Jan. 6, 1953 H. I. BECKER 2,624,822

RHEOSTAT

Filed July 29, 1950

Fig.1.

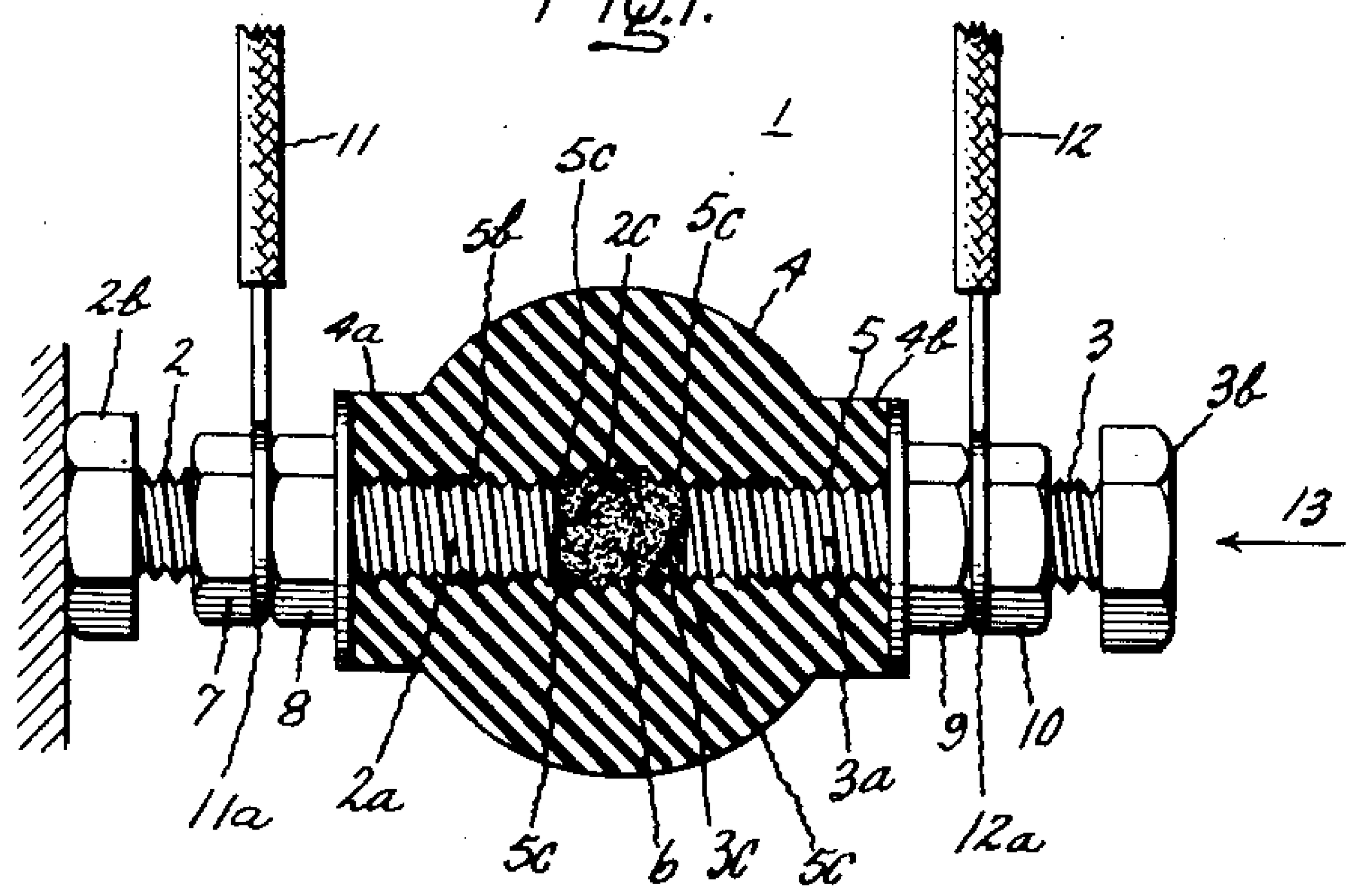


Fig.2.

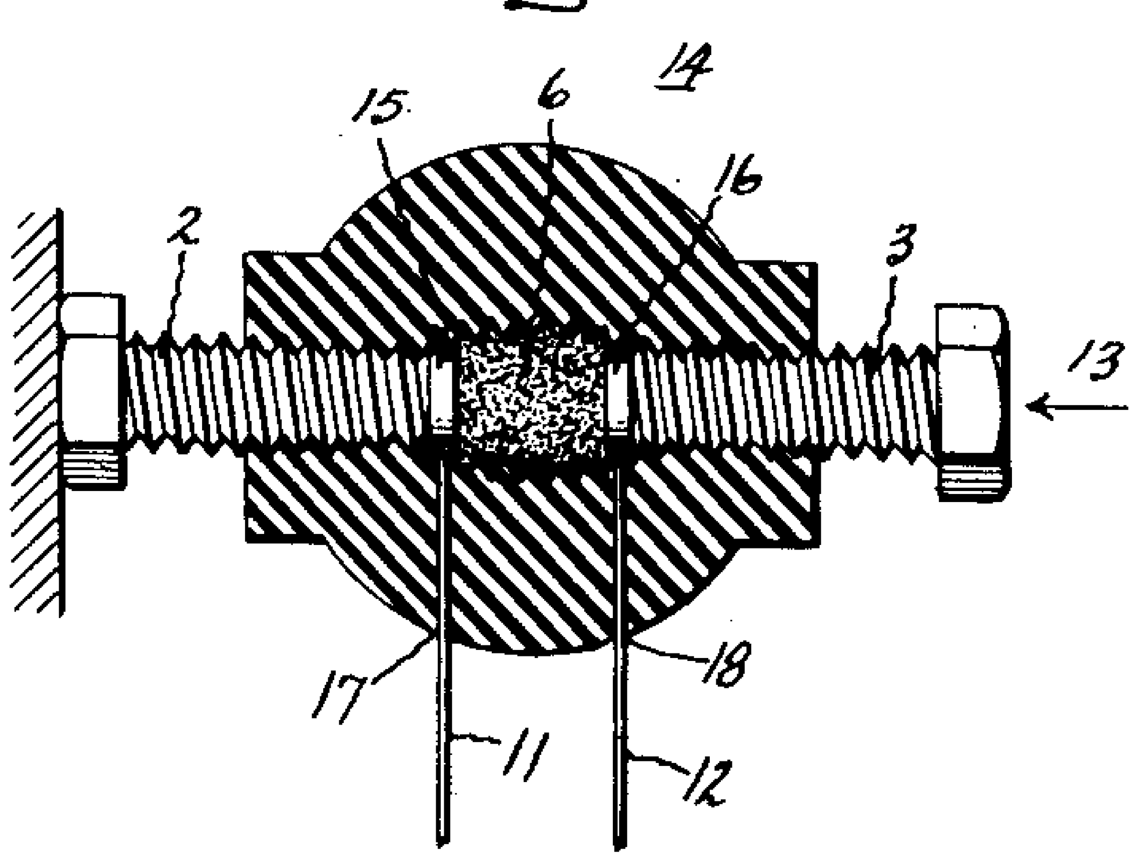
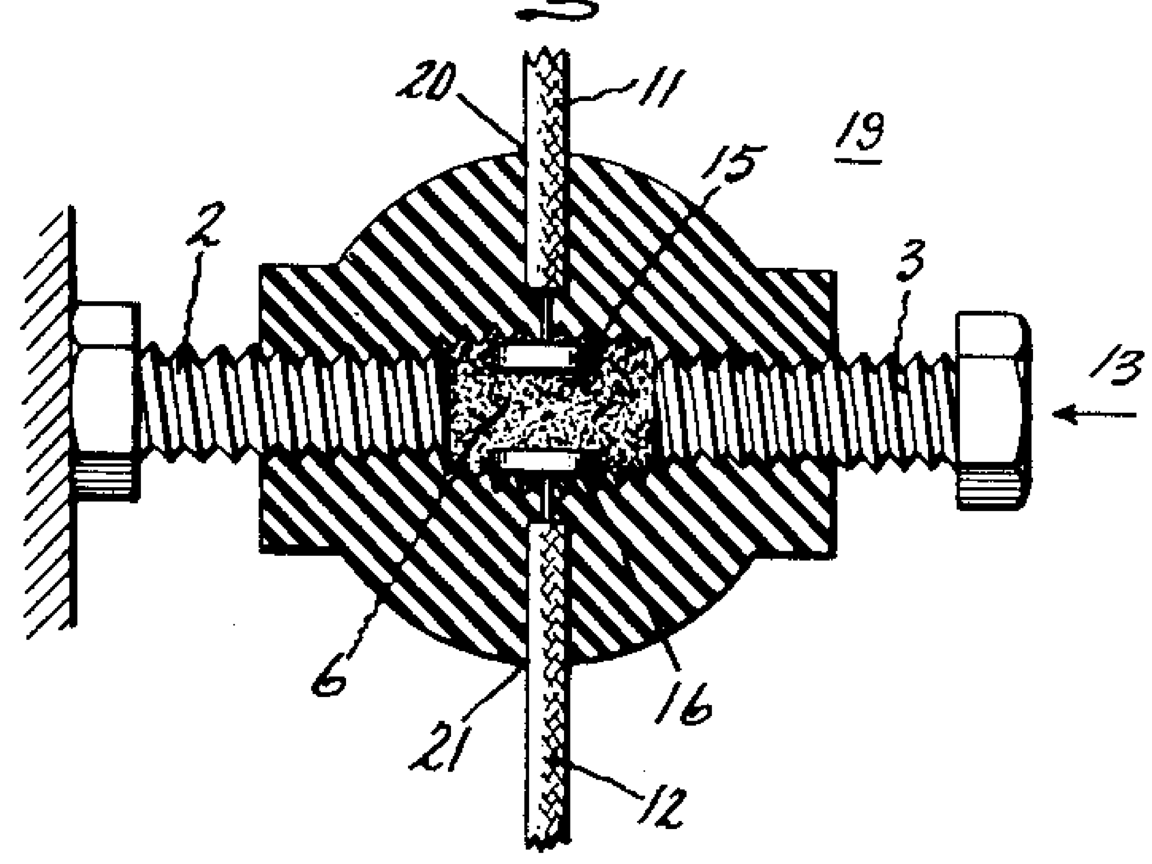


Fig.3.



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2,624,822

RHEOSTAT

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8 Claims. (Cl. 201—50)

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This invention relates to rheostats and more particularly to compression type rheostats and has for an object the provision of an improved, simple, reliable compression type rheostat.

A further object of my invention is to provide a compression type rheostat responsive to small mechanical displacements of a member thereof to produce stable predictable corresponding changes in resistance of the rheostat.

A device of the type described above is particularly useful as a pick-off element used as part of an electro-mechanical system to control the movement of a gyroscopic instrument in tracking a moving object for gun fire control and may also be used wherever accurate predictable resistance change is required responsive to small mechanical motions.

In carrying out my invention I may employ a structure including a quantity of compressible powdered resistance material enclosed within a bulbous flexible housing, adjustably spaced electrode means engaging the resistance material and means arranged to cooperate with the housing to compress and release the resistance material in a manner producing predictable resistance changes therein responsive to small mechanical displacements of the compression means.

For a complete understanding of my invention reference should be had to the following specification and the accompanying drawing in which Fig. 1 is a cross-sectional view of a device illustrative of a preferred embodiment of my invention, and Figs. 2 and 3 are cross-sectional views of devices illustrative of modifications of my invention.

To better understand the objects and advantages of my invention a brief review of the problems presented in the development of a reliable compression type rheostat may be helpful to the reader at this point.

In this respect those skilled in the art will understand that a compressible resistance material, such as powdered carbon, for example, may be compressed to vary the conductive condition thereof. Therefore, it would appear that by placing a compressible resistance material in a hollow housing between spaced electrodes and moving the electrodes toward each other and against the resistance material to compress the material, the conductivity thereof could be predictably varied in accordance with the pressure exerted on the material or the relative movement of the electrodes.

However, it has been found that the material tends to pack and when pressure is released the particles of the material do not return to their original normal position and, therefore, conductivity of the material for given pressures or mechanical displacements of the electrodes cannot be accurately predicted for repeated operations. Also, it has been found that the type of

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resistance material used and the temperature to which the material is to be subjected are factors to be considered in obtaining predictable conductivity responsive to given pressures or mechanical displacements of the electrodes. In this connection, powdered iron has been found to work much better than powdered carbon as a resistance material, except for the packing effect described above.

Therefore, in accordance with my invention, for low temperature applications I provide powdered iron in particles of spherical shape coated with a lubricant such as graphite. This combination of materials is desirable because of the range of resistance provided responsive to pressure change on the material and because accuracy in repeated operations is provided by an effect of the lubricant in reducing the packing effect. However, it has been found that powdered iron in any form tends to sinter at higher temperatures, as for example 100° C., thereby producing unpredictable results in repeated operations at high temperature.

Where high temperature operation is required it has been found that boron carbide produces the best results for accuracy in repeated operations and temperature range. Each of the two compositions of compression resistor powders, the spherical particles of iron with graphite lubricant and the boron carbide, have been found to be very superior to the previously known carbon powder. The carbon powder has a pressure-resistance characteristic which is not smooth and predictable, in which there is always some conductivity no matter how small the pressure, and upon application of increasing pressure the resistance may eventually reach substantially zero. In contrast to this, both the spherical iron particles with graphite and the boron carbide particles produce a resistance characteristic which varies smoothly with changes in pressure from practically an infinite resistance down to a value such as the five ohms attained in one practical embodiment of the applicant's invention.

Although employment of the special resistance materials as above described aids in reducing the tendency of the material to pack, the difficulty of packing is not reduced to a satisfactory minimum for accurate results on repeated operation. The structural features to be described below are therefore very desirable.

Referring to the drawing, in accordance with my invention, to minimize packing of the resistance material and thereby provide for predictable repeated changes in the conductive condition of the resistance material responsive to pressure change thereon, I provide a compression type rheostat of which the rheostat 1 shown in Fig. 1 is illustrative.

The rheostat 1 comprises a pair of stud type electrodes 2—3 of conducting material having respectively threaded portions 2a and 3a and adjusting heads 2b and 3b, and a substantially spherical flexible housing 4 of rubber or other suitable material having opposite projecting ends 4a and 4b, and a hollow concentric interior 5 therethrough, as shown in Fig. 1, presenting a threaded interior surface 5b to accommodate the electrodes 2—3 in adjustably spaced relation therein. The rheostat 1, also, comprises a quantity of compressible resistance material 6 responsive to compression and release thereof to change its conductive condition.

The resistance material 6 is positioned within the interior 5 of the housing 4 between the spaced electrodes 2—3 to be engaged by adjacent surfaces 2c and 3c of the electrodes 2—3 and adjacent portions 5c of the threaded interior surface 5b of the housing 4 when the electrodes 2—3 are moved toward each other.

To provide an initial desired resistance through the material 6, the electrodes 2—3 are screwed in the threaded housing 4 through the opposite ends 4a and 4b thereof to engage the material 6 and to exert an initial desired pressure thereon, thereby providing an initial set in the resistance material 6. To maintain the initial desired set in the resistance material 6, lock nuts 7—8 and 9—10 are provided on the respective electrodes 2 and 3 to lock the electrodes in adjusted position.

To conduct electric current to and from the electrodes 2—3 a pair of conductors 11—12 having respective washer type terminals 11a and 12a or other suitable means are positioned on the respective electrodes 2—3 and locked by the nuts 7—10, as shown in Fig. 1.

Where accuracy of the zero set condition is of minor importance, as for example where the rheostat 1 is to control the intensity of light in a room, the lock nuts 7—10 may be omitted and the studs 2—3 alone used to preset the resistance material.

In operation the rheostat 1, as above described, is responsive to forces exerted on the heads 2b and 3b of the electrodes 2—3 to further compress the resistance material 6 to predictably vary the resistance between the electrodes 2—3 in accordance with the forces exerted or the displacement of the spaced electrodes 2—3. For example, if the head 2b of the electrode 2 is held stationary as by abutment against a fixed member indicated and a force, as indicated by an arrow 13 is applied in the direction of the electrode 2, the electrodes 2—3 are moved together to compress the resistance material 6 and thereby vary the resistance between the electrodes 2—3. The flexible housing cooperates in compressing the material 6 by exerting a restorative force on the material through the medium of adjacent portions 5c of its interior surface 5b. Also, when pressure on the material 6 is released by reducing the force 13, the restorative force exerted by the flexible housing 4 prevents packing of the material 6 by forcing it back to its original zero set condition and thereby provides for consistent predictable results in repeated operations.

Thus, in accordance with my invention, I have provided a simple reliable compression type rheostat wherein accurate predictable resistance values are obtained in repeated operations.

It should be noted that the threads formed on the portion 5c of the interior surface 5b of the housing 4 also aid in breaking up the resistance material and avoiding the tendency to pack.

In the above, I have described a preferred embodiment of my invention. However, satisfactory results may also be obtained in each of the modifications of my invention of which the rheostats shown in Figs. 2 and 3 are illustrative. The modifications shown in Figs. 2 and 3 will now be described in order, and with reference to Fig. 1, to avoid prolonged description.

In Fig. 2 is shown a compression type rheostat 14 identical in structure and operation to rheostat 1, shown in Fig. 1 and described in detail, except that the studs referred to as electrodes 2—3 in Fig. 1 are made of insulation material instead of conductive material and disk shaped members 15—16 are positioned between the studs and the resistance material 6 to serve as electrodes. The conductors 11—12 are, therefore, electrically connected to the members 15—16 to conduct current through the rheostat. The conductors 11—12 are admitted to the interior of the housing 4 through a pair of apertures 17—18. The force indicated by the arrow 13 acts upon the stud 3 as described for Fig. 1. However, the force is transmitted through the medium of the electrode members 15—16 to compress the resistance material 6. This modification of my invention is advantageous where a more complete insulation of the rheostat is required.

Referring to Fig. 3 of the drawing there is shown therein a compression type rheostat 19 illustrative of a second modification of my invention. Rheostat 19 is identical to rheostat 14, shown in Fig. 2 except for rearrangement of the electrodes 15—16 to engage the resistance material 6 without engaging the studs 2—3. In rheostat 19 compression of the resistance material 6 is accomplished directly by the studs 2—3 as contrasted to rheostat 14 in which the control force 13 is transmitted from the studs 2—3 to the material 6 through the medium of the electrodes 15—16. This arrangement is preferred in certain cases because of space and wiring limitations. In rheostat 19 the wires 11—12 are admitted through opposite sides of the housing 4 through a pair of apertures 20—21.

Although not shown in Figs. 2 and 3, lock nuts 7 through 10, shown in Fig. 1, could obviously be employed also in the embodiments of Figs. 2 and 3 in order to positively lock the threaded compression members 2 and 3 in a predetermined initial position with respect to the housing 4.

Thus, in accordance with my invention, I have provided a simple compression type rheostat reliable in repeated operation to maintain predictable, accurate resistance changes responsive to an external control force.

While I have shown and described particular embodiments of my invention those skilled in the art will understand that various changes and modifications may be made therein without departing from my invention in its broader aspects, and I, therefore, aim in the appended claims to cover all such modifications and changes as fall within the true spirit and scope of my invention.

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

1. A compression type rheostat comprising a compressible resistance material, electrode means engaging said material to conduct electric current therethrough, a force transmitting means of insulation material responsive to controlled forces thereon to vary the pressure on said resistance material, a flexible housing of rubber-like material having a hollow interior therethrough to accommodate said force transmitting

means, said resistance material and said electrode means, said housing having a thickened central wall section to apply a restorative force to said resistance material to maintain predictable resistance values through said resistance material corresponding to the values of said controlled forces.

2. A compression type rheostat comprising a pair of compression members of insulating material having threaded external cylindrical surfaces, a hollow flexible housing of rubber-like material having a spherical exterior surface and a threaded interior surface therethrough to accommodate said compression members in spaced relation therein, a compressible resistance material positioned within said housing in engagement with said compression members and said housing interior to be compressed and released by said compression members responsive to controlled forces applied thereto, said housing being arranged to apply restorative forces on said resistance material as said controlled forces are decreased, electrodes extending into said housing in contact with said resistance material independent of said compression members for conducting an electric current through said resistance material.

3. A variable resistor comprising a flexible housing of rubber-like insulating material, a pocket of powdered boron carbide compressible resistance material therein, means for deforming said housing and compressing said resistance material and electrical contact means extending into said housing in electrical contact with said resistance material.

4. A variable resistor comprising a flexible housing of rubber-like insulating material having a thickened central wall section defining a pocket, said pocket being filled with a powdered compressible resistance material comprising spherical particles of iron and powdered graphite, means for deforming said housing and compressing said resistance material and electrical contact means extending into said housing in electrical contact with said resistance material.

5. A compression type rheostat comprising a pair of electrodes having threaded external cylindrical surfaces, a hollow flexible housing of rubber-like material having a spherical exterior surface and a threaded cylindrical interior surface therethrough to accommodate said electrodes in spaced relation therein, a compressible resistance material comprising a quantity of powdered boron carbide positioned within said housing and engaging adjacent surfaces of said electrodes and said housing interior to be compressed and released by said electrodes responsive to controlled forces applied to said electrodes and to be engaged by said housing interior surface to apply a restorative force thereon to maintain predictable resistance values through said resistance material corresponding to the values of said controlled forces, and lock nuts threaded on said electrodes and engaging said housing to maintain an adjusted relative position of said electrodes to maintain a zero set compressed condition of said resistance material.

6. A compression type rheostat comprising a pair of electrodes having threaded external cylindrical surfaces, a hollow flexible housing of rubber-like material having a spherical exterior surface and a threaded cylindrical interior surface therethrough to accommodate said electrodes in spaced relation therein, a powdered compressible resistance material comprising spherical particles of iron and powdered graphite positioned within said housing and engaging adjacent surfaces of said electrodes and said housing interior to be compressed and released by said electrodes responsive to controlled forces applied to said electrodes and to be engaged by said housing interior surface to apply a restorative force thereon to maintain predictable resistance values through said resistance material corresponding to the values of said controlled forces, and lock nuts threaded on said electrodes and engaging said housing to maintain an adjusted relative position of said electrodes to maintain a zero set compressed condition of said resistance material.

7. A compression type rheostat comprising a quantity of powdered boron carbide employed as a compressible resistance material, electrode means engaging said material to conduct electric current therethrough, a force transmitting means of insulation material responsive to controlled forces thereon to vary the pressure on said resistance material, a flexible housing of rubber-like material having a hollow interior therethrough to accommodate said force transmitting means, said resistance material and said electrode means; said housing including a thickened central wall section to apply a restorative force to said resistance material to maintain predictable resistance values through said resistance material corresponding to the values of said controlled forces.

8. A compression type rheostat comprising a pair of compression members of insulating material having threaded external cylindrical surfaces, a hollow flexible housing of rubber-like material having a spherical exterior surface and a threaded interior surface therethrough to accommodate said compression members in spaced relation therein, a powdered boron carbide compressible resistance material positioned within said housing in engagement with said compression members and said housing interior to be compressed and released by said compression members responsive to controlled forces applied thereto, said housing being arranged to apply restorative forces on said resistance material as said controlled forces are decreased, electrodes extending into said housing in contact with said resistance material independent of said compression members for conducting an electric current through said resistance material.

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