(12) UK Patent Application (19) GB (11) 2 044 398 A

(21) Application No 8006432
(22) Date of filing 26 Feb 1980
(30) Priority data
(31) 15331U
(32) 26 Feb 1979
(33) United States of America (US)
(43) Application published 15 Oct 1980
(51) INT CL[3] F16C 13/00//B05C 1/08
(52) Domestic classification F2U 17 21B 22B 22X 24B B2L 106A 135 161 162 B
(56) Documents cited GB 729561 GB 721974
(58) Field of search F2U
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(54) Fluid-Transfer Roller

(57) A cylindrical roller body (10) has a surface texture incorporating a random pattern of interconnected channels or "cracks" (18) and lands (20) and may be mounted for rotation contiguous with a second roller (22) having a fluid supply (30), for transferring fluid therebetween, thereby forming a uniform fluid layer (32), available for deposit. A chromium plated surface layer (16) is subjected to a sequential plating, etching, and polishing process for producing an array of interconnected, shallow cracks and smooth, segregated lands thereupon. The cracked cylindrical surface of the roller then presents a plurality of smooth, unconnected lands to fluids dispersed thereon. Similarly, the interconnected crack pattern permits lateral flow of fluid between lands to reduce the surface tension and improve fluid transfer characteristics. The roller can be used to transfer any fluid with more control, volumetric capacity and less surface tension dependency than conventional rollers of either greater smoothness or greater roughness.

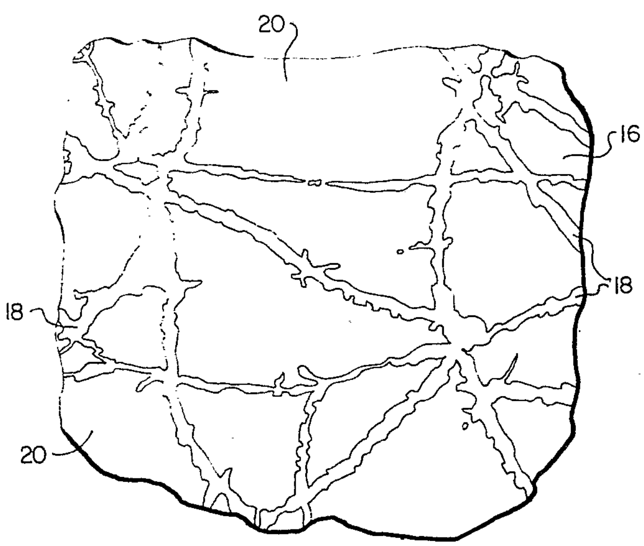

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FIG. 3

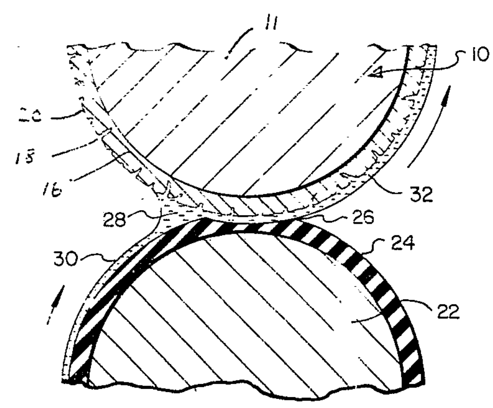

FIG. 5

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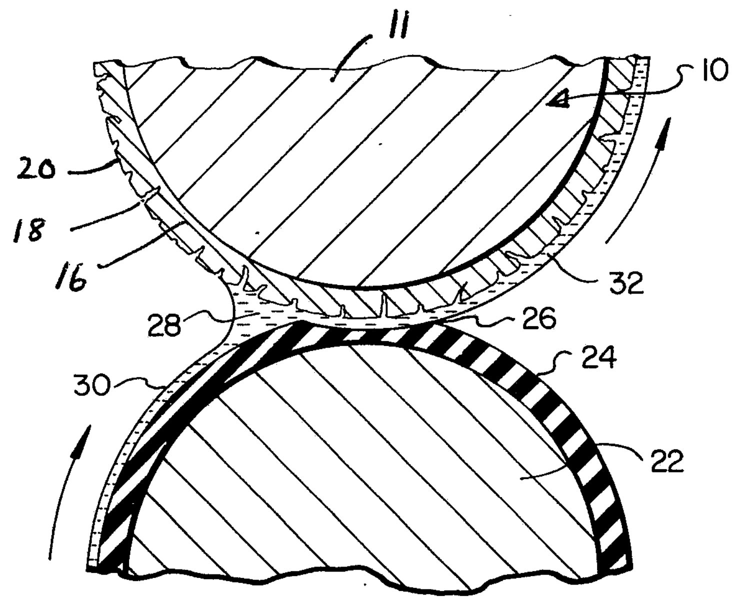

FIG. 5

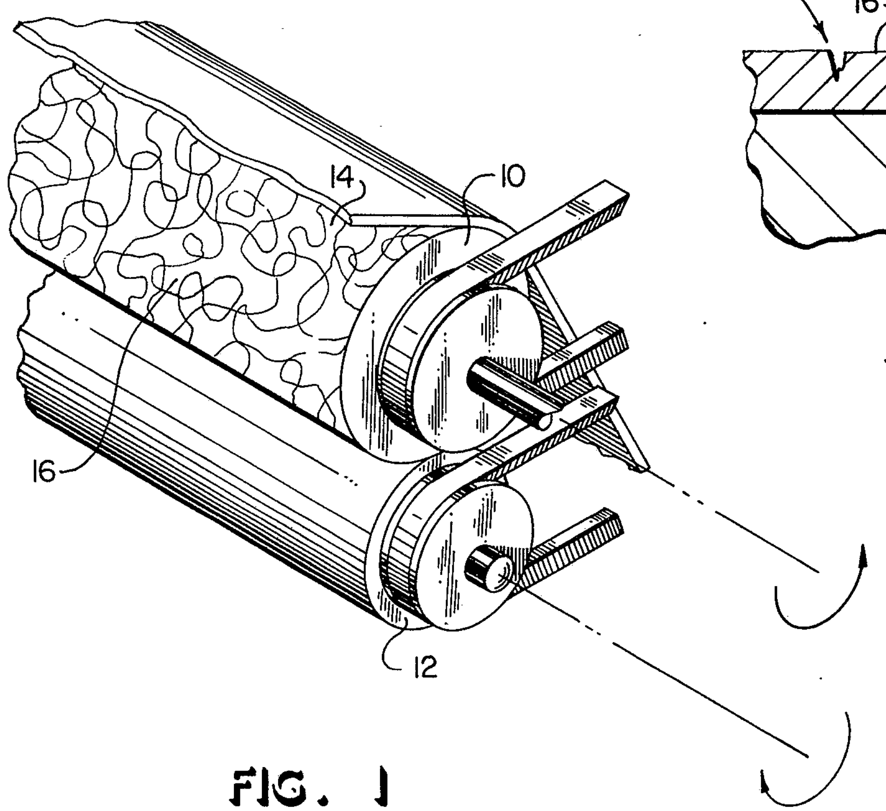

FIG. 1

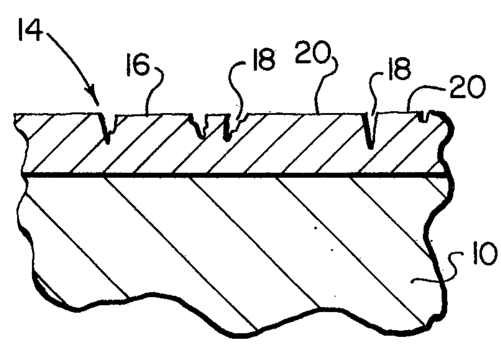

FIG. 2

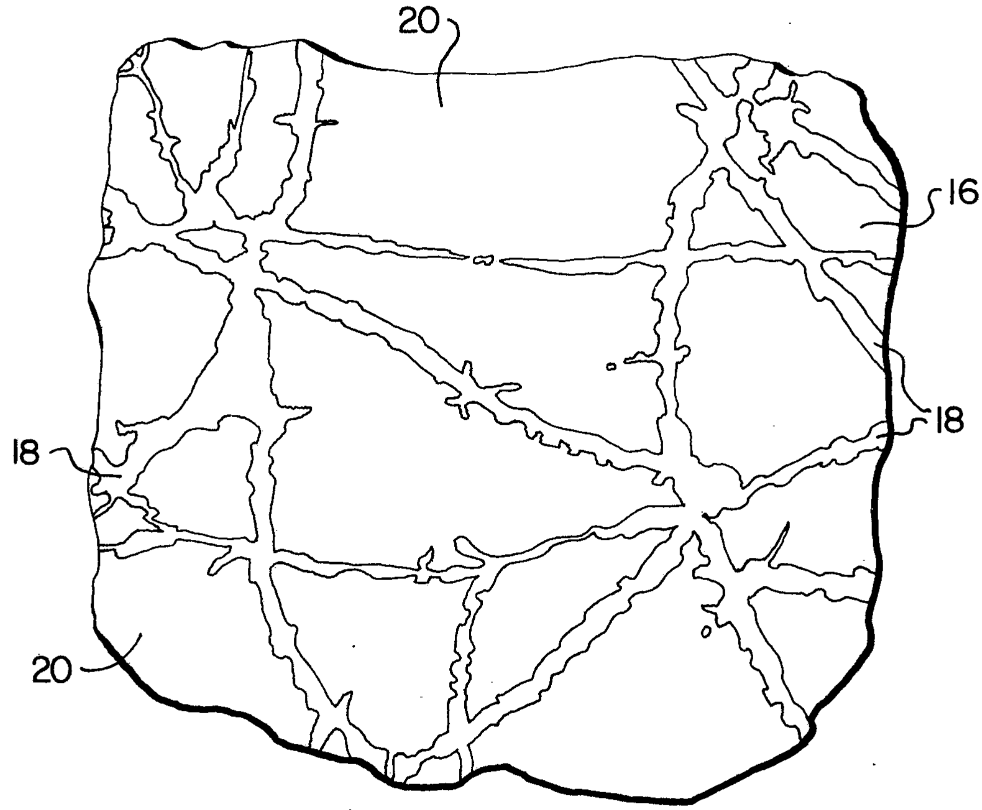

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FIG. 3

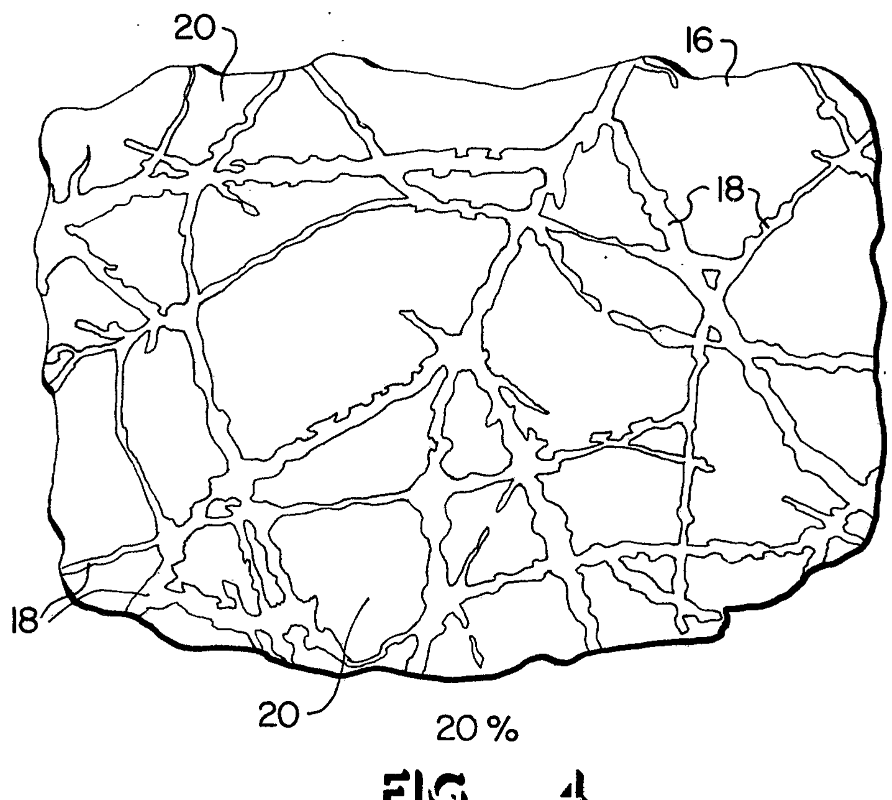

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FIG. 4

SPECIFICATION

Fluid Roller

The present invention relates to rollers.

Fluid transfer with cylindrical rollers has for years been an integral element in various industrial fluid systems. The precise roller design depends on the specific application, fluid viscosity, speed and related aspects. For example, fluid rollers are used in the printing industry in several distinct areas, ink is transferred over rollers in inking systems; fountain solutions are transferred over rollers in dampening systems; coatings, pigments and dyes are transferred directly to webs e.g. of paper or cloth. This is but one example of a class of fluid roller applications. Thus whilst the invention will be described by reference to printing systems, this is not meant to limit the scope of the present invention which finds application in the transfer of fluids of varying viscosities to a wide assortment of mediums.

Referring now to large lithographic printing presses in particular, a system of fluid dampening is generally utilized in conjunction with an inking system. The use of a dampening system requires controlled transfer of the dampening fluid through a plurality of rollers within the press. The transfer of the fluid must be controlled in speed thickness, and uniformity for printing quality and the elimination of streaks, run, smudges, and other problems associated with lithographic printing. The problem of fluid transfer control is not, however, limited to lithographic printing and is a specific requirement and need for many industries having various forms of roller applications.

One of the greatest problems of lithographic offset printing methods has been the application of moistening fluids to the surface of the lithographic printing plate in uniform and evenly distributed quantities and in regulated amounts so as to insure uniformly good quality reproduction of the printed image on the paper. A lithographic printing plate is a chemically treated sheet of metal wherein the printing area is provided to be ink receptive and the nonprinting area to be hydrophilic, or moisture receptive. It is thus necessary to apply a film of moistening fluid to the surface of the plate which film of moistening fluid is retained by the hydrophilic area, but is repelled by the printing area so that the printing area receives ink and the non-printing area is separated and isolated from the ink by the film of moistening fluid.

The prior art has provided numerous forms of roller configurations and surface characteristics for the printing industry, included among these, a polished, chrome plated dampener transfer roller for use in lithographic dampening. The chrome plated roller generally described in the prior art incorporates a smooth, polished chrome plated surface having a very hard and very smooth surface for facilitating dispersion of a film of fluid thereupon. The utilization of a chrome plated hydrophilic transfer has found widespread acceptance in the printing industry, although certain requirements in the lithographic press are necessarily associated therewith. One such requirement is the utilization of a surfactant or wetting agent such as alcohol, in the dampening solution transferred by the transfer roller. The use of alcohol reduces the surface tension of the dampening fluid permitting it to uniformly distribute itself across the polished, homogeneous surface of the subject roller. Alcohol has become, however, very expensive and more scarce with contemporary oil shortages.

The prior art of roller construction has also included rough surface rollers. Various rough surface rollers have also been disclosed with soft surface characteristics, although these have not been as successful. Certain aspects of hard, rough surface rollers such as an "Anilox" (registered Trade Mark) roll have certain advantages. One such advantage is the ability to carry greater fluid thicknesses due to the characteristic of the surface to fluid interface. The use of the prior art rough rollers produces real problems in operation. For example, such rollers are generally copper clad and surface plated which results in a surface which is easily damaged. Moreover, ink from the inking system often becomes embedded in the deep cracks on Anilox (registered Trade Mark) rollers. Other problems such as surface friction, emulsification, fluid turbulence and the resulting defects in uniformity of flow have thus prompted the industry to utilize other transfer roller designs. The advent of the smooth, polished hard surface hydrophilic roller was thus a major development in that the critical disadvantages associated with rough rollers both hard and soft, were overcome. However, elimination of the disadvantages also removed many of the advantages of the rough surface roller in the system itself. The same holds true for related industrial roller uses and the need for an improved fluid transfer roller is critically felt.

In any fluid transfer system where fluid rollers rotate at different surface speeds, as is often the case for controlled operation, the surface configuration of the rollers has a direct bearing on the amount of energy consumed to impart rotation. For example, a rough surface roller rotating at a different speed than a contiguous roller in surface indented relationship therewith will obviously result in high frictional forces between the rollers. For this reason, hard polished rollers often require less driving energy to operate as compared with a pressure indented roller rotating at a different speed. Where viscous fluids, such as polymer coatings are being transferred, the surface friction is even greater and the need for quantity transfer more evident.

It would be an advantage therefore to provide the advantages of a rough surface roller in a roller construction having many of the advantages of a smooth polished roller. The roller construction of the present invention overcomes many of the problems of the prior art and provides a roller having a surface configuration facilitating fluid transfer having advantageous features of many rough surface rollers and features of smooth polished hard surfaced rollers. The functional combination is facilitated through the creation of precisely etched surface crack configurations in a very hard surface polished material uniformly disposed about the roller. The nonuniform polished surface and interconnected cracks of the roller of the present invention provides improved fluid transfer characteristics with few of the conventionally associated problems.

According to one aspect of the present invention a fluid transfer roller has a cylindrical core and a hard outer surface plated around the core and having a random pattern of relatively shallow, interconnected cracks and polished lands formed thereon. Preferably the metallic surface is chromium, which may be etched and polished to the said random crack pattern. The surface of the roller thus preferably has a random configuration of interconnected relatively shallow cracks and segregated polished lands formed in a hard, durable surface. The cracks preferably comprise up to 30 percent of the surface area of the roller so that the roller presents a nonuniform, nonhomogeneous, fluid engaging surface configuration.

In a preferred form of this aspect of the invention the roller has a chrome plated cylindrical core which has been etched and polished to produce a random crack pattern between 10 and 17 percent of the surface comprised of cracks, or channels up to .010 inches deep prior to polishing. The surface preferably includes lands between the cracks polished to a smoothness of the order of 8 RMS. The roller may then find particular application as a fluid transfer roller in combination with a fluid supply, such as a trough, and a deposit area, such as a web, when means are incorporated to impart the fluid to the roller under pressure, as by a second, soft surfaced roller in pressure indented relationship. The interconnected nonhomogeneous crack patterns, it has been discovered, permit lateral flow of the fluid and mechanically break down the surface tension and it is believed thereby facilitate greater transfer capacity than with smooth surfaced rollers and greater control.

The cracks are preferably up to 0.003 inches e.g. 0.001 to 0.003 or 0.001 to 0.002 inches wide and up to 0.003 inches e.g. 0.001 to 0.003 e.g. 0.001 to 0.002 inches deep and the area of the cracks at the polished surface is preferably not more than 30% of the total surface area e.g. 9 to 26% or 14 to 17%. The lands between the cracks are polished preferably so that the total surface exhibits a smoothness of at least 8 RMS.

In another respect, the invention includes a method of fabricating a metallic fluid roller from a cylindrical core comprising the steps of applying a metal plating to the surface of the cylindrical core and then etching the plated core to impart a pattern of cracks and lands to the metal plated surface.

The invention, according to another aspect, embraces a fluid transfer system including the hard-surfaced roller mounted to rotate contiguous a fluid supply and a fluid deposit surface to transfer fluid from the former to the latter. Either the fluid supply or the fluid deposit may comprise a soft surface roller.

According to a further aspect of the invention a method of making a hard surfaced, fluid transfer roller having a hard metal plating on the outer surface of a cylindrical core includes providing a cylindrical core having a hard metal plating on the metal surface of the core, etching the plated surface to impart a random pattern of interconnected cracks and segregated lands to the metal plated surface; polishing the surface of the roller to produce smoothly finished lands between the pattern of interconnected cracks, the cracks comprising up to 30 percent of the surface area of the roller; and cleaning the surface and the cracks of the roller to render the surface of the roller fluid receptive. The lands are preferably polished between the cracks to a smooth finish whereby the finished crack pattern depth is generally between .001 and .002 inches. The cracks preferably comprise up to 30 percent of the surface area of the roller.

According to a further aspect of the invention a method of transferring fluid between a hard-surfaced roller includes mounting the hard-surfaced roller in pressure indented relationship with a soft-surfaced roller, rotating the hard-surfaced roller and crack pattern relative to the soft-surfaced roller; driving the hard and soft-surfaced rollers in contact with a fluid to be transferred; and passing the fluid between the hard and soft-surfaced rollers.

The invention may be put into practice in various ways and two specific embodiments of transfer rollers in accordance with the present invention and an assembly incorporating the rollers will be described by way of example to illustrate the invention with reference to the accompanying drawings in which:

Figure 1 is a perspective view of one embodiment of a fluid transfer roller in accordance with the present invention in a specific fluid transfer application;

Figure 2 is an enlarged cross-sectional view of the surface of the transfer roller shown in Figure 1, illustrating one embodiment of a crack pattern therein;

Figure 3 is an enlarged, top plan view of the surface of the transfer roller of Figure 1, illustrating in more detail one crack pattern embodiment in accordance with the present invention;

Figure 4 is an alternative embodiment of the crack pattern illustrated in Figure 3; and

Figure 5 is an enlarged, side elevational scrap cross-sectional view of the roller assembly shown in Figure 1 illustrating the principle of fluid transfer therebetween.

Referring first to Figure 1, there is shown one embodiment of a fluid roller 10 constructed in accordance with the present invention. The roller 10 is illustrated in pressure indented relationship with a second roller 12 for facilitating fluid transfer therebetween in accordance with one illustrative application of the present invention. A surface crack pattern 14 is indicated diagrammatically on the roller 10. The pattern 14 of the present invention is formed in a hard cylindrical outer surface provided by a plating 16 on the core 11 of the roller 10 in a manner described below to impart a select, non-continuous, non-homogeneous surface to the roller. In a dynamic operation mode, the pattern 14 of the roller 10 then provides advantages of both a continuous, smoothly polished roller and a rough, knurled, or "Anilox" (registered Trade Mark) roller, without associated disadvantages. For example, the surface 16 is hard and impervious to "dings" (the accidental passage of multiple layers of paper through the nip) while exhibiting surface indentations in accordance witf the invention.

Referring now to Figure 2 there is shown an enlarged side elevational cross-sectional view of the surface 16 and pattern 14 of the roller 10 of Figure 1. It may be seen that the pattern 14 is comprised of a vast, interconnected array of channels, or cracks 18 formed in the surface 16 and extending therein a generally predefined depth and width. Between adjacent cracks 18 polished lands 20 form the surface of the roller 10. Each land 20 is segregated by the random pattern of cracks 18 isolating one land 20 from another and permitting fluid flow therebetween. In this manner the surface 16 of the roller 10 exhibits a non-continuous, non-homogeneous surface to fluids dispersed or distributed thereon. Fluids deposited on the surface in either a static or dynamic mode exhibit certain phenomena of rheology not characteristic of either smooth or rough surfaces. For example, a drop of water placed upon stationary prior art rollers will generally "bead up" unless treated with a wetting agent to reduce surface tension. A drop of water when deposited on the surface 16 of the roller 20 of the present invention dispersed well across the surface as though a wetting agent were present. This is believed to be because of the interconnected cracks 18 which may be thought to mechanically break down the surface tension of the drop. This phenomenon has equally startling results when incorporated in a dynamic mode as described in more detail below.

Referring now to Figure 3, there is shown an enlarged top plan view of a section of the surface 16 of the roller 10 of Figure 1 in accordance with the present invention. The cracks 18 may be seen to be in a random pattern of generally uniform width and isolation or spacing relative to the lands 20. As used herein, the term "random pattern" refers to the interconnected, crack configuration providing the non-continuous, non-homogeneous surface shown and described herein. The cracks are random in configuration because of the formation process. However, they form a pattern of isolated lands 20 in a carefully controlled ratio of crack size and quantity to land area. This aspect has been found to be of critical importance in the construction of the present invention. Another critical aspect shown in this figure is the density of cracks 18 relative to the smooth lands 20. The crack density illustrated in Figure 3 is between 14 and 17 percent, and more particularly, on the order of 15% which has been found to be preferable relative to dynamic operation modes transferring relatively non-viscous fluids such as water. A crack depth of .001 to .002 inches and similar width has likewise been found to produce optimal results.

Referring now to Figure 4, there is shown an alternative crack pattern density of the order of 20 percent. It may be seen that the density figure is an average which denotes the surface discontinuity relative to the smooth lands 20. The size of the cracks 18 is preferably not effected. It has been found, however, that as the crack density increases there is a tendency for there to be pitted, shallow, crack areas in the lands 20. This condition, when not controlled to produce the smooth lands 20 shown in Figure 3, is a deviation from the crack pattern 14 of the present invention and may result in a pitted roller surface much like earlier prior art roller designs not affording the fluid transfer characteristic of the present invention. Pitted surfaces of certain prior art rollers do not exhibit lateral fluid flow in the cracks because they are not interconnected. In the dynamic mode, the interconnection of the cracks facilitates fluid transfer from fluid supply means provided under pressure, such as pressure indented rollers. The term "pressure indented" as used herein refers to that loading condition between rollers wherein the surface profile of one or both is effected, or indented, by the overlapping roller positions. In like manner, the crack pattern 14 facilitates deposit of the fluid to the particular medium to which it is transferred because the said fluid is always flowing within the crack pattern 14.

Referring now to Figure 5 there is shown an enlarged, diagrammatic view of one embodiment of a roller 10 according to the present invention. It will be appreciated that the plating layer 16 is shown on an enlarged scale compared to the core 11. Fluid is brought to the roller 10 by a second roller 22. This operational configuration is for purposes of example only; any suitable means for providing fluid to the roller 10 would be sufficient. If desired the said fluid may be supplied under pressure and other means (not shown) may be provided for said pressure supply arrangement. The second roller 22, as is conventional has a soft outer surface 24 for engaging the hard roller 10 in pressure indented relationships, as shown diagrammatically at the interface 26. A supply nip 28 of fluid 30 is formed at the juncture of the two rollers. Fluid 30 is then squeezed through the roller interface 26 and transferred along the surface of the roller 10. It is at this point in the fluid transfer process that the advantages or problems of the particular hard-surfaced roller are conventionally manifested. The thickness of the resulting fluid film 32 on the roller of the present invention has been shown in tests to be both more uniform and greater in size than many other prior art hard-surfaced rollers. This is not to say, however, that certain individual fluid transfer characteristics, such as film thickness could not be matched by select prior art roller designs, but such prior art designs also affect other transfer characteristics previously discussed. For example, an "Anilox" (registered Trade Mark) roller will transfer thicker film or fluid but often at lesser quality and efficiency than polished hydrophilic rollers. Aside from the fragility of copper clad plated rollers, when the surface texture of such a "rough" roller exceeds a critical value, differential drive forces between rollers become a problem and residues can build up in the cracks or pitted areas.

The manufacture of the roller 10 of the present invention incorporates various techniques of plating and etching some of which have been found successful in fabricating what can be thought of as an opposite configuration to the roller 20 of the present invention namely hollow piston cylinders for engines. The cracks in such instances are formed on the inside of the cylinder walls and are usually very deep to carry oil for purposes of lubrication. Such methods have been used and taught by various industrial plating companies wherein chrome and iron plating is formed with crack patterns of varying configurations and degrees. The crack pattern described for piston cylinders enables the piston walls to exhibit "pockets" for holding oil and reducing friction and wear. The "pores", as they are often referred to, are electrically etched into the hard metal surface. The plateaus, or lands 20, between the pores are honed or polished to provide a true bearing surface. Various electroplating-etching processes have been described to provide the necessary surface smoothness porosity characteristics. Since the surface characteristics of this process have not been directed to date toward fluid transfer rollers as described herein, the design parameters have not been heretofore established and the prior art has not recognized the viability of such an approach to a fluid transfer roller.

The particular crack pattern 14 described herein for the roller 20 has been shown by testing to be of synergistic genesis. The rheology characteristics are neither like those of the smooth or rough surface rollers of the prior art transfer rollers. Likewise, alterations of crack density, dimension and configuration as defined herein, have been shown to exhibit advantageous characteristics without the creation of critical disadvantages. Therefor, while the process of fabricating the roller 20 in accordance with the principles of the present invention is only generally set forth as to process steps, these steps will enable a man skilled in the art to produce the roller of the present invention,when directing the process specifically to the pattern 14 specifications herein defined. For purposes of example only, Electro-Plating, Inc. of Houston, Texas has been able to produce the specific roller configuration herein defined when incorporating the below enumerated steps. It should be noted however, that the fabrication of pattern 14 of the roller 20 is achieved in part, at least, through artisan skills in producing the intended and defined crack pattern and surface condition described. The following process steps are thus enabling to one so skilled in the art:

First, a cylindrical core is prepared for plating with chromium or the like. The core is precisely aligned relative to the plating anode for uniform plating therearound. When the plated metal reaches a pre-determined thickness of the order of .020 inches it is then electroetched, as that term is known in the industry, wherein the plating current is reversed, to remove portions of the plated material. The interconnected cracks 18 are believed to be formed at this time and generally extend into the surface 14 a distance of the order of .010 inches, depending on the thickness thereof. The etched roller is then honed or polished on a lathe or the like to reduce the plating thickness, critically define the surface dimension and configuration and produce the smooth uniform lands 20 and uniform crack depth in the configuration illustrated in Figures 1—4 and as above defined. The etching and polishing step must be coordinated to produce a crack pattern 14 as defined herein rather than conventional etched porosity and/or random crack depth density configurations. A crack depth between .001 and .003 inches, has been found satisfactory. For this reason the initial thickness of the plated metal upon the cylinder core is often greater than usual for conventional plated surfaces, the etching more controlled and the polishing critically coordinated to the aforesaid pattern.

In operation the roller 20 is prepared for its particular application by again etching the roller 20 with a suitable agent such as hydrochloric acid for chrome surfaces, in order to render all surfaces, lands 20 and cracks 18 fluid receptive. The roller 20 is then mounted for rotation in the particular system adjacent a fluid supply and deposit area for transfer therebetween. As shown in Figure 1, the roller 20 may be disposed against a soft surface roller, and each driven independently of the other, or in unison. It has been found that a degree of turbulence is imparted to the fluid film through the rotational interface 26. The turbulence due in part to lateral fluid flow in the cracks 18 substantially reduces the laminar flow problems generally associated with smoothly finished rollers.

For example, fluid rings or ridges can build up in laminar fluid transfer on smooth, continuous hydrophilic surfaces. The crack pattern 14 of the present invention alleviates such rings through dynamic surface action. This aspect is particularly useful in lithographic dampening systems where alcohol is often utilized in the dampening fluid or fountain solution to reduce surface tension. The use of the crack pattern 14 of the roller 20 reduces the need for alcohol and such wetting agents, thus improving cost effectiveness in the system of application.

In summary, the method and apparatus of the present invention provides a means for improving the transferability of fluid with fluid rollers. For a given fluid viscosity, roller speed and drive horse-power the roller 20 of the present invention will provide a more uniform transfer of fluid with substantially fewer transfer problems than with prior art apparatus. Additionally, more viscous fluids can be transferred with the rollers of the present invention than deemed operable by most prior art methods and apparatus.

Claims

1. A fluid transfer roller having a cylindrical core and a hard outer surface plated around the core and having a random pattern of relatively shallow, interconnected cracks and polished lands formed thereon.

2. A roller as claimed in Claim 1 in which the metallic surface is plated chromium.

3. A roller as claimed in Claim 1 or Claim 2 in which the plated chromium is etched and polished to afford the said random crack pattern.

4. A roller as claimed in Claim 3 in which the initial chromium thickness upon the cylindrical core is up to .020 inches and the average polished crack pattern depth is up to .003 inches.

5. A roller as claimed in any of the preceding claims in which the said cracks comprise between 9 and 26 percent of the surface area of the roller.

6. A roller as claimed in Claim 5 in which the said cracks comprise between 14 and 17 percent of the surface area of the roller.

7. A fluid transfer system comprising a hard surfaced fluid transfer roller as claimed in any one of the preceding claims mounted to rotate contiguous a fluid supply and a fluid deposit surface to transfer fluid from the former to the latter.

8. A system as claimed in Claim 7 in which the fluid supply is a soft surfaced roller adapted for rotating the hard-surfaced roller.

9. A system as claimed in Claim 7 or Claim 8 in which the fluid deposit surface is a soft surface roller adapted for rotating the hard surfaced roller.

10. A system as claimed in Claim 7 or Claim 8 in which the fluid deposit surface is a web of material positioned to pass over the surface of the hard roller for receiving the transferred fluid.

11. A method of manufacturing a hard surfaced, fluid transfer roller having a hard metal plating on the outer surface of a cylindrical core, which includes providing a cylindrical core having a hard metal plating on the outer surface of the core;

etching the plated surface to impart a random pattern of interconnected cracks and segregated lands to the metal plated surface;

polishing the surface of the roller to produce smoothly finished lands between the pattern of interconnected cracks, the cracks comprising up to 30 percent of the surface area of the roller; and

cleaning the surface and the cracks of the roller to render the surface of the roller fluid receptive.

12. A method as claimed in Claim 11 in which the metal plating is chromium.

13. A method as claimed in Claim 11 or Claim 12 in which the etching involves electroetching.

14. A method as claimed in Claim 11, 12 or 13 in which the step of etching the plated core includes immersing the core in hydrochloric acid.

15. A method as claimed in any one of Claims 11 to 14 in which the step of applying a metal plating includes imparting a plating thickness up to .020 inches.

16. A method as claimed in any one of Claims 11 to 15 in which the cracks comprise between 9 and 26 percent of the surface area of the roller.

17. A method as claimed in any one of Claims 11 to 16 which includes polishing the lands between the cracks to a smooth finish whereby the average crack pattern depth is up to .003 inches.

18. A method as claimed in any one of Claims 11 to 17 in which the cracks initially depend into the surface of the roller an average depth up to .010 inches and after polishing depend into the surface of the roller an average of .002 inches.

19. A method as claimed in any one of Claims 11 to 18 wherein the cracks depend into the surface of the roller after polishing an average depth between .001 and .002 inches.

20. A method as claimed in any one of Claims 11 to 19 wherein the cracks in the surface of the roller have an average width of between .001 and .002 inches.

21. A method of transferring fluid between a hard-surfaced roller as claimed in any one of Claims 1 to 6 which includes mounting the hard-surfaced roller in pressure indented relationship with a soft-surfaced roller, rotating the hard-surfaced roller and crack pattern relative to the soft-surfaced roller;

driving the hard and soft-surfaced rollers in contact with a fluid to be transferred; and

passing the fluid between the hard and soft-surfaced rollers.

22. A method as claimed in Claim 21 in which the step of passing the fluid between the hard and soft-surfaced rollers includes the step of engaging the fluid passing therebetween with the rotating crack pattern of the hard-surfaced roller and imparting turbulence to the passed fluid.

23. A method as claimed in Claim 21 or Claim 22 in which the step of passing the fluid between the hard and soft-surfaced rollers includes mechanically breaking down the surface tension of the fluid passing therebetween for facilitating fluid transfer.

24. A fluid transfer roller as specifically described herein with reference to the accompanying drawings.

25. A fluid transfer system as specifically described herein with reference to the accompanying drawings.

26. A method of manufacturing a fluid transfer roller as specifically described herein with reference to the accompanying drawings.

27. A method of transferring fluid as specifically described herein with reference to the accompanying drawings.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1980. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.