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(54) Method of coil coating a strip of blackplate or a substrate based on blackplate intended for use in the manufacture of cars and/or can parts.

(57) In the coil coating of an organic material coating layer onto a strip of blackplate or substrate based on blackplate intended for use in the manufacture of cans and/or can parts, e.g. drawn and wall-ironed cans or deep drawn cans, a screen printing process is used to obtain an even, continuous coating layer. The strip moves at a speed of 20 to 500 m/min. and the material is applied at a dry coating weight in the range 1 to 15 g/m^2. Use of screen printing permits low dry coating weights, and the coating weight obtained is largely independent of the strip speed and the viscosity of the applied material. The screen printing cylinder may apply the material to an applicator roll, which transfers it to the strip.

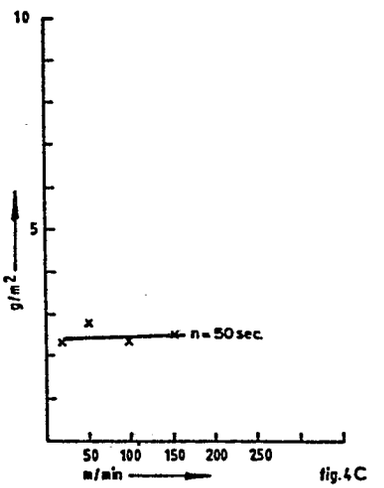

fig. 4C

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"Method of coil coating a strip of blackplate or a substrate based on blackplate intended for use in the manufacture of cans and/or can parts"

The invention relates to a method of coil coating a layer of organic coating material onto a strip of blackplate or a substrate based on blackplate intended for use in the manufacture of cans and/or can parts, e.g. drawn and wall-ironed cans or deep drawn cans.

Blackplate in this connection means cold rolled, annealed and temper rolled packing steel, usually in the range 0.1 to 0.5 mm thick. Proposals have already been made for manufacturing cans from blackplate coated with a thermosetting resin. For example, US-A-4032678 proposes manufacturing a drawn and wall-ironed can from blackplate coated with a thermosetting resin. The material normally used for such cans is tinplate.

The present applicants have realised, from a techno-economic study, that in order to arrive at an acceptable price for the coated strip, the blackplate should be coated under the following

conditions:

1. Because of the high raw material costs of the organic coating material, a thin layer of coating should be applied with a dry coating weight in the range of 1 to 15 g/m^2, and
2. The blackplate should be coil coated, at a strip speed preferably in the range of 100 to 500 m/min.

High strip speeds of this order are found in lines for the electrolytic tinning of blackplate. However, this plating technique is not available for coating with an organic material.

In known lines for coating with an organic material, such as those for coil coating of cold rolled strip, which has a gauge of more than 0.5 mm and is used for various applications e.g. in building construction as facade panels, strip speeds of up to about 100 metres per minute are used. In this case the coating is applied by roller-coating using smooth rolls. During this application with smooth rolls, an application system is used in which the coating material is conveyed by a smooth "licking roll" from a pan, and transferred to the strip by means of a smooth "application roll". Thus smooth, unprepared rolls are used for this coating

technique. It has been shown that this application system is unsuitable at a high strip speed.

The object of the present invention is to solve the problem of coil coating blackplate with an organic material coating layer in a manner which is technically acceptable at the required strip speed and the required layer thickness.

The invention consists in the use of screen printing to apply a continuous layer of the organic coating material, e.g. material containing a thermosetting resin, at a rate corresponding to a dry coating weight in the range 1 to 15 g/m^2 with the strip speed being in the range 20 to 500 metres per minute. The continuous layer may be of even thickness, but predetermined thickness variation may be employed.

Screen printing is known for the printing of strips of paper and textiles with ink or paint, the printing fluid being applied to the strip at spaced-apart regions, e.g. in the form of dots. In known screen printing processes, the printing fluid is forced through perforations or ducts from the inside of a hollow screen printing cylinder and applied onto the strip at locations spaced-apart according to the locations of the ducts.

It is thought surprising to use screen printing for a completely different application, namely the coil coating of blackplate, at high speed and with an extremely low coating weight, with a continuous layer of coating material.

The discrete portions, e.g. small points or dots, of coating material derived from the ducts in the screen printing cylinder are deposited and spread onto the strip, the quantity of coating material being applied to the strip being at least so much that a thin, continuous layer of coating material is obtained. The spaced-apart condition of the small holes of the printing cylinder can no longer be found on the coated blackplate; a coherent coat of coating material is obtained which can be even, i.e. with a substantially constant coating weight.

One major advantage of the use of screen printing for coating blackplate is, as will be explained in greater detail later, that the coating weight of the coating material after application can be almost independent of the strip speed during coating, and of the viscosity of the coating material, so that a product with a constant coating weight is obtained simply. This is apparently a

consequence of the small ducts in the screen printing cylinder, by which a kind of volumetric dosing of the coating material is obtained which is largely independent of the strip speed and viscosity of the coating material.

Another advantage, as will also be explained later, is that by using screen printing a coated blackplate with an extremely low coating weight can be obtained.

A further advantage is that the coating can be carried out at an extremely high strip speed.

The layer of coating material can be applied to blackplate from which thereafter drawn and wall-ironed or deep-drawn cans, for example, are to be manufactured. More generally, however, the layer of coating material can also be applied to a substrate of blackplate which, in addition to the blackplate just mentioned, also comprises blackplate which is provided with a pre-applied layer of another material, which layer forms an intermediate layer after final coating. One example of such a substrate based on blackplate is the coating of ECCS (Electrolytic Chromium Chromium-oxide Steel). Coated ECCS is frequently used for the manufacture of can lids.

More generally the coating material can be applied to conversion layers, such as for example a layer of phosphate, and to metal layers, e.g. of tin (Sn), chromium (Cr), nickel (Ni) and iron (Fe), and alloys and combinations thereof.

The coating material applied may be dissolved preferably in an organic solvent, and may also be diluted by means of thinning agent (diluent). The coating material to be applied may also be water-based, the water acting as the carrier of the coating material. In all these cases the solvent/diluent or the water may be driven off by heating the coated blackplate in a furnace, to obtain a dry layer of coating material with a corresponding dry coating weight.

The dry coating weight depends on the intended use of the coated blackplate. For drawn and wall-ironed cans, a dry coating weight of 5 g/m^2 or less will be sufficient. For deep-drawn cans, however, where the pre-coat is also the final coat, a dry coating weight of up to 15 g/m^2 may be specified.

If the blackplate is coil coated, the coiled strip is brought to a coating line, and there coated upon uncoiling.

The strip speed during coating should preferably be in the range of 100 to 450 m/min, and the dry coating weight of the coat of lacquer should preferably be in the range of 2 to 10 g/m^2.

A smooth applicator roll should preferably be used between the strip and the screen printing cylinder. The small points or blobs of coating material are then first deposited on to the applicator roll by the screen printing cylinder, and may run together (coalesce) to some extent before being transferred to the blackplate.

Screen printing may be used to apply a layer of coating material extending over the entire surface of the strip. The coating material may alternatively be applied in a pattern on the strip surface, in accordance with the parts to be taken from the strip later for the can production. In the latter case the strip surface between the pattern regions may be coated with an extra thin layer of coating material to preserve the strip surface until subsequent processing.

Discs, so-called blanks, for example, are taken from the strip thus coated, from which cans or lids for them are manufactured.

Although the strip can be coated on one side

only, the strip should preferably be coated on both sides in one operation by screen printing processes in accordance with the invention. In this way coated material is manufactured in an efficient way. The strip can be coated with coating weights which differ on the two sides of the strip, according to the desired coating weight on the inside and outside of the can.

The strip may be coated with coating compositions which differ on the two sides of the strip. In this case, the coating composition may differ in the type of coating material, in the quantity of solvent/diluent (thinner) etc.

Embodiments of the invention will now be described with reference to the drawing, in which:-

Figure 1 shows diagrammatically a process for coil coating of blackplate embodying the invention.

Figure 2 shows diagrammatically a known roller coating unit.

Figures 3A and 3B show diagrammatically a unit for direct and indirect screen printing respectively, suitable for use in the process illustrated in Figure 1.

Figures 4A to 4D inclusively are graphs of test results obtained in coating processes.

In the embodiment of the invention, schematically shown in Figure 1, a cold-rolled steel strip 1 is uncoiled from a coil 2 and fed to at least one screen printing unit 3 and/or 4, by which the strip is coated underneath and/or on top. By heating in a furnace 5, the coating is then dried, the solvent of the coating and the like being removed from the applied layer or layers of coating, and, if a thermosetting coating is used, the coating is cured. Finally the strip 1 is coiled into a coil 6.

Figure 2 shows a roller coating unit, known for coating cold-rolled steel strip for applications in civil engineering, comprising a smooth pick-up roll 7 dipping into the coating material in a pan 8. A doctor blade 9 scrapes off excess of coating material picked up by the roll 7. The material is transferred from the pick-up roll 7 to the passing strip 1 by an applicator roll 12. A backing roll 13 is provided on the other side of the strip.

In contrast, the invention employs a screen printing process.

The coating unit used in the invention may be a unit for direct screen printing, see Figure 3A, comprising a perforated rotary screen cylinder 10

and a doctor blade 11 within the cylinder for pressing the coating material through the ducts (perforations) onto the strip 1. The material is supplied to the interior of the cylinder.

The discrete portions of coating material applied to the strip by the screen printing unit spread out on the strip and run together to coalesce into a continuous and, at least locally, even coating layer which is subsequently dried and possibly cured, as described above.

Alternatively, indirect screen printing may be used, see Figure 3B. In this case an applicator roll 12 of a wear resistant synthetic material such as rubber, is suitably arranged between the perforated cylinder 10 and the strip 1. In this screen printing unit, the clots of coating material applied to the surface of the applicator roll spread out before they are applied to the strip, and may partly coalesce on the applicator roll.

In both cases, the strip is supported by a back-up roll 13 at the location of the coating units.

Two coating units for the two sides may be arranged one behind the other in the direction of strip transport, as shown in Figure 1, but they may

alternatively be opposite each other (not shown). In this case the strip is supported by the opposed coating units instead of by back-up rolls.

Figure 1 shows diagrammatically a linear strip path; in practice an S-shaped strip path is frequently used in screen printing.

Using a coating line of the type shown in Figure 1, with roller printing and screen printing the following tests were carried out:

- coating by reverse roller coating
- coating by forward roller coating
- direct coating by means of screen printing
- indirect coating by means of screen printing.

With forward roller coating the strip 1 and applicator roll 12 move in the same direction as shown in Figure 2. With reverse roller coating this relative movement is reversed.

The test results are summarised in the following table, giving the strip speed, the weight of the dry layer produced and the viscosity of the coating material.

TABLE

Strip speed (m/min)	Weight of dry coating layer (g/m^2)	Viscosity DIN diam. 4 (sec.)
Reverse roller coating		
100	5.1	55
150	6.9	55
200	8.0	55
250	9.7	55
•		
100	3.6	32
150	4.6	32
200	5.3	32
250	6.3	32
250	3.8	23
Forward roller coating		
50	3.5	88
100	4.7	88
150	6.0	88
200	7.1	88
50	2.0	47
100	2.9	47

150	3.6	47
200	4.0	47
250	5.1	47
50	1.7	33
100	2.3	33
150	3.0	33

Direct screen printing

20	2.3	50
50	2.7	50
100	2.3	50
150	2.4	50

Indirect screen printing

on blackplate

60	4.0	100
80	3.8	100
100	4.1	100

on ECCS

60	4.1	100
80	4.3	100
100	4.2	100
100	4.0	50

The test results are reproduced in Figure 4 graphically. In these graphs the strip speed is plotted along the horizontal axis and the coating weight is plotted along the vertical axis.

Figure 4A and 4B present the results of the reverse and forward roller coating. It is apparent that when coating by this method the coating weight increases with both strip speed and viscosity. Variations of coating weight arising from variations of strip speed and viscosity are difficult to control. Complicated, expensive control of the coating system is required. During the tests the pressing forces of the coating application system increased at high speeds. This led to failure of the coating application system at 250 m/min. Even if this difficulty could be eliminated by modifying the design, a range of high coating weights is still encountered at higher speeds. The possibility of obtaining lower coating weights using a low viscosity of the coating material, by adding a thinner, is less attractive because the product is made more expensive by the additional raw material costs, the energy required for expelling the thinner, and the extra installation required for processing the expelled thinner. Moreover,

environmental problems may arise. For the above reasons, therefore, roller coating is not suitable for the application in question, i.e. coating of blackplate for can production.

Figure 4C and 4D present the results of direct and indirect screen printing respectively. With this method of coating, a practically horizontal characteristic was found, with a much lower value for the coating weight than with roller coating. The coating weight is almost independent of the strip speed and viscosity of the coating material. By this printing technique, therefore, a coated product is obtained with a highly constant coating weight, regardless of strip speed variations and viscosity variations. The value of the coating weight is determined by the dimensions and mesh (pattern) of the ducts in the screen printing cylinder. As shown by the tests, a coating material with a very high viscosity can be used and very low coating weights can be obtained. During the screen printing tests, the maximum speed was only 150 m/min. There were no indications of possible difficulties at higher speeds.

CLAIMS:

1. Method of coil coating a layer of organic coating material onto a strip of blackplate or a substrate based on blackplate intended for use in the manufacture of cans and/or can parts, e.g. drawn and wall-ironed cans or deep drawn cans, wherein a screen printing process is used to apply the coating material to the strip in a manner such that a continuous coating layer is produced, the strip moving past the screen printing apparatus at a speed in the range 20 to 500 metres per minute, and the rate of application of the coating material corresponding to a dry coating weight in the range 1 to 15 g/m^2.

2. Use, in a process of coil coating a layer of organic coating material onto a strip of blackplate or a substrate based on blackplate intended for manufacturing cans and/or can parts, e.g. drawn and wall-ironed cans or deep drawn cans, of a screen printing process to apply the coating material to the strip in a manner such that a continuous coating layer is produced, the strip moving past the screen printing apparatus at a speed in the range 20 to 500 metres per minute, and the rate of application of the coating material corresponding to a dry coating

weight in the range 1 to 15 g/m^2.

3. Method according to claim 1 wherein the coating material comprises a thermosetting resin.

4. Method according to claim 1 or claim 3 wherein a smooth applicator roll transfers the coating material from a screen printing cylinder onto the strip.

5. Method according to any one of claims 1,3 and 4 wherein in the screen printing process the coating material is passed in discrete portions through a plurality of apertures in a screen printing cylinder, and said portions are subsequently united into said continuous layer on the strip.

6. Method according to claim 5 as dependent on claim 3 wherein the unification of the said discrete portions takes place at least partly on said applicator roll.

7. Method according to any one of claims 1 and 3 to 6 wherein the coating layer is of even thickness.

8. Method according to any one of claims 1 and 3 to 7 wherein the strip speed relative to the screen printing apparatus during coating is in the range 100 to 450 metres per minute and the said dry coating weight is in the range 2 to 10 g/m^2.

9. Method according to any one of claims 1 and 3

to 8 wherein the strip is coated on both sides in one operation.

10. Method according to claim 9 wherein the strip is coated with different coating weights on both sides of the strip.

11. Method according to claim 9 or claim 10 wherein the strip is coated with different coating compositions on both sides of the strip.

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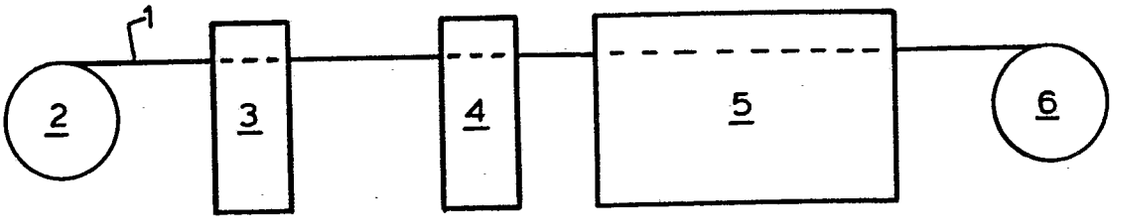

fig. 1

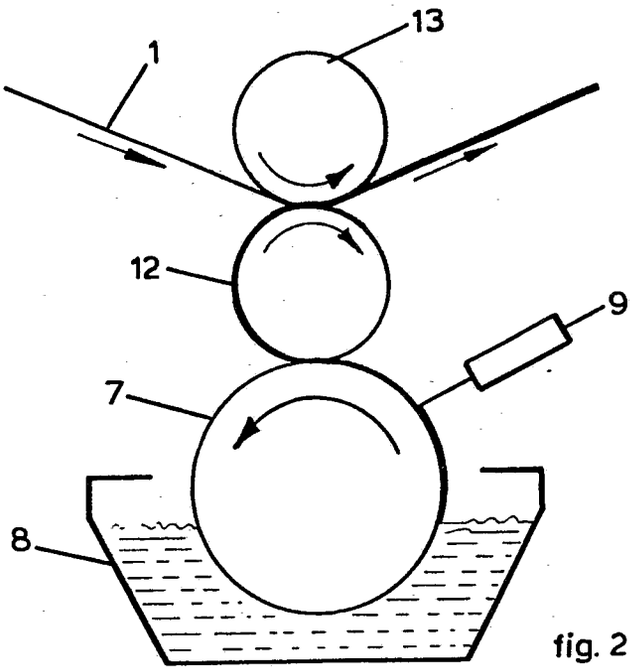

fig. 2

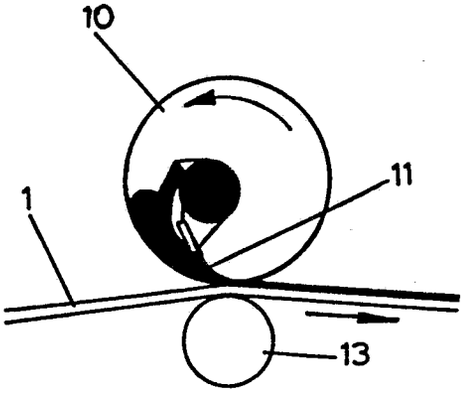

fig. 3 A

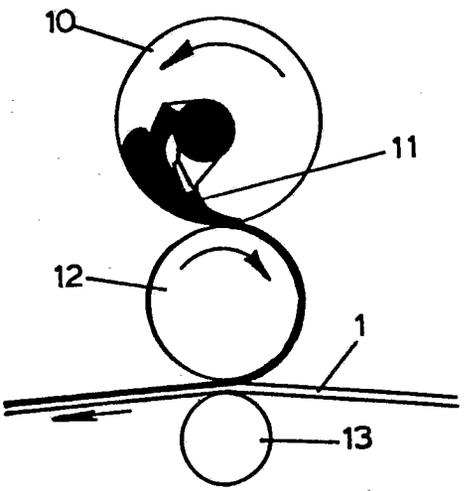

fig. 3 B

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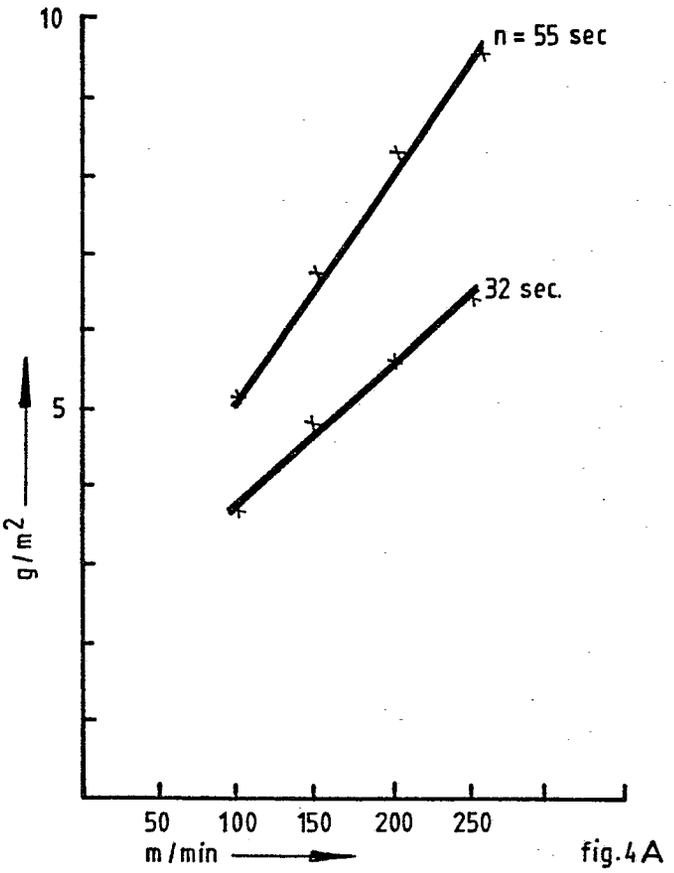

fig. 4 A

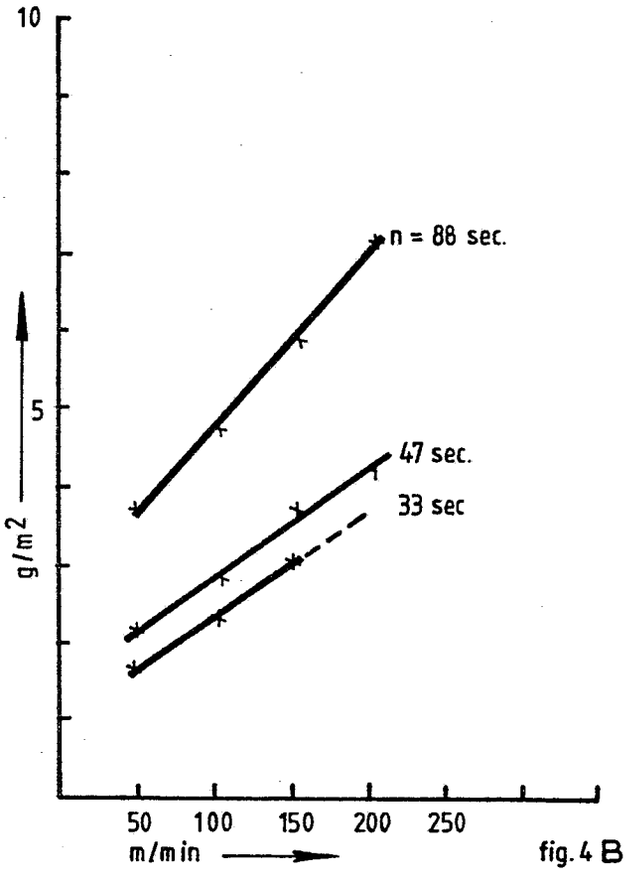

fig. 4 B

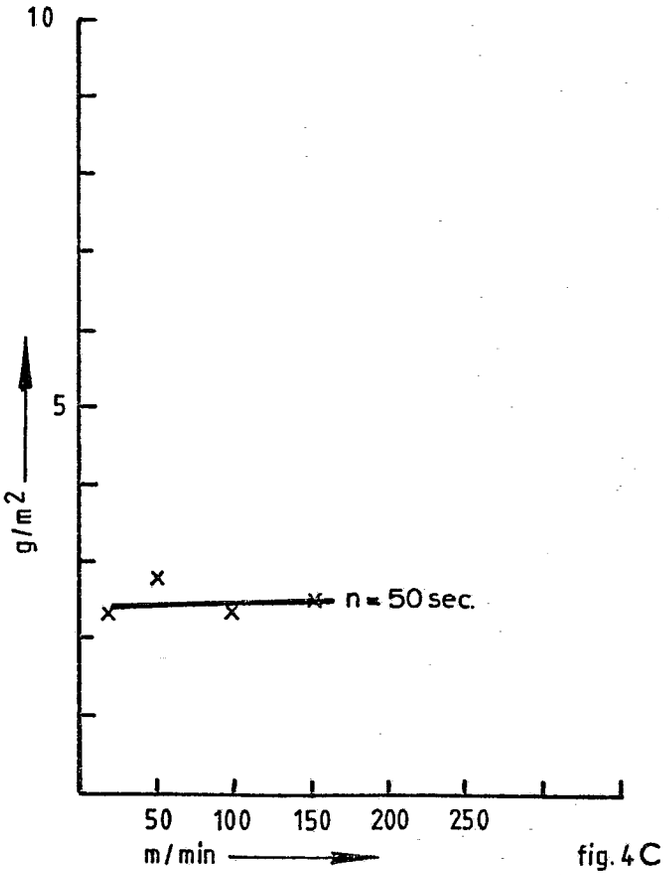

fig. 4 C

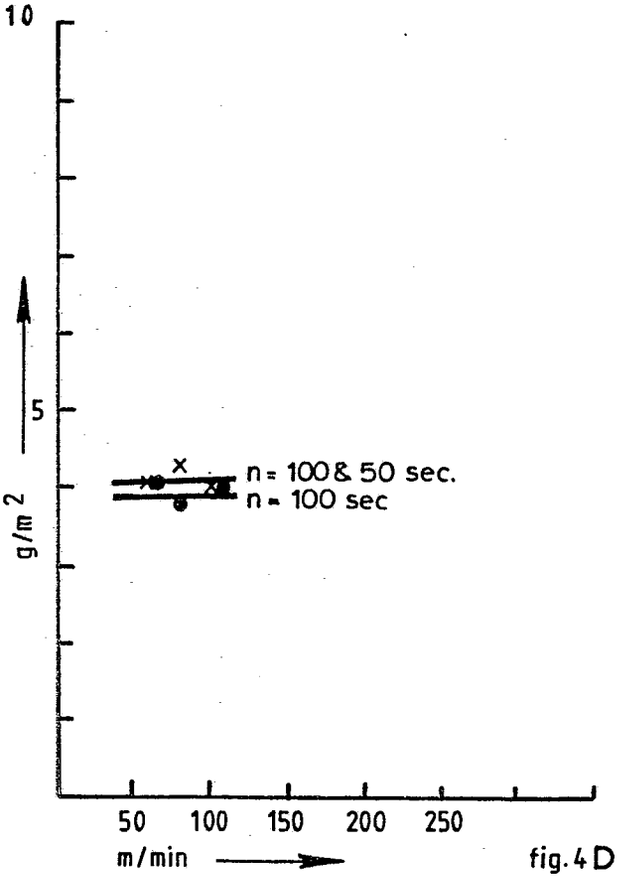

fig. 4 D

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EUROPEAN SEARCH REPORT

0195099
Application number

EP 85 10 3211

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int Cl 4)
Y	US-A-4 378 390 (M. YOSHIDA) * Column 1, lines 10-15; column 3, lines 19-66; column 5, line 65 - column 6, line 22 *	1-4	B 05 D 1/32 B 05 D 1/28 B 05 D 7/16 B 05 D 3/12
Y	FR-A-2 513 596 (P. BASUYAUX) * Page 2, line 20 - page 3, line 14 *	1-4	
A	FARBE & LACK, vol. 85, no. 9, September 1979, pages 744-748, Hannover, DE; E.V. SCHMID et al.: "Der Coil-Coating-Prozess von Leichtmetall " * Page 744, below - page 745, first column below *	1	
A	METALLOBERFLÄCHE, vol. 38, no. 5, 1984, pages 219-224, Munich, DE; K.-D. TÖLKE: "Qualitätseigenschaften bandbeschichteter Aluminiumoberflächen" * Page 219 *	1	TECHNICAL FIELDS SEARCHED (Int. Cl.4) B 05 D
A,D	US-A-4 032 678 (G.A. PERFETTI) * Column 2, lines 45-65; column 3, lines 44-54; example IV *	1,3,9	
A	FR-A-2 089 902 (STORK AMSTERDAM) * Page 3, lines 1-38 *	5	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	11-11-1985	FRIDEN N.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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