ABSTRACT: The disclosure sets forth a flexographic printing procedure utilizing metering rolls for flexographic processing, which metering rolls produce tone and color process printing of consistently and uniformly high quality throughout one press run and also from one press run to another. These metering rolls, which have from 250 to 600 cells per inch in any direction or from 62,500 cells to 360,000 cells per square inch of surface have a mean of about 160,000 cells per square inch of surface area. These cells are smaller in area than the smallest highlight dot produced by engraving. The recess is quite shallow, having a maximum depth of about 12 microns or less than one-half thousandth of an inch. The shape of each cell is essentially that of a hemisphere, with polished, smooth walls.
INK METERING ROLL FOR USE INTERMEDIATE A FOUNTAIN ROLL AND A PRINTING ROLL

DESCRIPTIONS OF THE INVENTION

The present invention relates to a flexographic printing procedure and it particularly relates to a flexographic printing procedure having special metering rolls for transferring the ink from the supply to the printing plate or roll. It has been quite difficult in flexographic processes to print quality one color halftone reproductions with graduated tonal or density values, and it has been found more difficult to print three and four color process reproductions in full, lifelike color.

These reproductions, whether in halftone or multicolor, are not of desired quality and involve considerable time, are quite costly, and result in much waste because of lack of uniformity during a single run and lack of reproducibility from one run to another.

It is among the primary objects of the present invention to provide an enhanced flexographic printing procedure in which it will be possible to print high quality one color halftone reproductions with graduated tonal and density values and three and four color process reproductions of many subjects in full, lifelike color, with a minimum expenditure of time, money and waste.

Another object is to provide a flexographic printing procedure which will give high uniformity in halftone reproductions, as well as color process reproductions, not only in a single run but also from one run to another. In many flexographic procedures for producing one color halftone reproductions, as well as multicolor reproductions, there has been an undesirable moire effect, particularly where one or more colors are printed, due to the conflicting angles of the screen on the typographical rubber printing plate and those on the surface of the mechanically engraved ink metering roll which supplies the ink to the printing surface of the plate.

It is therefore a further object of the present invention to produce a flexographic printing procedure which will largely or substantially eliminate this moire effect with the production of high quality of flexographic single color, as well as multicolor reproductions, which may be produced on a routine production basis by flexographic printing without special procedure and at a minimum of cost.

It is among the still further objects of the present invention to provide a procedure for producing single color and multicolor pictorial reproductions by flexographic printing, which, with maximum economy, versatility and efficiency, will make use of the very fast drying characteristics of flexographic inks, permitting ready impression of transparent, flexible and extensible cellulose and plastic films which may be readily printed up to six or more colors in perfect register, dried and rewound and converted into bags, wrappers and the like at high speed, up to 1000 feet per minute.

A particular advantage of the present invention resides in the fact that it is possible to print a display of the goods enclosed while providing maximum protection to the contents with a full color illustration of the contents appearing upon the bag or wrapper, as the case may be, or to display the goods after use or preparation where in many cases the goods themselves are not of maximum attractiveness in their raw or semiproccessed state.

This is particularly important where illiterate or alien shoppers will be able satisfactorily to select their merchandise through the illustrations appearing upon the wrapper without the need of reading the printed matter, which in many cases is presented in relatively fine print.

In typographic printing processes in which the image-forming ink is transferred to the desired surface by raised type, graduated tone printing is desirably accomplished in such a way that the ink will be carried by a multiplicity of raised portions or dots of varying sizes, ranging from highlight dots ranging from 0.003 inches to 0.005 inches in diameter to shadow areas in which the dots are nearly or completely square in shape, with little or no areas separating them.

On the other hand, in flexographic printing procedures using flexible rubber or elastomer-faced printing plates and a fluid, fast drying ink, the image surface of the plate is usually inked by a mechanically engraved metal roll, which may be referred to as the metering roll or the anilox roll. These engraved rolls are usually mechanically engraved with a multiplicity of cells or recesses, each surrounded by a wall or land area, ranging from about 120 to about 200 cells per inch in each direction and ranging in depth from about 14 thousandths of an inch to about 8 ten-thousandths of an inch.

The desired wet ink film thickness to be supplied to the surface of the printing roll or plate is usually between 1 and 2 ten-thousandths of an inch in thickness. With metering or anilox rolls with 120 to 200 cells per inch in each direction, an average ink film thickness is achieved on the surface of the printing plate by virtue of the fact that only about one-half of the total top one-thousandths of the surface of the anilox roll is composed of cells containing ink, while the other half of the roll surface is composed of surrounding metal land or fence structures which contain no ink.

Furthermore, only about half the total volume of ink contained in the cells on the surface of the anilox roll is actually transferred to the surface of the printing plate, the balance being retained in the cells of the anilox rolls, due to surface tension and other characteristics of the ink used.

Since the average ink film thickness is the result of allowing excessive individual ink particles to spread laterally across relatively uninked areas, the pattern of in distribution and transfer is not quite satisfactory, particularly where it is desired to print very fine individual dots as in the case of the finest high light dots, which may be individually smaller than the single cells in the surface of the previously available anilox or metering rolls.

In such cases the individual high light dots on the printing plate may actually be covered by the individual cells in the surface of the anilox roll and the shoulders as well as the surface of the dots are immersed in and flooded with ink, and the tonal values reproduced may be many percent, and sometimes several hundred percent, greater than desired.

As a result, it has been almost impossible to produce true, quality tone printing or multicolor process printing by the flexographic processes. The problem is even more complex in cases of full shadow areas, where the printing dots should be separated by very minute and shallow channels. Here the excessive ink particles applied to the printing surface, near or even bridging the separating channels between the dots, can and frequently do bridge the channels, filling them in with ink so that the desired tonal values are distorted and the fill-in reaches the point where the resulting printing quality is totally unacceptable.

It is therefore an additional object of the present invention to provide that the flexographic printing shall result in a product in which the cells will be well within the spread or area of the dots and will not be immersed in and flooded with ink, and so that there will be an avoidance of bridging separating channels between dots, with the production of desired tonal values without distortion and with an acceptable resulting printed quality.

Another result which this invention is designed to achieve is the avoidance of the moire pattern caused by a conflict between the angles of the screen used in producing the half-tone engraving and printing plate and the angle of the mechanically engraved surface of the metering or anilox roll.

Usually, the established standard screen angles used in single-color letterpress and lithographic printing are at a 45° angle and this is also true in two color, such as red and black work and in four color process printing in which the standard screen angle for the black is 45°. Also in three color process printing, the standard screen angle for cyan is 45°. Also the standard and most commonly used angle for the surface of the anilox or metering roll is 45°, with the result that there is a conflict between the screen angles of the darkest and most prominent colors, although in some anilox or metering
This will result in eliminating or minimizing any more effect. The wider lands, which form a series of continuous supporting bands or rails extending in a spiral direction around the surface of the metering or anilox roll give the necessary wear factor or service life.

**BRIEF DESCRIPTION OF DRAWINGS**

With the foregoing and other objects in view, the invention consists of the novel construction, combination and arrangement of parts as hereinafter more specifically described, and illustrated in the accompanying drawings, wherein is shown an embodiment of the invention, but it is to be understood that changes, variations and modifications can be resorted to which fall within the scope of the claims hereunto appended.

FIG. 1a is a diagrammatic side elevational view showing the flexographic printing press unit of the present application.

FIG. 1b is a side elevational view of an alternative form of flexographic printing unit, showing the use of a reversible angle doctor blade.

FIG. 2a is a top elevational fragmentary view of a metering or anilox roll showing in superimposed relationship the areas to be printed in the old system of accomplishing this, upon an enlarged scale as compared to FIG. 1.

FIG. 2b is a top elevational fragmentary view similar to FIG. 2a showing the change in relationship between the areas to be printed, upon an enlarged scale as compared to FIG. 1, in a new system according to the present invention.

FIG. 3a is a diagrammatic transverse vertical cross-sectional view of a cell in the surface of the roll, showing the hemispherical shape of the recesses in this special anilox or metering roll.

FIG. 3b is a fragmentary transverse section at right angles to FIG. 3a and upon the same scale as FIG. 3a.

FIG. 3c is an enlarged diagrammatic type plan view of the recesses and lands, showing the actual shape of the narrow lands and the wide lands, which is shown at 45° away from the angle at which it is positioned on the printing or anilox roll.

As shown in FIG. 1a, the ink control or metering or doctoring may be by a rubber covered roll 22 onto the anilox roll 23 which furnishes ink an simultaneously doctors the excess from the surface of the roll 23 because of the pressure between the rolls and speed differential at the point of contact 70.

As an alternative method shown in FIG. 1b, the surface of the anilox roll 23 may be doctorred by a reverse angle doctor blade which more completely removes the surface ink at higher speeds and at the preferred ink viscosities.

Referring to FIG. 1a, there is shown the ink supply 20 carrying the printing ink 21, which is picked up by the rotating rubber covered fountain roll 22. This ink is transferred by the roll 22 to the anilox or metering roll 23.

These two rolls are protected by a cover 24 to prevent splashing of the ink or dust or dirt settling thereon. The anilox roll, which is engraved or recessed according to the disclosure of the present invention, transfers the ink to the plate or printing cylinder 25, which in turn transfers the ink to the web 26, which may be paper, cloth, plastic or other materials.

The impression cylinder 27 supports the web 26 against the plate cylinder 25.

In FIG. 1a the point of contact or transfer between the fountain roll 22 and the anilox roll 23 is indicated at 70. The ink supply fountain or reservoir 20 is also preferably provided with an upwardly extending inch guide 30, which extends over the lower face of the metering roll 23 and diverts any excess ink back into the ink supply 21.

In the alternative form of the invention as shown in FIG. 1b, the ink container 80, with the splash guard 81, is provided with the ink supply 82, in which rotates the rubber covered fountain roll 70. The lower portion of this fountain roll is immersed in ink. The ink is carried upwardly as indicated by the arrow 83 to the point of contact 85, where it is transferred to the anilox roll 86. The anilox roll 86 contacts the downwardly extending doctor blade 87 at the point 88 to remove any excess ink. This particular blade is held in the jaws 89 of the
lever 90, which is pivotally mounted at 91. The ink is then transferred onto the plate or printing cylinder 92 having the elevated portions 93. This printing cylinder 92, through the elevated portions 93, will transfer the ink to the web 94 of paper cloth or other sheet material. The backing or impression roller 95 will support the web 94 against the elevated portions 93 of the printing plate on the plate cylinder 92.

Referring to FIG. 2a, there is shown the surface 35 of an anilox of metering transfer roll, which meters and transfers the ink from the fountain roll 22 to the plate cylinder 25. The large cross-hatch square in the illustration indicated at 36 shows an area of a single, full shadow-tone dot in a 100-line screen printing plate superimposed upon a corresponding area on the surface 35 of a 200-line screen anilox or metering roll. In the form of invention shown in FIG. 2b there will be an average of 16 cells or recesses 37 of the anilox roll in each direction for the full shadow dot area 36, the small round dots or cross section areas 38, 39 and 40, representing the smallest highlight dots that normally could be produced in a typographical or flexographic printing plate.

It will be noted that in another instance in 2b, a circular area, 33, 39 or 40, never falls within the compass or ambit of a single recess 37, whereas the full area of the full shadow dot area 36 is inked by at least 16 cells. The small highlight dots 38, 39 and 40 extend over at least one recess 37 and usually over several adjacent recesses. The dot 38, for example, extends entirely over one recess 31 and projects at the side onto the edge or periphery of other recesses. The area 39 projects over the adjacent corner of four recesses 42. The area 40 extends across the recesses 43.

It will be noted that there are a large number of cells that take care of even the smallest area to be printed and there is no danger of flooding nor will a small highlight dot “dip” into a single cell, inking the shoulders of the dot where one recess of a coarser 200 anilox roll might allow an excess of ink upon both the face and on the shoulders of a small high dot. This will result in cleaner printing at faster press speeds with quicker drying and elimination of any moire effect. It will prevent unevenly inked highlight dots and will give a high quality tone.

In FIG. 2b, the oblique parallel lands in one oblique direction are much wider (for example, 25 percent to 15 percent) than the corresponding lands running obliquely at 90° to them. The narrow lands between the recesses are generally curved midway of the recesses, or at the midpoint of each narrow land along the two parallel sides of each recess. The wide lands are continuous and uniform in width, forming continuous constant width tracks. The narrow lands are not continuous across the ends of the recesses they are lower than the wide lands by about one micron. This is particularly shown in FIG. 3c, in which the recesses 90 are shown as having curved or bulging sides 91, which bulge outwardly from the sides of the recess between the wide lands 65 and the narrow lands 66 which are positioned between the wide lands 65. As indicated diagrammatically in FIG. 3a, the top of the narrow lands 66 is a short distance below the top of the wide lands 65.

In FIG. 2b, the top of the wide lands 65 is above the top of the narrow lands 66, with the recesses 56 and the lands 65 being shown in FIG. 3a. In the detailed cross-sectional view of FIG. 3a, the anilox or metering roll 23 is shown in surface cross section with the lands 55 and the recesses 56, which, it will be noted, are all of hemispherical shape.

In FIG. 2b the top surface 65 of the wide land is slightly above (for example, one micron) the top surface of the narrow land 66. Desirably and by design, the lands in one direction will be larger or wider than the lands in the other direction, which gives a superior printed result. This type of printing permits one color tone work, as well as three or four color process work, at finer screens than 85-line, up to 100 to 150-line screen plates are most conveniently used.

The cells should be closed on all four sides to prevent the low viscosity ink (for example, 100 to 200 centipoises or 18 to 25 second on a 2 Zahn cup) from deforming from the pressure of the printing plate surface as it contacts the ink furnished to it by the anilox roll.

In this invention the low opposite walls or lands of each cell are deliberately made about 1 micron lower than the intervening high lands or walls. This will retain the low viscosity ink within the confines of the cell because the ink will not laterally flow through this thin or narrow orifice or intervening space over the low narrow wall and below the surface of the elastomeric plate.

The ink has a greater affinity for the elastomeric plate than it has for the chemically surfaces of the containing cells. Thus there is retained the essential advantage of a closed cell to confine the thin ink particles contained therein.

About three-fourths of the ink comes out of the recesses and is deposited upon the synthetic or natural rubber or elastomeric transfer surface.

As shown, the lands are narrower and lower in one direction and higher and wider in the other direction. Although the diagrammatic drawings show the recesses as square, looking downwardly, actually there are no sharp corners and the recess is curved in all directions and each cell is bounded by a wall which is curved in all directions.

At the same time there is gained the advantages of an essentially continuous ink film, inking the printing surface of a plate without the moire effect which normally results from the form of the recesses. The angle at which the half tone printing plate has been made. Because of this, the ink pattern formed on the elastomeric surface will spread from the continuous film extending over the narrow lands and will cover the wider lands sufficiently effectively to camouflage or eliminate the screen pattern of the anilox roll surface.

The difference in cell size between FIG. 2a and 2b is more than a change in degree but is an actual change in kind or substance, since changing the shape and surface and eliminating all corners has made it possible to obtain sufficient transfer of the ink (for example, 75 percent) from the recess. This will permit satisfactory color density to be obtained in a print made from much lower volume of ink on the anilox roll surface, due to the fact that the peculiar design of this particular roll results in a much larger percentage of the ink film transferring to the printing plate surface.

The important feature of the present invention resides in the geometric and surface finish of the recesses or cells 56 which have greater individual capacity due to their hemispherical shape, as contrasted to the pyramidal shape of larger recesses or cells. Moreover the unique configuration, being essentially free from sharp corners, will release ink contained therein to a much greater degree than pyramidal shaped recesses.

This is due to the smooth surface, together with the extremely low surface tension of the particular chrome plating which is very fine grain and very dense and essentially devoid of globular or spherical deposits, which usually results from electrodeposition of chromium.

The printing surface at all times will be supported by the land areas of the anilox roll 23 and the ink will be readily transferred from the anilox roll 23 to the plate cylinder 25 by surface attraction only.

The total ink film will be split between the surfaces of the anilox roll and the printing plate, and about 75 percent of the ink film will be transferred from the anilox roll to the printing plate surface, with only about 25 percent of the ink film remaining in the cells on the surface of the anilox roll.

As many changes could be made in the above described printing procedure, and many widely different embodiments of this invention could be made without departure from the scope of the claims, it is intended that all matter contained in the above description shall be interpreted as illustrative and not in a limiting sense.
Referring to FIGs. 1a and 1b, the excess ink that is squeezed from the rolls at the contact points 70 and 85 will flow back, as indicated at 76a and 85a into the pool of ink indicated at 21 in FIG. 1a and 82 in FIG. 1b.

The diagrammatic illustration in FIG. 3c shows the relative-ly wide lands 65 between which extend pockets 90 to hold the ink. These lands 65 extend at 45° or in a crisscross fashion around the printing or anilox roll and the top of the wide lands is above the top of the narrow lands 66.

The sides of the pockets will slope from the top edge 91 down to the bottom of the pocket, as indicated at 91a, with the slopes being indicated at 90. By this arrangement of lands and recesses, a superior procedure is achieved in transferring the ink to the sheet being printed.

Having now particularly described and ascertained the nature of the invention, and in what manner the same is to be performed, what is claimed is:

1. In a printing press having a fountain roll, a printing roll and an intermediate ink metering roll between said fountain roll and said printing roll, the improvement which comprises said intermediate ink metering roll having a surface portion recessed to define a multiplicity of regularly spaced cells, said cells being arranged so that there are from about 360 to about 800 cells per inch in each direction, said cells being defined by side and end lands, said cells being characterized by the side defining lands thereof being wider than the end defining lands, said narrower end lands, in addition, being recessed from the surface of said roller, said side lands forming substantially continuous tracks about said roller.

2. A device in accordance with claim 1 wherein the depth of said cells does not exceed about 12 microns and said narrower end lands are recessed a distance of about 1 micron.