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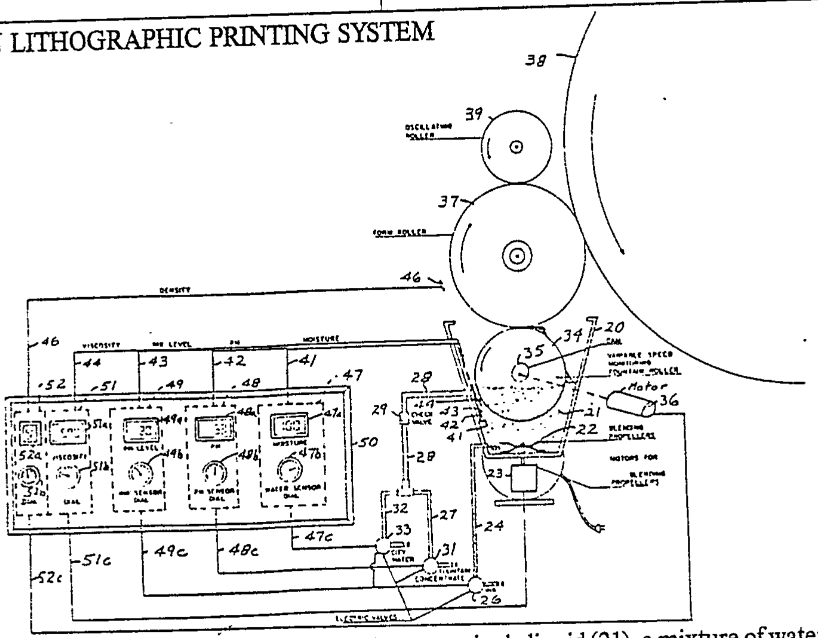

(57) Abstract

Water and oil base ink are delivered to lithographic plates as a single liquid (21), a mixture of water and ink, wherein the water is in the form of fine droplets. Preferably also, lithographic concentrate is added to the mixture as part of the water content. During a printing run the mixture (21) is automatically resupplied to the printing machine by a level sensor (43) that controls the amount of ink and water and by a pH sensor (42) that controls the concentrate percentage. The proportion of ink and water is controlled by a moisture sensor (41). The thickness of the film of mixture delivered to the lithographic plate is controlled by a density sensor (46). A viscosity sensor (44) controls the agitation of the mixture. A set of three rollers (34, 37, 39) is used to deliver the ink-water-concentrate mixture to the lithographic plate (38) in contrast to several dozen rollers conventionally used. The rollers (112) that supply ink and/or water to form rollers (113) have a surface with minutely intermixed hydrophilic and oleophilic areas (140, 141, 151, 152, 161, 162). The amount of water retained by a roller is dependent upon the total of the hydrophilic areas (e.g. 140), and the amount of oil-based ink retained by the roller is dependent upon the total of the oleophilic areas (e.g. 141). A preselected ratio of oil to water is obtained by selecting the ratio of hydrophilic areas (e.g. 140) to oleophilic areas (e.g. 141).

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EMULSION LITHOGRAPHIC PRINTING SYSTEM

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TECHNICAL FIELD

My invention relates to planographic printing and has particular reference to lithography and related processes that depend upon delineation of the printed subject matter by means of hydrophilic and oleophilic areas on a printing surface, the ink being repelled by the water-wetted areas and being retained by the grease or oil-absorbing areas. I have discovered that a mixture of ink and water and lithographic concentrate may be applied as a single liquid to lithographic plates and that the mixture ratios may be maintained automatically by means of sensors and controls responsive to the sensor outputs through a microprocessor computer or other means.

This invention also relates to the applying of ink and water to lithographic printing plates and printing cylinders, including direct printing plate cylinders and plates and plate cylinders for offset printing. The invention is useful in lithographic and letter press printing.

BACKGROUND OF THE PRIOR ART

Conventional printing machines for newspapers and other high-production printing presses generally use the lithographic process wherein metal plates are treated to have water-retaining or water-loving areas and grease-retaining or oil-loving areas to define the printed subject matter. This process is based upon use of inks that have an oil base and the ink is repelled by the water-dampened areas and absorbed by the oil-retaining areas. Such lithographic inks employ pigments that are not soluble in water so as to avoid any tinting.

In this prior art, the plates are wrapped around cylinders referred to as plate cylinders. Water is applied at one axially parallel line on the surface of the rotating cylinders, and, downstream from the water, ink is applied along another longitudinal line. The best quality printing is obtained not by printing directly from the plate cylinder, but by transferring the ink from the plate cylinder to a blanket cylinder coated with a rubberlike surface. A third cylinder called an impression cylinder presses a strip of paper against the surface of the blanket roller to print the paper. Thus, three principal cylinders are used, the plate cylinder, the blanket cylinder, and the impression cylinder.

In addition to these three principal cylinders, a cluster of cylinders or rollers is used to transport the water from a trough called a fountain to the plate cylinder, and an even more elaborate set of rollers is used to transport the ink from the ink trough or fountain to the surface of the plate cylinder. Frequently, as many as six rollers or cylinders are used in the water cluster, and as many as twenty or twenty-five rollers and cylinders are used in the ink cluster.

The inking of lithographic and letter press plates, whether flat or in cylinder form, has always been a difficult problem for high-production printing presses. The image to be printed is defined on the printing surface, usually photographically. To achieve this, photosensitive coatings are disposed on the printing surface, and the photographic exposure produces hydrophilic, or water-loving, areas that absorb water. These areas repel the ink, which is oil-based. The photographic treatment of the surface may also produce ōleophilic, or ink-loving, areas that repel water and positively retain the oil-based ink. The subject matter being printed, whether words or pictures, is thus defined by these hydrophilic and oleophilic areas on the plates.

As mentioned, the usual high-production presses use a cluster of rollers to apply water to the plates, and, downstream in printing motion, a second cluster of rollers applies the oil-based ink. In order to obtain a uniform distribution of water and ink, there are conventionally clusters of rollers for water and a separate cluster of interengaging rollers for ink. Each cluster may vary from five to sixteen or more in number.

The last roller in a cluster, the roller that applies ink or water to a plate cylinder, is generally constructed with a rubber surface and is generally known as a form roller. The form roller contacts the plate cylinder and generally has the same peripheral speed as the plate cylinder. The rollers that apply ink or water to the form roller generally have a metal surface and have a variable speed motor drive so that the peripheral speed may be quite different from the peripheral speed of the form roller in order to spread or thicken the film of oil or water. This relative slippage between these supply rollers and the form roller produces heat, which causes problems.

In addition to the variable of relative peripheral speeds, the pressure between the supply rollers and the form roller is quite critical and varies with the slippage. The adjustment of pressure between these rollers is time-consuming and reduces production time.

BRIEF SUMMARY OF THE INVENTION

I have discovered that the ink and water may be applied to the plate cylinder together as a mixture. I have discovered that this mixture may be continuously controlled in the proportions while being applied to the plate cylinder. Furthermore, I have found that the mixture results in a superior quality of image better than that obtained by the conventional inking and dampening systems. Further, I have discovered that my ink-water mixture may be applied by a simple set of rollers. For example, three cylinders have been satisfactory, thus avoiding large clusters. This results in a mixture applicator of small size that may be applied to any cylinder in conventional printing presses. This enables the blanket and/or impression cylinders of a printing machine to be used as a second plate cylinder, thus doubling the capacity of existing machines if the operator desires to make this conversion.

I have found that the mixture of water and ink may be made up of approximately equal quantities of water and ink for newspaper printing while maintaining the usual ratio of lithographic concentrate to the water part of the mixture. I maintain the mixture ratios by continuously sensing the mixture for viscosity, mixture level, pH, and water proportion. The density of the ink is photoelectrically determined by scanning the film of ink on a form roller or printed surface.

If the viscosity is too high or too low, the blending rotors or propellers in the trough or fountain are speeded up or slowed down automatically. If the ink level is too high, the ink and water flow is momentarily reduced by throttling down the ink and water flow valves (preferably electrically controlled) and the valves are opened when the ink mixture level is too low. If the pH is too high or too low, the concentrate flow is reduced or increased with relation to water flow depending upon whether acid or alkaline concentrate is being used. If the water proportion is too low, the water flow is increased and vice versa if the water proportion is too high. If the scanning of the form roller and/or paper shows that the water-ink film is too dark, the variable-speed fountain roller is decreased in speed; if too light, it is increased in speed, all automatically by the microprocessing computer or other means.

I have also discovered that an ink fountain roller or a water fountain roller or a combined ink and water fountain roller will function more effectively if its surface is divided into minute areas that are hydrophilic and other minute areas that are oleophilic. I have further discovered that the surface may also contain areas that repel both water and oil by coating with polytetrafluoroethylene, a substance that is sold by one manufacturer under the brand name and trademark of "Teflon". This material is generally referred to in the trade as TFE, and sometimes PTFE.

I have used a copper-coated fountain roller that is etched to define water-loving areas and counter-etched to define ink-loving areas. Also, these two areas may be formed on a roller having a chromium surface that is hydrophilic and which has copper areas formed on it to define oleophilic areas. The fountain rollers may be screened to define intaglio-like patterns or may contain dots of any desired size as in half-tone printing. The dots may represent the hydrophilic area and the background the oleophillic, or vice versa. In another form, the surface may have minute lines that are preferably parallel of alternating chromium and copper, preferably in a spiral pattern when placed on a cylinder. In still another form a chromium or other hydrophilic surface is constructed to have areas of rubber which is oleophilic.

The pattern need not be uniform. To counteract the usual water deficiency at the ends of the roller, the number of water-locing areas may be increased in proportion to the ink-loving areas.

This new type of roller is useful in my combined ink and water fountain, because it automatically picks up the required percentages of water and ink dependent upon the geometry of the yydrophilic and the oleophilic areas. The use of this new roller on the mixed water and ink makes the transfer of water and ink to the form roller independent (within limits) of the intimacy, or minuteness of dispersion of the ink and water mixture.

This automatic control of the correct amount of water and ink is further enhanced by having areas of the roller surface coated with TFE or equivalent materials. This material may be applied by sputtering or similar techniques that result in dispersed lots of TFE. This material repels both water and ink, and, by regulating the area covered with TFE, the amount of water and ink per revolution of the roller is closely controlled.

I have discovered further that my new type of fountain roller makes less critical the pressure of the contact line between fountain rollers, distributing rollers and form rollers.

BRIEF DESCRIPTION OF THE DRAWINGS

Various objects, advantages, and features of the invention will be apparent in the following description and claims considered together with the drawings forming an integral part of this application in which:

Fig. 1 is a diagrammatic view of my inking apparatus showing the various controls;

Fig. 2 is a three-dimensional view of the mechanical parts of Fig. 1, but deleting the control circuits.

Fig. 3 is a set of three related diagrams 3A, 3B, and 3C showing different stages of my photo-hardened surface adhered to a resilient rubber base.

Fig. 4 is a diagram showing the conversion of conventional blanket cylinders in conventional rotary presses to plate cylinders using my water and ink supply mechanism, thereby doubling output.

Fig. 5 is a diagram of five plate cylinders arranged to print both sides of four newsprint webs to obtain a total of eight printed sides.

Fig. 6 is a more detailed schematic drawing of the apparatus of Figure 1, wherein a mixture of water and ink is applied to a plate cylinder from a single fountain.

Fig. 7 is a three-dimensional illustration of either the fountain roller of Fig. 6 or the form roller of Fig. 6 having a surface formed in accordance with the invention.

Fig. 8 is a schematic diagram of one form of surface for the roller of Fig. 7, wherein one of the areas is in the form of dots and the other is the background.

Fig. 9 is a schematic diagram of the surface of the rollers of Fig. 7, wherein one of the hydrophilic or oleophilic areas is represented by open circles and the other is the background, but wherein there are also areas of water-repellent and oil-repellent material repreented by black circles.

Fig. 10 is a schematic illustration on an enlarged scale of the use of rectangular areas of either hydrophilic or oleophilic material on the surface of the roller of Fig. 7.

Fig. 11 is a schematic diagram of still a different surface for the roller of Fig. 7, wherein there are lines of either o leophilic or hydrophilic areas, and the background is composed of the other of these two areas.

Fig. 12 is a diagram on a greatly enlarged scale of a cross section along the line 12-12 of Figure 11, showing a scoring of the surface of the roller, and wherein a rubber-like material has been disposed in the score marks to form the oleophilic areas.

Fig. 13 is a schematic diagram of the surface for the roller of Fig. 7, wherein the lines on the surface are cross-hatched for greater density of either the oleophilic or hydrophilic material.

Figs. 14, 15, 16 and 17 are modified forms of roller combinations using the invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to Fig. 1, a trough 20, referred to in the industry as a fountain, holds a mixture 21 of ink, water, and fountain concentrate, and this mixture is finely divided or dispersed by a series of agitation propellers 22 driven by motors 23. The ink is supplied to the trough 20 by a pipe 24 controlled by an electric valve 26 connected to a source of ink under pressure (not shown). The fountain concentrate is supplied to the trough 20 by a pipe 27 connected to a pipe 28 having a check valve 29, and flow of concentrate is controlled by an electric valve 31 connected to a source of concentrate under pressure (not shown). Water is supplied by a pipe 32 also connected to the pipe 28, and flow is controlled by an electric valve 33 connected to a source of water such as a domestic or municipal water supply.

Partially immersed in the ink-water mixture 21 in the trough 20 is a fountain roller 34 driven by a variable speed motor 36. This roller 34 is in rolling contact with a form roller 37 which rotates at a uniform velocity. The viscosity of the ink-water mixture on the surface of the fountain roller 34 causes the two rollers 34 and 37 to not actually engage each other, approximately by the distance of the thickness of the ink-water film transferred to the form roller 37. A cam 35 is provided to adjust the pressure between the fountain roller 34 and the form roller 37, and this is a manual adjustment for the particular ink-water mixture and, once set, is not changed during printing. The form roller 37 is in rolling contact with a plate cylinder 38, on which is disposed a lithographic plate made of metal whose surface is treated to form hydrophilic areas and oleophilic areas that define the printed subject matter. The form roller transfers the ink-water mixture in finely dispersed form so that discrete particles of water adhere to the hydrophilic areas and discrete particles of oil base ink adhere to the oleophilic areas. When paper is roller against this surface of plate cylinder 38, the ink is transferred to the paper and the subject matter is printed.

I presently prefer to have a third roller to complete the transfer of the ink-water mixture, and this is an oscillating roller 39 in contact with form roller 37. This roller 39 oscillates back and forth on its fixed axis of rotation to spread evenly the film of ink-water mixture on the surface of form roller 37. As mentioned previously, these three rollers 34, 37 and 39 apply both ink and water to the plate cylinder in contrast to the conventional clusters of several dozens of rollers for the same purpose. My assembly of three rollers occupies such a small space in conventional printing machines or presses that they can be readily inserted into existing presses not only on plate cylinders, but also on blanket and impression cylinders that are converted to plate cylinders.

CONTROL OF THE MIXTURE

The mixture of ink, water, and concentrate is being continuously depleted during a printing run and must be continuously resupplied. I have devised an automatic mechanism to effect this resupply and presently prefer to control it by a microprocessor. To this extent my controller may be termed a mini-computer. However, prior automatic controls may also function effectively, and I do not limit myself to computer mechanisms.

Referring to Fig. 1, I dispose four sensors in the ink-water and concentrate mixture 21, a water concentration sensor 41, a pH sensor 42, a mixture level (ink level) sensor 43, and a viscosity sensor 44. I dispose a fifth sensor 46 opposite the form roller 34, and this sensor preferably measures photoelectrically the density of the film of mixture 21 on that roller. While this is shown as measured on roller 37, it could also be measured on roller 34 or by stroboscopic lights on cylinder 38 or the printed paper itself.

Each sensor 41-46 has its output conducted by wires of the same number to controllers 47, 48, 49, 51 and 52, respectively, preferably disposed in a panel 50 and each preferably having a readout, preferably digital. The moisture controller 47 has a readout 47a and a dial 47b for setting the controller 47 for the predetermined percentage of water in the mixture. Determining the percentage of water automatically determines the percentage of ink, inasmuch as the percentage of concentrate (pH) is about one percent, sometimes a little more and generally less than one percent. Leading from the bottom of controller 47 is a wire 47c connected to the water valve 33, which opens wider or closes down to admit more or less water.

The pH controller 48 has a readout 48a and a setting dial 48b to fix the pH. These concentrates (pipe 27) are proprietary products usually compounded to work with a proprietary lithographic ink, or in the case of color with a family of inks. Some concentrates are acidic and others are alkaline, the acids having a pH of 5 or 6 and the alkalines about 9 or 10. The exact percentage of concentrate depends upon the mineral content of the water supply and varies from city to city. Some printers try to avoid the concentration determination by using distilled water or deionized water. However, the dial setting is placed at the manufacturer's recommended pH, and the controller 48 maintains it by opening up or closing down valve 31 by means of a wire 48c. As mentioned previously, the concentrate percentage is small, usually around one percent or less.

The ink level (mixture level) in the trough 20 is controlled, because the amount of immersion of fountain roller 34 affects the thickness of the film of mixture on form roller 37. I prefer to keep it below the rotation axis of the fountain roller. The level sensor 43 delivers its output to the controller 49 having readout 49a and a setting dial 49b which controls the level. This is accomplished by a wire 49c leading from controller 49 to both the water valve 33 and ink valve 26 so that the flow of both may be increased or decreased in unison.

The viscosity sensor 44 delivers its output to the controller 51 having readout 51a and dial setting 51b and having a wire 51c leading to the variable speed mixture motor 23. Actuation of the motor 23 causes agitation resulting in more mixing of the water and ink into finer particles, to change the viscosity. Viscosity is also changed as the agitators heat up the mixture. Agitation may be effected in any desired manner. The viscosity determines the amount of ink-water-concentrate mixture that is picked up by the fountain roller 34. The amount of mixing of ink and water for satisfactory results may vary between wide limits. The mixing breaks up the water into droplets, each of which is surrounded by a film of oily ink. Generally, any mixture having eighty-five droplets or more per linear inch is satisfactory, but 200 or more is preferable.

The density sensor indicates several things, the color of the ink, the thickness of the film, the reflectivity of the surface of form roller 37, etc. For any given ink being used it forms an effective control for the film thickness on the form roller 37. The output of sensor 46 is delivered to controller 52 having a readout 52a and a dial setting 52b. Leading from the controller 52 is a wire 52c connected to the variable speed motor 36. This motor drives the fountain roller 34 faster to obtain a thicker film of mixture and slower to obtain a thinner film.

I presently prefer the controllers 47, 48, 49, 51, and 52 to include microprocessors which are solid state electronic circuits commonly used in computer control circuits. I prefer these over more conventional automatic controls because of the memory aspect that regulates the control electronically for a preselected setting of the dials 47b, 48b, 49b, 51b and 52b. The controllers do not necessarily supply the actuating current, but may deliver only control current to speed controls at the motors and variable controls at the valves.

Referring now to Fig. 2, the apparatus of Fig. 1 is shown in three dimensions. There it will be noted that the ink pipe 24 has branches 24a leading to each part of the trough 20 that has agitation propellers 22. Similarly, the water concentrate pipe 28 has a corresponding number of branch pipes 28a.

OPERATION

Referring to Fig. 1, to start an inking run, the panel 50 is energized and ink, water and concentrate flow into the trough 20 through pipes 24, 27, 32 and 28 until the desired level is reached. The level sensor 43 then actuates the valves 26 and 33 to shut off flow, and the pH sensor 42 controls the concentrate flow valve 33. At the same time the mixing propellers 22 are actuated and remain continuously in motion at greater or lesser speeds under the control of the viscosity sensor 44. The printing press is then actuated, causing plate cylinder 38 to rotate as well as fountain roller 34, form roller 37, and oscillating roller 39, and the printing process is in full operation.

The fountain roller 34 picks up mixture 21 from trough 20, and the excess is squeezed out at the contact line with form roller 37. The density sensor 46 delivers its output to the thickness controller 52, which delivers a signal by wire 52c to the motor 36 to speed up roller 34 if the film is too thin and slow up roller 34 if it is too thick.

The percentage of water (and inversely the percentage of ink) in the mixture is continuously monitored by sensor 41, and the water flow through valve 33 is automatically increased or decreased to keep the percentage at setting made by dial 47b. The percentage of water and ink in my process is approximately the same as that consumed by the same or similar press using conventional separate water and ink supply mechanisms. A typical mixture is fifty-four percent ink, forty-five percent water, and one percent concentrate.

The amount or percentage of concentrate is regulated automatically by pH sensor 42 and controller 48, which opens or closes valve 31 to give more or less concentrate.

The viscosity sensor 44 controls the propellers 22 by delivering its output to controller 51, which in turn delivers a current over wire 51c to motors 23 to control their speed.

The desired control setting for each controller is dialed into it by dials 47b, 48b, 49b, 51b and 52b. If microprocessors are used, this setting is stored in its memory. The readouts 47a, 48a, 49a, 51a and 52a give a visual check of the correct functioning of the system for the information of the operator.

ELASTIC SURFACE LITHOGRAPHIC PLATE

I have devised an elastic surface for lithographic plates that gives a quality of printing when printed directly to the paper that is equal to the conventional metal surface plate cylinder combined with the usual blanket cylinder to achieve offset printing. The elastic surface may be made of any rubber-like material.

The elastic surface is normally flat and after treatment is attached to a substrate of plastic or metal that may be attached to a plate cylinder of any construction for printing. The elastic material may be of any suitable kind that is not only flexible, but elastic and elastically deformable under the pressures normally used in rotary printing presses. The elastic material may be of any thickness; .006 inch is a practical minimum, but is not a limitation. The outer surface is smooth. I coat the outer surface with a light-sensitive hydrophilic material having a practical working range of thickness of .0001 to .001 inch and a possible range fifty percent lesser and greater than these dimensions. I project upon it an image of the subject matter to be printed. Where light impinges on the surface, the coating is hardened; where no light strikes, the coating remains soft, and that part of the coating is washed away with water. The result is a broken coating defining the subject matter to be printed. The image may be projected with a lens or the sheet of subject matter may be laid directly on the coating and light passed through the sheets to form hardened areas in the coating. The sheet of treated elastic material is then placed over the surface of a plate cylinder, and water and ink are applied to the treated surface.

The elastic material being oleophilic holds the ink, and the hardened surfaces repel ink and hold water. When paper is pressed against this surface, the raised hydrophilic surfaces of the coating are pressed into the elastic material, causing the ink in the ink-holding areas to be pressed into the fibers of the paper.

Referring to Fig. 3A, a composite printing surface 60 has an elastic base 61 of rubber or rubber-like material and a light-sensitive coating 62, wherein the light-sensitive surface has been "washed out"; the condition it assumes after an image has been projected upon it and after the coating has been washed to remove the areas which did not receive light. The light-hardened areas are the coating portions 62, and the washed-out cavities that reveal the elastic material 61 are indicated at 63.

Referring now to Fig. 3B, water and ink have been applied to the composite surface 60 either by conventional means or by the apparatus of Fig. 1, as desired. The elastic material 61 being oleophilic holds ink 64 in the cavities 63 (Fig. 3A), and the raised hardened surfaces 62 hold water 66.

Referring now to Fig. 3C, a sheet of paper 67 has been pressed against the composite surface with a force sufficient to elastically depress the hardened coating sections into the elastic material. The amount of elastic depression is about the thickness of the coating, bringing the inked elastic surface into contact with the paper. Additionally, depressing the hardened sections 62 into the elastic material 61 tends to force outwardly adjacent portions of the elastic material 61.

The exact amount of pressure is empirically determined for a particular elastic sheet and paper.

This pressure shown in Fig. 3C forces the colorless water 66 into the paper, and it may subsequently be removed by evaporation. More importantly, the ink 64 is forced into the paper 67 to effect the printing.

I presently prefer to use a photo-sensitive coating 62 that is commonly used in letter press printing that uses the "wash out" to create images. In this current use, the raised coating sections are inked by a roller, and the sections of the smooth base that are exposed by the "wash out" are non-printing. However, in my process the raised portions must reject ink. Accordingly, I mix gum arabic or synthetic equivalents in the light photopolymer, and the hardened coating sections are then hydrophilic and oleophobic. I do not know the chemical composition of these commercially available photosensitive materials, but I have used successfully a material sold by Hercules, Inc., known as "Hercules Merigraph" photopolymer resin. The elastic material 61 may be of any suitable type, natural or synthetic, and therefore may be referred to as rubber-like. I presently prefer silicone rubber.

PLATE-TO-PLATE PRINTING CYLINDER GEOMETRIES

My new lithographic surface makes it possible to eliminate the blanket cylinder in lithographic presses, because the quality of printing directly to the paper from my plate cylinder is equal to that from a blanket cylinder. More practically, this makes it possible to convert the blanket cylinders of conventional presses into plate cylinders and thereby print both sides of a sheet of paper simultaneously between them, thus doubling the output of conventional presses.

Referring to Fig. 4, there is illustrated two sets of cylinders of two each, which is a common geometry in most well known newspaper printing machines. The two lower cylinders 71 and 72 are normally the plate cylinders indicated by a "P", and the two higher cylinders 73 and 74 are normally the blanket cylinders indicated by a

"B". The plate cylinders 71 and 72 have a supply mechanism for water and ink indicated by the assembly 75 showing theprincipal mechanical parts of Figs. 1 and 2. Because my mechanism of Figs. 1 and 2 is so compact, it may be installed in space presently available in present newspaper presses to engage the two blanket cylinders 73 and 74 as shown and supply them with ink and water. Sheets of paper 76 and 77 are passed between the two sets of cylinders and printed on both sides simultaneously. This effectively doubles the output of existing presses with the same quality of printing.

Referring now to Fig. 5, there is illustrated a geometry that may be adapted to present presses and built into new presses wherein five or more plate cylinders are used. Because of my composite surface as shown in Fig. 3, each cylinder may be a high quality plate cylinder. Cylinders 81, 82, 83, 84 and 85 are each provided with a printing surface, and each is provided with an inking and/or ink and water supply (not shown). The subject matter being printed is the front and back of a page wherein high volume is desired, as in newspaper printing. This format is indicated by "F" for front and "B" for back at the cylinder and also at the surface of each strip or web of paper.

Passing between cylinders 81 and 82 is a web of paper 86 from a roll of paper 87. Cylinder 81 prints the front of the page and cylinder 82 prints the back of the page. Passing between cylinders 82 and 83 is a web of paper 88 from a roll 89, and the same "back" subject matter is printed by cylinder 82. Since cylinder 83 carries the same subject matter as cylinder 81, the front is also printed. Passing between cylinders 83 and 84 is a web 91 from a roll 92. Cylinder 84 prints the back image, and again cylinder 83 prints the front image. Passing between cylinders 84 and 85 is a web 93 from a roll 94. Cylinder 85 prints the front, and again cylinder 84 prints the back image.

In this geometry five cylinders print both sides of four sheets of paper, quadrupling the output of conventional presses wherein a set of three cylinders, a plate cylinder, a blanket cylinder, and an impression cylinder print one side of a newsprint web and a second set of three print the other side. In my geometry, five cylinders do quadruple the work of six cylinders in conventional presses. Cylinders 82, 83 and 84, which do double printing, may need a second supply mechanism for supplying ink and water, which is readily accomplished by using the mechanism of Fig. 1. Any number of cylinders may be employed to get the multiplying effect and may be in a horizontal or vertical string.

When more than two cylinders are employed simultaneously, the successive cylinders are strung out and are in peripheral contact with the preceding cylinder, but not the cylinder ahead of the preceding cylinder. Such an arrangement may be referred to as a string of cylinders as contrasted to a cluster of rubbing cylinders.

Referring to Fig. 6, there is illustrated a fountain or trough 110 containing a mixture of water and ink 111 in which is partially immersed a fountain roller 112, which carries this water and ink mixture to a form roller 113, which in turn is in contact with a plate cylinder 114. As oscillating roller 116 is in contact with the form roller 113, and it oscillates back and forth on its axis of rotation to smooth out any water and ink mixture on the form roller. The pressure of the fountain roller 112 against the form roller 113 is adjusted by virtue of a stationary shaft 117 on which the fountain roller rotates, which is eccentrically mounted about a center 118 so that the shaft acts as a cam and may be manually rotated by means of a handle 119.

The mixture of ink and water is blended by blending propellers 121 driven by a motor 122 actuated by a control wire 123. Ink from a supply source is controlled by a valve 124, fountain concentrate is controlled by a valve 128, and a supply of water is controlled by a valve 127. Check valves 128 and 129 isolate the water from the fountain concentrate, and the mixture of the two is delivered by a pine 131 to the trough, or fountain, 110.

The fountain roller 112 is rotated at a variable speed by a motor 132 acting through a drive shaft 133 as shown schematically.

The operation of the apparatus of Fig. 6 is as follows. Ink is supplied by opening the solenoid valve 124 by a suitable automatic control (not shown), and concentrate and water are added to the trough, or fountain, 110 by a suitable operation of the solenoid valves 126 and 127, preferably also by automatic control (not shown). The mixture 111 of water and oil is blended initimately by propellers 121 driven by the motor 122 under the control of automatic apparatus (not shown) to which the wire 123 connects the motor. The mixture of water and oil is not homogenized,but instead is merely intimately mixed so that there are discrete particles of water and oil present.

The fountain roller 112 is partially immersed in this mixture of water and ink, which collects on the surface by virtue of the oleophilic areas and the hydrophilic areas shown in more detail in Figs. 8 through 13. This water and ink mixture is carried to the form roller 113 by virtue of the contact between the two rollers. The amount of pressure between the two rollers is manually adjusted by rotating the lever 119 about the eccentric axis 118. The form roller 113 deposits the water and ink mixture on the plate cylinder 114 by virtue of its contact with that cylinder. This mixture will also be in the form of discrete particles of water and ink. If there is any lack of uniformity of dispersion of water and ink particles over the surface of form roller 113, this lack of uniformity is corrected by the oscillating roller 116 which oscillates back and forth on its axis of rotation as it rotates.

Referring to Fig. 7, there is illustrated one of the rollers in the train of rollers from the fountain 110 to the plate cylinder 114. At present, I prefer to have the fountain roller 112 formed in accordance with my invention, but the invention is applicable also to the form roller 113. Accordingly, Fig. 17 illustrates not only the fountain roller 112, or equivalent, but the form roller 113.

Illustrated in Fig. 8 is a schematic diagram of one type of surface on the roller of Fig. 7. This may consist of hydrophilic areas 140 on the surface of the roller, and the background may consist of oleophilic areas. It will be noted that the hydrophilic areas 140 are denser and use up a greater portion of the area toward the end of the cylinder of Fig. 8 as shown by the bracket 142 compared to the area designated by the bracket 143 where there is much less hydrophilic area as compared to the oleophilic background 141. This concentration of hydrophilic areas at the end of the roller corrects the usual condition found in fountain rollers and form rollers or other rollers in a cluster for applying ink or water or a mixture of both wherein conventionally there is insufficient amount of water at the ends of the rollers.

Illustrated in Fig. 9 is a roller having areas 145 which may be hydrophilic or oleophilic. If hydrophilic, then the background 146 is oleophilic, or vice versa. Interspersed among these areas 145 are areas 147 that repel both the water and oil. Accordingly, these areas limit the total amount of water and oil that can be picked up by a cylinder. At present, I prefer to use polytetrafluoroethylene, commonly referred to in the chemical trade as PTFE and sometimes TFE. The brand presently sold under the name of "Teflon" is preferred.

Illustrated in Fig. 10 is still another surface for the roller of Fig. 7, wherein the areas are rectangular in shape. Thus, squares or rectangles 151 may be formed on a background 152 to define hydrophilic or oleophilic areas. If the areas 151 are hydrophilic, the background 152 is oleophilic, or vice versa.

Illustrated in Figs. 11 and 12 is still another type of surface for the roller or rollers of Fig. 7, wherein material is deposited in very fine score marks made on the surface of the roller. Thus, generally parallel lines 155 may be formed of oleophilic material, and the spaces 156 between the lines may be hydrophilic. For example, this may be a chromium surface in which the lines are scored in a very fine pattern, and the score marks are then filled with a rubber-like material, which is then caused to adhere to the surface. This construction is illustrated in Fig. 12, wherein a plurality of score marks or grooves 157 are formed in the surface 156. The grooves 157 are filled with a rubber-like material 158. Rubber is normally oleophilic, and chromium hydrophilic. Thus, the areas 158 and 156 will define oleophilic and hydrophilic areas, respectively. The spacing and width of the score marks, or grooves, 157 with respect to the spaces 156 between them determine the relative amount of water and ink that is picked up or retained on the surface of the roller.

Illustrated in Fig. 13 is another modification similar to that of Fig. 11, but wherein there is a cross hatch of grooves that hold rubber-like material 161 and the areas 162 between the grooves or lines 161 define the hydrophilic areas.

An alternative construction for Figs. 11 and 13 is to have the lines 155 of Fig. 11 and the lines 161 of Fig. 13 formed of an oleophilic metal such as copper.

Referring to Fig. 14, there is illustrated apparatus similar to that of Fig. 6, but wherein there is added a squeegee roller to reduce or eliminate the build-up of water-ink mixture at the contact line or nip of the fountain roller and the form roller. In Fig. 14, a fountain trough 165 contains a blended mixture of water and oil-based ink 166 in which is partially immersed a fountain roller 167 having a rolling engagement with a form roller 168, which in turn has a rolling engagement with a plate cylinder 169. If desired, an oscillating roller 171 may engage the form roller 168 to evenly distribute the water and ink mixture over the surface of the form roller.

Provided at the fountain is a squeegee roller 172, which has a line of contact or nip 173 with the fountain roller 167, and this line or nip 173 is just above the normal level 174 of the water-ink mixture. The squeegee roller 172 preferably has a surface of rubber-like material, and by adjusting the pressure between rollers 172 and 167 the precise thickness of film of water and ink is achieved. I have found that the greater the pressure the greater is the proportion of ink to water, although the total of both is reduced by greater pressure. This pressure relationship, therefore, constitutes another proportion control between ink and water. This relationship applies whether the fountain roller 167 is a uniform surface roller or a surface having intermixed hydrophilic or oleophilic areas. I presently prefer to have the surface of squeegee roller 172 uniform as to attraction for water or ink, and I presently do not make this surface with intermixed hydrophilic and oleophilic areas. The surface of squeegee roller 172, however, could be composed of mixed hydrophilic and oleophilic area. I presently prefer to have the nip line 173 right at the level of the liquid 174 in order to bathe the nip in the mixture to maintain a full volume of mixture against the rollers.

Referring still to Fig. 14, the fountain roller 167 preferably has intermixed hydrophilic and oleophilic areas, the form roller 168 may have the standard rubber-like surface of conventional form rollers, the oscillating roller 171 may have a copper or nylon surface, and the plate cylinder may have a standard lithographic surface. Letterpress or flexograph plates may also be used.

Referring now to Figs. 8 through 13, there are various methods of construction of the surfaces of the rollers; therefore, only the presently preferred methods are described. The hydrophilic areas 140 on the surface of the roller of Fig. 8 are chromium, and the oleophilic background 141 is copper. This is preferably constructed by copper-plating a steel cylinder, polishing it, and then coating with a photo-resist. A photographic negative is then wrapped around the cylinder, and the cylinder is rotated to expose the resist to a strong light. The unexposed areas (areas 141) are then washed off, the remaining resist is hardened, and the cylinder is chromium-plated. The chromium is deposited only on the bare copper and not on the resist. The resist is then removed, leaving a pattern of chromium 140 (hydrophilic) and the background 141 of copper (oleophilic). The thickness of the chromium is so small, on the order of one thousandth of an inch or less, that the resultant roller is smooth for distribution purposes.

The application of PTFE to the roller of Fig. 9 may be accomplished by silk-screening liquid PTFE, or by flame spraying fine particles to spatter small particles on the surface, either directly or through a mask. Also, vacuum deposition may be employed wherein a static charge is placed on the roller, a mask is placed over the roller having holes where the PTFE is desired, and a pot of PTFE is heated to boiling or vaporizing temperature in the vacuum chamber.

The rectangular areas 151 of Fig. 10 may be formed similarly to areas 140 of Fig. 8.

The roller of Figs. 11, 12 and 13 may be formed in several ways. The grooves 157 may be etched by standard etching procedures such as the one described for Fig. 8. A steel roller is copper-plated, polished, and then chrome-plated. The chrome is then etched as shown in Fig. 12. The roller is next covered with unvulcanized rubber, vulcanized under pressure, and then the roller is ground to remove the excess rubber so that the remaining rubber 158 is flush with the surface of the chrome 156 as shown in Fig. 12.

I have also successfully used minute grinders to grind the grooves 157 and presently prefer to copper-plate and then chrome-plate a roller. The roller is mounted in a lathe for slow rotation while a battery of grinding wheels moves lengthwise on the carriage. The number of grooves per inch, measured transversely to the grooves, should be ten or more per inch. I presently prefer to form the grooves 157 in a spiral pattern at an angle of approximately fifteen degrees to the roller axis, although grooves parallel to the axis or at different angles to the axis will work. The grooves ground in the surface may be filled with a rubber-like material as previously described, or, where the chrome plate is think they merely cut through the chromium to expose the copper, which is oleophilic.

Another method of making a chrome and copper surface similar to Figs. 11 and 13 is to coat a resist on a copper-coated roller, wrap a negative with spiral lines, expose to light, and wash off the exposed resist. Chromium may then be placed on the bare copper in a spiral pattern or any other pattern, depending upon the negative.

The surface of the roller of Fig. 13 may be formed by knurling a chromium or other hydrophilic surface. If this causes raised edges along each groove, the roller may be ground to remove any projections, and the grooves are then filled with rubber as described previously and the excess rubber ground off.

Another method of forming oleophilic areas is to prick the surface with multiple needle-like tools. The resultant crater edges are then ground off, and the holes in the surface filled with a rubber-like material as described previously.

Various other techniques of manufacture are available, especially those known in the engraving and photoengraving industries and the mechanical or machine shop industry.

In this description I have referred to various rollers and cylinders being in contact with each other. Close inspection shows, however, that they seldom touch each other as they are always separated by a film of ink, water, or ink and water mixtures. The term "contact" is, therefore, used with this fact in mind to indicate that a roller bears against another roller or cylinder.

Fig. 15 is a schematic drawing of another modification which I have used to convert an existing press to my water and ink mixture. A conventional lithographic plate cylinder 180 is contacted or engaged by a conventional form roller 181, which in turn is engaged by a fountain roller 183, which is partially immersed in a water and ink mixture 184 held in a trough or fountain 186. In this series of three application rollers, the middle or intermediate roller is provided with a surface having intermixed hydrophilic and oleophilic areas. This intermediate roller substitution of my new roller in one type of conventional press results in minimum cost in converting an existing press. Here again, all three rollers 181, 182, and 183 could have the surfaces of intermixed hydrophilic and oleophilic areas.

It will be appreciated that my fountain rollers having intermixed hydrophilic and oleophilic surfaces (with or without PTFE areas) have great utility in applying my mixture of ink and water, but such a roller may also be advantageously used in conventional lithographic presses with separate ink and water-applying systems. The intermixed areas provide a means and method of regulating the amount of liquid picked up by a fountain roller and help to maintain the uniformity of film as well as correct water deficiency at the ends of the roller.

The cluster of rollers is often referred to in the industry as "distribution" rollers, whether for water or ink.

In letterpress, flexograph, or other nonlithographic printing system, the principles of my idea of using different surfaces on a single roller (such as steel and TFE) could be used in place of the usual Anilox roller, which uses mechanical means to reduce the amount of ink to be transferred.

Fig. 16 is a diagram of a modified form of the invention employing two form rollers, the upstream form roller applying more water than ink and the downstream form roller applying more ink than water. Such a sequence may give higher quality results. A trough or fountain 190 contains a blended mixture 191 of water and oil-based ink, and partially immersed in the mixture are form rollers 192 and 193 in rolling engagement so that they squeegee each other. However, the surfaces of these two fountain rollers 192 and 193 are quite different, roller 192 having a surface with a predominance of hydrophilic areas and roller 193 having a predominance of oleophilic areas. I presently prefer to have roller 192 pick up about eighty percent water and twenty percent ink and transport this to a form roller 194, which in turn is in engagement with a lithographic plate cylinder 196. The percentages are illustrative only as this percentage will vary with many factors, including paper finish, ink composition, paper humidity, pressure of the rollers and cylinder, etc.

I presently prefer to have on the surface of the fountain roller 193 intermixed hydrophilic and oleophilic areas, so that it picks up about twenty percent water and eighty percent ink, although, again, these percentages are illustrative and will vary according to many factors, including the percentages transported by the fountain roller 192. The water and ink are transported to an intermediate idler roller 197, which in turn transfers water and ink to a form roller 198, which then transfers water and the ink to the plate cylinder 196. The prior or upstream moistening of the plate cylinder gives more accurate water retention on the hydrophilic non-image-forming areas formed on the plate cylinder. The downstream roller gives more accurate ink retention on the oleophilic image areas, because the moistened areas will more accurately repel ink.

Both form rollers 194 and 198 may have oscillating rollers (not shown) to even the water and ink distribution. The fountain rollers 192 and 193 may have a greater concentration of hydrophilic areas at the ends, and, if desired, the form rollers 194 and 198 may have treated surfaces with end concentrations of hydrophilic areas.

Fig. 17 is a diagram for supplying ink only to a letterpress plate cylinder wherein the image to be printed is in relief. A fountain trough contains ink

102, but no water. Partially immersed in this ink is a form roller 104, which is squeegeed by a squeegee roller 103. The ink is transferred to a relief letterpress cylinder 107.

The amount of ink picked up is regulated by forming the surfaces of the squeegee roller 103 and form roller 104 to provide only a certain percentage of ink-carrying capacity. Intermixed areas of rubber and PTFE or copper and PTFE will regulate the amount of pickup. I presently prefer to make the surface of roller 104 of rubber having PTFE spots. These non-oleophilic surfaces, therefore, regulate the amount of ink transported to the letterpress plate cylinder 107. The liquid in fountain 101 could also be a mixture of water and oil-based ink for use on a lithographic plate cylinder.

Referring to Figs. 14, 16 and 17, the rotating action of rollers partially immersed in the water and ink mixture, or inbalance, causes the liquid to rise at the region of the nip because of adherence to the surface of such rollers. The nip should be close to the static level of the liquid in the fountain so that the dynamic action of the rollers will fill the space between the static level of the liquid surface and the nip. The nip may be below the surface of the liquid. If the nip is too far above the static liquid surface, then a squeezed-out bead will be formed along the lower edge of the nip. This bead is frequently uneven, which causes uneven amounts of liquid along the nip line, giving uneven delivery of liquid.

The volume of liquid mixture transported by the rollers may be regulated by varying the static level of the liquid with respect to the nip line, because there is less adherence for a roller that only slightly dips into the liquid.

CLAIMS

1. A method of applying ink and water to lithographic plates, comprising: mixing water and ink in approximately the proportions required for separate water and ink applications to a plate cylinder; and applying the mixture to a lithographic plate surface as a single liquid.

2. The method as claimed in Claim 7, wherein: said mixing step comprises mixing ink, water, and concentrate to form a single liquid of finely dispersed ink and water; said applying step comprises continuously applying the liquid to the lithographic plate surface; and said method further comprises the steps of: continuously flowing ink, water and concentrate to the mixture to replace the mixture consumed by the lithographic plate; and regulating the flow of ink, water and concentrate to the mixture to maintain a predetermined ratio of ink, water and concentrate.

3. The method as claimed in Claim 1, wherein the mixture is applied to a lithographic plate as a film, and said method includes the further step of controlling the density of the film in response to photoelectric scanning of the ink.

4. The method as claimed in Claim 2, wherein said regulating step includes: continuously sensing the pH of the mixture; and regulating the flow of concentrate to the mixture to maintain a predetermined ph.

5. The method as claimed in Claim 2, wherein said regulating step includes the steps of: continuously sensing the ink-water ratio; and regulating the flow of at least one of the ink and water to maintain a predetermined ink-water ratio.

6. The method as claimed in Claim 1, including the additional steps of: continuously monitoring the viscosity of the mixture; and agitating the mixture to maintain a predetermined viscosity.

7. Apparatus for applying ink and water to lithographic plates, comprising: means for mixing water and ink in approximately the proportions required for

separate water and ink applications to a plate cylinder; and means for applying the mixture to a lithographic plate surface as a single liquid.

8. The apparatus as claimed in Claim 7 for continuously supplying a water-ink mixture to a lithographic printer machine during a continuous printing run, said means for mixing comprising: a receptacle for the mixture having means for a flow of ink and means for a flow of water; means for regulating flow of ink to the receptacle; means for regulating the flow of water to the receptacle; means for sensing the water content of the mixture; and a control connected to at least one of the ink and water flow regulators and governed by the sensing means to maintain a predetermined water-ink ratio in the mixture.

9. The apparatus as claimed in Claim 8, wherein: agitators are disposed in the receptacles; a source of power is connected to the agitators to operate them; and a viscosity sensor is disposed in the receptacle and connected to the source of power to operate the agitators to maintain a predetermined viscosity in the mixture.

10. The apparatus as claimed in Claim 8, wherein: a level sensor is disposed at the receptacle; and a control is connected to the sensor and is connected to the water flow regulator and the ink flow regulator to maintain a predetermined level of mixture inthe receptacle to assist in more uniform application of the mixture to the lithographic plate.

11. The apparatus as claimed in Claim 8, wherein: means are provided for flowing lithographic concentrate to the receptacle; means are provided to regulate the flow of the concentrate; and means are provided to sense the pH of the ink-water-concentrate mixture and are connected to the concentrate flow regulating means to maintain a predetermined pH for said mixture.

12. The apparatus as claimed in Claim 8, wherein: the means for applying the mixture to a lithographic plate surface includes a fountain roller partly immersed in the receptacle and a form roller spaced from the

fountain roller to form an ink-water film between them and having a rolling contact with said lithographic plate to deposit the mixture on the lithographic plate surface.

13. The apparatus as claimed in Claim 12, wherein said form roller rotates at a uniform rotating velocity and is spaced from the fountain roller by the thickness of said film.

14. The apparatus as claimed in Claim 13, wherein: means are provided to sense the density of the ink-water film; a variable speed motor is connected to the fountain roller; and a motor controller is connected to the density sensor to rotate the fountain roller to create a film of predetermined density.

15. A lithographic surface for printing plates comprising a resilient and elastic rubber-like base that is oleophilic, having a smooth surface; and a photosensitive coating on the rubber-like base, having hardened hydrophilic areas and washed-out areas that reveal the rubber-like base, said hardened coating areas and washed-out areas defining the printing subject matter, whereby ink adheres to the rubber-like base and water adheres to the hardened coating areas.

16. The method of lithographic printing employing a smooth rubber-like base that is resilient, elastic, and oleophilic, comprising: forming on the base a coating of photosensitive material that is hydrophilic and oleophobic; exposing an image of the printing subject matter on the coating to harden parts of the coating; washing out the non-hardened parts of the coating to reveal the rubber-like base; applying water and oil base ink to the composite surface thereby depositing water on the hardened coating and ink on the revealed base; applying to the composite surface a material to be printed; and applying sufficient pressure to the material to be printed to elastically depress the hardened coating sections into the rubber-like base and to bring the ink-carrying rubber-like surfaces toward the material to be printed, whereby ink is transferred from

rubber-like base to the material to be printed.

17. A method of converting, to double-sided page printing, conventional printing presses employing a plate cylinder and a blanket cylinder, comprising: forming a printing image on the blanket cylinder that is the opposite side of the page to be rpinted by the plate cylinder; supplying ink to the image on the blanket cylinder; and passing a web of printing material between the two cylinders as they are contra-rotating in unison.

18. A rotary press for printing simultaneously both sides of a sheet of material to be printed, comprising: a pair of cylinders in apparent peripheral contact; a front page printing image disposed on one cylinder and a back page printing image disposed on the other cylinder; means for supplying ink to the images; and means for rotating the cylinders in opposite directions at the same peripheral speed so that flat material to be printed will pass between them to have both sides simultaneously printed.

19. The press as claimed in Claim 18, having more than two cylinders each in apparent peripheral contact with the preceding cylinder and rotating in a direction opposite from the preceding cylinder, so that material to be printed may be disposed between the added cylinder and the preceding cylinder to be printed on both sides simultaneously.

20. A roller for transporting at lease one of water and oil-based ink to a printing plate, comprising a surface having intermixed hydrophilic and oleophilic areas.

21. The roller as claimed in Claim 20 for use in printing apparatus employing a plate cylinder, wherein said roller retains water on the hydrophilic areas and retains ink on the oleophilic areas for transfer to the plate cylinder.

22. The roller as claimed in Claim 21, wherein the hydrophilic areas and oleophilic areas are formed in generally parallel lines.

23. The roller as claimed in Claim 21, wherein

at least one of the two areas is in the form of a multiplicity of dots.

24. The roller as claimed in Claim 23, wherein at least one of the hydrophilic areas and the oleophilic areas is in the form of dots and the other is in the form of the background.

25. The roller as claimed in Claim 21, wherein at least one of two areas is in the form of a multiplicity of rectangular shapes.

26. The roller as claimed in Claim 21, having ends wherein the relative proportions of hydrophilic areas to oleophilic areas is greater near the ends of the roller to counteract the normal water deficiency at the ends of the roller.

27. The roller as claimed in Claim 21, wherein the oleophilic areas are a rubber-like material.

28. The roller as claimed in Claim 21, wherein the hydrophilic surfaces are formed of chrominum and the oleophilic formed of copper.

29. The roller as claimed in Claim 21 for use in printing apparatus having a plate cylinder, a printing press fountain containing a blended mixture of water and oil-based ink, said roller disposed between the fountain and the plate cylinder for applying the water and ink to the plate cylinder, and means for applying the ink and water mixture to the roller, whereby water and ink are applied to the plate cylinder in a selected proportion of water to ink depending upon the relative amounts of hydrophilic areas and oleophilic areas.

30. The roller as claimed in Claim 29, wherein the roller is a form roller that applies the water and ink to the plate cylinder.

31. The roller as claimed in Claim 29, wherein the roller is a fountain roller receiving water and ink from the fountain.

32. The roller as claimed in Claim 29, wherein the roller is an oscillating roller in contact with an application roller.

33. The roller as claimed in Claim 29, wherein

there are at least two rollers, a form roller in contact with the plate cylinder and a fountain roller in contact with the form roller, and the water and ink mixture is applied to the fountain roller, both rollers having a surface of said intermixed hydrophilic areas and oleophilic areas.

34. The roller as claimed in Claim 29, wherein there are at least three rollers, a form roller in contact with the plate cylinder, a fountain roller, and an intermediate roller between the fountain roller and the form roller, at least the intermediate roller having a surface of intermixed hydrophilic and oleophilic areas.

35. A method of regulating the proportion of water to ink transported by an application roller having a surface with fixed amounts of hydrophilic areas and oleophilic areas comprising varying the pressure of a squeegee roller against said application roller.

36. Apparatus for use in a lithographic printing press, said apparatus comprising: a printing press fountain having a blended mixture of water and oil-based ink; a fountain roller contacting the water and ink mixture; and a squeegee roller contacting the fountain roller to limit the amount of water and ink mixture carried by the fountain roller.

37. The apparatus as claimed in Claim 36, wherein the fountain roller has a surface of intermixed hydrophilic and oleophilic areas.

38. The apparatus as claimed in Claim 37, wherein means are provided for adjusting the pressure between the squeegee roller and the fountain roller.

39. A method of regulating the amount of water and ink transferred from a fountain containing a water and ink mixture to a printing plate, comprising: immersing at least a portion of a fountain roller in the fountain mixture; regulating the relative proportion of the surface of the roller between hydrophilic, oleophilic, and hydro-oleophobic areas, whereby the amount of water picked up by the roller from the fountain is a function of the hydrophilic area, the amount of ink

picked up by the roller is a function of the oleophilic area, and the total pickup of both water and ink per revolution of the roller is a function of the hydro-oleophobic area related to the other two areas.

40. A method of regulating the proportion of water and oil-based ink transferred from a fountain containing a water and ink mixture to a printing plate, comprising: immersing at least a portion of a fountain roller in the fountain mixture; and regulating the relative proportions of the surface of the roller between hydrophilic and oleophilic areas, whereby the amount of water picked up by the roller is a function of the amount of hydrophilic area and the amount of oil-based ink picked up by the roller is a function of the amount of oleophilic area.

41. Apparatus for use with a lithographic plate cylinder rotatable in a direction, said apparatus comprising: a pair of form rollers engaging the plate cylinder, one being upstream and the other being downstream with regard to the rotatable direction of the plate cylinder; a fountain roller for the upstream form roller, said fountain roller having a surface of intermixed hydrophilic and oleophilic areas wherein the hydrophilic areas are greater than the hydrophilic areas; and a means for applying a mixture of water and oil-based ink to fountain rollers.

42. The apparatus as claimed in Claim 41, wherein the two fountain rollers engage each other to squeegee off excess mixture of water and oil-based ink.

43. Apparatus for inking a letterpress plate, comprising: a form roller having a surface of intermixed ink-attracting areas and ink-repelling areas; a fountain roller in rolling engagement with the form roller, having a surface of intermixed ink-attracting areas and ink-repelling areas that are preselected in relative proportions of the two areas; and means for applying ink to the fountain roller.

44. The apparatus as claimed in Claim 43, wherein ink is applied to the form roller surface before it is

engaged by the fountain roller and the fountain roller squeegees off the excess ink.

45. A method of metering and regulating the amount of ink and water transferred from a fountain trough containing a mixture of water and ink to a printing plate, comprising: immersing at least one of a fountain roller and form roller in the mixture, said fountain roller and form roller being in rolling engagement to define a nip; regulating the distance between the nip and the level of mixture in the fountain trough; and regulating the ratio of water to ink transported by said form roller to the printing plate by controlling the contact pressure between the fountain roller and the form roller.

46. A method of regulating the volume of ink transferred from a fountain to a nonlithographic printing plate, comprising: immersing at least a portion of a roller in the ink in the fountain; and regulating the relative proportions of the surface of the roller between hydro-oleophilic and hydro-oleophobic areas, whereby the amount of ink transferred by the roller is determined by the proportion of hydro-oleophilic areas to oleophilic areas.

47. A method of metering and regulating the amount of ink and water transferred from a fountain trough containing a mixture of water and oil-based ink to a printing plate, comprising: immersing two fountain rollers in the mixture in rolling contact with each other to define a nip; regulating the relative level of the mixture with respect to the nip; and regulating the ratio of water to ink transported by at least one of said rollers by controlling the contact pressure between the two fountain rollers.

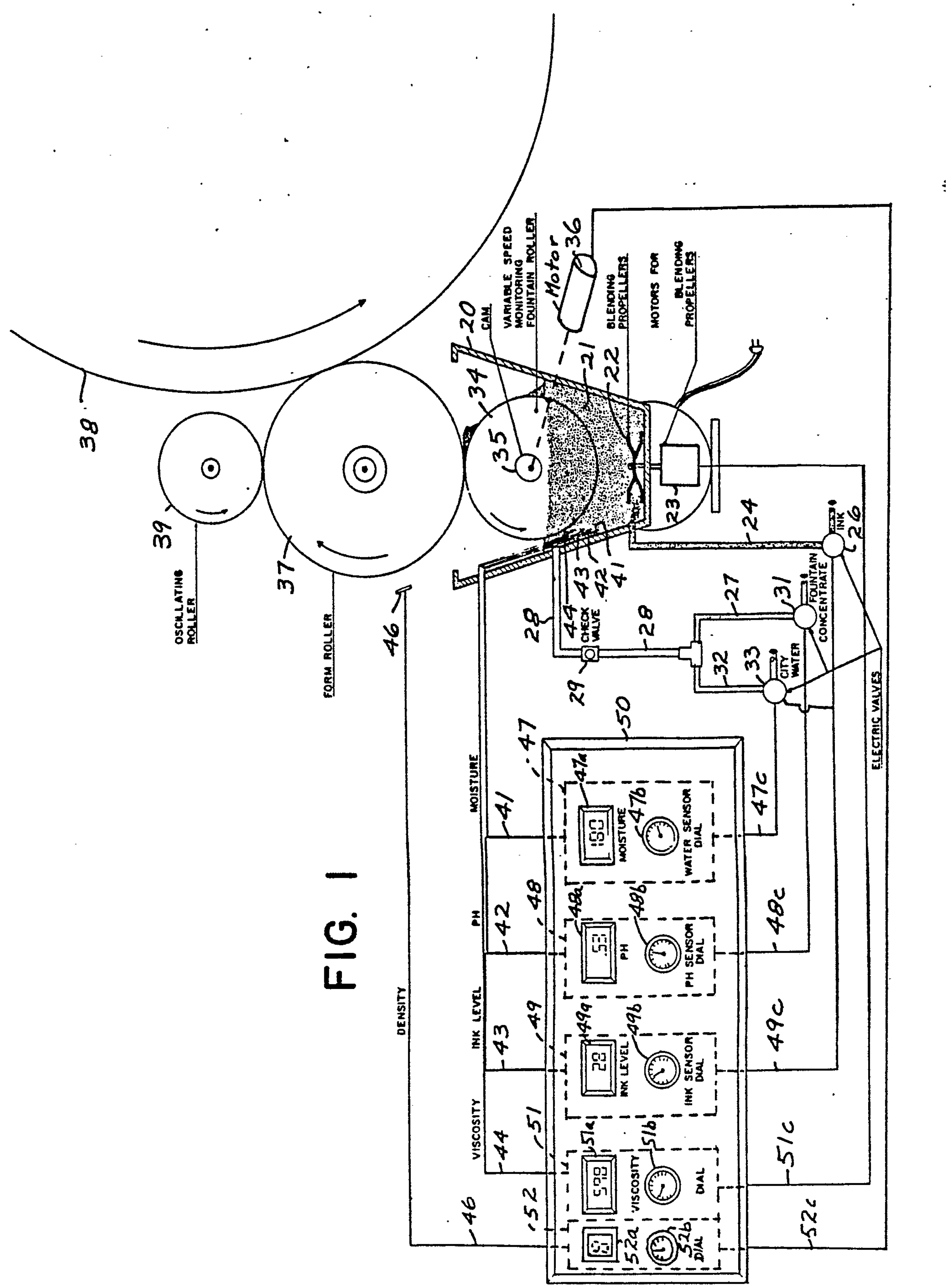

OSCILLATING ROLLER
FORM ROLLER
CAM
VARIABLE SPEED MONITORING FOUNTAIN ROLLER
Motor
BLENDING PROPELLERS
MOTORS FOR BLENDING PROPELLERS
CHECK VALVE
INK
FOUNTAIN CONCENTRATE
CITY WATER
ELECTRIC VALVES
MOISTURE
PH
INK LEVEL
VISCOSITY
DENSITY
WATER SENSOR DIAL
PH SENSOR DIAL
INK SENSOR DIAL
DIAL

FIG. 1

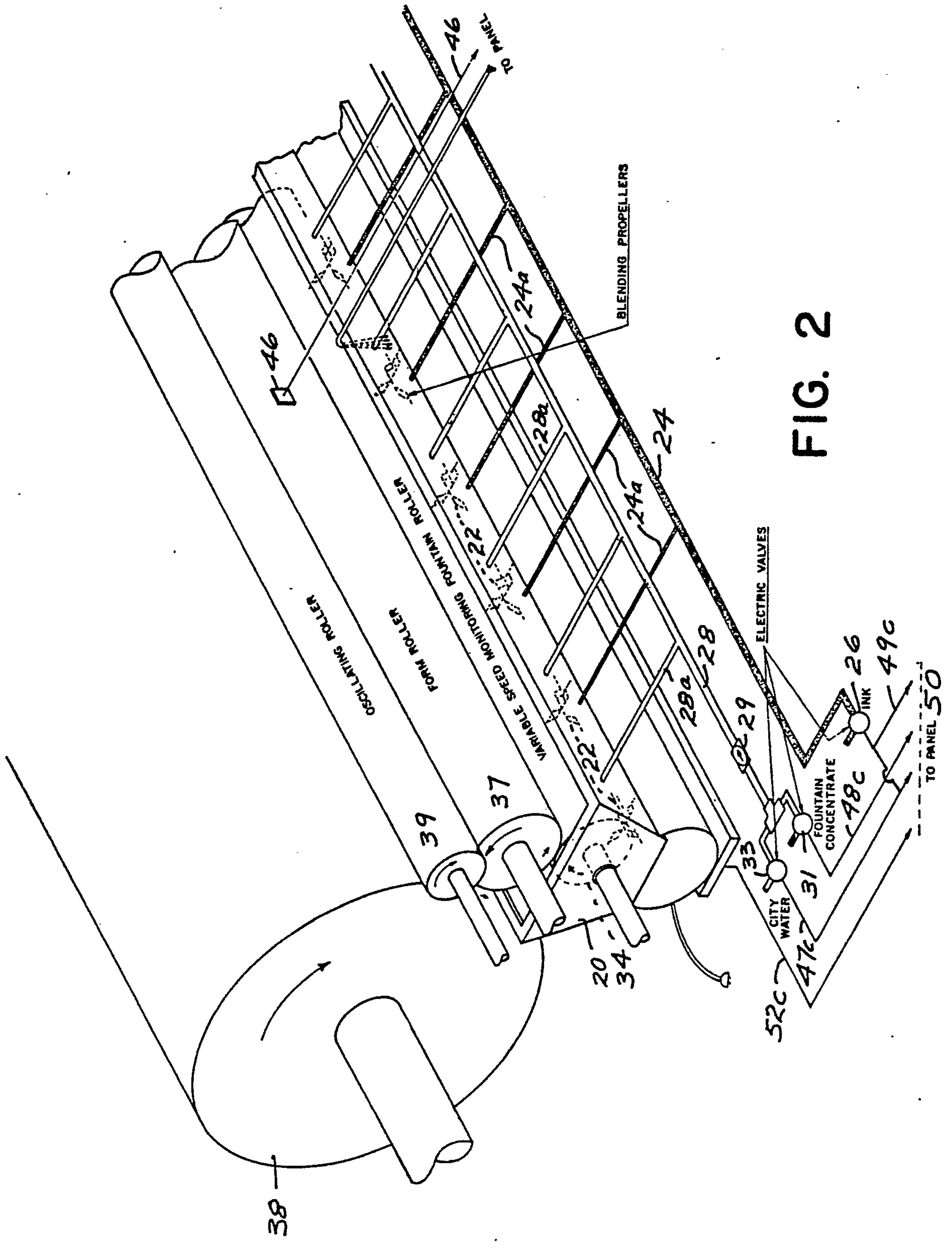

TO PANEL
46
BLENDING PROPELLERS
24a
28a
24
22
OSCILLATING ROLLER
FORM ROLLER
VARIABLE SPEED MONITORING FOUNTAIN ROLLER
ELECTRIC VALVES
28
29
26
49c
INK
FOUNTAIN CONCENTRATE
48c
50
TO PANEL
39
37
33
31
CITY WATER
47c
52c
20
34
38

FIG. 2

FIG. 3A

FIG. 3B

FIG. 3C

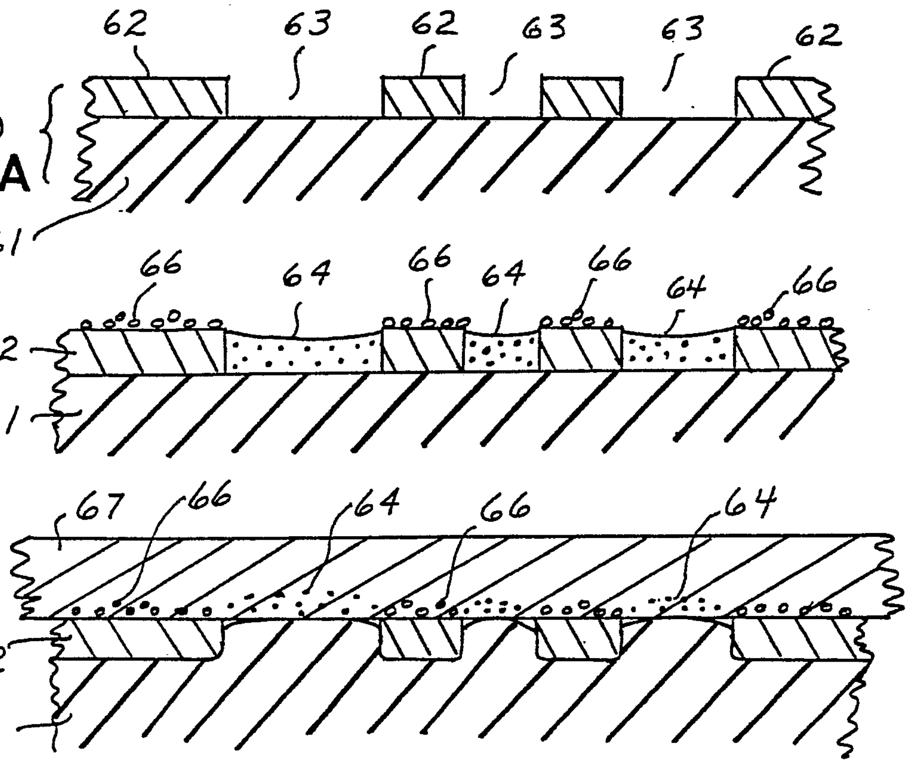


FIG. 3

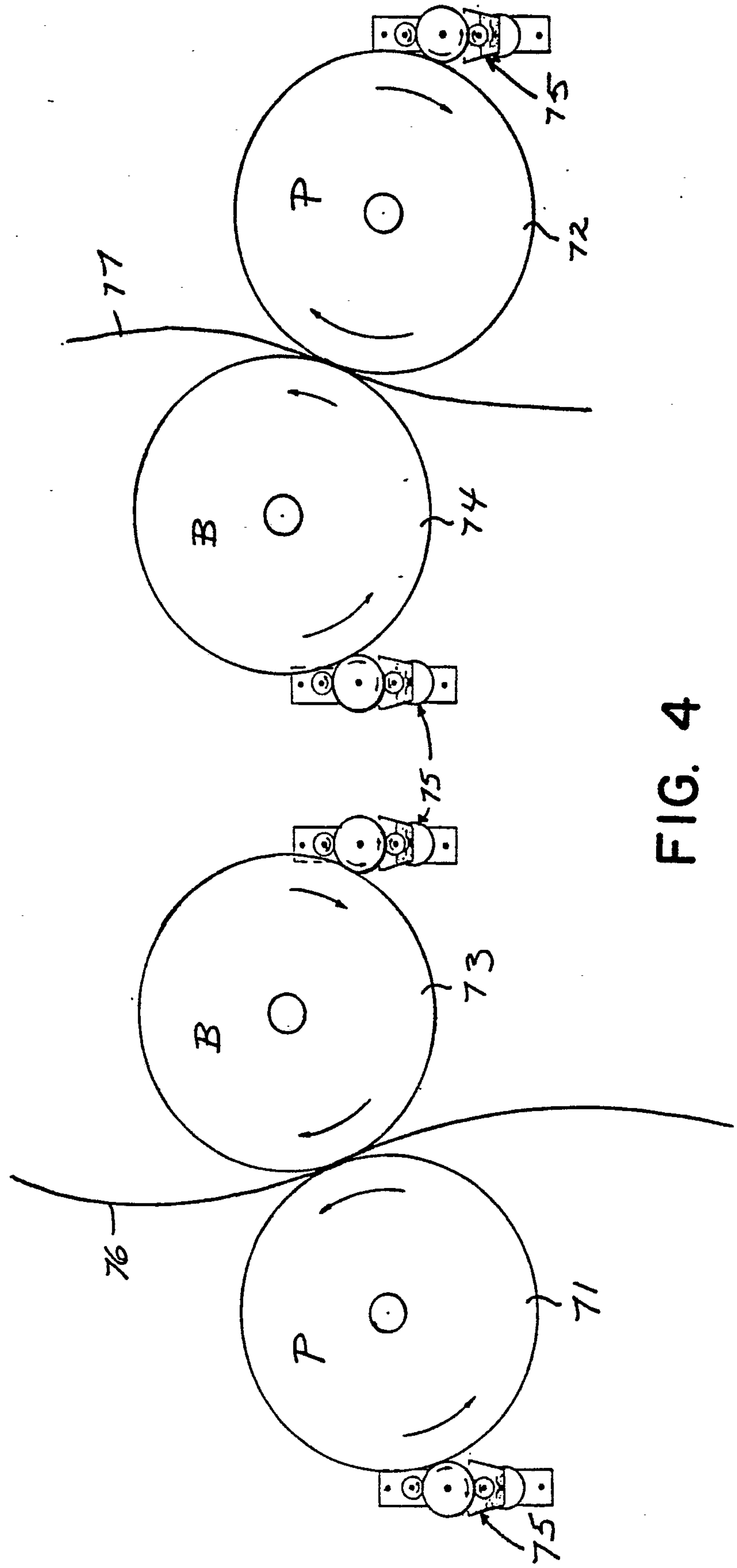


FIG. 4

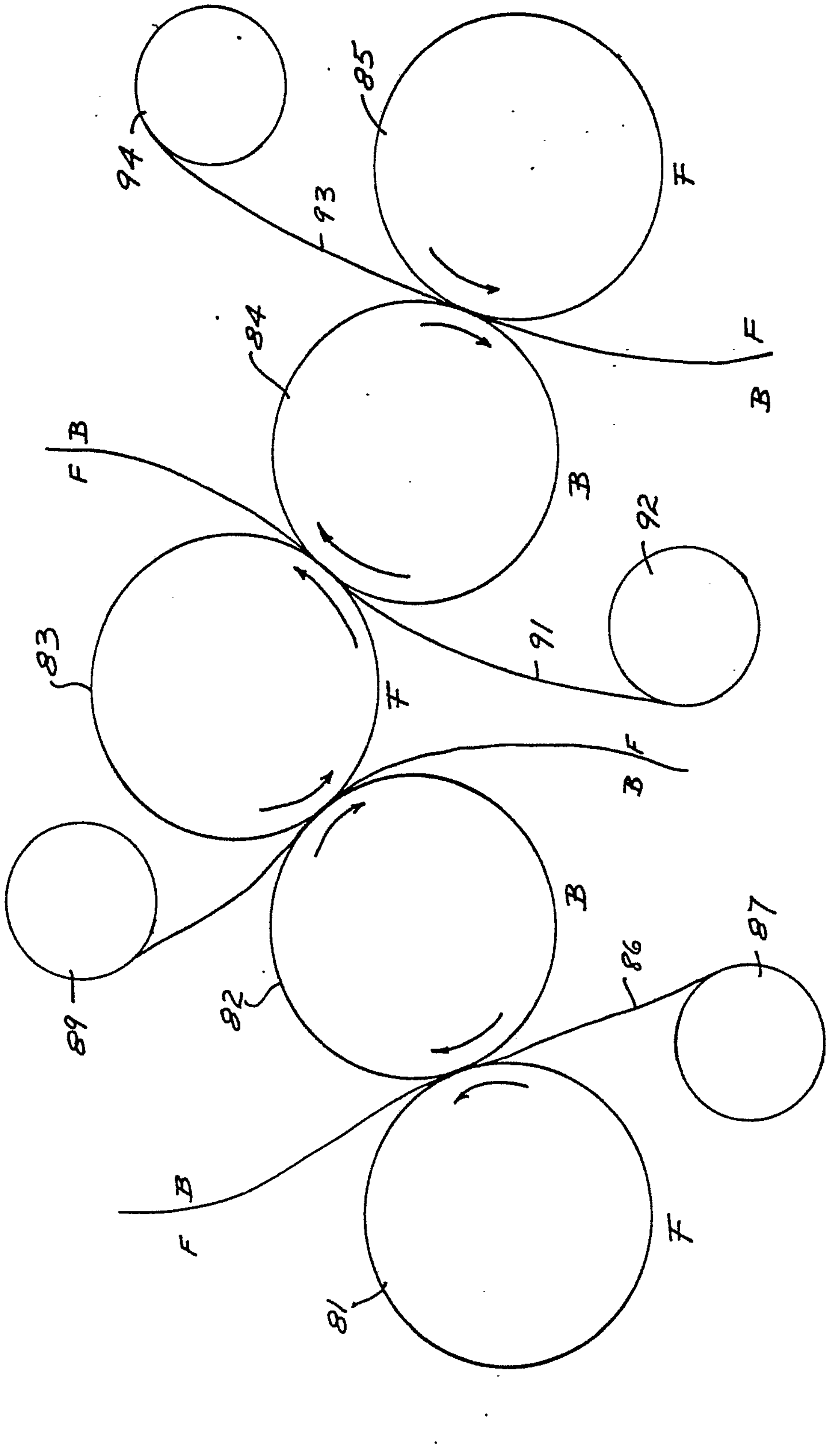
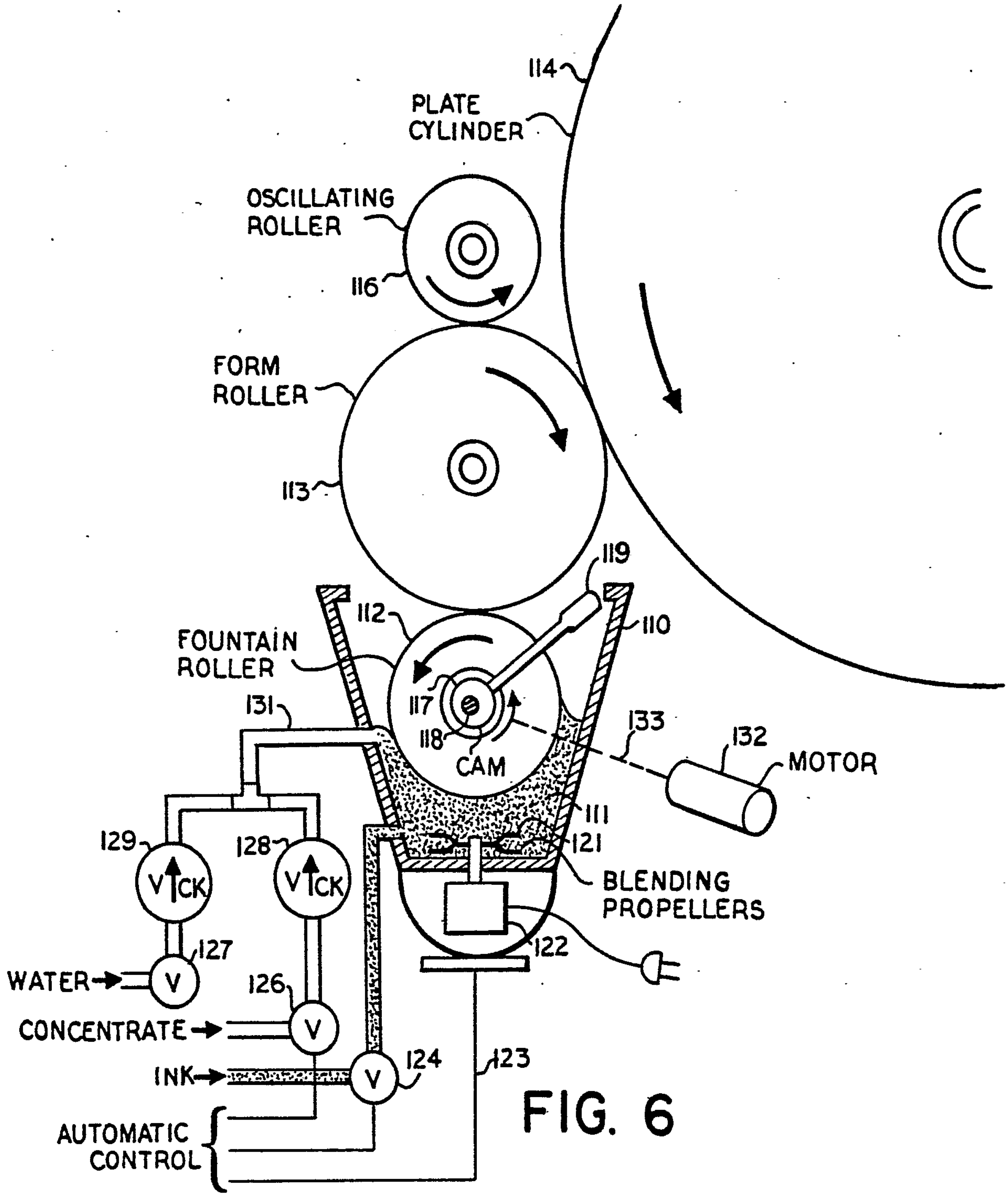
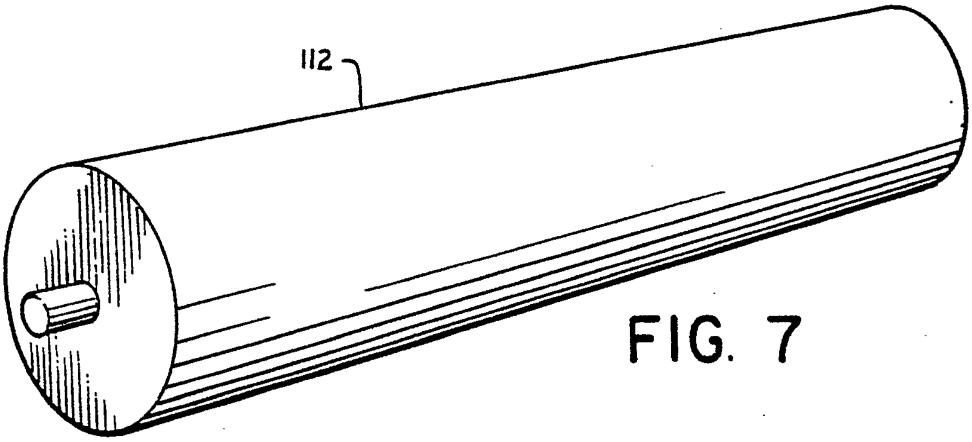


FIG. 5



114
PLATE CYLINDER
OSCILLATING ROLLER
116
FORM ROLLER
113
119
112
110
FOUNTAIN ROLLER
131
117
118
CAM
133
132
MOTOR
111
121
129
128
V CK
V CK
BLENDING PROPELLERS
122
WATER
127
V
126
CONCENTRATE
V
INK
V
124
123
AUTOMATIC CONTROL

FIG. 6



112

FIG. 7

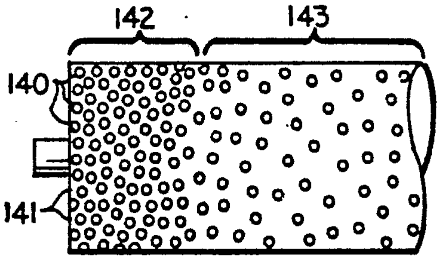


FIG. 8

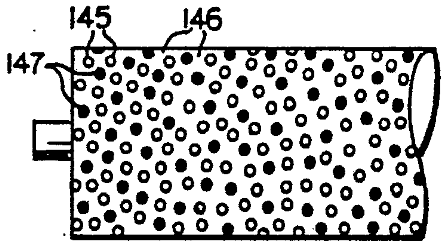


FIG. 9

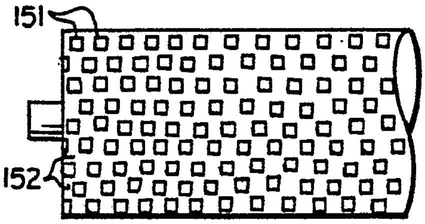


FIG. 10

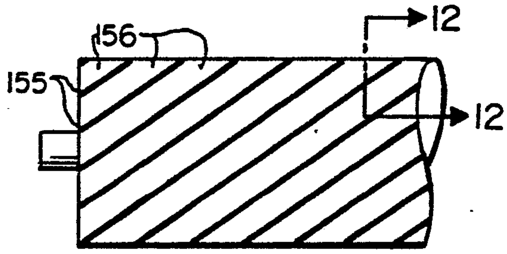


FIG. 11

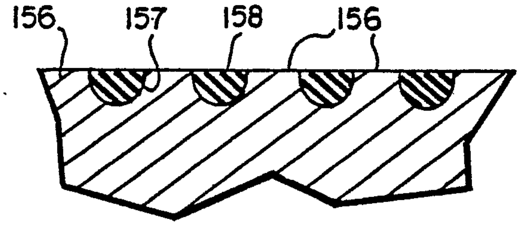


FIG. 12

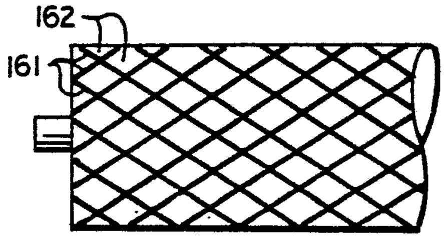


FIG. 13

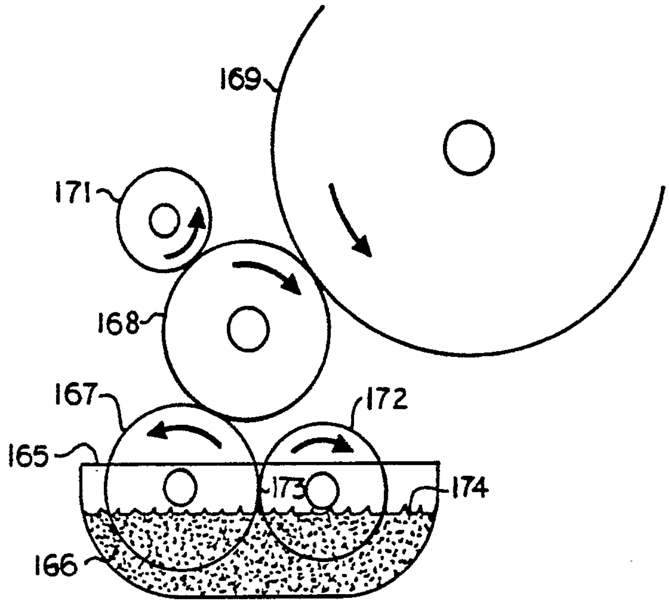


FIG. 14

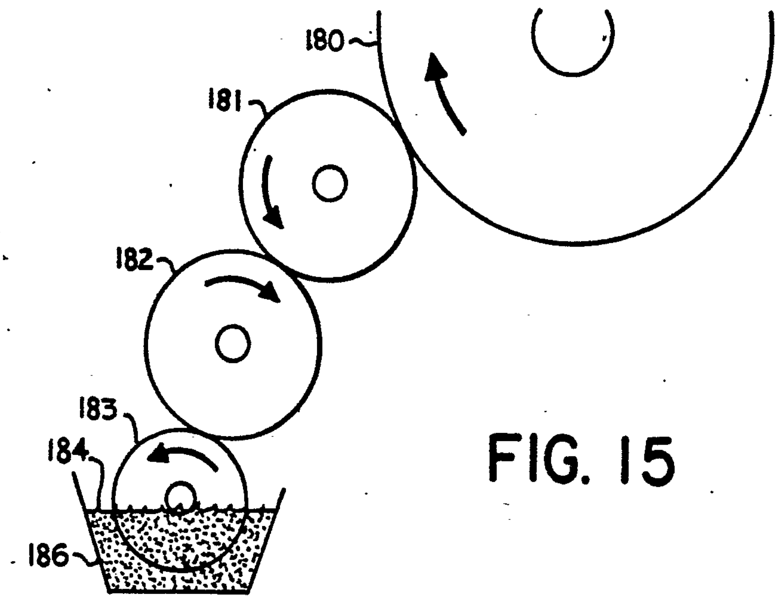


FIG. 15

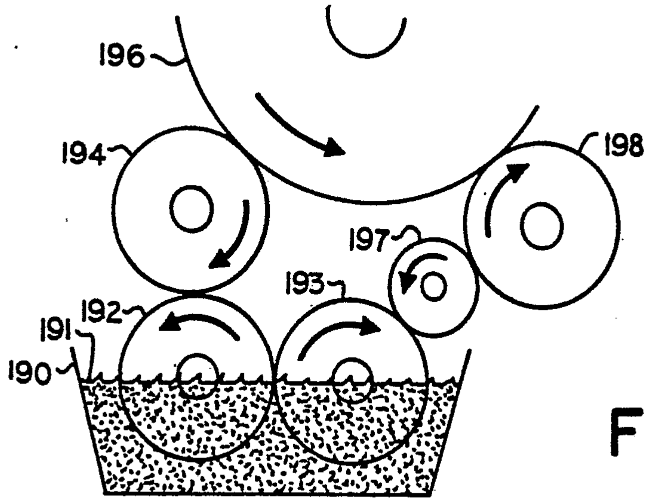


FIG. 16

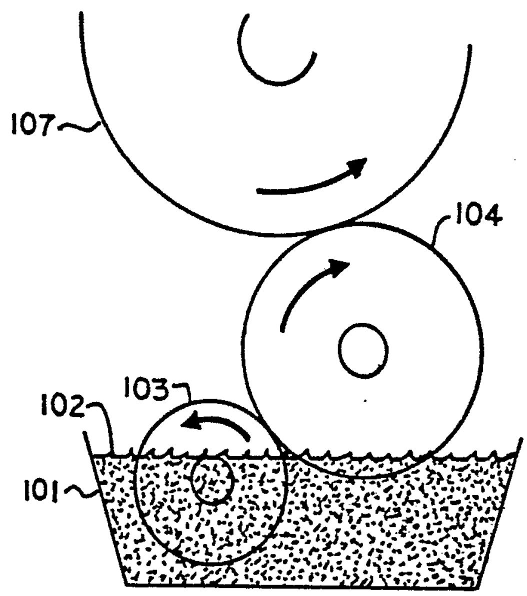


FIG. 17

INTERNATIONAL SEARCH REPORT

International Application No PCT/US79/01078

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

INT.CL.[3] B41L 25/14, B41M 1/06
U.S. CL. 101/147, 148,451

3-/01151

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
U.S.	101/147, 148, 450.1,451,452

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X	US, A, 2,690,119,Published 28 September 1954, Black	20,21,22,28
X	DE, B, 1,239,708,Published 03 May 1967, Schnall	1-6,20,21,22, 28
A	US, A, 1,675,695,Published 03 July 1928 Claybourn	6
A	US, A, 2,090,704,Published 13 September 1933, Rowell	1-6,20,21, 22,28
A	US, A, 2,728,690,Published 27 December 1955, Saeman	6
A	US, A, 2,971,458,Published 14 February 1961, Kumins	6
A	US, A, 3,234,871,Published 15 February 1966, Ostwald	3

* Special categories of cited documents: [15]

"A" document defining the general state of the art

"E" earlier document but published on or after the international filing date

"L" document cited for special reason other than those referred to in the other categories

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but on or after the priority date claimed

"T" later document published on or after the international filing date or priority date and not in conflict with the application, but cited to understand the principle or theory underlying the invention

"X" document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
18 APRIL 1980	23 APR 1980
International Searching Authority [1]	**Signature of Authorized Officer [20]**
ISA/US	Clyde I. Coughenour

C1151 International Application No. PCT/US79/01078

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

A,P	US,A,4,151,796, Published 01 May 1979, Uhrig	3,5
A,P	US,A,4,176,605, Published 04 December 1979, Yoshida	1-6,20,21, 22,28
A	GB,A,903,724, Published 15 August 1962, Boillet	1-6,20,21, 22,28
A	DE,A,2,607,293 Published 25 August 1977, Banch	4
A,P	DE,A,2,833,746 Published 22 February 1979, Mabrouk	5
A	N, Xerox Disclosure Journal, issued August 1976, Sypula, Measurement of Fountain Solution thickness By Microwave Radiation Tecnique, Volumn 1, Number 8, page 11.	3

V.☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [10]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1.☐ Claim numbers.........., because they relate to subject matter [12] not required to be searched by this Authority, namely:

2.☐ Claim numbers.........., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out [13], specifically:

VI.☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [11]

This International Searching Authority found multiple inventions in this international application as follows:

1.☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2.☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3.☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.

80/01151

International Application No. PCT/US79/01078

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

A	US, A, 3,252,411, Published 24 May 1966, Black	6
A	US, A, 3,513,000, Published 19 May 1970, Vrancken	1-6,20,21, 22,28
A	US, A, 3,687,694, Published 29 August 1972, Van Dusen	2
A	US, A, 3,714,891, Published,06 February 1973 Van Dusen	2
A	US, A, 3,758,330, Published,11 September 1973, Richman	6

V.☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [10]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1.☐ Claim numbers.........., because they relate to subject matter [12] not required to be searched by this Authority, namely:

2.☐ Claim numbers.........., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out [13], specifically:

VI.☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [11]

This International Searching Authority found multiple inventions in this international application as follows:

1.☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2.☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3.☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.

8101151

International Application No. PCT/US79/01078

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

A	US, A, 3,835,777, Published 17 September 1974, Krygeris	3,5
A	US, A, 3,947,356, Published 30 March 1976, Werhli	2,6
A	US, A, 4,088,074, Published 09 May 1978, Dahlgren	3,6
A,P	US, A, 4,146,474, Published 27 March 1979, Kagatani	4
A,P	US, A, 4,150,996, Published 24 April 1979, Druker	2

V. [X] OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [10]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. [ ] Claim numbers ______, because they relate to subject matter [12] not required to be searched by this Authority, namely:

2. [X] Claim numbers 2, because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out [13], specifically:

The claim depends from claim 7. It is assumed claim 1 was to be the parent claim and not claim 7.

VI. [X] OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [11]

This International Searching Authority found multiple inventions in this international application as follows:

1. [ ] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. [X] As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

1-6,20,21,22,28 (Claims search modified as a result of 17 March 1980 letter and phone call of 25 March 1980)

3. [ ] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

Remark on Protest

[ ] The additional search fees were accompanied by applicant's protest.

[ ] No protest accompanied the payment of additional search fees.