MACHINE FOR THE PROCESSING OF OPEN-WIDTH FABRICS AND RELATED METHOD

The machine comprises: a transport system (3) for transporting the fabric (T); at least one impact structure (5A, 5B) arranged in front of one end of the transport system for transporting the fabric; an accumulation area (17A, 17B) of the fabric associated to the impact structure. In the transport system blowing members (51 B) are provided so as to generate a support air flow from the bottom towards the fabric, in order to support the fabric during the motion along the transport system (3).
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"MACHINE FOR THE PROCESSING OF OPEN-WIDTH FABRICS AND RELATED METHOD"

DESCRIPTION

Technical Field

The present invention relates to a machine for processing open-width fabrics, preferably, but not exclusively, of the continuous type. More in particular, the present invention relates to a finishing machine for performing one or more of drying, tumbling, softening treatments or the like.

State of the Art

To modify the hand, i.e. the tactile characteristics of a fabric, a woven fabric or a knitted fabric, machines of various type have been designed and produced.

A first category of machines provides for a rotating basket, within which is arranged the fabric, which is treated by making the basket to rotate. These machines can operate in a continuous manner, and in this case the fabric crosses the rotating basket, entering from an end thereof and going out from the other end. Continuous machines of this type are described for example in WO-A-03004751 and WO-A-03004756.

In other configurations, the machines operate in a discontinuous manner, and therefore they process piece goods closed in a loop by joining together the head and the tail of the piece good. WO-A-2005/066407 describes an example of discontinuous machine.

These machines allow to obtain an optimum "shrinkage" of the fabric and an optimum hand, but they present major drawbacks as regards the formation of folds in the fabric, with consequent risks of non uniform processing effects. In some cases, the machines with rotating basket also tend to form knots during processing, particularly in discontinuous machines, and they require at the output a so-called rope opener machine, i.e. a machine which opens the fabric processed in rope inside the basket.

Machines are also known for discontinuous processing of fabrics closed in a loop, wherein the fabric is made to move at high speed along a closed path by means of a pneumatic device, which picks the fabric up from a collection tank and projects it at high speed against an impact grille so as to obtain a mechanical processing thereof. An example of a discontinuous machine of this
type is described in EP-A-0312509.

These machines can treat fabrics in a bath, or they can treat the dry fabric, or they can perform drying starting from a wet fabric and obtaining a dry fabric. With respect to the machines with basket, these discontinuous machines reduce the problem of the formation of the knots and folds, but they obtain a hand of lesser quality, require again a device for opening the fabric in rope at the end of processing and present problems in traction of the fabric and consequently lengthening of the fabric due to the strong stresses to which the fabric is subjected during raising from the tank below the pneumatic duct for transferring and impacting.

There are also machines for continuous drying and tumbling treatment of fabric in rope form. In this case the shrinkage of the fabric is not satisfactory, due to the tension exerted on the fabric during processing. The machines of this type allow to obtain a good hand of the fabric, but in some cases they bring to the formation of knots and, for the treatment of fabrics in rope form, they require a device for opening the fabric rope at the end of processing. Furthermore, the limited volume of high pressure air used for transferring the fabric, which cannot be changed at will due to the constraints resulting from the fact that the air is used to perform the transport and therefore the mechanical working of the fabric, involves a low ability of drying the fabric.


Continuous machines for drying and tumbling treatment of open width fabrics do not present the problem of the formation of the knots and folds and do not require the use of a rope opener at the output. However, with these machines for continuous open-width processing it is impossible to obtain good characteristics of hand of the fabric due to the excessive tension of the fabric during processing. The same factor involves a limited shrinkage of the fabric.

Also in this case, as well as in the continuous processing of fabrics in rope form, the limited volumes of high pressure air necessary for transferring the fabric require a prolonged time for obtaining the evaporation of the water from the fabric. In some cases drying cannot be achieved, as working cannot continue for a long time, as the fabric is however subjected to mechanical workings
of impact against the grilles. Therefore, the duration of the treatment is limited or in any case it depends upon the number of impacts that the fabric can tolerate or must be subjected to, in order to achieve the required textile hand characteristics. Beyond this limit the working cannot continue without damaging the fabric or in any case without altering the final characteristics thereof; therefore, in many cases these machines do not allow to dry the fabric completely.

This problem cannot be solved by drying the fabric and then subjecting it to the impact mechanical working, as this working must be done with the wet fabric, otherwise lumps of fibers form, which come away from the fabric, thus damaging it and making it unusable. Furthermore, it is not possible to perform tumbling and then drying, as in this case the fabric impacted in wet conditions, but not in bath, could produce the formation of folds and therefore of areas presenting working defects.

The document US-A-2007/266741 describes a highly versatile machine for continuous processing, which allows treatments of fabric both in width and in rope form, depending upon the requirements of the user. This machine is particularly effective, as it allows a high processing versatility, but it is subjected to the above mentioned limits which occur both in width and in rope form treatment of the fabric.

In the known machines the fabric is usually impacted pneumatically against the processing grilles using an air flow at high pressure and low rate, and this entails difficulties in obtaining the drying degree required in combination with the desired degree of mechanical processing.

Summary of the Invention

According to one aspect, an object of the present invention is to provide a machine which allows to overcome entirely or in part one or more of the drawbacks of the known machines.

The object of a preferred embodiment of the present invention is to provide a machine for finishing fabric in weft, in warp, or knitted in width form, and preferably in a continuous process, which allows to obtain an optimum effect of softening of the fabric, together with the maximum shrinkage thereof.

The object of another embodiment of the present invention is to provide a machine, which is able to perform processing of a wet fabric and if necessary adequately impregnated with a chemical product, which allows to obtain a high
drying capability of the fabric together with the effect of softening and shrinkage.

Substantially, according to one aspect, the present invention provides for a machine for processing fabrics in width form, comprising: a transport system for transporting the fabric; at least one impact structure arranged in front of an end of the transport system for transporting the fabric; an accumulation area associated with said impact structure. In the transport system flowing members are arranged, in order to generate a support air flow from the bottom towards said fabric, so as to support the fabric during the movement along said transport system. This air flow helps in lowering the tension in the fabric, by making it to "float" in the transport system, and facilitates drying. By controlling the flow rate of support air it is possible to accelerate or to slow the drying, making it at least partially independent of the mechanical working. In other words, it is possible to obtain a more or less quick drying of the fabric by setting a parameter which can vary relative to the impacting mode of the fabric.

The machine can be a machine of the discontinuous type. However, according to a preferred embodiment of the present invention, the machine is of the continuous type, with a gradual insertion of fabric at one end and gradual extraction of fabric from the opposite end of the machine. The stock of fabric contained in the machine is subjected to the finishing working or to any other working required, moving back and forth in opposite directions through the machine with a speed greater than the speed of feed into the machine and extraction from the machine. In this way each section of fabric is subjected to a multiple impact and drying treatment, moving towards and backwards for a certain number of times within the machine.

In this case the conformation of the machine can be substantially symmetrical, with a reversible transport system in front of which two impact structures and two accumulation areas are arranged.

According to preferred embodiments of the invention, the transport system is a pneumatic system, wherein the fabric is transferred by means of a high pressure-air flow. The transport system comprises in this case a duct, whose cross section is elongated in the direction orthogonal to the direction of feed of the fabric, in order to allow the treatment in open width. It is also possible to perform treatments in partially rope conditions, i.e. with the fabric not fully gath-
ered in the transverse direction. This is obtained by dimensioning the transport duct with a width lesser than the width of the fabric. In some embodiments the cross section of the transport duct can be varied so as both to be adapted to variable widths of the fabric and to treat the fabric not fully gathered in open width.

When the machine comprises a pneumatic transport duct, the blowing system is arranged preferably at the lower wall of the duct.

Further advantageous characteristics and embodiments of the machine are described hereunder and in the attached claims.

The present invention also relates to a method for treating a fabric in open width form, through feed in a transport system and impact against an impact structure. Characteristically, the method according to the present invention provides for an additional air flow which supports the fabric from the bottom to the top. This air flow can be combined with a flow of air for the transport, i.e. for causing the movement of the fabric along a pneumatic transport duct.

Advantageously, according to the present invention the air flow is used to support the fabric from the bottom to the top, for example to perform a drying of the fabric which can be controlled independently of the mechanical working thereof. If independent air flows are used, one for transporting the fabric and the other for supporting and drying, it is possible to modify the drying times independently of the mechanical processing, thus obtaining more efficient processing and end results of higher quality.

According to one aspect, the method according to the present invention allows, by supporting the fabric by means of an air flow from the bottom, to reduce the traction on the fabric during the transport thereof, thus reducing the drawbacks which, in the known machines, result from the fact that the pneumatically transported fabric is subjected to traction and therefore to elongation.

According to a further aspect, by supporting, i.e. sustaining, the fabric in a pneumatic manner through the air flow from the bottom to the top it is possible to obtain advantages also in terms of mechanical working, as the lower friction of the fabric along the transport duct or path reduces the dissipated energy and increases the kinetic energy with which the fabric is impacted against the impact structures.

According to a different aspect the present invention relates to a ma-
chine for processing fabrics in open width, comprising a transport system defining a path of feed of the fabric and comprising members for moving the fabric along the path, as well as an impact structure arranged in front of at least one of the ends and preferably in front of both the ends of the transport system, with accumulation areas of the fabric associated to the impact structure or structures. Furthermore, the transport system comprises below the path of feed and preferably also above the path of feed a series of members which generate air jets along the longitudinal development of the transport system, and these air jets are inclined so as to generate a thrust for supporting the fabric and a thrust for feeding the fabric along the path. In this case, instead of having blowing nozzles in the central area of the transport system intended only to generate the thrust for feeding the fabric and blowing apertures generating currents of air with a substantially vertical development having only the function of supporting the fabric, the two functions are combined and performed by the blowing members. Differently from other known solutions, in this case the blowing members are arranged along a substantial part of the longitudinal development of the path of feed.

In some embodiments the blowing members can be designed, arranged and controlled so as to cause an inversion in the direction of feed of the fabric along its path. This can be obtained for example by arranging blowing members fixed and oriented in opposite manner, with an alternate arrangement. A system of valves, gates or other control elements feed alternatively the ones or the others of the blowing members with different inclination, so as to push the fabric in a direction or in the opposite direction. In other embodiments the blowing members are movable, for example under the control of individual commands or under the control of a single command for more blowing members, so as to direct the flows of air in the adequate manner.

The blowing members intended for supporting and feeding the fabric can be replicated in a substantially similar manner also above the path of feed of the fabric, if necessary offsetting the lower blowing members relative to the upper blowing members. In this way it is possible to obtain an oscillation movement, i.e. an undulatory movement of the fabric along its path of feed, so as to facilitate the treatment of the fabric.

In some embodiments, above the path, or below the path, or both above
and below the path of feed of the fabric, the blowing members can be alternated with suction members so as to facilitate, increase or enhance the circulation of air and therefore the effect of feeding and drying exerted on the fabric along the path.

According to another aspect, the present invention relates to a machine for treating a fabric in continuous, preferably for performing a treatment substantially in open width, comprising: a reversible pneumatic transport duct, along which the fabric is fed through a pneumatic thrust alternatively in opposite directions; impact structures, arranged in front of the two ends of the pneumatic duct, against which the fabric is made to impact due to the effect of the pneumatic thrust; and blowing members which generate jets of air for thrust and support; and wherein means are provided to modify the flow rate of air substantially without modifying the thrust onto the fabric.

According to a further aspect, the present invention relates to a machine for continuous treatment of a fabric, preferably for performing a treatment substantially in open width, comprising: a reversible pneumatic transport duct, along which the fabric is fed through a pneumatic thrust alternatively in opposite directions; impact structures, arranged in front of the two ends of the pneumatic duct, against which the fabric is made to impact due to the effect of the pneumatic thrust; and blowing members which generate jets of air inclined relative to the direction of feed such that the air introduced in the duct by said blowing members has a component of speed parallel and a component of speed orthogonal to the direction of speed. Preferably the two components are variable so as to invert the movement of the fabric and/or to modify the overall flow rate of air independently of the pneumatic thrust generated on the fabric.

According to a further aspect, the present invention relates to a machine for continuous treatment of fabric, preferably for performing a treatment substantially in open width, comprising: a reversible pneumatic transport duct, along which the fabric is fed by means of a pneumatic thrust alternatively in opposite directions; impact structures, arranged in front of the two ends of the pneumatic duct, against which the fabric is made to impact due to the effect of the pneumatic thrust; first blowing members which generate jets of air inclined relative to the direction of feed such that the air introduced in the duct by said blowing members has a component of speed parallel to the direction of speed...
so as to generate a pneumatic thrust; and second blowing members which gen-
erate jets of air with at least one component substantially orthogonal to the di-
rection of feed for supporting the fabric and/or for increasing the drying effect. 
Preferably, the first and second blowing members can be adjusted independ-
ently of each other, for example to increase the pneumatic thrust without in-
creasing the overall flow rate of air, or for increasing the overall flow rate of air 
without increasing the thrust, and vice versa.

In these embodiments, the present invention provides a machine for con-
tinuous treatment of a fabric through impact, if necessary during a drying 
phase, with the possibility of adjusting in a flexible manner the speed of drying 
and/or the thrust of support and/or the speed of feed and therefore the kinetic 
energy of the impact against the impact structures, with consequent adjustment 
of the overall speed of the mechanical treatment.

Further characteristics and embodiments of the method according to the 
present invention will be described hereunder and in the attached claims, which 
form an integral part of the present description.

**Brief description of the drawings**

The invention will be better understood by following the description below 
and the attached drawing, which shows a non-limiting practical embodiment of 
the invention. More in particular, in the drawing:

figure 1 shows a perspective view of a machine according to the present 
invention with some parts removed;

figure 2 shows a view analogous to that of figure 1 with the transport duct 
open;

figure 3 shows a longitudinal section of the transport duct;

figure 4 shows an enlargement of the section of figure 3;

figure 5 shows a partially sectioned perspective view of a machine ac-
cording to the present invention in a different embodiment;

figure 6 shows a schematic longitudinal section of the central area of the 
machine of figure 5; and

figure 7 shows a longitudinal section similar to that of figure 6 in a further 
embodiment of the machine.

**Detailed description of an embodiment of the present invention**

Figs. 1 to 4 show a first embodiment of a machine according to the pre-
sent invention.

The machine, indicated as a whole with the number 1, comprises a pneumatic transport duct 3, with an approximately rectangular elongated cross section, and therefore characterized by a limited height and by a high development in the transverse direction of the machine, so as to allow the transport of a fabric in open width. The pneumatic transport duct 3 forms part of a pneumatic transport system of the alternate type to move in opposite directions a fabric T, constituted by a knitted or woven fabric, and to cause the impact thereof alternatively against the one or the other of two fixed impact structures 5A and 5B arranged in front of the two ends of the duct 3.

The feed of the fabric T along the transport duct 3 occurs by means of a flow of air fed through a system of feed and ducts which give an adequate flow rate of air at the adequate pressure in a central area of the pneumatic transport duct 3. In some embodiments, the transport air is fed to the pneumatic transport duct 3 by means of a fan 5, at the outlet of which a duct 7 is connected, which subsequently subdivides into an upper duct 7A and a lower duct 7B in fluid connection with nozzles with linear development, which extend transversally through the width of the duct 3, as better illustrated in figure 3 and as will be described hereunder. The air flow rate in the two ducts, the upper one 7A and the lower one 7B, can be controlled through gates 9A and 9B suitably arranged along said ducts, for example in the connecting area between the ducts 7A, 7B and the common supply duct, coming from the central fan 5.

As visible in the longitudinal section of figure 3, the ducts 7A, 7B can be put into communication with nozzles 11A, 13A and 11B, 13B arranged respectively above and below the substantially approximately horizontal median plane of the pneumatic transport duct 3. The nozzles 11A, 13A are oriented in opposite directions so as to push a flow of air towards the one or the other of the two ends indicated with 3A and 3B in figure 3 of the pneumatic transport duct 3, in front of which the impact structures 5A, 5B are arranged, which, in the illustrated example, are grille-shaped. These structures can however assume any suitable conformation, preferably such a conformation to allow the outflow of the air through the structure from the front part oriented towards the pneumatic transport duct 3 towards the back part, from which the air is taken again in the manner which will be described hereunder.
To the ducts 7A, 7B valves or gates 15A, 15B are associated, which, rotating according to the double arrow indicated in figure 3, allow to divert the flow of air towards the nozzles 11A, 11B, or towards the nozzles 13A, 13B. The movement of the gates or valves 15A, 15B is controlled in such a manner that they are either both in the position of figure 3 or both in the rotated position to convey the air to the nozzles 11A, 11B, so as to obtain a correct flow of transport air in one or the other direction of feed of the fabric T, indicated in figure 3 by the arrows FS and FD.

The fabric T hit by the inclined jets of air generated by the nozzles 11A, 11B or 13A, 13B, impacts at high speed against one or the other of the impact structures 5A, 5B, and then it falls in a collection or accumulation area or tank below. In figures 1 and 2 the collection areas are indicated with the numbers 17A, 17B respectively, and are defined by curved plates into which the fabric T falls after having impacted the structure 5A or 5B respectively.

As it is shown in particular in figure 3, at the two ends 3A and 3B of the pneumatic transport duct 3 motorized rollers 19A and 19B are arranged, which facilitate lifting of the fabric from one or the other of the two accumulation areas 17A, 17B, so as to facilitate the insertion thereof in the corresponding mouth of the pneumatic transport duct 3. In the operating condition of figure 3, the fabric is fed inside the mouth 3A of the duct 3 by means of the motorized roller 19A which facilitates lifting of the fabric.

At the opposite side, i.e. at the end 3B, the fabric T exits with a trajectory developing substantially above the corresponding motorized roller 19B, and then it impacts against the impact structure 5B. As the arrangement of the pneumatic transport duct 3 can vary so as to reverse the direction of impact of the fabric (arrows FS and FD), with an arrangement of this type, wherein at the exit end the fabric T is not in contact with the respective motorized roller 19A, 19B, it is possible to maintain the two rollers 19A, 19B rotating always in the same direction, indicated by the arrows in figure 3, i.e. in the direction which facilitates the feed of the fabric inside the duct 3 through the respective end 3A, 3B. Therefore, it is not necessary to modify the direction of rotation of the rollers 19A, 19B in a manner synchronized with the rest of the machine, with consequent simplification of the structure of the machine.

In some embodiments, the accumulation areas 17A, 17B are housed in
spaces 21A, 21B of the machine connected at the top with suction hoods 23A, 23B. The suction hoods are arranged at the opposite side from the ends 3A, 3B of the pneumatic transport duct 3 relative to the corresponding impact structure 5A, 5B. In this way, by extracting the air through the hoods 23A, 23B the effect of transfer of the fabric obtained by means of the flow of air injected in a direction or in the other in the pneumatic transport duct 3 through the nozzles 11A, 11B or 13A, 13B, increases.

The suction hoods 23A, 23B are connected, through ducts 25A, 25B, to a common suction duct 27 of a fan 29, which ejects the sucked air through a chimney 31.

The flow rate of air sucked through the hoods 23A, 23B and ejected through the fan 29 and the chimney 31 is only a part of the air circulating inside the machine, as a significant part of the flow rate of air exiting from one or the other of the ends of the pneumatic transport duct 3 is sucked through the one or the other of two suction mouths, one of which is indicated with the number 33A in figures 1 and 2 (the other being arranged in a symmetrical manner on the opposite side of the machine, not visible), inside a heating battery 37 arranged nearly below the pneumatic transport duct 3. Inside the battery 37 heating and/or conditioning means are arranged, for example a heating system with a burner, or an electric heating system, a diathermal oil system or a system of any other nature. In this way the air sucked through the mouth 33A, or the opposite corresponding mouth in the space 21B, is brought to the required temperature to be injected again inside the pneumatic transport duct 3. The quantity of recirculated air relative to the quantity of ejected air can be adjusted. By ejecting the air through the chimney 31 the humidity extracted from the fabric T under processing is discharged. By using again the air coming from the pneumatic transport duct the consumption of energy necessary for the heating decreases.

The air is taken from the battery 37 through the already mentioned fan 5 to feed the pneumatic transport nozzles 11A, 11B, 13A, 13B. The connection between the fan 5 and the battery 37 is not shown for the sake of clarity of the drawing. A further flow rate of air is sucked from the battery 37 by means of a different suction system, which injects air in the duct 3 according to a direction nearly orthogonal to the direction of transport of the fabric as described below.
At this end, in some embodiments two separate fans 41A and 41B are provided. It is also possible to provide for a single fan which has two separate supply ducts for the purposes described below. According to some embodiments, the two fans 41A, 41B can be adjusted independently one of the other, for example through respective inverters, to modify the flow rate of air on the two faces of the fabric T. If only one common fan is provided, it is possible to provide systems of valves or gates analogous to that indicated with 9A, 9B and previously described. It is also possible to use only one fan instead of three fans 5, 41A, 41B, with a suitable system for regulating the flow rate and the pressure in the downstream ducts towards the pneumatic transport duct 3. However, this configuration is more complex and difficult to be controlled and adjusted.

In the illustrated embodiment the fans 41A and 41B are connected through respective ducts 43A, 43B to an upper plenum 45A and to a lower plenum 45B respectively. The plenum 45A is in turn in fluid connection with two upper distribution boxes 47A, 47B, whilst the plenum 45B is in fluid connection with two lower distribution boxes 49A and 49B partially shown in figure 1 and in figure 2. The boxes 47A, 47B are arranged above the pneumatic transport duct 3, whilst the boxes 49A, 49B are arranged below the duct.

As it is shown in particular in the section of figure 3, the air injected through the duct 43A and the plenum 45A in the boxes 47A, 47B, flows inside the pneumatic transport duct 3 through apertures or holes 51A provided in the upper wall of the duct 3. In some embodiments, the apertures 51A can have a circular cross section, but it is also possible to use other shapes, for example rectangular, square or any polygonal shape with a given number of sides. It is also possible to provide apertures 51A with elongated shape, i.e. slots, oriented towards the direction of feed of the fabric or in a direction transverse relative to the feed of the fabric.

As it can be seen in particular in the enlargement of figure 4, the apertures 51A are preferably obtained through deep-drawing of the sheet 53A which forms the upper wall of the pneumatic transport duct 3, so that each aperture 51A is surrounded by an area of sheet curved towards the inside of the respective box 47A or 47B. In figure 4 the curved areas of the sheet 53A are indicated with 55A. This curvature 55A of the sheet 53A avoids the presence of edges
along the surface delimiting the pneumatic transport duct 3 at the top. Therefore the fabric T being fed in one or the other direction inside the duct 3, is not damaged even if it enters into contact with the upper surface defined by the sheet 53A.

Below the path of the fabric T a similar arrangement of apertures 51B delimited by curved areas 55B of a sheet 53B defining the lower wall of the pneumatic transport duct 3 is provided. The curvature of the sheet 53B in 55B has the same purpose as the curvature 55A described above. According to some embodiments, the upper apertures 51A are offset relative to the lower apertures 51B, as shown in figure 4, although a configuration would also be possible, wherein these apertures 51A, 51B are in reciprocal correspondence.

The lower apertures 51B therefore form a blowing system for the generation of a flow of supporting air from the bottom to the top of the fabric T during the feed thereof, whilst the apertures 51A form secondary pneumatic members (blowing or sucking) which generate a flow of air discordant or concordant with that generated by the blowing pneumatic system defined by the lower apertures 51B.

In this way the fans 41A, 41B inject inside the pneumatic transport duct 3 a high flow rate of air which acts from the bottom to the top on the fabric T through the apertures 51B and from the top to the bottom through the apertures 51A. In some embodiments the flow rate from the bottom to the top through the apertures 51B is greater than the flow rate through the upper apertures 51A. In other embodiments the apertures 51A can be omitted with all the set of air supply ducts; in this case inside the pneumatic transport duct 3, in addition to the transport air through the nozzles 11A, 11B, 13A, 13B, only air from the bottom to the top is injected for supporting the fabric T. In other embodiments, it is also possible to provide that through the apertures 51A air is sucked from the pneumatic transport duct 3 inside the boxes 47A, 47B by inverting the arrangement of the fan 41A, which in this case can make the sucked air to circulate again, injecting it inside the battery 47, or it can discharge it towards the outside injecting it in a chimney similar to that indicated with 31 for the fan 29. In some embodiments, when through the boxes 47A, 47B a suction is performed from the pneumatic transport duct 3 towards the fan, it is possible to provide that the air sucked through the boxes 47A, 47B is ejected from the ma-
chine whilst the air sucked through the hoods 23A, 23B is made to recirculate inside the machine.

With an arrangement of this type, substantially two functions are obtained: on the one hand, the fabric T is supported inferiorly and it is made to "float" by the flow of air coming from the apertures 51B. This effect decreases the tension in the fabric during the transport both in one direction and in the other (arrows FS and FD). The second effect obtained is the increase of the flow rate of air which strikes the fabric under processing. Whilst the air injected from the nozzles 11A, 11B, 13A, 13B is of low amount and at high pressure, so as to impart the required speed to the fabric T in order to impact it against one or the other of the impact structures 5A, 5B, the air injected through the apertures 51B and, if necessary, through the apertures 51A (or sucked through the apertures 51A) can be air at low pressure and high amount. This additional air, in addition to give a floating effect of the fabric decreasing the tension thereof, also allows to accelerate in a controllable manner the drying of the fabric, which is therefore to a large extent independent of the mechanical processing. The flow rate of air from the bottom and from the top of the fabric can be adjusted in a suitable manner, so as to obtain the required force for supporting the fabric, and an adequate drying effect. As observed, the upper flow rate can also be lower or it can be absent, for example by closing the corresponding duct, or stopping the corresponding fan. In other cases the flow rate from the top could be not provided, or it could be negative (suction).

Using independent air ducts for the pneumatic transport (nozzles 11A, 11B, 13A, 13B) and for floating and drying (apertures 51A, 51B) it is possible (dosing the quantity of air through the apertures 51A, 51B) to slow down or to accelerate the drying of the fabric relative to the impacting thereof against the impact structures 5A, 5B.

In a known manner, the machine 1 described above can be inserted inside a continuous processing line, which provides one or more additional sections upstream and/or downstream of the machine 1 and/or systems for the fabric to enter into or to exit from the spaces 21A, 21B.

The machine described above operates in all as follows: Firstly, the desired quantity of fabric is loaded inside the machine, forming a stock in one or in the other of the areas 17A, 17B of the spaces 21A, 21B. In the illustrated ex-
ample, one can assume that the stock of fabric is loaded in the area 17A, bringing an end of the fabric through the machine till the opposite exit. Once the fabric has been loaded, the flow of transport air is actuated, generated by the fan 5, so as to transfer the fabric from the accumulation area 17A towards the accumulation area 17B, so as to cause the impact of the fabric against the impact structure 5B, until the stock in the accumulation area 17A is all but finished. This condition is detected for example through load cells in a known manner, or through any other sensor or suitable detecting means.

Once the stock is finished or all but finished in the accumulation area 17A, the position of the valves 15A, 15B is inverted so as to invert the direction of feed of the fabric inside the transport duct 3 and therefore to extract it from the accumulation area 17B, with the aid of the roller 19B, and to impact it against the impact structure 5A. Once the stock in the accumulation area 17B is finished, the cycle is inverted again. All the process is performed for the time necessary to obtain the mechanical working of the fabric and/or the drying thereof till the desired degree. The air blown orthogonally or nearly orthogonally to the fabric through the apertures 51A, 51B, or the air injected through the apertures 51B and sucked through the apertures 51A, contributes to reduce the traction stresses on the fabric, by making it floating inside the duct 3, and dries the fabric in a manner independent from the mechanical processing thereof.

If the machine is configured for continuous working, the fabric is made to move slightly forwards as a whole from one of the two ends of the machine towards the other, feeding in a gradual manner the fabric in the space 21A and picking it up in a gradual manner from the space 21B. In this way each section of the fabric remains inside the machine for a prolonged time and is subjected to a series of impacts by reversing the feeding inside the pneumatic transport duct 3, and going therefore to impact against the impact structures 5A, 5B alternatively. The control of the feed of the fabric is so that after the required quantity of impacts and/or the required time inside the machine, each section of fabric is extracted and if necessary inserted in a section downstream so as to be subjected to other processing or wound in a roll, or accumulated in folders in a cross-lapper or other.

Figures from 5 to 7 show a different embodiment of the machine according to the invention in two possible variants.
With initial reference to figures 5 and 6, the machine, indicated as a whole with the number 101, comprises a pneumatic transport duct 103, whose configuration will be better illustrated with reference to figure 6.

Means for supplying air are associated to the pneumatic transport duct 3, being part of a transport system in which the path of feed of the fabric is defined. In some embodiments, to the transport duct 103 is associated a plenum or an upper storage tank 104, to which the air is supplied from a forced-draught fan 105 through a duct 107. In some embodiments, to the transport duct 103 is furthermore associated a plenum or upper storage tank 110, to which the air is supplied from a fan 106 through a duct 109.

In front of the ends of the duct 103 opposite impact grilles 113 are arranged, each of which is articulated around a substantially vertical axis 113A so as to be lifted and brought off-working, so as to allow a treatment in an alternate manner of the fabric, schematically indicated with T, according to what is better described below. Below the grilles 113 forming the impact structures of the machine, cradles 115 are arranged, oscillating around respective substantially horizontal axes 115A, for the purposes described below. In some embodiments, behind and preferably above the grilles 113 suction hoods 117 are arranged, connected to a duct 119, to which a suction fan 121 and if necessary a filter 123 are associated.

The air supplied to the transport system, comprising the pneumatic transport 103, by the forced-draught fans 105, 106 through the ducts 107, 109, is recovered and sucked through the hoods 117 and the duct 119 by means of the suction fan 121, so that a balanced flow is substantially generated, partially pushed by forced-draught fans and partially sucked by the suction fan.

Thanks to a valve 122 arranged in the duct 119, the suction is exerted alternatively through the one or the other of the two suction hoods 117, according to the conditions of feed of the fabric, as described below. In a modified embodiment, the valve 122 is omitted and the suction is continuous through both the suction boxes 117.

In some embodiments, a part of the air coming from the pneumatic transport duct 103 can be taken again and returned into circulation, instead of being ejected through a chimney 121A connected to the suction fan 121. At this end, below the cradles 115 apertures 116 are provided, through which the air
can be sucked and transported through ducts 118 to the entrance of the forced-draughts fans 105, 106. Rotating filters can be associated with the apertures 116.

The structure of the pneumatic transport duct 103 is shown in figure 6 in detail. In some embodiments, the pneumatic duct 103 has a limited height H and a great width in a direction orthogonal to the plane of figure 6, and more in particular a width which allows the fabric T to advance in an arrangement substantially in width, i.e. substantially extending in the cross direction, i.e. in the direction of the height of the fabric which represents the cross direction of the machine. In some embodiments it is possible to provide that the fabric is not integrally extending in cross direction, but its transverse dimension is greater than the transverse dimension of the duct 103.

In some embodiments the pneumatic transport duct 103 is defined by an upper wall 103A and by a lower wall 103B. To the lower wall 103B blowing members 131 are associated, having preferably the shape of ducts with a cross section elongated transversally to the machine direction and to the direction of feed F of the fabric along the pneumatic transport duct 103. These blowing members terminate into apertures 131A in the lower wall 103B of the pneumatic transport duct 103, which have walls inclined by opposite angles α relative to the longitudinal direction of the duct 103.

As it is understood from the diagram represented in figure 6, by modifying the inclination of the blowing members 131 bringing them from the position illustrated in continuous line to the position illustrated in dotted line in figure 6, flows of process air are generated indicated by the arrows in the figure with a speed having a component oriented in one or the other of the two directions of feed of the fabric T inside the pneumatic transport duct 103. The inclination of the blowing members 131 can be controlled for example by an actuator for each blowing members, or with a single common actuator and a transmission system, for example a bar hinged to the singles flowing members 131. Independently of the system used for controlling and modifying the inclination of the blowing members 131, these all will be preferably oriented in one or the other of the directions represented in figure 6 in a dotted line and as a continuous line respectively. It is also possible to provide some of the blowing members 131 oriented in a direction substantially orthogonal to the direction of feed F of the
fabric T in the pneumatic transport duct 103. However, in general a high num-
ber of and preferably the major part of the blowing members 131, or all the
blowing members 131 will be oriented in the same direction so as to exerted in
various points of the pneumatic transport duct 103 a support thrust in vertical
direction (i.e. substantially orthogonal to the direction of feed) and a thrust in
the direction of feed on the processed fabric T.

An arrangement of blowing members 132 substantially similar to that of
the blowing members 131 is associated to the upper wall 103A of the pneu-
matic transport duct 103. As shown in the diagram of figure 6, a relevant part
of, or preferably all the blowing members 132 are oriented in the same direc-
tion, concordant with that of the lower blowing members 131. In this way on the
fabric T a thrust in the direction of feed is generated also above the fabric and
not only below it. The jets generated by the blowing members 132 are such as
to cause also a thrust substantially orthogonal to the direction of feed.

In some embodiments, along the lower wall 103B and/or along the upper
wall 103A of the pneumatic transport duct 103 suction areas can be provided,
arranged for example only in some zones or in an alternate manner between
the blowing members 131 and/or between the blowing members 132. In the
embodiment shown in figure 6, suction zones or members 133 are provided
along the lower wall 103B of the pneumatic transport duct 103, in alternate po-
sition relative to the positions of the blowing members 131. A similar arrange-
ment of suction members 135 is provided along the upper wall 103A of the duct
103. Preferably, at least in some areas of the pneumatic transport duct 103, the
blowing members 131, 132 are arranged in reciprocally offset positions along
the direction of the path of feed of the fabric T in the duct 103.

Thanks to this arrangement, due to the effect of the thrust orthogonal to
the fabric exerted by the inclined air jets, the fabric takes an undulatory path, as
schematically indicated in figure 6. This effect can be emphasized by the alter-
nate arrangement of the suction members 133, 135. These latter, being pref-
errably arranged alternating with the blowing members 131, 132, will be offset
with respect to one another. The suction members 133, 135 allow an extraction
of air from the pneumatic transport duct 103 in different positions along the de-
velopment of the duct, so as to have inside the duct 103 a circulation of air with
a flow rate greater than that necessary to obtain the impact of the fabric against
the grilles 113. In this way, it is possible to make the mechanical impact effect independent from the drying effect, allowing for example to increase the quantity of humidity removed from the fabric in the unit of time without increasing the transport speed of the fabric and thus without increasing the kinetic energy of the impact of the fabric against the grilles 113. In some embodiments each suction member 133, 135 can be provided with a sort of hood 133A, 135A, inside which the air gathers and from which the air is extracted, which enters into it through holes 133B, 135B provided in the corresponding zones of the wall 103B and 103A respectively.

The hoods 133A, 135A can be connected to the ducts 119, for example by the interposition of gates or flow rate regulating valves, so as to adjust the flow rate of air through the suction members 133, 135, according to the processing requirements. It is also possible to provide different adjustments for the upper and lower suction members 135, 133 respectively, or also independent adjustments for each suction member 133 and for each suction member 135 or for group of said members. Adjusting the suction through the hoods 135A, 133A of the suction members 135 and 133 allows to modify the quantity of air fed in the pneumatic transport duct 103 which does not contribute to mechanical processing, i.e. to the thrust of the fabric against the grilles 113, but which mainly serves for conditioning of the fabric, i.e. for removing the humidity therefrom.

It is also possible to put the hoods 133A and 135A directly into communication with the plenum 110 and 104 respectively.

The function of this machine is clearly apparent from the description above. The fabric T is fed in continuous to the machine in a known manner, and it forms a stock of fabric on the input cradle 115 and on the output cradle 115. The overall speed of the fabric across the machine is substantially lower than the speed with which the fabric is fed along the pneumatic transferring duct 103 in the two directions alternatively, so that each portion of fabric is subjected to a certain number of movements in opposite directions inside the pneumatic feed duct 103.

For this purpose the blowing members 131 and 132 are oriented in one phase in a first direction (for example in the position illustrated with a continuous lines in figure 6) so as to feed the fabric forming the stock in one of the two
cradles 115 towards the opposite cradle 115. Because of the speed pneumatically imparted to the fabric by the air injected in the pneumatic transport duct 103, the fabric impacts against the grille 133 on the exit side, thus being subjected to a mechanical processing. Once the stock in the first cradle is finished or all but finished, the angles of inclination of the blowing members 131, 132 are changed, so as to invert the direction of feed of the fabric T in the duct 103, so that the fabric is fed from the cradle, in which the stock accumulated, to form again a new stock in previously emptied the cradle. This movement combined with the slow movement of gradual feed of the fabric allows continuous working.

The exhaustion of the stock on the cradles 115 can be detected by means of a load cell or in other suitable manner.

To facilitate the operation of the machine and to decrease or anyway to reduce the tension to which the fabric is subjected when it is inserted in the pneumatic transport duct from the respective cradle in which the stock has been formed, it is also possible to oscillate upwards that cradle 115 from which the stock is extracted to be subjected to the treatment in the pneumatic transport duct 103 and against the opposite impact grille 113. In order to allow the lifting of the cradle 115, the above grille 113 which remains temporarily inactive is lifted All this clearly appears from the diagram indicated in figure 6, where one of the grilles is lifted to facilitate the extraction of the stock, whilst the other is lowered to collect the fabric which impacts against the above grille, which is in working position.

In figure 7 a modified embodiment of the machines of figures 5 and 6 is shown. The same reference numbers indicate the same or equivalent parts to those described with reference to figures 5 and 6 and they will be not described again. The embodiment of figure 7 differs from the embodiment of figures 5 and 6 in that the lower blowing members 131 and upper blowing members 132 are fixed instead of oscillating, and in that the direction of feed of the fabric is reversed by actuating one or the other of two series of blowing members having alternate inclinations both above and below the path of feed of the fabric. More in particular, in figure 7 the number 131X indicates the blowing members oriented from the left to the right in the figure, whilst the number 131Y indicates the blowing members oriented from the right to the left. With reference to the upper part of the pneumatic transport duct 103, reference numbers 132X and
132Y indicate the two series of blowing members oriented from the left to the right and from the right to the left respectively. With this arrangement the fabric is pushed from the left to the right actuating the blowing members 131X and 132X. The air jets generated by these blowing members, in fact, have a component oriented from the left to the right (in the figure) in addition to a component oriented in vertical direction to impart to the fabric the support force and the undulatory movement. When the stock in the left cradle 115 (which has been brought in lifted arrangement) is exhausted, the above mentioned cradle is lowered, whilst the opposite one is lifted together with the corresponding grille 113 and the direction of feed of the fabric is reversed by deactivating the blowing members 131X, 132X and actuating the blowing members 131Y and 132Y.

It is also possible to provide some blowing members oriented orthogonally to the direction of feed of the fabric, or to provide blowing members inclined in the two directions only in the lower part or only in the upper part of the pneumatic transport duct 103, although this is less advantageous.

Preferably, as noted above, the blowing members 131, 132, 131X, 132X, 131Y, and 132Y will have exit mouths with a substantially slot-shaped development, i.e. elongated in the cross direction, i.e. orthogonally to the machine direction represented by the arrow F (direction of feed of the fabric). It is also possible for each blowing member to comprise a row of blowing mouths, for example circular or elliptical in shape, aligned in the cross direction, although this is less advantageous.

In some embodiments it is also possible that the inclination of the air jets can be adjusted, and not only set between two fixed values. In this way it is possible to obtain a further adjustment possibility, for example it is possible to adjust the flow rate of supporting and drying air, maintaining the thrust on the fabric constant. In fact, increasing or decreasing the angle of the flow jet relative to the direction of feed of the fabric, with the same air flow rate, the component of the air speed parallel to the direction of feed of the fabric decreases or increases, and thus the thrust on the fabric decreases or increases. Alternatively, by regulating the inclination of the air jets it is possible to maintain the component of thrust on the fabric unchanged, increasing or decreasing the air flow rate. This can be useful for example to maintain a given degree of mechanical treatment constant on the fabric (i.e. for example a constant impact kinetic en-
ergy and a constant number of reversals of the movement over the time unit) increasing or decreasing the drying air flow rate according to the requirements. For example, if the fabric shall be dried in a more energetic manner it is possible to increase the air flow rate and to increase the angle of incidence of the air on the fabric, so as to maintain the thrust component constant, so that the fabric is subjected to a more energetic drying without an increase of the pneumatic thrust on it. Vice versa, if the drying is too fast, it is possible to decrease the air flow rate by reducing the angle of incidence on the fabric, so as to maintain the pneumatic thrust at a sufficient level. In other situations, it should be necessary to increase or to decrease the thrust without increasing or decreasing the air flow rate and therefore the drying speed; in this case, it will be possible to increase or decrease the air speed component parallel to the direction of feed of the fabric by varying the inclination of the air jets, without however varying the flow rate.

Substantially, in this way a machine is obtained, in the pneumatic transport duct of which inclined air jets are generated to generate a pneumatic thrust of feed on the fabric, which are designed so that the direction of feed of the fabric in the pneumatic transport duct can be reversed and the air flow rate can be varied without varying the pneumatic thrust of feed of the fabric or vice versa. The same function is obtained in the embodiment of figures 1 to 4, separating the thrust function from the supporting function, so that the support air jets can increase or decrease in rate without significantly affecting the thrust, but increasing or decreasing the drying speed.

It should be understood that the embodiments described above with reference to the various attached figures can be also combined with each other.

In figures 6 and 7 the upper and lower blowing members 131, 132 are offset relative to each other, and intercalated with suction zones. In other embodiments it is possible to provide that the upper and lower blowing members 131, 132 correspond to each other and/or that further suction zones 133 are provided intercalated with consecutive upper blowing members 131 and/or with lower blowing members 132, or that these suction zones are completely omitted.

It is understood that the drawing only shows an example provided by way of a practical arrangement of the present invention, which can vary in forms and
arrangements without however departing from the scope of the concept underlying the invention. Any reference numbers in the appended claims are provided for the sole purpose of facilitating reading of the claims in the light of the description and the drawing, and do not in any manner limit the scope of protection represented by the claims.
CLAIMS

1. A machine for the processing fabrics in open width form, comprising:
a transport system defining a path of feed of the fabric and comprising handling
members for transporting the fabric along said path; at least one impact struc-
ture arranged in front of one end of said transport system for transporting the
fabric; a fabric accumulation area associated to said impact structure; charac-
terized in that in said transport system blowing members are provided, in order
to generate a supporting flow of air from the bottom towards said fabric, to sup-
port the fabric during the movement along the path of feed of the fabric in said
transport system.

2. The machine as claimed in claim 1, characterized in that said trans-
port system comprises reversible handling members suitable to feed said fabric
in opposite directions in said transport system, and in that in front of the two
opposite ends of the transport system respective impact structures are provided
for impacting the fabric, to each of which a respective accumulation area is as-
associated.

3. The machine as claimed in claim 1 or 2, characterized in that said
transport system comprises a transport duct.

4. The machine as claimed in claim 3, characterized in that said trans-
port system is a pneumatic transport system, which includes nozzles for inject-
ing air under pressure in said transport duct, said air under pressure drawing
said fabric in a direction of transport along said transport duct.

5. The machine as claimed in claim 4, characterized in that said pneu-
matic transport system comprises transport air nozzles oriented in opposite di-
rections and arranged in a central area of said transport duct.

6. The machine as claimed in claim 5, characterized in that said trans-
port air nozzles are arranged above and below the path of the fabric in said
duct, so as to act on opposite faces of said fabric.

7. The machine as claimed in claim 3, 4, or 5, characterized in that said
blowing members comprise nozzles arranged on a lower surface delimiting the
transport duct.

8. The machine as claimed in claim 7, characterized in that said noz-
zles are formed by apertures provided on a sheet defining the lower wall of said
duct, said apertures being surrounded by a curve portion of the sheet, oriented
downwards, to form rounded edges surrounding said apertures.

9. The machine as claimed in one or more of claims 3 to 8, characterized in that in said transport duct secondary pneumatic members are provided on an upper wall of said duct.

10. The machine as claimed in claim 9, characterized in that said secondary pneumatic members comprise blowing apertures.

11. The machine as claimed in claim 9, characterized in that said secondary pneumatic members comprise suction apertures.

12. The machine as claimed in claim 10 or 11, characterized in that said secondary pneumatic members comprise apertures provided on a sheet defining the upper wall of said duct, said apertures being surrounded by a curved portion of the sheet, oriented upwards, to form rounded edges surrounding said apertures.

13. The machine as claimed in claim 8, 10, 11, or 12, characterized in that it comprises a fan common to said secondary pneumatic members and said blowing members which generate the flow of support air from the bottom towards said fabric.

14. The machine as claimed in claim 9, 10, 11 or 12, characterized in that it comprises two distinct fans, for said secondary pneumatic members and for said blowing members respectively, which generate the flow of support air from the bottom towards said fabric.

15. The machine as claimed in one or more of the previous claims, characterized in that said blowing members are arranged and designed so as to generate air jets having such an inclination with respect to said path of feed of the fabric as to exert, in addition to a supporting air flow, also a thrust of feed on the fabric in the direction of feed of the fabric along said path.

16. The machine as claimed in claim 15, characterized in that said air jets form the handling members for moving the fabric along the path of feed.

17. The machine as claimed in claim 15 or 16, characterized in that said blowing members are arranged and designed so as to generate air jets having variable inclinations so as to obtain a feed of the fabric in opposite directions along said path of feed.

18. The machine as claimed in claim 17 or 18, characterized in that said blowing members are arranged and designed so as to assume adjustable incli-
nations according to the thrust to be exerted on the fabric.

19. The machine as claimed in claim 17 or 18, characterized in that said blowing members are movable between at least two positions with opposite orientations relative to the path of feed of the fabric, to generate a thrust on the fabric alternatively in one direction or in the opposite direction and to cause the feed thereof in one direction or in the opposite direction along said path.

20. The machine as claimed in claim 17, characterized in that it comprises, at least below the path of feed of the fabric, two series of blowing members, wherein the blowing member of one series have inclination opposite to that of the blowing members of the other series, the blowing members of the one and of the other series being actuated alternatively so as to reverse the direction of feed of the fabric along the path of feed.

21. The machine as claimed in one or more of the previous claims, characterized in that above and below the path of feed of the fabric blowing members are arranged alternated with suction members.

22. The machine as claimed in one or more of the previous claims, characterized in that to said impact structure or structures fabric accumulation cradles are associated, provided with a lifting and lowering movement to facilitate the feed of the fabric from the accumulation cradle to the transport system.

23. The machine as claimed in one or more of the previous claims, characterized in that it comprises blowing members both above and below the path of feed of the fabric, the blowing members arranged above the path of feed of the fabric being offset in the direction of feed of the fabric with respect to the blowing members arranged below the path of feed.

24. The machine as claimed in one or more of the previous claims, characterized in that: said transport system comprises a pneumatic transport duct, with air jets inclined so as to generate a pneumatic thrust for feeding the fabric, said inclined air jets being reversible to reverse the direction of feed of the fabric in the pneumatic transport duct, and in that means are provided for varying the air flow rate without varying the pneumatic thrust for feeding the fabric and vice versa.

25. A method for processing a fabric in width, by feeding the fabric along a path of feed in a transport system and impacting against at least one impact structure, characterized by supporting said fabric from the bottom in said trans-
port system by means of air jets.

26. The method as claimed in claim 25, characterized in that the fabric is pneumatically transferred inside said transport system.

27. The method as claimed in claim 26 or 26, characterized by transferring said fabric in said transport system alternatively in one direction and in the opposite direction so as to perform on said fabric a continuous treatment.

28. The method as claimed in claim 25, 26, or 27, characterized by generating an air flow above said fabric.

29. The method as claimed in one or more of claims 25 to 28, characterized by performing a mechanical impact treatment on said fabric against said impact structure and contemporaneously a drying treatment.

30. The method as claimed in claim 29, characterized by using a first air flow to transfer the fabric and a second air flow to perform the drying of the fabric, said first and second air flow being injected in a transport duct.

31. The method as claimed in claim 30, characterized by controlling said first and said second air flow independently one of the other.

32. The method as claimed in one or more of claims 25 to 29, characterized by generating at least below said fabric a plurality of air flows inclined relative to the path of feed of the fabric, so as to cause on the fabric simultaneously a supporting thrust and a feeding thrust.

33. The method as claimed in claim 32, characterized by generating said air flows in a plurality of positions along the path of feed of the fabric.

34. The method as claimed in claim 32 or 33, characterized by modifying periodically the inclination of the air flows so as to reverse the direction of feed of the fabric, maintaining a support thrust for supporting the fabric in said path.

35. The method as claimed in claims 32 or 33 or 34, characterized by generating also above said fabric a plurality of air flows inclined relative to the path of feed of the fabric, so as to cause on the fabric supporting a supporting thrust and a feeding thrust.

36. The method as claimed in claim 35, characterized in that the inclination of the air flows above the fabric are periodically reversed so as to reverse the direction of feed of the fabric.

37. The method as claimed in claim 35 or 36, characterized in that the air flows below and above the fabric are arranged offset relative each other in
the direction of feed of the fabric.

38. The method as claimed in one or more of claims 35 to 37, characterized in that said air flows above and below the fabric are alternated with suction areas, arranged at least above or at least below the fabric.

39. The method as claimed in one or more of claims 25 to 38, characterized by generating air jets above and below the fabric, offset one relative the other, so as to impose to the fabric an undulatory movement along the path of feed.

40. The method as claimed in one or more of claims 25 to 39, characterized by adjusting the pneumatic thrust on the fabric by varying the inclination of said air jets.
### International Search Report

**A. Classification of Subject Matter**

INV. D06B3/28  D06C19/00  F26B13/10

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

**B. Fields Searched**

Minimum documentation searched (classification system followed by classification symbols)

D06B  D06C  F26B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database consulted during the international search (name of database and, where practical, search terms used)

EPO-Internal

**C. Documents Considered to be Relevant**

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

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Name and mailing address of the ISA/Authorized officer:

European Patent Office, P.B. 5818 Patentlaan 2<br>NL: 2280 HV Rijswijk<br>Tel: (+31-70) 340-2040, Fax: (+31-70) 340-3016

Bichi, Marco
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