No. 860,058. PATENTED JULY 16, 1907.

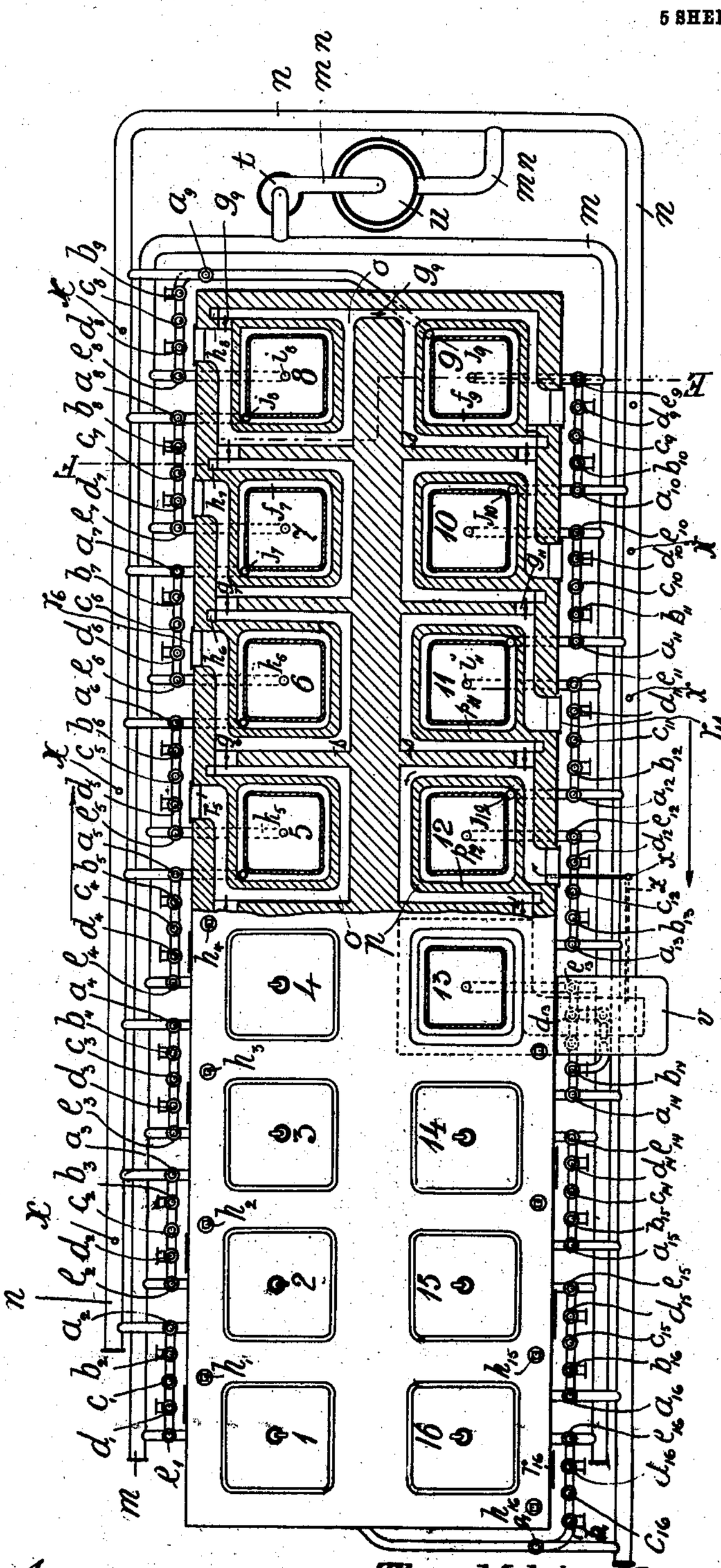
T. M. U. VON POST.

METHOD OF DISTILLING ORGANIC MATTERS.

APPLICATION FILED JUNE 29, 1905.

5 SHEETS—SHEET 1.

FIG. 1.



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5 SHEETS—SHEET 2.

Fig: 2.

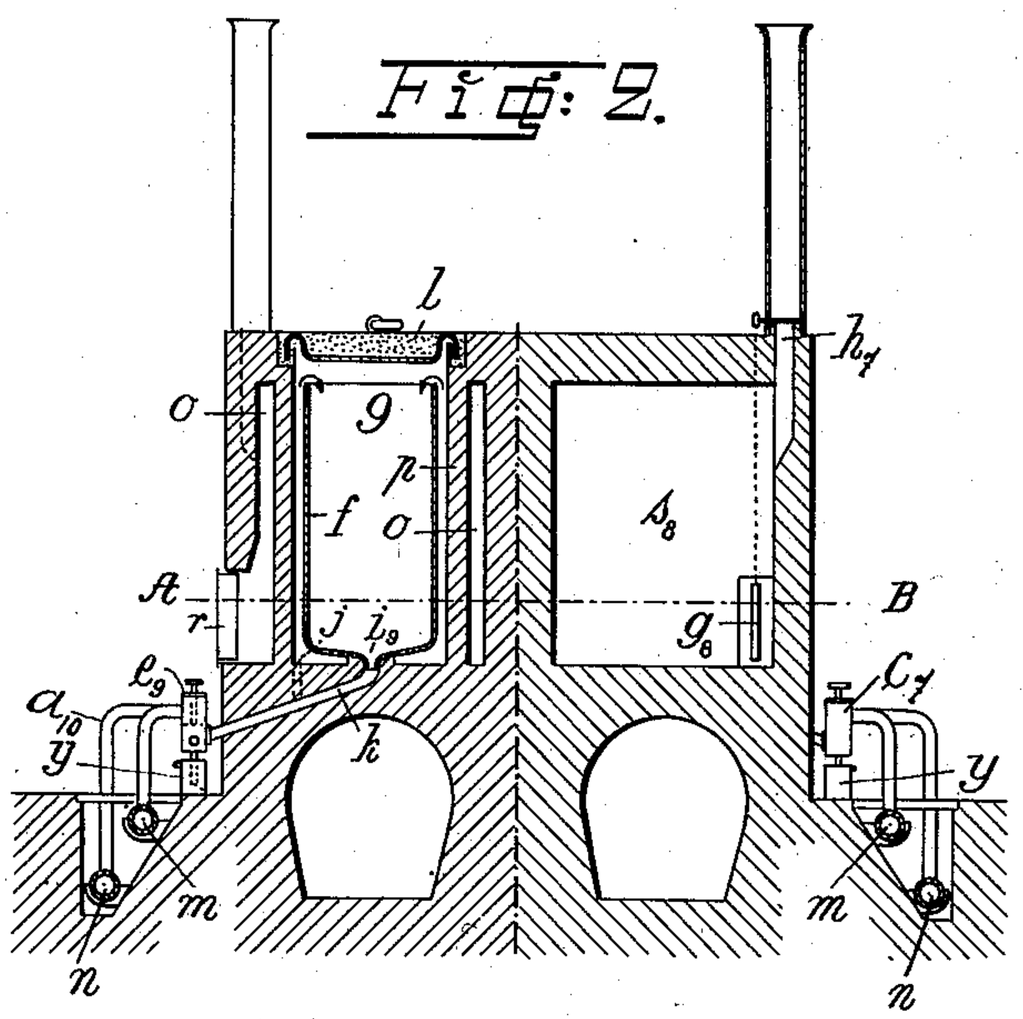
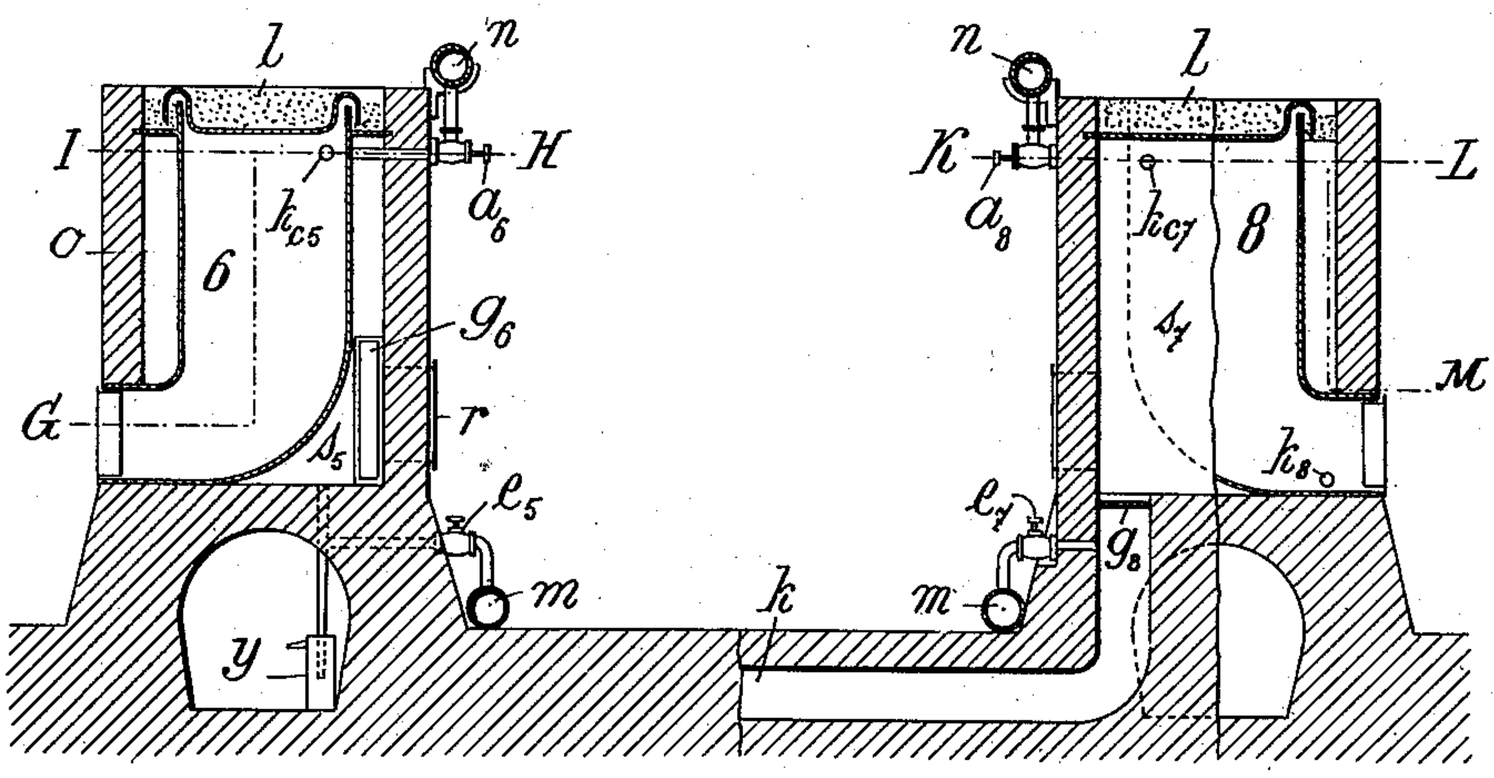


Fig: 4.



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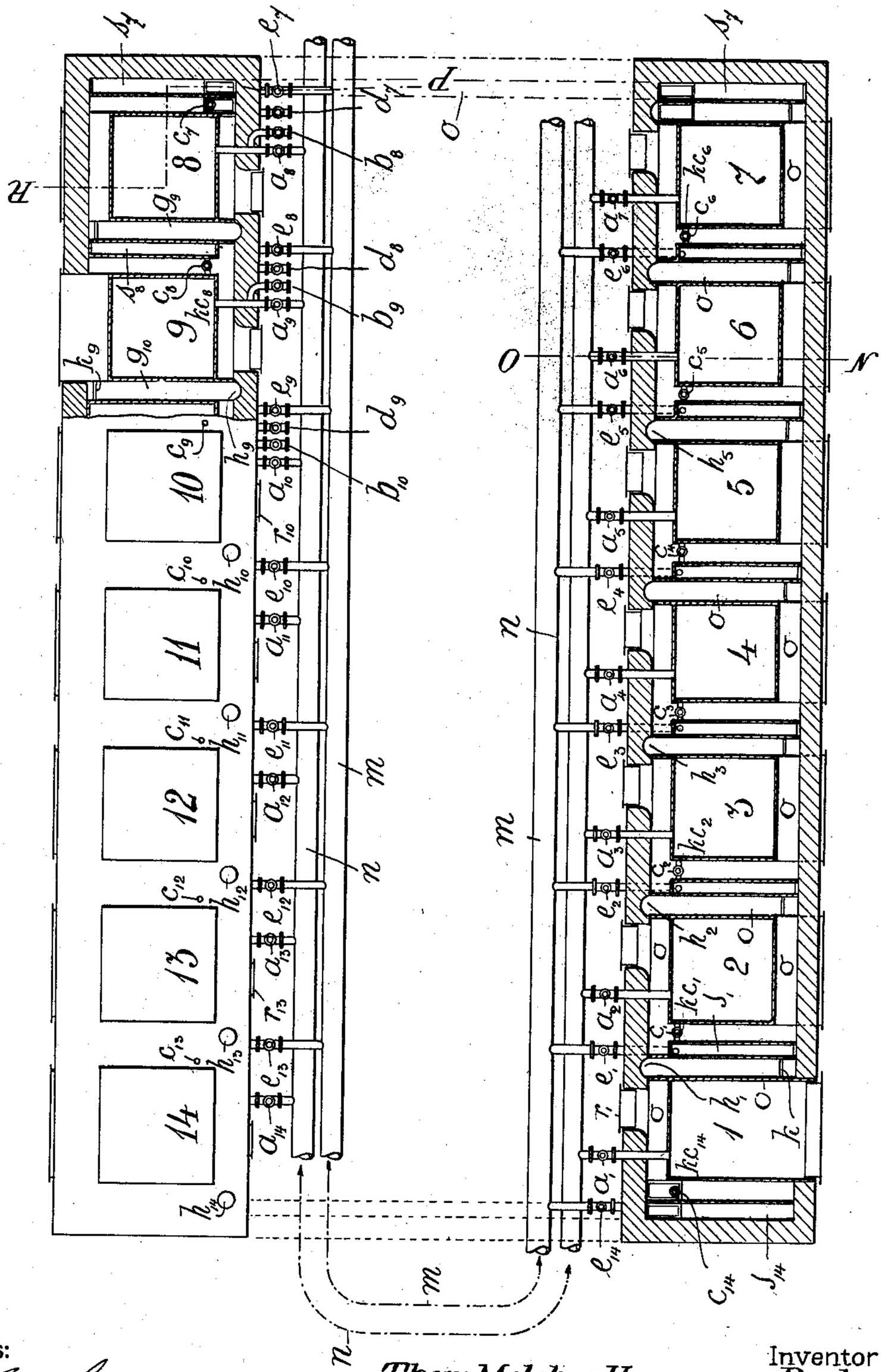
5 SHEETS—SHEET 3.

FIG: 3.



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5 SHEETS—SHEET 4.

Fig: 5.

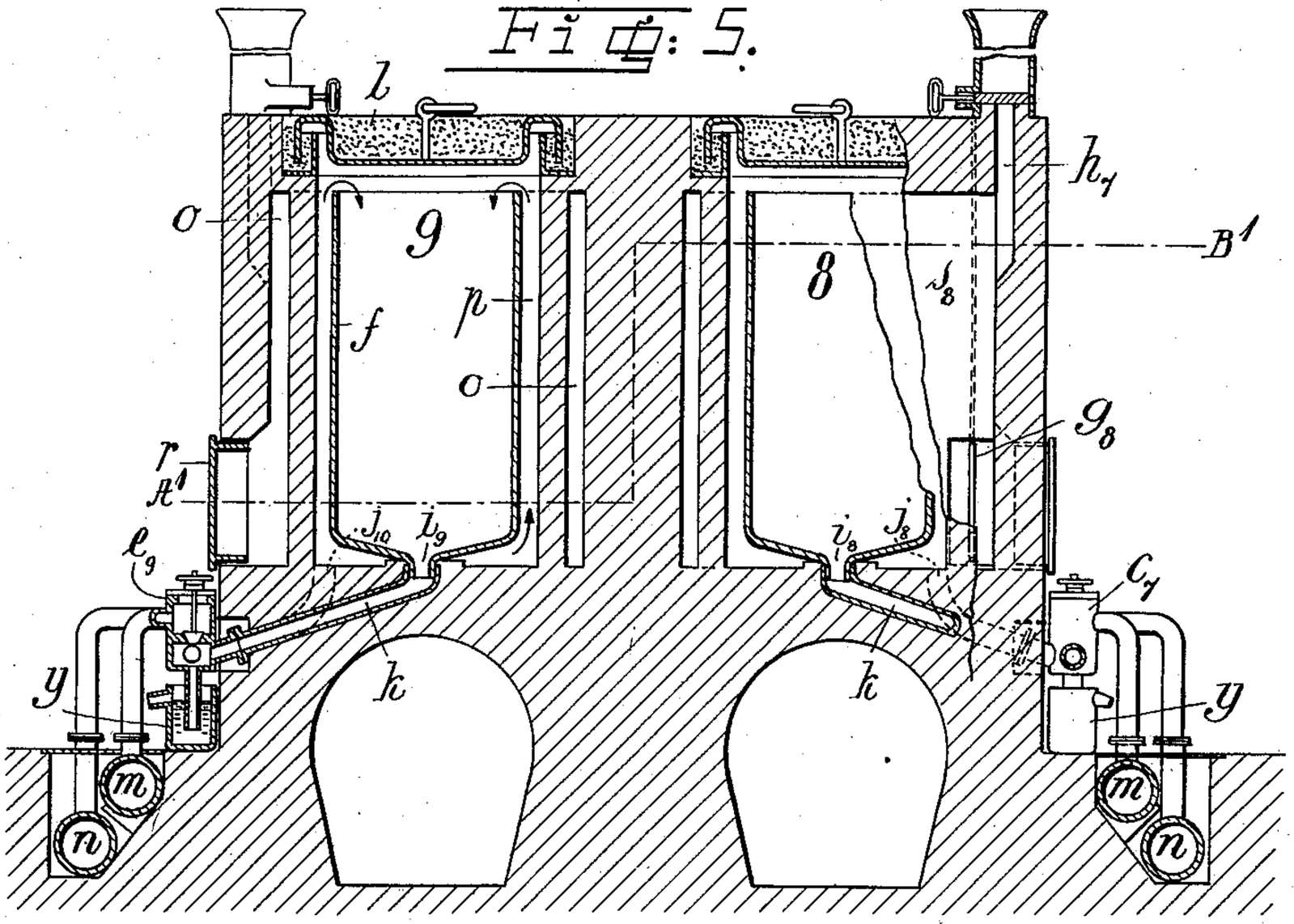
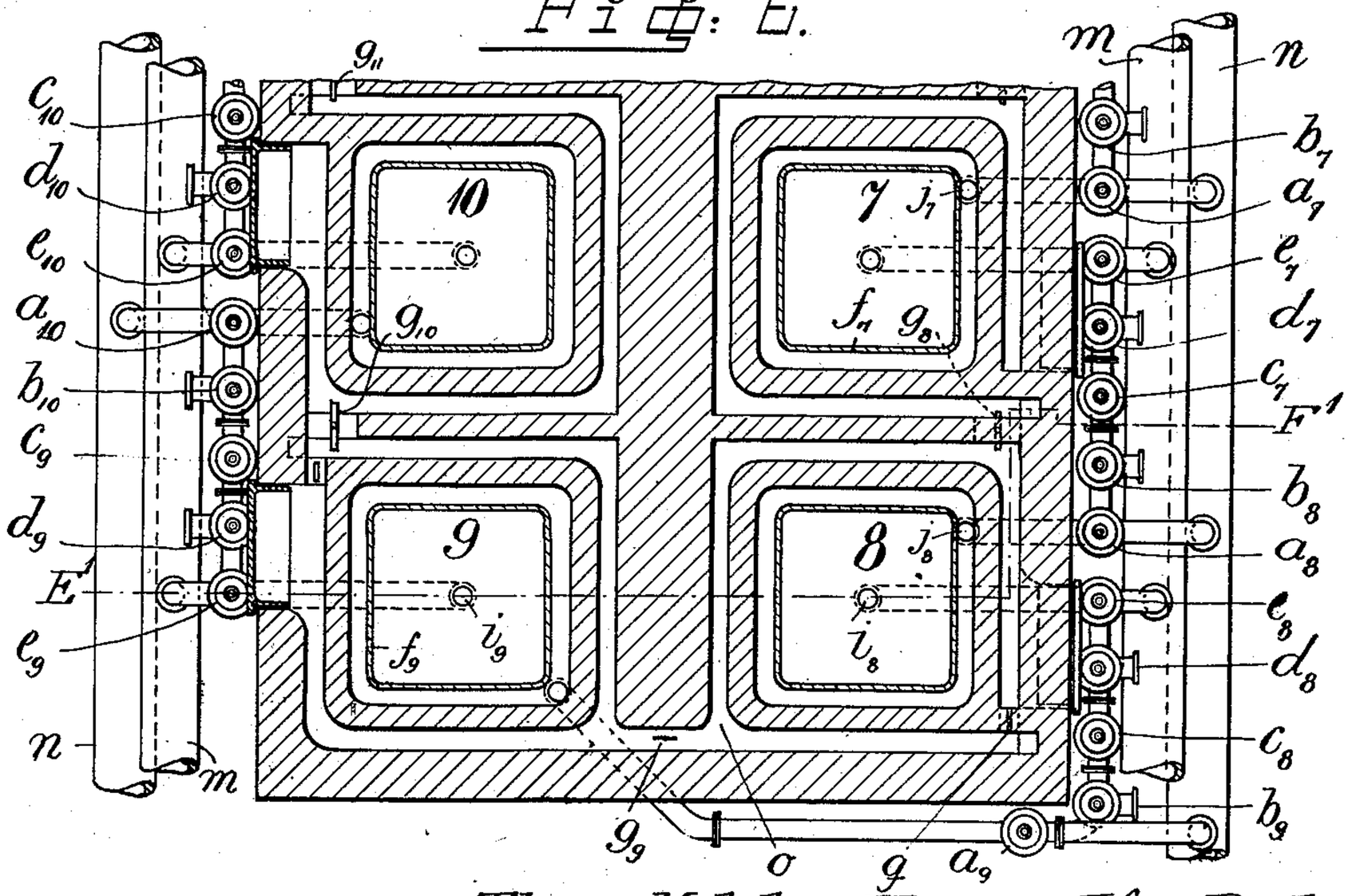


Fig: 6.



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No. 860,058. PATENTED JULY 16, 1907.

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5 SHEETS—SHEET 5.

Fig: 7.

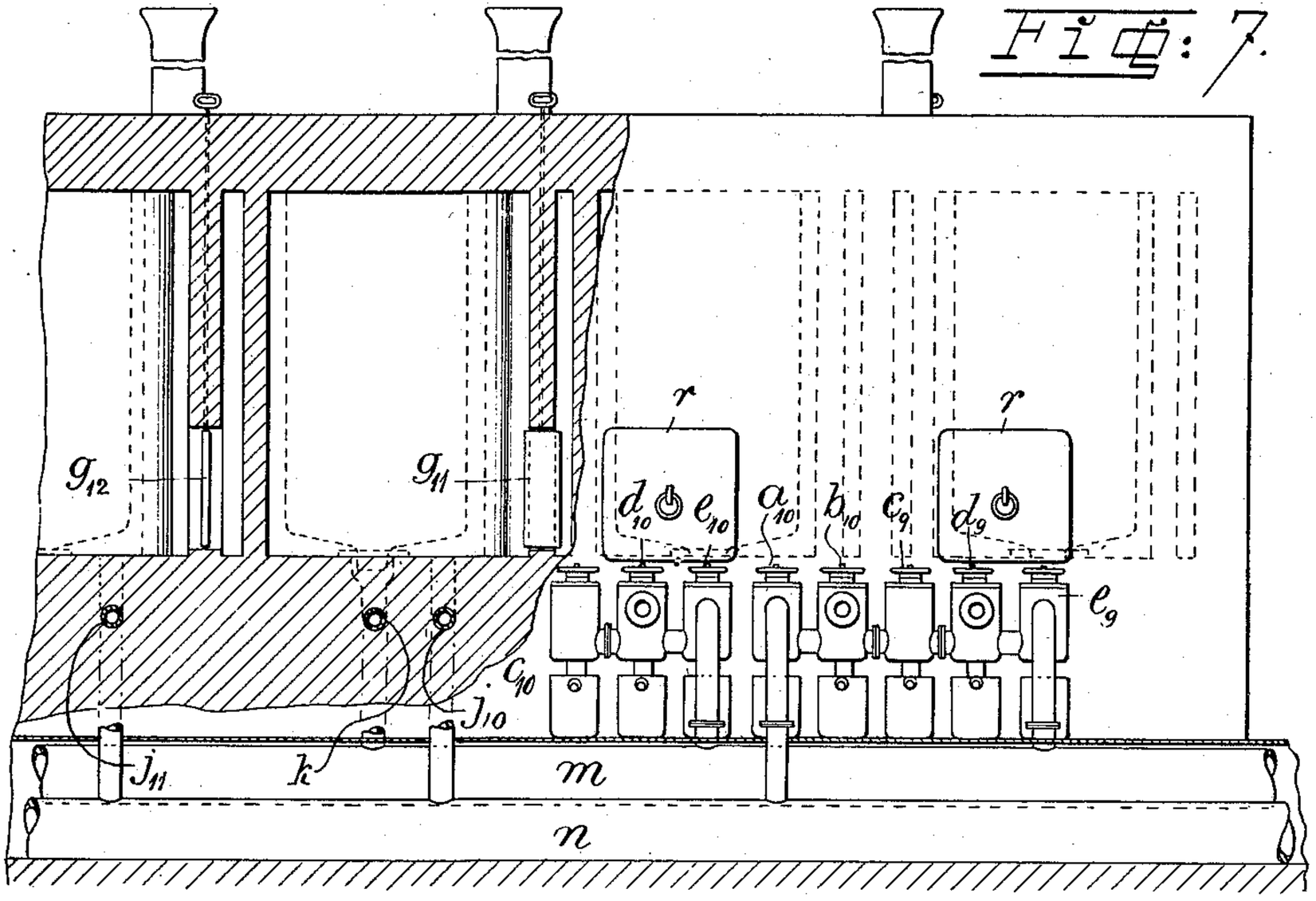
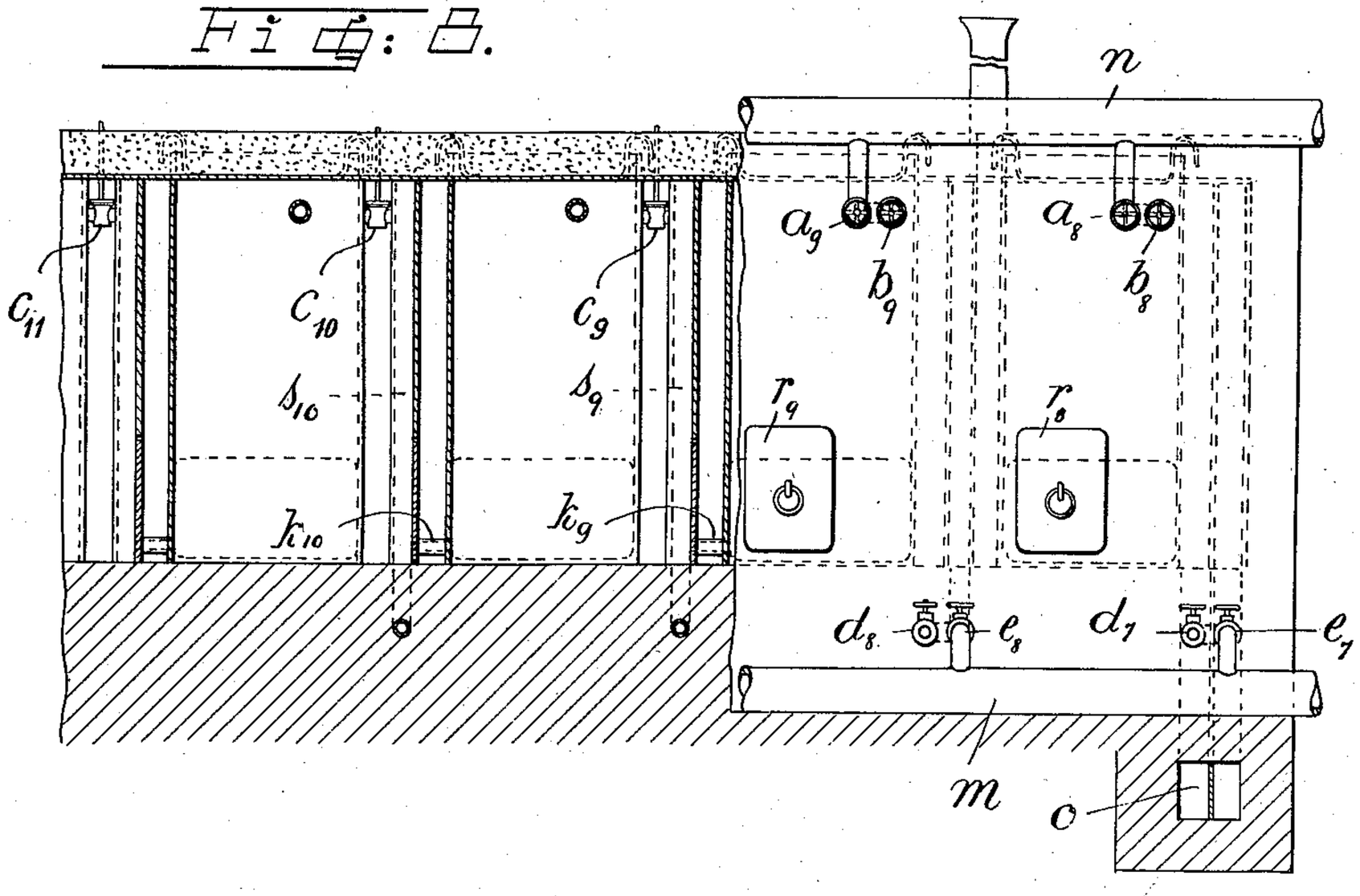


Fig: 8.



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UNITED STATES PATENT OFFICE.

THOM MELCHER UNGERN VON POST, OF STOCKHOLM, SWEDEN.

METHOD OF DISTILLING ORGANIC MATTERS.

No. 860,058. Specification of Letters Patent. Patented July 16, 1907.

Application filed June 29, 1905. Serial No. 267,658.

To all whom it may concern:

Be it known that I, THOM MELCHER UNGERN VON POST, a subject of the King of Sweden, residing in Västmannagatan 47, Stockholm, Sweden, have invented certain new and useful Improvements in the Methods of Distilling Organic Matters.

The present invention has for its object a continuous method of charring or dry distillation of organic matters, as, for instance, wood, peat, coal or the like, whereby those gases which are generated during the distilling process, but which are not condensed, are utilized in the manner more fully hereinafter stated.

Through the method which forms the subject of the present invention many disadvantages of existing methods are obviated, besides which the advantage is gained that the distilling process may be carried out as a "fractional distillation" and that each of the several fractions of the products of distillation may be easily collected separately by means of suitable devices—for instance such as those described in my Swedish patent No. 14856. For this purpose the retorts—which may be placed in horizontal or vertical or in any suitable position and may vary as to size and form—are combined with each other so as to form a circuit system like that used in brick kilns.

The method in question will be understood from the following specification where it is described in connection with the description of the means intended for carrying out the same and with reference to the accompanying drawings forming part of said specification.

In Figure 1 a series or system of kilns is shown, partly seen from above and partly in horizontal section on the lines A—B in Fig. 2. In Fig. 2 the same system of kilns is shown in vertical section on the broken line E—F in Fig. 1. In Fig. 3 is shown another form of the system of kilns partly seen from above and partly in horizontal section on the lines I—H, G—H; K—L and K—M in Fig. 4. Fig. 4 shows vertical sections on the lines N—O and P—R in Fig. 3. In Figs. 3 and 4 the same reference characters as those employed in Fig. 1 and 2 are used to indicate corresponding parts in both systems. Fig. 5 is a vertical section on the line E′—F′ of Fig. 6; Fig. 6 is a horizontal section on the line A′—B′ of Fig. 5; Fig. 7 is a front view, partly in section, embracing four retorts of the form of apparatus shown in Fig. 1, but upon a larger scale; and Fig. 8 is a similar view of the structure shown in Fig. 3 looking toward one bank of retorts from a position between said banks of retorts.

The system of kilns illustrated by the Figs. 1 and 2 comprises 16 retorts, 1, 2, 3 . . . 15, 16, placed in an upright (vertical) position but—of course, the number of the retorts may vary considerably. The said retorts are open at the top and each of them is surrounded by a chamber $f_1, f_2, \ldots f_{15}, f_{16}$, the said chambers being closed gas tight at the top by means of a cover 1 (see Fig. 2) insulated against heat by means of a layer of sand or the like. According to this form of the invention the retorts do not reach quite up to the said cover. Each of said retorts is provided at the bottom with an escape i_1, $i_2 \ldots i_{16}$ through a canal or pipe $k_1, k_2 \ldots k_{16}$ and inlets $j_1, j_2 \ldots j_{16}$ communicating with the chamber surrounding the following retort. These retorts, chambers and pipes are—as will be understood from the drawings and what has been said above—thus connected with each other so that they constitute a closed circuit. The different parts being connected with each other in the following order: a retort, the escape i, the pipes k, and inlets j leading to the chamber surrounding the following retort; then, in successive order, the chambers and the retorts within said chambers. The pipes or canals $k_1 \ldots k_{16}$ are provided with closing devices *e. g.* the valves $a_1 \ldots a_{16}$, $b_1 \ldots b_{16}$, $c_1 \ldots c_{16}$, $d_1 \ldots d_{16}$ and $e_1 \ldots e_{16}$. By means of the valves $c_1 \ldots c_{16}$ the communication between the several retorts may be shut off and by means of the valves $e_1 \ldots e_{16}$ and corresponding pipes each retort may be connected with a main pipe or canal m, common to all the retorts. The chambers $f_1 \ldots f_{16}$ which by means of the branch pipes $j_1 \ldots j_{16}$ communicate with the pipes $k_1 \ldots k_{16}$ leading from the retorts are connected with a main canal or pipe n, common to all the chambers in the system, by means of branch pipes $a_1 \ldots a_{16}$ which latter pipes may be closed by means of valves (on the drawing indicated by the same letters as the corresponding pipes) placed in said pipes, so that when desired each of the chambers may be shut off from the said main pipe n. The pipe n is provided with a number of valves x, by means of which the said pipe may at will be put in communication either with the open air or with the ovens or fireplaces necessary for the purpose. By means of the valves $b_1 \ldots b_{16}$ and $d_1 \ldots d_{16}$ different parts of the pipes $k_1 \ldots k_{16}$ may at will, be put in communication with the open air or be shut off. That part of each of the pipes k, in which the valves indicated by the letters a, b, c, d and e are placed, is arranged outside the outer wall of the kiln-system in order that the said valves may be easily accessible for controlling, cleaning etc. but on this account the said part of the pipes k should be covered and protected. The main pipes or canals m and n are connected with each other by means of the passage m—n in which passage is placed an exhauster t—a fan or the like—and a condenser or cooler u. The exhauster t may be placed in the passage m—n either in front of the inlet to the condenser or behind the outlet from the same, the position depending upon whether the gases generated during the distilling process are to be forced into the condenser or exhausted from the same. The circuit or passage formed by the retorts 1—16, the pipes k and inlets j and the chambers f surrounding the retorts is gas-tightly divided from a passage $O_1 \ldots O_{16}$—

which passage also extends through the whole system and forms a closed circuit—arranged for the conducting of the burning gases and the smoke by means of the walls $p_1 \ldots p_{16}$ and the brick-work at the bottom of the chambers f (see Fig. 2). The said fire- or smoke passage $O_1 \ldots O_{16}$ is, at each retort, or each second or each third one provided with an inlet $r_1 \ldots r_{16}$ for the introduction of burning gases, which inlets may be closed airtightly by means of shutters, doors or the like. Through this arrangement, it is made possible to use one single movable fire generator v common to the whole system, or a stationary fire generator—which may be shut from without—for each retort or for each second or each third retort. Besides this, there is between each retort a wall $s_1 \ldots s_{16}$ provided with an opening which may be closed by means of a damper-plate $g_1 \ldots g_{16}$ or the like. The said wall extends across the fire- or smoke passage $O_1 \ldots O_{16}$, dividing this into a number of sections, corresponding to the number of the retorts, the said sections being arranged so that they may be shut off from each other and being provided with outlets and dampers $h_1 \ldots h_{16}$ as shown on the drawings, (see Fig. 2,) or connected with a main pipe or passage common to all retorts and provided with an exhauster or the like. By means of these walls $s_1 \ldots s_{16}$ and projections extending from the brick-work $p_1 \ldots p_{16}$ of each of the chambers $f_1 \ldots f_{16}$ and abutting against the outer wall of the kiln-system the burning- or smoke gases are made to pass a good way around the retorts so that a great heating surface is gained, affording possibilities for a very good transport of heat from the burning- or the smoke gases to the contents of the retorts and the series of rooms formed by the chambers f and pipes k. Besides this there is a damper-plate for each of those retorts placed at the ends of the system in order that the burning- or smoke gases may be spread and led around the said retorts.

In this kiln-system the process in question is carried out as follows: Some, or all, of the retorts, being charged with the materials to be coaled or distilled, such as laths, wood and the like, burning gases are introduced through one of the openings r, *e. g.* r_{11} the dampers g_{12}, g_{13} and so forth up to and including g_5 and the damper h^5, being then held open, while all the dampers h^{12}, $h_{13} \ldots h_3$, h_4' are kept closed. At the beginning all the valves except the valves indicated by the letter e^1, e_2, $e_3 \ldots$ and so forth, are kept closed. The fan t is put in action and one of the valves x in the pipe or passage n is opened. Gradually the contents of the retort 11 begins to give off gaseous products which expel the air from the retort. In order to expel the air from the chamber f_{11} too, the valve e_{11} is throttled or closed while the valve b_{11} is kept open. The air being thus expelled from the retort 11 and from the chamber f_{11} the valve c_{11} is opened and the valve b_{11} closed whereupon the volatile products of the distillation enter the chamber f_{12} and pass through the same from below upwards into the retort 12 (see the arrows in Fig. 2) and then downwards through the said retort and from thence out into the pipe passage k_{12} expelling the air and carrying with them volatile products generated in this same retort. The air being expelled from the retort 12 the valve c_{12} is opened and the valve e_{12} closed, whereupon the gases generated by the distillation enter into the chamber f_{13} and the retort 13. In the same manner the process continues throughout the whole system of kilns until the whole room or circuit formed by the retorts 1 . . . 16, the chambers f, the pipes k, the passages or pipes m, n and mn, the fan or the exhauster t, and the condenser u is full of gases generated by the distillation. Through the action of the fan these gases are forced to circulate in a closed circuit, beginning at the valves a_{11} and continuing within the system of kilns, retort after retort to the valves e_{10}, therefrom through the pipes or passages m, mn, the condenser u, the pipe n back to the valve a_{11} and so on as stated above. The said gases, during their passage from the valve a_{11} through the respective chambers and retorts f_{11}; 11, f_{12}, 12 etc. absorb heat from the combustion and smoke canals O_{11}; $O_{12} \ldots$ etc. and give off this heat to the respective retorts 11, 12 . . . etc. and to the contents of the same, in doing which the temperature of both the said currents of gases decrease from retort to retort. The consequence of this is, however, that condensable products of the distillation which have a high evaporating temperature and which are generated in a preceding retort are condensed in a subsequent one. For the purpose of removing the said condensed products from the system of kilns there are separating apparatus y_1, $y_2 \ldots y_{16}$ for carrying off the same the said apparatus being connected with the retorts through the pipes $k_1 \ldots k_{16}$. As continuity in the process is thus gradually attained, the fire is displaced in relation to the place where the gases are taken out of the system of kilns through anyone of the valves e in such a way that for example, at a certain time the firing place is at r_{11} while the gases of distillation are carried off through the valve e_5. During the carrying out of this process it might happen, that the contents of the retort 11, which at that time constitute the whole or eventually a part of the so called coaling or coking zone of the system of kilns is almost entirely coaled nothing being now left to be done, but to expel the least volatile substances. In the retort 12 the process is at the same moment in a somewhat earlier stage of distillation and more volatile products than in the preceding retorts are given off, and in retort 13 the process of distillation is in a still earlier stage and so on, until the temperature is so low, that no real distillation has yet begun as might be the case for example in the retorts 2—5. That part of the kiln system that comprises the retorts 12—5 constitutes on this occasion either the distillation zone or the preliminary heating zone, as the case may be, and in these zones the distillation gases, fire-gases and the smoke give off their heat to the one after the other of the retorts whereby the retorts get heated. It is clear that the temperatures of the different retorts thus heated is lower the further on in the series of retorts in the direction of the flow of the gases, (see the arrows in Fig. 1) each of the retorts in the zone in question is located. By means of making fires in several firing places at the same time and by increasing the speed of the gases which transport the heat, the length of the said zones may be increased. The contents of the retorts 10, 9, 8, 7 which are ready coaled are now becoming cooled. Of these retorts the retort 10 is just ready coaled and the retort is still hot; but the retort 9 was ready coaled somewhat earlier and is still less hot and so on. The retorts named constitute at this instant the so called cooling zone.

The distillation gases, which flow through the distillation- or heating zones, thereby collecting and giving off products of distillation retort after retort, are led out from the system, as is above mentioned, through the valve e_5, from which they are carried off through the pipe m, and through the condensor u—for the purpose of separating the condensable products, which may happen to be present and still uncondensed—and further on through the pipe n and again into the system of kilns at the beginning of the cooling zone through the valve a_7. The said gases now flow through the said zone, thereby absorbing heat from the retorts one after the other and at the same time cooling these latter, until they reach the distilling zone in a heated condition and then the said gases continue their way onward through the closed circuit as described above. The retort 6 and eventually also the retort 7 or even more of the retorts are shut off from the kiln system and from the circuit of the distillation gases by means of the damper g_6 and valves c_5, c_6, a_6 and e_6. The said retort, which is now to be discharged and thereafter charged with new material for treatment constitutes at this instant the so called charging zone. For the purpose of executing said discharging and charging operations, the retorts are provided with ears or the like (not shown in the drawing). In these ears, hooks or the like, connected with suitable hoisting devices may be fastened for the purpose of hoisting up the retort. The cover being removed the retort which is loosely placed in the chamber f together with its content is hoisted up out of the said chamber and transported to the dumping-place for the coal and, the retort being there discharged it is transported to the depot for the coaling material where it is recharged.

In order to avoid loss of time in the discharging and charging of the retorts there ought to be a number of retorts in reserve, so that a charged retort may always be ready to be placed in the chamber f as soon as a retort has been taken out for discharging. By means of this method of charging and discharging the retort—*i. e.* by removing them from the kilns—the further advantage is gained that the capacity of production of the kiln system is increased as the retorts may be taken out while they are still hot, when their contents are ready coaled. To prevent the materials taking fire it is in such a case, however, necessary that another suitable cover be placed on the retort as soon as the cover 1 is removed. The retorts may however also be arranged in the way shown in Fig. 3 and 4, *i. e.* stationary and provided with discharging openings.

The change of retorts in the chamber f_6 being accomplished, the new retort must be coupled into the series of retorts in such a way that it forms part of the preliminary heating zone. This operation is thus carried out—: the dampers g_6 and h_6 are opened and the dampers h_5, g_7 and the openings r_6 are closed; besides which the valves c_5, c_6 are opened and the valve e_5 closed. The retort 7 being ready for discharging it is uncoupled from the system by opening the valve a_6 and closing the valves c_7 and a_7. In this way the charging zone is moved one step *i, e.* a retort forward in the system. By movement of the fire from the firing place r_{11} to r_{12} and by the said coupling into the system of the retort 6 the other zones too are moved one step (one retort forward). In the said manner the operation is carried on one retort after another, whereby at each step a new fraction is condensed and led away through the corresponding apparatus y.

To feed the fire, solid, liquid or gaseous combustible materials may be used and a part or the whole quantity of the air necessary for the combustion is obtained already heated by introducing the same through that fire-opening r, which at the period in question belongs to the last retort of the retorts constituting the cooling zone (for example the opening r_7) and allowing it to pass through the fire canals of the coaling zone to the fire-place. How the dampers and the valves in this case are to be regulated may be seen from the drawings without further description.

During the distillation greater quantities of gases are usually generated than are needed for use in the closed circuit; for which reason a gas-receptacle (not shown) is inserted in said circuit for accumulation of the excess of gases until there is use for the same. These gases are combustible and therefore they are used to the greatest possible degree for feeding the fire in the firing-zone which zone approximately coincides with the distillation- and the preliminary heating zones. For this firing with gas either cold gas may be used which gas thus is taken from the passage n through the valves x, which by means of movable pipe or tube-sections z or the like may be connected with the fire-place v or the opening r (see Fig. 1 the retort 12 and 13), or heated gas may be used in which case one of the valves b or d is connected by means of a hose or tube with the fireplace. From all of the said places a gas is received that does not contain any useful condensable products because the gas before its withdrawal from the said pipes has passed the condenser u.

In certain cases it may be advantageous to concentrate a greater heat in one place or to a certain retort in the system. For this purpose the movable fireplace v is provided with a number of pipes or tubes around which the fire sweeps and which tubes may be connected with the valves $d_1 \ldots d_{16}$ and $b_1 \ldots b_{16}$ in which case that valve c situated between the valves d and b in question is closed, and the consequence of this is that the circulating gases of the distillation are led out from the circuit of kilns and through said tubes into the fire-place, where they are heated to a high degree and from whence they are again led into the circuit of kilns.

The arrangements shown in Fig. 3 and 4 differ from those described above in this respect that the retorts—of which according to Fig. 3 there is a total of 14—are stationary and provided with discharging openings for the coal produced, but of course these retorts may also be loosely placed so that they may be hoisted up if this be found preferable. Besides this there are no chambers surrounding each retort but instead of these chambers there are hollow walls $s_1 \ldots s_{14}$ extending across the fire- or smoke passages $O_1 \ldots O_{14}$ and provided with openings and dampers $g_1 \ldots g_{14}$. Each of these walls communicates by means of the passages $k_1 \ldots k_{14}$ and $kc_1 \ldots kc_{14}$ with the retorts on each side of the wall. Thus in this case the retorts 1 . . . 14, the space within hollow walls $s_1 \ldots s_{14}$—replacing the chambers which according to Fig. 1, 2, surround the retorts—and the passages $k_1 \ldots k_{14}$, $kc_1 \ldots kc_{14}$ constitute the circuit room for the circulating gases

of distillation, corresponding to the room composed of the retorts 1 . . . 16, the pipes k_1 . . . k_{16} and the chambers f_1 . . . f_{16} in Fig. 1 and 2. Instead of the projection p in the brick work as above described there is according to the present form such a projection arranged extending directly from the retorts. On account of want of space the branch pipes containing the valves e and a are placed in the transverse walls s and on the retorts. Only a part of the valves indicated by the letters b and d is shown in the drawings. According to this form of the invention the retorts are provided with covers while according to Fig. 1 and 2 the chambers f, surrounding the retorts were provided with such covers. The separating apparatus y and the main pipes or passages m and n are placed in a somewhat different manner than in Fig. 1 and 2 (see Fig. 4). This system too, is provided with a fan or exhauster and condenser, in the same manner as the one first described although they are not shown on the drawings. How the kiln-system is arranged and acts in other respects may be easily understood with aid of the drawings and what has been said above.

From the description and drawings it may be seen that both the fire- or the smoke gases and the circulating gases of distillation have to pass a long way possessing many curves and obstacles. In order to overcome the resistance occasioned by these circumstances a fan or exhauster t is, as stated before, placed in the passage mn for the circulating gases of distillation. For obtaining a flow of the combustion gases through the system the natural draft may of course be used, but in such a case the gases must be let out at a temperature which would be too high to secure a good economy of heat. It must be kept in mind that in such a case the smoke must leave the chimney at a temperature of about 250° and 300° centigrade, while the distillation begins to take place at a temperature considerably lower than the one mentioned and is often finished at a temperature of about 350 to 450° centigrade. Thus it may be understood that the heat is not well utilized if the smoke is permitted to leave the chimney at the above mentioned temperature of about 250 to 300° centigrade. Therefore it is more advantageous to use an exhauster also for the smoke although motive power be necessary for the same. If an exhauster be used a transportable one common to all the system may be used and then placed either before the fire-place, forcing the combustion gases into the circuit of kilns or also after one of the dampers h where it exhausts the smoke. A stationary exhauster may also be used, but in such a case the passages, closed by means of the dampers h, must be connected with a common passage in which the exhausting apparatus is placed.

Through the transport of heat to the material to be coaled or distilled by means of currents of hot gas as above described the temperature may be easily controlled and the heat uniformly dispersed within each separate retort. On account of the speed with which the distillation gases, the fire- and smoke gases circulate, the coaling process will be accomplished in a shorter time and thus the capacity of production of the kiln-system will be greater than would be the case if the distillation gases generated were allowed to flow away only on account of the pressure due to their generation.

Having thus described my invention, I claim

1. The herein described method of distillation of organic matters consisting in heating a charge to the distilling temperature, conducting the hot gases so generated to another charge, raising the temperature of the second charge thereby, and condensing a portion of the condensable matters carried by said hot gases by the loss of heat in raising the temperature of the second charge.

2. The herein described method of distillation of organic matters consisting in heating a charge to the distilling temperature and progressively conducting the hot gases of distillation successively through other charges, thereby successively raising the temperature of said charges and also progressively producing a fractional condensation of the condensable matters.

3. The herein described method of distillation of organic matters consisting in heating a charge to the distilling temperature, conducting the hot gases so generated successively through other charges, thereby progressively cooling said gases, causing them to deposit condensable matters and at the same time raising the temperature of said other charges, and then progressively withdrawing the exhausted charges and applying external heat to the other charges in succession.

4. The herein described method of distillation of organic matters consisting in raising a charge to the distilling temperature by external heat, further heating the gases of distillation, and then passing said hot gases through a second charge to heat the latter to a lower temperature of distillation and to condense a portion of the condensable matters carried by the said hot gases.

5. The herein described method of distillation of organic matters consisting in raising a charge to the distilling temperature by external heat, further heating the gases of distillation, then passing said hot gases through a second charge to heat the latter to a lower temperature of distillation and to condense a portion of the condensable matters carried by the said hot gases, and drawing off the condensed matters from the second charge.

6. The herein described method of distillation of organic matters consisting in raising a charge to the distilling temperature, conducting the hot gases successively to other charges to heat the latter and progressively condense matters from the said gases, and finally subjecting the said gases to the action of a condenser.

7. The herein described method of distillation of organic matters consisting in raising a charge to the distilling temperature, conducting the hot gases successively to other charges to heat the latter and progressively condense matters from the said gases, subjecting said gases to the action of a condenser, and re-conducting the lean gases in reverse order by the charges to absorb heat therefrom.

8. The herein described method of distillation of organic matters consisting in raising a charge to the distilling temperature, passing the hot gases of distillation successively through other charges to raise their temperature and deposit condensable matters from the said gases, and cutting out of the circuit progressively the exhausted charges and advancing the heating zone for the charges in like order.

9. The herein described method of distillation of organic matters consisting in raising a charge to the distilling temperature by external heat, conducting the gases of distillation through successive charges to raise the temperature of said charges and at the same time cooling said gases to cause the deposition of condensable matters, withdrawing the condensable matters from the charges, extracting from the gases all condensable matters not deposited in the charges, returning the lean gases in reverse order past the charges to re-heat the gases, and utilizing the excess gases for the external heating of the charges.

10. The herein described method of distillation of organic matters consisting in raising a charge to the temperature of distillation by external heat and successive

charges to a lower temperature by the same external heat supply, conducting the gases of distillation from the first charge successively to the other charges, heating the said charges in succession by the said gases, simultaneously thereby causing the deposition of the heavier condensable matters in said gases coming from the first charge and the commingling with said gases of other gases of distillation carrying lighter volatile matters given off by the successive charges, drawing off from the successive charges the heavier distillates, and progressively renewing the exhausted charges and advancing the primary heating zone through the series of charges.

In testimony that I claim the foregoing as my own, I have hereto affixed my signature in the presence of two witnesses.

THOM MELCHER UNGERN VON POST.

Witnesses:
AUG. HAGELIN,
ALINA PETTERSSON.