

INK SUPPLY FILTER

This invention relates to filters; more particularly the present invention relates
5 to filters for ink which is being fed to the printhead of a printer.

The final, or "last ditch", filter currently used in ink jet printers comprises a disc
filter, fabricated from stainless steel, retained within flexible tubing, typically
fabricated from PTFE, through which flexible tubing and retained filter the
10 printing ink is fed to the printhead. The primary function of this final filter is to
protect the actuator of the printer from contamination by the ingress of dirt
once the actuator has left its controlled manufacturing environment. It is
known that the inadvertent ingress through the filter of one particle above
20 $20\mu\text{m}$ in size would result in printhead failure. Such stringent filtration has
15 hitherto required relatively massive filters which are deployed externally to the
printhead cover.

The present invention seeks to provide an improved filter in which these
problems are mitigated.

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According, therefore, to one aspect of the present invention there is provided
a filter assembly, preferably an ink jet print head filter assembly, for ink for a
printer, which filter assembly comprises:

at least one pair of supported filter elements which are in stacked
25 arrangement;

a filter housing; and

means contained within the filter housing for conveying the ink through
the filter elements so that the ink flow is either into or out of the volume
between the filter elements.

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The filter assemblies of the present invention can have small size but a large
filter area.

It is preferred that there is one pair of stacked filter elements; and that the filter elements are supported at least at their periphery.

5 In one embodiment, the conveying means comprises at least one manifold, contained within the filter housing, for conveying ink from a supply through the filter elements.

10 Preferably, the or each pair of filter elements is supported by a respective filter support formed from plastics material. The filter support and manifold may be a unitary structure.

It is particularly preferred that the or each filter support, and manifold, is formed by injection moulding, especially by reactive injection moulding.

15 By proceeding in this manner, it is found possible to eliminate flexible tubing which has been found to exhibit the disadvantage that particles can become dislodged therefrom on flexure of the tubing. Furthermore, injection moulded components have been found to have low shedding properties and can also have a high surface finish leaving little possibility for dirt to become entrapped.

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The filter elements may comprise finely woven wire the mesh of which is effective to prevent passage of particles of at least 20 μm in diameter. Preferably, the wire is of a metal which, in service, is resistant to corrosion by the fluids being filtered. Examples include stainless steel, titanium or gold with stainless steel being preferred. DUTCH TWILL weave has been found to be
25 very suitable, especially 320x2000 DUTCH TWILL (320 wires/inch (approximately 126 wires/cm) in one direction of weave, 2000 wires /inch (approximately 787 wires/cm) in the other direction). The filter elements may be suitably adhesively bonded to the filter support. Such woven wire media,
30 especially stainless steel, have been found to have very low shedding properties; furthermore, an adhesive bead seals cut edges of the woven wire to reduce further the possibility of shedding as well as to secure the filter

element in position.

The filter elements may comprise plastics membranes, for example, PTFE (polytetrafluoroethylene) membranes.

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In order to reduce further the likelihood of shedding, each pair of filter elements may comprise opposing faces of a filter. The use of a unitary, wrap-around filter, instead of individual filter elements, also enables the use of adhesive sealing to be avoided.

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The filter assembly of the present invention can be provided in very compact form (in particular, of a width less than that of the supplied nozzles of the printer) yet can, in service, suitably furnish a pressure drop across the filter housing of less than 10% of the pressure drop across the filter element.

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Preferably, the filter element has a contact area effective to ensure, in service, a pressure drop thereacross of less than 16 mm ink. In general, the filter assemblies of the present invention enable the pressure drop across the filter housing to be small relative to the pressure drop across the filter element while necessitating only a small internal ink volume. The filter housing is desirably tapered in the downstream direction to facilitate the expulsion of air from the filter housing.

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This invention particularly provides an ink jet print head assembly of generally rectangular cross-section wherein:

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the height of the assembly is the minor dimension and is effective to ensure, in service, a pressure drop across the filter assembly of less than 16mm ink;

the width is less than the width of an array of ink jet nozzles supplied through the filter; and

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the length of the filter housing corresponds substantially to the distance between the nozzle array and the electrical connectors to the drive circuitry for operating the print head.

Minimising the height of the filter assembly in this way allows it to fit easily beneath the print head cover and/or allows the print head cover to have a streamlined, low profile. Not only does this result in a product that is pleasing to the eye, such a configuration allows print heads to be stacked with their
5 nozzle arrays parallel to one another with minimum separation.

The filter assembly of this invention also suitably additionally comprises interfacial means for integrating the filter in line with an ink supply and with a printer. In accordance with a further aspect of this invention, there is provided
10 a printer, preferably an ink jet printer, which comprises a filter assembly in accordance with the herein described invention. In a particularly preferred embodiment of this aspect of the invention; the filter assembly is located beneath the printhead cover.

15 In a further aspect of this invention there is provided a method of filtering ink for a printer, which method comprises:

causing the ink to flow through at least one pair of supported filter elements which are in stacked arrangement, the flow being either into or out of the volume between the filter elements; and
20 supplying filtered ink to the printer.

The invention is further illustrated, by way of example, with reference to the accompanying drawings, in which:

25 Figure 1 represents a schematic, exploded view of a first embodiment of a filter assembly of the invention;

Figures 2a, 2b and 2c represent, respectively, a section along A-A; a top plan; and a side elevation of the filter support shown in Figure 1;

30 Figure 3 represents a section of the filter assembly of Figure 1 interfacially connected in line;

Figure 4 represents an isometric projection of an array of four filter assemblies each connected in line to an ink jet nozzle in a single print head.

Figure 5 represents a schematic, exploded view of a second embodiment of a filter assembly of the invention;

Figures 6a, 6b and 6c represent, respectively, a section along A-A; a top plan; and a side elevation of the filter support shown in Figure 5; and

Figure 7 represents a section of the filter assembly of Figure 5 interfacially connected in line.

Referring to the drawings, and in particular to Figure 1, there is disclosed a first embodiment of a filter assembly comprising generally a filter support 1; a top filter element 11 and a bottom filter element 12; a filter housing 2; a connection 3; and an O-ring 4.

With reference now to Figure 2, the filter support 1 comprises an injection moulded, plastics frame 13 of generally rectangular plan formed with an externally threaded conduit 14 at a first, upstream end and tapering in section towards the downstream end. The conduit can form a liquid-tight connection with an upstream supply of printing ink (not shown) and communicates, via port 15, with a generally trapezoidal volume 16 bounded by the frame 13. The frame 13 progressively decreases in width and in thickness from the upstream to the downstream end while the enclosed volume between the filter element and the filter housing increases concomitantly so that the cross-sectional area thereof is continuously matched to the ink flow in service, thereby minimising the height of the filter assembly without exceeding the aforementioned pressure drop. Both the upper and lower surfaces of the frame 13 have longitudinal flanges 17, 17' which restrain the filter elements 11, 12, to minimise flexure thereof. The elements 11, 12 are adhered to the frame 13 by an adhesive bead; the bead also encapsulates the cut edges of the filter.

The downstream end includes like upper and lower throats 18. Filter housing 2 forms a generally fluid tight fit with filter support 1 but has an externally threaded port 19 which, when secured, forms a fluid-tight fit with connection 3.

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In use, the connection 3 is joined in fluid-tight manner to the filter housing 2 via an O-ring 4 (which buffers the printhead against mechanical forces transmitted though the filter assembly and also permits movement caused by thermal cycling and differences in thermal coefficients of expansion) while the threaded conduit 14 is rigidly connected to an upstream supply of printing ink (not shown). A tension exerted by the actuated printhead (not shown) draws printing ink through conduit 14, into the volume 16. The ink then passes out of the volume 16 through filter elements 11, 12 and the filtered ink is then conveyed via throat 18, port 19 and connection 3 to the actuator (not shown).

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It is also possible, for convenience, to form the filter elements 11, 12 in a unitary, wrap-around manner.

A plurality of filter elements may be provided for use with a single printhead. For example, figure 4 shows an isometric projection of an array of four filter assemblies, each connected in line to a respective ink jet nozzle of the printhead.

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The printhead typically includes a number of printed circuit boards carrying, inter alia, wire connectors for the electrical circuitry of the printhead. The inventors have found that contact between the ink and encapsulant overlaying the wire connectors has a tendency to cause the encapsulant to swell and exert a stress on wire bonds on the printed circuit board, which can lead to electrical failure and permanent damage. In order to protect the encapsulant from such chemical attack by the ink, the encapsulant is covered by a foam filling or parylene coating which is injected into the printhead through a hole in the cover (not shown) of the printhead during assembly.

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Referring back to the printed circuit boards, chips are bonded to the board using a combination of gold and aluminium bonding. To avoid any problems associated with pyro-electric effects, firstly the inputs to the chip are gold-bonded at an elevated temperature to respective contacts on the circuit board, followed by room temperature aluminium bonding of the outputs of the chip to respective contacts on the printed circuit board. The inventors have found that if gold bonding is performed after aluminium bonding, a discharge may occur as the gold bonds are being formed, which can result in chip failure.

The printhead may include a heating arrangement to reduce the viscosity of the ink during droplet ejection. Any suitable heating arrangement may be used. For example, a heater can be attached directly to the base of the printhead, the base being formed preferably from aluminium. Alternatively, as the relatively modular and compact arrangement of the printhead has been found to provide good thermal conduction between the printhead and the printhead carriage, the carriage may be heated to provide the necessary increase in the temperature of the ink before droplet ejection.

With reference to Figure 5, there is disclosed a second embodiment of a filter assembly comprising generally a manifold 101; a top filter element 111 and a bottom filter element 112; a filter housing 102; a connection 103; and an O-ring 104. Thus, the second embodiment is similar to the first embodiment described above, except that the filter support 1 is replaced by the manifold 101.

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With reference now to Figure 6, the manifold 101 comprises an injection moulded, plastics block 113 of generally rectangular plan formed with an externally threaded conduit 114 at a first, upstream end and tapering in section towards the downstream end. The conduit can form a liquid-tight connection with an upstream supply of printing ink (not shown) and communicates with a passageway 115 located centrally within the block. The passageway, in turn, communicates with the like upper and lower rectangular arrays of ports 116

which give access to like upper and lower surfaces 117, respectively. Both the passageway and the ports progressively decrease in cross-section from the upstream to the downstream end while the enclosed volume between the filter element and the filter housing increases concomitantly so that the cross-sectional area thereof is continuously matched to the ink flow in service, thereby minimising the height of the filter assembly without exceeding the aforementioned pressure drop. Both the upper and lower surfaces have three longitudinal parallel ribs 118 which, in addition to peripheral rib 119, support the filter elements 111, 112 to minimise flexure thereof. The elements 111, 112 are adhered to the peripheral rib 119 by an adhesive bead; the bead also encapsulates the cut edges of the filter. Ribs 118 may be dispensed with provided that the filter element is supported about its perimeter by peripheral rib 119. The downstream end includes like upper and lower throats 120. Filter housing 102 forms a generally fluid tight fit with manifold 101 but has an externally threaded port 121 which, when secured, forms a fluid-tight fit with connection 103.

In use, the connection 103 is joined in fluid-tight manner to the filter housing 102 via an O-ring 104 (which buffers the printhead against mechanical forces transmitted through the filter assembly and also permits movement caused by thermal cycling and differences in thermal coefficients of expansion) while the threaded conduit 104 is rigidly connected to an upstream supply of printing ink (not shown). A tension exerted by the actuated printhead (not shown) draws printing ink through conduit 114, into the manifold 101 where it enters passageway 115 and ports 116. The ink then passes through filter elements 111, 112 and the filtered ink is then conveyed via throat 120, port 121 and connection 103 to the actuator (not shown).

Each feature disclosed in this specification (which term includes the claims) and/or shown in the drawings may be incorporated in the invention independently of other disclosed and/or illustrated features.

**CLAIMS**

1. A filter assembly for ink for a printer, which filter assembly comprises:
at least one pair of supported filter elements which are in stacked
5 arrangement;
a filter housing; and
means contained within the filter housing for conveying the ink through
the filter elements so that the ink flow through both filter elements is either into
or out of the volume between the filter elements.
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2. A filter assembly according claim 1 wherein there is one pair of stacked
filter elements.
3. A filter assembly according to claim 1 or 2 wherein the filter elements are
15 supported at least at their periphery.
4. A filter assembly according to any preceding claim, wherein said conveying
means comprises at least one manifold, contained within the filter housing, for
conveying ink from a supply through the filter elements.
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5. A filter assembly according to any preceding claim wherein the or each pair
of filter elements is supported by a respective filter support formed from
plastics material.
- 25 6. A filter assembly according to claims 4 and 5, wherein a filter support and
a manifold are formed as a unitary structure.
7. A filter assembly according to claim 5 or 6 wherein the or each filter
support is formed by injection moulding.
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8. A filter assembly according to claim 7 wherein the plastics material is a
thermosetting material and the or each filter support is formed by reactive





injection moulding (RIM).

9. A filter assembly according to claim 8 wherein the filter elements are adhesively bonded to the filter support.

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10. A filter assembly according to any of claims 1 to 8, wherein each pair of filter elements comprises opposing surfaces of a filter.

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11. A filter assembly according to any preceding claim wherein each filter element comprises finely woven wire effective to prevent passage of particles of at least $20\mu\text{m}$ in diameter.

12. A filter assembly according to claim 11 wherein the wire comprises stainless steel, titanium or gold.

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13. A filter assembly according to any preceding claim wherein, in service, the pressure drop across the filter housing is less than 10% of the pressure drop across each filter element.

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14. A filter assembly according to claim 13 wherein each filter element has a contact area effective to ensure, in service, a pressure drop thereacross of less than 16 mm ink.

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15. A filter assembly according to any preceding claim wherein the filter housing is tapered in the downstream direction.

16. A filter assembly according to any preceding claim comprising interfacial means for integrating the filter in line with an ink supply and with a printer.

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17. A filter assembly according to any preceding claim for an ink jet printhead and being of generally rectangular cross-section wherein:

the height of the assembly is the minor dimension and is effective to





ensure, in service, a pressure drop across the filter assembly of less than 16mm ink;

the width is less than the width of an array of ink jet nozzles supplied through the filter assembly; and

- 5 the length of the filter housing corresponds substantially to the distance between the nozzle array and electrical connectors to drive circuitry for operating the printhead.

- 10 18. A printer which comprises a filter assembly according to any preceding claim.

19. A printer according to claim 18 which is an ink jet printer.

- 15 20. A printer according to claim 17 or 18 comprising a printer cover, wherein the filter assembly is located internal to the printer cover.

21. A filter assembly substantially as hereinbefore described and with reference to the accompanying drawings.

- 20 22. A method of filtering ink for a printer, which method comprises:
causing the ink to flow through at least one pair of supported filter elements which are in stacked arrangement, the flow through both filter elements being either into or out of the volume between the filter elements;
and

- 25 supplying filtered ink to the printer.

23. A method according to claim 22 wherein the filter elements are included in a filter assembly according to any one of claims 1 to 18 and 21.

- 30 24. A method according to claim 22 or 23, wherein ink is supplied to at least one manifold, and conveyed through the or each manifold and through the filter elements.



25. A method of filtering ink substantially as hereinbefore described and with reference to the accompanying drawings.

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