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⑤④ **Improved method and apparatus for aftertreatment of a printed textile sheet by application of microwaves.**

⑤⑦ A printed textile sheet (F) is passed through a confined chamber (C) whilst being entrained on a flexible carrier belt (B) of given moisture content and temperature for contact with steam and exposure to microwaves. Combined steam wetting and microwave heating assure uniform and ideal colour fixation and development with a highly simplified construction and efficient utilization of thermal energy produced by microwave emanation.

EP 0 065 058 A1

IMPROVED METHOD AND APPARATUS FOR AFTERTREATMENT OF A PRINTED TEXTILE SHEET BY APPLICATION OF MICROWAVES

BACKGROUND OF THE INVENTION

5 The present invention relates to an improved method
and apparatus for aftertreatment of a printed textile
sheet by application of microwaves, and more particular-
ly to improvements in continual aftertreatment of a
printed textile sheet under emanation of microwaves
10 for obtaining a uniform and ideal colour fixation and
development.

 Colour fixation and development on a textile sheet
has since a long time been carried out by firstly pass-
ing the textile sheet through a dryer and, thereafter,
15 subjecting it to steam heating.

 For aftertreatment of a dyed textile sheet in
general, it has already been proposed to subject the
dyed textile sheet in wet state to emanation of micro-
waves. Here the term "microwaves" refers to electro-
20 -magnetic waves having frequencies in a range from 300
to 30,000 MHz.

 Microwaves have a wide variety of advantages in par-
ticular when used for treatment of a wet textile sheet.
Firstly, they permeate into and heat the textile sheet
very swiftly. Secondly, they can be selectively absorbed
25 in an object with large dielectric loss, thereby heat-
ing only requisite sections of the object, since their
heat generation is caused by dielectric loss. There is
almost no heating of unnecessary sections of the object,
30 thereby well avoiding waste of thermal energy generated
by microwave emanation. Thirdly, when an object is ex-
posed to microwaves, the object also generates heat by
itself and such heat naturally raises the temperature
of the ambient atmosphere. As a consequence, the amount
35 of the thermal energy otherwise needed for heating the

ambient atmosphere for the treatment can be greatly reduced. Fourthly, microwaves usually cause almost simultaneous temperature rise at different sections of an object exposed thereto. As a consequence, regional variations in temperature within the object can be significantly minimized and this leads to ideal and uniform heating of the object. Finally, heating conditions can easily and swiftly be controlled in accordance with demands in the actual treatment merely by adjusting the output voltage for microwave generation.

Exposing a textile sheet material to emanation of microwaves causes ionic conduction and dipole rotation of the fibrous materials composing the textile sheet, and of water and aqueous agents contained in the textile sheet. This is believed to result in swift and uniform heating of the textile sheet exposed to microwaves.

Based on recognition of these advantages, various systems have been proposed in the field of textile treatment. One example of such proposals is disclosed in US Patent Application Ser. No. 107,790 (EPC Patent Application No. 79850116.9) filed by the inventor (applicant) of the present invention on 28th December, 1979. In this proposed system, a textile sheet in the form of a roll is placed within a confined chamber replete with saturated or overheated steam, and rotated under concurrent emanation of microwaves.

This proposed system well makes use of the advantages inherent to microwaves. However, since the textile sheet in this system is exposed to steam and microwaves in the form of a roll, there is a significant difference in treatment effect between the section of the textile sheet close to the core of the roll and the section close to the periphery of the roll, since steam and microwaves both have easier access to the peripheral

sections of the roll. As a consequence, one cannot expect uniform treatment effect over the entire length of the textile sheet.

5 In order to remove this disadvantage, a more dynamic system has also been proposed by the inventor of the present invention. In accordance with this dynamic system, a pair of rolls of a textile sheet are placed within a confined chamber replete with saturated or overheated steam, and the textile sheet is continually
10 transferred from one roll to another and vice versa under concurrent emanation of microwaves.

This improved system well solves the uniformity problem. However, since the textile sheet has to be kept, even provisionally, within the confined chamber
15 during the treatment, this system is applicable to the so-called batch process only. In other words, this system is quite unsuitable for any continuous textile process in which a textile sheet has to be continually transferred from station to station.

20 In addition, when a printed textile sheet is subjected to any aftertreatment, it is preferred that at least the printed surface of the textile sheet should stay out of any contact with other objects such as guide rollers until colour fixation and development are finalized. From this point of view, it is rather undesirable
25 to prepare the textile sheet in a roll form before emanation of microwaves.

SUMMARY OF THE INVENTION

30 It is one object of the present invention to apply an aftertreatment by microwave emanation, as a part of a continuous textile process, to a printed textile sheet with highly uniform colour fixation and development.

It is another object of the present invention to
35 carry out an aftertreatment by microwave emanation of

a printed textile sheet without any contact of the printed surface with other objects such as guide rollers.

It is the other object of the present invention to streamline the aftertreatment of a printed textile sheet
5 for colour fixation and development.

In accordance with the basic aspect of the present invention, a printed textile sheet is transported through a confined chamber by a circulating and flexible carrier belt in order to be subjected to contact with steam and
10 emanation of microwaves.

In one preferred embodiment of the present invention, contact with steam proceeds concurrently with emanation of microwaves.

In another preferred embodiment of the present
15 invention, the textile sheet is exposed to microwaves after full contact with steam.

In the other preferred embodiment of the present invention, steam for contact with the textile sheet is generated by microwave generation.
20

BRIEF DESCRIPTION OF THE DRAWINGS

Of the drawings:

FIG. 1 is a side view, partly in section, of the first embodiment of the apparatus in accordance
25 with the present invention,

FIG. 2 is a side view, partly in section, of the second embodiment of the apparatus in accordance with the present invention, and

FIG. 3 is a side view, partly in section, of the
30 third embodiment of the apparatus in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the following description, elements used for different embodiments but substantially the same in construction
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tion and function are designated with the same reference numerals and symbols.

The first embodiment of the apparatus in accordance with the present invention is shown in FIG. 1, in which
5 the apparatus includes a housing 1 defining a substantially confined chamber C for aftertreatment of a printed textile sheet F. In this case, the apparatus is used in combination with a screen printer (not shown). For
10 introduction of the textile sheet F into the confined chamber C, an inlet 3 is formed at one longitudinal end of the housing 1. In the same way, an outlet 5 is formed at the other longitudinal end of the housing 1 for delivery of the textile sheet F from the confined chamber C.

15 The walls of the housing 1 preferably have a hollow double construction at least in the sections surrounding the confined chamber C, and a number of heating tubes 7 preferably running through the inner spaces. The heating tube 7 allows passage of any proper heating medium
20 such as steam therethrough in order to keep up the temperature within the confined chamber C, and prevent dewing on the wall surfaces.

A horizontal bulkhead 9 is arranged at a proper level within the confined chamber C and divides the
25 latter into upper and lower rooms. This horizontal bulkhead 9 also preferably has a double construction made up of a lower rigid base 9a and an upper shelter plate 9b which blocks free passage of microwaves through the bulkhead 9. At longitudinal ends the bulkhead 9 is
30 preferably provided with vertically extending sections for controlled running of the later described carrier belt.

At least one emanator 11 of microwaves is secured to the housing 1 whilst opening in the upper room of the
35 confined chamber C.

In order to render the confined chamber C replete with steam, supply and exhaust conduits 13 and 15 are mounted to the housing 1 whilst opening in the confined chamber C. In the illustrated embodiment, the supply conduit 13 opens at a position on the side of the outlet 5 whereas the exhaust conduit 15 opens at a position on the side of the inlet 3 for the textile sheet F. The supply conduit 13 is coupled to a given supply source 17 of saturated or overheated steam. Further, the opening of the supply conduit 13 is preferably encompassed by a perforated plate 19 which allows free passage of steam but not microwaves. Use of such a perforated plate 19 well prevents wasteful dissipation and dangerous leakage of microwaves via the steam system.

An endless carrier belt B is arranged within the confined chamber C for continual circulation partly in sliding contact with the top surface of the horizontal bulkhead 9. This carrier belt B is made of a flexible material such as felt which is absorptive of water or other liquid substance. In the lower room of the confined chamber C, this carrier belt B advances through a wet bath 21 and a heater 23 in order to always be kept at prescribed temperature and humidity. The carrier belt B further engages a tension adjuster 25 in order to be properly tensed during its circulation. Guide rollers 27 and 29 are arranged in order to keep the fixed circulation course of the carrier belt B. Either of the guide rollers 27 and 29 may be coupled to a given drive motor (not shown) so that the circulation speed of the carrier belt B can be positively controlled. The carrier belt B is further brought into contact with a size applicator 31 after heating.

A carrier belt 33 from the preceding printing station terminates near the inlet 3 into the confined chamber C and a carrier belt 35 to the next operational

station starts near the outlet 5 from the confined chamber C.

Before the introduction of the printed textile sheet F, emanation of microwaves and supply of steam are started in order to render the confined chamber C replete with microwaves and steam. Next, the textile sheet F brought from the preceding screen printing station by the carrier belt 33 is introduced into the confined chamber C via the inlet 3 and entrained on the carrier belt B on the top surface of the horizontal bulkhead 9 in order to travel towards the outlet 5 in contact with steam under emanation of microwaves. The size applied to the surface of the carrier belt B by the size applicator 31 enables tensionless but snug surface contact of the textile sheet F with the carrier belt B. The textile sheet F is kept at moderate temperature and humidity during its travel through the confined chamber C due to contact with the carrier belt B which is soaked and heated during its running through the lower room of the confined chamber C. Emanation of microwaves fills the confined chamber C with hot steam of 100 to 200°C temperature.

In the illustrated embodiment, the textile sheet F with the carrier belt B advances in the upper room of the confined chamber from the inlet to outlet side whereas steam flows in the upper room from the outlet to inlet side. This counter-march of the textile sheet F raises thermal efficiency of the steam greatly. The flowing direction of the steam, however, may be the same as the advancing direction of the textile sheet F in the upper room of the confined chamber C.

When the apparatus for the present invention is used in combination with a roll printer, the printed textile sheet F shall be continually unwound from a roll of the printed cloth in the printing station and led

to the inlet 3 of the housing 1 in any known manner.

According to the method of the present invention the printed textile sheet is advanced through the confined chamber C substantially without any tension while being
5 kept in a state moderately soaked and heated. The emanated microwaves instantly permeate into the structure of the textile sheet in order to effectively generate heat due to their dielectric loss. Selective absorption of the microwaves by the textile sheet ends in efficient
10 utilization of heat for the aftertreatment of the printed textile sheet. This concurs to bring about improved fixation and development of colours printed on the textile sheet. The process is greatly streamlined due to removal of the separate drying operation.

15 In the first embodiment, the textile sheet F was exposed to the microwaves concurrently with contact with the steam in the confined chamber C. Despite the effective utilization of thermal energy, this concurrent system is liable to cause uneven colour fixation and
20 development on the textile sheet obtained. This is in particular significant when the present invention is applied to aftertreatment of a textile sheet printed by screen printing.

In the case of screen printing, a number of patterns
25 of different colours are printed in the form of printing size on a textile sheet subsequently and intermittently. This time-phased printing procedure causes difference in moisture content between an early printed size pattern and a late printed size pattern due to
30 evaporation. The large number of patterns usually printed in screen printing contributes to big difference in moisture content. More specifically, the moisture content of a size pattern printed during the earlier stage of screen printing is by far smaller, due to evaporation,
35 tion, than that of a size pattern printed during the

later stage of screen printing.

As a consequence, a printed textile sheet just arriving from the preceding printing station includes size patterns of different moisture contents. Heating effect by microwave emanation varies greatly depending on the moisture content of the object exposed to the microwaves. Therefore, when a printed textile sheet is directly subjected to microwave emanation concurrently with contact with steam, heating effect by microwave emanation varies from pattern to pattern on the textile sheet. This naturally results in uneven colour fixation and development on the textile sheet. In order to obviate such unevenness, moisture content of the textile sheet should be adjusted so as to be uniform over the entire area before exposure to microwaves.

The second embodiment of the apparatus in accordance with the present invention well suffices this requirement and is shown in FIG. 2.

About the middle of the length of the confined chamber C, a vertical bulkhead 41 extends from the housing 1 towards the top surface of the horizontal bulkhead 9 whilst allowing free passage of the textile sheet F with the carrier belt B. This vertical bulkhead 41 divides the upper room of the confined chamber C further into upstream and downstream rooms along the travelling path of the textile sheet F. The upstream room forms a sort of moisture adjusting room.

The steam supply and exhaust conduits 13 and 15 in this embodiment both open in the upstream room whereas the emanator 11 opens in the downstream room. A further supply conduit 43 preferably opens in the downstream room and is selectively coupled, via a shifter valve 49, to a supply source of steam 45 and a supply source of dry air 47. Depending on the material used for the textile sheet F, either steam or dry air is supplied to the

downstream room via the supply conduit 43 by operating the shift valve 49.

5 In operation, the textile sheet F from the printing station is first brought into the upstream moisture adjusting room replete with steam supplied via the conduit 13 so that moisture contents of different patterns on the textile sheet F should be substantially equalized and the textile sheet F should be soaked sufficiently. Next, the textile sheet F is exposed to microwaves in
10 the downstream room for heating. Heating by microwave emanation can be carried out quite uniformly over the entire area of the textile sheet due to the equalized moisture content, thereby assuring ideally uniform colour fixation and development.

15 In the first and second embodiments, the steam for contacting the textile sheet is supplied into the confined chamber C by means of the steam circulation system 13 and 15. The third embodiment of the apparatus in accordance with the present invention shown in FIG. 3
20 employs a different system for generation of the steam. That is, generation of the steam is caused by emanation of the microwaves. This system greatly simplifies the construction of the apparatus by omitting the steam supply system used for the foregoing embodiments. In
25 addition, dissipation of the steam generated is well prevented in order to assure most efficient utilization of thermal energy.

On the inlet side of the housing 1, a roll 53 of
30 a flexible sheet S is placed over the carrier belt 33 from the preceding printing station. Preferably, this flexible sheet S takes the form of an elongated polyethylene film or densely woven cloth which allows free passage of microwaves but not steam. The woven cloth may contain glass or ceramic fibers. The flexible sheet
35 S is delivered from the roll 53, led into the confined

chamber C via a guide roller 51 arranged near the inlet 3, and superimposed on the textile sheet F for concurrent running. Since the carrier belt B is soaked before contact with the textile sheet F, the flexible sheet S
5 absorbs moisture from the carrier belt B through the textile sheet F as soon as the three layers come in contact on the horizontal bulkhead 9. As the wet flexible sheet S advances towards the emanator 11 in the confined chamber C, emanation of the microwaves causes
10 evaporation of the moisture in the flexible sheet, and the steam so generated is allowed to permeate into the textile sheet F. Since the steam so generated is not allowed to move into the space over the flexible sheet S, dissipation of thermal energy is well prevented,
15 and the thermal energy provided by microwave emanation is quite efficiently utilized. Since the textile sheet F is pressed to a certain extent between the flexible sheet S and the carrier belt B during exposure to microwaves, this system is well suited for aftertreatment of
20 towels, blankets and cloths made of bulky yarns which have fluffs on the surface. Presence of fluffs is liable to cause uneven microwave emanation effect.

CLAIMS

1. Improved method for aftertreatment of a printed textile sheet (F) by application of microwaves comprising continually introducing said printed textile sheet (F) into a confined chamber (C), advancing said textile sheet through said confined chamber whilst entraining same on a circulating, flexible and endless carrier belt (B) which is kept at a moisture content and a temperature suited for said aftertreatment, placing said textile sheet (F) in contact with steam during travel through said confined chamber (C), emanating microwaves into said confined chamber during said travel, and continually delivering said textile sheet outside said confined chamber.
2. Improved method as claimed in claim 1 in which emanation of microwaves is carried out concurrently with contact of said textile sheet with steam.
3. Improved method as claimed in claim 1 in which said textile sheet is subjected to emanation of microwaves after full contact with steam.
4. Improved method as claimed in claim 1 in which generation of steam is caused by emanation of microwaves.
5. Improved apparatus for aftertreatment of a printed textile sheet by application of microwaves comprising a housing (1) including a confined chamber (C) which has an inlet (3) and an outlet (5) for said textile sheet (F), a flexible and endless carrier belt (B) arranged for continual circulation within said confined chamber and having a horizontal section suited for supporting said textile sheet (F) during travel of said textile sheet through said confined chamber, means (9) for supporting said carrier belt for said circulation, means (21) for keeping said carrier belt at a moisture content and a temperature suited for said aftertreatment, means (13, 15) for causing contact of

said textile sheet with steam during said travel, at least one microwave emanator (11) attached to said housing (1) whilst opening in said confined chamber (C).

5 6. Improved apparatus as claimed in claim 5 in which said steam contact causing means includes supply (13) and exhaust conduits (15) of steam, both opening in said confined chamber.

10 7. Improved apparatus as claimed in claim 6 in which said supply conduit (13) of steam opens at a position near said outlet (5) for said textile sheet (F), and said exhaust conduit (15) of steam opens at a position near said inlet (3) for said textile sheet so that steam flows in a direction substantially opposite to the travelling direction of said textile sheet through
15 said confined chamber.

 8. Improved apparatus as claimed in claim 6 or 7 in which opening of said supply conduit (13) of steam is encompassed by a perforated plate (19) which allows free passage of steam but not microwaves.

20 9. Improved apparatus as claimed in claim 5 in which said confined chamber (C) is divided, by a bulkhead (41) attached to said housing, into upstream and downstream rooms arranged in succession along the travelling path of said textile sheet, said steam contact causing means includes supply (13) and exhaust
25 conduit (15) of steam, both opening in said upstream room of said confined chamber, and said microwave emanator (11) opens in said downstream room of said confined chamber.

30 10. Improved apparatus as claimed in claim 9 in which a further supply conduit (43) opens in said downstream room of said confined chamber and selectively coupled, via a shift valve, to one of separate supply sources of steam (45) and dry air (47).

35 11. Improved apparatus as claimed in claim 5 in

which said steam contact causing means includes a flexible sheet (S) running together and in contact with said textile sheet (F) through said confined chamber (C) which allows free passage of microwaves but not steam, and said microwave emanator (11) faces said flexible sheet (S) on the opposite side of said textile sheet (F).

12. Improved apparatus as claimed in claim 5, 6, 9 or 11 in which the walls of said housing (1) have a hollow double construction at least in the sections surrounding said confined chamber.

13. Improved apparatus as claimed in claim 12 in which a plurality of heating tubes (7) are arranged in the inner space of said double construction.

14. Improved apparatus as claimed in claim 5, 6 or 11 in which said carrier belt supporting means includes a substantially horizontal bulkhead (9) which divides said confined chamber into upper and lower rooms, said upper room being for passage of said textile sheet.

15. Improved apparatus as claimed in claim 14 in which said moisture content and temperature keeping means includes a wet bath (21) and a heater (23) arranged in said lower room of said confined chamber.

16. Improved apparatus as claimed in claim 14 in which an applicator of size (31) is arranged in said lower room of said confined chamber in order to apply size to said carrier belt before contact with said textile sheet.

17. Improved apparatus as claimed in claim 14 in which said bulkhead (9) has a double construction made up of a lower rigid base (9a) and an upper shelter plate (9b) which blocks free passage of microwaves.

CLAIMS

1. Method for aftertreatment of a printed textile sheet in which the textile sheet (F) is made to travel continuously through a confined chamber whilst being entrained on a circulating and flexible endless carrier belt (B), characterized in that the carrier belt (B) is kept at a moisture content and a temperature suited for development and fixation of dyes on the textile sheet (F), that the textile sheet is kept in a flat state on the carrier belt during travel through the confined chamber, and that the textile sheet is placed in contact with steam and microwaves having frequencies in a range from 300 to 30 000 MHz within the confined chamber.
2. Method as claimed in claim 1 in which emanation of microwaves is carried out concurrently with contact of said textile sheet with steam.
3. Method as claimed in claim 1 in which said textile sheet is subjected to emanation of microwaves after full contact with steam.
4. Method as claimed in claim 1 in which generation of steam is caused by emanation of microwaves.
5. Apparatus for aftertreatment of a printed textile sheet comprising a housing (1) defining a confined chamber (C) and a circulating and flexible endless carrier belt (B) suited for transporting the textile sheet in a flat state through the confined chamber, characterized by means for keeping the carrier belt (B) at a moisture content and a temperature suited for development and fixation of dyes on the textile sheet (F), means for exposing the textile sheet to steam during travel through the confined chamber, and at least one microwave emanation (11) arranged in the confined chamber which generates microwaves having frequencies in a range from 300 to 30 000 MHz.

6. Apparatus as claimed in claim 5 in which said steam contact causing means includes supply (13) and exhaust conduits (15) of steam, both opening in said confined chamber.

5 7. Apparatus as claimed in claim 6 in which said supply conduit (13) of steam opens at a position near said outlet (5) for said textile sheet (F), and said exhaust conduit (15) of steam opens at a position near said inlet (3) for said textile sheet so that steam flows in
10 a direction substantially opposite to the travelling direction of said textile sheet through said confined chamber.

8. Apparatus as claimed in claim 6 or 7 in which opening of said supply conduit (13) of steam is encompassed by a perforated plate (19) which allows free passage
15 of steam but not microwaves.

9. Apparatus as claimed in claim 5 in which said confined chamber (C) is divided, by a bulkhead (41) attached to said housing, into upstream and downstream
20 rooms arranged in succession along the travelling path of said textile sheet, said steam contact causing means includes supply (13) and exhaust conduit (15) of steam, both opening in said upstream room of said confined chamber, and said microwave emanator (11) opens in said
25 downstream room of said confined chamber.

10. Apparatus as claimed in claim 9 in which a further supply conduit (43) opens in said downstream room of said confined chamber and selectively coupled, via a shift valve, to one of separate supply sources of
30 steam (45) and dry air (47).

11. Apparatus as claimed in claim 5 in which said steam contact causing means includes a flexible sheet (S) running together and in contact with said textile sheet (F) through said confined chamber (C) which allows
35 free passage of microwaves but not steam, and said

microwave emanator (11) faces said flexible sheet (S) on the opposite side of said textile sheet (F).

12. Apparatus as claimed in claim 5, 6, 9 or 11 in which the walls of said housing (1) have a hollow
5 double construction at least in the sections surrounding said confined chamber.

13. Apparatus as claimed in claim 12 in which a plurality of heating tubes (7) are arranged in the inner space of said double construction!

10 14. Apparatus as claimed in claim 5, 6 or 11 in which said carrier belt supporting means includes a substantially horizontal bulkhead (9) which divides said confined chamber into upper and lower rooms, said upper room being for passage of said textile sheet.

15 15. Apparatus as claimed in claim 14 in which said moisture content and temperature keeping means includes a wet bath (21) and a heater (23) arranged in said lower room of said confined chamber.

20 16. Apparatus as claimed in claim 14 in which an applicator of size (31) is arranged in said lower room of said confined chamber in order to apply size to said carrier belt before contact with said textile sheet.

25 17. Apparatus as claimed in claim 14 in which said bulkhead (9) has a double construction made up of a lower rigid base (9a) and an upper shelter plate (9b) which blocks free passage of microwaves.

Fig. 1

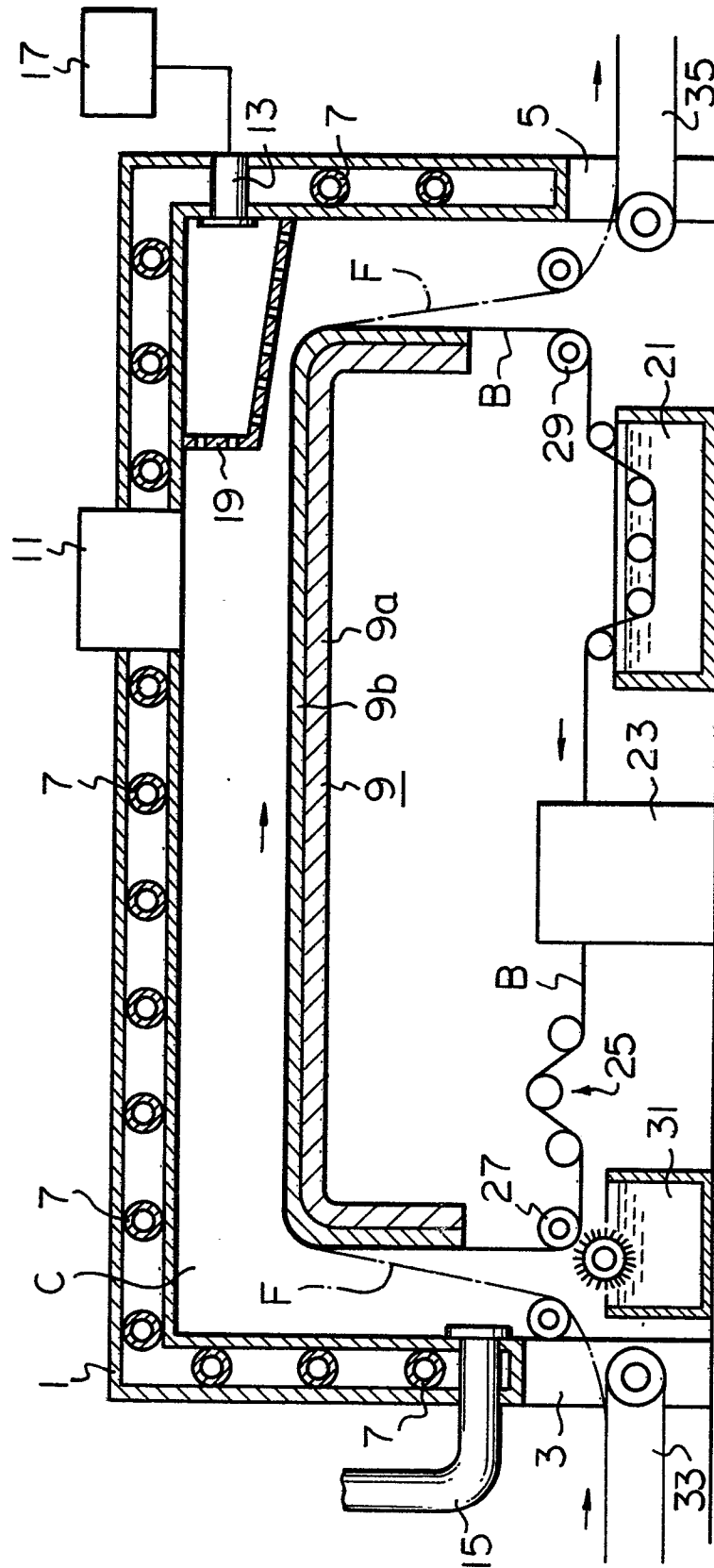


Fig. 2

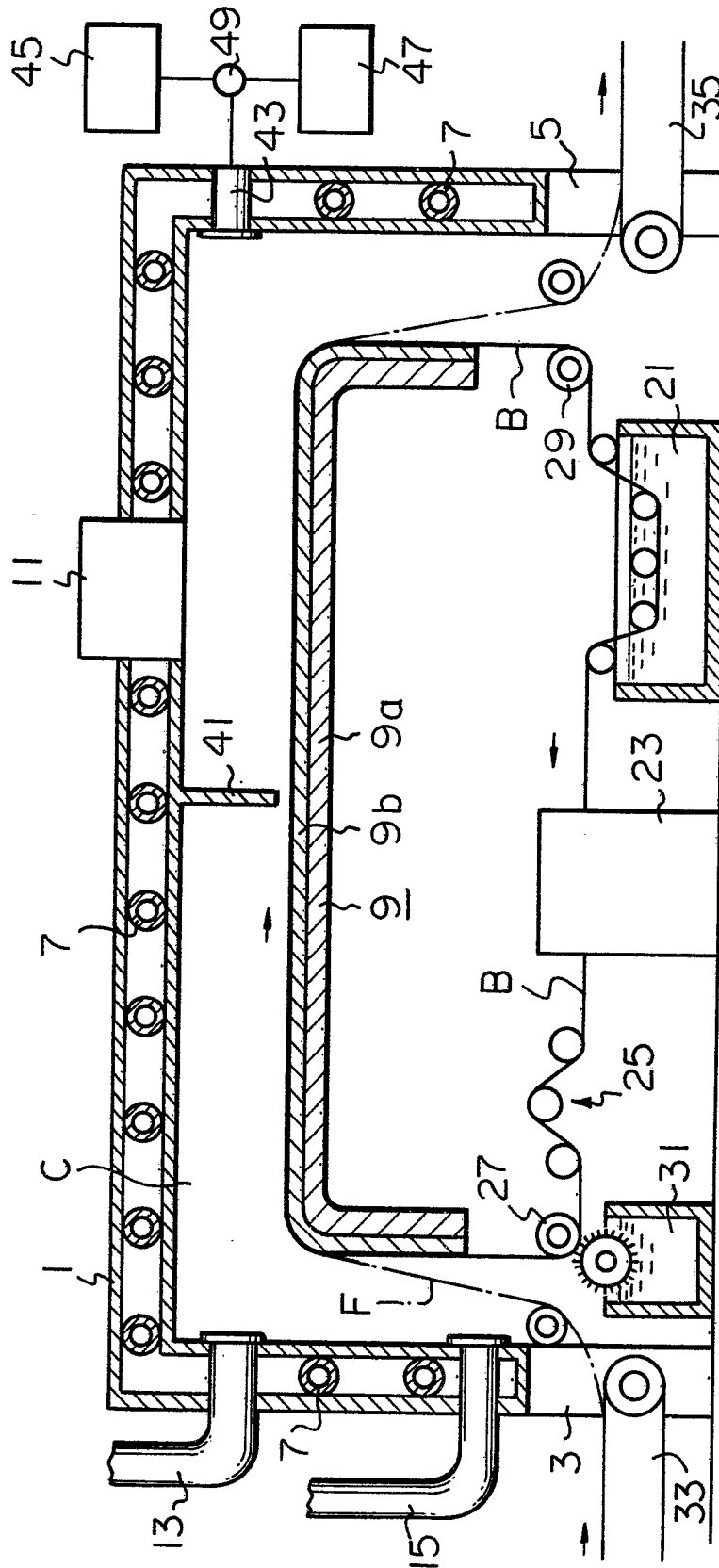
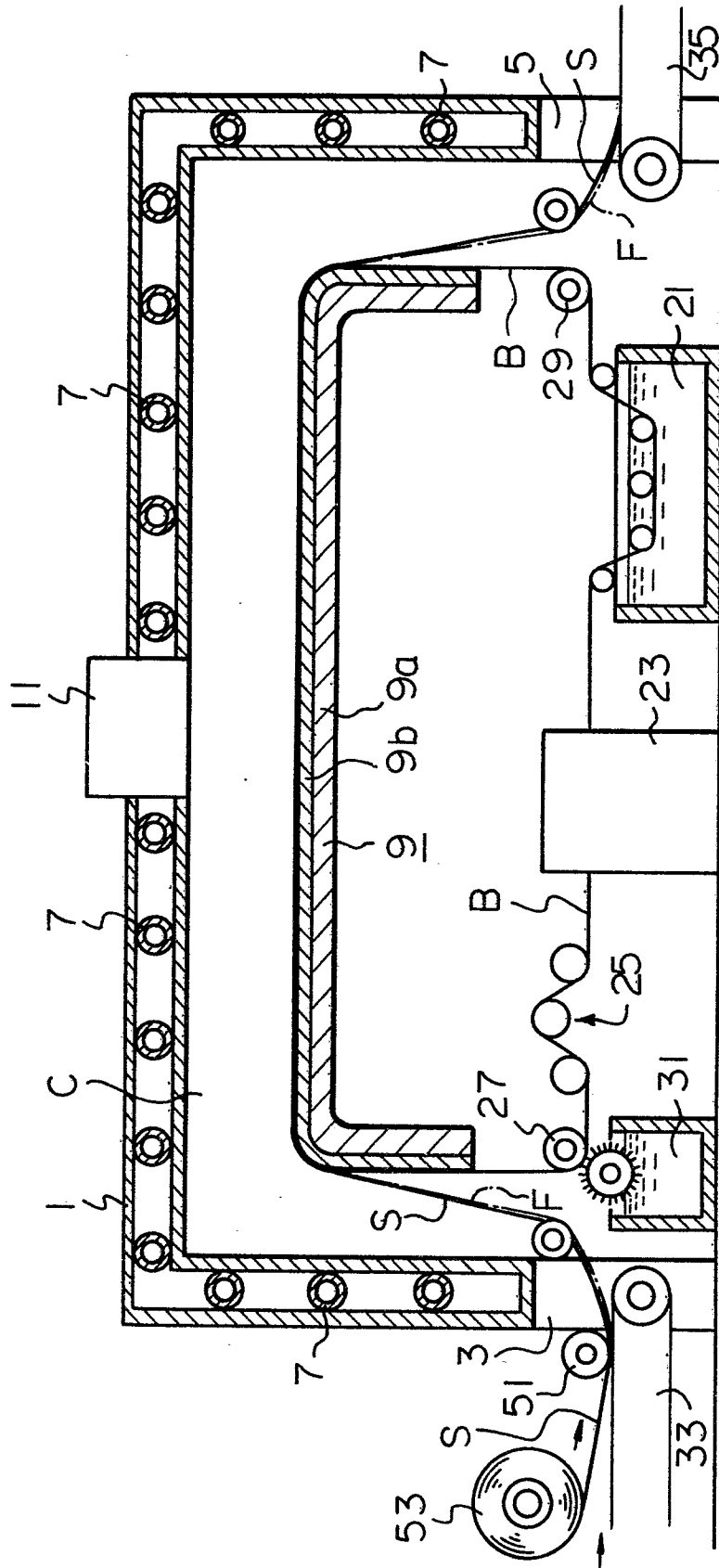


Fig. 3





European Patent
Office

EUROPEAN SEARCH REPORT

0065058

EP 81 85 0086

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
X	FR - A - 2 311 890 (DAWSON) & GB - A - 1 497 160 ---	1,5	D 06 B 19/00
A	GB - A - 1 124 787 (WOLSEY)		
A	FR - A - 2 375 384 (HOECHST)		
D/E	EP - A - 0 031 862 (THE ICHIKIN) * the whole abstract * -----	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl. 3)
			D 06 B D 06 P
			CATEGORY OF CITED DOCUMENTS
			X: particularly relevant if taken alone Y: particularly relevant if combined with another document of the same category A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: earlier patent document, but published on, or after the filing date D: document cited in the application L: document cited 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 The Hague		Date of completion of the search 18.01.1982	Examiner PETIT