E. WEINTRAUB.

ELECTRICAL RESISTOR.

APPLICATION FILED APR. 30, 1920.

1,415,748. Patented May 9, 1922.

Fig. 1,

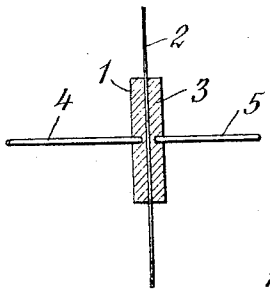


Fig. 2

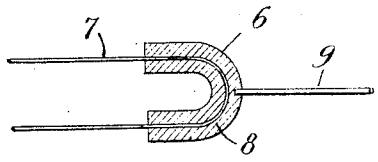


Fig. 3,

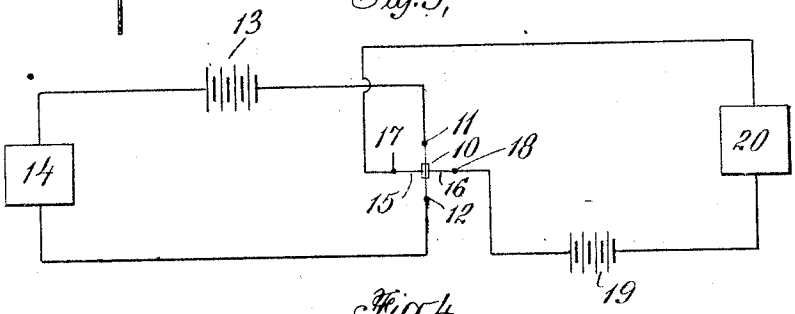


Fig. 4,

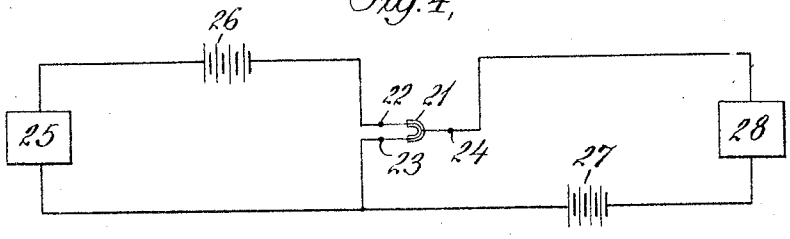
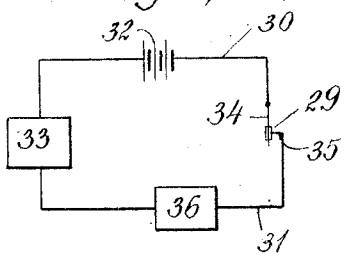


Fig. 5,



Inventor
Ezechiel Weintraub
By his Attorney's
Pennie, Davis, Marvin & Edmonds.

UNITED STATES PATENT OFFICE.

EZECHIEL WEINTRAUB, OF NEW YORK, N. Y.

ELECTRICAL RESISTOR.

1,415,748. Specification of Letters Patent. Patented May 9, 1922.

Application filed April 30, 1920. Serial No. 377,942.

To all whom it may concern:

Be it known that I, EZECHIEL WEINTRAUB, a citizen of the United States, residing at New York, in the county of New York, State of New York, have invented certain new and useful Improvements in Electrical Resistors; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to an electrical resistor possessing negative resistance characteristics and of such minute dimensions that small and rapid temperature changes may be accurately induced in the resistor substantially instantaneously, to produce unproportional changes in its electrical conductivity.

It is well known that metallic wires may be constructed with sufficiently minute diameters, for example, one to twelve microns, which, when heated by a varying electric current, will follow variations in such a current with corresponding undistorted temperature variations and substantially without lag. No means, however, are known whereby minute wires may be produced of chemical elements or materials possessing marked negative resistance characteristics and in which at the same time small and rapid temperature variations may be induced. This is particularly true of the chemical element boron and its different alloys, of silicon, carborundum, and similar substances, which are most suitable because they possess marked negative resistance characteristics, even at ordinary temperatures. The methods of obtaining boron and the properties of this element have been described in United States Patents Nos. 997,879, 1,019,569 and 1,074,672.

In accordance with this invention, the difficulties of producing resistors possessing a negative temperature coefficient of resistance, and which at the same time are capable of following rapid temperature fluctuations produced by a varying electric heating current in an electrical conductor, or by externally applied temperature variations, are overcome by the use of a very fine filament or minute wire core coated with a very thin layer of the negative resistance material. Such a resistor, in its completed form, will be termed a micronic resistor, because of its very minute diametrical dimension, namely, of the order of two or three microns in total outside diameter. The minute diameter wire core may be made of such materials as tungsten, molybdenum, tantalum, platinum, etc., or alloys of these metals. This minute core may then be coated with an extremely thin layer of the negative resistance material in any known manner. If boron is to be used as the negative resistance material, the wire of micronic dimensions may be heated in an atmosphere of a boron compound, such as boron chloride and hydrogen, as described in United States Patent No. 1,019,569. The amount of the reagents, the temperature and the time of treatment, as described in this patent, may be so regulated as to deposit an extremely thin coating of boron in intimate contact with the surface of the metallic wire core. The core and coating may be made in this way to have a total diameter of micronic dimensions, as will be readily understood. The extremely thin boron coating so obtained may be used as the negative resistance element in accordance with this invention. Contact may be made with the coating if desired, by fusing a fine wire or wires, into contact with its surface.

A micronic resistor possessing negative resistance, constructed in accordance with this invention, is readily adaptable for use in suitably associated electric circuits to amplify varying electrical currents, for example, telephone currents, and other electric currents for signaling or other purposes. The micronic resistor may be connected in electrical circuits so that both the minute wire core and the very thin coating are in the same circuit, or the circuit arrangement may be such that the minute wire core and the very thin coating may be in separate circuits which are associated by means of the negative resistance material coating. The micronic resistor and the manner of connecting the resistor in suitable electric circuits, as well as other objects and advantages of the invention, will be more clearly understood from a description of certain preferred embodiments thereof, as illustrated in the accompanying drawings, in which:—

Fig. 1 illustrates a longitudinal sectional view of the micronic resistor, the proportions being exaggerated for the purposes of illustration;

Fig. 2 illustrates a sectional view of a micronic resistor formed in a U-shape and having only one fine wire fused into contact with the coating, the proportions being exaggerated, as in the case of Fig. 1, for the purposes of illustration;

Figs. 3 and 4 illustrate the use of the micronic resistor in suitable circuit arrangements for the amplification of electric currents;

Fig. 5 illustrates the use of the micronic resistor in a series circuit connection.

Referring now to Fig. 1, the micronic resistor 1 comprising the minute wire core 2 and the extremely thin negative resistance material coating 3, has two fine wires 4 and 5 fused into contact with the coating 3. The fine wires 4 and 5 may be fused into contact with the coating 3 by passing an electric heating current through the core 2 and holding the fine wire, which may be of platinum, tungsten, or the like in slight contact with the coating 3 until the coating becomes heated to a point at which the affinity of the two materials will cause an intimate contact to be made. In Fig. 1 the composite resistor 1 and the two fine wires 4 and 5 are adapted to be connected in different electric circuits, that is, the circuit containing the core 2 would not necessarily be conductively connected other than through the negative resistance material coating to the electric circuit containing the fine wires 4 and 5.

In Fig. 2 the micronic resistor 6 comprising a core 7 and a negative resistance material coating 8 has only one fine wire 9 fused into contact with the coating 8. With this arrangement of micronic resistor and wire contact, the wire core 7 may be connected both in a circuit containing the wire core 7 only, and a circuit containing the fine wire contact 9.

In the arrangement shown in Fig. 3, a micronic resistor 10 of the type illustrated in Fig. 1, is used to amplify varying electric currents in the circuit 11, 12 containing a source 13 of electrical energy and a device 14 for varying both the amount of, and the frequency at which the electrical energy is utilized from the source 13. Two fine wires 15, 16, respectively, are fused into intimate contact with the negative resistance material of the composite resistor 10. These two wires form a part of an electrical circuit 17, 18 containing a source of electrical energy and a receiving or indicating device 20. In this arrangement fluctuations in the temperature of the core of the composite resistor 10 cause corresponding temperature variations in the negative resistance material and the latter, due to its negative temperature coefficient of resistance, causes large changes in the resistance of the circuit 17, 18. These large changes in resistance in the circuit 17, 18 serve to vary the flow of electric current from the source 19 in this circuit. These variations, are in effect, amplified variations corresponding to the initial current variations in the circuit 11, 12, and they may be received or indicated, for example, by the device 20, or utilized in any other way.

Fig. 4 illustrates a modification of the circuit arrangements shown in connection with Fig. 3, in which a micronic resistor of the type shown in Fig. 2 is used. In this case the composite resistor 21 has its wire core associated both with the circuit 22, 23 and the circuit 23, 24. The wire core of the composite resistor 21 in this arrangement, is common to both the input circuit 22, 23 and the output circuit 23, 24. The device 25, the source of electrical energy 26, the source of electrical energy 27 and the device 28 operate in a similar manner to the corresponding component parts of the arrangement shown in Fig. 3.

Fig. 5 illustrates the application of the micronic resistor 29 to an electric circuit 30, 31 for the purpose of amplifying the varying electric currents therein. In this arrangement, there is included in the circuit 30, 31, the source of electrical energy 32 and a source 33 of varying electric current which it is desired to amplify. The resistance of the micronic resistor 29 decreases when the strength of the current passing between the minute wire core 34 and the fine wire contact 35 increases. In consequence of the decrease of resistance of the micronic resistor 29, the current flowing in the circuit 30, 31 still further increases, thereby producing amplified current impulses corresponding to the variations of the source 33. The amplified current impulses may be received or indicated by means of the device 36 in any suitable manner.

I claim:—

1. An electrical resistor of micronic dimensions possessing a negative temperature coefficient of resistance.

2. An electrical resistor comprising an electrically conductive core having a diameter of the order of two microns coated with a thin layer of material possessing a negative temperature coefficient of resistance, the total diameter of said core and coating being of the order of three microns.

3. An electrical resistor comprising a minute metal wire core coated with a thin layer of material possessing a negative temperature coefficient of resistance, the total diameter of said core and coating being of micronic dimensions.

4. An electrical resistor comprising a minute metal wire core coated with a thin layer of a compound containing boron, the total diameter of said core and coating being of micronic dimensions.

5. An electrical resistor comprising a minute metal wire core coated with a thin

layer of the element boron, the total diameter of said core and coating being of micronic dimensions.

6. In an electric current amplifier, the combination with a source of electric current variations including an electric circuit, of an electrical resistor of micronic dimensions possessing a negative temperature coefficient of resistance associated with said circuit, and means for receiving or indicating the resulting amplified electric current variations.

7. In an electric current amplifier, the combination with a source of electric current variations including an electric circuit, of an electrical resistor comprising a minute metal wire core coated with a thin layer of material possessing a negative temperature coefficient of resistance, the total diameter of said core and coating being of micronic dimensions, and means for receiving or indicating the resulting amplified electric current variations.

In testimony whereof I affix my signature.

EZECHIEL WEINTRAUB.