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(54) Title: DEVICE FOR DETERMINING THE SHRINKAGE AND EXPANSION BEHAVIOUR OF A MATERIAL

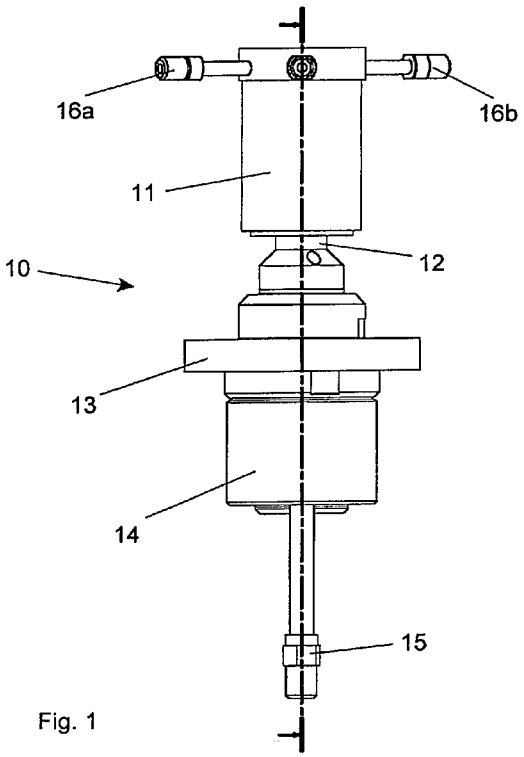

Fig. 1

(57) Abstract: The invention relates to a device for determining the shrinkage and expansion behaviour of a material, comprising a cylinder as well as a piston to be accommodated in said cylinder, which cylinder and which piston together form an annular measuring chamber in which the material to be examined can be contained during operation, rotation means for causing the cylinder and the piston to rotate relative to each other during operation, as well as force means for exerting a force during operation on the material contained in the measuring chamber. The object of the invention is to provide an improved dilatometer as referred to in the introductory paragraph, by means of which prolonged shear tests can be carried out. According to the invention, the device is characterised in that the cylinder is stationary and the rotation means engage the piston. As a result, the fixed housing, which forms the cylinder, can be given a stationary position in the construction together with all the connecting pipes and the peripheral equipment, whilst the piston can also be rotated for carrying out prolonged shear tests. This makes it possible to carry out more prolonged tests, whilst in addition the device may be of simpler design, since only one part is movably accommodated in the construction.

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Device for determining the shrinkage and expansion behaviour of a material

DESCRIPTION

The invention relates to a device for determining the shrinkage and expansion behaviour of a material, comprising a cylinder as well as a piston to be accommodated in said cylinder, which cylinder and which piston together form an annular measuring chamber in which the material to be examined can be contained during operation, rotation means for causing the cylinder and the piston to rotate relative to each other during operation, as well as force means for exerting a force during operation on the material contained in the measuring chamber.

Such a device is also referred to as a dilatometer. The known dilatometer is generally characterised by a sturdy cylinder construction, which, together with a piston, defines a cylindrical measuring chamber, in which a material to be examined can be contained. As a result of this construction, and in particular because the cylinder is rotatably driven, the known dilatometer only has a limited use. More in particular, only short test measurements can be carried out therewith. Since the known construction is only capable of making a limited number (fewer than two) rotations, it is only possible to examine the effect of a limited shear deformation of the material.

The object of the invention is to provide an improved dilatometer as referred to in the introductory paragraph, by means of which prolonged shear deformations can be examined. According to the invention, the device is characterised in that the cylinder is stationary and the rotation means engage the piston. As a result, the fixed housing, which forms the cylinder, can be given a stationary position in the construction together with all the connecting pipes and the peripheral equipment, whilst the piston can be rotated for carrying out unlimited shear tests. As a result, the device may moreover be of simpler design, since only one part is movably accommodated in the construction.

The device is further characterised in that the force means engage the cylinder. This, too, leads to a simpler design, because forces are now exerted on a stationary, immovable part of the device.

According to a special embodiment of the device according to the invention, the rotation means comprise a toothed belt transmission.

Furthermore, sealing rings are fitted between the cylinder and the piston in the measuring chamber, which has a positive effect on the accuracy and reproducibility of the measurements.

According to the invention, in order to make it possible to carry out the measurements, cooling means are provided, whilst the cylinder is provided with circular cooling channels. More specifically, the piston is provided with an axially extending inlet cooling channel and an outlet cooling channel that co-axially surrounds said inlet cooling channel.

According to a further embodiment, the device is characterised in that the force means comprise a controllable bellows which engages the cylinder via a lever construction.

The invention will be explained in more detail below with reference to a drawing, in which:

Figure 1 shows a first embodiment of a device according to the invention;

Figures 2a-2b are sectional views of the embodiment of the device shown in figure 1;

Figure 3 is a side view of the embodiment of the device shown in figure 1.

Like parts shown in the various figures will be indicated by the same numerals in the description of the figures below.

In figure 1, numeral 10 indicates a dilatometer device according to the invention. The dilatometer is made up of a cylinder 11 and a piston 12, which extends into the cylinder space 11. The piston 12 is dimensioned so that a measuring chamber 20 is formed in the cylinder 11, in which measuring chamber a material to be examined can be placed.

As a result of the concentrical arrangement (see figure 2a) of the cylinder 11 and the piston 12, the measuring chamber 20 is annular in shape, whilst the material to be examined (for example a plastic material) must also be accommodated as an annulus in the measuring chamber 20. See the detail view of figure 2b.

According to the invention, the cylinder 11 is stationary and the piston 12 can be rotatably driven in the cylinder space 11 by drive means 13. The part indicated at 13 forms part of the drive means (not shown) and is configured as a

toothed wheel, over which a toothed belt of a toothed belt transmission can be passed.

The rotary drive of the piston 12 by the drive means 13 makes it possible to determine various characteristic properties of the materials to be examined, which are present in the measuring chamber 20. The materials to be examined in the measuring chamber 20 may be in solid form, but also in liquid form, and the characteristic properties to be determined may concern specific phase transitions, such as crystallization and melting. Furthermore, shrinkage or expansion phenomena or the density of the materials to be examined can be determined as a function of the pressure, the cooling rate and the flow history in the material.

As a result of the piston being rotatably driven within the cylinder space 12, a shear test is initiated, during which the material to be examined, which is present between the stationary cylinder 11 and the rotating cylinder 20 in the measuring chamber 20, is mechanically loaded and deformed . By applying a force to the cylinder 11 via external force transmission means (not shown), specific conditions can be created in the measuring chamber, which act on the material to be examined in the measuring chamber 20, depending on the nature of the shear test to be carried out.

In this way it is possible to determine for example the expansion behaviour of a plastic material to be examined, with the plastic material on the one hand being subjected to a shear load but also being loaded under pressure by means of said externally applied force and optionally being cooled or heated by the means provided in the device 10.

More in particular, the shrinkage and expansion behaviour of the material to be examined in the measuring chamber 20 can be determined on the basis of the relative movement between the cylinder 11 and the piston 12. Said movement can be determined by means of suitable distance sensors.

Since the cylinder 11 is according to the invention stationary and the piston 12 is rotated within the cylinder space 11 by the drive means 13, a simpler design of the dilatometer is obtained, which makes it possible in particular to carry out prolonged shear tests, during which prolonged deformation of the material takes place. Because of the presence of cooling or heating means in the cylinder space 11, the cylinder 11 is provided with inlet channels 16a an outlet channels 16b for supplying and discharging a cooling or heating medium. As a result of the

construction of the dilatometer according to the invention, in which the piston 12 can be rotatably driven within the cylinder of space 11, the overall cylinder construction 11, including all the inlet and outlet channels for a cooling or heating medium, as well as all the other peripheral equipment, such as the position sensors and the force means, remain stationary within the construction.

The known dilatometers are only capable of carrying out brief shear tests, during which the cylinder 11 can be rotatably driven a limited (maximally two) number of times for carrying out a shear test on a material present in the measuring chamber. Thus, the material can only be briefly deformed, so that only a more limited number of measuring results are obtained.

As a result of the construction according to the present invention, the piston 12 can be rotated any number of times in both directions by the drive means 13, making it possible to use prolonged shear tests and thus to obtain more extensive measuring results.

As shown in figure 2a, the inlet channel 16a opens into a surrounding channel 16a', which surrounds the cylinder space 11, the piston 12 and the measuring chamber 20 and through which a cooling or heating medium can flow round said cylinder space 11, said piston rod 12 and said measuring chamber 20. The cooling or heating medium can be discharged after use via the surrounding channel 16b' and the outlet channel 16b. The piston 12 is also provided with means for supplying or discharging a cooling or heating medium. To that end the device 10 is provided with a stationary coupling block 14 having an inlet channel 15a and an outlet channel 16b. The coupling block 14 comprises a manifold, which connects the inlet channel 15a to the inlet subchannels 15c during rotation of the piston 12 by the gear 13. Said inlet subchannels 15c open into a flow channel 15d formed in the piston 12, which flow channel is in communication with a piston outlet channel 15e at the location of the measuring chamber 20, which piston outlet channel opens into the outlet channel 15b. In this way, too, the piston 12 can be efficiently cooled or heated, depending on the shear test to be carried out. The cylinder 11 is furthermore fitted with several temperature sensors 17.

Figure 3 shows a side view of the dilatometer according to the invention, which is accommodated in a housing 5, which is placed on a support surface via supports 5a-5b. The housing 5 is provided with force means 30, which are made up of a bellows construction which is capable of exerting a force on the

cylinder 31 via a lever transmission 31. The force transmission point is indicated by the arrow F in figure 3.

5

CLAIMS

1. A device for determining the shrinkage and expansion behaviour of a material, comprising

a cylinder as well as a piston to be accommodated in said cylinder, which cylinder and which piston together form an annular measuring chamber, in which the material to be examined can be contained during operation,

rotation means for causing the cylinder and the piston to rotate relative to each other during operation, as well as

force means for exerting a force during operation on the material contained in the measuring chamber, **characterised in that** the cylinder is stationary and the rotation means engage the piston.

2. A device according to claim 1, **characterised in that** the force means engage the cylinder.

3. A device according to claim 1 or 2, **characterised in that** the rotation means comprise a toothed belt transmission.

4. A device according to any one or more of the preceding claims, **characterised in that** sealing rings are fitted in the measuring chamber.

5. A device according to any one or more of the preceding claims, **characterised in that** cooling or heating means are provided, and the cylinder is provided with circular cooling or channels.

6. A device according to claim 1, **characterised in that** the piston is provided with an axially extending inlet cooling channel and an outlet cooling channel that co-axially surrounds said inlet cooling channel.

7. A device according to any one or more of the preceding claims, **characterised in that** the force means comprise a controllable bellows which engages the cylinder via a lever construction.

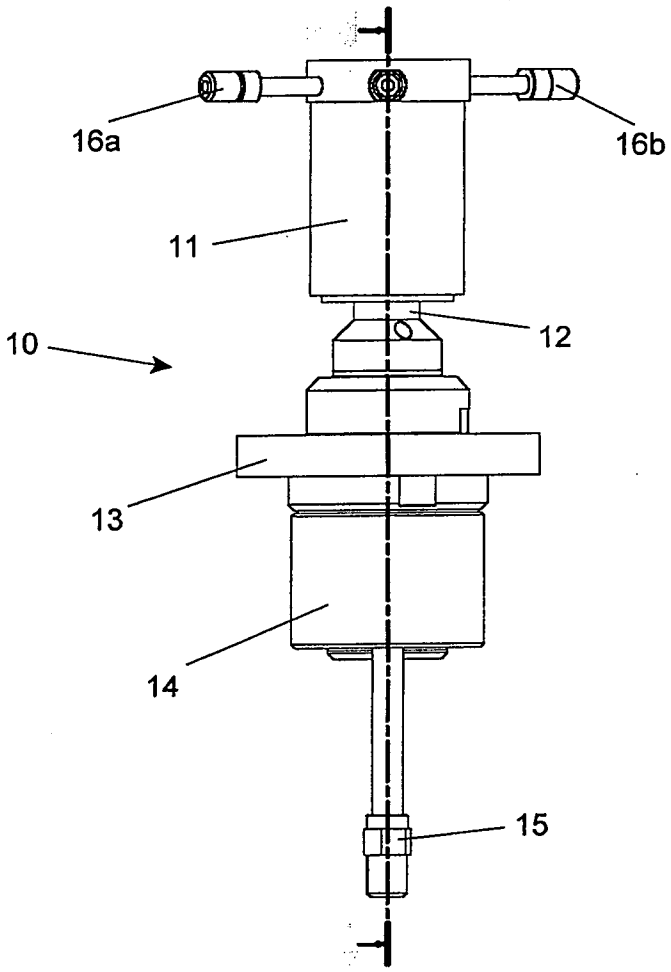

Fig. 1

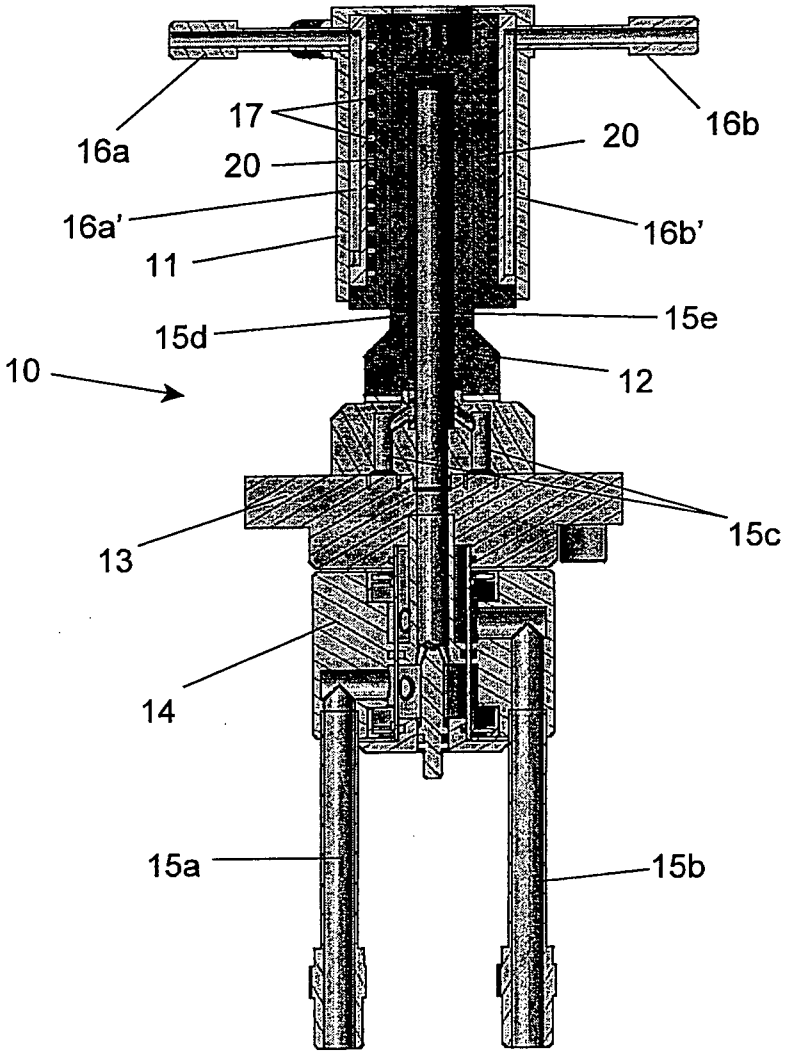

Fig. 2a

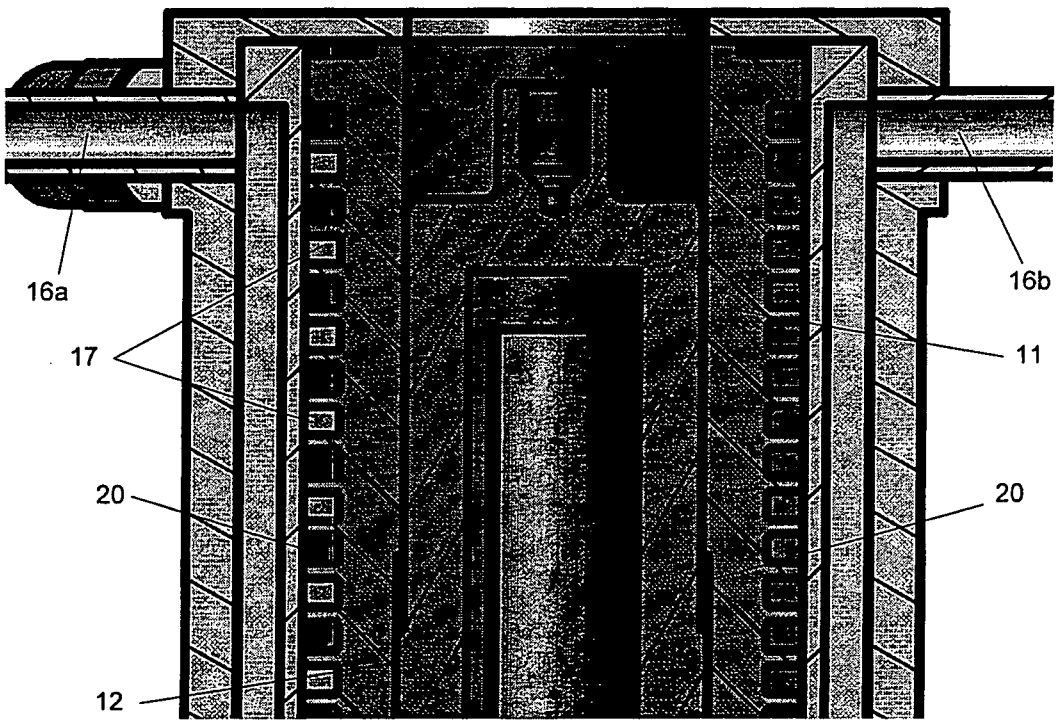

Fig. 2b

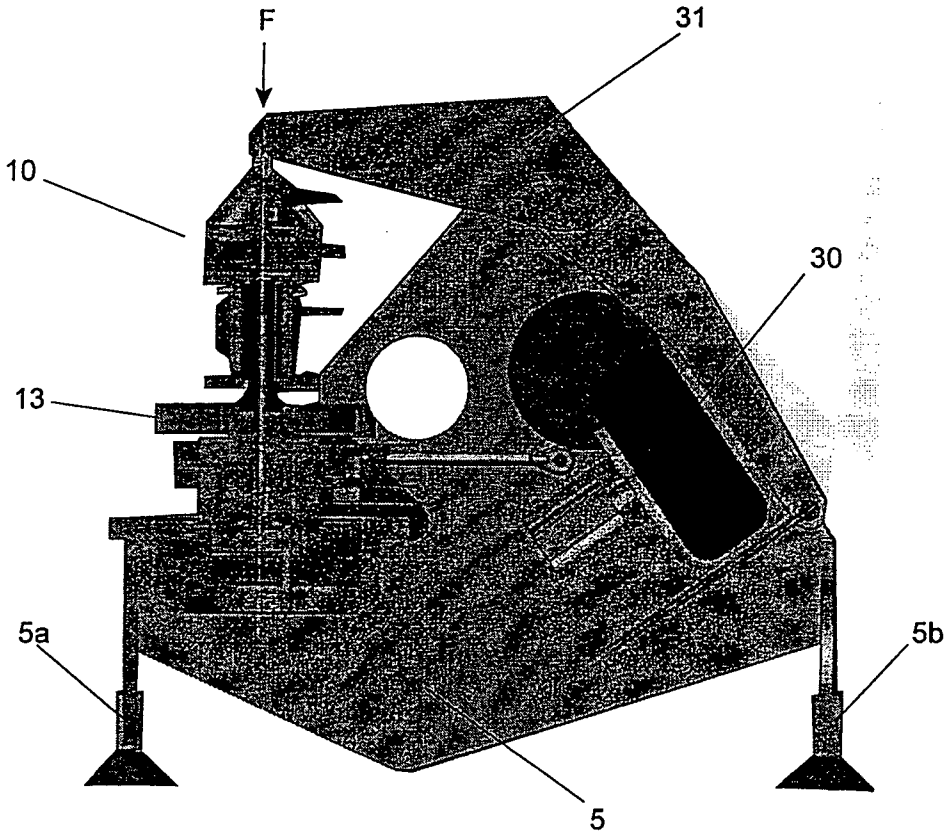

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/NL2008/000268

A. CLASSIFICATION OF SUBJECT MATTER
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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

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

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	M.H.E. VAN DER BEEK: "Specific volume of polymers : influence of the thermomechanical history" 2005, UNIVERSITEITSDRUKKERIJ TU EINDHOVEN , XP002521692 ISBN: 90-386-2567-7 Chapter 2: Concentric cylinder dilatometer: design and testing; Chapter 6: Conclusions and recommandations Figures 2.1, Design A (page 8), Design D (page 84). ----- -/--	1-7

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
1 April 2009	09/04/2009

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Steinmetz, Johannes

Form PCT/ISA/210 (second sheet) (April 2005)

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International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	A.K. FRITZSCHE, F.P. PRICE: "Cristallization of polyethylene oxide under shear" POLYM. ENG. SCI., vol. 14, no. 6, June 1974 (1974-06), pages 401-412, XP002521691	1,2,4,5
A	Section INSTRUMENTATION; page 404, paragraph 1; figures 1,2	3,6,7
X	M.H.E. VAN DER BEEK, G.W.M. PETERS, H.E.H. MEIJER: "A dilatometer to measure the influence of cooling rate and melt shearing on specific volume" INTERN. POLYMER PROCESSING XX, 2005, pages 111-120, XP002521690	1,2,4-6
A	figures 1-4	3,7
X	EP 1 707 948 A (STICHTING DUTCH POLYMER INST [NL]) 4 October 2006 (2006-10-04)	1,2,4-6
A	paragraphs [0009], [0010], [0013], [0016], [0017], [0020]; figure 1	3,7

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/NL2008/000268

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1707948 A	04-10-2006	WO 2006104382 A1	05-10-2006