United States Patent [19]

Fleissner

[11] **3,808,846**

[45] **May 7, 1974**

[54] **APPARATUS FOR THE CONTINUOUS TREATMENT OF NATURAL AND SYNTHETIC FIBERS WITH A SOLVENT**

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[22] Filed: **Dec. 10, 1970**

[21] Appl. No.: **97,012**

Related U.S. Application Data

[62] Division of Ser. No. 835,529, June 23, 1969, abandoned.

[52] **U.S. Cl.** **68/19.1,** 68/DIG. 5

[51] **Int. Cl.** **B05c 3/138**

[58] **Field of Search** ..... 68/DIG. 5, 5 D, 5 E, 9, 68/18 C, 19.1, 158

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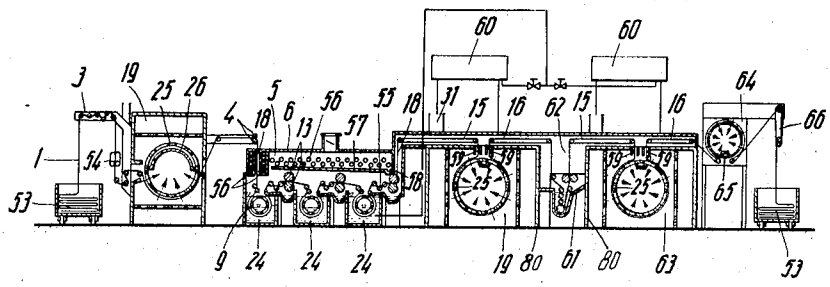
[57] **ABSTRACT**

The present disclosure is directed to an apparatus for the treatment of textile materials which comprises a wet-treatment device containing in its first portion a trough-shaped tank which contains a solvent, inlet means for introducing the materials to be treated to the wet-treatment device and into the solvent in a folded state, a sieve drum means subjected to a suction draft rotatably disposed in the second portion of the wet-treatment device, roller means for conveying the material being treated from the trough-shaped tank to the sieve drum means, press means disposed behind the sieve drum means for at least partially removing the solvent from the material being treated, dryer means disposed behind the press means, said dryer means comprising at least one sieve drum means subjected to a suction draft rotatably disposed in a treatment chamber, exhaust means provided at the outlet side of the treatment chamber, said recycle means also communicating with the solvent recovery device for recycling the substantially solvent free treatment medium back to the treatment chamber and outlet means for removing the material being treated from the dryer means.

25 Claims, 10 Drawing Figures



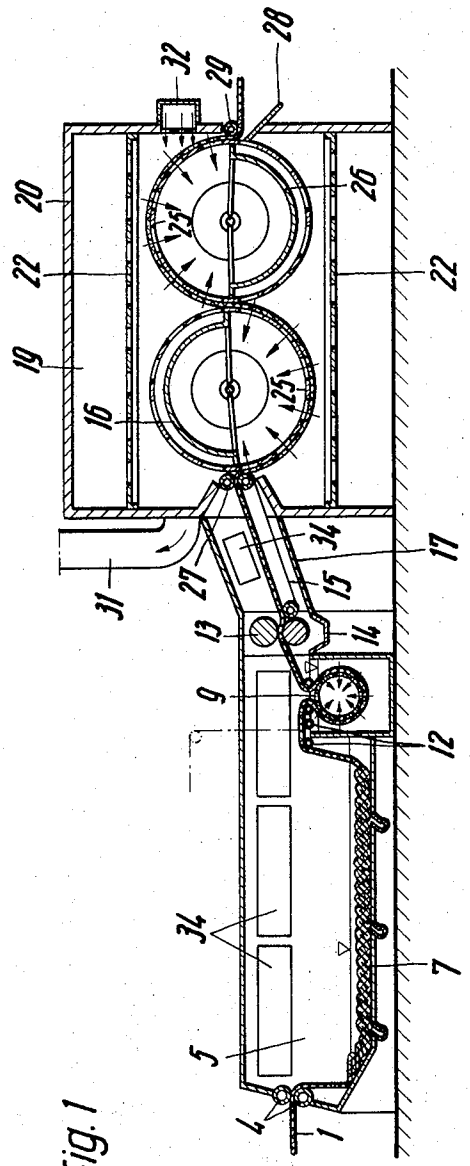


Fig. 1

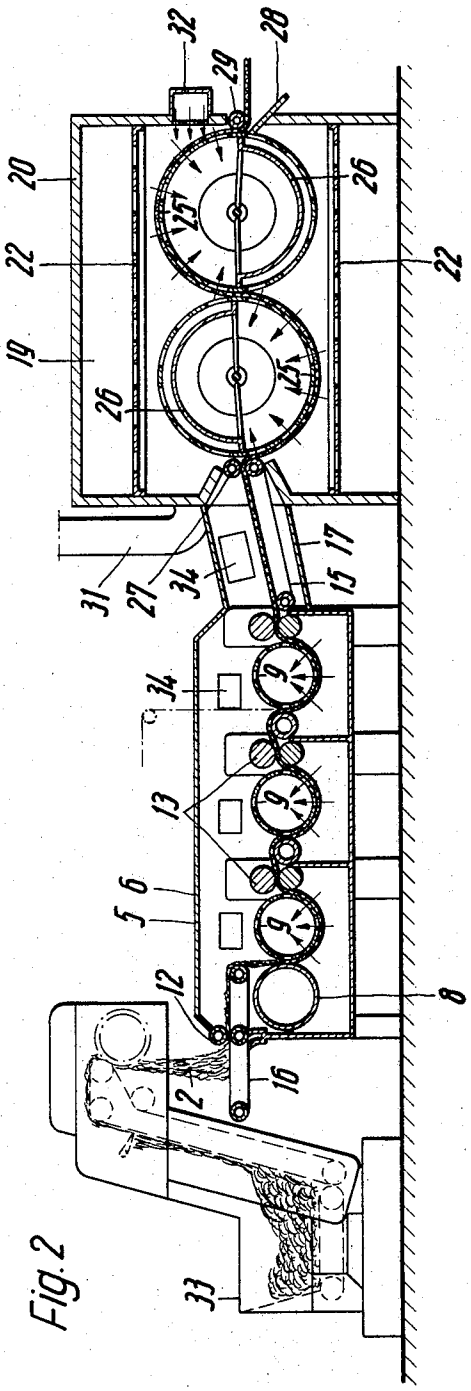


Fig. 2

Fig. 3

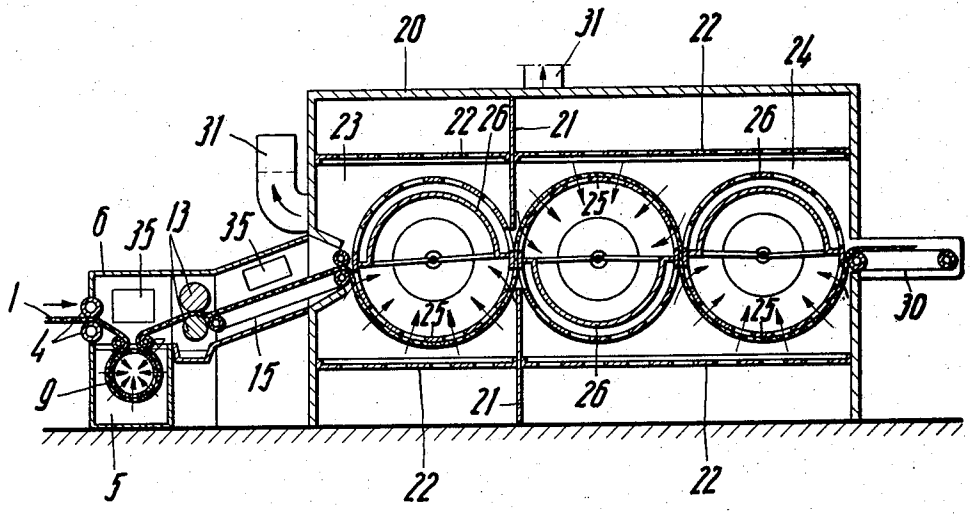


Fig.4

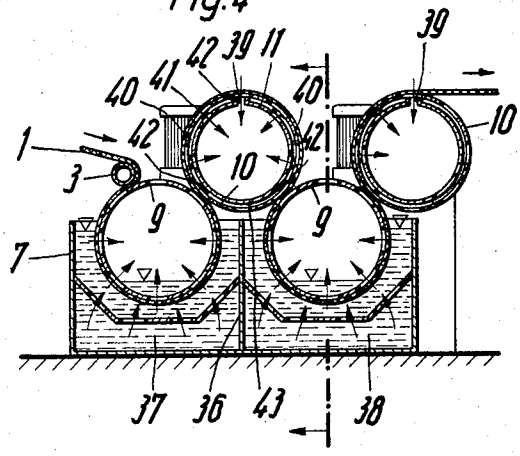


Fig.5

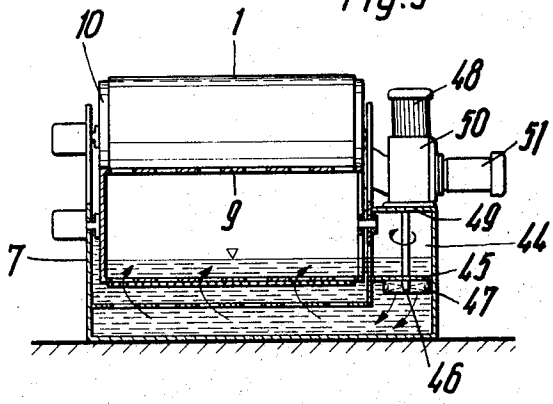
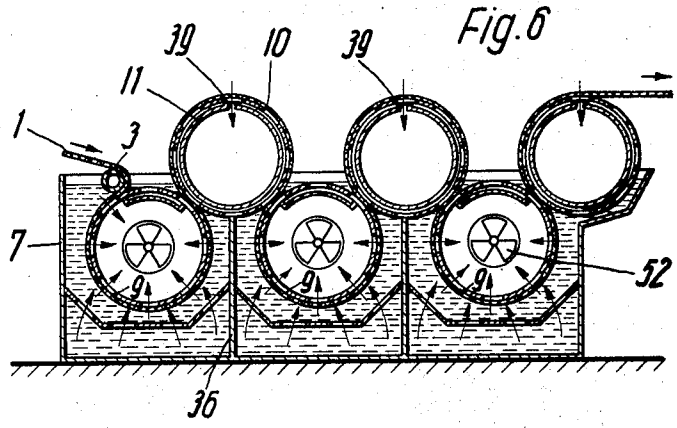


Fig.6



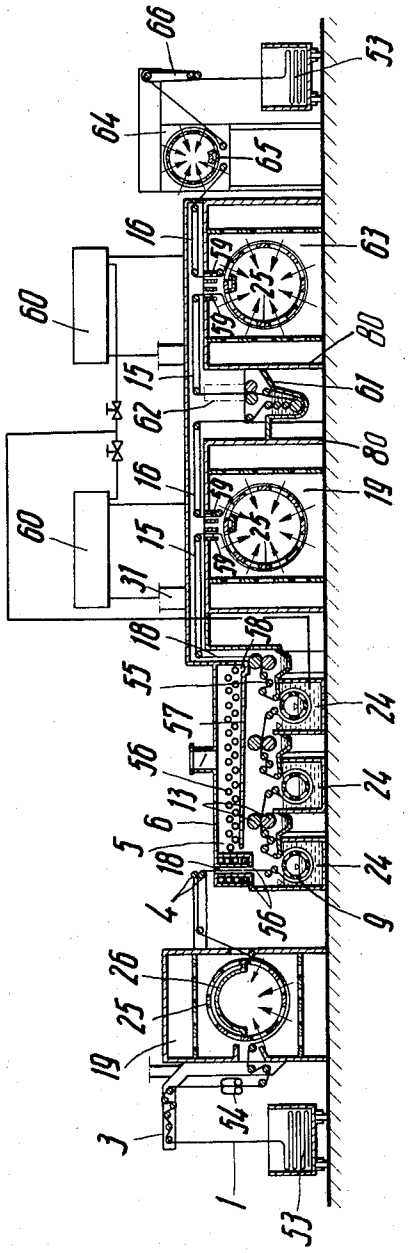

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Fig. 7

Fig. 8

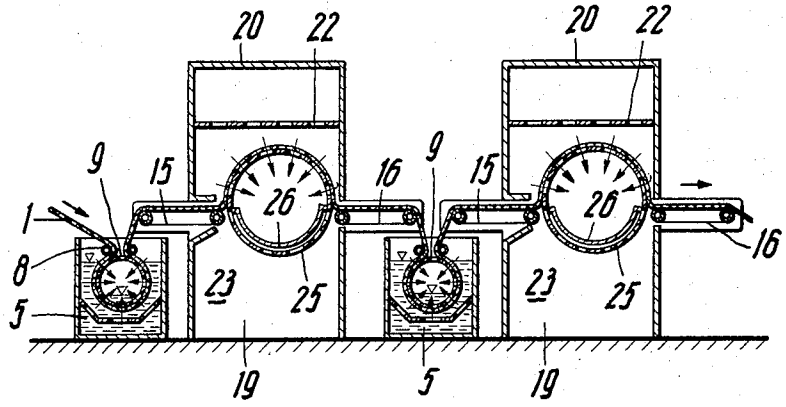


Fig. 9

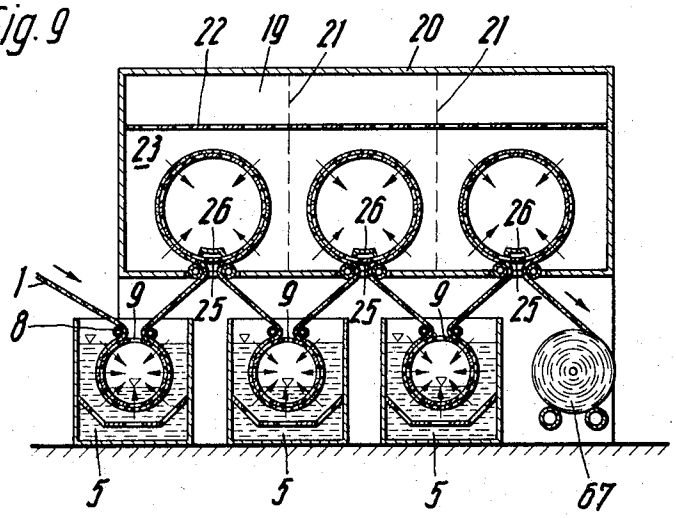
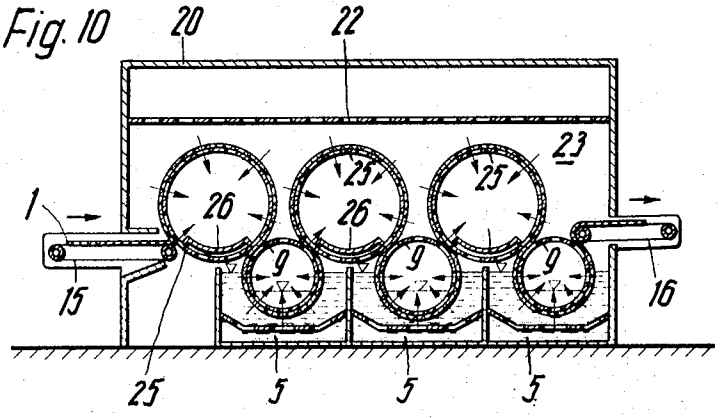


Fig. 10



APPARATUS FOR THE CONTINUOUS TREATMENT OF NATURAL AND SYNTHETIC FIBERS WITH A SOLVENT

This is a division of application Ser. No. 835,529, filed June 23, 1969, and now abandoned.

BACKGROUND OF THE INVENTION

The present invention relates to an apparatus for the continuous treatment of natural and synthetic fibers with a solvent, such as for example, chlorinated hydrocarbon compounds, wherein the solvents are recovered and once again employed in the treatment process. In this connection, the material can be coated, printed, or padded with preparations containing a solvent, as well as dyestuffs which can be fixed under the influence of heat and/or agents required for high-finishing, for example, synthetic resins, optical brighteners, bleaching agents or binders. Optionally, thickeners and additional auxiliary agents can be contained in the preparations. In the present process, the solvents are removed from the textile material preferably by means of a gas, such as air and/or steam, heated to a temperature above the evaporating temperature of the solvent. In this connection, it is advantageous to have the heated gas flow through the textile material.

Cleaning plants which work discontinuously are conventional, operating with chlorinated hydrocarbons. In these plants, the clothes are introduced into a drum which is thereafter immersed into a solvent. After the cleaning process, the solvent is removed by pumping and conducted into a recovery plant. The clothes are then dried within the drum. Also the solvent vapors are conducted into the recovery plant.

In the recovery plant, the dirt and oil particles are removed from the solvent and if water is present, this is also separated. The thus purified solvent can once again be utilized for the cleaning of clothes and similar textile articles.

Furthermore, a continuously operating cleaning plant has been suggested, said plant using solvents as a cleaning agent. This continuously operating unit consists of a cleaning plant and a drying and recovery plant. In the cleaning plant, the webb of material is conducted over two rows of rolls, the lower row of rolls being disposed in the solvent bath. Squeeze rolls can be associated with the upper row of rolls in order to achieve an improved cleaning effect. At the end of the cleaning bath, a press (wringer) is provided. The thus-pressed web of material is then conveyed to a dryer where the material is once again guided over rolls and is subjected to drying air emanating from nozzles. The material is subjected to high longitudinal tension and stress in the cleaning bath as well as in the dryer.

It has also been suggested to conduct dyeing and high-finishing processes with the aid of solvents. However, such treatments cause difficulties, particularly since special products suitable as solvents must be further developed and also because the fixing process must be adapted to the solvent.

The advantage of treatment with solvents resides especially in a substantially more economical mode of operation. The customary solvents evaporate more readily and rapidly, at a much lower temperature, then water. For example, the boiling point of trichlorotrifluorethane (1,1,2-trichloro-1,2,2-trifluoroethane) is 47.6°C. Also, the amount of heat required for the drying step is substantially smaller. Furthermore, by using solvents, the problems and expenses involved in waste water disposal, which are becoming increasingly larger, are substantially eliminated.

During a continuous treatment of textile fibers with solvents, a larger or smaller proportion of water is entrained into the solvent liquor, depending on the fibers being treated in the particular case and on the ambient atmospheric humidity. Accordingly, during the solvent washing step, the water mixes with the solvent which results in a constant enrichment with water. Consequently, the solvents employed must be conducted through a water separator (water trap) at certain intervals in order to remove the water. However, a more troublesome aspect is that the treatment effect likewise differs, due to the differing proportions of water in the solvent.

For the continuous treatment of the material with liquids, i.e., with solvents and also with other fluids, several treatment baths are generally provided, through which the material passes successively. Between the treatment baths, presses or suction devices are disposed for squeezing the material or for the partial withdrawal of moisture from the material. By pressing and also by the use of suction, the material is placed under high stresses. Thus sensitive goods, such as structured knitted goods, for example, can sustain damage during such dewatering processes.

SUMMARY OF THE INVENTION

An object of the present invention is to avoid the prior art disadvantages in the solvent treatment of textile materials.

Another object of the present invention is to provide an improved apparatus for the continuous treatment of material and synthetic fibers with a solvent wherein the solvent is recovered and once again employed in the treatment process.

A further object of the present invention is to provide an improved apparatus for the solvent treatment of textile materials wherein the treatment effect is very uniform and the efficiency of the apparatus is substantially improved.

Other objects and further scope of applicability of the present invention will become apparent from the detailed description given hereinafter; it should be understood, however, that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

Pursuant to the present invention it has been found that the above-mentioned disadvantages may be eliminated and a much improved process for solvent treating textile materials may be obtained by removing the solvent with a gas, e.g., air and/or steam, heated to a temperature above the evaporating temperature of the respective solvent, said gas being drawn through the fibers of said textile material. By subjecting the fibrous material to a throughflow in this manner, the solvents are evaporated substantially more rapidly and intensely. At the same time, it is possible to enrich the gas to a greater extent with evaporated solvent.

In a further embodiment of the present invention, it is suggested, in connection with an apparatus of the

type described above, to conduct the fixing of the dyestuffs, the high-finishing agents, the binder, the optical brightener, and the like, after the removal of the solvent from the textile material, at substantially higher temperatures than the evaporating temperature of the solvent. Said fixing can advantageously be conducted in an air and/or steam atmosphere. In this connection, the fixing treatment can be carried out essentially at the same temperatures as in the previous corresponding hot-air or hot-steam fixing processes.

A treatment which is even substantially more intense is obtained by providing that the fibers, at least during a portion of the wet treatment, have solvent liquor flowing therethrough, during which procedure the fibers are preferably guided on at least one sieve drum subjected to a suction draft. The aforementioned process cannot only be employed in general for the cleaning of textile articles, but also for fixing dyeing, optical brightening, and bleaching, as well as for the application of synthetic resins, i.e., high-finishing processes in general.

In order to eliminate the negative results obtained from the moisture entrained in the solvent bath, it is suggested to dry the material to be treated, immediately before the solvent treatment, to a constant moisture value, e.g., to a final moisture content of about 1 percent, or to dry the material entirely. A satisfactory, uniform drying or complete drying of the material is obtained by conducting a drying medium through the material. It is particularly advantageous to conduct the drying step in a sieve drum dryer which is subjected to a suction draft.

It has been surprisingly found that by employing the apparatus of the present invention, it is possible in an advantageous manner to dry and fix in one single process prior to the solvent treatment, textile fibers, particularly synthetic fibers, or woven or knitted materials of synthetic fibers. Thus it is possible to permanently apply, simultaneously with the drying step, a mechanically produced structure by the use of hot air and/or steam.

In general, such a fixing treatment prior to a wet treatment is disadvantageous, since during the fixing process any auxiliary agents or foreign substances which may be present also dry onto the fibers and firmly adhere thereto. However, it was found that even firmly adhering and even baked-in auxiliary agents or foreign substances are removed by the subsequent treatment with solvents.

In a further feature of the present invention, it is suggested to expose the textile material, during the drying step and the removal of the solvent as well as during at least part of the fixing process, to a suction draft, i.e., to hold and fix the textile material on a conveying means for example, a sieve means which is subjected to a suction draft. Because of the suction draft, the textile material is subjected to an intense throughflow of the heat-carrying medium, i.e., the gas or the steam, and the solvent evaporated during this process is simultaneously removed. However, for the drying process and the evaporation of the solvent, it is also possible to provide infrared irradiation, high frequency, contact heat, or other conventional heat transfer procedures. In many cases, especially in connection with the dyeing step, it is advantageous to conduct the web-shaped textile material without any contact, at least at the beginning of the drying process. It is also possible to apply hot air, gas or steam through nozzles to the material, or such a treatment can be additionally employed, for example, in conjunction with infrared irradiation.

According to the present invention, it is furthermore suggested, to remove moisture from the material in between two liquid treatments by conducting a drying step in place of a squeezing or suction removal step. This is readily possible without any great expenditure in case of solvents, in particular, since the solvents evaporate very rapidly, i.e., the material moistened by the solvents dries veryquickly. An especially gentle treatment is achieved by conducting or drawing a gaseous or vaporous treatment medium through the material disposed on the sieve drum, for purposes of drying the material. The sieve drum, provided for the partial intermediate drying of the material can be associated additionally with a nozzle drying device or an infrared irradiating device in order to dry the material more rapidly.

It is particularly economical to wash the material with solvents, then to dry the material in a continuous process in a solvent-containing atmosphere, and thereafter to finish the material by means of solvents, e.g., to dye, print and/or apply synthetic resins to the material. By drying the material with a solvent-containing atmosphere, the drying takes place more uniformly, and the danger of a migration of the preparations, for example dyestuffs or synthetic resins, during the drying step is prevented.

It has also been found to be especially advantageous to dry the material without any contact, after the application of the dye bath or the bath containing the synthetic resins and the like or to pre-dry the material to a moisture of below about 25–30 percent, and to thereafter fix the thus-applied dyestuffs, synthetic resins and the like onto or into the fiber. This is preferably done by the use of at least one sieve means subjected to a suction draft, for example a sieve drum. A sieve drum exhibits the advantage that, on the one hand, the material is held and guided without tension by the suction draft and, on the other hand, the treatment takes place very uniformly and intensely, since every fiber is surrounded by the flow of the treatment medium. During the predrying step, it has been proven to be advantageous to conduct the material vertically, and to dry the same by means of irradiation, nozzle drying devices and/or high frequency electrical energy. When the material is conducted and dried in this manner, no dyestuff migration leading to two-sidedness occurs. In the case of knitted goods which tend to shrink in width when guided freely over a certain distance, it is advantageous to guide the material, at least during the predrying or drying step, in tentering chains, preferably in a vertical orientation. By guiding the material in tentering chains, it is not only possible to entirely avoid a shrinkage in width, but the material can even be stretched in its width by this procedure.

Since many materials, especially textured knitted goods, should substantially finish their shrinking to as large an extent as possible during the wet treatment, it is suggested to conduct these materials in a buckled (dammed-up) condition over the permeable rolls and the sieve drums subjected to a suction draft. It is especially advantageous to alter the buckling during the treatment process. Thus, the buckling can be conducted in stages during the transfer from a permeable roll to a drying drum, and then again during the transfer

from the sieve drum to a subsequent roll immersed in the treatment bath. However, it is also possible to pass the material in a buckled manner only on the rolls immersed in the treatment bath or, conversely, to conduct the material in a smooth condition on these rolls and to convey the material in the buckled condition only on the drying drums.

According to the present invention, the thermosol dyeing process can be adapted to solvent treatment by dispersing the dispersion dyed in the solvent and applying the dyes uniformly to the textile material with the aid of the solvent. After the drying step and the removal of the solvent, the fixing (thermosoling) can then be carried out under the thermosol conditions of temperatures customary for the respective dye-stuffs.

In accordance with the present invention, it has furthermore been discovered that solvents can also be employed for the reinforcement of non-woven materials, stitched felts, and similar products, by dispersing or dissolving a binder in the solvent. By the use of solvents, here again a substantial increase in efficiency and a more economical mode of operation can be obtained.

In order to be able to subject to the solvent treatment materials which tend to roll up, such as, for example, knitted goods, as well as tension-sensitive goods, such for example, very thick carpets, particularly tufted and stitched felt carpets, non-reinforced non-woven materials, combed yarn and loose fibrous material, it is suggested to guide these materials during the treatment process on conveying elements which are subjected to a suction draft, particularly sieve drums subjected to a suction draft, and to do this during the impregating step as well as during the drying and fixing steps.

In order to conduct the above-mentioned processes, an apparatus is suggested wherein a dryer containing sieve drums is provided with a gastight housing, said dryer being provided with an air exhaust which is in communication with a solvent recovery plant. In this connection, after the recovery of the solvent, it is advantageous to recycle the gas, e.g. the air, employed for the removal of the solvent from the fibers back into the dryer for the purpose of removing further solvent. Due to this feature, it is unnecessary to remove the solvent completely from the gas, for example the air. This is practically impossible anyway. The solvent losses can thereby be substantially reduced. It is furthermore suggested for the treatment of fibrous material to dispose at least one sieve drum bath containing at least one sieve drum within a gastight housing, or to provide such sieve drum bath with a gastight housing, and to connect said housing with a solvent purification and recovery plant. In this connection, the treatment medium flows through the sieve drums by means of a suction draft or by means of a difference in levels between the liquid disposed outside of the sieve drum and the liquid present inside of the sieve drum. It is likewise possible to subject the sieve drum to an excess pressure (superatmospheric pressure) and to force the solvent through the sieve drum and through the material disposed about the sieve drum.

In order to achieve higher production, it is advantageous to provide several sieve drum baths in series, and to associate at least one residence bath with the sieve drum baths. In this connection, the residence bath is connected with the sieve drum bath or the sieve drum baths in a gastight manner, o is arranged in a common gastight housing.

In order to be able to remove moisture from materials, particularly tension-sensitive materials, between two solvent treatment stages, it is suggested to connect a permeable suction roll directly behind the roll immersed in the solvent bath. By means of such a suction roll, all tensile stresses which otherwise occur in the material, are substantially avoided.

In this connection, it is suggested to expose the suction roll to a throttled suction draft in the entire zone covered by the material and to a full suction draft at least a narrow zone. However, the zone which is free of material is completely shielded from the suction draft by a cover member. Such a staggering of the suction zones has the advantage that the material is taken over automatically by the suction roll and is guided to a subsequent conveying element, if such an element is appropriately associated with said suction roll. Thus the adherence of the material to the suction roll is thereby improved, and accordingly a completely tension-free conductance is ensured. Furthermore, the liquid entrained by the material from the bath can be removed in part by the throttled suction zone so that, at the suction slot proper, a more uniform and satisfactory dewatering can take place.

This subdivision into different zones can be attained in an effective manner by a stationary tube disposed in the suction roll, said tube being provided with webs for the purpose of sealing the individual suction zones from one another. At the webs, elastic sealing strips can be attached, or said webs can be provided with a labyrinth packing (seal) in order to avoid any large frictional forces. In the throttled partial zones of the tube, several bores are provided. The number of free bores is dependent on the desired vacuum pressure on the suction roll in these zones. The stationary tube furthermore exhibits a suction slot, or several suction slots, at those points where the full suction effect is to occur. In the zone wherein the suction roll is not covered by the material, the innter stationary concentric tube likewise exhibits no openings. The inner stationery tube is in communication with a suction device. In place of a tube, it is also possible to employ several cover parts, tube parts or baffle plates which, in this case, are suitably connected with each other at the sealing webs. In this embodiment sealing strips can be provided between the cover plates.

It is also possible to expose the suction rolls to a slight suction draft over the entire region covered by the material, and to form the dewatering zone or zones proper by providing at these points a blowing device such as a blowpipe outside of the suction roll. With the aid of this blowpipe, air is pressed through the textile material at a high velocity for dewatering purposes. This blowing device can also be additionally provided on a suction roll which is provided with at least one narrow zone subjected to the full suction draft.

In a multiple-bath unit, it is suggested to dispose the suction roll at the transfer point between two baths. In this connection, it is advantageous to associate the suction roll directly with two adjacent rolls in the treatment liquor, that is, in case of a multiple-bath unit, preferably with the rolls of two adjacent baths.

The lower portion of the suction roll can also be immersed in the bath liquid. The transverse partition between the two baths can be sealed to the roll by means of an elastic sealing strip.

It has proved to be advantageous to design the jacket of the suction rolls with as large a free area as possible.

The free area, in this connection, should be larger than 50 percent, preferably larger than 80 percent. Such large free areas are obtained, for example, by manufacturing the jacket of so-called "expanded metal" (metal mesh). Such an expanded metal consists of narrow webs with large cavities or hollow spaces in between. In connection with very pressure-sensitive materials, it is advantageous to stretch a fine-mesh screen fabric over the jacket of the suction roll.

The diameter of the suction roll proper is not to be too small. This suction roll is to exhibit at least approximately the same diameter as the rolls in the treatment bath.

In accordingly with another feature of the present invention, it is suggested, for the purpose of removing moisture from the material between and after the solvent treatment steps, to combine a washing plant with a dryer, particularly with a sieve drum dryer, in such a manner that the washing plant is provided with a housing forming a gas-tight structural unit with the dryer. When employing a multiple-bath washing plant, it is recommended to insert a suction drum after each bath.

In many cases however, it is more advantageous to dispose a sieve drum dryer above the bath containers and to provide the inlet and outlet opening or openings in the bottom of the sieve drum dryer housing.

In order to be able to execute the finishing process in a continuous procedure with the washing and drying steps, it is suggested to dispose, after the dryer, a printing unit and/or an impregnating device, as well as a drying and/or fixing device. Here again, the housings of these devices can form a gastight structural unit with the dryer.

If desired, the dryer housing can be subdivided by partitions into individual compartments, especially in the case where the process is to be conducted with differing treatment temperatures or drying temperatures. A suitable drying medium can be air, superheated steam, or a steam-air mixture, or, if required, it is also possible to employ protective gases or a vapor, for example, solvent vapors, as the drying medium.

In place of a dryer, a sieve drum steamer can also be provided. This, then, exhibits the advantage that it is possible to conduct, in addition to the above-mentioned drying process, also steam treatments with saturated steam or superheated steam between the individual bath treatments. Such a device can accordingly be used with a substantially greater versatility.

Particularly in the case of a steamer arrangement and solvent treatments, it is advantageous to dispose the treatment baths and the sieve drums in a common housing. In such a disposal of the treatment baths and the sieve drums in a common housing, it is furthermore suggested to dispose the sieve drums directly adjoining the throughflow rolls associated with the baths, so that the material can be transferred from the throughflow rolls directly to the sieve drums, and vice versa. In such an arrangements, it is also possible to pass the material in a radically extending (pleated) manner over all of the drums. Also, the construction of this device is not complicated since no additional guide elements, such as rolls or belts, are required.

A satisfactory seal of the above-mentioned device is obtained by disposing the inlet and outlet openings for the web-shaped material in the ceiling of the housing or in the proximity of the ceiling of the housing. Since the solvents employed in this connection are substantially heavier than air, the difference in the specific gravities provides a thorough separation and sealing effect in this arrangement. It is further suggested to construct the inlet and outlet openings of the treatment chambers, particularly the washing plant, as a duct and to provide said duct with a cooling unit. The solvent entering the well thus condenses on the cooled walls of the well and runs down along said walls. At the bottom, collecting channels can be provided by means of which the condensed solvent is returned into the bath. Furthermore, it has proven to be advantageous to provide an intermediate ceiling in the housing of the washing plant, said ceiling being provided with a cooling unit. For example, the intermediate ceiling can be equipped with cooling pipes. A large portion of the solvent evaporated from the washing plant condenses on this intermediate ceiling, and at the same time, the sealing effect of the upper portion of the housing is thereby improved as well. Furthermore a constant cooling of the solvent atmosphere in the washing plant is attained. Above the intermediate ceiling, a slight suction can be maintained so that the interior of the housing in the washing plant is under a slight vacuum pressure. Thus any efflux of the solvent at the inlet and outlet of the apparatus is avoided.

In order to remove the thus-formed condensate on the intermediate ceiling, said ceiling is disposed in an inclined manner, and a condensate collecting drain is provided on its lowermost side.

It has also proven to be advantageous to construct the inlet and outlet openings of the dryer and/or the fixing unit, above a sieve drum which is subjected to a suction draft, so that the material can be introduced to the sieve drum by free fall and can again be withdrawn therefrom in a vertical direction.

In accordance with another embodiment of the present invention, it is suggested to also employ the conventional washing, impregnating, and drying devices suitable for a water treatment and to dispose these devices in a compartment or chamber which is sealed in a gastight manner. The individual devices, as well as the chambers, are then connected with the recovery plant. The chamber can be made accessible by way of doors which prevent an efflux of the solvent.

Another arrangement of the apparatus according to the present invention comprises an impregnating device, a printing device and/or a coating device enclosed in an airtight fashion and a dryer provided with a gastight housing, as well as a solvent recovery plant and a fixing device which is combined with the dryer and which makes it possible to heat the textile material, in a shock-like manner, to a fixing temperature of, for example, about 170°–250°C.

In this connection, the dryer and the fixing device can be accommodated in a common housing which is subdivided into at least two treatment chambers, wherein at least the first treatment chamber is in communication with a solvent recovery plant.

However, it is also possible, and advantageous in many cases, to dipose the dryer and the fixing plant separately from each other, thereby making it also possible to operate the fixing plant by itself. Thus between the dryer and the fixing plant there should be provided room for at least a mandrel or a cart on which the textile material is disposed in folds.

In many cases, it is advantageous, especially for dyeing processes, to construct the dryer as a duct through

which the textile material is conducted without any contact. In this connection, the drying duct can be an infrared and/or nozzle dryer, as well as a high-frequency dryer.

The impregnating device, the printing device, or coating device should be enclosed so that it is gastight, and furthermore should be connected with the dryer in a gastight manner. Ultimately, these devices can be accommodated in the dryer housing.

When providing devices having at least one sieve drum subjected to a suction draft for drying and/or fixing purposes, a simple recovery of the evaporated solvent is made possible by placing these devices in communication with a cooler wherein a large part of the solvent contained in the treatment gas can be separated by condensation. The gas which still contains a minor portion of solvent, is then recycled to the treatment plant. Accordingly, a complicated and expansive absorber for the removal of the solvent is unnecessary in this device.

Very low solvent losses are produced when disposing a cooling unit after the final dryer or fixing unit, containing at least one cooling drum subjected to a suction draft, and also when providing that the blower of this cooling drum is in communication with an absorber, so that the cooling air drawn in by the cooling drum can be conducted into the absorber where it is freed from the residual solvent. The thus-recovered solvent is recycled to the treatment plant.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only and thus are not limitative of the present invention and wherein,

FIG. 1 shows a device for the treatment of woven and knitted goods with solvents;

FIG. 2 shows a device for the treatment of loose fibrous material with solvents;

FIG. 3 shows a drying and fixing device;

FIG. 4 shows a washing device with a suction units in a longitudinal sectional view;

FIG. 5 is a cross section of the apparatus of FIG. 4;

FIG. 6 shows another embodiment of the washing and suction device in a longitudinal sectional view;

FIG. 7 shows a washing and drying device in a longitudinal sectional view; and

FIGS. 8–10 show other embodiments of the washing and drying device.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the apparatus of FIG. 1, the textile material 1 to be treated is introduced into a wet treatment device 5, sealed in a gastight fashion by means of a driven pair of rolls 4. The wet treatment devices comprises, in the first portion, a trough-shaped tank 7 which is partially filled with a solvent. The web-shaped textile material is introduced into the solvent bath, in a pleated or folded condition and remains there for a certain period of time. Thereafter, the textile material 1 is fed by way of rolls 12, which can optionally be constructed as spreader rolls, to a sieve drum 9 which is subjected to a suction draft. While on the sieve drum, the textile material 1 is subjected to an intense throughflow of the solvent. The solvent, which is drawn from the sieve drum 9, is preferably pumped back into the trough-shaped tank 7 beneath the textile material. The conveyance of the textile material in the solvent bath is likewise effected on the sieve drum. Thereafter, the textile material 1 is squeezed by passing it through a press 13, where it is substantially freed of solvents. Underneath the press rolls 13, a collecting container 14 is disposed wherein the pressed-out liquid is collected and pumped to a recovery plant. It has been generally found that the solvent liquor removed from the material by the presses is highly contaminated. However, it is possible to pump part of the solvent liquor drawn from the sieve drum 9 to the solvent recovery plant. The thus-purified solvent can then be recycled to the wet treatment device 5.

By way of conveyor belt 15, the textile material 1 passes into the dryer 19. At the inlet to the dryer, a pair of rolls 27 is associated with the conveyor belt 15. The construction of the dryer 19 essentially corresponds to the conventional sieve drum dryers. In the dryer 19, sieve drums 25 subjected to a suction draft are disposed. Also, screen covers 22 are arranged above and below the sieve drums. A fan is provided at at least one front end of each drum, said fan generating a vacuum pressure in the sieve drum 25 thereby effecting a throughflow of the treatment medium through the textile material. The treatment medium exhausted by the fan (not shown) is blown back into the treatment chamber via heating elements and through screen covers to the sieve drums 25. The screen covers 22 distribute the treatment medium uniformly over the surface of the sieve drums. The treatment medium can be air steam, air-steam mixture or other gases. On the side of the sieve drum free of material being treated, a cover member is associated with the inside surface of the sieve drums, said cover member preventing any of the treatment medium from being drawn into the sieve drum at this point. The cover member 26 of the individual sieve drums can be disposes in an offset or staggered manner with respect to each other, so that an automatic transfer of the material is effected from one sieve drum to the next sieve drum. At the outlet of the dryer, a chute or slide 28 and a roll 29 are provided.

The solvent-enriched air can be partially removed, for example, at the inlet or front end of the dryer 19, by an air exhaust means 31 and passed to the recovery plant (not shown). The air which is substantially freed of the solvent can then be recycled from the recovery plant through a duct 32 at the front end of the dryer outlet into the drying chamber. The textile material 1 removed from the drying chamber is laid down in pleats or folds or wound on a mandrel.

In the wet treatment device 5, as well as in the housing 17 surrounding the conveyor belt 15, windows 34 are advantageously provided in order to observe the textile material. Similarly, windows (not shown) can also be arranged in the housing 20 of the dryer 19.

The apparatus according to FIG. 2 has a hopper feeder (box feeder) 33 through which the loose fibrous material is passed onto a conveyor belt 16 as a uniform fleece 2. The conveyor belt 16 extends into the gastight housing of the wet treatment device 5. At the inlet of the housing 6, a pair of rolls 12 is associated with the conveyor belt 16. The fleeve 2 of loose fibrous material is then conveyed to a drum 8 essentially corresponding, with respect to its diameter, to the sieve drum 9 disposed therebehind. The fleece is pressed and squeezed between the drum 8 and the sieve drum 9 and im-

mersed into the treatment liquor. On the sieve drum **9**, the fleece is exposed to an intense throughflow of the solvent bath. From the sieve drum **9**, the fleece is then transferred directly to a press **13**. From there, the fleece passes to another sieve drum **9** disposed in a bath with squeeze rollers connected thereafter. Depending on the type of treatment and the capacity desired, several such sieve drum baths can be arranged in series. In the illustrated device three sieve drums are provided. Now, the fleece **2** passes via a conveyor belt **15** into a dryer **19** in order to remove any still adhering solvent which may be still adhering to the material being treated. This dryer **19** corresponds to that of FIG. **1** with respect to its construction. Accordingly, identical parts bear the same reference numerals.

In the device of FIG. **2**, it is not only possible to treat continuously with a solvent, web-shaped textile materials, but also garments, if the conveyor belt **16** is long enough, or if the hopper feeder **33** is removed. It is also possible to treat, by means of this apparatus, skein-like goods or parallel groups of threads.

If a longer residence time or several treatments in the solvent bath are not required, for example in impregnating processes, then the textile material **1** can be conducted directly into the last sieve drum bath, as indicated by the dot-dash lines. The trough-shaped container in FIG. **1** and the sieve drum baths in FIG. **2** can be by-passed in this way in a very effective manner. Accordingly, the illustrated devices can likewise be employed for the impregnation, sizing, high-finishing, or reinforcing textile materials.

This device shown in FIG. **3** consists of a sieve-drum impregnating wet-treatment device **5** having a gastight housing **6** which is extended to the dryer housing **20.**

The inlet of the impregnating wet-treatment device **5** is sealed by a pair of rolls **4.** A sieve drum **9** subjected to a suction draft served for guiding the material through the impregnating liquor. A portion of the treatment bath is removed from the web-shaped textile material **1** by means of a press **13.** The textile material **1** then passes via a conveyor belt **15** into the dryer chamber **23** where a sieve drum **25** subjected to a suction draft is arranged. The side of the sieve drum **25** not covered with the material being treated is shielded from the suction draft in a conventional manner by the use of a stationary cover member **26.** On one or both front ends of the sieve drum **25,** fans (not shown) are disposed for the production of the suction draft and for circulating the treatment medium, for example air.

Part of the treatment medium enriched with the solvent is conducted via an exhaust duct **31** to a recovery plant (not shown). Exhaust apertures **35** are provided for removing the solvent vapors by means of a suction.

The dryer housing **20** is subdivided by a wall **21** into the drying chamber **23** and a fixing chamber **24.** In the fixing chamber **24,** substantially higher temperatures are utilized than in the drying chamber **23.** For example, the treatment medium circulated in this fixing chamber can be heated to about 250°C. or more. The heating device in the drying chamber **23** as well as in the fixing chamber **24** can be provided in a conventional manner above and beneath the fans, or above and beneath the sieve drums. It is possible to operate with steam, oil, gas or electric heating means.

Sieve drums **25** subjected to a suction draft are also disposed in the fixing chamber **24,** the textile material being alternately guided over these drums in a conventional manner. However, it is also possible to convey the textile material on only one side, i.e. only over the upper side or the lower side thereof, along the sieve drums. Such a guidance is required for the treatment of tufted carpets. Screen covers **22** for rendering the flow uniform are disposed above and below the sieve drums.

At the outlet of the illustrated apparatus, another conveyor belt **30** is provided. However, in place of this conveyor belt, a pair of rolls or a chute can be arranged at this point. An exhaust duct **31** is also provided in the fixing chamber **24,** which duct, if required, can likewise be extended to a solvent recovery plant. However, in most cases this exhaust duct **31** vents the treatment medium to the atmosphere.

Of course, it is also possible to provide any desired number of sieve drums, for example a higher number than that illustrated, or to use one or several conveyor belts subjected to a suction draft in place of sieve drums. Also, a combination of sieve drums and conveyor belts is possible. Furthermore, a combination of sieve drums and a residence compartment containing two rows of rolls, for example, as in a hot flue can be used, over which rolls the textile material is alternately conveyed. Also, a hot flue by itself can be employed, if the textile material can withstand the tensile force occurring in a hot flue.

The apparatus of FIGS. **4** and **5** comprises a tank **7** subdivided by a transverse partition **36** into two baths **37** and **38.** In each bath, a sieve roll **9** is disposed which has liquid flowing therethrough. The material **1** to be treated is fed to the sieve roll **9** via a roll **3** associated therewith and has the liquid flowing therethrough into said roll as a result of a difference in liquid level on the outside and inside of the sieve roll. At the transfer point from bath **37** to bath **38,** a suction roll **10** is disposed outside of the treatment fluid. In the illustrated embodiment, the pereable roll **10** has a full suction zone **39** and two throttled suction zones **40.** The cover member **11** has the shape of a tube and is provided with a few bores **41** in the zones **40,** as well as webs **42** which separate the individual zone **39, 40** and **43** from one another, the latter not being subjected to a suction draft.

The material **1** can, in this connection, be a sensitive knitted material or a sensitive non-woven product. However, it can also consist of groups of threads, e.g., yarns or spun cable.

As can be seen from FIG. **5,** the sieve rolls **9** are open at one front end. At this front end a liquid collecting tank **44** with an intermediate bottom **45** is laterally disposed. A pump **47** is provided in an opening **46** in the intermediate bottom **45.** The pump motor **48** is mounted on a transom **49** outside of the treatment fluid. This transom **49,** in the present embodiment, also carried the suction unit **50** with the motor **51** for the suction roll **10.**

The device of FIG. **6** is of similar construction as the device according to FIGS. **4** and **5.** The same parts thus bear identical reference numerals. In this device, the sieve rolls **9** are suction rolls and are completely immersed in the treatment liquor. In each sieve roll **9,** a pump **52** is arranged at a front end thereof, said pump producing the suction draft. The suction rolls **10** are partially immersed in the fluid and separate the individual baths from one another in cooperation with the transverse walls **36.** Such baths are also suitable for solvent treatment. For this purpose, cover hoods (not shown) are provided.

In the device of FIG. 7, a web-shaped textile material 1 is drawn off from a stack 53 by way of a material inlet creel 3 and is conveyed via web guides 54 into a sieve drum-dryer 19. The latter contains a sieve drum 25 subjected to a suction draft, said drum being shielded from the suction draft on the side free of material by means of a cover member 26. Here, the textile material 1 is either completely dried, or dried to a constant moisture content of between about 1–2 percent. The dry textile material passes via a pair of tension rolls 4 and a vertical inlet duct 18 into the washing plant 5. The washing plant has a gastight housing 6 surrounding three sieve drum washing baths 24. Each sieve drum washing bath 24 is provided with a sieve drum 9 which has the treatment liquid flowing therethrough. After each bath 24, a pair of squeeze rollers (a press) 13 is provided. By way of a dancer roll 55, the press velocity is controlled so that even is case of a shrinking material a material feed which is low in tension is ensured. The outlet of the washing plant 5 is again constructed as a duct 18. Cooling coils 56 are also disposed above an intermediate floor 57 so that the solvent vapor which enters the space above the intermediate floor 57 can be condensed at that location. The intermediate floor 57 is arranged in an inclined fashion so that the condensate can run into a collecting drain 58 and from there can be recycled into the last bath. The web-shaped textile material 1, after leaving the duct 18, is passed by means of a conveyor belt 15 to the inlet duct 59 of the dryer disposed thereafter which dryer is divided by partition walls 80 into a drying zone or unit 19 and a fixing zone or unit 63. By free fall, the material is deposited on the sieve drum 25 subjected to a suction draft, which is arranged therebelow. The drying air or the superheated steam, or the steam-air mixture is drawn through the material by the suction draft. The evaporating efficiency is correspondingly high. The solvent-enriched air or steam passes, via an air exhaust 31, to a cooler 60 wherein a large part of the solvent vapors are collected as condensate. This condensate is recycled to the washing baths, optionally by way of a purification plant. Also the exit of the dryer is formed as a duct 59.

Subsequently, the material 1 passes, by way of a further conveyor belt 16, to a foulord or padder 61 where it is impregnated with a dye liquor and/or a bath containing a synthetic resin. Thereafter, the web-shaped textile material 1 passes, without contact, through a predrying duct 62, where it is dried to a certain moisture content by means of nozzles, radiant heat and/or by means of high frequency. It has proved to be advantageous to dry the material in this predrying duct at least to a water content of about 20–30 percent.

The residual drying and the fixing of the dyestuffs, or the condensing of the synthetic resins, take place in a subsequently disposed sieve-drum drying and fixing unit 63 having essentially the same construction as the sieve drum dryer unit 19. A cooling unit 64 is inserted after the sieve drum drying and fixing unit 63, said cooling unit containing a sieve drum 65 subjected to a suction draft. The material guided around the sieve drum 65 is cooled with ambient air, by drawing this air through the material into the sieve drum. Thereafter, the drawn-in air is passed into an absorber (not shown) where the small amounts of solvent are removed from the air and recovered. The cooling unit 64 is associated with a swing arm depositer 66, which again deposits the web-shaped material 1 in the form of a folded stack 53. However, the web-shaped material 1 can also be wound up by means of a reeling-up device (not shown).

The device of FIG. 8 contains treatment baths 5 and drying devices 19 disposed separately from one another. In the treatment baths 5, a sieve drum 9 having liquid flowing therethrough is provided. In the present example, the sieve drum 9 is subjected to a flow due to a level difference, that is, the level of the liquid in the drum 9 is substantially lower than that outside of the drum. The drum 9 is open at one front end, so that the liquid flowing through the material 1 can exit at this front end into a collecting tank (not shown). From there, the liquid is recycled into the bath by means of a pump (not shown). Guide rolls 8 are associated with the drum 9. The material 1 passes to a sieve drum 25 of the drying device 19 by way of a conveyor belt 15. The drying device 19 has a heat-insulated housing 20 containing a sieve drum 25 subjected to a suction draft. The suction draft is produced by a fan (not shown) arranged at the front end of the sieve drum. The fan is associated with a heating unit. The air drawn from the sieve drum by the fan is conducted via the heating unit back to the space 23 around the sieve drum 25. In order to render the flow of the conveyed air uniform, a screen cover 22 is provided. In the sieve drum 25, a cover member 26 is disposed on that side free of material, shielding the suction draft on this side. The material 1 thereafter passes, via another conveyor belt 16, to a second treatment bath 5 and from there, in the same manner into a further dryer 19. Any desired number of baths 5 and dryers 19 can be combined.

In the device of FIG. 9, the same baths 5 as in the device of FIG. 8 are provided. Several sieve drums 25 are disposed in a common housing 20 in this device, which housing is located above the baths 5. The inner space of the dryer 19 can be subdivided into individual treatment chambers by walls 21, as indicated by the dashed lines. The remaining structure corresponds to the dryer of FIG. 8. At the end of the device, a reeling-up device 67 can be provided. However, it is also possible to employ a device laying the material down in pleats.

In the device of FIG. 10, the baths 5 are disposed in the dryer housing 20. In this connection, the sieve drums 25 are directly associated with the pereable drums 9 in the baths 5. Such an apparatus exhibits the advantage that it is also usable for solvent and steaming treatments, and that the material 1 can be conveyed through the device in a particularly gentle manner and without any tensile stress.

What is claimed is:

1. An apparatus for the treatment of textile materials which comprises, in combination, a washing plant comprising at least one sieve drum washing bath enclosed in a gastight housing, said housing being provided with substantially vertical inlet and outlet ducts in the inlet and discharge side of the housing, an intermediate ceiling disposed in said housing, said ceiling being inclined towards the discharge end of the housing, a sieve drum dryer disposed behind said washing plant, said dryer being divided by partition means into a drying zone and a fixing zone, each of said zones containing at least one sieve drum means subjected to a suction draft, a cooling device disposed behind the sieve drum dryer and a means for recovering the material being treated from the apparatus.

2. The apparatus of claim 1, wherein another sieve drum dryer containing at least one sieve drum means subjected to a suction draft is arranged in front of said washing plant.

3. The apparatus of claim 2, wherein creel means are provided for introducing the material to be treated to the other sieve drum dryer.

4. The apparatus of claim 3 wherein a pair of tension rolls are provided for conveying the material from the other dryer to an inlet of the washing plant.

5. The apparatus of claim 4, wherein cooling means are operatively associated with the washing plant for cooling the material entering said washing plant.

6. The apparatus of claim 1 wherein cooling means are disposed in a zone defined by the intermediate ceiling and the ceiling of the washing plant.

7. The apparatus of claim 6, wherein a collecting drain is provided near an outlet of the washing plant in the vicinity of the intermediate ceiling so that vapor condensing in said zone defined by the intermediate ceiling and the ceiling of the washing plant is collected in said collecting drain.

8. The apparatus of claim 7, wherein said washing plant includes a plurality of sieve drum washing baths arranged in series, and means are provided for recycling the condensate from the collecting drain to the last bath of the series in the washing plant.

9. The apparatus of claim 1, wherein a plurality of sieve drum means are arranged in series within said washing plant and a pair of squeeze rollers are disposed behind each sieve drum means disposed in the washing plant.

10. The apparatus of claim 9 wherein dancer rolls are disposed in front of each of said pair of squeeze rolls.

11. The apparatus of claim 1, wherein the drying zone has an inlet disposed above the sieve drum means in said drying zone so that the material being treated is introduced in free fall to said sieve drum means in said drying zone.

12. The apparatus of claim 11 wherein a first conveyor belt conveys the material being treated from the washing plant to the inlet of the drying zone and a second conveyor belt conveys the material being treated from the drying zone.

13. The apparatus of claim 12, wherein the fixing zone has an inlet disposed above the sieve drum means in said fixing zone so that the material being treated is introduced in free fall to said sieve drum means in said fixing zone.

14. The apparatus of claim 13 wherein a third conveyor belt conveys the material being treated to the inlet of the fixing zone and a fourth conveyor belt conveys the material being treated from the fixing zone.

15. The apparatus of claim 14 wherein an impregnating means containing a treatment liquor is disposed in the dryer between the drying zone and the fixing zone.

16. The apparatus of claim 15 wherein roller means are provided for conveying the material being treated to, through and from the impregnating means.

17. The apparatus of claim 16 wherein a pair of squeeze rolls are disposed behind the impregnating means.

18. The apparatus of claim 17 wherein a predrying duct containing heating means is provided immediately after and above the impregnating means, the material being treated being conveyed through said duct.

19. The apparatus of claim 18 wherein the drying zone and fixing zone are each provided with exhaust ducts, said exhaust ducts communicating with cooling means.

20. The apparatus of claim 17 wherein means are provided for conveying the condensate from the cooling means to a purifying plant and for recycling the purified solvent from said purifying plant to the washing plant.

21. The apparatus of claim 1 wherein the cooling device is a sieve drum means subjected to a suction draft.

22. The apparatus of claim 1, wherein swing arm depositing means is operatively associated with the cooling device for receiving the material therefrom, said swing arm also depositing the material in a folded stack.

23. An apparatus for the treatment of textile materials which comprises, in combination, a washing plant comprising at least one sieve drum washing bath enclosed in a gastight housing, said housing being provided with substantially vertical inlet and outlet ducts in the inlet and discharge side of the housing, an intermediate ceiling disposed in said housing, said ceiling being inclined towards the discharge end of the housing, a sieve drum dryer disposed behind said washing plant, containing at least one sieve drum means subjected to a suction draft for drying the textile material, and a means for introducing the textile into and recovering the material from the apparatus.

24. The apparatus of claim 23, wherein said sieve drum dryer is divided into a drying zone and a fixing zone, each of said zones having at least one sieve drum means.

25. The apparatus of claim 23, wherein said gastight housing is provided with gas exhaust means, said gas exhaust means being connected to a solvent recovery plant whereby a solvent used in said washing plant may be recovered by said solvent recovery plant.

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