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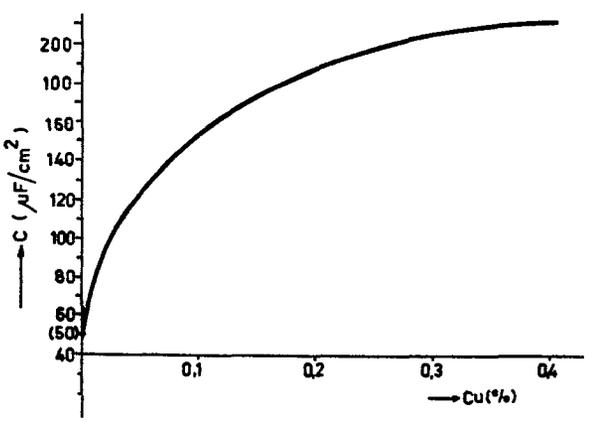
(54) Cathode foil for electrolytic capacitors.

(57) Improved cathode foil of an Al-Mn alloy for electrolytical capacitors with which a higher capacitance value and, in accordance with a further elaboration, a higher impact strength of the foil is obtained. To this end the foil has next to 0.2–2 weight % of Mn a Cu-content between 0.15 and 5.3% and preferably a Ti-content between 0.03 and 0.5%.



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"Cathode foil for electrolytic capacitors."

The invention relates to aluminium foil for electrolytic capacitors and to cathode foil in particular and to electrolytic capacitor manufactured with this foil.

An electrolytic aluminium foil capacitor consists of an anode foil of aluminium provided with a dielectric aluminium oxide skin obtained by anodic oxidation and an etched cathode foil of aluminium which are rolled together with a so-called separator of an insulating material to form a wound body. The wound body is impregnated with an electrolyte liquid and encapsulated.

It is important that the desired capacitance is concentrated on as small a surface area as possible, which means that the metal surface area to be oxidized (forming) must be as large as possible. To this end the surface of the aluminium foil obtained by rolling is subjected to an etching operation. Etching is usually performed electrolytically. To obtain a high capacitance per unit of surface area it is important that the surface area of the cathode foil, which is encapsulated in normal capacitors in a non-formed state, is also enlarged and that in the order of magnitude of the anode foil.

Aluminium of a very high purity, namely Al 99.99% is usually used for the anode foil.

According to US Specification 3,899,723 cathode foil consisting of an aluminium-manganese alloy having a manganese content of 0.2 to 2 weight % is used in an advantageous manner. Besides the fact that this foil has a high capacitance value after etching, so that after assembly with a formed anode foil it furnishes a capacitor having a high CV value, it has, prior to etching, a high impact strength and so the foil suffers less damage when handled prior to, during and after the etching operation compared to foil to which no manganese is added. The specification of this type of alloy having 0.9-1.4% Mn in accordance with the DIN standard 1725, page 1, stipulates the following maximum values for contaminations:

Si	0.5	Cr	0.05	other contaminations
Fe	0.6	Zn	0.2	each 0.05 to a total
Cu	0.1	Ti	0.1	of 0.15.

However, the effects aimed at did not appear to be quite optimal and it was therefore an object of the invention to obtain a further increase in the capacitance value and a still higher impact strength of the foil after etching.

The cathode foil according to the invention is therefore characterized in that it has next to a manganese content of between 0.2 and 2 weight % a copper content of between 0.15 and 5.3 weight %.

In accordance with a further elaboration of the invention an increase in the impact strength in particular is obtained if furthermore the titanium content of the cathode foil is between 0.03 and 0.5 weight %.

Preferably the Mn is between 0.5 and 1.5 %, Cu between 0.15 and 0.5 and Ti between 0.05 and 0.25 weight %.

Compared to the foil in accordance with the above-mentioned US Patent Specification 3,899,723 the foil according to the invention has a 20 to 30 % higher capacitance after etching with a given number of

Coulombs/cm^2 and, furthermore, an impact strength after etching with a given number of Coulombs/cm^2 which is approximately a factor of 2 higher.

The latter fact enables an increased through-etching of the foil so that an additional increase of the capacitance is possible, or the choice of a thinner foil as a starting material.

Example I.

By way of non-limitative example there now follows a comparison between foil in accordance with the above-mentioned DIN specification (1) and foil according to the invention (2). The relevant compositions in % by weight are:

(1)	Mn	1.0 %	(2)	Mn	1.0 %
	Cu	0.10 %		Cu	0.20 %
	Ti	0.02 %		Ti	0.08 %
	Fe	0.6 %		Fe	0.6 %
	Si	0.3 %		Si	0.3 %
	Zn	0.1 %		Zn	0.1 %
	Mg	0.2 %		Mg	0.2 %
	Cr	0.04 %		Cr	0.04 %
other contaminants each		$\leq$ 0.05			
together		$\leq$ 0.15			
	Al	remainder		Al	remainder

Both foils, having a thickness of 60 /um were electrolytically etched in an aqueous solution of 250 g/l NaCl at different numbers of Coulombs/cm^2.

The capacitance values were measured in a liquid consisting of a 5% solution of ammonium-pentaborate in water (resistivity 100 Ω.cm) versus a silver-plated counter electrode. The impact strength after etching was determined.

In Figure 1 of the accompanying drawing the capacitance measured (C in /uF/cm^2) and the impact strength σ measured (in mJ/15 mm foil width) of the two foils (1) and (2) are plotted versus the number of etching Coulombs Q per cm^2.

The pronounced improvement achieved by

the measure according to the invention, particularly in the practically suitable range of etching charges between 10 and 50 Coulombs/cm^2 is very spectacular. When using the cathode foil according to the invention together with anode foil, a spacer and an electrolyte solution in a complete electrolytical capacitor the capacitance value per volume will be found to be correspondingly higher.

Example 2.

Foils were produced which, starting from Al-99.99%, contained 1% Mn and increasing quantities of Cu from 0 to 0.4%. Etching and capacitance measurement were performed as described in example 1. Figure 2 shows the values of the capacitance (C in $\mu F/cm^2$) versus the Cu-content (in weight %).

CLAIMS:

1. A cathode foil of aluminium for electrolytical capacitors consisting of an aluminium-manganese alloy having a Mn-content between 0.2 and 2 weight %, characterized in that furthermore the alloy has a copper content of between 0.15 and 5.3 weight %.

2. A cathode foil as claimed in Claim 1, characterized in that the titanium content thereof is between 0.03 and 0.5 weight %.

3. A cathode foil as claimed in Claim 2, characterized in that the copper content thereof is between 0.03 and 0.5 and the titanium content between 0.05 and 0.25.

4. An electrolytical foil capacitor in which the cathode consists of etched foil as claimed in Claim 1, 2 or 3.

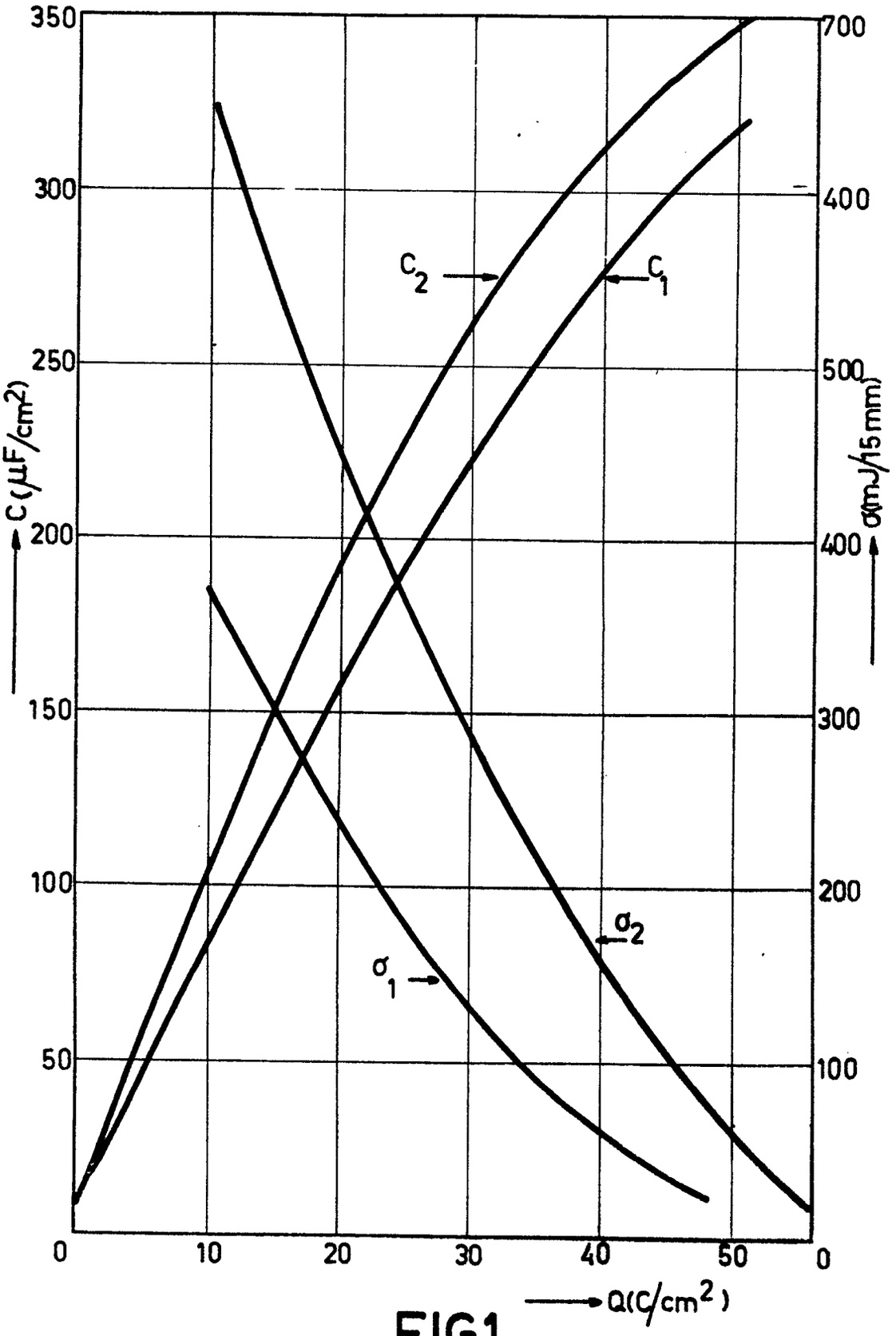
350
300
250
200
150
100
50
0
700
400
500
400
300
200
100
0
10
20
30
40
50
C (μF/cm²)
σ(mJ/15 mm)
Q(C/cm²)
C2
C1
σ2
σ1

FIG.1

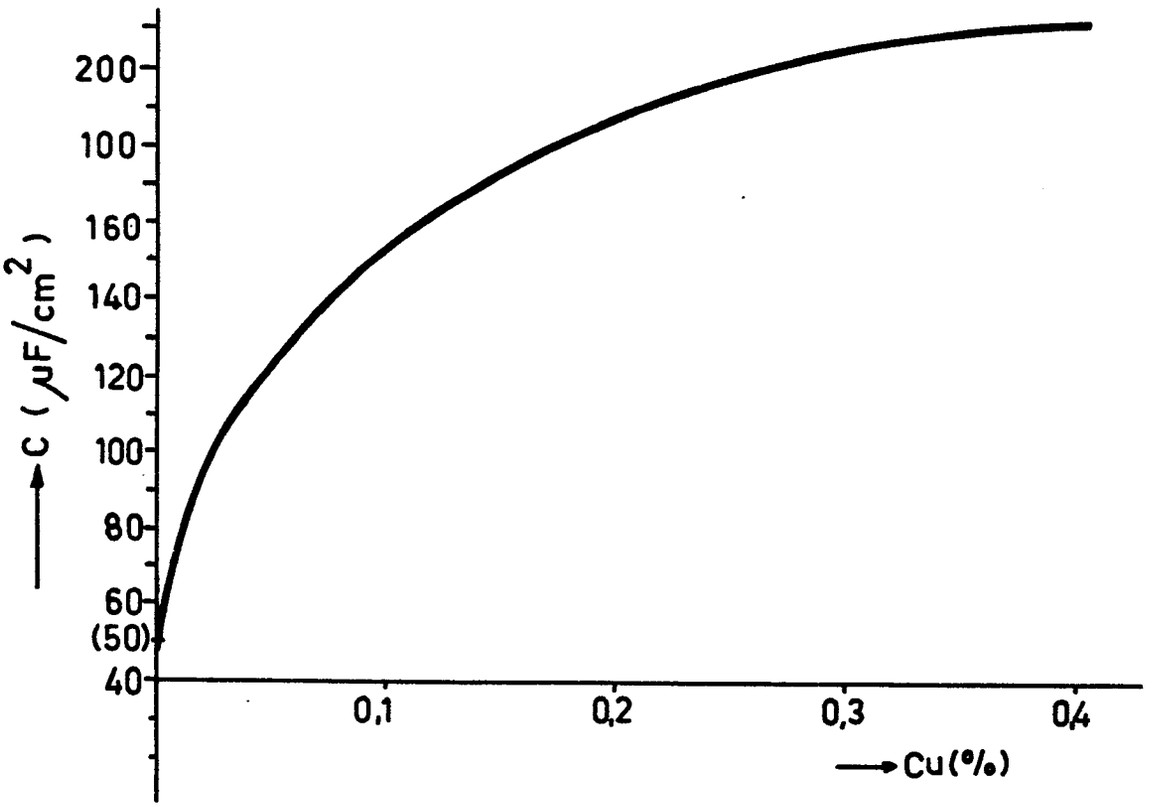

FIG.2

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EUROPEAN SEARCH REPORT

Application number
0000965
EP 78 20 0423

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
A,D	US - A - 3 899 723 (MUEHLHAUESSER et al.) (cited in the application) * Claims 1,2 *	1
A	GB - A - 945 700 (SWISS ALUMINIUM LTD.) * Claim 1 *	1

CLASSIFICATION OF THE APPLICATION (Int. Cl.²)

H 01 G 9/04
C 22 C 21/00
C 22 C 21/12

TECHNICAL FIELDS SEARCHED (Int.Cl.²)

H 01 G 9/04
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C 22 C 21/12

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

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	22-10-1978	LIPPENS

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