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2,081,914

ELECTROSTATIC CONDENSER

Filed June 21, 1932

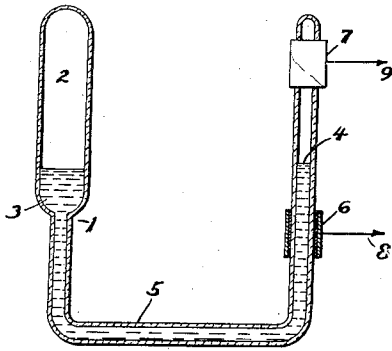


FIG. 1

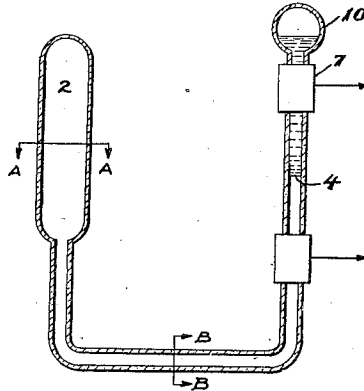


FIG. 2

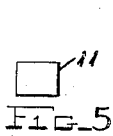


FIG. 5



FIG. 6



FIG. 7

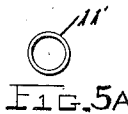


FIG. 5A

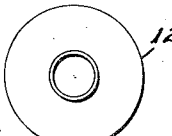


FIG. 6A

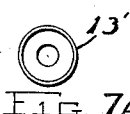


FIG. 7A



FIG. 2A



FIG. 2B

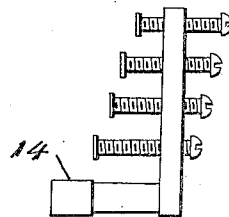


FIG. 3

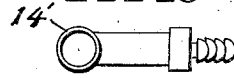


FIG. 3A

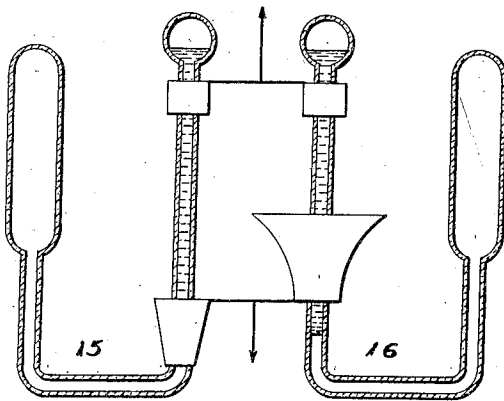


FIG. 4

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## UNITED STATES PATENT OFFICE

2,081,914

## ELECTROSTATIC CONDENSER

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Application June 21, 1932, Serial No. 618,487

2 Claims. (Cl. 175—41.5)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

My invention relates broadly to electrostatic condensers and more particularly to temperature operated variable condenser.

One of the objects of my invention is to provide a variable condenser which will automatically adjust itself to a predetermined capacity in accordance with a given change in temperature.

Another object of my invention is to provide a precision type temperature operated variable condenser in which the variation in capacity may be made a direct or inverse function of temperature.

A still further object of my invention is to provide a precision type temperature operated variable condenser in which the variation in capacity may be made a linear or non-linear function of temperature.

Other and further objects of my invention will be understood from the specification hereinafter following by reference to the accompanying drawing in which:

Fig. 1 shows one form of my invention wherein the capacity is made to increase with increasing temperature. Fig. 2 shows a form of the invention wherein the capacity decreases with increasing temperature. Figs. 2A and 2B are sectional views made on lines A—A and B—B, respectively, of Figure 2. Fig. 3 is a side elevational view of one form of adjustable condenser electrode suitable for use on thermometer tubes of the type shown in Figs. 1 and 2. Fig. 3A is a bottom plan view of the electrode shown in Fig. 3. Fig. 4 shows a still further form of my invention in which two temperature operated variable condensers are arranged in tandem. Figs. 5, 6 and 7 show some of the other forms of condenser electrodes that may be substituted for those shown in Figs. 1, 2 and 4. Figs. 5A, 6A and 7A are bottom plan views of the electrodes shown in Figs. 5, 6 and 7, respectively.

Very frequently in the design of scientific apparatus, for example, heterodyne frequency meters and like electrical apparatus, it becomes necessary, in order to guard against the effects of temperature changes, to place the apparatus in constant temperature ovens, or to make certain parts of the apparatus of alloys having low temperature coefficients of expansion. Where the apparatus is large and complicated, these steps are generally inconvenient and frequently result in large manufacturing costs. One alternative method has been to provide an auxiliary compensating capacity across the main capacity and to so design this compensating capacity that it will correct for the effect of changes in the

temperature of the main capacity. Such compensating capacities have been based upon the fact that an expanding or contracting metallic element may be made to displace one or more plates of a variable condenser. These devices have had several deficiencies, namely: the capacity change for a given increase in temperature is not the exact reverse of that for the equivalent decrease in temperature; the sensitivity is not sufficient to care for minute changes in temperature, and it is difficult to design such devices to care for complicated situations wherein the desired change in capacity may be a complicated function of temperature.

The present invention comprises a combination of elements to overcome the above deficiencies in temperature operated compensating capacities.

Fig. 1 shows one form of the invention in which reference character 1 designates a gas type thermometer having a gas chamber 2, a supply of conducting liquid 3 such as mercury, and a column 4 of such liquid in a stem 5 of insulating material such as glass. Surrounding a portion of the stem 5 is a lower electrode 6 having a predetermined electrostatic capacity with conducting column 4. Surrounding another portion of the stem 5 is an upper electrode 7. The electrodes 6 and 7 may be connected to any desired apparatus by connections 8 and 9.

When the temperature of the medium surrounding gas chamber 2 increases, the liquid column 4 is forced upward thus increasing the electrostatic capacity existent between electrodes 6 and 7. This capacity is, in effect, the sum of two capacities in series. The first of these capacities is that existent between the lower electrode and the conducting column. In the case of the arrangement shown in Fig. 1, that capacity remains substantially constant so long as the top of the conducting column remains above the upper part of the lower electrode. The second of these capacities is that existent between the upper electrode and the conducting column. When the temperature decreases, the contraction of the gas in chamber 2 causes the column 4 of conducting liquid to be lowered thus decreasing the capacity in circuit between terminals 8 and 9. It will be apparent that in the case of Fig. 1, the lower electrode 6 might have been eliminated by connecting terminal 8 directly with the conducting liquid, however, I prefer that this be not done.

In the case of Fig. 1, it will be noted that the capacity between terminals 8 and 9 increases

with increasing temperature. It is generally the case that an inverse characteristic is desired and an arrangement of the invention to provide such a characteristic is shown in Fig. 2 wherein the capacity decreases with increasing temperature. In this case, the excess liquid is held in a second chamber 10 and the column 4 is supported by the pressure of the gas in chamber 2 acting upon the lower part of the liquid column. In all other particulars Fig. 2 is similar to Fig. 1.

In many classes of scientific equipment the capacity compensation which is required, is a complicated function of temperature. To satisfy this need, I have found it useful to make the electrodes 6 and 7 of special shapes. Electrodes of various shapes are shown in Figs. 3, 5, 6 and 7 where reference characters 11 and 11', 12 and 12', 13 and 13', and 14 and 14' denote respectively the profile and plan views of four such electrodes. It will be understood that an almost infinite variety of shapes is possible. The form of electrode shown at 14 is adjustable by moving the screw elements. I have found it convenient to make the inside diameter of a portion of each electrode sufficiently small that it will fit snugly around the tube of the thermometric device thereby providing a simple means for selectively fixing the electrodes along the filament. Other methods of accomplishing the same result will be apparent, for example, a separate insulating support, or a set screw device, may be provided for this purpose.

Under certain conditions, it may be necessary to provide for compensation over a very wide range of temperature in which case several units may be employed in tandem by connecting the electrodes in parallel. Such an arrangement is shown in Fig. 4 where two units denoted re-

spectively by reference characters 15 and 16 are employed, each satisfying the particular condition to be met over the range of temperature provided in the design of the thermometer of each unit. It will be noted that except for the position and design of the lower electrodes in Fig. 4, each unit is similar to that shown in Fig. 2.

I have found the variable condenser of my invention highly efficient in its operation and while I have described it in certain preferred embodiments, I desire it to be understood that modifications may be made, and that no limitations are intended other than are imposed by the scope of the appended claims.

The invention described herein may be manufactured and used by or for the Government of the United States for governmental purposes without the payment of any royalty thereon.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. A variable capacity having in combination a filament of conducting fluid and a metallic element in electrostatic capacity relation with said filament, said metallic element having a support member and screwthread devices for adjusting to a predetermined value the capacity existent between said filament and said screwthread devices.

2. A temperature operated variable capacity comprising a tube of insulating material, a filament of conducting fluid partly filling said tube, a metallic member outward of said tube and shaped in such manner that the horizontal distance between said metallic member and the axis of said filament at one end, varies with the longitudinal displacement of said filament along said tube.

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