(No Model.) 3 Sheets—Sheet 1.

I. KLEIN.

PROCESS OF AND APPARATUS FOR ELECTROLYTICALLY FORMING TUBULAR BODIES.

No. 555,452. Patented Feb. 25, 1896.

FIG. 1.

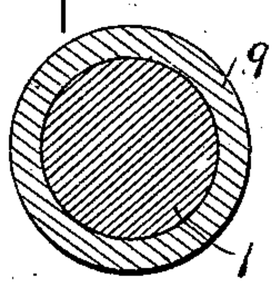


FIG. 2.

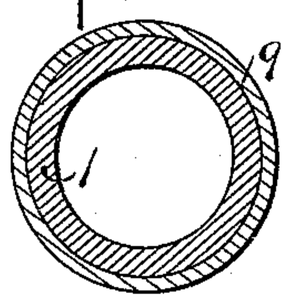


FIG. 3.

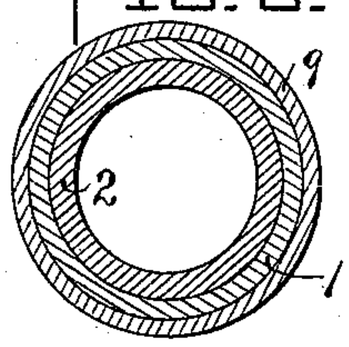


FIG. 4.

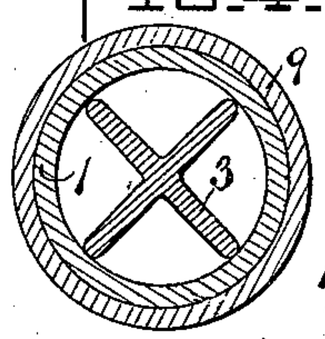


FIG. 5.

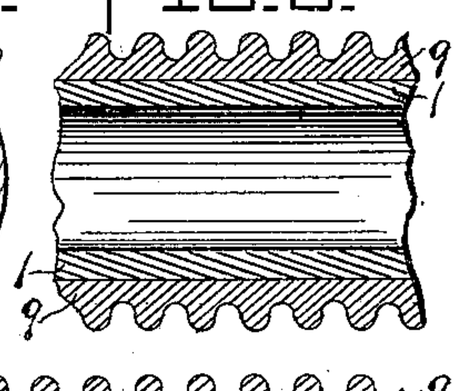


FIG. 6.

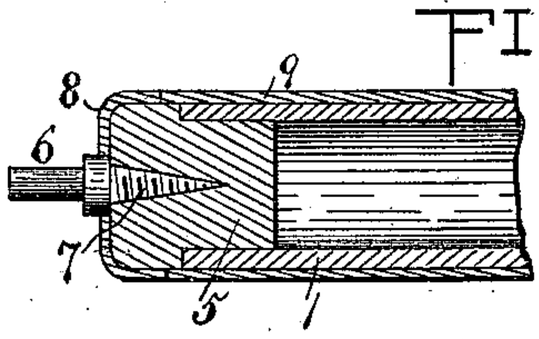


FIG. 9.

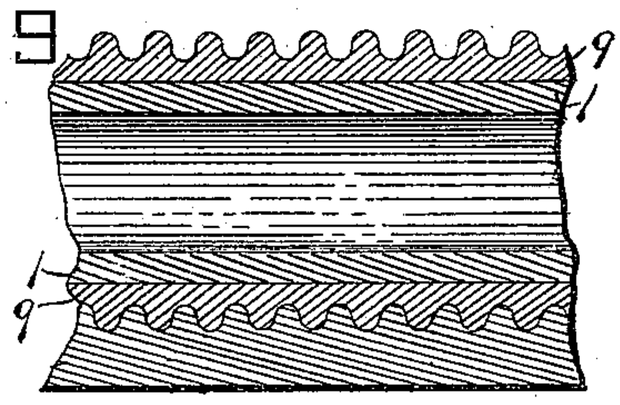


FIG. 7.

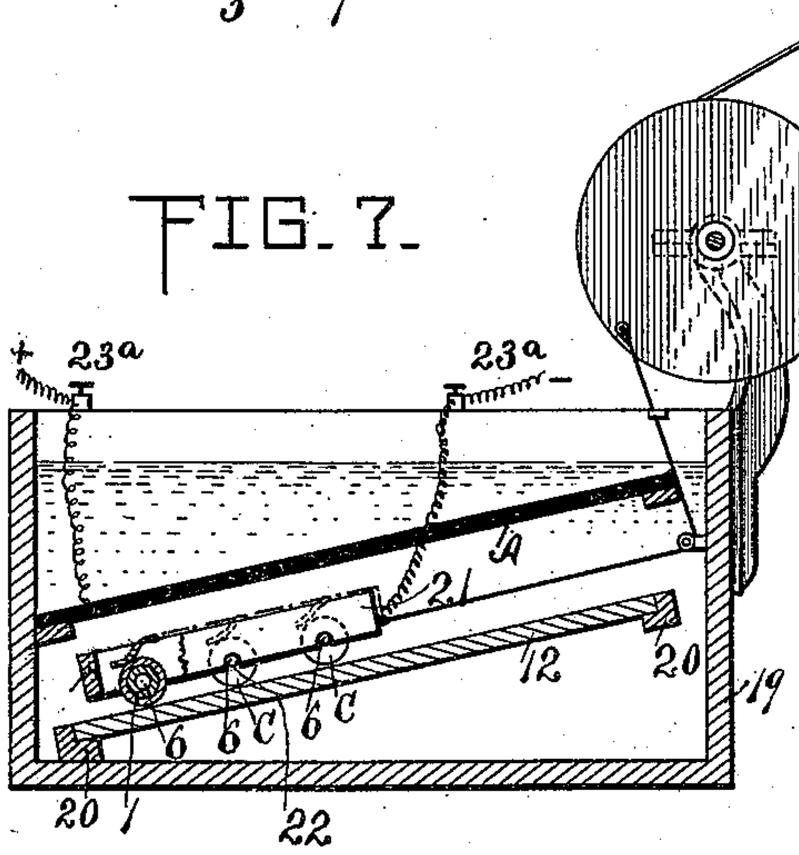


FIG. 8.

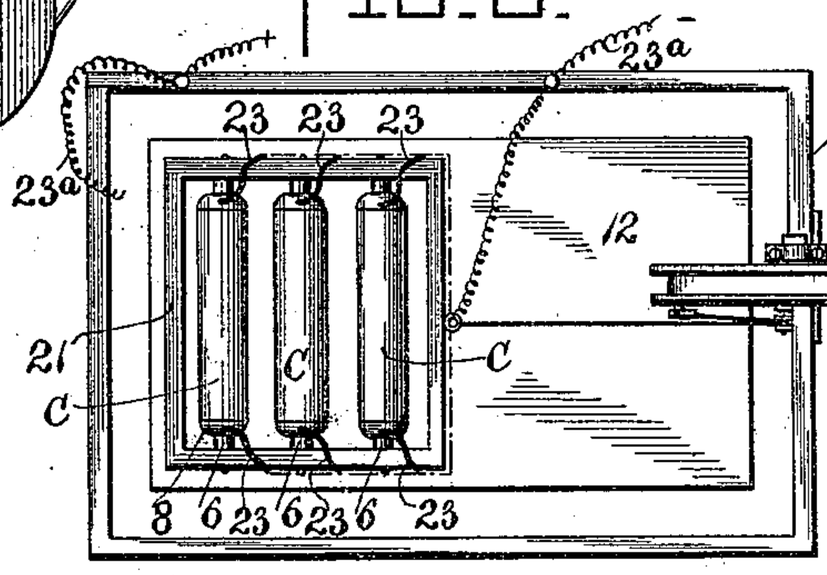


FIG. 10.

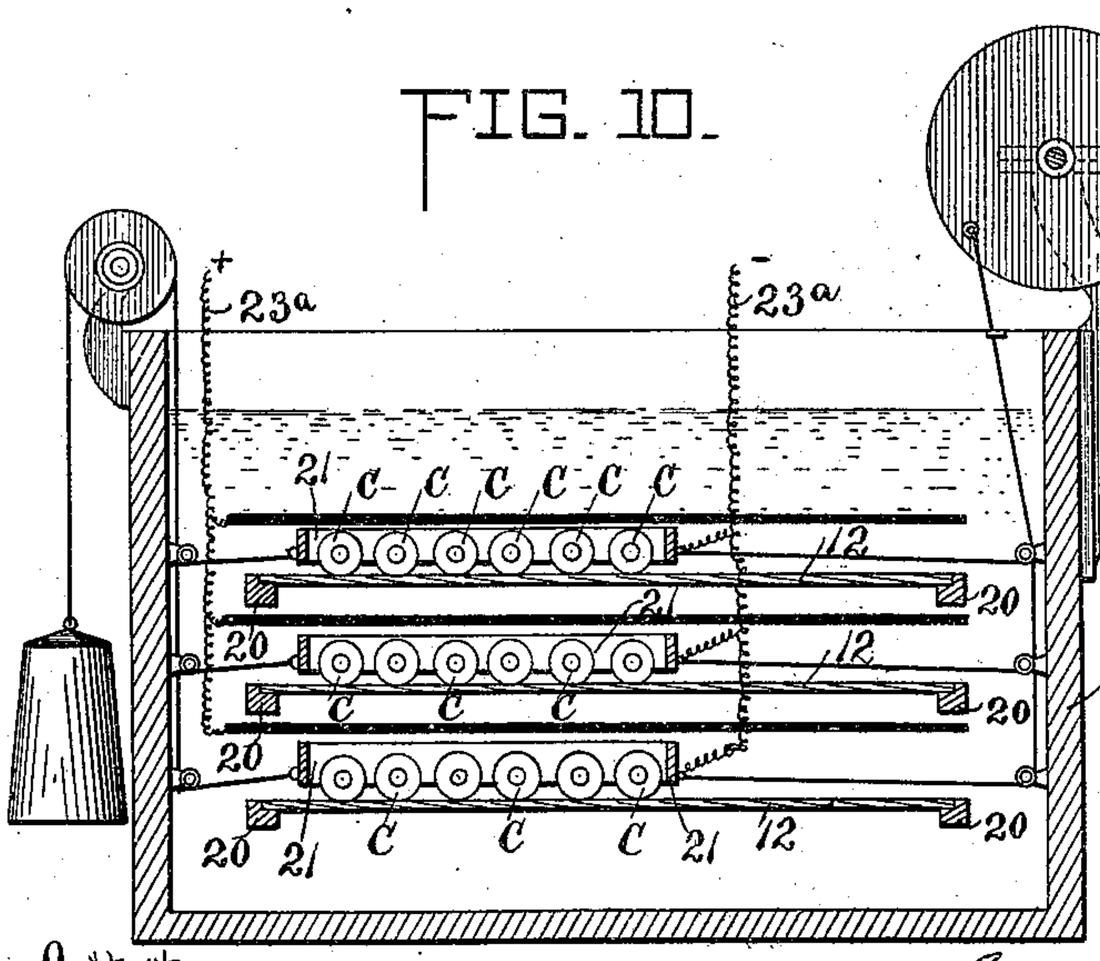
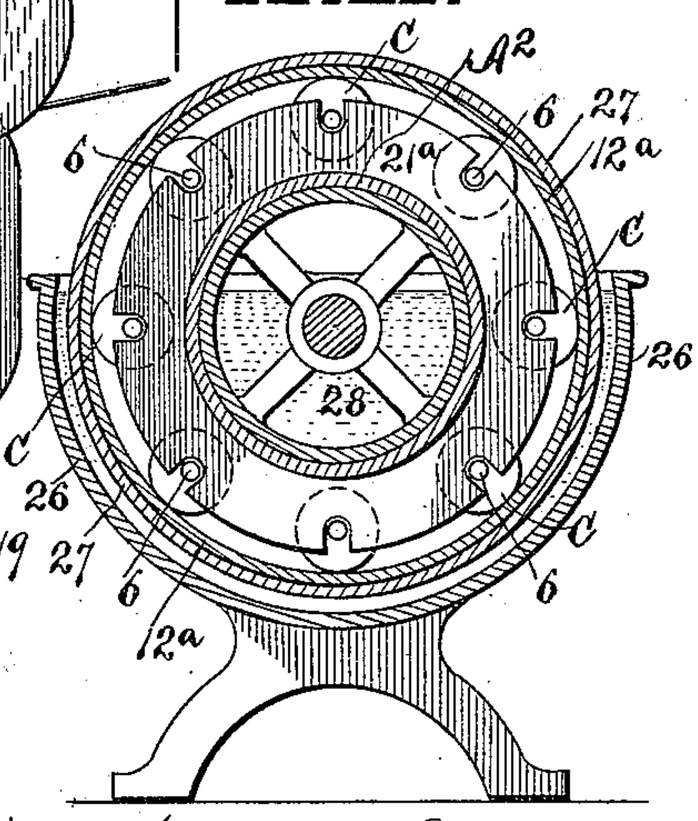


FIG. 14.



Attest.
W. Ellwood Allen.
Mary E. Allen

Inventor.
Ignatz Klein.
By Knight Bros
Attys.

(No Model.) 3 Sheets—Sheet 2.

I. KLEIN.

PROCESS OF AND APPARATUS FOR ELECTROLYTICALLY FORMING TUBULAR BODIES.

No. 555,452. Patented Feb. 25, 1896.

FIG. 11.

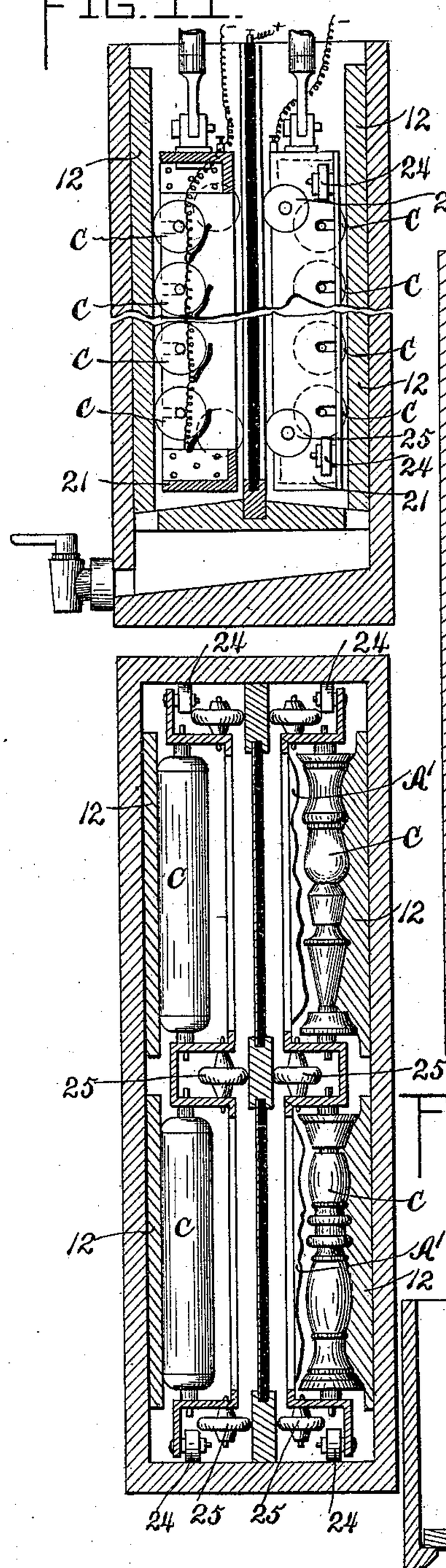


FIG. 15.

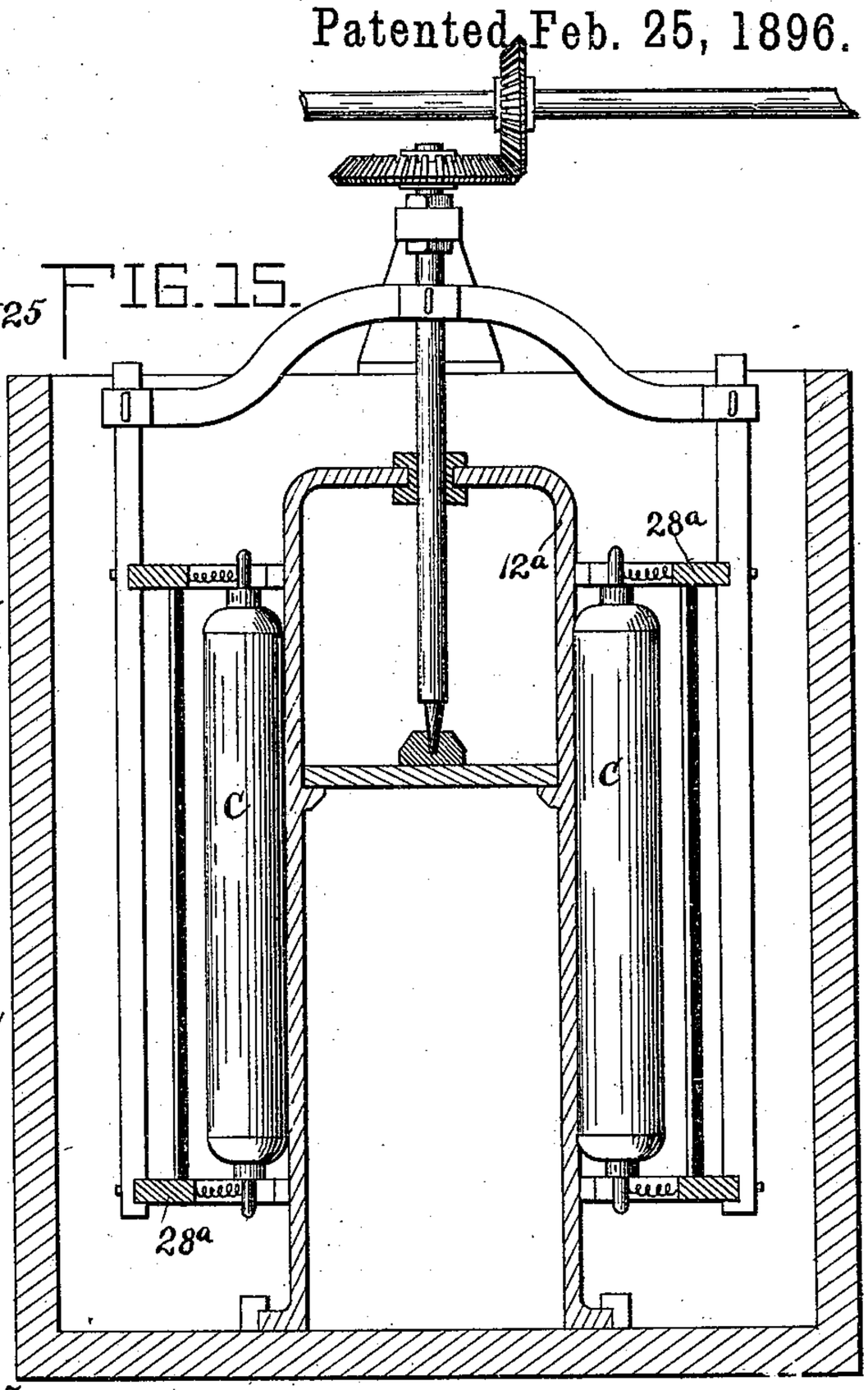
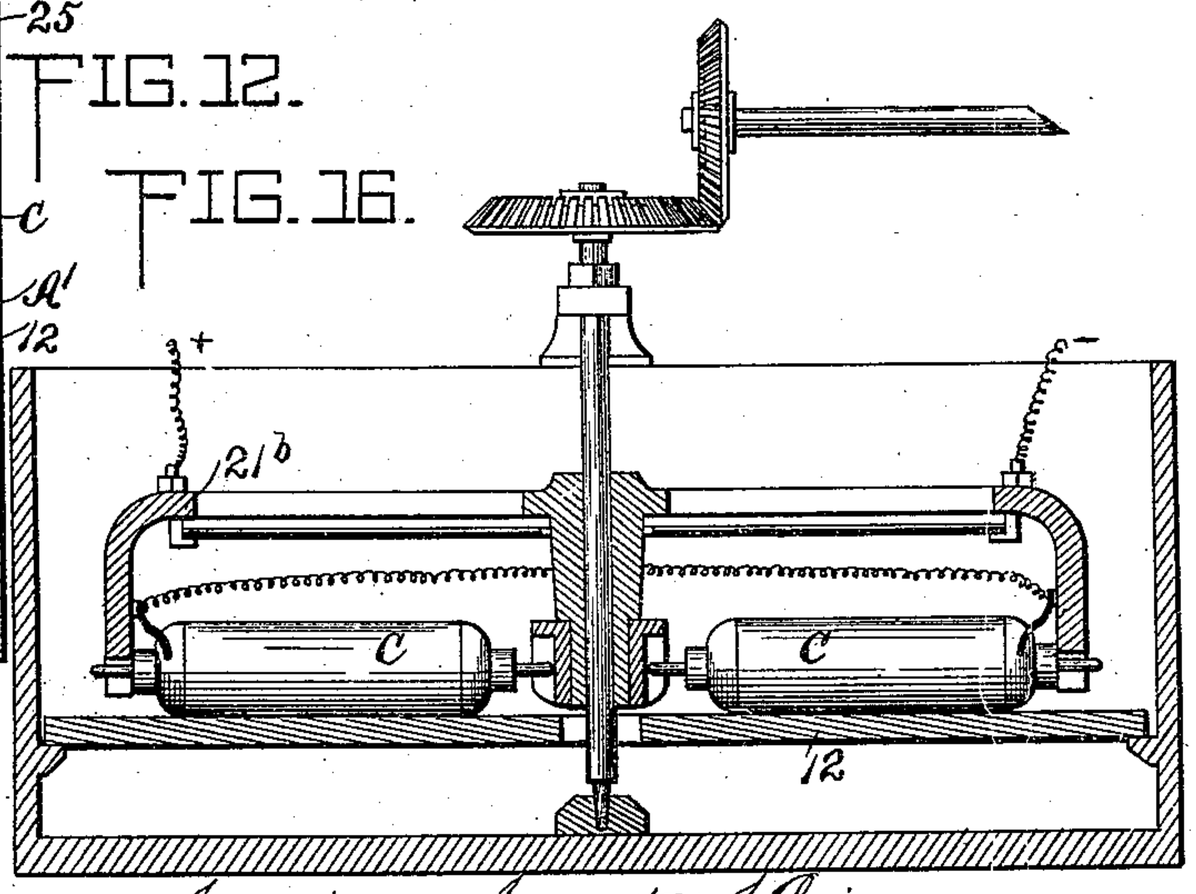


FIG. 12.

FIG. 16.



Attest.

W. Ellwood Allen.

Mary E. Allen

Inventor. Ignatz Klein.

By Knight Bros Attys.

(No Model.) 3 Sheets—Sheet 3.

I. KLEIN.

PROCESS OF AND APPARATUS FOR ELECTROLYTICALLY FORMING TUBULAR BODIES.

No. 555,452. Patented Feb. 25, 1896.

FIG. 13.

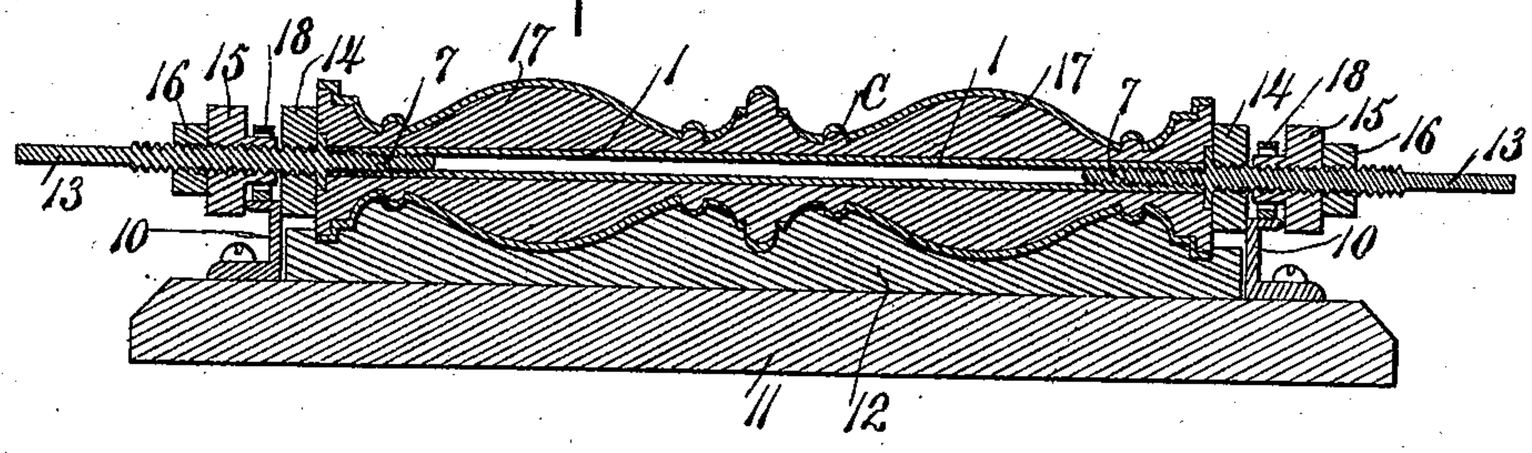
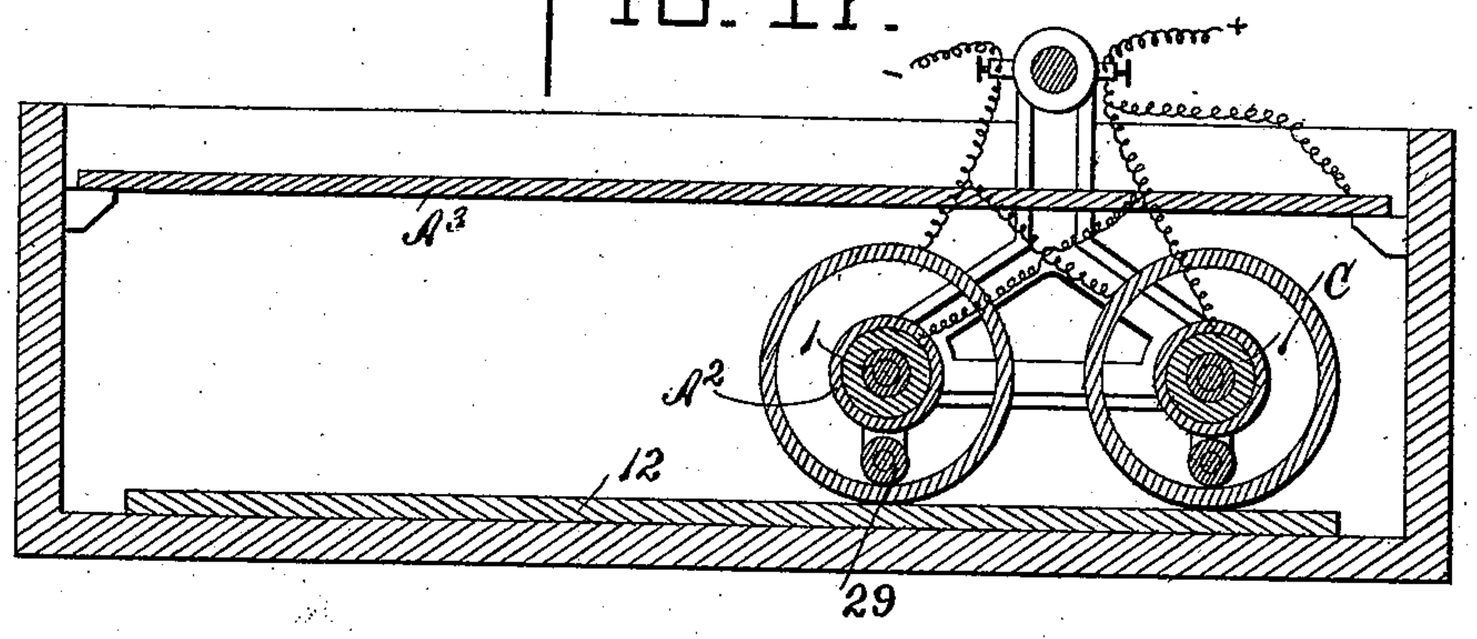


FIG. 17.



Attest.
N. Ellwood Allen
Mary E. Allen.

Inventor.
Ignatz Klein.
By Knight Bros
Attys.

UNITED STATES PATENT OFFICE.

IGNATZ KLEIN, OF BUDA-PESTH, AUSTRIA-HUNGARY.

PROCESS OF AND APPARATUS FOR ELECTROLYTICALLY FORMING TUBULAR BODIES.

SPECIFICATION forming part of Letters Patent No. 555,452, dated February 25, 1896.

Application filed December 7, 1894. Serial No. 531,143. (No model.) Patented in Austria March 19, 1892, No. 5,178; in Hungary March 19, 1892, No. 4,785, and in Germany March 31, 1892, No. 79,764.

To all whom it may concern:

Be it known that I, IGNATZ KLEIN, a subject of the Emperor of Austria-Hungary, and a resident of Buda-Pesth, in the Empire of Austria-Hungary, have invented a new and useful Improvement in the Process of and Apparatus for Electrolytically Forming Tubular Bodies, (for which I have obtained Letters Patent in Austria, No. 5,178, dated March 19, 1892; in Hungary, No. 4,785, dated March 19, 1892, and in Germany, No. 79,764, dated March 31, 1892,) of which the following is a specification.

This invention relates to the rolling of metallic deposits precipitated by galvanic process, its object being to compress and mold such metal. The characteristic feature of this rolling process is that cathodes having the form of rollers, on which the electrolytically-obtained metal is to be deposited, and which may be made of any desired longitudinal profile during the formation of the deposit, are in co-operation with straight or curved plates having corresponding profile, adequate pressure being at the same time applied. In consequence of this procedure the deposit takes the form of a tubular body, whose longitudinal profile corresponds to those of the cathodes and the roller-plate, such body at the same time attaining a high tensile strength. With such a device, moreover, several roller-plates having different profiles may be simultaneously employed in one and the same electrolytic bath. The number of tubular bodies to be simultaneously produced, however, depends on the dimensions of the rolling device.

There are practically two kinds of tubular bodies—viz., those to be employed as independent hollow bodies or tubes and those to be used as bodies with metallic coating—*i. e.*, where the deposit is to remain on the core or mold as a metallic coating. For both kinds the mold or core consists essentially of a solid casing, frame, or core provided with an easily-fusible coating. The casing or frame of the core is made of any suitable resisting material—such as metal, wood, &c.—and is either solid or hollow.

The invention will be fully understood upon reference to the accompanying drawings, in which—

Figures 1, 2, 3, and 4 are transverse sectional views illustrating as many different constructions of the core upon which the metal is deposited to give it the desired form. Fig. 6 is a sectional longitudinal view of a core. Figs. 5 and 9 are sectional views illustrating the profile of a core and the corresponding rolling surface. Figs. 7 and 8 are respectively a vertical section and a plan of one form of complete apparatus for carrying out the invention, and wherein is employed an inclined rolling surface, so that gravity will move in one direction the roller-carriage which is intermittently drawn in the opposite direction. Fig. 10 is a view similar to Fig. 7, illustrating an apparatus for producing a larger number of articles simultaneously, and wherein a gravitating weight imparts movement in one direction. Figs. 11 and 12 are respectively a vertical section and a plan of a further modification of apparatus, wherein the rolling movement is in a vertical direction and the necessary pressure is obtained by confining the roller-carriage between the anode and rolling surface. Fig. 13 is a sectional view illustrating a varied profile with its corresponding rolling surface. Fig. 14 represents, in transverse section, a cylindrical rolling surface with interiorly-arranged roller-carriage and only partly immersed in the electrolytic bath, so that a part of the condensation by rolling takes place independently of precipitates. Fig. 15 is another cylindrical arrangement of rolling surface, but having the roller-carriage mounted to rotate on a vertical axis and having the rollers trunnioned on vertical axes and traversing the exterior of the cylindrical surface. Fig. 16 is a centrifugal arrangement of roller-carriage on a plane surface. Fig. 17 is an apparatus whereby both the inner and outer surface of a cylindrical body may be coated with metal.

1 represents the core, which may be of any suitable construction and made either solid, as shown in Fig. 1, or hollow, as shown in the other figures. Long hollow cores are strengthened or made rigid by inserting a tube 2, Fig. 3, or a suitable cross-piece 3, Fig.

4, into the same. The ends of hollow cores are tightly stopped by plugs 5, Fig. 6, provided with spindles or journals 6, which may be screwed in, as at 7, and metal contact-caps 8. The cores 1 are first given a coating 9, which may either be a suitable plastic substance, such as gypsum, cement, clay, papier-maché, &c., or a direct coat or layer of easily-fusible substance which can be burnished and which is not affected by the liquid in the bath—for instance, lead and its alloys, wax, stearine, paraffine, &c., or compounds of same, according to the kind of tubular body to be made. They are then given the form of the body to be produced, their surfaces being at the same time made into conductors.

For producing the cores or molds 1 on a large scale, it is preferable to employ the device shown in Fig. 13, which consists of two rails 10, secured exactly parallel to each other on the bed 11, the rolling-plate 12, located between the rails 10 and the cores 1, each having a pair of spindles 13 carrying guide-rollers 14 and adapted to run upon the rails 10 by means of the collars 15, in which said spindles are adjustably secured by the nuts 16 and the screw ends 7 in the core. In the first place the filling 17, of clay or the like, is molded on the inner core 1 by rolling backward and forward on the plate 12, then burned hard, and finally covered with a layer of tallow or grease. The spacing-rings 18 are then put on the collars 15 and the core rolled backward and forward on the same plate 12 until finished. By employing several rings 18, of varying and increasing sizes, the core may be covered with several concentric layers. Cores may in this way form the rollerlike cathodes, which I shall designate as C.

The most important modifications of devices for carrying out the rolling process are shown in the following figures:

The simplest modification of the device is that shown in Figs. 7 and 8, where, in a trough 19 containing the electrolytic bath, is mounted on supports 20 the roller-plate 12, made of glass, porcelain, or similar hard substances not affected by the bath. Several cores 1 are placed on this plate and mounted parallel in a frame 21 in such manner that their spindles 6 are entered from underneath and journaled in slits 22 in two oppositely-arranged ledges of the frame, so that the frame lying free on the spindles can be readily raised from the cores. The passing of the electric current to the negative pole of any suitable source of electricity or generator (not shown) from the surfaces of the cores made into conductors is affected by the wire 23^a attached to the lamels or brushes 23 mounted on the frame and bearing on the contact-caps 8 on the ends of the cores 1. Parallel to the frame in which the cores are mounted is the anode-plate A, which is connected to the positive pole of the source of electricity by the wire $23^{a\times}$. As soon as the trough is filled with the liquid and the circuit closed, the frame, resting freely or carrying weights, or otherwise put under pressure, is drawn backward and forward between the anode and roller-plate until the deposit has formed in the required quantity and thickness on the cores, which should make several revolutions during this rolling procedure.

The plate 12 may be arranged in a horizontal or inclined position or at any desired angle, and any desired number or form of the cores to be rolled simultaneously may be employed so long as the plate 12 is sufficiently large and of the same longitudinal profile as the cores, Figs. 5 and 9.

Fig. 10 is a modification showing a multiple arrangement of the device shown in Figs. 7 and 8, and a series of plates 12 and frames 21 carryings cores 1 being arranged in one and the same trough.

Figs. 11 and 12 show in longitudinal and cross-section a trough, in which any desired number of rows of cores of any desired profile can be rolled in vertical direction, the guiding of the frame being effected by rollers 24, Fig. 11, and the pressing of the cores on the rolling-plates 12 being by elastic press-rollers 25. The pressing of the frame may also be effected in any other suitable manner.

The anode-plate A′, curved according to the generatrix of the core, may also be mounted on the frame 21 and receive the same movement as the latter, as shown in Fig. 12.

The plate 12 instead of being straight may be concave, but in this case the frame 21 guiding the cores must be made of like form. Furthermore, as shown in cross-section in Fig. 14, the plate may be made in the form of a hollow cylinder 12^a and the frame as a turn-table. The roller-cylinder 12^a is secured to end walls of the semicylindrical receptacle 26 containing the fluid by means of the edging 27. 28 is the turn-table in the receptacle 26, such turn-table carrying the cylindrical anode A^2 and two annular plates 21^a, one at each end, in the periphery of which the spindles 6 of the cores 1 are mounted in open slits. If the turn-table 28 is moved first in one and then in the other direction, or always in the same direction, the cores being thus pressed on the roller-cylinder by centrifugal force or in other suitable manner, the precipitate deposited on the cores will be compressed in the same manner as described in connection with the foregoing devices.

It will be evident that the device can be constructed so as to operate in vertical position.

Fig. 15 is similar to the modification shown in Fig. 14, the roller-cylinder 12^a being in this case vertically arranged in the center of the trough, while the cores, mounted on a turn-table 28^a, are rolled on the periphery of the roller-cylinder, and are pressed against the cylinder, for instance, by springs.

In the modification shown in Fig. 16 the cores are mounted in a rotary disk or frame 21^b and radially to the axis of rotation of same.

Several of such devices may be arranged one above the other, their rotary disks being secured to a central shaft common to all.

In Fig 17 is shown a device for rolling the deposit on both the inner and outer faces of two hollow cores 1, the inner face by rollers 29 and the outer by plate 12, A^2 being the inner and A^3 the outer anodes.

It is preferable that all these devices are only worked at a moderate speed and with a decreased pressure when commencing the operation.

The operation herein characterized by rolling can also be used for electroplating, electronickeling, electrosilvering, &c., by substituting the plates or cylinder by a corresponding burnishing device.

The advantages of the rolling process as against the known similar process consist, besides the possibility of producing tubular bodies of good quality and form and in any desired quantity by means of simple devices, in that by the constant agitation of the liquid in the bath layers rich in metal are constantly deposited on the cathodes; that in most cases a minimum space and a minimum quantity of liquid are required; that by removing the air-bubbles adhering to the cathodes the generation of oxides and consequent excessive accumulations at any one part are avoided, and, finally, that the finished tubular body can be readily withdrawn from the core by melting the coating without doing any injury either to the body itself or to the core or mold.

Having now described and ascertained the nature of this invention and in what manner the same is to be performed, I declare that what I claim is—

1. The process of electrolytically forming and condensing metallic bodies of circular section which consists in immersing cathodes of the desired number and longitudinal profile in the form of rollers in a suitable electric bath depositing the metal upon said cathodes and rolling them upon an immersed rolling-plate of corresponding profile, while the deposit is taking place and until the process is completed as set forth.

2. In an apparatus for electrolytically depositing metal bodies of circular section and condensing the metal in continuous operation while the depositing is taking place, the combination of an electrolytic bath one or more movable frames, a number of cores corresponding to the number of bodies to be simultaneously formed mounted in parallel series to be independently rotatable in said frame, and a rolling-plate immersed in the bath, corresponding to the profile of the roller-shaped cathodes, and upon which the same may be rolled in continuous operation till the desired thickness of deposit is obtained.

3. The art of electrolytically depositing and condensing metallic bodies, which consists in providing a suitable cathode-core for the body, electrolytically depositing metallic coating on both sides of said core simultaneously and rolling both the surfaces in continuous operation during the process of depositing, by means of interior and exterior rolling surfaces extending at least the length of the body being prepared as set forth.

4. In an apparatus for electrolytically depositing and simultaneously condensing metal bodies of cylindrical section, the combination of the bath, a rolling-plate, and the cathode in the form of a cylindrical core, having the metallic contact-cap upon its end and having the contact-brush bearing on said cap as set forth.

5. In an apparatus for electrolytically producing metal, the combination of a suitable receptacle adapted to contain a metallic solution, a gravitating carriage, means for moving the carriage against its gravitating tendency, one or more rotatable cathodes carried by the carriage, a supporting-plate against which the cathodes operate, a suitable anode, and an electric battery, substantially as set forth.

6. In an apparatus for electrolytically producing metal, the combination of a suitable receptacle adapted to contain a metallic solution, one or more cylindrical or tubular cathodes having electrical connection with one pole of an electric battery, a suitable supporting plate or base against which the cylindrical cathodes operate, means for rolling the cylindrical cathodes, a suitable anode supported exteriorly to the cylindrical cathodes, and one or more rollers and anodes supported in the cylindrical cathodes and adapted to deposit and roll the metal upon the inner surface of the cathode, said anodes being connected to the other pole of the electric battery, substantially as set forth.

7. An apparatus for forming hollow bodies by electrodeposition of metal, which consists in a suitable bath, means for moving a hollow cathode within said bath rolling surfaces within and without the hollow body coextensive at least with the length of said body, for simultaneously applying pressure to both sides thereof, an anode held in proper relation to the outside of the cathode and an additional anode held in proper relation to the inside of the cathode and suitable electrical connection, all arranged substantially in the manner and for the purpose set forth.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

IGNATZ KLEIN.

Witnesses:
ALOIS KOVICS,
IGNATZ JUTIH.