No. 737,566. PATENTED SEPT. 1, 1903.

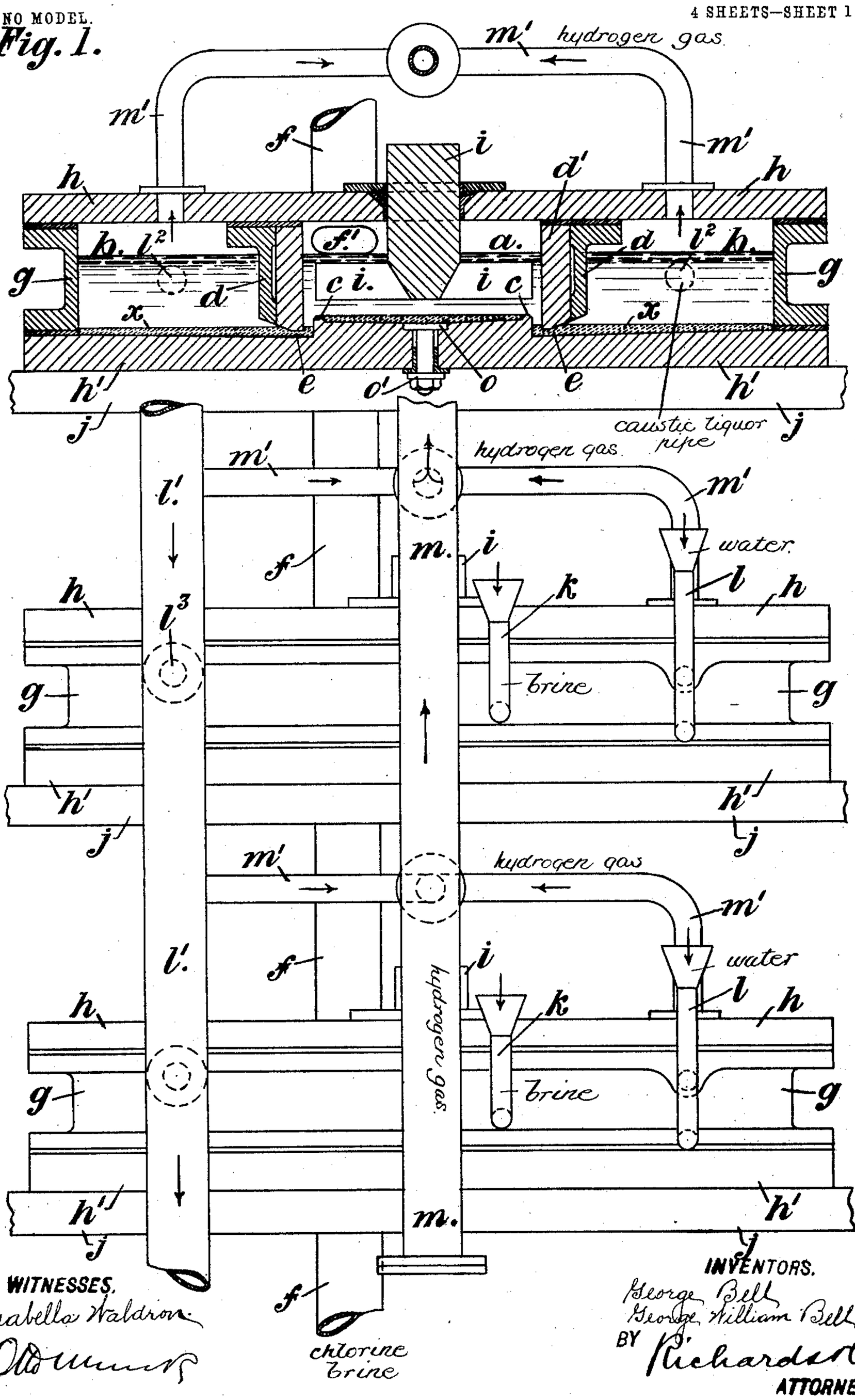
G. & G. W. BELL.

ELECTROLYTIC APPARATUS.

APPLICATION FILED JUNE 18, 1901.

NO MODEL. 4 SHEETS—SHEET 1.

Fig. 1.



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NO MODEL. 4 SHEETS—SHEET 2.

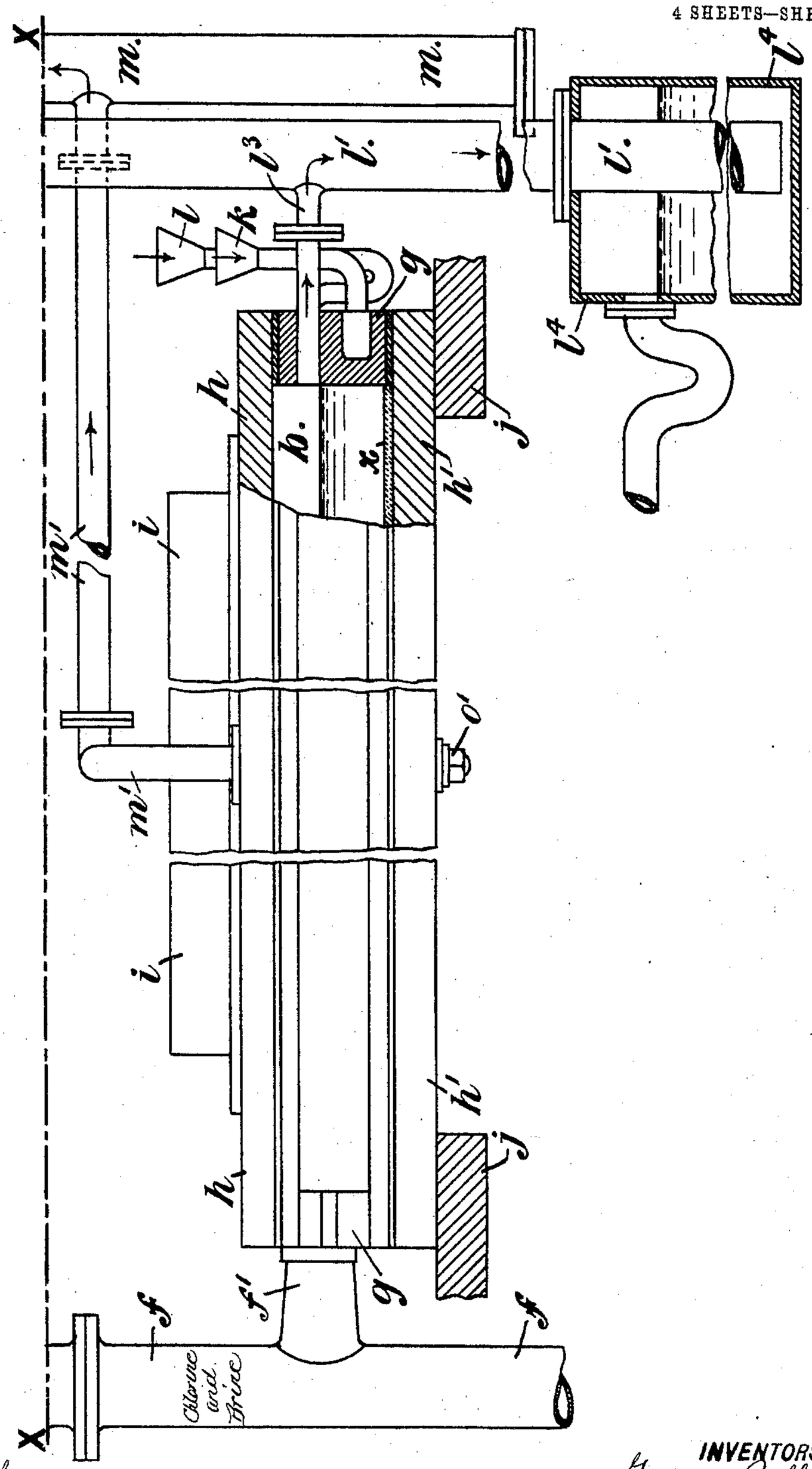

Fig. 2.

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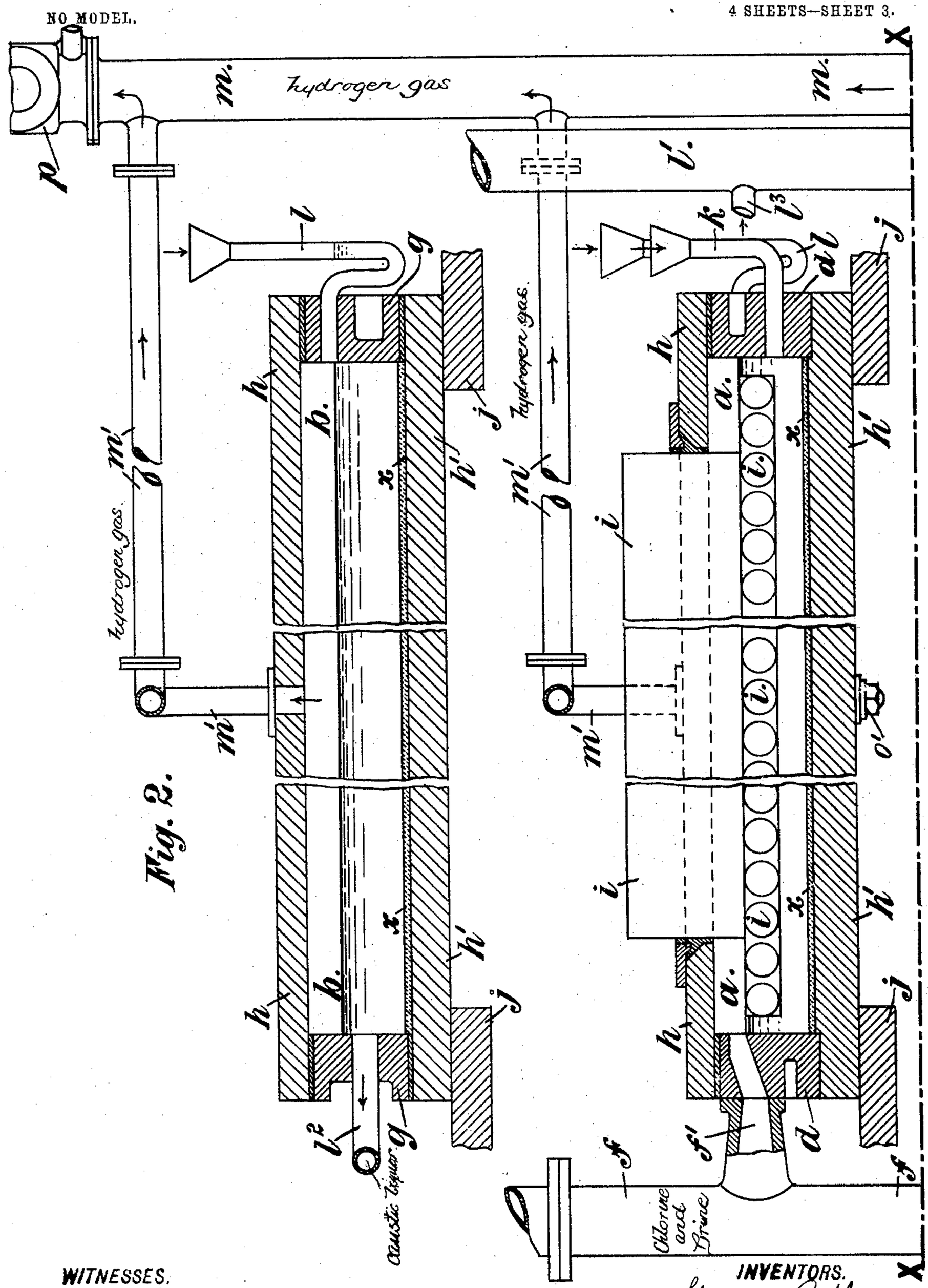
NO MODEL. 4 SHEETS—SHEET 3.

Fig. 2.



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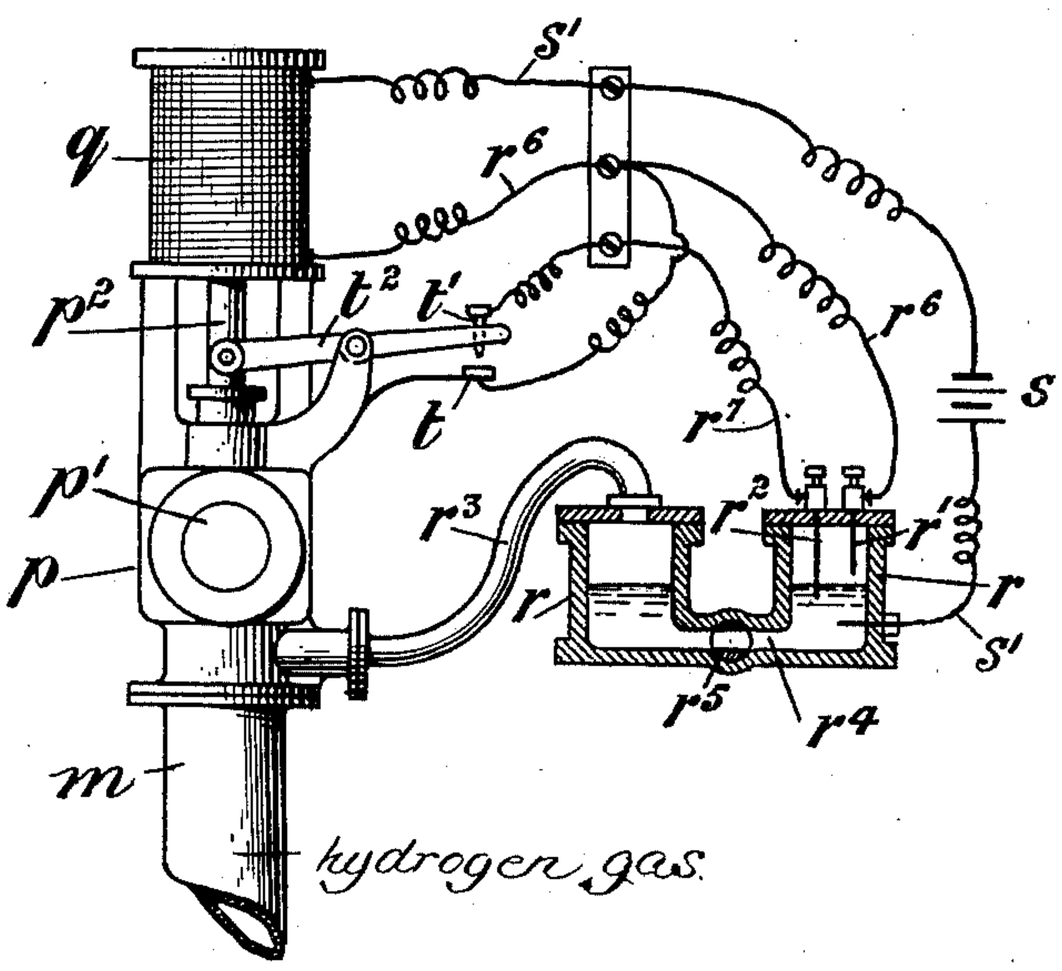
NO MODEL. 4 SHEETS—SHEET 4.

Fig. 3.



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No. 737,566. Patented September 1, 1903.

UNITED STATES PATENT OFFICE.

GEORGE BELL AND GEORGE WILLIAM BELL, OF LIVERPOOL, ENGLAND.

ELECTROLYTIC APPARATUS.

SPECIFICATION forming part of Letters Patent No. 737,566, dated September 1, 1903.

Application filed June 18, 1901. Serial No. 64,971. (No model.)

To all whom it may concern:

Be it known that we, GEORGE BELL and GEORGE WILLIAM BELL, subjects of the King of England, and residents of Liverpool, in the county of Lancaster, England, have invented certain new and useful Improvements in or Connected with Electrolytic Cells or Apparatus, of which the following is a specification.

This invention has reference to the electrolysis of salts in solution, and more particularly for the electrolytic decomposition of alkaline salts for the production of alkali—such, for instance, as pure alkaline hydrate and chlorin from alkaline-metal chlorids—and it relates more especially to cells or apparatus for the manufacture of such substances electrolytically in which the alkaline base liberated by electrolysis in one chamber forms an amalgam with mercury (or similar fluid metal) in contact with the electrolyte, and such mercury amalgam is moved away from the electrolyte and passed into and oxidized in a separate chamber or place by bringing it into contact with water or other oxidizing fluid, and this movement or translation of the mercury to and from the chambers of the apparatus is effected directly or indirectly by the pressure of a gas acting on the surface of the mercury or by the hydrostatic head of a liquid adapted to act equivalently upon it.

The cell or apparatus itself has no movement, the mercury alone being alternately moved from one chamber to the other, and according to this invention this action is, nevertheless, carried on without stopping the electrolysis or decomposition of the electrolyte. Also the bottom of this decomposing or anode chamber is protected against destructive or erosive actions of the liquids and also wear and tear due to friction of the mercury over same and processes taking place in the cells. This is effected by so constructing the cell or the bottom parts of the anode-chambers of the cell on which the mercury lies and over or past which it flows that under any circumstances a certain proportion of the mercury entering the anode-chamber and the lower portion or laminæ of it, which will contain little amalgam, is left on the bottom of the decomposing or anode chamber when the mercury discharge to the oxidizing-chamber takes place. It is thus protected by this layer of mercury against all erosive actions and frictional action due to the wash of the mercury, and the electrolytic process continues after the upper lamina containing mercury amalgam has been removed and while it is being removed. Also the current is continuously taken away by this lower residuary lamina of metallic mercury.

The invention is illustrated in the accompanying drawings, in which—

Figure 1 is an end elevation, partly in transverse section, showing cells according to this invention; and Fig. 2 is a side elevation of same, part of which is on Sheet 3. Fig. 3 is a diagrammatic view showing the valve-controlling mechanism.

The cell here shown, which is illustrative of improvements under this invention, is adapted or arranged in such a manner that the pressure to be applied to the mercury for effecting its flow and return is utilized in the oxidizing-chambers only, the return flow of mercury from the anode or decomposing chambers being effected by gravity on the pressure being released.

Referring to the drawings, *a* is the anode-chamber, and *b* represents the oxidizing-chambers.

d represents partitions between the anode-chamber and the oxidizing-chambers.

e represents the passages under the lower edge of the partitions *d*, forming luted communications for the flow of mercury between these two chambers.

o is the cathode-plate in the bottom of the chamber *a* for conveying away the current, *o'* being the contact-binder for the conductor.

With regard to the gaseous-fluid and liquid conducting pipes connected with the cell *f* is the chlorin or gas discharge pipe of the cells, (but which also serves as the brine-escape pipe,) *f'* being the branches communicating between the main pipe *f* and the gas-space above the liquor in the chambers *a*.

k represents the pipes conveying brine to the anode-chambers *a* of the apparatus, the brine being fed through a suitable supply-pipe with regulating tap, which discharges into the open bell-mouth of the pipe *k*.

l is a trapped pipe for conveying water to one of the oxidizing-chambers *b*, and l^2 is a branch conveying caustic liquor from one

chamber b to the other chamber b, while l^3 is a branch conveying the caustic liquor from the chamber b to the main l', which is common to all the cells for running off the caustic liquor. The trap of the supply-pipes l is of sufficient depth to withstand the maximum pressure of the hydrogen gas and prevent it escaping.

m is the main pipe, and m' represents branches connecting it with the chambers b, by which the hydrogen gas evolved in these chambers is carried off from them and on which a valve is provided for causing hydrogen gas to accumulate and a pressure to increase and to be released alternately.

The floor of the anode-chamber a is above that of the oxidizing-chambers b, and according to this inventon the outlet and inlet from this floor are disposed at such a level, or in the way by which the mercury flows from and to this chamber there is a part the level of which is above the level of the floor of the chamber, that this floor is always kept covered with a thin layer or depth of mercury. In the construction shown there is a ledge c on the outer edges of the floor, which is raised above the floor-level, and the luted passage e lies between the outer face of these ledges and the chambers b. The passages or lutes between the chambers a and the chambers b are by a continuous opening under the lower edges of the partitions d, which always dip into the mercury x in the bottom of chambers b, and these lutes form seals in connection with the lower edges, whereby the two fluids floating on the mercury surfaces in the different chambers are effectively isolated and cannot pass from one to the other. In other cases having a different structural character and mode of action different forms or parts may be employed to effect the end or action referred to; but in any event the point or level of the mercury-outlet from the chamber a or the outlet-conduits is or are so constructed and arranged in relation to the floor of the anode-chamber that only that amount of mercury which is amalgam or contains it flows or is forced from this chamber.

In the construction shown the body g of the cell is assumed to be made of iron, including the partitions d, which have a lining d' of slate or other suitable material, while the covers h and bottom h' are of slate or other suitable material.

i represents the anodes, which consist of a vertical trunk passing through the cover h and horizontal bars projecting right and left on either side from the lower end of the trunk, and current is conveyed to the vertical trunk by the suitable electrical connections. In the case shown three cells are shown supported one above the other on supports j, and the pipes m and l' are common to all these three chambers; but of course more than three cells may be placed in this way, or, on the other hand, single cells may be employed.

With regard to the mode of moving the mercury to and from the anode and cathode chambers the creation of pressure within the oxidizing-chambers b and the subsequent release of this pressure is controlled by a valve p on the upper end of the main hydrogen-pipe m. When this valve is closed, the hydrogen generated in the chambers b by the oxidation of the sodium contained in the mercury amalgam when the mercury has been introduced into it from the chamber a collects and its pressure gradually rises, and when it has reached a certain point and the mercury to a large extent again brought back to the metallic state the pressure on the face of the caustic liquid presses on the mercury and forces this mercury up through the luted passages e into and over the bottom of the chamber a, where it is held the required length of time to receive a fresh charge of sodium by the electrolyzing of the salt in this chamber. When it is sufficiently charged, the valve p is opened, the hydrogen escapes through branch p', the pressure falls, and a freshly-made quantity of amalgam from the top of the quantity in the chamber flows into the chambers b.

According to this invention this is effected by an electrical controlling apparatus, which is illustrated in Fig. 3. This apparatus comprises an electromagnet q, acting directly on the spindle p^2 of the valve p, and a contact device consisting of a chamber r, containing mercury, having contact-points r' r^2 in it, in connection with which the mercury operates. In the case shown the vessel r has two chambers, one of which is connected by a pipe r^3 with the hydrogen-pipe m and the other contains the contact-points r' r^2 and communicates with the pressure-chamber through a conduit r^4, the area of which is controlled by a cock r^5. In connection with this vessel r there is a circuit-wire s', in which the generator s exists, one end of this circuit being permanently in contact with the mercury in the vessel r and the other with one end of the coil of the electromagnet q. The ends of the contacts r' r^2 are at different levels, r' being the higher, and this is connected by a wire r^6 with the other end of the coil of the magnet q, while the lower one, r^2, is adapted to be put in and out of circuit with the magnet-coil through means of a contact-piece t, connected with r^6, and a contact-piece t', connected with r^2 by the wire r^7 on the end of lever t^2, connected with and operated by the valve-rod p^2.

In action, assuming the valve to be closed and the contact parts t t' away from each other, the circuit through r^7 open, and the two terminals r' r^2 out of contact with the mercury in r, (which would be the condition when the valve p is first closed.) Then as the pressure of hydrogen accumulates in the chambers b and the pipe m it acts on the mercury in chamber r through the connecting-pipe r^3, and the mercury in the terminal vessel rises and comes in contact, first, with the lower

contact or terminal r^2; but as the circuit connected with this terminal is open by the contact parts $t\,t'$ being apart no current can pass through the wires and magnet-coil, and the magnet q is not energized. Then by the further rise of the mercury by the further rise of pressure the higher terminal r' is touched by it, and the circuit by way of the coil of the magnet q through the circuit-wires r^6 and s' is closed and the magnet is energized and the valve-rod p^2 of the valve p is pulled toward the magnet and the valve is opened. This action also closes the circuit by the wire r^7 at the contact-point t' and is brought onto t by the movement of the rod p^2 and lever t^2. The effect of course of the opening of the valve p is that the pressure in the oxidizing-chambers b and in the chamber r is dissipated, and the mercury in the part of the chamber r containing the contacts falls and at a rate slower than the mercury discharged in the cell. In falling it first leaves the higher contact r', so that the primary circuit through r^6 is opened; but the secondary circuit through r^7 and the contact-points $t\,t'$ is still closed and the magnet q remains energized, so that the valve is still open and kept open until the mercury also leaves the second and lower terminal r^2. When this circuit is also opened, all current is cut off from the magnet, and the valve p is then no longer held by it and closes, and pressure at once begins to accumulate in the chambers b. To prevent the liquid—namely, water or caustic—being forced out of the chambers b, the trap of the pipes l is made sufficiently deep; also, the lower end of the caustic-liquor-discharge main pipe l' is trapped by a trap l^4 to prevent the escape of hydrogen.

It will be seen that the time taken in the performance of a complete cycle of operations will depend upon the differences of level of the two terminals of the valve-controlling device and of the velocity of rise and fall of the mercury in this device, and this latter can be regulated by regulating the opening through which the mercury passes and also the relative height of contact-points. This valve device is also applicable where the transfer of mercury from one chamber to another is effected by the action or pressure of artificial or extraneous gaseous pressure with slight modification.

What is claimed in respect of the herein-described invention is—

1. In an electrolytic apparatus, an electrolyzing-chamber having a mercury cathode and a suitable anode, an oxidizing-chamber communicating with the same at the lower part, through which communication mercury flows from one chamber to the other, a valve controlling the pressure of gas in one of said chambers, for forcing the mercury from one chamber to another, an electromagnet for operating said valve, and a liquid-metal-containing electric-contact vessel communicating with said valve-controlling chamber, whereby said pressure in said chamber acts on the liquid in the liquid-metal contact vessel, contacts disposed at different heights in said vessel, and electric circuits connecting the magnet-coil with the contacts and liquid in said vessel; substantially as set forth.

2. In an electrolytic apparatus, an electrolyzing-chamber having a mercury cathode and a suitable anode, an oxidizing-chamber communicating with the same at the lower part, through which communication the mercury flows from one chamber to the other, a valve controlling the pressure of gas in one of said chambers, for forcing the mercury from one chamber to another, an electromagnet for operating said valve, and a liquid-metal-containing electric-contact vessel communicating with one of said chambers, whereby said pressure in said chamber acts on the liquid in the liquid-metal contact vessel, contacts disposed at different intervals in said vessel, an electric connection between the higher contact with the one end of the magnet-coil, an electric connection between the other end of said coil, an electric connection between the other end of said coil and the liquid in the vessel, an electric connection between the lower contact and one end of the magnet-coil through a break-and-make device connected with and operated by the valve; substantially as set forth.

3. In an electrolytic apparatus, an electrolyzing-chamber having a mercury cathode and a suitable anode, an oxidizing-chamber communicating with the same at the lower part, through which communication the mercury flows from one chamber to the other, a valve controlling the pressure of gas in one of said chambers for forcing the mercury from one chamber to another, liquid-metal contact vessel r having two chambers, a pipe r^3 connecting one chamber of said vessel with the gas-pressure conduit-contacts r' r^2 in the other chamber of said vessel at different heights, electric connection s' between the magnet-coil and the liquid of said vessel, electric connection r^6 connecting the contact r' with the other end of said coil, electric connection r^7 connecting the lower contact r^2 with the contact $t\,t'$ operated by said valve; substantially as set forth.

In witness whereof we have hereunto set our hands in presence of two witnesses.

GEORGE BELL.
GEORGE WILLIAM BELL.

Witnesses:
JNO. W. BROWN,
WM. JNO. HUMPHREYS.