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(54) Electroforming process.

(57) The invention concerns an electroforming process for the manufacture of a metallic article by electro-deposition in an electrolytic bath, comprising the steps of making a master the cathode, having an electroconductive external surface with the same shape as the wanted internal surface of said article; carrying out a first electro-deposition; filling the concave surfaces, the recesses and interstices with plastic material, electroconductive at least on the surface and able to harden; carrying out a second electrodeposition to a thickness that with said first electrodeposition layer the article wanted thickness is reached; and extracting the master from the article.

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ELECTROFORMING PROCESS

The present invention concerns the manufacture of metallic articles by electrolytic techniques and more particularly it relates to the improvements to electroforming processes.

Metallic articles of any shape, can be realized, as known, by electrodeposition techniques in electrolytic bath. Such a process proves particularly useful when an article with a quite complex interior surface is to be made. In this case, mechanical machining by machine tools proves extremely difficult as it must be carried out blindly; vice versa by using electroforming only a master having an external shape similar to the internal shape of the wanted article is required and then the metal can be deposited in a galvanic bath till to the wanted thickness onto the master is attained.

However, while electroforming is being carried out, a metal overdeposition occurs in correspondence with convex surfaces and a lack of deposition occurs in correspondence with concave surfaces. It is clear

that the latter problem is more serious as to a good execution of the article, as the structure is badly weakened in the area where mechanical stresses are usually encountered.

Said phenomenon can be due to a non-uniform distribution of the electrical field present inside the galvanic bath, where the master acts as cathode while an electrode of suitable material acts as anode.

In fact the density of current lines increases in correspondence with convex surfaces and decreases in correspondence with concave surfaces and consequently the amount of metal transferred as ions in the electrolyte is higher where the current is higher and vice versa.

To overcome this disadvantage various methods have been tried: some results have been obtained by those utilizing a bath composition with low metal concentration, low current density or auxiliary anodes in combination with masking operations. However the results attained are not quite satisfactory because the performances of the manufactured articles are not yet high as to mechanical strength. A further method utilizes metallic inserts to be placed in correspondence with greater concavity surfaces. Thus a uniform metal layer can be deposited on the insert in order to strengthen the structure of the object. Yet the manufacture of said inserts often requires high accuracy particularly in the internal surface, that is not much different from that required of the machining of the article it self.

The electroforming process, object of the present invention, overcomes said disadvantages and solves the technical problem described above; according to said process metallic articles of any shape and with high strength and precision features may be made.

It is a particular object of the present invention an electroforming process for the manufacture of a metallic article by electrodeposition in electrolytic bath, in which a master is made the cathode having an electroconductive external surface with the same shape as the wanted internal surface of said article, that comprises:

- a first electrodeposition;

- a filling of the concave surfaces, of the recesses and interstices with plastic material, electroconductive at least on the surface and able to harden;
- a second electrodeposition having such thickness that with said first electrodeposition can reach the article wanted thickness;
- the extraction of said master from said article.

These and other characteristics of the present invention will become clearer from the following description of a preferred way of embodiment thereof, given by way of example and not in a limiting sense, taken in connection with the annexed drawing, in which there is represented a cross sectional view of an article manufactured according to the object of the invention.

In the drawing reference 1 denotes the master on which the wanted article is manufactured. The material used for its manufacture will have preferably low electric resistance, so as to obtain a satisfactory growth of the electrodeposit.

For some uses the master can be manufactured also with insulating material, provided the external surfaces are made electroconductive. The material used must also make easier the extraction or the destruction of the master once the metallic deposition is over.

Either low-melting materials or materials that can be corroded or dissolved by suitable acids or solvents are used to this aim. Of course they must not attack the materials of the article.

Practical realization of the master does not present great difficulties, as it can be obtained by a series of machining operations effectuated by machine tools or by means of fusing and pressing operations.

The master is then immersed in the electrolytic bath and connected with the negative terminal of the power supply. The anode and the electrolyte will be able to supply the metal necessary to the electrodeposition according to the usual technique. After a suitable time inter-

val, depending on both the chemical concentration in the electrolyte and current density, a first low thickness metallic layer 2 is deposited on to the master. This layer ensures the electrical continuity between the different parts of the internal surface of the article, but it does not yet ensure a sufficient mechanical strength. Electrical continuity can be important in a number of specific applications in the field of waveguides for microwave systems.

Now the master covered with the first metallic layer 2 is extracted from the bath and the concave surfaces, the recesses and the interstices lacking of metallic deposition are filled with a coating of plastic electro-conductive material, denoted by 3 in the drawing. To this aim epoxy - resins containing metal can be used, being easy to mould under plastic conditions and very strong after the hardening. Therefore, the master can be also machined by usual machine tools as any metal.

In case either non-conductive materials are to be used or the conductivity of available material is poor the surface of filling material is made conductive, with a metal layer, denoted by 4 in the drawing.

This layer can be obtained by coating the surface of the filling material with suspended silver in volatile liquids.

A further layer of metal similar to the one already deposited can be deposited over layer 4, for instance by brush - plating technique.

In this manner material discontinuity on the master surface can be avoided in view of a further deposition. This last deposition is obtained by immersing once again the master into the electrolytic bath and keeping it there till the wanted metal thickness is obtained; such layer is denoted by 5 in the drawing.

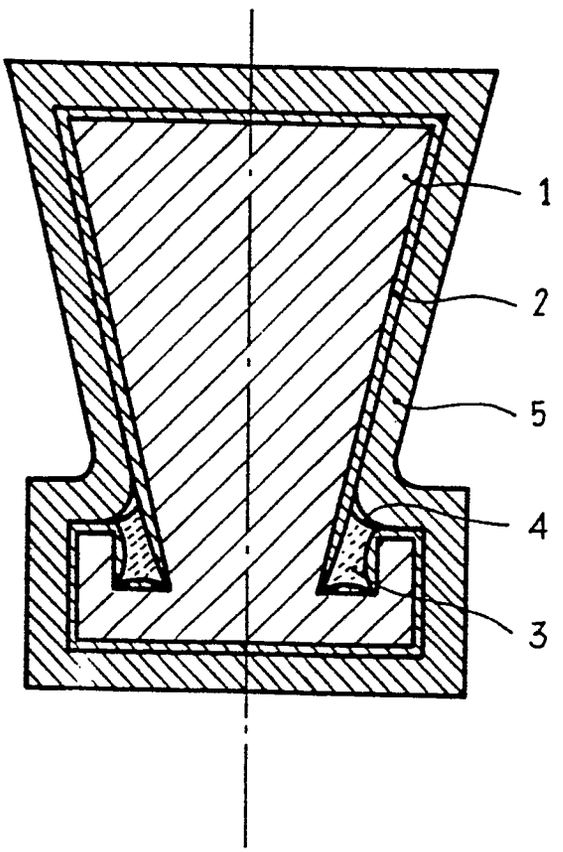
Afterwards the article can be separated from the master by one of the methods previously described, and finished according to the requirements; for instance the external surface, that is rather gran-

ulous due to the kind of process, can be duly smoothed and surfaces intended to be joined with corresponding surfaces of other articles can be rectified.

It is clear that what described has been given only by way of example and not in a limiting sense and that variations and modifications are possible without going out of the scope of the invention.

What we claim is:

1. Electroforming process for the manufacture of a metallic article by electrodeposition in electrolytic bath in which a master is made the cathode, having an electroconductive external surface with the same shape as the wanted internal surface of said article, characterized in that it comprises:
   - a first electrodeposition (2);
   - a filling (3) of the concave surfaces, of the recesses and interstices with plastic material, electroconductive at least on the surface and able to harden;
   - a second electrodeposition (5) having such thickness that with said first electrodeposition can reach the article wanted thickness;
   - the extraction of said master (1) from said article.
2. Electroforming process according to claim 1, characterized in that said plastic material consists of electroconductive resins.
3. Electroforming process according to claim 1, characterized in that on that plastic material there are deposited one or several electroconductive metallic layers (4).
4. Electroforming process as well as articles manufactured by such a process according to the previous claims, the whole as described in the text and depicted in the annexed drawing.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EUROPEAN SEARCH REPORT

Application number
EP 80100664.4

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
	CH - A - 404 333 (METACHEMICAL PROC. LTD.) + Totality + --	1,2,3
	GB - A - 1 336 057 (KABUSHIKI) + Totality + --	1,2
	GB - A - 685 247 (MINISTER OF SUPPLY) + Pages 1,2; fig. + --	1,3
	US - A - 3 867 264 (CARSON) + Abstract and column 8 + --	1,2,3
	US - A - 3 565 718 (STEDING) + Columns 2,7,8 + ----	1

CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)

C 25 D 1/00
C 25 D 5/10
C 25 D 7/00

TECHNICAL FIELDS SEARCHED (Int.Cl.³)

C 25 D

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	14-04-1980	SLAMA