NPO

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OCT 29 1970

REPLY TO
ATTN OF: GP

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.	: 3,493,291
Government or Corporate Employee	: California Institute Technology
Supplementary Corporate Source (if applicable)	: Jet Propulsion Laboratory
NASA Patent Case No.	: XNP-04111

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 . . ."

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Enclosure
Copy of Patent cited above

FACILITY FORM 602

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Feb. 3, 1970

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3,493,291

HIGH TEMPERATURE LENS CONSTRUCTION

Filed June 22, 1966

2 Sheets-Sheet 1

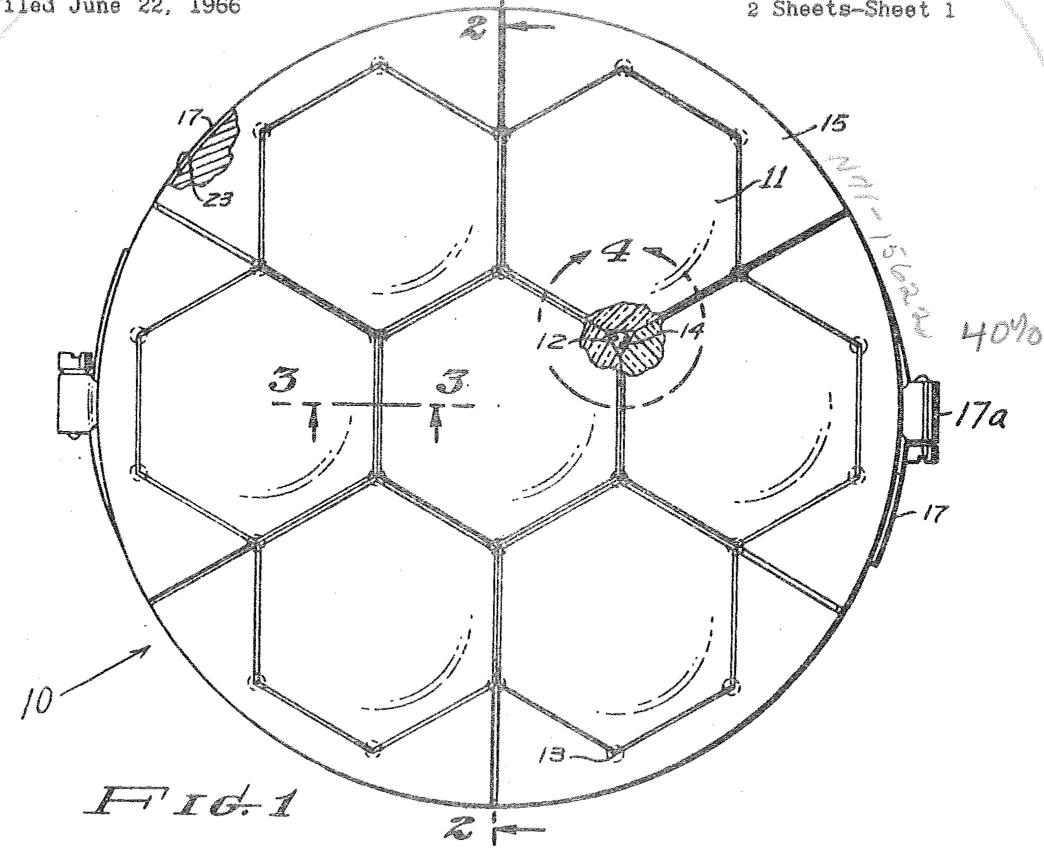

FIG. 1

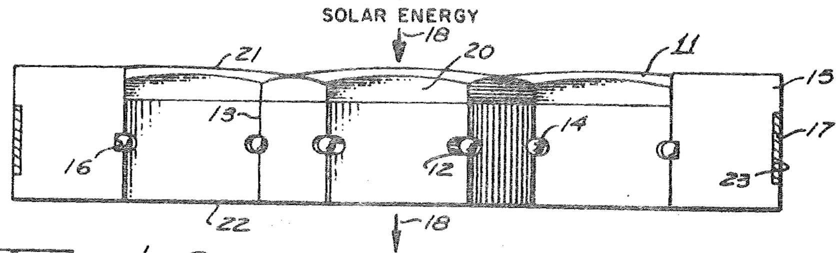

FIG. 2

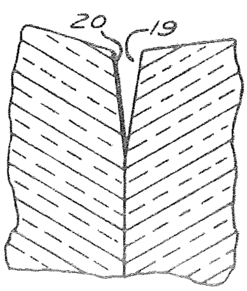

FIG. 3

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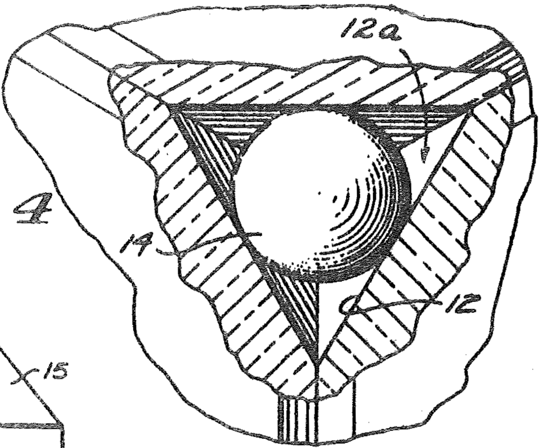

FIG. 4

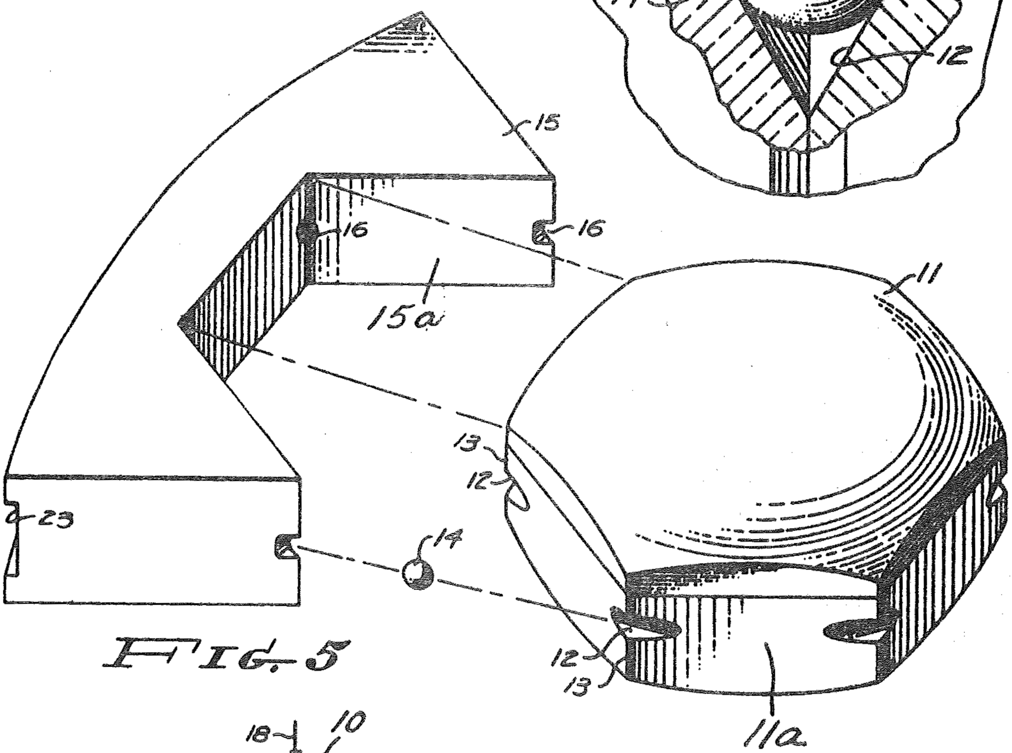

FIG. 5

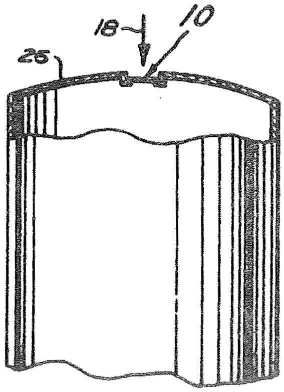

FIG. 6

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United States Patent Office 3,493,291
Patented Feb. 3, 1970

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3,493,291

HIGH TEMPERATURE LENS CONSTRUCTION

James E. Webb, Administrator of the National Aeronautics and Space Administration with respect to an invention of Kenneth R. Lorell, Altadena, Calif.

Filed June 22, 1966, Ser. No. 560,969
Int. Cl. G02b 3/00, 7/02
U.S. Cl. 350—213 1 Claim

ABSTRACT OF THE DISCLOSURE

An assembled lens formed of a plurality of adjacently disposed, individual lens blocks, each having an articulated peripheral surface including a plurality of substantially flat segments terminating along lines defining a plurality of corners disposed between adjacent segments and each corner being relieved midway between the ends thereof by an opening defining a transverse slot extending between the adjacent flat segments of the peripheral surface so that as the blocks are assembled an expanded recess common to the adjacent blocks is established at the corners thereof for receiving a spherical key seated therein and adapted to preclude relative displacement of the lens blocks, and a retainer ring having an articulated surface adapted to circumscribe and to mate with the exposed segments of the blocks for clamping the lens block into a rugged unitary lens member.

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 Section 305 of the National Aeronautics and Space Act of 1958, Public Law 85-568 (72 Stat. 435; 42 U.S.C. 2457).

This invention relates to a lens assembly and, more particularly, to improvements thereof.

Solar furnaces and solar simulators normally require a source of solar energy either from the sun or from an artificial source. The solar energy must have an entrance to the furnace or simulator through an opening. The opening of the furnace or simulator normally is provided with a lens inserted therein so that the internal environment of the furnace or simulator may be controlled.

As the lens in operation is subjected to high heat, a clear material that can withstand high heat must be used. As a practical matter quartz has been found to be a material that is clear and can withstand high heat without permanent deformity or destruction. Also, due to the high operative temperatures encountered, material expansion and contraction must be accommodated. Further, since the solar energy enters the chamber of the simulator at the input side of the lens and exits from the opposite, or output side of the lens an uneven heat distribution in the lens is experienced. To prevent lens destruction, the lens often is assembled by using several smaller quartz blocks in a group or cluster.

In the prior art of constructing a lens assembly by using several small blocks, the blocks of the lens assembly were held in place by cementing them together or by inserting the blocks in sections of an Invar web. The past designs worked satisfactorily as long as the temperatures encountered were low enough so that the supporting structures did not deform nor fail, or the cement did not melt. Though changes in the Invar web material or in the cement may satisfy conditions for a predetermined temperature range, the supporting material is of such size or quantity as to cause interference with transmission of the solar energy. It is, therefore, desirable to develop and provide a lens assembly that is stable and nondestructive

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at high temperatures and minimizes interference with the transmission of solar energy.

Accordingly, it is an object of this invention to provide a lens assembly which can be subjected to high temperature without structural failure.

It is an additional object of the present invention to provide a structurally stable lens assembly with a minimum interference to solar energy.

It is a further object of this invention to provide a lens assembly which will admit a maximum amount of solar energy through an established opening with a minimum of interference.

It is still a further object of the present invention to provide a lens assembly such that heat absorbed by the input surface will not cause the destruction of a lens block.

These and further objects of this invention will be apparent to those skilled in the art upon consideration of the accompanying specification, claim, and drawings of which:

FIG. 1 is a plan view of one embodiment of the present invention showing a complete lens assembly and having a sectional area showing a spherical interlock member in place;

FIG. 2 is a sectional view taken through 2—2 of FIG. 1 and illustrating the interlock features of the lens assembly;

FIG. 3 is an enlarged, fragmentary, sectional view taken through 3—3 of FIG. 1 for the purpose of illustrating the chamfered portion of the lens blocks;

FIG. 4 is a fragmentary, partially sectioned plan view, on an enlarged scale of the area designated 4 in FIG. 1;

FIG. 5 is an exploded fragmented view of a selected portion of the lens block assembly;

FIG. 6 is a partially sectioned elevational view of a portion of a typical solar furnace with which the disclosed embodiment of the present invention may be employed.

Reference is now made to the drawings, particularly to FIG. 1, wherein there is illustrated the lens assembly **10** embodying the principles of the present invention. The lens assembly is made up of a multiplicity of identical lens blocks **11** fabricated from quartz and carefully clustered together in a side-by-side, contiguous relationship within a common plane to form a compact lens unit. Each of the lens blocks **11** is of a hexagonal configuration having an articulated peripheral surface including a plurality of planar side surfaces **11***a*, FIG. 5, terminating at apexes or corners **13** established at the junctures of the side surfaces. A relief opening or slot **12** is formed midway, and traverses each of the corners **13** to extend between adjacent side surfaces. When the blocks have been assembled into a unitary structure, the slots **12** of the various blocks **11** are brought into alignment in a common plane to form enlarged recesses **12***a*, FIG. 4, common to the adjacent blocks and within which an interlocking or spherical key **14** is seated.

The interlocking member **14** preferably is formed of sapphire and is of a spherical configuration, FIGS. 4 and 5. Each spherical key is provided with a diameter such that the member **14** is of a sufficient size to extend into and substantially fill the recesses **12***a*. Hence, it can be appreciated that the interlocking members **14**, in practice, served to retain adjacent blocks in a common plane and to prevent the individual lens block **11** from being displaced relative to the plane of the lens assembly **10**.

With the spherical interlocking or key members **14** in place within the recesses **12***a*, the lens blocks **11** are carefully circumscribed by an articulated retainer ring **15**. The ring **15** is formed of any suitable number of segments and is fabricated from a suitable material such as aluminum. Since the ring 15 is to engage side surfaces of the hexagonal lens blocks 11 the ring is provided with a plurality of planar surfaces 15*a*, separated by apexes or corners in a manner such that the planar surfaces of the ring 15 may be brought into mating engagement with the surfaces of the lens blocks. Further, the ring 15 is provided with a plurality of recesses or slots 16 disposed at the corners provided between the planar surfaces thereof and adapted to be aligned with the slots 12, whereby the slots 12 and 16 serve to establish a plurality of recesses similar in nature and function to the recesses 12*a*, aforedescribed.

A circumscribing band 17 is placed about the outer periphery of the ring 15 to apply a confining pressure to the lens assembly 10 for forcing the blocks 11 together and to retain the individual blocks as a unit having a plurality of input surfaces 21 and exit surfaces 22. In the embodiment illustrated in FIG. 1, the band 17 is received in a groove 23 recessed or formed into the outer periphery of the retainer ring 15. The band 17 is adapted to be tightened through the use of conventionally screw-threaded band-clamps or couplings 17*a* which may be adjusted for tightening or tensioning the band, and consequently for forcing the ring 15 into engagement with the lens blocks 11. During use within a solar furnace or solar simulator, a solar energy source, represented by arrow 18, is caused to strike the input surface 21 of the lens blocks 11. The energy from the energy source causes an increase in temperature at the input surface. The lens blocks 11, thus is caused to experience a temperature differential between the input surface 21 and the output surface 22, which results in an expansion occurring in a non-uniform manner. Due to the non-uniform expansion of lens blocks 11, provisions must be made for accommodating the non-uniform expansion to prevent destruction of the lens blocks 11. This is achieved by providing the sides of the lens blocks 11 with a slight, approximately five degree, straight chamfer 20 extending inwardly and diagonally from the input surface 21 to provide an expansion space 19, arranged adjacent the input surface 21.

In the assembly of the lens, the spherical interlock members 14 are inserted into the slots 12 of the lens blocks 11 as the blocks are carefully grouped into a compact cluster. The retainer ring 15 is placed about the cluster of blocks in a manner such that the recesses 16 provided in the retainer ring between the surfaces 15*a* serve to cooperate with the adjacent slots 12 of the blocks 11 to form an enlarged recess which receives therein an interlocking or spherical key 14. The retainer ring 15 subsequently is banded by the band 17 seated in groove 23 and secured in place through the assistance of the tightening clamp 17*a*, whereby a unitized lens assembly 10 is provided to be employed in any desired manner.

The lens assembly 10, as illustrated in FIG. 6, in practice, is inserted within an input opening of a solar furnace or simulator 25. In this environment, the lens assembly allows solar energy, from an external source, to enter the chamber normally provided for the solar furnace or simulator 25 for utilization in a manner well known to those involved in solar experiments. When the lens assembly 10 is utilized in a solar furnace or simulator 25, wherein the chamber thereof is to be vacuumized, it is preferred that for sealing purposes the various contacting surfaces 11*a* of the blocks 11 of the lens assembly 10 be ground to "match," however, if desired, the mating surfaces of the blocks 11 may be coated with a suitable epoxy and cured thus to provide an air-tight seal. Once the internal pressures existing within the solar furnace or simulator 25 are reduced to a value below the external pressures existing without the simulator, a force resulting from barometric pressure differentials is applied to the lens blocks 11. However, displacement of the individual blocks 11 from the plane of the lens assembly 10, and relative to each other, is effectively precluded due to the interlocking effect of the interlock or spherical key members 14 seated within the recesses 12*a*.

As solar energy from either a natural or artificial source is caused to strike the lens assembly 24, the energy is allowed to flow through the assembly with a minimum of interference. Use of the interlock members 14 seated within the slots 12 provides an interlocking mechanism which provides for minimum interference with the flow of solar energy. Solar energy striking the lens assembly 10 effects a rise in temperature within the blocks 11. This rise in temperature, in practice, is not uniform throughout the thickness of the blocks 11, therefore a non-uniform expansion of the block is achieved, with the greater degree of expansion occurring near the input surfaces 21. This non-uniform expansion, however, is accommodated by the chamfer 20, adjacent to the input surfaces 21 which cooperate to provide a plurality of expansion spaces 19. Hence, the spaces 19 permit the material of the lens blocks 11 to expand for thus allowing non-uniform expansion to occur throughout the lens blocks 11 without damaging the assembly 10.

What is claimed is:

1. A lens assembly to be employed in a high-temperature environment for transmitting solar-like energy therethrough comprising:
   (A) a plurality of mated hexagonal lens blocks arranged in co-planar relationship, each block including:
      (1) an input and output surface, the surfaces being in parallel relationship,
      (2) six side surfaces normal to said input and output surfaces;
   (B) a slot in each block at each of the apex junctures between adjoined side surfaces, the slots being substantially parallel to said input and output surfaces; said slots combining at each optical juncture of adjacent blocks to form a common recess;
   (C) a plurality of spherical key members, one disposed in each recess to lock the mated blocks against relative movements;
   (D) a segmented ring circumscribing and in intimate mated engagement with the peripherally located mated blocks and keyed to said peripherally located blocks in the same manner as the blocks are keyed to each other;
   (E) a bevel on each side of each block adjacent the input surface thereof to provide a chamfer with adjacent mating blocks for accommodating thermal expansion imposed on the blocks; and
   (F) a band circumscribing said ring including an adjustable band-tensioning means for tensioning the band to thereby apply radially directed pressure to the assembly.

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U.S. Cl. X.R.

126—270; 350—253