No. 719,871. PATENTED FEB. 3, 1903.

C. J. REED.

ELECTROLYTIC APPARATUS.

APPLICATION FILED MAY 5, 1899.

NO MODEL. 2 SHEETS—SHEET 1.

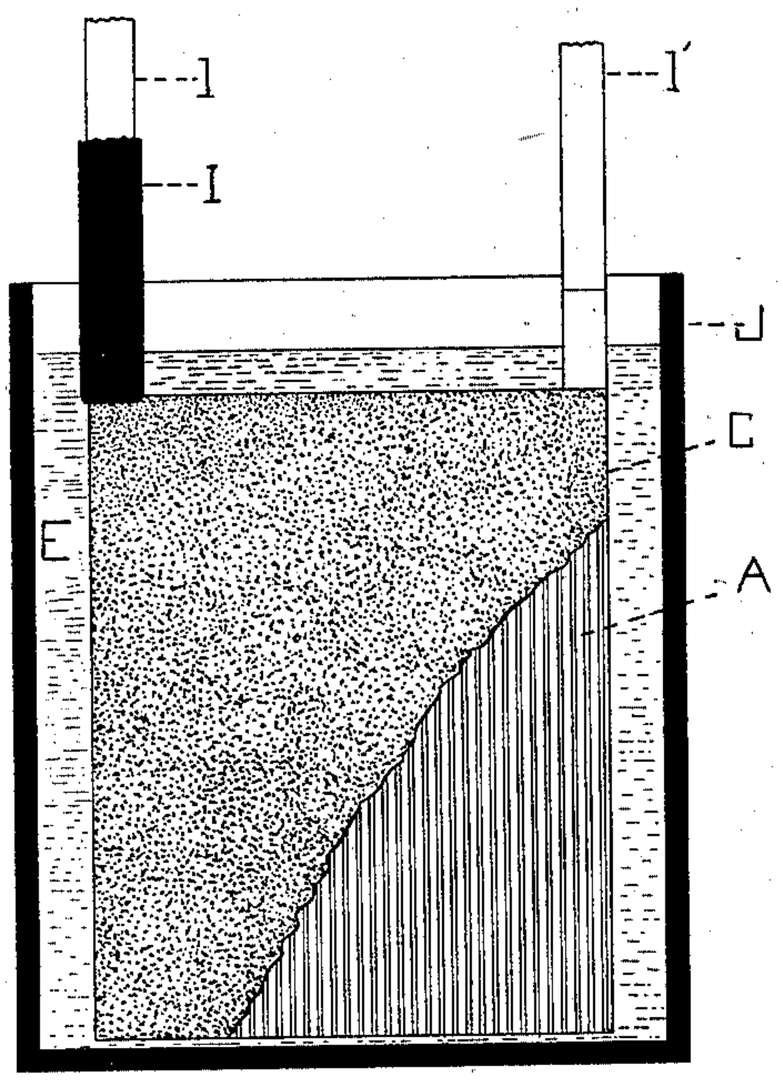

Fig. 2.

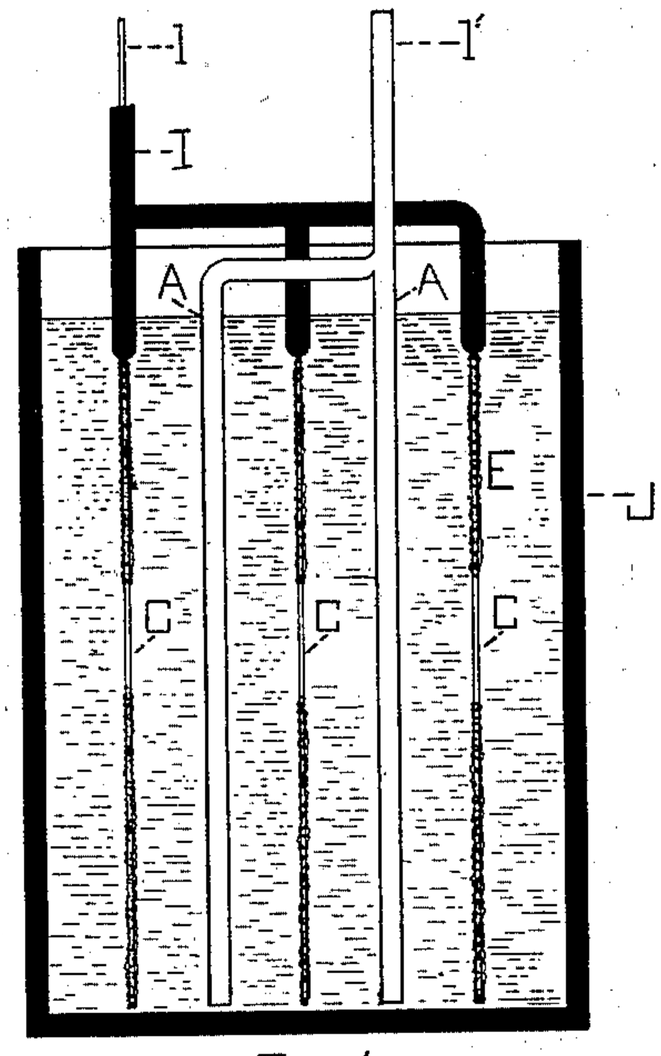

Fig. 1.

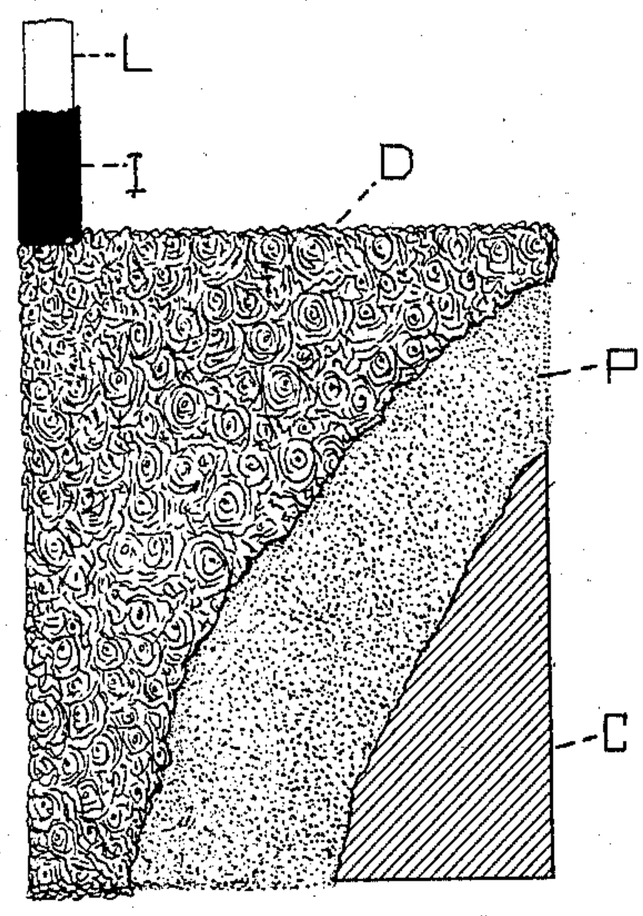

Fig. 3.

Witnesses
H. H. Downshough
Frank D. Connor

Inventor
Charles J. Reed

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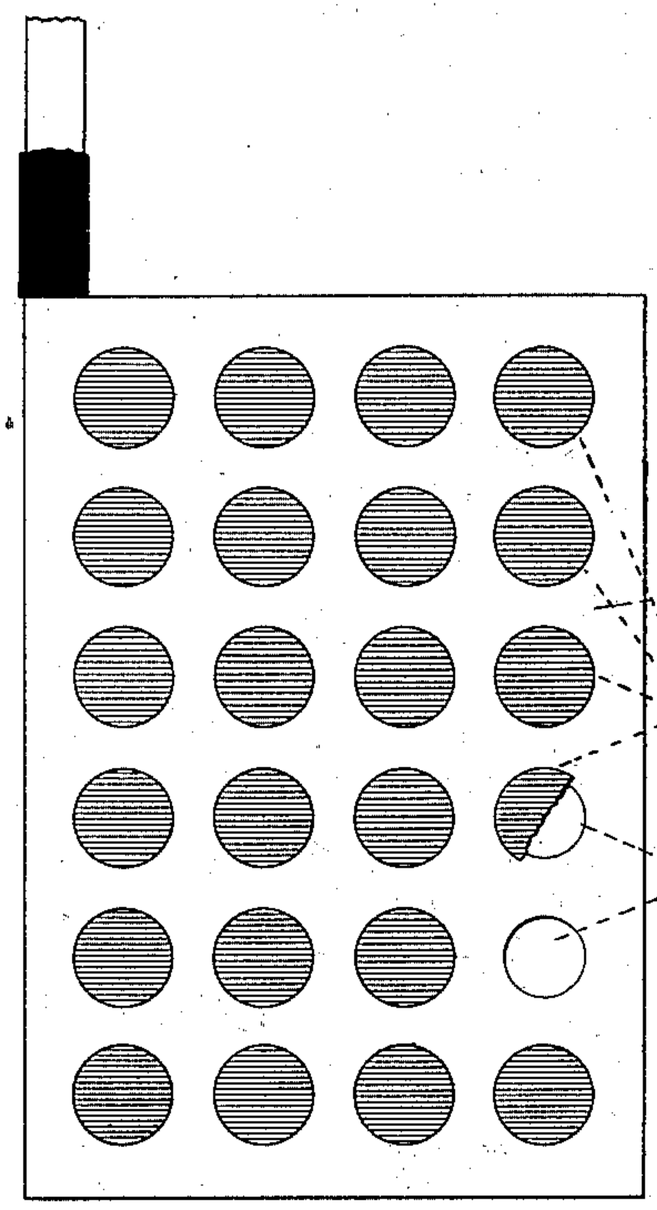

Fig. 4.

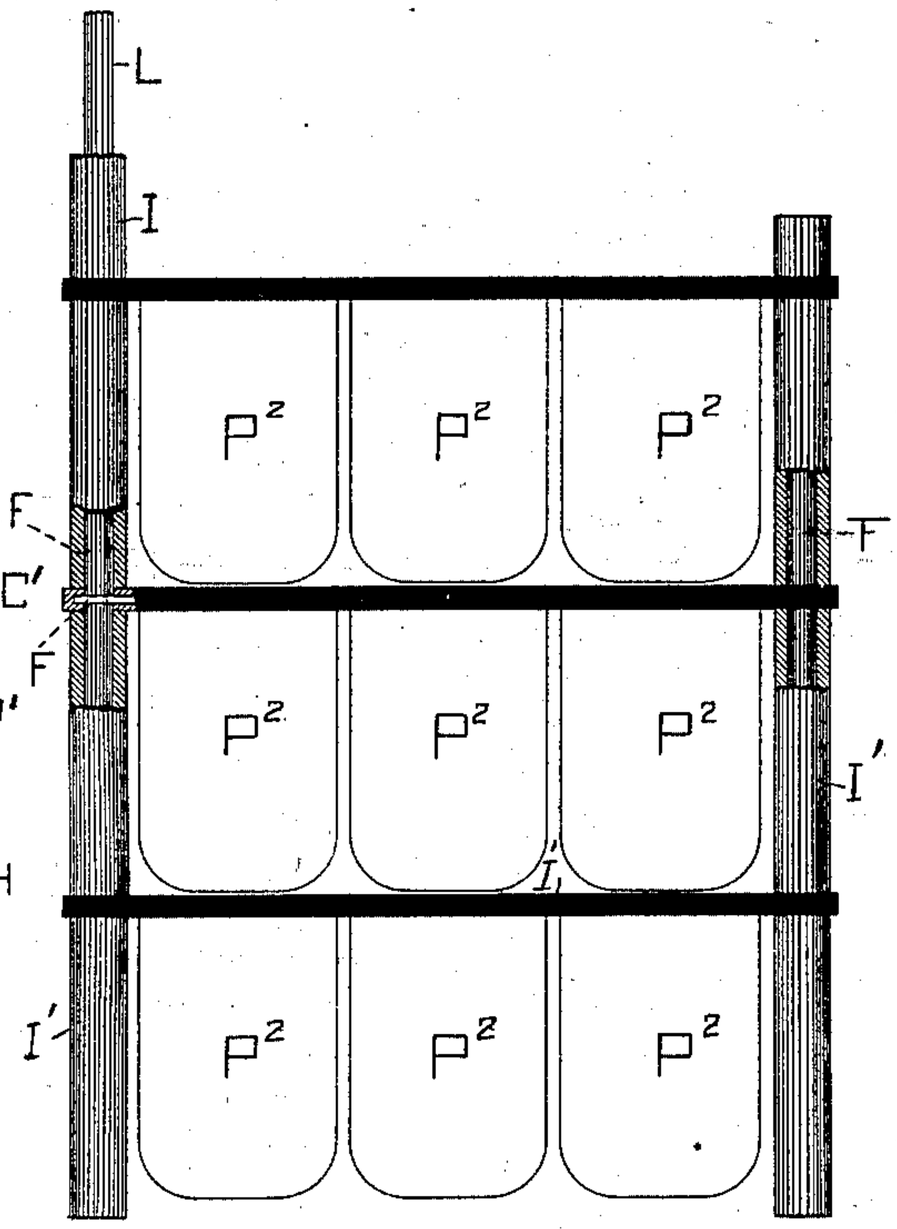

Fig. 5.

Witnesses

H. H. Dorsbaugh

Frank D. Connor.

Inventor

Charles J. Reed

UNITED STATES PATENT OFFICE.

CHARLES J. REED, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO THE SECURITY INVESTMENT COMPANY, A CORPORATION OF PENNSYLVANIA.

ELECTROLYTIC APPARATUS.

SPECIFICATION forming part of Letters Patent No. 719,871, dated February 3, 1903.

Application filed May 5, 1899. Serial No. 715,683. (No model.)

To all whom it may concern:

Be it known that I, CHARLES J. REED, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented a new and useful Improvement in Electrolytic Apparatus, (Case No. 825,) of which the following is a specification.

My invention relates to electrolytic apparatus in which it is desired to deposit in the metallic state from an electrolyte a highly-electropositive metal, such as sodium, potassium, cadmium, or zinc; and it has for its object to provide a simple and efficient means for facilitating the depositing action of the apparatus and at the same time preventing the growth or formation of arborescent crystals.

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

Figures 1 and 2 are vertical sections, at right angles to each other, of an electrolytic cell; and Fig. 3 is a side view of one of the cathodes. Figs. 4 and 5 are side views of modified forms of cathodes.

Similar letters refer to similar parts throughout the several views.

In the electrolytic deposition of highly-electropositive metals from aqueous solutions it is customary in order to prevent the rapid redissolving of the metal to employ a cathode consisting either entirely or in part of mercury, the object of the mercury being to form an amalgam with the deposited metal, which is more difficult to dissolve than metal deposited in the free state. The employment of pure mercury as a cathode is objectionable on account of its being in a liquid state and on account of the impossibility of using it in any other form than that of a horizontal sheet, the upper surface alone being active. Copper and certain other metals have such an affinity for mercury that plates made of these metals and placed in a vertical position will retain on their surfaces a limited amount of mercury.

I find in practice that in certain electrolytic operations the mere presence of a sufficient and even an excessive quantity of mercury on the surface of a cathode-plate will not always prevent the growth of arborescent crystals or tree-like formations. I find that even in the presence of a large amount of mercury these crystalline growths are likely to extend a great distance from the surface, and thus cause trouble by short-circuiting or by local action cause the deposited metal to be rapidly redissolved, and thereby render the operation inefficient. This I find to be particularly the case where it is attempted to deposit sodium upon an amalgamated copper plate from a solution of sodium chlorid or other suitable electrolyte. I find in these cases that after a small deposit has formed the further deposition of sodium practically ceases, it being really redissolved as fast as it is deposited. The same is true to a great extent in the deposition of metallic zinc from a solution of zinc sulfate or other suitable electrolyte containing a zinc salt. I find, however, that if a highly-electropositive metal, such as sodium or zinc, be deposited, not on an amalgamated copper plate or other highly-electronegative metal, but upon an amalgam consisting of mercury and a metal different from but nearly as electropositive as the one which is to be deposited, the character of the deposit is entirely changed, the growth of arborescent crystals being almost entirely prevented. I find, for example, that when sodium is deposited on a suitable amalgam of zinc and mercury a much greater deposit can be obtained without the evolution of hydrogen gas and without the formation of arborescent crystals and that the deposit is much more permanent when allowed to remain in the electrolyte than has heretofore been possible. In a similar manner, if zinc be electrolytically deposited upon a suitable amalgam of mercury and lead the deposit of zinc instead of being arborescent and having tree-like growths will be very even and almost smooth—very much like a deposit of metallic copper. I have found, also, that an amalgam of the metals named or an amalgam of any other metal possessing the peculiar property of preventing crystalline growths will not be self-sustaining in a substantial solid form of large size, because it is necessary to use an amount of mercury which reduces any of the metals suitable for this purpose to a pasty or fragile condition. I find, therefore,

that it is impracticable to construct cathodes of a simple amalgamated vertical plate of one metal or of an alloy that is suitable to receive an electrolytic deposit of a highly-electropositive metal without the production of arborescent crystalline growths. For example, a cathode constructed of a large amalgamated sheet of lead to receive a deposit of zinc or a large amalgamated sheet of zinc to receive a deposit of sodium would not have mechanical stability enough to hold together or maintain its integrity.

I am well aware that it is possible to amalgamate a sheet of lead or zinc with so small a quantity of mercury that it may hold together if subjected to little or no mechanical strain; but an amalgam of that character containing so small a proportion of mercury has not the power to receive electrolytic deposit of the highly-electropositive metals without the formation of the objectionable arborescent growths.

I find that in order to get the best results a certain proportion of mercury is necessary and that this should be sufficient to convert the amalgam into an incoherent mass or paste, though the result may be obtained to a limited degree by using less mercury.

In my improved form of apparatus I use a cathode having a framework or body of any desired form and of any suitable metal, such as copper, that is not easily destroyed or rendered soft or brittle by mercury. This cathode, or such portion of it as is intended to receive the electrolytic deposit, is provided with a paste or amalgam of mercury and lead or other suitable electropositive metal. This paste or amalgam is chemically and electrolytically inactive in the operation and serves only as an electric conductor to receive the electrolytic deposit and as a sponge to hold mercury. I find, as above stated, that an amalgam of mercury and lead in suitable proportions on a cathode of this kind will receive an electrolytic deposit of zinc which will be smooth and hard and almost entirely free from crystalline growths. An amalgam in suitable proportions of zinc and mercury on a cathode of this kind will also receive a similar deposit of sodium which could not be otherwise obtained.

I do not limit myself to any particular proportions in making the amalgam, as I find that the proportion of mercury and the other metal composing the amalgam may be varied between wide limits and substantially the same result obtained. I find, however, it is advantageous to use sufficient mercury to make the amalgamated metal soft and unstable. It is for this reason that it is practically necessary to have a mechanical support or conductor for holding the paste, which shall not be softened or rendered brittle by the mercury. I find copper to be well suited to act as a conducting-support for holding the amalgam.

Referring to Figs. 1, 2, and 3 of the drawings, J represents a jar, of glass, hard rubber, or other suitable material, containing an electrolyte E, having in solution a salt of an electropositive metal, such as zinc. A represents anodes which may contain the electropositive metal or which may be composed of a substance not easily dissolved or destroyed by electrolytic and chemical action, such as platinum, carbon, lead, or lead peroxid. The anodes are electrically connected to the lug l'. C represents cathodes of my improved form, consisting of vertical plates of copper electrically connected to the lug l. Where the lug l passes out through the electrolyte, I prefer to protect it from electrolytic and chemical action by a covering I, of hard rubber or other suitable insulating material. As shown in Fig. 3, the cathode-plate, consisting of a copper plate C, has a covering of amalgam paste P, in this case a mixture of mercury and lead, a portion of it having been removed to show the plate C beneath. Upon the exterior surface of this paste coating the electrolytic deposit D of zinc is formed. I am aware that cathodes consisting of amalgamated lead plates have been used for the deposition of metallic zinc; but it has always been necessary to use a very small quantity of mercury in amalgamating the lead plate in order not to destroy it mechanically, and this has prevented the obtaining of a smooth and uniform deposit. The same result may be obtained less perfectly by covering only parts of the conducting framework or support with the amalgam, or a plate may be constructed having a conducting-framework or mechanical support of copper or other metal not easily destroyed or softened by mercury and panels or receiving areas of a more highly electropositive metal, such as lead or zinc, the latter being well amalgamated, but not having sufficient mercury to reduce it to a paste.

Fig. 4 shows a cathode consisting of an amalgamated sheet of copper C′, having numerous perforations H, the perforations being filled with rivets or plugs of amalgamated lead P′, which act in the same manner as the paste P, in the form shown in Fig. 3, to receive a smooth deposit of zinc.

Fig. 5 shows a plate made up of a copper framework F, which I prefer to protect from electrolytic and chemical action by an insulating-covering I′ and to which is attached a number of panels of amalgated sheet-lead or amalgamated sheet-zinc P^2, the former being adapted for receiving a deposit of zinc and the latter for receiving a deposit of sodium.

I am evidently not limited to any particular method of forming the amalgam. For example, the cathode C of Fig. 3 may be first covered with lead and then amalgamated or the amalgam may be first prepared and then applied to the plate. In the form shown in Fig. 4 the perforations may be filled with amalgam or they may be filled with lead plugs and the plugs afterward amalgamated.

The operation of my invention is as follows:

An electric current from a dynamo or other suitable source is passed through the electrolyte E, containing in solution an electropositive metal, such as zinc, through the electrodes A and C in the proper direction to cause deposition of the metal on the paste P, (shown in Fig. 3,) the plugs P′ of Fig. 4, or the panels P^2 of Fig. 5. As the metal is deposited upon the sheets of paste, the plugs, or the panels it absorbs part of the mercury from the paste, thus becoming well amalgamated and forming a smooth and uniform deposit. If when the operation is completed the deposited metal be allowed to redissolve, either by standing in contact with a corrosive electrolyte (which may be rapidly accomplished by connecting the lug *l* through any suitable electric conductor or translating device, not shown in the drawings, to the lug *l′* of an anode consisting of a highly-oxidizing substance, such as peroxid) or by passing an electric current through the cell in the opposite direction, the liberated mercury is reabsorbed by the paste, which returns to its initial consistency. The operation of redepositing and redissolving may be repeated indefinitely.

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

1. In an electrolytic apparatus, the combination with a cathode consisting of a substantially vertical conducting-plate, covered with an adherent coating of amalgam composed of mercury and a highly-electropositive metal, of a receptacle containing said cathode, an anode and a solution of a salt of a metal that is electropositive in a different degree from said amalgamated metal, substantially as herein set forth.

2. In an electrolytic apparatus, the combination with a cathode consisting of a substantially vertical amalgamated conducting-plate, having on its surface a coating of amalgam consisting of mercury and a metal that is highly electropositive, of a receptacle containing said cathode, an anode and a solution of a salt of a metal that is more highly electropositive than the amalgamated metal, substantially as herein set forth.

3. In an electrolytic apparatus, the combination with a cathode consisting of one or more substantially vertical conducting-plates, each having on its surface an adherent mixture of mercury and a metal more highly electropositive than the body of the plate, of a receptacle containing said electrode, an anode and a solution of a salt of metal that is more highly electropositive than the amalgamated metal, substantially as herein set forth.

4. In an electrolytic apparatus, the combination with a cathode consisting of a substantially vertical conducting-framework provided with one or more areas of amalgam of mercury and a highly-electropositive metal, of a receptacle containing said cathode, an anode and a solution of a salt of a metal that is more highly electropositive than the amalgamated metal, substantially as herein set forth.

5. In an electrolytic apparatus, a cathode consisting of a substantially vertical conducting-framework provided with one or more areas of amalgam of mercury and a metal more highly electropositive than the framework, the amalgam having upon its surface an electrolytic deposit of a still more highly electropositive metal, substantially as herein set forth.

6. In an electrolytic apparatus, a cathode consisting of one or more substantially vertical copper plates, each having upon its surface a coherent covering of amalgam consisting of a mixture of mercury and lead, substantially as herein set forth.

7. An electrolytic apparatus comprising a cathode consisting of one or more substantially vertical copper plates, each having upon its surface a coherent covering of amalgam, consisting of a mixture of mercury and lead, an anode and a solution containing zinc, substantially as herein set forth.

In testimony whereof I have hereunto subscribed my name this 1st day of May, 1899.

CHARLES J. REED.

Witnesses:
JAMES W. LAWS,
ROBT. B. FLETCHER.