

Print Station

Field Of The Invention

The present invention relates to a print station. In particular the present invention is directed to a modular print station adapted for use with high speed printing and with high speed multi-layer printing operations.

Background Of The Invention

The print station of the present invention is designed for use with high-speed multi form collators.

Multi-layer printing operations are used for production of items such as statements, invoices and consignment notes. A multi-layer document is used and may contain several layers, which have common printed items, together with variable information that differs from layer to layer. For the convenient handling of such documents, form collators are conveniently used.

The present invention provides a print station that can be used in combination with high speed paper handling equipment to produce high speed print. The print station of the present invention is adapted for use either as a stand alone item for single layer printing, or it can be used in multiple to facilitate simultaneous printing on multiple paper streams.

Summary Of The Invention

Therefore, according to a first aspect of the present invention, although this need not be the broadest, nor indeed the only aspect of the invention there is provided a print station characterised by:

a support pedestal a carry arm adjustably mounted on the stand and a base unit
a print unit mounted on the carry arm said print unit having a print head array holding one or more print heads, said carry arm further supporting an ink supply system said ink supply system being arranged so as to be at a constant level with respect to the print head array.

Preferably, the pedestal has a base unit adapted for mounting either on a floor mount or adjustable mounting on a rail system to be used in conjunction with a multiple stream paper handling apparatus.

In such an arrangement it is then possible for a plurality of print stations to be mounted on a rail, and to incorporate the rail system into a multi-layer printer using known paper handling equipment.

5 In a preferred embodiment each print station has an associated print station receiving assembly mounted attached to the paper handling equipment. A series of paper carrier rollers directs the paper to the print head in the extended, operational position and maintains, the paper flow speed, tension and alignment over the print head array.

Typical paper handling equipment may include gluing and cutting equipment to produce a final printed cut and collated product.

10 Combining the above equipment with customised digital printing software allows for separate printing information to be supplied to each print station thereby enabling printing of variable information on each of a number of layers of paper held on a paper handling collating machine. Such software additionally separates the information flowing to each print head array into separate data packets directed to each print head such that the array produces the
15 desired print result.

In a particularly preferred embodiment, software is developed to allow the user to create and edit the desired document information for printing, the software manipulating the information to produce a multi-layer output with a combination of fixed and variable print information on each sheet of a multi-sheet booklet. Software of this type is described in our co-pending
20 patent application, International Patent Application wo01/12444.

Preferably the print head array is mounted so as to enable a relatively high quality print over the area to be printed. By incorporating an array of print heads a wide print field is achieved using a static print head compared with the more familiar print head scanning over the area to be printed. Data handling software assists in ensuring the correct print instructions are
25 supplied to each print head in the array.

In one embodiment of the invention a print head array includes a print head array assembly plate adapted to hold an array of up to 20 print heads in a 4x5 array of staggered print heads, each print head being arranged normal to the direction of print. Such an array can produce an image quality of 260 dpi.

In an alternative embodiment a print head array of up to 20 print heads is arranged in a 4x5 array at an angle to the print direction. Such an array produces a sharper image of up to 285 dpi.

5 In each case, each of the print heads is associated with a respective print head carrier used to mount the print heads onto the print head array assembly plate. This arrangement secures the print heads in position and enables print heads to be removed and replaced as an when necessary without loss of position information.

10 Preferably, the print heads are movable between operational positions and an elevated cleaning position. The print station has an associated air lift mechanism in connection with the print head array to facilitate the lifting process.

The ink supply to the print heads is carried on the carry arm. The ink supply, in a preferred embodiment includes a first ink supply reservoir, said first ink reservoir being in fluid communication with a second ink supply reservoir, pump means associated with said first and second ink supply reservoirs to enable flow of ink from the first ink supply reservoir to the second ink supply reservoir, said second ink supply reservoir serving to supply ink to the print heads.

Preferably, the second ink supply reservoir includes an inlet chamber into which ink from the first ink supply reservoir is received and an outlet chamber, the outlet chamber having a plurality of outlets, each outlet being adapted to supply ink to a respective print head.

20 The inlet and outlet chambers are arranged such that a constant level of liquid can be maintained in the outlet chamber during use.

By ensuring a constant level of ink in the outlet chamber the pressure of ink and flow rate at each print head is maintained. Thus, an even print quality is produced across the print head array.

25 **Brief Description Of The Drawings**

The present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 represents a print station in front view in accordance with a first aspect of the present invention;

Figure 2 represents the print station of Figure 1 in perspective view;

Figure 3 illustrates the print unit of the print station of Figure 1;

Figure 4 illustrates in plan view a first print head array assembly plate;

5 Figure 5 illustrates the arrangement of the print head, carrier and print head array assembly plate of Figure 4;

Figure 6 illustrates in plan view a second print head array assembly plate;

Figure 7 illustrates in plan view the print head array assembly plate of Figure 6

Figure 8 illustrates a print head cleaning unit adapted for use with the print head array assemblies of Figures 4 and 6;

10 Figure 9 illustrates the print unit of Figure 3 from a below;

Figure 10 shows in perspective view a part of the ink supply system of the print station of Figure 1

Figure 11 illustrates in plan view the ink supply reservoir of Figure 10;

Figure 12 illustrates the reservoir of Figure 11 in cross sectional side view;

15 Figure 13 illustrates the ink reservoir of Figure 11 in cross sectional view;

Figure 14 represents schematically the print station of Figure 1 in association with a collator;

Figure 15 represents a part of arrangement of print stations in accordance with the invention mounted for multi layer printing operations; and

20 Figure 16 depicts a print station in accordance with the invention incorporating an alternative ink supply arrangement.

Description Of The Preferred Embodiment

Figures 1 and 2 illustrate a print station 10 formed in accordance with a first aspect of the invention. Various constructional details of the print station are shown in Figures 3-13 and a multi-layer printer incorporating the print station 10 is shown in Figures 14-16. Shown
5 generally in the drawings is a print station 10, including a support pedestal 12, a carry arm 14 mounted on the pedestal 12. The carry arm 14 holds on one side a print unit 16 and on an opposing side an ink supply system 18.

The support pedestal 12 includes a pillar 20 upstanding from a base unit 22. The base unit 22 is adapted for mounting to a floor, by any convenient means, and in this case by means
10 of bolts. In this type of mounting the position of the print station 10 is generally fixed. The base unit can also be mounted to a rail 24, as shown in figures 14 and 15. In the position shown in Figure 14 and 15, the base unit 22 is slidably positioned on the rail 24, by locating rail upstanding rail elements in corresponding grooves in a lower surface of the base unit 22. A desired position of the print station 10 with respect to the rail 24 is maintained by locking
15 the base unit 22 in position with locking handle 26.

The pillar 20 includes a pair of spaced grooves 28 which extend along the length of the pillar 20. A connection plate 27 has a pair of spaced apart runners 29 on one side thereof, the runners 29 fitting snugly into the grooves 28 and being slidably moveable therein. The carry arm 14 is located on the connection plate on an opposite side to the runners 29. The carry
20 arm 14 can therefore be moved along the length of the pillar 20 to any desired height.

The vertical position of the carry arm 14 is secured by means of a locking mechanism 30, shown in detail in Figure 2. To secure the position of the carry arm 14 the adjusting screw 32 is used to locate the position of the arm and the locking nut 34 is secured against the plate 36 to lock the arm 14.

25 The print unit 16 and ink supply system 18 are locked onto the arm 14, which in turn, is slidably with respect to the pillar 20. By locking both the print unit 16 and the ink supply system 18 on the carry arm 14 the relative heights of the two units are maintained constant.

The print unit 16 includes a housing 40 defined by sidewalls 42 and a back brace 41. A print head array assembly plate 44 serves as a base for the print unit 16. As can be seen from
30 Figure 2, the inner surfaces of the side elements 42 each include a pair of guide channels 46. The guide channels 46 receive printed circuit boards 48 therein carrying the necessary electronic hardware to supply information to the printer. The circuit boards 48 and

associated components can be seen in Figure 3. Also shown in Figure 3 is a tray 50 used to collect excess ink in the cleaning process is shown.

The print head array assembly plate 44 serves to hold a number of print heads 54.

5 The print head array assembly plate 44 may take either of two forms. A first form is shown in Figures 2, 3, 6 and 7 and a second form is shown in Figures 4 and 5. In each case the plate 44 consists of a plate having therein an array of apertures 52, each aperture 52 serving as a receiving seat for a respective print head 54. The apertures 52 are generally rectangular and have rounded edges to accommodate the print heads 54 securely. Moreover, in each case the array of apertures is arranged in a 5x4 array, that is, up to 20 print heads 54 can be
10 located in each assembly plate 44.

In the case of the plate 44 shown in Figures 4 and 5 the array is generally in line with the plate and in normal to the direction of paper flow and print run through the print unit 16. Each line of the array is staggered with respect to the lines on either side to ensure a full run of printing across the width of the array. By contrast, the array of apertures 52 in the plate
15 depicted in Figures 2, 3, 6 and 7 is arranged at an angle of approximately 45° to the plate and to the direction of print through the unit 16. By rotating the array slightly it has been found that the print quality is improved.

The mounting mechanism for securing a print head 54 in each of the aperture 52 is the same in each case and is shown in detail in Figure 5. The print head 54 is secured in a print head
20 carrier 56 by screws 58. The print head carrier 56 consists of generally a backing plate to which the print head 54 is secured by the screws 58. The print head 54 is positioned with the printing end facing downwards and sitting slightly below the level of the plate 44 so that it can contact paper below the plate 44 for printing. Figure 9 illustrates the print heads 54 in position in the plate 44.

25 The carrier 56 is secured to the plate 44 by means of screws (not shown) that pass through mounts 60 located on either side of the carrier 56 and connect into screw apertures 62 in the print head assembly plate 44. Printing information from a central processing unit is supplied to each separate print head 54 through a respective flexible cable 64 as depicted in Figure 3. Moreover, each print head 54 has a separate ink supply cable 66 attached to the print head
30 at inlet port 68.

Positioned above the carry arm locking mechanism 30 is an air ram 38 used for raising the print head array and assembly plate 44 within the print unit 16 against the locked position.

The air ram 38 allows the unit 16 to be raised by 25mm above the paper level for cleaning purposes. The air ram 38 is actuated through switch 40. Thus, the air ram allows a small upward movement of the print heads 54 to allow paper positioning and adjustment and cleaning of the print heads without any alteration of the resting position of the carry arm and therefore the relative printing positions of the paper, print head 54 array and the ink supply system. Thus, the temporary movement of the print heads does not alter the print intensity from the print unit 16. Following the completion of any head cleaning or paper adjustment, the print heads return to the set position when the air ram pressure has been removed and, therefore no change in the set occurs.

- 10 The ink supply cables 66 are connected to the ink supply system 18 on the opposing side of the on the carry arm 14. The cables 66 connect to outlets in an ink supply reservoir 70.

The in supply system 18 includes a first ink supply reservoir 72 mounted on the base unit 22. The first ink supply reservoir has two uppermost openings, being an outlet 74 and a return inlet 76. The first in supply reservoir 72 is also supplied with a breather valve 78 that serves to allow air into the reservoir 72 as in is gradually withdrawn therefrom thereby allowing an even pressure to be maintained in the reservoir 72. Extending from the outlet 74 is a supply line 80 which travels upwardly to a pump 82 held in a housing 84. The pump 82 is a diaphragm pump selected for its ability to produce an even ink flow. In operational conditions the pump 82 produces a flow of ink from the reservoir 72 through the pump. On the outflow side of the pump 72 is an inline filter 86 which removes undesirable particles from the ink. The filter is selected to remove all particulate matter of greater than 4 microns.

The supply line 80 enters the uppermost ink supply reservoir 70 through the base thereof. The upper ink supply reservoir 70 is shown in greater detail in Figures 10-13.

25 The reservoir 70 is divided into a number of separate chambers separated by internal partitions. An inlet chamber 88 is in fluid communication with, and filled by the supply line 80. The inlet chamber 88 is located to one side of the reservoir 70 and holds a substantial volume of ink therein. This chamber is designed to allow the ink therein to settle allowing ink bubbles and turbulence in the ink to dissipate. Ink flow from the chamber 88 over the internal partition 90 into the outlet chamber 92. The ink entering the outlet chamber 92 is settled and flows evenly.

The outlet chamber 92 includes a plurality of outlets 94 at the base thereof. The outlets 94 are spigots each of which has a respective ink supply cable 66 attached thereto. Thus each print head 54 has a separate supply of ink from the reservoir 70. It will be observed that the

outlets 94 are all in horizontal alignment. The outlet chamber 92 connects with an overflow chamber 96 via the overflow partition 98, which is common to both chambers. A return line 99 enables ink from the overflow chamber to be returned to first ink supply reservoir 70.

5 In use ink in the reservoir 70 is maintained at a level that ensures that the outlet chamber is always full ensuring an even head pressure on the outlets 94 and, ultimately, an even ink flow to the print heads. As was noted earlier, the print heads 54 and the ink supply reservoir 70, both being carried on the carry arm 14, are maintained at a constant relative height during printing operations. Thus, the ink flow characteristics to each print head 54 are the same giving an even print across the entire width of the printed area.

10 The ink supply reservoir is fitted with a cover incorporating a breather valve 100.

Figures 14 and 15 shown how the print station 10 is installed for use with high speed multi-layer printing operations. The print station 10 is installed on the access side of a known multi-layer form collator 102 on the rail 24. The rail 24 is a generally I-shaped beam and includes a pair of spaced uppermost linear track elements 103. The track elements 103 slot
15 into grooves 105 in the underside of the base unit 22 and the print station 10 can therefore be moved along the track elements. The station 10 is positioned by moving the station over the rail 24 and locking in position using the locking handle 26, which lock against the track elements 24. The height of the print unit 16 and ink supply reservoir 70 are adjusted by altering the height of the carry arm 14 using the locking mechanism 30.

20 In order to initialise the print unit and print heads the system is charged with ink by closing the ink return valve 104 from the second reservoir 70 and opening the breather valve 100. Actuating the pump 82 creates a flow of ink to the reservoir 70 and ultimately to the outlets 94, through the ink supply cables 66 and to the print heads 54. During the printing operation a constant head pressure on the print heads is maintained by ensuring that the outlet
25 chamber 92 is full to the point of overflow into the overflow chamber 96 at all times.

Attached to the back of the collator 102 is a set of tensioning rollers 106, 108, 110 and 112. The rollers are spaced apart so as to allow the print unit 16 to be moved into position on between the rollers as indicated in Figure 14. The normal paper handling operations of the collator 102 are omitted for clarity, however it is to be understood that the paper flow to the
30 rollers proceeds so that paper is directed over the outer surface of the rollers 106 and 108 and 110 in an anti-clockwise direction. As the paper passes around roller 110 the paper is directed into the base of the print unit 16 immediately below the print heads 54.

As data is received in each individual print head through respective data cables the print head array produces a stream of print. The paper to be printed is delivered over the roller 112 and returned to the paper train of the collator 102.

5 Simultaneous printing operations as described above occur on each print station 10 mounted on the rail 24. As the printed layers are delivered to the paper train the collator 102 collects the layers, glues and cuts in line with its normal function. The combination of the print stations 10 and form collator and associated operating software producing a multi-layer product incorporating both fixed and variable information on each sheet.

10 In the case where only single layer printing is required a single print station is secured to any convenient stable surface preferably a floor adjacent the paper handling equipment.

Where maintenance of the ink supply is needed, or where the supply has been interrupted for some reason it is possible to clean the print heads either by a flushing technique or by vacuum. In the case of flushing the system, the return valve are closed to allow ink to be pumped through the print heads 54 as previously described with any excess ink being
15 collected in the tray 50. It is also possible to collect any excess ink emerging from the print heads on a lint free cloth.

Alternatively applying the vacuum cleaning tool 114 shown in Figure 8 may individually clean the print heads 54. The tool 114 includes an opening 116 connecting to a vacuum line 118. The vacuum 118 leads to the vacuum unit 120 located at the left hand side of the pillar 20. A
20 print head 54 is cleaned by applying the opening to the print head and pressing to actuate the vacuum.

A print station 10 including an alternative ink supply arrangement is shown in Figure 16.

In this case the print station 10 is supplied with a first ink supply reservoir 122 mounted in an elevated position above the print unit 16. The supply reservoir is in fluid communication with
25 and supplies ink to a secondary reservoir 124. The ink supply cables 66 are supplied from the secondary reservoir 124. The system is charged in ink and ink flow to the print heads 54 is largely under the influence of gravity.

The invention has been described with reference to the embodiments thereof depicted in the drawings. The drawings are used for purposes of explanation and should not be taken as
30 limiting the form of the invention. There are in fact many arrangements by which a print station having the features of the invention may be realized. Modifications of the invention

such as would be apparent to a skilled addressee are deemed to be within the scope of the invention.

Claims:

1. A print station (10) characterised by:
a support pedestal (12), a carry arm (14) adjustably mounted on the stand and a
5 base unit (22);
a print unit mounted on the carry arm said print unit having a print head array (44)
holding one or more print heads (54), said carry arm further supporting an ink supply
(18), said ink supply being arranged so as to be at a constant level with respect to the
print head array.
- 10 2. A print station according to claim 1, characterised in that the support pedestal has a
base unit adapted for mounting on a floor.
3. A print station according to claim 1, characterised in that the support pedestal is
adjustably mounted on a rail system (24) to be used in conjunction with a multiple
stream paper handling apparatus.
- 15 4. A print station according to claim 3, characterised in that the base unit is slidably
positioned on the rail, by locating rail upstanding rail tracks (103) that locate in
corresponding grooves (105) in a lower surface of the base unit
5. A print station according to claim 3 or 4, characterised in that the position of the base
unit with respect to the rail is maintained by locking the base unit in position with
20 locking handle (26).
6. A print station according to any one of the preceding claims, characterised in that the
height of the carry arm is adjustable.
7. A print station according to any one of the preceding claims, characterised in that the
support pedestal includes one or more grooves (28) that extend along the length of
25 the pillar, said carry arm being slidably mounted in said grooves.
8. A print station according to claim 7, characterised in that a connection plate (27) has
a pair of spaced apart runners (29) on one side thereof, the carry arm being located
on the connection plate on an opposite side to the runners, wherein the runners fitting

snugly into the grooves and are slidably moveable therein, such that the carry arm and connection plate are slidably moveable in the grooves.

9. A print station according to claim 1, characterised in that the vertical position of the carry arm on the support pedestal is secured by means of a locking mechanism (30), including an adjusting screw (32) that serves to locate the position of the carry arm and a locking nut (34) that is secured against a plate (36) to thereby lock the carry arm in a selected position.
10. A print station according to claim 1, characterised in that the print unit is movable between an extended operational position and a retracted position, wherein in said extended position said print unit is received in a print station receiving comprising a plurality of paper carrier rollers (106,108,110 and 112), said rollers directing a stream of the paper to the print heads in the extended, operational position and maintaining, the paper flow speed, tension and alignment over the print head array.
11. A print station according to claim 1, characterised in that the print unit includes a housing adapted to hold the print head array and associated circuitry and wherein said print head array includes a print head assembly plate (44) adapted to hold up to 20 print heads in a 5x4 array.
12. A print station according to claim 11, characterised in that the print head assembly consists of a plate having therein an array of apertures (52), each aperture 52 serving as a receiving seat for a respective print head.
13. A print station according to claim 12, characterised in that the apertures in the print head assembly plate are arranged so that the print heads in the plate are aligned normally to the direction of print.
14. A print station according to claim 12, characterised in that the apertures in the print head assembly plate are arranged so that the print heads in the plate are at an angle of 25-65° to the direction of print.
15. A print station according to any one of claims 12-14, characterised in that each print head is secured in a print head carrier (56) that in turn is secured in the apertures in the print head assembly plate.

16. A print station according to claim 15, characterised in that the print head carriers each consist of a backing plate to which the print head is attached such that the print head is secured in the print head assembly plate facing down wards and sitting slightly below the level of the plate so that the print head can contact paper below the plate for printing.
17. A print station according to claim 16, characterised in that the print assembly plate and each print head therein is, movable between operational position and an elevated cleaning position.
18. A print station according to claim 17, characterised in that the print station has an associated air lift mechanism in operative connection with the print head array to facilitate the elevation of the print heads
19. A print station according to claim 1, characterised in that each print head has a separate ink supply cable (66) attached to a print head at inlet port (68) in the print head, said ink supply cables being in fluid communication with the ink supply system.
20. A print station according to claim 1, characterised in that the ink supply system includes a first ink supply reservoir (72,122), said first ink reservoir being in fluid communication with a second ink supply reservoir (70) to enable flow of ink from the first ink supply reservoir to the second ink supply reservoir, said second ink supply reservoir serving to supply ink to the print heads.
21. A print station according to claim 20, characterised by pump means (82) associated with said first and second ink supply reservoirs, said pump means optionally including an inline filter and serving to supply ink from the first ink supply reservoir to a second ink supply reservoir.
22. A print station according to claim 20, characterised in that flow of ink from the first ink supply reservoir to the second ink supply reservoir occurs under the influence of gravity.
23. A print station according to any one of claims 20-22, characterised, in that the second ink supply reservoir includes an inlet chamber (88) into which ink from the first ink supply reservoir is received and an outlet chamber (92), the outlet chamber having a plurality of outlets (94), each outlet being in fluid communication with a respective ink

being separated by a first partition (90) to thereby to allow the ink in the inlet chamber to settle such that air bubbles and turbulence in the ink may dissipate, settled ink flowing from the inlet chamber over the internal partition into the outlet chamber, whereby an even flow of ink from the outlet chamber in to the ink supply cables is encouraged.

24. A print station according to claim 23, characterised, in that the outlet chamber connects with an overflow chamber (96) via an overflow partition (98) common to both chambers, whereby ink in outlet chamber flows over the overflow partition to thereby maintain a constant level of ink in the outlet, the overflow chamber being in fluid communication with the first ink supply reservoir to enable return of the ink in the overflow chamber to the first ink supply reservoir.

25. A printing system characterised in that a plurality of print stations according to any one of claims 2-24 are arranged on a monorail system for use in combination with known form collator apparatus.

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