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(54) Process and means for making metal inking rolls, particularly for flexographic printing, with highly hardened superficial engraved layer, and rolls obtained with such process and means.

(57) A process for making metal inking rolls, particularly for flexographic printing, comprises: at least the selection of an ammonia hardenable material, particularly stainless, to provide the roll structure, the selection of a structure wherein the minimum thickness of the wall, when tubular, is a direct function of diameter and inverse function of the length, whereby, when supported at the ends and stressed in the middle, on a surface relatively distributed, may be permanently distorted in the axial attitude instead than transversely or at the cross- section; at least a post-engraving treatment to increase the surface hardness of the screen to at least 60 HRC and at least a final straightening step, to reduce the screen eccentricity at least to 0,02 mm.

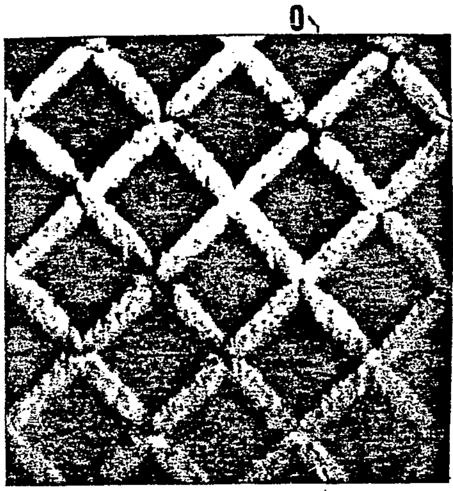

FIG.2

EP 0 304 047 A1

Process and means for making metal inking rolls, particularly for flexographic printing, with highly hardened superficial engraved layer, and rolls obtained with such process and means

The present invention relates to a process and means for making metal inking rolls, particularly for flexographic printing, which are precisely screened, with highly hardened superficially engraved layer, adapted to simplify and better their making,.as well as their function and duration characteristics Moreover, the present invention relates to rolls obtained with such process and means.

In the present state of the art, inking rolls are made in three substantially different ways. In accordance with a first conventional process, resulting in a product of very high initial quality, though decaying in a relatively short time, the roll are made of metal and the outer layers are, at first, mechanically engraved and then plated, with a layer of chrome, by galvanization The thickness of such plating layer cannot be thicker than a few microns (maximum 15), in order not to waste the unplated screen surface as engraved. This plating layer of chrome provides an hardness and an ink and/or solvent anticorrosion characteristic, drastically superior than that of the roll body. However, these rolls, have a life so short, as low is the thickness of the chrome plating thereon. In fact, in use, rolls are continuously, hardly engaged, by a metal doctor Such doctor, of course, wears the shart projections of the screen, which, being of reduced area, are subjected to very high specific pressures. This rubbing is strongly wearing and the very thin layer of chromium totalizing a small area has a life relatively short. The destructive effect of the doctor reached its top in case of an, even small, eccentricity. This dictated eccentricity tolerances lower than 20 microns, since even at this level bad inking occurs, resulting in correspondingly bad printing, even if the rolls are substantially new. This for two reasons: the first was that rolls are hardly doctored on the projecting side, which thus resulted poor of inking and secondly the corresponding rear surface, diametrally opposed, only scarcely adhered to the flexographic and to the doctor. Moreover, the phenomenon was progressive, since wearing of embankment of cell concavities, reduced, more and more, the ink capacity of cells.

Another known process, included a complicate provision of a ceramic covering on a cylindric, metallic, substratum; such covering was grinded and the screen was laser engraved. Laser engraving provided cells which were similar to those obtained from metal, though less precise, even if with more capacity. The ceramic covering layer had a thickness of 0,1 - 0,2 mm and was very hard, thus it had a much longer life than that of rolls obtained with the first process by a time factor from 5 to 10. However, the complications involved were such that the same cost was many times multiple than that of rolls of the first kind described, even if the engraving quality thereof was higher. Moreover, they were excessively fragile. It might happen that even a slight contact with a small metal piece a very small shock or the like could irreparably damage a very expensive roll.

In accordance with a third process: a substratum of steel was, galvanically plated with a layer of copper, having a thickness of about 0,5 mm; such plated roll was engraved with a pointed tool, made of diamond and provided with a go and back movement, controlled by an electronic device. This process provides a screen of cells with quality and characteristics substantially corresponding to those resulting from the first described process. Whereas, herein, the higher softness of copper imposed, even in this case, a galvanic plating with chromium, with the said defects pointed out hereabove.

The invention, as claimed, is intended to remedy these drawbacks. The inventor, with ingenious perception has conceived a simple and non expensive process, founded on a preparation step, which substantially repeats that of the first described process, but resulting in a longer life, substantially corresponding to that of the second process. Thus, the screen precision is maintained as provided by the engraving tool, not being any longer altered and compromised by the chromium plating and/or by deformations, due to impact of engraving tool, against a soft material, such as copper. In fact, in accordance with the present invention, the superficial hardening does not involve an additional layer, since it is provided inwardly, by nitriding, to hardness degree comparable with that of ceramic rolls, without having the fragility of same and at precision degrees strongly superior than those obtained with the three conventional processes.described In accordance with a preferred embodiment of the presente invention, a nitriding, particularly a low temperature.nitriding process, is employed It includes several arrangements pointed to keep the roll distortion to the minimum. Such reduced distortion, occurring despite of arrangement provided, is eliminated with a centering control device adapted to provide the necessary corrections, generally reducing them within the tolerance limits. The inventor is completely away of not having invented a nitriding hardening process, which is in itself known, though it is ascertained that such nitriding hardening was never used in screened inking roll production. In fact, such a process did not attain any result, as proved by the same inventor. The condition in which a heating treatment may be conceived, in relation to rolls of this kind, is that it is seen in an, ample and complete contest, wherein, selection and sizing of materials, engraving technologies and conditioning of materials and of their structural cycles, choice of the qualifying heating treatments and project of the important process steps, assiduous dimensional and shape testing and correcting interventions, study, realization and use of tools of working and testing, provide an, essential whole for the proposed result. Of course, some components of the whole are more important than others, however while it is certain that the concomitance, of all of them, gives the optimal result, any lacking, even of one of the, could be decisive, depending on the particular operating condition. Particularly important is the possibility of assiduously intervening, with testing and corrective means, to affect shape and centering, including a selection a low temperature nitriding hardening process, whereby deformations are eliminated or contained in a range easily controllable by the means according to the present invention. Such means includes substantially a machine, resulting from the combination of devices to support and rotate the roll and a bridge hydraulic press. Such means and bridge being mutually itineratable. A plant , mainly to control the descent, including a programmed and programmable electronic circuitry and operating in function of the eccentricity tested. In order to set the arrangement that the machine may operate the necessary corrections on the rolls to be provided, so that they result without induced and undesired distortions, it is necessary to make out it from a solid blank and/or project the wall thickness of the roll and operate the machine accordingly; above all in order that the axial straightness of the roll viz. the elimination of the undesirable eccentricity is not transformed into a local distortion of the section, in other words, in a deflection affecting the cross section and this for the very manufacturing purpose, since for use reasons they are not a problem. Whereas, such generous structure is not only undamageous to use but even advantageous to this respect.

Some ways of carrying out the invention are described, in detail, below through examples and with reference to drawings which illustrate specific embodiments thereof, in which:

EXAMPLE I

.As reference example, three lengths 1), 2) and 3) of nitridingable steel bars, respectively corresponding to 1) UNI 30 Cr, Mo 10; 2) UNI 40 Cd 4 , 3) UNI Lf 2, all of them having a diameter of mm 110 and a length of 1470 mm, to provide the same number of screened inking, rolls, for flexographic printing, having a diameter of 100 mm x 1170 mm. of length. Each of three lengths, was tempered, providing the following common procedure: heating to 1000° C., in air and tempering to 630° C., followed by cooling in an oven. Then, each of them was rough turned, to the diameter of 102 mm and the roll bosses were provided. At the end of rough-turning, a new stabilization was executed, providing the following heating procedure: heating to 600° C., with cooling in an oven. At the end of this cycle, each roll, was turned to size, with grinding finish, and its resistance was tested and resulted to be, for all of them, 75 Kg/cm^2. The pieces were submitted to grinding of the surfaces to be engraved. On such grinded surfaces the mechanical engraving was provided with a new die, characterized by a screen of 120 cells per linear centimeter, providing a pressure of about 10.000 Kg/cm^2, during about 10 hours; it was performed in a single running, at a speed of 20 r.p.m., with a die feeding pitch of about 80 micron. Upon engraving, the three engraved rolls were tested, for eccentricity: roll 1) had, in the middle of its length, an eccentricity of mm 0,35, the second one 2) an eccentricity of 0,07 mm and the third one 3) an eccentricity of 0,02. The first one (1) was momentarily discarded and the other ones were subjected to gaseous nitriding. Gaseous nitriding took place at a temperature of 500° C., during 15 hours, in a suitable oven, in an atmosphere of hydrogen nitrogen, with vertical hanging of the roll. Cooling took plate in an oven. Once cooled, their hardness was tested and resulted to be 60 HRC for roll (2) and 63 HRC for roll 3), i.e. substantially corresponding to the hardness of chromium plated conventional rolls. Then, the eccentricity was tested and resulting in roll 2) to be 0,12, and in roll 3) 0,075. The nitride and engraved surface was tested, in several points of the screen and it was appraised that both rolls, had changed their state, from shining and without pores, into opaque and porous. For the two reasons, resulted from testing, even these two rolls 2) and 3) had to be discarded; at any rate, at least for the important reason of the poor degree of finishing of the screen surface.

.EXAMPLE II

Two lengths 4) and 5) of nitridingable steel bars, respectively corresponding to 4) UNI LF 2; 5) UNI 31 Cr, Mo V 9, having a diameter of mm 110 and a length of 1470 mm, for providing two screened inking rolls, for flexographic printing, having a diameter of 100 mm x 1170 mm.were taken Each of two lengths was tempered, providing the following common procedure: heating to 1000° C., in air and tempering to 630° C. and successive cooling in an oven. Then they both were rough turned, to a diameter of 102 mm and the bosses thereof were provided. At the end of rough-turning a new stabilization was executed, providing the following heating procedure: heating to 600° C. with cooling in an oven. At the end of this cycle, each roll was turned to size, with grinding finish, and the resistance was tested and resulted to be in either cases 75 Kg/cm^2. The pieces were submitted to grinding of the surface to be engraved. On the so grinded surfaces a mechanical engraving was executed, with a new die, characterized by a screen of 120 cells per linear centimeter, with a pressure of about 10.000 Kg/cm^2, during about 10 hours, whereby a single running was executed, at a speed of 20 r.p.m., with a feeding pitch of about 80 micron. Upon engraving, the two engraved rolls were tested, for eccentricity: roll 4) had, in the middle, an eccentricity of mm 0,03, and roll 4) an eccentricity of 0,02 mm. In accordance with the present invention, both rolls were subjected to ionic nitriding. Ionic nitriding took place at a temperature of 400° C., during 11 hours, in a suitable oven, in plasma ambient, provided by a high intensity nitrogen with other filling current, with vertical hanging of the roll. Cooling took place in an oven. Once cooled the hardness of pieces was tested and resulted to be, 65 HRC for roll 4) and 65 HRC for roll 5), i.e. even higher than that of chromium plated rolls. The the eccentricity was tested and resulted to be for roll 4) 0,06, and for roll 5) 0,07. The engraved and nitride surfaces were tested, in several points of the screen, and it was appraised that both rolls, had changed attitude, which remained the same i.e. shining and without pores. Since the sole obstacle to qualify the rolls in a high quality range was their lack of precision, both rolls were subjected to straightening, in accordance with the present invention. Such straightening of the two rolls reduced their eccentricity: for roll 4) to 0,015 mm and for roll 5) to 0,018 mm. Both rolls, were tested for printing and proved, firstly to be, even at the beginning of the use, better than plated conventional rolls, though subjected to a very slow degradation due to a slight oxidation and corrosion, though strongly contrasted by nitriding, as well as by an hardness not exceptionally high.

EXAMPLE III

According to a preferred embodiment of the present invention, two bar lengths 6) and 7) of stainless, ammonia hardenable steel, both with AISI 420 denomination, having a diameter of mm 110 and a length of 1470 mm, to provide two screened inking rolls, for flexographic printing having a diameter of 100 mm x 1170 mm.of length, were taken Each of two lengths was tempered, providing the following common procedure: heating to 1000° C., in air and tempering to 630° C, and successive cooling in an oven. Then, both were rough turned, to the diameter of 102 mm and the bosses were provided. At the end of rough-turning, either pieces, a new stabilization was provided, including the following heating procedure: heating to 600° C., with cooling in an oven. At the end of this cycle, each roll was turned to size, with grinding finish, and the resistance was tested and resulted to be 80 Kg/cm^2 in either cases. The pieces were submitted to grinding of the surfaces to be engraved. On such grinded surfaces a mechanical engraving with a new die, characterized by a screen, with 120 cells per linear centimeter, by a pressure of about 12.000 Kg/cm^2, during about 10 hours, whereby a single running was executed, at a speed of 20 r.p.m., providing a feeding pitch of about 80 microns. Upon engraving, each of the worked rolls was checked, gauging its eccentricity: the roll 6) had, in the middle, an eccentricity of mm 0,015, and roll 7) an eccentricity of 0,01 mm. In accordance with the present invention, either rolls were ionic nitrided. Ionic nitriding took place at a temperature of 400° C., during 9 hours, in a suitable oven, in a plasma ambient provided by a high intensity nitrogen with other filling, current, with vertical hanging of the roll. Cooling took place in an oven. Once cooled the pieces, its hardness was tested and resulted to be 72 HRC, equal in either cases, i.e. substantially the same than that of ceramic rolls. Then, the eccentricity of each was tested and resulted to be as follows: 0,04 mm in roll 6) and 0,03 mm. in roll 7). The nitrided and engraved surface was tested, in several points of each screen and it was appraised that both rolls, had not changed the previous state, which was still very bright, absolutely poreless and having a shape characterized by sharp corners and having perfect definition. Since the sole obstacle to qualify the rolls, in the range of those of very high quality, was the slight lack of precision, straightening of rolls, in accordance with the present invention, was provided. This working run operation improved the two rolls, so that they attained an acceptable tolerance, reducing the eccentricity to 0,01 mm in both rolls. Both rolls, were tested for printing and gave very high results both from the point of view of duration and inking flexibility, even in comparison with printing obtained from chromium plated rolls, i.e. completely without imperfections and in perfect constancy of results.

A comparison was made, between the data regarding conventional available rolls and the rolls obtained in accordance with the present invention and a mark of merit was given to the different features, which render appreciable an inking roll for flexography. With such data a table, table I, was drafted and is herewith set forth:

TABLE I

KIND OF INCISION	MATERIAL	TREATMENT				PRECISION	HARDNESS	ECCENTRICITY	LIFE	SCREEN FINISHING OR PRINTING	COST OR PRICE
		HEATING	GALVANIC	MECHANIC							
				INCISION	STAGHTNG						
LASER	CERAMIC	NO	NO	NO	NO	8	10	9	10	7-8	10
MECHANIC	Chrome(-Fe)	YES-NO	YES	YES	YES	8	6	8	6	8-9	2.5
MECHANIC	Chrome(-Cu)	NO	YES	YES	YES	8	6	9	6	8-8	3.5
MECHANIC	STEEL	YES	NO	YES	YES	9	9	9	9	9-10	7
MECHANIC	INOX STEEL	YES	NO	YES	YES	5	6	5	6	5-4	3

The marks of merit are substantially empirical but abundantly confirmed by practical testing. For example, the most significant mark, i.e. that of screen finishing and of printing quality gives a difference, between the conventional chromium plated roll and the preferred embodiment, in accordance with the present invention, of about 20%. in favour of the latter At this stage, in order to better explain the results and the operation of the straightening means, reference is made to the figures of the drawings, wherein: With reference to figures 1 and 2 attached showing:

Figure 1, a 250x micro-photography of a screen for a conventional inking roll for flexography, with 19600 cells/cm^2, of the kind obtained mechanically, on a steel substratum, with a chromium plating layer 15 microns thick.

Figure 2, a 250x micro-photography of a screen for an inking roll for .flexography, with 19600 cells/cm^2, of the kind obtained mechanically, on a stainless steel substratum, nitrided with the modality set forth in example III hereabove, thus in accordance with the present invention. It corresponds also to the challenge of merit set forth in the last line of table I.

Figure 3 a schematic front view of a bridge press for providing the straightening operation in accordance with the present invention and as set forth in the examples.

Figure 4 a side view of the press of Figure 3.

Referring now to figures 1 and 2, the cell sizes were surveied and it was remarked that effectively their capacity, of containing the ink or the like, emerging from the ratio 0-hollow/1-solid, is superior, in Figure 2, by about 20%, in comparison with Figure 1, confirming the difference of the mark given. Fromthe same survey, it is noted that the screen of figure 2, in accordance with the present invention, is sharper and neater, with more defined corners, less superficial cracks and thinner walls, in comparison with the conventional ones of figure 1, substantially corresponding to the second line of table I.

Before explaining the straightening operation, it must be pointed out that the same is possibile, at a condition that is effected on a roll, whose screen was already treated by nitriding, which treatment, in turn, may be used at a condition that are known the ways and means to eliminate constitutional eccentricity, as well as those resulting from the heat treatment. But even the straightening operation must be effective and providing a permanent distortion, in a direction exactly opposed to that wherein the rise occurs, substantially eliminating it. The condition, wherein such useful distortion results is that the action is provided through a surface, sufficiently large, in order not to damage the screen, and deforming the cross section of the roll locally, instead of eliminating or at least correcting, reducing it, the rise. The condition of not distorting the section, which would increase the problem instead of solving it, when the rolls are provided from solid rolls, is to use tubular blanks, whose wall thickness complies structure criteria. The minimum wall thickness, in tubular rolls, being direct function of the diameter and inverse function of the length, must be such that, when it is supported at both ends and stressed in the middle on a surface relatively distributed, may be permanently distorted in the axial attitude earlier than at the transverse or cross-section.

Referring now to figures 3 and 4 the straightening means will be described. They comprise: a frame 9, in the form of lathe bed, with longitudinal guides 90 and 91 alongside and thereon The side guides 90 are engaged by the arms 80 of the bridge press 8, comprising the pressing unit 8′ driven by pumping station 8″. The unit may slide longitudinally, on wheels 89, which rolls on the guides 90. On the upper guides 91 each of the stock units 7, 7′ may be slidden.therealong One of them, the unit 7, is a driver and includes a catchplate head 70, to rotate the roll (not shown) to be straightened, to test its eccentricity and localize it. The other unit 7′ is substantially a tailstock, but both have cylinder-piston units 77, 77′, connected to a pumping station (not shown). The roll, not shown, to be straightened, is shown mounted between the centers 6, and its eccentricity is tested in several points, drawing a suitable map. The control panel 5 of the machine, monitors such eccentricity and provides the control to correct it. The direct pressure on the roll is provided through a concave half bush, made of soft metal such as copper.

Claims

1. Process for making metal inking rolls, particularly flexographic printing, of the kind comprising a structure completely made of steel, with screen mechanically engraved, by a die, subject to conventional preparation of at least superficial layers, including, both from mechanic, and heating treatment point of view, the screen, characterized in that it comprises: at least the selection of an ammonia hardenable material, particularly stainless, to provide the roll structure, the selection of a structure wherein the minimum thickness of the wall, when tubular, is a direct function of its diameter and inverse function of its length, such that, when supported at the ends and stressed, in the middle, on a surface relatively distributed, may

be permanently distorted in the axial attitude instead than at the transverse or cross- section; at least a nitriding step post-engraving, to increase the surface hardness of the engraved screen to at least 60 HRC and finally at least a step of straightening, to correct the eccentricity at least to 0,02 mm.

2. Process for making metal inking rolls, particularly flexographic printing, as claimed in claim 1, characterized in that the selection of ammonia hardenable steel is made among the stainless steels capable of reaching, through nitriding, a surface hardness of at least 60 HRC

3. Process for making metal inking rolls, particularly for flexographic printing, as claimed in claim 2, characterized in that the ammonia hardenable, stainless steel, is capable of attaining, through nitriding, a surface hardness up to 77 HRC.

4. Process for making metal inking rolls, particularly for flexographic printing, as claimed in claim 3, characterized in that an ammonia hardenable, stainless steel bar, with 420 AISI.denomination, is used

5. Process for making metal inking rolls, particularly for flexographic printing, as claimed in claims 3 and 4, characterized in that the austempering preliminary to rough-turning occurs providing the following procedure: heating to 1000° C., in air and tempering at 630° C. and successive cooling in an oven.

6. Process for making metal inking rolls, particularly for flexographic printing, as claimed in claims 3, 4 and 5, characterized in that stabilization post-rough turning occurs providing the following heating procedure: heating to 600° C., and quenching in an oven.

7. Process for making metal inking rolls, particularly for flexographic printing, as claimed in claims from 3 to 6, characterized in that the mechanical engraving with die, occurs with a pressure from 6.000 to 20.000 Kg/cm^2, respectively for screens included in a range between 3 and 220 cells per linear centimeter.

8. Process for making metal inking rolls, particularly for flexographic printing, as claimed in preceding claims, characterized in that a roll is made out from a solid bar and/or, if tubular, its wall thickness is projected as direct function of diameter and inverse function of length, so that when supported at both ends and stressed in the middle on a surface relatively distributed, may be permanently distorted viz. straightened in the axial attitude instead of at the transverse or cross- section.

9. Process for making inking rolls, particularly for flexographic printing, as claimed in claim 1, characterized in that the ionic nitriding process is employed.

10. Process for making metal inking rolls, particularly for flexographic printing, as claimed in claim 9, characterized in that a low temperature ionic nitriding process is employed.

11. Process for making metal inking rolls, particularly for flexographic printing, as claimed in claim 10, characterized in that ionic nitriding is executed at a temperature of 400° C., during 9 hours, in a suitable oven in a plasma ambient provided by a high intensity nitrogen with other filling current, with vertical hanging of the roll, the quenching being made in an oven.

12. Process for making metal inking rolls, particularly for flexographic printing, as claimed in claim 1, characterized in that straightening process occurs scanning the position and size of any eccentricity and providing a distorting pressure of at least 100 tons in the middle of the roll supported at the ends, through a large halfbush made of soft metal such as copper or the like.

13. Process for making metal inking rolls, particularly for flexographic printing, as claimed in claim 1, characterized in that the straightening process occurs with a testing and correcting instrument operating on the shape and centering including substantially a machine, resulting from the combination of means (6, 6′, 7, 7′, 70, 77, 77′) to support and rotate the roll and a bridge hydraulic press (8), wherein the bridge (80) is mutually itineratable and a plant, mainly to control the descent, including a programmed and programmable electronic circuitry (5) and operating in function of the eccentricity tested resulting in a permanent deformation of the roll axis, is provided.

14. Means for making metal inking rolls, particularly for flexographic printing, characterized in that for straightening a bridge press (8) is employed, comprising at least a frame (9), in the form of lathe bed, with longitudinal guides (90 and 91) along its sides and on its top, wherein the side guides (90) are engaged by the arms (80) of the bridge press (8), comprising a proper press unit (8′), driven by a pumping station (8″), wherein the whole unit may be moved longitudinally on wheels (89), which rolls on bottom guides (90), while on the upper guides (91) may be slided each of two units (7, 7′) one of which (7) is a driver and includes a catchplate head (70) to rotate the roll to be straightened to test eccentricity and localize it and wherein the other unit (7′) is substantially a tailstock, both units being provided with devices (77, 77′) cylinder-piston, connected to a pumping station.

15. Metal inking rolls, particularly for flexographic printing, characterized in that they have a surface hardness up to 77 HRC, an eccentricity lower than 0,02 mm and a very bright and absolutely poreless engraved and nitrided surface, as well as a shape exactly corresponding to that engraved by the die, characterized by sharp corners, having a perfect definition and the same size (figure 2).

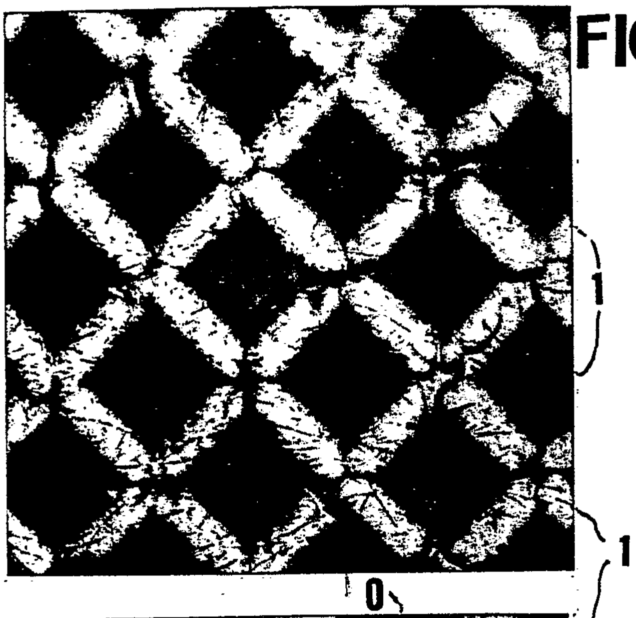

FIG.1

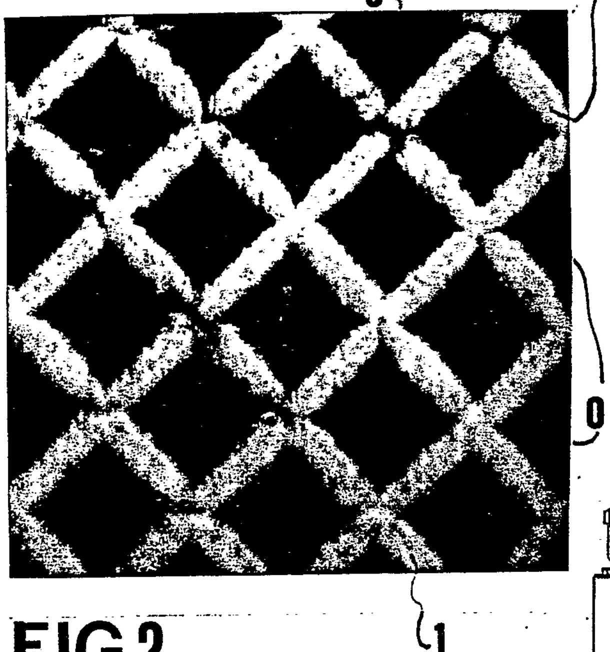

FIG.2

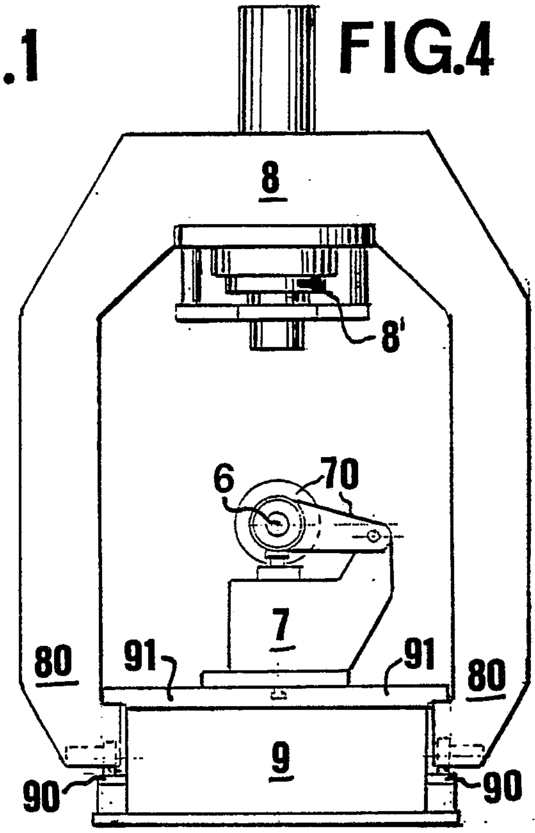

FIG.4

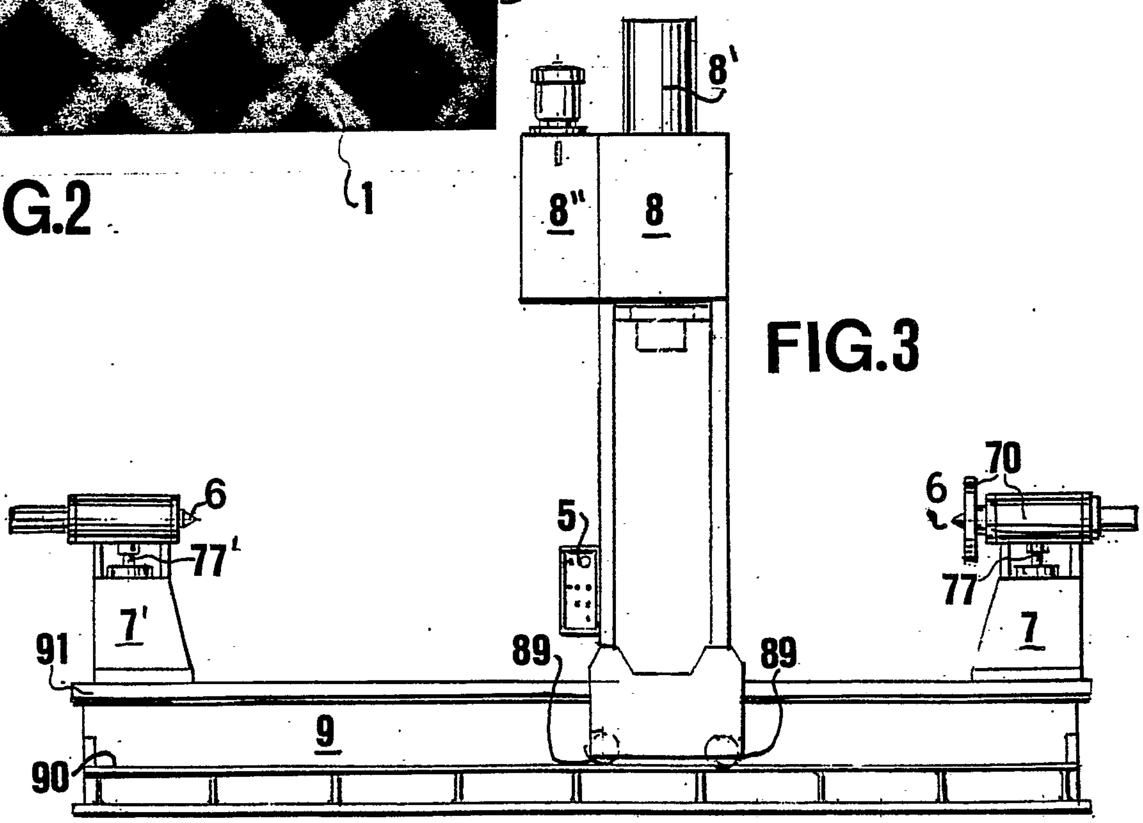

FIG.3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 88 11 3412

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-4 637 310 (M. SATO et al.) * Whole document * ---	1,15	B 41 N 7/00 C 21 D 9/38 B 21 D 3/10 C 23 C 8/36
Y	US-A-3 415 103 (C.H. CRAWFORD et al.) * Claims; figures; column 1 *	1,15	
X	 ---	14	
A	EP-A-0 190 391 (ROCKWELL INT.) ---		
A	US-A-4 537 127 (T.A. FADNER et al.) ---		
A	US-A-2 726 703 (W.W. FULTZ) ---	14	
A	US-A-4 124 199 (W.R. JONES et al.) ---	9-11	
A	GB-A- 877 675 (ELEKTROPHYSIKALISCHE ANSTALT BERNHARD BERGHAUS) -----	9-11	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

C 21 D
B 41 N
B 21 D
C 23 C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	15-11-1988	MOLLET G.H.J.

CATEGORY OF CITED DOCUMENTS

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