.

I claim:

1. A low temperature cryostat of the type utilized to test the strength of materials at temperatures varying from atmospheric temperatures to extremely low temperatures, comprising in combination:

(a) a Dewar vessel open at one end and including an inner container and an outer container each having a front wall portion, side wall portions, a rear wall portion and a bottom wall portion;

(b) a cover for tightly closing said Dewar vessel;

(c) means for injecting cryogenic fluid into said Dewar vessel;

(d) means for supporting within said Dewar vessel a material to be tested, said means including;

 (1) a pair of load inserts spaced from each other along the length and between said rear wall portions of said inner and outer containers,

 (2) a pair of U-shaped yokes disposed in parallel relationship and having the base of their U attached to the rear wall portions and said load supports of said containers and the legs of their U attached to the side wall portion of said containers,

(a) said U-shaped yokes having in their legs at their ends remote from their base opposed loading slots,

(3) an end clamp pivotally mounted in said opposed loading slots of each said yoke and arranged to support a material to be tested at its ends in said opposed loading slots,

(e) a load rod reciprocally extending through the front wall portions of said inner and outer containers of said vessel;

(f) a clamp attached to the end of said load rod inside said vessel arranged to be clamped to the material to be tested at a portion thereof between said end clamps; and

(g) means for reciprocating said load rod.

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