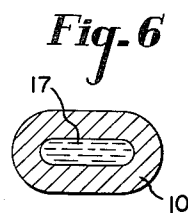
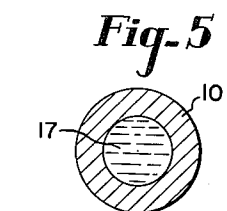
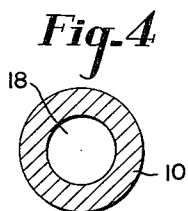
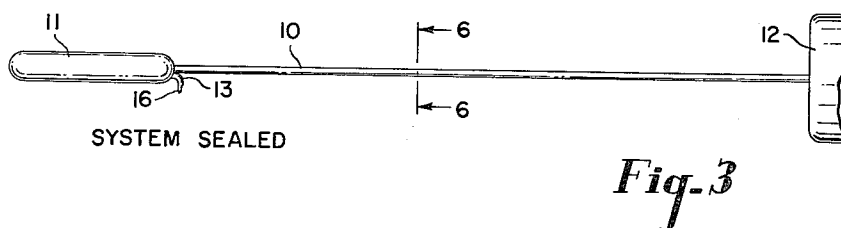
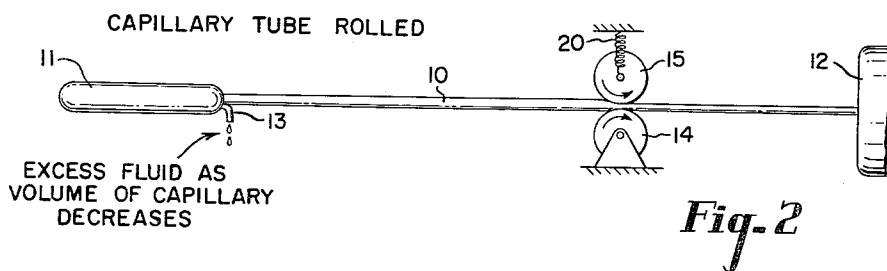
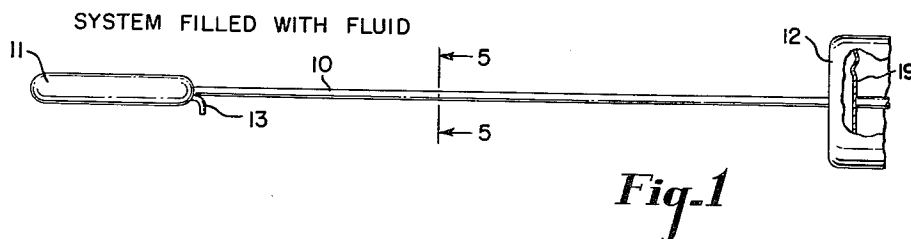


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METHOD OF MAKING A CAPILLARY TUBE FLUID
FILLED TRANSMISSION SYSTEM
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CAPILLARY TUBE

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METHOD OF MAKING A CAPILLARY TUBE FLUID FILLED TRANSMISSION SYSTEM

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The present invention is concerned with a novel method of making a capillary tube fluid transmission system; in particular, the method involves the filling of the transmission system with fluid, and after the capillary tube is filled, the tube is rolled to decrease the bore volume.

Heretofore, when capillary fluid transmissions were made, a capillary tube was attached at one end to a sensing bulb and at the other end to an actuator. After the housing of the fluid was completely assembled, the non-compressible fluid was placed into the housing to fill the sensing bulb, the capillary tube, and the actuator. Obviously, care must be taken to insure that no compressible fluid or air remains in the system.

In such a capillary fluid transmission system, the output of the actuator depends upon the increase in volume of the fluid in the bulb or sensing element. When the volume of the fluid in the capillary tube is substantially large as compared to the volume of the fluid in the bulb, the effect of temperature on the capillary tube is quite great. Often the change in temperature of the capillary tube introduces an error in the system which cannot be tolerated.

Several schemes have been proposed for compensating for the effect of the temperature change of the capillary tube; however, these schemes are often quite complicated and tend to increase the cost of the manufacture of such a system. If the volume of the capillary tube is small in proportion to the volume of the temperature bulb or sensing unit, the error introduced into the system by a change in the temperature of the capillary tube is small and can be tolerated. The dimension of the internal bore of the capillary tube can be reduced; however, the smaller the bore of the capillary tube, the more difficult the normal filling of the system with fluid becomes without the introduction of a compressible fluid such as air.

The present invention provides for a fluid filled system which has a capillary tube with a very small internal bore dimension; and yet, the possibility of introducing a compressible fluid into the system when the system is filled with noncompressible fluid is lessened. The housing for the system is connected in a normal manner with a sensing unit, a capillary tube, and an actuator; however, the internal bore of the capillary tube is quite large. The system is then filled with noncompressible fluid, and the capillary tube is rolled to decrease the cross-sectional area of the internal bore. As the capillary tube is rolled, the excess noncompressible fluid is bled off of the system. When the capillary tube has reached a desired dimension, the system is sealed.

Therefore, an object of the present invention is to provide an improved method of making a capillary, fluid filled transmission system.

Another object of the present invention is to provide an improved method of making a capillary fluid transmission system with a minimum volume of fluid in the capillary tube.

These and other objects will become apparent upon the study of the specification and drawings in which:

FIGURE 1 is a view of the fluid filled system having a bulb, a capillary tube, and an actuator.

FIGURE 2 is a schematic showing of the rolling operation wherein the capillary tube is rolled to decrease the cross-sectional area of the internal bore.

FIGURE 3 is a view of the system which has been sealed after the cross-sectional area of the capillary tube is reduced and the excessive fluid in the system has been removed.

FIGURE 4 is a cross-sectional showing of the capillary tube which is not filled with fluid.

FIGURE 5 is a cross-sectional view of the capillary tube with the fluid fill.

FIGURE 6 is a cross-sectional view of the capillary tube after the rolling operation with the cross-sectional area of the bore reduced.

Referring to FIGURE 1, a capillary fluid filled transmission system is shown. A capillary tube 10 which might be of any length and have a cross-sectional area as shown in FIGURE 4 is connected at one end to a bulb or temperature responsive element 11, and at the other end to an actuator 12. The temperature responsive bulb is hollow; so that, when the bulb is filled with a medium 17 such as a vapor or a noncompressible liquid which changes in volume upon a change in temperature, a response indicative of temperature is obtained. The actuator is of a conventional type which has a means responsive or diaphragm 19 to a change in volume of the fluid therein. One particular type of actuator has a flexible diaphragm across one side so a change in volume of the fluid therein produces a mechanical movement of the diaphragm and thus an associated apparatus. With the housing of the system connected as shown, the bulb, the capillary tube, and the actuator are filled with the fill medium 17 through a tube 13 attached to the bulb.

Since the cross-sectional area of the internal bore 18 of the capillary tube is quite large little difficulty is experienced in completely filling the system with a noncompressible fluid. Obviously, when a liquid is used, if an air bubble or any other compressible fluid is left in the housing or introduced during the filling operation, a change in volume of the fluid in bulb 11 will not have the correct effect upon the output of actuator 12. As long as the cross-sectional area of the capillary tube is substantially as shown in FIGURE 4 or has a relatively large cross-sectional, area dimension, the filling operation without the introduction of any air is relatively simple.

After the system is completely filled with fluid, the capillary tube is rolled as shown in FIG. 2. The schematic showing of the rolling operation involves a fixed roller 14 and a movable roller 15 which is spring biased toward roller 14 by a compression spring 20. The type of loading on roller 15 can vary with the particular type of capillary tube; however, a constant downward force on roller 15 has been found to maintain the internal bore dimension of the capillary tube relatively constant. While the rolling operation in FIGURE 2 is shown schematically, the rolling operation may involve a number of passes back and forth over the complete length of the capillary tube until the dimension or internal bore 18 of the capillary tube is substantially as shown in FIGURE 6. During the rolling operation, the volume of fluid in the capillary tube is decreased, and the excess fluid of this system is removed through the tube 13.

After the capillary tube has reached a desired internal bore dimension as shown in FIGURE 6, the system is sealed at tube 13 in an appropriate manner. The sealed fluid transmission system is shown in FIGURE 3 with the reduced cross-sectional area capillary tube.

The method has been described as applied to a capillary liquid transmission system; however, the invention is applicable to other fluid filled capillary tube systems whether vapor or liquid is used as the fill, and the intention is to

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limit the invention by the scope of the appended claims in which I claim:

1. The method of making a thermostat element having a remote bulb connected by a fluid filled system to an actuator, which consists of attaching a bulb and an actuator to opposite ends of a length of tube, filling the bulb, tube and actuator with relatively noncompressible fluid, rolling the tube to reduce the cross-sectional area of the tube bore, and sealing the system to prevent fluid loss when the fluid in said bulb increases in volume.

2. In a method of making a noncompressible fluid filled control apparatus in which the increase in volume of the fluid in a sensing unit is reflected to a pressure operated control device by a capillary tube connection, attaching a sensing unit and a pressure operated control device to the opposite ends of a length of tube, filling the sensing unit, the tubing, and the control device with a noncompressible fluid with a free opening to allow fluid to escape, rolling the tubing to decrease the size of the opening throughout the tubing, and sealing the free opening.

3. The method of making a noncompressible fluid filled capillary tube having a bore size which is difficult to insure that all the compressible fluid is removed, filling the tube with noncompressible fluid, rolling the tube to reduce the bore cross sectional area, and sealing the tube.

4. The method of making a noncompressible fluid filled capillary tube having a bore size which is so small that difficulty is experienced in filling the capillary in a normal

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manner to insure that there is no compressible fluid therein, filling the tube with noncompressible fluid, rolling the tube with a constant pressure to reduce the cross-sectional area of the bore of the capillary tube, and sealing the tube to prevent the noncompressible fluid from escaping when the volume of the fluid is increased.

5. The method of making a thermostat element having a remote bulb connected by a medium filled system to an actuator which consists of attaching a bulb and an actuator to opposite ends of a length of tube comprising the steps of, filling the bulb, tube and actuator with a fluid medium, rolling the tube with a constant pressure to reduce the cross-sectional area of the tube bore and the volume of fluid medium therein, and sealing the system to prevent loss of medium when the medium in said bulb increases in volume.

6. The method of making a fluid filled capillary tube having a bore size which is difficult to insure that all of the undesired fluid is removed, filling the tube with the desired fluid, rolling the tube to reduce the cross-sectional area of the bore and the volume of fluid contained therein, and sealing the tube.

References Cited in the file of this patent

UNITED STATES PATENTS

1,827,766	Rosenburgh	Oct. 20, 1931
2,047,296	Squires	July 14, 1936
2,366,141	Alderfer	Dec. 26, 1944