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Not recorded

(54) Title: **APPARATUS AND PROCEDURE FOR MEASURING DEFORMATION IN A TENSILE TEST.**

(57) Summary:

Apparatus for measuring the tensile deformation of a specimen, comprising: an articulated arm configured to be attached to a testing machine, where the articulated arm comprises at least two rigid sections (1, 2), and anchoring means (8); a guide (10) mounted at one end of the second section (2) of the articulated arm.

Two U-shaped frames (11, 12) are mounted on this guide (10), where each of these frames (11, 12) carries a respective optical sensor (15, 13), each of which (15, 13) has the capacity to move along said guide (10); where inside the U of these supports (11, 12) there is a specimen (17), including two objectives (16, 14) that can be attached to that specimen (17), and these objectives (16, 14) are configured to measure the deformation of said specimen (17) by means of the measurement by said optical sensors (15, 13) of the displacement of said objectives (16, 14).

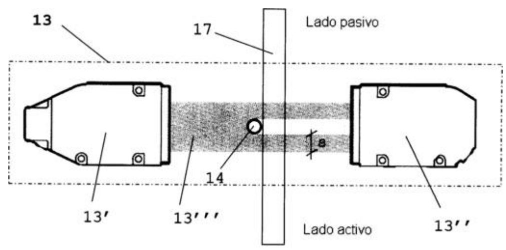

Figura 4

ES 2 364 212 B1

DESCRIPTION

Apparatus and procedure for measuring strain in a tensile test.

Field of Invention

The present invention relates to the procedures and equipment (apparatus or extensometers) for measuring strain in a tensile test.

Background to the invention

Extensometers are currently commonly used to measure the deformation of a tensile specimen and can be grouped into four types:

1. *Resistive contact extensometry*. Its operation is based on the use of strain gauges. The main drawbacks are as follows:
    - The bases of measurement are relatively small.
    - The tours are also relatively small.
    - The nominal bases can be modified during the installation of the extensometer so a subsequent correction will be necessary.
    - They cannot work at high temperatures if they are not equipped with special refrigeration equipment.
    - The extensometer comes into contact with the specimen so it can suffer damage at the break if it is violent.
    - Contact can cause stress concentration and can precipitate the appearance of breakage.

2. *Inductive contact extensometry*. Its operation is based on the use of LVDT comparators. The main drawbacks are as follows:
    - The nominal bases can be modified during the installation of the extensometer so a subsequent correction will be necessary.
    - They cannot work at high temperatures.
    - The extensometer comes into contact with the specimen so it can suffer damage at the break if it is violent.
    - Contact can cause stress concentration and can precipitate the appearance of breakage.
    - The weight of the set is relatively high, so the pressure on the supports can accentuate the notch effect.
    - The accuracy for small deformations decreases compared to previous models.

3. *Video-extensometer*: extensometry based on images with one or more fixed or mobile cameras. The main drawbacks are as follows:
    - On some equipment, a pre-calibration may be required.
    - Optimal lighting conditions are needed.
    - The device is very cumbersome and makes it difficult to switch between several testing machines. Some models are associated with a specific one and cannot be disassembled.
    - The complexity of use is greater, as it is usually associated with its own control software.
    - Some models have not solved the measurement of the measurement base, so this may be necessary. operation prior to the test.
    - They cannot work at high temperatures.

- Accuracies for small deformations decrease.
- It is very expensive.

4. *Laser extensometer*: extensometry based on the use of reflection lasers. The main drawbacks are as follows:

    - The device is very cumbersome and makes it difficult to exchange between several testing machines.
    - The complexity of use is great, as it is usually associated with its own control software.
    - Some models have not solved the measurement of the measurement base, so this operation may be necessary prior to the test.
    - The identification of the measuring base is carried out on the basis of reflective elements that are pasted on the specimen.
    - They cannot work at high temperatures.
    - Accuracies for small deformations decrease.
    - It is very expensive.

The Spanish patent ES 2324696 B2 describes an apparatus and a procedure for measuring deformation in a tensile test on a specimen. The device is made up of an articulated arm, at one end of which there is a guide on which two laser sensors are mounted, with the ability to move along the guide.

However, the apparatus described in ES 2324696 B2 has the disadvantages that: the laser sensors are placed relatively close to the specimen, so they can suffer some physical damage in the event of accidental breakage; it cannot measure deformation in specimens immersed in a liquid; it cannot measure deformation at elevated temperatures; Their use with small specimens is cumbersome.

Summary of the invention

The present invention seeks to solve the above-mentioned drawbacks by means of a procedure and apparatus that allow the determination of deformation in uniaxial tensile tests, in which the measurement is made without contact with the specimen, so that possible damage to the equipment can be prevented in the breakage of the specimen. itself.

Specifically, in a first aspect of the present invention, an apparatus is provided for measuring the tensile deformation of a specimen, comprising: an articulated arm configured to be attached to a testing machine, where said articulated arm comprises at least two rigid sections related by an articulating axis. intermediate arm, and anchoring means connected to one end of a first section of the articulated arm and configured to act as a means of fixing the articulated arm to a pillar of the testing machine; a guide mounted on one end of the second section of the articulated arm. Two U-shaped frames are mounted on the guide, which are located parallel to each other and perpendicular to the guide. Each of the frames carries a respective optical sensor, each of which has the ability to move along the guide by displacement of the respective support; inside the "U" of the supports there is a specimen whose axis coincides with that of the guide, including two objectives that can be attached to said specimen at two points of the same. These objectives are configured to measure specimen deformation by optical sensors measuring the displacement of the targets.

In a preferred realization, the two optical sensors are two digital optical micrometers. In this case, each digital optical micrometer preferably comprises a transmitter configured to emit a beam of light and a receiver configured to receive that beam of light and, when that target gets in the path of that beam of light and generates a shadow in that beam, detects that shadow and translates it into a displacement of that target.

Alternatively, the two optical sensors are two laser micrometers. Preferably, the two

lenses are attached to the specimen by means of elastic bands.

Preferably, each of these two lenses is made up of an elongated element. In this case, they prefer to elongated elements are cylindrical in shape.

In another aspect of the present invention, a procedure is provided for measuring strain in a tensile test by means of an extensometer. The procedure includes the following stages:

a) mark two points P_p and P_a on a specimen, separated along the specimen by a distance L_0 by means of Cylindrical diameter targets ∅ fixed to the specimen by means of an elastic element;

b) calculate the L0 distance using optical sensors such as those described above, using the expression:

$$L_0 = L_0^{'} - \varnothing = \left(R + \left(R_p - p_0\right) + \left(R_a - a_0\right)\right) - \varnothing$$

where R is the length of a reference standard, Rp and Ra are the sensor reading when the reference standard is introduced on the extensometer, and p0 and a0 are the initial sensor reading when the targets are placed;

c) measure during the application of increasing tensile stress the relative displacements ΔLa and ΔLp of the specimen points P a and P_p, using the same sensors so that the variation in the spacing between the points can be determined by means of the expression:

$$\Delta L = L(t) - L_0 = \Delta L_a - \Delta L_p = \left(a_0 + p_0\right) - \left(a_i + p_i\right)$$

d) calculate the strain produced by the expression

$$\varepsilon = \frac{\Delta L}{L_0}$$

in which ΔL is the variation in length suffered by the measurement base, L0.

The process and apparatus of the invention also allow to carry out the measurement of the deformation of the Specimen directly, without prior calibration.

Another advantage of the procedure and apparatus of the invention is that they allow the automatic calculation of the measurement base of the apparatus without making initial measurements.

Finally, the procedure and apparatus of the invention makes it possible to measure deformations on a specimen of in a transparent container in which the temperature can be modified, and even immersed in a liquid, if it is it is also transparent.

Other advantages of the invention will become apparent in the following description.

Brief description of the figures

In order to help a better understanding of the characteristics of the invention, in accordance with a preferential example of practical realization of the same, and to complement this description, it is attached as part part of it, a set of drawings, whose character is illustrative and not limiting. In these drawings:

Figure 1 shows a perspective of an apparatus for measuring strain in a tensile test of a specimen, according to a realization of the invention.

Figure 2 is a diagram showing the detail of the attachment of the target to the specimen by means of an elastic band, in of accordance with a realization of the invention.

Figure 3 shows, schematically, the variables to be measured during the tensile test. During the test, the equipment continuously records the distance between two points of the specimen. Two points are identified on the specimen: P_p Pa:Pp is the point near the passive side of the testing machine and P_a is the point near the active side. The variables to be measured are the displacements of these two points, ΔLp and ΔLa.

Figure 4 shows the dimension "a" measured by the sensor next to the active side, Sa.

Figure 5 shows the dimension "p" measured by the sensor next to the passive side, Sp.

Figure 6 represents the measure of the displacement variation, ΔLa, suffered by the point P_a.

Figure 7 represents the measure of the displacement variation, ΔLp, suffered by the point P_p.

Figure 8 depicts the measurement of the extensometer measurement base, L0, from the previous measurement with a reference standard of length L.

Detailed Description of the Invention

In this text, the term "comprises" and its variants are not to be understood in an exclusive sense, i.e. these terms are not intended to exclude other technical characteristics, additives, components or steps.

In addition, the terms "approximately", "substantially", "around", "some", etc. should be understood as indicating values close to those that these terms accompany, since due to errors of calculation or measurement, it is impossible to obtain these values with complete accuracy.

The characteristics of the process and apparatus of the invention, as well as the advantages derived from them, can be better understood by the following description, made with reference to the drawings listed above.

The following preferred embodiments are provided by illustration only, and are not intended to be limiting to the present invention. In addition, the present invention covers all possible combinations of embodiments particular and preferred indicated here. For experts in the field, other objects, advantages and characteristics of the invention will follow partly from the description and partly from the practice of the invention.

The apparatus for measuring the tensile deformation of a specimen of the invention is described below, according to the diagram of the same in Figure 1.

As detailed below, the apparatus or extensometer for measuring specimen strain has an articulated arm that is attached to the testing machine and is equipped with two optical sensors, and two objectives or targets, preferably cylinders of small diameter, which can be attached to the specimen at as many reference points on the specimen. for the measurement of its deformation.

The articulated arm preferably comprises at least two rigid sections 1, 2 which are connected or related to each other by means of an intermediate joint 3, the axis of which is indicated by reference 3. At the free end of one of the sections of the articulated arm (the one referenced with the number 1 in figure 1), an anchor base 8 is connected that serves as a means of fixing the arm to a pillar of the testing machine. At the free end of the other section of the articulated arm (the one referenced with the number 2 in figure 1), are mounted, through another joint 4, a guide 10, on which two "U" shaped frames 11, 12 move, whose mission is to support two optical sensors 13, 15. The frames are also linearly movable on the guide 10 in order to adjust the extensometer's measuring base to different lengths. In Figure 1, the set formed by guide 10 and the two U-shaped frames 11, 12 has been referenced as 26.

Anchor base 8 is connected to section 1 of the articulated arm by means of an extreme articulation 5 of axis parallel to the axis of intermediate articulation 3 between sections 1 and 2 of said arm.

In a particular embodiment, the anchor base 8 mentioned above may be made up of an adjustable flange of axis parallel to that of articulation 3 between the sections of the articulated arm 1 and 2. The adjustable flange is preferably made up of two halves 6 and 7 with adjustable spacing and preferably equipped with a radial pressure screw 9.

As already mentioned, the apparatus of invention also includes two fixable objectives 14 (O_a) and 16 (O_p), in as many reference points of a specimen 17, P_a Pp, for the measurement of its deformation.

Objectives 14 and 16 attached to specimen 17 consist of an elongated element, preferably a cylinder, of a light material and of a certain diameter ∅. Its length must be adequate to be able to cause an excitation in the sensors 13, 15, while remaining attached to the test specimen. The diameter of the cylinders is preferably between approximately 2 and 4 mm. Examples that are not limited to lightweight material are: all types of plastic, aluminium,... These objectives 14, 16 are attached to specimen 17 by means of, preferably, an elastic band, 21.

The specimen was fed to the testing machine by means of the two anchors or jaws, one passive 18 and the other active 19, which are schematized in Figure 3.

The sensors used for the measurement of displacement are preferably two optical precision micrometers 13, 15 (one 13 located on the active side and another 15 located on the passive side). The 13" precision optical micrometer, whose diagram is shown in Figure 4, is made up of two elements, a 13' transmitter and a 13" receiver. The transmitter element 13' emits a light by means of a light source, preferably an LED, and more preferably gallium nitrite, which provides a green light. This light is transmitted through a collimator lens that creates a continuous and parallel beam of light 13'''. The 13" receiver element collects the light beam by means of a telecentric optical system that allows only parallel light to form the images on a CCD and a CMOS camera that

They capture the image of the measurement point. When an object intercepts the 13" beam of light between the 13" transmitter and the 13" receiver, or in other words, it generates a shadow on the receiver (in white on the 13" beam in Figure 4), the CCD and the camera detect the lack of light at a certain position in the measurement field and internally translate it into a length. Other details of the precision optical micrometer are beyond the scope of the present invention.

Figure 5 illustrates the other optical micrometer 15, with its 15" transmitter, 15" receiver, 15" beam of light and shadow (in white) generated by an object on the 15" beam.

These sensors can be replaced by laser micrometers that also work according to the same scanning or shadow principle.

In order to carry out the invention procedure, it is necessary to know the gap between two points of specimen 17, L(t), at all times, while applying increasing stresses. This separation is illustrated in the Figure 3. The initial distance between these two points, before the test begins, is called the extensometer's measurement base, L0. From these parameters, the deformation, ε, of the specimen 17 tested at each moment can be determined, based on the expression:

$$\varepsilon = \frac{L(t) - L_0}{L_0} = \frac{\Delta L}{L_0}$$

where ΔL is the increase in length suffered by the measurement base of the extensometer at each instant.

To measure the separation of the aforementioned points, the invention process uses two high-precision digital optical micrometers, which follow at all times the displacement of two objectives 14, 16 attached to these points.

The procedure for measuring with the apparatus described can be seen in Figure 3, where a tensile test is schematically represented, with specimen 17 and the two anchors or jaws of the specimen to the testing machine, one passive 18 and the other active 19.

Colon, P_p, close to the passive side, and P_a, close to the active side, initially located at a distance L0, for a certain instant of time they become located at a distance L(t). The colons move, ΔLp & ΔThe, respectively, the displacement closer to the active jaw being greater.

According to the invention procedure, the sensor near the active jaw, Sa, 13 measures the distance "a" between the shadow generated by the objective, Oa 14, and the end of the light beam near the active jaw (Figure 4), while the sensor near the passive grip, Sp, 15 measures the distance "p" between the shadow generated by the passive lens, Op 16, and the end of the light beam near the active jaw (Figure 5). Figure 4 shows the dimension "a" measured by the sensor next to the active side, Sa. Figure 5 shows the dimension "p" measured by the sensor next to the passive side, Sp.

The first step, before placing the objectives on the specimens, is the initial measurement of the extensometer measurement base. To do this, a reference standard of length R is used, which has different lengths depending on the needs of the test in terms of length of the measurement base. This is schematized in Figure 8. The length of the pattern is such that it generates an in-range reading on both sensors at once. The measures obtained with the pattern, Ra Rp, active and passive side, respectively, are maintained as long as the sensors are not moved. If there is any change in the position of the sensors, the initial measurement operation of the measuring base must be repeated.

The objectives are then placed on the randomly selected reference points along the specimen shaft so that each of them coincides within the measurement range of the corresponding sensor. The two reference points are called P_a (the closest to the active side) and P_p (the closest to the passive side) and are separated by a distance L0. The initial sensor reading after positioning the objectives is a0 for the Sa sensor and p0 for the Sp sensor.

The measuring base, L_0, is determined from the expression:

$$L_0 = L_0^{'} - \varnothing = \left(R + \left(R_p - p_0\right) + \left(R_a - a_0\right)\right) - \varnothing$$

where ∅ is the diameter of the target.

The strain of the specimen is then measured as increasing tensile stress is applied, using the Sa and Sp sensors mentioned above. The displacements ΔLa and ΔLp of the points P_a and P_p, respectively, are determined from the displacement measured at each instant by the sensors, a_i and pi and the initial displacement, a0 and p0 (Figures 6 and 7).

$$\Delta L_a = a_0 - a_i$$

$$\Delta L_p = p_i - p_0$$

The increase in length suffered by the measurement base is calculated by the expression:

$$\Delta L = L(t) - L_0 = \Delta L_a - \Delta L_p = (a_0 + p_0) - (a_i + p_i)$$

Then, the principle of operation of the apparatus of the invention is demonstrated, knowing how far each point of the bar has been separated individually, measured by each of the optical sensors, it is possible to obtain the increase in length, and therefore, the deformation of the bar.

Finally, the deformation produced by the expression

$$\varepsilon = \frac{\Delta L}{L_0}$$

where ΔL is the difference between the displacements of the points P_a and P_p of the specimen at each instant and L0 the initial measurement base.

The measuring ranges of the selected sensors depend on the magnitude to be measured: if you want to measure very precisely, you use small ranges, while if you don't require a lot of precision, you can use extensometers with a longer range that allow the measurement of longer elongations.

If both properties are required, i.e. precision for small elongations and large measuring ranges with low precision, sensors with different properties can be mounted in parallel so that both requirements are met.

Depending on the type of specimen, its length, the machine used and the space available between anchors 18 and 19, the sensors will be positioned in different ways, being able to move vertically.

In order to measure the measurement base or distance between the points of contact of objectives 14, 16, and specimen, 17, it is necessary to know the measurement of a reference standard 20.

As already mentioned, the basis of measurement, L_0, is determined from Figure 8 and the expression:

$$L_0 = L'_0 - \varnothing = (R + (R_p - p_0) + (R_a - a_0)) - \varnothing$$

In short, with the procedure and apparatus of the invention, uniaxial tensile tests can be carried out with the following properties:

* Measurement of the strain in a uniaxial tensile test without contact with the specimen, to prevent possible damage in the breakage of the specimen.

* Measurement of specimen deformation directly, without prior calibration.

* Automatic calculation of the extensometer measurement base, without initial calibrations.

* Possibility of measuring very accurately over short distances or large elongations with less precision.

* Possibility of measuring deformations on a specimen inside a transparent container in which it can be modify the temperature.

* Possibility of measuring deformations in specimens immersed in transparent liquids.

DEMANDS

1. Apparatus for measuring the tensile strain of a specimen, comprising:

- an articulated arm configured to be attached to a testing machine, where the articulated arm comprises at least two rigid sections (1, 2) connected by an intermediate articulation axis (3), and means of anchoring (8) connected to one end of a first section (1) of the articulated arm and configured to act as a means of fixing the articulated arm to a pillar of the testing machine;

- a guide (10) mounted on one end of the second section (2) of the articulated arm;

while the apparatus is **Characterized** Why

on this guide (10) are mounted two frames (11, 12) in the shape of a "U", where these two frames (11, 12) are located parallel to each other and perpendicular to said guide (10), where each of these frames (11, (12) it carries a respective optical sensor (15, 13), each of which (15, 13) has the capacity to move along said guide (10) by displacing the respective support (11, 12); where inside the "U" of these supports (11, 12) there is a specimen (17) whose axis coincides with that of said guide (10), including two objectives (16, 14) attachable to said specimen (17) at two points of the same, these objectives (16, 14) being configured to measure the deformation of that specimen (17) by means of the measurement by those optical sensors (15, 13) of the displacement of these objectives (16, 14).

2. The apparatus of claim 1, wherein said optical sensors (13, 15) are two digital optical micrometers.

3. The apparatus of claim 2, wherein each digital optical micrometer (13, 15) comprises a transmitter (13', 15') configured to emit a beam of light and a receiver (13", 15") configured to receive such beam of light and, when said objective (14, 16) interposes itself in the path of said beam of light and generates a shadow in that beam, detect this shadow and translate it into a displacement of said objective (14, 16).

4. The apparatus of claim 1, where said optical sensors (13, 15) are two laser micrometers.

5. The apparatus of any of the previous claims, where these two objectives (14, 16) are fixed to said test tube (17) by means of elastic bands (21).

6. The apparatus of any of the previous claims, where each of these two objectives (14, 16) are formed by an elongated element.

7. The apparatus of claim 6, where these elongated elements are cylindrical in shape.

8. Procedure for measuring deformation in a tensile test by means of an extensometer, characterized by the fact that it includes the following stages:

a) mark two points P_p and P_a in a specimen (17), separated along the specimen by a distance L_0 by means of two cylindrical objectives (14, 16) in diameter $\varnothing$ fixed to the specimen (17) by means of an elastic element;

(b) calculate by means of optical sensors (14, 16) in accordance with any of the above claims the distance L0, using the expression:

$$L_0 = L'_0 - \varnothing = \left(R + \left(R_p - p_0\right) + \left(R_a - a_0\right)\right) - \varnothing$$

where R is the length of a reference standard, Rp and Ra are the sensor reading (14, 16) when the reference standard is introduced on the extensometer, and p0 and a0 are the initial sensor reading (14, 16) when the objectives are set (14, 16).

(c) measure relative displacements during the application of increasing tractive stress ΔThe and ΔLp of the points P_a and P_p of the specimen (17), by means of the same sensors (14, 16) so that it can be determine the variation of the spacing between the points by means of the expression:

$$\Delta L = L(t) - L_0 = \Delta L_a - \Delta L_p = \left(a_0 + p_0\right) - \left(a_i + p_i\right)$$

d) calculate the strain produced by the expression

$$\varepsilon = \frac{\Delta L}{L_0}$$

where ΔL is the variation in length suffered by the measurement base, L0.

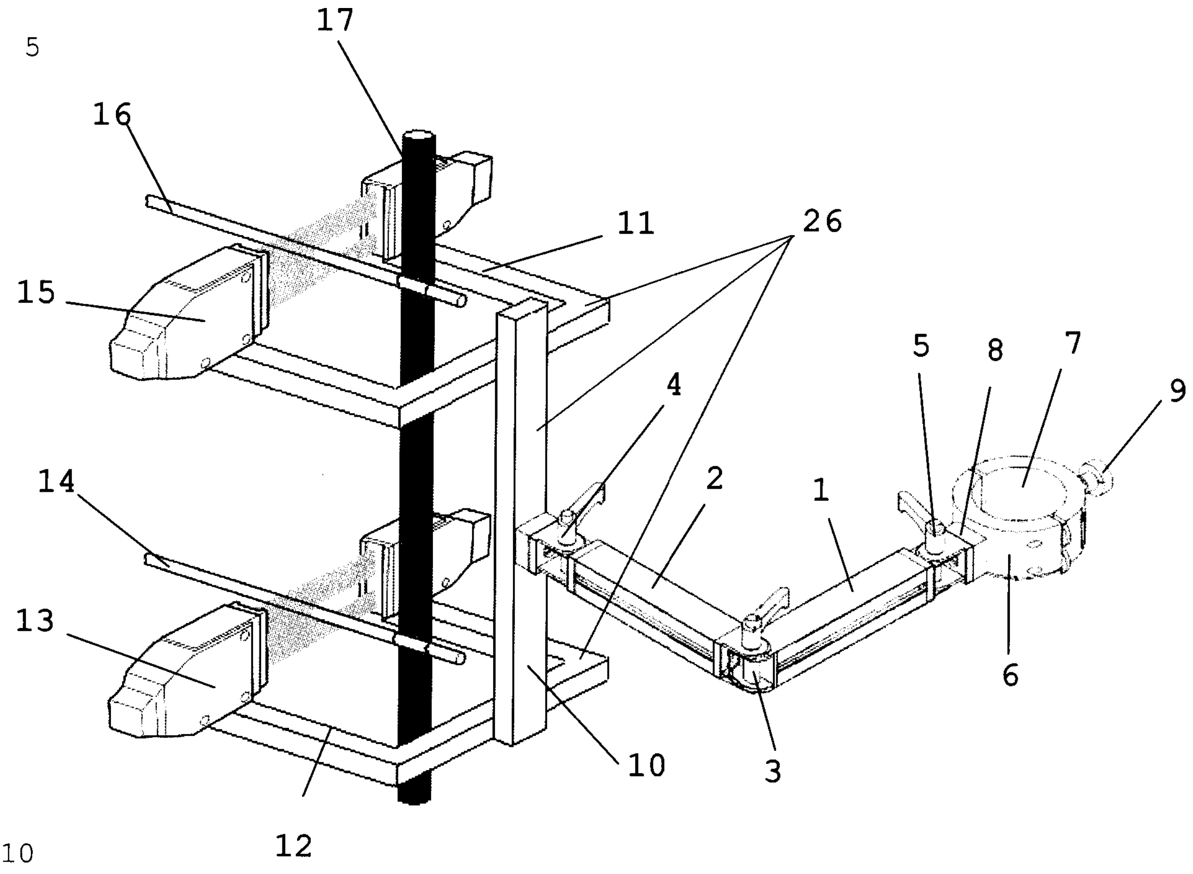

Figura 1

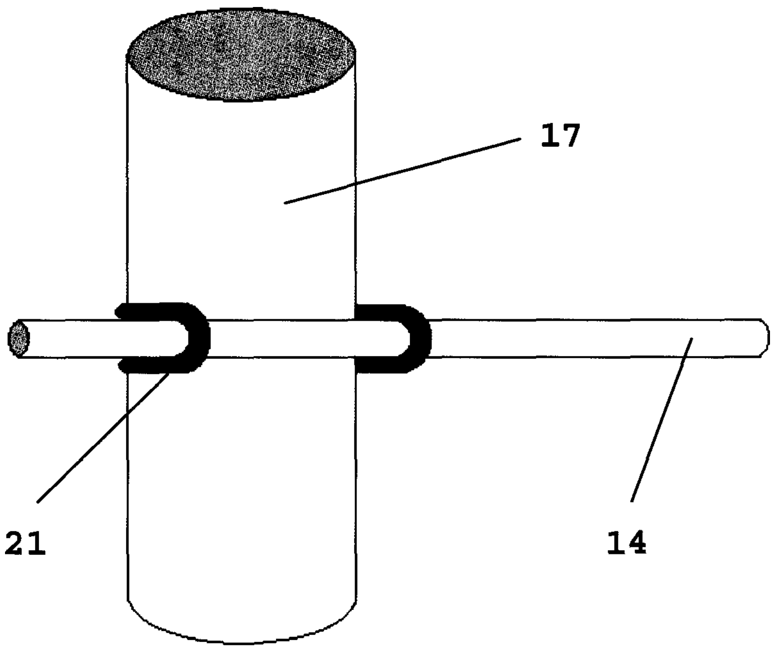

Figura 2

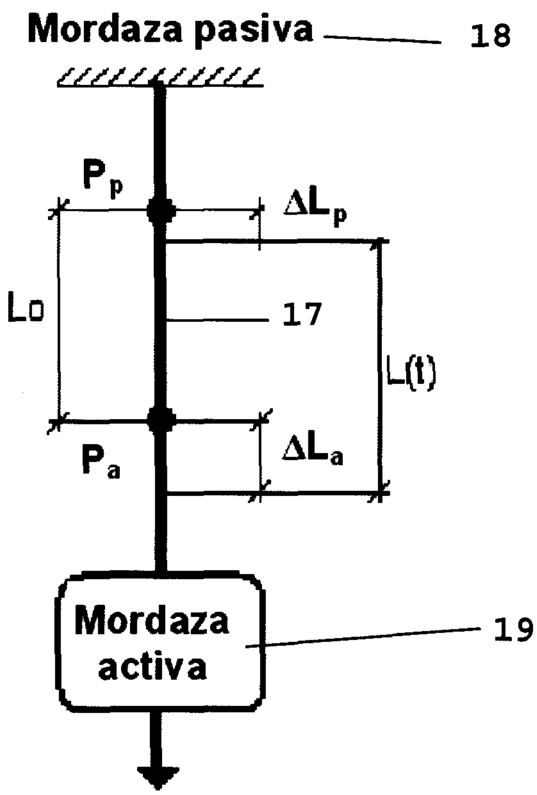

Figura 3

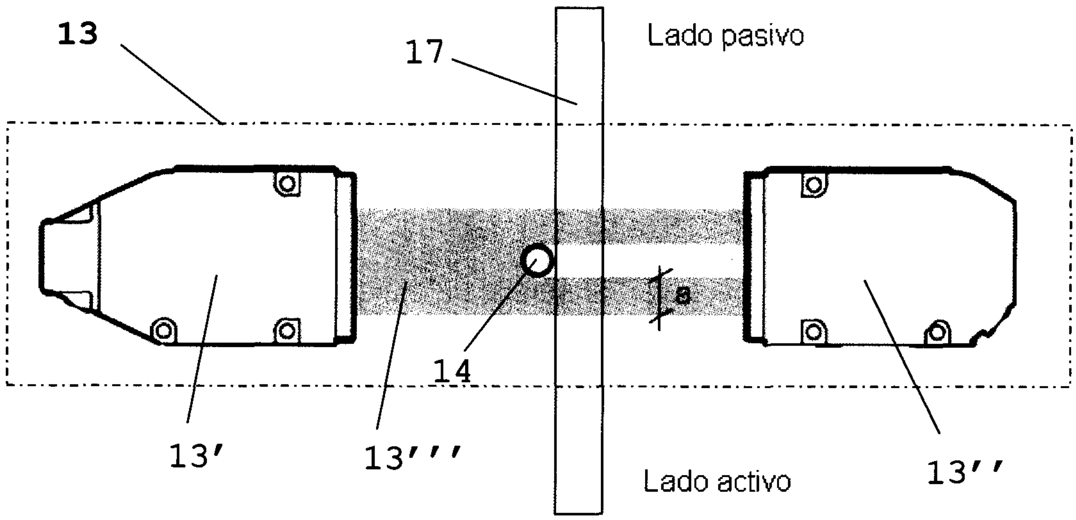

Figura 4

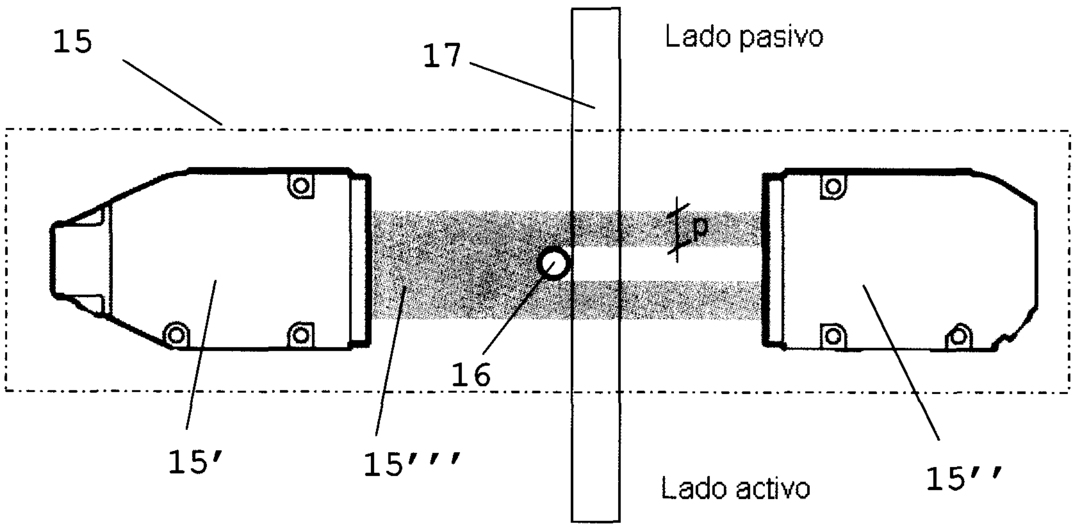

Figura 5

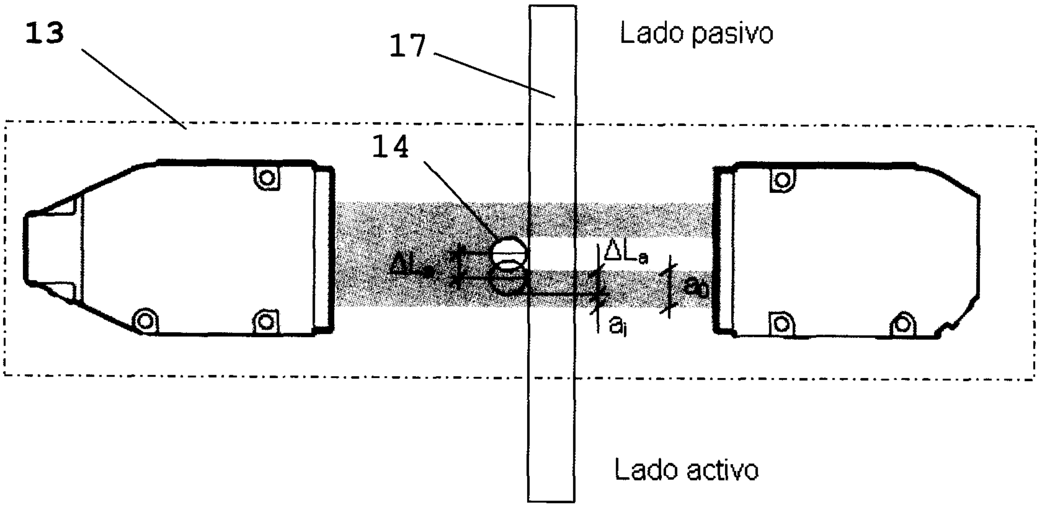

Figura 6

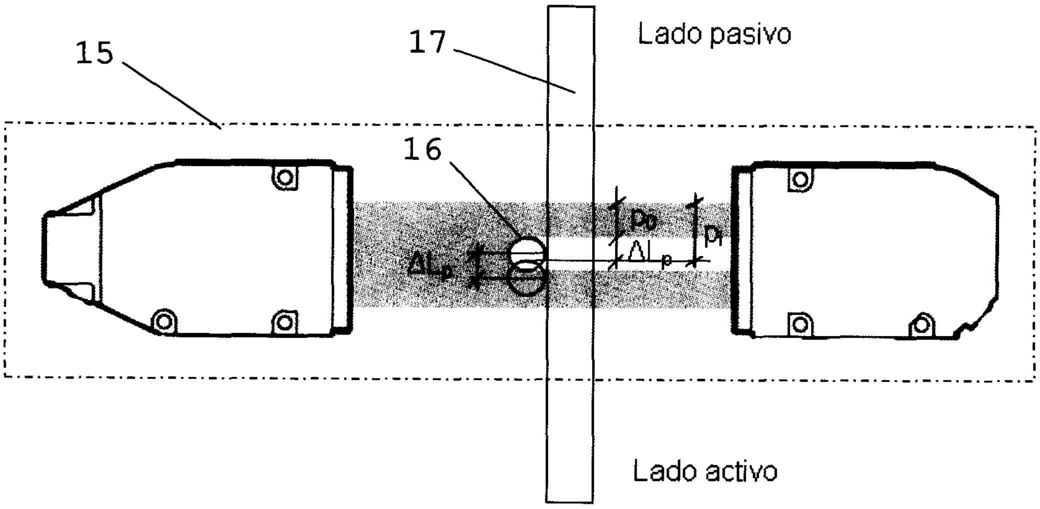

Figura 7

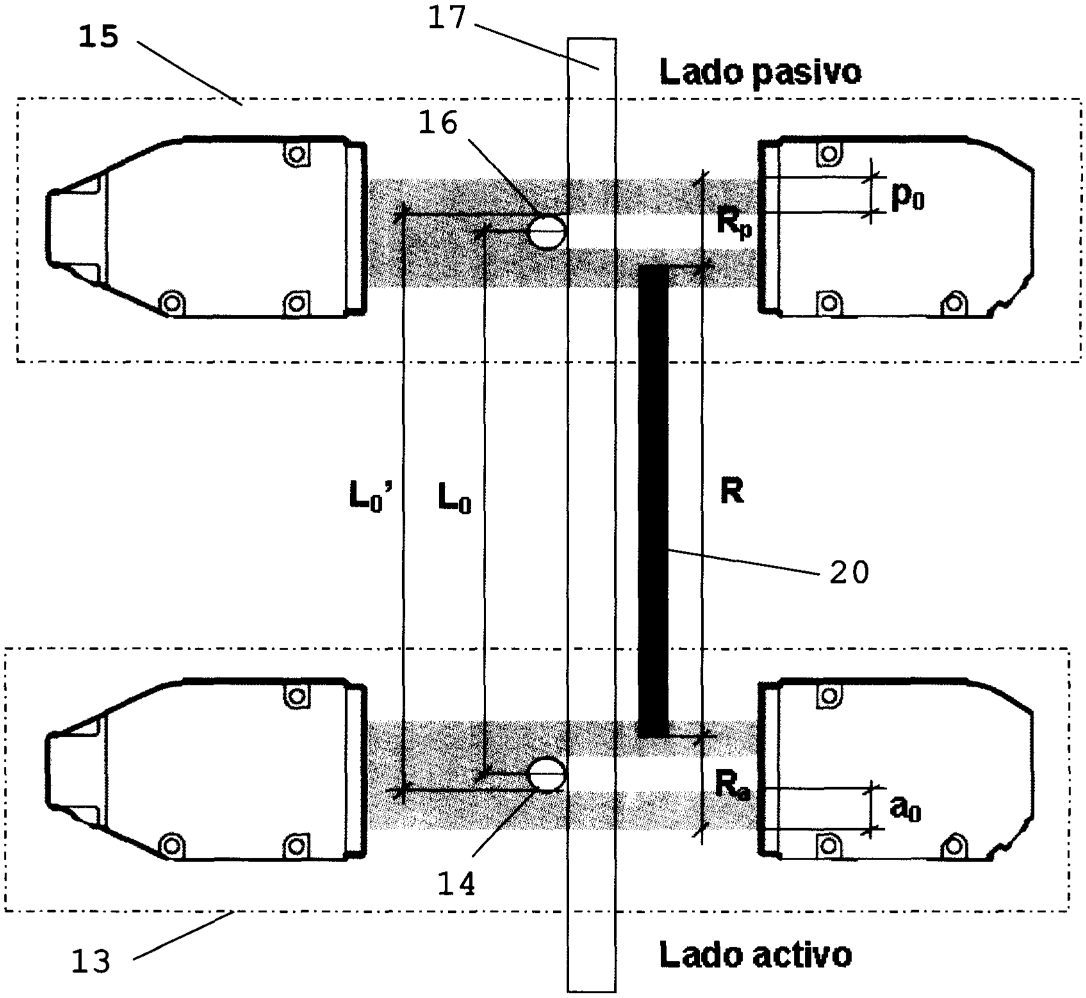

Figura 8

SPANISH OFFICE
PATENTS AND

TRADEMARKS SPAIN

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(32) date:

REPORT ON THE STATE OF THE ART

(51) **Int. Cl. :** ***G01N3/08*** (2006.01)
G01B11/16 (2006.01)

RELEVANT DOCUMENTS

Category	Documents cited	Affected claims
Y	ES 2324696 A1 (UNIV CANTABRIA) 12.08.2009, pages 2-8; Figure 1.	1-8
Y	CN 201407995 Y (UNIV SHENZHEN) 17.02.2010, Summary of the EPODOC and WPI database; and Figure 1. Retrieved from EPOQUE.	1-8
A	FR 2952717 A1 (COMMISSARIAT ENERGIE ATOMIQUE) 20.05.2011, summary; Figures 3A,3B,4.	1
A	FR 2706613 A1 (AEROSPATIALE) 23.12.1994, summary; Figure 2.	4
A	US 2006096385 A1 (WENSKI EDWARD G) 11.05.2006, summary; Figure 1.	4

Category of documents cited
X: of particular relevance
And: of particular relevance combined with others of the same category
A: reflects the state of the art
Or: referred to unwritten disclosure
P: published between the priority date and the filing date
E: previous document, but published after the date of submission of the application

This report has been prepared

for all claims

■ for claims no:

Date of preparation of the report	**Examiner**	**Page**
11.08.2011	B. Tejedor Miralles	1/4

Minimum documentation searched (classification system followed by classification symbols) G01N, G01B

Electronic databases queried during the search (name of the database and, if possible, search terms used)

INVENES, EPODOC, WPI, NPL, INTERNET

Date of Written Opinion: 11.08.2011

Statement

Novelty (Art. 6.1 LP 11/1986)	Claims 1-8	**YES**
	Demands	**NO**
Inventive step (Art. 8.1 LP11/1986)	Demands	**YES**
	Claims 1-8	**NO**

The application is considered to meet the requirement of industrial application. This requirement was assessed during the formal and technical examination phase of the application (Article 31.2 of Law 11/1986).

Basis of the Opinion.-

This opinion has been made on the basis of the patent application as published.

1. Documents considered.-

The following is a list of the documents pertaining to the state of the art taken into consideration for the realization of this opinion.

Document	Publication or Identification Number	Publication Date
D01	ES 2324696 A1 (UNIV CANTABRIA)	12.08.2009
D02	CN 201407995 Y (UNIV SHENZHEN)	17.02.2010
D03	FR 2952717 A1 (COMMISSARIAT ENERGIE ATOMIQUE)	20.05.2011
D04	FR 2706613 A1 (AEROSPATIALE)	23.12.1994
D05	US 2006096385 A1 (WENSKI EDWARD G)	11.05.2006

2. Reasoned declaration in accordance with Articles 29.6 and 29.7 of the Implementing Regulations of Law 11/1986 of 20 March 1986 on Patents on novelty and inventive step; Quotes and explanations in support of this statement

Claim 1:

The closest state of the art is considered to be document D01. This document fully discloses all the elements cited in the preamble to claim 1 (page 4, lines 18-47; page 5, lines 6-53; D01). This document also discloses the use of several laser sensors in parallel (page 3, lines 60-63 and page 5, line 28; D01) and that the specimen is located parallel to guide 10, including two objectives that can be attached to the specimen at two points on the specimen. However, it differs from that claim in the arrangement of the type of optical sensors, in such a way that the specimen is between the transmitter and receiver; that is, the sensors, instead of being placed on the same guide, are on a frame that is in turn attached to the guide and that, likewise, move along it (page 5, lines 22-23; D01). The technical effect achieved is that the specimen is between the transmitter and the receiver of the optical sensor. The technical problem to be solved is how to perform the measurement without contact with the specimen. Document D02 discloses an optical sensor for performing strain measurements. It consists of a transmitting device and a receiving device arranged facing each other, with the specimen between the two devices, as well as an objective (shading device) arranged in the specimen (summary; D02). On the other hand, this document omits the design of the arrangement of the sensors. However, it is not apparent that the mounting of optical sensors on a frame solves any technical problem in the face of the known provisions of the prior art (document D03 is cited as an example) and that in order to have such a configuration, an expert in the field would find the same solution or another equivalent construction variant to leave the specimen between the transmitter and the receiver of the optical sensor. Therefore, a person skilled in the art would use the technical feature disclosed in document D02 to solve the technical problem posed. Thus, said claim 1 does not present an inventive step according to article 8.1 of the Patent Law 11/1986.

Dependent claims 2-7:

Claims 2 and 3 refer to digital optical micrometers with the same elements as those disclosed in document D02. Therefore, these claims lack inventive step according to Article 8.1 of the Patent Law 11/1986.

Claim 4 states that optical sensors are laser micrometers. This element is common knowledge in the state of the art. By way of example, documents D04 and D05 are cited, in which the use of this element for the same purpose is appreciated. Therefore, claim 4 lacks inventive step according to Article 8.1 of Patent Law 11/1986.

Claims 5-7 are merely particular executions that a subject matter expert would select from among those possible to achieve the desired effect. Therefore, claims 5, 6 and 7 do not present an inventive step according to Article 8.1 of the Patent Law 11/1986.

Claim 8:

The closest state of the art is considered to be document D01. This document presents a procedure for measuring strain in a tensile test. It differs in the establishment of the base length as a result of the arrangement of the sensors used. However, those differences are inherent in that provision and independent of the claimed method of calculation, which a person skilled in the art would infer from the known prior art, since it is a mere particular calculation. Therefore, this claim does not present an inventive step according to Article 8.1 of Patent Law 11/1986.