No. 723,631. PATENTED MAR. 24, 1903.

E. G. ACHESON.

METHOD OF HEATING MATERIAL.

APPLICATION FILED SEPT. 26, 1902.

NO MODEL.

Fig. 1.

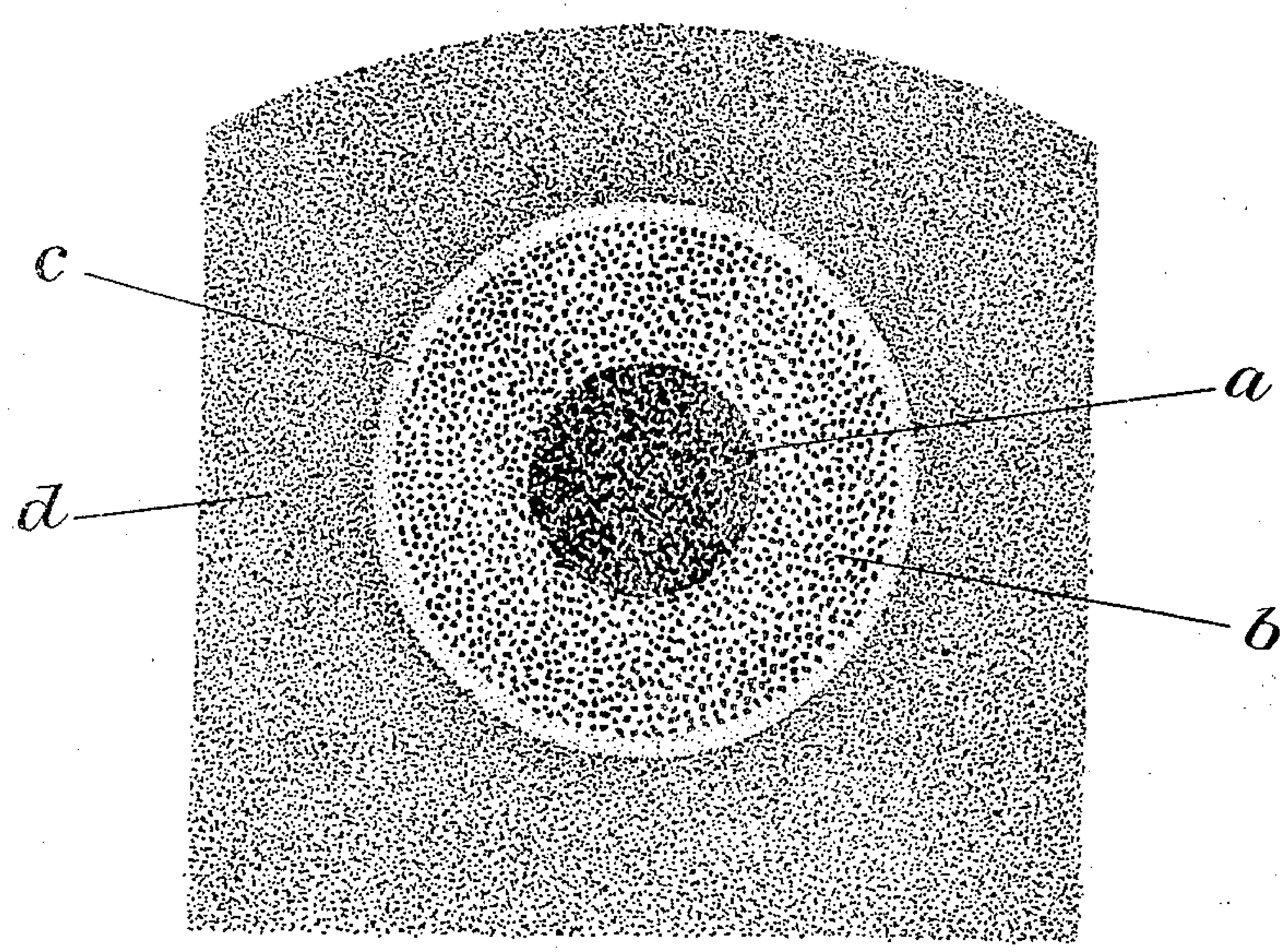


Fig. 2.

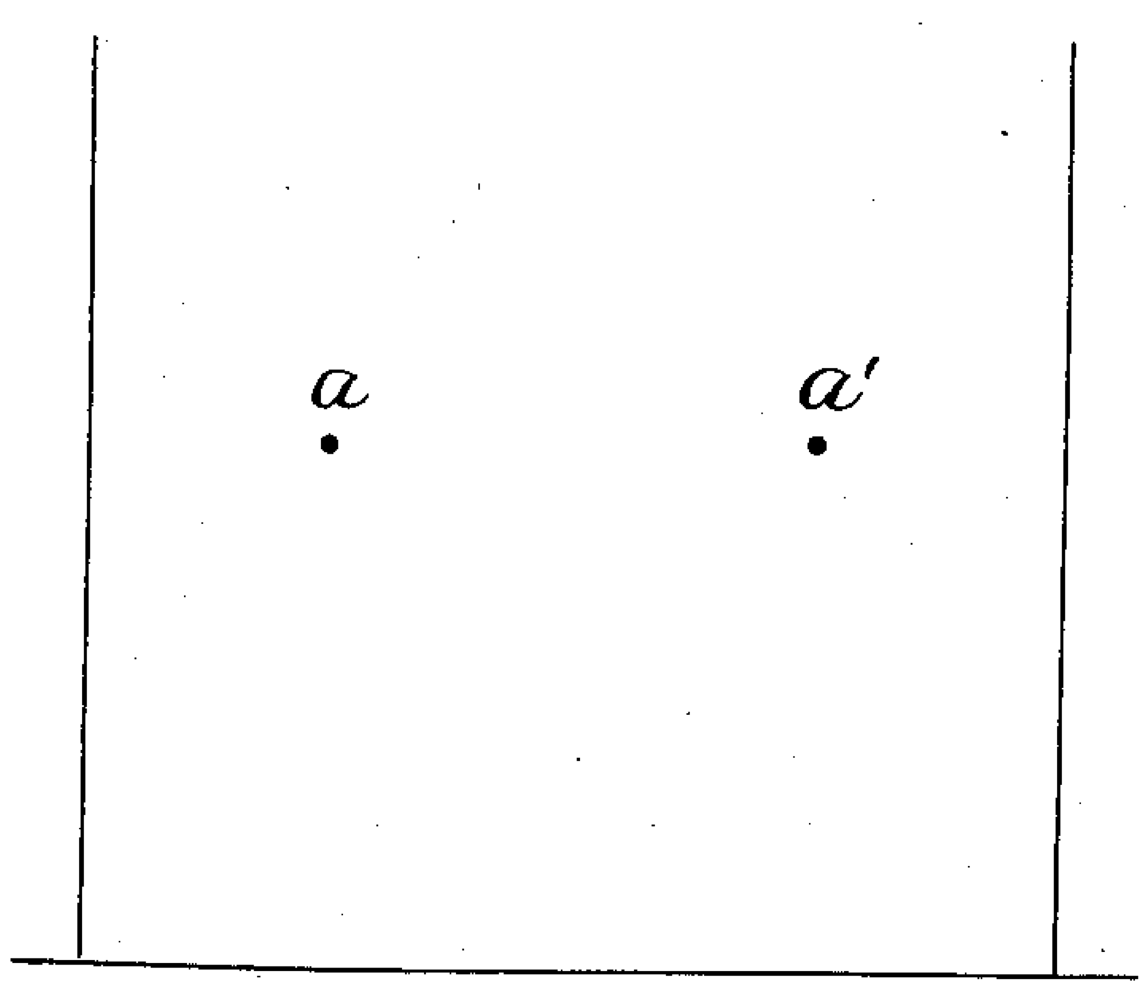


Fig. 3.

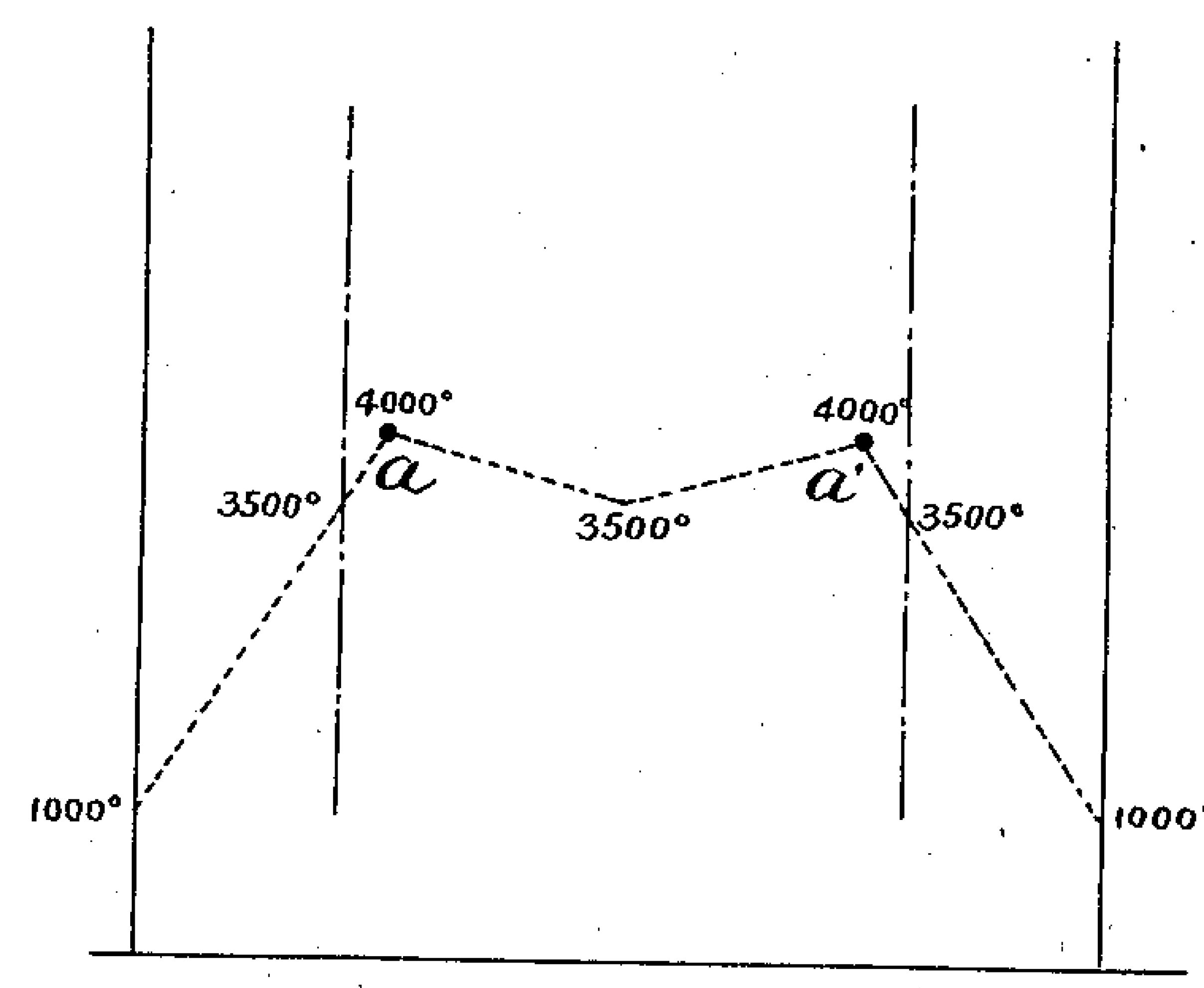
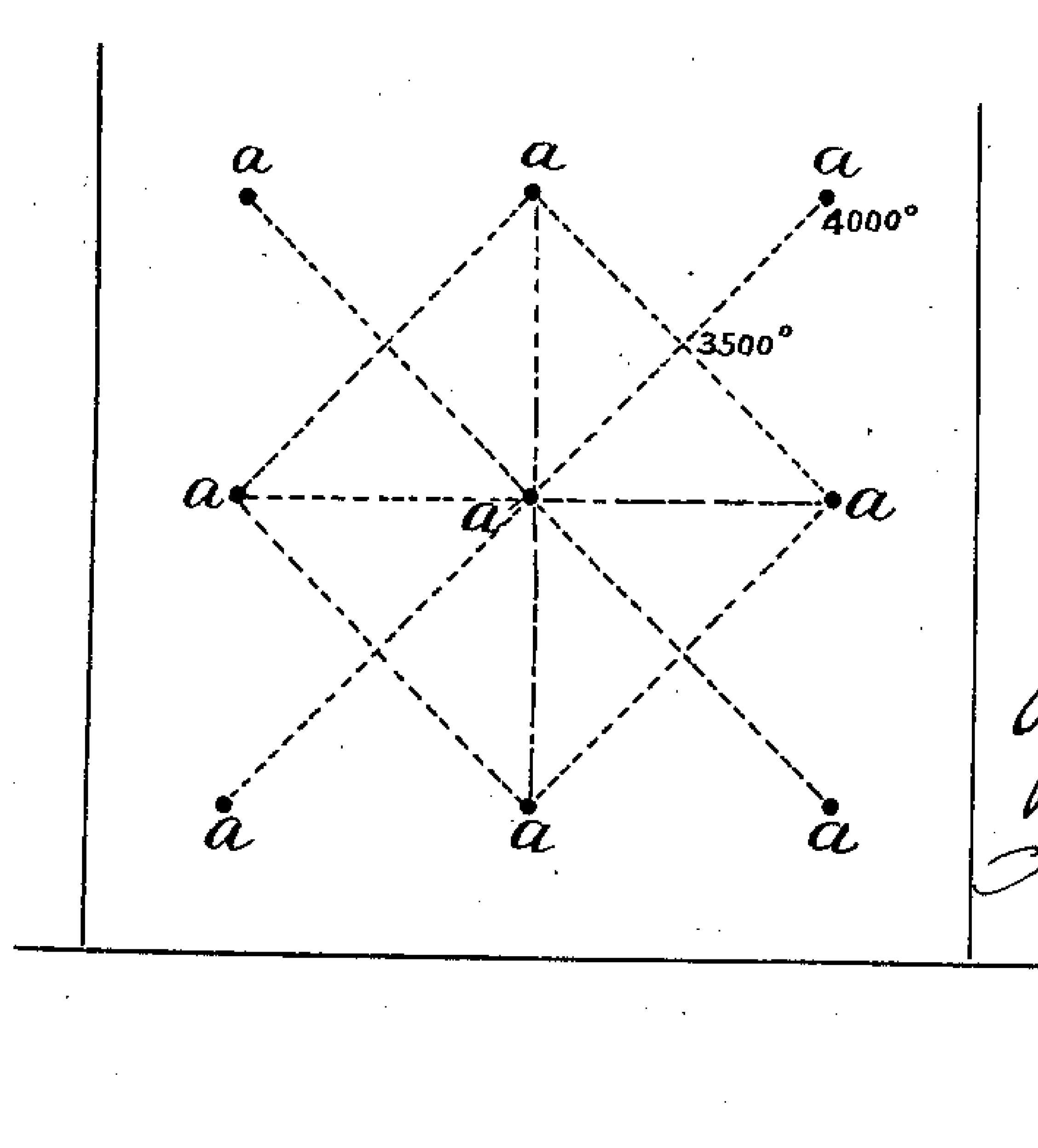


Fig. 4.



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UNITED STATES PATENT OFFICE.

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METHOD OF HEATING MATERIAL.

SPECIFICATION forming part of Letters Patent No. 723,631, dated March 24, 1903.

Application filed September 26, 1902. Serial No. 124,991. (No specimens.)

To all whom it may concern:

Be it known that I, EDWARD GOODRICH ACHESON, a citizen of the United States, residing in Stamford township, in the county of Welland, Province of Ontario, Canada, have invented certain new and useful Improvements in Methods of Heating Material, of which the following is a specification.

This invention relates to a method of conducting such operations as are dependent upon definite temperature conditions. In the specific example hereinafter given the use of electricity as a heating agent is described in connection with a chemical reaction taking place between relatively narrow temperature limits. My invention, however, is not restricted to electric-furnace operations, nor to operations taking place at high temperatures, but is applicable in general to such processes as require for their most efficient conduct definite temperature conditions throughout the mass under treatment.

I will describe my method as applied to the production of white stuff, referring to the accompanying drawings, wherein—

Figure 1 is a diagrammatic view showing the relations of the several materials remaining in the furnace at the close of the ordinary carborundum operation. Figs. 2, 3, and 4 are diagrams showing temperature conditions according to my method.

It is well known that in the production of carborundum or crystallized carbid of silicon a certain amount of an amorphous compound technically known as "white stuff" is formed and that this amorphous compound, being produced at lower temperatures than the carborundum, appears as a layer or envelop surrounding the latter. An analysis of this white stuff gives the following composition: carbon 37.3 per cent., silicon 59.1 per cent., leaving 3.6 per cent. compound of iron, aluminium, calcium, and oxygen in undetermined amounts, the metals entered through impurities contained in the carbon and silicon of the charge.

In Fig. 1, *a* indicates the carbon core, which forms the heating resistance of the ordinary carborundum-furnace. *b* is the body of carborundum which at the close of the operation surrounds the core, *c* the relatively thin envelop of the white stuff, and *d* the residual or undecomposed charge. If the temperature of the mass in immediate proximity to the core be assumed as 6,000° Fahrenheit and that of the exterior portions as 1,000° Fahrenheit, it will be seen that the temperature limits within which the white stuff is formed are quite narrow. The layer as formed in the usual carborundum-furnaces does not ordinarily exceed one and one-half inches in thickness, and from this fact it may be concluded that the difference between the temperature required for the production of the white stuff and the temperatures at which such white stuff passes into the crystalline carborundum does not exceed a few hundred degrees. It follows, therefore, that in a furnace designed for the production of this material with the maximum efficiency the heat must be so distributed throughout the charge that the temperature will at no point attain that of its conversion into carborundum and at no point fall below that necessary for its production.

The white stuff, like carborundum, results from the reaction between carbon and silica, the silica being conveniently supplied in the form of sand. This mixed charge comprising the sand and carbon is practically infusible and possesses a low degree of heat conductivity. The products of the operation—white stuff and the residual carbon of the core—are likewise solid bodies at the temperature of the reaction, and the white stuff possesses a heat conductivity not differing to any substantial extent from that of the original charge.

Referring now to Figs. 2 and 3 of the drawings, it will be understood that if the heat be supplied to such a charge at a plurality of regions *a a'* within the mass the temperature gradient will fall in every direction around the regions of application of the heat. The character of the gradient, as diagrammatically shown in Fig. 3, will depend upon the conductivity of the mass for heat and upon the loss of heat by radiation or otherwise from the limiting-surfaces of the charge, being relatively steeper in the direction of the radiating-surfaces. The gradient will therefore fall at a definite rate to a region or regions of minimum temperature between the regions of maximum temperature represented by the points of application of the heat and will fall, as indicated, at a considerably higher rate toward the external or radiating surfaces of the mass.

The limiting temperatures, superior and inferior, of the particular reaction under consideration are not accurately known. It may be assumed, however, and probably with an approximation to correctness, that such limiting temperatures are 4,000° and 3,500° Fahrenheit, respectively. In accordance with these figures the regions of maxima have been shown in Fig. 3 as so placed in relation to each other that the temperature of the intermediate minimum shall not be less than the inferior limit of the reaction. Thereby it is assured that the production of the compound in question will take place throughout the entire intermediate region, while at the same time it will be stable at and around the regions of application of the heat.

In the diagrammatic illustrations of Figs. 2 and 3 two regions of maximum temperature are indicated. In a practical furnace the number of such regions of maximum temperature may be indefinitely increased, care being taken, as above explained, that they be so located relatively to one another that the intermediate minima shall afford sufficient heat for the accomplishment of the reaction or operation desired. For instance, I have employed a furnace having an internal length of forty-eight inches, width of twenty-five inches, and depth of twenty-five inches. In this was placed a charge of carbon and sand. Within the charge mixture were embodied four cores of granular carbon, each core being two and one-half inches in diameter by forty-eight inches in length. This furnace was operated for twelve consecutive hours. The amperes at the moment of starting registered five hundred and within a few minutes had increased to fifteen hundred, remaining approximately constant at the latter figure until the end of the run. The voltage throughout was about eighty. On opening the furnace a reaction had occurred, and the desired product—white stuff—had been formed. The reaction had involved all of the material confined within the cores and the material lying outside of the cores for a distance of three nches.

It will be obvious that the heat may be applied at the regions of maximum temperature along lines or along surfaces, either of which may constitute the regions of maximum temperature herein referred to.

From the foregoing explanation it will be seen that it is not sufficient for the operation of my method that a series of heating-conductors be employed, nor does a series of conductors equally spaced and embedded in the charge constitute of itself an apparatus capable of carrying out my method. It is necessary that the resistance-conductors or other devices for the application of heat to the mass of material be definitely spaced with relation to each other at distances largely determined by the heat conductivity of the charge, the duration of the operation, and the superior and inferior temperature limits of the operation. Under such conditions only will the temperature variations within the mass of material under treatment fall within the temperature limits of the operation.

By the term "mass of material under treatment" as herein employed is meant not necessarily the entire body of the charge, but such portions thereof as fall within the proper temperature limits. This includes substantially the whole of the mass lying between the regions of application of the heat and such portions external thereto as are heated to the necessary extent. It will be understood, however, that the portions near the radiating-surfaces, in other words, the outer layers of the charge, constitute an inert envelop for the mass under treatment. Their function is practically that of an inert protection and heat-retaining covering.

By the expression "temperature limits of the reaction" is meant the superior and inferior temperature limits between which the reaction can proceed. The inferior limit is the minimum temperature at which the reaction can be carried on, and the superior limit is the maximum temperature at which the product is stable.

I claim—

1. The method of conducting reactions which proceed under definite temperature conditions, which consists in maintaining within a mass of material regions of definite maximum and of minimum temperature, both of which are comprised within the temperature limits of the reaction, whereby the operation is conducted throughout the entire mass of the material under treatment.

2. The method of conducting reactions which proceed under definite temperature conditions and the product of which remains unfused at the working temperature, which consists in maintaining within a mass of material regions of definite maximum and of minimum temperature both of which are comprised within the temperature limits of the reaction, whereby the operation is conducted throughout the entire mass of the material under treatment.

3. The method of conducting reactions which proceed under definite conditions of temperature and heat conductivity, which consists in maintaining within a mass of material regions of definite maximum and of minimum temperature, both of which are comprised within the temperature limits of the reaction, whereby the operation is conducted throughout the entire mass of the material under treatment.

4. The method of producing "white stuff"

which consists in maintaining within a mass containing silica and carbon in suitable proportions, regions of definite maximum and minimum temperature, both of which are comprised within the temperature limits of the reaction, whereby the operation is conducted throughout the entire mass of the material under treatment.

5. The method of producing "white stuff" which consists in maintaining within a mass containing silica and carbon in suitable proportions a plurality of regions of maximum temperature, so located with relation to one another that the temperature variations within the material under treatment shall be included within the temperature limits of the reaction, whereby the operation is conducted throughout the entire mass of the material under treatment.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

EDWARD GOODRICH ACHESON.

Witnesses:
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