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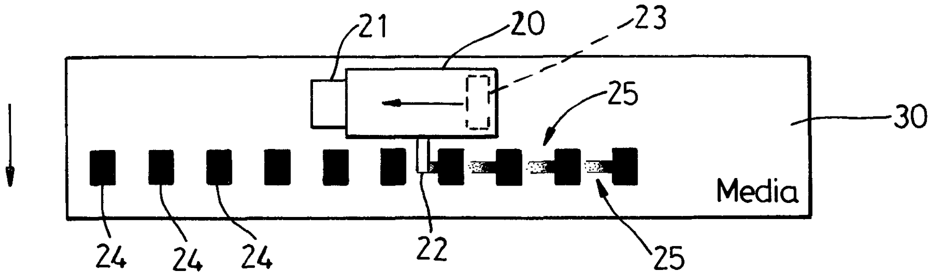
# (54) Printing and printers

(57) A method of operation for a printer (4) and a printer system, the method comprising applying at least one test portion of ink (24) to a print medium (30), rubbing the test portion with a rubber (22), sensing the sensing test portion with a sensor (21), sending a signal representative of the sensed rubbed test portion to a processor associated with the printer so that said processor is capable of determining the extent of ink migration (25) caused by the rubber.

*Fig. 3c*

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## Description

### Field of the Invention

**[0001]** This invention relates to printing and printers and especially, but not exclusively, to digital printing and printers.

### Background

**[0002]** Digital printers, such as inkjet, laser printers, dot matrix printers, LED printers, or gel printers, (to name a few) have been around for many years. They can be black and white or colour printers (e.g. four colour, or six colour, or more). They print onto a print medium, typically paper. Paper comes in different kinds with different colours and different ink-retention properties. It is necessary to use the correct kind of paper with a digital printer, or else there is a risk that the ink will not dry properly (too much ink applied for the particular kind of paper used) or the colours will not look right, or both.

**[0003]** Digital printers have what is termed a "printing pipeline" configured in them at the source of manufacture to set parameters and variables to ensure, amongst other things, that the correct ink load is applied when printing on a specified, correct, paper. Some digital printers can accommodate different kinds of paper/media by having more than one pipeline setting, the user determining which media will be used and selecting the appropriate available pipeline setting from a group or set of pre-set possibilities. The predefined set of supported media is relatively closed, and the engineers who develop a printer calculate an ink limit and other pipeline parameters by internal testing in the development factory on the supported media. Any media for which acceptable pipeline parameters cannot be found, are not supported by the printer, and are not included in the supported media list.

**[0004]** Ink-jet printing is a non-impact printing process in which droplets of ink are deposited on a print medium in a particular order to form alphanumeric characters, area-fills, and other patterns. Low cost and high quality of the hardcopy output, combined with relatively noise-free operation, has made ink-jet printers a popular alternative to other types of printers used with computers.

**[0005]** Ink-jet printing involves the ejection of fine droplets of ink onto a print medium such as paper, transparency film, or textiles in response to electrical signals generated by a microprocessor. There are two basic means currently available for achieving ink droplet ejection in ink-jet printing: thermally and piezo-electrically. In piezoelectric ink-jet printing, the ink droplets are ejected due to the vibrations of piezoelectric crystals, again in response to electrical signals generated by the microprocessor.

**[0006]** In thermal ink-jet printing, an ink-jet image is formed when a precise pattern of dots is ejected from drop generating device known as a "print head" onto a printing medium. The typical ink-jet print head has an array of precisely formed nozzles (or ejector portions) attached to a thermal inkjet print head substrate, such as silicon, nickel, or polyamide, or a combination thereof. The substrate incorporates an array of firing chambers or drop ejector portions that receive liquid ink (colorants dissolved or dispersed in a solvent) through fluid communication with one or more ink reservoirs. Each firing has a film resistor, known as a "firing resistor" located opposite the nozzle so ink can collect between the firing resistor and the nozzle. The print head is mounted on a carriage that travels along the width of the printer (otherwise referred to as the "scan axis").

**[0007]** Although the invention is particularly concerned with ink-jet printing, the invention may also find application with regard to other printing technologies, such as laser printing, LCD printing, LED printing, LEP gel printing, and/or toner-based printing (e.g. photocopiers).

**[0008]** According to a first aspect of the invention there is provided a method of operation of a printer comprising printing at least one test portion of ink onto a print medium, rubbing the test portion with a rubber, determining the presence or absence of ink in the region of the rubbed test portion that has migrated due to the rubbing to determine whether the printing provides an acceptable image quality.

**[0009]** The method may also comprise setting pipeline parameters based upon the signal representative of the sensed rubbed test portion in accordance with predefined rules.

**[0010]** Thus a pipeline setting can now be created dynamically and automatically by the printer itself, using information that it has obtained relating to the drying time and/or permissible ink load, that the paper it is used with can support. This gives a wider range of bespoke, tailored, parameters than simply selecting from a few available preset, factory-set, options. It also can avoid a user choosing the wrong setting by accident (or deliberately).

**[0011]** Another aspect of the invention relates to a printed document produced using data obtained from the method of the first aspect of the invention.

**[0012]** According to another aspect of the invention there is provided a printer system comprising a printer head, a sensor and a rubber;

**[0013]** the system being configured such that, in use, the printer head is adapted to print at least one test portion of ink to a print medium, the rubber is operative to rub across the test portion, and the sensor is adapted in use to sense a region adjacent the rubbed test portion and to produce data indicative of migration or absence of migration of ink from the rubbed test portion.

**[0014]** A processor may further be adapted to use the data to determine acceptable values of pipeline parameters associated with the print medium.

**[0015]** According to a further aspect of the invention there is provided printer control software which is adapted, when loaded on a processor associated with a printer, to cause the printer to apply at least one test portion of ink to a print medium, to cause a rubber to rub across the test portion, to cause a sensor to sense the rubbed test portion, to cause a signal representative of the rubbed test portion to be sent to the processor so that the processor is capable of determining the presence or absence of ink migration caused by the rubber.

**[0016]** The software may be stored on a machine readable data carrier such as a CD, DVD, tape or any suitable data carrier. Optionally, the software may determine the extent of the ink migration.

**[0017]** Yet a further aspect of the invention relates to apparatus for a printer, the apparatus comprising a sensor and a rubber, the arrangement of the apparatus is such that, in use, the rubber is adapted to rub across a test portion of ink printed onto a print medium by the printer and the sensor is adapted to sense the test portion after the test portion has been rubbed.

**[0018]** According to another aspect of the invention there is provided a printer system comprising means for printing, means for sensing, means for rubbing and means for data processing, the system being such that, in use, the means for printing applies at least one test portion of ink to a print medium, the means for rubbing is operative to rub across the test portion, the means for sensing senses the rubbed test portion and issues data indicative of the rubbed test portion, and the means for data processing uses said data to determine the presence or absence of, or the extent of, ink migration caused by the means for rubbing.

**[0019]** According to a further aspect of the invention there is provided a method of calibrating a printer comprising printing a test patch on a print medium, rubbing the test patch, optically sensing the rubbed test patch to produce signals indicative of the rubbed test patch, and calibrating printer settings based upon the signals indicative of the rubbed test patch.

**[0020]** According to a further aspect of the invention there is provided a method of printing a document comprising:

i) printing ink onto a print medium;

ii) sensing a position of ink of the printed ink;

iii) determining if the position of the printed ink is correct; and

iv) if it is determined that the printed ink is in a correct position, continuing to print; or

v) if it is determined that the printed ink is not in a correct position, altering a pipeline setting or other print-controlling setting determinative of position of printed ink; and

a) returning to step i) of the method; or

b) continuing to print.

**[0021]** The method may further comprise the step of rubbing the printed ink prior to sensing a position of ink of the test content at step ii) of the method.

**[0022]** According to a further aspect of the invention there is provided a method of reducing smudges in a printed document comprising printing a test patch on a print medium, rubbing the test patch, optically sensing the rubbed test patch to produce signals indicative of whether or not the rubbed test patch has smudged, and dynamically setting pipeline parameters to values associated with a section of the signal that corresponds with a patch that has not smudged.

**[0023]** According to a further aspect of the invention there is provided a method of determining whether or not acceptable pipeline parameters exist for a print medium, comprising printing content onto a print medium, optically sensing the printed content to produce data indicative of physical characteristics of the printed content, and determining whether or not acceptable pipeline parameters exist for the print medium based upon said data indicative of physical characteristics of the printed content.

**[0024]** The method may further comprise determining values for the acceptable pipeline parameters if it is determined that acceptable pipeline parameters exist. The method may also comprise setting the pipeline parameters at the determined acceptable values.

**[0025]** The printed content may be a test patch.

**[0026]** According to a further aspect of the invention there is provided a printer system having a print head, an optical sensor and an associated processor, wherein the print head is arranged to print content onto a print medium, the optical sensor is adapted to sense printed content and to produce data indicative of the printed content, and the processor is adapted to use said data to determine whether or not acceptable pipeline parameters exist for the print medium.

**[0027]** The processor may further be adapted to determine values of the acceptable pipeline parameters, if it is determined that acceptable pipeline parameters exist. The processor may also be adapted to set the pipeline parameters to the determined acceptable values.

**[0028]** According to a further aspect of the invention there is provided a method of printing comprising test printing and a subsequent printing of a print job to be printed, the test printing comprising printing at least one test portion of ink onto a print medium, sensing the position of the printed test portions to generate a first signal representative of the position of the printed test portions, rubbing the test portions with a rubber, sensing an area adjacent the rubbed test portions to generate a second signal representative of ink that has migrated from the position of the printed test portions due to rubbing, subtracting the first signal from the second signal to produce a difference signal, using the difference signal to determine whether the printing of the test portions of ink provides an acceptable image quality, and determining print pipeline parameters that were used to print a test portion which has an acceptable image quality; the subsequent printing of said print job comprising printing the print job using print pipeline parameters that resulted in the printing of a test portion with acceptable print quality in said test operation.

**[0029]** According to a further aspect of the invention there is provided a method of printing comprising setting print pipeline parameters for a printing operation using information obtained from a processor-controlled test print operation in which a test patch of ink is printed and then rubbed to enable a processor to determine whether the ink is smudged, and automatically using in the printing operation pipeline parameters from a test print operation determined to result in print of an acceptable quality.

**[0030]** According to a further aspect of the invention there is provided a printer comprising a printer head and a photospectrometer.

**[0031]** According to a further aspect of the invention there is provided a device for determining whether or not a print quality of ink printed on a print medium is acceptable, the device comprising an ink migrator, a sensor and software, wherein the ink migrator is adapted to migrate wet ink printed on the print medium, the sensor is adapted to generate a signal that represents the presence or absence of ink in the region of the print medium that has been subjected to the ink migrator, and the software is adapted to use the signal that represents the presence or absence of ink to determine whether or not the print quality is acceptable.

BRIEF DESCRIPTION OF THE DRAWINGS

**[0032]** Various examples of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

**Figure 1** is a schematic representation of a printer comprising an embodiment of the invention;

**Figure 2** is a schematic representation of an embodiment of the invention comprising a system for printing a document;

**Figures 3a to 3d** are progressive schematic top views of a print head carriage of an embodiment of the invention performing a self-optimisation operation on a print medium;

**Figures 4a to 4d** are progressive schematic front views of Figures 3a to 3d;

**Figure 5** is a more detailed representation of three rubbed ink patches produced using an embodiment of the invention;

**Figure 6** is a combined photo-spectrogram of data obtained using an embodiment of the invention by scanning the ink test portions shown in Figure 5 before application of a rubber and after application of the rubber;

**Figure 7** is a graphical representation of the difference in readings between the photo-spectrograms of Figure 6;

**Figure 8** is a schematic representation of a printer according to an embodiment of the present invention;

**Figure 9** is a flow diagram of various steps of a self-optimisation procedure implemented by a printer in accordance with an embodiment of the invention;

**Figure 10** is a flow diagram of various steps of software installed on a printer driver of a printer that is implementing the self-optimisation procedure in accordance with the embodiment of the invention of Figure 9;

**Figures 11 and 12** are schematic side views of a printer according to an embodiment of the invention which show how a pinch wheel and feed roller arrangement are used to rub printed ink test portions; and

**Figure 13** is a schematic representation of an attachment device according to an embodiment of the present invention.

**Detailed Description of Some Examples of the Invention**

**[0033]** In use a printer is adapted to print indicia (e.g. words/text, pictures/ drawings, photographs/representations of photographs, artwork, borders, lines, shapes or decorative features) onto a print medium, such as one or more sheets of paper. The term print medium used herein generally includes media such as card, plastic sheet or film, transparencies, photographic paper, labels, iron-on transfer material, and matt paper/glossy paper, as a non-exhaustive list of examples.

**[0034]** It is to be appreciated that by the term 'printer' we intend to cover equipment that is capable of printing ink onto a print medium and accordingly includes equipment such as multiple-function machines (e.g. a combined printer, scanner and photocopier), fax machines and other open-media systems. We also intend that the term includes machines (that may yet to be realised) that are designed to have printing capabilities primarily for the purpose of testing a particular print medium to determine suitable pipeline parameters such as dry time/ink density combinations (as herein described) but which are not generally designed for producing printed documents generally as a conventional printer is capable of.

**[0035]** The term "ink" is meant to include liquid inks, gel inks and powder inks (e.g. toner that needs heat to fuse to a page/surface) and gels: it is not used in a sense to restrict its physical form. Ink marks an article to be printed and its application can be controlled by the printer.

**[0036]** A print operation or print job can be considered as the physical act of the printer applying ink to a medium in order to print indicia. In some embodiments, the print operation or print job may also comprise a processor sending electronic signals to a print head to cause the indicia to be printed. Furthermore, the print operation or print job may include an off-printer processor receiving instructions from a user to print indicia, and sending an electronic signal to the printer to cause the indicia to be printed.

**[0037]** Pipeline and alignment parameters are used to define various settings that are used during a print operation. A non-exhaustive list of pipeline and alignment parameters includes:

i) colour mapping — to convert the desired colour into the required amounts of ink;

ii) colour conversion —for converting a colour mapping of a first printer to a colour mapping of a second printer, for example for converting the colour map for a four channel colour printer (having black, cyan, magenta and yellow inks) to the colour map for a six channel colour printer (having black, cyan, magenta, yellow, light magenta and light cyan inks);

iii) ink limiting — defines characteristics of the combination of the ink and media used to ensure that separate colours are printed correctly, a parameter called INK LIMIT is used to define the maximum amount of ink per unit area that can be absorbed for a specific ink-media interaction;

iv) linearisation — converts the ink quantity into colour, for example, to compensate for the fact that human-perceivable changes in colour are not linear in comparison with actual changes in ink composition;

v) print head to printer spacing - adjusting this parameter enables optimum image quality to be obtained for media having different thicknesses;

vi) dry time — time allowed for ink to dry before the print job continues, this can be part-defined by the following pipeline parameters;

vii) speed of the carriage/print head;

viii) number of passes of the print head — defines how many times the printer carriage passes over the media to print;

ix) uni-directional or bi-directional print operation — defines whether the printer carriage prints when passing over the media in only one direction, or in two directions.

**[0038]** Any, some, or all of the above pipeline or alignment parameters should be set for a print job to ensure a high image quality and acceptable print job. Where pipeline parameters are discussed in the following examples, it should be appreciated that such pipeline parameters can also include alignment parameters.

**[0039]** Figure 1 shows a printer 4 comprising a printer head assembly shown generally at 10, a central processing unit 11, a memory 12 (which preferably comprises both re-writeable memory (e.g. RAM, EEPROM) and non-re-writeable memory (e.g. ROM)), a communications port 14, for example enabling connection to a PC, laptop, PDA or a network, and/or being adapted to receive a portable machine readable data carrier such as a memory card (e.g. Memory Stick™) USB storage devices, CDs, DVDs, flash memory cards. The printer 4 further comprises a paper tray 13 which stores a supply of paper to be printed on and a paper feed assembly (not illustrated) to convey the paper from the paper tray 13 to the printer head assembly 10.

**[0040]** In the memory 12 of the printer there are stored various pre-defined pipeline parameters. The pipeline parameters can include Look Up Tables (LUTs) for each type of print medium and for each type of print quality that the printer is designed to handle. That is to say, a LUT for each type of paper that the printer is designed to be used with and for different print densities (e.g. dpi) etc. Values within the LUTs can be set according to the values of pipeline parameters, including some or all of, colour mapping, colour conversion, ink limiting and linearistaion pipeline parameters. In some embodiments, the LUT can be considered as a pipeline parameter in its own right, and discussion of setting a pipeline parameter can include directly or indirectly setting values in an LUT. In particular, any discussion of setting values for ink density and dry time can include directly or indirectly setting values within an LUT.

**[0041]** An LUT can be loaded from memory 12 by a colour mapper in accordance with a specific print job. The LUTs contain data which is indicative of how much ink (of a particular type) needs to be dispensed to produce a desired colour (where mixing is required) or a desired print quality, and each of those in respect of each type of print medium that the printer is designed to handle. For example, to achieve a particular print quality on a particular paper type it may be required that a particular number of ink drops is required to be propelled onto the print medium during the printing process for each pixel. It will be appreciated however that the LUTs may be stored in a PC 3 as shown in Figure 2, in the printer itself, or in a processor (for example a server) intermediate of the PC and the printer, as may appropriate parts of, or the whole of, printer driver software that uses the LUTs.

**[0042]** Other pre-defined settings for other pipeline parameters may be stored in memory 12. Some or all of the speed of the print head, uni-directional or bi-directional print carriage movement and the number of passes may have pre-defined settings to provide sufficient time for the ink to sufficiently dry, and avoid smudging of the document after it has been printed.

**[0043]** It will be appreciated that, alternatively, instructions could be sent to the printer 4 not from a PC but from a server, laptop or PDA, for example.

**[0044]** An initialising/self-optimisation operation of the printer 4 will now be described in which the printer will determine whether a paper, on which a user wishes to print, is of a suitable type for the printer and if it is of a suitable type, and appropriate pipeline parameters, including a combination of ink density and dry time combination is determined therefor. For the sake of simplicity, the printer 4 as will now be described in use is a monochrome ink jet printer which carries a supply of pigmented black ink, such as carbon black.

**[0045]** Pigmented inks cannot be supported on certain kinds of print media, in particular what are known as swellable glossies, because the pigment cannot be absorbed and so the ink never would dry (or takes too long to dry). Also, for medias that are supported (for example porous glossies) it is necessary to determine the dry time needed, or the maximum amount of ink per cell that the print head can fire without damaging the printer and to achieve the best image quality as possible.

**[0046]** With reference to Figures 3a to 3d and 4a to 4d, a print head carriage assembly comprises a print head 20 which is mounted for translational movement across a print medium 30 (e.g. a sheet of paper, plastic film, cardboard or the like). In this embodiment the print head 20 carries a cartridge (not shown) of pigmented black ink of known type. In other embodiments of the invention, colour printers can be used which can have, for example, 4 or 6 different colours (e.g. Cyan, Magenta, Yellow and Black (CMYK) or Cyan, Magenta, Yellow, Black, Light Magenta, Light Cyan and Light Magenta (CMYKLmLc)).

**[0047]** Integrally provided with the print head 20 there is provided a photospectrometer 21 which is capable of optically scanning ink printed onto the medium 30. Alternatively the photospectrometer may be a separate unit attached to the print head. In some embodiments a different optical sensing device could be used instead of a photospectrometer, for example a photometer, or any light sensitive component or optical sensor that is capable of producing an electronic signal indicative of characteristics of a printed patch could be used.

**[0048]** In further embodiments still, the sensor that is used to determine whether or not ink migration has occurred may not be an optical sensor but may be any type of sensor that can determine the presence or absence of ink. For example, a magnetic senor may be used with magnetic inks in order that the magnetic sensor can determine whether or not magnetic ink is present, and optionally the amount of magnetic ink present, in regions of the print medium.

**[0049]** The photospectrometer produces an output signal representative of whether the point in space from which it is sampling light is reflecting light of a particular wavelength, and is indicative of the intensity of the light at that wavelength (for that point in space). It may have a wide wavelength pass filter or a narrow wavelength pass filter. Conceivably, the wavelength's passed may be adjustable, possibly by a user/software.

**[0050]** The photospectrometer 21 is provided with an output connection (not illustrated) that is connected to a processor. In this embodiment the processor 11 is present in the printer 4 itself, although in other embodiments all, or some, of the processing can be performed by an off-printer processor. An off-printer processor can be located on a server, on a user's computer connected to the printer 4, either directly or over a network, or any other device in communication with the printer 4. The output connection of the photospectrometer is typically a wired connection, but it could be wireless.

**[0051]** The photospectrometer may be a line sensor (of known type).

**[0052]** In embodiments of the invention the sensor will be used to create customised pipeline profiles for unknown print media, and can distinguish between glossy and non-glossy media. For example, a pipeline that fires double the amount of ink per unit area can be used for glossy paper as opposed to non-glossy paper.

**[0053]** For embodiments arranged for use with a colour printer, a system associated with the photospectrometer may be capable of determining the wavelength of light reflected by the medium 30, and hence determine the colour of the medium and/or any ink present on the medium 30. The system associated with the photospectrometer may be capable of determining which colour inks have migrated after being rubbed, and if the system determines that the wavelength of the light reflected from any migrated ink corresponds with cyan ink (for example), the pipeline parameters associated with the cyan ink channel can be adjusted. Alternatively, the LUT could be adjusted (or a different LUT that already exists selected automatically) so that a different ink channel is used to produce the colour of the ink that has been migrated, for example an amount of cyan ink could be replaced with an amount of light cyan ink in a six channel colour printer.

**[0054]** The print head carriage assembly 10 further comprises an actuateable attachment assembly (shown generally at 23) which in use is arranged to mechanically releasably attach a rubber 22 to the carriage 20. Of course, in other embodiments the rubber 22 may not be releasable from the carriage 20, and may not even be provided on the carriage 20 (so as long as there is an operative rubber, as discussed later). In some embodiments the rubber may be permanently attached to the carriage 20 and may be moved away from a position that would contact the paper 30 when it is not desired to be used. For example, the rubber may be capable of pivoting, or otherwise moving, out of the paper path flow to an out-of-use position when a self-optimizing routine is not being performed.

**[0055]** It will be appreciated that by a rubber, we include a wiper, blotter, ink displacer, migrator, or any other means of displacing wet ink from its original position on a medium to a new position on the medium. The rubber need not necessarily rub/smudge the ink, but can cause wet ink to be displaced/migrate by applying a force to the ink. The term "rubber" refers to the function of migrating ink, and is not necessarily indicative of the nature of the material of which the "rubber" is made. The force can be in a direction that is along the surface of the paper, possibly transverse to the direction of paper flow or parallel with the direction of paper flow. Alternatively, the force can be in a direction into the surface of the paper.

**[0056]** On receiving a signal indicative of a desire to print on an unknown medium the driver software loaded in the printer 4 selects a program called UNKNOWN MEDIA TEST. In some embodiments the UNKNOWN MEDIA TEST program may be run as a safeguard even when a user specifies the type of media that they are printing on.

**[0057]** The program first causes a sheet of the medium to be conveyed towards the printer head assembly 10 so as to be accessible thereby as shown in Figures 3a and 4a.

**[0058]** The UNKNOWN MEDIA TEST program is then operative to cause the printer head 20 to print a plurality of patches 24 of black ink, as shown in Figure 3a, in a first pass from left to right. Each ink patch 24 has a progressively increasing ink load from left to right on the print medium 30, that is, as the print head 20 translates across the print medium each ink patch (of pre-determined area) has an increasing amount of ink per unit area. Therefore the far right ink patch 24 will have more ink per unit area than the far left ink patch. The values of the pipeline parameters associated with each of the printed ink patches 24b are stored in printer memory 12 (or alternatively in an off-printer memory), so that the acceptable values of the pipeline parameters associated with a determined acceptable ink patch can be retrieved when it is determined which ink patch/es are acceptable.

**[0059]** Alternatively, the same amount of ink is used to print each of the ink patches, and a set amount of time is allowed to pass between printing each ink patch.

**[0060]** In other embodiments, a combination of varying the amount of ink and allowing a set amount of time to pass between printing ink patches can be used.

**[0061]** Once the print head 20 has applied a required number of test patches, the UNKNOWN MEDIA TEST program then causes the carriage assembly 10 to translate across the medium from right to left towards the first printed patch 24 and activate the photospectrometer 21 at the same time (as shown in Figures 3b and 4b). In so doing the photospectrometer optically scans the just-applied test patches 24 and the data gained therefrom is stored in the memory 12 of the printer 4. The data includes the physical position and extent of the printed patches. As is explained more fully below, this provides a reference signal to minimise noise and also to minimise consistent irregularity/biases.

**[0062]** In other embodiments, the measured data captured by the photospectrometer that can be used to determine physical characteristics of the ink patches can be stored in an off-printer memory, for example in the memory of a PC, or on a server connected to the printer over a network. Alternatively, if measured data is not captured by the photospectrometer to provide a reference signal, data representing the physical characteristics of the theoretical printed ink patches (according to the print instruction) can be stored in a memory, either an on-printer memory or an off-printer memory.

**[0063]** On completing the initial passes, the UNKNOWN MEDIA TEST program then causes the carriage assembly 20 to return towards the right-hand end of the patches 24 so as to be able to collect the rubber 22. Attachment of the rubber 22 to the carriage 20 is preferably achieved by way of a detachable mechanical connection, but could alternatively be achieved, for example, by providing the carriage 20 with an electromagnetic device and the rubber 22 with magnetically attractable material. In an alternative, the rubber resides at the left hand side of the printer and after printing the patches the printer carriage is already at the correct side of the printer to be coupled to the rubber (that is there is no need for the printer carriage to return specifically for the rubber).

**[0064]** Feed rollers (not shown in Figures 3a to 4d) which grip the print medium 30 then convey said print medium 30 in a direction which is substantially perpendicular to the direction of translational movement of the carriage 10 (as seen best in Figure 3c). This then provides alignment in the longitudinal/feed direction of the paper between a rubbing surface 26 of the rubber 22 and the row of test patches 24.

**[0065]** The program determines when a pre-determined minimum ink drying time (say of the order of a few seconds, or few or several tenths of a second) has elapsed since the ink patches 24 were printed and on expiry of that time the carriage 20 is caused to translate across the row of patches 24, from right to left as shown in Figures 3c and 4c. The rubbing surface 26 of the rubber 22 is arranged to contact with the patches 24, and if the ink of any of the patches is not dry, then the action of the rubbing surface 26 will cause smudging, or migration, of that ink in the general direction of the movement of the carriage 20. Figure 4d shows the rubber 22 in a non-use position. At least the rubbing surface 26 comprises a waterproof or substantially non-porous material and when the rubber is in a non-use position, a foam pad 27 absorbs ink from the rubbing surface 26.

**[0066]** As can be seen (schematically) in Figures 3c and 3d the wet ink of the patches has been smudged into the (previously) unmarked spaces between patches 24. In essence, if the ink is dry then it stays within the boundary of the of the originally printed ink patch, in spite of the action of the rubber 22. If, however, the ink is not dry then the action of the rubber 22 will cause the wet ink to move outside the original boundary.

**[0067]** In some embodiments the photospectrometer 21 (or other optical sensor) can be mounted on the carriage 20 in a position that is behind the rubber 22 when the carriage moves transversely across the media 30. This can enable the rubbing and scanning of ink patches 24 to be performed in a single pass of the carriage 20 over the media 30.

**[0068]** In some embodiments, the photospectrometer 21 scans several different lines (shown as 28 in Figure 5) across the patches 24 in order to monitor the whole patch. Optionally, the optical sensor may be adapted to scan along several lines (shown as 28 in Figure 5) at the same time during a single pass of the carriage 20. The rubber 22 may only require a single pass over the media in order to perform a satisfactory rubbing action.

**[0069]** The printer 4 can now determine whether any migration which has occurred is acceptable. Alternatively, a PC, a server, or any other device in communication with the printer 4 over a network can determine whether or not any migration that has occurred is acceptable.

**[0070]** In Figure 5a more detailed representations of three ink patches 24' of different ink densities are shown. Figure 5b shows the same three ink patches 24" after they have been subjected to a rubber.

**[0071]** The result if the ink is already dried when the rubber is rubbed across the ink patches will be similar to the left hand patch 24" shown in Figure 5b. The patches 24" in the middle and on the right of Figure 5b have some ink migration, which means that pipeline parameters, including the settings of ink amount and dry time, may be unacceptable. If no ink patches are left un-smudged the pipeline parameters can be altered by, for example, increasing the dry time and/or reducing the amount of ink applied. The UNKNOWN MEDIA TEST program can be re-run with the altered pipeline parameters in an attempt to obtain settings for the amount of ink and dry time (and any other pipeline parameter) that will provide an acceptable print job and image quality.

**[0072]** As ink patches are printed with different pipeline parameters including ink densities and dry times, at least, some patches may be dry at the time of rubbing and therefore no ink migration occurs. Some patches may still be wet at the time of rubbing and therefore ink migration does occur. Evaluating for which ink patches ink migration has and has not occurred can allow the value of acceptable pipeline parameters to be bracketed/ ranged and determine what values for the ink density/ load (at least) are acceptable.

**[0073]** In other embodiments, even if an acceptable patch has been printed, with no ink migration, the settings and values of the pipeline parameters may be changed, and the program run again to obtain better pipeline parameters. For example, to enable a minimum or maximum amount of ink to be used while maintaining a desired print quality. The "best" pipeline parameters can be determined according to an individual user's preferences.

**[0074]** The signal recorded by the photospectrometer 21 as it travels along the line 28 for the three un-rubbed patches 24' of Figure 5a is shown as 50 in the spectrograms of Figure 6. The signal recorded by the photospectrometer 21 as it travels along the line 28 for the three rubbed patches 24" of Figure 5b is shown as 51 in the spectrograms of Figure 6. The scale of the vertical axis relates to the amount of "blackness" determined by the optical scanner on a scale of 0 to 100, where 0 represents black, and 100 represents white. The horizontal axis of the spectrogram relates to transverse distance along the medium, and in embodiments where the medium is scanned by a device moving at constant speed, the horizontal axis can also be equated to time.

**[0075]** As can be seen, a first signal representation 50 is essentially in the form of a repeating pulse. The signal representation 50 is representative of data obtained from optically scanning the un-rubbed ink patches of Figure 5a. A second signal representation 51 is representative of the three patches 24' subsequent to being rubbed at the minimum dry time as shown in Figure 5b. The representation 51 is more irregular in nature, which results from the migration of some of the ink caused by the action of the rubber 22.

**[0076]** In order to determine the extent of ink migration, the program implements a simple algorithm that will use the signals 50, 51 shown in Figure 6 to determine whether a certain combination of ink density and dry time is acceptable or not for the printer 4. Such an algorithm may, for instance, subtract the first signal 50 from the second signal 51 to provide a resultant signal 52 as shown in Figure 7, and then calculate the integral of the resultant signal 52 for individual ink patches. Comparing the integral (that is the area under the resultant signal 52) for individual ink patches with a pre-determined certain threshold indicative of an acceptable ink migration value previously characterized and stored in memory 12, can determine whether or not the image quality is acceptable, and therefore whether not the pipeline parameters have been set at acceptable values.

**[0077]** Alternative algorithms to determine whether or not the resultant signal 52 is acceptable may include calculating a peak value of the resultant signal 52, calculating an average value of the resultant signal or analysing any other characteristic of the resultant signal 52 that indicates a deviation from zero "blackness".

**[0078]** It will be appreciated that in some circumstances a permitted amount of sensed ink migration may be acceptable or it may be that substantially no ink migration is acceptable.

**[0079]** An advantage to performing a first optical scan is that any irregularities in the printed patches or the medium, for example, any marks that may be on the paper, or any unevenness in the printed ink patches, will not be construed as indicating an unacceptable set of pipeline parameters that has caused the ink to migrate after it has been rubbed. Also, the effect of any background "noise" that may be sensed by the optical scanner when obtaining the first signal 50 can be kept to a minimum by comparing the first signal 50 with the second signal that may also be effected by the same "noise".

**[0080]** Any irregularities/noise present in the first signal 50 will also be present in the second signal 51, so that when the two are subtracted to provide the resultant signal 52, the irregularity/noise will be removed.

**[0081]** If none of the patches are acceptable then the process described above may be repeated by printing a second row of test patches but this time increasing the dry time (by a pre-determined amount) and/or reducing the amount of ink before applying the rubber 22 thereto. Alternatively, or additionally, any of the pipeline parameters may be adjusted before a further row of test patches are printed.

**[0082]** For swellable glossy medias the rubbed patches 24 will always have a high degree of ink migration and so for such media, the system may not find a combination of pipeline parameters, including ink density and dry time, to provide an acceptable image quality. A message may be given to the user that the printer does not support the media and that the media should be removed from the printer system. Alternatively or additionally if the system determines by the tests that the ink will not dry properly on the paper that is loaded into the printer it may not permit the printer to print on the paper, overriding a user's instructions to print.

**[0083]** Figure 8 shows an embodiment of a printer 60 according to an embodiment of the present invention. Printer 60 receives paper 62 from a roll 64, as opposed to pre-cut sheets from an in-tray.

**[0084]** Printer 60 has a cutter 66 that consists of a blade mounted on a cutting carriage 68 and an actuator 70 to move the cutter carriage 68 transversely across the paper 62. The cutter 66 also comprises a pinching device or mechanical holding device 72 to compress and hold the paper 62 before it is cut in order to ensure that the paper 62 is in a known position and that a good clean cut is obtained. If the paper 62 is not held firmly when it is being cut, an off-straight cut could be performed.

**[0085]** The cutter 66 is located downstream of the print head carriage 74, and is arranged to move transversely across the paper 62 at predetermined times/positions in order to cut the paper 62 to the correct size at the correct position. For example, the cutter 66 may be arranged to cut the roll of paper into predefined sheets after they have been printed.

**[0086]** Embodiments of the present invention can take advantage of the cutter 66 by mounting a rubber 76 and optical scanner 78 (which may be a spectrophotometer) on the cutter carriage 68 to smudge and scan ink patches that have been printed by the printer 60 as discussed in relation to Figures 3 and 4. The rubber 76 and/or optical scanner 78 may be releasably, or permanently, attached to the cutter carriage 68. Alternatively, the rubber 76 and/or optical scanner 78 may be integral with the cutter carriage 68. Mounting the rubber 76 on the cutter carriage 68 enables the transverse motion of the existing cutter carriage to be used to move the rubber 76 across ink patches that have been printed on the paper 62. Similarly, mounting the rubber and/or optical sensor, or spectrophotometer, on the print head carriage uses an existing printer component to carry these elements.

**[0087]** In alternative embodiments, only one of the rubber 76 and the optical scanner 78 may be located on the cutter carriage 68, and the other may be located on the print carriage 74 as discussed in relation to Figures 3 and 4.

**[0088]** The blade of the cutter may be withdrawn from cutting the paper 62 when it is desired to rub ink patches. Additionally or alternatively, the rubber 76 may be withdrawn from rubbing the paper 62 when it is desired to cut the paper 62. In some embodiments, neither the blade of the cutter 66 nor the rubber 76 need to be withdrawn as long as the rubber 76 and optical scanner 78 are located such that they have access to the printed patches following a cutting operation. That is, the blade of the cutter 66 must not cut the paper so that the rubber 76 and/or scanner 78 cannot perform a subsequent scanning and/or rubbing operation of the region of the paper 62 with the patches. The region of the paper 62 with the ink patches printed thereon should not be cut from the roll 64 during a rubbing and/or scanning operation.

**[0089]** In some embodiments, either, or both, of the rubber 76 and the optical scanner 78 may be integral with, or permanently or releasably attached to, either, or both, of the cutter carriage 68 and the print head carriage 74.

**[0090]** For embodiments where the rubber 76 or optical scanner 78 are located on the cutter carriage 68, the rubber 76 or optical scanner 78 can be activated by using the same algorithm that is used to activate a CUTTER routine (which is a special carriage movement routine). Alternatively, a different routine may be used to activate movement of the cutter carriage 68 and withdraw either or both of the rubber 76 and blade from contacting the paper 62.

**[0091]** In some embodiments, the cutter assembly can be used to smudge ink patches by using the mechanical holding device 72 present as part of the cutter 66. This may be used instead of, or in addition to, mounting a rubber 76 on the cutter carriage 68. Pressure can be applied to the region of the paper 62 on which ink patches have been printed by the mechanical holding device 72 to cause any wet ink to migrate away from the contact points of the mechanical holding device 72, and outside of the original boundaries of the patch. An optical scanner 78 may still be present on the cutter carriage 68 or the print head carriage 74, and the region of the paper having the ink patches printed thereon can be fed from the mechanical holding device 72 to the carriage 68, 74 having the optical scanner 78 so that the ink patches can be scanned.

**[0092]** The paper can be advanced and retracted by the printer's paper feed system to enable printed patches to be moved in the paper feed direction relative to other components (e.g. the rubber or optical sensor) to enable these other components to perform their function on the patches.

**[0093]** Service stations are known in the art, and are used to clean print heads. A service station is a unit or item that can be inserted into a printer, typically a large format printer as provided by Hewlett-Packard™, and includes a wiper that is positioned perpendicularly to the print head of the printer. The wiper can be used to clean off any ink that may have accumulated on ink nozzles in the print head, and ensures that a high quality print job can be maintained. The wiper is moved relative to the print head, or the print head is moved relative to the wiper, so that a region of the wiper is in contact with, and passes over, the ink nozzles. The wiper can be formed of a water-repellent rubber. After use, the wiper may be cleaned by a scraper assembly that is also present in the service station.

**[0094]** The positioning of the wiper in a known service station can be adapted to smudge ink patches and act as a rubber according to embodiments of the present invention.

**[0095]** A rubber for smudging ink patches according to some embodiments of the present invention may be similar to the wiper that is present in a service station, and may be made out of a water-repellent rubber as is the wiper in a service station.

**[0096]** A rubber and/or optical scanner may be attached to, or form part of, a service station. That is, according to some embodiments of the invention, the rubber and/or optical scanner may be retro-fitted (either permanently or temporarily) to the printer when it is desired to self-optimize pipeline parameters for a print job.

**[0097]** Figure 2 is a schematic illustration of a system 100 for printing a document. The system comprises a workstation 2 including a personal computer (PC) 3 which is connected to the printer 4. The workstation 2 includes a user interface including a screen 5, a keyboard 6 and a mouse 7. The PC 3 has as a processor 3a, a memory 3b, and I/O software devices 3c by means of which the processor communicates with the screen 5, the keyboard 6 and the mouse 7 and a communications port 8 by means of which it communicates with a network such as the Internet or a local network such as a LAN having peripheral devices and/or other computers (e.g. PCs), or a WAN, or a MAN, for example.

**[0098]** The PC 3 also comprises printer driver software 9 that allows the PC 3 to communicate with, and instruct, the printer 4.

**[0099]** Figure 9 illustrates a method of performing a self-optimisation routine according to an embodiment of the present invention for determining a suitable ink density and dry time for an unknown media. The method could be used to determine other pipeline parameters in addition to, or instead of, ink density and/or dry time.

**[0100]** The method performs steps 100 to 110 as discussed with reference to the apparatus illustrated in Figures 3 and 4, with the optional step of a user indicating to the printer that it is printing on an unknown media type. In embodiments where the user does not indicate to the printer that it is not printing on an unknown media, the printer may assume that the media is unknown as a default position.

**[0101]** Figure 10 illustrates the steps performed by software installed on a printer driver for performing a self-optimisation routine according to an embodiment of the present invention. The software could be used to determine other pipeline parameters in addition to, or instead of, ink density and/or dry time. Steps 200 to 211 have been discussed in relation to the apparatus shown in Figures 3 and 4.

**[0102]** As can be seen from Figures 9 and 10 the program can be configured to implement, in this example, one of three options once the existence or non-existence of ink-migration, or the extent of ink migration has been determined for each ink patch. If only one ink patch is determined to be acceptable, then the ink density value applied and dry time associated with the acceptable ink patch is selected from the values stored in memory associated with all of the printed ink patches. The selected values of the ink density and dry time values associated with the acceptable ink patch are stored in memory at step 111 or 212 so that the determined pipeline parameters that should be used with a subsequent print job. The memory in which the ink density and dry time values associated with all of the ink patches are stored may be the same memory in which the selected ink density and pipeline values are stored. The stored ink density value and dry time are used to calibrate/mask the LUTs required for the print job. In this embodiment a bespoke LUT is created based upon the ink density value and dry time that were used to print the acceptable ink patch. In other embodiments, one of a set of pre-defined LUTs is selected to be used based upon the values of the ink density and dry time that were used to print the acceptable ink patch.

**[0103]** In alternative embodiments, even if an acceptable ink patch has been determined, the method may repeat steps 103 to 110, or 202 to 211 in an attempt to obtain more accurate/fine tune the pipeline parameters that can be used to produce a more efficient/better print job.

**[0104]** In embodiments where it is desirable to fine tune the ink load/dry time following a test that has produced an acceptable and an acceptable ink patch, the method can be arranged to print another set of test ink patches in the range between the acceptable ink patch and the nearest (in ink load) smudged/unacceptable ink patch. This further set of ink patches comprises ink patches with ink density values that are intermediate the ink density values of the adjacent (in terms of ink load, and they may be physically adjacent each other also) acceptable and unacceptable ink patches from the previous test. Performing this further test can provide more detail as to which pipeline parameters are ok, and provide a test with finer granularity.

**[0105]** If none of the ink patches are deemed to be acceptable then a second set of ink patches is printed at step 112 or 213. The subsequent set of ink patches have the same ink density values as the first set of ink patches but the time interval between printing the patches and rubbing the same with the rubber is increased to a maximum possible dry time. If the results of such a second test are again negative (i.e. it is determined that there are no acceptable patches) then it is indicated to the user that a medium has been determined that the system does not support at step 113 214. The unsupported type of medium may be a swellable glossy medium.

**[0106]** If the results of the second test indicate that at least one ink patch is acceptable, steps 103 to 110, or 202 to 211, may be repeated for dry times intermediate of the minimum and maximum dry times.

**[0107]** In other embodiments, if none of the ink patches are deemed to be acceptable at step 112 or 213, a subsequent set of ink patches can be printed that have the same drying time before rubbing, but use less ink to print the patches. Alternatively, any, some or all of the pipeline parameters associated with printing the ink patches can be adjusted before a subsequent set of ink patches are printed. In some embodiments, the software/method may perform a set number of iterations of the method before the program moves on to step 113 or 214 and indicates that an unsupported media is being used. The set number of iterations may be 1, 2, 3, 4, 5, 10, 20 or 100 or any other number that is deemed to provide an efficient balance between the use of resources required for trying different pipeline parameters and the consequences of not finding suitable pipeline parameters.

**[0108]** In some embodiments, an iteration of the method/software steps may be performed for each individual pipeline parameter that can be adjusted, and the optimum values for each of the pipeline parameters can be selected from its associated iteration.

**[0109]** If more than one ink patch is determined as being acceptable, then the patch with the highest ink load/level, in this example, is selected as being suitable for providing the pipeline parameters for the print job, and the selected ink density value and dry time are stored in memory at step 114 or 215. In alternative embodiments, a user may specify rules that they desire to be implemented if more than one ink patch are deemed acceptable. Such rules may include: selecting the highest or lowest ink density value in order to obtain the highest image quality or most ink efficient print job; selecting the highest or lowest dry time in order to obtain the highest image quality or quickest print job; or any other preference for one or more of any other pipeline parameters.

**[0110]** Advantageously the testing procedure described allows the printer to automatically disregard any print media that may damage the printer (or that will probably result in poor quality printing) and let it self-calculate the ink limit for media that are 'system unknown'. This reduces the possibility of a printed document being smudged after printing, and also reduces the chances of staining with the ink the user or the printer (provoking damage to the system), and also provides an optimized pipeline for high image quality.

**[0111]** It will be appreciated that where a plurality of ink patches are printed, each of a different ink density/load, the range of ink density values can be 'spaced' with an acceptable range starting from a minimum ink density to a maximum ink density. It may be that if at least one ink patch is deemed to be acceptable, but an adjacent patch (say with a higher ink density value) is deemed to be unacceptable, then a further round of testing could be conducted at one or more ink density values intermediate of the acceptable value and the unacceptable value.

**[0112]** For example, after the first row of ink patches has been evaluated, a second row of ink patches can be printed on the same medium, for example the same sheet of paper, spaced apart from the first row of ink patches. The second row of ink patches may be spaced apart from the first row of ink patches by such a distance that any migrated ink from the first row of ink patches does not effect measurements taken of the second row of ink patches. Alternatively, subsequent rows of ink patches may be printed on a separate sheet of medium/paper to the sheet of medium/paper that earlier rows of ink patches have been printed on.

**[0113]** There may be a number of desires, which may conflict with each other, when deciding which of a plurality of acceptable ink patches provides the optimum pipeline parameters for a specific print job. The desires can include:

i) not to use too much ink that the printed document will smudge;

ii) to use sufficient ink to provide a high quality print job;

iii) not to use an unnecessarily high amount of ink that does not significantly increase the quality of the print job, and therefore is an inefficient use of ink;

iv) not to use too high a dry time in order to optimize the speed of the printer;

v) to use a minimum number of carriage passes to optimize the speed of the printer;

vi) to minimize processing and memory resource required to perform a self-optimize routine.

**[0114]** An individual user's preferences can be taken into account when determining whether or not an ink patch is acceptable. For example, if a number of ink patches are deemed acceptable, the method may select which one of the ink patches provides the optimum pipeline parameters based on a user's preferences. Some users may require efficient use of ink and therefore the pipeline parameters associated with the acceptable ink patch that uses the least amount of ink may be selected. Alternatively, some users may require as much ink as possible to ensure the highest possible print quality without smudging and therefore the pipeline parameters associated with the acceptable ink patch that uses the most amount of ink may be selected. Other users may require as quick as a print job as possible, and are not concerned about the amount of ink used. It may be possible for a user to set a number of preferences for a print job, and give priority to which settings are more important to him.

**[0115]** In response to a user's preferences and/or in response to results obtained from a self-optimisation routine (for example a "smudge test" as discussed above), the ink limit pipeline parameter may be adjusted by changing a dots-per-square-inch (dpi) setting associated with the print job. Increasing the dpi setting associated with a print job can be achieved by any, some, or all, of: firing more ink per dot; printing dots closer together; and firing more dots per unit area.

**[0116]** It may be in an embodiment that if all of the patches are deemed to be acceptable in a first test operation then a further round of testing is conducted at a reduced dry time.

**[0117]** It may be that in some embodiments, only one set of patches is tested for one dry time and that if none of the patches are deemed to be acceptable then the program determines that the medium is not supported.

**[0118]** In some embodiments, the optical scanner may be used to assess the quality of a printed ink patch. If characteristics of the printed ink patches determined from the electronic signal returned by the optical scanner do not meet a required threshold, the ink patch may be deemed unacceptable even if the ink does not migrate after it has been rubbed. For example, for an ink patch printed with black ink as shown in Figure 5, and the vertical axis provides a scale that indicates the "blackness" of the scanned region with 0 indicating black and 100 indicating white, a patch may be deemed unacceptable if it has a "blackness" value of less than 20, 25, 30 or 40 or any other value according to an individual user's needs.

**[0119]** Some embodiments of the invention may be used to control the quality of printed documents, by optically sensing test patches and/or printed indicia (which may or may not be part of a printed document itself) to produce an electronic signal indicative of the sensed printed patch/indicia. The electronic signal can then be evaluated to determine whether or not the printer is providing an acceptable image quality. Determining whether or not the image quality is acceptable can include evaluating whether or not ink has smudged, the density of printed inks, and any other characteristic as discussed herein.

**[0120]** If a scanned patch, or any other printed indicia, is evaluated and it is determined that it is of unacceptable image quality, an alarm signal may be generated according to some embodiments of the invention. The alarm signal may cause a printing operation to stop automatically and/or alert a user that an acceptable image quality has been determined. The user may be alerted by the method sending the user an email indicating that an unacceptable print quality has been determined. The unacceptable print quality may be that the printed patch, or other printed indicia, has been smudged.

**[0121]** Although use of a plurality of ink patches has been explicitly disclosed, in some circumstances it may be desirable to print only one ink patch for testing at a time so that a second ink patch would only be printed, and rubbed and analysed, if the first patch was deemed to be unacceptable. A second ink patch may also be printed if the first patch was acceptable, and it is desired to try to achieve a better ink density/dry time combination.

**[0122]** One test patch may be printed according to some embodiments of the present invention, and the one test patch can be evaluated to check that suitable pipeline parameters have been set. The evaluation may comprise a yes/no check that the pipeline parameters associated with the printed ink patch. If the yes/no check determines that the pipeline parameters are acceptable, then the print job can be allowed to start or continue. If the yes/no check determines that the pipeline parameters are unacceptable, then the print job may be refused without performing any further tests, and optionally a message to this effect may be displayed to the user.

**[0123]** This embodiment may be particularly advantageous where one of a predefined set of pipelines (for example a LUT) has been selected by a user for use with a print job, and the invention can check that the selected pipeline parameters will not damage the printer or produce an unacceptable print job. Alternatively, this embodiment may be used as a final operation after pipeline parameters have been set by a self-optimisation routine and before the actual print job starts.

**[0124]** In some embodiments, a plurality of rows of ink patches may be printed at the same time with different pipeline parameters. The plurality of rows can then be scanned and evaluated quicker than printing and evaluating rows on an individual basis, to enable the final pipeline parameters to be achieved quicker.

**[0125]** In an alternative implementation it may be that each print medium loaded into the printer is tested before a print job is performed thereon to determine (i) whether the medium is suitable and if it is, (ii) to determine the optimum, or at least acceptable, pipeline parameters including ink density/dry time combination. Such a configuration would essentially form a security check against a user inadvertently or deliberately damaging the printer by telling a printer that it was printing on one type of medium and presenting a different type of medium to the printer. In some embodiments, a self-optimisation routine according to embodiments of the invention may be performed every time a paper tray of a printer is refilled, every time a new roll of paper is connected to the printer, or every time a new print job is started with a printer.

**[0126]** Where the printer is a colour printer it may be that testing is required in respect of ink patches of various colours (including black) and/or various combinations of colours. In one embodiment, all of the colour channels (which may be CMYK for a four channel printer or CMYKLmLc for a six channel printer) available to the printer may be used to print a black patch that consists of all of the different colours of ink (including black) printed on top of each other. Optionally, the colour of the printed patches can be evaluated by the photospectrometer before and after smudging, and the pipeline parameters associated with individual colour channels can be adjusted according to which, if any, colour inks migrate. In alternative embodiments, separate ink patches can be printed for each coloured ink and the patches can be evaluated and pipeline parameters set based upon readings obtained by the optical scanner on a per-colour channel basis.

**[0127]** In some circumstances it may be possible/desirable that subsequent to the step of rubbing the ink patches, the photospectrometer (or whatever sensor is employed) examines region/s outside of the boundary of each ink patch as originally printed. In the case of a row of a plurality of patches this would be the unprinted gaps between the patches. Furthermore it may be that the step of sensing the patches in their un-rubbed condition could be omitted and that only the region outside the boundaries of the originally printed patches would be analysed. That is, the reference data is obtained from memory and corresponds to ideal ink patches that have been printed exactly according to the instructions provided to the printer. This relies upon the accuracy of the paper registration and/or the accuracy of a theoretical step function from black to white at the boundary of the printed ink patch.

**[0128]** The ink patches shown in the accompanying drawings are essentially of oblong-rectangular shape, but any shape of ink patch could be used. It is desirable in some embodiments however that where a plurality of ink patches are tested they are all of substantially the same shape and all of the substantially the same area.

**[0129]** The invention is intended to be used, in particular, but not exclusively, with domestic printers and business-grade printers. Such printers may have dpi values of the orders of 60, 150, 300, 600, 1200, 4800, for example. However, the invention may find application in the field of industrial printers.

**[0130]** Although the printer 4 is described as containing the necessary process and driver software to control the testing procedure, it may be that in a distributed intelligence/functionality configuration that one or both of the processor and the driver software is remote from the printer, say in a PC connected to the printer or any other device that is in communication with the printer.

**[0131]** In an alternative embodiment of a rubber, a length of a thin, for example water-repellent, material is provided which is wound on a spool. Advantageously it would not require cleaning, because for each rub a fresh part of the material would be used and the soiled parts of the material could be automatically wound onto a second spool. Alternatively, a number of rubs could be performed with each region of the material before it is replaced with a fresh region of the material. The number of rubs performed could be in the range of 1 to 50, or more, 1 to 20, 1 to 10, or about 5 rubs, for example. Alternative methods of providing the rubber with a fresh rubbing surface can include: providing a replaceable/cleanable pad; providing a replaceable/cleanable cover for a pad; providing a plurality of rubbing surfaces around the circumference of a roller, and rotating the roller so that a fresh rubbing surface contact can be used; and optionally providing a mechanism for self-cleaning the rubbing surfaces of the roller as it rotates. This is not an exhaustive list.

**[0132]** Taking advantage of a paper feed system, Figures 11 and 12 show yet a further embodiment of apparatus to cause ink migration according to the present invention. A pinch wheel 35 is able to be used to migrate wet ink from printed ink patches by simply moving the paper on which the ink patches are printed between the wheel 35 and main feed roller 36.

**[0133]** In the embodiment shown in Figure 11, the media, which in this example is paper 30, is fed between a pinch wheel 35 and a feed roller 36. The pinch wheel 35 rotates in an anti-clockwise direction and the feed roller 36 rotates in a clockwise direction to feed the paper 30 from left to right as illustrated in the Figure, and towards a print head carriage 20 and optical sensor 21. The print head 20 prints a series of patches 24 onto the paper 30, as discussed with reference to Figures 3 and 4. The size of the ink patches 24 has been exaggerated in the Figures for illustrative purposes.

**[0134]** After a predetermined time, the carriage 20 is passed over the paper 30 again to optically scan the patches 24 with the optical sensor 21. In other embodiments, the optical scanner 21 may scan the patches 24 that have been printed during the same carriage movement that prints the ink on the paper 30. In other embodiments, the carriage 20 may make one pass over the paper 30 to print patches 24 onto the paper 30, and optically scan the printed patches 24 in a return pass over the printed patches 24.

**[0135]** Optically scanning the patches 24 on the paper 30 may include using the optical sensor 21 to generate an electronic signal that enables any, or all, of the: size, position, density, colour or any other physical characteristic of the patches of ink 24 to be determined. The electronic signals returned by the optical sensor 21 may be processed by a processor (not shown) to determine the physical characteristics of the patches 24. The processor may be located in the printer itself, alternatively, or additionally, an off-printer processor located on a device that is connected to the printer may perform some or all of the processing to determine the characteristics of the printed patches 24.

**[0136]** In some embodiments, no processing may be performed on the electronic signals returned by the optical sensor 21 at this stage, and the signals may be stored in memory as they are, until required to be processed at a later stage.

**[0137]** In further embodiments still, the optical scanner may not scan the printed patches before they have been smudged, and it may be assumed that the patches were printed in the correct locations, and without any smudging prior to the patches being deliberately smudged.

**[0138]** As shown in Figure 12, once the patches 24 have been printed on the paper 30, and scanned by the optical sensor 21 a first time, the pinch wheel 35 is rotated in a clockwise direction and the feed roller 36 is rotated in an anti-clockwise direction to move the paper 30 from right to left as illustrated in the Figure. Moving the paper 30 from right to left causes the region of the paper 30 that has had patches 24 printed on it to move away from the print head carriage 20, and towards the pinch wheel 35 and feed roller 36. As the region of the paper 30 having the patches 24 printed thereon passes between the pinch wheel 35 and feed roller 36 the paper is compressed, or squashed, so that any wet ink is forced outwards away from the contact points 35a, 36a with the pinch wheel 35 and feed roller 36. Any wet ink is caused to migrate to an area of the paper that was not originally printed on by the print head carriage 20. Any ink that has dried will not be displaced by the compression applied by the pinch wheel 35 and feed roller 36.

**[0139]** In this embodiment, the paper 30 is fed back between the pinch wheel 35 and feed roller 36 until the region of the paper 30 that has had the patches 24 printed thereon has completely passed the contact areas 35a, 36a with the pinch wheel 35 and feed roller 36. In other embodiments, the paper 30 may be fed through the pinch wheel 35 and feed roller 36 and stopped when the region of the paper 30 having the patches 24 printed thereon is located between the contact areas 35a, 36a of the pinch wheel 35 and feed roller 36. In some embodiments the region of the paper with the ink patches printed thereon is moved back and forwards between the pinch wheel 35 and the feed roller 36.

**[0140]** There may, or may not, be some slippage of the paper 30 as it is fed between the pinch wheel 35 and the feed roller 36. The slippage may cause some rubbing of the ink by the pinch wheel 35 and may produce an alternative ink displacement/migration effect in addition to the compression/squashing of the ink.

**[0141]** After the pinch wheel 35 and roller 36 have compressed the region of the paper 30 that has the patches 24 printed thereon, the paper 30 is fed back towards the print head carriage to return to the position as is shown in Figure 11. The region of the paper 30 that has the patches 24 printed thereon is positioned so that it is located under the print head carriage 20 with optical sensor 21. The carriage 20 performs a pass over the patches 24 without printing any ink so that the optical sensor 21 can optically scan the paper 30 to produce an electronic signal that can be used to determine characteristics of the ink patches 24 as discussed earlier in relation to the first scan. The determined characteristics of the patches 24 may be the same characteristics that were determined when the patches were optically scanned during the first scan.

**[0142]** In embodiments where the electronic signals generated by the optical sensor 21 in the first scan of the patches 24 have been stored in memory and not been processed, the electronic signals obtained from this second scan of the patches may be processed to determine characteristics of the patches at the same time as the electronic signals obtained from the first scan of the patches 24.

**[0143]** The physical characteristics of the ink patches 24 determined from the second scan of the patches 24 are compared to the physical characteristics of the ink patches 24 determined from the first scan of the patches, as previously discussed in relation to Figures 6 and 7.

**[0144]** In embodiments where the patches 24 were not scanned before the patches were smudged, the physical characteristics determined from the scanned ink patches 24 can be compared with theoretical characteristics of the printed ink patches 24 determined from the print command that caused the ink patches 24 to be printed.

**[0145]** In some embodiments of the invention, care needs to be taken that the region of the paper with the ink patches printed thereon is not moved to a position within the paper path where any wet ink can stain a part of the printing system. For example, when the paper 30 is moved back past the pinch wheel 35 and feed roller 36 as shown in Figure 12, care must be taken that the paper 30 is not fed back away past the pinch wheel 35 and feed roller 36 too far so that it could stain another part of the printer if the ink was still wet.

**[0146]** The results of the comparison between the physical characteristics determined by the first and second scans are used by a processor to decide what subsequent action should be taken. Subsequent action can include: determining whether or not acceptable pipeline parameters are obtainable for the ink/media combination in use; determining whether or not further patches should be printed and evaluated to better define the pipeline parameters; and setting some or all pipeline parameters in accordance with identified acceptable patches in order to successfully complete the self-optimisation routine.

**[0147]** Figure 13 shows an attachment 302 according to an embodiment of the present invention that can be attached to a print head carriage, or cutter carriage, or other device that moves transversely across a printed medium 300 as discussed above. The attachment consists of a first rubber 304 on one side of the attachment 302, a second rubber 306 on the opposite side of the attachment 302, and an optical sensor 308 positioned between the first and second rubbers 304, 306. The attachment can be configured so that one or both of the rubbers 304, 306 can be moved away from an in-use position in which they would contact and rub the paper 300 (as indicated by solid lines 304 and 306) to an out-of-use position where they would not contact the paper 300 (as indicated by dotted lines 304' and 306'). The rubbers 304, 306 may be capable of sliding between an in-use position and an out-of-use position, alternatively, the rubbers 304, 306, may be moved angularly about a pivot point between an in-use and an out-of-use position.

**[0148]** It will be appreciated that in some embodiments the attachment 302 may be releasably attached to a carriage that moves transversely across the medium within the printer, in other embodiments the attachment may be permanently attached to, or integral with, a carriage within the printer.

**[0149]** This embodiment of the invention allows a rubbing and optical scanning operation to be performed during a single pass of the attachment over the medium 300 irrespective of whether the attachment 302 is moving from left-to-right or right-to-left. If the attachment 302 is being moved from left-to-right, the first rubber 304 can be moved to an out-of-use position as indicated by 304'. As the attachment 302 moves over the paper 300, the second rubber 306 rubs the ink patches that have been printed on the paper 300 before the optical sensor 308 scans the paper to monitor for any ink migration during the same carriage pass. In some embodiments it will not be necessary to move the rubbers 304, 306 to an out-of use position, as it may not matter that the ink patches are rubbed after they have been scanned by the optical sensor 308.

**[0150]** This embodiment of the invention may be advantageous where a plurality of rows of test ink patches are evaluated at the same time. This embodiment allows the optical sensor 308 and rubbers 304, 306 to be used in successive passes of a carriage carrying the attachment in opposite directions on adjacent rows. For example, the attachment may rub and scan a first row of ink patches from left-to-right in a first pass, and then rub and scan a second row of ink patches from right-to-left in a second pass.

**[0151]** In other embodiments, the printing, rubbing and scanning can all be performed during a single pass of a carriage over the printer. A print head, rubber and optical sensor can all be positioned in a row to perform their operations as the carriage passes over a medium.

**[0152]** It is an aim of some embodiments of the present invention to perform a self-optimisation routine with a minimum number of carriage returns, and avoid unnecessary carriage travel.

**[0153]** It is an aim of many embodiments of the invention to be able to print in optimum conditions on a wide range of media. The media does not necessarily have to have been previously tested by the manufacturer of the printer and does not have to have been characterized by a development engineer during the development of the printer. Any media can be used a user of the printer. The printer should be able to adapt to the media.

**[0154]** It also an object of many embodiments of the present invention to provide the self-optimisation routine as discussed by using only small, simple and cheap hardware components in addition to the hardware that is already present in existing printing systems.

**[0155]** In some embodiments of the invention it may not be a printer that performs the test to determine whether or not an acceptable image quality has been obtained. A separate device may be used to evaluate whether or not an acceptable image quality has been obtained. The separate device may consist of an ink migrator adapted to migrate wet ink of a printed test portion, and a scanner or detector to determine whether or not ink migration has occurred. The device may require that a print medium on which test portions of ink have been printed be used with the device (e.g. fed into the device). Alternatively, the device may be hand-held and a user may locate the device over the test portions to be tested.

**[0156]** In some embodiments of the invention there may be provided a first printer adapted to perform a test print operation to print and evaluate test portions of ink, and a second printer adapted to print a subsequent print job using pipeline parameters determined from the test print operation. The first and second printers may be in communication with each other in order that pipeline parameters determined from the test print operation can be communicated from the first "test" printer to the second "print job" printer.

**[0157]** In many embodiments of the invention, there will be one printer that is arranged to perform a test print operation to determine acceptable pipeline parameters associated with the ink and print medium being used, and the same printer is used to perform subsequent print jobs with inks and print medium of the same type that were used for the test print operation. Using the same printer to perform the test print operation and the print job ensures that any variations in the set-up of the printer being used are accounted for, and that no assumptions as to how the printer is set-up are made. Any assumptions as to how the printer is set-up/used in practice may be inaccurate and can result in an unacceptable print/image quality.

## Claims

1. A method of operation of a printer comprising printing at least one test portion of ink onto a print medium, rubbing the test portion with a rubber, determining the presence or absence of ink in the region of the rubbed test portion that has migrated due to the rubbing to determine whether the printing provides an acceptable image quality.

2. The method according to claim 1, further comprising the step of determining printer driver settings associated with the print medium that provide an acceptable image quality.

3. The method according to claim 1, further comprising the step of refusing to print on the print medium.

4. The method according to claim 1, further comprising the step of repeating the method of claim 1 with test portions of ink that have been printed with different printer driver settings.

5. The method according to claim 2, wherein determin-

ing acceptable printer driver settings comprises either a computer processor automatically creating bespoke printer driver settings for the print medium, or a computer processor automatically selecting acceptable printer driver settings from a pre-defined set of printer driver settings.

**6.** The method according to claim 5, wherein creating bespoke printer driver settings for the print medium comprises setting ink load and/or drying time requirements for a print operation on the particular print medium.

**7.** The method according to claim 6, wherein automatically selecting acceptable printer driver settings from a pre-defined set of printer driver settings comprises selecting a pre-defined look-up table from a plurality of pre-defined look-up tables.

**8.** The method according to claims 5 to 7, wherein the determined acceptable printer driver settings are used for subsequent printing operations on print medium with the same characteristics as the print medium upon which was printed the test portion of ink.

**9.** The method of any one of claims 1 to 8, which comprises printing a plurality of test portions of ink of a different ink density.

**10.** The method of any preceding claim, which comprises optically sensing the position of the, or all, test portions of ink before rubbing said test portion or portions.

**11.** The method of any preceding claim, which comprises rubbing the test portion a pre-determined time after printing said test portion.

**12.** The method of claim 11 which comprises comparing (i) sensed data indicative of the test portion before being rubbed to (ii) sensed data indicative of the test portion after being rubbed.

**13.** The method of any preceding claim, wherein the image quality is determined to be unacceptable, and further comprising printing at least one further test portion of ink and using the rubber to rub said at least one further test portion at a different time interval after said at least one further test portion was printed than the time interval between printing the earlier test ink portion and rubbing the earlier test ink portion.

**14.** The method of any preceding claim wherein a first test portion is printed with a first ink density and a second test portion is printed with a significantly different ink density.

**15.** The method of any preceding claim comprising a method of testing characteristics of the print medium before a print job is executed thereon.

**16.** The method of any preceding claim further comprising:

printing a plurality of test regions each with a different ink load and/or drying time prior to being rubbed by the rubber;
determining which test portions resulted in an acceptable print quality;
setting print pipeline parameters for a subsequent print operation using a knowledge of the respective pipeline parameters that were used for the respective plurality of test regions.

**17.** A printer system comprising a printer head, a sensor and a rubber;
the system being configured such that, in use, the printer head is adapted to print at least one test portion of ink to a print medium, the rubber is operative to rub the test portion, and the sensor is adapted in use to sense a region adjacent the rubbed test portion and to produce data indicative of migration or absence of migration of ink from the rubbed test portion.

**18.** The printer system according to claim 17, further comprising a processor associated with the system, wherein the processor has executable software adapted to evaluate said data indicative of the rubbed test portion in order to determine whether the rubbing of the test portion of ink resulted in migration of ink.

**19.** The printer system of claim 17 or claim 18, in which the sensor is mounted, or adapted to be capable of being releasably mounted, on a printer head carriage.

**20.** The printer system of any one of claims 17 to 19 in which the rubber is mounted or is adapted to be capable of being releasably mounted, on a printer head carriage.

**21.** A method of calibrating a printer comprising printing a test patch on a print medium, rubbing the test patch, optically sensing the rubbed test patch to produce signals indicative of the rubbed test patch, and calibrating printer settings based upon the signals indicative of the rubbed test patch.

**22.** Printer control software which is adapted, when loaded on a processor associated with a printer, to cause the printer to apply at least one test portion of ink to a print medium, to cause a rubber to rub across the test portion, to cause a sensor to sense the rubbed test portion, to cause a signal representative of the rubbed test portion to be sent to the processor so that the processor is capable of determining the presence or absence of ink migration caused by the rubber.

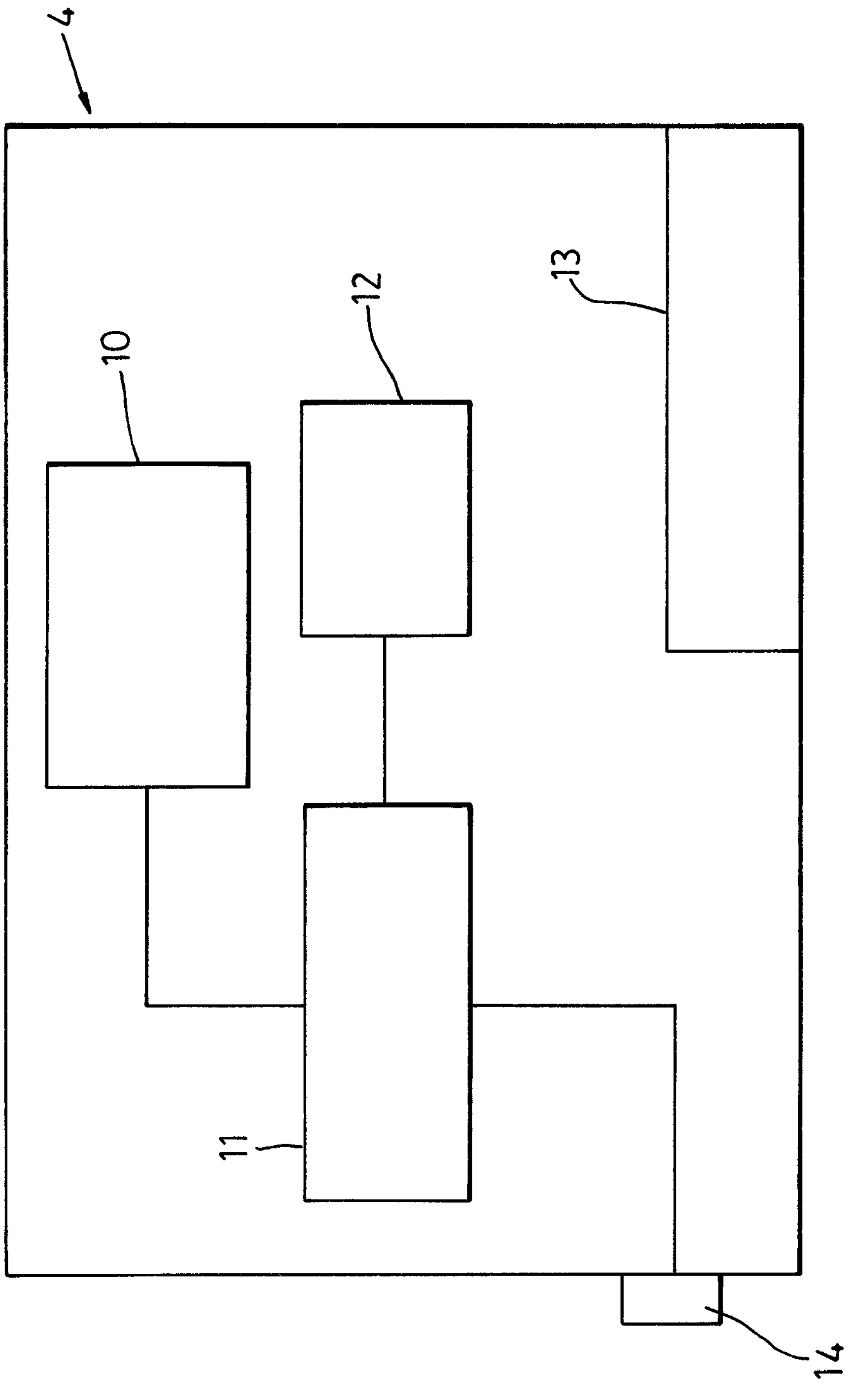



Fig. 1

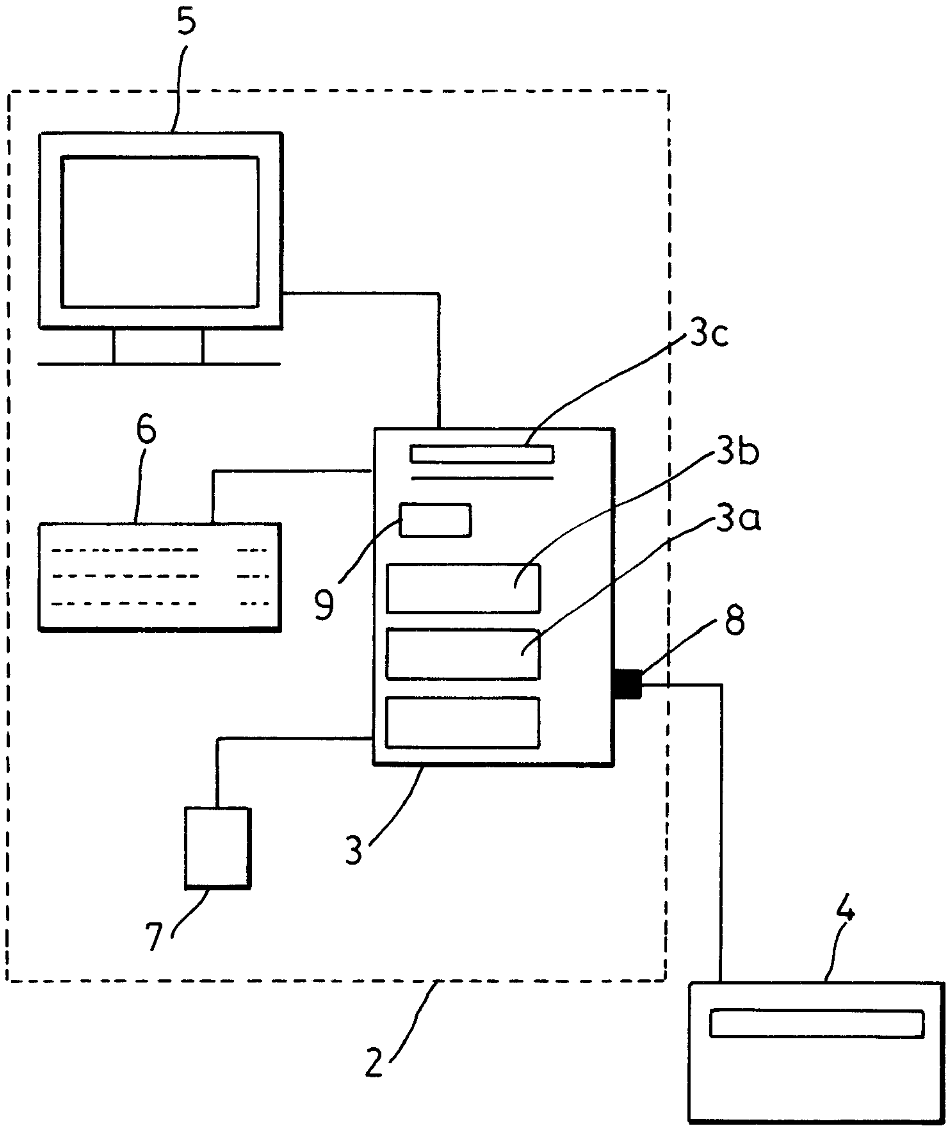



*Fig. 2*

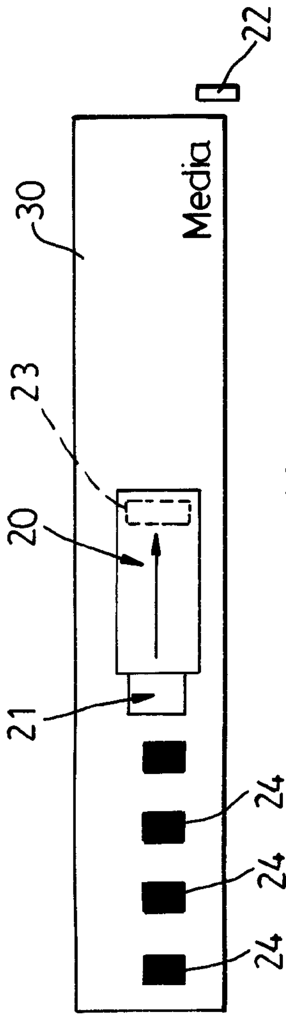



Fig. 3a

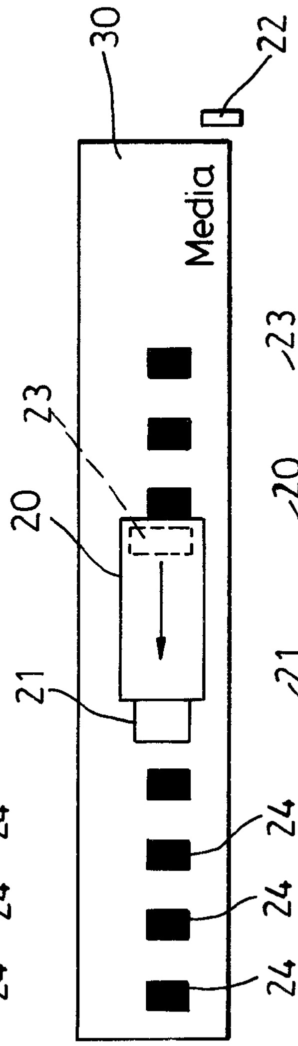



Fig. 3b

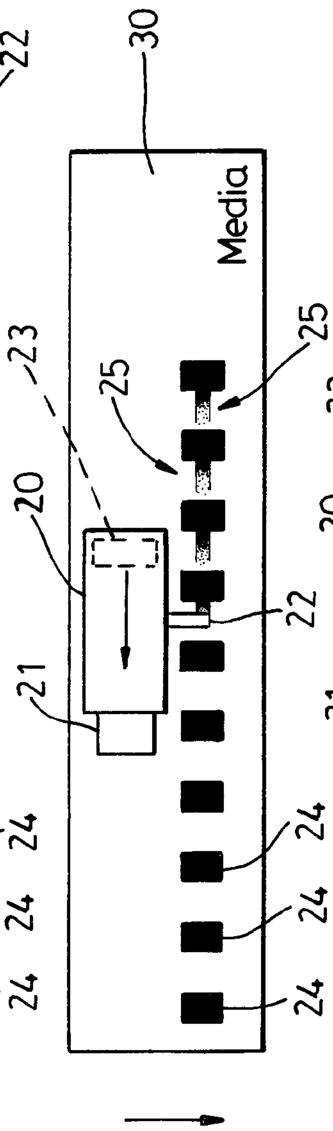



Fig. 3c

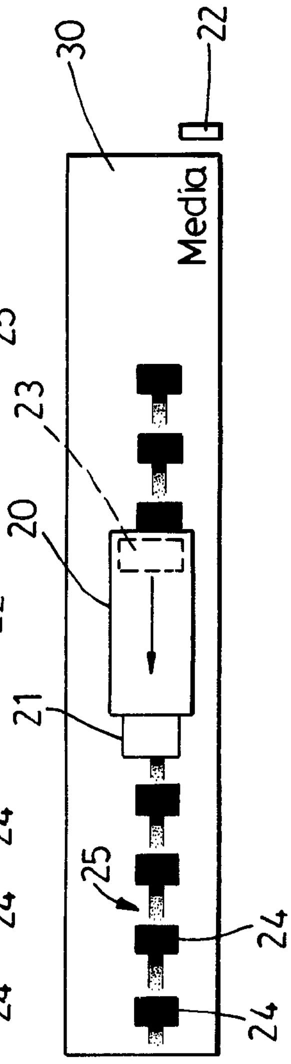



Fig. 3d

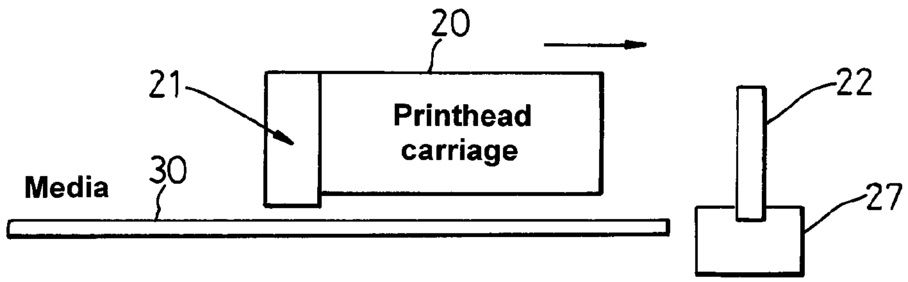



*Fig. 4a*

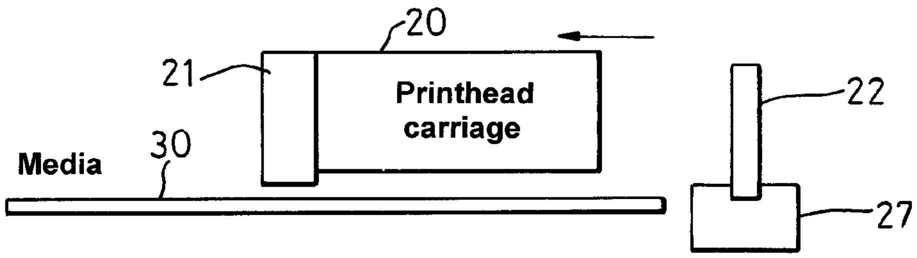



*Fig. 4b*

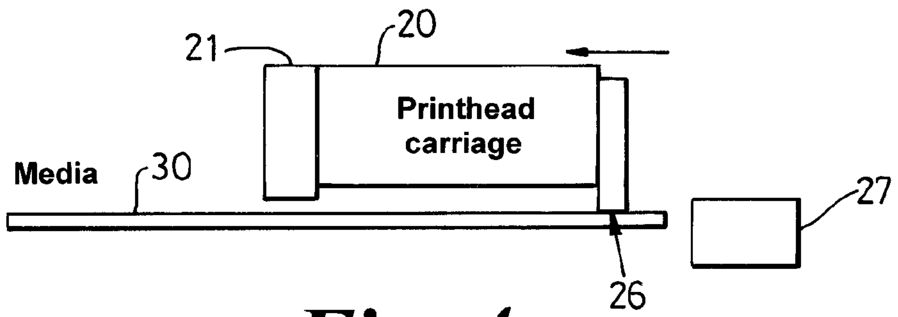



*Fig. 4c*

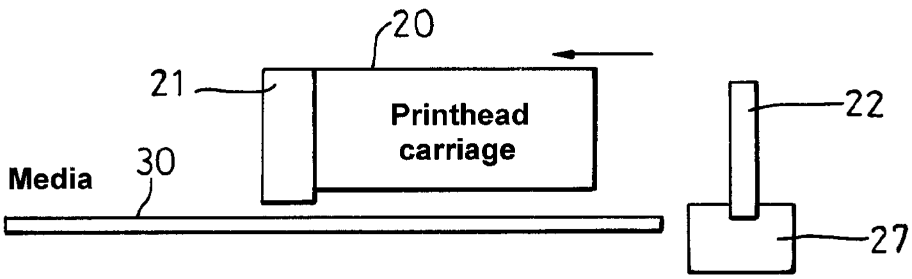



*Fig. 4d*

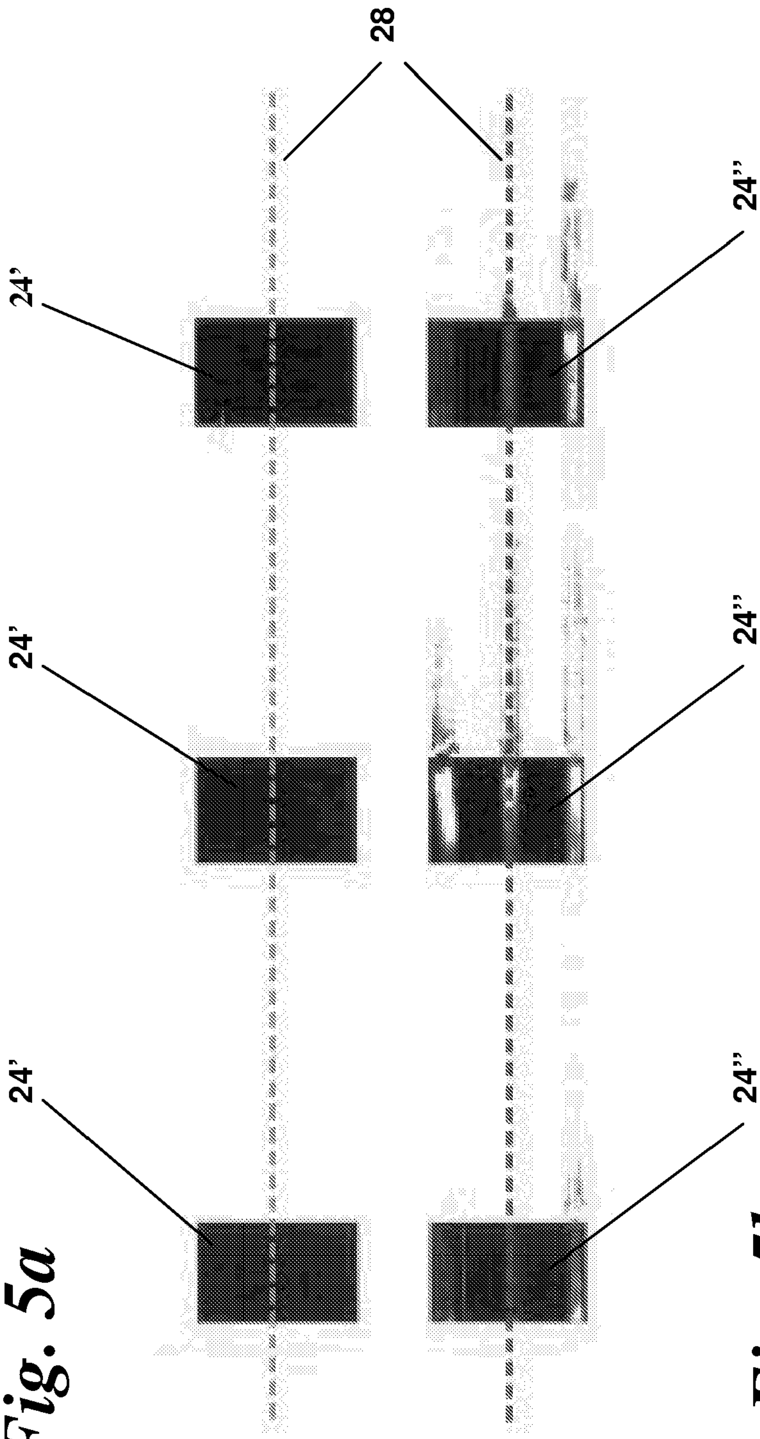



Fig. 5a

Fig. 5b

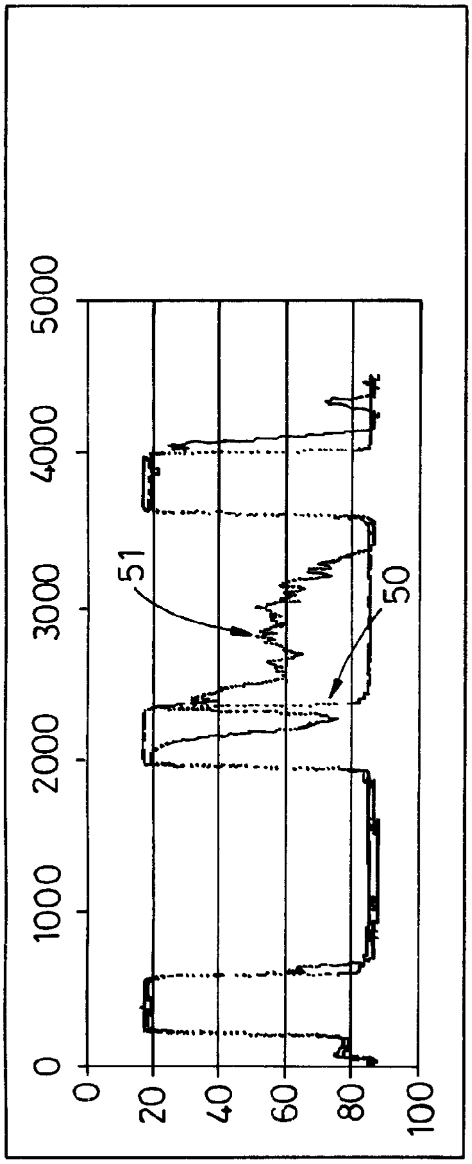
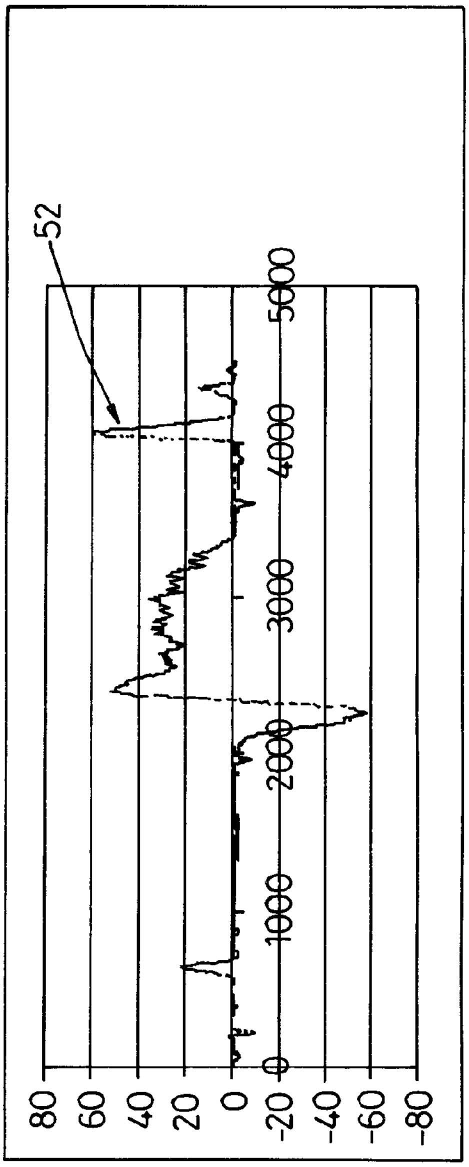

0
1000
2000
3000
4000
5000
0
20
40
60
80
100
51
50

*Fig. 6*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0
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2000
3000
4000
5000
80
60
40
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-20
-40
-60
-80

*Fig. 7*

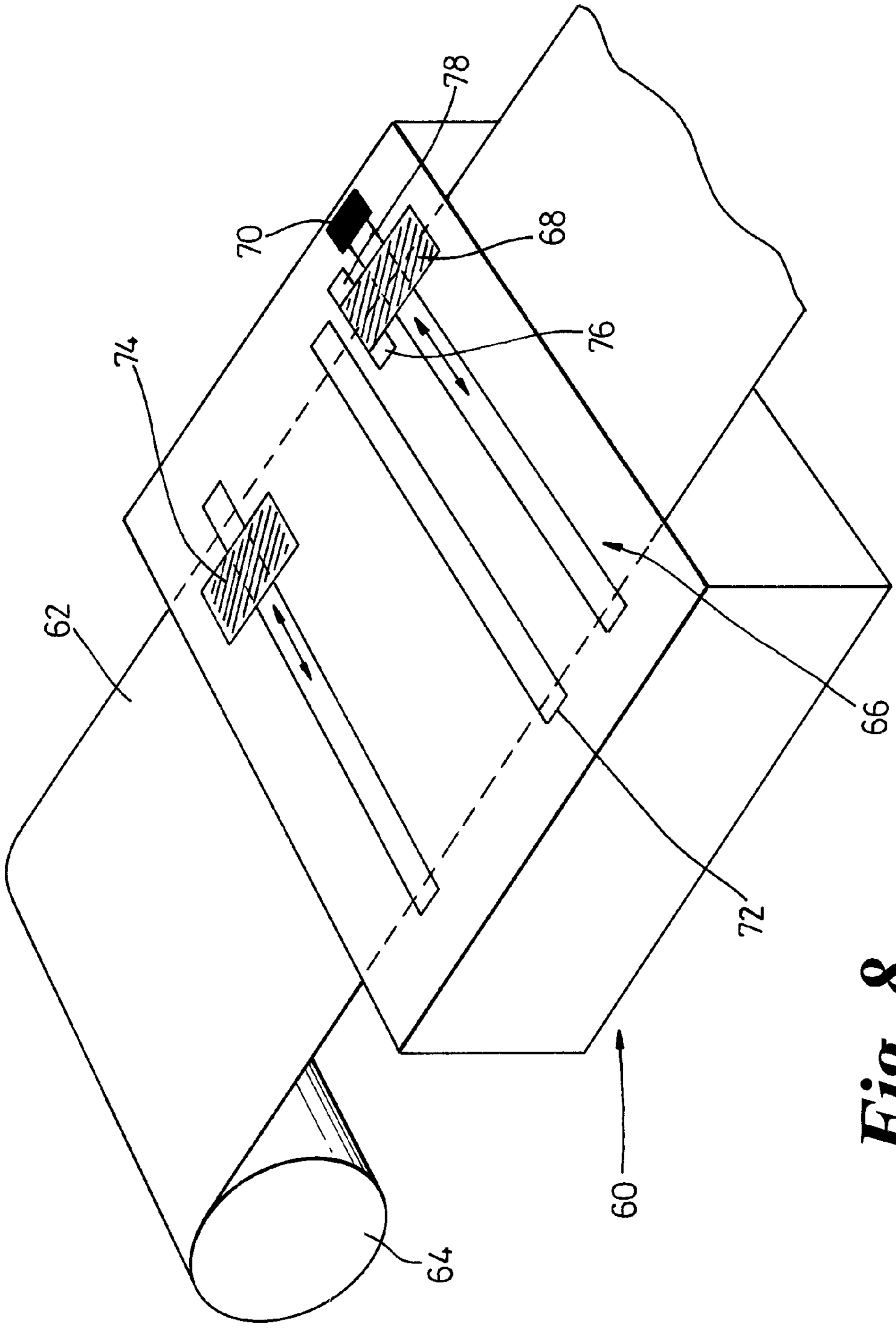


*Fig. 8*

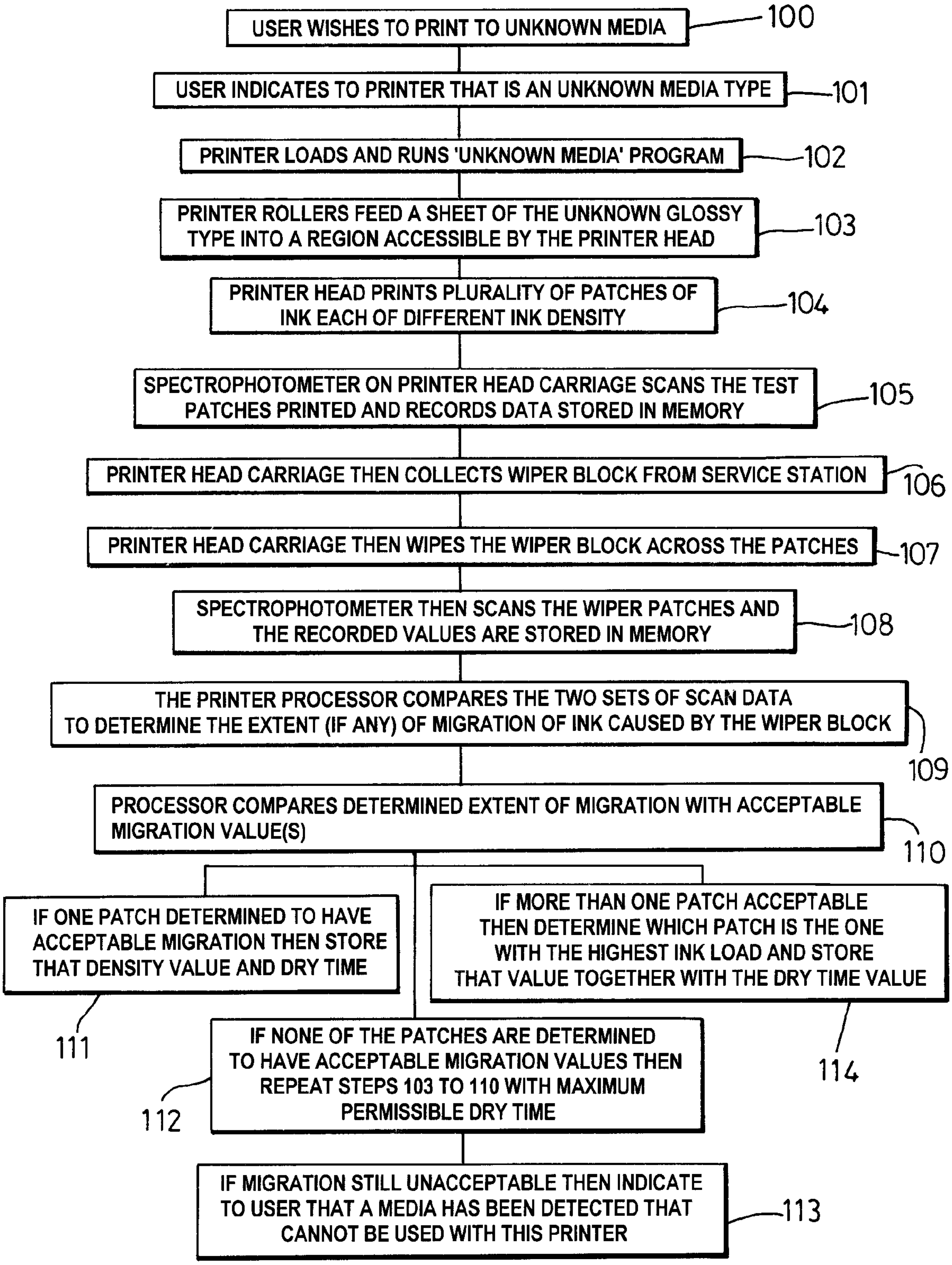
USER WISHES TO PRINT TO UNKNOWN MEDIA
100
USER INDICATES TO PRINTER THAT IS AN UNKNOWN MEDIA TYPE
101
PRINTER LOADS AND RUNS 'UNKNOWN MEDIA' PROGRAM
102
PRINTER ROLLERS FEED A SHEET OF THE UNKNOWN GLOSSY TYPE INTO A REGION ACCESSIBLE BY THE PRINTER HEAD
103
PRINTER HEAD PRINTS PLURALITY OF PATCHES OF INK EACH OF DIFFERENT INK DENSITY
104
SPECTROPHOTOMETER ON PRINTER HEAD CARRIAGE SCANS THE TEST PATCHES PRINTED AND RECORDS DATA STORED IN MEMORY
105
PRINTER HEAD CARRIAGE THEN COLLECTS WIPER BLOCK FROM SERVICE STATION
106
PRINTER HEAD CARRIAGE THEN WIPES THE WIPER BLOCK ACROSS THE PATCHES
107
SPECTROPHOTOMETER THEN SCANS THE WIPER PATCHES AND THE RECORDED VALUES ARE STORED IN MEMORY
108
THE PRINTER PROCESSOR COMPARES THE TWO SETS OF SCAN DATA TO DETERMINE THE EXTENT (IF ANY) OF MIGRATION OF INK CAUSED BY THE WIPER BLOCK
109
PROCESSOR COMPARES DETERMINED EXTENT OF MIGRATION WITH ACCEPTABLE MIGRATION VALUE(S)
110
IF ONE PATCH DETERMINED TO HAVE ACCEPTABLE MIGRATION THEN STORE THAT DENSITY VALUE AND DRY TIME
111
IF MORE THAN ONE PATCH ACCEPTABLE THEN DETERMINE WHICH PATCH IS THE ONE WITH THE HIGHEST INK LOAD AND STORE THAT VALUE TOGETHER WITH THE DRY TIME VALUE
114
IF NONE OF THE PATCHES ARE DETERMINED TO HAVE ACCEPTABLE MIGRATION VALUES THEN REPEAT STEPS 103 TO 110 WITH MAXIMUM PERMISSIBLE DRY TIME
112
IF MIGRATION STILL UNACCEPTABLE THEN INDICATE TO USER THAT A MEDIA HAS BEEN DETECTED THAT CANNOT BE USED WITH THIS PRINTER
113

*Fig. 9*

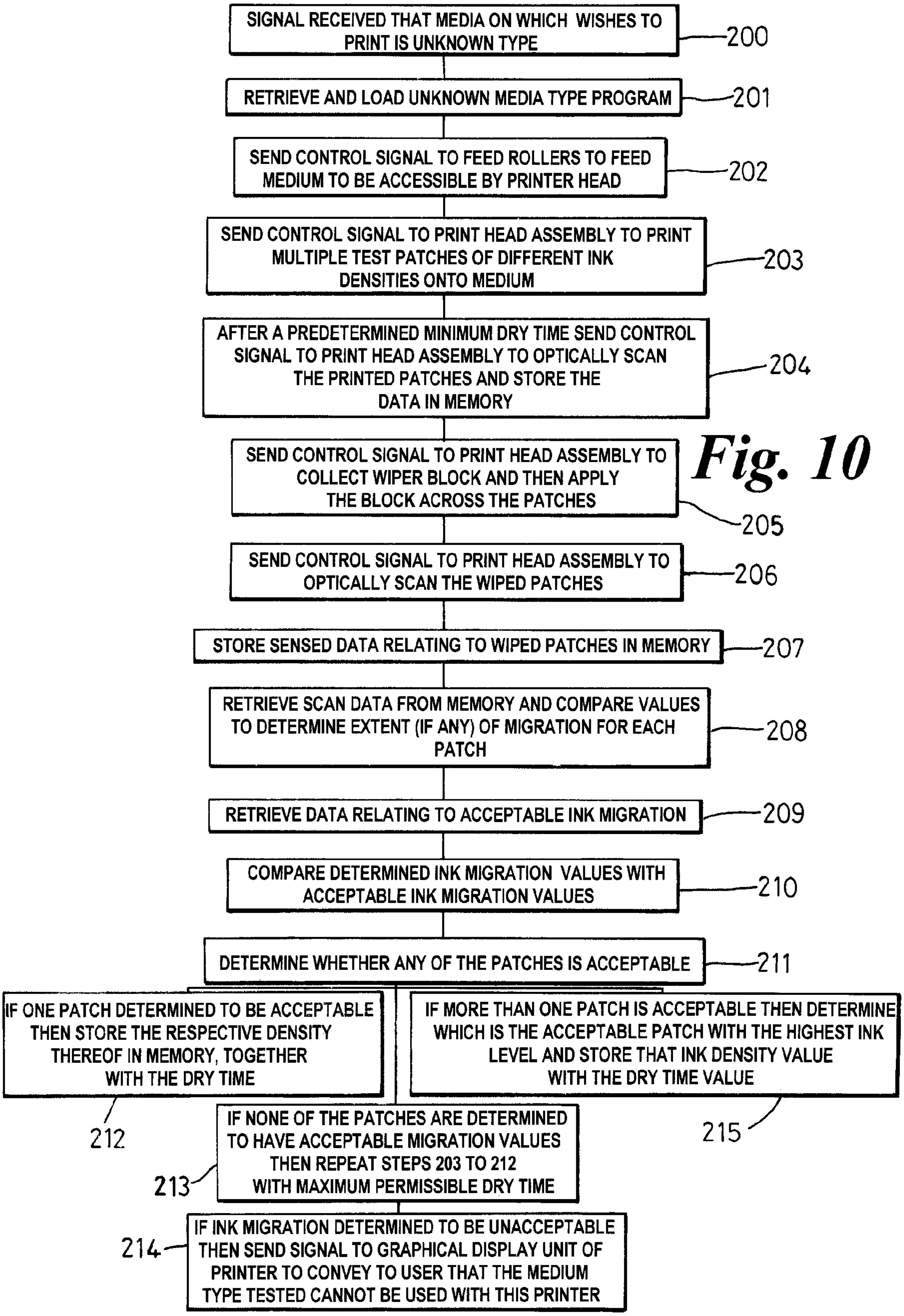
SIGNAL RECEIVED THAT MEDIA ON WHICH WISHES TO PRINT IS UNKNOWN TYPE
200
RETRIEVE AND LOAD UNKNOWN MEDIA TYPE PROGRAM
201
SEND CONTROL SIGNAL TO FEED ROLLERS TO FEED MEDIUM TO BE ACCESSIBLE BY PRINTER HEAD
202
SEND CONTROL SIGNAL TO PRINT HEAD ASSEMBLY TO PRINT MULTIPLE TEST PATCHES OF DIFFERENT INK DENSITIES ONTO MEDIUM
203
AFTER A PREDETERMINED MINIMUM DRY TIME SEND CONTROL SIGNAL TO PRINT HEAD ASSEMBLY TO OPTICALLY SCAN THE PRINTED PATCHES AND STORE THE DATA IN MEMORY
204
SEND CONTROL SIGNAL TO PRINT HEAD ASSEMBLY TO COLLECT WIPER BLOCK AND THEN APPLY THE BLOCK ACROSS THE PATCHES
205
SEND CONTROL SIGNAL TO PRINT HEAD ASSEMBLY TO OPTICALLY SCAN THE WIPED PATCHES
206
STORE SENSED DATA RELATING TO WIPED PATCHES IN MEMORY
207
RETRIEVE SCAN DATA FROM MEMORY AND COMPARE VALUES TO DETERMINE EXTENT (IF ANY) OF MIGRATION FOR EACH PATCH
208
RETRIEVE DATA RELATING TO ACCEPTABLE INK MIGRATION
209
COMPARE DETERMINED INK MIGRATION VALUES WITH ACCEPTABLE INK MIGRATION VALUES
210
DETERMINE WHETHER ANY OF THE PATCHES IS ACCEPTABLE
211
IF ONE PATCH DETERMINED TO BE ACCEPTABLE THEN STORE THE RESPECTIVE DENSITY THEREOF IN MEMORY, TOGETHER WITH THE DRY TIME
212
IF MORE THAN ONE PATCH IS ACCEPTABLE THEN DETERMINE WHICH IS THE ACCEPTABLE PATCH WITH THE HIGHEST INK LEVEL AND STORE THAT INK DENSITY VALUE WITH THE DRY TIME VALUE
215
IF NONE OF THE PATCHES ARE DETERMINED TO HAVE ACCEPTABLE MIGRATION VALUES THEN REPEAT STEPS 203 TO 212 WITH MAXIMUM PERMISSIBLE DRY TIME
213
IF INK MIGRATION DETERMINED TO BE UNACCEPTABLE THEN SEND SIGNAL TO GRAPHICAL DISPLAY UNIT OF PRINTER TO CONVEY TO USER THAT THE MEDIUM TYPE TESTED CANNOT BE USED WITH THIS PRINTER
214

*Fig. 10*

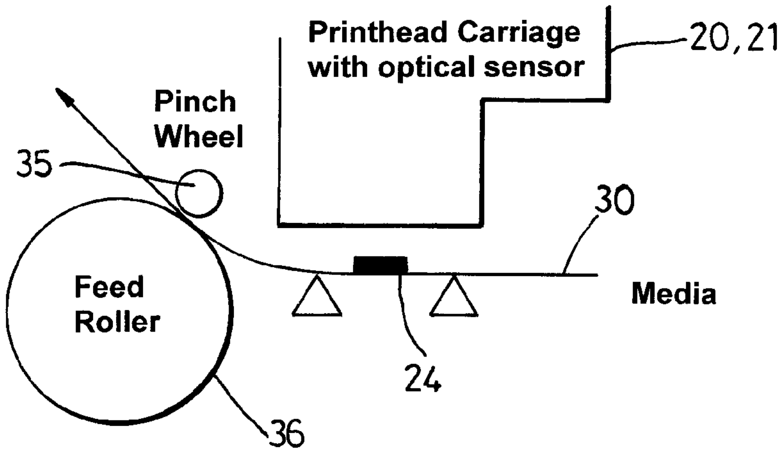
Printhead Carriage
with optical sensor
20, 21
Pinch
Wheel
35
30
Feed
Roller
Media
24
36

*Fig. 11*

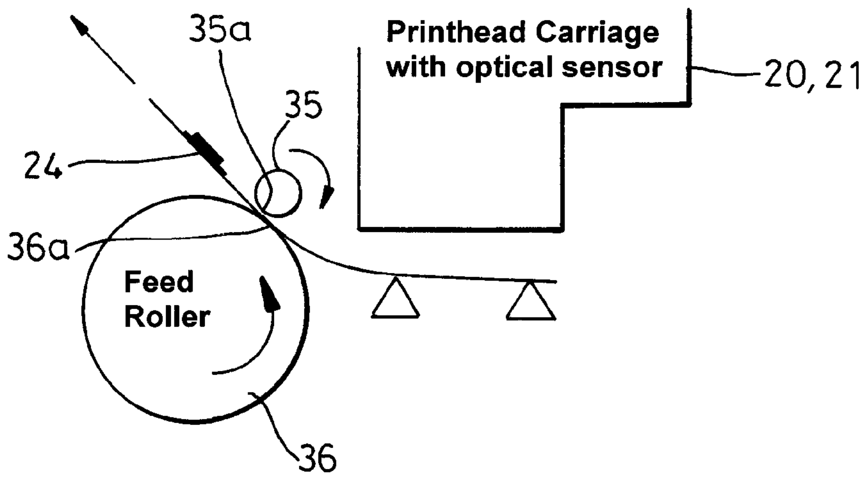
35a
Printhead Carriage
with optical sensor
20, 21
35
24
36a
Feed
Roller
36

*Fig. 12*

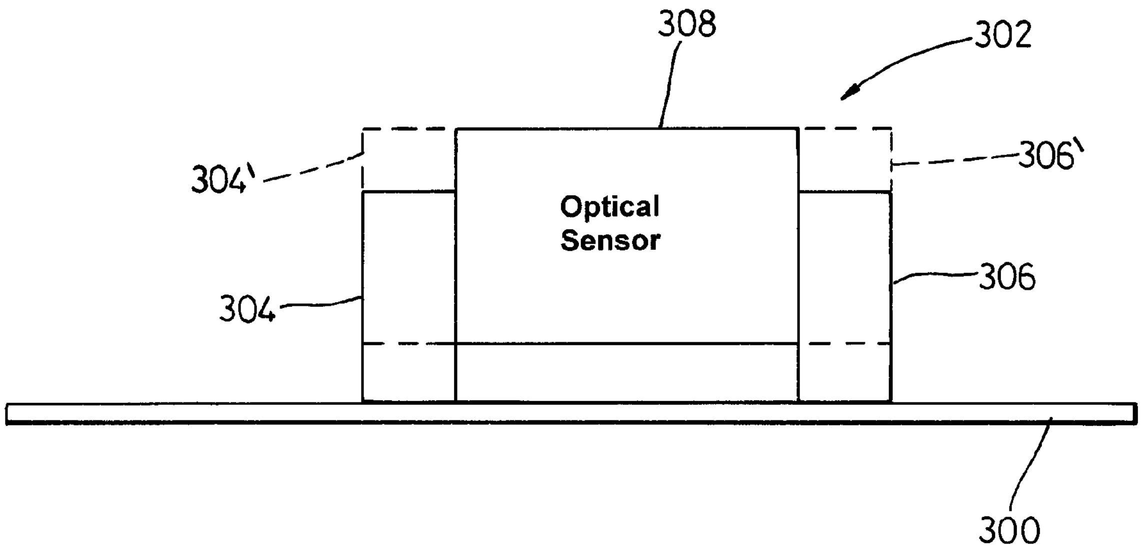


*Fig. 13*

European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 05 10 5368

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
| X | PATENT ABSTRACTS OF JAPAN vol. 018, no. 149 (P-1708), 11 March 1994 (1994-03-11) & JP 05 323807 A (NEC OFF SYST LTD), 7 December 1993 (1993-12-07) | 1,3,11, 21,22 | B41J2/125 |
| Y | * abstract * | 2,4,5,7 | |
| A | | 17-20 | |
| Y | US 5 933 179 A (FOGLE ET AL) 3 August 1999 (1999-08-03) | 2,4,5,7 | |
| A | * the whole document * | 1,17,21, 22 | |
| A | US 6 036 298 A (WALKER ET AL) 14 March 2000 (2000-03-14) * column 8, line 50 - column 9, line 13 * | 19,20 | |

TECHNICAL FIELDS SEARCHED (IPC)

B41J

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 22 November 2005 | Urbaniec, T |

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

3

## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 05 10 5368

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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22-11-2005

| Patent document cited in search report | | Publication date | Patent family member(s) | | | Publication date |
|---|---|---|---|---|---|---|
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| US 5933179 | A | 03-08-1999 | NONE | | | |
| US 6036298 | A | 14-03-2000 | DE | 19881121 | T0 | 05-08-1999 |
| | | | GB | 2332303 | A | 16-06-1999 |
| | | | JP | 2001500448 | T | 16-01-2001 |
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82