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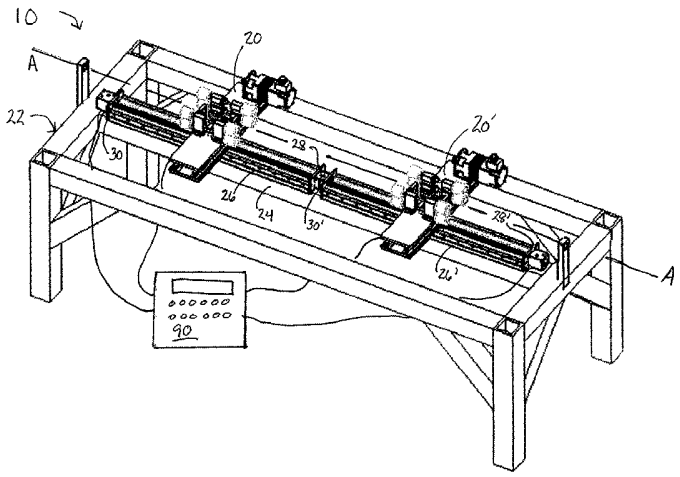

(57) Abstract: An apparatus (10) is capable of continuously advancing a tubular filter product (100, 200) through a stream of filtration media (102, 202), the tubular filter product defining a central longitudinal axis (A), the apparatus driving the tubular filter product, both linearly forward along the axis and rotationally about the axis. The apparatus includes a first shuttle assembly (20) and a second shuttle assembly (20'), each arranged for reciprocating movement along the axis (A), between a rearward home position (28, 28') and a forward return position (30, 30'). The second shuttle assembly (20') is arranged adjacently rearward of the first shuttle assembly (20) along the axis (A). Each of shuttle assemblies (20, 20') includes a first roller (58) and a second roller (58') spaced apart transversely, one on either side of the axis (A), the first and second rollers being movable toward and away from one another between an engaged and a disengaged position a roller motor (78) coupled to rotationally drive the first roller (58), an actuator (53) coupled to the first and second rollers to controllably move the first and second rollers between the engaged and disengaged positions. A first and a second drive motor (31, 31') are coupled to controllably drive the first and second shuttle assemblies (20, 20'), respectively, between their rearward home positions (28, 28') and forward return positions (30, 30') along the axis (A). An adjustable controller () is coupled to the first drive motor (31), the second drive (31') motor, and to the roller motor (78) and the actuator (53) of each of the first and second shuttle assemblies (20, 20'). In operation, one of the first and second shuttle assemblies (20, 20') is driven axially forward toward its return position (30, 30') by its drive motor (31, 31') with its first and second rollers (58, 58') in the engaged position and with its first roller (58) being rotationally driven by its roller motor (78) to, in turn, the tubular filter product both linearly through the stream of filtration media and rotationally. Meanwhile, the other shuttle assembly is driven axially rearward toward its home position (28') by its drive motor (31') with its first and second rollers (58, 58') in the disengaged position.

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ADVANCING TUBULAR FILTER PRODUCTS

TECHNICAL FIELD

This invention relates to the manufacture of filter products, and more particularly, to apparatus and methods for advancing tubular filter products or cores thereof during manufacture of filter products.

BACKGROUND

Filter products are frequently designed and/or customized with the goal of achieving optimal performance in the processing and treatment of various fluids. End users of filter products often desire subtle yet distinct changes in filtration performance that can be achieved, economically and consistently, only through use of precise and accurate manufacturing techniques.

One such filter product can be described as a cylindrical "filter cartridge," which includes a length of filtration media disposed about a hollow interior passage. In some cases, such cylindrical filter cartridges also include an internal core, which is a hollow tube that supports the filtration media.

These filter cartridges are typically made by introducing the supporting core to the filtration media, which is then wrapped, melt-blown, or otherwise disposed on the supporting core. The core typically remains with the filtration media as an integral part of the filter product. or subsequently removed leaving the filtration media disposed about the hollow interior passage. In some cases, the core is introduced in a continuous length to the filtration media, individual filter products being cut from the continuous length after the filtration media is disposed on the core. In other cases, core pieces of pre-determined length are introduced to the filtration media.

SUMMARY

In one aspect, the invention provides an apparatus for continuously advancing a tubular filter product through a stream of filtration media. The tubular filter product defines a central longitudinal axis (A) and the apparatus drives the tubular filter product, both linearly forward along the axis and rotationally about the axis. The apparatus includes a first shuttle assembly and a second shuttle assembly, each arranged for reciprocating movement along the axis (A) between a rearward home position and a forward return position. The second shuttle assembly is arranged adjacently rearward of the first shuttle assembly along the axis and each of the first and second shuttle assemblies includes a first roller and a second roller spaced apart transversely, one on either side of the axis. The first roller and the second roller are movable toward and away from one another between an engaged position and a disengaged position. Each shuttle assembly further includes a roller motor coupled to rotationally drive the first roller and an actuator coupled to at least one of the first and second rollers to controllably move them between their engaged position and their disengaged position. The apparatus further includes a first drive motor coupled to controllably drive the first shuttle assembly between its rearward home position and its forward return position along the axis and a second drive motor coupled to controllably drive the second shuttle assembly between its rearward home position and its forward return position along the axis and an adjustable controller coupled to the first drive motor, the second drive motor and the roller motor and the actuator of each of the first shuttle assembly the second shuttle assembly.

Variations of this aspect of the invention can include one or more of the following features in any combination. In operation of the apparatus, each of the first and second shuttle assemblies is driven back and forth between its respective home position and its respective return position by its respective first or second drive motor with its first roller and its second roller in the engaged position and its first roller being rotationally driven by its roller motor during at least a portion of its movement toward its return position and with its first roller and its second roller in the disengaged position during movement toward its home position. At any given time, at least one of the first and the second shuttle assemblies is moving toward its return position with its first and second rollers in their engaged position and its first roller

being rotationally driven by its roller motor. The apparatus further includes a frame having guide members to aid in guiding the filter product. At least one of the first shuttle and second shuttle assemblies further includes a guide to aid in guiding the filter product. The apparatus further includes a guide track along which at least one of the shuttle assemblies travels between its home position and its return position. The actuator is pneumatically driven. Each of the first and second drive motors is either a servo motor or a stepper motor. The first roller is one of a driven set of rollers. The second roller is one of a passive set of rollers.

The invention also includes any method of using the apparatus, including the uses of either "pushing" or "pulling" a filter product or a preformed product, such as a tubular core, that is subsequently processed to form a filter product.

In another aspect, the invention is a method of forming a filter product. The method includes continuously driving a filter core along a linear path defined by a central axis (A) of the filter core; continuously rotating the filter core about the central axis; and continuously streaming a filtration media onto the filter core to form a filter product. In the method, a linear speed and a rotational speed of the filter core are independent of one another.

Variations of this aspect of the invention can include one or more of the following features, in any combination. The steps of continuously driving and continuously rotating the filter core include contacting the filter core with a roller that is rotationally driven and driven linearly forward. The roller is part of a shuttle assembly. Two such shuttle assemblies are provided, each being moveable along the axis (A) between a home position and a return position, the method including repeatedly moving each of the two shuttle assemblies between its home position and its return position with the roller of each of the shuttle assemblies in contact with the filter core during at least a portion of its movement toward the return position and free of contact with the filter core during movement toward the home position. At any given time, at least one of the first and second shuttle assemblies is moving toward its return position with its roller being rotationally driven and in contact with the filter core. Each of said first and second shuttle assemblies is moved toward its home position faster than it is moved toward its return position. The filtration media includes melt blown fibers. The rotational speed of the filter core remains constant.

The linear speed of said filter core remains constant. The filter core includes multiple filter core pieces joined together.

The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF DRAWINGS

Fig. 1 illustrates, isometrically, an apparatus of the invention for advancing a tubular filter product.

Figs. 1A and 1B are side and top views, respectively, of the apparatus of Fig. 1.

Fig. 2 illustrates, isometrically, a shuttle assembly of the apparatus of Fig. 1.

Figs. 2A, 2B and 2C are top, front and side views, respectively, of the shuttle assembly of Fig. 2.

Fig. 3 is a schematic illustration of a method of using the apparatus of Fig. 1 to advance a filter product during manufacture.

Fig. 3A is a schematic illustration of an embodiment of a filter core for use with the apparatus of Fig. 1.

Fig. 4 is a schematic illustration of another method of using the apparatus of Fig. 1 to advance a filter product during manufacture.

Like reference symbols in the various drawings indicate like elements.

DETAILED DESCRIPTION

Referring to Figs. 1, 1A and 1B, an apparatus 10 for advancing a tubular filter product (discussed in detail below) includes two substantially identical shuttle assemblies 20, 20' mounted adjacent to one another on a frame 22. Frame 22 includes two horizontal cross members 25, 25' located at opposite longitudinal ends of the frame with a center member 24 extending therebetween. Attached to extend upwardly from a central portion of each cross member 25, 25' is a guide member 27, 27'. An aperture 29, 29' is defined by each guide member 27, 27', the apertures being aligned with one another to define the axis A of manufacture of the filter product.

Each shuttle assembly 20, 20' is slidably disposed on a guide track 26, 26', each guide track, in turn, being attached to center member 24 of frame 22. Shuttle assemblies 20, 20' are slidably mounted for fore and aft movement (direction of arrows B-B) between opposite, first 28, 28' and second 30, 30' longitudinal ends of their respective guide tracks 26, 26' along the axis A of manufacture of the filter product. The first 28, 28' and second 30, 30' longitudinal ends of guide tracks 26, 26' thus serve as home and return positions, respectively, for shuttle assemblies 20, 20'. Shuttle assemblies 20, 20' are each driven between their home 28, 28' and return 30, 30' positions by drive motors, 31, 31', respectively. In one example, drive motors 31, 31' are stepper or servo type motors selected to be capable of moving their respective shuttle assemblies 20, 20' at a linear rate of 10 to 40 inches (25 to 102 cm) per minute.

Because shuttle assemblies 20, 20' are substantially identical, the structure of only shuttle assembly 20 is hereinafter described in detail. Referring now also to Figs. 2, 2A, 2B and 2C, shuttle assembly 20 includes two identical filter product guides 68 affixed to and extending upwardly from a base plate 50. One guide 68 is positioned on each longitudinal end of base plate 52 and each guide 68 defines an aperture 70. The size of apertures 70 is typically selected based on the size of the filter product (or internal filter core) to be advanced by apparatus 10 in the manufacturing process, which is further discussed below. Guides 68 are mounted on plate 50 so that the centers of apertures 70 are aligned to define an axis A'. A pair of tongue rails 74 (Fig. 2C) are also affixed to and extending upwardly from base plate 50. Two slideable plates 52, 52' having attached, downwardly extending groove rails 76 are coupled to base plate 50 by engagement of tongue rails 74 with groove rails 76. Slideable plates 52, 52' are arranged laterally adjacent one another and are slideable toward and away from one another (i.e., toward and away from axis A') along tongue rails 74. A pneumatically driven actuator 53 (Fig. 2C), e.g. an air driven cylinder/piston arrangement, is provided on base plate 50 between slideable plates 52, 52' for driving the slideable plates toward one another and into an engaged position, and also for driving the slideable plates away from one another and into a disengaged position.

A driven set 54 of four rollers 58 is mounted on and extends upwardly from slideable plate 52 and a passive set 56 of four rollers 58' is mounted on and extends

upwardly from adjacent slideable plate 52'. Sets 54, 56 are arranged on their respective slideable plates 52, 52' to oppose one another, one set on either side of axis A'. Furthermore, each set is coupled to move laterally (direction of arrows C-C) toward and away from axis A', between an engaged and a disengaged position, in conjunction with any sliding movement of its respective slideable plate 52, 52'. While rollers 58, 58' can be of any material, in one example they have a polyurethane outer surface that is either smooth or ribbed to provide the desired friction with a tubular filter product to be advanced (as further described below).

The four rollers 58, 58' of each set 54, 56 are mounted in pairs, one pair atop the other, the rollers being attached, one each, on the opposite, longitudinal ends 62, 64 of identical axles 60. Each axle 60 is supported by two bearing mounts 72 to extend substantially parallel to axis A'. Each axle 60 of driven set 54 of rollers 58 is equipped with a gear 80 located on a central portion of the axle, the two gears 80 being aligned one atop the other. A roller motor 78, e.g., an electric motor, is mounted to slideable plate 52 and positioned so that driven set 54 of rollers 58 is located between motor 78 and axis A'. A rotationally driven shaft 79 of the motor is aligned parallel to axles 60 of driven set 54, the shaft having an attached gear 82 that is aligned with gears 80 of axles 60 of driven set 54 of rollers 58. A timing belt (not shown), chain, or other linkage engages gears 80 and gear 82 so that driven rotation of motor shaft 79 results in driven rotation of axles 60, and, in turn, rollers 58, of driven set 54. In one example, roller motor 78 is selected to be capable of rotating rollers 58 at a speed of 50 to 500 rotations per minute.

An adjustable controller 90 is electrically coupled to actuators 53 and roller motors 78 of each shuttle assembly 20, 20' and to linear drive motors 31, 31'. Controller 90 is generally programmable and acts to coordinate the speed and movements of each of the above-described movable components of apparatus 10 in a predetermined manner. Controller 90 can carry out any combination of such movements, including, for example, those described below with particular reference to Figs. 3 and 4.

Referring now also to Fig. 3, in one mode of operation, Apparatus 10 is positioned longitudinally adjacent a filtration media emitting apparatus 101, which emits a stream of filtration media, for example, melt blown fibers 102 for forming a filter product 100. A tubular filter core 104 is positioned within apertures 29, 29' of guide members 27, 27' of frame 22 and also within apertures 70 of guides 68 on each of shuttle assemblies 20, 20'. The sets 54, 56 of rollers 58, 58' of one of the shuttle assemblies 20, 20', e.g., shuttle assembly 20', are moved to their engaged position, i.e., slideable plates 52, 52' of shuttle assembly 20' are slid toward one another by actuator 53 so that rollers 58, 58' of shuttle assembly 20' contact filter core 104. Roller motor 78 of the shuttle assembly 20' is activated to drive rollers 58, which, by way of friction, cause filter core 104 to likewise rotate. Simultaneously, shuttle assembly 20' is driven forward, i.e., toward its return position 30', by its linear drive motor 31' so that rollers 58, 58' act to frictionally (preferably static friction) drive filter core 104 forward (direction of arrow M in Fig. 3) and through the stream of melt blown fibers 102. The speed of rotation and the speed of linear travel of core 104 are independently adjusted to allow a predetermined amount of fibers 102 to collect on the core to produce filter product 100 having the desired filtration properties.

Meanwhile, the sets 54, 56 of rollers 58, 58' of the other shuttle assembly, e.g., shuttle assembly 20, are separated from one another in their disengaged position, i.e., slideable plates 52, 52' of shuttle assembly 20 have been slid away from one another by actuator 53 so that rollers 58, 58' of shuttle assembly 20 do not contact filter core 104. Shuttle assembly 20 is driven rearward, i.e., toward its home position 28, by its linear drive motor 31. Notably, shuttle assembly 20 is driven rearward to its home position 28 faster than shuttle assembly 20' is driven forward toward its return position 30' so that shuttle assembly 20 reaches its home position 28 while shuttle assembly 20' is still moving forward toward its return position 30 and is still driving core 104.

After reaching its home position 28 (and, in many embodiments, after also waiting in home position 28 for a predetermined amount of time or until a signal generated based upon the position of shuttle assembly 20'is received by controller 90), shuttle assembly 20 is initially driven forward, toward its return position 30, with its sets 54, 56 of rollers 58, 58' in their disengaged position, i.e., rollers 58, 58' are not

acting upon core 104 during initial forward movement of shuttle assembly 20. However, once shuttle assembly 20 reaches approximately the same forward speed as shuttle assembly 20' (which continues to move toward its return position 30'), the sets 54, 56 of rollers 58, 58' are moved to their engaged position so that rollers 58, 58' of shuttle assembly 20 contact filter core 104. At this point, the sets 54, 56 of rollers 58, 58' of both shuttle assemblies 20, 20' are acting upon filter core 104 and driving the core linearly forward and rotationally.

When shuttle assembly 20' reaches its return position 30', its sets 54, 56 of rollers 58, 58' are moved to their disengaged position so that the rollers 58, 58' of shuttle assembly 20' are no longer in contact with filter core 104, while shuttle assembly 20 continues to move forward toward its return position 30 with its sets 54, 56 of rollers 58, 58' now acting alone to contact and drive filter core 104 rotationally and linearly forward. Shuttle assembly 20' is then moved rearward along axis A to its home position 28', whereupon it is controlled (by controller 90) to begin forward movement toward its return position and engage core 104 with its rollers 58, 58' in substantially the same manner as that described immediately above with respect to shuttle assembly 20.

This cycle of movements by shuttle assemblies 20, 20' is continuously repeated and, in this manner, filter core 104 is continuously driven, both linearly and rotationally, e.g., at a constant rate, through stream of melt blown fibers 102 to continuously and, if desired, consistently produce filter product 100. Filter product 100 is subsequently further processed by e.g., cutting filter product 100, as with cutter 110 illustrated in Fig. 3, into individual pieces or otherwise removing portions of filter product 100 to form individual filters, e.g., filter cartridge 112.

Referring now also to Fig. 3A, while the filter core 104 advanced in the process described immediately above is a continuous unitary body or, for example, it is a continuous body of joined pieces 104A that are attached contiguously to form filter core 104'. Attachment can be by the insertion of an intermediate member 105 between (and/or within the central openings of) adjacent pieces 104A. Alternatively, adjacent pieces 104A are joined by any form of welding, adhesive, or any other means for achieving a continuous body that can be advanced by apparatus 10.

Referring now to Fig. 4, in another mode of operation, apparatus 10 is positioned to "pull" tubular filter product 200 from (i.e., "through") a stream of melt blown fibers 202 emitted by melt blown fiber emitting apparatus 201. In this arrangement, shuttle assemblies 20, 20' again operate in the reciprocating manner described above with reference to Fig. 3, but apertures 29, 29' and 70 of guides 27, 27' and 68 are sized to accept and guide the formed filter product 200. Tubular filter product 200 can be formed on a core in a manner similar to previously described filter product 100, or filter product 200 can be continuously formed on a rotating mandrel 203 that remains otherwise stationary, i.e., the mandrel does not move in a linear direction. In the case of the latter example, apparatus 10 acts to continuously "pull" filter product 200 off rotating mandrel 203, and if desired, apparatus 10 can aid in this removal process by rotating filter product 200 at a different speed (or even a different direction) than the rotation of the mandrel. As with filter product 100, discussed above, formed filter product 200 can be cut, as at cutting station 110, to form individual filters such as filter 212 illustrated in Fig. 4.

In any use of apparatus 10, including any of the particular uses described above, the rotational speed of rollers 58 (and thus the rotational speed at which filter core 104 or filter product 200) of shuttle assemblies 20, 20' can be varied entirely independently of the speed at which shuttles 20, 20' are driven linearly forward (and thus the speed at which filter core 104 or filter product 200 are driven linearly forward). This independence of rotational speed from linear speed provides great flexibility in the manufacture and design of filter products because slight adjustments can be made to either speed independently of the other to adjust the properties of the resulting filters as desired.

Although a limited number of examples of the apparatus and methods of the invention have been described in detail above, any number of variations will be recognized by those of ordinary skill in the art and the breadth of the invention should in no way be limited beyond the terms set out in the following claims.

WHAT IS CLAIMED IS:

1. An apparatus (10) for continuously advancing a tubular filter product (100, 200) through a stream of filtration media (102, 202), the tubular filter product defining a central longitudinal axis (A), the apparatus driving the tubular filter product, both linearly forward along the axis and rotationally about the axis, the apparatus comprising:

a first shuttle assembly (20) and a second shuttle assembly (20'), each arranged for reciprocating movement along the axis (A), between a rearward home position (28, 28') and a forward return position (30, 30'), said second shuttle assembly (20') being arranged adjacently rearward of said first shuttle assembly (20) along the axis (A), each of said first shuttle assembly (20) and said second shuttle assembly (20') comprising:

a first roller (58) and a second roller (58') spaced apart transversely, one on either side of the axis (A), the first roller and the second roller being movable toward and away from one another between an engaged position and a disengaged position;

a roller motor (78) coupled to rotationally drive said first roller (58); and

an actuator (53) coupled to at least one of said first roller and said second roller to controllably move said at least one of said first and said second roller between said engaged position and said disengaged position;

a first drive motor (31) coupled to controllably drive the first shuttle assembly (20) between said rearward home position (28) and said forward return position (30) along the axis (A);

a second drive motor (31') coupled to controllably drive the second shuttle assembly (20') between said rearward home position (28') and said forward return position (30') along the axis (A); and

an adjustable controller (90) coupled to the first drive motor (31), the second drive (31') motor and the roller motor (78) and the actuator (53) of each of said first shuttle assembly (20) and said second shuttle assembly (20').

2. The apparatus (10) of claim 1, wherein, in operation, each of said first shuttle assembly (20) and said second shuttle assembly (20') is driven back and forth

between its home position (28, 28') and its return position (30, 30') by its one of said first drive motor (31) and said second drive motor (31') with said first roller (58) and said second roller (58') in the engaged position and said first roller (58) being rotationally driven by said roller motor (78) during at least a portion of its movement toward its return position (30, 30') and with said first roller (58) and said second roller (58') in the disengaged position during movement toward said home position (28, 28'), and wherein, at any given time, at least one of said first shuttle assembly (20) and said second shuttle assembly (20') is moving toward its return position (30, 30') with its first roller (58) and its second roller (58') in the engaged position and said first roller (58) being rotationally driven by said roller motor (78).

3. The apparatus (10) of any of the foregoing claims, further including a frame (22) having guide members (27, 27') to aid in guiding the filter product (100, 200).

4. The apparatus (10) of any of the foregoing claims, wherein at least one of said first shuttle assembly (20) and said second shuttle assembly (20') further includes a guide (68) to aid in guiding the filter product (100, 200).

5. The apparatus (10) of any of the foregoing claims further comprising a guide track (26, 26') along which at least one of the shuttle assemblies (20, 20') travels between its home position (28, 28') and its return position (30, 30').

6. The apparatus (10) of any of the foregoing claims wherein said actuator (53) is pneumatically driven.

7. The apparatus (10) of any of the foregoing claims wherein each of said first drive motor (31) and said second drive motor (31') is one of a servo motor and a stepper motor.

8. The apparatus (10) of any of the foregoing claims wherein the first roller (58) is one of a driven set (54) of rollers.

9. The apparatus (10) of any of the foregoing claims wherein the second roller (58') is one of a passive set (56) of rollers.

10. A method of forming a filter product comprising:

continuously driving a filter core along a linear path defined by a central axis (A) of the filter core (104);

continuously rotating the filter core about the central axis;

continuously streaming a filtration media (102, 202) onto the filter core (104) to form a filter product (100, 200),

wherein a linear speed and a rotational speed of the filter core are independent of one another.

11. The method of claim 10, wherein said steps of continuously driving and continuously rotating the filter core (104) include contacting the filter core with a roller (58) that is rotationally driven and driven linearly forward.

12. The method of claim 11, wherein said roller (58) is part of a shuttle assembly (20, 20').

13. The method of claim 12, wherein two of said shuttle assemblies (20, 20') are provided, each being moveable along said axis (A) between a home position (28, 28') and a return position (30, 30'), the method including oscillating each of said two shuttle assemblies between its home position (28, 28') and its return position (28') with said roller (58) of each of said fist shuttle assembly (20) and said second shuttle assembly (20') being rotationally driven and in contact with the filter core (102) during at least a portion of its movement toward said return position (30, 30') and free of contact with said filter core (102) during movement toward said home position (28, 28').

14. The method of claim 13, wherein, at any given time, at least one of said first shuttle assembly (20) and said second shuttle assembly (20') is moving toward its return position with its roller (58) being rotationally driven and in contact with the filter core (102).

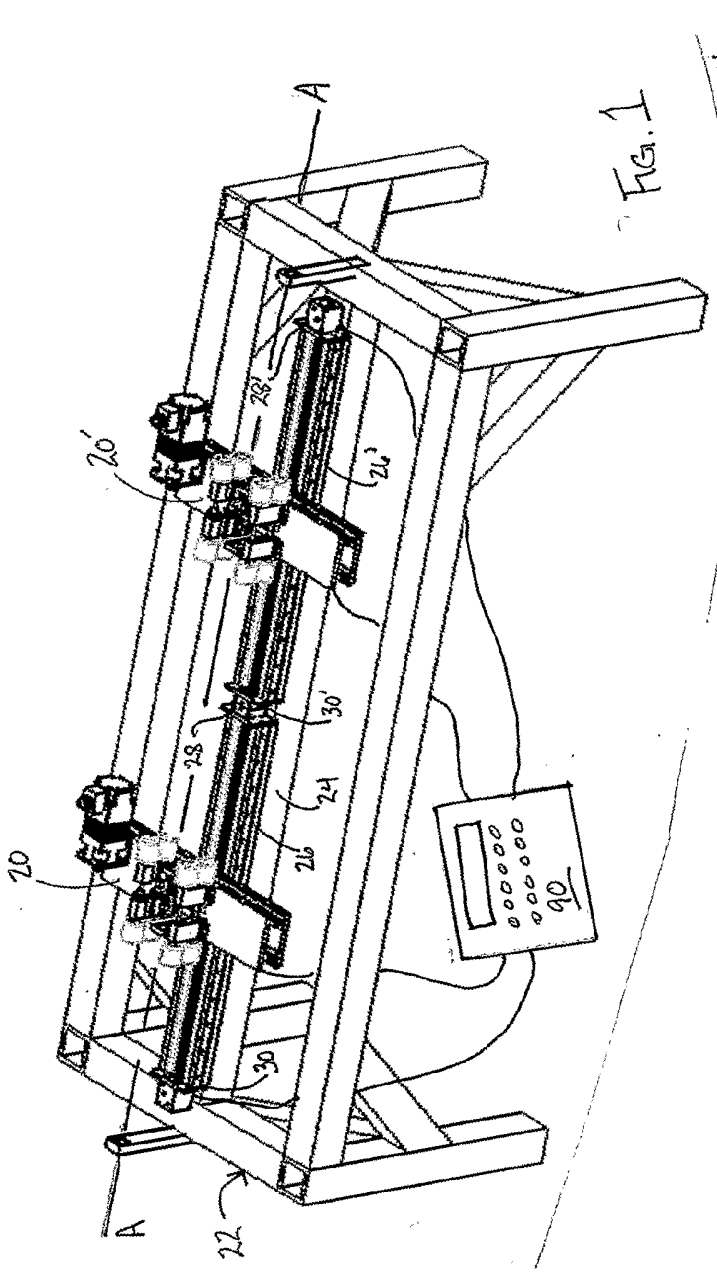
15. The method of claim 13 or 14, wherein each of said first shuttle assembly (20) and said second shuttle assembly (20') is moved toward its home position (28, 28') faster than it is moved toward its return position (30, 30').

16. The method of any of claims 10-15, wherein said filtration media (102, 202) includes melt blown fibers.

17. The method of any of claims 10-16, wherein the rotational speed of said filter core (104) remains constant.

18. The method of any of claims 10-17, wherein the linear speed of said filter core (104) remains constant.

19. The method of any of claims 10-18, wherein the filter core (104') comprises multiple filter core pieces (104A) joined together.


A
20'
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26
20
30
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22
90

FIG. 1

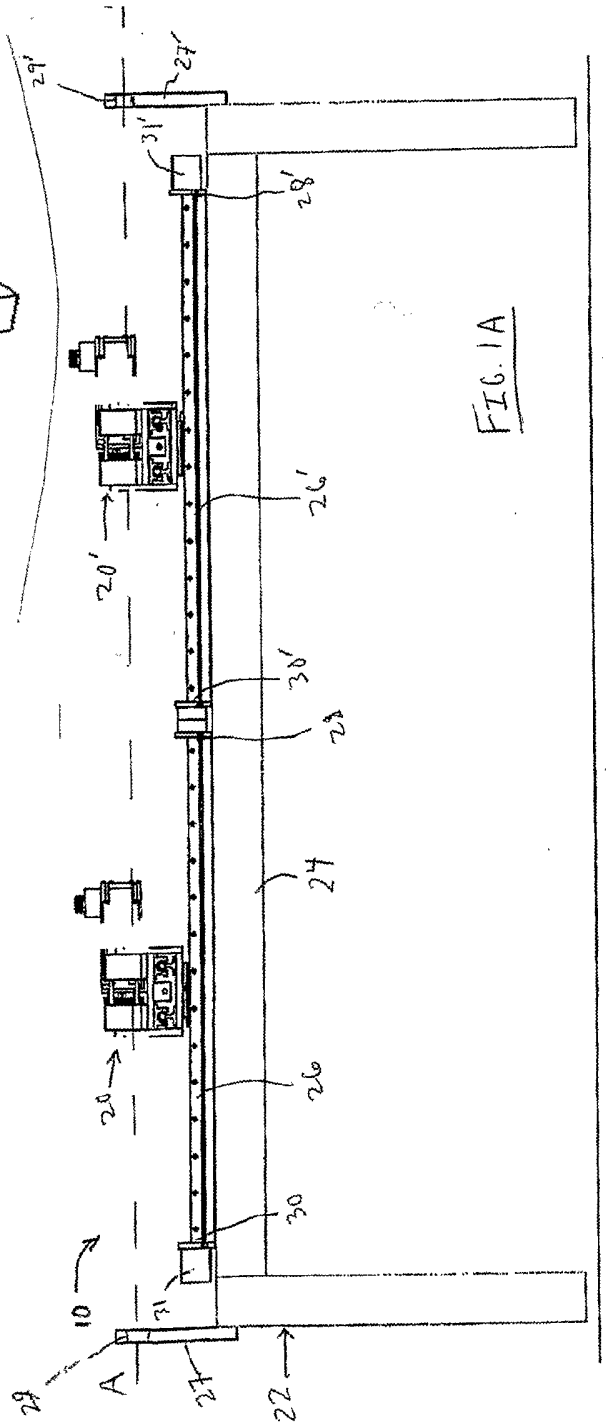
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FIG. 1A

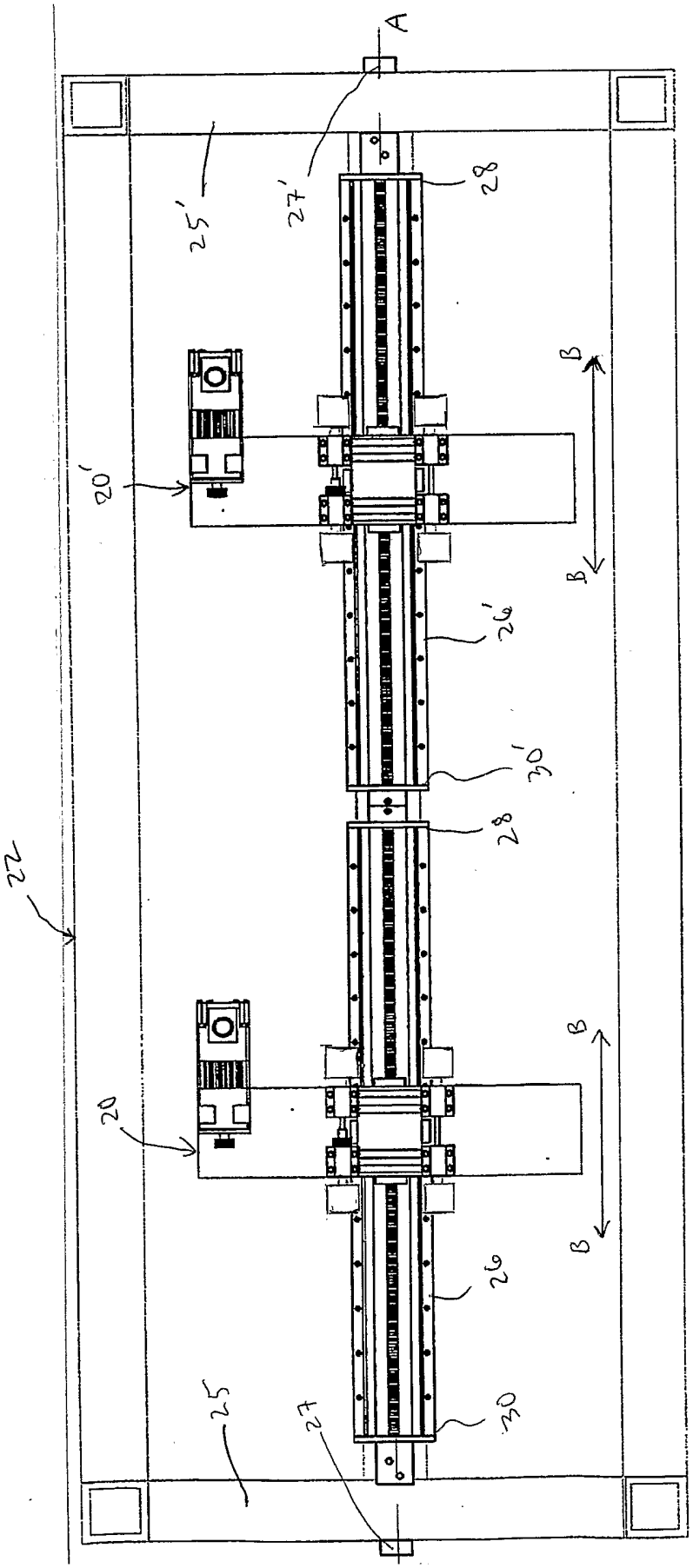


FIG. 1B

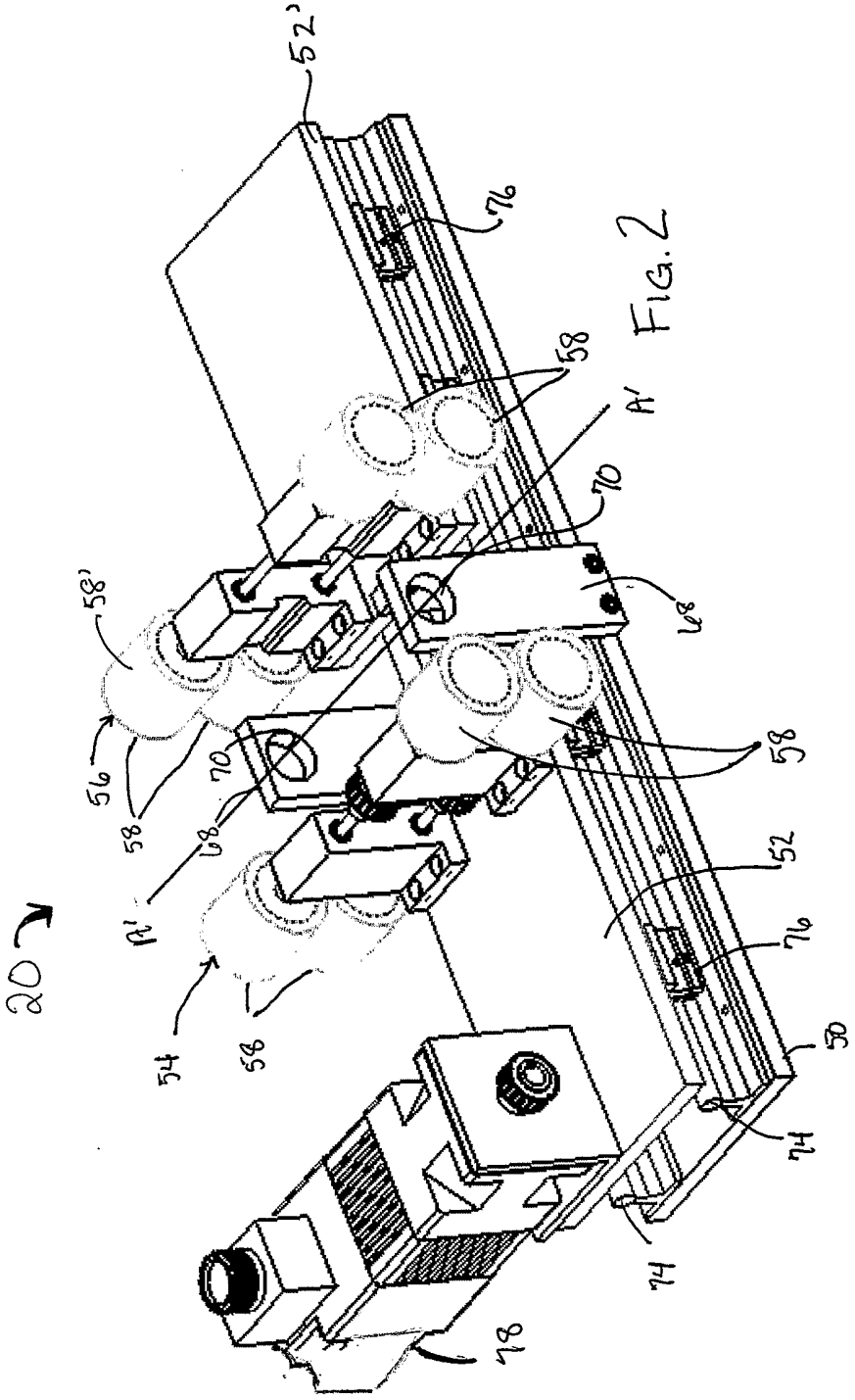
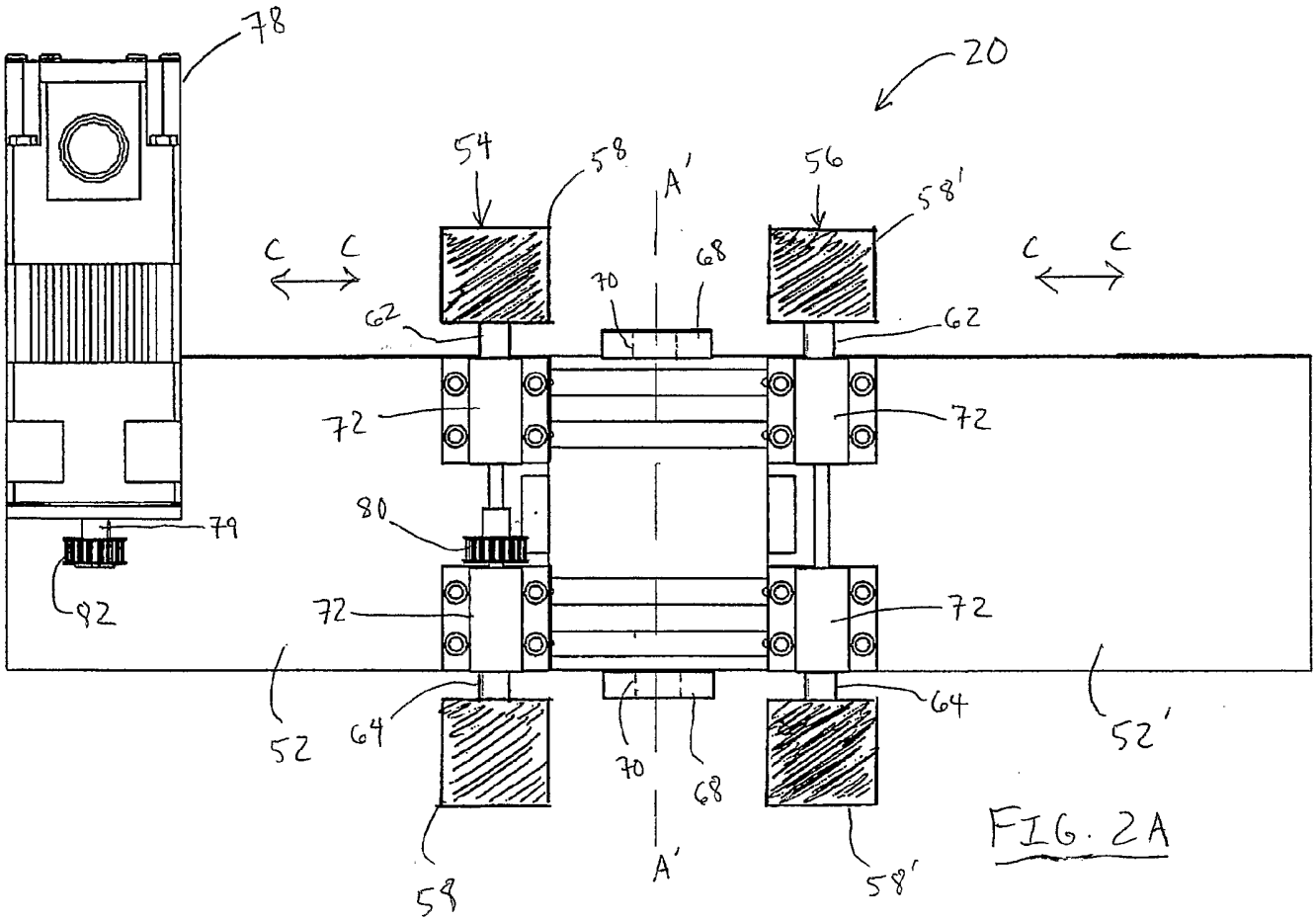


FIG. 2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72
64
64
52
52'
70
68
A'
59
58'

FIG. 2A

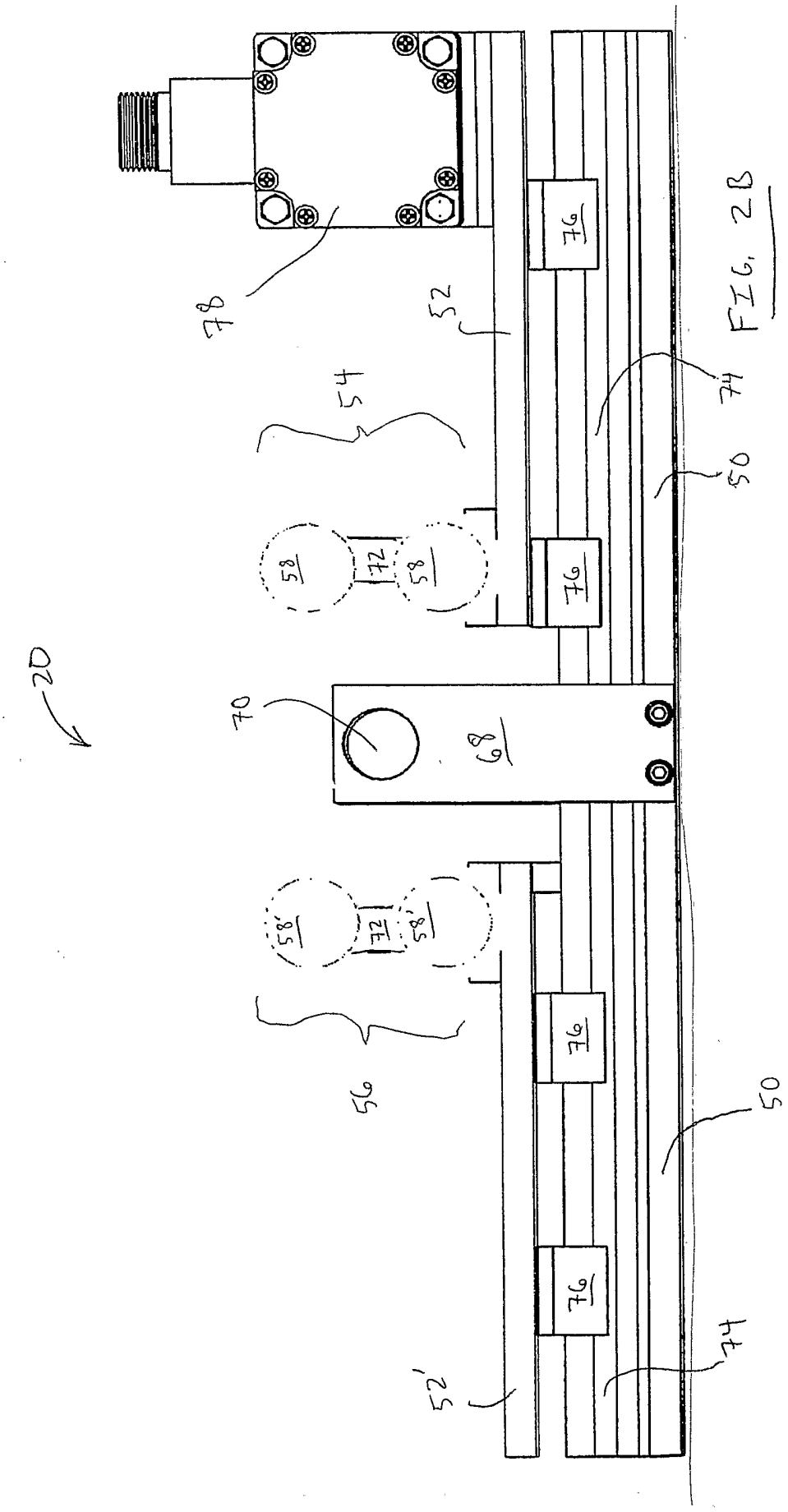

FIG. 2B

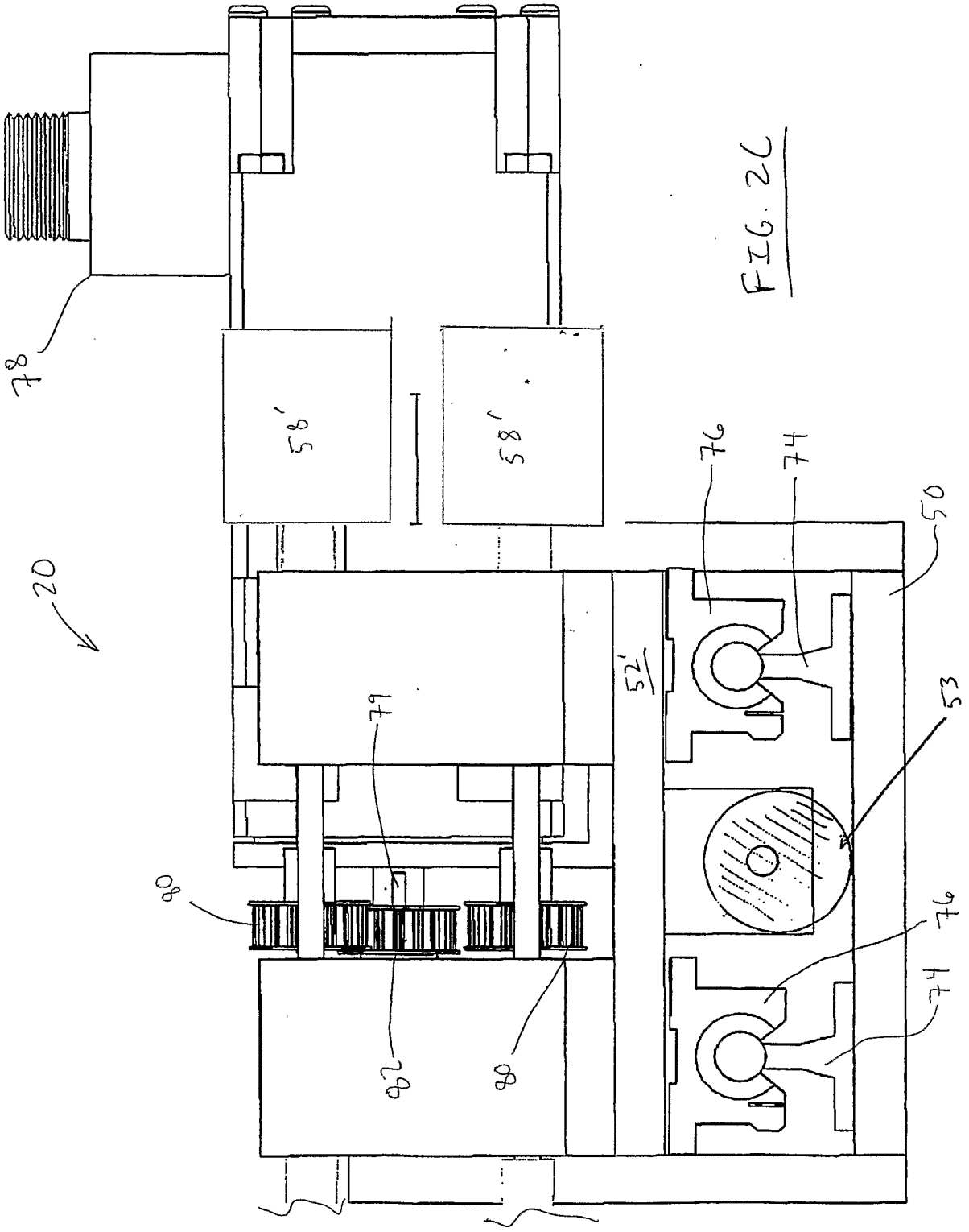

FIG. 2C

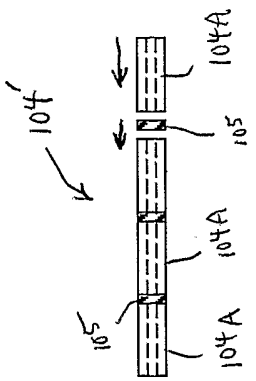

FIG. 3A

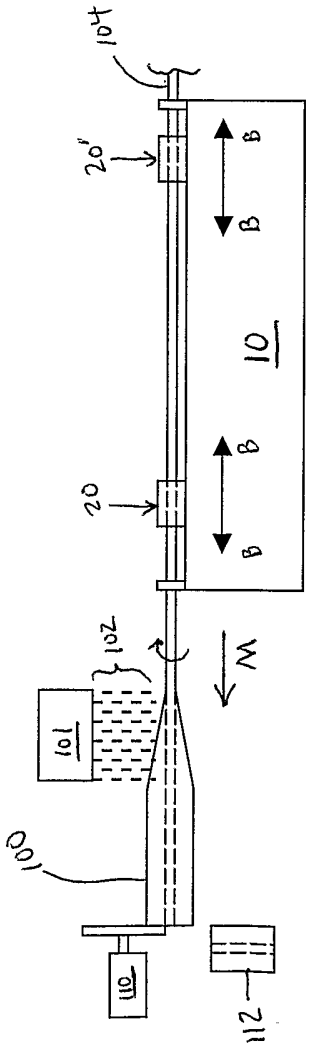

FIG. 3

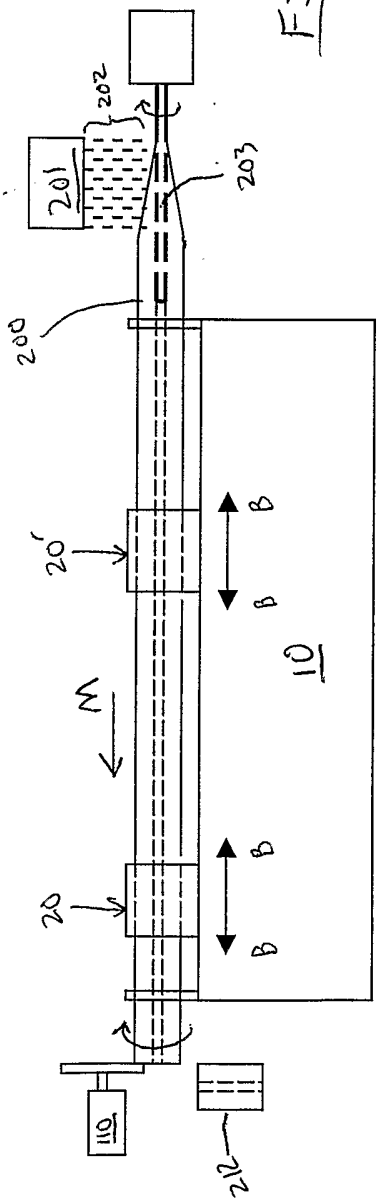

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 02/18139

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : B01D 27/02, 29/13,29/48; B32B 1/10
US CL : 156/167,172,433,446,448-449,456

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)
U.S. : 156/167,172,433,446,448-449,456

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 practicable, search terms used)
Please See Continuation Sheet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 4,116,738 A (PALL) 26 September 1978, see the whole document.	10-11 --- 12
A --- X	US 6,342,283 B1 (MOZELACK ET AL) 29 January 2002, see the whole document.	1-3 & 13-15 --- 10-12
A	US 4,847,125 A (SCHWARZ) 11 June 1989, see the whole document.	1-3 and 10-15
A	US 5,366,576 A (CLACK) 22 November 1994, see the whole document.	1-3 and 10-15
A	US 5,591,335 A (BARBOZA ET AL) 07 January 1997, see the whole document.	1-3 and 10-15

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent 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

Date of the actual completion of the international search	Date of mailing of the international search report
24 August 2002 (24.08.2002)	01 OCT 2002
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230	Authorized officer Michael W Ball Telephone No. (703) 308-0651

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US02/18139

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

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

1. ☐ Claim Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim 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. ☒ Claim Nos.: 4-9 and 16-19
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:
Please See Continuation 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.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 01/18139

BOX II. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claim(s) 1-9, drawn to an apparatus for advancing a tubular filter product.

Group II, claim(s) 10-19, drawn to a method of forming a filter product.

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:
As noted above, the 1st group is directed to an apparatus for advancing a tubular filter product, while the 2nd group is directed to a method of forming a filter product. This provides a prima facie evidence that, they lack corresponding special technical feature. In any event, even assuming there is a common technical feature between these two groups, they do not relate to a single general concept, because claim 10 is either anticipated by or obvious over the teachings of, for example, Pall (see figures 1 and 4). Accordingly, the special technical feature linking (if any) these two groups does not provide a contribution over the prior art. Therefore, the holding that these groups do not relate to a single general inventive concept is proper.

Continuation of B. FIELDS SEARCHED Item 3:
EAST
search terms: filter, melt-blowing