

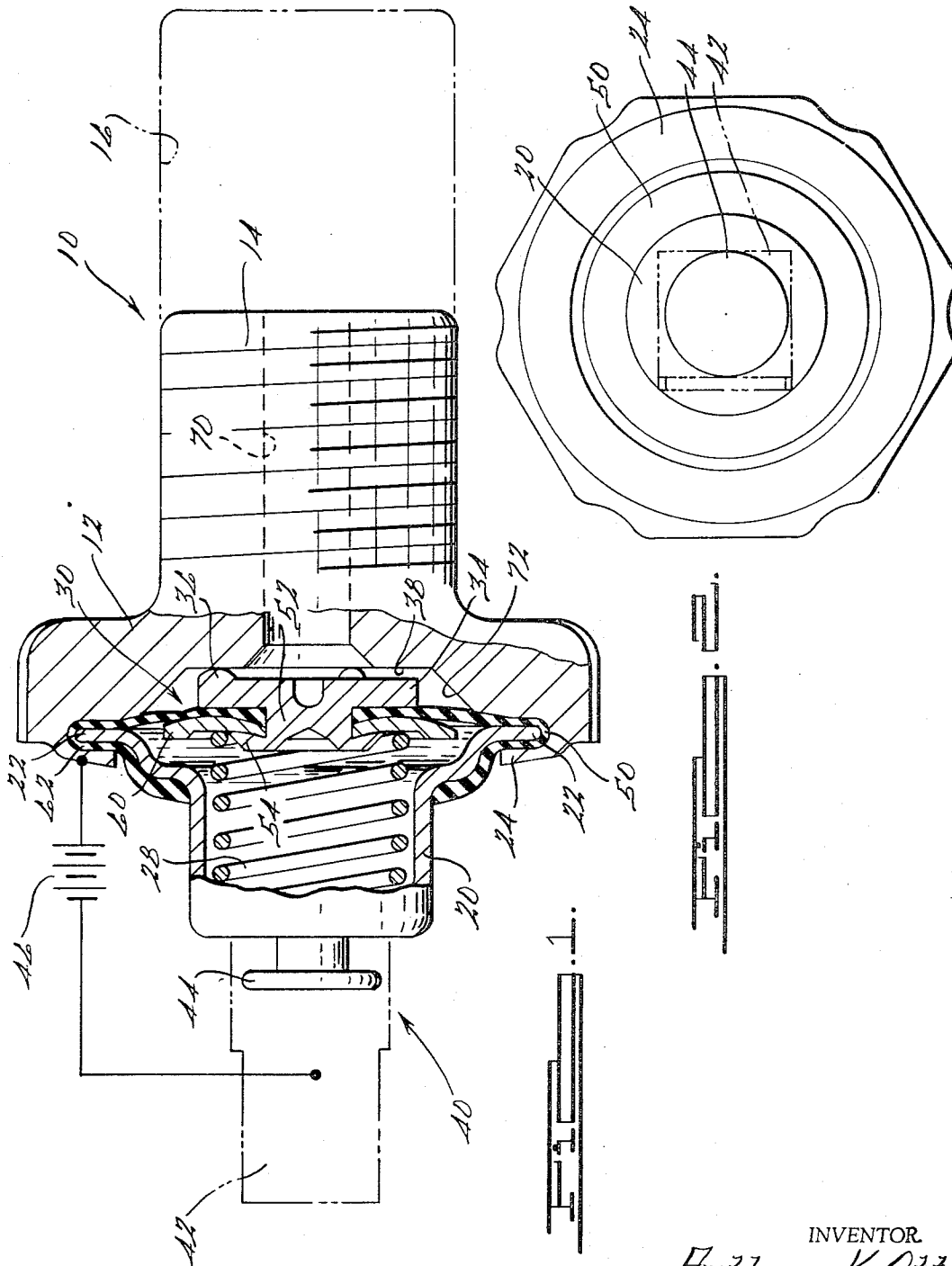
Feb. 27, 1968

A. K. OTTO

3,370,336

RESILIENT MEMBER CALIBRATION METHOD

Filed Jan. 4, 1966



INVENTOR
Anthony K. Otto
BY
Harless, Dickey & Pence
ATTORNEYS.

1

3,370,336

RESILIENT MEMBER CALIBRATION METHOD
Anthony K. Otto, Ann Arbor, Mich., assignor to King
Seeley Thermos Co., Ann Arbor, Mich., a corporation
of Michigan

Filed Jan. 4, 1966, Ser. No. 518,640

10 Claims. (Cl. 29—173)

This invention relates generally to an improved method of calibrating the characteristics of a resilient member and more particularly to an improved method of varying the effective length of a resilient member, and thus the application of a preload force on a portion of an environmental device, by the application of sufficient heat to the resilient member to carry the member beyond the stress relieving point and detecting the variation of the characteristic being calibrated.

While the following invention will be described in conjunction with or in the environment of a pressure responsive switch, it is to be understood that the novel method disclosed herein may be utilized in calibrating a resilient member in other environments wherein heat may be applied to the resilient member and the effects thereof detected or predicted. For purposes of explanation, pressure responsive is intended to be generic to both pressure and vacuum. Referring specifically to pressure responsive switches, first and second contacts are maintained either in contact or out of contact with each other by means of a spring member and a fluid pressure to be sensed is utilized in forcing the contacts to separate or close, respectively. It has been the practice to provide different spring members in the device to accommodate the specific pressure to be sensed. For example, if a pressure responsive switch is utilized in sensing the oil pressure of an automobile or the like, and the switch is adapted to be operated at a pressure normally found in an automobile, one type of spring having a particular characteristic may be utilized, while at the same time if an identical switch is being utilized in a different fluid system requiring the opening of the contacts at a different pressure, a second spring is utilized having different characteristics. Thus, it has been necessary to stock a variety of springs having a variety of lengths and preload characteristics which are suitable for use in the particular environment of the switch.

The improved method of the present invention alleviates the problems of the prior art in that a single spring may be utilized in a variety of applications requiring different characteristics by merely varying the above noted characteristics of the spring member after the spring has been placed into the particular device with which it is being utilized. This "in situ" calibration is accomplished by providing the spring member with sufficient heat to raise the temperature of the spring beyond the stress relieving or yield point while the spring is preloaded by either stretching or compressing the spring, thereby causing the spring to take a permanent set at a new free length. This heating process, in one application of the invention, is controlled by the operating point at which the contacts of the device or other members being operated by the spring respond to the particular critical pressure being impressed on the device.

Accordingly, it is one object of the present invention to provide an improved method of varying the effective characteristics of a resilient member.

It is another object of the present invention to provide an improved method of varying the characteristics of a resilient member which may be performed in situ in the device with which the resilient member is to be utilized.

It is still a further object of the present invention to provide an improved method of varying the character-

2

istics of a spring member such that a single spring member having a single initial set of characteristics may be utilized to perform in an environment requiring any one of a number of different sets of characteristics.

It is another object of the present invention to provide an improved method of varying the true length of a resilient member and thus the effective length and preload force of the member when the member is in use.

It is still another object of the present invention to provide an improved method of varying the characteristics of a resilient member wherein the characteristics of the resilient member may be varied through the initial application of a preselected quantity of heat to the member to raise the temperature beyond the yield point of the member thereby varying the effect of the member in the environment.

It is still another object of the present invention to provide an improved method of varying the characteristics of a resilient member whereby improved results are achieved in the operation of the device in which the resilient member is utilized and to permit greater deviation in the tolerances of parts being utilized in the device.

It is still a further object of the present invention to provide an improved method of varying the characteristics of a resilient member by heating the resilient member at a rate of heat to cause a permanent set in the member at a new free length, this rate of heat being much greater than the rate of heat being applied to the spring member during use.

It is still a further object of the present invention to provide an improved method of varying the characteristics of a resilient member wherein the manufacturing and assembling costs of the device utilizing the spring member are greatly reduced and the operating characteristics of the resilient member are greatly enhanced.

Further objects, features, and advantages of this invention will become apparent from a consideration of the following description, the appended claims and the accompanying drawing in which:

FIGURE 1 is a sectional view of a pressure-responsive switch in which the features of the present invention may be utilized, and

FIGURE 2 is an end view of the pressure-responsive switch of FIGURE 1, illustrating its general configuration and the input terminal thereof.

Referring now to FIGURE 1, there is illustrated a pressure-responsive switch 10, which environment for the invention has been chosen purely for illustrative purposes to demonstrate the use of the novel method of the present invention. The pressure-responsive switch 10 generally comprises a base member 12 formed of a conductive material having a threaded end 14 which is adapted to be threaded into a corresponding threaded aperture 16 in the pressure system to be sensed, or in the pressure system of a test stand which may be utilized in developing a standard pressure for calibrating the switch 10.

The switch 10 includes a cap member 20 which is also fabricated of a conductive material and is adapted to be fastened to the base member 12 by means of a flange 22 in sealing engagement with an overlapping flange portion 24 formed on the base member 12. The cap 20 is generally formed of a bell shape having a hollow interior for housing a resilient member or spring 28, the spring 28 being utilized to urge a diaphragm switch assembly 30 into engagement with the base member 14. One end of the spring member 28 is positioned to bear against the left portion of the bell-shaped housing 20 at the interior thereof and in electrical contact therewith, and the other end of the spring 28 is in engagement with

the diaphragm switch assembly 30, also in electrical contact therewith.

Referring particularly to the diaphragm switch structure 30, a first switch member 34 is formed of conductive material, and as stated above, is urged into electrical contact with the base member 12 by means of the spring 28. The switch member 34 includes a plurality of contact points 36, which are illustrated as being in mating engagement with a contact surface 38 of the base member 14 when in the rest position. As seen from the above description, a conductive path is provided through the housing member 20 and spring member 28 to the contact member 34 and surface 38. A terminal assembly 40 is fastened to an exterior surface of the housing member 20 in electrical contact therewith by any suitable fastening means. The terminal assembly 40, generally comprises a terminal member 42 and a second terminal member 44, both of which are adapted to receive connections to an exterior electrical circuit as for example, the power supply circuit 46 illustrated.

With the contacts 36, 38 closed, the circuit is completed through the contacts 36, 38, the body member 12 back to the other side of the source 46. Thus it is seen that the contacts 36, 38 control the supply of current through the spring member 28 in the situation where the spring is being calibrated. In the normal use of the switch 10, an indicating device is placed in series circuit with the source and the energization thereof is controlled by the condition of the contacts 36, 38. It is to be understood that the switch 10 may be utilized in any other type of circuit consistent with the operation of the switch 10.

The diaphragm switch assembly 30 further includes a diaphragm member 50, which is also of a generally bell-shaped configuration formed in the molding process of the diaphragm member 50. The diaphragm is fabricated of any material having the required elasticity and inertness to the material of the fluid being sensed, as for example, the oil and acids of an automobile lubricating system. The interior of the diaphragm member 50 is formed with an aperture which is fitted around a central hub portion 52 of the contact member 34. The hub portion 52 is provided with a flange 54 which is bent over to form a cavity thus compressing the inner portion of the diaphragm member 50 between the main contact body 34 and the flange 54. A washer element 60 may be provided to further enhance the sealing engagement between the diaphragm member 50 and the contact member 34, as will be seen from the remainder of the description.

A fluid seal is necessary between diaphragm member 50 and the contact member 34 to preclude fluid from leaking around the fluid seal and into the cavity formed by the bell-shaped cap member 20. Also, an outer edge of the diaphragm member 50 is formed with a generally U-shaped sealing portion 62 which is adapted to fit around a peripheral edge 22 of the bell-shaped cap member 20. Thus, the compression of the flange member 24 toward the main portion of the body member 12 causes the diaphragm 50 to be compressed between the flange 22 and the flange 24 and also the flange 22 and the main portion of the body member 12. In this manner, a second fluid-tight seal is created to preclude fluid from leaking around the main body member and to the exterior of the switch.

The switch assembly as shown in FIGURE 1, is illustrated in the rest position with the contacts 36, 38 closed. The body member 12 is illustrated as being formed with a fluid passage 70 in a longitudinal central portion thereof, wherein the fluid passage 70 is in fluid communication with an interior passage 72 to permit fluid to flow from an exterior source (not shown), through the fluid passage 70 into the interior passage 72, the latter being in fluid communication with the contact member 34 and the diaphragm 50.

In utilizing the method of the present invention the pressure switch 10 described in conjunction with FIGURES 1 and 2 is inserted into fluid communication with

a source of known pressure, either fixed or variable. A fixed pressure is chosen or a variable pressure is adjusted to the point at which it is desired to operate the contacts 36, 38. The base portion 12 has been provided with the threaded portion which may be inserted by threading, into the aperture 16 formed in the test stand or other pressure producing device, as described above. Thus, fluid pressure is impressed on the contact and diaphragm members 34, 50 by means of passage 70 and cavity 72.

As described above, the spring member 28 initially provides a preload force retaining the contacts 36 in engagement with the contact 38, which preload force is greater than the force developed in opposition thereto by the standard pressure being applied through the passage 70. Thus a net force is produced urging the contacts 36, 38 into closing engagement, this net force being the difference between force produced by spring member 28 and a force produced against the diaphragm 50 and the contact member 34.

The source of electrical energy 46 is then connected to the base member 12 and the terminal 42, the source of electrical energy 46 being of sufficient capacity to provide current through the spring 28 to raise its temperature beyond the yield point of the spring member 28. Upon connection of the source of electrical energy 46 to the base member 12 and the terminal 42, current will commence to flow from the positive side of the source of electrical energy, in the case of a DC source as illustrated, through the base member 12, contact 38, contact 36, contact member 34, washer element 60, spring member 28, and terminal 42 back to the negative side of the source 46. Thus a heating current is provided through the spring member 28 which tends to raise the temperature of the spring member in accordance with the amount of electrical energy being supplied.

When the temperature of the spring member 28 reaches the yield point, the effective length of the spring will then shorten in accordance with the particular configuration of the spring, the materials thereof and other parameters of the spring 28. Thus, the preload force tending to retain contact member 34, and thus contacts 36, 38, in the position shown is reduced. At such time as the preload force has been reduced sufficiently to reduce the net force tending to hold the contacts 36, 38 closed to zero, the contacts 36, 38 will open thereby discontinuing the flow of current through the spring member 28. The spring member 28 will have acquired a permanent set at the new effective length thereby reducing the effective preload force on the contact member 34.

For example, assume a spring member 28 is provided having a free length of approximately 1 inch, and the spring is inserted into a device such as that illustrated in FIGURE 1 wherein the spring is compressed to approximately $\frac{1}{2}$ inch, a force of, for example, approximately 2 pounds is produced on the diaphragm contact assembly 30. Accordingly, it is required to produce an effective force of approximately 2 pounds by means of the pressure being impressed on cavity 72 and thus diaphragm assembly 30 in order to offset the preload force produced by spring member 28 and thus separate contacts 36, 38. If, upon heating of the spring member 28, the effective length of the spring member is reduced to $\frac{3}{4}$ of an inch, the total compression of the spring member will be reduced from $\frac{1}{2}$ inch to $\frac{1}{4}$ of an inch. Thus, the effective preload force will be approximately $\frac{1}{2}$ or reduced from 2 pounds to 1 pound. Therefore, a fluid pressure is required which is only half of the original pressure needed to offset the preload force produced by spring member 28 and to open contacts 36, 38.

It will be noted that the system described inherently senses the new preload force provided by spring member 28 which is required to offset the force produced by the fluid pressure on contact assembly 30. Thus, when the desired preload force has been achieved, the heating current for the spring member 28 is removed thereby causing

the spring member 28 to assume a permanent set at a new length, which length is that required to produce a preload force which is substantially equal to that produced by the desired pressure.

For example, the switch assembly may take the form of a calibrating jig and a variable standard pressure may be utilized in calibrating a plurality of springs in the same jig. Also, it is not necessary that the spring is heated by electrical current, and it is contemplated that an external source of heat may be provided wherein the electrical circuit through the contacts 36, 38 is utilized in controlling the source of heat. Similarly, certain structural modifications are contemplated wherein the spring member 28 is in tension rather than compression and/or the contacts 36, 38 are maintained open with the preload force of the spring member.

While it will be apparent that the embodiment of the invention herein disclosed is well calculated to fulfill the objects of the invention, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims.

What is claimed is:

1. A method of varying an effective characteristic of a resilient member comprising the steps of placing the resilient member in a condition responsive assembly with the resilient member distorted to provide a preload force on a condition responsive element within the assembly, applying a predetermined force against the condition responsive element opposing said preload force and of a magnitude in accordance with a condition to be determined, applying heat to said resilient member at a sufficient rate to raise the temperature of the resilient member and vary the preload force, and ceasing the application of heat so that the ultimate preload force is approximately the same as the predetermined force.

2. The method of claim 1 wherein the effective characteristic being varied is the preload force of the resilient member for any given degree of distortion and the free length of the resilient member is varied by the application of the heat.

3. The method of claim 2 wherein the rate of applied heat is sufficient to raise the temperature of the resilient member beyond the yield point of the resilient member.

4. The method of claim 1 wherein the resilient member is placed in a pressure responsive switch assembly having a first contact and a diaphragm contact assembly including a second contact, the application of the preload force tending to maintain one of said contacts in

a first position and said predetermined force tends to move said one of said contacts to a second position prior to cessation of the application of heat.

5. The method of claim 4 wherein the movement of said one of said contacts is effective to cause cessation of the application of heat to the spring member.

6. The method of claim 1 wherein the application of heat to the resilient member further includes the step of connecting a source of relatively high current electrical energy across the resilient member for electrically heating the resilient member.

7. The method of claim 6 wherein the resilient member is placed in a pressure responsive switch assembly having a first contact and a diaphragm contact assembly including a second contact, the application of the preload force tending to maintain one of said contacts in a first position and said predetermined force tends to move said one of said contacts to a second position prior to cessation of the application of heat.

8. The method of claim 7 wherein the movement of said contacts is effective to cause cessation of the application of heat to the spring member.

9. The method of claim 8 wherein said resilient member is deformed between a fixed member and said diaphragm contact assembly and the electrical energy is applied to the resilient member and the first and second contacts such that the movement of the contacts to the second position discontinues the application of heating current to the resilient member.

10. The method of claim 9 wherein the contacts are maintained in the closed position in response to the preload force being greater than the predetermined force and the contacts are opened in response to the reduction of the preload force below the predetermined force, and wherein the predetermined force is generated by fluid pressure applied to the diaphragm contact assembly.

References Cited

UNITED STATES PATENTS

1,935,147	11/1933	Drexler	29—173
2,216,878	10/1940	Densmore	29—446 X
2,236,206	3/1941	Becker	29—173
2,490,320	12/1949	Pashby	29—593 X
2,673,730	3/1954	Hupp	267—1
2,904,876	9/1959	Edelen	29—505
3,107,417	10/1963	Jaquish et al.	29—407 X

THOMAS H. EAGER, *Primary Examiner*.