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ELECTRICAL APPARATUS FOR MEASURING PRESSURE

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FIG. 1

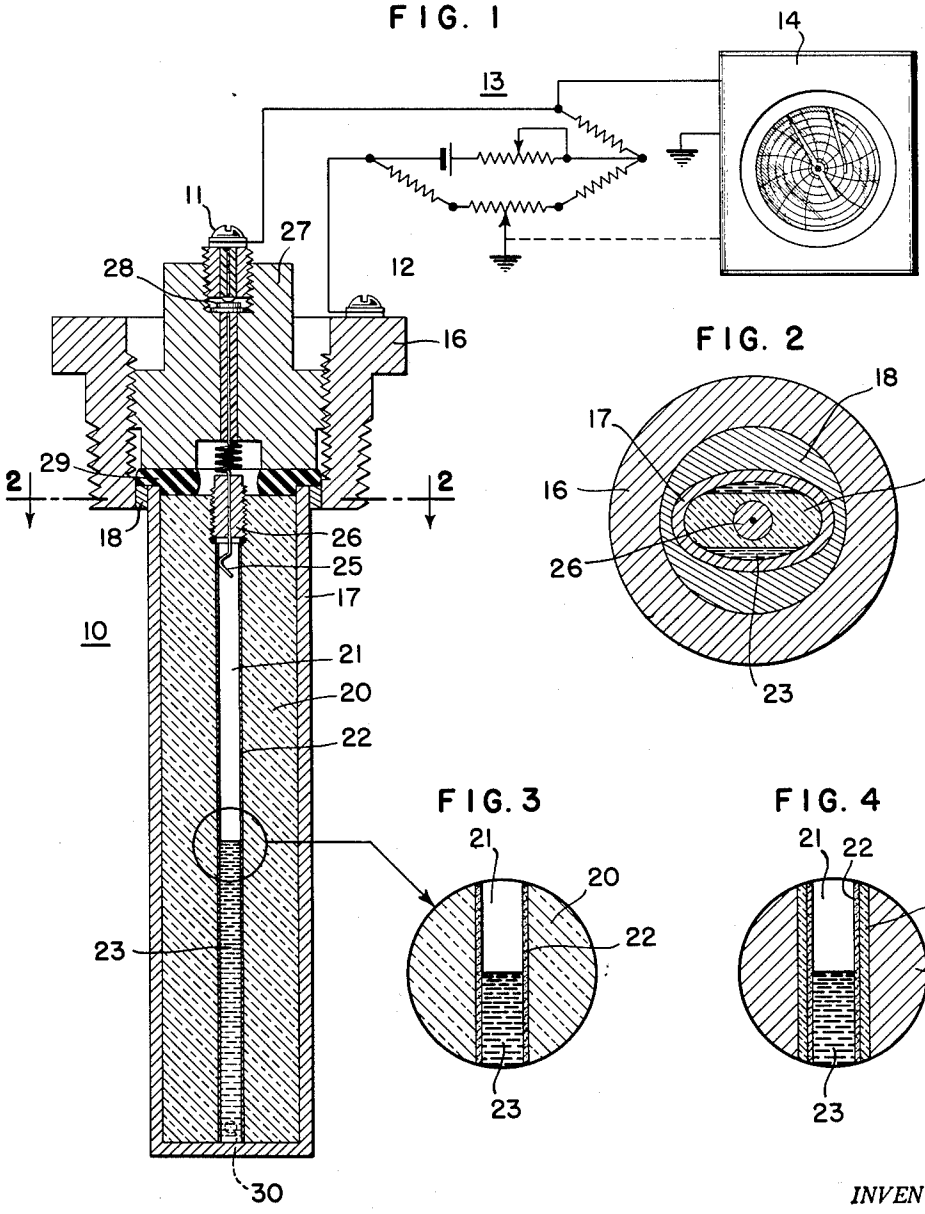


FIG. 2

FIG. 3

FIG. 4

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ELECTRICAL APPARATUS FOR MEASURING PRESSURE

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3 Claims. (Cl. 73—398)

A general object of the present invention is to provide a new and improved temperature compensated pressure to electric transducer. More specifically, the present invention is directed to a pressure to electric transducer which utilizes a hollow collapsible tube whose internal volume change causes a volume of electrically short circuiting liquid to rise and fall in a hole whose sides are coated with an electrically conductive coating having an appreciable resistance.

In a copending application of Philip J. Donald, for "Measuring Apparatus," Serial No. 315,003, filed October 16, 1952, there is disclosed a pressure to electric transducer of the general type of the present application. In said Donald application there is shown an apparatus comprising a collapsible tube into which is placed a glass capillary tube having an electrically conductive coating thereon. This capillary tube is placed within a protective element which fills a major portion of the collapsible tube and this element acts to reduce the volume of electrically short circuiting liquid required for shorting the coating on the capillary. This is necessary as the most readily available electrically short circuiting liquids have an appreciable temperature coefficient of expansion which means, if full temperature compensation is to be effected, the amount the liquid increases in volume with temperature change must be the same as the volume increase of the collapsible tube holding the same. The reduction of the necessary volume of short circuiting liquid in an apparatus of the Donald type greatly enhances the utility and field of application for such an apparatus by improving the temperature characteristics of the apparatus. As accomplished in the present application, this change works toward a more rugged and universal type of apparatus without any sacrifice in the ease of assembly of the component parts.

It is accordingly a further object of the present invention to provide a new and improved pressure to electric transducer having enhanced temperature compensating characteristics.

Another object of the present invention is to provide a pressure to electric transducer where a hollow collapsible tube has mounted therein a temperature compensating element with an electrically conductive coating directly on the temperature compensating element.

Still another object of the present invention is to provide a temperature compensating element which acts as a support for an electrically conductive coating and as a protective element which prevents an enclosing collapsible tube from being stressed beyond its elastic limit.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed hereto and forming a part of this specification. For a better understanding of the invention, however, its advantages, and specific objects obtained with its use, reference should be had to the accompanying drawings and descriptive matter in which is illustrated and described a preferred embodiment of the invention.

Fig. 1 is a cross sectional view of the present invention showing the manner in which it may be connected to suitable indicating apparatus;

Fig. 2 shows a cross sectional view of a portion of Fig. 1 taken along the center lines 2—2;

Fig. 3 shows an enlarged view of a portion of the apparatus of Fig. 1; and

Fig. 4 shows a modified arrangement of the apparatus shown in Fig. 1 with an enlarged section as in Fig. 3.

Referring now to Fig. 1, the numeral 10 indicates generally the pressure to electric transducer of the present apparatus. This transducer 10 has a pair of output connecting terminals 11 and 12 which are arranged for connection to a suitable electrical network 13. The output of the network 13 is arranged for connection to a suitable measuring and indicating instrument 14 which may have the network 13 as an integral part thereof. The instrument 14 is effective to sense the electrical balance conditions of the network 13 and by means of suitable mechanism included in the instrument a rebalancing of the network 13 may be effected. An apparatus which is suitable for use in this particular arrangement is shown in the Walter P. Wills Patent, 2,423,540, issued July 8, 1947.

Considering further the transducer 10, this transducer comprises a supporting member 16 in the form of a nut which is threaded on the inside as well as the outside. The threading on the outside is arranged for engaging a suitable matching threading on an enclosure to which the apparatus may be mounted. Attached to the lower portion of this nut 16 is a collapsible elliptical tube 17 which may be of the type known as a Bourdon tube. The cross sectional view of this Bourdon tube may be as shown in Fig. 2 and while this particular cross section is shown, it is to be understood that there are other cross sectional dimensions which are suitable for use in the present apparatus. The tube 17 is fastened to the nut 16 by means of a filler element 18 also shown in cross sectional view in Fig. 2. This filler element may be welded into position with the collapsible tube 17 also welded thereto so as to be sealed tightly to the nut 16. The lower end of the tube 17 may be sealed in any desired manner.

Positioned within the collapsible tube 17 is the protecting and temperature compensating element 20. This temperature compensating element, as shown in Fig. 1, is made of a non-porous ceramic material which has a low temperature coefficient of expansion. As shown in Fig. 2, this element 20 is arranged so that the sides thereof are flattened and the ends thereof are rounded so as to engage the distant ends of the collapsible tube 17. By having this particular configuration it is possible, when the tube 17 is exposed to a high pressure, to have the tube 17 collapse against the element 20 before the tube has exceeded its elastic limit. It is to be appreciated that the actual dimensions shown have been exaggerated in order to facilitate a more complete understanding of the invention.

Running the length of the element 20 is a hole 21, also shown in enlarged section for purposes of clarity. This hole 21 has the sides thereof coated with a suitable electrically conductive coating 22. This coating, in one form of the invention, was made of an iridized metallic oxide which is applied directly to the sides of the hole 21. This is also shown in enlarged section in Fig. 3.

Provided for short circuiting this coating 22, in accordance with the state of collapse of the tube 17, is an electrically short circuiting liquid 23 which may be, for example, mercury.

Making electrical contact with the electrically conductive coating 22 is a contactor 25 which bears against the sides of the hole 21 and the coating 22. This contactor extends up through a sealing plug and holder 26.

The connector then extends up through a second plug 27, which is threadedly engaging the inner threads of the nut 16, to a contactor 28. This latter arrangement is all arranged so that there is no electrical short circuiting between the terminals 11 and 12 except through the coating 22 and the liquid 23. For forming a mechanical seal at the upper end of the tube 17, there is provided a soft resilient element 29 which is arranged to be compressed into the upper end of the tube 17 by the plug 27 when the latter is turned down into position.

In considering the operation of the apparatus set forth in Fig. 1, the nut 16 will generally be positioned so as to mount the apparatus 10 in an enclosure where the pressure is to be measured. When so positioned, the pressure within the enclosure applied to the outside of the tube 17 will cause the internal volume of the tube 17 to decrease by an amount proportional to the pressure applied. This decrease in volume will cause the electrically short circuiting liquid 23 to rise into the hole 21 so that the coating 22 will be electrically short circuited to vary the electrical resistance between the terminals 11 and 12 of the apparatus. This change in resistance will be reflected into the network 13 of the instrument 14 and the instrument 14 will be effective to rebalance the network in accordance with the changes in electrical signal in the apparatus 10. This will be suitably indicated and recorded upon the instrument 14 in a well known manner. In the event that the filler element 20 is resting directly upon the bottom of the tube 17, it is necessary to provide a hole 30 for the passage of the liquid 23 from the space outside of the filler element 20 to the hole 21.

As concerns the temperature compensation features of the present apparatus, as stated previously, it is desired that the volume of the electrically short circuiting liquid be maintained at a minimum. This minimum volume must be sufficient so that the partial collapsing of the tube 17 will still provide a desired range of movement of the liquid 23 up and down through the hole 21. As the liquid 23 is frequently mercury, which has a large temperature coefficient of expansion, it is necessary that the internal volume of this mercury be kept low so that the volume changes due to changes in volume of the tube 17 be substantially the same as the changes in volume of the liquid 23. The temperature coefficient of expansion of the element 20 is preferably selected to be substantially zero so that the only two factors involved in the temperature compensation will be matching the volume of the liquid 23 to the temperature expansion characteristics of the tube 17.

To minimize the volume of the liquid 23 in the apparatus, the components are so arranged that the liquid 23 will occupy space only where it will perform some useful function, that is, outside of the element 20 between the tube 17 and the element 20 where the volume changes will be detected and inside of the hole 21 where the electrically short circuiting action will occur. This will mean that there is no extra liquid within the apparatus for which special temperature compensation need be provided.

If desired, the apparatus shown may incorporate the features of the above-mentioned Donald case, wherein a gas pressure may be applied above the liquid within the tube 21 so as to maintain the liquid 23 outside of the tube 21 filling all space within the tube 17. In this way, it is insured that all volume changes which take place inside of the tube 17 will be reflected directly in the rise and fall of the liquid 23 in the hole 21.

As shown in Fig. 1, the electrically conductive coating is placed directly upon the element 20 and this is permissible since the element 20 is made of a non-porous ceramic material. In the apparatus shown in Fig. 4, the element 20 has been changed into a metallic element 35 which may be of a metal such as Invar. As the metal element 35 will have electrical conducting characteristics, it is essential that the conductive coating 22 be insulated therefrom. To accomplish this end, a suitable insulating layer is placed between the conducting coating 22 and the element 35. This layer 36 may be a ceramic material of substantially the same temperature coefficient as the element 35 and which is fused directly on the sides of the hole 21.

It will be obvious that the operation of an apparatus incorporating the modification in Fig. 4 will be the same as that of Fig. 1 with the rise and fall of the mercury or liquid 23 electrically short circuiting the conductive coating 22 in accordance with the pressure changes of the tube 17.

While in accordance with the provisions of the statutes, there has been illustrated and described the best forms of the invention known to me, it will be apparent to those skilled in the art that changes may be made in the form of the apparatus disclosed without departing from the spirit of the invention as set forth in the appended claims, and that in some cases certain features of the invention may be used to advantage without the use of other corresponding features.

Having now described the invention, what it is desired to secure by Letters Patent is as follows:

1. A pressure to electric transducer, comprising in combination, an elongated hollow elliptical tube which is sealed at both ends, a metallic element having a predetermined temperature coefficient of expansion extending along the length of the interior of said tube and having a hole running the length of said element, said hole being in communication with the interior of said tube and having a non-porous insulating coating thereon, said coating having a coefficient of expansion the same as said element, an electrically conductive coating having an appreciable resistance per unit area directly covering said insulating coating on the side of said hole, a first terminal engaging said coating, an electrically short circuiting liquid filling a portion of said tube and extending into said hole, a second terminal engaging said liquid, said liquid being arranged to variably short out said coating to vary the resistance between said terminals in accordance with variations in pressure applied to the outside of said tube.

2. Apparatus for converting a pressure signal into an electric signal, comprising, an elongated collapsible tube, a filler element positioned within said tube and having a predetermined temperature coefficient of expansion, said element having a cross sectional area slightly less than the cross sectional area of said tube, a hole extending along the length of said element, said hole communicating with the interior of said tube and having the sides thereof formed of an insulating material and a metallic oxide coating affixed directly on the sides thereof and extending along the length thereof, a liquid having electrical short circuiting properties filling a portion of said tube and being arranged to rise and fall in said hole with changes in pressure on said tube, and a pair of terminals engaging said coating and said element.

3. Apparatus as set forth in claim 2 wherein said filler element is a metal having a non-porous ceramic coating on the sides of said hole with the metallic oxide coating on said ceramic coating.

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