No. 848,422. PATENTED MAR. 26, 1907.

F. WYNNE.

METHOD OF MAINTAINING OR INCREASING THE FLUIDITY OF MOLTEN OR SEMIMOLTEN MATERIALS BY MEANS OF ELECTRICITY.

APPLICATION FILED JUNE 23, 1905.

2 SHEETS—SHEET 1.

Fig. 1.

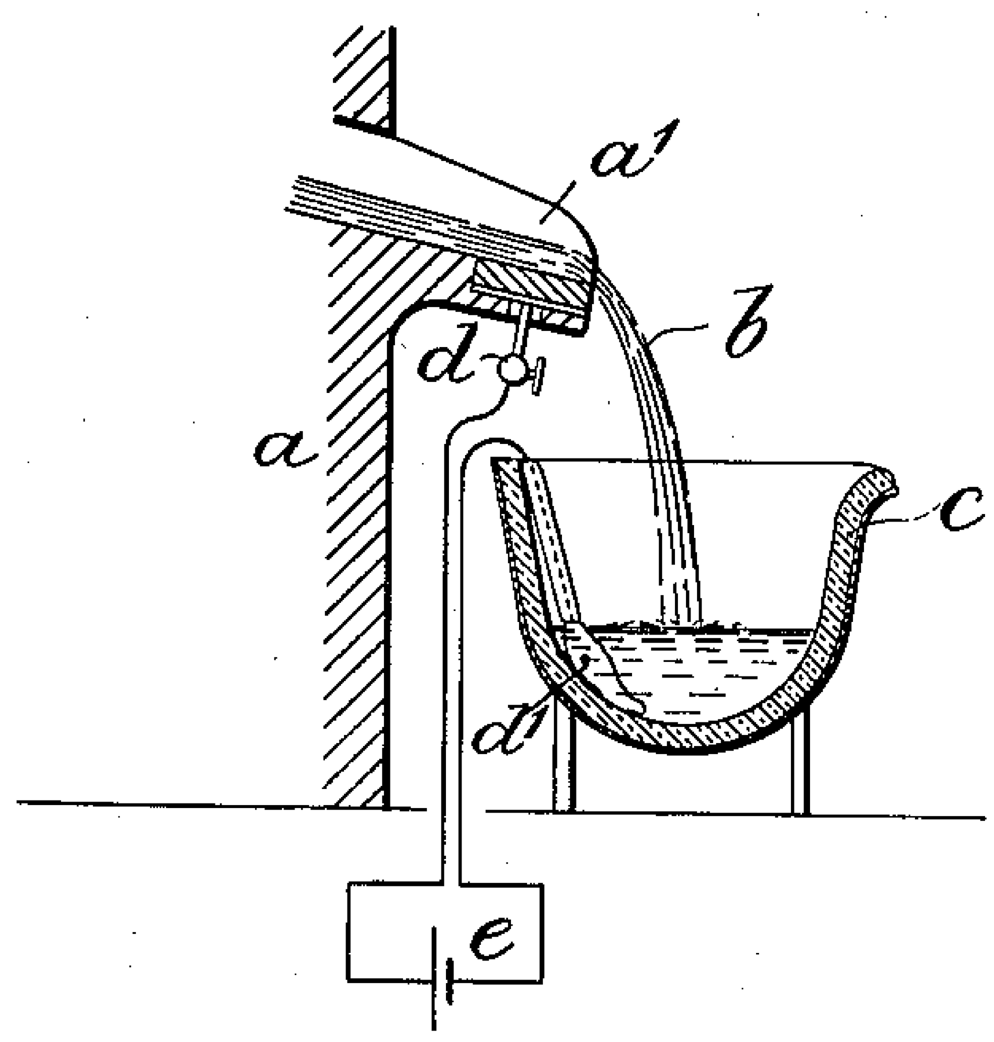

Fig. 2.

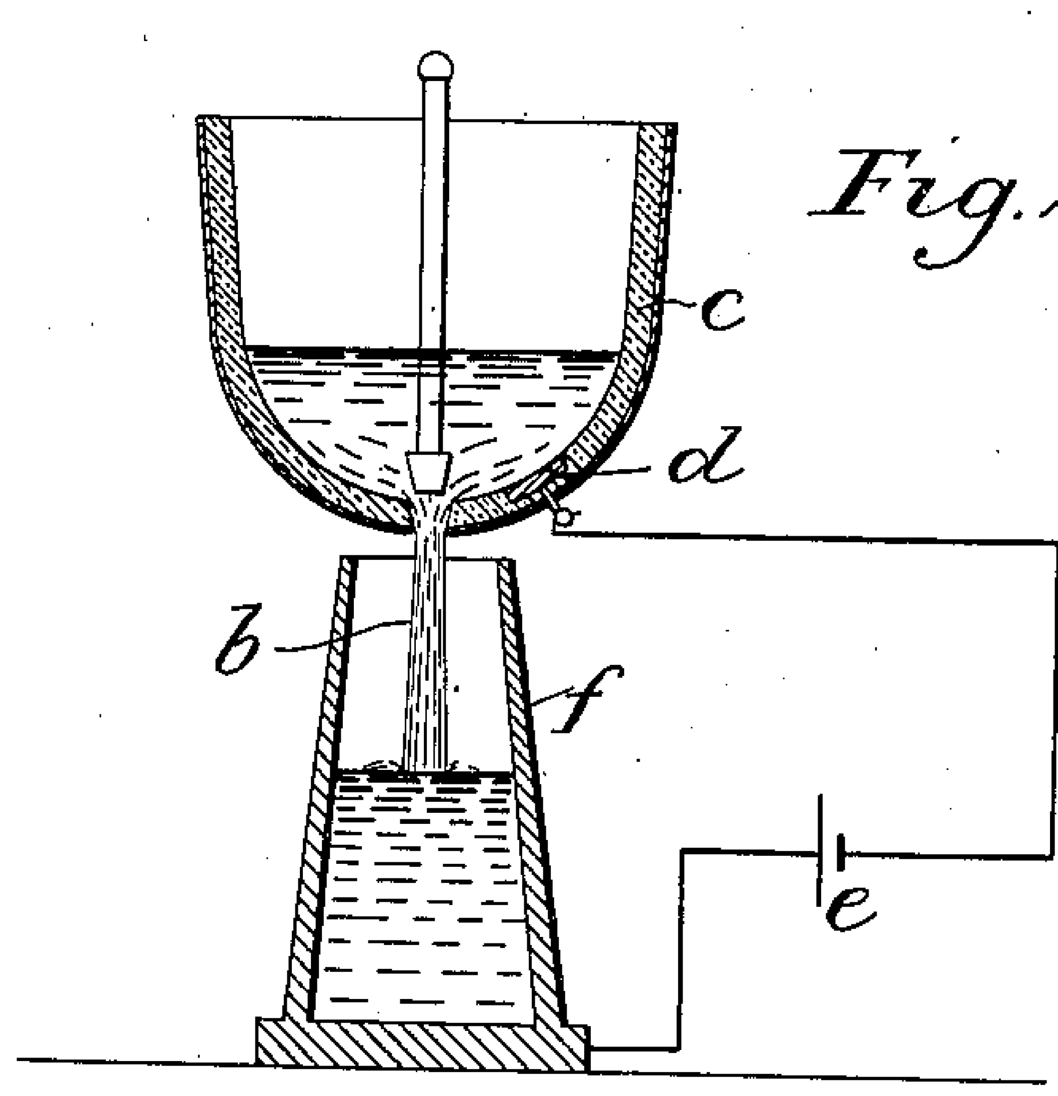

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Fig. 3.

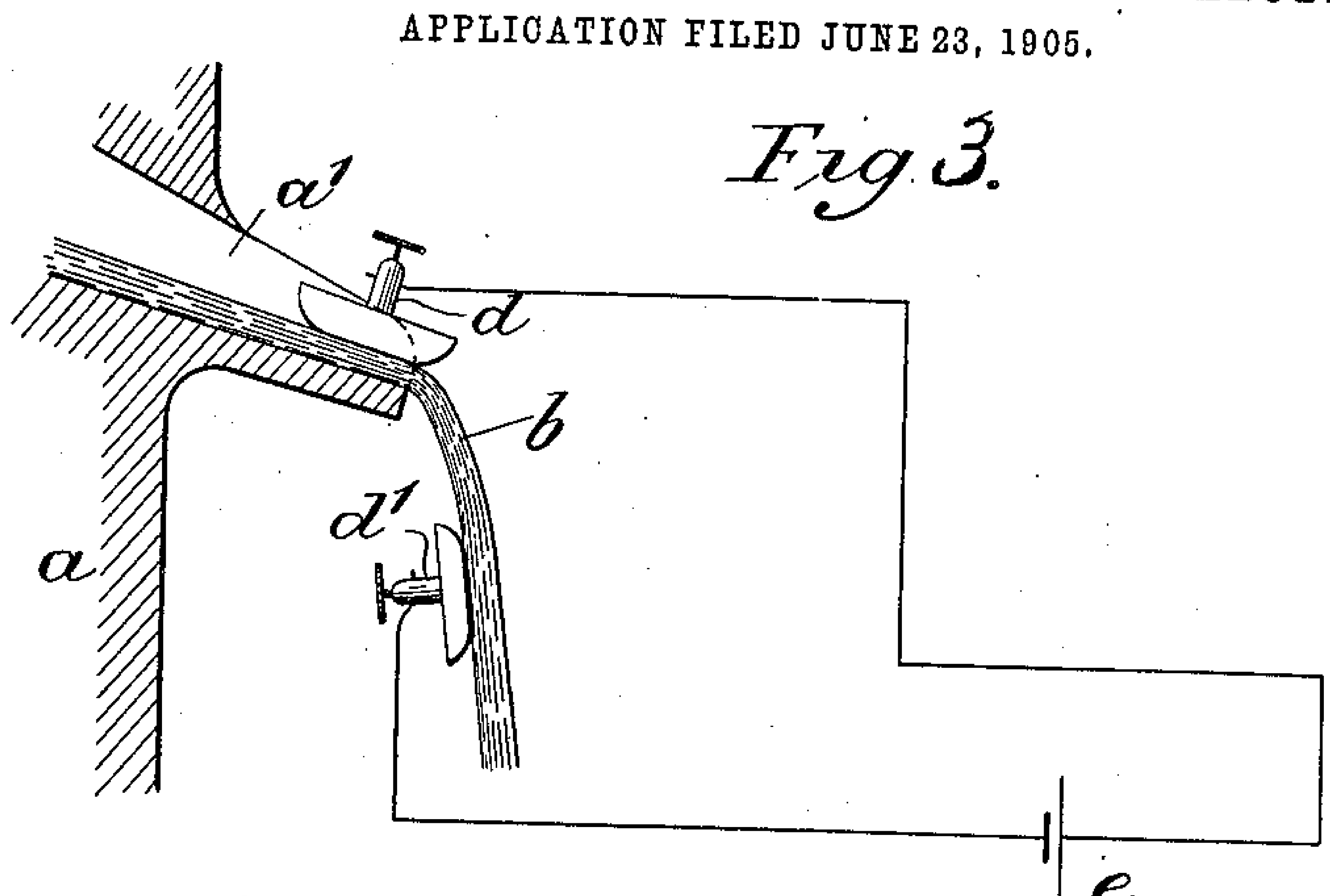


Fig. 4.

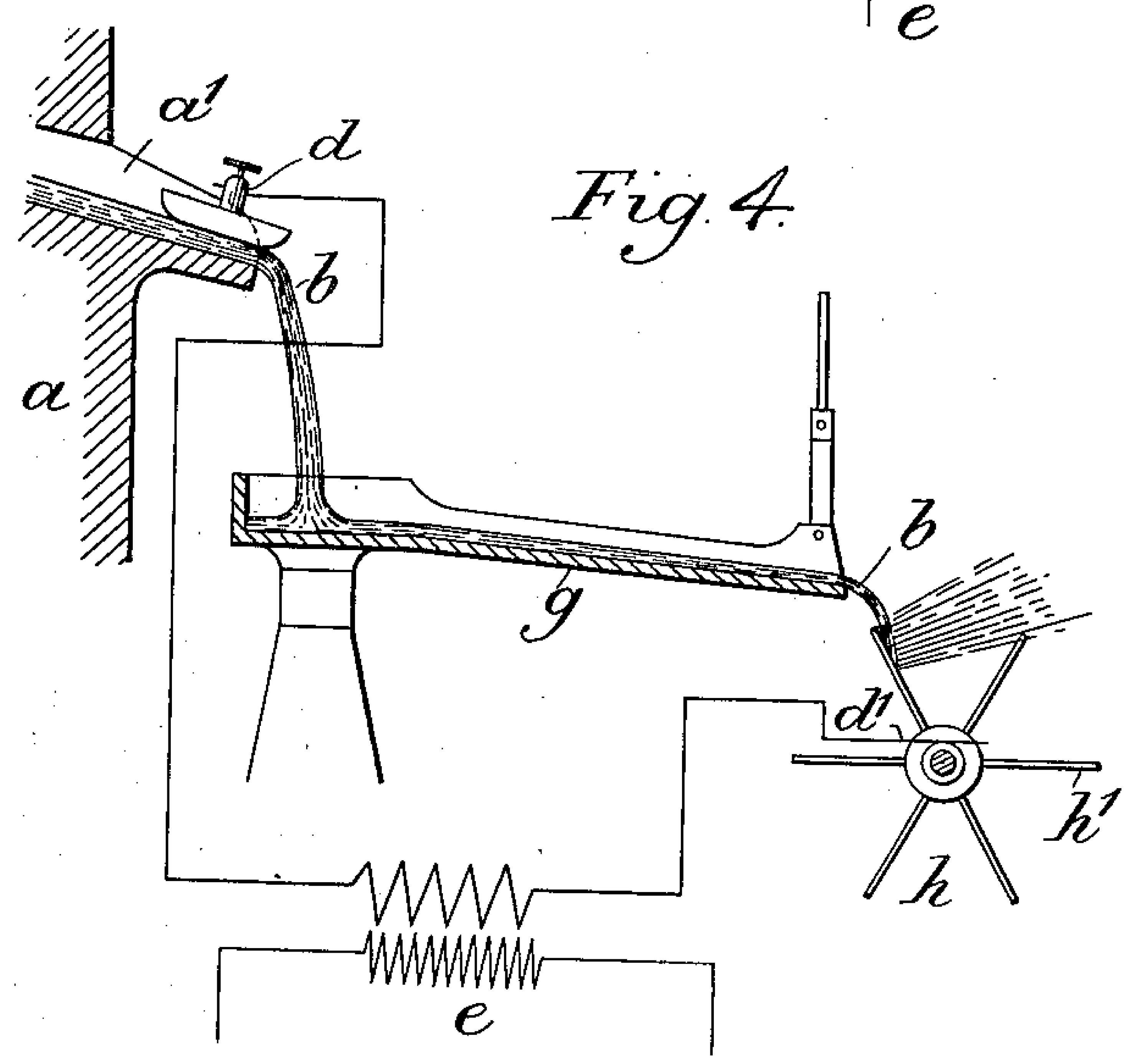
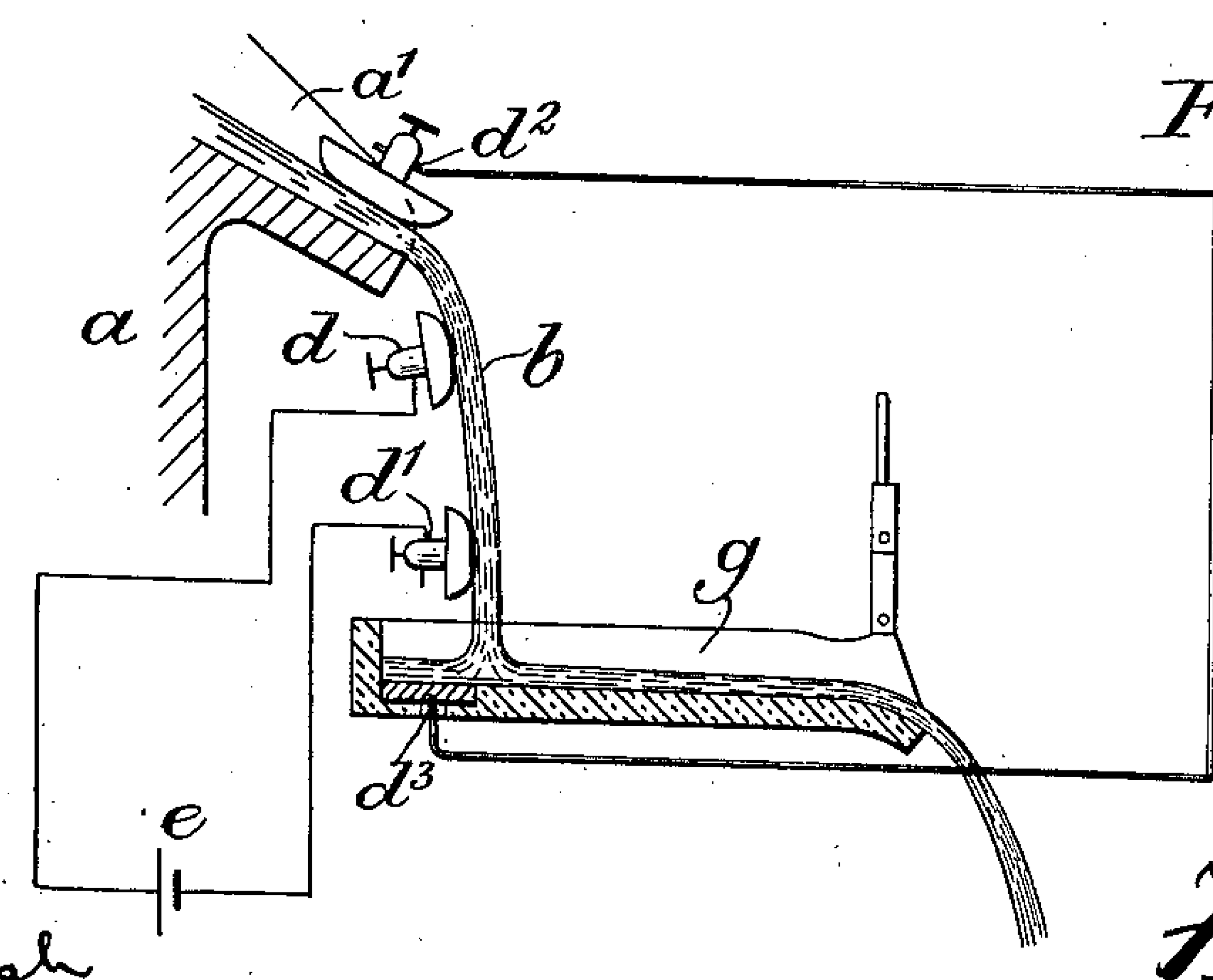


Fig. 5.



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UNITED STATES PATENT OFFICE.

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METHOD OF MAINTAINING OR INCREASING THE FLUIDITY OF MOLTEN OR SEMIMOLTEN MATERIALS BY MEANS OF ELECTRICITY.

No. 848,422. Specification of Letters Patent. Patented March 26, 1907.

Application filed June 23, 1905. Serial No. 266,667.

To all whom it may concern:

Be it known that I, FRANK WYNNE, a subject of the King of Great Britain and Ireland, residing at Westminster, in the county of London, England, have invented a Method of Maintaining or Increasing the Fluidity of Molten or Semimolten Materials by Means of Electricity, of which the following is a specification.

This invention has reference to a method whereby material that has been heated to a red heat or to a higher temperature, and thereby rendered molten or semimolten, can be further heated while flowing from one receptacle or place to another, as from a furnace or melting-pot to a ladle, casting-mold, rolling-table, or distributing trough or runner or from a ladle to a mold, rolling-table, or distributing trough or runner, the object being to effect a reheating or superheating of such molten material during its flow, so as to minimize as far as possible the cooling action which necessarily takes place as soon as the heated molten material is withdrawn from the furnace or melting-pot or to considerably increase the temperature of such material in order to cause it to assume a more liquid condition than would otherwise be the case to admit of its being cast or otherwise dealt with in a better manner and sometimes for the purpose of better oxidizing parts thereof when passing through the air or other oxidizing atmosphere. According thereto the heating of a stream of red-hot or white-hot molten or semimolten material, (hereinafter referred to as "red-hot molten material",) which may be a molten silicate, such as glass or slag, or a metal or metallic alloy, or other material intended to be cast, molded, rolled, sprayed, or otherwise dealt with, is effected by causing an electric current of sufficient strength to flow continuously through the stream or a part or parts thereof while the same is falling freely through the air or other atmosphere from a melting-furnace or other receptacle to a ladle or other receptacle or place. The electric current may be produced external to and independently of the stream of red-hot molten material and be led into the same at suitable parts thereof, through conductors or electrodes arranged in electrical connection therewith at different points, so that the electric current will be caused to traverse the intervening length or portion of molten material longitudinally, the receptacles from and into which the molten stream flows being, where necessary, insulated from each other to insure that the current shall flow in the proper manner through the stream or a part or parts thereof with the least possible leakage, due to part of it being shunted past the stream. The conductors or electrodes (hereinafter called "electrodes") may be arranged in various ways, and in some cases alternative electric circuits may be provided or additional electrodes fitted, so that the electric current can be caused to traverse different parts of the red-hot molten stream.

In all cases the electric current is caused to flow in a continuous manner and in such quantity through the stream of hot molten or semimolten material as to maintain or increase the fluidity thereof, but not to such an extent as to vaporize or pulverize the same, the object being to maintain or increase the fluidity of the material while it is falling through and is exposed to the cooling action of the surrounding atmosphere, so as to better adapt it for subsequent treatment or use.

By heating the red-hot molten material electrically while it is falling through the air or other atmosphere from one place to another, as described, waste of electric current, such as is liable to take place if the material be heated electrically while within a vessel or conduit owing to leakage of current through the wall of the vessel or conduit, is to a very large extent prevented.

It will be obvious that apparatus for enabling a stream of red-hot molten material to be heated electrically in the manner set forth can be constructed in various forms.

In the accompanying drawings, Figures 1 to 5, inclusive, illustrate diagrammatically several arrangements for carrying the invention into practice. Fig. 1 shows an arrangement in which an electric current is caused to traverse a stream of red-hot molten material while the same falls through the air from a melting-furnace into a ladle. Fig. 2 shows an arrangement in which the stream of red-hot molten material is electrically heated as it flows from a ladle into a casting-mold. Fig. 3 shows another arrangement whereby an electric current is transmitted to a stream of red-hot molten material. Fig. 4 shows the application of an electric current to a stream of red-hot molten material while falling from a furnace to a trough or runner and from the trough or runner to disintegrating apparatus. Fig. 5 illustrates another arrangement of electrical connections whereby the electric current is caused to traverse the stream of red-hot molten material by two paths.

Referring to Fig. 1, *a* represents a melting-furnace, from the spout *a'* of which a stream *b* of red-hot molten material can be caused to fall into a ladle *c*, by which such material can be conveyed to a casting-mold, a rolling-table, or other place, according to the nature of the material and the purpose for which it is to be applied. An electrode *d*, connected to one terminal of a convenient source of electric current—such, for example, as a battery *e*, Fig. 1, or a dynamo-electric generator or a transformer, Fig. 4—is arranged so that electrical connection is made with the molten material in the furnace *a* or at a point adjacent thereto, the electrode *d* being fitted, in the example illustrated in Fig. 1, in the bottom of the spout *a'*, so that electric connection is made with the red-hot molten material as it flows from the furnace over the electrode. The other electrode *d'*, which is connected with the other terminal of the source of electric current, is, as shown, placed in the bottom of the ladle *c*, which is insulated from the furnace *a*, so that as the stream of red-hot molten material falls through the air into the ladle the electric circuit will be completed between the terminals *d d'* through the intervening mass of red-hot molten material, which will undergo a heating or reheating process in consequence of the electric current flowing continuously therethrough, so that the cooling of the material which would otherwise take place after leaving the melting-furnace will be largely reduced or entirely prevented, or the red-hot material may even be heated to a much higher temperature than that at which it leaves the furnace, so as to be rendered more liquid, the degree of heating being capable of variation by varying the strengh of the current used.

In the arrangement shown in Fig. 2 the stream of red-hot molten material is electrically heated as it is discharged from a ladle *c* into an ingot-mold *f*, one electrode—viz., *d*—being placed in the bottom of the ladle and the other being formed by the mold *f*, so that the reheating will be effected during the casting operation.

In some cases the red-hot molten material may be reheated electrically both while flowing from the melting-furnace to the ladle, as shown in Fig. 1, and also while flowing from the ladle to the mold or other place—for example, a rolling-table—when molten glass or like material is to be subjected to a rolling operation. Also, if the red-hot molten material is not conveyed from the melting-furnace to the mold, rolling-table, or other place by the aid of a ladle the electric current can be applied to it while flowing direct from the furnace to the mold, rolling-table, or other place. The electrodes *d d'* may be applied to the molten material in various ways. In Fig. 1 they are disposed one at the furnace-outlet and the other at the ladle and in Fig. 2 one at the ladle and one at the mold; but they may also be constructed of suitable shape and arranged to make connection with the stream of red-hot molten material at any part thereof independent of any or some of the receptacles in which the red-hot molten material is held.

In the arrangement shown in Fig. 3 the electrode *d'* is arranged in contact with a portion of the stream of red-hot molten material at a part thereof that is falling through the air instead of through a part thereof that is in a lower receptacle, as in Figs. 1 and 2.

In Fig. 4 the stream of red-hot molten material flows from a furnace *a* onto a guiding trough or runner *g*, from which it falls upon a disintegrating apparatus, which may comprise a wheel *h*, having radial blades or paddles *h'*, whereby the falling molten material will be broken up, and thereby disintegrated. In this example the stream of red-hot molten material is heated electrically while falling from the furnace-outlet *a'* onto the trough *g* and also when falling from the trough *g* onto the disintegrating-wheel *h*. Conveniently one electric circuit may be employed for the double electrical heating, one electrode—viz., a^7—being placed in the furnace-outlet *a'* and the other—viz., *d'*—being connected to the wheel *h*, the circuit being completed through the trough and the molten material therein, or independent electrical circuits may be provided for heating the two portions of the stream, if desired.

In Fig. 5 the electric current is applied to the stream of red-hot molten material at four points—viz., by the electrodes *d d'*, connected with the stream at intervening points thereof, and by electrodes d^2 d^3 at the furnace-outlet *a'* and at the trough *g*, respectively. The electrodes *d d'* are connected to the opposite poles of the electric generator *e*, and the electrodes d^2 d^3 are connected together by an external conductor d^4, so that upon closing the circuit the electric current supplied to the electrodes *d d'* will divide, part traversing the portion of the stream of red-hot molten material from *d* to *d'* direct and part traversing the stream of material from *d* to d^2, thence through the external conductor d^4 to d^3, and thence through the part of the stream between d^3 and *d'*. In like manner other connections may be arranged to provide different electrical circuits.

Where necessary—as, for example, in Figs. 1, 2, and 4—the receptacle from which the red-hot molten stream falls or into which it flows should be insulated in order to prevent short-circuiting of the electric current.

When the electrodes are connected direct to the stream of red-hot molten material, the heating effect of the electric current can be varied by varying the distance apart of the electrodes, so as to increase or decrease the length of the molten stream traversed by the current, or the same result may be obtained by varying the distance apart of the two receptacles between which the stream flows and to which electrical connection is made; but in all cases the strength of the electric current is regulated so as only to maintain or increase the fluidity of the stream, but not to disintegrate or pulverize it.

In all cases where electrodes and conductors are used to transmit current to the stream of red-hot molten material such electrodes, which may be generally made of dense carbon, and the conductors should be of sufficient section to prevent their being unduly heated by the passage of the electric current therethrough and to prevent waste of electrical energy. The electrodes should also offer sufficient area of contact with the molten material, particularly when this is a silicate, to allow of the passage of sufficient current to the silicate, in some cases through a layer of red-hot but not necessarily molten silicate.

What I claim is—

1. A method of heating a stream of red-hot molten or semimolten material electrically while falling from one place to another through a gaseous medium, said method consisting in causing an electric current to flow continuously lengthwise through the portion of the falling stream that is surrounded by and in contact with the gaseous medium.

2. A method of maintaining or increasing the fluidity of a stream of red-hot molten or semimolten material while falling from one place to another through a gaseous medium, said method consisting in opposing the ohmic resistance of a length of the stream surrounded by and in contact with the gaseous medium to the passage of a continuous electric current applied to the different points in the length of the stream and of a strength to effect the required electrical heating thereof.

3. A method of maintaining the fluidity of a stream of red-hot molten or semimolten material, said method consisting in leading an electric current of the required strength into and from and so as to cause it to flow continuously in a lengthwise direction through a continuous portion of the stream that is falling from one place to another and is surrounded by and is in contact with a gaseous medium.

4. The hereinbefore-described method of increasing the fluidity of a stream of red-hot molten or semimolten material, said method consisting in causing an electric current of suitable strength to flow continuously in a lengthwise direction through a continuous length of the stream that is falling from one place to another through and is surrounded by and in contact with a gaseous medium.

5. The hereinbefore-described method of maintaining the fluidity of a stream of red-hot molten or semimolten material, said method consisting in causing a regulated continuous current of electricity to flow lengthwise through a portion of the stream that is falling from one place to another through and is closely surrounded by and in contact with a gaseous medium, and leading away the electrically-heated material as a continuous molten stream to the place where it is to be utilized.

6. The hereinbefore-described method of increasing the fluidity of a stream of red-hot molten or semimolten material, said method consisting in causing a regulated current of electricity to flow lengthwise through a portion of the stream that is falling from one place to another through and is surrounded by a gaseous atmosphere and conducting the electrically-heated and liquefied material as a continuous stream to a place where it is to be further dealt with while in a liquid state.

7. The hereinbefore-described method of maintaining or increasing the fluidity of a stream of a molten or semimolten silicate, said method consisting in causing an electric current to flow lengthwise through a continuous portion of the stream that is falling from one place to another through and is surrounded by and is in contact with a gaseous atmosphere.

8. A method of heating a stream of red-hot molten or semimolten material electrically while falling from one place to another, said method consisting in causing an electric current to flow continuously lengthwise through the portion of the falling stream.

9. A method of heating a stream of red-hot molten or semimolten material electrically while flowing from one place to another, said method consisting in causing a continuous electric current to flow through the entire falling portion of the stream.

Signed at London, England, this 9th day of June, 1905.

FRANK WYNNE.

Witnesses:
H. D. JAMESON,
R. F. WILLIAMS.