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(54) **A gauge device**

(57) A readily transportable device of relative light weight comprising a pair of tensioned guides for providing accurate and stable reference planes. An embodiment comprises a pair of rods or guides in tension between a pair of end members, the end members being spaced apart by a pair of arcuate compression members. The tensioned guides provide planes of reference for measuring devices moved therealong adjacent a component to be measured. The device is especially useful for making on-site dimensional measurements of components, such as irradiated and therefore radioactive components, that cannot readily be transported to an inspection laboratory.

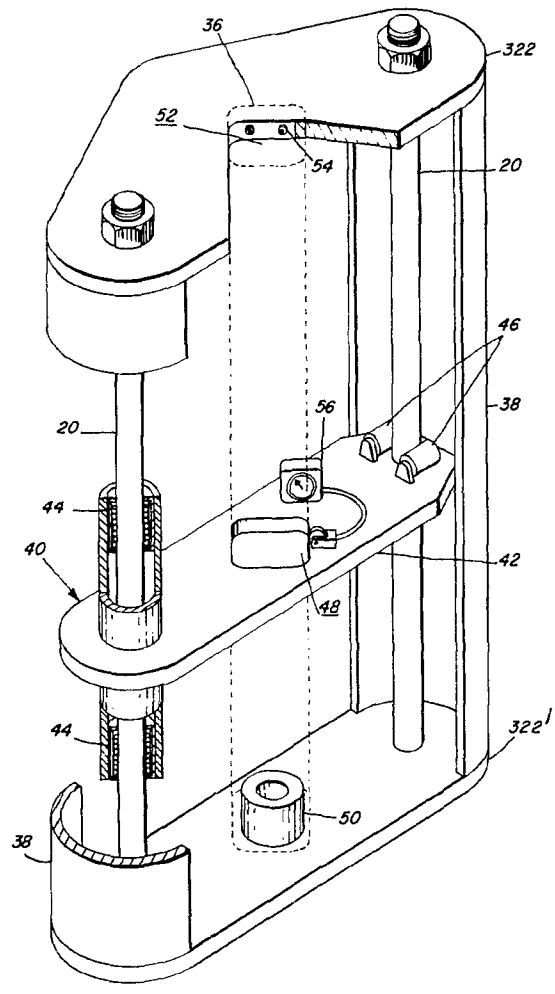

FIG.1

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The drawing(s) originally filed was/were informal and the print here reproduced is taken from a later filed formal copy.

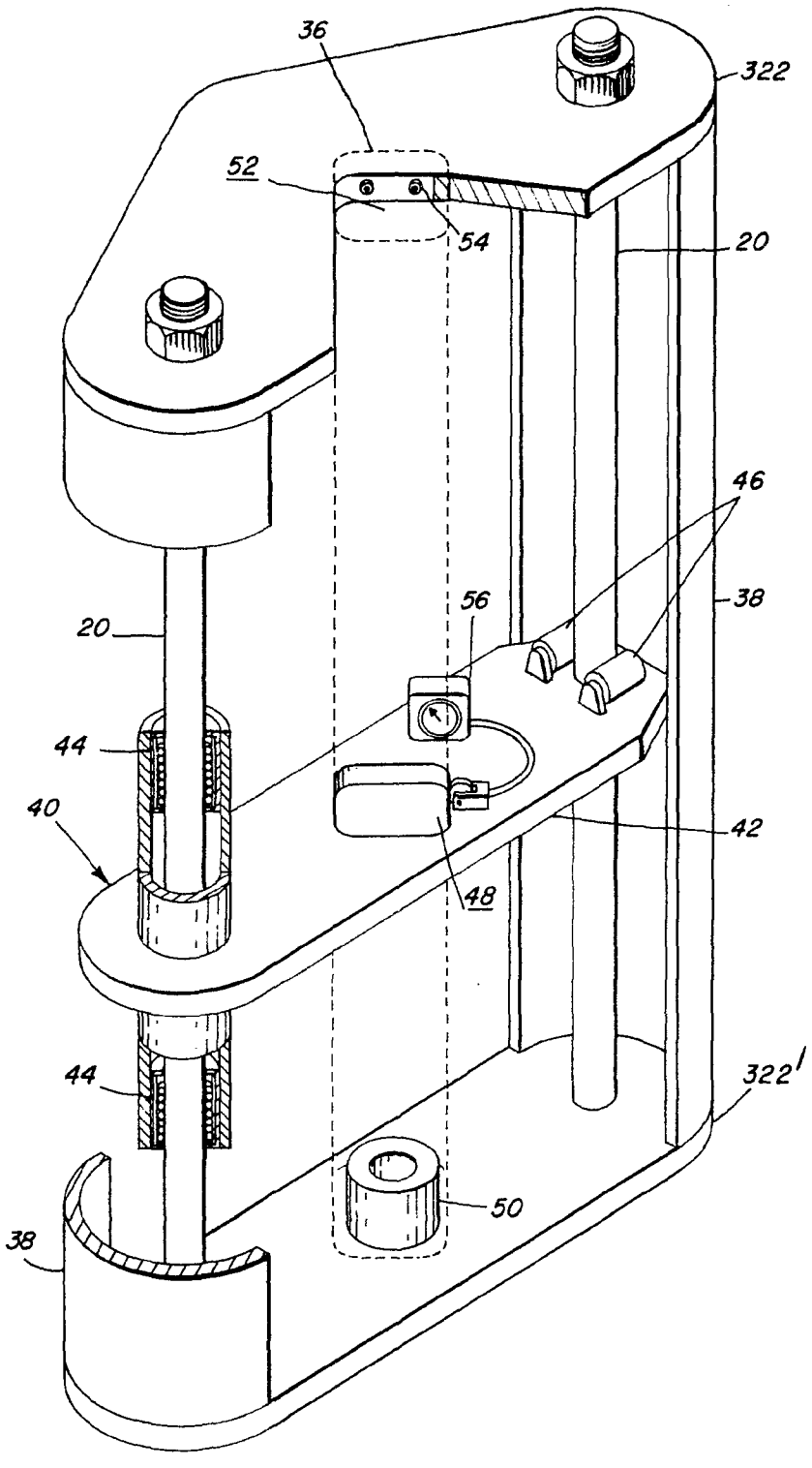

FIG.1

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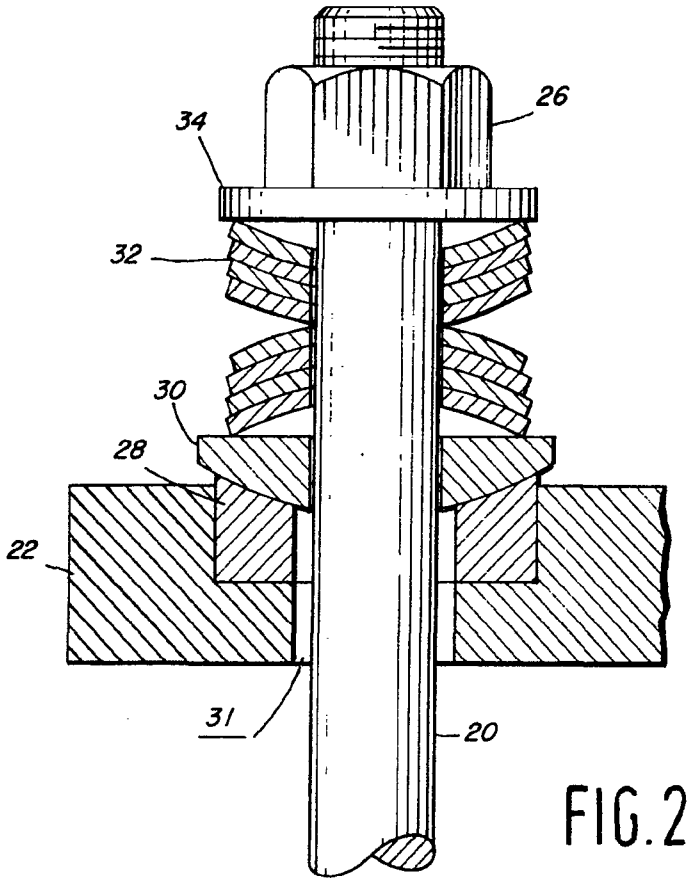

FIG.2

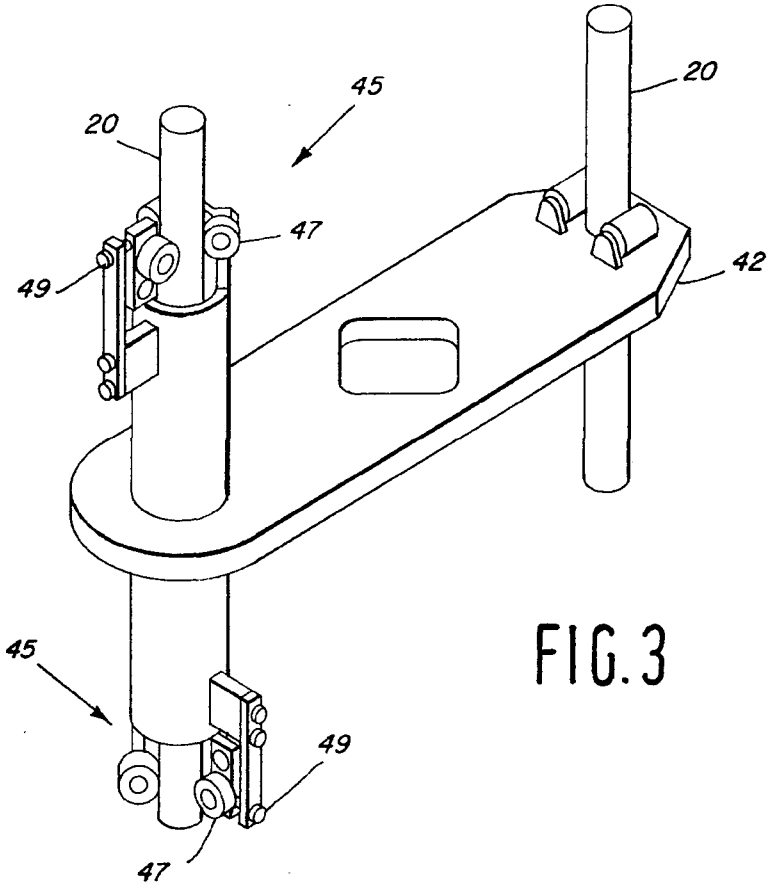

FIG.3

SPECIFICATION

A gauge device

There are numerous components in industrial and utility installations which require on-site pre-service inspection and/or periodic in-service inspection to verify continued serviceability. Such inspection frequently includes dimensional measurements. A notable example is the on-site inspection of components of a nuclear reactor, especially replaceable components such as control rods, fuel elements and fuel channels. A typical fuel assembly having a removable and reusable flow channel 36 is shown in U.S. Patent No. 3,689,358. Such an elongated fuel channel may be in the order of 13 cm in transverse cross section dimensions and in the order of 4 m in length. Dimensional tolerances over the length of such a channel may be in the order of 0.127 mm or less. To perform the necessary measurement of such a component, it is clear that an elongated accurate and stable plane of reference is required.

Prior attempts to provide accurate and stable measurement reference planes have involved structural members with large moments of inertia and great mass. Examples are thick granite or metal surface plates and multiple beam structures. An example of the surface plate approach is shown in German Patent Publication 2,532,840. Beam structures are exemplified by U.S. Patent Nos. 4,036,686 and 4,048,009. Such prior approaches generally have been unsatisfactory because of the difficulty of transporting such massive structures and because of distortion thereof from handling and from thermal stresses.

The present invention provides a gauge device comprising: a pair of spaced, elongated guides secured in tension between first and second spaced-apart end members; and compressive load bearing means positioned between said end members to maintain said end members in spaced apart position, said compressive load bearing means comprising a pair of arcuately shaped side members positioned such that said guides are between said side members, the tension in said guides being sufficient to provide realignment forces greater than the torsion resistance of said compressive load bearing means whereby said guides are maintained in parallel alignment.

To enhance self-alignment of the guides, spherical ball seats can be provided between the guide ends and the end support plates. Resilient means, such as spring washers, can be used to maintain constant tension of the guides. A carriage can provide a mounting platform for the desired measuring instruments and it is movable along the guides adjacent to the component to be measured.

The present invention will be further described, by way of example only, with reference to the accompanying drawings, in which:-

Figure 1 is a partly cut-away isometric view of a gauge device of the invention;

Figure 2 is an illustration of an embodiment of an attachment of the tensioned rails to the end members; and

Figure 3 is a partial isometric view illustration of an alternative manner of mounting a carriage on the tensioned guides.

The invention as shown in Figure 1 comprises a pair of spaced, parallel guides or rods 20 maintained in tension between spaced end plates 322, 322'. The plates are attached (as by welding) to opposite ends of a pair of compressive load bearing members 38 of half tubular form. The guides 20 are formed on at least one end with threads to receive tightening nuts. (At their other ends the guides 20 similarly may be fitted with nuts or formed with suitable heads). It is believed evidence from consideration of this arrangement that forces which tend to move the guides out of their parallel alignment are resisted by the tension forces in the guides 20. To ensure such self-realignment, the tension in the guides 20 should be sufficient to provide guide alignment forces greater than the torsion resistance of the compressive load member or means. Also, it is preferable that the device be constructed in a symmetrical manner with the guides 20 being symmetrically positioned with respect to the compressive load bearing member or members and with the longitudinal axes of the guides 20 and the compressive load bearing means being in a common plane.

To enhance the ability of the tensioned guides 20 to maintain their parallel alignment, the guides 20 are preferably supported (at least at one end) against the end support plate 322 through a spherical ball seat. Such a ball seat arrangement as illustrated in Figure 2 includes an annular ball seat 28 secured in a recess in the end support plate 22 and a washer-like mating ball segment 30, fitted over the guide 20. An adequate clearance 31 is provided to allow guide 20 to assume its aligned position free of contact with the end member 22 or the ball seat 28. Suitable resilient means, shown as a plurality of spring washers 32, are positioned between the ball segment 30 and a flat washer 34 beneath the nut 26 to maintain the guide 20 under a predetermined tension load.

Illustrated in Figure 1 is a version of the invention adapted to measure the dimensions of a fuel channel 36 (shown in phantom view) having the form of an elongated square tube. The guides 20 are tensioned between an upper end plate 322 and a lower end plate 322'. Secured between end plates 322 and 322' is a pair of load bearing members 38 of half tubular form. This half tubular form partly surrounds and protects the guides 20 and reduces the width of the device.

Mounted on the guides 20 for movement therealong is an instrument bearing carriage 40. The carriage 40 includes a base plate 42 mounted at one end to one of the guides 20 by means of a pair of linear ball bushings 44 and guided at its other end along the other guide by a pair of guide rollers 46. Suitable means, such as a motor driven screw, flexible belt, chain, cable or the like (not shown), can be provided to move the carriage 40 along the guides.

An alternative and preferred manner of mounting the carriage for movement along the guides 20 is illustrated in Figure 3. In this arrangement the base

plate 42 is mounted at one end to one of the guides 20 by means of a pair of spaced sets of rollers 45 there being at least three rollers 47 spaced around the guide in each such set of rollers. Preferably one of the rollers 47 of each set is adjustably mounted, for example on a pivotable arm as shown in Figure 3, and means such as a screw 49 are provided for adjustment of the engagement of the rollers 47 with the guide 20.

The base plate 42 of the carriage 40 is formed with a central cutout 48 to pass the channel 36 to be measured. To hold the channel 36 in alignment with the upper and lower end plates, the lower end plate 322' is fitted with a tubular alignment member 50 sized to fit inside the bottom end of the channel and the upper end plate 322 is formed with a cutout portion 52. Adjustable screws 54 can be provided as contact surfaces by which the alignment of the channel 36 with the upper end plate 322 can be adjusted.

The carriage 40 provides a mounting platform for moving any desired measuring instruments along the channel 36 such a profilometer 56 many types of which are known.

In an example of the embodiment of Figure 1 the guides 30 are centerless ground rods formed of 440 C stainless steel with a diameter of about 3.81 cm and a length of about 4.72 meters. The guides 20 are spaced apart about 52.1 cm and they are tensioned to a stress of about 137.9 MPa. The end plates 322 and 322' are formed of 606 IT6 aluminum alloy with a thickness of about 6.4 cm. The compressive load bearing members 38 are formed of 606 IT6 aluminum alloy with a thickness of about 1.27 cm and a radium of curvature of about 15.24 cm. The weight of the device is in the order of 360 Kg.

CLAIMS

1. A gauge device comprising: a pair of spaced, elongated guides secured in tension between first and second spaced-apart end members; and compressive load bearing means positioned between said end members to maintain said end members in spaced-apart position, said compressive load bearing means comprising a pair of arcuately shaped side members positioned such that said guides are between said side members, the tension in said guides being sufficient to provide realignment forces greater than the torsion resistance of said compressive load bearing means whereby said guides are maintained in parallel alignment.

2. A device as claimed in claim 1, wherein said guides are symmetrically positioned with respect to said side members.

3. A device as claimed in claim 1 or claim 2, wherein the longitudinal axes of said guides and said side members are in a common plane.

4. A device as claimed in any one of the preceding claims, wherein each guide is spaced from the adjacent arcuate side member by a distance about equal to the radius of curvature of said side members.

5. A device as claimed in any one of the preceding claims, including means for receiving and holding in alignment with said end members a component to be measured.

6. A device as claimed in any one of the preceding claims, including a carriage mounted on said guides for movement therealong.

7. A device as claimed in claim 6, wherein one end of said carriage is supported for movement along one of said guides by a pair of spaced linear ball bushings and is restrained from rotation by means engaging the other of said guides.

8. A device as claimed in claim 6, wherein one end of said carriage is supported for movement along one of said guides by pair of spaced sets of rollers, including at least three rollers in each set, and is restrained from rotation by means engaging the other of said guides.

9. A device as claimed in any one of claims 6 to 8, including a component measuring instrument mounted on said carriage.

10. A device as claimed in any of the preceding claims, wherein said guides are in the form of rods.

11. A device as claimed in claim 10, wherein said guides are formed with threads on at least one end and are fitted with nuts for adjustment of the tension in said guides.

12. A device as claimed in claim 11, including spherical ball seating means between said nuts and the adjacent end member.

13. A device as claimed in claim 11 or claim 12, including resilient means between said nuts and the adjacent end member.

14. A device as claimed in claim 13, wherein said resilient means comprises spring washers.

15. A device as claimed in claim 1, substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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