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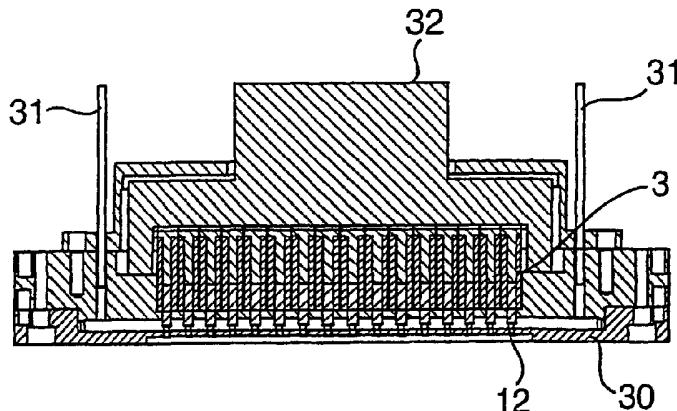
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[Continued on next page]

(54) Title: SOLENOID VALVE FOR A DROP ON DEMAND INK JET PRINTER



(57) Abstract: The invention relates to a solenoid valve made using certain materials which is capable of operation at high frequen-  
cies and which can be made as a compact unit. The plunger (1) is of a unitary construction and is made of an electromagnetically  
soft material having a saturation flux density greater than 1.4 Tesla. Furthermore the plunger (1) has a diameter of 3mm or less  
and a length or diameter ratio of less than 15:1. The invention also relates to a method for operating a drop on demand ink jet printer  
incorporating such a valve.

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# INTERNATIONAL SEARCH REPORT

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<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC 7 F16K31/06 G06K15/10				
According to International Patent Classification (IPC) or to both national classification and IPC				
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) IPC 7 F16K G06K				
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched				
Electronic data base consulted during the international search (name of data base and, where practical, search terms used)  EPO-Internal				
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>				
Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.		
A	US 5 641 148 A (PENEA JAMES A ET AL) 24 June 1997 (1997-06-24) column 2, line 60 -column 3, line 52; figure 3	1,12,26, 27,45		
A	WO 98 56585 A (JETLINE AB ;MIELKE ULF (SE)) 17 December 1998 (1998-12-17) cited in the application abstract	1,12,26, 27,45		
A	WO 94 08794 A (WILLETT INT LTD ;WALTON ROBERT LIONEL (GB)) 28 April 1994 (1994-04-28) page 10, paragraph 3 -page 11, last paragraph; figure 1	1,12,26, 27,45		
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<input checked="" type="checkbox"/> Further documents are listed in the continuation of box C.				
<input checked="" type="checkbox"/> Patent family members are listed in annex.				
° Special categories of cited documents :				
<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border: none; vertical-align: top;">                     "A" document defining the general state of the art which is not considered to be of particular relevance                      "E" earlier document but published on or after the international filing date                      "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)                      "O" document referring to an oral disclosure, use, exhibition or other means                      "P" document published prior to the international filing date but later than the priority date claimed                 </td> <td style="width: 50%; border: none; vertical-align: top;">                     "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention                      "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone                      "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.                      "&amp;" document member of the same patent family                 </td> </tr> </table>			"A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family
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Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016		Authorized officer  <p style="text-align: center; font-size: 1.2em;">Christensen, J</p>		

## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/GB 03/03024

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 985 715 A (CYPHERT DAVID L ET AL) 15 January 1991 (1991-01-15) abstract -----	1,12,15, 26,27
X	EP 0 709 192 A (CANON KK) 1 May 1996 (1996-05-01)	28-33,37
A	column 6, line 31 -column 8, line 38; figures 1-3 -----	34-36, 38-44

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/GB 03/03024

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2.  Claims Nos.:  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
  
3.  Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1.  As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2.  As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3.  As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
  
4.  No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

The additional search fees were accompanied by the applicant's protest.

No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-27, 37-44 (when depending on claim 27),45

The technical features of claim 1:

A valve mechanism for controlling flow comprising:

- a1) a plunger reciprocating between a rest position and an operative position
- a2) an electrical coil generating a magnetic field to operate the plunger depending on the current passing through the coil
- a3) a valve chamber with an outlet bore in communication with a nozzle outlet into which the distal end of the plunger extends to open or close a fluid flow path
- a4) the plunger is unitary and made of electromagnetically soft material with a saturation flux density greater than 1.4 Tesla
- a5) the plunger has a diameter of 3 mm or less and a length to diameter ratio of less than 15:1

The independent claims 12,26 and 45 correspond to claim 1

2. Claims: 28-36, 37-44 (when depending on claim 28),

The technical features of claim 28:

A drop on demand printer comprising:

- b1) a nozzle to form a printer dot on a substrate
- a1) a plunger reciprocating between a rest position and an operative position
- a2) an electrical coil generating a magnetic field to operate the plunger depending on the current passing through the coil
- b2) a computer in operative combination with the printer
- b3) a mechanism for observing the ejected droplet
- b4) computer detect difference between observed droplet and desired droplet and apply correction to the current applied to the coil of the valve to regulate the flow to maintain the desired observed droplet.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

The independent claims 32,34 and 36 correspond to claim 28

**INTERNATIONAL SEARCH REPORT**  
information on patent family members

In **International Application No**  
**PCT/GB 03/03024**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5641148	A	24-06-1997	NONE
WO 9856585	A	17-12-1998	SE 507821 C2 20-07-1998 WO 9856585 A1 17-12-1998 AU 3468197 A 30-12-1998 SE 9601403 A 16-10-1997
WO 9408794	A	28-04-1994	AU 5284493 A 09-05-1994 WO 9408794 A1 28-04-1994
US 4985715	A	15-01-1991	NONE
EP 0709192	A	01-05-1996	JP 8118727 A 14-05-1996 DE 69525303 D1 21-03-2002 DE 69525303 T2 14-08-2002 EP 0709192 A2 01-05-1996 US 6042213 A 28-03-2000