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[54] **ACTION UNIT FOR MEASURING DEVICES**

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[58] **Field of Search**.....73/384, 387, 386; 74/89.2, 89.22

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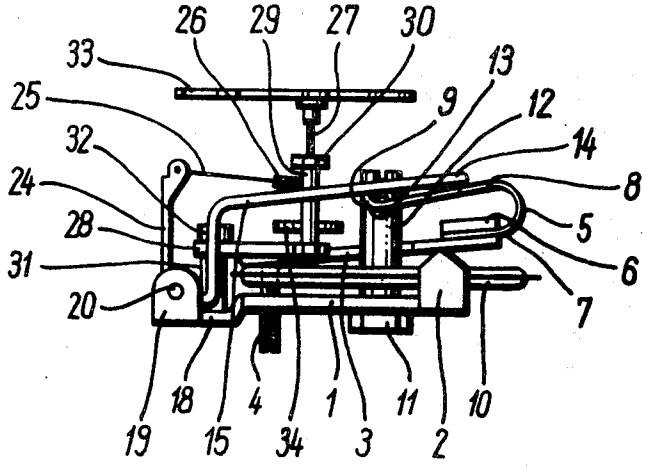
[57] **ABSTRACT**

An action unit for a measuring device such as an aneroid barometer incorporates a U-shaped blade spring one limb of which is fixed to an adjustable support while the other limb, which is longer than the first limb, provides a bearing surface for an intermediate member engaged by an actuator pin of the measuring device. The actuator pin is disposed between the yoke and the terminal edge of the longer limb of the blade spring and the intermediate member bears on said terminal edge and on points between said edge and the yoke, and said intermediate member is extended to provide means for actuating an indicator through a movement-amplifying linkage system.

7 Claims, 2 Drawing Figures



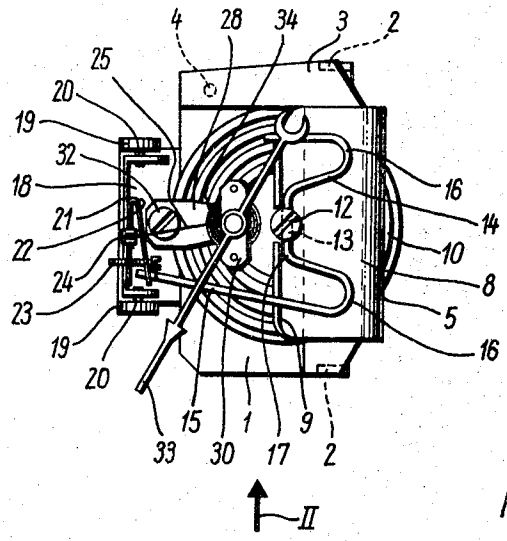


Fig. 1

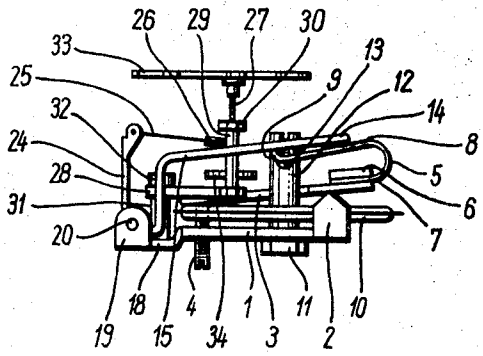


Fig. 2

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ACTION UNIT FOR MEASURING DEVICES

The invention relates to an action unit for an aneroid barometer. Such devices embody a responder member such as an evacuated capsule having a pair of diaphragms secured to a carrier. Such action units include a diaphragm pin extending substantially perpendicularly to the surface of one diaphragm and the movements of the pin are transmitted by one end of a transmission lever to an indicator while the other end of the lever is connected to a free limb of a bent U-shaped blade spring the center plane of which lying in the U-cross-sectional surface of the spring stands radial to the axis of the diaphragm pin with the yoke remote from this axis, and one limb of this spring is secured to the carrier whereas the free limb is in operative connection without play with the diaphragm pin by means of an intermediate member.

With these action units the free end of the U-shaped blade spring is bent outwardly parallel to the yoke and this bent part bears against a cross bearer under the pre-stress of the U-spring and the longitudinal direction of which coincides with the longitudinal direction of the bent edge and is screwed to the diaphragm pin. Thereby the free edge of the bent part of the U-spring is radial to the axis of the diaphragm pin. The U-spring has a relatively great width and its free limit is provided in its central region with a recess which surrounds the diaphragm pin. By the pre-stressing of the U-spring the two diaphragms of the diaphragm capsule are forced apart so that the diaphragm capsule is under pre-stress. The movement of the free edge of the bent part of the U-spring does not run exactly perpendicularly to the outer surface of the diaphragm, that is not parallel to the axis of the diaphragm pin, but describes an arc.

Further, the tangents to the center portion of this arc do not run in general in the axial direction of the pin. This has the disadvantageous result that the pressure sensitivity of the barometer, that is the deflection for a definite change in pressure, is undesirably small. Thereby further the response sensitivity, that is the commencement of the change of the indicator for a definite pressure change, is undesirably great. This is because the U-spring exerts on the diaphragm pin not only a force in the axial direction thereof but also exerts a force on the diaphragm pin with a component perpendicular to this axis whereby the diaphragm carrying the diaphragm pin is twisted.

With such a construction the whole U-spring is arranged on that side of the diaphragm capsule the diaphragm of which carries the diaphragm pin. The length of the limb of the U-spring is less than the radius of the diaphragm capsule.

In another arrangement the limb length is greater than the radius of the barometer capsule, and the barometer capsule is surrounded on both sides by the limbs of the U-spring. With this arrangement the diaphragm pin is provided with a cross bore which runs parallel to the yoke of the U-limb. A short pin is disposed in this bore which rests in a corresponding depression of the free limb of the U-spring and which transmits the pre-stressing force of the U-spring to the diaphragm pin. The disadvantageous tipping of the diaphragm pin on pressure changes which is caused by the arcuate movement of the free U-spring limb is common to all these constructions, which all have a relatively small response sensitivity.

The object of the present invention is to increase the response or pressure sensitivity of such mechanisms, especially for barometers. For this purpose the free limb of the blade spring is longer than the spacing from the yoke to the pin axis and the intermediate member which lies on the one hand in a bearing element of the diaphragm pin and on the other hand bears on the free limb of the blade spring both in the region between the diaphragm pin axis and the blade spring yoke and also in the region externally of the diaphragm pin axis and the blade spring yoke.

The particular advantage of this arrangement lies in the fact that in this way it is possible to allow the diaphragm pin to execute a movement in the direction of its axis without disturbing transverse components. This has the advantageous result that the response or pressure sensitivity of a barometer or the like constructed in this way is substantially improved.

This improvement is obtained by a linearization of the movement of the free end of the spring limb; thereby at the same time the direction of movement is so disposed that it coincides with the longitudinal axis of the diaphragm pin. These advantages are obtained by the fact that the intermediate member bears at least at two points in the longitudinal direction of the spring limb which are disposed on both sides of the diaphragm pin axis.

A further advantage of an action unit according to the invention lies in the fact that the technical production and assembly expenditure is not increased in practice and that nevertheless by the new arrangement of the force transmission from the diaphragm pin to the blade spring the desired course of movement and increased response and pressure sensitivity is attained.

The invention can for example be carried out in such manner that the diaphragm pin is provided with a radial bore the axis of which is disposed parallel to the outer surface of the diaphragm and perpendicularly to the yoke of the blade spring, that is in the longitudinal direction of the spring limb. A pin inserted in a bore of the diaphragm pin then serves as the intermediate member which in some cases bears against embossings or with the interposition of support washers or the like against the blade spring limbs. The desired course of movement of the diaphragm pin is attained by a suitable choice of the bearing points on the blade spring. The bearing points execute different movements according to their spacing from the yoke of the blade spring.

In a preferred arrangement of the invention a pin is not used as the intermediate member but the intermediate member is of bent W-shape and the central portion lies in the bearing element of the diaphragm pin with its axis parallel to the length of the yoke. This constructional form has the particular advantage that a U-spring an be used the length of which is not small compared with the limb length perpendicular to it. The bent W-shaped intermediate member bears at least at four points on the free limb of the blade spring and ensures that the outer corners of the free blade spring limb are not substantially unloaded as compared with the central region. This way ensures that the free blade spring limb does not flex in a direction which runs parallel to the diaphragm pin axis. The relatively large superficial engagement of the bent W-shaped intermediate member on the free limb of the blade spring ensures

that the blade spring limb is not curved perpendicularly to the limb length.

Although in this embodiment of the invention the intermediate member bears at least at four points on the free blade spring limb and therefore a relatively high friction to movements is to be expected, nevertheless a substantial increase in the response or pressure sensitivity of the device is quite unexpectedly obtained which demonstrates that known spring suspensions do not operate vertically to the diaphragm capsule.

With the known action units a transmission lever is fitted to the free blade spring limb, for example riveted to it, which transmits the movement of the diaphragm pin or of the free blade spring limb to an indicator with a ratio corresponding to its length. In this case it is disadvantageous that this transmission lever must always be arranged externally of the center of the blade spring since the diaphragm pin is arranged in the center region thereof. Thereby a one-sided loading of the free limb of the blade spring is produced which leads to unilateral flexure of the free limb of the blade spring perpendicularly to the surface of the limb.

In a preferred embodiment of the invention the intermediate member embodies an extension which serves as a transmission lever. For example on end section of the bent W-shaped intermediate member is extended and this extension is used as a transmission lever. This embodiment has on the one hand the advantage that a special fastening of the transmission lever to the U-spring is avoided. This special fastening often effects a weakening of the spring limb (by riveting) or a local stiffening of the spring limb (for example by adhesive or by multi-point riveting). With the arrangement of the application however the transmission lever does not influence the blade spring limb practically at all so far as, as is always assumed, the intermediate member is inherently sufficiently stiff flexurally. This stiffness is however practically always available since the forces to be transmitted to the indicator are relatively small because they only have to overcome the return force of a spiral or hair spring provided on the indicator shaft and the relatively small friction forces of the indicator.

The intermediate member can rest on the free limb of the blade spring with the interposition of support washers, small plates or the like. In a preferred constructional form of the invention the free limb of the blade spring is bent outwardly away from the U-section and the intermediate member lies directly on the terminal edge. Since the blade spring thickness is relatively small, the bearing operates in the manner of a knife-edge bearing; the intermediate member can therefore execute a tipping movement about this edge with very low friction.

With a preferred embodiment of the invention the spacing from the diaphragm pin axis of the bearing point of the intermediate member on the terminal edge of the free limb of the blade spring, in the projection on the center plane of the U-cross-section, is less than the spacing from the diaphragm pin axis of the bearing point of the intermediate member on the free limb of the blade spring between the diaphragm pin axis and the yoke. The ratio of these distances is then so chosen dependently on the spring dimensions and the spring constants that the desired movement of the portion of the intermediate member which transmits the blade spring force to the diaphragm pin, is obtained. By a suitable choice of these distances the result is secured that the diaphragm pin moves during air pressure changes practically exactly in the direction of its longitudinal axis and thus perpendicularly to the diaphragm surface.

In embodiments of the invention the intermediate member is bent from a length of spring steel wire, although the spring properties of such wire are not involved. In this case a wire of circular cross-section is usually used but also other cross-sectional profiles are possible. Likewise it is possible to produce an intermediate member in one piece of plastics, for example as an injection moulding. The production as an injection moulding has the particular advantage that the intermediate member can be easily produced with locally different cross-sections; in this way the cross-sections can be adapted to the particular loading or to the particular function. In this case the bearing surfaces on the blade spring limb may be made for example ball-shaped whereas the parts stressed in flexure have a corresponding U, I or other particularly flexure-stiff profile.

The bearing element of the diaphragm pin in which the intermediate member lies can be constructed for example as a knife edge element, that is it may have an approximately V-shaped outer surface shape. It is also possible to make the bearing element spherical and to provide the intermediate member at this point with a ball-socket-shaped projection whereby a free low-friction rocking on all sides is possible. In preferred embodiments of the invention the wall of a cross bore through the diaphragm pin is used as the bearing element for the intermediate member. This is the simplest and most economical solution which meets all requirements. The axis of the cross bore then runs parallel to the yoke length or the terminal edge of the free blade spring limb. Since in practice only movement of the intermediate member in the bearing element tangential to its periphery occurs, such a cylindrical bearing element meets all requirements.

The fixed blade spring limb can surround the diaphragm capsule and be fastened to the side of the diaphragm capsule remote from the diaphragm pin to a support or casing. For adjustment of the indicator in order to bring the indicated value into agreement with the measured value a screw guided in the casing can then press against the fixed blade spring limb between the fastening point and the yoke of the blade spring.

With preferred embodiments of the invention the fixed blade spring limb is arranged on the same side of the diaphragm capsule as the free blade spring limb. In this case the fixed blade spring limb is secured to a bridge which is pivotal about an axis approximately parallel to the diaphragm and approximately perpendicular to the diaphragm pin axis. The bridge is of approximately L-shape in plan with the pivot axis parallel to the longer limb of the L. A screw fixed to the casing engages the end of the short limb of the L by adjustment of which the bridge is rotatable about its pivot axis. By adjustment of the bridge, justification of the indicator, that is adjustment of the indication on the scale to the pressure actually present, is possible. When it relates not to a barometer but to another measuring device the zero point setting can be justified by means of this pivoted bridge.

One constructional arrangement of the invention is described by way of example in the following description with reference to the drawing in which:

FIG. 1 is a plan of a barometer system and action unit constructed according to the invention, and

FIG. 2 is a side view in the direction of the arrow II of FIG. 1.

A base plate 1 embodies on one side opposed lugs 2 bent up from the plane of the base plate through 90°, which run out into points. A flat L-shaped carrier 3 rests on the points of the lugs 2 and is pivotal about the axis defined by the said points. The carrier lies on the points of the lugs 2 in each case in the end region of the longer limb of the L. The free end of the shorter limb of the L lies on a grub screw 4 which is screwed into a threaded bore traversing the base plate 1 approximately perpendicularly. By turning the grub screw 4 the carrier 3 can be rocked in for fine adjustment.

A u-shaped bent blade spring 5 is fixed to the long limb of the L of the carrier 3 by means of a clamp plate 6 being for example riveted, screwed or the like. The blade spring 5 embodies a shorter fixed limb 7 and a longer free limb 8. The end of the fixed limb 7 is secured to the carrier 3 by the clamp plate 6. The blade spring 5 embodies a relatively great span in the direction transversely to the length of the limb. Preferably this length span of the blade spring 5 is greater than the length of the free limb 8. The free end of the free limb 8 is bent out of the U-cross-section parallel to the yoke connecting the two limbs of the blade spring 5; the resulting narrow edge 9 stiffens the free limb 8 in reference to flexure moments which load it transversely to the length of the limb.

The base plate embodies a bore somewhat offset laterally to the center between the two lugs 2, through which is inserted a fastening pin for a diaphragm capsule 10 and is fastened by means of a nut 11 screwed into position, or the fastening may be by a set screw. In this example the diaphragm capsule responds to changes of atmospheric pressure and is formed by two diaphragms. The diaphragm remote from the base plate 1 carries centrally a diaphragm pin 12 the axis of which is perpendicular to the outer surface of the diaphragm. The length of the lugs 2 is greater than the height of the diaphragm capsule 10 so that the carrier 3 and the blade spring 5 are located on the side of the diaphragm capsule remote from the base plate 1. The line connecting the tips of the two lugs 2 passes close to the diaphragm pin 12.

The diaphragm pin 12 is provided in the neighborhood of its free end with a cross bore 13 the axis of which is approximately parallel to the line connecting the tips of the two lugs 2 or parallel to the length of the edge 9. The center part of a W-shaped bent spring steel wire member is inserted through the transverse bore 3 and this member serves as an intermediate member 14 which produces an operative connection between the diaphragm pin 12 and the blade spring 5. One end portion of the W-shaped intermediate member is provided with an extension 15 which serves as a transmission lever for the measuring movement, and functions as a movement transmitting linkage system.

The intermediate member 14 bears at least at four points on the blade spring; two of these bearing points are located in the region of the two loop curves 16 of the W and the other two are formed by the bearing of the terminal sections of the W on the free corner of the edge 9. The center portion 17 of the intermediate member 14 bears on the wall of the cross bore 13 under the action of the pre-stressed blade spring 5.

The center portion 17 can execute a rocking movement and/or a small rolling movement in the cross bore 13. As will be seen from FIG. 2, the spacing of the bearing point of the intermediate member 14 on the edge 9 is less distant from the bearing point of the center portion 17 on the cross bore 13 than the bearing point at which the intermediate member 14 rests on the blade spring 5 in the region of the base curve 16. As shown in FIG. 1 the arrangement is symmetrical to the center plane of the U-section of the blade spring 5 in which also lies the longitudinal axis of the diaphragm pin 12. The different spacings of the bearing points of the pivot axis of the intermediate member 14 provide that for pressure changes the diaphragm pin 12 is moved almost exactly in its axial direction and practically no transverse movement components are present.

The base plate 1 embodies a projection 18 on the side remote from the line connecting the two lugs 2, which is likewise provided with two mutually opposite lugs 19 bent at 90° out of the plane of the base plate. Coaxial bearing grub screws 20 are screwed into the two lugs 19. A rocking bracket 21 produced in the form of a sheet pressing is pivoted on the tips of the bearing grub screw, and one limb of a U-shaped bent adjuster spring 22 is fastened to the bracket 21.

The spacing of the other limb of the adjuster spring from the rocking bracket 21 is adjustable by means of a screw 23 screwing in the said bracket. The extension 15 of the intermediate member 14 is bent twice and the free end of the extension 15 lies on the free end of the adjuster spring 22. By turning the screw 23 the position of the bearing point of the end of the extension 15 on the adjuster spring 22 can be varied to vary the transmission ratio of the movement of the extension 15 to the rocking movement of the rocking bracket 21.

The rocking bracket 21 carries a radially projecting arm 24 to which the pull rod 25 is pivotally connected and to the other end of which a chain or cord 26 is fitted which extends around an indicator spindle 27.

The indicator spindle 27 is supported on a carrier arm 28 and a counter plate 30 opposite the carrier arm and connected to it by two supports 29. The carrier arm 28 is arranged about parallel to the base plate 1 and secured to a pillar 31 fitted on the base plate 1 by means of a clamp screw 32. The indicator spindle 27 carries an indicator 33 which moves over a scale, not shown. A spiral spring or hair spring 34 is secured at its inner end to the indicator spindle 27 and its outer end is fixed to one of the supports 29. The spiral or hair spring 34 provides a return force which holds the lever mechanism without play in the position obtained by cooperation of the diaphragm capsule 10 and the blade spring 5.

The mode of operation of the arrangement of this invention is as follows: The evacuated diaphragm capsule or bellows 10 is biased by the U-shaped spring 5, the free leg 8 of which exerts a pulling force on the bellows carrying the diaphragm pin 12, via the central section 17 of the intermediate member 14 supported in the bore 13 of the diaphragm pin 12. Upon a change in atmospheric pressure, the diaphragm pin 12 moves in the

direction of its axis toward the carrier **1** or away therefrom, and the spring **5** is more strongly tensioned, or relaxed. This movement is transmitted, by the transmission lever **15**, to the pivotably mounted swivel bracket **21**. The pivotal motion of the swivel bracket **21** is transmitted, via the pull rod **25** and the chain or cord **26** to the indicator spindle **27** and thus to the pointer **33**.

Upon movement of the diaphragm pin **12** in the direction of the support **1**, when the atmospheric pressure increases, the free end of the transmission lever **15** likewise moves in the same direction. Thereby, the swivel bracket **21** is pivoted in the clockwise direction about its arm **25**, as seen in FIG. **2**. Thus, the pull rod **25** moves in the direction of the pointer shaft **27**, and under the effect of the coil spring **34**, the chain **26** is wound upon the indicator spindle **27**, whereby the pointer **33** executes a rotation in the clockwise direction, as seen in FIG. **1**. Upon a drop in atmospheric pressure, the operation takes place in the reverse direction.

It should be understood that the invention is not limited to the constructional example shown but changes are possible without departing from the framework of the invention. In particular it is possible to use the arrangement described for the widest range of measuring devices in which it happens that the movement of a measuring element subjected to the action of an external pre-stress should have no disturbing cross components. In particular also the intermediate member is not limited to the constructional embodiment described. It is for example possible for the cross bore **13** to be turned through 90° about the longitudinal axis of the diaphragm pin **12** and to effect the force transmission by means of a in bearing at two points on the blade spring **5**. The free limb **8** of the blade spring **5** would in this case embody an aperture through which the diaphragm pin **12** projects. The pin then rests on the free limb **8** of the blade spring on both sides of the aperture. With this arrangement the extension **15** can be directly attached to the pin, it can also in known manner be secured to the blade spring **5**. The essential feature of the invention consists in the fact that by the multiple bearing of the intermediate member on the blade spring, movement of the diaphragm pin **12** or the like in the axial direction of this pin can be secured.

What I claim is:

1. A movement for a measuring device, such as an aneroid barometer, comprising a support member, a diaphragm capsule having one surface attached to said support member, a diaphragm pin mounted transversely on the opposite surface of said diaphragm capsule, a transmission lever extending from an intermediate member connected to the free end of said diaphragm pin, a pointer mechanism including a spring biased pointer, operating means connecting said transmission lever to said pointer mechanism for moving said pointer, and a U-shaped leaf spring having one leg supported on said support member and the other leg in contact with said intermediate member, the plane of symmetry of said U-shaped leaf spring passing through the legs thereof being disposed radially with respect to the axis of said diaphragm pin and said U-shaped leaf spring being open toward said diaphragm pin, said other leg of said U-shaped leaf spring extending past the diaphragm pin axis, said intermediate member extending through a bore in said diaphragm pin and contacting said other leg of said U-shaped leaf spring at two distinct bearing points, one of said bearing points being in the zone between said diaphragm pin axis and the base of said U-shaped leaf spring and the other bearing point being outside this zone, said intermediate member being spaced from said U-shaped leaf spring between said bearing points.

2. A movement as defined in claim **1**, wherein said transmission lever and said intermediate member are formed as one piece.

3. A movement as defined in claim **1**, wherein said operating means includes a bridge pivotable on said support member about an axis approximately perpendicular to said diaphragm pin axis, said bridge being connected to said transmission lever and said pointer to transfer movements of said transmission lever to said pointer.

4. A movement as defined in claim **1**, wherein said support member is provided with a pair of spaced lugs disposed on a line passing closely adjacent said diaphragm pin, an L-shaped carrier member being supported on said spaced lugs and said one leg of said U-shaped leaf spring being attached to said carrier.

5. A movement as defined in claim **1**, wherein said intermediate member has a W-shape and the central portion thereof extends through said bore in said diaphragm pin in parallel with said U-shaped leaf spring, so that said intermediate member contacts said other leg of said U-shaped leaf spring at four bearing points disposed in pairs symmetrically on either side of said plane of symmetry of said leaf spring.

6. A movement as defined in claim **5**, wherein the end of said other leg of the U-shaped leaf spring is bent outwardly into direct contact with said intermediate member.

7. A movement as defined in claim **5**, wherein said intermediate member is formed from a length of spring steel wire.

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