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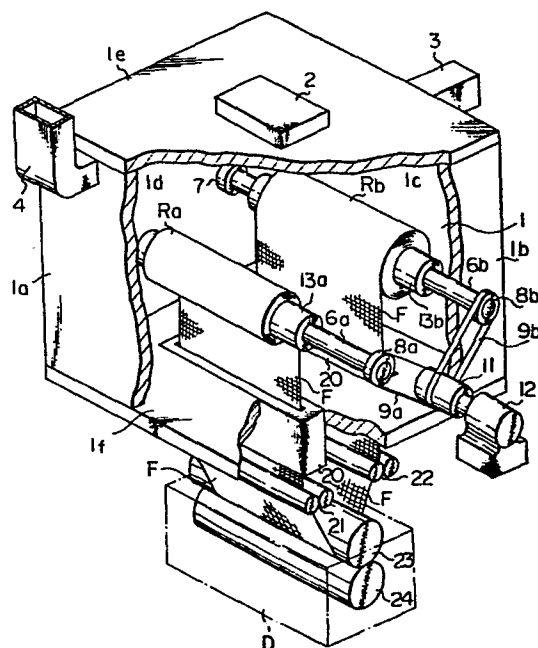
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54 **Improved method and apparatus for treatment of textile sheet material by application of microwaves.**

57 Within a confined chamber (1) replete with saturated or overheated steam, a textile sheet material (F) such as a woven cloth is continuously transferred from one roll (Ra) to another roll (Rb) and vice versa under concurrent emanation of microwaves for uniform treatment over entire length and thickness. The textile sheet material (F) may be subjected to dyeing or other aqueous treatment during the transfer.

Fig. 3



IMPROVED METHOD AND APPARATUS FOR TREATMENT OF TEXTILE SHEET MATERIAL BY APPLICATION OF MICROWAVES

BACKGROUND OF THE INVENTION

5 The present invention relates to an improved method and apparatus for treatment of textile sheet material by application of microwaves, and more particularly to improvements in treatment of a textile sheet material such as a woven cloth within an atmosphere
10 replete with saturated or overheated steam under emanation of microwaves for obtaining a uniform treatment effect over the entire length and thickness of the textile sheet material.

 Fixation and development of dyes on a textile sheet
15 material such as a woven cloth have since a long time been carried out by placing the textile sheet material in an atmosphere impregnated with steam.

 As a substitute for such a steam process, it has already been proposed to subject a wet textile sheet
20 material to emanation of microwaves. Here, the term "microwaves" refers to electro-magnetic waves having frequencies in a range from 300 to 30,000 MHz.

 Microwaves involve a wide variety of advantages in particular when used for treatment of a wet textile
25 sheet material. Firstly, microwaves permeate into the textile sheet material extremely quickly, heating it within a very short time. Secondly, due to heat generation caused by dielectric loss, microwaves can be selectively absorbed in an object with large dielectric
30 losses, thereby heating only requisite sections of the object. There will be no heating of unnecessary sections of the object, thereby avoiding waste of thermal energy. Thirdly, the object exposed to microwaves generates heat itself, which raises the temperature of the ambient
35 atmosphere. As a consequence, the amount of thermal

energy otherwise necessary for heating the ambient atmosphere can be greatly reduced. Fourthly, since microwaves cause an almost simultaneous temperature rise at different sections of the object exposed there-
5 to, regional variations in temperature within the object can be significantly minimized, thereby enabling optimal and uniform heating of the object. Finally, adjustment of the output voltage for microwaves enables simple and easy control of heating conditions in accordance with requirements in actual treatment.
10

Exposing a textile sheet material to irradiation of microwaves causes ionic conduction and dipole rotation of the fibers composing the material and of the water and/or agents contained in the material. This
15 contributes to a rapid and uniform heating of the textile sheet material.

A wide variety of systems have been proposed in order to utilize microwaves in practical treatment of textile sheet materials, but only a few of them have
20 proven to be conventionally feasible in industrial scale.

One reason for this difficulty is the manner of microwave emanation. Various emanation methods in general used for this emanation are roughly classified into
25 three major types, i.e. the use of an emanator with a hairpin curved wave guide, the use of an emanator with a densely hairpin curved wave guide, and an open-type emanator.

In case the emanator is equipped with a wave guide,
30 the wave length of the microwaves emanated wields a great influence upon the heating effect and, consequently, the textile sheet material is liable to undergo uneven heating caused by possible variations in the wave length. As a consequence, the emanators of this type
35 are quite unsuitable for treatment of wet textile sheet

materials which usually require a highly uniform heating effect.

In case an open-type emanator is used which includes a metallic hexadral emanation chamber, it is
5 strongly required to use means for equalizing the intensity of the magnetic field surrounding the material placed in the chamber. Otherwise, emanators of this type are quite unsuitable for use in industrial scale although they may operate in laboratory tests.

10 Another reason for the difficulty in utilization of microwaves is the risk of fusing the fibers composing a textile sheet material by heating it by means of microwaves. This causes serious problems in particular when the textile sheet material is composed of thermo-
15 plastic synthetic fibers, such as acrylic fibers. Such fusion of the fibers is caused by presence of water and high boiling point agents in the textile sheet material after scouring and finishing. For example, when a textile sheet material is made of acrylic fibers, swelling
20 of the fibers starts at a temperature very close to 100°C and, regardless of the dielectric constant, this swelling causes corresponding dipole rotation in the fibers. This dipole rotation results in abrupt evacuation of water, temperature rise and eventual fusion of
25 the fibers composing the material. In order to obviate such fusion of the fibers, evacuation of water contained in the fibers has to be prevented at least during treatment by microwaves.

The other reason to the difficulties involved in
30 practical use of microwaves is the control of the above-described evacuation of water contained in the fibers. To obtain such control, it has been proposed to clamp a textile sheet material between a pair of running conveyor belts or to place it on a running wet sheet
35 during transportation through the microwave emanation

zone. In either case, there is a risk that any contamination on the belts or the sheet may be taken over by the textile sheet material and this seriously degrades the commercial value of the end product.

5 In order to remove said difficulty, it has already been proposed in US Patent Application Ser. No. 107,790 (filed on 28th December, 1979) and EPC Patent Application No. 79850116.9 to place a textile sheet material in the form of a roll within a confined chamber replete with saturated or overheated steam and
10 rotate the roll under concurrent emanation of microwaves.

This new system removed most disadvantages of the conventional treatment by microwaves. However, since
15 the textile sheet material is exposed to the steam and microwaves in a roll form, there is a significant difference in treatment effect between the section of the textile sheet material close to the core of the roll and the section of the textile sheet material
20 close to the periphery of the roll. As a consequence, one cannot expect a uniform treatment effect over the entire length and thickness of the textile sheet material.

25 SUMMARY OF THE INVENTION

It is the object of the present invention to apply a treatment by microwave emanation to a textile sheet material with highly uniform treatment effect over the entire length and thickness of the material.

30 In accordance with the present invention, a pair of rolls of a textile sheet material are placed within a confined chamber filled with saturated or overheated steam and, by rotating the rolls, the textile sheet is continually transferred from one roll to another and
35 vice versa under concurrent emanation of microwaves.

During the transfer, the textile sheet material may undergo any aqueous treatment with agent such as dyeing.

BRIEF DESCRIPTION OF THE DRAWINGS

5 Of the drawings:

FIG. 1 is a partially sectional perspective view of a confined chamber for treatment of textile sheet material according to the invention;

10 FIG. 2 is a partially sectional perspective view of a modified embodiment of the invention;

FIG. 3 is a partially sectional perspective view illustrating an embodiment wherein the textile sheet is subjected to a dyeing process in addition to the treatment by microwaves;

15 FIG. 4 is a partially sectional perspective view illustrating a modification of the embodiment of Fig. 3; and

FIG. 5 is a sectional view of a shelter assembly, arranged to prevent leakage of steam and microwaves from the confined chamber into the dye bath below said chamber.

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DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the following description, elements of the apparatus substantially same in construction and function are designated with common reference symbols.

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The first embodiment of the apparatus in accordance with the present invention is shown in Fig. 1, in which a confined chamber 1 for treatment of a textile sheet material F is composed of four side walls 1a to 1d, a ceiling 1e and a floor 1f. Though not shown in the drawing, a door is formed in one of the side walls 1a to 1d for enabling transportation of the sheet material F into and out of the confined chamber 1.

30

35 A microwave emanator 2 internally equipped with a

microwave generator is mounted to the ceiling 1e having its emanation terminal opening into the confined chamber 1. Alternatively, the microwave emanator 2 may be connected to a separate microwave generator by a suitable connection. Preferably, the microwave emanator 2 should be located at the central part of the ceiling 1e for uniform application of the microwaves.

A supply duct 3 for saturated or overheated steam is attached, opening into the confined chamber 1 in order to keep the confined chamber 1 replete with such steam. Used steam is discharged through an exhaust duct 4 opening into the confined chamber 1. For uniform distribution of the steam within the confined chamber 1, these ducts 3 and 4 should preferably open into the confined chamber 1 through the opposite side walls 1a and 1c or 1b and 1d.

A pair of parallel shafts 6a and 6b, being adequately spaced from each other, are arranged within the confined chamber 1. The shafts 6a and 6b are rotatably supported by associated bearings mounted to the side walls. In the drawing, only one bearing 7 mounted to the side wall 1d is illustrated. One end of the shaft 6a extends outside the confined chamber 1 through the associated side wall 1b and fixedly carries a pulley 8a. Likewise, the exposed end of the shaft 6b fixedly carries a pulley 8b. The pulleys 8a and 8b are operationally coupled, by means of belts 9a and 9b, to a pulley 11 fixed on the output shaft of a reversible drive motor 12 arranged outside the confined chamber 1. The drive motor 12, however, may also be arranged within the confined chamber 1. Further, the pulley-belt coupling may be replaced by a suitable sprocket-chain coupling.

Cores 13a and 13b are mounted on the shafts 6a and 6b for formation of rolls Ra and Rb of the textile sheet

material F thereon, respectively, and rotate with the associated shafts 6a and 6b.

According to the most simple embodiment, the cores 13a and 13b are fixedly inserted over the associated shafts 6a and 6b. In this case, the textile sheet material F has to be introduced into the confined chamber 1 in sheet form and wound on to one of the cores 13a and 13b to form a roll Ra or Rb before starting the treatment. Likewise, when the treatment of the textile sheet material F is over, it must be delivered out of the confined chamber 1 in sheet form from one of the rolls Ra or Rb.

According to a preferred embodiment, the cores 13a and 13b are releasably coupled to the associated shafts 6a and 6b by means of chucking mechanisms which provisionally locks outer ends of the cores 13a and 13b to the inner ends of the associated shafts 6a and 6b, each shaft consisting of a pair of separate coaxial shaft sections. In this case, the textile sheet material F can be introduced, before starting the treatment, into the confined chamber 1 in the form of the roll Ra or Rb wound the core 13a or 13b, which is then locked to the shaft 6a or 6b by the chucking mechanism. Likewise, when the treatment is over, the textile sheet material F can be delivered out of the confined chamber 1 in the form of the roll Ra or Rb,

Either system can be freely chosen depending on the requirement in practical processing.

In the illustrated embodiment, parallel running is employed for the pulleys 9a and 9b and, consequently, the shafts 6a and 6b are driven for rotation in the same direction. So, when the shafts 6a and 6b rotate in the clockwise direction in the drawing, the textile sheet material F is delivered from the left side roll Ra and wound on the right side roll Rb, whereas, when the

shafts 6a and 6b rotate in the counterclockwise direction, the textile sheet material F is delivered from the right side roll Rb and wound on the left side roll Ra.

5 As a consequence, the outermost layer of the material in the one roll at its largest diameter becomes, after transfer of the material to the other roll, the innermost layer of the material in the other roll at its largest diameter. Here, winding of the textile material F is carried out in a manner such that
10 the surface side of the textile sheet material F in the one roll remote from the axis of the one shaft is also remote, in the other roll, from the axis of the other shaft. Since the confined chamber 1 is replete with
15 saturated or overheated steam and microwaves are emanated at least during the transfer of the textile sheet material F between the rolls Ra and Rb, the textile sheet material F is exposed to and treated with the steam and the microwaves quite uniformly over its entire
20 length.

Transfer of the textile sheet material F between the rolls Ra and Rb may be carried out twice or more times depending on the requirements in the practical processing.

25 The second embodiment of the apparatus in accordance with the present invention is shown in Fig. 2, in which arrangements of the elements are almost same as in the first embodiment except for the arrangement of the belts 9a and 9b. In this case, cross running is
30 employed for the pulleys 9a and 9b and, consequently, the shafts 6a and 6b are driven for rotation in opposite directions. So, when the shaft 6a rotates in the clockwise direction, the shaft 6b rotates in the counterclockwise direction in order to wind up the textile sheet material F on its associated roll Rb,
35

whereas, when the shaft 6b rotates in the clockwise direction, the shaft 6a rotates in the counterclockwise direction in order to wind up the textile sheet material F on its associated roll Ra.

5 This embodiment differs from the first embodiment in that, in winding of the textile sheet material F, the surface side of the textile sheet material F remote from the axis of the shaft of the first roll, on the other roll is close to the axis of the other shaft.
10 Thus, in addition to the longitudinal uniformity, the textile sheet material is treated with the steam and the microwaves quite uniformly over its entire thickness.

 The third embodiment of the apparatus in accordance
15 with the present invention is shown in Fig. 3, in which the manner of winding up the textile sheet material F is same as that in the first embodiment shown in Fig. 1. That is, the surface side of the textile sheet material F on the one roll remote from the axis
20 of the one shaft is also remote, in the other roll, from the axis of the other shaft. This embodiment, however, differs from the first embodiment in that the textile sheet material F is subjected to dyeing or other aqueous treatment with agent during the transfer
25 between the rolls Ra and Rb.

 In the embodiment illustrated in Fig. 3, a dye bath D is located below the floor 1f of the confined chamber 1 and, in order to block leakage of the steam and the microwaves from the confined chamber 1,
30 shelter assemblies 20 are arranged through the floor 1f at positions below the rolls Ra and Rb.

 The construction of the shelter assembly 20 is shown in detail in Fig. 5, in which the shelter assembly 20 includes a thick housing 201, a ventilation duct
35 202 opening into the space defined by the housing 201,

and a perforated cover 203 closing the opening of the duct 202 for blocking leakage of electric waves through the duct 202. The top of the space is covered by an adjustable slit plate 204 providing a passage for the textile sheet material. By adjusting the slit plate 204, the size of the passage can be changed freely in accordance with the processing conditions. A block filter 206 is arranged vertically within the space below the slit plate 204. The block filter 206 includes a plurality of electric wave damping elements 206a aligned in a vertical direction and facing the travelling path of the textile sheet material F. The block filter 206 further includes an electric wave absorber 206b vertically extending on the opposite side of the above-described travelling path.

The extremely small size of the passage provided by the slit plate 204 well blocks leakage of the steam and the microwaves out of the confined chamber 1 whilst allowing free passing of the textile sheet material F. Even when the microwaves leak through the passage, they are almost fully enfeebled during their travel through the block filter 206. Preferably, a water reservoir 207 is arranged in the space below the lower terminal of the block filter 206 in order to absorb microwaves possibly surviving even after the travel through the block filter 206.

Reverting to the arrangement shown in Fig. 3, guide rollers 21 and 22 are arranged below the shelter assemblies 20 and immersion rollers 23 and 24 are arranged in the dye bath D, both in known manners.

When the shafts 6a and 6b rotate in the clockwise direction in the drawing, the textile sheet material F is delivered from the roll Ra on the left side shaft 6a, through the shelter assembly 20 and the guide rollers 21 towards the dye bath D whilst being treated

with the steam and the microwaves in the confined chamber 1, further through the guide rollers 22 and the shelter assembly 20 after immersion in the dye bath D whilst being again treated with the steam and microwaves in the confined chamber 1, and wound up on the roll Rb on the right side shaft 6b.

The fourth embodiment of the apparatus in accordance with the present invention is shown in Fig. 4, in which the manner of winding up the textile sheet material F is the same as in the second embodiment shown in Fig. 2. That is, the surface side of the textile sheet material F in the one roll remote from the axis of the one shaft is, on the other roll, close to the axis of the other shaft. Like the third embodiment, the textile sheet material undergoes dyeing or other aqueous treatment with agent during the transfer between the rolls Ra and Rb. In the case of the illustrated construction, a dye bath D is arranged below the floor 1f of the confined chamber 1.

When the left side shaft 6a rotates in the clockwise direction and the right side shaft 6b in the counterclockwise direction, the textile sheet material F is delivered from the roll Ra on the left side shaft 6a, through the shelter assembly 20 and the guide rollers 21 towards the dye bath D whilst being treated with the steam and the microwaves in the confined chamber 1, further through the guide rollers 22 and the shelter assembly 20 after immersion in the dye bath D whilst being again treated with the steam and the microwaves in the confined chamber 1, and wound up on the roll Rb on the right side shaft 6b.

Example.

Using the apparatus shown in Fig. 4, textile sheet materials of various kinds were treated and dyed in accordance with the present invention under various

process conditions shown in the following table.

As a result of the experiments, it was confirmed that there was no substantial difference in colour effect along the entire length of each textile sheet
5 material. It was further confirmed that, even when a very thick textile sheet material was processed, there was no substantial difference in colour effect along the overall thickness of the sheet material.

Sample No.	Unit weight of the sheet material in g/m ²	Temperature in the confined chamber in C°	Type of the colour**	Length of the sheet material in m.	Traveling speed of the sheet material in m/min	Number of transfer	Number of immersion into the dye bath	Power of the micro-waves at 2450 MHz in KW	Kind of fibers*
1	120	95	I	1600	100	1	1	10	C
2	350	100	I	800	40	1	2	10	C
3	120	100	II	1600	100	1	1	10	C
4	120	100	III	1600	100	1	2	8	C
5	120	90	IV	1600	100	1	2	8	A
6	350	100	II	800	40	1	2	10	R
7	300	100	V	1000	600	2	2	8	W
8	120	130	VI	1600	100	1	1	10	PE
9	300	130	VI	800	100	2	2	10	PE

* C; Cotton fiber

A; Acryl fiber

R; Rayon fiber

W; Wool fiber

PE; Polyester fiber

** I; Direct colour

II; Reactive colour

III; Pad colour

IV; Cation colour

V; Acid colour

VI; Dispersion colour

CLAIMS

1. Improved method for treatment of a textile sheet material by application of microwaves comprising placing one roll of said textile sheet material wound on a first rotary core within a confined chamber replete with saturated or overheated steam, delivering said textile sheet material from said one roll on said first rotary core in order to wind up on another roll on a second rotary core, delivering said textile sheet material from said another roll on said second rotary core in order to wind up on said one roll on said first rotary core, transfer of said textile sheet material between said rolls being repeated at least twice, and emanating microwaves into said confined chamber at least during said transfer of said textile sheet material.
2. Improved method according to claim 1 in which winding-up of said textile sheet material on said rolls is carried out in a manner such that the surface side of said textile sheet material in said one roll remote from the axis of said first rotary core is also remote, in said another roll, from the axis of said second rotary core.
3. Improved method according to claim 1 in which winding-up of said textile sheet material on said rolls is carried out in a manner such that the surface side of said textile sheet material in said one roll remote from the axis of said first rotary core is close, in said another roll, to the axis of said second rotary core.
4. Improved method according to any of the preceding claims in which said textile sheet material is subjected, at least once, to dyeing during said transfer between said rolls.

5. Improved method according to claim 4 in which said dyeing is carried out outside said confined chamber.

6. Improved apparatus for treatment of a textile
5 sheet material by application of microwaves comprising
a housing (1) defining a confined chamber,
a pair of mutually spaced and parallel shafts
(6a, 6b) arranged within said confined chamber and adapted for winding up said textile sheet material in a
10 roll form,
driving means (8a, 8b, 9a, 9b, 11, 12), for winding up said textile sheet material, driving said shafts
(6a, 6b) for simultaneous axial rotation alternately in reverse directions,
15 at least one emanator (2) of said microwaves attached to said housing, opening into said confined chamber, and
means (3, 4) for making said confined chamber replete with saturated or overheated steam.
- 20 7. Improved apparatus according to claim 6 in which
said shafts (6a, 6b) being driven by said driving means for simultaneous rotation in a same direction.
8. Improved apparatus according to claim 6 in
25 which
said shafts (6a, 6b) being driven by said driving means for simultaneous rotation in different directions.
9. Improved apparatus according to one of claims 6 to 8 further comprising
30 a dye bath (D) arranged outside said confined chamber,
means (21, 22) for guiding said textile sheet through said dye bath during its transfer between rolls on said shafts, and
35 shelter assemblies (20) mounted to said housing

along the courses of said textile sheet material to and from said dye bath and adapted for blocking leakage of said microwaves and steams out of said confined chamber.

10. Improved apparatus according to claim 9 in
5 which each said shelter (20) assembly includes

thick walls (201) defining a space outside said confined chamber through which said textile sheet material travels,

an adjustable split plate (204) arranged at the
10 junction between said space and said confined chamber, allowing free passage of said textile sheet material into and out of said space, and

a microwave block filter (206) arranged within said space through which said textile sheet material
15 travels.

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AMENDED CLAIMS

CLAIMS

1. Method for treatment of a textile sheet material (F) within a confined chamber (1) replete with saturated or overheated steam under concurrent emanation of microwaves, characterized by
- 5 placing one roll (Ra) of the textile sheet material (F) wound on a first rotary core (13a) in the confined chamber (1),
- 10 delivering the textile sheet material from the one roll on the first rotary core in order to wind up same on the other roll (Rb) on a second rotary core (13b), and
- 15 delivering the textile sheet material from the other roll on the second rotary core in order to wind up same back on the one roll on the first rotary core, transfer of the textile sheet material (F) between the rolls (Ra, Rb) being repeated at least twice.

Fig. 4

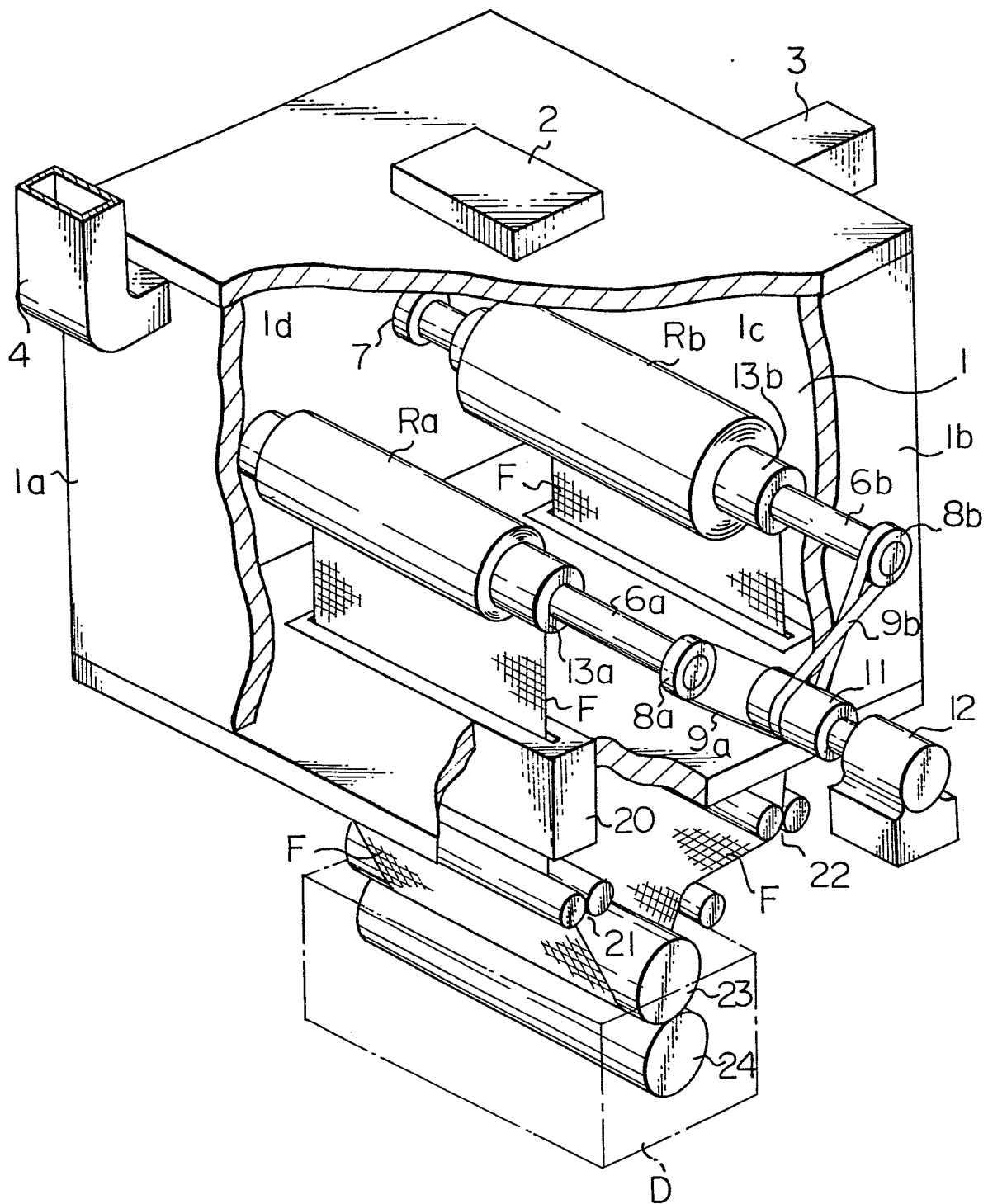
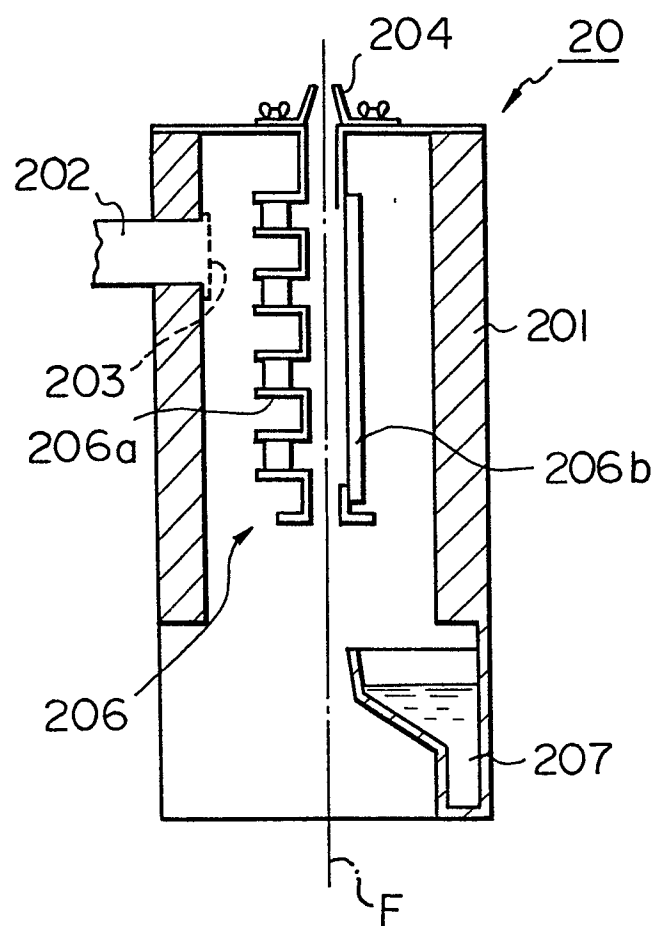


Fig. 5



European Patent
Office

EUROPEAN SEARCH REPORT

0063203

Application number

EP 81 85 0071

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
ED	<u>EP - A - 0 031 862</u> (THE ICHIKIN) * Whole document *	1,6	D 06 B 19/00
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A	<u>EP - A - 0 003 684</u> (DAWSON)		
A	<u>EP - A - 0 016 563</u> (WOOL DEVELOPMENT)		
A	<u>GB - A - 1 124 787</u> (WOLSEY)		
A	<u>FR - A - 1 344 538</u> (CIBA)		
A	<u>GB - A - 1 156 638</u> (BENZ)		
A	<u>US - A - 3 477 073</u> (UNITED PIECE DYE WORKS) ----		
			TECHNICAL FIELDS SEARCHED (Int. Cl.)
			D 06 B D 06 P F 26 B
			CATEGORY OF CITED DOCUMENTS
			X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
			&: member of the same patent family, corresponding document
☒ The present search report has been drawn up for all claims			
Place of search	Date of completion of the search	Examiner	
The Hague	10-12-1981	PETIT	