United States Patent

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[72] Inventor **Kenneth Lewis Hackley**
Oxford, Ohio

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[73] Assignee **U.S. Plywood-Champion Papers Inc.**
Hamilton, Ohio
a corporation of New York

[54] **METHOD OF INKING A PRINTING ROLL USING A METERING ROLL AND REVOLVING DOCTOR ROD**
6 Claims, 8 Drawing Figs.

[52] **U.S. Cl.** **101/350,** 118/118
[51] **Int. Cl.** **B41f 31/06,** B411 27/14
[50] **Field of Search** 101/348, 349, 350; 118/117, 118, 119, 104

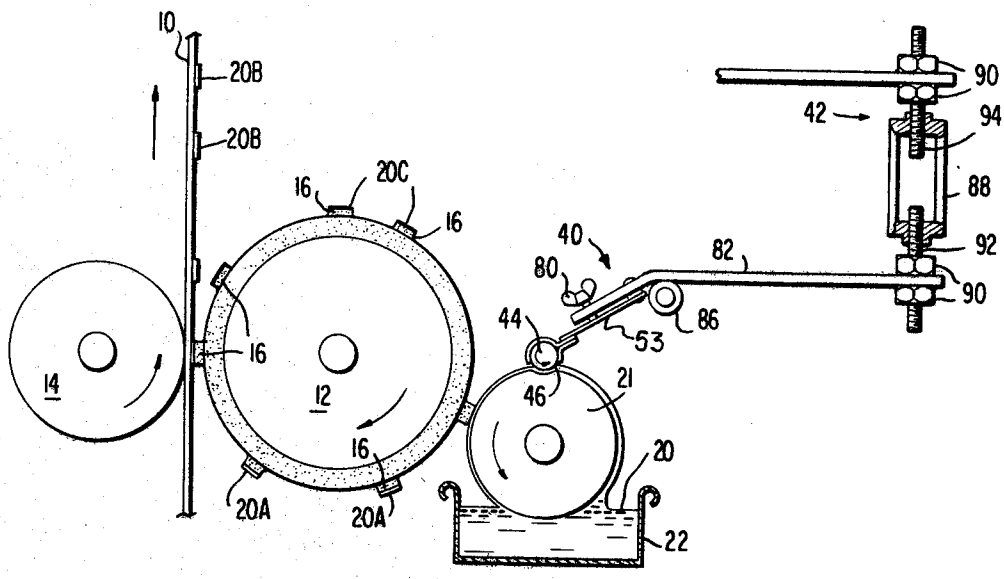
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Primary Examiner—William B. Penn
Assistant Examiner—E. M. Coven
Attorney—Daniel P. Worth

ABSTRACT: A printing apparatus and method wherein ink is conveyed to a printing roll via a metering roll, covered with a resilient surface, which is doctored by a flexible doctor having a moving doctor edge.



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SHEET 1 OF 2

FIG. 1
PRIOR ART

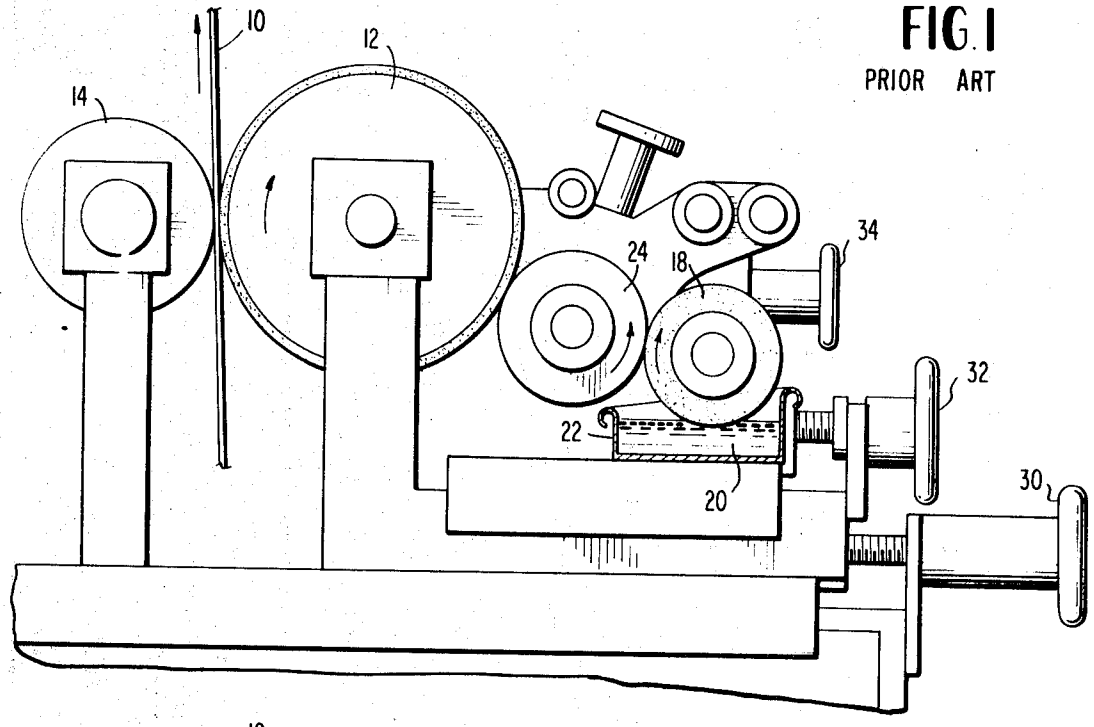


FIG. 2

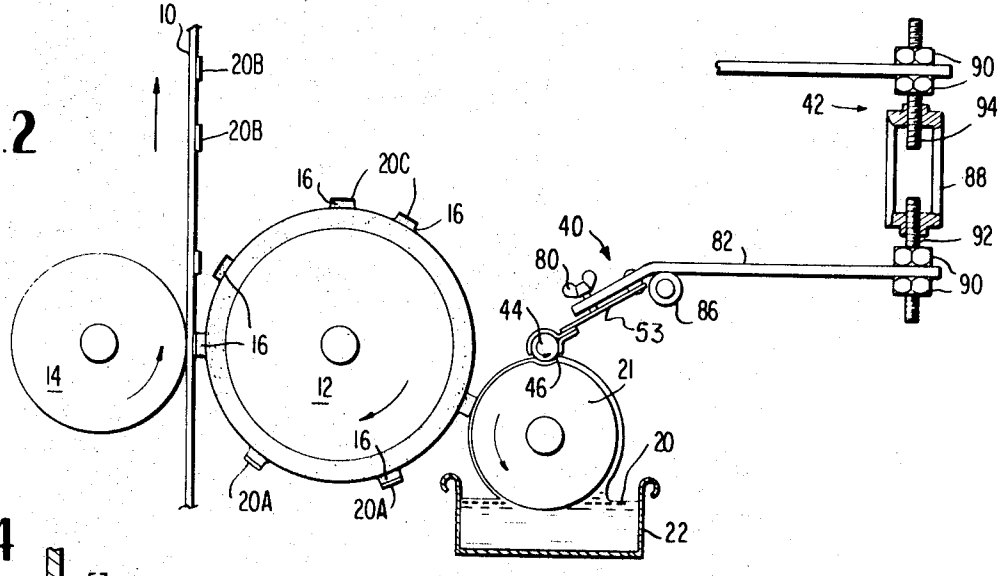
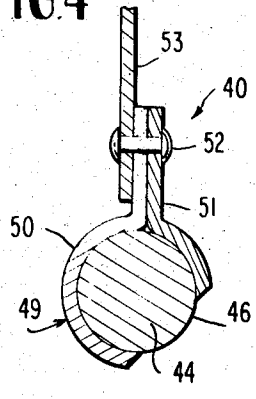


FIG. 4



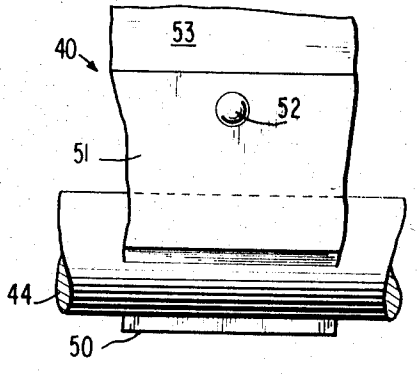


FIG. 5

INVENTOR
KENNETH LEWIS HACKLEY

BY Daniel P. Worth

ATTORNEY

FIG.3

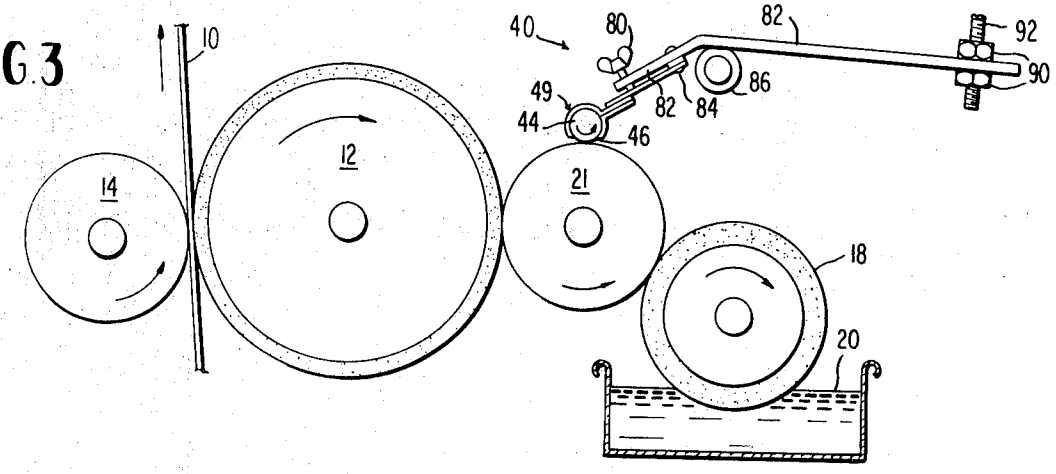


FIG.6

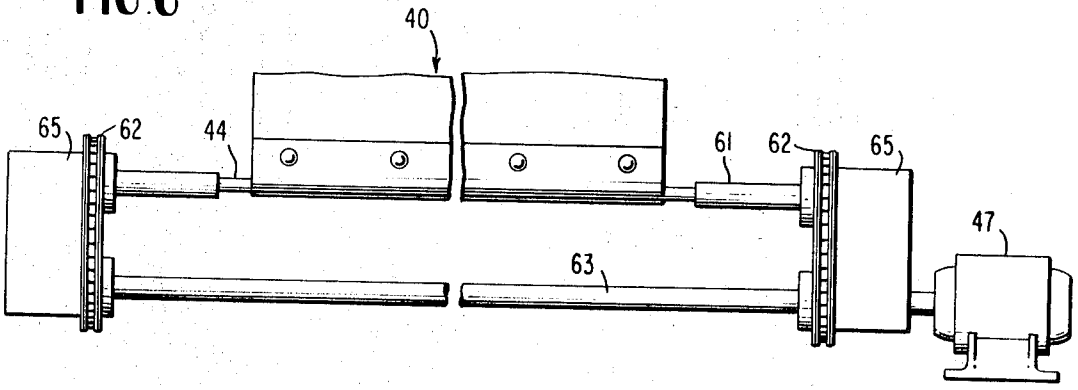
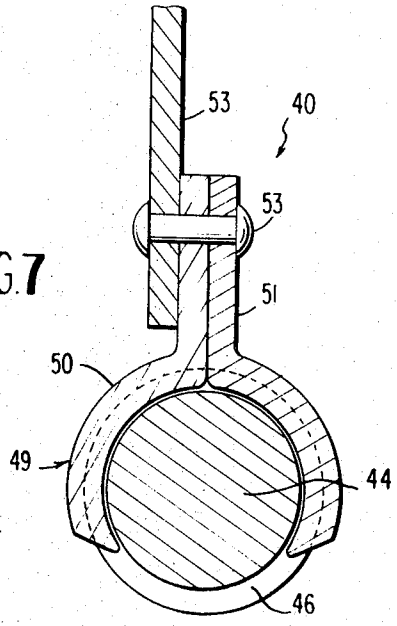


FIG.7



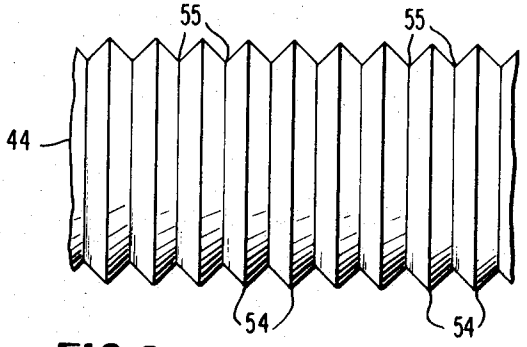


FIG.8

INVENTOR
KENNETH LEWIS HACKLEY
BY Daniel P. Worth
ATTORNEY

METHOD OF INKING A PRINTING ROLL USING A METERING ROLL AND REVOLVING DOCTOR ROD

BACKGROUND OF THE INVENTION

This invention relates to a printing apparatus and method. The printing apparatus in one preferred embodiment relates to a flexible doctor blade with a moving doctor edge for doctoring ink from the surface of a resiliently covered metering roll. A method according to the invention relates to doctoring ink to the desired amount by using a flexible doctor blade with a moving doctor edge against a resiliently surfaced metering roll and moving the edge in a direction opposite to that in which the metering roll is turning.

The invention is particularly suited for use in a flexographic or aniline printing system in connection with which it will be described it being understood that the invention is not necessarily limited thereto.

In the past it has been common practice to control the amount of ink reaching a printing roll by doctoring the ink on one or another of the preceding rolls upon which the ink is conveyed from the ink fountain (or pan) to the printing roll. Prior art structures for accomplishing this doctoring commonly include flexible single element blades which are brought to bear against one of the inking rolls, spaced blades which are brought up to a predetermined distance away from the inking roll, the use of multiple inking and transfer rollers—particularly in systems employing an Anilox roller—to work the ink and meter it, and combinations of these ideas. The prior art systems have presented difficulties in operation and in cleaning and maintenance of the printing system. For example, operating speeds have been limited by "misting" caused by a fog of ink formed by the high peripheral speeds of the rollers conveying the ink. Cleaning is important during all printing runs, but becomes more so when, for example, the printing press has been allowed to sit unoperated for some time, when the printing rollers have been out of use for some time and collected dirt, or when there is a change in the color of the ink being used whereupon the old ink has to be thoroughly removed in order to maintain fidelity of color reproduction during a press run, and so forth.

SUMMARY OF THE INVENTION

Accordingly it is an object of the present invention to provide apparatus and method for printing. Also among the objects of the present invention are a printing method and apparatus wherein a flexible doctor blade having a moving doctor edge is employed in conjunction with a resiliently covered metering roll preferably an inking roll. Further objects are to improve flexographic printing apparatus and methods.

The invention contemplates in a printing apparatus having an inking and printing construction that includes a printing roll upon which printing indicia are carried, which indicia receive ink from a metering roll and apply it to a web, the metering roll having a resilient surface thereon and receiving ink from a source and conveying the ink in metered quantities to the printing roll indicia, and a doctor means for removing ink from the metering roll, the improvement comprising a doctor means having a moving doctor edge continuously biased against the metering roll and including a flexible doctor rod with a circular cross section extending across said metering roll; a flexible socket rotatably supporting said rod and extending along the rod at least the width of said metering roll; a spring mounting of uniform stiffness throughout the entire working length of said doctor rod, said mounting comprising a flexible platelike structure of resilient material, to one edge of which platelike structure said flexible socket is fixedly attached through its length; and means for rotating said rod at a predetermined speed in a predetermined direction.

The invention also contemplates a method of inking a printing roll comprising applying ink to a resiliently surfaced metering roll, conveying said ink on said resilient surface past a moving flexible doctor edge to a printing roll, and supporting said moving doctor edge in a continuous flexible socket on a spring mounting of uniform stiffness, both said socket and spring extending along said doctor for the entire width of the metering roll surface to which the doctor is applied while continuously biasing said doctor and socket against said inking roll.

Preferably the metering roll is the inking roll, i.e., that roll which delivers ink to the printing roll.

A feature of the present invention is the employment of a resilient continuously supported flexible moving doctor edge in a printing system and method.

Advantages of the present invention are wide flexibility in the control of the quantity and quality of ink passed to the printing roll; flexibility in controlling the ultimate appearance which can run everywhere from a pale color to a raised embossed sort of print by regulating the ink quantity through changing the force by which the doctor is applied against the metering roll; easy clean-up including even an ability to clean itself; and ability to use higher viscosity inks, hence reduce solvent and dryer requirements.

Prior art systems have been characterized by accumulating foreign bodies of different varieties adjacent or upon the doctor blade. This dirt can comprise dirt, lumps of ink, fibers that have flown off the web and foreign bodies from sources unknown. Use according to the present invention of a moving doctor edge enhances the removal of these foreign bodies from the ink film that is transmitted to the printed sheet.

Speed limitations have arisen in prior art devices due to "misting". The present invention can reduce misting by enabling use of higher viscosity inks and reduction of the amount of solvents used so often to thin the inks.

Additional objects, advantages and features of the invention will be understood from reading the following specification in conjunction with the annexed drawings wherein:

FIG. 1 schematically represents a typical prior art flexographic printing and inking unit;

FIG. 2 schematically represents the preferred form of the present invention as incorporated into the printing and inking unit of a flexographic press;

FIG. 3 schematically represents a modification of the embodiment of FIG. 2,

FIG. 4 is an enlarged side cross section of a flexible doctor blade used in the embodiments of FIGS. 2 and 3;

FIG. 5 is an enlarged plan view of the blade illustrated in FIG. 4;

FIG. 6 is a fragmentary schematic plan view of one manner of rotating the rod by power applied at both ends;

FIG. 7 is an enlarged side cross section of a modified flexible doctor blade using a grooved rod and suitable for use in the embodiments of FIGS. 2 and 3; and

FIG. 8 is an enlarged plan view of the grooved rod used in FIG. 7.

FIG. 1 schematically illustrates a representative prior art aniline or flexographic printing system for printing on one side of the web **10** which is illustrated as moving vertically upwardly between the printing roll **12** and the backup or impression roll **14**. In the illustrated aniline or flexographic printing system the printing roll **12** is provided with a resilient surface, such as by being of solid rubber or having a rubber surface, and impression roll **14** is of steel. The printing indicia **16** (not shown in FIG. 1, shown in FIG. 2 exaggerated in size for clarity) are formed to protrude from the surface of the roll **12** and likewise, being integral therewith, are of the same material as the rest of the surface, i.e., are also of rubber and of one piece with the remainder of the resilient surface on the printing roll.

A fountain roller **18** moves through the ink **20** that is held in the ink pan **22** and in so doing transfers ink from the pan to a metal surfaced roll, the Anilox or engraved metering roll **24**. The engraved metering roll **24** actually has a metal surface with a pattern of small depressions in it, as is well known in the art, the size and spacing of which determine the amount of ink that is removed from the inking roll and transferred to the printing roll.

Various means are illustrated in FIG 1 to adjust the spacing between or pressure between the various rolls. As illustrated schematically, an adjusting means **30** is provided to move the printing roll **12** back and forth relative to the web and impression roll, a similar adjusting means **32** is provided to adjust the spacing or pressure between the metering roll **24** and the printing roll **12**. Finally, the adjusting means **34** is provided to move the inking roller **18** relative to the metering roll **24**

The inking roll **18** is preferably rubber covered, or at least is provided with some form of resilient surface, as is well known in the art, which is capable of associating with the ink **20** in such a manner as to remove it from the pan and transfer it to the metering roll.

In FIGS. **2** and **3** are schematically illustrated the preferred flexographic printing apparatus and method of this invention wherein the printing roll **12** again is a rubber covered roller having the indicia **16** thereon and which cooperates with the steel impression roll **14** to apply printing to one side of the web **10**. In FIG. **2** the ink **20** is removed from the pan **22** by the resiliently surfaced metering roll **21** and transferred past the doctor means assembly **40** to the printing roll **12**. In FIG. **3** the ink moves from fountain roller **18** over the metering roller **21** thence to the printing roller **12**. In either event the ink is doctored by blade **40** between the pan and the printing roller **12**. A biasing means **42** is provided to adjust the amount of pressure exerted by the doctor assembly **40** against the inking roll **18**.

In FIGS. **1**, **2**, and **3**, but as illustrated in detail only in FIG **2**, it is to be understood that the printing indicia **16** carry metered quantities of ink **20A** into the nip and then deposit them as printed characters **20B** on the web **10**. Actually, due to splitting of the ink film a residual amount of ink **20C** is carried away from the web on indicia **16**. Also, it is to be understood that the printing surface and indicia may comprise a small rubber printing plate affixed to either a rubber or steel roll by suitable means such as glue, pressure sensitive tape or the like as is well known in the industry.

During operation of the printing systems described in FIGS. **1**, **2**, and **3**, the inking rolls **24** move at exactly the same surface velocity as do the rubber printing indices **16**. The printing indices **16** move at exactly the same surface velocity as the web **10**. Variations in surface velocity which are permissible are very small, and normally run on the order of plus or minus 0.1 percent such variations are embraced in my use of the term "same velocity" as related to the metering and inking roll velocities

In FIG. **2** the metering roll **21** also serves as a fountain and inking roller. In FIG. **3** the metering roll also serves as an inking roll. The excess of ink and any debris retained therein may flow back to the pan **20** as illustrated. Also, the doctor assembly **40** and especially rod **44** are biased sufficiently to slightly indent the resilient cover on the metering roll at the bite formed by the rod **44** and metering roll **46**. The metering, inking, and fountain rollers are of conventional construction and may comprise a rubber sleeve on a hard core, e.g., a metal core.

The doctor assembly **40** is constructed generally as shown in FIGS. **4**, **5**, **7**, and **8** and more particularly as is taught in U.S. Pat. No. 2,729,192 issued on Jan. 3, 1956 to Edgar Warner, which patent is incorporated herein by reference. As illustrated in FIGS. **4**, **5**, **7**, and **8** the doctor includes a flexible small diameter doctor rod **44** of circular cross section, that can have a cylindrical surface as shown in FIGS. **4**, **5** or an alternately ribbed and grooves surface as shown in FIGS. **7**, **8** and further described below. The doctor rod provides a moving doctor edge **46** which is held against the resilient surface of metering roll **21** and which is driven by motor and gear reducer assembly **47** (FIG. **6**) in a direction such that its surface at the nip travels opposite to that in which the roller **21** travels. Thus, as seen in FIG. **2** the metering roll **21** rotates counterclockwise and so does rod **44** and similarly in FIG. **3** as to roller **24** and rod **44** which both rotate counterclockwise. By driving the rod so that its surface **46** at the nip travels in the direction opposite to that of the roller, undesirable material such as dirt, fiber, agglomerations of dried ink, etc. is discouraged from passing through the nip and is retained on the upstream side of the doctor assembly, or flows back to the pan with the excess.

The doctor rod is long, extending completely across the surface of the inking roll and has a small enough diameter to be quite flexible. For example, in an embodiment tested the doctor rod was of chromium plated steel, had a diameter of .375 inches, was rotated at a speed of 10 to 20 r.p.m., and was biased against an inking roll having a rubber surface of 4.067 inches in diameter, with surface hardness 80—100, Durometer A scale, and moving at a surface speed as high as 0—300 fpm. The rubber surface desired for the printing roll and printing indicia should preferably be of a resilient material having a hardness of 30—100 as measured with Shore Durometer A.

The doctor rod **44** is rotatably supported within a flexible socket **49** that extends along the full width of the rod at least for the width of the rubber inking roll and preferably for a small distance on either side thereof to avoid edge effects. The socket is a member that surrounds more than half the circumference of rod **44** but exposes the portion **46** as the moving doctor surface. The socket is (FIGS. **4**, **5**, **7**, and **8**) comprised of two separate parts a holder **50** and clip **51** each having a partly circular portion supported on a flat, straight part, as viewed in cross section. The socket is made of stainless steel and is fixedly attached as by welding or riveting (e.g., rivet **52**) to a spring mount **53** so as to provide relatively uniform spring strength. The spring mounting **53** is of uniform thickness throughout the entire working length of the doctor rod. The spring mounting preferably comprises a flexible platelike structure of resilient material, such as spring steel.

As best seen in FIGS. **2** and **3** doctor assembly **40** is biased against the inking roll by a plurality of turnkeys or thumbscrews **80** which are arranged in a line along the edge of the main support plate **82**. The spring mounting **53** of the doctor blade is secured to the plate **82** by a rivet **84**, or rather a plurality of rivets **84** or equivalent fasteners such as nuts and bolts. The plate is secured to a shaft **86** which turns in journal bearings (not shown) that are mounted on the side frames of the printing machine. The plate and doctor are positioned by manipulating the turn buckle **88** and/or by adjusting the locknuts **90** on the respective left and right-hand threaded screws **92**, **94**. Actually, a rough adjustment is made of the plate using the turn buckle and a fine or vernier adjustment made using the thumbscrews. The thumbscrews are particularly advantageous to make local adjustments along the rod, i.e., across the metering roll, whereby the flexibility of the mounting plate **53** and of the doctor rod **44** is taken advantage of by flexing the same into appropriate contact with the surface of the roller **24** by means of thumbscrews. Such local adjustments allow regulation of ink quantity.

Where the doctor rod has ribs and grooves in it, as shown in FIG. **7**, **8**, the rod surface has alternately arranged circumferential ribs **54** and grooves **55** and the socket **49** supporting the rod is contoured to grip the rod. A rod of this construction is taught in U.S. Pat. No. 3,084,663 issued on Apr. 9, 1968 to Edgar Warner for a "Doctor Blade for Coating Apparatus."

According to the method of my invention, ink is applied to the resiliently surfaced metering roll **21**, the ink is conveyed on said resilient surface past a moving flexible doctor edge **46** to a printing roll **12**, and the printing roll applies ink to the web in a printing fashion The moving doctor edge is supported in the continuous flexible socket **49** on the spring mounting **53** of uniform spring action, both the socket and spring mounting extending along the doctor for substantially the entire width of the inking roll surface to which the doctor is applied while continuously pressing the doctor rod against the inking roll.

As already known in the prior art, the rod **44** can be driven by any suitable means: in the case of printing on wide machines or to facilitate the use of smaller rods the driving force may be applied to both ends of the rod simultaneously as

illustrated in FIG. 6 and as taught in further detail in Warner U.S. Pat. No. 2,729,192. Preferably the driving means (e.g., FIG. 6) is mounted on the plate **82**, allowing the entire doctor unit to be placed in operation simply and reducing the amount of printing press modification. Referring to FIG. 6 the driving force is applied to each end of rod **44** by a flexible connection such as flexible shaft **61** driven as by chain drives **62** from a relatively large diameter cross-shaft **63** which synchronizes the drives on opposite ends of the rod **20**, reducing torsion, and reducing the danger that small rods may be twisted to the point of fracture if they should seize in their sockets.

A motor reducer or electric motor gear drive **47** applies power to the cross-shaft **63**. The chain drives **62** and fixed ends of the flexible shafts **61** are shown as supported in suitable bearing **65**. If desired, the cross-shaft can be eliminated and both ends of the rod separately driven by separate motors. Alternatively, some applications (e.g., narrow presses) may only require driving from one end in which case a power source (e.g., an electric motor) is connected to one end of the rod. A separate or independent motor drive **47** (as distinguished from driving via the gear train of the printing press which drives the various rolls **12, 14, 18, 21, 24**) is preferred as this facilitates removing the doctor means as a unit when making the press ready for a printing operation and servicing the press in other ways.

The doctor edge is continuously moved in a direction opposite to that of the inking roll at the nip. Actually, in the embodiments of FIGS. **2** and **3**, if both the moving doctor rod and the inking roll are driven counterclockwise the opposite direction at the nip requirement will be met.

During several test runs using the invention, a number of useful advantages appeared:

For example, when a prior art press according to FIG. **1** was operated it typically could only use thirty second viscosity (as measured with No. 2 Zahn cup manufactured by General Electric Co., Instrument Department, Lynn, Massachusetts and described in Flexography Magazine, Jan. 1961, p. 22, 23 and 56) ink, a low viscosity ink. However, when practicing the invention it was observed that increased viscosity, hence higher total solids content of the ink, was possible: the practice of the invention permitted the use of sixty second viscosity ink. The use of inks having higher total solids reduces the costs of organic solvents, permits more rapid drying, and enhances the depth or richness of the printed color.

Metallic inks, such as metallic gold inks, are normally difficult to print: when printing them it has been conventional practice to overvarnish them in order to secure a proper finish and to minimize the effects of flaking. The use of the present invention to print a gold ink allowed use of a higher solids content ink and provided a nonscuffing metallic gold finish not requiring varnishing to protect the gold.

Ink film thickness control was realized during practice of the invention. Actual measurements of ink thickness showed that thicknesses from that not measurable by calipers or micrometers up to .0015 — .002 inches were achieved by adjustment (via screws **80**) of the blade pressure independent of (and in tests, without changing) other factors such as the press speed, ink viscosity and the like. Ink thickness was increased by reducing the force with which the rod was pressed against the inking roll.

I claim:

1. A method of inking a printing roll having a printing surface on which are printed indicia, which method comprises:

applying ink in excess of the quantity required for printing to a resiliently surfaced metering roll;

conveying said ink on said resilient surface to the bite formed by a rotatable flexible doctor rod biased against said metering roll;

supporting said doctor rod in a flexible socket on a spring mounting of uniform stiffness, said socket being a member closely embracing the rod to a substantial extent around the periphery leaving a portion exposed to be in direct contact with said metering roll, both said socket and spring mounting extending along said doctor for the entire width of the metering roll surface to which the doctor is applied while continuously biasing said doctor in said socket against said metering roll;

rotating said printing roll and metering roll so that they form a nip and the surface velocity of each at the nip is the same in the same direction; and

rotating said doctor rod while so biased at a surface velocity less than the surface velocity of said metering roll and in a direction of rod rotation the same as said metering roll.

2. A method according to claim **1** wherein said rod has a substantially cylindrical surface.

3. A method according to claim **1** wherein said rod has a surface comprising alternately arranged circumferential ribs and grooves and said socket is contoured to grip said rod.

4. A method according to claim **1** wherein said applying step is conducted by revolving said metering roll in a bath of ink.

5. A method according to claim **1** wherein said printing surface has resilient printing indicia protruding therefrom and said metering roll carries ink past said bite to said indicia.

6. A method of printing in accordance with claim **1** further comprising the steps of moving ink on said resilient surface past the bite to said printing surface and applying at least a portion of the ink thereto, and applying ink from said printing surface to a substrate.