

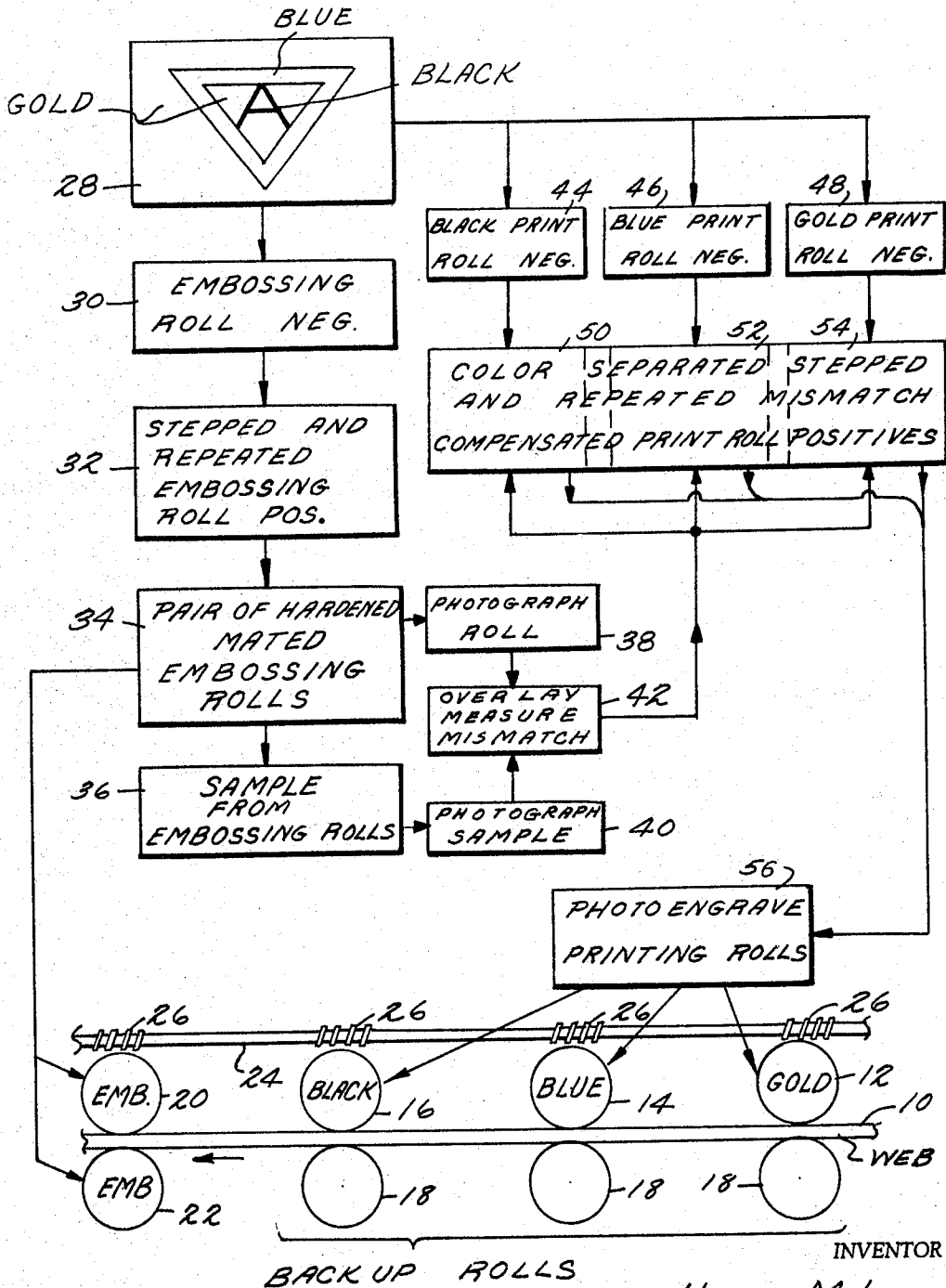
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MAKING ACCURATELY REGISTRABLE PRINTING AND EMBOSSEING ROLLS

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MAKING ACCURATELY REGISTRABLE PRINTING AND EMBOSSEING ROLLS

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This invention relates to the art of registering printing and embossing on a web, such as paper, supported or unsupported metal (e.g., aluminum) foil, paper-paper foil laminate, metal strips, etc., which is subjected to successively disposed and inline-operated printing and embossing rolls, and particularly to the making of such rolls so that their respective patterns will invariably register accurately on a web.

In the prior art, such as in the Roehm Patent 2,390,618, and in the Broderick Patent, 3,005,364, the printing rolls and embossing rolls are all made from respective films produced by a blanking-out or like process from a master art work to effect the desired separate patterns for each of the different colors to be printed and still a different one for the embossing roll or rolls. That represents a conventional way of effecting an engraving of printing and embossing rolls. In practicing such convention, however, it has been experienced that accurate registration between inline printing and embossing cannot be invariably obtained.

It has been determined that a real problem causing nonregistration between the printed and embossed patterns on a web, lies in the variations caused in the web during the embossing operation. One of the main variations in the pattern embossed on the web, as opposed to the embossing pattern itself, which is on the embossing roll, is due to web stretch in the axial direction of the embossing roll, i.e., transversely of the longitudinally traveling web. It has been discovered that this stretch may move the embossing out of register with the printed pattern as much as $\frac{1}{16}$ inch, which is beyond the commercially acceptable limits of embossing registration. Furthermore, it has been discovered that the amount of such stretch that will take place cannot be predicted. It is more evident on the deeper embossed patterns, rather than the more shallow ones. It has also been noted that the printing and embossing registration effected in accordance with the prior art, appears comparatively good at the transverse center of the web, but gradually increases from center outwards toward each edge, whereat the misregister may be as much as the previously mentioned $\frac{1}{16}$ inch, if not more.

As a further example of the transverse variation that may be experienced, consider the following situation. Assume a web is to be continuously printed and embossed with a plurality of labels, such as bottle labels, across its width. To effect such a web, the printing and embossing rolls are made the necessary length to accommodate the desired number of label engravings across the width of the roll surface. This may represent eight labels, for example, and there may be eight label engravings around the surface of the rolls, making a total of sixty-four per roll, for example. In engraving the label areas, each row thereof on a potential embossing roll is engraved to be aligned with a plane passing through the axis of the roll, i.e., is engraved to be aligned longitudinally on a radial plane. In this manner, the successive rows of labels embossed on a traveling web are caused to be perpendicular to the direction of web travel, as long as the web is not allowed to skew. However, the embossings resulting on the web, in each row, are stretched transversely progressively more from a central

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point outwards to each edge. This means that each label embossing is itself stretched slightly, and, also, as a whole, is moved outwardly. It is surprising to note, however, that any printing previously placed on the web by one or more printing rolls, does not stretch in the same manner. Consequently, the printing and embossing for each label in every row on the web, except for the central label or labels in each row, is out of registration, and progressively more so as the outer edges of the web are approached. It is therefore evident that any printing cylinder or roll, which is made in accordance with only the original art work and not also in accordance with such variations which result on an embossed sample, cannot cause printed labels which will invariably be registrable with the embossing produced by such embossing rolls.

It is a primary object of this invention to overcome such disadvantages of the prior art, that is to say, to provide an improved process for making printing and embossing rolls, with respective patterns that will invariably register on a web, which includes, in one embodiment, making an embossing roll with an embossing pattern on its roll surface, and then making with the aid of that roll the required number of printing rolls having on their roll surface a respective printing pattern substantially compensated for any stretch which the embossing roll may effect in its axial direction on the web, so that the printing and embossing patterns effected on a web by the so made rolls will invariably register accurately.

Other objects and advantages of this invention will become apparent to those of ordinary skill in the art upon reading the appended claims and the following detailed description of this invention in conjunction with the attached drawing which illustrates an embodiment of the invention in flow diagram form.

As the foregoing preamble indicates, it is desired to effect registered printing and embossing on web 10 by the respective printing rolls 12, 14 and 16, which respectively cooperate with their relatively smooth backup rolls 18, and the upper and lower mated embossing rolls 20, 22. Each of the printing and embossing rolls when produced in accordance with this invention and synchronously operated as diagrammatically indicated by a common shaft 24 and respective sets of worm gears 26 thereon, will cause the printing and embossing on web 10 as it exits from the embossing rolls to be in accurate registration, without any question.

To produce the printing and embossing rolls, use is made of a master art work 28 which normally contains just one sample of the design to be printed and embossed. In the particular piece of art work shown, several colors are indicated, the A being black on a gold background and surrounded by a double-lined triangle providing a triangular border which is in blue and to be raised relative to the remainder of the design. The problem, then, is to endeavor making the outer elevation change-line correspond exactly with the outer edge of the blue triangular border, and similarly for the inner edge of that blue triangular border. This problem has tended to be solved to some degree in the past, as suggested by the Roehm and Broderick patents above mentioned, but the process in each of these patents leaves something to be desired since by neither process will there knowingly be no variance in the registration of printing and embossing. On the other hand, with this invention, variance is eliminated and registration improved invariably.

In the process, the master art work 28 is photographed to effect a single negative 30 to be used for purposes of engraving an embossing roll. This single negative is first subjected to a step and repeat camera to effect a stepped and repeated positive 32, which is actually the positive

film used for engraving a relatively soft steel cylinder. This positive has the full number of repeated design areas across its width and down its length so as to fill the potential embossing cylinder around its circumference and across its face to the desired extent.

At this stage, any one of several procedures may be employed, the end point of each of which results in a pair of hardened mated embossing rolls 34. For example, the result of the step and repeat camera may be that contemplated in the Roehm patent above mentioned, meaning that a photoengraving procedure utilizing a carbon tissue etching process may be employed. On the other hand, any one of the different methods referred to in the above mentioned Broderick patent may be employed, i.e., the method he discloses and claims as well as the prior art methods discussed therein. Generally, it is desired to utilize the positive 32 to mark with an indexing scribe or the like the proper areas and outlines for each of the respective designs and engrave same deep enough to effect initial registration in the first embossing roll being made. Then, the embossing roll is completed in its engraving either by hand, or by a known die and mill method. In the latter, a single design is photoengraved and hand tooled into a die or relatively narrow length metal roller, which is then hardened and used to make a mill or male counterpart of that die. The mill may then be used either in a rolling manner to cover successive circumferential strips of the embossing roll being produced, or it may be employed to "bump" engrave that roll by rocking the mill back and forth on each successive die area of the embossing roll being made.

In any event, the embossing roll is fully engraved, hand tooling being employed to the degree desired, and then it is hardened. It is desirable if not necessary to harden the embossing roll not only because it itself is employed to make a mating embossing roll, if desired, as is usually the case, but also because in many instances the web is metallic and the pressure required between the finished embossing rolls 20 and 22 is sufficiently high to ruin the patterns on the embossing rolls if they are not fully hardened.

A conventional asphalt-resist-etch process such as fully set forth in the Sunderhauf et al. Patent 2,662,002, for engraving a second cylinder into an embossing roll which will mate with the first produced embossing roll may be employed, if a second embossing roll is required as it usually is. In some instances, however, it may be unnecessary to use anything other than a relatively smooth back-up roll instead of a mating embossing roll.

Once a second embossing roll is so engraved, it is then desirable to subject it to a heat treating process also, so that both embossing rolls will be substantially of the same hardness. This may bring forth the potential problem of distortion or the like being set up in the second embossing roll and tending to cause mismatch between the two embossing rolls. However, even if it does result, this may be obviated by running the two hardened embossing rolls together, face to face, in the best possible mating relationship, with an asphalt resist or the like therebetween, following with an etching to cause the two embossing rolls to be perfectly mated, as is well known in the art.

After making the pair 34 of hardened mated embossing rolls, they are placed in desirable apparatus, such as that described in the Sunderhauf et al. Patent 2,662,002, for purposes of producing a sample therefrom. In other words, a foil strip sheet, or other type web, is embossed to full depth by the pair of hardened mated embossing rolls 34 for a time sufficient to impress at least one row of the embossing designs for their full circumferential length and preferably for at least one full revolution of the rolls. This latter provides a sample 36 with a full impression of the whole embossing pattern determined by the embossing rolls.

Each of the plurality of embossed designs which appear in each row of the sample 36 generally correspond

to the respective embossing designs and rows thereof on the embossing rolls 34, but as previously indicated, the production of an embossing from such rolls causes the embossed designs to have variations when compared to the embossing designs on the embossing rolls themselves. More particularly, such variations in the embossing designs on sample 36 are due to stretch in the embossed sample pattern, in the direction of the row or rows thereon, i.e., axially with respect to the embossing rolls. More specifically, this transverse stretch in the embossed pattern on the sample is greater at the outer edges of a row of embossed designs than at the center of that row, the stretch increasing progressively from a minimum, which is negligible, if not zero, at the center, in the axial direction toward both edges to an intolerable maximum. Though only an embossed sample 36 on which no printing has been effected, is here being discussed as to the transverse stretch caused by the embossing rolls, it should be appreciated that such stretch would also be caused thereby in a preprinted web, resulting in the misregister problem. It is the main purpose of this invention to obviate any such stretch, since it produces results which cannot be tolerated nor compensated for in any conventional manner. I have discovered that such stretch itself is not intolerable but only the misregister that has previously resulted from such stretch. Accordingly, my approach to the solution of the problem is, in accordance with this invention, to recognize the stretch variation and let it occur as it will, but compensate for it automatically.

This invention compensates for such stretch by making the printing roll or rolls such that they incorporate approximately the same amount of variation as contained in the sample 36. Then, when the web is printed, the printing for the successive labels in each row from the center thereof will be positioned slightly farther outwardly than is conventional, so that the transverse stretch caused by the embossing rolls will place the embossing in accurate registration with the printed patterns. At first blush, it may be expected that the printed patterns would also be further stretched and moved farther outwards by the embossing rolls, but for some unexplainable reason this does not occur and the embossing registers accurately with the printing every time.

To cause the printing rolls to be so compensated, the embossed pattern on sample 36 is effectively compared with the embossing pattern on one of the embossing rolls 34 to obtain a measure of the difference in the positions of the effective embossing and embossed designs thereon. A convenient way of accomplishing this comparison is to effect an ink print, or preferably a photograph 38 of one of the embossing rolls, and a photograph 40 of the sample 36. Both of these photographs, then, of course, contain corresponding rows of embossed and embossing designs, and these are then centrally overlaid with a pairing of the respective designs of the two photographs being effected. The two photographs, by being centrally overlaid, are made to coincide at their central point, where it is known that they vary, but little, if any, due to the negligible stretch at the corresponding point in sample 36.

A measure of mismatch between the overlaid photographs 38 and 40 is then effected by conventional measuring techniques. In particular, the measuring may be such as to note the amount of variation from the central point to corresponding points on each of the paired designs in a row. The resultant mismatch 42 provides the required indication of how much the printing patterns need to be effectively stretched, i.e., moved outwards, on their respective printing rolls, in order to compensate for the embossing stretch, and effect the desired registration.

At this point, it may be indicated that, in accordance with prior art procedures, the master art work 28 is employed to make the respective negative films 44, 46, and 48 for the different colors involved. In turn, each of these negatives is then stepped and repeated to make a

respective multi-design positive. In making the positives, however, the measured mismatch 42 is employed in order to make those positives compensated for the mismatch, resulting in the color separated, stepped and repeated, mismatch compensated, print roll positives 50, 52 and 54. This compensation may be effected, for example, by causing each printing design in each row of the respective positive to be positioned in accordance with the position of the respective embossed design in the sample pattern of sample 36. To do this, the respective measures of mismatch 42 may be employed during the repeat operation in the making of each row of designs in each of the positives 50, 52 and 54, to indicate how far to the left or right the particular negative 44, 46 or 48 should be stepped to effect the resultant repeat-positive so that it will be at a position corresponding to the respective embossed design in the photograph 40. In this manner, none of the individual printing designs in any row of any of the positives 50, 52 or 54 is itself stretched, but its position relative to the longitudinal center line of the positive is farther outward than for the corresponding embossing design in photograph 38. In other words, the printing roll positives match the sample photograph 40 as best possible to give the best overall registration results between the printing and embossing.

The color separated films 50, 52 and 54 are then employed in step 56 in a conventional manner to photoengrave the respective printing rolls 12, 14 and 16.

As previously indicated, the printing patterns as engraved on the printing rolls from such compensated films will be stretched approximately in correspondence to the stretch given to the sample pattern 36 resulting from the production of a sample from embossing rolls 34. Since printing patterns made in accordance with this invention and applied to web 10 by printing rolls 12, 14 and 16 will not further stretch transversely while the web passes between the embossing rolls 22 and 32, the stretch in the embossed pattern will therefore be compensated for and will register accurately with the printing patterns.

Though it is preferable, for reasons well known in the art, to have the printing rolls precede the embossing rolls as shown in the drawing, the arrangement may be reversed if desired and the printing and embossing rolls when made in accordance with this invention will still cause accurate registration of their patterns on the web.

It is therefore apparent that this invention has provided a process which accomplishes the objects and has all the attendant advantages herein mentioned. Other objects, advantages, and modifications of the process will occur to those of ordinary skill in the art upon reading this disclosure and the appended claims, but it is to be realized that the foregoing description and accompanying drawing are to be interpreted as illustrative rather than limitative, the scope of the invention being determined by the appended claims in accordance with the spirit of this disclosure.

What is claimed is:

1. In the art of registering printing and embossing on a longitudinally moving web subjected to successively disposed printing and embossing rolls, the improvement in the process of making said rolls comprising the steps of making at least one embossing roll having an embossing pattern on its roll surface, and then making with the aid of the said one embossing roll at least one printing roll having on its roll surface a printing pattern substantially compensated for any stretch which said one embossing roll may effect in its axial direction on said web, whereby the printing and embossing patterns effected on said web will accurately register invariably.

2. In the art of registering printing and embossing on a web subjected to successively disposed printing and embossing rolls, the improvement in the process of making said rolls comprising the steps of making at least one hardened embossing roll having an embossing pattern on

its roll surface, producing from said hardened embossing roll a sample having a sample pattern corresponding to the said embossing pattern but stretched in the axial direction of the embossing roll, and making with the aid of said sample at least one printing roll having on its roll surface a printing pattern which is stretched in the axial direction of the printing roll in substantial correspondence with the said stretch in the sample pattern, whereby printing and embossing patterns effected on said web by printing and embossing rolls so made will invariably accurately register in said axial direction notwithstanding the production of stretch in that direction by the embossing roll.

3. In the art of registering printing and embossing a given design a plurality of times simultaneously across a longitudinally moving web subjected to successively disposed printing and embossing rolls, the improvement in the process of making said rolls comprising the steps of making at least one hardened embossing roll having on its roll surface in the axial direction thereof a plurality of embossing designs each of which corresponds to the embossed portion of said given design and totally effect an embossing pattern, producing from said hardened embossing roll a sample having a sample pattern including a plurality of sample designs respectively corresponding to the said embossing designs but stretched in the axial direction of the embossing roll, and making with the aid of said sample at least one printing roll having on its roll surface in the axial direction thereof a printing pattern including a plurality of printing designs each of which corresponds to a printed portion of the said given design and which are successively spaced apart in the axial direction respective distances which are further than for the corresponding embossing designs on the said hardened embossing roll, said distances being determined in accordance with the said stretch in the sample pattern.

4. In the art of registering printing and embossing on a web subjected to printing and embossing rolls successively disposed in the order named, the improvement in the process of making said rolls comprising the steps of making at least one hardened embossing roll having an embossing pattern on its roll surface, producing from said hardened embossing roll a sample having a sample pattern corresponding to the said embossing pattern but stretched in the axial direction of the embossing roll, determining mismatch due to the said stretch in said direction between the sample pattern and, at least effectively, the embossing pattern on said hardened embossing roll, and then making at least one printing roll with a printing pattern on its roll surface compensated axially for the determined mismatch, whereby printing and embossing patterns effected on said web by the so made printing and embossing rolls will invariably accurately register in said axial direction notwithstanding the production of any stretch in that direction by the embossing roll.

5. A process as in claim 4 wherein the step of determining mismatch includes photographing the embossing pattern on said hardened embossing roll, photographing the embossed pattern on said sample, overlaying the two photographs for central coincidence, and measuring the variations in mismatch at various points from the center outwardly in the said axial direction.

6. A process as in claim 4 for use in making printing and embossing rolls which will effect across said web repetitions of a given design having printed and embossed portions in register, wherein said making of the hardened embossing roll includes producing on its said roll surface, juxtaposed in said axial direction, a plurality of embossing designs each of which corresponds to the said embossed portion of said given design and totally represent said embossing pattern, said sample pattern being produced to include all the designs in said direction, said mismatch being determined by effectively causing coincidence of the sample pattern with the embossing roll pattern at a predetermined point while pairing the designs on the two patterns and noting the difference from that point in said

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axial direction to like points on at least some of the paired designs of the two patterns, the making of the printing roll then including disposing each of the printing designs, which correspond to the said printed portion of said given design and totally represent the said printing pattern, on the said roll surface of said printing roll juxtaposed in the axial direction thereof the same distance from a given point, which corresponds to said predetermined point on said sample, as the corresponding embossing design on the hardened embossing roll plus the respective said difference.

7. In the art of registering printing and embossing on a web subjected to successively disposed printing and embossing rolls, the improvement in the process of making said rolls comprising the steps of making a pair of hardened mated embossing rolls having an embossing pattern, producing from said hardened rolls a sample having said pattern embossed thereon, and then making at least one printing roll by compensating for mismatch between the pattern on said sample and the pattern on said embossing rolls to cause on said one printing roll a printing pattern which, when printed on said web and the web is subjected to said hardened embossing rolls, will invariably cause the resultant printed and embossed patterns on the web to register accurately.

8. A process as in claim 7 including the step of measuring in a direction axial with respect to the embossing rolls the variations between effective representations of the patterns on said sample and embossing rolls to obtain said mismatch.

9. A process as in claim 8 wherein the variations of said patterns on said representations are measured generally from the center thereof outward in said axial direction toward both edges.

10. In the art of registering printing and embossing on a web subjected to synchronously driven printing rolls and a pair of mating embossing rolls successively disposed in the order named, the improvement in the process of making said rolls comprising the steps of engraving a first cylinder with an embossing pattern, including a plurality of axially juxtaposed embossing designs each of which is representative of the part to be embossed of an overall design taken from a master matrix, to effect a first embossing roll, heat hardening said first embossing roll, en-

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graving a second cylinder with said first embossing roll to effect a second embossing roll mated to the first, heat hardening the second embossing roll to effect with said hardened first embossing roll the aforesaid pair of mating embossing rolls, producing from said hardened pair of embossing rolls by matingly rolling same together for at least one full revolution under a predetermined amount of pressure an embossed sheet having a full embossing impression resulting from the said full revolution and containing a plurality of embossed designs respectively similar to said embossing roll designs but stretched in the axial direction thereof increasingly from the center outwardly, photographing said embossed sheet to provide a photograph of the said full impression of the embossed designs, photographing one of said embossing rolls to provide a photograph of the embossing designs thereon, centrally overlaying and pairing the designs on said photographs to obtain measurements of stretch from center axially outward of each design in the photograph of the said sheet, utilizing said stretch measurements in conjunction with said master matrix to make the required number of films containing a plurality of printing designs disposed to compensate for the said embossing stretch, and photoengraving respective cylinders with said films to produce printing rolls with respective patterns which when printed on said web and the web then properly subjected to said hardened embossing rolls, will invariably cause the resultant printed and embossed patterns on the web to register accurately.

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