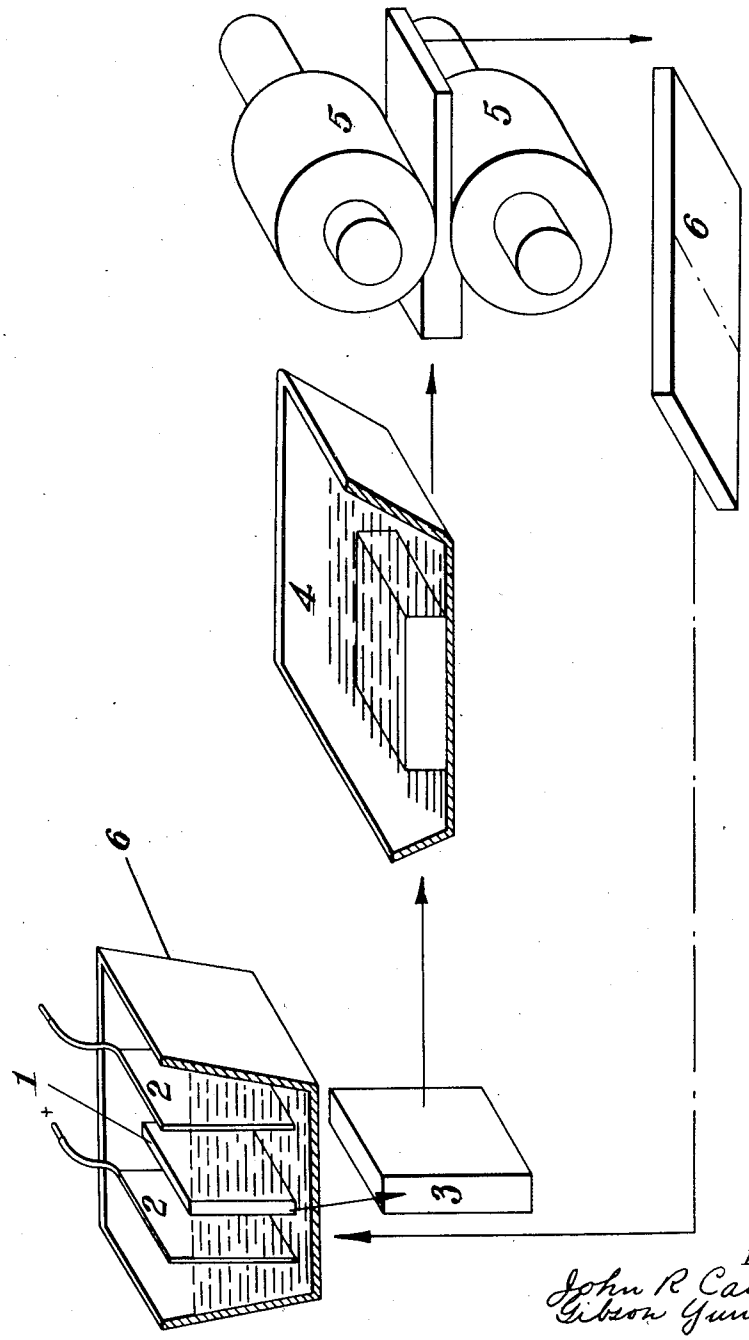
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PROCESS OF PRODUCING METAL ARTICLES ELECTROLYTICALLY, PARTICULARLY SHEETS

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INVENTOR

John R Cain
Gibson Gunglert
Allen & Allen

ATTORNEYS

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JOHN R. CAIN, OF WASHINGTON, DISTRICT OF COLUMBIA, AND GIBSON YUNGBLUT, OF DAYTON, KENTUCKY, ASSIGNORS TO THE RICHARDSON COMPANY, OF LOCKLAND, OHIO, A CORPORATION OF OHIO

PROCESS OF PRODUCING METAL ARTICLES ELECTROLYTICALLY, PARTICULARLY SHEETS

Application filed August 19, 1927. Serial No. 214,194.

It is the object of our invention to provide an electroplating process, as applied to iron, by means of which it is practical and economical to produce in a continuous process sheets or other objects of electrolytic iron of uniform texture and high surface stability essentially by starting with an iron piece, plating upon it on both sides with iron of such physical properties that it can be cold rolled or otherwise worked without annealing, in such fashion as to produce economically not only the desired commercial object but also a cathode blank for the continuation of the process.

Thus, as applied to the manufacture of sheets of electrolytic iron, our process broadly consists in starting with a cathode blank, plating upon it to a desired thickness and then rolling to decrease the thickness of the piece and increase its length, thereupon cutting it into at least one commercial sheet and at least one cathode blank for use in the continuous repetition of the process, or into two or more starting cathodes.

It will be obvious that such a process requires a method of electrodepositing iron which will give deposits not only capable, of themselves, of being worked without uneconomical annealings or heatings, but also closely similar in chemical and physical properties to the cathode blank, since in our process the cathode blank becomes an integral part of the finished article. It is of course an object of our invention to avoid the separation of a deposit from a cathode blank, i. e. the stripping operations which, so far as we are aware, have invariably characterized commercial methods of producing sheets of of electrolytic metal. The electrodeposited iron must therefore be very closely similar to the metal of the cathode blank, as otherwise mechanical working might tend to separate one from the other. And further it is highly desirable that the deposited metal be of such character that it may be immediately cold rolled along with the cathode blank without any annealing whatsoever, that is to say, our electrodeposits of iron must be initially soft, malleable and ductile. In the commercial use of our process we must therefore employ an electrolytic method which will give such deposits over days and weeks of continuous operation. We are not aware of any other commercial process for the manufacture of electrolytic iron which does not result, during such continuous use, in the production of brittle and non-malleable deposits, than the process referred to herein.

It is not our object in this application to claim the electrolytic method for the production of soft iron nor the apparatus therefor. These are described in the co-pending application of John R. Cain, Serial No. 173,793, filed March 8, 1927.

It is our object in this application to describe and claim the process for the production of objects of electrolytic iron continuously, of which process the said electrolytic steps form but a part.

The cold rolling which is preferably in our process imparts a surface condition which is excellent for cathode use, due to its polishing action. We are enabled to obtain upon such polished surfaces, when using the electrolytic method referred to above, deposits of desirable structure which are closely similar to the material of the cathode blank itself. This similarity, together with the softness and malleability characteristic of our iron deposit not only makes possible the production of articles in a continuous process, but by minimizing the necessity of annealing and pickling treatments, as hereinafter pointed out, adds greatly to the economy of our process.

It will be necessary in factory production to anneal the product occasionally, because a long series of platings, rollings and replatings results in a product of which the inner layers have been attenuated many times so that their grain structure will not be proper.

We have illustrated by a diagram the steps of our process, which diagram forms the sole figure in the drawing.

Our preferred electrolytic process is as follows:—The electrolyte is a solution of neutral ferrous-chloride (or sulphate), and is kept at a temperature near the boiling point. A circulation of electrolyte with filtration

to remove scums and precipitates is preferable. Soluble anodes are used which may consist in whole or in part of an iron-bearing material such as ferrous sulphide which will act to prevent the production of an acid condition in the bath during electrolysis, i. e. a harmful increase of hydrogen-ion concentration. Suitable anodes are described in the co-pending application of John R. Cain, Serial No. 173,793. Thus our anodes may comprise ferrous sulphide with or without a percentage of metallic iron, iron oxide, ferric sulphide, ferrous silicate, etc., and these anodes may be supplemented by the additional use of soluble anodes of iron or iron-bearing material not containing sulphide. Besides the use of anodes which have a "conditioning" effect upon the electrolyte, other means may concurrently be used to maintain a low hydrogen-ion concentration as described in the said application Serial No. 173,793.

The current density can be very high, say one to three amperes to the square inch, and plating from the soluble anodes onto the cathodes will take place rapidly and uniformly. The deposit will be quite soft, smooth and malleable.

It is a characteristic of the process that during long continuous electrolytic action, continuous control of the hydrogen ion concentration is maintained. We prefer to maintain our electrolyte at a pH of 4 or greater.

In the drawing, we indicate a starting piece 1, which will be, for example, an electrolytic iron sheet. This sheet is placed in a tank 6 with anodes 2, 2 on each side thereof, where it is plated to greater thickness, following the process described.

The result is a piece 3, which is then washed at 4, and cold rolled at 5, say for example, to twice its length, resulting in the piece 6. The piece 6 is then in polished condition ready for further plating, and can be cut so as to provide another starting piece, with a remainder used to sell commercially, or the remainder can also be used as a starting piece, or a series of starting pieces. It will be understood that in the plating operation sufficient metal is deposited to allow for the necessary trim.

By using our plating process which yields soft iron without brittleness, there is no need of any heating or annealing prior to the first cold rolling operations (providing the cathode blank is itself soft and ductile). Consequently, also, there is no necessity of a costly procedure to provide suitable soft cathode blanks. Since the only factor in our process tending to produce hardness in the iron is the strain due to working, it is only necessary occasionally to anneal the cathode blanks after repeated workings have rendered portions of them harder than is desirable. Also, of course, while the cathode residues in a finished product may have improper grain structure due to working, an ordinary annealing will bring the product to commercial uniformity.

Our process thus contemplates the production of cold-rolled cathode blanks with only an occasional annealing after several repetitions of the cold-working stage of the process. Any irregularities in the cathode blank surfaces such as might be formed by hot-working with subsequent pickling, will tend to be repeated in the structure of the electrodeposits laid down thereon. Thus while we prefer to manufacture sheets by a process involving mainly cold-working, nevertheless our process can be used for the manufacture of articles of thick section, such as bars, which the user may prefer to handle subsequently by ordinary hot-working methods. It should be noted, however, that our process when so used, loses one of its outstanding advantages and we prefer, before returning to the electrolytic bath cathode blanks generated in a hot-working process, to give them a pass through cold rolls in order to polish their surfaces.

As indicated, it may be required to anneal the starting pieces every third or fourth cycle. Thus, if a piece .005 inches thick is used as a start, and is plated to .010 inches and then rolled to .005 inches again, and a piece cut off to form the cathode in another cycle, the original metal in the second rolled out piece will have been drawn out twice, and may be imagined as .0025 inches thick, etc. In the third cycle the original metal will be .00125 inches thick, etc. In this progressive attenuation of portions of the metal, the grain structure thereof is distorted, and it becomes necessary to restore a uniform grain structure by an occasional annealing, preferably under reducing conditions so as to minimize or avoid the formation of surface scale.

We have described one embodiment of our process in the manufacture of sheets which consists broadly in plating upon a cathode blank and rolling the plated structure out to form a commercial article and another cathode blank which is returned to the plating bath. Many variations of the fundamental process are possible, several of which we now describe.

Our process is not limited to the cold-rolling of sheets, but is equally applicable to the various other ways of working metal to change its dimensions. Thus, we may use as our cathode blank a tube of electrolytic iron, which during the plating operation is increased in thickness of wall. The resultant piece is then removed from the bath and passed through a tube-drawing die, thereby increasing its length and reducing its wall-thickness. A piece is then cut off and returned to the bath as a cathode blank and the remainder sold as finished tubing.

Again, starting with a small cathode blank

in, let us say, sheet form, we may plate upon it and roll it out to increase its length. We may then use the lengthened piece, without cutting, as a cathode blank in the same or a separate electrolytic tank, again increasing its thickness. We may then roll it again, and return it to a bath, repeating this process until we have a sheet of metal of any desired length, which can then be coiled and sold. We will, of course, at some stage of the process cut off a cathode blank which can be returned to the initial plating step of the series, thus making the entire process, irrespective of the number of steps involved, continuous.

A further variation may be practiced where the finished commercial articles to be produced are of thick section, and where it is desired to subject to mechanical working only a portion of the metal therein. The process described for the production of sheets may be applied to the production, not of a commercial article but of cathode blanks for a subsequent and discontinuous operation. Thus if our object is the manufacture of bars of very thick section, we start with a cathode blank .005 inches in thickness, double its thickness in electroplating bath, roll it out to .005 inches again, cut off a cathode blank for a repetition of the process, and transfer the remainder of the sheet after trimming to a separate electrolytic tank where its thickness may be increased to 1.0 inches or greater. In doing this, it will be clear that we have expended mechanical energy in rolling only a very small fraction of the metal in the finished bar or other article.

Our process in whatever variation is directed to the production of finished or semi-finished shapes of very pure iron, direct from raw materials which may be ores, with a minimum of plant investment. It avoids the stripping operations of present day electrolytic sheet-forming processes and utilizes cathode blanks which become a part of the finished article. It contemplates the use of a plating process which gives a very soft deposit and yet provides for the production of desired articles without stripping, by reason of the employment of a cold rolled portion of the product as the cathode for subsequent plating steps.

Having thus described our process, what we claim as new and desire to secure by Letters Patent is:

1. A process for forming iron pieces which consists in starting with a plate of iron, plating the plate with soft electrolytic iron, cold rolling the plate, and then dividing the cold rolled product to provide at least one cathode plate, with a remainder piece over, and repeating this process using the cathode plates produced in each step, with an intermediate annealing to restore grain structure.

2. A process for forming iron articles which comprises starting with a blank of soft workable electrolytic iron, plating the blank with soft electrolytic iron of essentially the same characteristics, then working the piece to extend it so as to produce at least one cathode blank with a remainder left over.

3. A cyclic process for forming iron articles which comprises starting with a blank of soft workable electrolytic iron, plating the blank with soft electrolytic iron of essentially the same characteristics, then working the piece without initial heat treatment, to extend it so as to producee at least one cathode blank, and a remainder over which consists of at least one commercial article similar to said cathode blank, and returning said cathode blank to the bath for a repetition of the aforesaid steps.

4. A cyclic process for forming iron articles which comprises starting with one of said articles of soft, workable electrolytic iron, plating iron of essentially the same characteristics upon it in an electrolytic plating bath until the weight thereof is at least doubled, then working said plated piece to produce at least two of said articles, at least one of which is returned to the bath for a repetition of said steps.

5. A cyclic process for forming soft iron articles which comprises making one of said articles a cathode in an electroplating bath plating upon said article iron of essentially the same characteristics until the weight thereof is at least doubled, then working said plated piece to produce at least two of said articles, at least one of which is returned to the bath as a cathode, and continuously repeating said steps, maintaining the electrolytic conditions of said bath so as to give soft workable iron deposits throughout the entire operation, and annealing said cathode-articles whenever repeated workings have given them characteristics essentially dissimilar to the characteristics of the deposits.

6. A cyclic process for forming iron articles which comprises starting with one of said articles of soft, workable electrolytic iron and have a cold-rolled surface, plating iron of essentially the same physical characteristics upon it in an electrolytic plating bath until the weight thereof is at least doubled, then working said plated piece to produce at least two of said articles, at least one of which is returned to the bath for a repetition of said steps, said working step including a cold-rolling operation whereby said articles to be returned to the bath will have a cold-rolled surface.

7. A process for the continuous production of wire, rod, band, strips, sheets and the like of electrolytic iron which comprises making a length of said articles a cathode in an electroplating bath, plating thereon electrolytic iron of essentially the same characteristics, working said plated piece to extend

it, returning it to a bath to further thicken it, working it further to extend it, and repeating said steps until a finished article is obtained of the desired length plus the length of at least one original cathode which is cut off and returned to a bath.

8. A process for forming iron pieces which consists in starting with a plate of iron, plating the plate with soft electrolytic iron, cold rolling the plate, and then dividing the cold rolled product to provide at least one cathode plate.

JOHN R. CAIN.
GIBSON YUNGBLUT.