(No Model.) 4 Sheets—Sheet 1.

J. GREENWOOD.

ELECTRODE FOR USE IN THE MANUFACTURE OF CHLORIN AND CAUSTIC SODA.

No. 514,318. Patented Feb. 6, 1894.

Fig. 1.

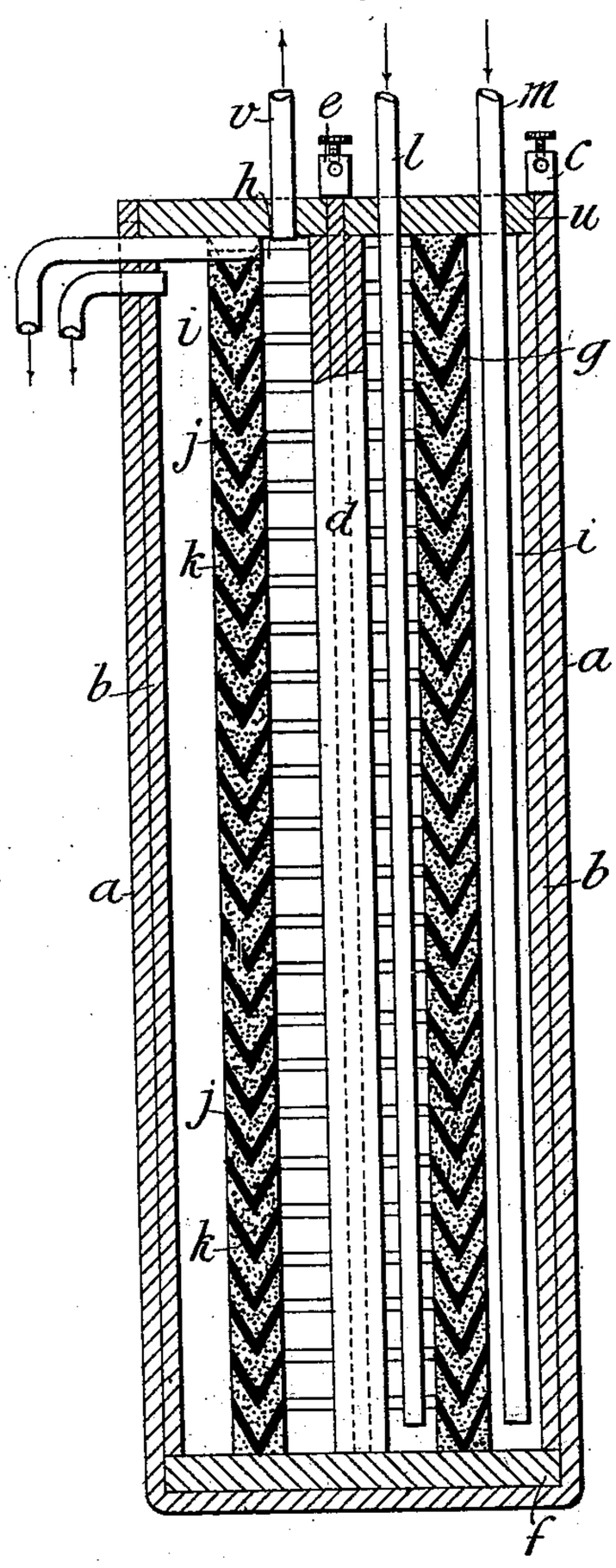

Fig. 2.

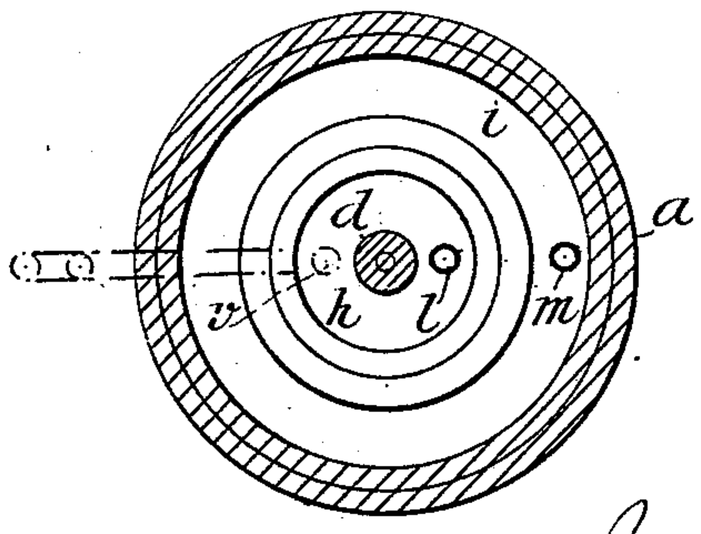

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Fig 3.

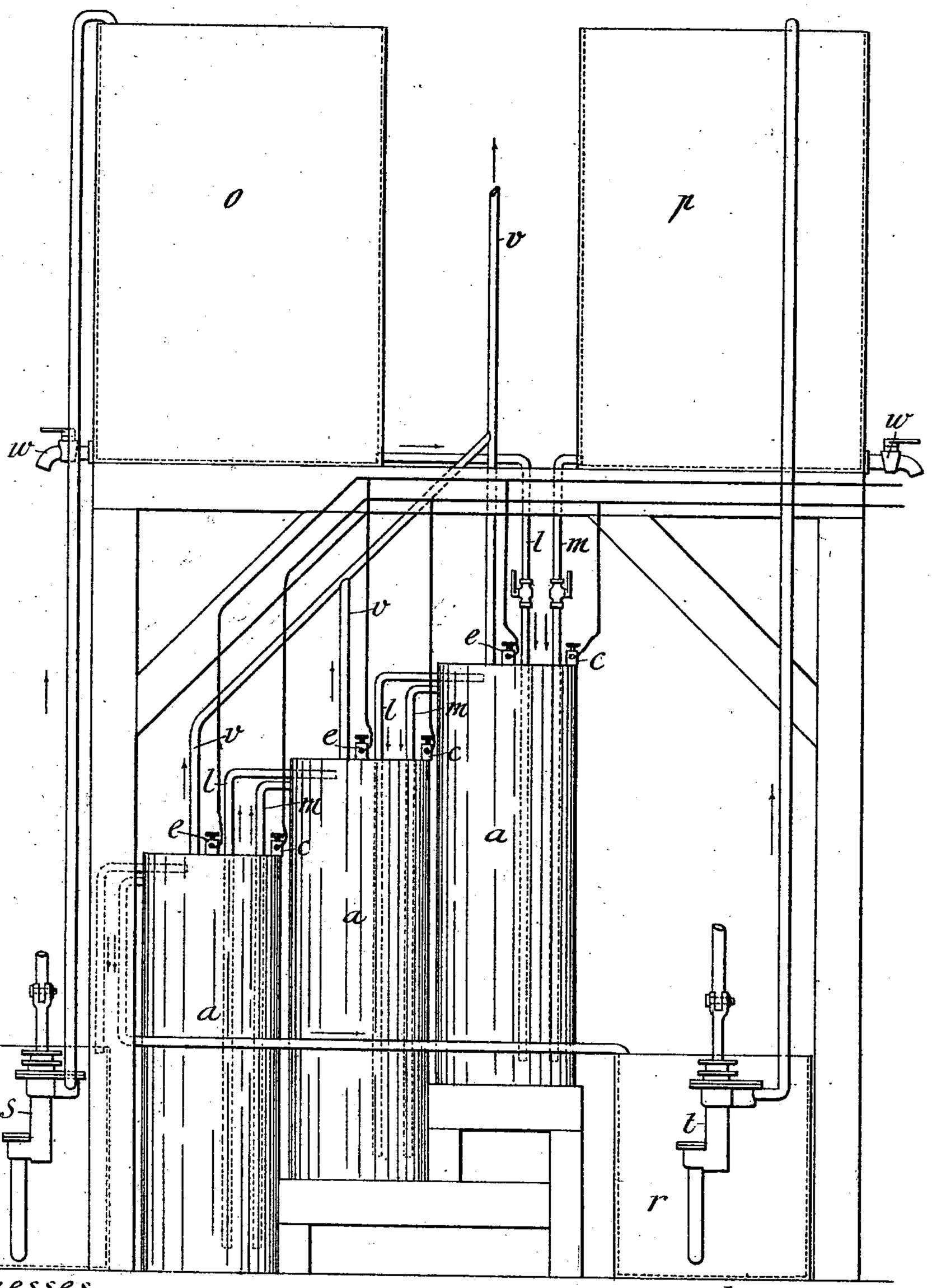

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Fig 4

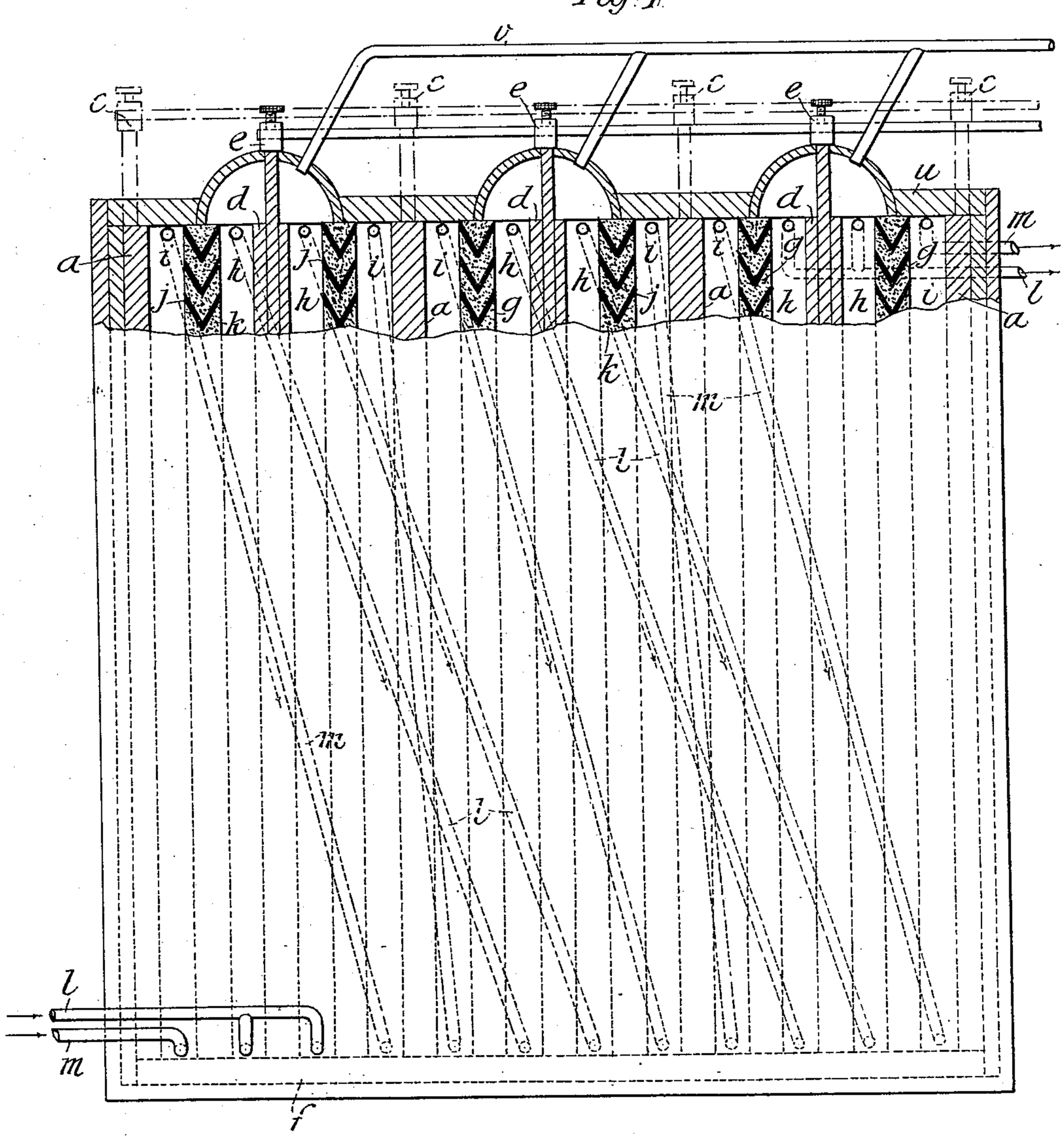

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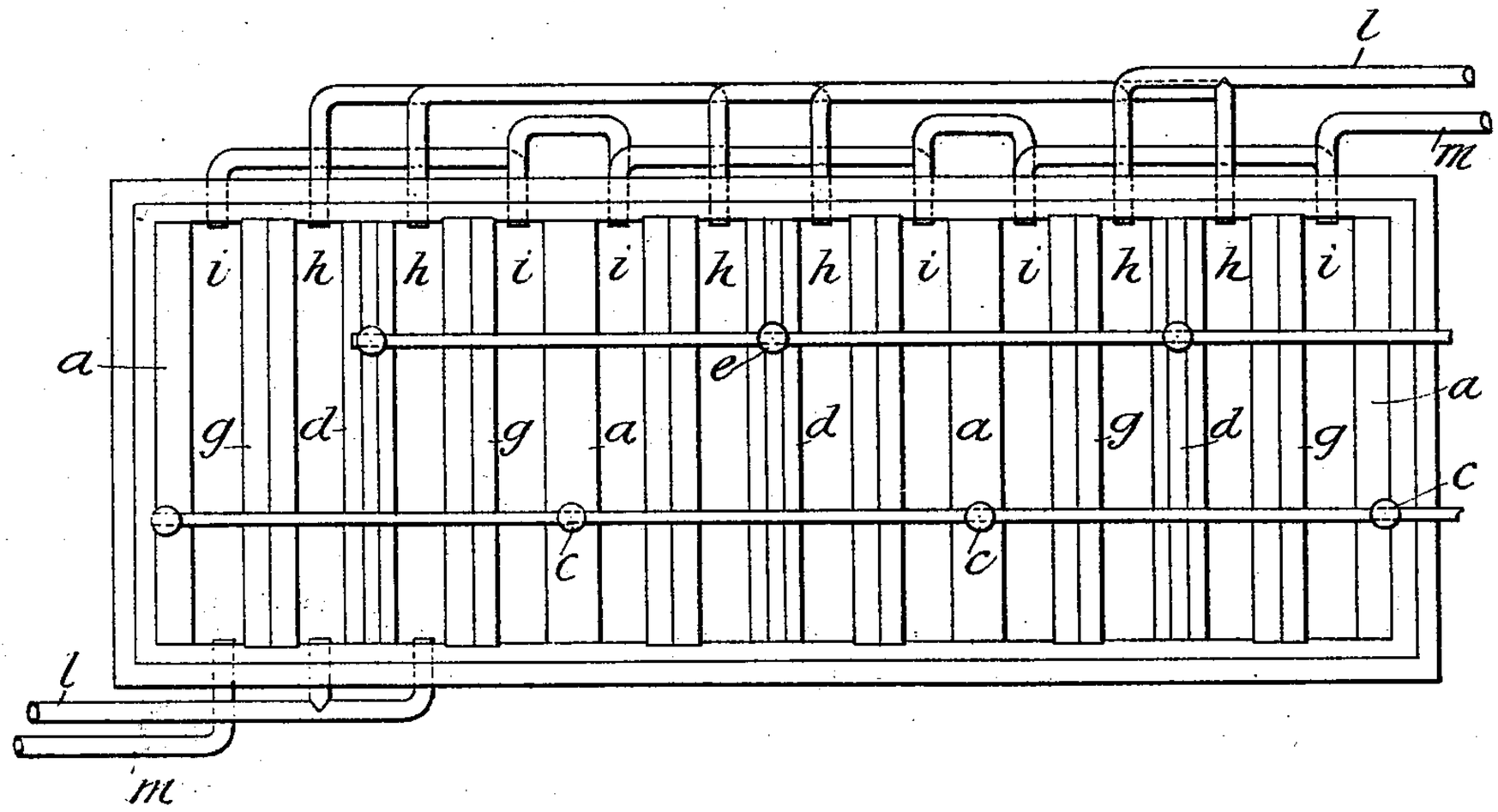
Fig. 5.



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UNITED STATES PATENT OFFICE.

JAMES GREENWOOD, OF LONDON, ENGLAND, ASSIGNOR TO THE CAUSTIC SODA AND CHLORINE SYNDICATE, LIMITED, OF SAME PLACE.

ELECTRODE FOR USE IN THE MANUFACTURE OF CHLORIN AND CAUSTIC SODA.

SPECIFICATION forming part of Letters Patent No. 514,318, dated February 6, 1894.

Original application filed January 10, 1893, Serial No. 388,012. Divided and this application filed October 18, 1892. Serial No. 449,282. (No model.) Patented in England February 5, 1891, No. 2,134; in Germany April 10, 1891, No. 62,912; in France May 11, 1891, No. 213,377; in Norway May 13, 1891, No. 2,372; in Belgium May 15, 1891, No. 94,903; in Cape of Good Hope June 5, 1891, No. 182; in Natal June 10, 1891; in Victoria June 17, 1891, No. 8,816; in South Australia June 19, 1891, No. 1,959; in New South Wales June 20, 1891, No. 3,065; in Queensland June 22, 1891, No. 1,350; in Italy June 30, 1891, XXV, 29,711, and LVIII, 359; in Portugal July 1, 1891, No. 1,596; in Turkey July 8, 1891, No. 234; in Spain July 18, 1891, No. 12,110; in Ceylon September 14, 1891, No. 369; in India December 4, 1891, No. 259; in Canada July 29, 1892, No. 39,524; in Austria-Hungary February 6, 1892, No. 41,706 and No. 77,721, and in Transvaal March 15, 1892, No. 347.

To all whom it may concern:

Be it known that I, JAMES GREENWOOD, a subject of the Queen of Great Britain, residing at London, England, have invented new and useful Improvements in the Manufacture or Production of Chlorin and Caustic Soda, this application being a division of my former application, patented January 10, 1893, No. 489,677, (patented in Great Britain, No. 2,134, dated February 5, 1891; in Germany, No. 62,912, dated April 10, 1891; in France, No. 213,377, dated May 11, 1891; in Norway, No. 2,372, dated May 13, 1891; in Belgium, No. 94,903, dated May 15, 1891; in Cape of Good Hope, Reg. Fol. 689/182, dated June 5, 1891; in Natal, dated June 10, 1891; in Victoria, No. 8,816, dated June 17, 1891; in South Australia, No. 1,959, dated June 19, 1891; in New South Wales, No. 3,065, dated June 20, 1891; in Queensland, No. 1,350, dated June 22, 1891; in Italy, XXV, 29,711, and LVIII, 359, dated June 30, 1891; in Portugal, No. 1,596, dated July 1, 1891; in Turkey, No. 234, dated July 8, 1891; in Spain, No. 12,110, dated July 18, 1891; in Canada, No. 39,524, dated July 29, 1892; in Ceylon, No. 369, dated September 14, 1891; in India, No. 259, dated December 4, 1891; in Austria-Hungary, No. 41,706 and No. 77,721, dated February 6, 1892, and in Transvaal, No. 347, dated March 15, 1892,) of which the following is a specification.

This invention relates to improvements in the manufacture or production of chlorine and caustic soda by means of electrolysis.

In manufacturing or producing caustic soda and chlorine according to my invention, a solution of sodium chloride or common salt is decomposed by a current of electricity in one or a series of vessels of cylindrical, square, oblong, or other convenient or suitable form, made of iron or combined metal and carbon having porous partitions or diaphragms, all as more particularly hereinafter described by reference to the accompanying drawings, in which—

Figures 1 and 2 are respectively a vertical and a horizontal section of a vessel of circular form for producing caustic soda and chlorine gas according to this invention. Fig. 3 is an elevation showing three of the said vessels arranged in combination with suitable tanks and pumps for carrying out the process. Figs. 4 and 5 are respectively an elevation (partly in section) and a plan with the cover removed of a vessel of an oblong form.

Similar reference letters indicate similar or corresponding parts throughout the drawings.

A circular form of vessel shown in Figs. 1 to 3 shall first be described.

a indicates the wall of the electrolytic vessel, which wall, when of copper, or other metal than iron, is coated within with carbon in the manner hereinafter described, the carbon being shown at *b;* but if the wall is of iron it is used uncoated. The wall of the vessel also serves as the cathode, the terminal *c* of which is connected with the negative pole of a dynamo or other electrical generator. In the center of the said vessel, a combined metal and carbon cylinder *d.* is placed around a metal core, in a vertical position, and forms the anode, the terminal *c.* of which core is connected with the positive pole of the said dynamo or other electrical generator. This carbon cylinder is formed of several segments, each of which has a film of copper deposited on its inner surface, and to which surface the metal core can adhere. Thus the adhering surface is the surface which receives the deposit of copper to which the metal core adheres. For working on a large scale however, I find that the plate form or type of anode, as shown in Fig. 4, is preferable to the cylinder type or form. It is the carbon that is required to be combined with the copper or other suitable metal. I find that type-

metal is the most suitable in actual practice. The metal-carbon combination referred to above, is formed by electrolytically depositing a film of copper or other suitable metal upon the adhering surface of the carbon, and then soldering the same to the copper or other metal required to be combined with it, thus forming a perfectly homogeneous combination of the metal and carbon, which is well adapted for electrodes in which metal is altogether unsuitable for the purpose. The anode *d* is insulated from the cathode *a* by means of a slate or other insulating plate *f* placed at the bottom of the vessel.

At a suitable distance between the anode *d* and the cathode *a*, a porous partition or diaphragm *g* divides the vessel into what may be described as the anode or chlorine section *h* and the cathode or caustic soda section *i*. The use of this diaphragm *g* enables the usual porous partition of high resistance hitherto employed to be entirely dispensed with. The diaphragm is preferably formed by a number of V-shaped troughs *j* of porcelain or other suitable substance such as glass or slate which are filled with carded asbestus fiber *k* or other suitable porous material such as a quantity of powdered steatite. These troughs are built up inside each other, as shown clearly in Fig. 1, so as to prevent the diffusion of the chlorine gas evolved in the anode section *h* into the cathode section *i*, thus separating the products obtained in each of the said sections in the most effectual manner. Both the sections *h* and *i* are filled at the commencement with a solution of sodium chloride which is caused to flow into them at the bottom through the pipes *l* and *m*, respectively, from the supply tanks *o* and *p*. The solution will quickly circulate upward (whereby the polarization will be reduced to a minimum) and will be decomposed by means of a current of electricity which is caused to pass through the same, whereby chlorine will be evolved in the anode section *h* and caustic soda will be formed in the cathode section *i*.

The flow of the solution can be regulated and maintained in a known, simple and automatic manner such, for example, as by placing the supply-tanks *o* and *p* at a suitable elevation, as shown in Fig. 3, and also by arranging the vessels so that the two solutions can flow through their respective sections in the entire series into delivery tanks *q*, *r*. From the said delivery tanks the solutions are pumped by suitable pumps, such as *s*, *t* back to the supply-tanks *o*, *p* the circulation being maintained until the solutions are sufficiently decomposed and the caustic soda solution is of the strength required for any particular purpose, the solution of sodium chloride in the tank *p* being gradually changed to caustic soda.

Each electrolytic vessel is sealed by a porcelain or other suitable cover *u*, and pipes *v* are connected with the sections *h*, *h* to conduct the chlorine gas away.

w, *w* are cocks for drawing off the contents of the tanks *o* and *p* as required.

In the oblong form of vessel shown in Figs. 4 and 5, the electrolytic vessel is divided into a series of anode and cathode sections by the anodes and cathodes in the form of plates marked *d* and *a* respectively and extending, as also do the porous partitions *g* across the vessel between the sides thereof. The cathodes which in this instance do not form the walls of the vessel, are indicated as not being carbon covered. The pipes *l* and *m* are arranged so as to allow the solutions to flow through their respective chambers, chlorine and caustic soda being produced and collected in a similar manner to that described with reference to Fig. 3.

The caustic soda solution produced by the method hereinbefore described contains a certain proportion of sodium chloride in solution, and for some purposes it is found advantageous to eliminate such sodium chloride. This is accomplished by transferring the caustic alkaline liquor from the tank *p* to evaporating pans in which the liquor is concentrated until the sodium chloride is precipitated and the caustic soda alone remains in solution. If, however, the caustic soda is required in the solid form the evaporation is continued to a further stage until the residual liquor becomes so concentrated as to solidify on cooling and is then packed in the usual manner.

It will be understood from the preceding, that whether the anode be of the plate type, or of the cylinder type or form, there is a metal core extending through it, the carbons and the metal core forming a solid homogeneous plate or cylinder.

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

A compound electrode composed of a body of carbon, a cavity or space extending into such body, an electro-deposited film of metal on the surface of such cavity, and a copper or other metal rod or plate soldered to said metallic film.

JAMES GREENWOOD.

Witnesses:
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