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- (81) **Designated States** (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM,

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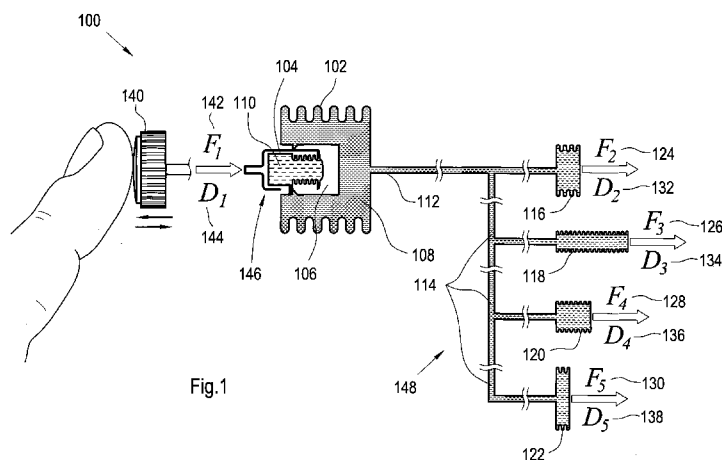
Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))
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(54) **Title:** SYSTEM OF FORCE DISPLACEMENT INSENSITIVE TO TEMPERATURE CHANGES



(57) **Abstract:** A dual bellows system and method that includes a main bellows which interacts with a thermally compensating bellows, whereby interaction of the main bellows with the thermally compensating bellows results in a transfer of force and/or displacement that is insensitive to temperature changes.

SYSTEM OF FORCE DISPLACEMENT INSENSITIVE TO TEMPERATURE CHANGES

Cross Reference to Related Applications

This application claims the benefit of U.S. Provisional Application No. 62/100,828, filed
5 January 7, 2015, the content of the entirety of which is explicitly incorporated herein by reference
and relied upon to define features for which protection may be sought hereby as it is believed that
the entirety thereof contributes to solving the technical problem underlying the invention, some
features that may be mentioned hereunder being of particular importance.

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present invention is not entitled to antedate such material by virtue of prior invention.

Background of the Invention

The system and method generally relates to transfer of fluid force displacement insensitive
to temperature changes, in particular for watches for example.

20 Systems which transfer of forces via fluids are subject to inaccuracies due to thermal
expansion of the fluid. In particular, when more than one fluid is used in the system, differing
thermal expansions increase the difficulty of overcoming these inaccuracies.

Consequently, what is needed is a system which a transfer of force and/or displacement is
insensitive to temperature changes.

Summary of the Invention

A dual bellows system and method is provided that includes a main bellows which interacts with a thermally compensating bellows, whereby interaction of the main bellows with the thermally compensating bellows results in a transfer of force and/or displacement that is insensitive to temperature changes.

Brief Description of the Drawings

FIG. 1 is a schematic representation of a system for transfer of force displacement insensitive to temperature changes.

Those skilled in the art will appreciate that elements in the figures are illustrated for simplicity and clarity and have not necessarily been drawn to scale. For example, dimensions may be exaggerated relative to other elements to help improve understanding of the invention and its embodiments. Furthermore, when the terms `first`, `second`, and the like are used herein, their use is intended for distinguishing between similar elements and not necessarily for describing a sequential or chronological order. Moreover, relative terms like `front`, `back`, `top` and `bottom`, and the like in the description and/or in the claims are not necessarily used for describing exclusive relative position. Those skilled in the art will therefore understand that such terms may be interchangeable with other terms, and that the embodiments described herein are capable of operating in other orientations than those explicitly illustrated or otherwise described.

Detailed Description of the Preferred Embodiment(s)

The following description is not intended to limit the scope of the invention in any way as they are exemplary in nature and serve to describe the best mode of the invention known to the inventors as of the filing date hereof. Consequently, changes may be made in the arrangement and/or function of any of the elements described in the disclosed exemplary embodiments without departing from the spirit and scope of the invention.

Referring now to **FIG. 1**, the invention describes a system 100 particularly adaptable to a wrist watch which displays time via a fluid meniscus in a capillary tube, such as described in

PCT/IB2010/002054, filed 2010-08-20; PCT/IB2010/002055, filed 2010-08-20;

PCT/US12/48044, filed 2012-07-25; PCT/IB2012/002591, filed 2012-12-05;

5 PCT/IB2012/002641, filed 2012-12-10; PCT/IB2013/000660, filed 2013-04-12;

PCT/EP2010/063567, filed 2010-09-15; PCT/IB2014/000373, filed 2014-03-17;

PCT/IB2014/001624, filed 2014-08-26, and PCT/IB2014/002031, filed 2014-10-03, the contents

of all of which are incorporated herein by reference and relied upon. But the present invention can

also be used in devices other than watches which use fluids to activate precision mechanisms such

10 as hydraulic systems which activate dosages or in a level indication system. The dual bellows

system 100 includes: a main bellows 102 which interacts with a thermally compensating ("TC")

bellows 104, whereby interaction of the main bellows 102 with TC bellows 104 results in a transfer

of force and displacement that is insensitive to temperature changes.

The TC bellows 104 is disposed within a cavity 106 of the main bellows 102. The main

15 bellows 102 of the dual bellows system 100 has at least a first liquid 108. The TC bellows 104 is

made up of at least a second liquid 110. The liquid 108 of the main bellows 102 has different

thermal properties than the liquid 110. The dual bellows system 100 also has at least one tube 112

and a tube manifold 114. The tube 112 of the dual bellows system 100 is in fluid communication

with at least one other bellows 116.

20 The tube manifold 112 of the dual bellows system may be connected to a plurality bellows

116, 118, 120, 122. The several bellows 116, 118, 120, 122 of the dual bellows system 100 may

be, as the particular application may require, of different cross-sections, the cross sections typically

(but not necessarily) being cylindrical. The plurality of bellows 116, 118, 120, 122 may therefore

generate varying forces (F_{N+1}) 124, 126, 128, 130 (and so on) and generate varying displacements

25 (D_{N+1}) 132, 134, 136, 138 (and so on). The varying displacements D_N are typically (but not

necessarily) linear displacements. The dual bellows system 100 further has a crown 140 which

provides a mechanical force (F_1) 142 and/or displacement (D_1) 144. The forces, displacements and

cross-sections are mathematically dependent on one another.

The dual bellows system 100 has a first closed system 146 (within bellows 104) and a second closed system 148 (bellows 102 and all other bellows in fluid communication therewith). The force and/or displacement from the first closed system 146 is transferred to the second closed system 148.

5 By virtue of the above arrangement, temperature fluctuations have no or minimal effect on the force and/or displacement produced in the second closed system.

The present patent application incorporates by reference in its entirety US Provisional Patent Application Serial No. 61/623,160 filed 12 April 2012, US Provisional Patent Application 61/793,013 filed on 15 March 2013, and US Patent Application Serial No. 14/391,395 filed on 9
10 October 2014, all entitled "Compensated Capillary Indicator."

The present patent application further incorporates by reference in its entirety US Provisional Patent Application Serial No. 61/787,727 filed 15 March 2013, and US Provisional Patent Application, entitled "Temperature Driven Winding System".

The present patent application incorporates by reference in its entirety US Provisional
15 Patent Application Serial No. 13/391,386 filed 21 February 2012.

In a principal advantage of the invention, a system is provided in which a transfer of force and/or displacement is insensitive to temperature changes.

In another advantage, a system is provided which is intellectually stimulating and interesting to observe, such as in a watch movement.

20 It should be appreciated that the particular implementations shown and described herein are representative of the invention and its best mode and are not intended to limit the scope of the present invention in any way. Furthermore, any connecting lines shown in the various figures contained herein are intended to represent exemplary functional relationships and/or physical couplings between various elements. It should be noted that many alternative or additional physical
25 connections or functional relationships may be present and apparent to someone of ordinary skill in the field.

Moreover, the apparatus, system and/or method contemplate the use, sale and/or distribution of any goods, services or information having similar functionality described herein.

The specification and figures are to be considered in an illustrative manner, rather than a restrictive one and all modifications described herein are intended to be included within the scope of the invention claimed, even if such is not specifically claimed at the filing of the application. Accordingly, the scope of the invention should be determined by the claims appended hereto or later amended or added, and their legal equivalents rather than by merely the examples described above. For instance, steps recited in any method or process claims should be construed as being executable in any order and are not limited to the specific order presented in any claim. Further, the elements and/or components recited in any apparatus claims may be assembled or otherwise operationally configured in a variety of permutations to produce substantially the same result as the present invention. Consequently, the invention is not limited to the specific configuration recited in the claims.

Benefits, other advantages and solutions mentioned herein are not to be construed as necessary, critical, or essential features or components of any or all the claims.

As used herein, the terms "comprises", "comprising", or any variation thereof, are intended to refer to a non-exclusive listing of elements, such that any process, method, article, composition or apparatus of the invention that comprises a list of elements does not include only those elements recited, but may also include other elements described in this specification. The use of the term "consisting" or "consisting of" or "consisting essentially of" is not intended to limit the scope of the invention to the enumerated elements named thereafter, unless otherwise indicated. Other combinations and/or modifications of the above-described elements, materials or structures used in the practice of the present invention may be varied or otherwise adapted by the skilled artisan to other design without departing from the general principles of the invention.

The patents and articles mentioned above are hereby incorporated by reference herein, unless otherwise noted, to the extent that the same are not inconsistent with this disclosure.

Other characteristics and modes of execution of the invention are described in the appended claims.

Further, the invention should be considered as comprising all possible combinations of every feature described in the instant specification, appended claims, and/or drawing figures which may be considered new, inventive and industrially applicable.

Multiple variations and modifications are possible in the embodiments of the invention described here. Although certain illustrative embodiments of the invention have been shown and described here, a wide range of modifications, changes, and substitutions is contemplated in the foregoing disclosure. While the above description contains many specifics, these should not be construed as limitations on the scope of the invention, but rather as exemplifications of one or another preferred embodiment thereof. In some instances, some features of the present invention may be employed without a corresponding use of the other features. Accordingly, it is appropriate that the foregoing description be construed broadly and understood as being given by way of illustration and example only, the spirit and scope of the invention being limited only by the claims which ultimately issue in this application.

Claims

What is claimed is:

1. A dual bellows system (100), comprising: a main bellows (102) which interacts with a thermally compensating bellows (104), whereby interaction of the main bellows (102) with thermally compensating bellows (104) results in a transfer of force and displacement that is insensitive to temperature changes.
2. The dual bellows system of claim 1, in which the thermally compensating bellows rests within a cavity (106) of the main bellows (102).
3. The dual bellows system of claim 1, in which the main bellows (102) comprises a first liquid (108), and the thermally compensating bellows (104) comprises a second liquid (110).
4. The dual bellows system of claim 1 in which the first liquid (108) has different thermal properties than the second liquid (110).
5. The dual bellows system of claim 1 further comprising at least one tube (112).
6. The dual bellows system of claim 1 in which at least one tube (112) comprises a tube manifold (114).
7. The dual bellows system of claim 1 in which at least one tube (112) is in fluid communication with at least one bellows (116).
8. The dual bellows system of claim 1 in which the tube manifold (114) is connected to a plurality bellows (116, 118, 120, 122).
9. The dual bellows system of claim 1 in which the plurality of bellows (116, 118, 120, 122) are of different cross-sections, the cross sections being optionally cylindrical.

10. The dual bellows system of claim 1 in which the plurality of bellows (116, 118, 120, 122) generate varying forces (124, 126, 128, 130) and generate varying displacements (132, 134, 136, 138), the varying displacements optionally being linear displacements.
11. The dual bellows system of claim 1 further comprising a crown (140) which provides
5 a mechanical force (142) and/or displacement (144).
12. The dual bellows system of claim 1 in which the forces, displacements and cross-sections are mathematically dependent on one another.
13. The dual bellows system of claim 1 in which the system comprises first closed system (146) and a second closed system (148), whereby the force and/or displacement from
10 the first closed system is transferred to the second closed system.
14. The dual bellows system of claim 13, wherein temperature fluctuations have no or minimal effect on the force and/or displacement produced in the second closed system.

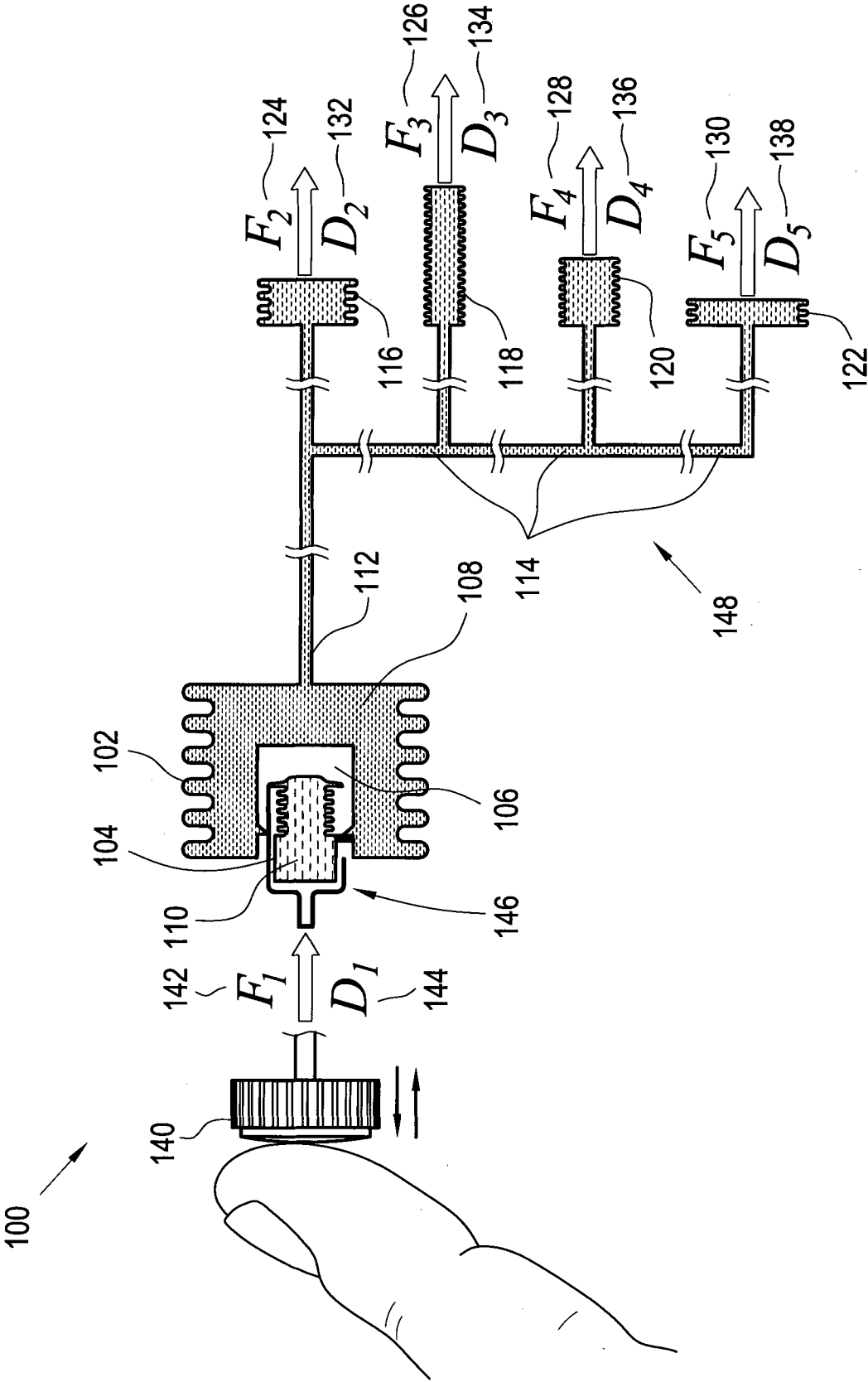


Fig.1

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2016/000004

A. CLASSIFICATION OF SUBJECT MATTER

INV. G04B1/26 G04B27/00
ADD.

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)

G04B F25D F17C

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 practicable, search terms used)

EP0-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	W0 2013/153436 A2 (PRECIFLEX SA [CH]) 17 October 2013 (2013-10-17) page 2, lines 1-18; figures 1,2 page 5, lines 25-26 -----	1-5,11, 13,14 6-10,12
X A	W0 2004/008053 A1 (KRYOTECH INC [US]) 22 January 2004 (2004-01-22) page 13, lines 20-22; figures 1,2,9 page 14, lines 2-14 page 19, lines 28-30 -----	1-3,5-9 10-14
X A	US 4 207 746 A (MCFARLIN DAVID J [US]) 17 June 1980 (1980-06-17) figures 1,2 -----	1,3,5-9 10-14
A	US 1 730 448 A (JAMES W. BRYCE) 8 October 1929 (1929-10-08) column 1; figure 5 -----	1-14

☐ Further documents are listed in the continuation of Box C.

☒ 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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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

18 May 2016

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2016/000004

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