

No. 652,611.

Patented June 26, 1900.

J. HARGREAVES.
COMBINED DIAPHRAGM AND ELECTRODE.

(No Model.)

(Application filed Feb. 12, 1898.)

2 Sheets—Sheet 1.

Fig. 1

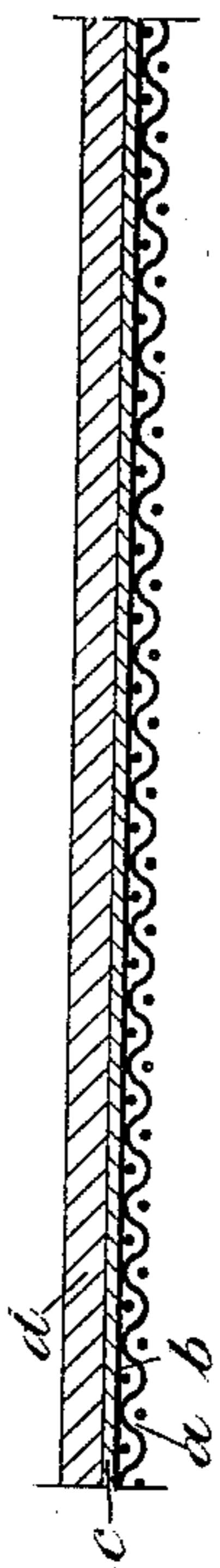


Fig. 3.

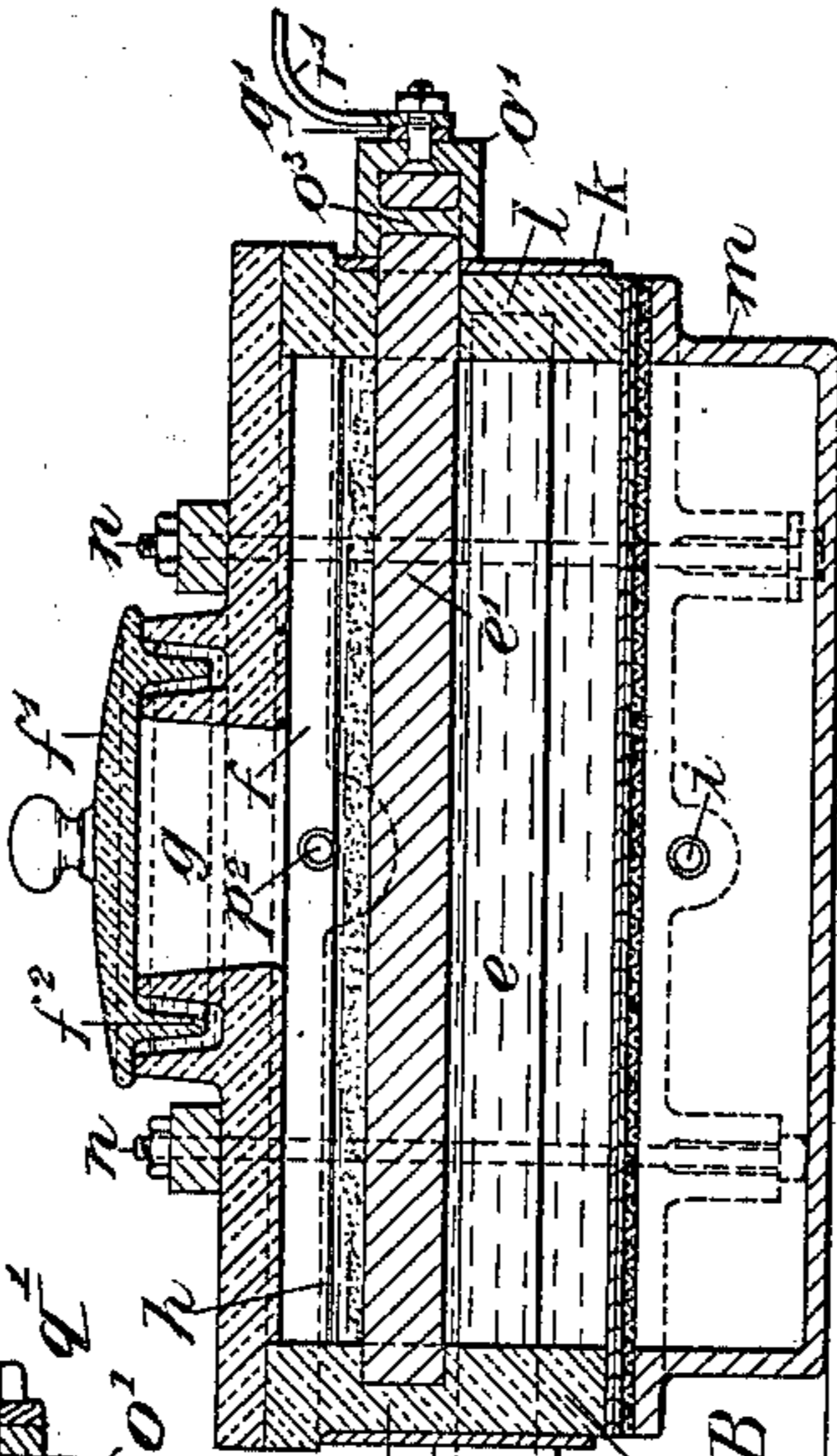


Fig. 3a

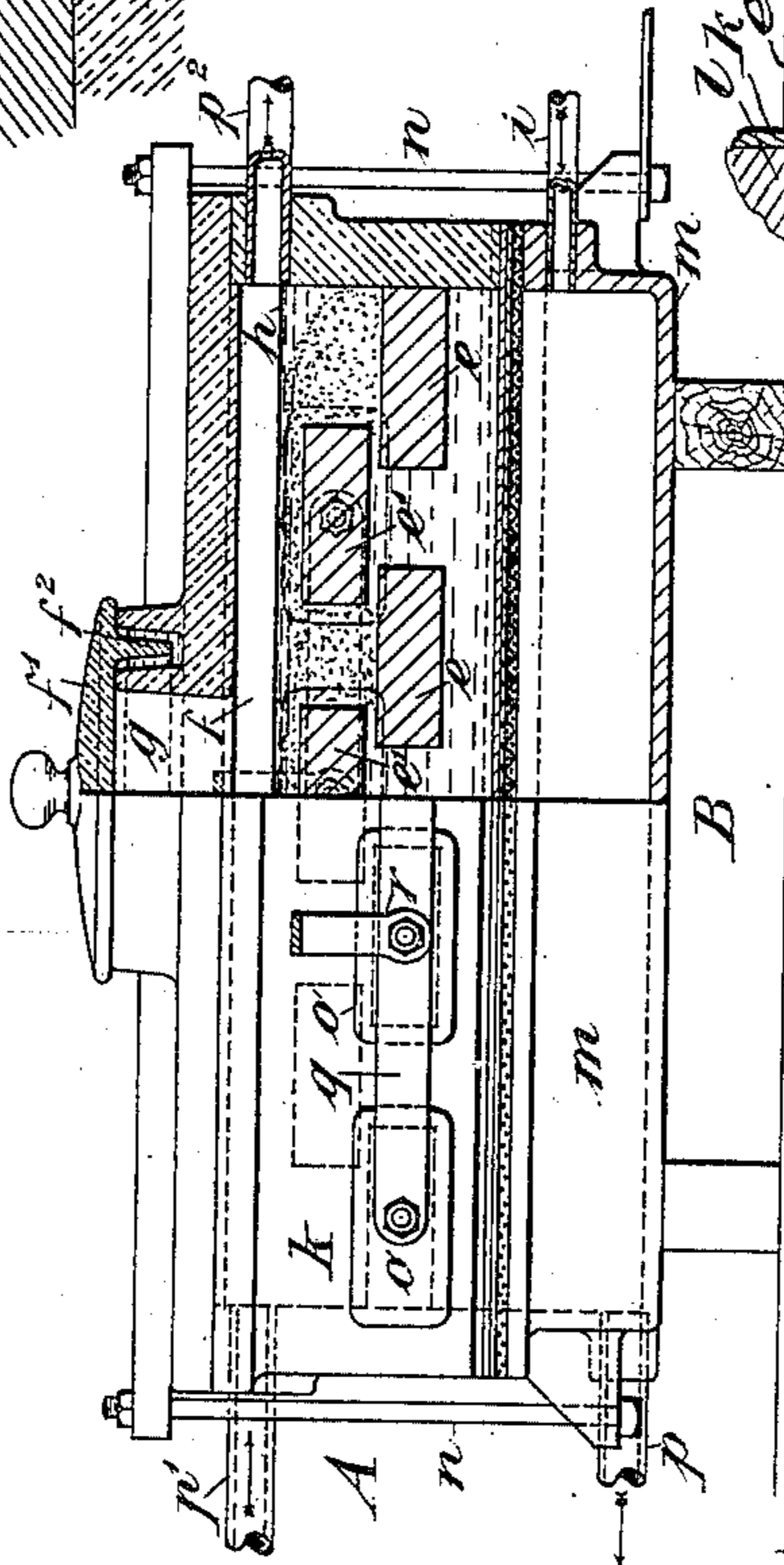


Fig. 2.

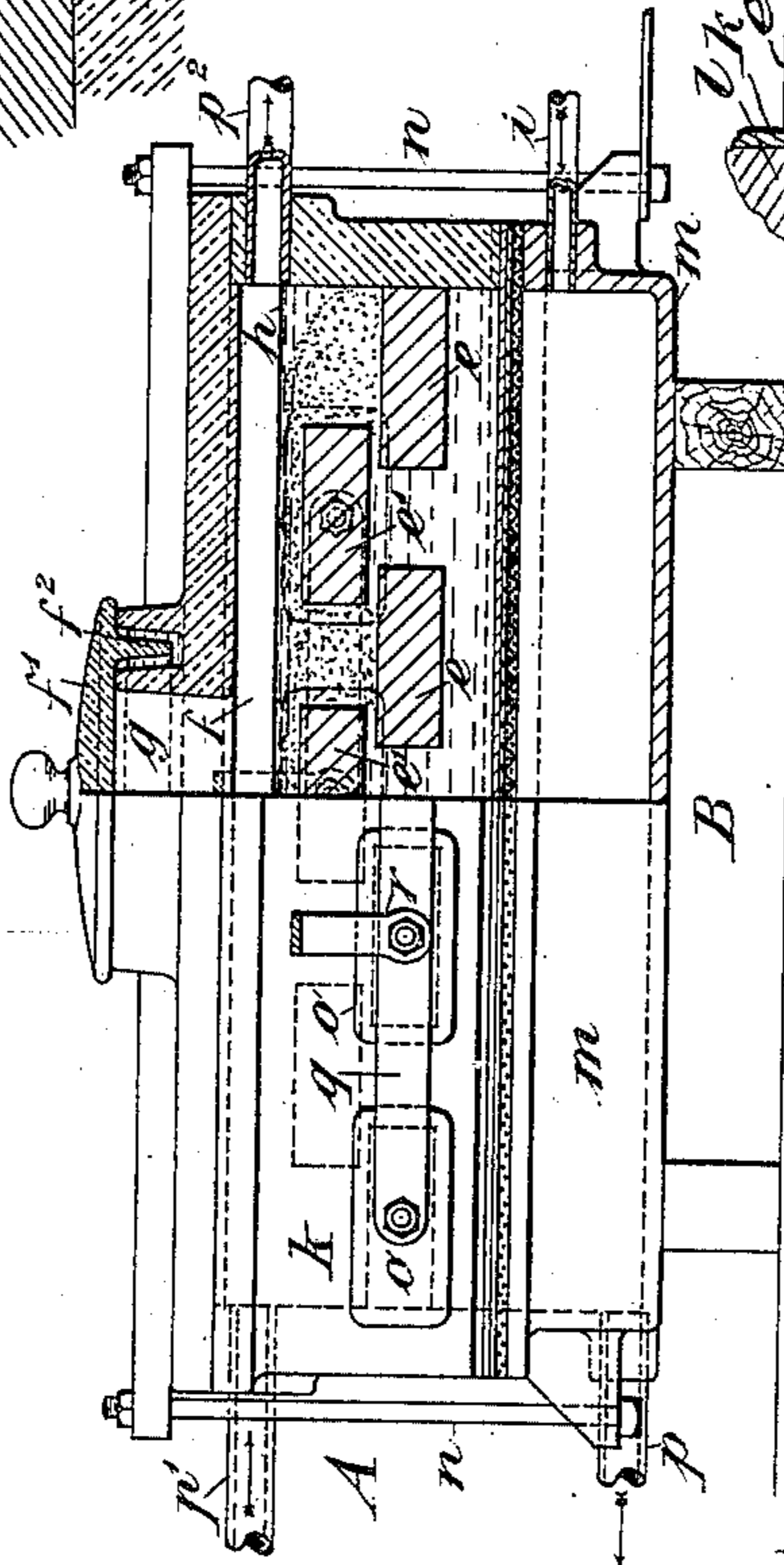
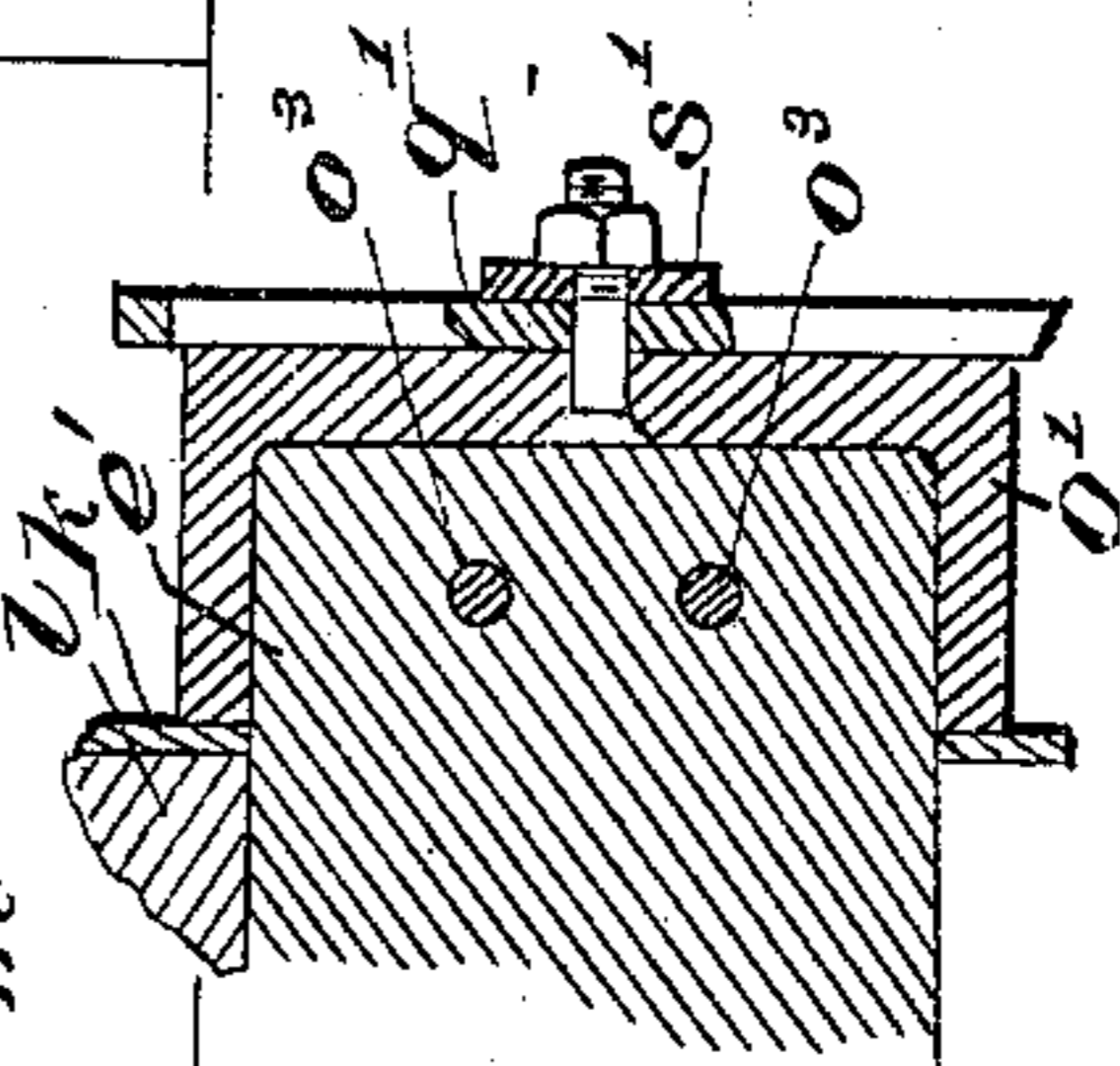


Fig. 3b



Witnesses.
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Fig. 4.

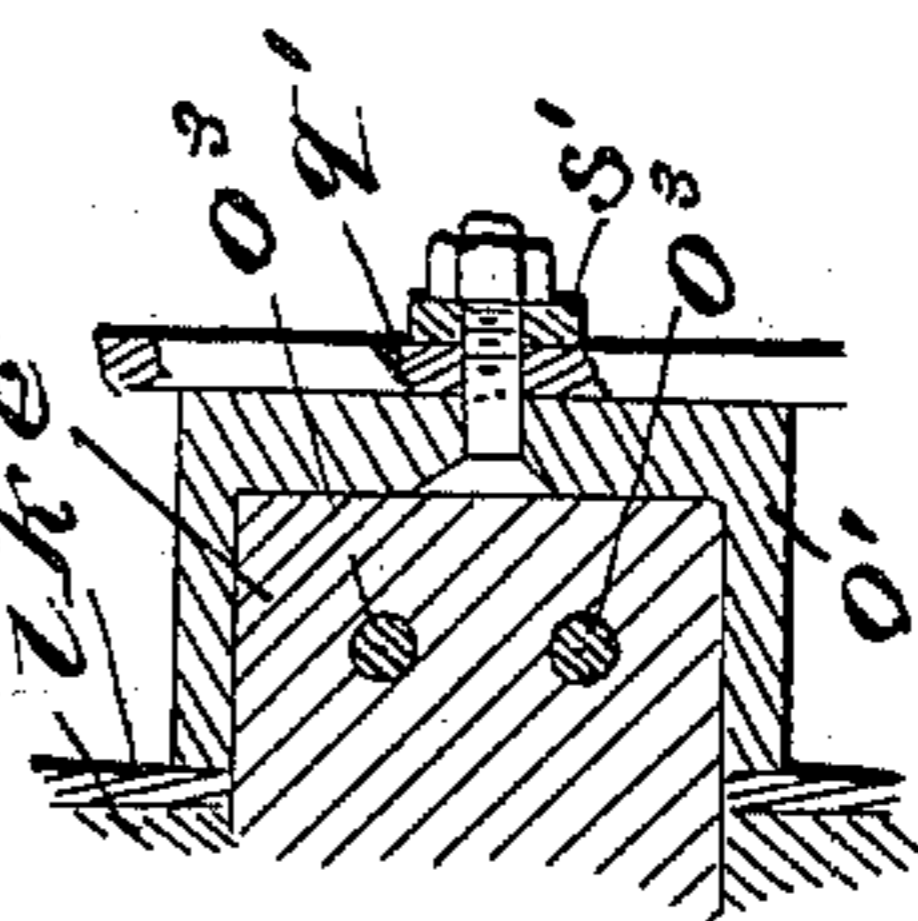
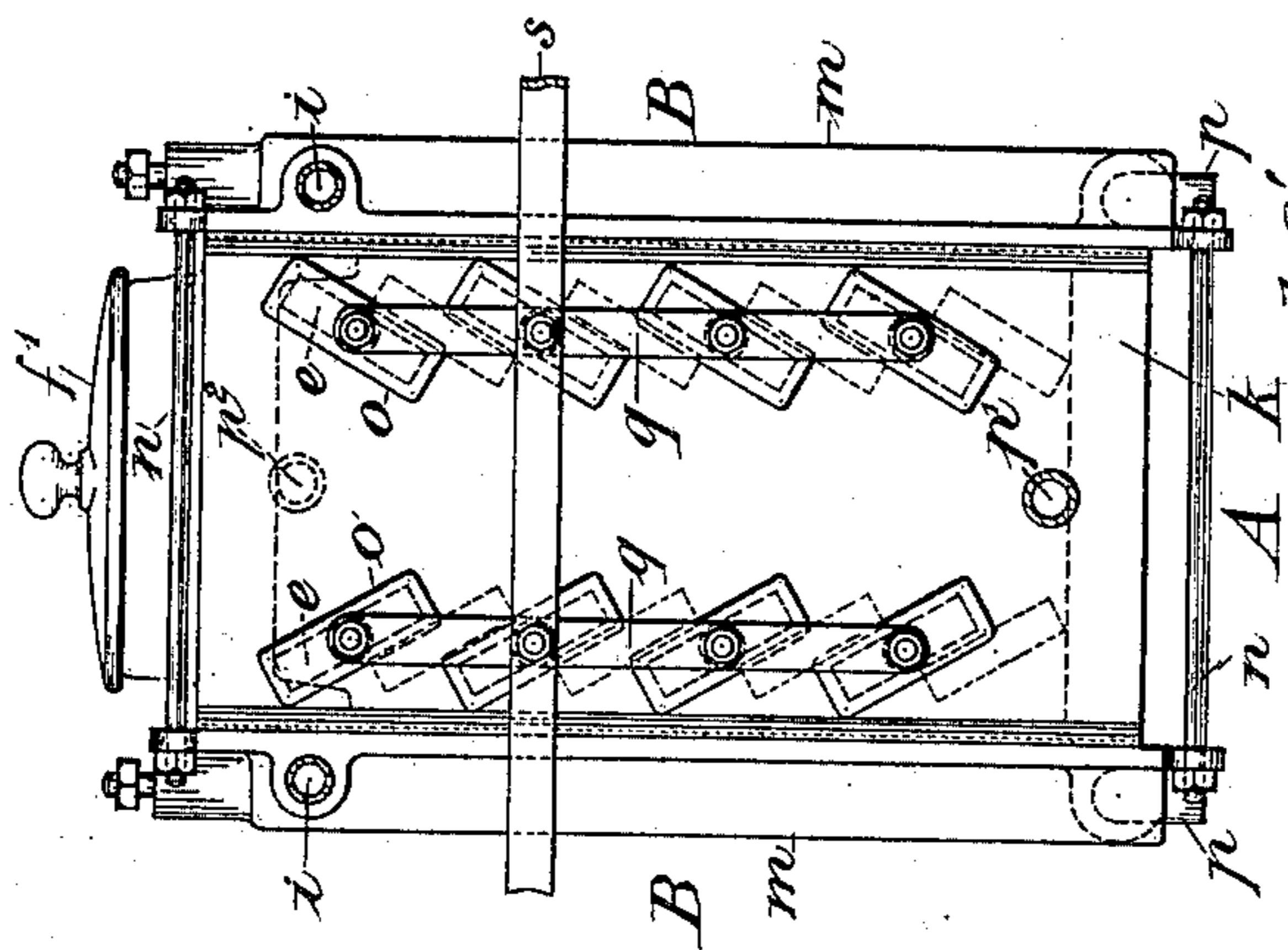


Fig. 4a.

Fig. 5.

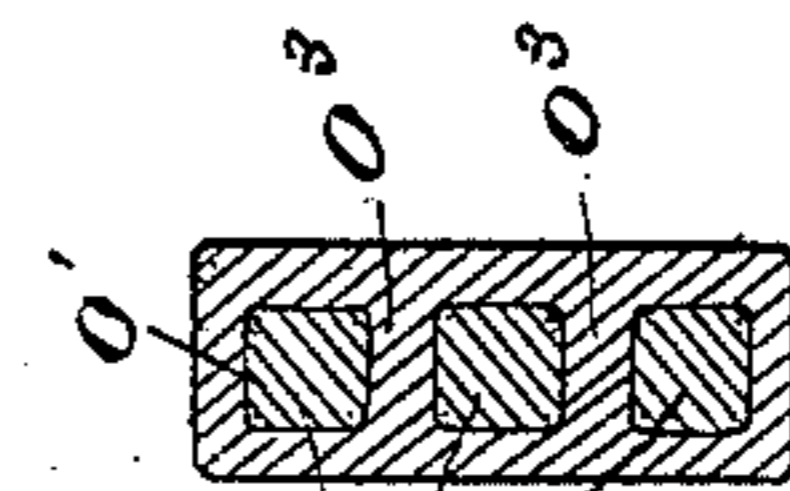
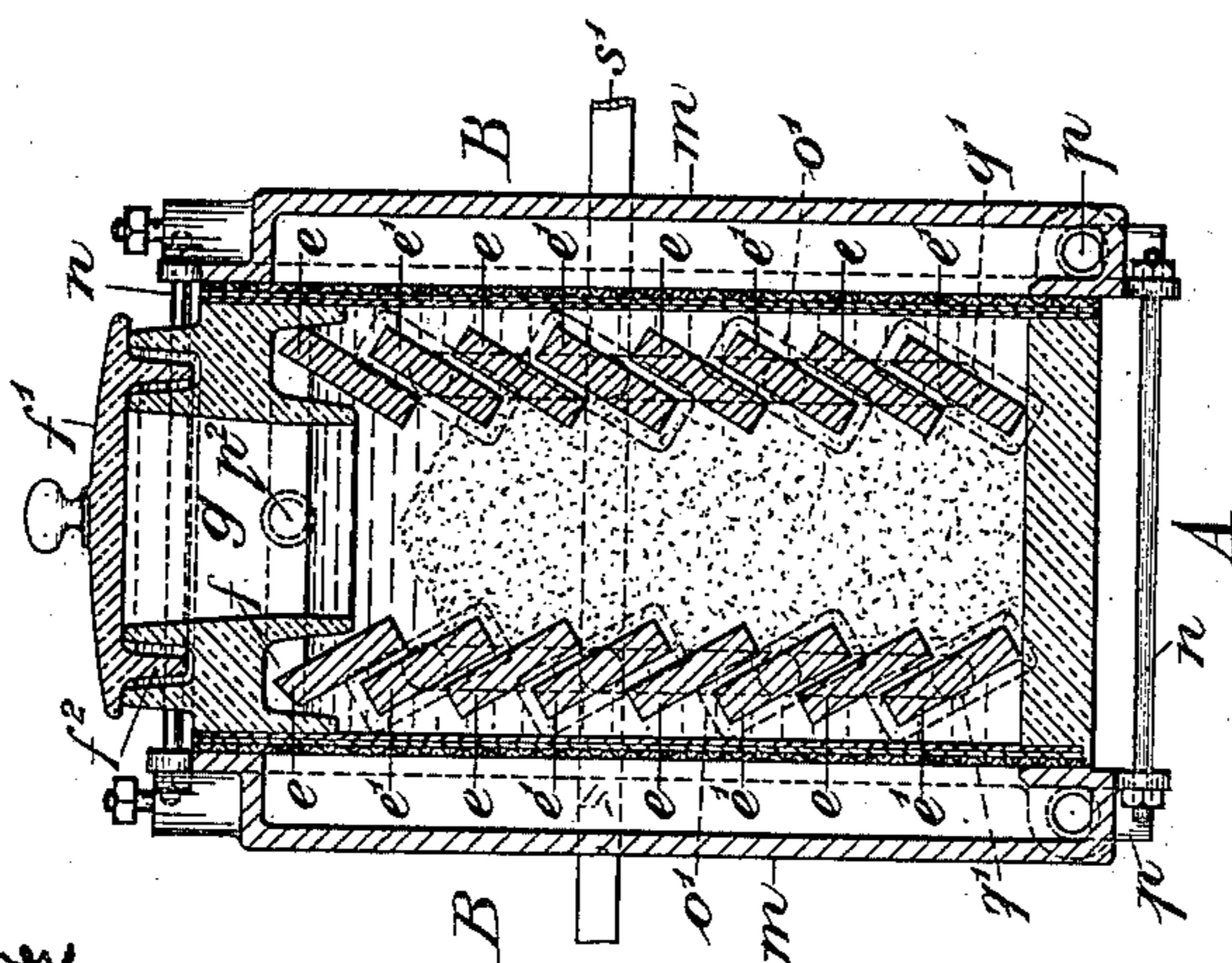


Fig. 5a.

Witnesses.

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UNITED STATES PATENT OFFICE.

JAMES HARGREAVES, OF FARNWORTH-IN-WIDNES, ENGLAND, ASSIGNOR TO
THE GENERAL ELECTROLYTIC PARENT COMPANY, LIMITED, OF SAME
PLACE.

COMBINED DIAPHRAGM AND ELECTRODE.

SPECIFICATION forming part of Letters Patent No. 652,611, dated June 26, 1900.

Application filed February 12, 1898. Serial No. 670,101. (No model.)

To all whom it may concern:

Be it known that I, JAMES HARGREAVES, a subject of the Queen of Great Britain and Ireland, residing at Farnworth-in-Widnes, in the county of Lancaster, England, have invented a certain new and useful Combined Diaphragm and Electrode Applicable for Use in the Electrolysis of Salts and Method of Preparing Same, (for which I have applied for a patent in Great Britain, No. 17,161, to bear date July 20, 1897,) of which the following is a specification.

This invention relates to the decomposition of salts by electrolytic means, and particularly to an improved construction of and method of preparing a combined diaphragm and electrode for use in electrolytic cells.

In the accompanying drawings, Figure 1 is a section of a combined diaphragm and electrode constructed according to my invention. Fig. 2 is a part elevation and longitudinal section of a cell of the horizontal type embodying my improvements, Fig. 3 being a corresponding transverse section. Figs. 3^a and 3^b are respectively a vertical and a horizontal section, drawn to a larger scale, of the cast-metal cap for the electrodes illustrated in Figs. 2 and 3. Fig. 4 is an end elevation, and Fig. 5 a vertical section, respectively, of a vertical type of cell constructed according to my improved method. Figs. 4^a and 4^b are respectively a vertical and a horizontal section, drawn to larger scale, of the cast-metal cap for the electrodes illustrated in Figs. 4 and 5.

According to one part of my invention one side of the diaphragm is composed of a comparatively hard or dense material, the other side being formed of an open, porous, or spongy material. As the hard or dense material offers high resistance to the current, it is preferable to make it as thin as practicable. With this object the said hard or dense material may be attached to the cathode, the said cathode being formed of wire-cloth.

In constructing the diaphragm-electrode the wire-cloth *a* is tightly stretched upon a suitable frame and covered with a pasty, porous, or spongy substance *b*, such as clay or paper, adapted for temporarily performing a retentive function. The hard or dense material *c* is then applied to the upper sur-

face of the porous or spongy substance or to the other side of the cloth, the clay or paper serving to allow the said hard or dense material to fill the meshes or openings in the cloth and to adhere firmly to the latter, but to preserve the side of the cathode which in working is placed farthest from the anode from being coated with such material. If desired, perforated metal may be used for the cathode.

In preparing a combined electrode and stratified diaphragm according to my improved method I do not confine myself to the use of any special materials for forming the hard or dense portion of the diaphragm; but Portland cement will in many instances be found well adapted to the purpose. The cement is preferably made of such consistency that it may be applied in the form of a thin, but complete, coating with the aid of a brush or trowel; but it may be spread evenly in a powdered condition upon the porous or spongy substance or upon the cathode and fixed by passing a wet brush over it. After applying the said coating of hard or dense material *c* a covering *d* of some material of a soft or porous nature—such as asbestos cloth, slag wool, or the like—is caused to adhere to the coating. In practice I have found a material composed of asbestos with lime indurated by saturation with a solution of silicate of soda to give good results. When the said diaphragms are to be used in a horizontal position, the covering of soft or porous material may be composed of loose asbestos pulp or some light amorphous precipitate, such as silicate of magnesia. In some cases I use the aforesaid soft or porous materials, or any of them, in such quantity as to fill the space between the diaphragm and the anode or anodes.

In order to provide for the free escape of the products of electrolysis from the surface of the cathode, I allow a deposit of metallic oxid to form upon the said cathode before using it, or I may deposit upon the surface of the said cathode a thin layer of some soluble substance, which upon being dissolved or removed will leave a narrow space between the material of the diaphragm and the wire-cloth forming the cathode. The deposited

metallic oxid is reduced to metal by the current and produces a rough or spongy coating on the cathode, same rendering the action of the cathode more prompt and effective, the escape of hydrogen being facilitated, polarization reduced, and a larger area of the cathode exposed for contact with the liquid.

The anodes $e e'$ may be placed in such a manner that they form a kind of grid, upon or against which rests the salt to be decomposed. In cells wherein the anodes are arranged horizontally, as shown in Figs. 2 and 3, the upper part f of the cell is made sufficiently high to form a chamber for receiving a large charge of salt, which is preferably charged into the cell in a solid state through the charging-aperture g and is dissolved, as required, by the electrolyte h , the latter being allowed to rise slightly above the level of the anodes $e e'$. In charging the cell with salt care must be taken not to disturb the electrolyte and to prevent the ingress of salt between the anodes and the diaphragm. Steam is injected into the cathode-compartment of the cell by way of the pipe i for the purpose of heating the cell, the steam tending to assist in dissolving the salt. With a view to avoiding leakage through the sides of the anode-compartment A at the places where the anodes $e e'$ pass through them plates of suitable metal, such as type-metal, may be cast around the ends of the anodes, the insides of the said plates being coated with a thick serving of pitch or similar material.

In constructing a cell of the horizontal type the mode of procedure is as follows: A lead plate k , perforated for the reception of the ends of the anodes $e e'$, is served with a coating of pitch, the side walls $l l$ of the cell being formed against the coated side of the lead plate. The several anodes are placed in position, as shown in Figs. 2 and 3, with their ends protruding through the unpitched side of the lead plate, and a forming-board or sand is so disposed between the plates as to leave a space of the required dimensions between the pitched side of the lead plate and the board or sand. Into this space is run the cement which is to constitute the walls of the cell, the sides and the ends being formed simultaneously. Having thus constructed the upper or anode compartment A of the cell, the lower or cathode compartment B is formed by applying a tray m , which may be of cast metal, the diaphragm-electrode being inserted between the two compartments, which are then secured together by means of bolts $n n$. In the vertical type of cell, Figs. 4 and 5, the walls of the central or anode compartment may be formed in a similar manner. In this construction there are two cathode-compartments B B, the anodes $e e'$ in the compartment A being disposed in the form of a grid, against which the salt rests. In arranging these anodes the slabs of carbon are each placed at an angle to the vertical, so that each

slab overlaps the next adjacent slab, ingress of salt to the space between the anode and the diaphragm being thereby prevented. The extremities of the anodes $e e'$ are inclosed in caps $o o'$. These caps are formed of lead or type-metal cast around such extremities, the metal occupying a hole or holes previously drilled through the anodes and also covering their ends. By these means the metal which enters the holes forms rivets $o^2 o^3$, whereby the cap is held firmly in position. In cooling the metal has a tendency to shrink upon the carbon, and thereby becomes firmly attached thereto, at the same time forming a good electrical connection between the carbon and the cap.

The anodes $e e$ in the horizontal cell are connected up in series by means of the connecting-bar q , while the anodes $e' e'$ are similarly connected by the bar q' , the positive wire from the source of electric energy being attached to the terminals $r r'$. The anodes $e e$ on each side of the vertical cell are connected in series by bars $q q$, these bars being coupled by means of the cross-bar s . The intermediate or alternating anodes $e' e'$ on each side of this cell are connected by bars $q' q'$ and coupled by the cross-bar s' . The bars s and s' are furnished with terminals, to which the positive wire is secured. In either construction of cell the negative wire may be connected directly with the tray m .

In operating with the aid of the improved cell water is supplied to the anode-compartment A, the salt, which may be in the form of crystals, being then inserted through the feeding-orifice g . This orifice is closed by a cover f' , furnished with an annular projection f^2 , which dips into a water seal, whereby the escape of chlorin is prevented, or leakage of chlorin through defects in the joints of the compartment A may be obviated by producing a slight vacuum in such compartment by means of a fan applied to the chlorin-outlet. During the progress of the operation steam is ejected by way of the pipe i into the cathode-compartment, the resulting product issuing by way of the pipe p .

When treating salt solutions in a cell, such as shown in Figs. 2 and 3, the strong brine enters the anode-compartment by way of the pipe p' , while the weakened brine and chlorin are led away by the pipe p^2 . The pipe p' is not required when treating pure salt, the pipe p^2 being, however, retained for permitting the escape of chlorin. When treating salt solutions in a cell of the vertical type, Figs. 4 and 5, the inlet p' for strong brine is preferably at the lower part of the vessel. The weakened or exhausted brine, together with the chlorin, may be conveyed by way of the pipe p^2 to a separating vessel, the chlorin being conducted thence to a suitable receiver or utilized directly from said vessel. If the salt liquor contains insoluble matter in any important quantity, the liquid is conducted to a suitable saturating vessel for effecting

the settlement of the insoluble impurities, and thereby intercepting their passage into the electrolytic cell.

5 The pipes employed for connecting the cells or vessels may be constructed of vulcanite or other suitable non-conducting material.

What I claim as my invention, and desire to secure by Letters Patent, is—

10 1. The herein-described method of preparing a combined diaphragm and electrode for use in electrolytic cells consisting in covering wire-cloth or perforated plate with a thin layer of clay or equivalent material adapted temporarily to perform a retentive function
15 and ultimately to be dissolved or washed away, then applying a coating of Portland cement or equivalent hard or dense material

and finally covering the latter with asbestos cloth or equivalent soft or porous material whereby a stratified diaphragm dense as to 20 one side and porous as to the other is obtained, substantially as set forth.

2. In a combined electrode and diaphragm the combination with a wire-cloth cathode, such as *a*, of a superposed layer of paper, 25 clay, or other temporarily-retentive material *b*, a coating of Portland cement *c*, and a covering *d* composed of asbestos, substantially as and for the purposes specified.

JAMES HARGREAVES.

Witnesses:

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WILLIAM TOULOUSE.