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NASA CASE NO. LAR 14775-1

PRINT FIG. 1

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Serial No.: 07/881,912
05-12-92 LaRC

NASA Case No. LAR 14775

AWARDS ABSTRACT

APPARATUS FOR ELEVATED TEMPERATURE COMPRESSION OR TENSION TESTING OF SPECIMENS

Future generation supersonic civilian transport must be capable of flying in excess of mach 2 and yet be able to carry roughly 200-300 passengers. To meet the weight requirements imposed by such a design, advanced graphite reinforced composites are being considered for both primary and secondary structural components. In general, these advanced composite materials exhibit many of the characteristics required for certification over the expected lifetime of the aircraft. However, the high operating temperature along with the increased toughness of the new polymer matrix composites has made it apparent that elastic linear, rate-independent analysis procedure will not be sufficient for a complete characterization of the material behavior.

A novel testing apparatus has been designed to determine certain characteristics of materials which are important in evaluating the suitability of these materials for use on supersonic civilian aircraft. The testing apparatus consists of applying tension and compression loads to opposite ends of a test specimen and measuring the resultant tensile and compressive strain in the test specimen. Heat is applied to the test specimen through two supports which surround the specimen and are heated by some external means. To prevent heat loss, the supports and specimen may be surrounded by thermal insulation. The supports also prevent buckling of the specimen during compression testing.

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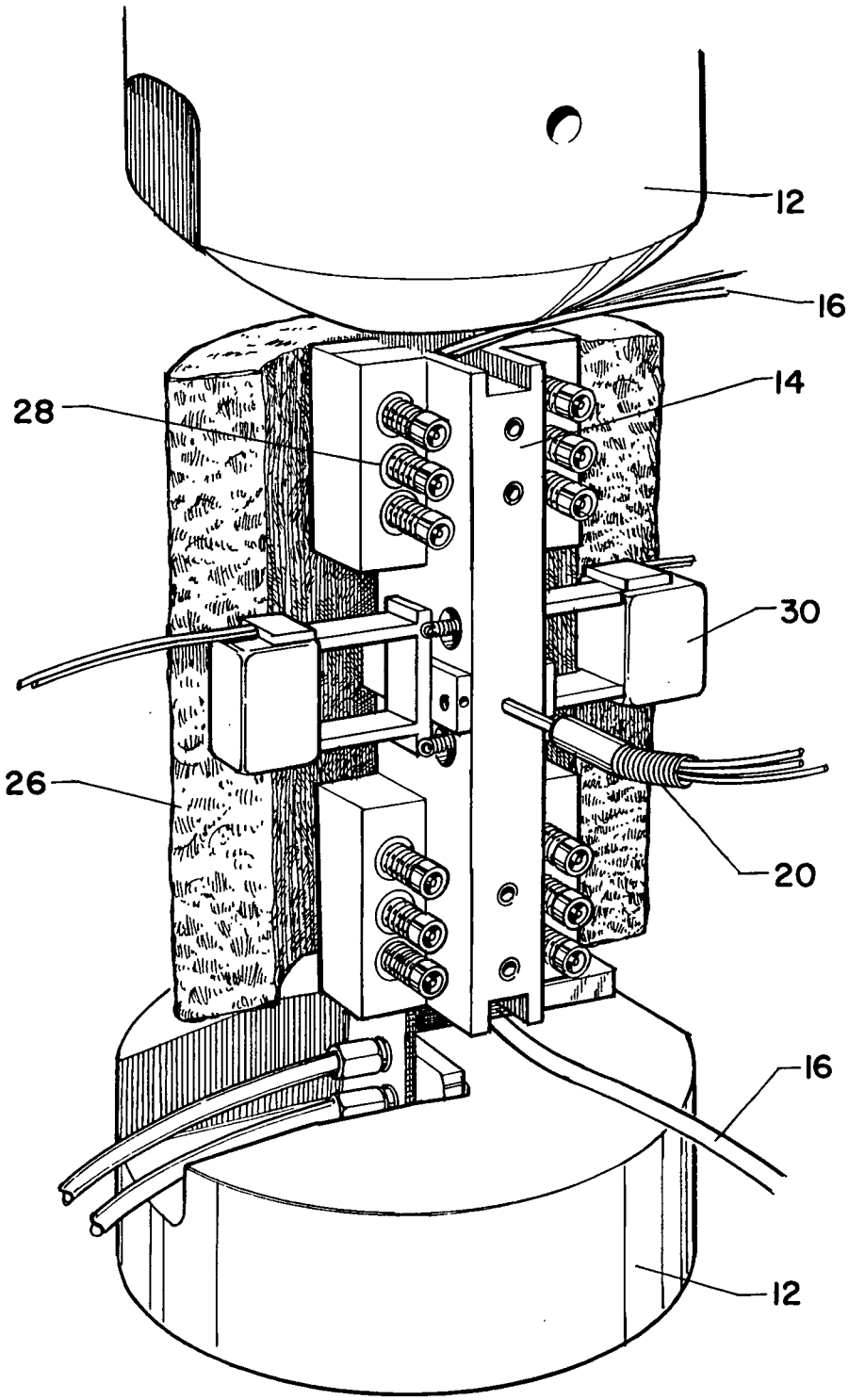

FIG. 1

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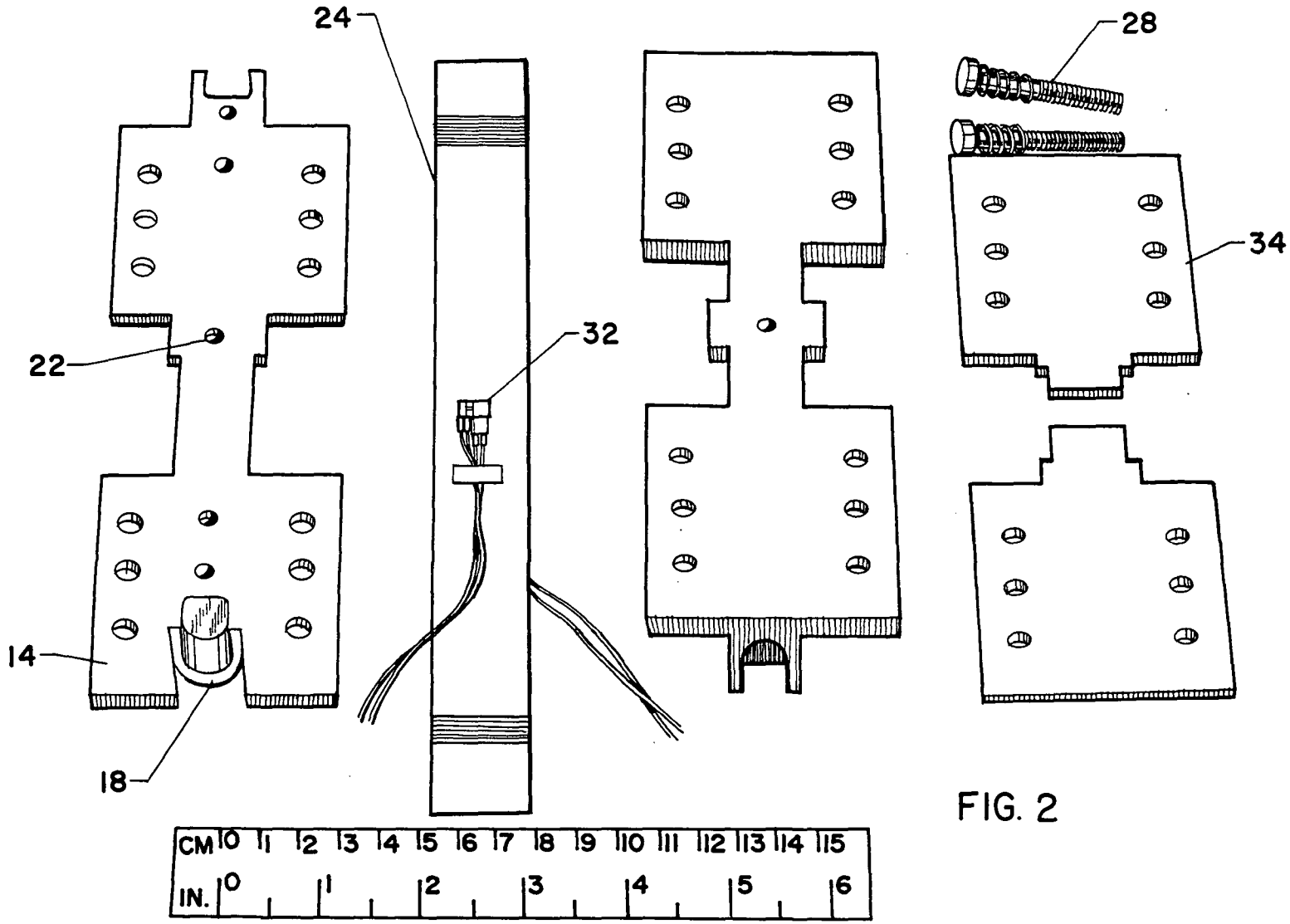

FIG. 2

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APPARATUS FOR ELEVATED TEMPERATURE COMPRESSION OR TENSION TESTING OF SPECIMENS

Origin of the Invention

Technical Field of the Invention

The present invention relates generally to a structural testing apparatus for thin beams, and more particularly to an apparatus which applies uniform out-of-plane normal stresses and a thermal load to the thin beam.

Background of the Invention

Future generation supersonic civilian transport must be capable of flying in excess of mach 2 and yet be able to carry roughly 200-300 passengers. To meet the weight requirements imposed by such a design, advanced graphite reinforced composites are being considered for both primary and secondary structural components. In general, these advanced composite materials exhibit many of the characteristics required for certification over the expected lifetime of the aircraft. However, the high operating temperature along with the increased toughness of the new polymer matrix composites has made it apparent that elastic linear, rate-independent analysis procedure will not be sufficient for a complete characterization of the material behavior. A novel testing apparatus has

been designed to determine certain characteristics of materials which are important in evaluating the suitability of these materials for use on supersonic civilian aircraft.

It is accordingly an object of the present invention to provide a testing apparatus which will apply thermal loads and in-plane tension or compression loads simultaneously.

It is another object of the present invention to provide an apparatus which maintains a constant temperature over the length and width of the specimen.

It is another object of the present invention to provide a testing apparatus which prevents buckling during compression testing.

It is yet another object of the present invention to accomplish the foregoing objects in a simple manner.

Additional objects and advantages of the present invention are apparent from the drawings and specification which follow.

Summary of the Invention

According to the present invention, the foregoing and additional objects are obtained by providing a testing apparatus for applying compression or tension loads in combination with a thermal load to a test specimen. The testing apparatus consists of applying tension and compression loads to opposite ends of the test specimen and measuring the resultant tensile and compressive strain in the test specimen, for example, the load may be provided by a pair of grips which hold opposite ends of the specimen. Heat is applied to the test specimen through two supports which surround the specimen and are heated by some external means, such as a heater rod located within each support. To prevent heat loss, the supports and specimen may be surrounded by thermal insulation. The supports also prevent buckling of the specimen during compression testing.

Brief Description of the Drawings

FIG. 1 is a cut away view of the apparatus; and

FIG. 2 is an exploded view of the apparatus.

Detailed Description of the Invention

The testing apparatus shown in figure 1 consists of grips 12 for applying tension and/or compression loads, supports 14 which prevent buckling of the specimen during compression tests and heating elements 16 which cause the supports 14 to heat the specimen during testing and maintain a constant temperature. The supports 14 are made of 2024 aluminum machined into two matching pieces. Each support 14 contains two resistance heater rods 16 which fit snugly into a hole 18 (see figure 2) bored lengthwise through each support 14. A two zone control of the applied heat is achieved by using separate control units for each support 14 with a thermocouple probe 20 used for feedback. These probes 20 are located at the mid-section of each support 14 and embedded full depth into the support 14 via a tolerance fit hole 22. Heat from the support 14 is transferred to the test specimen 24 through direct contact between the supports 14 and the specimen 24 along the entire length of the support 14 and across the entire width of the specimen 24.

Heat loss is controlled by enveloping both the specimen 24 and the supports 14 in a reflective foil lined clam-shell type of fiberglass insulator 26, one-half of which is shown in figure 1. Stable control of the applied heat is maintained to within 1°C by monitoring thermocouple probe 20 measurements taken along the length of the insulated supports.

Buckling of the specimen during compression testing is prevented by connecting the two supports 14 with spring tensioned screws 28 along their length. Because of the continuous support along the length of the

specimen 24, only a small amount of lateral force is needed to suppress buckling, thus ensuring a minimal impact on the strain response during the compression tests. Teflon tape is used to reduce friction between the specimen 24 and supports 14.

Axial strain is measured by using extensometers 30 or strain gages 32. In the first instance, two extensometers 30, mounted opposite each other, are placed along the specimen's thin edge in the center section, as shown in figure 1. For tests requiring both axial and transverse strain measurement, back-to-back, center mounted strain gages 32 are used. Partial shims 34 are mounted between one support 14 and the specimen 24. Heat is transferred from the support 14 through the shims 34 to the specimen 24 while leaving a small gap between the support 14 and the specimen 24 to allow for placement of the strain gage 32 in the center of the specimen 24 as shown in figure 2.

What is claimed is:

APPARATUS FOR ELEVATED TEMPERATURE COMPRESSION OR TENSION TESTING OF SPECIMENS

Abstract of the Disclosure

In order to support materials selection for the next generation supersonic civilian passenger transport aircraft, a testing apparatus has been developed to evaluate certain materials under conditions of high load and elevated temperature. In order to elevate the temperature of the material during standard tension and compression testing the test specimen is surrounded by a pair of supports which include internal heating means. These supports also prevent buckling of the specimen during compression testing.