

Dec. 6, 1932.

D. D. ROSENBURGH

1,889,792

CAPILLARY FLUID TRANSMISSION SYSTEM

Filed Oct. 19, 1926

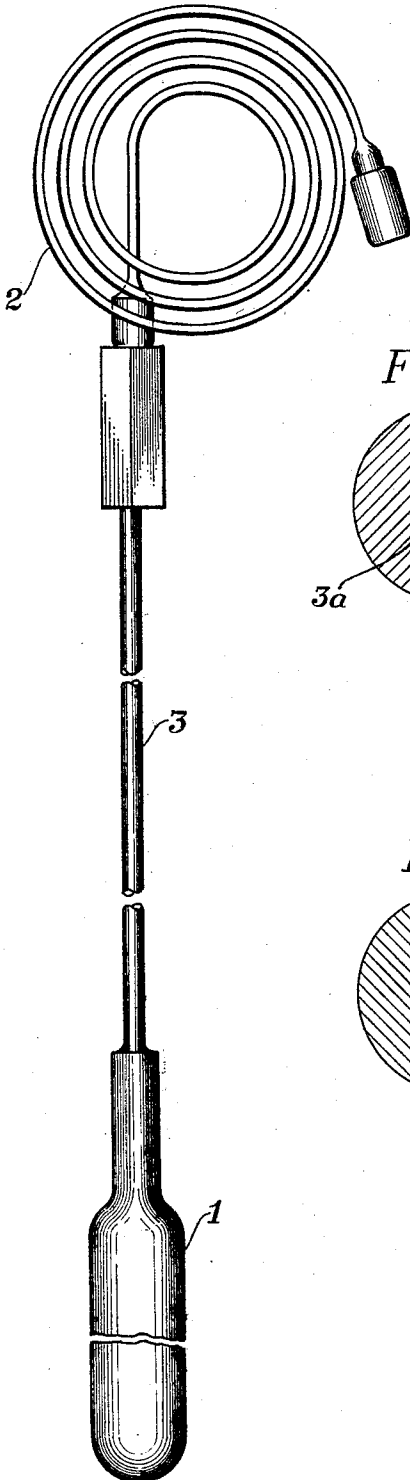


Fig. 1

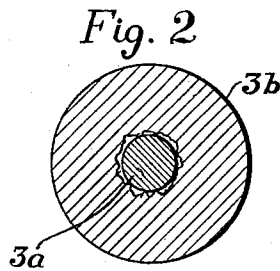


Fig. 2

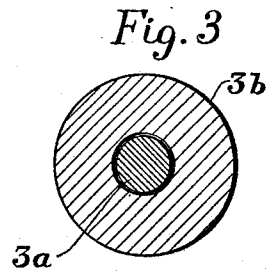


Fig. 3

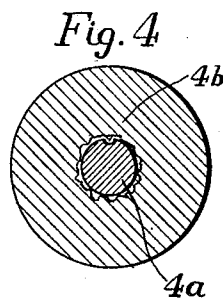


Fig. 4

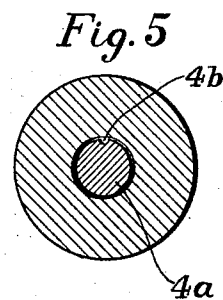


Fig. 5

INVENTOR
Darius D. Rosenberg
BY Alfred B. Rogers
his ATTORNEY

UNITED STATES PATENT OFFICE

DURWOOD D. ROSENBURGH, OF ROCHESTER, NEW YORK, ASSIGNOR TO TAYLOR INSTRUMENT COMPANIES, OF ROCHESTER, NEW YORK, A CORPORATION OF NEW YORK

CAPILLARY FLUID TRANSMISSION SYSTEM

Application filed October 19, 1926. Serial No. 142,632.

This invention relates to instruments including a capillary fluid transmission system and more particularly to apparatus of the type disclosed in the patent to Hodgkinson No. 1,063,349 dated June 3, 1913.

It has been generally recognized as a desideratum to reduce the size of the capillary for transmitting the fluid pressure from the bulb to the pressure element so far as this is compatible with the pressure requirements at the latter.

Aside from the point of cost, there is another even more cogent reason for reducing the volume of the transmitting liquid, or mercury in particular, to a practical minimum: Mercury, for instance, has a high coefficient of expansion. Changes in the temperature surrounding the transmission system cause a change in the volume of the transmitting liquid, with the result that this expansion or contraction, as the case may be, reacts upon the pressure condition in the pressure responsive element, which pressure condition should be and is intended to be solely a function of the changes in the volume of the liquid in the bulb in response to changes of the temperature conditions to which the bulb is subjected. The greater the volume of the transmitting liquid, the greater is the influence of changes in its temperature upon the indication of the instrument. In all cases where the transmission system is subjected to material variations in temperature it is necessary to compensate for the changes in the volume of the transmitting fluid caused thereby.

Compensation may be obtained to a certain extent by using a filler wire, such as disclosed in the patent mentioned, of a material having a smaller co-efficient of expansion than the material of the capillary tube. Due to the differential expansion and contraction the variable interspace between the wire core and the walls of the tube thus may have a compensatory effect for the variations in the volume of the transmitting liquid. However, the compensation afforded is, in the usual case, not entirely satisfactory.

It is the primary object of this invention

to provide a simple transmission system which may afford complete compensation.

Another, more general object is to produce a transmission conduit having a substantially uniform cross-sectional area.

Still another particular object is a method of forming a capillary transmission system of a substantially uniform and smaller effective cross-section than was heretofore possible.

Up to the present time it was the general practice, with systems having a filler core, to obtain a capillary having as small a bore as possible and then feeding as large a core as possible into it. A tube having a bore about .020" diameter together with a wire having a diameter of about .012" may be considered as typical in the prior art. The clearance is about .004.

The bores of capillaries, as a general rule, are comparatively irregular. The diameter as a whole varies within wide limits and there are many deformations, such as furrows, depressions and other cavities, all tending to increase the interspace and thereby the volume of the transmitting liquid. In addition to these cavities which directly increase the interspace, there are rough spots distributed along the walls of the capillary, all having the tendency to impede or obstruct the passage of the wire through it. The largest wire which may be fed into any tube is considerably smaller in diameter than the bore. It is thus practically impossible to enter a filler core of less than .006" difference in diameter.

All these inconveniences and disadvantages may be overcome by my invention, which, briefly expressed, consists in drawing or swaging a tube down upon a core to any desired extent.

For a full understanding of the invention, reference is made to the accompanying drawing in which

Fig. 1 is a diagrammatic view of an instrument embodying the invention;

Fig. 2 is a sectional view on a relatively large scale, of a tube and a wire in assembled relation prior to the drawing or swaging operation;

Fig. 3 is a similar view of the same after the drawing or swaging operation; and

Figs. 4 and 5 are views similar to Figs. 2 and 3, showing a modified form of the invention.

In the drawing 1 represents a temperature-responsive bulb such as is generally used in connection with indicating, regulating and recording instruments of the class involved. The Bourdon tube 2 represents, in a general way, all forms of pressure responsive devices adapted to operate under fluid pressure and 3 is a capillary transmission system.

In practice I select a wire 3a, which has substantially the desired diameter and then enter it into a tube 3b sufficiently larger in bore so as to readily pass into and through it. In fact, the clearance between the walls of the capillary and the core may be considerably larger than the usual tolerance, because the tube is to be reduced in size any way. However, as a matter of common sense, in order to avoid all unnecessary waste of energy and expense, it is preferable to use a wire which just readily enters the tube or a tube which just slips over a core. In this way the operation of entering the wire into the tube does not consume much time and at the same time, the amount of drawing or swaging required is reduced to a relatively small amount.

With the wire in position in the tube, the latter is drawn or swaged upon it. The drawing or swaging operation may be conducted and controlled to obtain any desired degree of fit, as will be readily understood. However, so far as the particular purpose is concerned, it is preferably so conducted as to leave just enough clearance to allow a film of mercury to form therein. In practice I find that a good fit is obtained when it requires a considerable force to move the wire by pulling. So long as the wire can be moved, the interspace is ordinarily not too small. The capillary may be tested by forcing air through it under a definite pressure, say about 4 pounds per square inch, into a body of water, and counting bubbles per unit of time. The proper setting of the drawing or swaging may be empirically determined for any size of tube and wire correlated therewith and the clearance or interspace may be varied for different practical requirements, having reference to the pressure conditions desired at the pressure-responsive element i. e. the Bourdon tube or the like. In other words the allowable pressure gradient between the two ends of the transmission line may vary between certain limits, depending also to some extent upon the length of the line.

By measuring the volume of liquid in a capillary of a given length, prepared according to this invention, I found that the clearance may be made as small as .0004" and even .0002". Clearances lower than .0002" are,

so far as my experiences have shown, inoperative.

At any rate, by reducing the clearance or interspace, through the instrumentality of a drawing or swaging apparatus, to a definite minimum for each particular set of conditions, the volume of the transmission liquid is reduced to a practical minimum and the extent of compensation called for is a minimum. This is in contradistinction to the prior art which had to accept as the minimum clearance or interspace that which was formed by entering as large a wire as was possible.

Not only is the interspace reduced in a general way, but the irregularities in the bore, the furrows, depressions and cavities which are present in tubes as unavoidable incidents are reduced in size and extent or even more or less eliminated. Especially the swaging operation has a peculiar equalizing effect in this respect.

The result of the drawing or swaging operation, aside from the net reduction in diameter, is the more particular and important leveling or smoothing out of the rough, irregular surface of the bore and the elimination of a previously unavoidable space, which from the standpoint of operation was unnecessary and merely required more compensation than would have been necessary without it.

It is needless to emphasize that a relatively smooth interspace makes it possible to obtain a minimum of resistance to flow for a minimum of volume of fluid. This translated into practical parlance, means that it is possible to obtain a fast instrument with a minimum of transmission fluid.

Whenever a very fast instrument is desired, the resistance to flow may be precisely determined by the provision of a groove 4b, in the surface of the core 4a, as indicated in Figs. 4 and 5. The groove may vary from a fine thin capillary thread to a groove of more substantial size depending upon the speed desired. The tube is drawn or swaged upon the core as before to eliminate substantially all the waste space and reduce the interspace to a relatively smooth clearance space allowing a film to form.

Depending on the volume of mercury, the diameter of the core and the bore may be increased to obtain the differential movement necessary for the accommodation of the expanding mercury. The higher the speed i. e. the quicker the response desired, the greater must be the cross-section of the transmission conduit, and the greater is consequently the volume of mercury. For this reason the differential movement must be correspondingly great and this can be easily obtained by using a core and a bore of relatively large diameter. Instead of using a wire of a diameter between

.012"-.015", the core may have a diameter of .060"-.065", or even higher.

At any rate, by providing a groove in the wire core, it is possible to precisely determine the speed of the instrument with a minimum of volume of mercury.

Instead of providing the groove in the surface of the core, it may be formed in the bore of the tube during the process of drawing. However, I prefer to score or groove the wire core, as shown.

The invention not only has the advantages described, but also the outstanding commercial advantage that it is no longer necessary to use tubes of an extremely small bore with or without wire filler. Tubes with larger bore, which are easier to make and are less expensive, are now available for the purposes described.

It is understood that in place of a solid core a tubular core may be used. However, for practical purposes a solid core is preferable.

In the foregoing, the invention has been described in the light of its principal object of producing a wire-filled capillary. It is understood, however, that it is equally important for producing the usual form of capillary tube without filler wire.

I claim:

1. In apparatus of the character described, a capillary tube having a uniformly smooth bore of substantially circular cross-section and containing a filler core of uniformly smooth surface, the difference in diameter between the bore and the core being less than .003".

2. In apparatus of the character described, a capillary tube having a uniformly smooth bore of substantially circular cross-section and containing a filler core of uniformly smooth surface, the difference in diameter between the bore and the core being less than .002".

3. In apparatus of the character described, a capillary tube having a uniformly smooth bore of substantially circular cross-section and containing a filler core of uniformly smooth surface, the difference in diameter between the bore and the core being no more than .0015".

4. In apparatus of the character described, the combination with a bulb containing an expansible fluid and a device sensitive to variations in fluid pressure, of a metal capillary tube for interconnecting the bulb and the said device, said tube having a capillary bore substantially free from furrows and ridges such as are incident to the usual drawing operation.

5. In apparatus of the character described, the combination with a bulb containing an expansible fluid and a device sensitive to variations in fluid pressure, of a metal capillary tube for interconnecting the bulb and

the said device, said tube having a capillary bore of uniform circular cross-section throughout its length and substantially free from furrows and ridges such as are incident to the usual drawing operation.

6. A metal capillary tubing for fluid transmission systems, having a capillary bore substantially free from furrows and ridges such as are incident to the usual drawing operation.

7. A metal capillary tubing for fluid transmission systems, having a capillary bore of uniform circular cross-section throughout its length and substantially free from furrows and ridges such as are incident to the usual drawing operation.

8. In apparatus of the character described, the combination with a bulb containing an expansible fluid and a device sensitive to variations in fluid pressure, a capillary tube for interconnecting the bulb and said device, said tube being provided with a capillary bore adapted to receive a filler core having a smooth uniform surface throughout its length, the surface of said bore having substantially the same degree of smoothness as the surface of said filler core.

9. A capillary tubing for fluid transmission systems provided with a capillary bore adapted to receive a filler core having a smooth uniform surface throughout its length, the surface of said bore having substantially the same degree of regularity as the surface of said filler core.

In testimony whereof I affix my signature.

DURWOOD D. ROSENBURGH.