W. A. PHILLIPS.

APPARATUS FOR DRYING POWDER.

APPLICATION FILED AUG. 13, 1913.

1,232,839.

Patented July 10, 1917.

2 SHEETS—SHEET 1.

Fig. 1

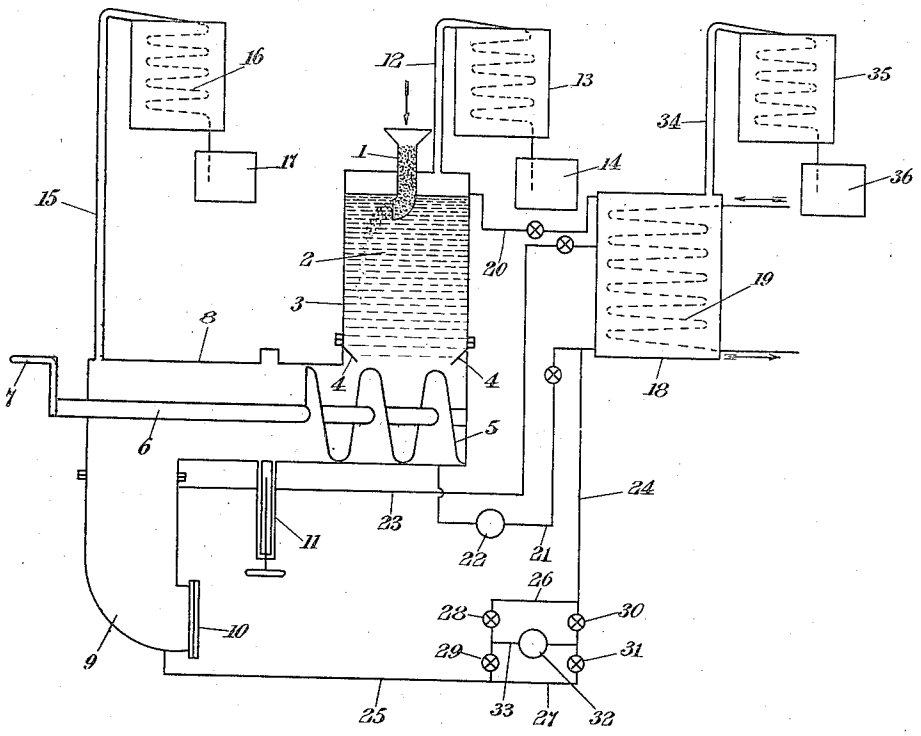
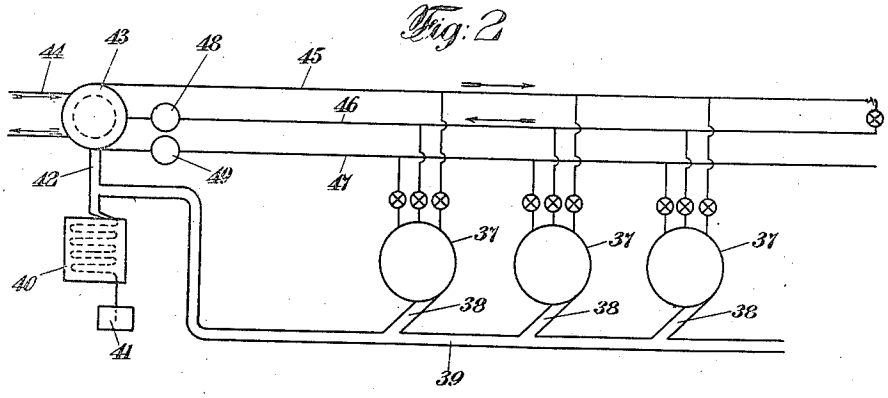


Fig. 2



Witnesses:

D. C. Seagrave

Mabelle L. Dore

William A. Phillips, Inventor

By his Attorneys

Prindle & Wright

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2 SHEETS—SHEET 2.

Fig. 3

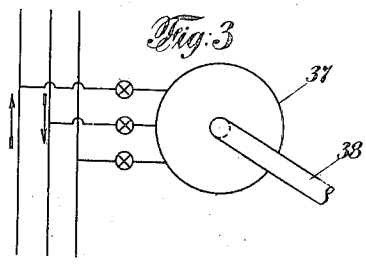


Fig. 1

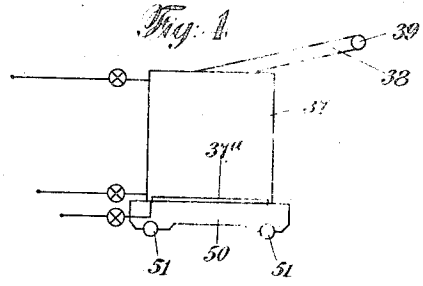


Fig. 5

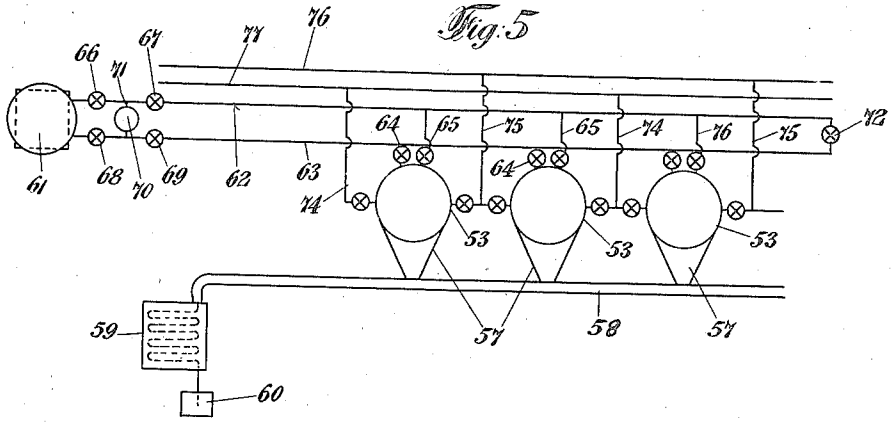


Fig. 6

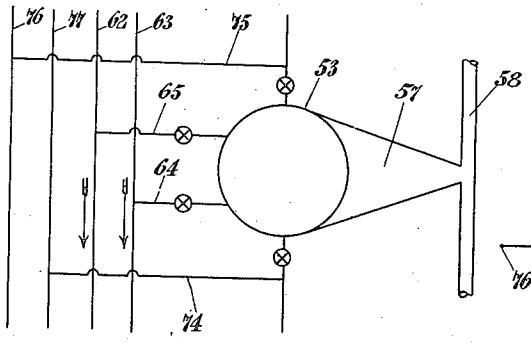
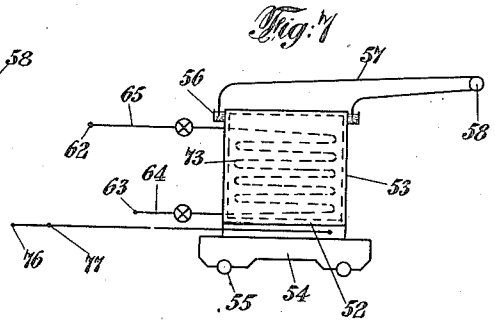


Fig. 7



Witnesses:

L. C. Seagrave

Mabelle I. Hare

William A. Phillips Inventor

By his Attorneys

Prindle & Knight

UNITED STATES PATENT OFFICE.

WILLIAM A. PHILLIPS, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO E. I. DU PONT DE NEMOURS POWDER COMPANY, OF WILMINGTON, DELAWARE, A CORPORATION OF NEW JERSEY.

APPARATUS FOR DRYING POWDER.

1,232,839. Specification of Letters Patent. Patented July 10, 1917.

Application filed August 13, 1913. Serial No. 784,487.

To all whom it may concern:

Be it known that I, WILLIAM A. PHILLIPS, of Philadelphia, in the county of Philadelphia, and in the State of Pennsylvania, have invented a certain new and useful Improvement in Apparatus for Drying Powder, and do hereby declare that the following is a full, clear, and exact description thereof.

My invention relates to an apparatus for drying explosives of many different kinds, but it has special reference to drying smokeless powders. It is to be understood, however, that my invention is applicable to the drying of many different products of similar kind which are of such a nature that they may be dried in accordance with my invention hereinafter set forth.

Hitherto, it has been customary to recover the solvents used in producing smokeless powders, by methods which have been disadvantageous in many ways. Smokeless powders have been previously dried by the circulation of hot air through the powder grains. The hot air thus circulated through the powder grains carried off the greater part of the solvent, this air being subsequently conducted to a condenser to remove the solvents from the current of air; the maximum amount of solvent that could be recovered in this manner was about sixty per cent.; and it was necessary to treat the powder for a further period of from one to four months in order to reduce the solvent still contained in the powder to a sufficient extent to give proper ballistic results. But even after the drying of the powder for this extended period, a comparatively large percentage of solvent was still left in the powder, which solvent was not entirely uniformly distributed in the grains thereof, and the grains furthermore showed signs of strain and distortion. Again, the solvent retained in the grains is liable to become partially oxidized, to form hydrogen peroxid, ozone, acids, and other objectionable substances which may decompose the powder. And the vapors of solvents evolved from the powder during storage in air-tight containers are capable of forming an explosive mixture with the air, resulting at times in an explosion. Furthermore, the very long heating necessary to recover the solvent in the solvent recovery and to finish the drying in the dry-house shortens the life of the powder by quickening the spontaneous decomposition of the nitric esters, thus leading to the possibility of grave accidents. A further disadvantage of said heating is the fact that a portion of the stabilizers is caused to escape by volatilization. A further frequent cause of decomposition is the presence of bacteria in the powder.

The object of my invention is to provide an apparatus whereby the above disadvantages are avoided. By means of my invention, furthermore, a more complete recovery of the solvents is obtained, and the powders thus produced show remarkable results in ballistic qualities, keeping qualities, resistance to the injurious influence of moisture, heat, etc.

My invention comprises in general an apparatus for drying powder by the use of a liquid, such for example as oil instead of by the application of air. The oil used for this purpose should preferably be stable and not subject to chemical change. It must be free from acid, have a high flash point, and possess a low viscosity and a low solidifying point. An oil of this character will penetrate the pores of the powder grains and will extract the solvents and absorb the same therefrom by osmosis. The even drying avoids the strain and distortions which were produced in the grains dried by former apparatus.

My invention is capable of being carried out in many different ways, but for the purpose of illustration, I have shown certain forms of my invention in the accompanying drawings, in which,

Figure 1 is a diagrammatic representation of one form of apparatus that may be used for carrying out my invention,

Fig. 2 is a diagrammatic representation of another form of apparatus which may be used for carrying out my invention,

Figs. 3 and 4 are diagrammatic representations of details of an apparatus of the type shown in Fig. 2,

Fig. 5 is a diagrammatic representation of another arrangement of apparatus which

may be used for carrying out my invention, and

Figs. 6 and 7 are diagrammatic representations of details of a type of apparatus such as that shown in Fig. 5.

Reference being had particularly to Fig. 1, the powder from the cutters is conducted through a funnel 1, the lower end of which is sealed within a body of oil 2 contained within a tank 3. At its lower end the tank 3 has baffles 4 to guide the grains of powder to a screw conveyer 5 located in the bottom of the tank 3 and having a shaft 6 and operating handle 7 which extends laterally out through a horizontal extension 8 attached to the lower end of the tank 3. When the powder grains have thus been received by the tank 3 they are thereafter conveyed by the conveyer 5 to a vertical drying chamber 9 which is attached to the end of the horizontal extension 8. The lower end of the vertical drying chamber is closed by a cover 10. When the powder has been treated in the drying chamber 9 the conveyer 5 is moved to the left of the apparatus, as shown in Fig. 1, and a valve 11, located in the horizontal section 8, is moved upwardly so as to separate the tank 3 from the drying chamber 9. Any vapors of solvents, such, for example, as ether, alcohol, acetone, etc., that are produced in the tank 3 are conducted upwardly through a pipe to a condenser 13, from which the liquid solvents are conducted to a receptacle 14. The condenser 13, as in the case of all the other condensers to be referred to in this application, may be cooled by a current of water, or in any other desired manner. The solvent vapors which are formed in the drying chamber 9 are conveyed through a pipe 15 to a condenser 16, from which the condensed solvents are collected by means of a receptacle 17. Means are provided for circulating a body of oil in the tank 3 and in the drying chamber 9 and also for withdrawing the oil from the drying chamber 9. This is accomplished by means of an oil chamber 18 having a heating coil 19 therein preferably provided with a supply of steam. The heating chamber 18 is connected to the top of the tank 3 by a valved pipe 20 and to the bottom of the tank 3 by a valved pipe 21, the latter being provided with a circulating pump 22. The oil chamber 18 is also connected to the top of the drying chamber 9 by a valved pipe 23 and to the bottom thereof by pipes 24 and 25. The pipes 24 and 25 are connected to each other by two parallel pipe connections 26 and 27, each of which has a pair of valves 28, 29, 30 and 31. A pump 32 is provided in another pipe 33 which is bridged between the pipe connections 26 and 27 at points located between the pairs of valves, as indicated in Fig. 1. Any vapors that are formed in the oil chamber 18 are conveyed upwardly through a pipe 34 to a condenser 35, from which the condensed solvents are collected by means of a receptacle 36.

I have shown somewhat similar arrangements in the other figures. In the arrangement shown in Figs. 2, 3 and 4, the powder grains are delivered into a series of movable containers or drying chambers 37, each of which has a column 38, which may be connected to a pipe 39 leading to a condenser 40, having a discharge receptacle 41 for the condensed solvents. If desired, the movable containers 37 may have doors 37a near the bottom thereof to facilitate the removal of the powder. The same condenser 40 is arranged in this instance to receive vapors by means of a pipe 42 from an oil chamber 43, provided with heating coils 44 in the same manner as in the arrangement shown in Fig. 1. Pipes similar to those shown in Fig. 1 as being connected to the oil chamber 18 are provided in this instance. Circulating pipes 45 and 46 are provided to circulate heated oil through the containers 37 and a third pipe 47 is provided to draw the oil from the containers. Pipes 46 and 47 are supplied with pumps 48 and 49 to bring about the movement of the oil in the pipes 46 and 47. As shown in Fig. 4, each of the containers may be carried upon a skid 50 having wheels 51 so as to permit the same to be readily moved from one point to another in the plant.

The arrangement shown in Figs. 5, 6 and 7 is constructed in a manner somewhat similar to that shown in Figs. 2, 3 and 4. In this instance, however, the powder grains are carried in a wire cage or bag 52 made in any desired manner, said wire cage or bag 52 being received in movable containers or drying chambers 53 situated upon movable skids 54 having wheels 55. The top of each of the movable containers 53 has a water seal 56 in which is received the larger end of a solvent header 57. The smaller ends of the solvent headers 57 communicate with a common pipe 58 leading to a condenser 59 having a discharge receptacle 60. In this instance, an oil tank 61 is provided, having pipes 62 and 63 connected by means of branches 64 and 65 with the containers 53 in order to circulate oil through the same. In this modification a pair of valves 66 and 67 are provided in the pipe 62 and a similar pair of valves 68 and 69 are provided in the pipe 63. A pump 70 is located in a pipe 71 bridging the two pipes 62 and 63 between the two pairs of valves just referred to. At their ends the pipes 62 and 63 may be connected together and have a valve 72 at the point where the pipes are connected. In this arrangement the oil is not heated in the oil chamber 61, but there may be provided instead heating coils 73 in each of the chambers 53, said heating coils being connected by means of valved pipes 74 and 75 to steam

pipes 76 and 77 in order to provide a supply of steam for the heating coils.

In the operation of the apparatus shown in Fig. 1, the powder from the cutters is conveyed into the tank 3 filled with a suitable body of oil to effect the drying of the powder. The powder is conveyed into the tank 3 through the funnel 1, the lower end of which is sealed in the body of oil, so that no vapors arising from the powder and the oil can escape from the tank 3. As soon as the powder has become immersed in the oil, the transfer of the solvent from the powder to the oil begins even at ordinary temperatures, and the volume of the liquid increases as the volume of the powder decreases. The transfer of solvent from the powder to the oil may be hastened by circulating warm or hot oil from the oil chamber 18, the oil in which may be heated by means of the steam coils 19 therein. In order to effect the circulation of the oil at this period in the process, the pump 22 may be operated so as to circulate the oil from the oil chamber 18 through the valved pipes 20 and 21. Any solvent vapors which arise from the tank 3 during such treatment are condensed in the condenser 13 and conveyed to receptacle 14. The powder which has been subjected to this preliminary treatment may be then removed by means of the conveyer 5 to the drying chamber 9. If desired, the process may, in fact, be carried out continuously by continually feeding in the powder through the funnel 1 and removing the same through the door 10 from the drying chamber 9, in the manner to be hereinafter described. If desired, after the powder grains have been conveyed to the drying chamber 9, the conveyer 5 may be withdrawn to the left of valve 11 shown in Fig. 1 and said valve 11 may be closed so as to separate the tank 3 from the drying chamber 9. Oil may then be circulated, if desired, in the drying chamber 9 by means of the pump 32, the valves 28, 29, 30 and 31 being in proper position, until the solvent in the powder has been removed. Any vapors which are evolved by the treatment in the drying chamber 9 are condensed in the condenser 16 and recovered in the receptacle 17, and any vapors which are evolved at any stage in the process from the oil chamber 18 are condensed in the condenser 35 and collected in the receptacle 36. If now it is desired to remove the powder from the drying chamber 9, the oil is withdrawn from the same by closing the valve in the pipe 23 and operating the pump 32 with the valves 28, 29, 30 and 31 in proper position for this purpose. The oil having been drained from the drying chamber 9 in this manner, the door 10 is detached and the body of powder removed from the drying chamber. If desired, the powder removed from the dying chamber 9 can be subjected to a washing operation with gasolene or other solvent of the oil remaining upon the powder, so as to remove said oil therefrom. And to remove the gasolene, or other similar solvent the powder may be subjected to aeration.

The operation of the form of apparatus shown in Figs. 2, 3 and 4 is, in general, the same as in the case of the operation of my invention with the apparatus shown in Fig. 1. It differs, however, in the following respects: The movable containers 37, having been charged with a quantity of powder while on the movable skids, said containers are moved into a position in which the several pipes of the apparatus may be connected, and the solvent pipes 38 are then connected to the pipe 39, and pipes 45, 46 and 47 are also connected to the containers 37. Heated oil may now be circulated from the oil chamber 43 to the several containers 37 until the powder therein has been sufficiently dried. Meanwhile, any vapors evolved from the containers 37 and the oil chamber 43 are condensed in the condenser 40 and recovered in receptacle 41. After the powder has been dried in this manner, the oil circulating pipes are closed by turning the valves located therein and the oil in the containers 37 is removed by means of pipe 47 through the operation of the pump 49. The containers 37 may now be disconnected and conveyed to any suitable place where the powder located therein may be subjected to a washing operation with gasolene, or other suitable solvent of the oil, so as to remove the remainder of the oil present on the powder. The solvent remaining on the powder may be removed by aeration, if desired. In order to economize space, the several containers may be operated when nearly filled with powder. It is to be understood, however, that the several containers 37 may be operated in such a manner that the treatment of the bodies of powder in the several containers may be finished in sequence so as to economize time, labor, etc. It is also to be understood that, if desired, the circulation of the oil may be effected through the several containers in sequence on the counter current principle, so that the body of powder which has been subjected to the longest period of treatment is being subjected to oil coming direct from the oil chamber, while the other containers receive the oil from the first mentioned container in sequence.

The apparatus shown in Figs. 5, 6 and 7 is operated in the same manner as the apparatus shown in Figs. 2, 3 and 4, except in the following respects: In this instance, the cages 52, having been charged with suitable quantities of powder, are placed in the receptacles 53 and are then moved upon the movable skids 54 to their proper positions to permit the various pipes of the drying

system to be connected thereto. The solvent headers 57 are then placed in position so that they are connected to the common pipe 58, and the remaining pipes of the system are connected to the containers 53. Oil is now circulated from the oil receptacle 61 through the containers 53 and, if it is desired to circulate a heated current of oil currents of steam are led through the heating coils 73 in the bottom of the containers. Any vapors produced in the system in this instance are evolved from the containers 53 and are thereupon condensed in the condenser 59 and recovered from the receptacle 60. When the drying operation has been completed, the oil present in the containers is removed by means of the pump 70 and conveyed into the oil chamber 61. In this instance, the several containers may be operated in serial order in the manner described in connection with the apparatus shown in Figs. 2 to 4.

In the treatment by means of oil in the several forms of my apparatus above described, the oil is caused to mix homogeneously, so that all portions of the oil are brought into intimate and uniform contact with the powder under treatment. As a result, there is also an agitation within the bodies of powder which carries off any air bubbles. Furthermore, the circulation of the liquid through the bodies of powder distributes the heat uniformly throughout the same, so that thereby the solvent is uniformly transferred to the oil in an efficient manner. Powder which is treated in this manner may be dried in a few days, whereas the previous method in use, involving the application of heated air, required a period of several months to complete the drying operation. The use of oil causes the powder to be more quickly dried, owing to the greater conductivity of oil for heat and, furthermore, permits the transfer of a large number of thermal units to the powder in a short time without unduly raising the temperature thereof. Furthermore, there is a more complete contact between the oil and the powder, as the oil penetrates and permeates the grains thoroughly. The operation is such as to cause an efficient removal of the solvent from the powder by osmosis. The treatment of powder in accordance with my invention is for such a short period of time that practically no deterioration of the powder takes place, and there is consequently avoided the disadvantageous result of previous processes in which the rate of spontaneous decomposition increases rapidly during storage, the rapidity of decomposition being greater the longer the powder has been subjected to elevated temperatures. It will thus be seen that powders dried in accordance with my invention have a longer period of life and may be carried in storage and handled with much greater safety than the powders dried by former processes. Furthermore, on account of the absence of solvent vapors evolved during storage, there is not the tendency to form explosive mixtures with air, which makes powders dried by previous processes unsafe when stored for a considerable length of time. The circulation of the oil, in addition to expelling air bubbles, also has the effect of expelling the water which is found in the powder mass and which has been left therein from the solvents used, which solvents contain about seven per cent. of water, and also expelling the microscopic drops of water which have condensed on the grains during their shaping and cutting. The presence of such moisture would contribute considerably to the deterioration of the powder, a fact which is proven by the short life of powders in moist climates. Besides being anhydrous, the powders dried in accordance with my invention are non-hygroscopic, owing to the fact that a slight amount of the oil remains in the grains after the treatment. Another advantage of my invention is that it does not result in the volatilization of stabilizing agents, such, for example, as diphenylamin, which are incorporated in powders to neutralize the traces of acid fumes evolved during spontaneous decomposition. If desired in the treatment in accordance with my process, in order to avoid any loss of the diphenylamin or other stabilizers by solution in the oil, a quantity of the stabilizer may be added to the oil before treatment of the powder. The temperature of the oil in the treatment of the powder may be as high as 100° C., or even higher, and the various parts of the apparatus may be constructed, if desired, in such a manner as to make use of such temperatures. It will also be seen that the treatment in accordance with my invention destroys all bacteria contained in the powder by sterilization.

In addition to the advantages pointed out above, there are still further advantages in the use of my invention. The solvents, such as ether, alcohol, acetone, etc., are almost completely recovered. Furthermore, it is found that powder treated in the manner indicated retains its ballistic properties constant. If desired, the powder may be dried without any elevation of temperature above atmospheric temperature. The powder treated in the manner indicated, in accordance with my invention, is comprised of grains that are homogeneous in structure and show neither distortion nor strain. There is an entire absence of danger due to superheating, formation of electric charges, sparks, etc., during the treatment. By using a circulating current of oil, the drying operation may be more readily controlled than in the case of previous apparatus. Again, the

circulating oil does not depend, as in the case of heated air, for the removal of solvent through the action of vapor tension, but is accomplished by osmosis. The amount of heat expended in the apparatus is very small and the plant necessary is not large.

While I have described my invention in detail, I wish it to be understood that many changes may be made therein without departing from the spirit of my invention.

I claim:

1. In combination, a liquid container, means for supplying a solid thereto, and means for circulating a liquid through the container, comprising a circulating device, a tank having heating coils and a vapor pipe and condenser connected to the tank.

2. In combination, a liquid container, a vapor pipe and condenser attached thereto, means for supplying a solid thereto, and means for circulating a liquid through the container comprising a circulating device.

3. In combination, a liquid container, a vapor pipe and condenser attached thereto, means for supplying a solid thereto, and means for circulating a liquid through the container, comprising a tank having heating coils and a vapor pipe and condenser connected to the tank.

4. In combination, a liquid container having two treating chambers for solids, displaceable means for conveying a solid from one to the other, and means for closing communication between the same when the conveying means is displaced.

5. In combination, a liquid container having two treating chambers for solids, a screw conveyer for conveying a solid from one to the other, and means for closing communication between the same.

6. In combination, a liquid container having two treating chambers for solids, vapor pipes and condensers connected to the two chambers, means for conveying a solid from one to the other, and means for closing communication between the same.

7. In combination, a liquid container having two treating chambers for solids, vapor pipes and condensers connected to the two chambers, a screw conveyer for conveying a solid from one to the other, and means for closing communication between the same.

8. In combination, a liquid container having two treating chambers for solids, vapor pipes and condensers connected to the two chambers, a screw conveyer for conveying a solid from one to the other, and a valve for closing communication between the same.

9. In combination, a liquid container having two treating chambers for solids, vapor pipes and condensers connected to the two chambers, means for circulating oil in said two chambers, comprising a tank having a heating coil, and a vapor pipe and condenser, means for conveying a solid from one to the other, and means for closing communication between the same.

10. In combination, a liquid container having two treating chambers for solids, vapor pipes and condensers connected to the two chambers, means for circulating oil in said two chambers, comprising a tank having a heating coil, and a vapor pipe and condenser, a screw conveyer for conveying a solid from one to the other, and means for closing communication between the same.

11. In combination, a liquid container having two treating chambers for solids, vapor pipes and condensers connected to the two chambers, means for circulating oil in said two chambers, comprising a tank having a heating coil, and a vapor pipe and condenser, a screw conveyer for conveying a solid from one to the other, and a valve for closing communication between the same.

12. In combination, a liquid container having two treating chambers for solids, vapor pipes and condensers connected to the two chambers, means for circulating oil in said two chambers, comprising a tank having a heating coil, and a vapor pipe and condenser, means for conveying a solid from one to the other, means for closing communication between the same, an inlet for solids to one of the chambers, and an outlet for solids from the other chamber.

13. In combination, a liquid container having two treating chambers for solids, vapor pipes and condensers connected to the two chambers, means for circulating oil in said two chambers, comprising a tank having a heating coil, and a vapor pipe and condenser, a screw conveyer for conveying a solid from one to the other, means for closing communication between the same, an inlet for solids to one of the chambers, and an outlet for solids from the other chamber.

14. In combination, a liquid container having two treating chambers for solids, vapor pipes and condensers connected to the two chambers, means for circulating oil in said two chambers, comprising a tank having a heating coil, and a vapor pipe and condenser, a screw conveyer for conveying a solid from one to the other, a valve for closing communication between the same, an inlet for solids to one of the chambers, and an outlet for solids from the other chamber.

15. In combination, a liquid container having two treating chambers for solids, a displaceable screw conveyer for conveying a solid from one to the other, and means for closing communication between the same when the screw conveyer is displaced.

16. In combination, a liquid container having two treating chambers for solids, a screw conveyer for conveying a solid from one to the other, and a valve for closing communication between the same.

17. In combination, a liquid container

having two treating chambers for solids, a displaceable screw conveyer for conveying a solid from one to the other, and a valve for closing communication between the same when the screw conveyer is displaced.

18. In combination, a liquid container having two treating chambers for solids, vapor pipes and condensers connected to the two chambers, displaceable means for conveying a solid from one to the other, and means for closing communication between the same when the conveying means is displaced.

19. In combination, a liquid container having two treating chambers for solids, vapor pipes and condensers connected to the two chambers, a displaceable screw conveyer for conveying a solid from one to the other, and means for closing communication between the same when the screw conveyer is displaced.

20. In combination, a liquid container having two treating chambers for solids, vapor pipes and condensers connected to the two chambers, a displaceable screw conveyer for conveying a solid from one to the other, and a valve for closing communication between the same when the screw conveyer is displaced.

21. In combination, a liquid container having two treating chambers for solids, vapor pipes and condensers connected to the two chambers, means for circulating oil in said two chambers, comprising a tank having a heating coil, and a vapor pipe and condenser, displaceable means for conveying a solid from one to the other, and means for closing communication between the same when the conveying means is displaced.

22. In combination, a liquid container having two treating chambers for solids, vapor pipes and condensers connected to the two chambers, means for circulating oil in said two chambers, comprising a tank having a heating coil, and a vapor pipe and condenser, a displaceable screw conveyer for conveying a solid from one to the other, and means for closing communication between the same when the screw conveyer is displaced.

23. In combination, a liquid container having two treating chambers for solids, vapor pipes and condensers connected to the two chambers, means for circulating oil in said two chambers, comprising a tank having a heating coil, and a vapor pipe and condenser, a displaceable screw conveyer for conveying a solid from one to the other, and a valve for closing communication between the same when the screw conveyer is displaced.

24. In combination, a liquid container having two treating chambers for solids, vapor pipes and condensers connected to the two chambers, means for circulating oil in said two chambers, comprising a tank having a heating coil, and a vapor pipe and condenser, displaceable means for conveying a solid from one to the other, means for closing communication between the same when the conveying means is displaced, an inlet for solids to one of the chambers, and an outlet for solids from the other chamber.

25. In combination, a liquid container having two treating chambers for solids, vapor pipes and condensers connected to the two chambers, means for circulating oil in said two chambers, comprising a tank having a heating coil, and a vapor pipe and condenser, a displaceable screw conveyer for conveying a solid from one to the other, means for closing communication between the same when the screw conveyer is displaced, an inlet for solids to one of the chambers, and an outlet for solids from the other chamber.

26. In combination, a liquid container having two treating chambers for solids, vapor pipes and condensers connected to the two chambers, means for circulating oil in said two chambers, comprising a tank having a heating coil, and a vapor pipe and condenser, a displaceable screw conveyer for conveying a solid from one to the other, a valve for closing communication between the same when the screw conveyer is displaced, an inlet for solids to one of the chambers, and an outlet for solids from the other chamber.

In testimony that I claim the foregoing I have hereunto set my hand.

WILLIAM A. PHILLIPS.

Witnesses:
S. W. FOULKROD,
ELEANOR N. KEMP.