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PATENTED JAN. 17, 1905.

W. McA. JOHNSON.
ELECTROCHEMICAL SEPARATION OF METALS.

APPLICATION FILED JUNE 23, 1902.

2 SHEETS—SHEET 1.

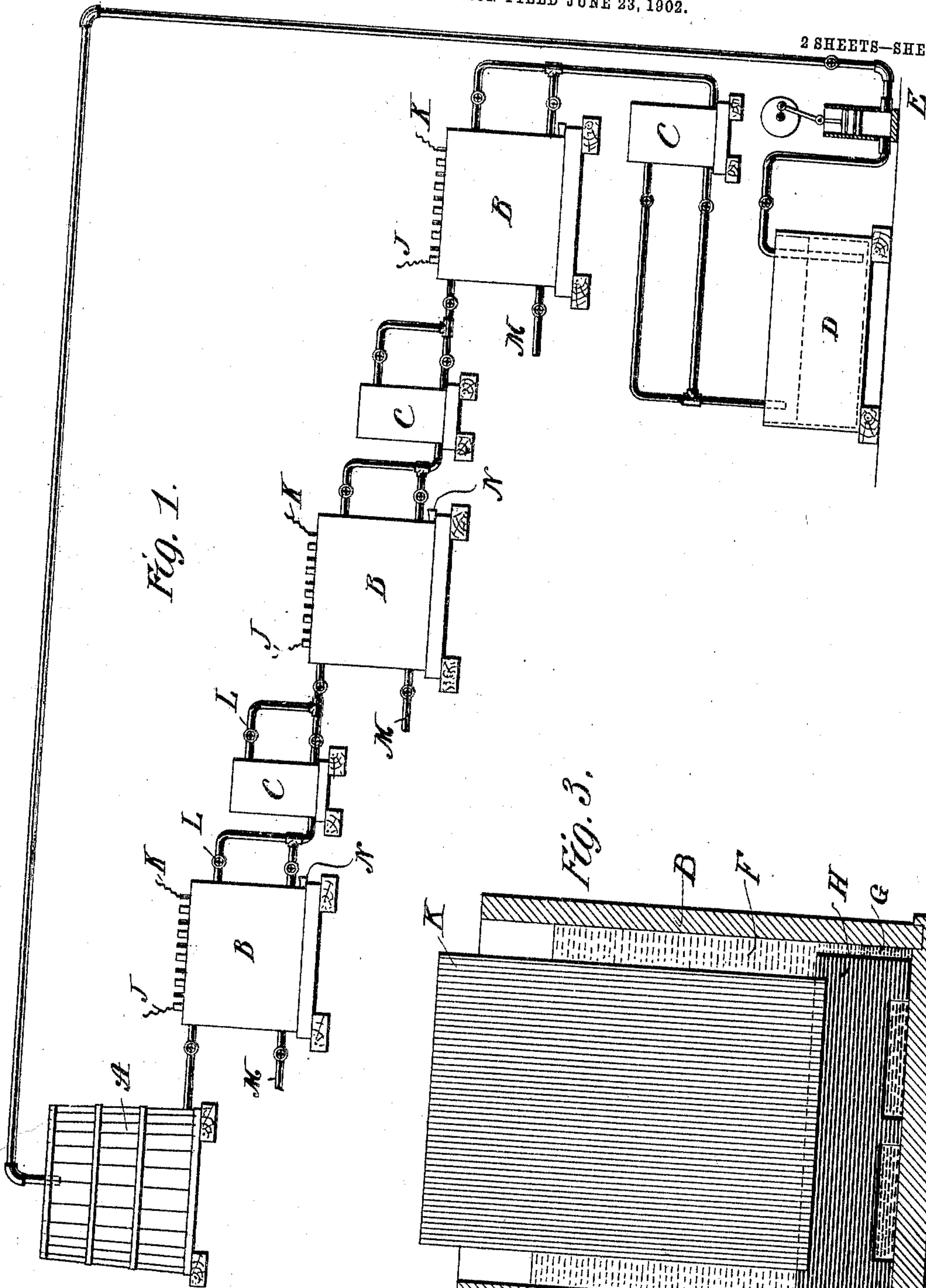


Fig. 1.

Fig. 3.

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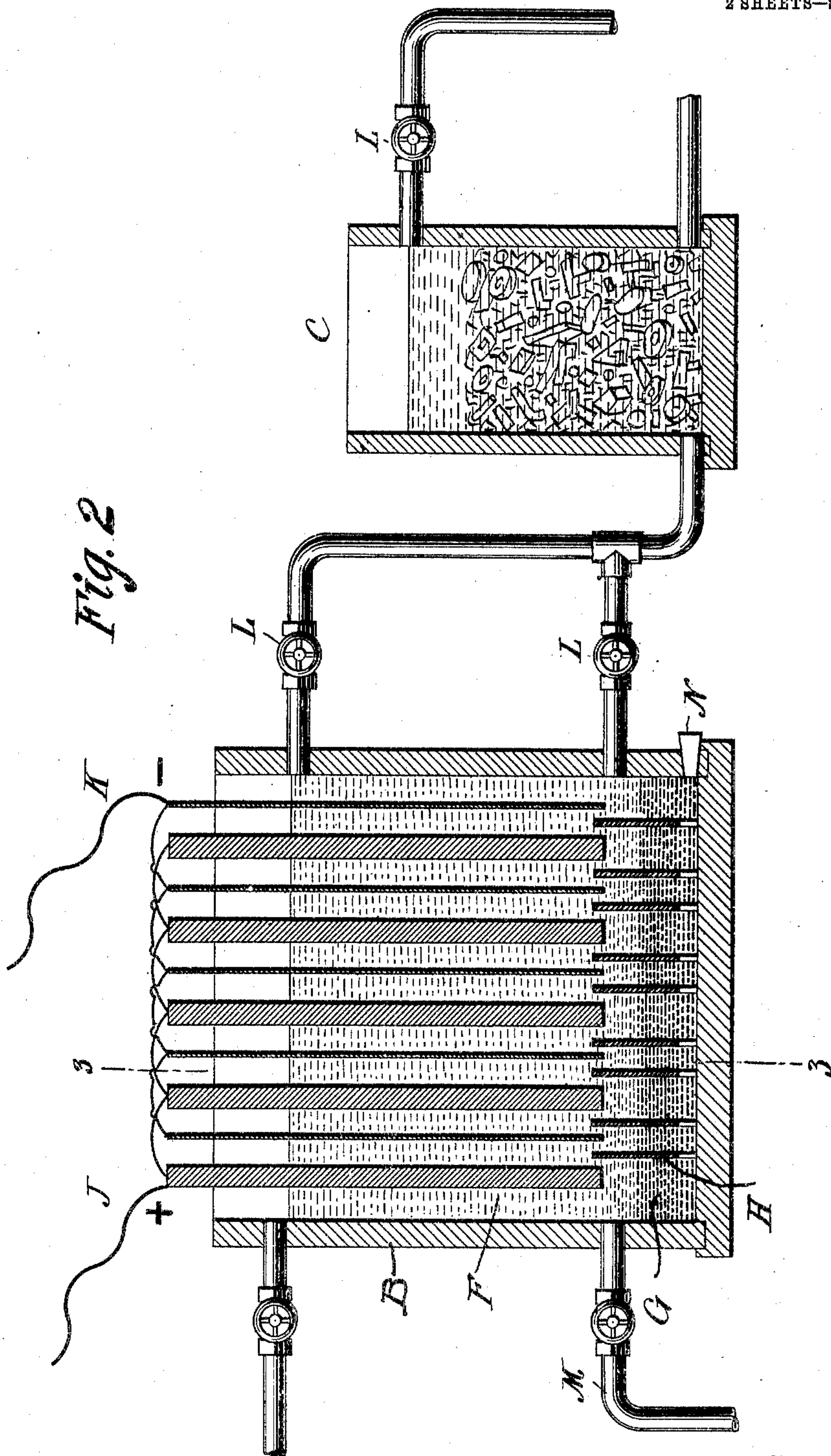
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UNITED STATES PATENT OFFICE.

WOOLSEY McA. JOHNSON, OF HARTFORD, CONNECTICUT.

ELECTROCHEMICAL SEPARATION OF METALS.

SPECIFICATION forming part of Letters Patent No. 780,191, dated January 17, 1905.

Application filed June 23, 1902. Serial No. 112,739.

To all whom it may concern:

Be it known that I, WOOLSEY McA. JOHNSON, a citizen of the United States, residing at Hartford, county of Hartford, and State of Connecticut, have invented certain new and useful Improvements in the Electrochemical Separation of Metals, of which the following is a full, clear, and exact description.

My invention relates to the art of metallurgy, and particularly to a process for the separation of iron.

The object of this invention is to perfect a process by which iron or a commercial alloy thereof may be refined on a practical and commercial scale at a reasonable cost. The disposal of different elements which are sometimes found combined with iron is in this process effected in such a way that they may be recovered for commercial utilization.

The invention will be found to consist in the improvements hereinafter to be described.

In the drawings, Figure 1 represents a conventional illustration of an apparatus for carrying out the process. Fig. 2 is a sectional elevation of an electrodeposition-tank and a cementing-tank. Fig. 3 is a sectional view of a deposition-tank on the plane of the line 3 3 of Fig. 2.

To briefly describe the parts of an apparatus as shown for this process, A is a reservoir, in which may be stored a suitable electrolyte.

B B are deposition-tanks, which may conveniently be arranged in terraces.

C C are cementing-tanks, in which scrap-iron or the like is placed and through which the electrolyte, when desired, may be caused to pass.

D is a receiving-reservoir, into which the electrolyte may descend.

E is a pump, which may be used to raise the electrolytic solution from D up to the gravity-tank A.

The tanks and attached parts should be constructed of some material which will not interfere with the function of the electrolyte.

In the particular form of deposition-tank herein shown the anodes J and cathodes K are arranged in parallel and spaced apart at suitable distances. The anodes may consist of the iron which it is desired to refine. The

cathodes may be of thin sheet iron or steel formed by a rolling process or by previous electrodeposition. A considerable space is provided below the ends of the anodes and cathodes in the deposition-tank in order that the sludge G, consisting of the substances unacted upon by the electric current, may not interfere with the action of the cell when it falls to the bottom. Between the lower ends of the plates are slabs of slate H or the like, which prevent the path of the current from forming arcs in such a way as to cause deposition to occur in the form of a bulb at the end of the cathode. The electrolyte F may consist of a solution of ferrous ammonium chlorid. If desired, diaphragms may be used between the plates, constructed of a suitable material, such as cypress-wood or asbestos. The deposition-tanks may be provided with drainage-pipes M at a suitable distance from the bottom, through which the electrolyte may be drawn off when it is desired. The sludge, which may contain more or less of the solution, may be conveniently withdrawn from the bottom of the tank through the outlet at N after the main body of the electrolyte above has been drawn off. The iron of which the anodes are composed may be suitably formed into slabs, bars, and the like by casting from a pig which has been previously refined in some desirable manner. The ores used may contain, for example, sulfur, phosphorus, arsenic, antimony and the elements, lead, tin, copper, platinum, silver, gold, &c. Many of these elements may follow the iron through the blast-furnace and through the Bessemer process and be present in the plates which form the anodes. The solution of the electrolyte may be slightly acid with acetic acid or some other weak organic acid. A solution of a ferrous ammonium sulfate may be used when the presence of a very small percentage of sulfur in the deposition is permissible. Satisfactory results may be obtained from the use of some cheap commercial solution of iron salts.

This process has been proved satisfactory even where the electrolytic solution contained some copper at the start.

The process of deposition may be conducted

economically at temperatures up to 60° centigrade, which accelerates the action. A current whose density is small—say from ten to twenty amperes per square foot—is desirable.

5 The potential between the plates may be about one and one-half volts.

During the process of deposition when the solution of the electrolyte is found to contain too large a percentage of copper, &c., either
 10 derived from the anodes or from an impure electrolyte, it is run off from a deposition-tank B into a tank C containing scrap-iron, in which by the cementation process the copper will be withdrawn from the solution and held up by
 15 the scrap. Whenever a sample of the cathodes is found to assay in too large a percentage of copper and the like, the electrolyte may be drawn off into a cementation-tank and then after purification returned to a deposition-
 20 tank. In this manner the solution may be kept in a condition which will insure the deposition of a metal of the desired degree of purity. To insure the deposition in a uniform manner, it is desirable to run the electrolyte
 25 continuously through the cementation-tanks. During the passage of the electric current through the cell everything unacted upon by the current will gradually separate from the iron and fall down to the bottom. In this
 30 way phosphorus, arsenic, antimony, and carbon will fall down as sludge, mostly as phosphids, arsenids, &c., of iron. The precious metals which have been contained in the anode will also find their way to this sludge and from
 35 this they may afterward be reclaimed by refining. The sludge collected from this process will thus assay in many cases a very high percentage of valuable elements. When the anode contains manganese, nickel, or co-
 40 balt, these elements will be deposited with the iron as an alloy upon the cathode, but freed from sulfur, phosphorus, and the like, and also copper.

By this process it has been found feasible
 45 to separate the metals in a manner which is commercially successful. Besides being operated at a very small cost, it is possible to deposit a very high grade of iron or alloy thereof, and this, too, even where ores con-
 50 taining a high percentage of impurities were used. An ore of so low a grade as to be practically useless under the ordinary refining processes can be utilized in this improved process with most excellent results.

55 What I claim is—

1. A process for the separation of metals which includes immersing an electrode in an acid solution of ferrous ammonium chlorid, subjecting it to electrolytic action and depos-
 60 iting upon another electrode, the electrolytic solution being from time to time subjected to a cementation process, substantially as described.

2. A process for the separation of metals

which includes immersing an electrode in a so- 65
 lution of ferrous ammonium chlorid contain-
 ing a small amount of organic acid, subject-
 ing it to electrolytic deposition, purifying the
 electrolyte by a cementation process from
 time to time, and when necessary removing 70
 any sludge which may be formed to be after-
 ward otherwise refined, substantially as de-
 scribed.

3. A process for the refining of iron which includes immersing an electrode of impure 75
 iron in a solution of a double salt of iron
 slightly acid, subjecting it to electrolytic depo-
 sition upon another plate of iron, from time
 to time purifying the solution by a cementa-
 tion process with scrap-iron, and when neces- 80
 sary removing the sludge formed during the
 deposition process, substantially as described.

4. A process for the refining of iron con-
 sisting in immersing an electrode of the im- 85
 pure metal in a solution of ferrous ammonium
 chlorid slightly acid with acetic acid, depos-
 iting the iron electrolytically upon a sub-
 stantially pure iron electrode, purifying the
 solution by a cementation process and remov-
 ing the sludge formed during the deposition 90
 process, substantially as described.

5. A process for the refining of iron con-
 sisting in immersing an electrode of the im-
 pure metal in a solution of ferrous ammonium
 chlorid containing a slight amount of acetic 95
 acid, from time to time purifying the solu-
 tion by a cementation process with scrap-iron
 and depositing the iron of the impure elec-
 trode electrolytically upon a substantially
 pure iron electrode, substantially as described. 100

6. The process for a separation of alloy of
 iron, copper and precious metals which in-
 cludes immersing an electrode of the alloy in
 a solution of soluble salts, subjecting the same
 to electrolytic action and depositing the iron 105
 upon another electrode, collecting the pre-
 cious metals in the form of a sludge and sub-
 jecting the electrolyte from time to time to a
 process of cementation for removing the cop-
 per and maintaining the iron in the electro- 110
 lyte in a ferrous condition.

7. A process for the refining of iron which
 consists in immersing an electrode of the im-
 pure iron in a solution slightly acid, subject-
 ing it to electrolytic action for depositing the 115
 iron on another electrode and from time to
 time subjecting the electrolytic solution to a
 cementation process with iron in another re-
 ceptacle for removing certain of the elements
 contained therein and maintaining the solu- 120
 tion in a ferrous condition.

Signed at New York, N. Y., this 17th day of
 June, A. D. 1902.

WOOLSEY McA. JOHNSON.

Witnesses:

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