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A. O. BENECKE.

ELECTRICAL RESISTANCE.

APPLICATION FILED JUNE 1, 1906.

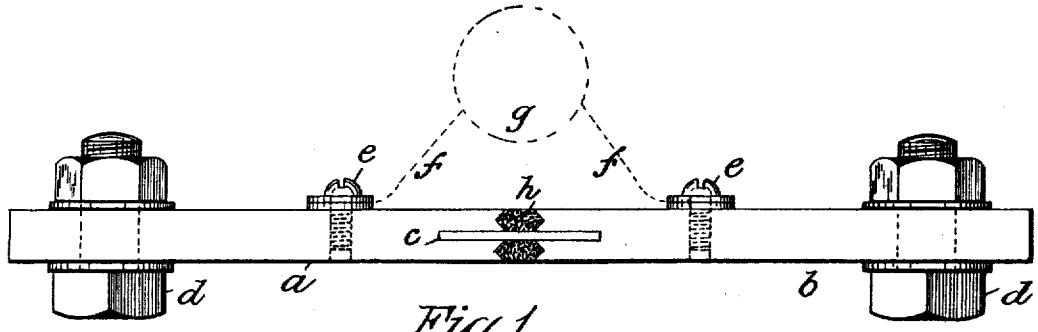

Fig. 1.

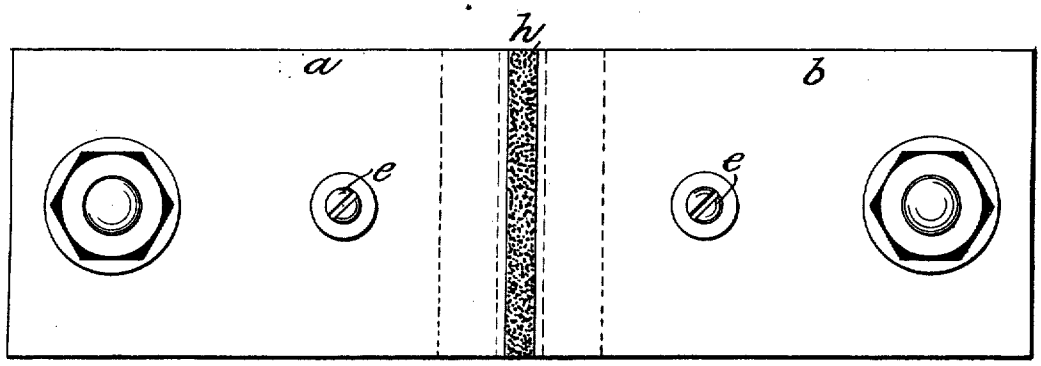

Fig. 2.

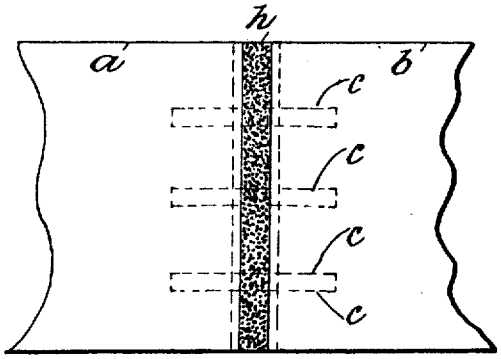

Fig. 3.

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ELECTRICAL RESISTANCE.

No. 845,997. Specification of Letters Patent. Patented March 5, 1907.

Application filed June 1, 1906. Serial No. 319,697.

To all whom it may concern:

Be it known that I, ADELBERT O. BENECKE, a resident of Newark, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Electrical Resistances, of which the following is a specification.

My invention relates to improvements in resistances which are intended to carry comparatively large currents, and especially to shunts for electrical measuring instruments.

The object of my invention is to reduce the mechanical size of such resistances to a minimum, which is particularly important in electrical measuring instruments, shunts which have to be inserted in the conductors carrying the current to be measured. If such resistances were given a sufficient cross-section not to become overheated by the amount of electrical energy consumed in the same by conversion into heat, they would be so enormously large that their use would become prohibitive.

There have been made several attempts in the art to design such resistances in such a manner that the dissipation of the heat generated in the same is aided by the cooling effect of the air-currents or by the radiation from large surfaces. The most successful attempt in this direction is disclosed in United States Patent No. 497,482, granted to Edward Weston, dated May 16, 1893. In the specification of this patent the inventor states that he has been able to send a current of one thousand amperes through each square inch of cross-section of German silver without overheating.

My invention has enabled me to pass a current of ten thousand or even thirty thousand amperes to each square inch cross-section of a similar material without overheating the same. I have accomplished this result by making the terminal plates of my resistances of a material of high electrical conductivity, as copper with ample cross-section and mass to carry the current for which the resistance is intended without being heated to any appreciable amount, and by reducing the cross-section of the resistance material inserted between these terminals to such an extent that the necessary lengths to make up a resistance of required value becomes so small that any heat generated in the same will be rapidly conducted away and absorbed by the large and massive terminals.

In carrying out my invention I make use of the structure hereinafter described, and illustrated by the accompanying drawings, in which—

Figure 1 is a side view of my improvement. Fig. 2 is a plan view of the same, and Fig. 3 illustrates a slight modification.

Like letters of reference refer to similar parts throughout the specification and drawings.

The device consists, essentially, of the massive terminals *a* and *b*, made of a material of high electrical conductivity, connected together by the resistance material *c* of small cross-section and corresponding short lengths. In practice I find it convenient to fix the resistance material into the ends of the terminals *a* and *b* by slotting the adjacent ends of the terminals, as illustrated in Fig. 1, and then inserting the edges of the resistance material into such slots and soldering the same into position. However, any convenient method may be employed for uniting the resistance material with the terminals in intimate metallic contact.

In the selection of suitable resistance material it often happens that such material when heated by the passage of an electrical current in the open atmosphere will oxidize, and thereby deteriorate. To prevent this oxidation and keep the resistance material from direct contact with the atmosphere, I find it convenient to serrate or dovetail adjacent ends of the terminals, as illustrated in Fig. 1, and to fill the space surrounding the resistance material with some non-conducting fireproof substance *h*. For example, powdered glass held together by some suitable binder, or mica, asbestos, or any other material will answer the purpose, so long as it will keep the resistance material from contact with the atmosphere and will form an electrical insulator.

As a convenient means of connecting such a resistance into an electrical circuit I provide bolts and nuts *d*, by which the ordinary bus-bars may be connected to the ends of the device.

In case the device is used as a shunt for electrical measuring instruments I provide

furthermore, the binding screws *e*, to which the electrical measuring instrument *g* is connected by means of conductor-wires *f*.

The resistance material *c* may be in the form of a single thin sheet, as shown in Fig. 1, or in the form of a number of sheets arranged side by side or one on top of the other or in the form of a single wire or a number of wires, as substantially illustrated in Fig. 3.

I have found by experiments that the cross-section of the resistance material can be reduced almost indefinitely; but in practice I find that in order to produce a number of such devices of uniform resistance the length of the resistance material should best be not reduced to more than a length of about two-tenths of an inch. It is evident that the shorter these lengths are chosen the more difficult it will be to keep the same exactly within desired limits.

In operation when such a resistance is connected in a circuit the current will pass from the terminal *a* to the terminal *b* through the resistance material *c*. A certain amount of electrical energy will be consumed in the resistance material and converted into heat. This amount is directly proportional to the resistance and to the square of current passing through the same. The heat developed in the resistance material in case the density of the current is as large as I have mentioned above would under ordinary circumstances be sufficient to fuse the resistance material and therewith to render the device inoperative. The extreme short lengths of the resistance material thereby bringing the terminals into such close proximity, however, as employed by me in connection with the massive terminals prevent any overheating of the resistance material, as all heat generated in the same is rapidly conducted away by the terminals whose masses are sufficient to absorb the heat without becoming themselves overheated.

It frequently happens in practice that it is desirable to have a resistance of greater carrying capacity than is found in a structure made in accordance with Figs. 1 and 2. Under such conditions it is only necessary to couple up several units of this type in parallel in the circuit or, better still, to place several of the same one upon the other and connect them all together by means of the connecting bolts and nuts *d*. In this manner it is possible to construct the resistances after a single unit or standard, when they may be coupled together, as described, to produce the required resistance.

I claim—

1. An electrical resistance device, consisting of two blocks of metal of high specific conductivity, and a conductor of high specific resistance and short length connecting said blocks of metal, the free length of said conductor being such that the heat generated therein by the passage of a current therethrough, is conducted to and absorbed by said blocks of metal as rapidly as such heat is generated, whereby said conductor will not be overheated.

2. An electrical resistance device, consisting of a short conductor of high specific resistance, connecting two masses or blocks of metal of high specific conductivity, the free length of said conductor being such that the heat generated by the passage of an electric current therethrough will be absorbed by said blocks of metal as rapidly as generated, whereby said conductor will not become overheated.

3. An electrical resistance device, comprising two blocks or masses of metal of high specific conductivity separated by a short space, a conductor of high specific resistance connected to said blocks and spanning said space, the length of said conductor being such that the heat generated by the passage of a current therethrough, is conducted to and absorbed by said blocks or masses of metal as rapidly as generated, whereby said conductor will not become overheated.

4. A resistance device for electric circuit, comprising two blocks or masses of metal of high specific conductivity, and a conductor of high specific resistance connecting said blocks or masses of metal, said conductor being of such small cross-section as to produce the desired resistance within such a short length thereof, that the heat generated by the passage of an electric current therethrough will be conducted to and absorbed by the said blocks or masses of metal as rapidly as generated, whereby said conductor will not become overheated.

5. An electrical resistance device, consisting of two blocks of metal of high specific conductivity, and a conductor of high specific resistance and short length connecting said blocks of metal, the free length of said conductor being such that the heat generated therein by the passage of a current therethrough, is conducted to and absorbed by said blocks of metal as rapidly as generated, whereby said conductor will not be overheated, and a fire-proof insulating material inclosing the free surface of said conductor.

6. An electrical resistance device, consisting of a short conductor of high specific resistance, connecting two masses or blocks of metal of high specific conductivity, the free length of said conductor being such that the heat generated by the passage of an electric current therethrough will be absorbed by said blocks of metal as rapidly as generated, whereby said conductor will not be overheated, and a fireproof insulating material inclosing the free surface of said conductor.

7. An electrical resistance device, comprising two blocks or masses of metal of high spe-

cific conductivity separated by a short space, a conductor of high specific resistance connected to said blocks and spanning said space, the length of said conductor being such that the heat generated by the passage of a current therethrough, is conducted to and absorbed by said blocks or masses of metal as rapidly as generated, whereby said conductor will not be overheated, and a fireproof insulating material inclosing the free surface of said conductor.

8. A resistance device for electric circuits, comprising two blocks or masses of metal of high specific conductivity, and a conductor of high specific resistance connecting said blocks or masses of metal, said conductor being of such small cross-section as to produce the desired resistance within such a short length thereof, that the heat generated by the passage of an electric current therethrough will be conducted to and absorbed by the said blocks or masses of metal as rapidly as generated, whereby said conductor will not become overheated, and a fireproof insulating material inclosing the free surface of said conductor.

9. An electrical resistance device, consisting of two blocks of metal of high specific conductivity, and a conductor of high specific resistance and short length connecting said blocks of metal, the free length of said conductor being such that the heat generated therein by the passage of a current therethrough, is conducted to and absorbed by said blocks of metal as rapidly as generated, whereby said conductor will not be overheated, and means for connecting up said resistance device in an electric circuit.

10. An electrical resistance device, consisting of two blocks of metal of high specific conductivity, and a conductor of high specific resistance and short length connecting said blocks of metal, the free length of said conductor being such that the heat generated therein by the passage of a current therethrough, is conducted to and absorbed by said blocks of metal as rapidly as generated, whereby said conductor will not be overheated, and a shunt-circuit leading around said conductor.

11. An electrical resistance device, consisting of a short conductor of high specific resistance, connecting two masses or blocks of metal of high specific conductivity, the free length of said conductor being such that the heat generated by the passage of an electric current therethrough will be absorbed by said blocks of metal as rapidly as generated, whereby said conductor will not be overheated, a shunt-circuit leading around said conductor and means for connecting up said resistance device in an electric circuit.

12. An electrical resistance device, comprising two blocks or masses of metal of high specific conductivity located in close proximity to each other and a conductor of high specific resistance and short length having its ends embedded into said blocks of metal respectively, thereby leaving a short free length of conductor between said blocks of metal.

13. An electrical resistance device, comprising two massive terminals, composed of blocks of metal of high specific conductivity located in close proximity, and a conductor of high specific resistance having its ends embedded into said blocks of metal respectively, to leave a short free length of metal between said terminals.

14. An electrical resistance device, consisting of two blocks of metal of high specific conductivity and a high-resistance conductor connecting said blocks of metal, said conductor being of such short free length that the heat generated therein by the passage of a current therethrough is absorbed and dissipated by said blocks of metal as rapidly as generated.

This specification signed and witnessed this 18th day of May, 1906.

ADELBERT O. BENECKE.

Witnesses:

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