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METHOD OF PRODUCING MATCHING EMBOSSING ROLLS

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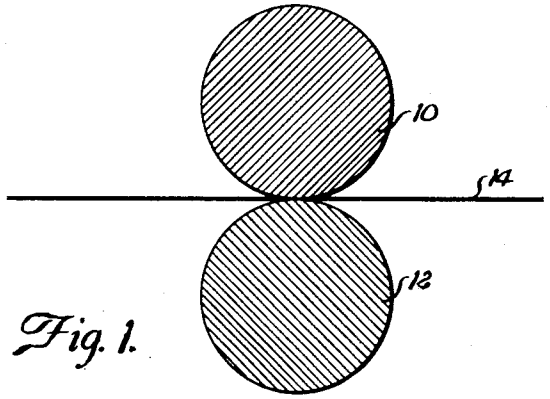


Fig. 1.

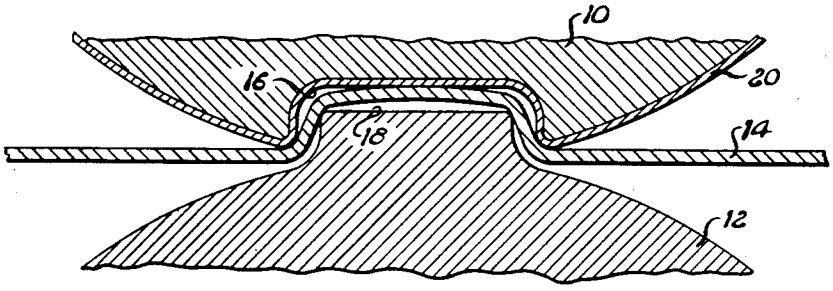


Fig. 2.

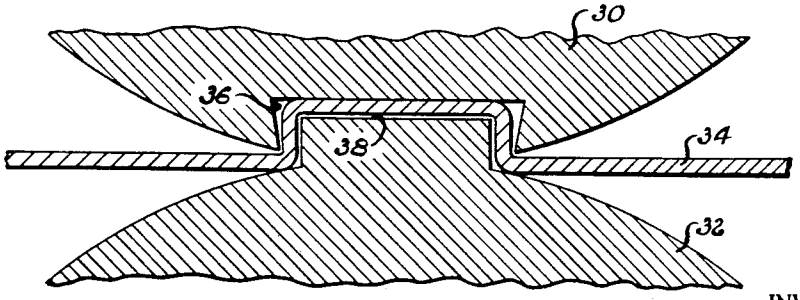


Fig. 3.

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METHOD OF PRODUCING MATCHING EMBOSSING ROLLS

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This invention relates to photoengraved embossing rolls and to methods of producing such rolls.

Photoengraved embossing rolls have become increasingly important in recent years in the manufacture of decorative labels and wrappers made of thin paper or metallic foil for use in the packaging field. Such rolls comprise a pair of cooperating steel cylinders having mating decorative surfaces formed on their peripheries, one of said rolls constituting the male member, having the decoration impressed thereon in the form of minute projections, and the other roll constituting the female member, having corresponding recesses. Photoengraving is generally considered to be the most accurate and the cheapest method of forming the decorative embossing surfaces on such rolls. Conventional photoengraving methods involve the steps of sensitizing the surface of the roll intended to become the female, photographically transferring the desired design to said sensitized surface, and repeatedly applying chemical etching agents to the surface of the steel roll to impress the desired design thereon by gradual erosion in the sensitized areas affected by the photographic transfer treatment. After the decoration of the female roll is completed, the other roll is mated thereeto to form the male decoration thereon by the usual methods involving pressure transfer of the design through a waxy acid resist coating followed by repeated etching of the male roll.

Although photoengraved embossing rolls produced in this manner posess many recognized advantages, one serious disadvantage of such rolls is the fact that the etching operation tends to produce sharp, undercut edges on the female roll and corresponding sharp edged projections on the male roll. Furthermore, in rolls made by the above described method, there is no clearance provided at the bottom and sides of the female cavities and the corresponding male projection. Consequently, when such rolls are employed for the decoration of very thin paper or metallic foil, the rolls have a highly objectionable tendency to cut entirely through and tear the sheet being embossed.

An object of the present invention is to provide new and improved photoengraved embossing rolls, and methods of producing such rolls.

Another object of the invention is to provide photoengraved embossing rolls with sufficient clearance between the mating decorative surfaces of such rolls to prevent objectionable cutting of thin sheets being embossed.

Still another object of the invention is to eliminate substantially all sharp edges from the etched surfaces of photoengraved embossing rolls.

Other objects and the nature and advantages of the instant invention will be apparent from the following detailed description, taken in conjunction with the accompaying drawing, wherein:

FIG. 1 is a vertical sectional view of a cooperating pair of photoengraved embossing rolls embodying the present invention, embossing a thin sheet of material being advanced therebetween;

FIG. 2 is an enlarged fragmentary vertical sectional view of the meeting portions of the rolls shown in FIG. 1, and

FIG. 3 is a view corresponding to FIG. 2 of a pair of embossing rolls representing the known prior art.

In accordance with the present invention, the first operation performed in the production of a pair of mated rolls from a pair of similar perfectly smooth steel cylinders is the formation of the female roll by standard photoengraving methods. In the usual manner, this operation involves the application of a light-sensitive coating to one of the rolls, transferring the desired design to said coating from a previously prepared photographic plate, removing the unaffected portions of the coating from the roll, and repeatedly etching the surface of the roll to impress the design therein. In the usual methods practiced heretofore, the female roll would be considered to be completed at this stage of the operation, and the next step would involve the formation of the male roll therefrom.

The next operation, in accordance with the present invention, is the deposition of a thin layer of a hard material, such as an electroplated coating of metallic chromium, covering the entire periphery of the female roll including the etched cavities therein. For this purpose, the thickness of the electroplated chromium layer is so thin that it does not mask or otherwise diminish the effective depth of the etched cavities which it covers on the surface of the female roll.

The next operation, in accordance with the present invention, is the formation of the male roll by transferring the design from the chrome plated female roll. This transfer operation may be accomplished by conventional methods. The blank male roll and the chrome plated female roll may be mounted rotatably in a standard transfer machine with the female roll positioned directly above the male roll and separated therefrom by about one-half inch. A thin layer of a waxy, acid resist composition coating may then be applied uniformly over the peripheral surface of the blank male roll. Then the two rolls may be brought together under sufficient pressure to squeeze the resist coating away from all areas of the bottom roll except those portions which are contacted by the etched pattern in the upper female roll. The pressure is continued while the rolls are rotated in contact with each other, and the upper female roll is repeatedly wiped clean of the acid resist which has been picked up from the lower male roll. When no more wax is picked up from the male roll, the pattern of the cavities on the upper female roll will appear on the lower male roll as minute projections in a corresponding printed pattern. The two rolls may now be separated to allow the male roll to be dipped into a chemical etching bath which may contain a mixture of acetic and nitric acids. The etching bath eats away a minutely thin layer of the entire peripheral surface of the steel roll except in those areas which are coated by the acid resist pattern. This etching operation may be repeated as many times as is necessary to remove a sufficient thickness of metal from the uncoated surface of the male roll to accomplish proper mating of the two rolls.

Now the chrome plated female roll is subjected to a deplating operation to remove at least a portion of the metallic chromium surface layer therefrom. Since the projecting pattern on the male roll should have been perfectly mated with the corresponding recessed pattern on the female roll prior to the deplating of the chromium layer from the female roll, the removal of the chromium from the female roll results in the provision of clearance between the projecting portions of the pattern and the corresponding recesses at the sides and bottom thereof. The thickness of the chromium layer removed in the deplating operation determines the amount of clearance provided. All or only a portion of the chromium layer may be removed from the female roll to satisfy this purpose.

Although the primary purpose of the chromium coat-

ing on the female roll is to provide the desired clearance between the mated portions of cooperating embossing rolls made in accordance with methods embodying the present invention, the chromium plating and deplating of the female roll also fulfills other important purposes. The plating and deplating operations tend to round off and substantially minimize or eliminate any sharp edges from the etched surfaces of the rolls. For this reason, it may be considered desirable to replate the female roll with a minutely thin layer of chromium subsequent to the previously mentioned deplating operation, while still retaining the desired clearance attained. Likewise, it may sometimes be considered desirable to place a thin layer of chromium onto the male roll in order to assist in reducing any sharp edges in the projecting pattern etched thereon. Ordinarily, the reduction of sharp edges by the plating and deplating operation is most noticeable in the case of the female roll when it alone receives the chromium coating. However, due to the fact that the male and female rolls are perfectly mated, both rolls benefit in the reduction of sharp edges thereon. Incidentally, another important purpose served by the retention of a thin layer of chromium on either one or both of the completed embossing rolls is the provision of a hard, wear-resistant surface capable of repeated use without any substantial deterioration of the pattern thereon.

Embossing rolls embodying the present invention are particularly useful for the embossing of thin papers, metallic foil, or thin sheets made of plastics or textiles which require only very light pressure, equivalent to practically no pressure, to accomplish embossing thereof. Under such circumstances, it is unnecessary to provide the embossing rolls with an extra wear-resistant coating, and it is contemplated that ordinary prehardened steel rolls are sufficiently wear-resistant. Hence, the specified chromium plating and deplating operations are essential to the present invention principally to provide the desired clearances and to round off any sharp edges on the etched patterns.

Referring now to the drawings, FIGS. 1 and 2 show a pair of cooperating superposed embossing rolls **10** and **12** embodying the present invention. The roll **10** is the female and it is positioned directly above and adjacent to the roll **12**, which is the male. The rolls **10** and **12** are in embossing engagement with opposite sides of a thin sheet of material **14**, such as paper or metallic foil, shown being advanced therebetween during simultaneous rotation of the rolls at equal speed. As is best shown in FIG. 2, at the adjacent portions of the peripheries of the rolls the upper female roll **10** is provided with a cavity **16** which constitutes a fragment of the female pattern etched therein, while the lower male roll **12** is provided with a protuberance **18** constituting a fragment of the male pattern. It should be observed that there are no sharp edges on the walls of the cavity **16** or the protuberance **18**, and the curved portions thereof are definitely rounded with a curvature of relatively large radius. Likewise, it should be observed that the sheet of material **14** has been bent to conform to the configuration of the mated cavity **16** and the protuberance **18** and the bent portion of the sheet **14** at all points possesses a curvature of relatively large radius. Furthermore, there is an appreciable amount of clearance between the protuberance **18** and the corresponding portions of the sides and bottom of the cavity **16** through which the sheet of material **14** extends. Due to this improved arrangement, the embossing rolls **10** and **12** embodying the present invention bend the sheet of material **14** to effect embossing thereof without cutting or tearing such sheet.

A thin layer of metallic chromium **20** may, in some instances, be allowed to remain on the peripheral surface of the upper female roll **10** following the deplating thereof to obtain the desired clearances. Whether or not this layer **20** is present in the completed female **10** depends upon whether it is necessary to remove the entire thickness of the chrome layer to obtain the desired clearances between the cavity **16** and the protuberance **18**. Of course, as has been previously stated, in some cases it might be considered desirable to apply the thin layer **20** of chromium following the deplating operation in order to assist in minimizing the presence of any sharp edges in the cavity **16**, and for similar reasons a thin layer of chromium (not shown) may be applied to the completed male roll **12**.

In order to demonstrate visually some of the advantages of the methods and products embodying the present invention, there is shown in FIG. 3 a pair of ordinary embossing rolls **30** and **32** which are representative of the known prior art. A sheet of material **34** is shown being embossed by being advanced between the rolls **30** and **32** during simultaneous rotation thereof. The upper female roll **30** is provided with an etched cavity **36** constituting a fragment of the female pattern, and the lower male roll **32** is provided with a corresponding protuberance **38** constituting a fragment of the male pattern. It is important to notice that the side walls of the cavity **36** are slightly slanted away from the open side of the cavity. This slanting effect is caused by the natural tendency of acid etchants to undercut the surfaces they etch. Undercutting of the side walls of the cavity **36** leaves it with sharply pointed outer edges, and similar sharp edges are formed on the corresponding portions of the protuberance **38** due to the fact that this protuberance is made by transfer mating from the female roll **30**. No substantial amount of clearance exists between the protuberance **38** and the sides and the bottom of the cavity **36**. Consequently, the embossing rolls **30** and **32** exhibit an undesirable tendency to cut and tear the sheet **34** during embossing thereof.

Chrome plating of the female embossing roll, in accordance with the present invention, is thus effective to provide the needed working clearance between the mated embossing rolls, and to minimize or substantially eliminate any sharp edges on etched surfaces. Although the invention has been described with particular reference to photoengraved embossing rolls, it is evident that the invention may be applied advantageously in the production of embossing rolls made by methods other than photoengraving, such as mill and die engraving methods, since the problem of providing clearance also exists in the case of such other rolls.

It will be obvious to those skilled in the art that various changes may be made without departing from the spirit of the invention and therefore the invention is not limited to what is shown in the drawings and described in the specification but only as indicated in the appended claims.

What is claimed is:

1. A method of producing the matching surfaces of a pair of cooperating, cylindrical male and female embossing rolls comprising the steps of:

(*a*) forming on the peripheral surface of said female roll an etched, recessed undercut pattern having relatively sharp edges;

(*b*) depositing a thin coat of hard, wear-resistant metal on the peripheral surface of said female roll and in said recessed pattern, filling said undercut edges, maintaining the effective depth of said recessed pattern and substantially rounding off said sharp edges;

(*c*) forming on the peripheral surface of said male roll an etched male pattern complementary to said recessed female pattern including said rounded off edges;

(*d*) deplating said female roll and providing a predetermined clearance between said complementary patterns on said rolls and maintaining said rounded off pattern edges on said female roll pattern.

2. The method of claim 1 including the step of:

(*e*) replating the peripheral surface of said female roll to preserve the rounded off edges of the recessed pattern thereon.

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