

May 29, 1945.

R. AVIGDOR

2,376,892

DIAPHRAGM CONTROLLED OPERATING UNIT

Filed June 10, 1942

2 Sheets-Sheet 1

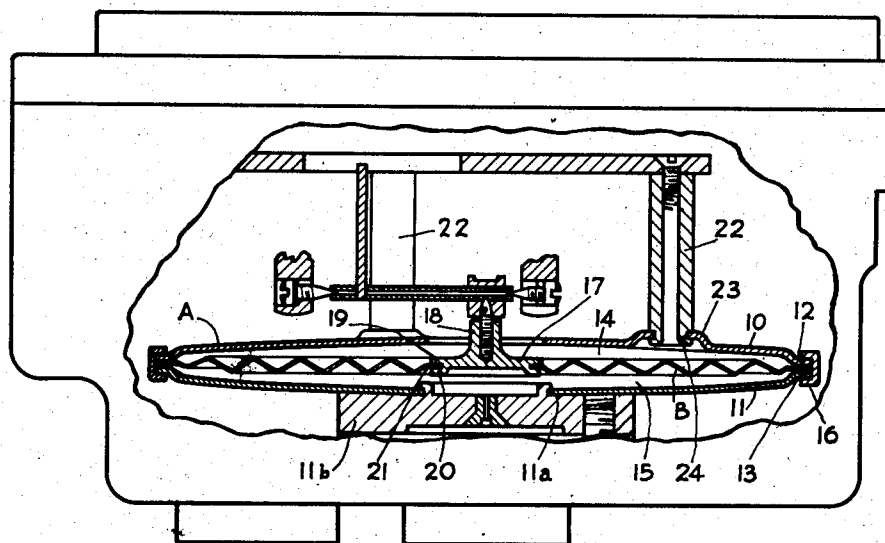


FIG. 1

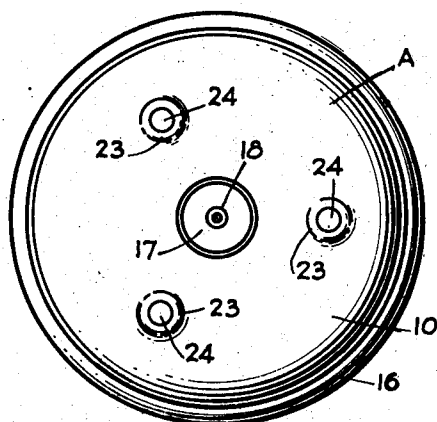


FIG. 2

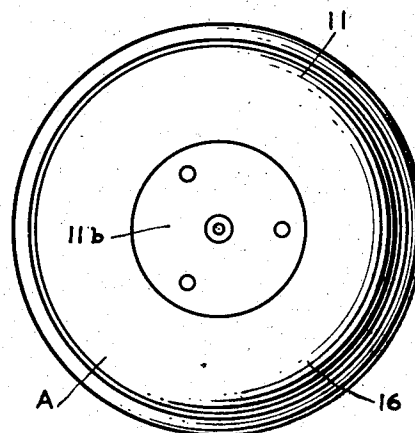


FIG. 3

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By C. F. Wenderoth, attorney

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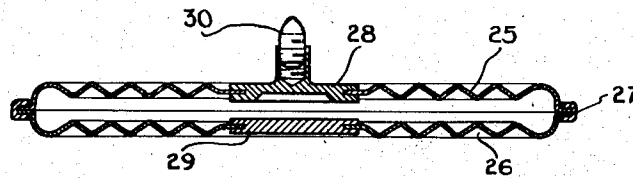


FIG. 4

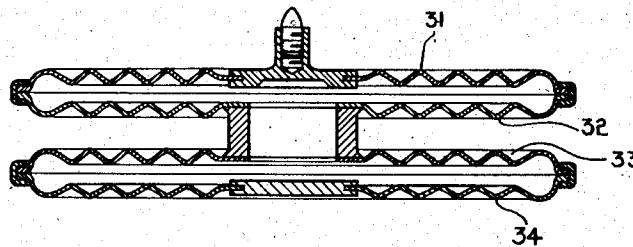


FIG. 5

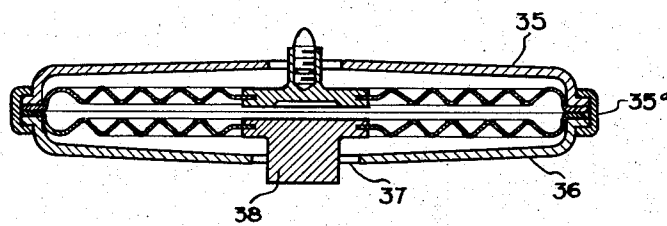


FIG. 6

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UNITED STATES PATENT OFFICE

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DIAPHRAGM CONTROLLED OPERATING UNIT

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In Canada March 14, 1942

6 Claims. (Cl. 137-157)

This invention relates to a heat compensating, diaphragm controlled, operating unit for devices operated by fluid pressure.

Up to the present time many devices operated by fluid pressure have been produced for use in various fields. A particular problem which is confronted in the manufacture of such devices, and which is manifest particularly in the case of instruments, is to provide an instrument which will record with a reasonable degree of accuracy under all conditions. One serious difficulty is presented by constant changes in temperature conditions which cause expansion and/or contraction of parts of the device. In one particular example, airplane instruments, for instance, temperatures from plus 80° F. to minus 60° F. may be encountered in a short space of time, with the result that due to expansion and/or contraction of parts of the instrument, inaccurate readings result.

A number of attempts have been made to reduce inaccuracies caused by expansion and/or contraction of parts due to temperature change. In some cases in instrument manufacture, bi-metallic members have been employed between the instrument mechanism and the diaphragm operating element for reducing the effects mentioned. Bi-metallic helical springs have also been used connecting with the pointer operating shaft of the instrument. However, while various methods of this character have reduced such inaccuracies in some degree, the problem still remains as a serious one.

I have found that inaccuracies due to expansion and/or contraction of parts caused by change in temperature conditions encountered, can be reduced to a very fine degree at least and in many cases eliminated. It is, therefore, an object of the present invention to produce means for reducing to a fine degree, or eliminating, inaccuracies in fluid operated devices caused by expansion and/or contraction of metals due to temperature changes.

A further object of the invention is to provide an extremely simple structure employing a minimum number of parts for accomplishing this result.

A still further object of the invention is to provide a means of this character which will employ no more parts than are necessary for an instrument of this character and without incorporating extra parts for heat compensation.

With these and other objects in view, the invention generally comprises a diaphragm controlled operating unit comprising a plurality of opera-

tively connected elements, at least one of which is a diaphragm, the diaphragm being so formed as to expand and/or contract to its greatest degree substantially at right angles to its normal operating plane in response to temperature conditions, at least one of said elements being expandible and/or contractible to its greatest degree, in a predetermined direction, in response to temperature conditions, whereby expansion and/or contraction of said elements controls the effect on said device when connected with said diaphragm of displacement of the diaphragm and said elements due to temperature conditions.

The structure of the unit may be varied to suit requirements and the parts may be varied in thickness and in material to produce a cooperative combination which will achieve predetermined results to control, offset or neutralize the effects caused by expansion and/or contraction of the parts. Under the present invention, it is possible without the addition of extra heat compensating devices to so choose and arrange the parts that a cooperation between parts of a diaphragm, a diaphragm and its casing, a diaphragm and connecting parts between the casing and the mechanism operated by the diaphragm, etc., to cause the device to react in a predetermined manner to temperature conditions. This may be done in many cases when using similar materials and in other cases by the use of different materials having a different rate of expansion and/or contraction.

The invention will be clearly understood by reference to the following detailed specification taken in conjunction with the accompanying drawings.

In the drawings—

Fig. 1 is a transverse section showing a unit according to the present invention illustrating said unit in cross-section and in relation to other parts of the construction with which it is associated.

Fig. 2 is a top plan view of the unit illustrated in Fig. 1.

Fig. 3 is a bottom plan view of said unit.

Fig. 4 is a transverse section taken through an alternative form of the unit.

Fig. 5 is a transverse section taken through a still further form of the unit; and

Fig. 6 is a transverse section taken through a unit showing the manner in which a casing may be associated with an alternative form of construction.

Referring to the drawings and particularly Figs. 1 to 3, A indicates a diaphragm controlled operat-

ing unit for devices operated by fluid pressure which in the form illustrated includes two plate-like members 10 and 11 so formed that their peripheral edges 12 and 13 and/or portions thereof adjacent the peripheral edges may clamp therebetween a diaphragm B. The plate-like members otherwise are spaced apart from one another so as to form on each side of the diaphragm the chambers 14 and 15. The plate-like members 10 and 11 are held in airtight engagement with the peripheral edges of the diaphragm by means of a ring-like member 16 which is forced onto their peripheral edges under pressure so as finally to grip these edges in tight clamping engagement such that the joint effected between the edges of the plate-like members and the diaphragm is completely airtight.

The diaphragm is provided with a member 17 designed to carry the connecting post 18 through which the diaphragm may be operatively connected to parts of an instrument or the like which it is designed to operate. This member is preferably formed with the upper and lower integral clamping elements 19 and 20 which overlap the inner peripheral edge 21 of the diaphragm and are forced thereover into an airtight engagement therewith. Thus, by employing such a form of connection between the plates 17 and the diaphragm and the connecting member 16 to connect the plate-like members 10 and 11 at their peripheries, clamp the diaphragm B, a varied and wide choice of material may be made with respect to the material of the diaphragm and the material of the enclosing casing. Moreover, substantial variations may be made with respect to the size and thickness of these parts.

In the form of construction at present referred to, the plate-like member 10 is designed to carry a plurality of posts 22, being formed for instance, with suitable bosses 23 and apertures 24 through which the posts may be secured. These posts are designed to support, as illustrated, a mechanism actuated by the diaphragm. Furthermore, it will be noted that the lower ends of the posts are peened over and forced into airtight or air sealing engagement with the plate-like members. Likewise, in the case of the plate-like member 11 formed with the orifice 11a provided with the mounting member 11b, it is preferred to project a portion of the latter within this orifice and force it into air sealing engagement with the inner periphery of this plate-like member surrounding such orifice.

By so choosing the materials and/or size and construction for the diaphragm B, plate-like members 10 and 11, and/or the posts 22, I am able to control the effect on the device, or displacement of the diaphragm and elements of the construction due to temperature conditions so that in the case of an instrument, for instance, no inaccuracies in the reading will result due to any displacement of the parts by temperature causes or through which a given displacement may be provided for where this might be desirable.

In the form of construction being dealt with, the diaphragm B is of such character that it will expand and/or contract as a result of temperature conditions in a plane substantially at right angles to its normal operating plane. The plate-like members 10 and 11 are of such area and thickness that they will expand and/or contract, as a result of temperature conditions, radially of their centers. Thus, by controlling the rate of expansion of the plate-like members 10 and 11 and co-relating such expansion to that of the ex-

pansion of the diaphragm B, the effects of the expansion of the latter on the operating mechanism connected with the diaphragm through the post 18 may be directly controlled. In other words, since the plate-like members 10 and 11 firmly grip the peripheral edge of the diaphragm B, radial expansion of such members 10 and 11 at a given rate will offset the expansion of diaphragm B by effecting a linear stretching or linear counter-expansion of such diaphragm to any chosen degree. Accordingly, the movement of the post 18 in the direction of its axis, to operate the mechanism with which it is operatively connected, may be controlled to impart, to the mechanism, that degree of movement which is desired and either exclude or directly control any movement thereof caused by expansion and/or contraction of the diaphragm due to temperature conditions.

Control of the movement of the post 18 caused by the effects of expansion and/or contraction of the diaphragm B by temperature conditions may be effected in the manner described or in conjunction with the supporting structure such as the posts 22 or may be controlled directly between the supporting structure such as the posts 22 and the diaphragm. In this connection, by so choosing the supporting structure such that it will expand and/or contract as a result of temperature conditions to its greatest degree in a given direction, the result of such expansion and/or contraction when co-related to the expansion and/or contraction of the diaphragm B may be employed to control the effects of such abnormal expansion and/or contraction of the diaphragm on the mechanism operated thereby. For instance, by directing the mass of the material of the posts 22 so that they will expand and/or contract axially to their greatest degree at a given rate, and co-relating this expansion and/or contraction of the diaphragm B, the axial expansion of the posts 22 is immediately co-related to that axial movement of the post 18 caused by expansion and/or contraction of the diaphragm B. Therefore, the effects of such abnormal movement of the post 18 may be directly controlled in relation to the results desired from the mechanism operated thereby.

The control of expansion and/or contraction of the diaphragm as above referred to may be carried out by a choice of materials having different coefficients of expansion or may be controlled by variation of the mass of material in question. Thus, the diaphragm and the casing or plate-like members 10 and 11 may be chosen of the same material and of the same or similar thickness or of the same material of different thicknesses. On the other hand, these parts may be chosen of materials which are different from one another and of the same or similar thickness or of different thicknesses. In this way, therefore, a minute control may be obtained of the effect of the movement of the diaphragm due to temperature conditions. Moreover, such control, it will be clear, may be effected with or without the use of the supporting posts 22 or other mounting structure or may be caused as a combination between the diaphragm and the supporting structure alone.

The control of the effects of expansion and/or contraction of a diaphragm element as a result of temperature conditions may be achieved following the principles of the present invention in different types of structures. The application of the principle of the present invention to cap-

sule type diaphragm units and multiple diaphragm units is illustrated in Figs. 4 and 5. Dealing first with Fig. 4 wherein a capsule type diaphragm unit is disclosed, the diaphragm elements 25 and 26 may be connected together, and preferably are, by means of a ring-like member 27 forced into engagement therewith and may also be provided with a stiffening plate 28 and a similar plate 29, both forced into engagement with the elements 25 and 26 respectively. The diaphragm element 25 may be formed of one material and the element 26 of another, each having a coefficient of expansion different from the other and co-related in such a manner, that the effects of expansion and/or contraction of these diaphragm elements due to heat conditions, may control the resulting effect on the mechanism of the instrument connected through the post 30. On the other hand, by choosing the elements 25 and 26 so that one may be thicker than the other and not necessarily of a different material, the effects of expansion and/or contraction as above referred to may be controlled.

By employing the ring-like member 27 as a means of securing the diaphragm elements together and, in the case where these elements are of a different material, any electrolytic action which might be set up between the elements, and thus render the combination impractical for use in some fields, may be eliminated by interposing between the clamped surfaces of the elements a suitable dielectric. Consequently, it will be readily appreciated that the invention has a wide application and is operable under varied conditions.

The far reaching effect of the invention may be further illustrated by reference to Fig. 5 showing a multiple capsule type diaphragm unit. This structure includes the diaphragm elements 31, 32, 33 and 34. It will be readily appreciated that by constructing the unit in such a way as to vary and co-relate the materials of these four elements, one to the other, that minute control of the movement of these diaphragms due to temperature conditions, and the resulting effect, may be obtained. Likewise by co-relating the size and thickness of these elements, the desired resulting effect may be obtained.

In Fig. 6 a manner in which plate-like members may be associated with the diaphragm element is shown wherein the plate-like members 35 and 36 are disposed on each side of the capsule and clamp therebetween the circumferential flange of the capsule, the plate-like members being secured together by means of a ring-like member 35a forced into pressure engagement therewith and in effect forming an airtight seal around the structure. In this case, the plate-like member 36 is orificed at 37 and the capsule is formed with a projection 38 which is a continuation of a plate or the like enclosing the bottom element of the capsule and corresponding to plate 29 as shown in Fig. 4. Through this construction, the full effects of the diaphragm unit or capsule are obtained, whereas in addition the benefits of a casing such as described in Figs. 1 to 3 are also obtained.

Thus, by providing a combination such that expansion and/or contraction of the diaphragm due to temperature conditions is counteracted or controlled by a linear stretching of the diaphragm in a desired degree, depending upon the extent of control desired, the present invention meets this problem in a very simple man-

ner. Alternatively, by co-relating the expansion and/or contraction of the diaphragm with other normal elements of the construction, such as the supporting structure between the unit and the mechanism operated thereby, the abnormal effects of expansion and/or contraction of the diaphragm by temperature causes is controlled in a simple manner. As a result, therefore, it will be clear that by so choosing and constructing normal operating parts of such a mechanism so as to co-relate the expansion and/or contraction of such parts in question to the expansion and/or contraction of a diaphragm element caused by temperature conditions, the resulting effect of the latter may be minutely controlled and such control may be a neutralizing of the effects so caused or the use of such effects in some degree where this is desirable.

While, through the use of the principle outlined in the foregoing specification, it is possible to control the effect of expansion and/or contraction of the diaphragm due to temperature causes, it will, of course, be apparent that the invention will compensate for minute variations in the physical characteristics of the material. It is a well established and obvious fact that the value of Young's modulus of elasticity varies with the state or condition of the material in relation to temperature and other causes. The invention, therefore, must compensate for minute variations in the physical characteristics of the material used, effected through temperature or other causes.

Variations of structure are, of course, within the scope of the invention and it should be appreciated that the unit may be employed as a pressure transmitting unit. Consequently in the following claims, the statement "diaphragm controlled fluid pressure operated unit for pressure operated devices" should be understood to include pressure transmitting devices.

What I claim as my invention is:

1. A heat compensating, diaphragm controlled operating unit for a fluid pressure operated device, comprising a diaphragm having predetermined properties of thermal expansibility and contractibility whereby its maximum expansion and contraction is in a direction substantially at right angles to the principal plane of the diaphragm, means for transmitting movement from the diaphragm to said device, and thermal responsive supporting means for said device in spaced position around said movement transmitting means and operatively connected to said diaphragm and having properties of thermal expansibility and contractibility predeterminedly correlated to those of said diaphragm so as to control the effective extent of transmitted movement from said diaphragm to said device due to temperature changes, said supporting means having a coefficient of expansion different from that of said diaphragm.

2. A heat compensating, diaphragm controlled operating unit for a fluid pressure operated device, comprising a diaphragm having predetermined properties of thermal expansibility and contractibility whereby its maximum expansion and contraction is in a direction substantially at right angles to the principal plane of the diaphragm, means for transmitting movement from the diaphragm to said device, and thermal responsive supporting means for said device in spaced position around said movement transmitting means and operatively connected to said diaphragm and having properties of thermal expan-

sibility and contractibility predeterminedly correlated to those of said diaphragm so as to control the effective extent of transmitted movement from said diaphragm to said device due to temperature changes, said supporting means having a coefficient of expansion different from that of said diaphragm and being thermally expandible and contractible in a predetermined direction different from that of said diaphragm.

3. A heat compensating, diaphragm controlled operating unit for a fluid pressure operated device, comprising a diaphragm having predetermined properties of thermal expansibility and contractibility whereby its maximum expansion and contraction is in a direction substantially at right angles to the principal plane of the diaphragm, means for transmitting movement from the diaphragm to said device, and a diaphragm casing substantially encompassing said diaphragm and being in peripheral clamping engagement therewith and having properties of thermal expansibility and contractibility predeterminedly correlated to those of said diaphragm as to control the effective extent of transmitted movement from said diaphragm to said device due to temperature changes, said diaphragm casing having a coefficient of expansion different from that of said diaphragm and being thermally expandible and contractible in a predetermined direction different from that of said diaphragm.

4. A heat compensating, diaphragm controlled operating unit for a fluid pressure operated device, comprising a diaphragm having predetermined properties of thermal expansibility and contractibility whereby its maximum expansion and contraction is in a direction substantially at right angles to the principal plane of the diaphragm, means for transmitting movement from the diaphragm to said device, a diaphragm casing substantially encompassing said diaphragm and being in peripheral clamping engagement therewith, and a super-structure on said casing and interconnecting the latter and said device, said super-structure having properties of thermal expansibility and contractibility predeterminedly correlated to those of said diaphragm as to control the effective extent of transmitted movement from said diaphragm to said device due to tem-

perature changes, said super-structure having a coefficient of expansion different from that of said diaphragm.

5. A heat compensating, diaphragm controlled operating unit for a device operated by fluid pressure comprising a casing, a diaphragm disposed within the casing and secured around its periphery in airtight engagement with said casing, supporting means on said casing designed to support mechanism for operative connection with the diaphragm, said casing being formed from a metal having a higher coefficient of expansion than the diaphragm and of an area and thickness to cause expansion and contraction of greatest degree in directions radially of its center in response to heat conditions encountered, said diaphragm being so formed as to expand and contract to its greatest degree substantially at right angles to its principal plane in response to heat conditions encountered, whereby said casing causes linear expansion and contraction of said diaphragm in response to heat conditions, said supporting means on the casing possessing such thermal properties as to expand and contract to its greatest degree in a predetermined direction responsive to heat conditions, and being of a metal having a predetermined coefficient of expansion, the properties of thermal expansibility and contractibility of the casing and supporting means being predeterminedly correlated to those of the diaphragm as to control the effective extent of transmitted movement from said diaphragm to said device due to temperature changes.

6. A heat compensating, diaphragm controlled operating unit for a fluid pressure operated device, comprising a diaphragm having predetermined properties of thermal expansibility and contractibility, and thermal responsive supporting means for said device in spaced position around said movement transmitting means and operatively connected to said diaphragm and having properties of thermal expansibility and contractibility predeterminedly correlated to those of said diaphragm as to control the effective extent of transmitted movement from said diaphragm to said device due to temperature changes.

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