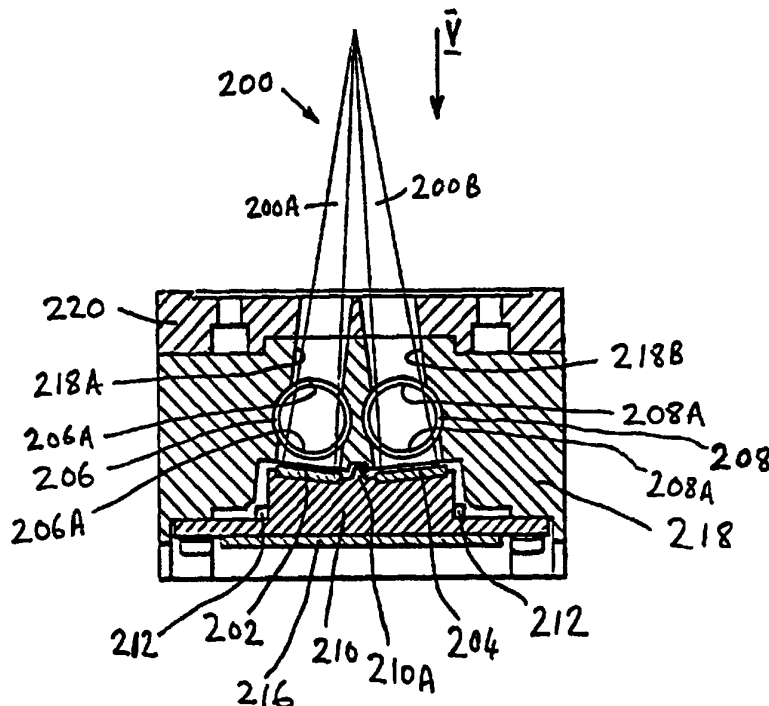




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(54) Title: CIGARETTE MANUFACTURE



(57) Abstract

A scanning device for a cigarette making machine comprises a low energy X-ray beam emitter (110) for passing an X-ray beam through the cigarette rod (116), and an X-ray detector (126; 202) arranged to receive the beam after it has passed through the cigarette rod and to produce an output signal which can be amplified and fed to a control circuit (130) for the cigarette making machine.

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Cigarette Manufacture

In the manufacture of cigarettes it is common to use a nucleonic device for scanning the finishing cigarette rod, usually before it is cut into individual rod lengths, to enable cigarette weights to be controlled by means of a trimming device which removes a variable proportion of the tobacco stream forming the cigarette filler. The rod weight signal can also be used to enable underweight cigarettes or cigarettes with pronounced voids to be ejected further downstream, usually in the filter attachment machine. The use of nucleonic scanning devices for these purposes has been common in the cigarette industry for many years.

According to the present invention, a scanning device for a cigarette making machine comprises a low-energy X-ray beam emitter for passing an X-ray beam through the cigarette rod, and a detector (e.g. a photodiode) arranged to receive the beam after it has passed through the cigarette rod and to produce an output signal which can be amplified and fed to a control circuit for the cigarette making machine.

This invention is based on an appreciation that a low-energy X-ray beam of the type described (which for convenience will be referred to as an X-ray beam) can be used safely in the environment of a cigarette making machine and produces a satisfactory weight signal when used in combination with a photodiode detector with a height approximately equal to the diameter of a cigarette rod. Low-energy X-ray sources have become available as proprietary items. Previously available higher-energy sources were not suitable for cigarette scanning, mainly because the predominately higher frequencies penetrated too readily to give a useful rod weight signal. A low energy X-ray source, on the other hand, can be used in combination with a photodiode by which a beam about the same height as, or slightly less than, the diameter of the cigarette rod can be received and monitored to provide a signal averaging the rod density across its diameter; the reference here to the height of the beam is based on the assumption that the beam is directed horizontally through the rod, though the beam may alternatively, for example, be vertical.

Reference is made above to a low-energy X-ray beam emitter. By way of explanation, commonly available X-ray tubes until fairly recently were intended to operate at an energy level of tens or hundreds of Kilovolts, (depending on the applied definition of X-rays). A suitably low

1 energy source usable in the present invention, on the other hand, has an
2 energy level of a different order of magnitude, namely approximately 13
3 Kilovolts, which results in frequencies up to that represented by a
4 wavelength of approximately 1 Angstrom. We at present believe that a
5 suitable energy level is in the range 6-20 Kilovolts and is preferably in the
6 range 10-16 Kilovolts.

7 Examples of a cigarette making machine and of cigarette rod
8 scanning systems according to this invention are shown
9 diagrammatically in the accompanying drawings. In these drawings:

10 Figure 1 is a front view of part of a complete cigarette making
11 machine;

12 Figure 2 is an enlarged cross-section on the line II-II in Figure 1;

13 Figure 3 is an enlarged cross-section on the line III-III in Figure 1;

14 Figure 4 is a cross-section in a vertical plane of a different X-ray
15 device; and

16 Figure 5 is a view in the direction of the arrow V in Figure 4.

17 Figure 1 shows diagrammatically a conventional Molins-type
18 cigarette making machine in which a cigarette filler stream is formed by
19 showering tobacco up a chimney 10 towards a suction band 12. Part of
20 the filler stream is removed by a trimmer 14 which is vertically movable in
21 any well known manner to control the weight per unit length of the
22 finished cigarette rod; alternatively, the trimmer may be in a fixed position
23 and the band, in the region of the trimmer, may be moved up and down.
24 The portion of the cigarette filler stream remaining on the band 12
25 following the trimmer 14 is enclosed in a continuous wrapper web 16
26 with the aid of a garniture tape 18 and a cooperating upper assembly 20
27 by which the filler stream is finally shaped so that the wrapper web 16
28 can be sealed around it to form a finished cigarette rod 22. A scanning
29 device 24 scans the cigarette rod and controls the vertical position of the
30 trimmer 14.

31 An additional position control for the trimmer is provided by a
32 scanning device 26 immediately upstream (or alternatively immediately
33 downstream) of the trimmer 14. The device 26 provides a quick
34 response to changes in the density of the tobacco forming the filler
35 stream, while accurate long-term control of the weights of finished
36 cigarettes is provided more particularly by the scanning device 24. The
37 use of dual scanning devices is known per se: the Molins Mark 8 cigarette
38 making machine used a pneumatic device as a quick scanner in

1 combination with a nucleonic scanning device scanning the completed
2 cigarette rod (see for example U.S. patent No. 3,089,497).

3 The cigarette scanning device 24 is preferably an X-ray device
4 according to this invention, and the filler stream scanning device 26 is
5 preferably either an infrared device (as shown) or a simpler/cheaper form
6 of low-energy X-ray device which may be powered by the same power
7 supply as the device 24. These devices are shown more fully in Figures
8 2 and 3 respectively. However, these devices may in principle be
9 interchanged.

10 With reference to Figure 2, an X-ray tube 110 is provided to emit
11 an X-ray beam through an outlet 112 including a window member 114
12 which is transparent to the X-rays (e.g. beryllium) but may include a
13 mask (not shown) causing the cross-sectional outline of the beam to be
14 rectangular. The beam emitted through the window 114 has a height
15 slightly less than the diameter of a cigarette rod 116 which is guided by a
16 rod guiding device comprising upper and lower members 118 and 120
17 and side windows 122 and 124 of titanium or other material (e.g.
18 aluminium) through which the X-ray beam can pass. What remains of
19 the beam, as a result of variable attenuation by the cigarette rod,
20 impinges on a photodiode 126 which may be silicon-based and has a
21 height approximately equal to the cigarette diameter. A signal from the
22 photodiode passes to an amplifier 128 from which a rod density signal is
23 transmitted to a control circuit 130 of a basically known type by which
24 control operations, for example trimming as described above, are
25 achieved.

26 The X-ray beam may have a width, in the direction of the cigarette
27 axis, which is less than the diameter of the cigarette, for example 6mm or
28 possibly as little as 3mm. The photodiode 126 has a similar width
29 measured in the direction of the cigarette axis, so as to receive
30 substantially the entire beam that has passed through the cigarette rod.

31 It should be noted that the rod guiding members 118 and 120
32 have suitably concave rod guiding surfaces which have a width,
33 measured in the direction of the beam, sufficient to guide the rod with
34 reasonable accuracy horizontally as well as vertically.

35 In nucleonic scanning systems commonly used until now, it has
36 been common to use narrower rod guide members (measured in the
37 direction of the beam) so as to allow the height of the beam to be almost
38 equal to the cigarette diameter. This is believed to have been

1 considered necessary because of the relatively low energy level of the
2 nucleonic beams commonly used. As a result, it has been necessary to
3 make provision for different rod guide devices to be used for slightly
4 varying rod diameters. The higher flux level available in accordance with
5 the present invention, combined with the essentially different nature
6 (wave energy) of an X-ray beam, allows the use of wider rod guide
7 members 116 and 118. As a result the height of the beam that passes
8 through the cigarette rod may be somewhat less than the cigarette
9 diameter, but that can be tolerated because of the energy level being
10 sufficient to produce an adequate signal, and the benefit in this lies in the
11 fact that a given rod guide device can be used for a wider range of
12 cigarette diameters since the resulting scanning signal is not so sensitive
13 to the precise vertical position of the rod axis as the beam passes only
14 through the wider part of the rod.

15 Power is supplied to the X-ray tube only while the cigarette
16 making machine is in operation and a rod is passing through the rod
17 guide 118,120. For example, a transducer may be used to detect the
18 presence of the cigarette rod in or near the rod guide and to control an
19 interlock so that power can be transmitted to the X-ray tube only during
20 the presence of a cigarette rod.

21 A silicon photodiode may be sensitive to temperature. To
22 eliminate any temperature effect, a similar second photodiode may be
23 bonded to the photodiode 126 in back-to-back arrangement, possibly
24 with an interposed layer of copper to ensure good heat conductivity and
25 to ensure that X-rays do not pass through the first photodiode (the
26 measurement photodiode) and enter the second photodiode. The
27 output from the two photodiodes can then be connected to a differential
28 electrical circuit whereby the temperature-related element of the
29 photodiode 126 signal is cancelled by an identical signal from the
30 second photodiode.

31 In addition to the back-to-back arrangement for temperature
32 compensation (or as an alternative) the temperature of the photodiode or
33 photodiodes may be controlled by a controllable cooling element
34 encapsulated with the photodiode(s). For control purposes the
35 temperature of the photodiode(s) may be detected by means of a
36 platinum or nickel resistance thermometer or a thermistor or other
37 semiconductor device bonded to the photodiode(s).

38 The photodiode 126 may be replaced by a vertical array of

1 narrower photodiodes (measured vertically) each of which thus receives
2 a portion of the beam passing through a different "slice" of the cigarette
3 rod. The control circuit may compensate for the fact that the "slices"
4 above and below the central one become progressively narrower
5 (measured in the direction of the beam) and thus absorbs less of the
6 beam. By this means, density differences in the cigarette rod at different
7 levels can be monitored. Moreover, the signal from each element of the
8 photodiode array can be monitored to detect the presence of a foreign
9 body which is more opaque to the beam than is the tobacco. Cigarettes
10 including foreign bodies detected in this way can be subsequently
11 ejected in any known manner. The advantage in this case is that a
12 relatively small foreign body lying in only one or possibly two "slices" of
13 the cigarette rod can be more reliably detected than in prior systems in
14 which the foreign body could only be detected if it had a detectable
15 effect on the total beam passing through the entire height of the cigarette
16 rod.

17 The X-ray tube may have a tungsten target, as commonly used.
18 Alternatively, the target may be of a different material, for example
19 copper, producing a lower "characteristic frequency".

20 The moisture content of the tobacco may be detected by any
21 known means to provide a compensation signal which is fed to the
22 control circuit 130.

23 The enhanced resolution of an X-ray scanning system according
24 to this invention, compared with existing nucleonic scanners, may be
25 used to detect and reject cigarettes with a low-density filling in a region
26 at which the cigarette rod is cut, either in the cigarette maker or in the
27 filter assembly machine: such cigarettes are liable to have poor quality
28 ends.

29 Figure 3 illustrates diagrammatically the scanning device 26 which
30 scans the cigarette filler stream before trimming. At this stage, the filler
31 stream 50 is carried by the band 12, as mentioned above, with the aid of
32 suction transmitted through the band 12 from a suction chamber 52.
33 Side rails 54 and 56 confine the sides of the filler stream. A line 58
34 represents the average level at which the filler stream is subsequently
35 trimmed by the trimmer 14.

36 The scanning device 26 (what may be termed a "feed-forward
37 scanner") comprises an infrared source 60 which transmits an infrared
38 beam (possibly via a group of optical fibres) horizontally through the

1 filler stream 50 and towards an infrared detector 62. The rails 54 and 56
2 have apertures for this purpose which are sealed on the inner faces of
3 the rails by transparent windows 64 and 66. It should be noted that the
4 infrared beam is transmitted through the tobacco stream at
5 approximately the level 58 at which the filler stream is subsequently
6 trimmed. Alternatively, however, the infrared beam may be transmitted
7 through the tobacco stream at a higher or lower level, or may extend
8 across the full height of the tobacco stream between the band 12 and
9 the line 58.

10 An alternative to an infrared device for feed-forward scanning
11 might be an optical device measuring simply the height of the filler
12 stream.

13 Any suitable electro-mechanical arrangement may be used for
14 controlling the position of the trimmer 14 in response to both the rapid
15 feed-forward signal from the infrared device 26 and the rod weight signal
16 received from the X-ray scanning device.

17 Figure 4 shows a different X-ray scanning device by which a
18 low-energy X-ray beam 200 from an X-ray tube (not shown) is directed
19 towards two photodiodes 202 and 204 which may in this case be
20 identical to one another. Portions 200A and 200B of the X-ray beam 200
21 are shown separately, though the beam emitted from the X-ray tube is
22 not divided.

23 The beam 200A passes through a tube 206 for guiding a cigarette
24 rod, while the beam 200B passes through a similar tube 208 containing a
25 reference beam absorption member or what may be termed a "reference
26 cigarette" (not shown) which may comprise, for example, a hollow nylon
27 tube designed to have a beam absorption characteristic similar to the
28 average for the cigarette rod. The tubes 206 and 208 have titanium
29 covered windows 206A and 208A which each have a width W (measured
30 in the direction of the cigarette rod axis) which in this example is less
31 than the cigarette diameter.

32 Each of the photodiodes 202, 204 is mounted on a
33 temperature-controlled aluminium member 210 so as to be normal to the
34 axis of the respective beam 200A or 200B. For the purpose of
35 controlling the temperature of the member 210 and hence of the
36 photodiodes, there are two heating strips 212 the power to which is
37 controlled by a temperature sensor 214 mounted in or adjacent to one
38 side of the member 210. An amplifier circuit (of any known kind) for

1 amplifying the output signals from the photodiodes is incorporated in a
2 board 216 which is mounted on the back of the member 210 so as to be
3 at a controlled temperature to ensure stability of operation of the
4 amplifier.

5 The tubes 206,208 are mounted in a stainless steel block 218
6 which has suitably inclined bores 218A,218B to allow the passage of the
7 beams 200A,200B. Extensions of the bores are provided in a member
8 220 which is secured to the block 218 and serves as a mounting for the
9 X-ray tube (not shown).

10 A ridge 210A on the member 210 serves as a barrier preventing
11 scatter of X-rays from either beam to the other photodiode.

12 The scanning device shown in Figures 4 and 5 has a vertically
13 directed X-ray beam, but its orientation may be changed so that the
14 beam is horizontal. However, for scanning the two cigarette rods in a
15 twin-track cigarette making machine a vertically directed beam is
16 appropriate. For this purpose, portions of the beam from a single X-ray
17 tube may be directed towards three photodiodes: the outer portions via
18 the two cigarette rods (assuming these are horizontally spaced) and the
19 centre portion via a reference cigarette. Alternatively, four quadrants of
20 the X-ray beam (as viewed in a cross-section through the beam) may be
21 directed towards four photodiodes two of which (e.g. opposite
22 quadrants) are associated with the two cigarette rods and the other two
23 providing reference signals for the respective cigarette rods. This
24 arrangement would ensure, if desired or necessary, that the intensities of
25 the portions of the beam directed towards the four photodiodes are
26 equal. For this purpose it is possible to use a beam cone from the X-ray
27 tube of up to 40° cone angle.

28 In both of the above-described X-ray scanning devices, the X-ray
29 tube may be a Lohmann ABE160, and may be powered by a switch
30 mode power supply, operating at 100-200 Kilocycles. The heating strips
31 214 (Figure 4) may be semiconductor devices of the type having a
32 proportional integral differential controller so as to be capable of
33 producing a variable heat output. The photodiodes may be large-area
34 PIN Silicon photodiodes, an example of which is available from Graseby
35 GK Intertest Ltd. (their part No. ST0029).

Claims:

1. A scanning device for a cigarette making machine comprising a low energy X-ray beam emitter (110) for passing an X-ray beam through the cigarette rod (116), and an X-ray detector (126;202) arranged to receive the beam after it has passed through the cigarette rod and to produce an output signal which can be amplified and fed to a control circuit (130) for the cigarette making machine.

2. A device according to claim 1 in which the beam has a wavelength of approximately 1 Angstrom.

3. A device according to claim 1, in which the beam emitter is a low-energy X-ray source powered at an energy level within the range 6 to 20 Kilovolts.

4. A device according to claim 3, in which the energy level is within the range 10 to 16 Kilovolts.

5. A device according to claim 4, in which the energy level is approximately 13 Kilovolts.

6. A device according to any preceding claim, in which the detector (125;202) is a photodiode.

7. A device according to claim 6, in which the detector is a PIN-type Silicon photodiode.

8. A device according to any preceding claim, in which the detector is mounted adjacent to a reference detector (204) having an output which is connected to the control circuit in such a way that temperature effects on the output from the reference detector tend to compensate for temperature effects on the output from the main detector, the two detectors being maintained at substantially the same temperature.

9. A device according to claim 8, in which the two detectors are mounted together in a back-to-back arrangement.

10. A device according to claim 8, in which the two detectors (202,204) are mounted side-by-side on a temperature-controlled member maintained at a substantially constant temperature.

11. A device according to claim 10, including a temperature detector (214) for detecting the temperature of the temperature controlled member (210), and means (212) for cooling or heating the temperature-controlled member in response to the temperature signal from the temperature detector in order to achieve the substantially constant temperature.

12. A device according to claim 10 or claim 11, in which different parts (200A,200B) of the beam emitted by the X-ray beam emitter are directed towards the respective detectors (202,204) and including a reference beam absorption member through which the part of the beam directed towards the reference detector is arranged to pass.

13. A device according to any one of claims 10 to 12, in which the amplifier (216) for the output signal from the or each detector is mounted on the temperature-controlled member (210) so that its temperature is also maintained substantially constant.

14. A device according to any preceding claim, in which the control circuit (130) is arranged to control the trimming of the cigarette filler stream before it is enclosed in a wrapper to form a continuous cigarette rod, and in which trimming is also controlled in response to a signal from a second X-ray device or an infrared or other scanning device (26) arranged to scan the filler stream (50) before trimming takes place.

15. A device according to any preceding claim for use in a cigarette making machine producing two parallel cigarette rods, in which parts of the beam from a single X-ray beam emitter are arranged to pass through the respective rods.

16. A device according to claim 15 in which each of four quadrants of the X-ray beam, as viewed in a cross-section through the beam, is directed either towards an X-ray detector via one of the two

1 cigarette rods, or towards an X-ray detector serving to provide a
2 reference signal in association with the detector for one of the cigarette
3 rods.

4
5 17. A device according to claim 1 and substantially in
6 accordance with any one of the examples described with reference to
7 the accompanying drawings.

Fig.1.

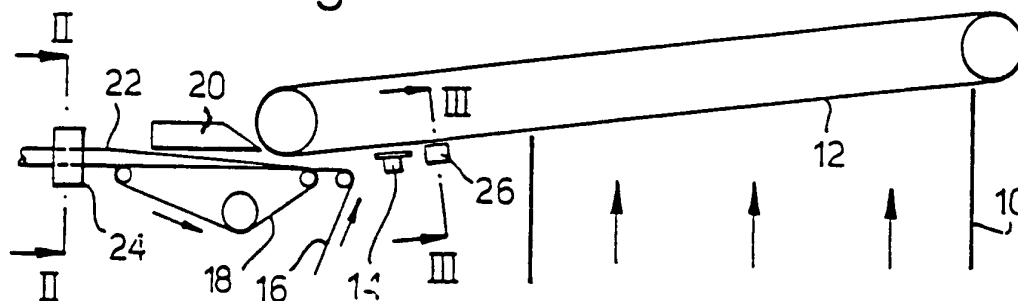


Fig.2.

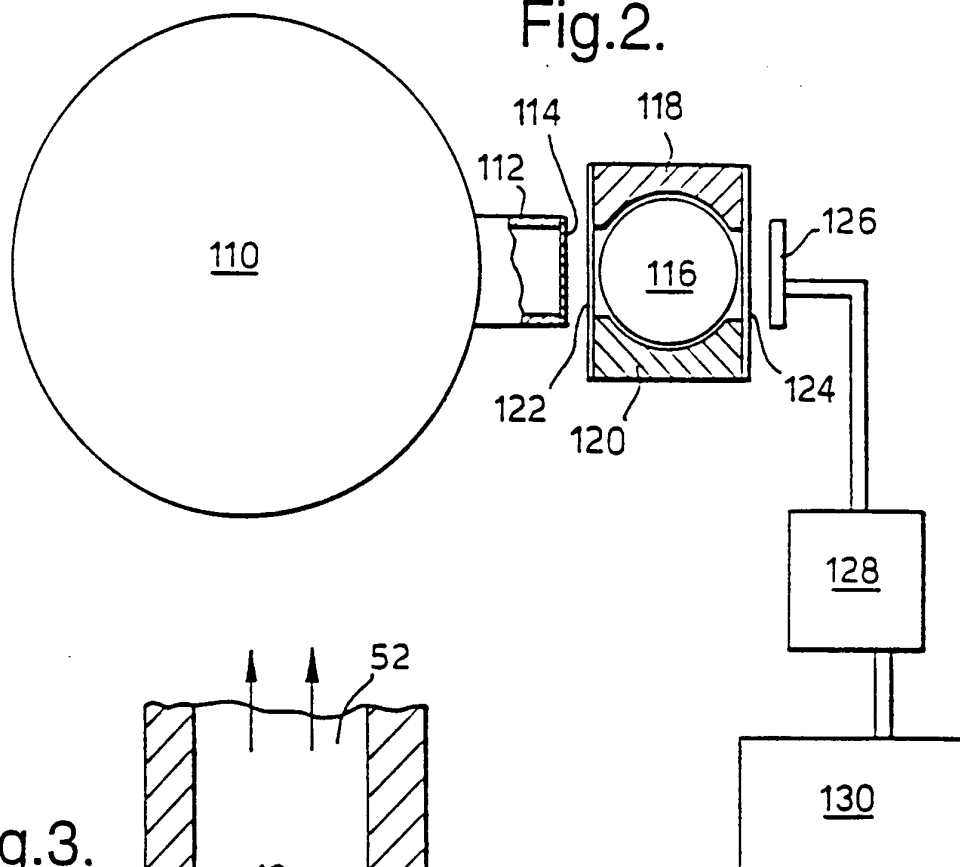
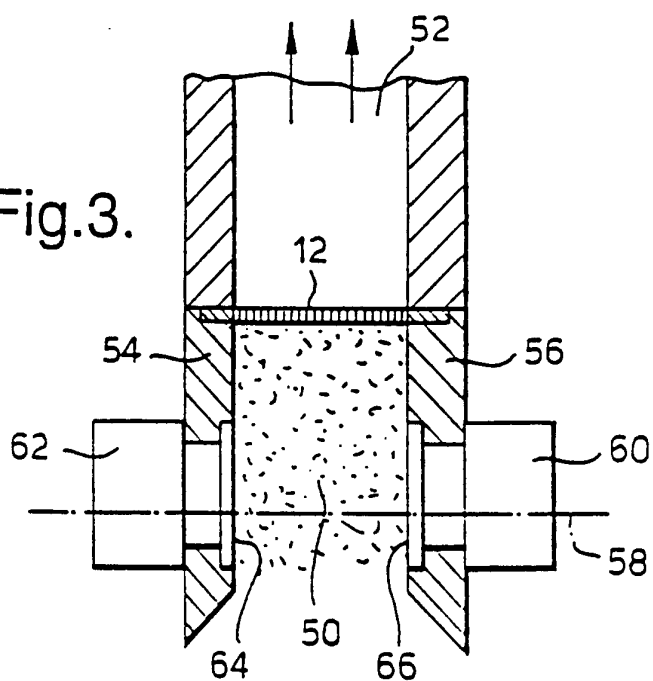


Fig.3.



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Fig.4.

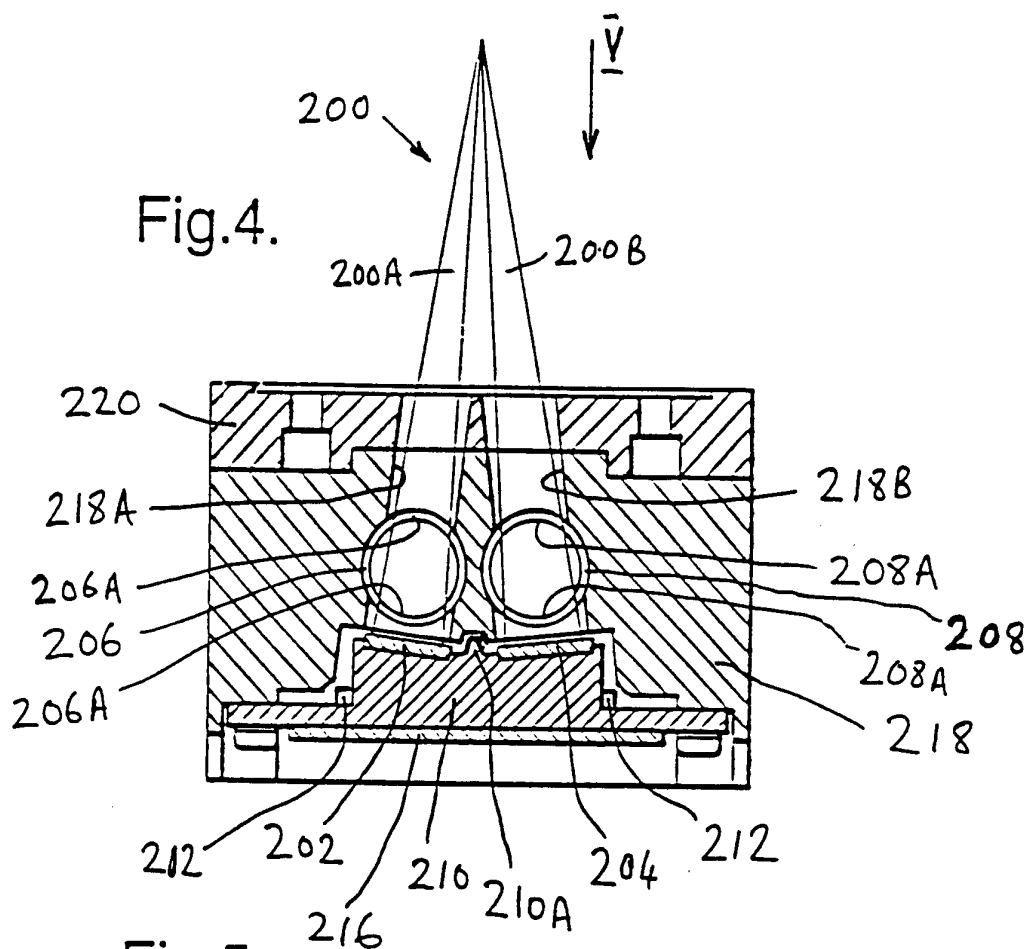
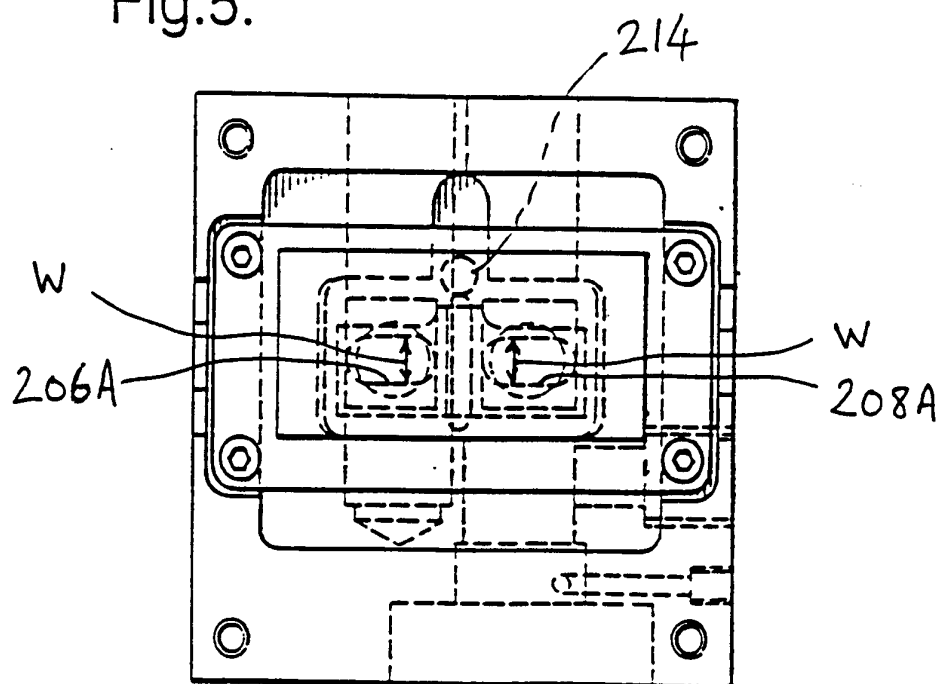


Fig.5.



INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 95/01142

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A24C5/34

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 A24C G01N

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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB,A,2 133 965 (HAUNI-WERKE KORBER) 8 August 1984 see page 4, line 25 - page 7, line 73; figures 1-5 ---	1,3,4,14
A	GB,A,2 182 836 (HAUNI-WERKE KORBER) 28 May 1987 see page 6, line 33 - page 7, line 30; figures 1-3 ---	1,14
A	US,A,3 056 026 (BIGELOW) 25 September 1962 see the whole document ---	1,3-5,8, 12
A	US,A,3 095 091 (BLUNT) 25 June 1963 ---	
A	US,A,3 089 497 (MOLINS) 14 May 1963 cited in the application -----	

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 95/01142

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB-A-2133965	08-08-84	DE-A- 3400410 JP-A- 59135880 US-A- 4785830	26-07-84 04-08-84 22-11-88
GB-A-2182836	28-05-87	DE-A- 3637306 JP-A- 62118873 US-A- 4865052	14-05-87 30-05-87 12-09-89
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US-A-3095091	25-06-63	NONE	
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