United States Patent

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[54] **ELECTROGRAPHIC LIQUID INKER EMPLOYING A VACUUM HEAD AND MEANS FOR RAPIDLY VALVING OFF THE HEAD**
10 Claims, 2 Drawing Figs.

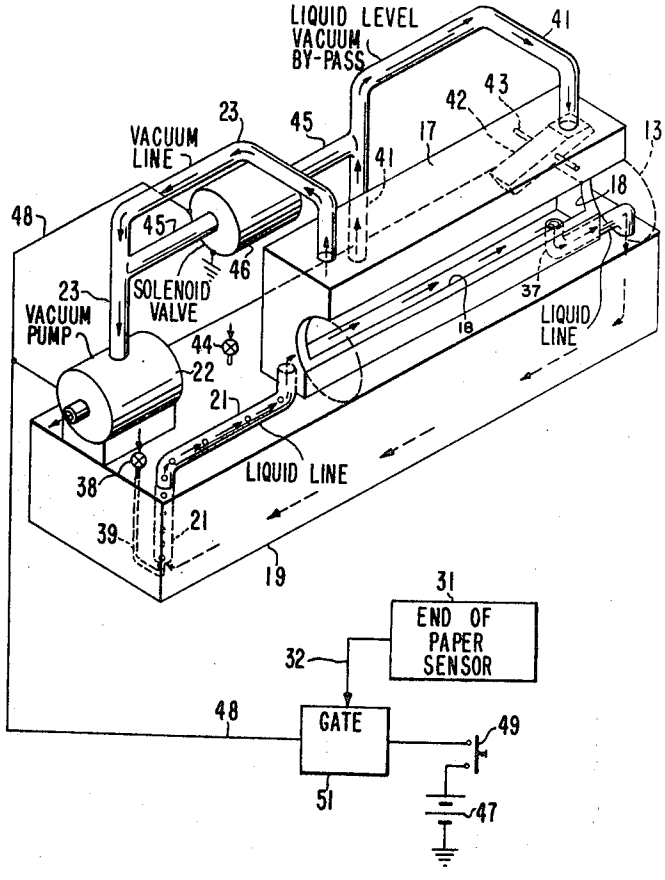
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[50] Field of Search ..... 346/74ES, ESX, MP; 118/637, LX 410, 429, 6.8; 117/37LX; 101/364, 366; 346/Consulted; 355/Consulted

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ABSTRACT: An electrographic liquid inker of the type employing a vacuum head is disclosed. The liquid inker includes a hollow inking channel having an inking slot along one side thereof disposed adjacent the charge image bearing surface of an electrographic recording web to be inked. The inking channel is disposed above an ink reservoir and the inking channel is connected in fluid communication with the reservoir. A vacuum pump is connected with its suction side to the top of the inking channel for drawing a vacuum head on the channel to cause liquid ink to be drawn from the reservoir up into the channel and to cause the electrographic recording web to be inked to be drawn up against the marginal edges of the inking slot, thereby sealing same and permitting liquid ink to come into contact with the charge images to be developed for developing same. The web with the charge images to be developed is drawn across the inking slot, whereby strip recordings are inked.



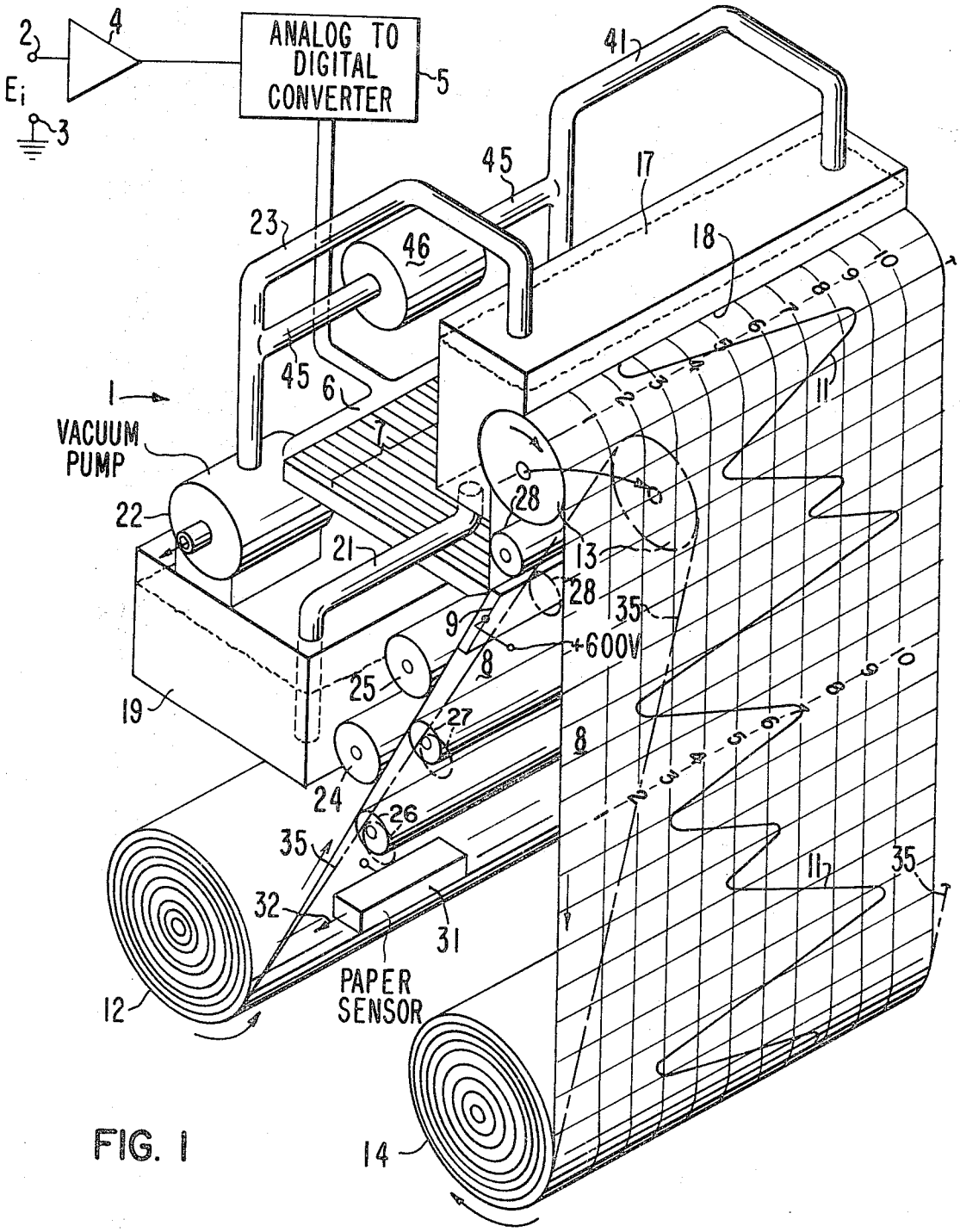
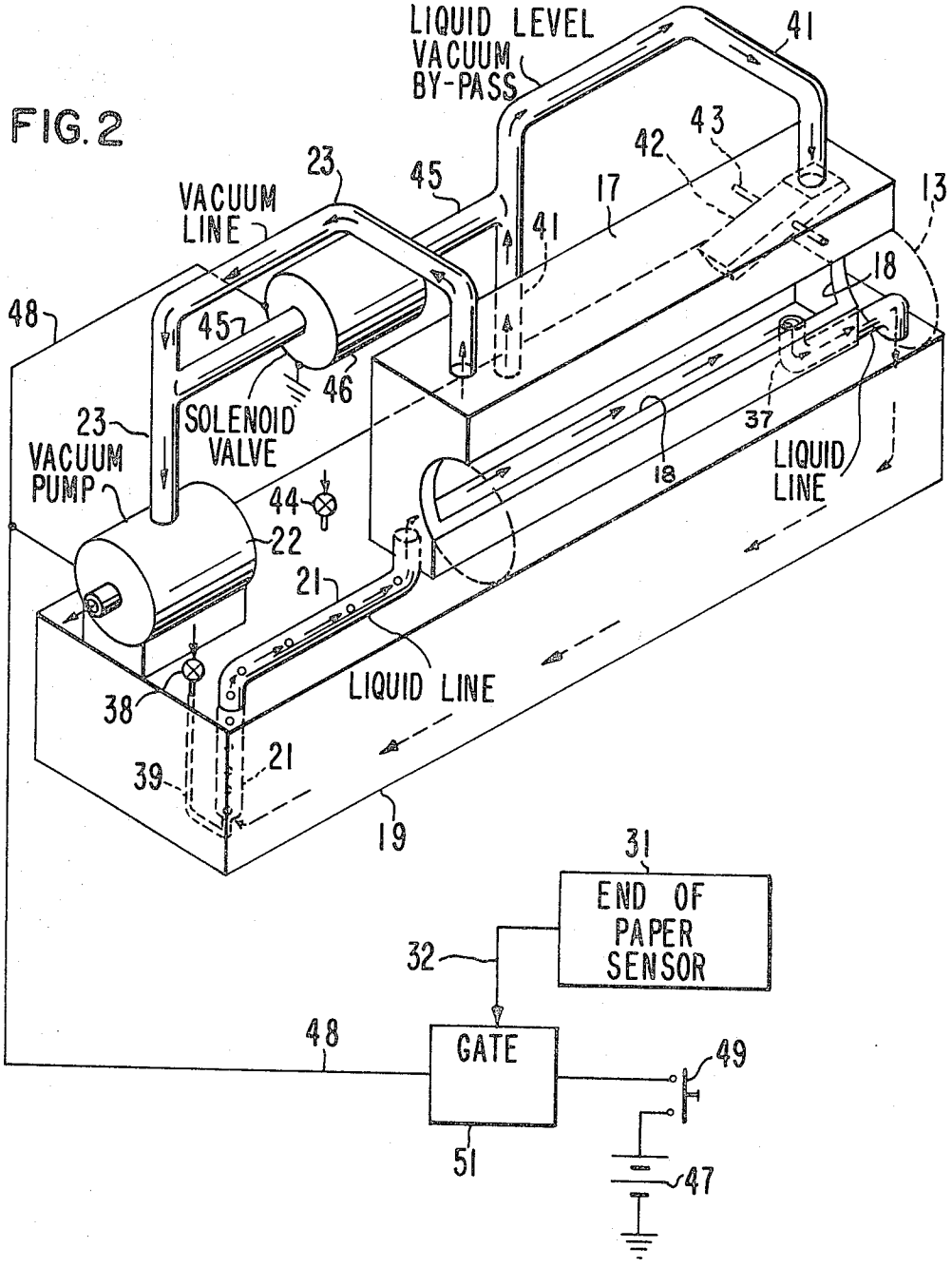


FIG. 1

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FIG. 2



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ELECTROGRAPHIC LIQUID INKER EMPLOYING A VACUUM HEAD AND MEANS FOR RAPIDLY VALVING OFF THE HEAD

A vacuum line is provided interconnecting the partially evacuated air space above the liquid in the inking channel and the air space above the liquid ink in the reservoir. A valve is provided in the vacuum line which is normally closed such that a vacuum pressure head may be established between the air space in the reservoir and the air space in the inking channel to produce the vacuum head on the inking channel. Means are provided for sensing when the seal will be lost between the web and the inking slot such that the valve in the vacuum line may be opened to remove the vacuum head on the inking channel and to permit the ink to quickly drain by gravity feed into the reservoir.

One of the means for sensing when the seal will be lost includes a sensor which senses the end of the recording web. Another sensor is provided via an interlock which must be opened before the recording web can be disengaged from the inking slot. In a preferred embodiment, the sensors also serve to turn off the vacuum pump to further assist in dissipating the vacuum head on the inking channel.

DESCRIPTION OF THE PRIOR ART

Heretofore, electrographic recorders have been proposed employing a liquid inking channel disposed above an ink reservoir and having a vacuum drawn on the inking channel for pulling ink from the reservoir up into the channel for inking a recording web pulled across and sealing the inking slot. Such an electrographic recorder and inking apparatus is described and claimed in copending U.S. Pat. application Ser. No. 577,443 filed Sept. 6, 1966, now U.S. Pat. No. 3,392,706, and assigned to the same assignee as the present invention.

One of the problems with this prior art inker is that if the seal produced between the web and the inking slot is inadvertently lost, as by disengaging the web from the inking slot or by pulling the end of the web past the inking slot, ink which is in the inking channel pours through the inking slot into the recorder cabinet or other structure in the immediate vicinity of the inking slot. Therefore, it is desirable to provide means which will sense when the seal between the recording web and the inking slot is about to be lost and to cause the ink to be rapidly drained from the inking slot back into the reservoir such that when the seal is broken at the inking slot the ink will not pour from the slot.

SUMMARY OF THE PRESENT INVENTION

The principal object of the present invention is the provision of an improved electrographic liquid inker apparatus.

One feature of the present invention is the provision, in an electrographic liquid inker employing a vacuum head on an inking channel, of means for quickly valving off the vacuum head such that the liquid in the inking channel may quickly drain by gravity feed into the liquid reservoir.

Another feature of the present invention is the same as the preceding feature including a sensor for sensing impending loss of the liquid seal on the inking slot and for energizing the valve for valving the vacuum head, whereby inadvertent leakage from the inking channel is avoided in use.

Another feature of the present invention is the same as the preceding feature wherein the means for sensing impending loss of the seal on the inking slot includes means for sensing the end of the recording web to be inked or means for sensing impending disengagement of the recording web from the inking slot.

Another feature of the present invention is the same as any one or more of the preceding features wherein the means for valving the vacuum head includes a valve disposed in a vacuum line interconnecting the air space above the liquid level in the reservoir to the air space above the liquid level in the inking channel such valve being in the normally closed position and being rapidly opened for valving the vacuum head to permit rapid draining of the inking channel.

Other features and advantages of the present invention will become apparent upon a perusal of the following specification taken in connection with the accompanying drawings wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic perspective view, partly in block diagram form, of an electrographic recorder employing features of the present invention, and

FIG. 2 is an enlarged perspective view, partly schematic and partly in block diagram form, of an electrographic inker employing features of the present invention and of the type employed in the recorder of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, there is shown an electrographic recorder 1 employing features of the present invention. Briefly, the electrographic recorder 1 includes a pair of input terminals 2 and 3 to which an input signal E_i is applied to be recorded. The input signal is fed to a preamplifier 4 where it is amplified and fed to an input of an analog-to-digital converter 5. The analog-to-digital converter converts the analog input signal E_i into a binary data output 6 which is fed to an array of electrographic writing electrodes 7 extending in a direction crosswise of an electrographic recording web 8.

The electrographic recording web 8 includes a conductive paper backing supporting a thin dielectric film forming a charge retentive surface. The charge retentive surface is disposed adjacent the electrode array 7 and the conductive paper backing of the web 8 is disposed adjacent a writing electrode plate 9 operated at a suitable positive potential as of plus 600 volts, whereas the electrodes 7 are normally operated at plus 300 volts except for the selected electrode which is writing the signal on the recording web. The selected electrode 7 is operated at ground potential to establish a minus 600 volts writing potential to deposit a charge image on the recording web 8.

The recording web 8 is pulled from a supply roll 12 past the writing electrode array 7 by means of a friction drive roller 13. A takeup roll 14 takes up the paper from the drive roller 13.

An inking channel 17, more fully described below, is disposed adjacent the drive roller 13. The inking channel 17 includes an inking slot 18 cut in the side thereof adjacent the recording web 8 for causing the liquid ink within the channel to come into liquid contact with the charge image to be developed. The charge image attracts charged colloidally suspended inking particles from the ink to the charge image for developing same. Ink is supplied to the inking channel 17 from an ink reservoir 19 which is in liquid communication with the inking channel 17 by means of a liquid conduit 21. A vacuum pump 22 is connected to the top of the inking channel 17 by means of a gas conduit 23 connected to the vacuum side of pump 22 for drawing a vacuum, as of minus 15 inches of water, on the top of the liquid in the inking channel 17. The vacuum drawn on the inking channel 17 causes the ink to be drawn from the reservoir 19 via the fluid conduit 21 into the inking channel 17.

A pair of electrographic chart printing roller electrodes 24 and 25 are disposed on the charge retentive side of the recording paper 8 between the supply roll 12 and the writing electrode array 7. Each of the roller electrodes 24 and 25 includes a different amplitude scale embossed thereon and means are provided for selectively applying a writing potential to either one of the scale electrodes 24, 25 for laying down different charge images on the recording web 8 to define different amplitude scales, as desired. The amplitude scale charge images are developed by the electrographic toner in the inking channel 17 in the same manner as the trace 11 of the input signal to be recorded. Three backup rollers 26, 27 and 28 are disposed on the conductive paper backing side of the web 8 for holding the web against the writing electrodes 24, 25 and 7.

A paper sensor 31 such as a microswitch having a contact feeler riding against the paper 8 is provided for detecting the end of the recording web 8. The output 32 of the paper sensor

is employed as an interlock control in a manner as more fully described below. The drive roller **13**, backup rollers **26**, **27** and **28** together with writing electrode plate **9** and the paper sensor **31** are supported within an enclosure, not shown, such that these elements may be pivoted away from the inking channel **17** to a position as indicated by the dotted lines **35** in order to facilitate threading of the recording paper **8** over the drive roller **13** and takeup roll **14**.

Referring now to FIG. **2**, there is shown the electrographic inker in greater detail. More specifically, a second liquid conduit **37** is disposed at the opposite end of inking channel **17** from the first conduit **21** for interconnecting the inking channel **17** with the reservoir **19**. An air bleeder valve **38** bleeds air from outside of the reservoir **19** via a bleeder pipe **39** into the bottom of the liquid supply line **21**. The air which is fed via the bleeder valve **38** into the liquid supply line **21** forms a series of bubbles which rise through the liquid in the liquid line **21** to produce a liquid flow pattern as indicated by the arrows. In this manner, a continuous flow of electrographic liquid toner is obtained from the reservoir **19** through the liquid lines **21** and **37** and the inking channel **17** to provide a continuous supply of electrographic toner particles to the inking slot **18**.

A vacuum air line **41** interconnects the air space above the liquid in the inking channel **17** with the air space above the liquid in the reservoir **19**. A float valve **42**, pivotable about an axis **43**, is provided in the inking channel **17** for controlling the liquid level in the inking channel **17**. When the liquid level in the inking channel **17** is below the top of the inking slot **18** the float valve **42** is closed such that the vacuum pump **21** draws a vacuum on the top of the inking channel **17** via vacuum line **23**. However, when the liquid level within the inking channel **17** reaches a predetermined height above the inking slot **18**, the float valve **42** is opened causing the partial vacuum created in the top of the inking channel **17** to be transferred via a vacuum bypass line **41** to the top of the reservoir **19**, thereby preventing the liquid level in the inking channel **17** from rising above a level which will open the float valve **42**.

An air bleeder valve **44** is disposed in the top wall of the reservoir **19** for establishing the vacuum head between the liquid level in the reservoir **19** and the liquid level in the inking slot **17**. Typically, it is desirable to have a vacuum pressure on the inking slot **18** of about minus 15 inches of water. The pressure to be established within the reservoir **19** by means of the bleeder valve **44** is thus minus 15 inches of water less the height of the inking slot **18** above the height of the liquid level in the reservoir **19**. For example, if the liquid level within the inking channel **17** is 7 inches above the level of the ink in the reservoir **19** and it is desired to have minus 15 inches of water on the inking slot **18**, the bleeder valve **44** should be adjusted to provide a pressure of about minus 8 inches of water above the liquid in the reservoir **19**.

A vacuum line **45** is provided interconnecting vacuum line **23** and vacuum line **41**. A solenoid operated valve **46** is connected in series with the vacuum line **45**. The solenoid valve **46** is normally operated in the closed position such that the vacuum line **45** is blocked. This permits the vacuum head to be established on the inking channel **17** relative to the liquid level of the reservoir **19**. The solenoid valve **46** and the vacuum pump **22** are energized by means of a current source **47** via lead **48** containing a series connected interlock switch **49** and a gate **51**.

The interlock switch **49** is affixed to the enclosure of the recorder in such a way that the paper **8** cannot be disengaged from the inking channel **17** without opening the interlock switch **49**. Thus, when the paper transport apparatus and the drive roller are engaged with the inking channel **17** the interlock switch **49** is in the closed position. The gate **51** is typically in the open position permitting the current from the source **47** to be fed to the solenoid valve **46** and the vacuum pump **22**. Gate **51** is placed in the closed position when the output of the paper sensor **31** senses the end of the paper **8**. With the cabinet closed, the paper transport mechanism is engaged with the inking channel and operating current is supplied from the supply **47** via interlock switch **49** and gate **51** to actuate the vacuum pump **22** and to retain the solenoid valve **46** in the closed position.

When the end of the paper is sensed by sensor **31**, an output **32** is fed to the gate **51** and the gate is closed. This deenergizes the vacuum pump **22** and the solenoid valve **46** to permit the valve **46** to be opened. When valve **46** is open the vacuum head on the inking channel **17** is immediately dissipated since the vacuum in vacuum line **23** is communicated through the valve **46** and vacuum line **45** and thence through vacuum line **41** to the air space in the top of the reservoir **19** such that there is no pressure differential between the top of the inking channel **17** and the liquid level of the reservoir, thereby permitting the liquid within the inking channel **17** to feed by gravity into the reservoir **19**.

The solenoid valve **46** should be relatively fast acting such that within a few tenths of a second the pressure may be equalized on the reservoir and the inking channel **17** such that within the first few tenths of a second a substantial amount of the liquid ink has drained from the inking channel **17**. The drainage should be completed within approximately 1 second. Similarly, opening of the cabinet opens the interlock **49** causing the vacuum head on the inking channel **17** to be dissipated, as aforedescribed, for draining the inking channel into the reservoir.

Although the solenoid valve **46** has been shown for interconnecting the top of the inking channel **17** with the top of the reservoir **19**, the valve may also be employed for valving atmospheric pressure into the top of the inking channel **17**, thereby valving off the vacuum pressure head on the inking channel **17** and permitting the ink to drain from the channel by gravity to the reservoir **19**.

When the valve **46** is connected such that it does not necessarily equalize the pressure between the top of the inking channel **17**, and the top of the reservoir **19**, as shown in the drawings, care must be taken such that the ink draining into the reservoir **19** does not produce a sufficient compression of the air space above the liquid level in the reservoir **19** to produce a back pressure sufficient to support a liquid column of sufficient height such that the liquid remains within the inking channel **17**. This undesired result can be avoided by providing a sufficiently large air space above the liquid level in the reservoir **19** or by providing a relatively large air leak out of the top of the reservoir **19** for permitting the air pressure to escape from the reservoir. Another possibility is to use a check valve in the top of the reservoir which will prevent the pressure from building up above atmospheric pressure in the reservoir **19**.

Since many changes could be made in the above construction and many apparently widely different embodiments of this invention can be made without departing from the scope thereof it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. In an electrographic apparatus for reproducing an image on a recording medium by applying liquid ink to a charge image formed on the recording medium, the combination comprising:

reservoir means for containing the liquid ink;

inking means having an upper portion and a lower portion in fluid communication, the lower portion also in fluid communication with the ink in the reservoir means and the lower portion provided with an inking slot for applying the liquid ink to the recording medium;

vacuum means in fluid communication with the upper portion of the inking means for producing and maintaining a vacuum head in the inking means for drawing the liquid ink from the reservoir means into the lower portion of the inking means leaving a partial vacuum air space in the upper portion of the inking means; and

valve means for valving off the vacuum head in the inking means.

2. The apparatus of claim 1 wherein means is provided for regulating the level of the liquid ink in the lower portion of the inking means.

3. The apparatus of claim 1 wherein means is provided for circulating the liquid ink between the reservoir and the lower portion of the inking means.

4. The apparatus of claim 1 wherein the inking means is located higher than the reservoir means and when the vacuum head in the upper portion of the inking means is valved off the liquid ink in the lower portion of the inking means drains by gravity flow into the reservoir means.

5. The apparatus of claim 1 wherein the valve means valves off the vacuum head by establishing fluid communication between the space above the liquid ink level in the reservoir means and the upper portion of the inking means.

6. The electrographic apparatus of claim 5 wherein the valve means comprises:

a fluid conduit interconnecting the air space above the liquid ink level in the reservoir means and the partial vacuum air space in the upper portion of the inking channel; and

a valve connected in the fluid conduit to substantially block fluid passage, the valve being selectively operated for

opening the fluid conduit and establishing fluid communication between the partial vacuum air space in the upper portion of the inking channel and the air space above the liquid ink level in the reservoir means.

7. The electrographic apparatus of claim 5 wherein means is provided for sensing the end of the recording web medium for activating the valve means and establishing fluid communication between the partial vacuum air space in the upper portion of the inking channel means and the air space above the liquid ink level in the reservoir means.

8. The electrographic apparatus of claim 7 wherein the means for sensing the end of the recording medium and for activating the valve means includes means for turning off the vacuum means.

9. The electrographic apparatus of claim 5 wherein means is provided for disengaging the recording medium from the inking channel means, and means is provided forming an interlock with the recording web disengaging means for actuating the valve means.

10. The electrographic apparatus of claim 9 wherein the interlock means includes means for turning off the vacuum means.