June 25, 1946. E. C. RAGATZ 2,402,773

RHEOSTAT

Filed March 20, 1943 2 Sheets-Sheet 1

Fig. 1

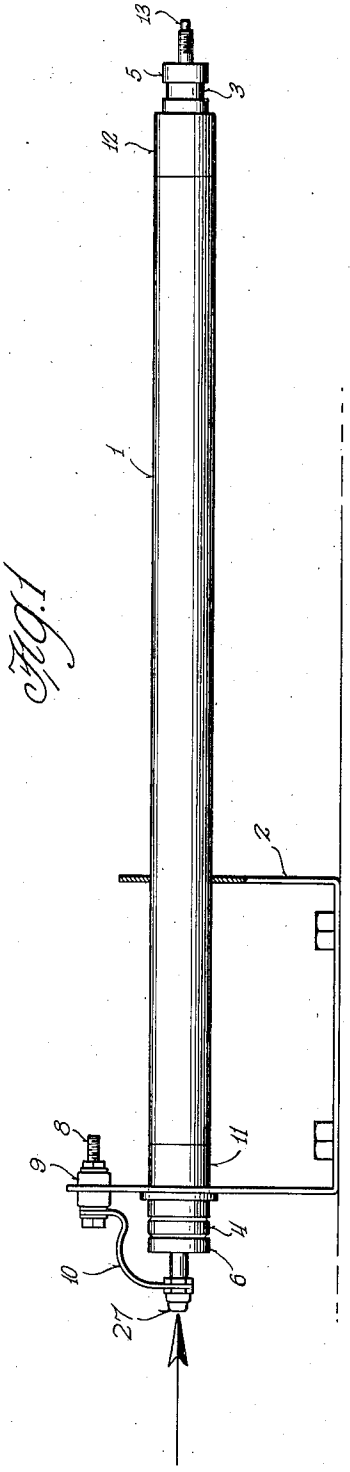


Fig. 5

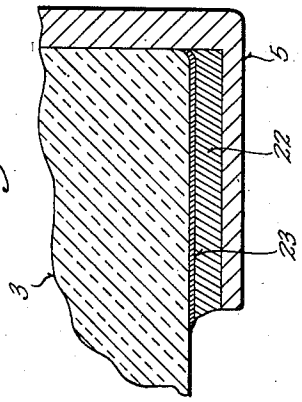


Fig. 4

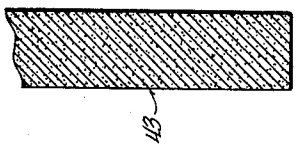


Fig. 3

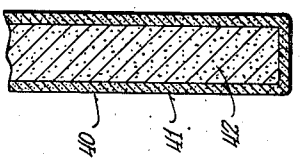
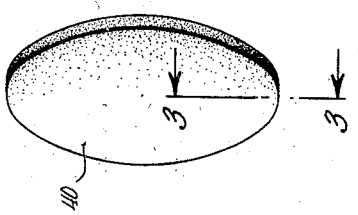


Fig. 2



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June 25, 1946. E. C. RAGATZ 2,402,773

RHEOSTAT

Filed March 20, 1943 2 Sheets-Sheet 2

Fig. 6

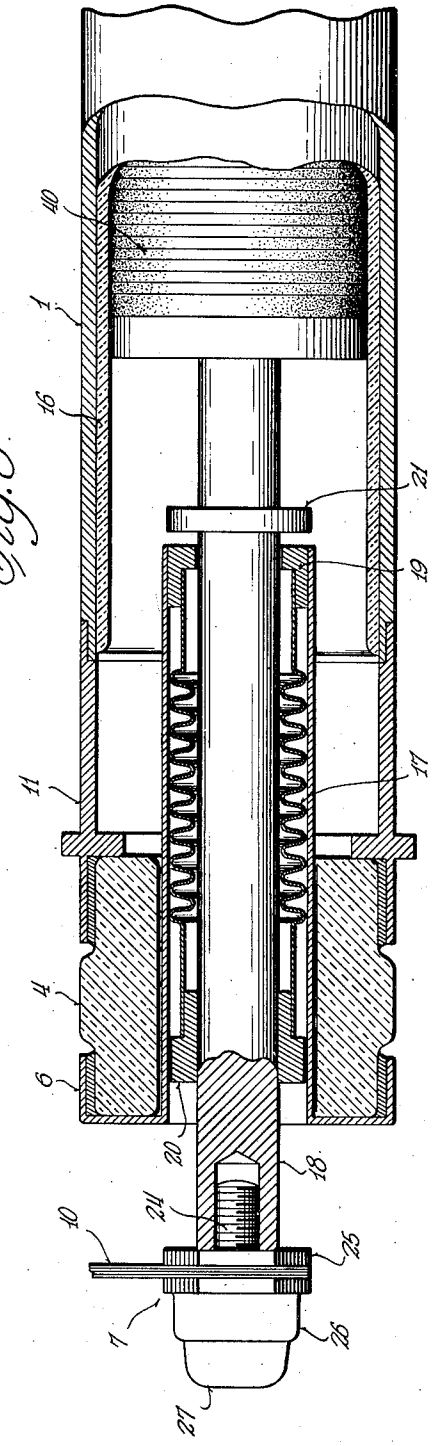
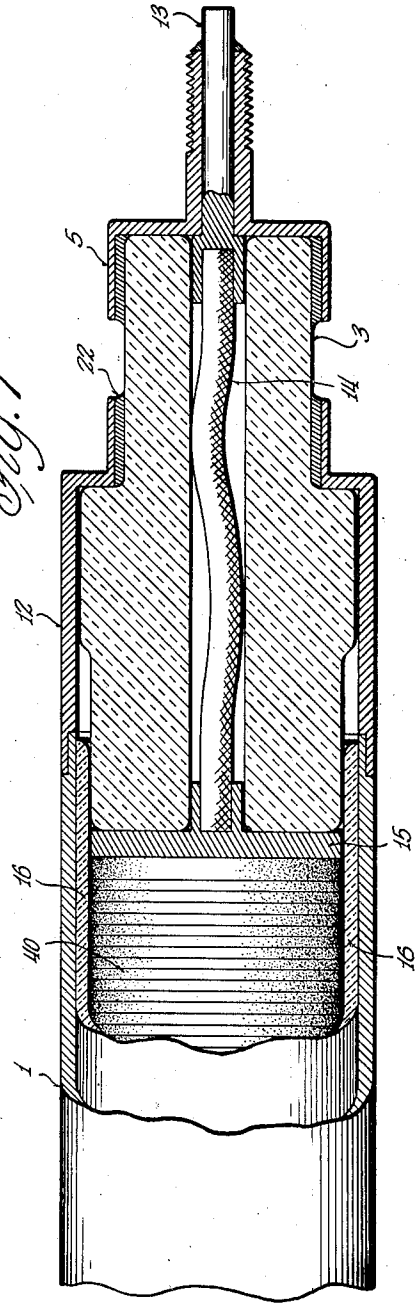


Fig. 7



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RHEOSTAT

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4 Claims. (Cl. 201—51)

1

This invention relates, in general, to rheostats and specifically to rheostats wherein the resistance change is obtained by variation of pressure upon a pile of individual resistors.

This invention resides in an improved form thereof in which the ohmic resistance, in response to a given applied pressure to the pile of individual resistors, is predictable and consistant, the same resulting from control of the atmosphere surrounding the individual resistors.

It is common practice to use individual resistors such as plates of carbon arranged in a pile or column. The plates are contained in an insulated rack or in an insulated tube with the faces of the plates in contact with each other and a screw or plunger device is arranged to apply the pressure at one end of the column. A particular type of such a pressure rheostat employs plates made of graphite, coated with amorphous carbon, which plates provide a low internal resistance and a high surface or contact resistance. With little pressure upon the pile of the plates the resistance is nearly all made up of surface contact resistance and with high pressure upon the pile the resistance is practically only that of the internal resistance of the plates. Another type of pressure rheostat utilizes plates homogeneous throughout of amorphous carbon.

Amorphous carbon when used in the prevailing atmosphere may undergo a change in its contact resistance dependent upon the extent of access of the atmosphere to the surface of the carbon and the degree of temperature of the carbon. Such changes may not be of marked degree and may well be permissible in the rheostat for the ordinary control of electrical machines and devices. There is, however, a demand for rheostatic control wherein a precise control is required and wherein the resistance must be in close limits when a pre-determined pressure is applied. It is in the latter field that my invention applies.

It is a commercial practice to form the carbon as used in the individual plates of the pressure rheostat at temperatures in the neighborhood of 1500° F. The carbon is formed in pots or crucibles placed in a gas-fired furnace, which uses gas made from coal. The carbon in its formation is kept in the furnace for a period long enough to have the carbon in a fixed state so far as temperature is concerned.

I have discovered that carbon formed in this manner and when used in a rheostat from which oxygen is excluded will not change in contact resistance, if the temperature is kept below the formation temperature of the carbon. Likewise

2

such carbon placed in a vacuum and operated below the formation temperature will not change to an appreciable degree in its contact resistance. It is understood, of course, that carbon has a negative temperature coefficient, and change in resistance due to temperature alone is not considered. My invention therefore provides for a rheostat in which the measure of resistance is dependent upon pressure applied and in which like pressures will cause like resistance to be repeated.

It is an object of this invention to remedy the shortcoming and fault of a particular type of change in resistance of amorphous carbon as used in the pressure type rheostat.

It is a further object of this invention to provide a rheostat device of the pressure type of such capacity and of such construction that it may be used for the percision control of motors and other electrical devices in the usual industrial applications.

It is a still further object of this invention to provide a rheostat device of the pressure type utilizing carbon type discs, which discs are protected from the access of oxygen.

An example of my invention is hereinafter more particularly described by reference to the accompanying drawings forming a part hereof.

The several figures of the drawings are briefly described as follows:

Figure 1 is an assembly view in side elevation of a rheostat constructed in accordance with this invention;

Figure 2 is a perspective view of an individual resistor in the form of a graphite disc coated with amorphous carbon;

Figure 3 is a transverse sectional view of a fragment of the disc shown in Figure 2;

Figure 4 is a transverse sectional view of a fragment of a disc composed entirely of amorphous carbon;

Figure 5 is a longitudinal sectional view of a gas-tight joint as used in the construction of the rheostat;

Figure 6 is a longitudinal sectional view of the end of the rheostat on which pressure is applied and as shown in Figure 1; and

Figure 7 is a longitudinal sectional view of the stationary end of the rheostat as shown in Figure 1.

As depicted in the drawings, the rheostat proper housed in the steel tube 1 is mounted in a U-shaped frame 2, forming an assembly arranged to receive pressure in the direction indicated by the arrow in Figure 1. The steel tube 1 is provided with a ceramic insulating lining 16 which re-

ceives individual resistors 40 of the type shown in Figure 3 or Figure 4 to be described in more detail later.

Referring now more particularly to Figure 6, a pressure plunger 18 is shown mounted within a corrugated flexible metal tube 17 with its inner end in electrical connection with the end of the pile of resistors 40 and with its outer end in electrical contact with a flexible jumper connection 10. A metal plug 19 is attached by a gas-tight connection to the inner end of the flexible tube 17. The outer wall of the metal plug 19 is attached with a gas-tight connection to a metal thimble 6. The outer end of the flexible metal tube 17 is attached to a metal plug 20 which, in turn, is attached to the pressure plunger 18; both of said latter two attachments being gas-tight. The steel tube 1 is provided with a hermetically joined extension in the form of a metal sleeve 11 which provides a support for a gas impermeable porcelain tube 4, the latter being connected to metal thimble 6 as shown. The joint construction between metal sleeve 11 and porcelain tube 4 and the joint construction between metal thimble 6 and porcelain tube 4 is impermeable to gas and will be described in detail later on. The pressure plunger 18 is drilled and threaded to receive the stud 24 formed as a part of the metal socket 26. The flexible jumper 10 is fastened to metal socket 26 by means of nut 25 and thus brought into electrical connection with the plunger 18. Within the metal socket 26 there is a porcelain button 27 to which pressure may be applied as indicated in Figure 1.

The construction of the stationary end of the rheostat is shown in detail in Figure 7 in which a metal sleeve 12 forms an extension of the steel tube 1, thus providing a support for a gas impermeable porcelain tube 3. To the outer end of porcelain tube 3 is attached by gas-tight connection a metal thimble 5. On the end of the pile of discs 40 is a metal contact disc 15 to which is attached flexible conductor 14, the other end of which conductor is attached to a stud 13. The stud 13 is attached to metal thimble 5 by a gas-tight connection which, in this case, is a silver solder joint not shown. The metal thimble is threaded on its end portion, as shown, to afford connection to a circuit.

The metal thimble 6, the metal sleeve 11, the metal sleeve 12, and the metal thimble 5 are attached to their respective porcelain tubes 4 and 3 by a construction as shown in detail in Figure 5. Illustrating this, the porcelain tube 3 is coated with a copper film 23 which, in this particular construction, is sprayed on. The metal thimble 5 or the sleeve, as the case may be, is then placed over the end of the porcelain tube and the intermediate space is then filled with solder 22 by a soldering operation. This type of juncture has been found to be gas-tight.

Referring to Figure 1, the electrical connection is completed from the jumper 10 to bolt 8, which is secured into the U-shaped frame 2 by the bushing of insulating material 9.

With pressure applied to the porcelain button 27 as indicated in Figure 1, the pressure plunger 18 moves inwardly displacing the resistor discs 40 a slight distance depending upon the length of the column of discs and the thickness of the discs. The pressure plunger 18 is prevented from being moved outwardly further than necessary by shoulder 21 formed on plunger 18 as shown.

Referring to Figures 2, 3, and 4 the carbon type disc is shown in Figure 2 and a fragment in transverse section in Figure 3. This type of disc has a graphite interior 42 and a surface carbon coating indicated as at 41. In Figure 4 a fragment of the disc is indicated at 43, which is a carbon type disc with carbon material throughout. The type of disc used in the rheostat as described depends upon the electrical service in which the rheostat is used and also upon the over-all resistance range required of the rheostat.

It appears that the contact resistance of the pressure type rheostat depends largely on the volatile content of the carbon surfaces.

By contact resistance is meant the resistance developed to the passage of current between the contacting or substantially contacting surfaces of the carbon.

This dependence of contact resistance on volatile content is explained by the fact that the volatile matter is adsorbed on the carbon surfaces and pores in the form of rather tightly adherent films under certain conditions. These films control the closeness with which one piece of carbon can approach another piece with the applied pressure held constant. The thinner the film, the closer the approach and the lower the resistance and vice versa.

The volatile matter of such carbons might be composed of many substances depending on the complete history of the carbon—that is, a more or less active carbon used for selective adsorption of say lethal gases would have a volatile matter largely composed of these gases and in an application for adsorption of heavy hydrocarbon gases from natural gas it follows that the volatile matter is largely hydrocarbons. However, in the manufacture and use of carbons as applied to resistors, the volatile matter is composed largely of a complex mixture of compounds of carbon and oxygen, water, and other gases whose presence and amounts depend on the manufacturing conditions.

The success of my invention is probably attributable to the formation of carbon elements having a comparatively small amount of adherent film of volatile matter of a fixed character, and the enclosure of such carbon elements within a gas tight chamber containing an inert gas.

While this invention has been above described by reference to a specific instance of an embodiment thereof, it is intended that the protection of Letters Patent to be granted hereon be not unnecessarily limited thereby, and that such protection extend to the substance of the advance contained in this disclosure and defined in the claims hereto appended.

What I claim as my invention is:

1. In a compressible pile rheostat, a hermetically sealed casing having a deflectable wall, an inert atmosphere within said casing, a plurality of contiguous conducting elements having surfaces of amorphous carbon, said elements forming a pile, an insulating surface forming a support for said pile within said casing, electrodes having connections externally of said casing engaging the ends of said pile, and pressure producing means adapted to cause said electrodes to be forced toward one another with accompanying deflection of said deflectable wall and to apply pressure to said pile.

2. In a compressible pile rheostat adapted to preserve consistent pressure-resistance relationship at constant temperature the combination comprising a pile of heat stabilized carbon containing elements, a non-deflectable housing por-

tion enclosing said pile and composed of a substance permanently impervious to gaseous diffusion, an electrically conducting stationary terminal in engagement with one end of said pile, a deflectable housing portion composed of material permanently impervious to gaseous diffusion joined to said non-deflectable housing portion by a joint permanently impervious to gaseous diffusion, an electrically conducting movable terminal in engagement with the opposite end of said pile insulated from said first named terminal and adapted to be forced towards said first named terminal to apply pressure to said pile with accompanying deflection of said deflectable housing portion, and an atmosphere of gas non-reactive with respect to carbon permanently maintained within said housings and surrounding said pile.

3. In a compressible pile rheostat adapted to preserve consistent pressure-resistance relationship at constant temperature the combination comprising a pile of heat stabilized carbon containing elements, a non-deflectable housing portion enclosing said pile composed of a substance permanently impervious to gaseous diffusion, means within said housing adapted to provide an insulated guide support for maintaining said carbon elements electrically distinct and in pile formation, an electrically conducting stationary terminal in engagement with one end of said pile and extending outwardly through said non-deflectable housing portion to the exterior thereof through a joint permanently imprevious to gaseous diffusion, a deflectable housing portion composed of material permanently impervious to gaseous diffusion joined to said non-deflectable housing portion by a joint permanently impervious to gaseous diffusion, an electrically conducting movable terminal in engagement with the opposite end of said pile insulated from said first named terminal and extending outwardly through said deflectable housing portion to the exterior thereof through a joint permanently impervious to gaseous diffusion, said movable terminal being adapted to be forced towards said first named terminal to apply pressure to said pile with accompanying deflection of said deflectable housing portion, and an atmosphere of gas non-reactive with respect to carbon permanently maintained within said housings and surrounding said pile.

4. In a compressible pile rheostat adapted to preserve a consistent pressure-resistance relationship at constant temperature the combination comprising a pile of heat stabilized carbon containing elements, a non-deflectable housing portion in the form of a metallic tube permanently impervious to gaseous diffusion enclosing said pile, an insulating lining in said tube adapted to provide an insulating guiding support for maintaining said carbon containing elements electrically distinct and in pile formation, an insulating bushing composed of material permanently impervious to gaseous diffusion in one end of said tube joined thereto by a fused joint permanently impervious to gaseous diffusion, an electrically conducting stationary terminal in engagement with the end of said pile adjacent said bushing and extending outwardly therethrough and joined thereto by a fused joint permanently impervious to gaseous diffusion, a second insulating bushing formed of material permanently impervious to gaseous diffusion in the opposite end of said tube and joined thereto by a fused joint permanently impervious to gaseous diffusion, a deflectable metallic bellows permanently impervious to gaseous diffusion secured to said second named bushing by a fused joint permanently impervious to gaseous diffusion, a movable electrically conducting terminal in engagement with the other end of said pile and extending outwardly therefrom through said bellows through a fused joint permanently impervious to gaseous diffusion, and an atmosphere of gas non-reactive with respect to carbon permanently maintained within said housing bushings and bellows surrounding said pile.

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