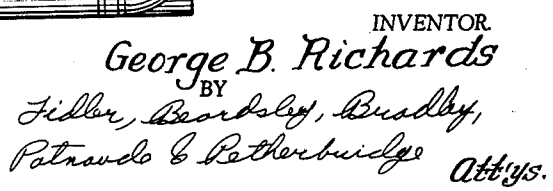


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May 5, 1964

G. B. RICHARDS

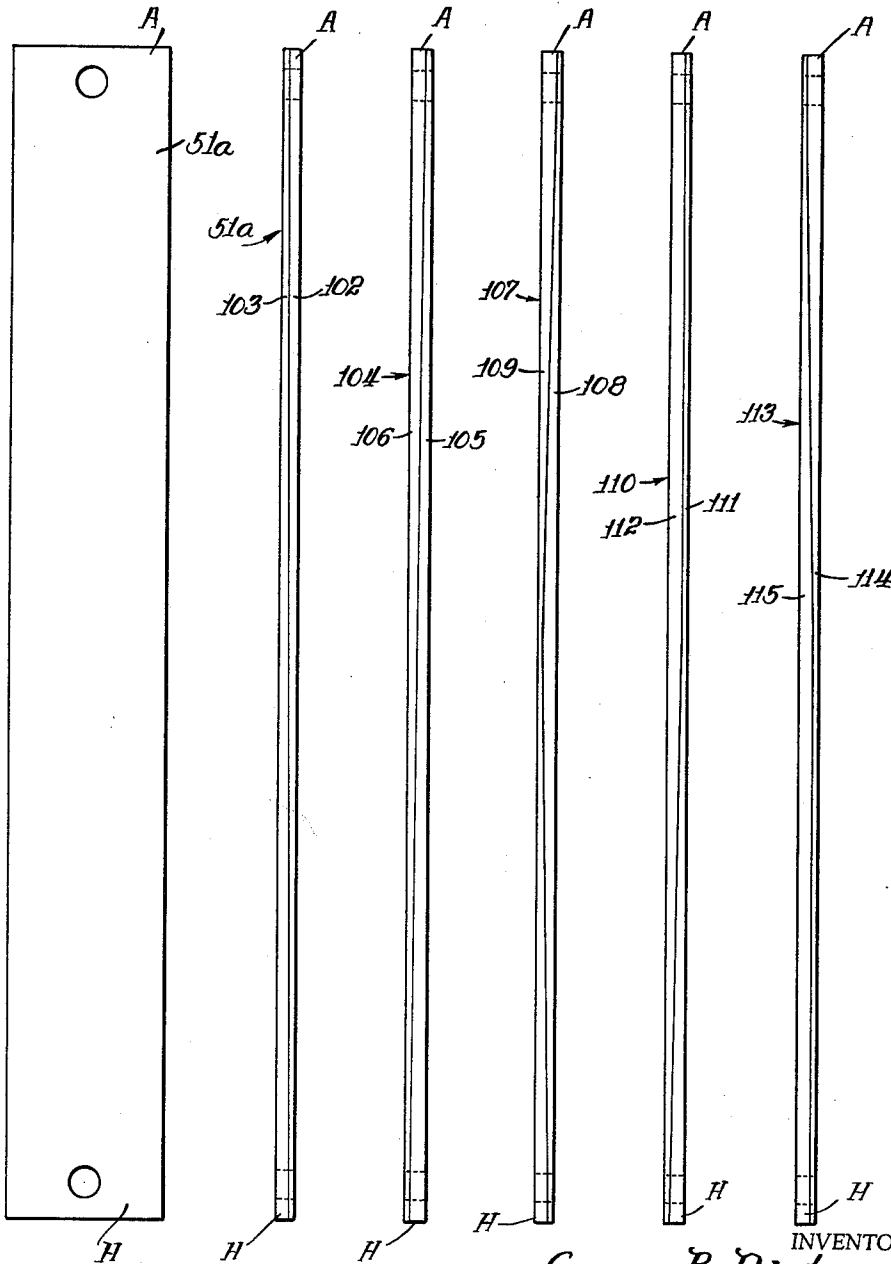
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FLUID SEPARATOR

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Fig. 4 *Fig. 5A* *Fig. 5B* *Fig. 5C* *Fig. 5D* *Fig. 5E*



INVENTOR.
George B. Richards
BY
Fidler, Bousdoley, Bradley,
Patnaude & Petherbridge Attys.

May 5, 1964

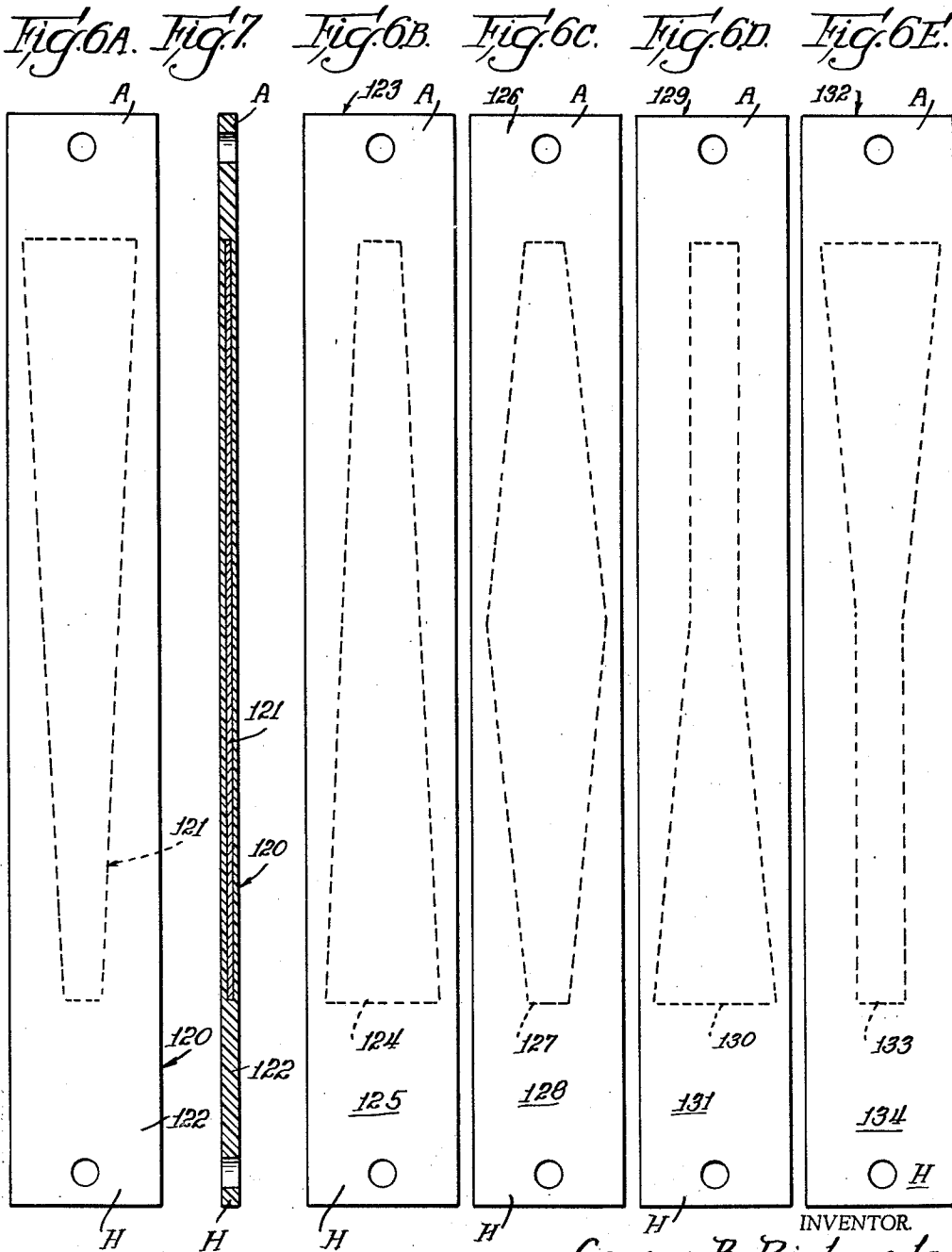
G. B. RICHARDS

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FLUID SEPARATOR

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INVENTOR.
George B. Richards.

BY
Fidler, Beardsley, Bradley,
Patnaude & Petherbridge Attys.

May 5, 1964

G. B. RICHARDS

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FLUID SEPARATOR

Filed Feb. 20, 1963

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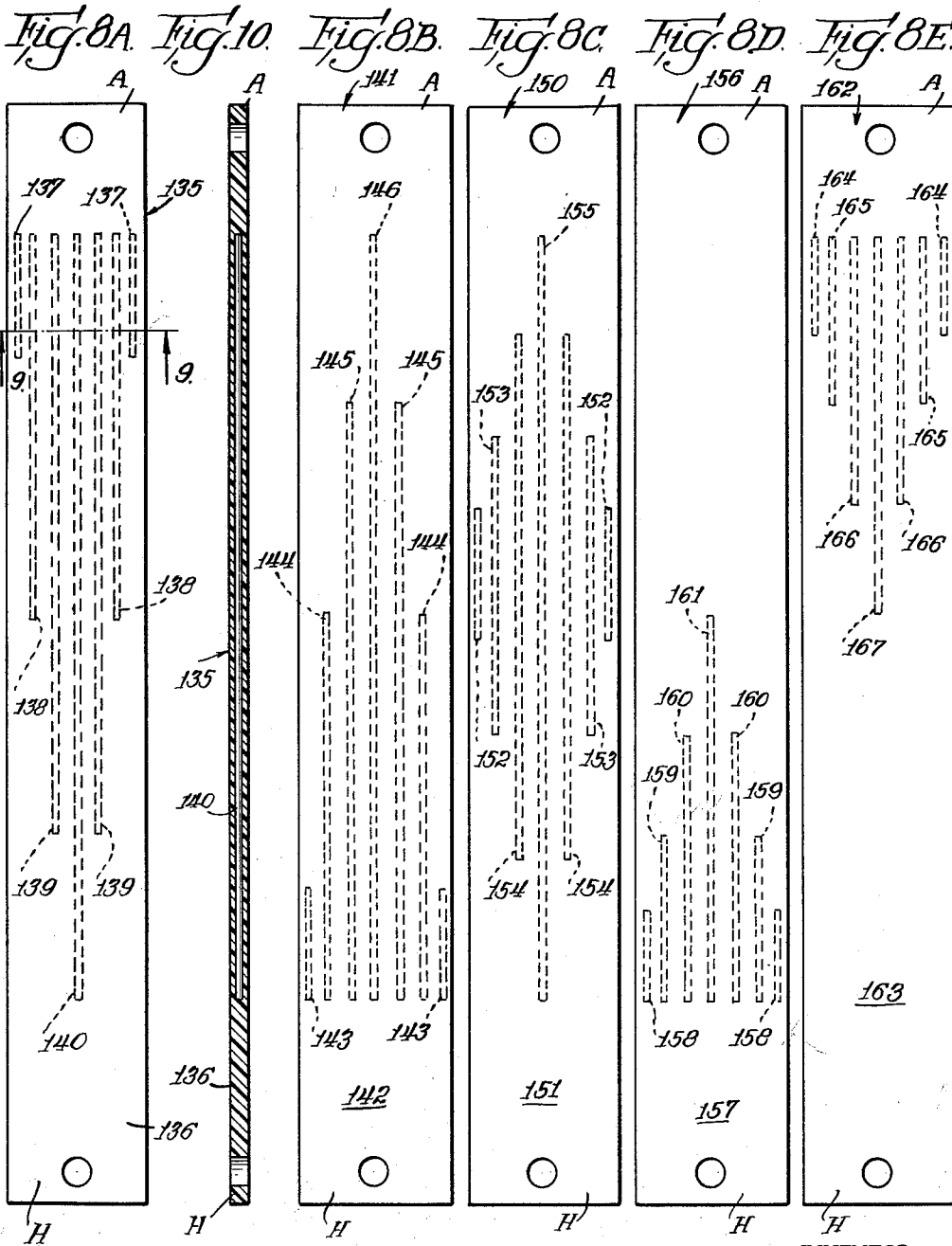


Fig. 9

George B. Richards
BY
Fidler, Beardsley, Bradley,
Patnau & Petherbridge att'ys.

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FLUID SEPARATOR

George B. Richards, Lake Forest, Ill., assignor to Liquid Controls Corporation, North Chicago, Ill., a corporation of Illinois

Filed Feb. 20, 1963, Ser. No. 259,836

13 Claims. (Cl. 137-202)

This invention relates to actuator mechanisms and has to do more particularly with a new and improved actuating mechanism of the character wherein an actuator is connected to resilient bowed pressure elements which position the actuator from movement in either of two directions along a predetermined path.

One example of an actuator mechanism of the general character to which the present invention relates is shown, described and claimed in United States Patent No. 3,021,861, granted February 20, 1962, to Henry Robert Billeter and George B. Richards. The said Billeter and Richards patent in the illustrative embodiment discloses the actuator mechanism as employed in a liquid-level controlled device such as an air eliminator or liquid segregator or others wherein is provided a casing defining a chamber having an opening thereinto, a plurality of internal face portions disposed about an axis, an actuator movable in the chamber along the axis, a plurality of normally flat, resilient strip members or pressure elements having first portions secured to said casing adjacent the face portions, second portions secured to the actuator, and intermediate portions which are free and maintained in bowed shape, each strip member being bent back upon itself and of sufficient length to form two generally opposed portions, one lying against the corresponding face whereby each of the strip members exerts a force on the face with which it cooperates and the strip members position the actuator on the axis for movement therealong between a first position wherein the strip members lie against the corresponding faces to a predetermined extent, and a second position wherein the strip members lie against the faces to a lesser extent. In the illustrative embodiment, the strip members are moved between positions exposing orifices in the faces and positions closing such orifices and thus serve as valve elements.

In the invention disclosed in the aforesaid patent the strip members, or strips, are of uniform cross section throughout their effective lengths and have uniform resistance throughout their effective lengths to bending stresses. Thus as the actuator is moved from one position to another the strips maintain the same extent of bending and thus the same energy is recovered from the strips as is introduced so that there is substantially no resistance offered nor assistance rendered by the strips to the movement of the actuator. Thus the strips neither aid in nor resist the movement of the actuator along the axis of movement.

I have found that there are numerous situations wherein it is desired that the strips impart a force to the actuator in one direction or another along the axis of movement to aid in or resist the movement thereof along the axis of movement at least in a portion of the movement. For example, it is sometimes desirable to provide an aiding force or a resisting force, or an aiding and then a resisting force, or a resisting and then an aiding force, or an action wherein for a portion of the travel of the actuator there is an aiding or a resisting force but for the remainder of the travel there is neither an aiding nor a resisting force thereon. The present invention in its several embodiments provides a means for accomplishing the above described actions.

In accordance with the present invention, the strips are formed to have in each of various portions along the length of the intermediate portion, and more particularly

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in the zone where the maximum bending of the strip takes place, different resistances to bending stress. Therefore, as the actuator is moved between its two positions, the strips will vary in their resistance to bending and thus will provide a force in the direction of the axis of movement of the actuator which will assist or resist the force applied to the actuator depending upon the construction of the strips. In accordance with the invention, the strips are so formed as to provide either an aiding force or a resisting force, or first an aiding force and then a resisting force, or first a resisting force and then an aiding force, or an action wherein for a portion of the travel of the actuator there is an aiding or a resisting force and for the remainder of the travel there is neither an aiding nor a resisting force. This result is provided by forming the strips from two components formed of different materials having different specific resistances to bending stress, with the relative transverse cross-sections of the two components being different in various portions of the strip member along its length. In one embodiment, this is accomplished by forming the strip member of laminations of different materials having different specific resistances to bending stress, with the relative thicknesses of the two components being different in various portions of the strip member along its length. In another embodiment, one component is embedded in the other component and has a different transverse cross-section in various portions of the strip member along its length. In a further embodiment, a plurality of members forming one component are embedded in the other component and extend for different lengths, thereby providing a total cross-section of the first component which is different in various portions of the strip along its length. In all the embodiments, the resistance to bending stress will be the greatest in that portion wherein there is the largest transverse cross-section of the component having the greater specific resistance to bending stress.

It will be understood that while the actuator is disclosed as taking the form of a float which is supported by a liquid and rises and falls with the rise and fall of the level of the liquid, the actuator may be adapted to be moved in either direction by forces generated by other means than the level of a liquid. Thus the actuator may include means other than a liquid supported float moving along the axis of movement, with the strips serving to position the actuator for movement along such axis. In such case, the actuator is supported and actuated by other means (not shown) and the strips serve to position the actuator and to apply an axial force on the actuator which tends to move it along the axis. Where the actuator is thus formed, it may be positioned for movement along an axis other than a vertical axis. Thus, while the present invention finds wide application in connection with float actuators and is disclosed in connection therewith, it is not limited to such applications.

It will also be understood that while in the present application the strips or pressure elements or at least one of them is disclosed as serving as a valve member to close an orifice, the pressure elements may serve merely as guiding or positioning elements and having no valving function.

The present invention is especially well suited to use in a fluid separator for separating two immiscible fluids of different specific gravities, such as an air eliminator or a liquid segregator, and is disclosed in connection with an air eliminator but is not limited to such use.

An object of the present invention is to provide an actuating mechanism having an actuator and bowed strips for guiding the actuator wherein the strips are so formed as to exert a force on the actuator in a direction along the line of movement of the actuator.

Another object is to provide an actuating mechanism

having an actuator and bowed strips for guiding the actuator for movement along a predetermined path, which strips in the various embodiments of the invention are adapted to exert on the actuator an aiding force, or a resisting force, or an aiding force followed by a resisting force, or a resisting force followed by an aiding force, or an action wherein for one portion of the travel of the actuator there is neither an aiding nor a resisting force and for another portion of the travel there is an aiding or a resisting force.

Still another object is to provide an actuator mechanism which is simple and inexpensive to build, strong and rugged in construction, effective in operation and which requires a minimum of servicing, repair and replacement of parts over a long period of service.

Another object is to provide a novel float guide means for liquid-level controlled devices.

Another object is to provide a novel float guide means for a float-type actuator including bowed strips so formed as to guide the float along a predetermined path and adapted in the various embodiments of the invention to exert on the actuator a lifting force, or a depressing force, or a lifting force followed by a depressing force, or a depressing force followed by a lifting force, or an action wherein for a portion of the travel of the actuator there is neither a lifting force nor a depressing force and for another portion of the travel there is a lifting force or a depressing force.

Other objects and advantages of the invention will appear from the following description taken in connection with the appended drawings, wherein:

FIG. 1 is an end elevational view of one form of air eliminator embodying the invention;

FIG. 2 is an enlarged vertical section taken along line 2—2 of FIG. 1;

FIG. 3 is an enlarged sectional view taken along line 3—3 of FIG. 2;

FIG. 4 is a face view of one of the strips shown in FIGS. 1 to 3;

FIG. 5A is a side elevational view of the strip of FIG. 4;

FIGS. 5B to 5D are side elevational views showing laminated strips wherein the two components vary in thickness in various portions along the length of the strip.

FIGS. 6A to 6E are a face view of strips formed by embedding one component in the other component, which strips correspond generally in their resistance to bending stress with the strips of FIG. 5A to FIG. 5E, respectively.

FIG. 7 is a transverse sectional view taken along line 7—7 of FIG. 6A.

FIGS. 8A to 8E are face views of strips formed by embedding a plurality of members formed of one component and of different lengths in the other component, which strips correspond generally in their resistance to bending stress with the strips of FIGS. 5A to 5E, respectively;

FIG. 9 is a view of a section taken along line 9—9 of FIG. 8A; and

FIG. 10 is a view of a section taken along line 10—10 of FIG. 9.

Inasmuch as my invention is especially well adapted for use in air eliminators, I have illustrated it in a preferred embodiment in its application to an air eliminator. However, it will be understood as the description proceeds that the invention also is equally well adapted to other uses where an actuator and especially a liquid-level controlled actuator is employed.

Referring now particularly to FIGS. 1 to 3 of the drawings, there is shown an air eliminator which includes a head 20 formed by a hollow casing or housing 21, having a bottom flange 22 by which the head is secured to a flange 23 of a tank 24 which may be of any conventional construction. The head 20 is suitably secured to the tank 24, as for example, by machine screws 25.

The interior of the air eliminator tank 24 communicates with the interior of the head 20 through openings 30 (one of which is shown) formed in a plate 31, secured

in the casing 21, as by a guide shaft 74 threaded into the top of the casing 21 and a nut 33 threaded on the lower end of the shaft 74.

The casing 21, which at its lower portion is of generally circular cross-section and at its upper portion is of generally rectangular cross-section, defines a float chamber 35, which communicates relatively freely through the openings 30 with the interior of the tank 24.

The upper portion of the casing 21 is preferably of generally rectangular cross-section and defines a valve chamber. Opposite portions of the valve chamber are provided with openings 39a and 39b in its ends which are closed by end plates 40a and 40b respectively, suitably secured to the casing.

The end plates 40a and 40b are both provided with openings 42a and 42b adapted to receive a pipe such as the pipe 43a shown threaded into the end plate 40a in FIG. 2. In the embodiment of the invention illustrated in FIG. 2 the opening 42b in the other end plate 40b is closed as by a screw plug 49, although it is adapted to receive a pipe similar to the pipe 43a.

Interposed between the casing 21 and each of the end plates respectively are orifice plates 45a and 45b which are suitably secured in place and which are provided with vertically elongate orifices 46a and 46b respectively. The end plates 40a and 40b are recessed and provide with the respective orifice plates 45a and 45b, chambers 47a and 47b which communicate with the float chamber through the orifices 46a and 46b, except when the latter are closed by the valves hereinafter described.

Disposed against the inner face of the orifice plate 45a is a cover gasket 60a, formed with an orifice 61a corresponding in shape to the orifice 46a. A similar gasket 60b is provided for the orifice plate 45b. The gaskets 60a and 60b are clamped between the casing, and the orifice plates respectively, although they alternatively may be adhesively secured to the respective orifice plates in order to insure that they are not displaced and that the orifices in the plates and gaskets remain in alignment. Ring gaskets 62a and 62b are provided between the orifice plates 45a and 45b and the cover plates 40a and 40b respectively. The gaskets are formed from a suitable material which is sufficiently resilient to provide an effective seal between the respective members and which is resistant to the liquid with which the air eliminator is adapted to be used. I have found that a synthetic rubber such as neoprene is excellently adapted for use in forming the gasket although other materials having the desired characteristics may be applied.

The chambers 47a and 47b are connected by two passages 48 formed in the upper portion of the casing 21. Thus, even though the right-hand chamber 47b is closed from the exterior by the screw plug 49, nevertheless, it communicates with the exterior through the two passages 48, the left-hand chamber 47a and the pipe 43. The passages 48 thus equalize the fluid pressure in the chambers 47a and 47b. The orifice plates 45a and 45b as well as the gaskets 60a and 60b and 62a and 62b are provided with openings 143, registering with the passages 48, whereby to permit free communication between the chambers 47a and 47b. When the valves (hereinafter described) are in open position, the interior of the casing 21 (that is, the float chamber 35) communicates with the pipe 43 not only through the left-hand orifice 46a, but also through the right-hand orifice 46b.

Where it is desired that the valves function independently to exhaust air from the interior of the head to separate points, the plug 49 is replaced by a pipe (not shown) threaded in the opening 42b and an orifice plate (not shown) which has no openings corresponding to openings 143 is substituted for the orifice plate 45b. Thus, there is no communication between the chambers 47a and 47b.

The orifices 46a and 46b (as well as the orifices 61a and 61b) are adapted to be closed by valve elements 51a and 51b which are similar in construction and according-

ly only one of the valve elements and the associated portions of the air eliminator will be described in detail.

The valve element 51a sometimes called a "read" takes the form of an elongated normally flat strip of flexible, resilient material, as hereinafter more fully described, which is inert to the liquid with which the air eliminator is adapted to be used.

The valve element 51a is of sufficient width to extend across and completely close the orifice 46a when the valve is in closed position and is of sufficient length to permit it to be mounted and actuated as hereinafter described.

The valve element or strip 51a is rigidly secured to the casing at a point below the orifice 46a and in such position that the adjacent portion of the strip lies against the face of the inside cover gasket 60a, as shown in FIG. 2, at all times. To this end, the lower end of the strip is secured, as by a machine screw 63, to a boss 64 projecting from the body in position to suitably support the lower end of the valve element in the desired position.

The boss 64 has an inclined face to which the unbent end of the strip 51a is attached. This insures that the portion of the strip which lies against the gasket 60a is firmly maintained thereagainst.

The other end of the strip 51a is attached to a tubular stop 70 which is formed with a straight, flat face 70a providing a flat surface against which the inner end of the strip is held and against which the adjacent portion of the strip lies to varying degree as explained hereinafter. The face 70a extends parallel to the inner face of the gasket 60a for a purpose which will appear hereinafter. The stop 70 is connected to a guide stem 71 attached to and forming a portion of a float 72.

From the foregoing it will be seen that the stop 70 serves not only as means for halting the upward movement of the float 72, but it serves also to actuate the strips 51a, 51b by transmitting to the attached ends thereof movement corresponding to the movement of the float 72. Also the stop 70 provides reaction surfaces 70a and 70b in opposing relation to the surfaces of the gaskets 60a and 60b and against which the inner portions of the strips bear. Thus the stop may also be termed an abutment member. The stop 70 is the embodiment shown is secured to and movable with the float ball and may be considered to be part of the float. Since the assembly 100 of the float ball, guide stem and stop serves to actuate the strips, it may be termed an "actuator."

The stem 72 extends through and is sealingly secured in the "ball" portion 73 of the float and projects therefrom at each end. At its upper end the stem 71 is inserted into the stop 70 and is connected thereto as by spinning. The screws 80a serve to connect the ends of the valve elements 51a to the stop 70 as shown particularly in FIG. 2 of the drawings. Double channel-shaped clips 82a are provided at the side of the stop 70 and are secured by the screws 80a for the purpose of retaining the ends of the valve element 51a against twisting out of position relatively to the stop 70. The stem 71 is hollow and receives the upstanding guide shaft 74 which is rigidly secured in and upstands from the plate 31. The stem 71 thus serves to guide the float 72 for movement in a vertical direction within the float chamber 35.

The strip 51a is so secured to and supported by the casing and the float that in all positions thereof throughout its range of movement from its lower, open position (as shown in full lines in FIG. 2) to its upper, closed position (as shown in broken lines in FIG. 2), it has a free, intermediate portion extending between the portion which bears against the face of the gasket 60a and the portion which bears against the opposing face 70a of the stop, which free portion is bent back upon itself and assumes a curved shape. As explained more fully hereinafter, the strip 51a exerts equal and opposed forces on the gasket 60a and the face 70a. However, as the actuator moves up and down the curvature of the free portion of the strip

51a changes and the force varies. Consequently, the energy stored in the strip varies.

The inner walls of the orifice plates 45a and 45b and hence the faces of the gaskets 60a and 60b are disposed symmetrically with respect to the central axis of the casing as are the reaction surfaces which are in opposition to the faces of the gaskets respectively. The actuator is positioned by the elements 51a and 51b for movement along such axis.

The two valve elements 51a and 51b are connected to the casing 21 and to the stop 70 at diametrically opposite points whereby the two valves 51a and 51b are disposed in opposition. Accordingly, they exert on the stop 70 and accordingly on the float 72 equal and opposite forces so that the float normally is freely positioned by the strips 51a and 51b in the float chamber and does not bear against the guide shaft 74. The guide shaft 74, however, is provided so as to protect the float and strips from damage due to extraneous forces during movement of the air eliminator, as in shipment. Each of the elements 51a and 51b serves as a pressure element which yieldably resists lateral displacement of the actuator.

The second strip or element 51b is formed and supported in a similar manner to the element 51a as above described and cooperates with the inner face of the gasket 60b and the opposing face 70b of the stop 70 in a similar manner.

Since the assembly consisting of the strips 51a and 51b, the stop 70, and the float 72 is freely positioned, the forces exerted by the respective strips 51a and 51b against the faces of their respective orifice plates 45a and 45b (that is, against the gaskets 60a and 60b) are equal and the strips therefore are completely balanced against each other.

Moreover, the arrangement is such that each of the strips 51a and 51b is under stress throughout its entire range of movement which stress causes the strip to be urged against its orifice plate, throughout a portion of the strip, during its entire range of movement. As will be seen from the drawings, when the float is in its lower position (as shown in full lines in FIG. 2) the strips 51a and 51b bear against the faces of their respective orifice plates 45a and 45b throughout only the lower portions of the strips and at an area on each of the orifice plates below the orifices 46a and 46b. However, as the float 72 rises to its upper position (as shown in broken lines in FIG. 2), as established by the abutment of the stop 70 against the upper wall of the float chamber 35, the strips 51a and 51b bear against greater areas of their respective orifice plates and close the orifices 46a and 46b and bear against the plates at portions above the orifices in order to provide complete closures for the two orifices 46a and 46b. Thus it will be seen that strips 51a and 51b are urged into their positions closing and sealing the orifices 46a and 46b by the resilience of the strips 51a and 51b themselves.

In the operation of the air eliminator thus far described, the tank 24 is suitably connected to a liquid line (not shown) from which it is desired to remove air. Assuming that the air has been removed and liquid stands in the head 20 at a level sufficient to raise the float to its uppermost position (as illustrated in broken lines in FIG. 2) the strips 51a and 51b are in closed positions. Thus the strips lie against their respective orifice plates 45a and 45b and extend entirely over and sealingly close the respective orifices 46a and 46b so that no liquid can escape from the head.

It will be noted that the strips 51a and 51b lie flat against their respective orifice plates throughout a substantial zone thereof and particularly a zone on both sides of and above and below the orifices 46a and 46b so that the latter are fully closed. As noted above, the spring pressure of the strips 51a and 51b provided by reason of their bowed or arcuate form insures that the closing portions thereof are maintained against their respective orifice

plates, regardless of whether or not the air or liquid within the float chamber 35 is under pressure.

When air (or other fluid) enters the float chamber 35 from the liquid line such air displaces the liquid in the float chamber 35 and causes the level to fall. When this occurs, the float 72, which is buoyantly supported by the liquid, also falls and carries with it the stop 70 to which the strips 51a and 51b are attached. The downward movement of the stop 70 causes the ends of the strips 51a and 51b attached thereto to move downwardly in a direction parallel to the faces of the orifice plates with the result that the portions of the strips 51a and 51b which previously lay against the orifice plates are stripped or "peeled" away from the orifice plates 45a and 45b progressively downwardly and as the downward movement of the float continues the orifices 46a and 46b are progressively uncovered in a direction from the upper portions thereof toward the lower portions.

There is a small force resulting from the pressure differential on the two sides of each strip which is applied over that portion of the face of each of the strips which overlies the corresponding orifice and which force tends to maintain each strip against its orifice plate to close the orifice. This force, however, is very small and is relatively ineffective in opposing the opening of the strip. It will be seen that each of the strips is progressively pulled away from its orifice plate and, owing to the resiliency of the strip and the arcuate shape into which the strip is forced by the manner in which it is attached to the casing and to the stop, the strip is moved away from the orifice plate in progressively small increments so that only a small portion of the area of the strip which overlies the orifice plate is moved away from the plate at any instant. Thus, the orifice is progressively uncovered in increments and any fluid pressure-generated force opposing the movement of such small increments of the strip away from the orifice plate is extremely small.

As stated above, each strip is so supported and the arrangement of the associated elements is such that the free portion of the strip retains a curved shape in all positions of the float. Thus it will be seen that as the float moves downwardly and carries with it the corresponding end of the strip which is secured to the stop 70, the adjacent portion of the strip is progressively flattened and the portion of the strip adjacent the end which is attached to the casing is progressively curved. In other words, the arc or bend in the strip is transferred from a portion nearer to the inner anchored end which is attached to the stop to a portion nearer to the outer anchored end which is attached to the casing.

It will be understood that the amount of energy stored in the strip by reason of its bent condition depends upon its degree of resistance to bending offered by the strip and primarily that zone of the intermediate portion where the maximum bending takes place. Thus, when the actuator is moved in a direction to move the zone of maximum bending toward a portion of the strip which exhibits an increased resistance to bending, energy is stored in the strip. In such case, the strip exerts a force on the actuator along the direction of movement of the actuator opposing movement of the actuator. This requires that a force be applied to the actuator to move it in such direction. On the other hand, where the actuator is moved in a direction to move the zone of maximum bending to a portion of the strip which exhibits a decreased resistance to bending, energy is given up by the strip. Thus, where the actuator is in such a position that the resistance to bending of the strip in the portions on opposite sides of the zone of maximum bending is different than at the zone of maximum bending, there will be a force created by the strip tending to urge the actuator to a position of less stored energy.

As explained more in detail hereinafter, the strips 51a and 51b in the device shown in FIGS. 1 to 3 increase in their resistance to bending stress progressively in a direc-

tion from the end which is fixed to the housing (which end is indicated by H in FIG. 5A) toward the end which is fixed to the actuator (which end is indicated by A in FIG. 5A). Thus, in all positions of the actuator the strips exert a downwardly directed force on the actuator along the direction of the axis of the casing, which force progressively decreases as the actuator moves downwardly. Thus, it will be seen that the form of the strips is such that the strips provide a greater effective weight of the actuator when the latter is in a lower position than when it is in an upper position.

The rate of the variation in lifting effect provided by the strips 51a and 51b is provided as hereinafter explained and can be changed by suitable construction of the strip.

As soon as the orifices 46a and 46b have been uncovered by the above-described opening movement of the strips 51a and 51b the air or other fluid trapped in the float chamber 35 above the level of the liquid in the system and which normally is under some pressure is caused to flow out of the float chamber through the orifices 46a and 46b and the vent pipe 43a by which it is conducted to a point of disposal.

Should the liquid level in the float chamber fall sufficiently, the downward movement of the actuator will be halted by it bottoming against the plate 31.

When the air or other fluid has been discharged to such an extent that the liquid level rises sufficiently to support and lift the float 72, the latter is elevated and causes the strips 51a and 51b to be moved in a reverse direction to that described above in connection with the opening of the valve. That is to say, that as the float 72 moves upwardly, the strips are caused to progressively move against their respective orifice plates to an increasing degree and to progressively close their respective orifices until the orifices are completely closed and the strips extend in contact with their respective orifice plates both above and below the orifices. When the strips are in closed position, no further air or other fluid can escape from the float chamber 35. It will be understood that during the upward movement of the float 72 and the progressive movement of the outer portion of the outer portions of the strips into increasing engagement with their respective orifice plates, and the peeling off of the inner portions from the surfaces 70a and 70b, the zone of maximum curvature of the free portions is transferred toward the ends attached to the actuator. Thus, the amount of energy stored in the strips increases as the actuator moves upwardly and accordingly the lifting force increases.

The variation in resistance to bending stress of the strip 51a (as well as all the other forms of strips disclosed herein) is provided by forming the strip of two different components each having a different specific resistance to bending stress and suitably joined to form a single unitary strip. The first component, which preferably is formed of a material having the greater specific resistance to bending, preferably is formed of a suitable spring metal such as "Elgiloy" for example, although it may be formed of a resilient, non-metal material such as rubber, or a synthetic plastic material. The other component preferably is formed of a material having a lesser specific resistance to bending. In the embodiment shown in FIGS. 5A to 5E, the second material may be either a metal or a non-metallic resilient material such as rubber or a suitable synthetic plastic. In either case, the components are suitably bonded together in face-to-face relation. In the embodiments shown in FIGS. 6A to 6E and 8A to 8E, the second component is a synthetic plastic or rubber in which the first component is imbedded. When rubber is used to form the second component, it preferably is a rubber of approximately 40 durometer. Where a synthetic plastic is used, it preferably has a resiliency approximately equal to a 40 durometer rubber. It will be understood, however, that the resiliency of both components is not critical and that it is only necessary that the

strip have sufficient resiliency to operate in the manner described and to seal the orifice in those cases where an orifice is provided.

Preferably, the strip is of uniform width and thickness throughout its length. In fact, all of the various strips disclosed herein may be of uniform overall dimensions and thus can be selected and installed interchangeably in an actuator mechanism without modification of the remainder of the mechanism.

Referring now to FIGS. 4 and 5A, the strip 51a includes a first component 102 formed preferably of spring metal and a second component 103 formed preferably of metal having a lesser specific resistance to bending stress disposed in face-to-face relation with the first component and bonded thereto. The first component 102 increases in thickness from the end H which is adapted to be attached to the housing toward the end A which is adapted to be attached to the actuator. Thus the strip 51a increases in its resistance to bending from the end H to the end A. Thus it will be seen that the construction of the air eliminator shown in FIGS. 1 to 3 in utilizing the strips 51a and 51b (one of which is shown in detail in FIG. 5a) provides a construction in which in all positions of the actuator there is a downward force exerted on the actuator by the strips. This has the effect of adding weight to the float and this expedient can be employed in lieu of ballasting the actuator, such as may be necessary, for example, where the actuator is used with a relatively heavy liquid. This construction is used where it is desired to open the valves more quickly with less inertia, because the apparent mass of the actuator in its upper position exceeds its true weight, which force is available in a mechanical advantage of two to one for closing the valves.

In FIGS. 5B to 5E, there are shown other forms of laminated strips which provide different variations in resistance to bending strips than the strip 51a and which may be substituted for the strips 17a and 51b in the air eliminator of FIGS. 1 to 3.

The strip 104 shown in FIG. 5B includes a first component 105 formed of a material having a predetermined resistance to bending stress and a second component 106 formed of a material having a lesser resistance to bending stress. The first component 105 tapers in thickness from the end H adapted to be fixed to the housing to the end A, adapted to be fixed to the actuator. This strip thus provides an effect which is the reverse of the effect provided by the strip 51a. In other words, the resistance to bending increases as the actuator moves downward. Consequently, the construction provides a lesser effective weight for the actuator when the latter is in its lower position. Where this strip is used, there is an upward force on the actuator created by the strips. This construction is used, for example, where it is desired to reduce the effective mass of the actuator so that there is little or no inertial effect in closing and a greater effective mass available for opening the valves.

The strip 107 shown in FIG. 5C includes a first component 108 and a second component 109 having a lesser resistance to bending than the first component. It is so formed as to have the greatest resistance to bending stress at its central portion. This is accomplished by increasing the thickness of the component 108 from adjacent the end H toward the central portion and then decreasing the thickness from the central portion toward the end A. Thus, when the actuator is in its lower position, there is less resistance to the upward force of the actuator. However, this resistance increases until the actuator reaches a mid-position and the zone of maximum bending is approximately at the central portion of the strip. Upon further movement of the actuator, the zone of bending occurs at a portion of the strip wherein the component 108 is decreasing in thickness and thus the resistance to the movement of the actuator decreases. Thus, it will be seen that when the actuator moves up-

wardly from its lowermost position toward its uppermost position, there is first a downward force on the actuator, which delays the upper movement of the actuator, whereafter there is an upward force on the actuator. This change takes place quickly and thus there is a "toggle" or "over the center" action. The arrangement preferably is such that the over-centering action takes place just as the strips tend to close the adjacent orifice and thus the orifice is closed rapidly. Thus there is no delay in closing the orifice once the actuator has moved into position to do so. This construction is used where it is desired to have the valves either opened or closed at a minimum time interval, as, for example, where it is desired to avoid any wire "drawing" effect. The quick closing of the valves permits the valves to remain in relatively open position until they are actuated to close the orifice. At the same time, the construction provides a quick opening of the valves when the liquid level falls.

In some instances, it may be desirable that the strips exert no upward nor downward force on the actuator in one portion of its travel and exert a force axially in one direction when the other is in another portion of its travel. Strips suitable for such operation are shown in FIGS. 5D and 5E.

In the case of the strip 110 shown in FIG. 5D, the first component 111 tapers in thickness from adjacent the end H to the central portion and is of uniform thickness from the central portion to adjacent the end A. Thus the strip 110 decreases in resistance to bending stress from the end H to the central portion and has a uniform resistance to bending stress throughout the remaining portion. Where strips of this form are used in the air eliminator, there is an upward force on the actuator when the latter is in its lower position, and after it passes the central position, there is no force exerted on the actuator by the strips. This construction is used where it is desired to have a rapid initial closing action followed by a normal further closing action. Such construction is employed, for example, where fluid in the fluid separator is under high pressure and it is desired that the full weight of the actuator be available to open the valves. On the other hand, when the actuator is in its lower position, it will respond quickly to rise to the liquid level of the chamber.

In the case of the strip 113 shown in FIG. 5E, the construction is such that the resistance to bending is the reverse of that of the strip in the strip 110 shown in FIG. 5D. In this case, the strip 113 is formed with a first component 114 which is of uniform thickness from the end H to the central portion and increases in thickness from the central portion to the end A. For such a strip, the strips neither add to nor subtract from the weight of the float of the actuator when the latter is in its lower position, but serves to provide a greater effective weight when the actuator moves to its upper position. Thus the actuator will respond normally when in its lower position, but will open the valve rapidly when the liquid level falls at a time when the actuator is in its upper position.

In the case of the strips shown in FIGS. 5A to 5E, the two components preferably are complementary in thickness and the strip has a uniform thickness.

The strips shown in FIGS. 6A to 6E correspond generally in their actions respectively to the strips shown in FIGS. 5A to 5E. However, the construction is somewhat different. In the strips shown in FIGS. 6A to 6E, the first component is formed preferably of spring metal and varies in width in the various portions of its length; it is preferably of uniform thickness. It is imbedded in the second component which is formed of a material such as synthetic plastic or rubber and is preferably of uniform width and thickness. The composite strip may be constructed by forming the second component around the first component.

The strip 120, shown in FIGS. 6A and 7, includes a

first component 121 preferably of spring metal which is imbedded in the second component 122, preferably of synthetic plastic or rubber. The first component 121 increases in width adjacent the end H toward the end A and thus the strip increases in its resistance to bending stress from adjacent the end H to adjacent the end A.

The strip 123, shown in FIG. 6B, includes a first component 124 imbedded in the second compartment 125 and tapers in width from adjacent the end H to adjacent the end A.

The strip 126, shown in FIG. 6C, includes a first component 127 imbedded in a second component 128. The first component increases in width from adjacent the end H to the central portion and then decreases in width from the central portion to adjacent the end A.

A strip 129, shown in FIG. 6D, includes a first component 130 imbedded in a second component 131. A first component 130 decreases in width from adjacent the end H to the central portion and then is of uniform width from the central portion to adjacent the end A.

The strip 132, shown in FIG. 6E, includes a first component 133 imbedded in a second component 134. The first component is of uniform width and adjacent the end H to adjacent the central portion and then increases in width from the central portion to adjacent the end A.

Referring now to FIGS. 8A to 8E, there is shown a modified form of a set of strips which correspond generally in their resistance stress to bending to the strips shown in FIGS. 5A to 5E, respectively. However, the first component is constituted by a plurality of elongate members such as wires or rods imbedded in the second component. It will be understood as the description proceeds that the variation in resistance to bending stress of the strips 8A to 8E is not uniform and progressive as in the case of the strips 5A to 5E, but occurs in steps. However, the overall general effect of the resistance to bending is analogous to that of the strips 5A to 5E, respectively.

The strip 135, shown in FIGS. 8A, 9 and 10, includes a second component 136 formed of material such as a synthetic plastic or rubber having imbedded therein a first component consisting of a plurality of rods or wires formed of a material having a greater resistance to bending stress such as spring steel.

The first component preferably includes a plurality of rods or wires 137, 138, 139 and 140, disposed in spaced relation and extending parallel to the longitudinal axis of the strip 135. The rods or wires are of different lengths and so arranged as to provide the effect of a generally tapering form of the first component. To this end, a single series of rods or wires 137, 138 and 140, may be provided but preferably a symmetrical arrangement such as illustrated in FIG. 8A is employed. More particularly, the first component includes a pair of short rods or wires 137 which extend from adjacent the end A toward the end H for a short distance. A second pair of rods or wires 138 are provided which extend for a somewhat greater length than the members 137. A third pair of members 139 extend for a still further distance in the direction of the end H than the members 138. Finally, a single, central member 140 is provided which extends from adjacent the end A to adjacent the end H.

Referring now to FIG. 8B, there is shown a strip 141 including a second component 142 in which is imbedded wires 143, 144, 145 and 146 arranged in a reverse manner from the members forming a first component of the strip 136. In other words, the shortest members 143 are located adjacent the end H. The next longest member 144 extends further toward the end portion A. The still longer members 145 extend for a further distance and the single central member 146 extends to adjacent the end portion A.

The strip 150, shown in FIG. 8C, includes a second component 151 in which the first component is imbedded. The first component includes a pair of short members 152 which are located adjacent the central portion of the

strip. A second pair of members 153, somewhat longer than the members 152, are located so as to extend beyond the members 152 in both directions. A third pair of members 154 are still longer than the members 153 and extend beyond the ends of the latter in both directions. Finally, the single, longest member 155 extends from adjacent the end H to adjacent the end A.

The strip 156, shown in FIG. 8D, comprises a construction which, as above noted, is generally equivalent in its resistance to bending stress to the construction shown in FIG. 5D. The strip 156 includes a second component 157 in which is imbedded members 158, 159, 160 and 161. The members 158 extend for a short distance from adjacent the end H toward the end A. The members 159 extend for a further distance from adjacent the end H; the members 160 extend for a still further distance, and the member 161 extends adjacent the central portion of the strip 156. There are no rods or wires in the portion of the strip from adjacent the central portion to adjacent the end A. Thus, this portion of the strip has a resistance to bending stress which is provided solely by the resilience of the material of the second component 157. In this portion of the strip, the second component is of uniform width and thickness of material, and the resistance to bending stress is uniform throughout such portion. However, as will be understood from the foregoing description, the bending stress in the portion of the strip in which the members 158, 159, 160 and 161 are imbedded will vary in accordance with the amount of material of the first component.

The strip 162, shown in FIG. 8E, includes a second component 163 and a first component consisting of rods or wires 164, 165, 166 and 167. A second component is located in the portion of the strip between the central portion and the end A and thus the action is the reverse of that provided by the strip shown in FIG. 8D.

It will be understood that in connection with all of the forms of strips herein shown, the resistance to bending stress at any portion along the length of the strip will be determined by the cross-sectional area of the material and primarily by the cross-sectional area of the material forming the first component. That is to say, that the portion of the strip where the cross-sectional area of the first component is the greatest, the strip will have at that section the greatest resistance to bending stress and, where the cross-sectional area of the first component at any point along the length of the strip is the smallest, the strip will have the least resistance to bending stress.

It will be understood that any of the strips disclosed herein may be substituted for the strips 51a and 51b in the fluid separator of FIGS. 1 to 3. It will be understood that where such other strips are substituted the two strips will be identical to each other.

I claim:

1. A fluid separator comprising casing means defining a chamber and providing a set of faces opposed relatively to an axis, an actuator movable along said axis and a plurality of normally flat resilient strip members, said strip members having first portions secured to said means adjacent said faces, respectively, and second portions secured to said actuator, said first and second portions of each strip member being spaced apart by a third and intermediate portion which is free and maintained in bowed shape, each strip member being formed at each of various portions along the length of the intermediate portion of a material having a different specific resistance to bending stress, each of said strip members being bent back upon itself and being of sufficient length so it forms two generally opposed portions, one lying against the corresponding face whereby each of the strip members exerts a force on the face with which it cooperates and said strip members position the actuator on the axis for movement therealong between a first position wherein said strip members lie against the corresponding faces to a predetermined extent and a second position wherein said

strip members lie against said faces to a lesser extent, at least one of said faces having an orifice opening into said chamber and positioned to be closed by the corresponding strip member when said actuator is in said first position and to be exposed when said actuator is in said second position.

2. A fluid separator according to claim 1 wherein each of said strip members includes a first component formed of a first material and a second component formed of a second material having a different specific resistance to bending stress than said first material.

3. A fluid separator according to claim 2 wherein said first component increases in total transverse cross-sectional area from the end of and intermediate portion which is nearest to said first portion and toward the end which is nearest said second portion.

4. A fluid separator according to claim 2 wherein said first component decreases in total transverse cross-sectional area from the end of said intermediate portion which is nearest to said first portion and toward the end which is nearest said second portion.

5. A fluid separator according to claim 2 wherein said first component increases in total transverse cross-sectional area from the end of said intermediate portion which is nearest said first portion to the central zone of said intermediate portion and then decreases in total cross-sectional area from said control zone to the end which is nearest said second portion.

6. A fluid separator according to claim 2 wherein said first component decreases in total cross-sectional area from the end of said intermediate portion which is nearest said first portion and toward the central zone of said intermediate portion.

7. A fluid separator according to claim 2 wherein said first component increases in total cross-sectional area from the end of said intermediate portion which is nearest to said second portion and toward the central zone of said intermediate portion.

8. A fluid separator according to claim 1 wherein each of said strip members is formed from two materials each having a different specific resistance to bending stress.

9. A fluid separator according to claim 1 wherein each strip member is formed of laminations bonded together with the laminations being formed respectively of materials having different specific resistances to bending stress.

10. A fluid separator according to claim 1 wherein each strip is formed of a first material having imbedded therein a member formed of a second material having a different specific resistance to bending stress than said first material.

11. A fluid separator according to claim 1 wherein each strip member is formed of a first material having imbedded therein a plurality of members formed of a material having a different specific resistance to bending

stress than said first material, said plurality of members being disposed side by side and extending in the direction of the length of said strip.

12. A fluid separator comprising casing means defining a chamber and providing a set of faces opposed relatively to an axis, an actuator movable along said axis and a plurality of normally flat resilient strip members, said strip members having first portions secured to said means adjacent said faces, respectively, and second portions secured to said actuator, said first and second portions of each strip member being spaced apart by a third and intermediate portion which is free and maintained in bowed shape, each strip member being formed of at least two different materials each having a different specific resistance to bending stress, said strip having at each of various portions along the length of the intermediate portion a different resistance to bending stress, each of said strip members being bent back upon itself and being of sufficient length so it forms two generally opposed portions, one lying against the corresponding face whereby each of the strip members exerts a force on the face with which it cooperates and said strip members position the actuator on the axis for movement therealong between a first position wherein said strip members lie against the corresponding faces to a predetermined extent and a second position wherein said strip members lie against said faces to a lesser extent, at least one of said faces having an orifice opening into said chamber and positioned to be closed by the corresponding strip member when said actuator is in said first position and to be exposed when said actuator is in said second position.

13. An actuator mechanism comprising means providing a set of faces opposed relatively to an axis, an actuator movable along said axis and a plurality of normally flat resilient strip members, said strip members having first portions secured to said means adjacent said faces, respectively, and second portions secured to said actuator, said first and second portions of each strip member being spaced apart by a third and intermediate portion which is free and maintained in bowed shape, each strip member being formed at each of various portions along the length of the intermediate portion of a material having a different specific resistance to bending stress, each of said strip members being bent back upon itself and being of sufficient length so it forms two generally opposed portions, one lying against the corresponding faces whereby each of the strip members exerts a force on the face with which it cooperates and said strip members position the actuator on the axis for movement therealong between a first position wherein said strip members lie against the corresponding faces to a predetermined extent and a second position wherein said strip members lie against said faces to a lesser extent.

No references cited.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,131,709

May 5, 1964

George B. Richards

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 5, line 48, for "72" read -- 71 --; column 7, lines 1 and 2, for "withing" read -- within --; column 11, line 8, for "compartment" read -- component --.

Signed and sealed this 19th day of January 1965.

(SEAL)

Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents