July 9, 1963 C. P. SALMON 3,096,691

TRANSDUCER

Filed June 27, 1960

Fig. 1.

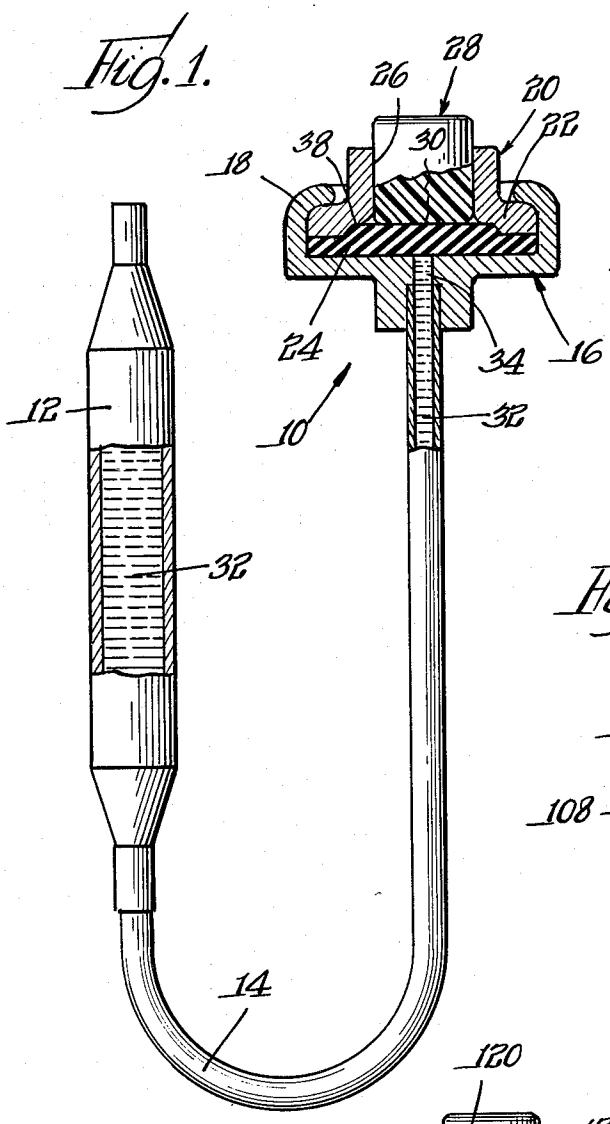


Fig. 2.

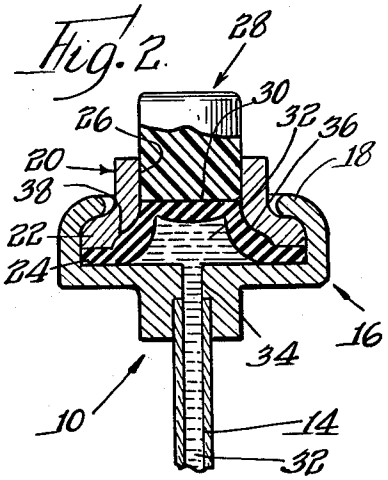


Fig. 3.

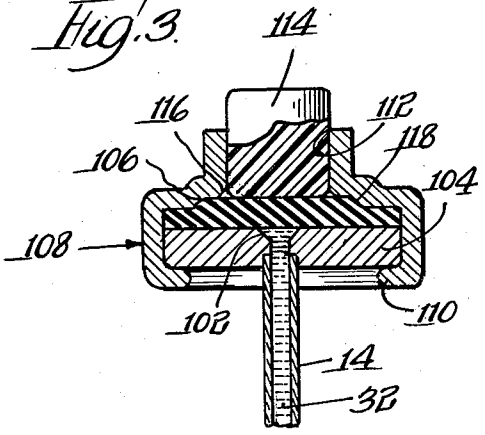


Fig. 4.

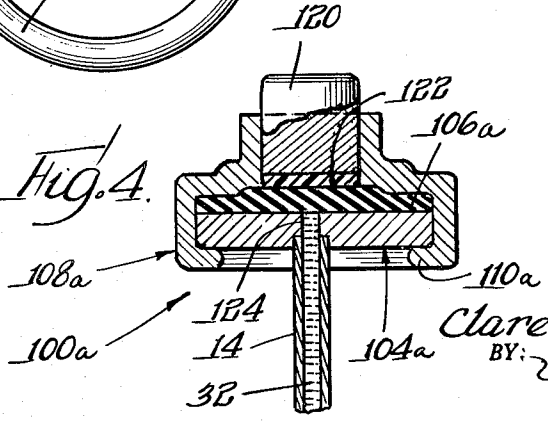
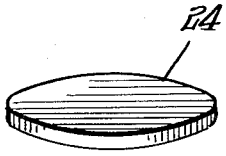


Fig. 5.



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This invention relates generally to transducers and especially to transducers of the type adapted to convert fluid expansion to linear mechanical movement.

Transducers of the type described commonly utilize an elastomeric element for converting the volume expansion of a thermally responsive material to the linear motion of a piston. One frequently employed arrangement calls for the elastomeric element to define a blind bore which receives a portion of the piston. In this arrangement, expansion of the thermally responsive material causes the piston to be "squeezed" partially out of the blind bore. Elastomeric elements of this type, while offering great utility, have proved expensive to manufacture because their complex shape requires molding or other, no less costly, production methods.

An alternative scheme calls for use of a simple, flat diaphragm interposed between the expansible material and the piston; and although structures of this general nature avoid expensive, molded rubber parts, they have heretofore exhibited unduly short cycle-life, failure of the diaphragm ordinarily occurring before thirty-thousand cycles have been completed.

Therefore, an important object of the present invention is to provide a transducer which employs a simple, flat elastomeric element while exhibiting extended cycle-life.

A more general object of the invention is to provide a new and improved transducer of the type which is adapted to convert fluid expansion to linear mechanical movement.

Another object of the invention is to provide a transducer which is susceptible of substantial minaturization.

Yet another object of the invention is to provide a transducer which is economical to manufacture.

A further object of the invention is to provide a transducer which displays a low hysteresis lag.

Additional objects and features of the invention pertain to the particular structure, arrangements and materials whereby the above objects are attained.

A structure in accord with the invention includes a cup-shaped housing, a fitting confined in the housing by deforming the edges of the open end of the housing thereover, an elastomeric disc situated in the housing beneath the fitting, a sleeve bearing defined in the fitting and disposed perpendicularly to the disc, a piston means slidably received in the sleeve bearing and displaying an anti-friction surface to one side of the disc, and means in the housing communicating an expansible fluid to the opposite side of the disc.

The invention, both to its structure and mode of operation, will be better understood by reference to the following disclosure and drawing forming a part thereof, wherein:

FIG. 1 is an enlarged, side-elevational view partially in cross-section of a transducer constructed in accordance with the present invention and showing the piston in its retracted position;

FIG. 2 is a view similar to the showing of FIG. 1 but omitting the showing of the sensing bulb and illustrating the piston in its extended position;

FIG. 3 is a showing similar to FIG. 2 illustrating a modified transducer constructed in accordance with the invention;

FIG. 4 is another showing similar to FIG. 2 of a further modified embodiment of the invention; and

FIG. 5 is a perspective view of the elastomeric disc used in the transducer of the invention.

Referring now in detail to the drawing, specifically to FIGS. 1 and 2, a transducer indicated generally by the numeral **10** will be seen embodied in a thermostatic device, the transducer **10** being particularly connected to a sensing bulb **12** by means of a capillary tube **14**. The transducer **10** will be seen to include a cup-shaped housing **16**, the open end of which is defined by deformable lips **18**. A fitting **20** is confined within the housing **16** by crimping the lips **18** over flange portions **22** of the fitting. In accordance with the invention, an elastomeric disc **24** is situated in the housing **16** beneath the fitting **20**; and as will be noted, the crimping over of the lips **18** is adapted to compress the peripheral portions of disc **24** between the flange portions **22** of fitting **20** and the floor of housing **16**. Thus, the transducer is sealed against leakage.

With reference for the moment to FIG. 5, the elastomeric disc **24** will be seen to take the shape initially of a cylinder possessing a radius substantially in excess of its height. In other words, the disc **24** is, initially, substantially flat; and accordingly, it may be fabricated by die cutting or blanking from vulcanized sheet stock. Considerable economies in manufacture can thus be realized. Returning to FIG. 1, it will be observed that the disc **24** is compressed to approximately one-half its thickness at the periphery beneath flange portion **22** whereas the central portion of the disc **24** remains unstressed.

The fitting **20** is arranged to define a sleeve bearing **26** which opens perpendicularly from disc **24**; and in accordance with an important feature of the invention, a piston **28** is slidably received into the sleeve bearing **26** to display an anti-friction surface **30** to the disc **24**. In the specific embodiment of the invention shown in FIGS. 1 and 2, the entire piston **28** is fabricated from polytetrafluoroethylene resin in order to establish the proper anti-friction surface.

An expansible fluid **32** is contained within the sensing bulb **12**, within the capillary tube **14** and within a hollowed portion **34** of housing **16**, portion **34** being arranged to communicate the fluid **32** to one side of disc **24**. Since, for the embodiment of FIGS. 1 and 2, the transducer **10** is selected to be a component of a thermostatic device, increasing the temperature of the sensing bulb **12** will cause a thermal expansion of the fluid **32**; and this expansion will be realized within the transducer **10** by an extension of disc **24** as is well shown in FIG. 2, there being a concomitant linear displacement of piston **28**.

In accordance with an important feature of the invention, the edges **36** of sleeve bearing **26** are rounded adjacent disc **24** to facilitate extension of the disc thereover. Moreover, it has proved advantageous to provide relieved shoulder portions **38** in the sleeve bearing **26** radially inwardly from the flange portions **22**. The relieved shoulders **38** also facilitate extension of the disc **24**.

With continuing reference to FIG. 2, it will be observed that the elastomeric disc **24** is substantially stressed when the piston **28** has been displaced outwardly by expansion of the fluid **32**. The stresses thus imposed on the elastomeric disc **24** tend to return the disc to its initial position upon contraction of the fluid **32**, as might be experienced upon cooling of sensing bulb **12**. The customarily provided, external spring loading of piston **28** also cooperates in returning the components of the transducer **10** to their initial position upon contraction of the fluid **32**.

Housing **16** may be advantageously fashioned by machining, extrusion or stamping operations employing such common materials as copper, brass, bronze and steel. Fitting **20** may be likewise suitably formed. The fluid **32** may be of any suitable type and preferably exists in its

liquid phase throughout the operating temperature range of the device in which it is to be utilized. Moreover, fluid **32** is desirably selected to be chemically inert to the elastomeric disc **24** as well as to the other components into which it comes in contact. Silicon oils and polyglycols have proved eminently suitable for use as the fluid **32**. In specific embodiments of the invention, disc **24** has been advantageously fashioned from synthetic rubber of the acrylonitrile type.

Turning now to FIG. 3, the capillary tubing **14** will be seen connected to a modified transducer **100**. Specifically, capillary tubing **14** is arranged to communicate with a flaring cavity **102** defined in a disc-shaped fitting **104**. Cavity **102** opens against one side of an elastomeric disc **106** which is confined between the fitting **104** and the floor of a housing **108** as by crimping the lips **110** of housing **108** over the edges of fitting **104**.

The housing **108** is arranged to provide a sleeve bearing **112** in which a piston **114** is slidably received. The sleeve bearing **112** defines rounded edges **116** adjacent the disc **106**, rounded edges **116** being similar to the rounded edges **36** of the embodiment shown in FIGS. 1 and 2. Sleeve bearing **112**, in addition, defines relieved shoulder portions **118** which are similar to the relieved shoulder portions **38** of the embodiment of FIGS. 1 and 2.

Piston **114** is desirably fabricated from polytetrafluoroethylene resin in order to provide the proper anti-friction surface in abutment with the disc **108**; and the other components of the transducer **100** are constructed in a similar manner and from materials similar to the corresponding components of the embodiment of FIGS. 1 and 2.

In FIG. 4, a further modified form of the transducer is shown. There, a transducer **100***a* incorporates a piston **120** which is fabricated from steel; and a polytetrafluoroethylene resin washer **122** is interposed between piston **120** and the elastomeric disc **106***a*. Furthermore, the capillary tube **14** communicates the expansible fluid **32** to one side of the disc **106***a* by means of a cylindrical cavity **124**. In other respects the transducer **100***a* is constructed similarly to the transducer **100**; and accordingly, like numerals have been used to designate like elements, the suffix letter "*a*" being employed to distinguish those elements associated with the transducer **100***a*.

While particular embodiments of the invention have been shown, it should be understood, of course, that the invention is not limited thereto since many modifications may be made; and it is, therefore, contemplated to cover by the appended claims any such modifications as fall within the true spirit and scope of the invention.

The invention is claimed as follows:

1. A transducer adapted to convert fluid expansion to linear mechanical movement, said transducer comprising: cup-shaped housing means having deformable lips at the open end thereof; fitting means confined in said housing means by deforming said lips thereover; an elastomeric disc situated in said housing means beneath said fitting means; a sleeve bearing defined in one of said first and second mentioned means and disposed perpendicularly to said disc; piston means slidably received in said sleeve bearing and displaying an anti-friction surface to one side of said disc; and means in the other of said first and second mentioned means communicating an expansible fluid to the opposite side of said disc.

2. A transducer according to claim 1 wherein said piston means includes a metal piston member and a polytetrafluoroethylene washer element disposed between said piston member and said disc.

3. A transducer according to claim 1 wherein said piston means is fabricated from polytetrafluoroethylene resin.

4. A transducer according to claim 1 wherein said sleeve bearing defines a rounded edge adjacent said disc.

5. A transducer according to claim 1 wherein said sleeve bearing defines relieved shoulder portions adjacent said disc.

6. A transducer adapted to convert fluid expansion to linear mechanical movement, said transducer comprising: cup-shaped housing means having deformable lips at the open end thereof; fitting means confined in said housing means by deforming said lips thereover; an elastomeric disc situated in said housing means beneath said fitting means; a sleeve bearing defined in one of said first and second mentioned means and disposed perpendicularly to said disc, said sleeve bearing defining a rounded edge and relieved shoulder portions adjacent said disc; piston means slidably received in said sleeve bearing and fabricated from polytetrafluoroethylene resin to display an anti-friction surface to one side of said disc; and means in the other of said first and second mentioned means communicating an expansible fluid to the opposite side of said disc.

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