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W. S. ROMME.

PROCESS OF AND APPARATUS FOR DECOMPOSING SOLID SUBSTANCES.

(No Model.)

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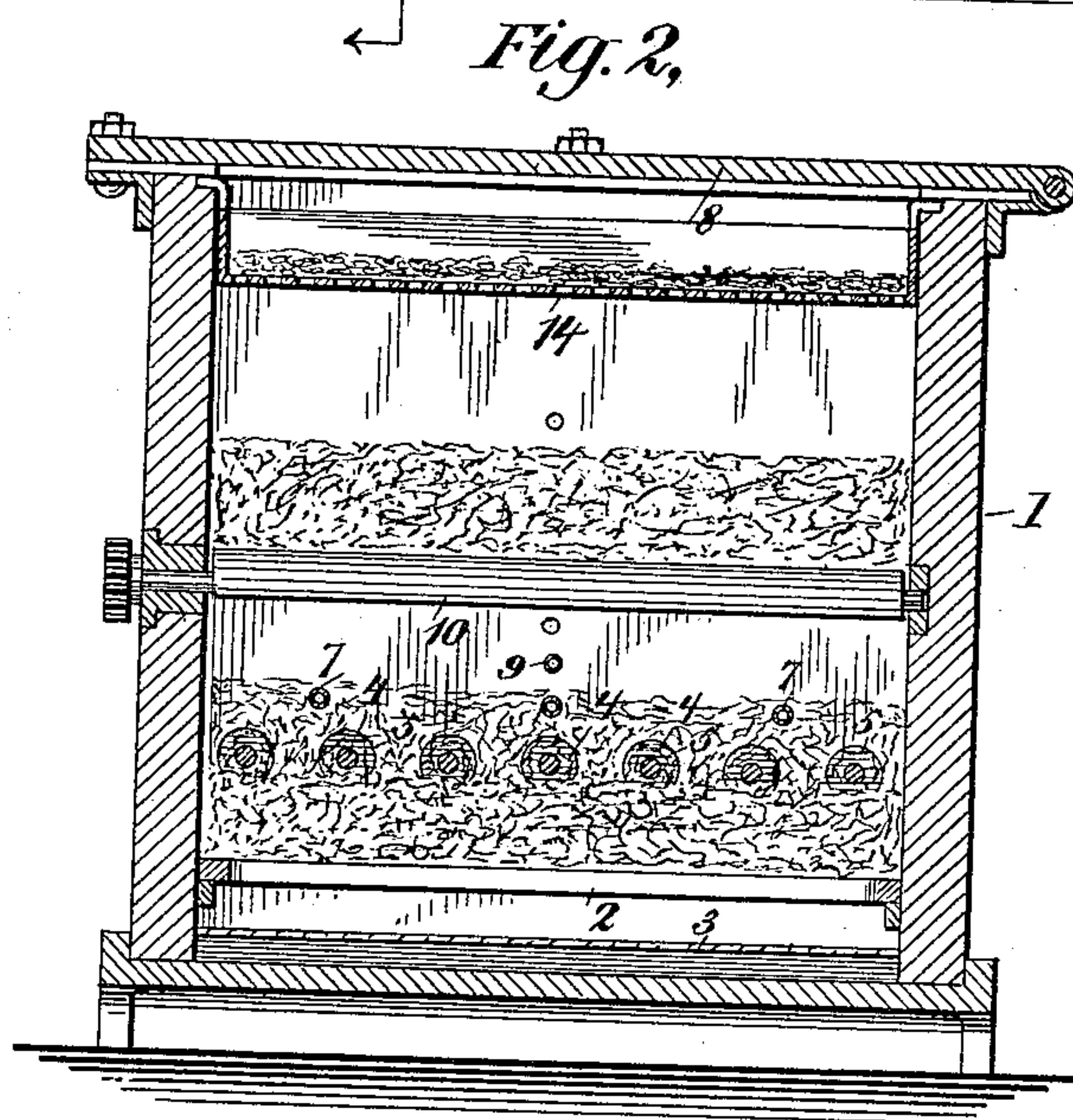
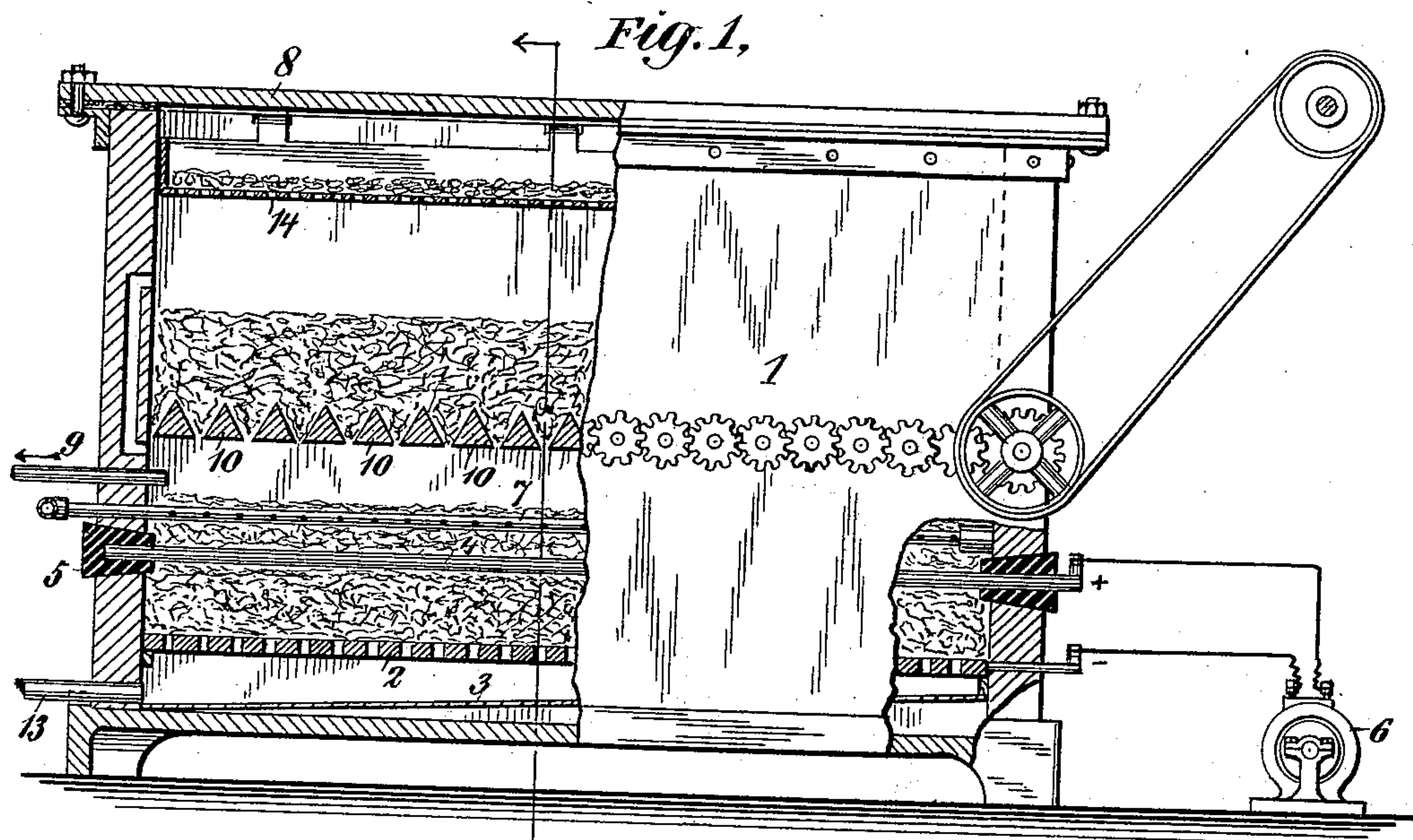
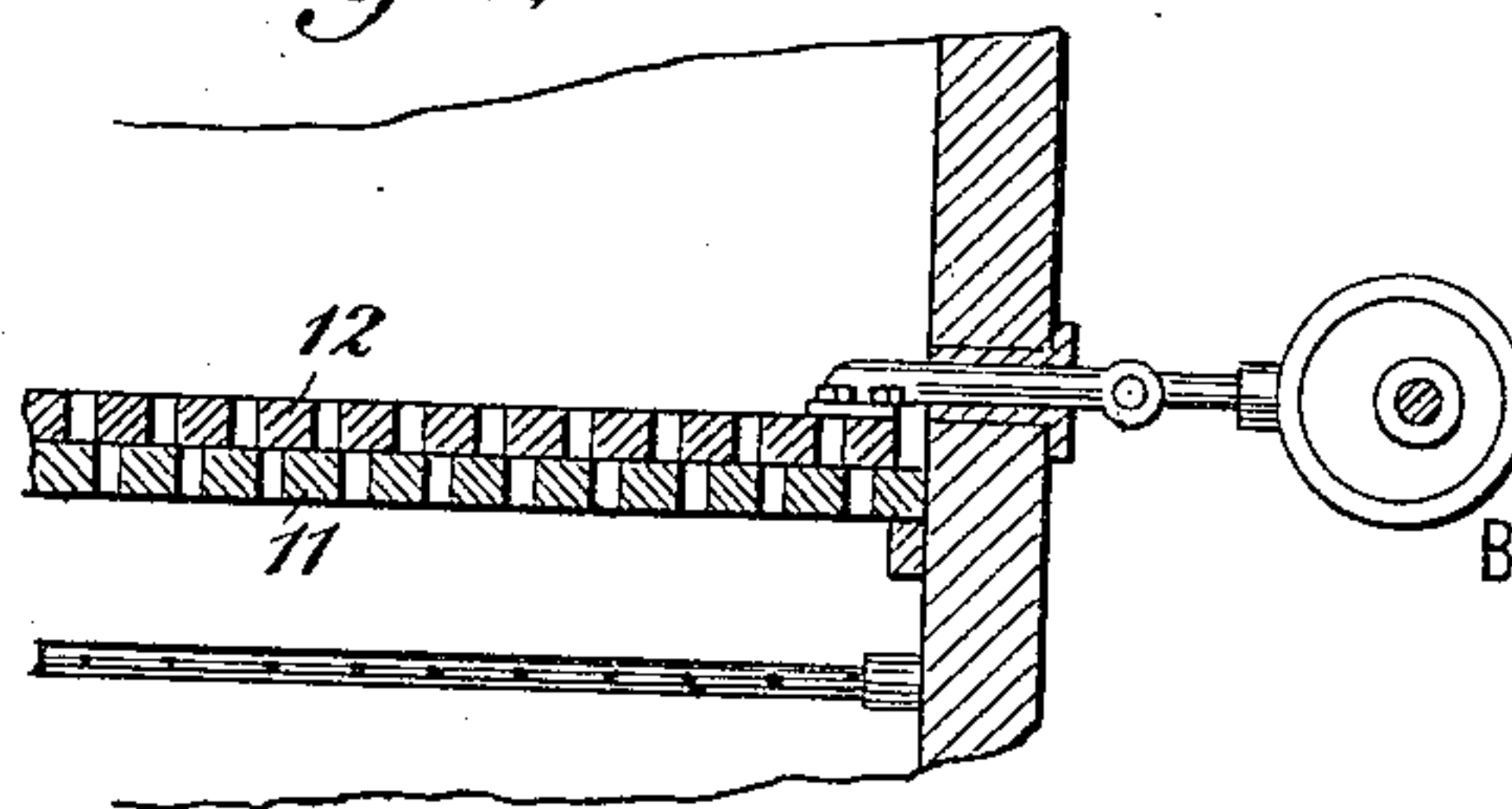


Fig. 3,



WITNESSES:

D. H. Mayhew
H. C. Lane

INVENTOR

William S. Romme

BY

E. M. Marbleton

ATTORNEYS

UNITED STATES PATENT OFFICE.

WILLIAM S. ROMME, OF NEW ROCHELLE, NEW YORK.

PROCESS OF AND APPARATUS FOR DECOMPOSING SOLID SUBSTANCES.

SPECIFICATION forming part of Letters Patent No. 606,981, dated July 5, 1898.

Application filed December 18, 1896. Renewed October 26, 1897. Serial No. 656,479. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM S. ROMME, a citizen of the United States, residing at New Rochelle, in the county of Westchester and State of New York, have invented a new and useful Process of and Apparatus for Electrically Decomposing Solid Substances; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to a process of electrically decomposing solid substances and to an apparatus for carrying out the process. The process is particularly intended by me for the decomposition of salts of alkalies, such as the chlorids of sodium and potassium and the production of hydrates or hydroxids and chlorin therefrom, but is equally applicable to the treatment of other salts and compounds which it is possible to decompose electrically.

My invention consists in causing water or other suitable fluid, a solvent of the substance treated, to percolate through the mass treated while the decomposition is going on, the fluid being used in such quantity as suffices merely to keep the mass moist without submerging it in the fluid; and my invention consists also in the apparatus used for carrying out the process.

The objects of my invention are, first, to provide a process of electrical decomposition of substances, such as those above mentioned, which shall require a comparatively small expenditure of electric current and shall avoid waste of current through the unnecessary decomposition of the water or other fluid solvent of the substance treated; second, to provide a process of electrical decomposition by which the substance to be decomposed may be placed in the decomposition-chamber and between the electrodes in a solid condition, thus avoiding the necessity of dissolving the substance treated as a step preliminary to the charging of the decomposition-chamber and which shall avoid the clogging of the fluid in the decomposition-chamber with the soluble products of decomposition, shall permit the withdrawal of the soluble products of the decomposition as they are formed and in a prac-

tically pure state while the process is going on and which may be carried out by the aid of simple apparatus, and shall be comparatively inexpensive; third, to provide a process of electrical decomposition by which all danger of recombination of the products of the decomposition may be removed, and, fourth, to provide a simple, effective, and comparatively inexpensive apparatus for carrying out the process. These objects are attained in the process of and apparatus for the electrical decomposition of solid substances herein described, the apparatus being illustrated in the drawings which accompany and form a part of this specification, in which the same reference-numerals indicate the same or corresponding parts, and in which—

Figure 1 is an elevation and partial longitudinal section of the apparatus. Fig. 2 is a transverse section of the apparatus; and Fig. 3 is a detail section illustrating a device for feeding down the substance to be treated to the field between the electrodes, which may be substituted for the device for the same purpose shown in Figs. 1 and 2.

In my process the substance to be treated is placed between the electrodes in a solid state. It is then moistened with water or other solvent of the substance treated to permit the ready passage of an electric current and the action of the current on the substance and an electric current is passed through the mass. During the time the electric current is passing I cause a stream of water or other solvent to percolate through the mass undergoing treatment, which keeps it moist and in condition to be acted upon by the electric current and insures a uniform action upon the substance treated and in flowing away carries with it the soluble products of decomposition. Only enough water is used to keep the mass undergoing treatment moist throughout, and I avoid the use of water in such quantity that the water itself is decomposed to any considerable extent, as work done in decomposing water is wasted. By using merely enough water to keep the mass under treatment moist I avoid the decomposition of the water itself by the electric current, and do not require an electric current of as great potential as has been required by most of the former systems of electrical decomposition,

in which the substance treated is first dissolved and the solution treated and in which there is a large quantity of free fluid present between the electrodes. In such systems it has usually been found necessary or preferable to employ a porous layer or partition of some sort separating the positive and negative electrodes, and which is ordinarily termed a "diaphragm," to prevent the substances liberated at the positive and negative electrodes from recombining. The diaphragm adds considerably to the electrical resistance of the cell and so necessitates a higher potential than is required by my system.

As my system of decomposition is conducted there is practically no free fluid between the electrodes, and what fluid is present is saturated with the substance under treatment and does not absorb the gas which may be liberated at one electrode. The absence of free fluid is due to the fact that the mass under treatment is merely kept moist with the fluid. This process also avoids all of the troubles and inconveniences to which systems of decomposition in which the substance to be treated is first fused are necessarily subject.

In the drawings, 1 is the tank, within which the treatment takes place, the walls of which are formed of some electric non-conductor.

2 is the negative electrode, which should be composed of some substance which will not be acted upon by the fluids in the tank, and which, for the decomposition of the salts of sodium and potassium, may with advantage be zinc. This electrode, as shown in the drawings, is a perforated plate, though as the equivalent of this construction a series of bars connected together and placed close to each other may be used. The electrode forms a false bottom to the tank. Beneath the electrode 2 is an inclined false bottom 3, which serves to catch the fluid as it flows through the perforations in the electrode.

4 4 are the positive electrodes and should be composed of some material which will not be affected by the fluids or gases within the tank and which may with advantage be carbon rods or sticks. They are supported at the ends in insulating-plugs 5. The ends of both the positive and negative electrodes project through the sides of the tank 1 and are connected to conductors leading to terminals of a dynamo 6 or other source of current. Near the positive electrodes are one or more pipes 7 for introducing water and which are perforated to spray the water and so distribute it uniformly over the substance treated.

In the decomposition of many substances—such, for instance, as potassium and sodium chlorid—one product of the decomposition is a gas, which, if collected, may be utilized to advantage. For this reason the tank may be provided with a cover 8, which may be closed and which will prevent the escape of gas. In the drawings this cover is shown as bolted down; but other well-known fastening devices which permit a more ready removal of

the cover may be used instead. In order to draw off the gaseous products of decomposition, a pipe 9 is provided which may, if necessary, be connected to an exhaust-pump. Instead of drawing off the gas it may be absorbed in an absorbent material, such as lime, within the tank 1. In the drawings I have shown a removable tray 14 for holding lime in the upper part of the tank, and have shown passages 15 in the sides of the tank through which the gas may pass into the upper part of the tank into proximity with the lime in the tray 14.

In order that the operation may be continued uniformly for a considerable period of time without removing the cover 8 to recharge the apparatus, I provide in the tank 1 and above the positive electrodes a series of polygonal bars 10, revolvably mounted in the sides of the tank 1 and geared together so that they may be revolved together. The bars are close to each other and prevent the passage of the substance to be treated, except when they are revolved. When they are revolved, they feed the substance down slowly.

Instead of using a series of polygonal bars 10 for feeding down the substance to be treated I can use a simpler feeding device, (shown in Fig. 3,) consisting of two perforated plates 11 and 12, the lower, 11, being stationary and the upper, 12, being movable laterally and being provided with an eccentric-rod and eccentric by which it may be vibrated.

My process is applicable to the treatment of any solid substance capable of being decomposed electrically, whether such substances be in the form of cakes, lumps, crystals, granules, or powder. The feeding apparatus illustrated in Figs. 1 and 2 is of course applicable only to the feeding of substances in a granular or pulverulent state, or the lumps or crystals of which are of no very great size. If it is required to treat substances in cakes or lumps of considerable size, some other appropriate feeding mechanism must be used, or it may be necessary to charge by hand from time to time.

The manner of carrying out the process may be illustrated by describing the production of chlorine and sodium hydrate or hydroxid from sodium chlorid—i. e., common salt. The salt in granular or crystalline form is placed between the positive and negative electrodes and also in the chamber above the grate-bars 10, and the mass of salt which lies between the electrodes is moistened by water from the pipes 7. The water dissolves a portion of the salt and holds it in solution in condition to be acted upon by the electric current. When the mass is moist throughout, the electric current is turned on and passes from the positive electrodes to the negative electrode. In passing through the mass of salt the electric current decomposes the salt in solution into its elements—viz., metallic sodium and chlorine gas. The chlorine gas rises

and is drawn through the pipe 9 and may be utilized in various ways—as, for instance, in the production of bleaching-powder. It may also be absorbed by an absorbent material, as lime, in the tank 14. The metallic sodium liberated immediately combines with the water to form caustic soda or “sodium hydrate” or “hydroxid,” as it is more properly termed. The caustic soda is carried by the water through the perforations in the negative electrode and falls upon the inclined false bottom 3, from whence it runs out through the pipe 13. Water is constantly supplied, but in such quantity only as suffices merely to keep the mass moist to take the place of the water which combines with the sodium and flows off through the perforations in the lower electrode. If the quantity of water used be properly regulated, the fluid which flows from the pipe 13 will be a strong solution of caustic soda containing little or no sodium chlorid.

It will be observed that as the decomposition goes on the products of the decomposition are carried away immediately. In former processes of decomposition where the salt has first been dissolved the caustic soda is left in the solution when formed and so clogs the solution. Moreover, as the process proceeds the salt solution becomes weaker and it is impracticable to utilize all of the salt in the solution.

The electrical resistance in my process is proportionately less than in those systems and apparatus in which a solution is treated and in which diaphragms separating the electrodes are employed. In my process the chlorin is liberated above the greater part of the mass of salt. The wasteful decomposition of the water itself by the electric current is practically avoided, and this is an advantage aside from the current saved, because when the water itself is decomposed some ozone is generated and attacks the positive electrodes, soon destroying them. All of these objections are avoided in the process above described. The treatment of the salt in a solid state instead of dissolving it before placing it in the apparatus has the further advantage that the apparatus may be much smaller than when solutions are used.

During the progress of the treatment the grate-bars 10 are slowly revolved, or if the form of feeding device shown in Fig. 3 is used the upper plate 12 is vibrated. This feeds the salt down slowly into the lower portion of the tank, thus supplying fresh salt to take the place of that which has been decomposed and keeping the quantity of salt between the electrodes practically constant. This insures uniformity in the operation of the apparatus and keeps the potential required practically uniform. Sodium carbonate when treated in a similar manner is decomposed into carbonic acid gas and sodium oxid. The sodium oxid when formed is immediately converted into the hydrated oxid or hydroxid and passes off as before. Salts of substance similar to the so-

dium salts—such as, for instance, the potassium salts—may be treated in the same manner with corresponding reactions.

Instead of introducing water through the pipes 7 as a liquid I may introduce it as steam, which will immediately become liquid in the tank. Steam, however, penetrates the mass undergoing treatment more readily than a liquid.

I do not mean to imply by terming the process herein described “a process for the decomposition of solid substances” that the decomposition takes place while the substance under treatment is in a solid condition. I so term my process to distinguish it from the processes most generally used heretofore, in which the substance to be decomposed is dissolved as a preliminary step and in which an excess of the solution is present while the decomposition is going on, so that a diaphragm or other device is required to prevent recombination of the products of the decomposition. It is probable that in my system only that portion of the substance which is actually in solution at any given instant is undergoing decomposition at that instant. By my process, however, the amount of fluid present is so small that it is always saturated with the substance treated, and for this reason does not absorb readily any gas which may be liberated.

Having thus completely described my invention, what I claim, and desire to secure by Letters Patent, is—

1. The herein-described process of decomposing solid substances electrically, which consists in placing the substance to be acted upon between electrodes, and causing a liquid solvent of the substance treated to percolate through the mass in such quantity as suffices merely to keep the mass moist, without submerging the mass in said fluid, and passing an electric current through the mass, substantially as described.

2. The herein-described process of decomposing soluble salts of sodium and like substances, which consists in placing the salt in a solid state between electrodes, and causing water to percolate through the mass in such quantity as suffices merely to keep the mass moist, without submerging the mass in the water, and passing an electric current through the mass, substantially as described.

3. The herein-described process of decomposing sodium chlorid and like chlorids electrically, which consists in placing the sodium or other chlorid in a solid state between electrodes, and causing water to percolate through the mass in such quantity as suffices merely to keep the mass moist, without submerging the mass in the water, and passing an electric current through the mass, substantially as described.

4. The method of electrolyzing a readily-soluble metallic salt, which consists in supplying to a granular body of such salt a liquid solvent in such quantity that the solvent will

be retained between the particles of the salt by capillarity without submerging the body, in passing through such body and solvent a continuous current of electricity, and replacing as required such portions of the solvent as may have been removed by electrolysis and evaporation, substantially as described.

5. In an apparatus for electrically decomposing solid substances, the combination, with a tank adapted to contain the substance treated, of electrodes within said tank, placed one above the other and between which the substance treated may be placed, and adapted to be connected to an electric generator and to pass an electric current through the mass to be treated, the upper electrode having passages through which the substance to be treated may descend to the space between the electrodes, and the lower electrode being provided with openings through which fluids may pass, means for supplying a fluid to the mass within said tank, and means for collecting the soluble products of the decomposition which flow through the openings in said lower electrode, substantially as described.

6. In an apparatus for electrically decom-

posing solid substances, the combination, with a tank adapted to contain the substance treated, of electrodes within said tank, placed one above the other and between which the substance treated may be placed, and adapted to be connected to an electric generator and to pass an electric current through the mass to be treated, the upper electrode having passages through which the substance to be treated may descend between the electrodes, and the lower electrode being a perforated plate forming the bottom of the chamber in said tank in which the decomposition takes place, means for supplying a fluid to the mass within said tank, and a collecting-chamber below said lower electrode adapted to receive the soluble products of the decomposition which flow through said electrode, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

WILLIAM S. ROMME.

Witnesses:

FRANCES A. SPERRY,
HARRY M. MARBLE.