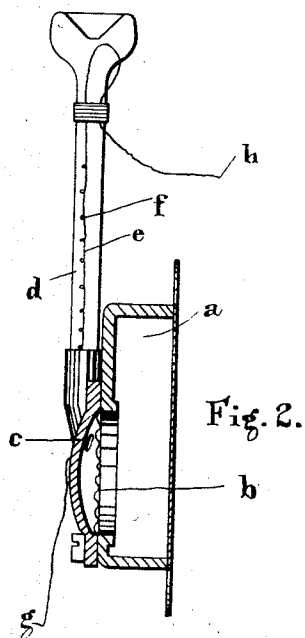
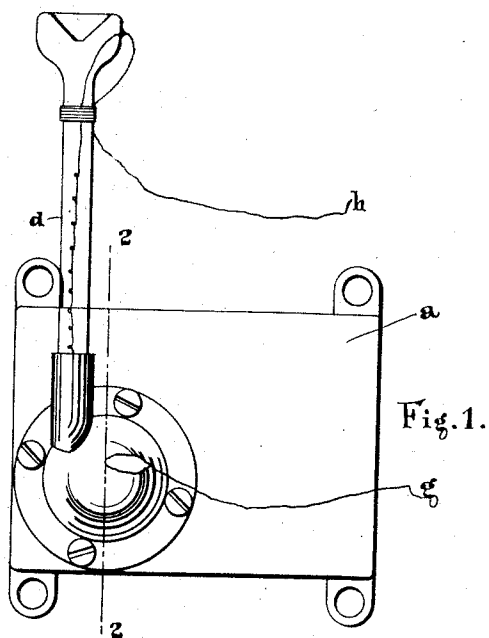


G. HOOKHAM.  
RESISTANCE DEVICE.  
APPLICATION FILED MAR. 18, 1909.

946,364.

Patented Jan. 11, 1910.

2 SHEETS—SHEET 1.



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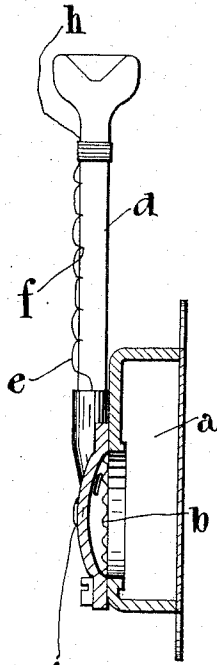


Fig. 3.

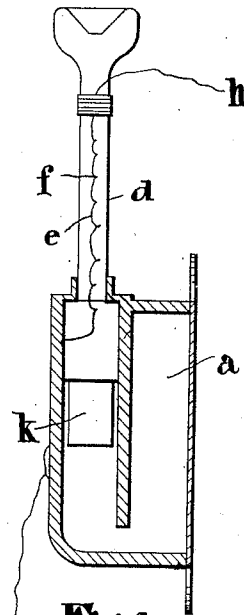


Fig. 4.

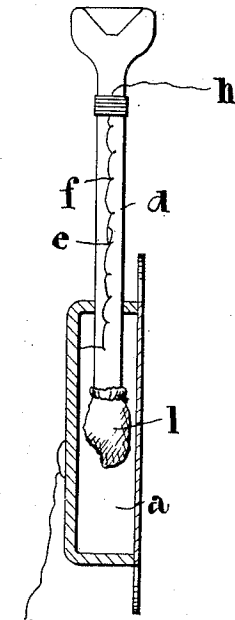


Fig. 5.

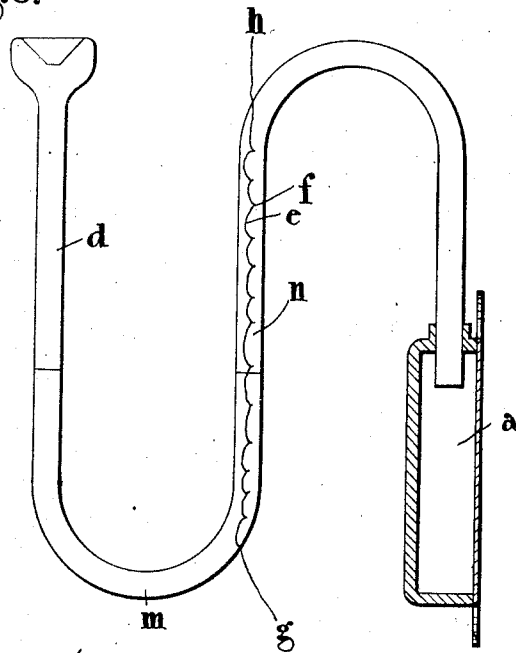


Fig. 6.

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# UNITED STATES PATENT OFFICE.

GEORGE HOOKHAM, OF BIRMINGHAM, ENGLAND.

## RESISTANCE DEVICE.

946,364.

Specification of Letters Patent.

Patented Jan. 11, 1910.

Application filed March 13, 1909. Serial No. 483,281.

*To all whom it may concern:*

Be it known that I, GEORGE HOOKHAM, a subject of the King of Great Britain and Ireland, and residing at 4 New Bartholomew street, Birmingham, in the county of Warwick, England, have invented certain new and useful Improvements in Resistance Devices, of which the following is a specification.

My invention relates to electrical resistance devices, and has for its object the elimination of temperature errors in such devices.

The invention consists in a resistance element in which as the temperature rises a mercury column expands or rises by reason of the expansion of a liquid under heat and makes successive contacts cutting out or increasing resistance in the circuit in which the resistance is placed.

The invention further consists in a resistance element in which mercury rises along one or more wires in a thermometer tube and so reduces the effective length and resistance of the wire.

The invention further consists in forming the wire with a number of small knots or kinks at intervals, such kinks being amalgamated and of such size that they retain a small quantity of mercury and make immediate contact with the mercury column when it comes in contact with them.

The invention further consists in a resistance element of the type indicated above having a large chamber containing oil or other expansible liquid separated from the mercury column by a diaphragm and so arranged that when the temperature rises the expansion of the oil forces the diaphragm outward and causes the mercury to rise in the tube.

The invention also consists in the improved resistance element hereinafter described.

Referring to the accompanying drawings, Figure 1 is an elevation of a resistance element, while Fig. 2 is a transverse section on the line 2—2 Fig. 1. Figs. 3 to 6 show modified forms of the invention.

In carrying the invention into effect according to one modification I construct an oil chamber *a*, having at one side a diaphragm *b*, preferably of celluloid. At the outside of the diaphragm I place a bulging piece of metal *c*, forming a chamber containing mercury, and into this chamber is fitted

the thermometer tube *d*. The resistance wire *e*, passes down this tube and is provided with a number of kinks *f*, which are amalgamated so that when the mercury rises in the tube these kinks make successive contacts with the mercury column. The wire may if desired be placed outside the tube *d* as shown in Fig. 3 and the kinks *f* brought through the tube, the wire being sealed into the glass.

It is important that there should be no communication for mercury between the kinks in order to prevent its draining down the wire, and therefore when the wire is placed entirely inside the tube I prefer to use iron or steel wire with copper deposited on the kinks the spaces between them being previously coated with any material that will prevent the deposition of the copper. Connecting wires *g h* are provided, the connection *g* being soldered or otherwise fixed to the bulging piece of metal *c* thus making contact with the mercury column, while the other connection *h* is joined to the upper end of the wire *e*. It will be seen that in this arrangement when the liquid in the chamber *a*, expands the diaphragm *b* is forced outward and forces the mercury column up the tube *d*, making successive contacts with the kinks, *f*, in the wire *e*. When the mercury falls a small drop of mercury remains in each kink so that on the mercury column again rising an immediate contact is made with the wire when any kink is reached.

The resistance element may be obtained by the use of a mercury thermometer so arranged that the expansion of the mercury itself causes the rising of the column and in order to insure perfect contact the wire may be coated with platinum and then with palladium. Instead of a diaphragm in the modification described with reference to Figs. 1 and 2 part of the thermometer bulb may be made variable in area in any suitable manner such for instance as by the use of a plunger *k* as shown in Fig. 4 working fluid-tight in a cylinder or by the use of a flexible metal or leather bag *l* Fig. 5 and if of leather this may be soaked in glycerin or gelatin to protect it from the oil. The top of the tube in which the mercury rises may terminate in an air tight chamber or may be open at the top and may be partially closed by means of a porous plug. In the outer chamber a cheap liquid having a consider-

able rate of expansion when heated should be used and olive oil is found to be very suitable. In some cases it may be desired to arrange the resistance element so that its resistance increases instead of diminishes with rise in temperature as for instance in the case of a shunted meter. This may be effected as shown in Fig. 6 by placing the mercury in a U-shaped tube *m* one limb of which is connected through a column of air with the thermometer device so that the mercury in this limb is forced downward and increases the effective length of the resistance wires.

For the purpose of the resistance itself iron wire plated with copper may be used, the wire being amalgamated with mercury where it is desired to make the contacts with the mercury column.

Having now described my invention what I claim as new and desire to secure by Letters Patent is:—

1. A variable resistance element comprising in combination a resistance wire, a mercury column, a vessel containing liquid which expands when heated and a diaphragm separating said liquid from said mercury column, as set forth.

2. A variable resistance element comprising in combination a resistance wire, kinks

or knots in said wire at intervals, a mercury column and means for moving said mercury column along said wire, as set forth.

3. A variable resistance element comprising in combination a resistance wire, a number of small knots or kinks at intervals in said wire, said kinks being amalgamated, a mercury column and means for moving said mercury column along said wire, as set forth.

4. A variable resistance element comprising in combination a resistance wire, a number of knots or kinks at intervals in said wire, said knots or kinks being amalgamated, a mercury column, a vessel containing liquid and a flexible partition between said liquid and said mercury column, as set forth.

5. A variable resistance element comprising in combination a thermometer tube, a resistance wire passing down said tube, a mercury column in said tube, a vessel containing liquid and a flexible partition between said liquid and said mercury column, as set forth.

In testimony whereof, I affix my signature in presence of two witnesses.

GEORGE HOOKHAM.

Witnesses:

S. H. HOLDEN,  
A. B. FISHER.