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(54) Conversion circuit for continuous inkjet printers

(57) The invention provides a method of, and apparatus for, converting a signal derived from a phase detector electrode (22) in a CIJ printer to a form which does

not degrade when passing between the printhead (5) and the main processing section (6) of the printer. The preferred method and apparatus employ a virtual earth.

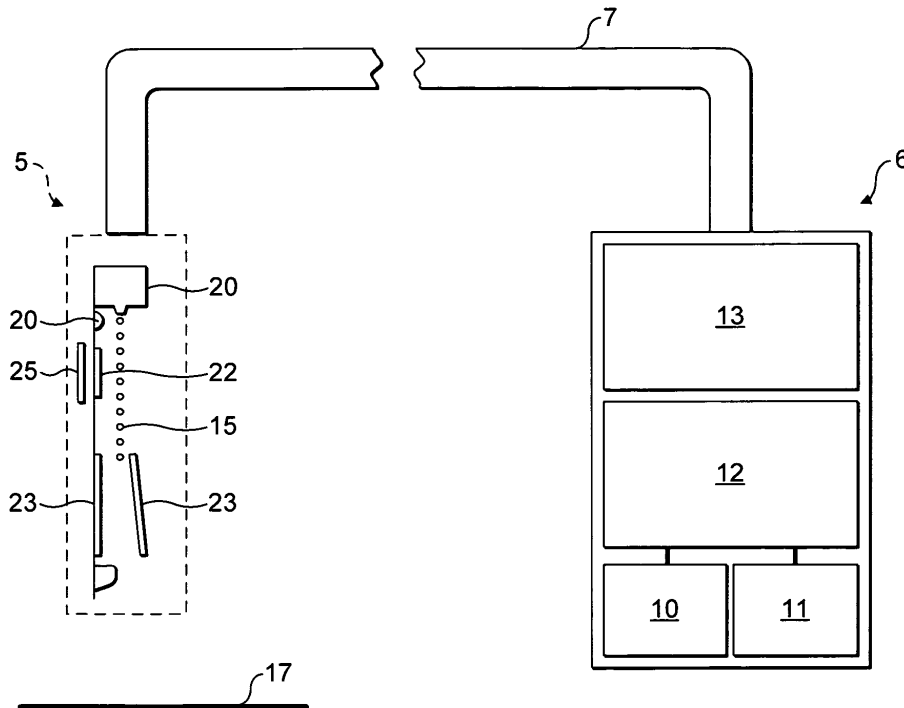


FIG. 1

EP 1 944 163 A1

Description

Field of the Invention

[0001] This invention relates to a continuous inkjet (CIJ) printer.

Background to the Invention

[0002] CIJ printers typically comprise a printhead; and a print control unit sited at a location remote from the printhead, and connected to the printhead by a conduit. The conduit carries the various electrical wiring and fluid lines to enable the printhead to function under the control of the control unit.

[0003] It will be appreciated that not all CIJ printer installations are the same. It is common for the print control unit and the printhead to be sited at different respective positions, resulting in differing lengths of conduit being provided.

[0004] One of the electrical signals carried by the conduit is a phase detection signal. Typically this electrical signal is very small in magnitude, requiring relatively sensitive receiver circuitry within the print control unit to receive and process the signal. Differing length conduits cause differences in the transmission path of the phase signal; for example, longer conduits exhibit greater capacitance, which attenuates the amplitude of the phase signal. As a consequence, adjustment to gain or threshold voltage is required to compensate for the attenuation of different lengths of the cable. This increases the complexity of the installation process and limits the ability of a user, on site, to vary the installation configuration.

[0005] It is an object of this invention to provide a method and/or apparatus which will go at least some way in addressing the aforementioned problems; or which will at least offer a novel and useful alternative.

Summary of the Invention

[0006] Accordingly, in one aspect, the invention provides a method of treating an signal derived from a phase detection electrode incorporated in the printhead of a continuous inkjet printer, said printhead being connected to a processing unit by means of a at least one electrical conductor, said method being characterised in that the signal from said phase detection electrode is converted to a form which is unaffected by the length of said electrical conductor.

[0007] Preferably said method involves the use of a virtual earth circuit.

[0008] Preferably a voltage derived from said phase detection electrode is applied to the inverting input of an operational amplifier, the non-inverting input to said amplifier being earthed.

[0009] Preferably said method further includes passing a signal derived from said virtual earth circuit, through an inverting stage. Said inverting stage preferably uses

a second operational amplifier.

[0010] In a second aspect the invention provides a continuous inkjet printer having a printhead which includes a phase detection electrode, a processor to process signals derived from said phase detection electrode and at least one electrical conductor linking said printhead to said processor, said printer being characterized in that it includes a conversion circuit to convert signals derived from said phase detection electrode as an ink droplet passes said phase detection electrode, to a form which remains substantially constant irrespective of the length of said at least one electrical connector.

[0011] Preferably said conversion circuit incorporates a virtual earth.

[0012] Preferably said virtual earth is provided by an operational amplifier, the non-inverting input to which is earthed.

[0013] Preferably said conversion circuit includes a further operational amplifier configured to invert a current derived from said first-mentioned operational amplifier.

[0014] Many variations in the way the present invention can be performed will present themselves to those skilled in the art. The description which follows is intended as an illustration only of one means of performing the invention and the lack of description of variants or equivalents should not be regarded as limiting. Wherever possible, a description of a specific element should be deemed to include any and all equivalents thereof whether in existence now or in the future.

Brief Description of the drawings

[0015] An embodiment of the invention will now be described with reference to the accompanying drawing in which:

Figure 1: shows, schematically, a typical CIJ configuration to which the invention is applied; and

Figure 2: shows a circuit diagram including the various components for performing the invention.

Description of Working Embodiment

[0016] Referring firstly to Figure 1, the circuit to be described below is intended for use with a CIJ printer of conventional form. To this end, the printer comprises a printhead 5 and a printer operating unit 6, the two parts 5 and 6 being linked by an umbilical 7 which, in the conventional manner includes a multiplicity of electrically conducting cables or electronic signal lines, together with a multiplicity of tubes for conveying ink and make-up fluid.

[0017] The precise form and operation of the printhead 5 and operating unit 6 is not essential to the understanding of this invention. By way of example, the operating unit will typically include reservoirs 10 and 11 for ink and make-up fluid respectively, an ink system 12, and an electrical/electronic processor 13. The processor 13 controls

the operation of the ink system 12 and the printhead 13 to ensure droplets 15 of ink are emitted from the printhead in the appropriate manner to produce the desired marking on a substrate 17.

[0018] As is well known to those skilled in the art, selected ones of the droplets 15 emanating from the drop generator 20 have a charge induced thereon by a charge electrode 21, and then pass a phase detection electrode 22. The charged drops induce a voltage at the phase detection electrode, the measurement of which enables the timing of charge application, in subsequent drops, to be correctly maintained. The charged droplets then pass through a deflection field created between deflector plates 23, which determines the positions at which the charged drops impact the substrate 17. Uncharged drops pass directly to a catcher or gutter and are returned to the operating unit 6 via a tube within the conduit 7.

[0019] As stated above, the voltages induced at the phase detection electrode are generally small in magnitude and the magnitude and/or quality of the signal typically varies with varying lengths of conduit 7 or, more exactly, to the length of the conductor within conduit 7 which conveys the signal from the charge electrode 22 to the operating unit 6. The present invention addresses this drawback by incorporating a conversion circuit, indicated schematically as 25 in Figure 1, which converts the base voltage signal induced at the detection electrode 22 to a form which is unaffected by the length of the umbilical 7.

[0020] The conversion circuit preferably incorporates a virtual earth and is conveniently of the form shown in Figure 2.

[0021] As used herein, a virtual earth is intended to mean a circuit which provides a very low impedance to signals connected to it. In an operational amplifier, such as U5A in Figure 2, if a negative feedback circuit is created, due to the very high loop gain, then if the non-inverting (+) input to the amplifier is earthed as shown, then the inverting input (-) will assume a similar potential i.e. the 'virtual earth'.

[0022] Thus, U5A effectively short circuits the input from the phase detector electrode to ground, and measures the current to ground as an ink drop passes the phase detection electrode. This current is independent of variation due to conduit length.

[0023] In this particular configuration, current at the input is represented as a voltage developed across R4. For $R4 = 1M\Omega$ the circuit develops $1V/\mu A$ of input current.

[0024] The voltage at U5A output swings negative for positive input current. A second inverting amplifier stage, U5B, with voltage gain defined by $R12/R50$ restores the signal to the desired polarity. This stage has input resistance equal to R50.

[0025] It will thus be appreciated that the invention provides a method and apparatus which overcomes the problem arising from a varying quality of signal from the phase detector electrode. This, in turn, means that a CIJ printer installation can be re-configured without the need

for intervention from skilled operatives to adjust the machine to compensate for changes in the length of the conduit 7.

Claims

1. A method of treating an signal derived from a phase detection electrode (22) incorporated in the printhead (5) of a continuous inkjet printer, said printhead (5) being connected to a processing unit (6) by means of at least one electrical conductor, said method being **characterised in that** the signal from said phase detection electrode (22) is converted to a form which is unaffected by the length of said electrical conductor.
2. A method as claimed in claim 1 involving the use of a virtual earth circuit .
3. A method as claimed in claim 1 or claim 2 wherein a voltage derived from said phase detection electrode (22) is applied to the inverting input of an operational amplifier (U5A), the non-inverting input to said amplifier being earthed.
4. A method as claimed in claim 3 further including passing a signal derived from said virtual earth circuit, through an inverting stage.
5. A method as claimed in claim 4 wherein said a second operational amplifier (U5B) is employed to effect said inverting stage.
6. A continuous inkjet printer having a printhead (5) which includes a phase detection electrode (22), a processor (6) to process signals derived from said phase detection electrode and at least one electrical conductor linking said printhead (5) to said processor (6), said printer being **characterized in that** it includes a conversion circuit to convert signals derived from said phase detection electrode (22) as an ink droplet passes said phase detection electrode, to a form which remains substantially constant irrespective of the length of said at least one electrical connector.
7. A printer as claimed in claim 6 wherein said conversion circuit incorporates a virtual earth.
8. A printer as claimed in claim 7 wherein said virtual earth is provided by an operational amplifier (USA), the non-inverting input to which is earthed.
9. A printer as claimed in claim 8 wherein said conversion circuit includes a further operational amplifier (U5B) configured to invert a current derived from said first-mentioned operational amplifier (USA).

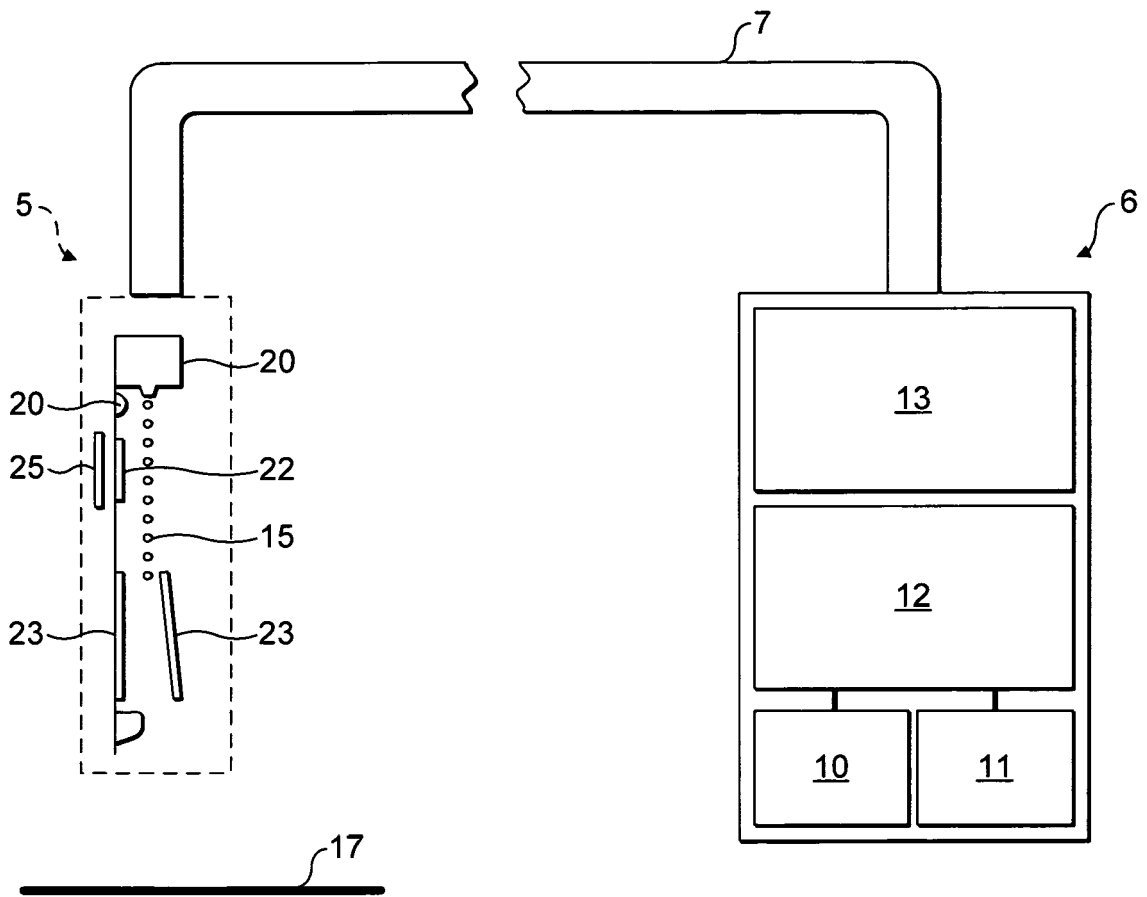


FIG. 1

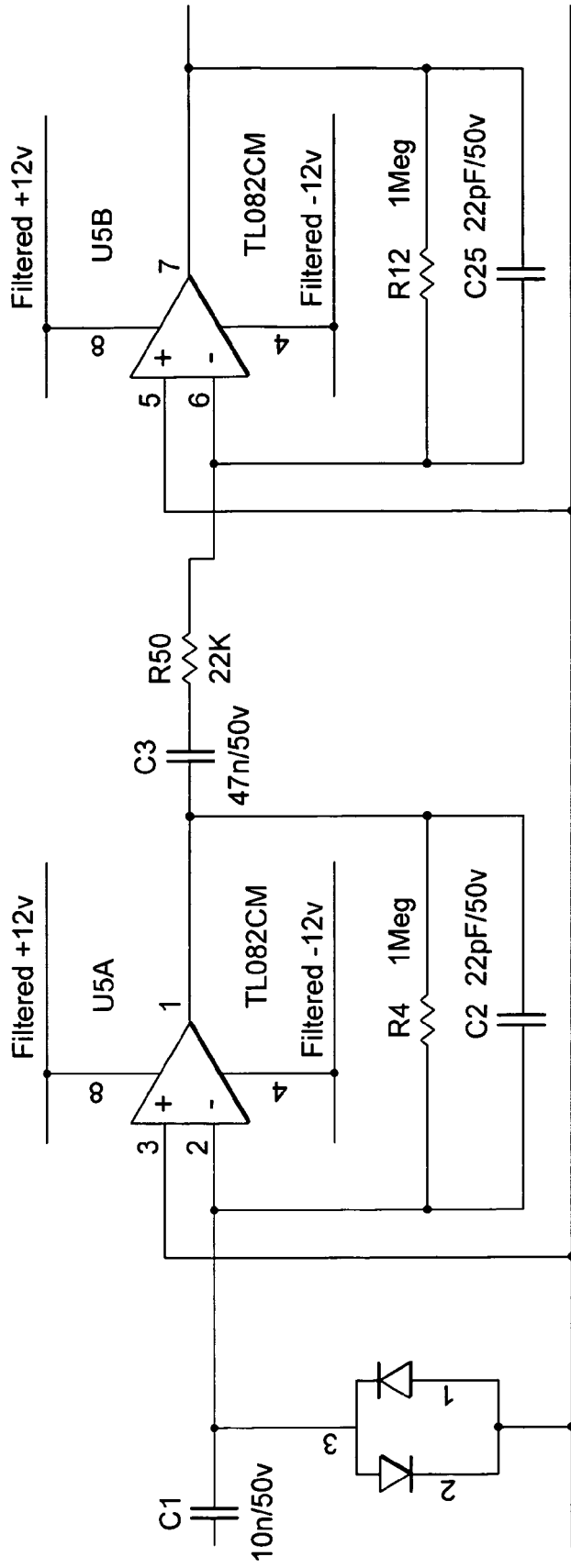


FIG. 2



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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			B41J
Place of search		Date of completion of the search	Examiner
The Hague		21 April 2008	Bonnin, David
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

2
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ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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