(No Model.) 8 Sheets—Sheet 1.

C. F. DAHL.

RECOVERING SODA.

No. 396,546. Patented Jan. 22, 1889.

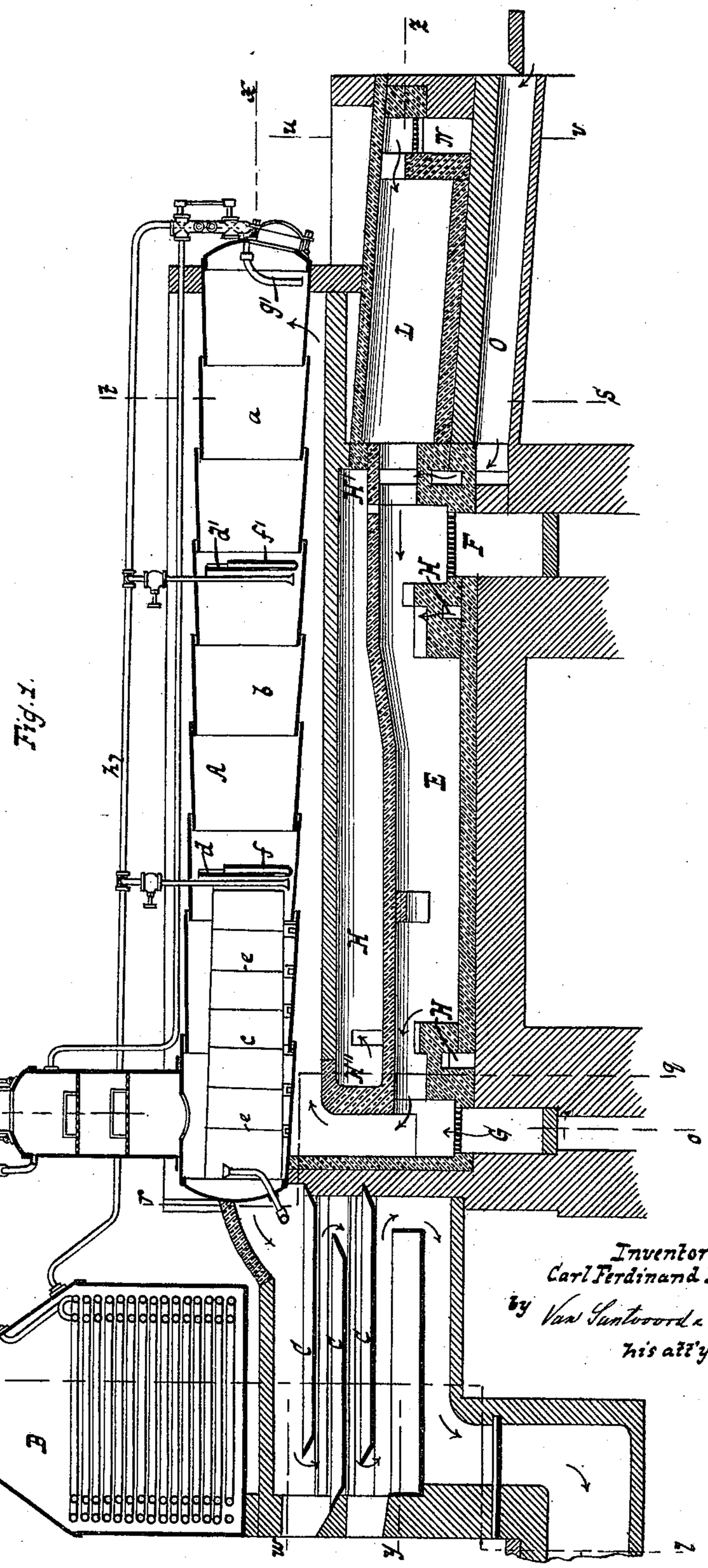


Fig. 1.

(No Model.) 8 Sheets—Sheet 2.

C. F. DAHL.

RECOVERING SODA.

No. 396,546. Patented Jan. 22, 1889.

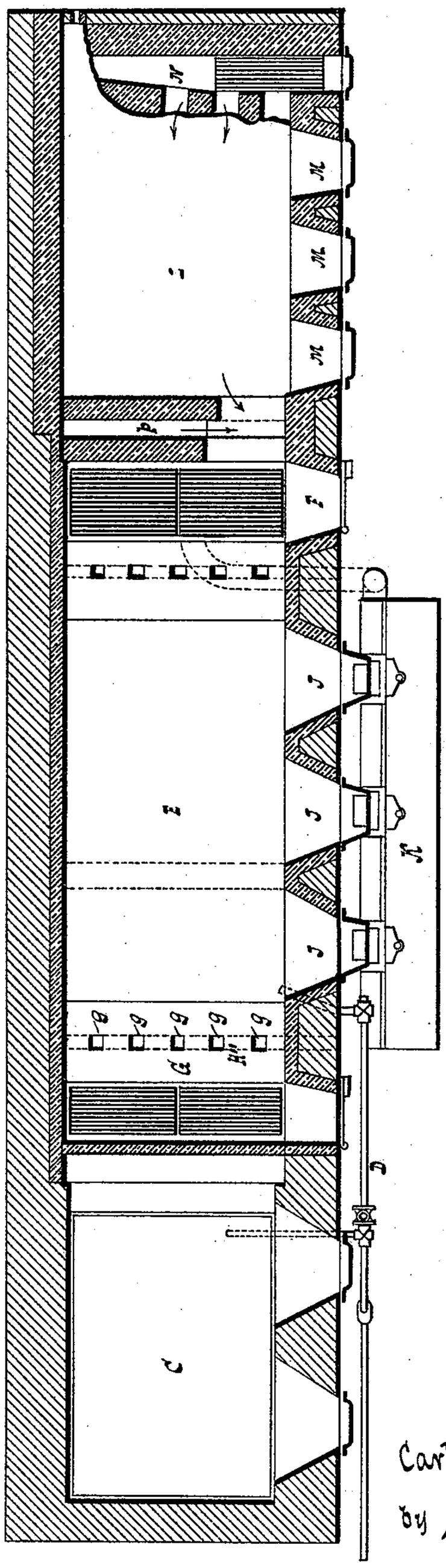


Fig. 2.

Witnesses:
A. Faber du Faur Jr.
William Miller

Inventor:
Carl Ferdinand Dahl.
by Van Santvoord & Hauff
his Att'ys.

(No Model.) 8 Sheets—Sheet 3.

C. F. DAHL.

RECOVERING SODA.

No. 396,546. Patented Jan. 22, 1889.

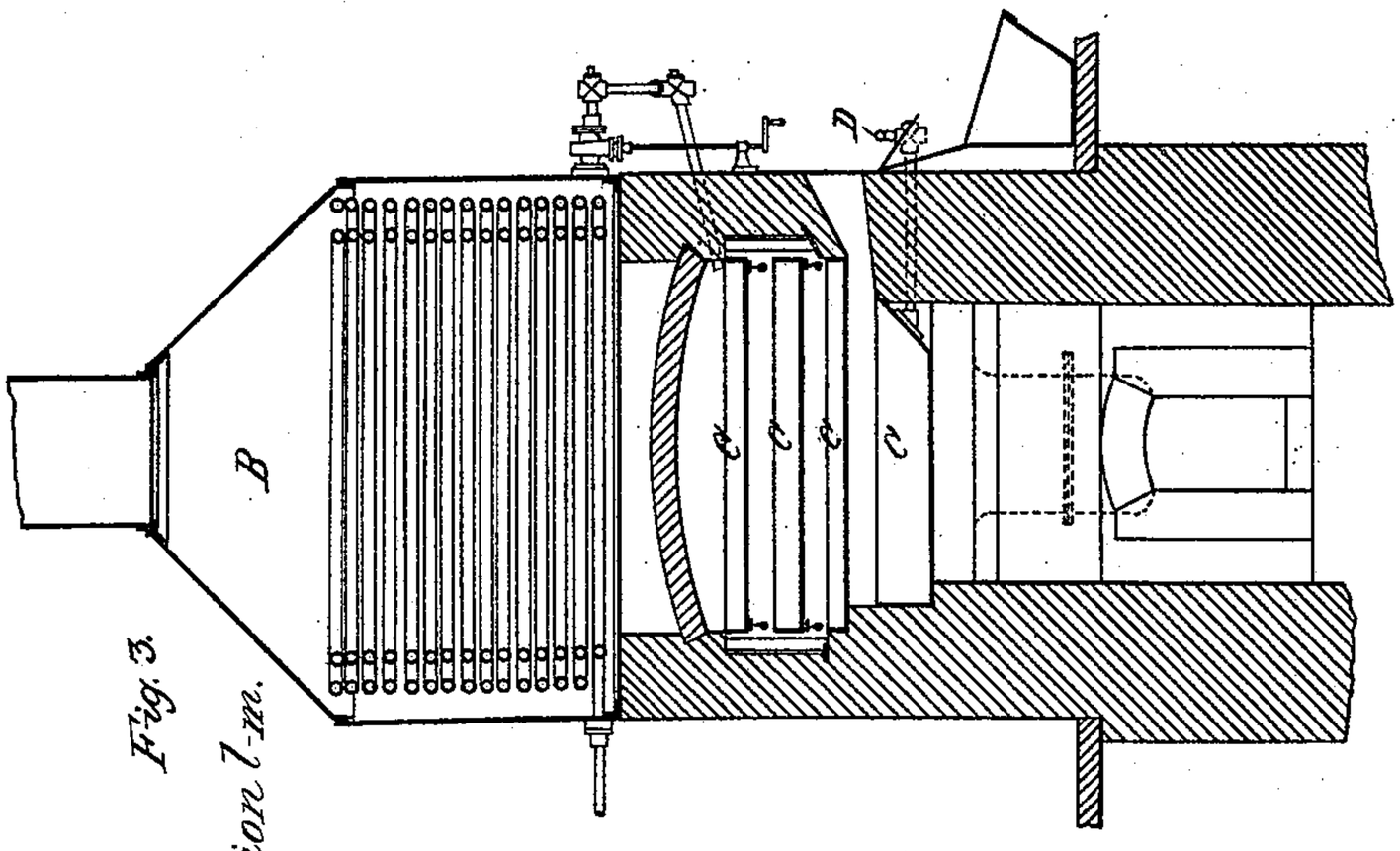


Fig. 3.

Section 1-m.

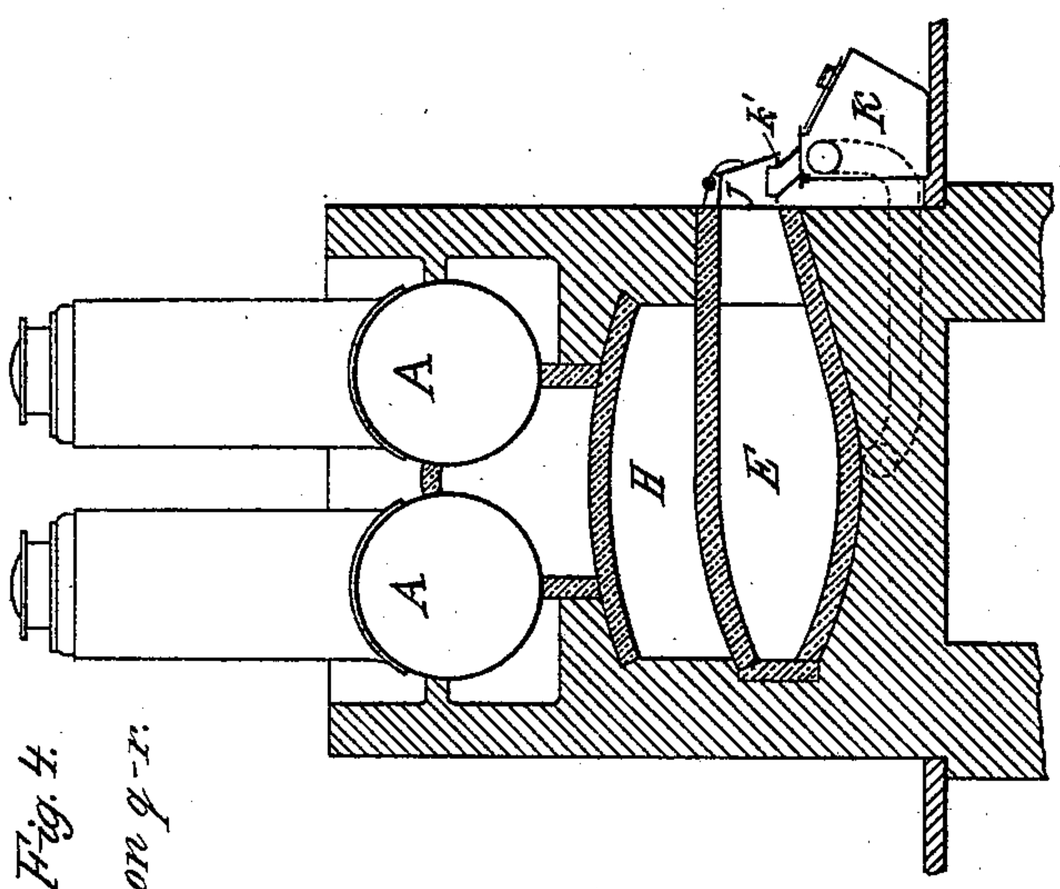


Fig. 4.

Section y-x.

Witnesses.
William Leffler,
Eduard Wolff.

Inventor
Carl Ferdinand Dahl
by Van Santvoord & Hauff
his att'ys

(No Model.) 8 Sheets—Sheet 4.

C. F. DAHL.

RECOVERING SODA.

No. 396,546. Patented Jan. 22, 1889.

Fig. 5. Section s-t.

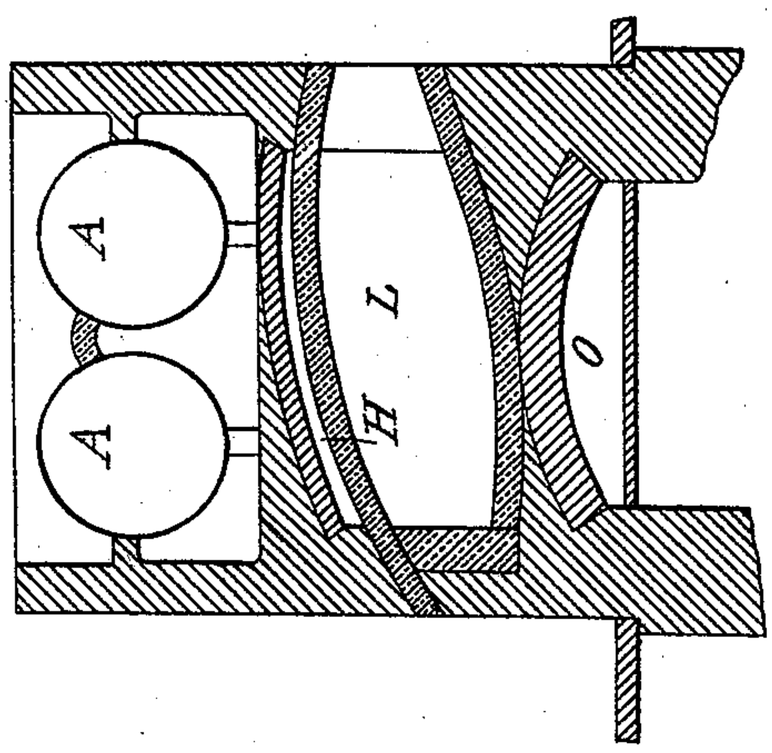
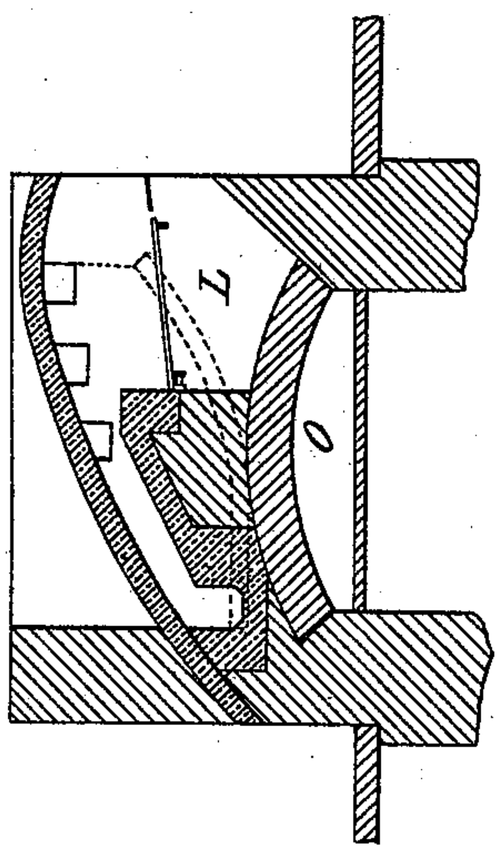


Fig. 6. Section u-v.



Witnesses.
William Miller
Eduard Wolff.

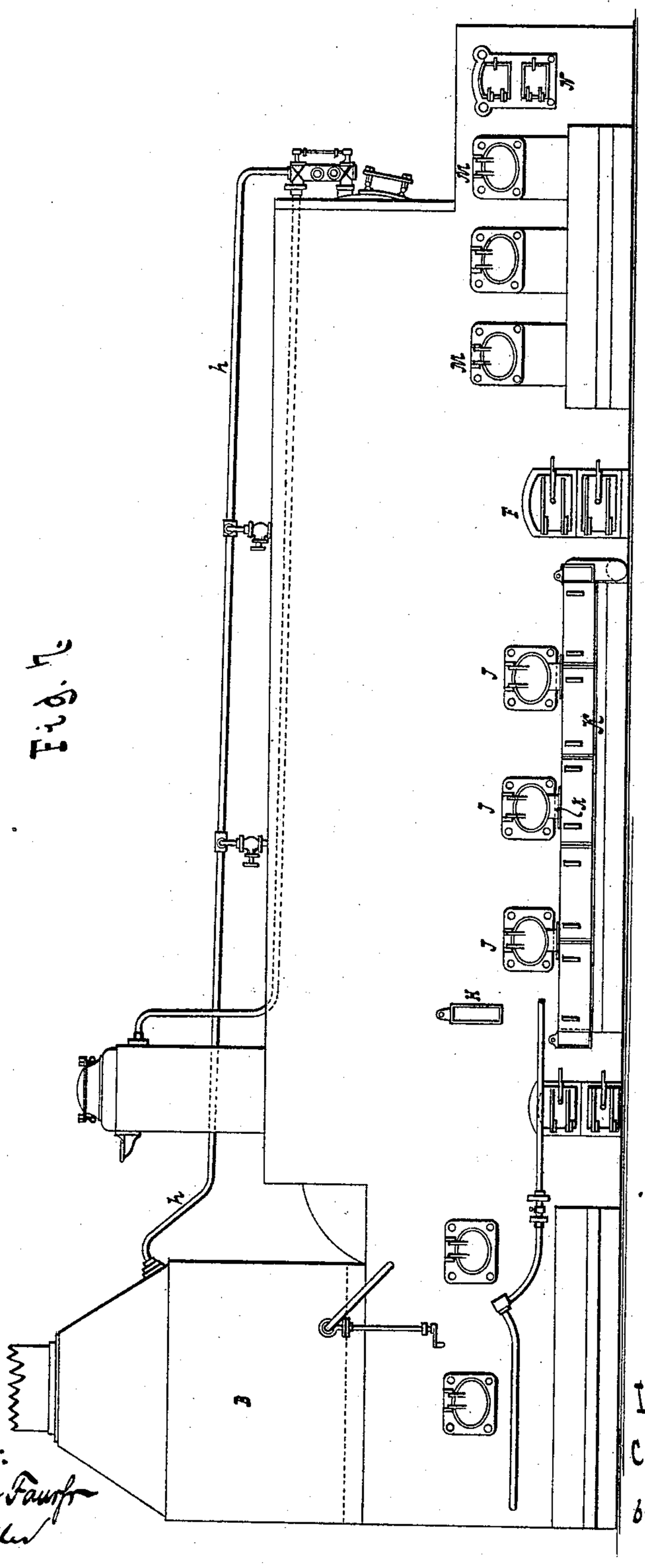
Inventor
Carl Ferdinand Dahl
by Van Santvoord & Hauff
his attys

(No Model.) 8 Sheets—Sheet 5.

C. F. DAHL.

RECOVERING SODA.

No. 396,546. Patented Jan. 22, 1889.



Witnesses:
A. Faber du Faur
William Miller

Inventor:
Carl Ferdinand Dahl.
by Van Santvoord & Hauff
his Att'ys.

(No Model.) 8 Sheets—Sheet 6.

C. F. DAHL.

RECOVERING SODA.

No. 396,546. Patented Jan. 22, 1889.

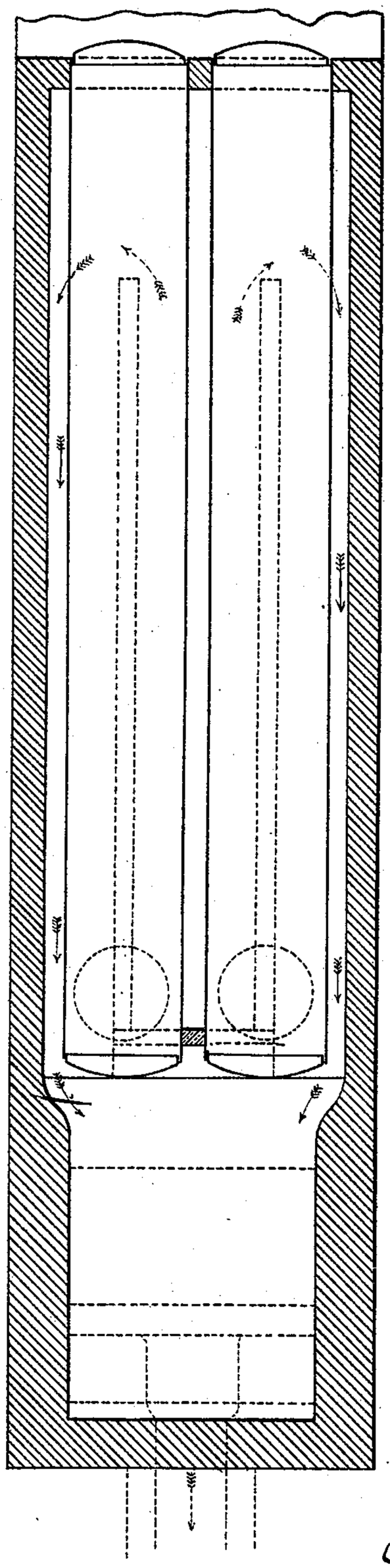


Fig. 8. Section xx.

Witnesses.
William Miller
Eduard Wolff.

Inventor
Carl Ferdinand Dahl
By Van Santvoord & Hauff
his attys

(No Model.) 8 Sheets—Sheet 7.

C. F. DAHL.

RECOVERING SODA.

No. 396,546. Patented Jan. 22, 1889.

Fig. 10.

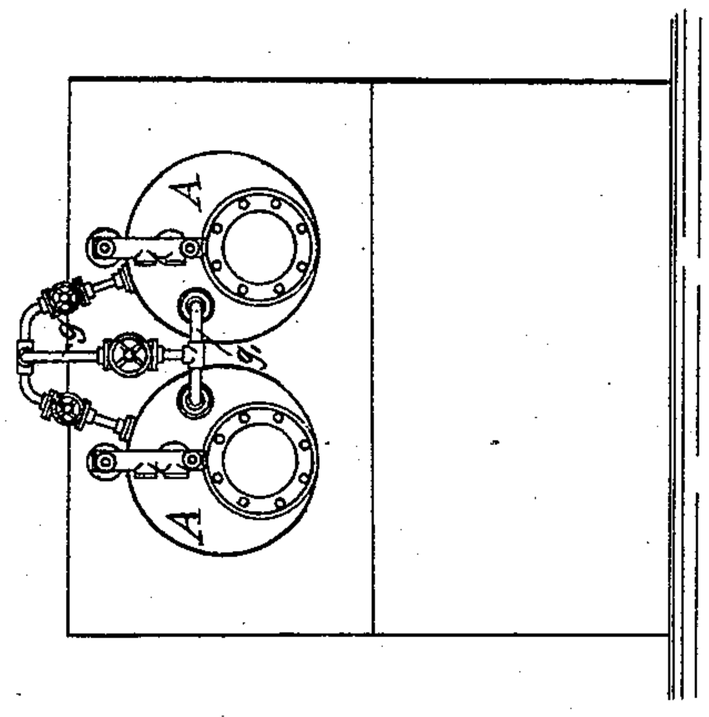
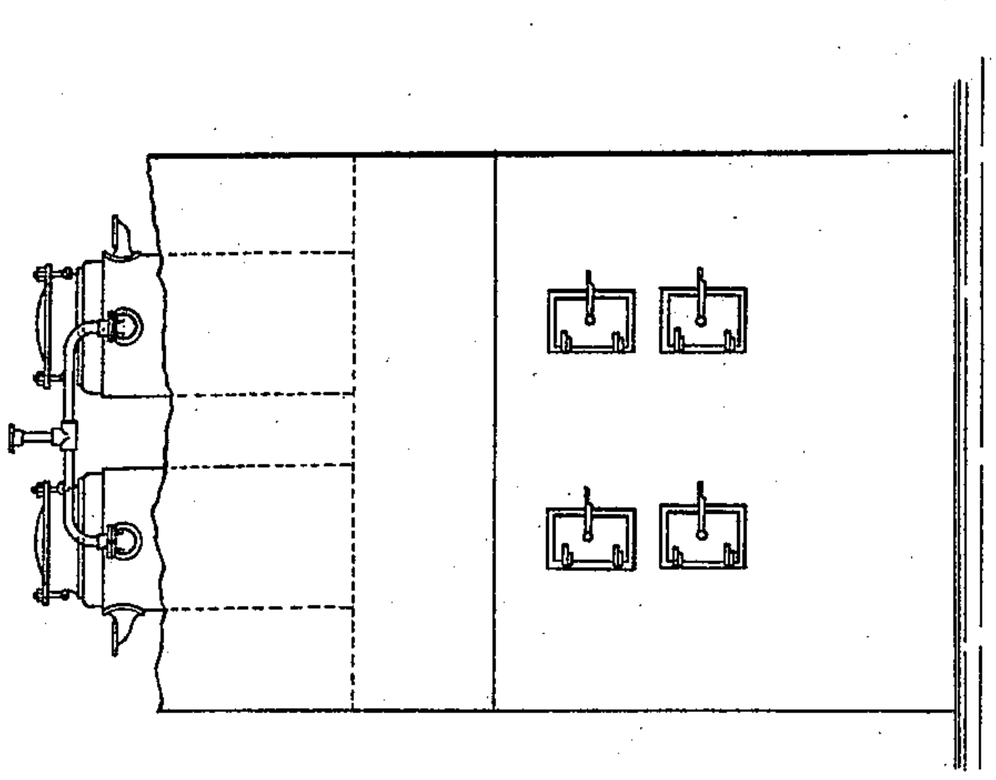


Fig. 9.



Witnesses
William Muller
Edward Wolff.

Inventor
Carl Ferdinand Dahl
by Van Santvoord & Hauff
his attys

(No Model.)

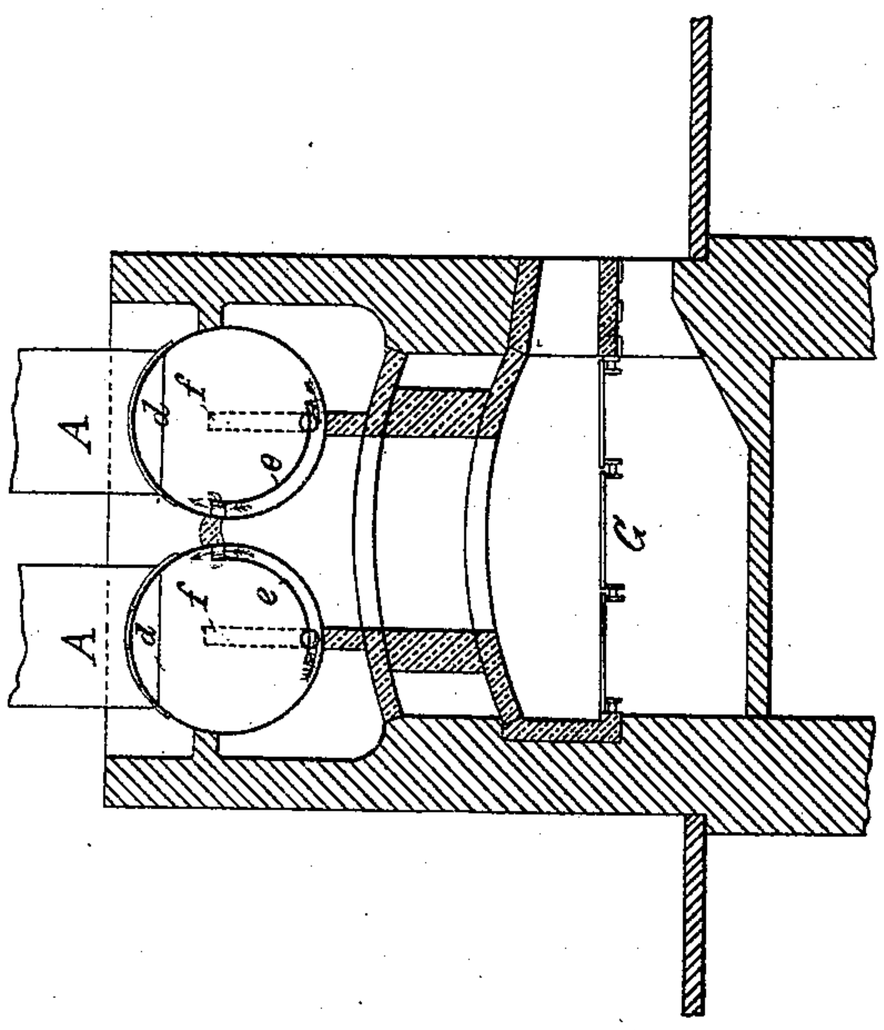
8 Sheets—Sheet 8.

C. F. DAHL.

RECOVERING SODA.

No. 396,546. Patented Jan. 22, 1889.

Fig. 4. Sezzion o-p



Witnesses
William Miller
Eduard Wolff

Inventor
Carl Ferdinand Dahl
by Van Santvoord & Hauff
his att'ys

UNITED STATES PATENT OFFICE.

CARL FERDINAND DAHL, OF DANTZIC, PRUSSIA, GERMANY.

RECOVERING SODA.

SPECIFICATION forming part of Letters Patent No. 396,546, dated January 22, 1889.

Application filed April 16, 1887. Serial No. 235,131. (No model.)

To all whom it may concern:

Be it known that I, CARL FERDINAND DAHL, a subject of the King of Prussia, residing at Dantzic, in the Kingdom of Prussia, German Empire, have invented new and useful Improvements in Inodorous Furnaces for Recovering the Salts which are Contained in the Lyes Used in the Manufacture of Wood Fiber, of which the following is a specification.

It is the purpose of my invention to recover from the aqueous alkaline lyes resulting from the manufacture of wood fiber, and containing the incrusting substances of the wood, straw fibers of alfa, and other matters, the valuable salts contained in the lyes. It is my purpose, also, to provide a mode of procedure whereby the production of smoldering gases may be avoided, and whereby the inconveniences usually experienced in the recovery of alkalies may be avoided.

Referring to the accompanying drawings, Figure 1 is a longitudinal vertical section of an apparatus embodying my invention. Fig. 2 is a horizontal section on the line *y z*, Fig. 1. Fig. 3 is a vertical cross-section on the line *l m*, Fig. 1. Fig. 4 is a similar section on the line *q r*, Fig. 1. Fig. 5 is a vertical cross-section on the line *s t*, Fig. 1. Fig. 6 is a section on the line *u v*, Fig. 1. Fig. 7 is a side elevation. Fig. 8 is a horizontal section on the line *w x*, Fig. 1. Fig. 9 is a partial end elevation. Fig. 10 is an elevation taken from the opposite end. Fig. 11 is a cross-section on the line *o p* of Fig. 1.

The recovery of the salts contained in the lyes takes place in three stages, and the operations effected during these processes are the following: first, the evaporation of the water in kettles, boilers, pans, and the like until the lyes are concentrated to from 35° to 40° Baumé, the fire-gases being led to the lye in the counter-current in such a manner that, first, the gases escaping into the flue, and which have been cooled to about 150° centigrade, come directly in contact with the concentrated lye; second, the inspissation of the concentrated lyes to the consistency of mud in a fire-proof vat by an open fire, so that the gases which are produced flow at a right angle into an auxiliary fire arranged beside the vat, and are thus intimately mixed with heated air and completely burned, whereupon they are led underneath the boiler; third, the reduction into gas of the incrusting substances in smelting down the salts in a retort-shaped furnace, which is connected with the inspissating-vat in such a manner that the gases mixed with previously-heated air enter into the main fire of the vat, are then burned, and aid in this way the inspissation of the lye.

The evaporation of the water begins in the evaporators A and A. (See Figs. 1, 4, 7, 8, and 11.) These two evaporators (which are constructed and completely fitted according to legal requirements) are each divided by two partitions, *d d'*, Fig. 1, into three compartments, *a b c*. These partitions *d* are of such a height that the vapor produced in the first two compartments may enter without being throttled into the third compartment and then into the dome. The raw weak lye is forced into the compartment *c*. As the combustion-gases arriving from the vat and the secondary fire strike first against these compartments of the evaporators, the plates *e*, Figs. 1 and 11, are hung concentrically to the casing of the evaporators in these compartments in order to prevent the salts from burning and attaching themselves to the bottoms of the evaporators, as an extremely quick circulation of the weak lye is thereby produced along the hottest part of the shell, as shown by the arrow in Fig. 11. The formation of incrustations will entirely be prevented by this simple means, especially at this most dangerous place.

The evaporators are placed in a position which is a little inclined forward, so that the larger the quantity of water lost by the lye the larger will be the quantity of lye gathered in the compartment *c* on the partition of the compartment *b* and on the bottom, owing to the greater specific weight of the lye. This heavier lye passes through a pipe, *f*, arranged in the partition *d* into the compartment *b*, where the evaporation of the water is continued. The lye, the weight of which has still increased, and which is accumulated on the bottom, passes through the pipe *f'* into the compartment *a*, where the lye remains until it has obtained a certain degree of consistency. The difference of this consistency depends on the composition of the lyes. The degree to which the lye is evaporated in the

evaporators is previously determined by examination. These evaporators must naturally frequently be cleaned. To facilitate this operation, the front wall of the same is provided with a man-hole, and corresponding therewith two man-holes are also cut into the partitions *d d'*. These holes are closed during the working of the apparatus by means of plates, which are fixed to the partitions *d* by sash-fasteners.

To withdraw the lye from the three compartments of the evaporators at once for cleaning the latter, or for any other purpose, I arrange in the compartment *a*, as well as in the compartments *b* and *c*, near the partitions *d d'*, blow-off pipes.

The pressure in the evaporators is kept at a low degree, and a pressure of one kilogram above the atmospheric pressure will be sufficient to blow off the lye. The vapor produced in the kettles is freed in the domes from any vapors or gases of the lye that may be mingled therewith. For this purpose two perforated plates are arranged in the dome, one over the other, (see Fig. 1,) which are both covered with a layer of iron shavings, whereby all the foreign parts will be retained when the vapor passes through the said layer. The pure water-vapor is employed either for caustifying the fresh lye or for drying purposes, and for further evaporating the lye withdrawn from the kettles.

The lye inspissated in the evaporators is withdrawn at certain intervals from the compartment *a* by means of the blow-off pipes *g* and *g'*, Figs. 1, 7, and 10, in quantities of about two hundred and fifty liters, and conveyed through the pipe *h*, Fig. 7, into the boiler B. This boiler, Figs. 1, 3, and 7, consists of a vessel which is made of wrought-iron and provided with a conical neck and an upright tube, by which the vapor produced by the evaporation of the lye passes through the roof into the open air. To prevent the formation of smoldering gas, the evaporation is carried out entirely without any pressure.

The heating in the boiler is effectuated by the vapor produced in the evaporators in evaporating the lye. This vapor flows through a serpentine or worm, the arrangement of which is shown in Figs. 1 and 3. Under normal conditions thirty per cent. of water is abstracted from the raw lye, and in the boiler the lye further loses twenty-three per cent. of its original weight. From the boiler B the lye is drawn off into the uppermost of the open evaporating-pans C.

The four pans C, Figs. 1 and 3, are open flat vessels made of wrought-iron and having shovel-shaped bent-up ends. They are walled in behind the evaporators and below the boiler and placed in an alternating way one over the other in such a manner that the fire-gases which have circulated round the evaporators in the direction of the arrow, Figs. 1 and 8, pass over the upper pan in the direction of the arrow and flow in their way to the chimney over the surface of the lower pan, and at the same time along the bottom of the upper pan. In their way along the evaporators the gases are, by means of suitable draft-regulating devices, cooled as much as is generally possible during the working—that is to say, to about 150° centigrade—in consequence of the tortuous passage through which they are led, whereby time is allowed them to part with a portion of the contained heat, and owing to the circumstances that by the smokeless gases the walls of the evaporators are always free from flying ashes and remain consequently highly capable of transmitting heat. At the aforesaid temperature the fire-gases may directly come in contact with the lye without causing the formation of offensive and injurious gases from the same. The walling in of these pans offers the great advantage that the gases arriving from the evaporators, which otherwise would escape without being utilized into the chimney, abstract by the direct contact from the inspissated lye still further fifteen per cent. of its original content of water. The inspissating process of the lye in the pans can be observed from the rear front of the furnace through working-holes, which ordinarily are closed by doors, Figs. 1 and 9, and through which the pans may easily be cleaned. Owing to the particular arrangement of the four pans one above the other, the lye passes from one pan always into the pan beneath, and is finally introduced from the lowest pan through the pipe D, which can be closed by means of a cock into the inspissating-vat, which must therefore lie at a sufficient distance below the last pan, so that the lye, which is already thickly liquid, may easily flow down. The flat form of the pan is necessary, as in deeper pans the salts will easily be fixed on the bottom, so that no heat can pass through the same, while the shape of the pans shown in the drawings and bent up on the ends is particularly advantageous for cleaning the pans from the outside, and also for the flowing over of the lyes.

The inspissating-vat E, Figs. 1, 2, and 4, consists of a flat vaulted box made of brick-work and lined with refractory material, in which the lye stands almost up to the fire-bridge. The fire-place F, which is provided with a plane grate, serves to produce the flame, which is introduced by natural draft into the vat, and passes, guided by the low vaulted ceiling of the box, closely over the lye, whereby a further quantity of water will be evaporated; but as the incrusting substances contained in the lye also begin to be decomposed under the open flame and to develop large quantities of offensive gases, which must be prevented from escaping, a second fire-place, G, Figs. 1, 3, and 11, having also a plane grate, is arranged on the wall of the inspissating-vat which is opposite to the fire-place F. The grate of this fire-place G is arranged at such a depth that a free flame will already exist where the mixture of offensive piercing-gases and fire-gases

enter into the vat. The gas-mixture arriving from the vat enters at a right angle into the flame of the fire-place G, and will surely burn if a sufficient quantity of air be introduced, and this air is added to the gas-mixture already in the vat. To preserve the walls of the inspissating-vat as long as possible, notwithstanding the high degree of heat, the refractory walls are cooled from the outside by arranging therein intermediate spaces or air-channels, H, (see Fig. 1,) which are to be considered as generators. These intermediate spaces communicate on one side with the open air and discharge on the other side at H′ from the ceiling into the fire-place F, and at H through *g g* into the partition between the vat and the auxiliary fire-place. As the air in these intermediate spaces is highly heated, the cold air will energetically push in from without. There will consequently be in the vat so large a surplus of heated air in the gases that at the entrance of the offensive gases into the flame of the fire-place G a complete combustion of the said gases will take place, so that not only all the foul substances will certainly be destroyed, but the whole quantity of heat contained in the carbon of offensive and acrid gases will be utilized for the evaporation in the kettles. There is but one condition—namely, that the mixture of the gases does not contain a large quantity of water-vapor.

Through the doors J, Figs. 2, 4, and 7, which are inserted in the longitudinal wall of the vat, the lye is continuously stirred up during the inspissation, whereby the dephlegmation of the lye and the development of the gases is enlivened.

When the lye has attained the consistency of a viscid mud, the fire of F is reduced, and the lye is pushed or rabbled into the tightly-closed box *k*, which is placed before the vat.

The side doors, J, of the vat are of particular construction. To prevent noxious gases escaping from the furnace and entering into the building when stirring up the lye and in rabbling the same, the door is opened only for a moment, when the rabbles are introduced or withdrawn. During the working the door is closed and the handle of the rabble or rake is moved in a small indentation in the door, while the workman may look into the vat through an opening provided for that purpose. The bottom of the closure J communicates through the pipe *k′ k′*, Fig. 4, with the box *k*, so that the mud can be introduced into the box without opening for that purpose the doors of the inclosed chamber or space J.

The hot inspissated mud of the lye still continuously develops noxious and offensive gases, which are led through a pipe from the box underneath the grate of the fire-place F and carried away into the flame by the air which flows in. When the mud is cooled, the cover of the box, which has hitherto been tightly closed, is opened, and the lye, having now the consistency of molten asphaltum, is tapped off by means of spades and thrown through the working-holes M into the melting-furnace, which is arranged beside the inspissating-vat and separated from the same by the fire-place F. (See Figs. 2 and 7.)

The bottom of the furnace L, which is also made of refractory material, and which has the form of a retort, is constructed in such a way that it inclines from all points toward the orifice of exit for the recovered salts. The ceiling is vaulted over the furnace and as low as possible. (See Figs. 1, 5, and 6.) On the small wall of the retort, opposite to the inspissating-vat on the fore front of the furnace, is the fire-place N of the melting-furnace, beside and above the orifice for the salts. The flame of this fire-place is compelled by the construction of the fire-place to flow from the orifice through the whole furnace, and the working is a continuous one, while the melting lye slipping down on the sloping bottom is always replaced by other lumps of mud subsequently thrown into the furnace. In melting down these lumps the last portion of water (twelve per cent.) is evaporated by the flame, and the incrusting substances which detach from the melting salts are completely reduced into gas as the muddy mass slides from all points of the furnace toward the orifice, which is the hottest place of the furnace. The salt freed from the incrusting substances flows out continuously.

To destroy with certainty the large quantities of acrid noxious gases which are here produced, and to utilize in the furnace itself the considerable quantity of latent heat which is therein, the gases are led from the melting-furnace into the fire-place F of the inspissating-vat. As the combustion would not immediately take place for want of air, it is necessary to previously supply the offensive gases with the air necessary for their combustion. This is effectuated in the same manner as shown in the inspissating-vat. The wall between the fire-plate F and the melting-furnace incloses an air-channel communicating by an air-shaft arranged beneath the furnace. The air-channel O discharges laterally and from below in several holes into the opening *p p*, which puts the melting-furnace in communication with the fire-place F, Figs. 1 and 2. The air passing through this channel and highly heated by the hot masonry in escaping from the air-channel meets directly the noxious gases, whereby a whirl is produced which intimately mixes the gas and air. This hot mixture flows into the fire-place, where it burns immediately without smoke when the air-supply is sufficient.

The circulation of the fire-gases in the furnace is generally as follows: The flame of the fire-place of the melting-furnace produces a large quantity of noxious gases by the volatilization of the incrusting substances. In the burner P these gases are sufficiently mixed with air to be consumed immediately after

their entrance into the fire-place F. All these fire-gases pass through the inspissating-vat and take off from the lye which is therein a large quantity of these noxious gases. The gases mix then with the introduced previously-heated air and escape from the inspissating-vat at a right angle into the open flame of the auxiliary fire-place G. There is in consequence of the introduced hot air such a surplus of oxygen in the gas-mixture that a complete combustion will take place. The hot smokeless gases now pass underneath the evaporators, flow simultaneously below and along the two evaporators from the rear to the fore end, divide here in returning on the exterior sides of the boiler, Figs. 1 and 8, and pass together over the pans C. Although, on account of the large heating-surface which the evaporators offer in consequence of the arrangement of the same and of the quality of the gases, heat has been withdrawn from the fire-gases in a larger quantity than can be ordinarily obtained in steam-boilers, yet the pans take off from the gases, which have 150° of heat and strike against the first pan, such a quantity of heat that the gases escape into the chimney with a temperature which is absolutely necessary to maintain a sufficiently powerful draft in the furnace. In comparison with the hitherto-used systems of recovering salts in retort-furnaces this new method offers, apart from the complete inodorous working of the furnace, considerable economy of combustibles by completely utilizing the fire-gases to an extent never hitherto attained.

In the above-described normal process the evaporation of the lye and the mud in the several stations takes place as follows: evaporators, thirty per cent.; boiler, twenty-three per cent.; pan, fifteen per cent.; inspissating-vat, twenty per cent.; melting-furnace, twelve per cent.

Alterations in the strength of the lye and modifications in the attendance of the several apparatus have, however, a certain influence on the intensity of the evaporation.

In the case of lyes originally particularly strong or which contain larger quantities of turpentine or sulphide of sodium, the above-described process must be somewhat modified and the inspissation in the evaporators must be suppressed. Such lyes would develop in evaporators a large quantity of noxious gases, which would escape, when forced into the boiler, through the upright tube into the open air and produce a pernicious effect. These lyes are worked in such a manner that the inspissating process begins in the boiler in charging the evaporators with pure water and in utilizing otherwise in the workshop the large excess of water-vapor resulting therefrom; or the evaporators may be supplied with weak wash-lyes having only about 3° Baumé, and which are in this way duly concentrated without particular expense being caused by the inspissation.

A main condition in the whole device is the regular course of the evaporation in the evaporators, boilers, and vats. During this first part of the process at least two-thirds of the quantity of water must be abstracted from the lye, which, according to the above explanations, will take place under normal conditions. If too aqueous lyes are introduced into the inspissation-vat, the produced mixture of fire-gases—the acrid, offensive gases mentioned—gases, and previously-heated air would absorb so large a quantity of water-vapor that the auxiliary fire would not be able to effectuate a complete combustion, so that the offensive gases would escape into the open air. The introduction of this evaporation, which allows of the entrance into the inspissating-vat of only weakly aqueous lyes, is an advantage of the new system which causes the excellent working of the furnace.

The small production of water-vapor in the vat does not prevent the combustion of the aforesaid noxious gases, and the furnace, apart from its other advantages, is for these reasons of great importance with respect to hygiene, as the absence of any bad smell is of the utmost importance for the whole cellulose industry.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is—

1. In an apparatus for inspissating lyes used in the manufacture of cellulose, the combination, with inclined evaporators divided by partitions into several compartments, of a boiler, a worm contained therein, and a connection between said worm and the dome of the evaporator, whereby the worm is supplied with vapor produced by the action of the evaporator, substantially as described.

2. The combination, with the inclined evaporators divided by partitions into several compartments, of the boiler containing a worm connected to the dome of the evaporator, and the flat open pans arranged below the evaporators, and one beneath the next preceding one, substantially as described.

3. The combination, with the melting-furnace L and the inspissating-vat E, of the kettle A, boiler B, and evaporating-pans C, said parts being so arranged that the heat from one part serves to heat the succeeding part, suitable fire-places or heaters, N F G, and a receiver, K, communicating with one of said fire-places, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

CARL FERDINAND DAHL.

Witnesses:
O. WICHMANN,
B. ROI.