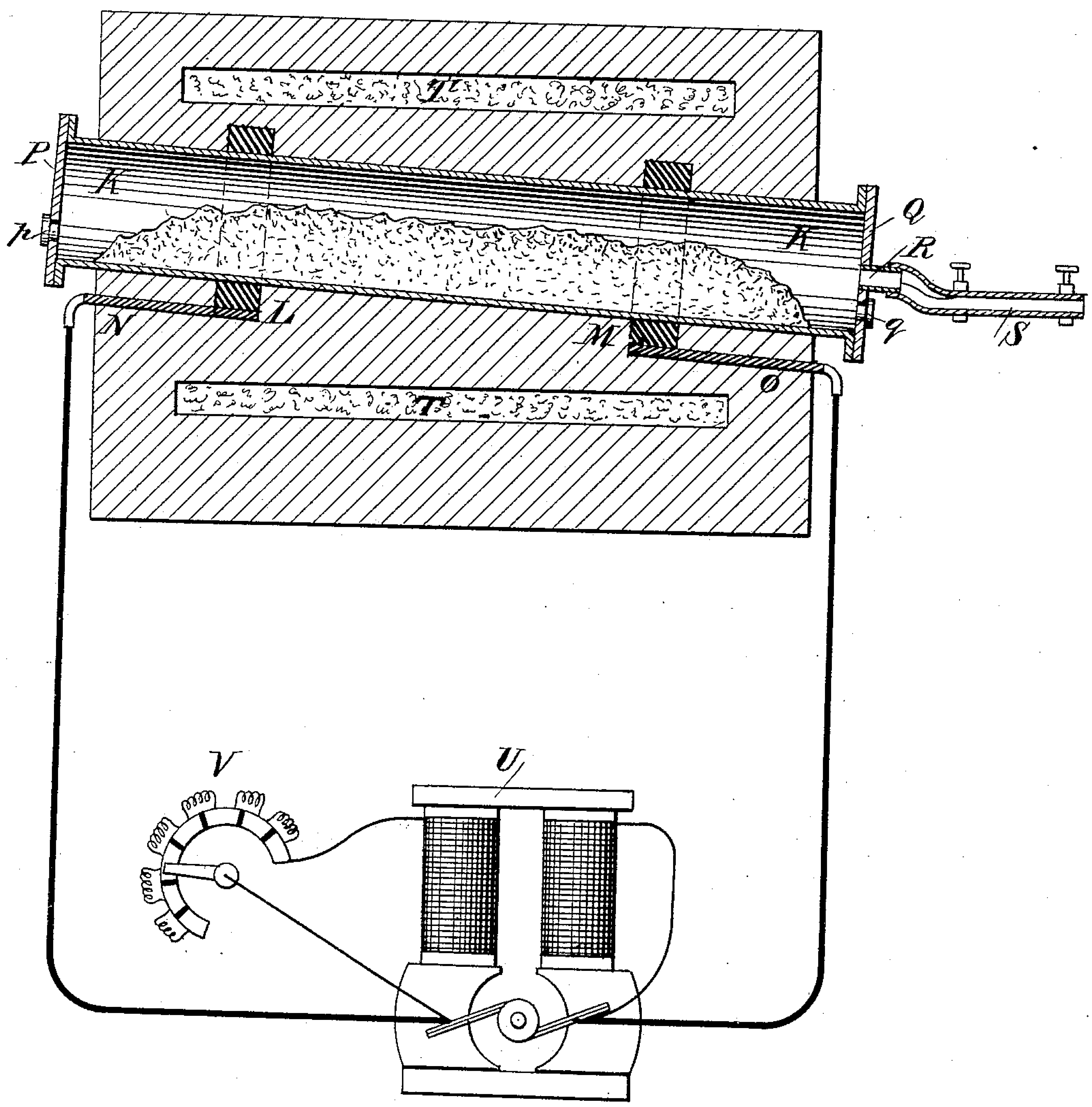
(No Model.)

C. S. BRADLEY & F. B. CROCKER.

PROCESS OF HEATING AND REDUCING ORES BY ELECTRICITY.

No. 335,499. Patented Feb. 2, 1886.



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UNITED STATES PATENT OFFICE.

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PROCESS OF HEATING AND REDUCING ORES BY ELECTRICITY.

SPECIFICATION forming part of Letters Patent No. 335,499, dated February 2, 1886.

Application filed March 14, 1885. Serial No. 158,805. (No model.)

To all whom it may concern:

Be it known that we, CHARLES S. BRADLEY, a citizen of the United States, residing at Yonkers, in the county of Westchester and State of New York, and FRANCIS B. CROCKER, a citizen of the United States, residing at New York, in the county and State of New York, have invented a new and useful Process of Heating and Reducing Ores by Electricity, of which the following is a specification.

In a large number of chemical and metallurgical processes in which high temperatures are required, and in which it is impossible, on account of the nature of the operation, to heat the materials by the direct action of fire in a reverberatory or blast furnace, it is customary to treat such materials in closed externally-heated crucibles or retorts. For example, the reduction of sodium, potassium, and zinc, and the manufacture of aluminium chloride, are carried on in this way; but this method is very troublesome and expensive. The crucibles or retorts are rapidly destroyed, and being necessarily small, in order that it shall not require too long to heat them through, the labor of charging and managing a large number of small retorts becomes very great.

The object of our invention is to overcome these and other difficulties, and to obtain the heat necessary to carry on such operations in a convenient and efficient manner, and to concentrate the heat exactly where it is needed; and, furthermore, our invention has for its object the attainment in commercial processes of temperatures very much higher than have ever been reached before.

Our invention is applicable to a large number of chemical and metallurgical processes; but in order to enable others to use the invention we shall describe in detail two or three of its most typical applications.

In the accompanying drawing, the figure illustrates one form of our apparatus, and represents a vertical longitudinal section of a furnace constructed according to our invention. The electrical arrangements are shown also in the figure diagrammatically.

The apparatus shown in the figure is especially designed to be employed for the reduction of sodium or potassium; and it consists of a hollow cylinder, K K, made of some suitable material which is a conductor of electricity. In this particular case it is represented as being made of wrought-iron, and is similar to the cylindrical retorts usually employed for making sodium and potassium. This cylinder K is set at a slight inclination in brick-work, as shown. On this cylinder there are two rings, L and M, of copper or other suitable metal. These rings fit the cylinder closely, so as to make good electrical connection.

To the rings L and M are respectively connected two heavy strips of copper, N and O, which lead to the outside of the furnace. The cylinder K is provided at each end with covers or caps P and Q. In these caps there are holes *p* and *q*, closed by screw-plugs. The door Q is also fitted with a pipe, R, to the end of which a condenser, S, is attached.

In the brick-work of the furnace there are spaces T T, which may be filled with asbestus, mineral wool, or other suitable non-conductor of heat; or these spaces may be left empty, air alone being a very good insulator of heat.

In working this furnace for the production of sodium the mixture of sodium carbonate, charcoal, and chalk usually employed in making sodium is charged into the cylinder K through the door P. The copper strips N and O are then connected, respectively, to the poles of a dynamo-electric machine, U, by large copper conductors, as indicated in the drawing, and a current of electricity is caused to pass along the cylinder K from the ring L to the ring M, the current being partly carried by the mixture contained in the cylinder, which mixture is a conductor by virtue of the carbon it contains, and partly by the metal out of which the cylinder K is made. These rings L and M distribute the current uniformly all around the cylinder. The dynamo U should be constructed to give a current of great "quantity," and the conductors and strips N and O, connecting it with the cylinder K, being made of heavy copper bars, so that the electrical resistance of the iron cylindrical shell K and of the mixture it contains will constitute the greater portion of the resistance of the circuit, consequently almost all the energy of the current will be converted into heat along the cylinder K, and since it is surrounded by non-conductors of heat the heat will accumulate and the temperature gradually rise until the heat consumed in the reduction of the sodium and lost by conduction through the walls of the furnace equals the heat produced by the passage of current.

The strength of the current, and consequently the temperature of the cylinder K, may be regulated and maintained at the proper point by means of the switch V, which governs the electro-motive force of the dynamo-machine by varying the resistance of the shunt-circuit which supplies the field-magnets, as shown.

The general method of carrying on the process is the same as in the process now commonly used for making sodium, and the sodium vapor produced by the action of the heat upon the mixture of sodium carbonate and charcoal passes out through the pipe R into the condenser S of the well-known form, P, in which it condenses and collects. The temperature and action within the cylinder may be seen by taking out the plug in either of the holes *p* or *q*. These holes also serve as poke-holes, through which the material may be poked or stirred. Fresh material is charged into the cylinder K through the door P, and any residue is taken out through the door Q. The charging of fresh material and discharging of residue is facilitated by the slope of the cylinder K, as shown in the drawing. In this way the process is made continuous and easy to manage.

Among the advantages of our process are: first, it is continuous, as we have just explained; second, the retort or cylinder is heated perfectly uniformly, instead of being heated, as sodium-retorts usually are, on the under side; third, the retort is set in solid brickwork, and is supported and held firmly in its proper place and shape on all sides; fourth, the temperature can be regulated perfectly.

In consequence of these advantages of our process the wrought-iron retorts will last almost indefinitely, whereas the retorts in the ordinary sodium process are very rapidly destroyed. In fact the renewal of retorts constitutes at present over one-half of the total cost of making sodium. This destruction of retorts is caused by the uneven heating, the strain due to their own weight and that of the materials they contain, and the "scaling" action of the hot gases, all of which difficulties, as we have already shown, are avoided in our process.

In actual practice our apparatus may be constructed and arranged as follows: We generally prefer to have a number of furnaces or apparatuses like the one shown in Fig. 1, and connect them so that the current will flow through them in series. For this purpose a dynamo must of course be used of correspondingly higher electro-motive force.

Potassium may be reduced by our process in precisely the same manner as we have described for sodium, except that a little higher temperature is required.

In employing our process for making zinc we use the same mixture of roasted zinc ore (zinc oxide) and carbon that is ordinarily used; but the cylinder A should be made of carbon instead of iron. The material consisting of graphite and clay, out of which the common graphite crucibles are made, is well adapted to the purpose. Otherwise the apparatus and process are substantially the same as the sodium process already described.

Instead of using a cylinder made in one piece, a chamber may be built up of a number of pieces. For example, the retort K in the figure may be made of plates of iron, and in the case of the furnace for reducing zinc a chamber may be built of bricks composed of the material referred to above out of which graphite crucibles are made.

The manufacture of aluminium chloride may be carried on by our process in an apparatus similar to that shown in Fig. 1; but in this case the cylinder K should be placed vertically, as in the ordinary form of apparatus used for making this chloride. The cylinder should in this case be made of graphite and clay, as in the zinc process already described, and the cylinder is heated by passing an electric current through it, as in the figure. The well-known mixture of alumina and carbon made up into balls is charged into the retort, and a stream of chlorine gas is introduced at the bottom of the cylinder, and the action of this upon the heated mixture of alumina and carbon produces aluminium chloride, which distills over through a pipe leading out of the upper part of the cylinder, and is collected in a suitable vessel or chamber.

It is obvious that other chemical and metallurgical processes may be carried on according to our invention in substantially the same manner as those we have described. It is also evident that various forms of furnace and built of various materials may be employed without departing from our invention. For example, in the form of furnace shown in the figure, instead of entirely surrounding the materials with an electrical conducting-cylinder, through which a current is passed, a conductor may be placed in the bottom alone and the materials laid upon it; or conductors may be placed in the sides or in the top of the chamber, in which latter case the materials would be heated by radiation from the heated conductors above them, which in some cases is a very desirable arrangement.

In an application for Letters Patent of the United States now pending (filed February 23, 1883, Serial No. 85,957) Charles S. Bradley, one of the present inventors, has described an electro-metallurgical process in which an electric current is employed to perform two functions: first, to effect the electrolytic decomposition of the materials treated, and, second, to supply the heat necessary to maintain said materials in the fused state while they are being electrolyzed.

The present invention resembles the above to a certain extent; but in the present invention the electric current which we employ performs no electrolytic action, the reaction which takes place being purely chemical, and the function of the current being solely to develop the heat which is a necessary condition of the reaction. For this reason our invention does not require the use of a continuous current of electricity. An alternating current may be employed, if desired, which is an advantage, since large alternating-current dynamos may be constructed more cheaply than the continuous-current machines, and it is also less trouble and expense to run them.

I am aware that in English Patents No. 4,043 of 1878 and No. 2,110 of 1879 processes are described in which materials are heated by means of electric currents. In one of these patents the heat of the electric arc is employed to fuse metals. In the other patent a furnace is described to be used for metallurgical processes, cooking meats, &c., in which the heat is produced by passing an electric current around the sides of the furnace; but no mention is made of mixing the materials with carbon and passing an electric current through the mixture.

In United States Patent No. 282,964, dated August 14, 1883, Delaplaine *et al.* describe a process for melting the tin off of common scrap sheet-tin by placing the scrap in a closed furnace and passing an electric current through it; but in this process there is no chemical action, and no carbon is mixed with the material.

We do not claim as our invention the arrangement of the material to be subjected to be treated in the form of a shallow deposit, or a furnace adapted to receive such a charge in the form of a shallow deposit; and we also disclaim the arrangement of oppositely-located carbon plates for conducting the current to the charge as being our invention.

Having now described our invention, what we claim, and desire to secure by Letters Patent, is—

1. The electrical heating process hereinbefore described, which consists in passing an electric current along the walls of a retort, which are composed of a conducting material, and are in superficial contact with a mixture of conducting material and material to be heated, which mixture is thereby included in the circuit, so that the walls of the retort and the mixture will constitute the greater portion of the resistance of the circuit, substantially as and for the purpose set forth.

2. The electrical heating process hereinbefore described, which consists in placing a mixture of charcoal and the material to be heated in a cylindrical iron retort surrounded by material which is a bad conductor of heat, and passing an electric current through the walls of the retort, so that the mixture in contact with them is included in the circuit, and so that the walls of the retort and the mixture will constitute the greater portion of the resistance of the circuit, substantially as and for the purpose set forth.

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