ABSTRACT

Provided is a nonwoven fabric manufacturing apparatus and a nonwoven fabric manufacturing method capable of equally coping with minute dimensional differences while reducing cost in response to various dimensional requirements. The nonwoven fabric manufacturing apparatus includes a die 2 having a nozzle row 20, a resin supply means 3 supplying the thermoplastic resin to the die 2, a hot air supply means 8 supplying hot air to a thermoplastic resin extruded from the nozzle row 20 of the die 2 to draw the thermoplastic resin into fibers, and a collector 5 having a conveyor belt 11, the collector 5 collecting the thermoplastic resin that has been drawn into fibers to form a nonwoven fabric web 12 by the self-fusion property.
NONWOVEN FABRIC MANUFACTURING APPARATUS AND NONWOVEN FABRIC MANUFACTURING METHOD

TECHNICAL FIELD

[0001] The present invention relates to a nonwoven fabric manufacturing apparatus and a nonwoven fabric manufacturing method which draw a thermoplastic resin extruded from a die into fibers with hot air to manufacture a nonwoven fabric, and particularly, to a nonwoven fabric manufacturing apparatus and a nonwoven fabric manufacturing method suitable for a melt-blown nonwoven fabric manufacturing apparatus which draws a thermoplastic resin extruded from a die having a nozzle row into fibers to manufacture a nonwoven fabric.

BACKGROUND ART

[0002] Recently, nonwoven fabrics have been widely used in devices for automobile or the like. Further, the type of automobile has been diversified according to the requests of customers, and there have been increasing cases in which the design of devices even for the same use in which nonwoven fabrics are used changes depending on the type of automobile. Thus, nonwoven fabrics having various dimensions tend to be requested by, for example, automobile manufacturers with a small amount for each dimension.

[0003] A nonwoven fabric manufacturing apparatus employs a melt spinning method which jets a thermoplastic resin extruded through fine holes of a nozzle head of a die with hot air to thereby draw the thermoplastic resin into fibers, and collects the fibers on a conveyor to form a web by self-fusion property thereof (refer to Patent Documents 1 to 3, for example). The die is disposed along a direction perpendicular to a moving direction of the conveyor, that is, a width direction of the web to be formed. The nozzle row of the die in which the many fine holes are arrayed also extends in the direction perpendicular to the moving direction of the conveyor. The width dimension of a nonwoven fabric obtained as the web in this manner is determined to be a fixed width depending on the length of the nozzle row of the spin head.

[0004] Thus, the following operation has been conventionally performed. Specifically, a die corresponding to a specific dimension is prepared for replacement, or a nonwoven fabric having a width corresponding to a device for an automobile of a specific type having high yield is manufactured and the manufactured nonwoven fabric is, for example, further cut so as to correspond to a specific dimension and supplied in response to a request for another product having the specific dimension. However, when replacing dies for each dimension, the replacement operation takes time and cost for preparing various types of dies increases. Further, the number of dies to be prepared is limited. Thus, it is not possible to cope with minute dimensional differences. Further, adjusting the dimension by cutting increases the number of steps and causes deterioration of the cutting yield, which disadvantageously causes an increase in manufacturing cost and variation in dimension.

[0005] More specifically, the melt-blown nonwoven fabric manufacturing method as described in Patent Documents 1 to 3 is widely used mainly for manufacturing a material for a filter as a technique of manufacturing a nonwoven fabric made of fine fibers of 1 μm or less to 10 and several μm. The technique draws molten resin flows ejected from a nozzle row in which fine holes having a diameter of, for example, 0.15 mm are arranged in a linear manner at a fine pitch with a high-speed air flow and collects the drawn molten resin flows on a moving conveyor to thereby obtain a nonwoven fabric having a width equal to the length of the nozzle row. FIG. 17 is a schematic view of a melt-blown method wherein molten resin flows 10 extruded from a nozzle row 20 of a die 2 are collected on a conveyor 11 which is running in a direction indicated by an arrow to thereby form a nonwoven fabric 12.

[0006] The most important device for carrying out this technique is a nozzle. In particular, in order to obtain fine fibers, a nozzle that has a nozzle row having holes with a diameter of 0.15 mm or less is required and machining for the nozzle takes several months. Further, when the length of the nozzle is 1 m or more, the cost thereof also becomes extremely high. Further, preparing both an appropriate die and an appropriate nozzle requires a higher cost. For example, in order to obtain a nonwoven fabric having a width of 0.9 m when manufacturing a nonwoven fabric having a width of 1 m, the formed nonwoven fabric having a width of 1 m is cut by a 0.1 m width and the cut piece is discarded. As a result, a waste material is disadvantageously generated. If a die and a nozzle capable of manufacturing a nonwoven fabric having a width of 0.9 m are prepared in order to avoid the above problem, the high cost as described above is required. Further, down-time of the machine is made longer because of such replacement of dies, which also leads to a reduction in the productivity.


SUMMARY OF INVENTION

Technical Problem

[0010] In view of the above circumstances, an object of the present invention is to provide a nonwoven fabric manufacturing apparatus and a nonwoven fabric manufacturing method capable of equally coping with minute dimensional differences while reducing cost in response to various dimensional requirements, reducing equipment investment, and obtaining nonwoven fabrics having different widths without reducing the productivity.

Solution to Problem

[0011] In order to solve the above problems, the present invention provides a nonwoven fabric manufacturing apparatus that includes a die having a nozzle row, the nozzle row extruding a thermoplastic resin, a resin supply means supplying the thermoplastic resin to the die, a hot air supply means supplying hot air to the thermoplastic resin extruded from the nozzle row of the die to draw the thermoplastic resin into fibers, and a collector having a conveyor belt, the collector collecting the thermoplastic resin that has been drawn into fibers to form a web by the self-fusion property, wherein the die is disposed in such a manner that the angle of the die can be changed in a direction inclined relative to a width direction of the web that is perpendicular to a moving direction of the conveyor belt so that a width dimension of the web to be formed can be adjusted to a dimension corresponding to the angle of the die.
A resin inflow port of the die is preferably turnably attached to a resin supply port of the resin supply means so that the angle of the die can be changed by adjusting a turning angle of the attachment.

Specifically, an attachment structure between the resin inflow port of the die and the resin supply port of the resin supply means is preferably a butt connection structure between flanges and the flanges can be fixed to each other with changing an angle therebetween.

Preferably, the flanges can be fixed to each other with changing the angle therebetween using a quick coupling.

The die is preferably provided with slits as the hot air supply means through which hot air is blown out from both sides across the nozzle row.

Preferably, the collector includes a mesh-like conveyor belt and a suction box that sucks air on an upper surface of the belt from a rear surface of the belt, and at least a suction unit of the suction box that faces the die across the conveyor belt is disposed in such a manner that the angle thereof can be changed to a direction inclined relative to a width direction that is perpendicular to the conveyor belt moving direction.

In particular, the nonwoven fabric manufacturing apparatus preferably includes an interlocking mechanism that changes at least the angle of the suction unit of the suction box in interlocking with an angle change of the die.

Further, the present invention also provides a nonwoven fabric manufacturing apparatus in which a resin inflow port of a die having a nozzle row that extrudes a thermoplastic resin is turnably attached to a resin supply port of a resin supply means, wherein an expansion portion having an outer peripheral surface whose diameter expands toward a tip in a fan shape is provided in one of the resin inflow port and the resin supply port, a recessed portion is provided in the other one of the resin inflow port and the resin supply port, the recessed portion having an inner peripheral surface whose diameter decreases toward a tip and receiving the expansion portion inside thereof to allow the outer peripheral surface to abut on the inner peripheral surface to thereby lock the expansion portion relatively rotatably in a circumferential direction as well as inseparably in an axial direction, and the resin inflow port of the die is turnably attached to the resin supply port of the resin supply means by a support structure that includes the expansion portion and the recessed portion.

The expansion portion is preferably formed on an outer periphery of a tip of a joint tube that constitutes the resin inflow port or an outer periphery of a tip of a resin supply tube that constitutes the resin supply port.

The recessed portion preferably includes a flange that is formed on an outer periphery of a tip of a resin supply tube that constitutes the resin supply port or an outer periphery of a tip of a joint tube that constitutes the resin inflow port and a holding cylinder that is disposed in a protruding manner on a tip surface of the flange and has the inner peripheral surface.

Preferably, the outer peripheral surface of the expansion portion is formed in a conical surface and the inner peripheral surface of the recessed portion is formed in a conical hole surface that faces the outer peripheral surface in parallel thereto.

Further, the present invention also provides a nonwoven fabric manufacturing apparatus in which a resin inflow port of a die having a nozzle row that extrudes a thermoplastic resin is turnably attached to a resin supply port of a resin supply means, wherein one of the resin inflow port and the resin supply port includes a cylindrical portion and an expansion portion having an outer peripheral surface whose diameter expands on a tip of the cylindrical portion, a holding body is provided in the other one of the resin inflow port and the resin supply port, the holding body having a recessed portion receiving the expansion portion inside thereof to thereby lock the expansion portion relatively rotatably in a circumferential direction as well as inseparably in an axial direction, a cylindrical support portion is provided in a region on a tip of the holding body, the cylindrical support portion having an inner peripheral surface that is continuous with an inner surface of the recessed portion and relatively rotatably supports an outer peripheral surface of the cylindrical portion, and the resin inflow port of the die is turnably supported with respect to the resin supply port of the resin supply means by a support structure that includes the expansion portion and the holding body.

A bearing member is preferably interposed between the outer peripheral surface of the cylindrical portion and the inner peripheral surface of the cylindrical support portion.

A bearing member is preferably interposed between an outer surface of the expansion portion, the outer surface facing a base end side of the expansion portion, and an inner surface of the recessed portion of the holding body, the inner surface facing a base end side of the recessed portion and being opposed to the outer surface of the expansion portion.

A seal member surrounding a resin flow path is preferably disposed between an outer surface of the expansion portion, the outer surface facing a tip side of the expansion portion, and an inner surface of the recessed portion of the holding body, the inner surface facing a tip side of the recessed portion and being opposed to the outer surface of the expansion portion.

Preferably, the cylindrical portion is composed of a joint tube that constitutes the resin inflow port or a resin supply tube that constitutes the resin supply port, and the expansion portion is formed on an outer periphery of a tip of the joint tube or an outer periphery of a tip of the resin supply tube.

The holding body preferably includes a flange that is formed on an outer periphery of a tip of a resin supply tube that constitutes the resin supply port or an outer periphery of a tip of a joint tube that constitutes the resin inflow port and a holding cylinder that is disposed in a protruding manner on a tip surface of the flange and has the recessed portion and the cylindrical support portion continuous with the recessed portion.

Preferably, the outer peripheral surface of the expansion portion is parallel to the outer peripheral surface of the cylindrical portion, and the holding body includes a recessed portion having an inner peripheral surface parallel to the outer peripheral surface of the expansion portion and a cylindrical support portion having an inner peripheral surface whose diameter decreases in a stepwise manner continuously with the recessed portion, the inner peripheral surface being parallel to the outer peripheral surface of the cylindrical portion.

Further, the present invention also provides a nonwoven fabric manufacturing method that includes preparing a nonwoven fabric manufacturing apparatus including a die having a nozzle row, the nozzle row extruding a thermoplastic resin, a resin supply means supplying a thermoplastic resin to the die, a hot air supply means supplying hot air to a
thermoplastic resin extruded from the nozzle row of the die to draw the thermoplastic resin into fibers, and a collector having a conveyor belt, the collector collecting the thermoplastic resin that has been drawn into fibers to form a web by the self-fusion property; disposing the die in such a manner that the angle of the die can be changed in a direction inclined relative to a width direction of the web that is perpendicular to a moving direction of the conveyor belt; and adjusting a width dimension of the web to be formed to a dimension corresponding to the angle of the die by changing the angle of the die.

Advantageous Effects of Invention

[0030] According to the nonwoven fabric manufacturing apparatus and the nonwoven fabric manufacturing method pertaining to the present invention as described above, the die is disposed in such a manner that the angle thereof can be changed in the direction inclined relative to the width direction of the web that is perpendicular to the moving direction of the conveyor belt so that the width dimension of the web to be formed can be adjusted to a dimension corresponding to the angle of the die. Therefore, it becomes first possible to manufacture nonwoven fabrics having various widths using the same die. As a result, it is possible to eliminate time and cost for preparing various types of dies and replacing the dies depending on the dimension, to cope with minute dimensional differences, to omit dimensional adjustment by cutting, to largely reduce manufacturing cost, and to manufacture uniform nonwoven fabrics with no variation in dimension.

[0031] Further, the resin inflow port of the die is turnably attached to the resin supply port of the resin supply means and the angle of the die can be changed by adjusting a turning angle of the attachment. Thus, even when the attachment angle of the die is changed, no trouble occurs in supply of the resin. Further, a desired space and cost can be achieved by a simple structure having high efficiency.

[0032] Further, the attachment structure between the resin inflow port of the die and the resin supply port of the resin supply means is the butt connection structure between the flanges and the flanges can be fixed to each other with changing an angle therebetween. Thus, it is possible to hold the die in a stable attitude also after changing the angle while maintaining sufficient connection strength.

[0033] Further, the flanges can be fixed to each other with changing the angle therebetween using the quick coupling. Thus, it is possible to promptly perform the angle change operation.

[0034] Further, the die is provided with the slits as the hot air supply means through which hot air is blown out from both sides across the nozzle row. Thus, the angle of the slits for supplying hot air is changed integrally with the nozzle row. Accordingly, it is possible to supply hot air to an accurate position also after the angle change.

[0035] Further, the collector includes the mesh-like conveyor belt and the suction box that sucks air on the upper surface of the belt from the rear surface of the belt, and at least the suction unit of the suction box that faces the die across the conveyor belt is disposed in such a manner that the angle thereof can be changed to the direction inclined relative to the web width direction that is perpendicular to the conveyor belt moving direction. Thus, it is possible to reliably suck hot air from the die and an accompanied flow thereof also after changing the angle of the die and thereby stably obtain uniform nonwoven fabrics.

[0036] Further, the interlocking mechanism that changes at least the angle of the suction unit of the suction box in interlocking with angle change of the die is provided. Thus, it is possible to largely reduce operation burden and operation time.

[0037] Further, the expansion portion having the outer peripheral surface whose diameter expands toward the tip in a fan shape is provided in one of the resin inflow port and the resin supply port, and the recessed portion is provided in the other one of the resin inflow port and the resin supply port, the recessed portion having the inner peripheral surface whose diameter decreases toward the tip and receiving the expansion portion inside thereof to allow the outer peripheral surface to abut on the inner peripheral surface to thereby lock the expansion portion relatively rotatably in the circumferential direction as well as inseparably in the axial direction. Further, the resin inflow port of the die is turnably attached to the resin supply port of the resin supply means by a support structure that includes the expansion portion and the recessed portion. Thus, it is possible to rotate the die without generating a gap between the joined surfaces. Further, it is not necessary to previously remove the resin inside thereof before the angle change. Further, it is possible to promptly perform the operation and obtain nonwoven fabrics having different widths without reducing the productivity.

[0038] Further, the outer peripheral surface of the expansion portion is formed in a conical surface and the inner peripheral surface of the recessed portion is formed in a conical hole surface that faces the outer peripheral surface in parallel thereto. Thus, it is possible to hold the die in a stable attitude also after changing the angle thereof while maintaining sufficient connection strength.

[0039] Further, one of the resin inflow port and the resin supply port includes the cylindrical portion and the expansion portion having the outer peripheral surface whose diameter expands on the tip of the cylindrical portion, and the holding body is provided in the other one of the resin inflow port and the resin supply port, the holding body having the recessed portion receiving the expansion portion inside thereof to thereby lock the expansion portion relatively rotatably in the circumferential direction as well as inseparably in the axial direction. Thus, it is not necessary to previously remove the resin inside thereof before the angle change. Further, it is possible to promptly perform the operation and obtain nonwoven fabrics having different widths without reducing the productivity. Further, the cylindrical support portion is provided in the region on the tip of the holding body, the cylindrical support portion having the inner peripheral surface that is continuous with the inner surface of the recessed portion and relatively rotatably supports the outer peripheral surface of the cylindrical portion. Thus, the cylindrical support portion and the cylindrical portion support each other when the die rotates, thereby preventing the die from being inclined. Therefore, for example, even when a rotational force is applied to the die from one end thereof, the axes of the die and the resin inflow port are not inclined relative to the resin supply port. Accordingly, it is possible to allow the die to smoothly rotate in a stable state and also to prevent seizure caused by the end of the upper surface of the expansion portion partially making contact with the flange or the
recessed portion. As a result, it is possible to provide an apparatus having excellent usability and maintaining the flexibility of design.

[0040] Further, the bearing member is interposed between the outer peripheral surface of the cylindrical portion and the inner peripheral surface of the cylindrical support portion. Thus, it is possible to more stably and smoothly rotate the die.

[0041] Further, the bearing member is interposed between the outer surface of the expansion portion, the outer surface facing the base end side of the expansion portion, and the inner surface of the recessed portion of the holding body, the inner surface facing the base end side of the recessed portion and being opposed to the outer surface of the expansion portion. Thus, it is possible to more stably and smoothly rotate the die having a heavy weight.

[0042] Further, the seal member surrounding the resin flow path is disposed between the outer surface of the expansion portion, the outer surface facing the tip side of the expansion portion, and the inner surface of the recessed portion of the holding body, the inner surface facing the tip side of the recessed portion and being opposed to the outer surface of the expansion portion. Thus, it is not necessary to allow the expansion portion and the recessed portion of the holding body to directly make contact with each other to apply a seal function. Accordingly, the flexibility of design is improved, and it is possible to simplify the structures of the expansion portion and the holding body to reduce the manufacturing cost.

[0043] Further, the cylindrical portion is composed of the joint tube that constitutes the resin inflow port or the resin supply tube that constitutes the resin supply port, and the expansion portion is formed on the outer periphery of the tip of the joint tube or the outer periphery of the tip of the resin supply tube. Thus, it is possible to achieve a rational structure, to reduce the number of components, and to reduce the cost.

[0044] Further, the holding body includes the flange that is formed on the outer periphery of the tip of the resin supply tube that constitutes the resin supply port or the outer periphery of the tip of the joint tube that constitutes the resin inflow port and the holding cylinder that is disposed in a protruding manner on the tip surface of the flange and has the recessed portion and the cylindrical support portion continuous with the recessed portion. Thus, the assembly is easily performed, the flexibility of design is improved, and the manufacturing cost can be reduced.

[0045] Further, the outer peripheral surface of the expansion portion is parallel to the outer peripheral surface of the cylindrical portion, and the holding body includes the recessed portion having the inner peripheral surface parallel to the outer peripheral surface of the expansion portion and the cylindrical support portion having the inner peripheral surface whose diameter decreases in a stepwise manner continuously with the recessed portion, the inner peripheral surface being parallel to the outer peripheral surface of the cylindrical portion. Thus, the structure is simplified, no high-accuracy machining is required, and lower cost can be achieved.

**BRIEF DESCRIPTION OF THE DRAWINGS**

[0046] FIG. 1 is an explanatory diagram illustrating a nonwoven fabric manufacturing apparatus according to a first embodiment of the present invention.

[0047] FIG. 2(a) is an explanatory diagram illustrating a state of manufacturing a nonwoven fabric with a die of the nonwoven fabric manufacturing apparatus facing a direction perpendicular to a conveyor belt moving direction and FIG. 2(b) is an explanatory diagram illustrating a state of manufacturing a nonwoven fabric with the die inclined by a predetermined angle 0 from the direction perpendicular to the conveyor belt moving direction.

[0048] FIG. 3(a) is a plan view illustrating an attachment structure between a resin inflow port of the die and a resin supply port of a resin supply means and FIG. 3(b) is a vertical cross-sectional view thereof.

[0049] FIG. 4(a) is a plan view illustrating a modification of the attachment structure and FIG. 4(b) is a vertical cross-sectional view thereof.

[0050] FIG. 5 is an explanatory diagram illustrating a nonwoven fabric manufacturing apparatus according to a second embodiment of the present invention.

[0051] FIG. 6(a) is an explanatory diagram illustrating a state of manufacturing a nonwoven fabric with a die of the nonwoven fabric manufacturing apparatus and a suction unit of a suction box that faces the die both facing a direction perpendicular to a conveyor belt moving direction and FIG. 6(b) is an explanatory diagram illustrating a state of manufacturing a nonwoven fabric with the die and the suction unit of the suction box inclined by a predetermined angle 0 from the direction perpendicular to the conveyor belt moving direction.

[0052] FIG. 7 is an explanatory diagram illustrating a support structure according to a third embodiment of the present invention.

[0053] FIG. 8 is a vertical cross-sectional view illustrating a principal part of the support structure which includes an expansion portion and a recessed portion.

[0054] FIG. 9 is an explanatory diagram illustrating a modification of the support structure.

[0055] FIG. 10 is a schematic view of a nonwoven fabric manufacturing apparatus according to a fourth embodiment of the present invention viewed from the front thereof, the nonwoven fabric manufacturing apparatus being provided with an auxiliary mechanism which rotates a die.

[0056] FIG. 11 is a schematic view of the nonwoven fabric manufacturing apparatus viewed from the lateral side thereof.

[0057] FIG. 12 is a schematic view illustrating another example of the nonwoven fabric manufacturing apparatus provided with the auxiliary mechanism which rotates the die.

[0058] FIGS. 13(a) and 13(b) are explanatory diagrams illustrating a state in which an axis is inclined in the third embodiment.

[0059] FIGS. 14(a) and 14(b) are vertical cross-sectional views illustrating a principal part of a support structure which includes an expansion portion and a recessed portion according to a fifth embodiment of the present invention.

[0060] FIG. 15 is a vertical cross-sectional view illustrating a modification of the support structure.

[0061] FIG. 16 is a vertical cross-sectional view illustrating another modification of the support structure.

[0062] FIG. 17 is a schematic view illustrating a melt-blown method.

**REFERENCE SIGNS LIST**

[0063] A Attachment structure (support structure)

[0064] 1 Nonwoven fabric manufacturing apparatus

[0065] 2 Die

[0066] 2a Pin hole

[0067] 3 Resin supply means
DESCRIPTION OF EMBODIMENTS

Next, embodiments of the present invention will be described in detail with reference to the accompanying drawings.

First, a first embodiment of the present invention will be described with reference to FIGS. 1 to 4(b).

As illustrated in FIGS. 1, 2(a), and 2(b), a nonwoven fabric manufacturing apparatus 1 of the present embodiment is a melt-blown nonwoven fabric manufacturing apparatus which is provided with a die 2 having a nozzle row 20 which extrudes a molten polymer (thermoplastic resin), a resin supply means 3 which supplies a molten polymer to the die 2, a hot air supply means 8 which supplies hot air to the molten polymer extruded from the nozzle row 20 of the die 2 to thereby draw the molten polymer into fibers, a collector 5 which has a conveyor belt 11 and collects the molten polymer that has been drawn into fibers to form a nonwoven fabric web 12 by the self-fusion property thereof. In particular, the die 2 is disposed in such a manner that the angle thereof can be changed in a direction inclined relative to a web width direction that is perpendicular to a moving direction of the conveyor belt 11. The width dimension of the web 12 to be formed is adjusted to a dimension corresponding to the angle of the die 2.

The die 2 of this example is a T-die for uniformly distributing a molten polymer from a resin inflow port 21 toward the nozzle row 20 from which the molten polymer is extruded. The die 2 constitutes a spin head which has air slits (not illustrated) formed on both sides of the nozzle row 20 and hot air is blown out through the air slits. The present invention is not limited at all to the die having such a structure. The nozzle row 20 has many fine holes 20a which are arrayed side by side in a direction perpendicular to the cross section of the die 2. The hot air slits (blowout ports, not illustrated) are formed on both sides of the fine holes 20a in parallel to the nozzle row 20. Although an example in which a single nozzle row 20 is arranged is illustrated in this example, a plurality of nozzle rows may, of course, be arranged.

A molten polymer extruded through each of the fine holes 20a of the nozzle row 20 is drawn with hot air which is blown out at high speed from the slits on both sides so as to sandwich an exit of each of the fine holes 20a and formed into fine fibers. In this manner, the molten polymer is extruded through each of the fine holes 20a and drawn into fibers, and collected on the conveyor belt 11 of the collector 5 to form the nonwoven fabric web 12.

The resin supply means 3 includes an extruder 30 which melts and extrudes a polymer (thermoplastic resin), a filter 36 which removes foreign substances, a gear pump 37 for continuously feeding a specified amount of molten polymer to the die 2, and a support pipe portion 38 which has a resin supply port 31 which is formed on an end of the support pipe portion 38 and connected to the resin inflow port 21 of
the die 2 to attach the die 2 thereto. The resin inflow port 21 of the die 2 is turnably attached to the resin supply port 31 of the support pipe portion 38. The angle of the die 2 can be adjusted as illustrated in FIGS. 2(a) and 2(b) by changing the turning angle of the attachment.

[0148] As illustrated in FIGS. 3(a) and 3(b), an attachment structure A of the turnable die 2 is a butt connection structure between a flange 23 of the resin inflow port 21 and a flange 39 of the resin supply port 31. Specifically, a long hole 39b having a length in a predetermined angle range along the circumferential direction is formed on the flange 39 on one side and a screw hole 23a with which a bolt (a bolt with a hexagonal hole) 80 inserted through the long hole 39b is screwed is formed on the flange 23 on the other side. Accordingly, the angle change is completed merely by loosening the bolt 80, then rotating the die 2 by a necessary angle, and then tightening the bolt 80. In this example, four sets of long holes 39b and screw holes 23a are formed at equal positions. However, the number of sets is not particularly limited. An O-ring 81 is attached to the inside of an O-ring groove 82 at a position closer to the inner peripheries of the flanges 23, 39 so as to prevent leakage of the molten polymer. As can be easily conceived, it is possible to perform the angle change by an operation within an extremely short time.

[0149] As described above, in this example, the die 2 is turnably supported by the support pipe portion 38 which has the resin supply port 31 of the resin supply means 3. However, the present invention is not limited at all to such a support structure. The resin supply port 31 of the resin supply means 3 may be turnable together with the die, and the structure which turnably supports the die 2 may be composed of a support body which is independent of the resin supply means 3. Further, in this example, the support structure turnably supports the resin inflow port 21 which is formed on the central part of the die 2 so as to turn around the central part. However, the resin inflow port 21 is not necessarily turnable around the central part, and is also preferably turnably supported around a deviated position or an end position. In particular, supporting the die 2 by the support body independent of the resin supply means 3 as described above enhances the flexibility of design.

[0150] As another example of the attachment structure A, as illustrated in FIGS. 4(a) and 4(b), the flange 23 and the flange 39 are fixed to each other with a quick coupling 83 instead of the bolt. Accordingly, it is possible to perform the angle change by an operation within a shorter time. That is, it is preferred to configure the quick coupling 83 in such a manner that the outer peripheral end surfaces of the respective flanges 23, 39 are each formed to have a conical structure so as to be tapered surfaces whose diameters gradually increase toward a joint side, and a clamp 84 which has a recessed groove 84c on the inner peripheral side thereof, the recessed groove 84c being formed of tapered surfaces parallel to the tapered surfaces of the flanges and having a generally V shape, and covers the outer peripheral end surfaces of both of the joined flanges from the outer side thereof is fastened with an eyebolt 85 and a wing nut 86.

[0151] Also in this case, similarly, the O-ring 81 is attached to the inside of the O-ring groove 82 at a position closer to the inner peripheries of the flanges 23, 39 so as to prevent leakage of the molten polymer. In order to change the angle of the die (spin head) 2, it is only required to slightly loosen the wing nut 86 of the clamp 84, then rotate the die 2 by a necessary angle, and then fasten the wing nut 86. This is an operation within an extremely short time. In addition, various structures such as a structure capable of automatically controlling the turning angle using a gear and a motor can be employed.

[0152] A known system can be employed as the hot air supply means 8. In this example, as illustrated in FIG. 1, the hot air supply means 8 includes a heater 141 which is disposed in the middle of a pipe which connects a compressor 140 and the die 2 to each other and the slits (not illustrated) through which hot air is blown out from both sides across the nozzle row 20 of the die 2. The angle of the slits is changed integrally with the nozzle row 20 together with the die 2.

[0153] The collector 5 includes the mesh-like conveyor belt 11 and suction boxes 170, 171 which suck air on the upper surface side of the belt from the rear surface side thereof. The molten polymer extruded from the nozzle row 20 of the die 2 is drawn by hot air from the slits so as to be formed into fiber flows and collected on the conveyor belt 11. The conveyor belt 11 runs in a direction indicated by arrows by a drive roller 55, a guide roller 56, a tension roller 57, and conveyer rollers 53, 54. Thus, the polymer fiber flows collected on the conveyor belt 11 under the die 2 are formed into the nonwoven fabric web 12. The formed web 12 is discharged from the collector 5, passes through a calender roll 151, and is wound up by a winder 152.

[0154] The suction boxes 170, 171 are provided for reliably collecting the fiber flows on the conveyor belt 11 and cooling the collected fiber flows. The suction boxes 170, 171 suck air respectively by blowers 172, 173. In particular, the blower 172 which is powerful is connected to the suction box 170 in order to suck hot air and an accompanied flow thereof right under the die 2.

[0155] According to the present embodiment, as illustrated in FIG. 2(a), the width of the nonwoven fabric web 12 that is manufactured with the nozzle row 20 of the die 2 facing the direction perpendicular to the conveyor belt moving direction is a width dimension W0 that is substantially equal to the length of the nozzle row. On the other hand, as illustrated in FIG. 2(b), when the nozzle row 20 is inclined by the predetermined angle 0 from the direction perpendicular to the conveyor belt moving direction, although the fiber flows drop on the conveyor belt 11 through the respective fine holes 20a of the nozzle row 20 having the same length as above case, a width dimension W1 of the nonwoven fabric web 12 to be obtained is approximately W0/2. Thus, it is possible to obtain a nonwoven fabric having a width narrower than the length of the nozzle row 20. In this manner, it is possible to obtain various nonwoven fabrics using the same die 2 by changing the angle of the die 2 (spin head) relative to the running direction of the conveyor belt 11.

[0156] Regarding the property of a nonwoven fabric to be manufactured, when the amount of molten polymer extruded from the nozzle row 20 of the die 2 is the same, the weight per unit area (fabric weight) increases in the case of FIG. 2(b) compared to the case of FIG. 2(a) by an amount corresponding to a reduction in the width-direction dimension. Therefore, in order to obtain nonwoven fabrics having the same fabric weight, but having different dimensions, it is only required to adjust the amount of molten polymer to be extruded.

[0157] Next, a second embodiment will be described with reference to FIGS. 5, 6(a), and 6(b).

[0158] In the present embodiment, a suction box that faces a die 2 across a conveyor belt 11 includes a suction side suction box 170A and an exhaust side suction box 170B. The
suction side suction box 170A which serves as a suction unit is supported on the exhaust side suction box 170B in such a manner that the angle thereof can be changed in a direction inclined relative to the web width direction like the die 2 described above.

[0159] Typically, the dimension of a suction port of the suction box 170 right under the nozzle row 20 is 50 mm to 75 mm in the front and back of the nozzle row, that is, 100 mm to 150 mm in the vertical direction along the conveyor belt moving direction and the length of the nozzle row plus several tens mm in the horizontal direction along the web width direction perpendicular to the conveyor belt moving direction. However, in the present invention, the angle of the die 2 is changed. Thus, the suction box 170 is required to have a larger size that can cover the angle range of the die 2. Accordingly, the blower 172 is also required to have a large suction force.

[0160] On the other hand, when the angle of the suction side suction box 170A can be adjusted corresponding to the angle of the die 2 as in the present embodiment, it is possible to reliably suck hot air for drawing a polymer and the accompanied flow thereof even with the minimum dimension corresponding to the dimension of the die to obtain uniform nonwoven fabrics, and also to prevent an increase in the size of the blower 172.

[0161] In this example, the suction side suction box 170A is provided inside a larger suction box 171 in a twofold manner. The suction side suction box 170A is turnably attached to a bottom wall of the suction box 171 through a support cylinder 170a located on the lower end of the suction side suction box 170A so as to turn around the support cylinder 170a. The support cylinder 170a penetrates the bottom wall of the suction box 171 and projects to an internal space of the exhaust side suction box 170B arranged on the lower side. An internal space of the suction side suction box 170A and the internal space of the exhaust side suction box 170B communicate with each other through the support cylinder 170a. The blower 172 is connected to the exhaust side suction box 170B. The suction side suction box 170A is preferably provided with an interlocking mechanism which automatically turns by the same angle in interlocking with the angle change of the die 2.

[0162] Next, a third embodiment will be described with reference to FIGS. 7 to 9.

[0163] The means for rotating the die in the above first embodiment is the butt connection structure between the flanges as the attachment structure between the resin inflow port of the die and the resin supply port of the resin supply means as illustrated in FIGS. 3(a), 3(b) and 4(a), 4(b). In such a structure, when the flange connection is loosened, a gap is formed between the joined surfaces. Thus, it is necessary to remove a resin inside thereof before loosening the flange connection. These operations require time. As a result, a certain limit may be generated in improvement of the productivity.

[0164] In view of the above, the present embodiment improves the above situation. FIG. 7 is a schematic view illustrating connection between a resin inflow port 21 of a die 2 and a resin supply port 31 of a resin supply means 3 according to a nonwoven fabric manufacturing apparatus 1 of the present invention. A support structure A which turnably supports the resin inflow port 21 of the die 2 with respect to the resin supply port 31 of the resin supply means 3 is provided between the tip of a joint tube 40 which constitutes the resin inflow port 21 and the tip of a resin supply tube 50 which constitutes the resin supply port 31.

[0165] As illustrated in FIG. 8, the support structure A of the present embodiment includes an expansion portion 41 which is formed on the resin inflow port 21 and a recessed portion 32 which is formed on the resin supply port 31 and coaxially receives the expansion portion 41. The expansion portion 41 has an outer peripheral surface 41 which expands toward the tip of the resin inflow port 21 in a fan shape. Specifically, the expansion portion 41 is integrally formed with the outer periphery of the tip of the joint tube 40 which constitutes the resin inflow port 21.

[0166] The recessed portion 32 has an inner peripheral surface 32b whose diameter decreases toward the tip, and receives the expansion portion 41 inside thereof to allow an outer peripheral surface 41a of the expansion portion 41 to abut on the inner peripheral surface 32b to thereby lock the expansion portion 41 relatively rotatably in the circumferential direction as well as inseparably in the axial direction. Specifically, the recessed portion 32 includes a flange 51 which is formed on the outer periphery of the tip of the resin supply port 31 and a holding cylinder 52 which is disposed in a protruding manner on the tip surface of the flange 51 and has the inner peripheral surface 32b.

[0167] The outer peripheral surface 41a of the expansion portion 41 is formed in a conical surface. The inner peripheral surface 32b of the recessed portion 32 is formed in a conical hole surface which faces the outer peripheral surface 41a in parallel thereto. Accordingly, the outer peripheral surface 41a and the inner peripheral surface 32b are closely joined to each other throughout the entire circumferences and the entire surfaces. In addition, a sufficient pressure joining force acts between the outer peripheral surface 41a and the inner peripheral surface 32b by the self-weight of the die. Thus, even if a resin flows into a gap 13 between the tip surface of the expansion portion 41 and the tip surface of the flange 51, the resin does not leak out.

[0168] The holding cylinder 52 is a holding fitting made of metal in which a recessed groove 52 which receives the flange 51 so as to be fitted thereto is formed on a surface on the base end side and a through hole 52d which corresponds to a bolt insertion hole 51d of the flange 51 is formed to communicate with the bolt insertion hole 51d in the axial direction. The holding cylinder 52 is fixed to the flange 51 with the bolt 33 which passes through the bolt insertion hole 51d and the through hole 52d, the washer 34, and the nut 35 with the holding cylinder 52 attached to the outer peripheral part of the expansion portion 41. Accordingly, the expansion portion 41 is inseparably locked inside the formed recessed portion 32.

[0169] Theoretically, the gap 13 between the tip surface of the expansion portion 41 and the tip surface of the flange 51 may not be formed. However, if these tip surfaces come into close contact with each other, the expansion portion 41 cannot turn in the circumferential direction with respect to the recessed portion 32. As a result, it is necessary to loosen the bolt 33, and the resin may thereby leak out. Thus, a degree of close contact that enables the expansion portion 41 to turn with the bolt 33 fastened is required. In order to generate a joint state having such a delicate degree of close contact, machining with high accuracy is required. Thus, it is actually preferred to actively form the gap 13 to prevent the nonexist-
ence of the gap 13 causing a close contact state which makes the expansion portion 41 unturnable even with a low machining accuracy.

[0170] The resin flows into the gap 13. However, the expansion portion outer peripheral surface 41a and the recessed portion inner peripheral surface 32b are joined to each other by pressure as described above, and it is therefore possible to prevent the outflow of the resin by virtue of these surfaces which serve as a seal. In order to achieve more reliable seal effect, it is desired to perform lapping on the outer peripheral surface 41a and the inner peripheral surface 32b. Further, a packing, for example, a heat-resistant resin is desirably disposed in the gap 13 in an uncrushed state at ordinary temperature. The packing has a larger thermal expansion coefficient than metal, for example, the connection tube. Thus, the packing is expected to reliably seal the gap 13 to stop the resin in an operating state in which the temperature increases.

[0171] In the present embodiment, the expansion portion 41 is provided in the resin inflow port 21 and the recessed portion 32 is provided in the resin supply port 31 as the support structure A. However, as illustrated in FIG. 9, conversely, a similar recessed portion may be provided in the resin inflow port 21 and a similar expansion portion may be provided in the resin supply port 31. In this case, the recessed portion 32 on the die is supported on the outer peripheral surface of the expansion portion on the resin supply means 3 inseparably in the axial direction as well as turnable in the circumferential direction.

[0172] In the present embodiment, the outer peripheral surface 41a of the expansion portion 41 is formed in a conical surface and the inner peripheral surface 32b of the recessed portion 32 is formed in a conical hole surface parallel to the outer peripheral surface 41a. However, the outer peripheral surface of the expansion portion may be formed in a curved surface whose diameter expansion ratio varies, for example, an outwardly convex spherical surface in addition to the conical surface whose diameter expands at a constant ratio along the axial direction as described above as long as the diameter of the outer peripheral surface expands in a fan shape. Similarly, the inner peripheral surface of the recessed portion may be formed in a curved surface whose diameter reduction ratio varies, for example, an inwardly convex spherical surface in addition to the conical hole surface whose diameter decreases at a constant ratio as long as the diameter of the inner peripheral surface decreases toward the tip.

[0173] In curved surfaces other than a conical surface or a conical hole surface, it is difficult to have a sufficient machining accuracy. Thus, when such curved surfaces are employed, it is preferred to set the outer peripheral surface of the expansion portion to have a smaller curvature along the axial direction than the inner peripheral surface of the recessed portion without setting the curved surfaces parallel to each other. Further, it is more preferred that only the outer peripheral surface of the expansion portion be formed in a curved surface other than the conical surface, for example, an outwardly convex spherical surface and the inner peripheral surface of the recessed portion be formed in a conical hole surface having a constant diameter reduction ratio in the same manner as the above embodiment.

[0174] Next, a fourth embodiment will be described with reference to FIGS. 10 to 12.

[0175] The die 2 typically has a large weight. Therefore, the die 2 cannot be supported only by the support structure A in some cases. Thus, in the present embodiment, as illustrated in FIGS. 10 and 11, the die 2 is additionally supported by a hanging tool 15 from a frame 14 located above the die 2. The hanging tool 15 is supported on the frame 14 through a rotatable hanging tool support device 16 and capable of rotating in interlocking with turn of the die 2.

[0176] The die 2 can be manually rotated by a necessary angle by the structure of the support structure A. However, the temperature of the die 2 is 200 to 350° C. and therefore high. In addition, when the weight of the die 2 is large, a considerable force is also required. Thus, the rotation of the die 2 is preferably mechanically performed because of safety reasons. As an auxiliary mechanism which rotates the die 2, a mechanism which rotates the die 2 from the lower side will be first described.

[0177] As illustrated in FIGS. 10 and 11, the mechanism rotates the die 2 by setting a rotary positioning device 6 which is engaged with the die 2 to rotate the die 2 by a predetermined angle under the die 2. The rotary positioning device 6 is provided with an engagement member 61 and a rotary table 62a. A pin 61b which is engaged with a pin hole 2a formed on the die 2 is disposed in a protruding manner on the upper surface of the engagement member 61. The engagement member 61 is fixed to the upper surface of the rotary table 62a. In addition, the rotary positioning device 6 further includes a turning device 62 which turns the rotary table by any angle and a lifting device 63 which moves the turning device 62 up and down together with the engagement member 61.

[0178] When rotating the die 2 using the rotary positioning device 6, the rotary positioning device 6 is first set under the die 2 in a manner to align the turning center axis of the rotary table 62a with the turning center axis of the support structure of the die 2 in a state engaged with the die 2, and the turning device 62 is then turned and stopped at a position where the angle position of the pin hole 2a of the die 2 matches the angle position of the pin 61b of the engagement member 61 and the pin hole 2a and the pin 61b are thereby engaged with each other. Then, the lifting device 63 moves the turning device 62 upward together with the engagement member 61 so that the pin hole 2a and the pin 61b are engaged with each other. Then, the turning device 62 is turned by a necessary angle to thereby turn and stop the die 2 through the pin 61b of the engagement member 61. Then, the lifting device 63 moves the turning device 62 downward so that the lifting device 63 is detached or retracted from the lower side of the die 2.

[0179] The rotary positioning device 6 may be set under the die 2, for example, by fixing the rotary positioning device 6 to a mount or frame of the conveyor using an appropriate method. A turning mechanism of the turning device 62 and a lifting mechanism of the lifting device 63 may be manually driven or driven by a motor or the like. As the turning device 62, for example, a rotary index can be applied. In this example, the die 2 is auxiliary rotatably supported through the hanging tool 15 and the hanging tool support device 16. However, the hanging tool 15 and the hanging tool support device 16 may be omitted.

[0180] Next, as the auxiliary mechanism which rotates the die 2, a mechanism which rotates the die 2 from the upper side will be described. As illustrated in FIG. 12, this method uses the hanging tool 15 and the hanging tool support device 16. Further, the mechanism includes a turning device 6a which turns the hanging tool support device 16 together with the hanging tool 15. Specifically, a rotary component 64, for example, a gear or a pulley is attached to the upper end of the
hanging tool support device 16 which is rotatably attached to the frame 14 which supports the die 2. Further, the rotary component 64 is driven to rotate by a predetermined angle by a geared motor or a rotary index (not illustrated). Accordingly, it is possible to allow the die 2 which is hung by the hanging tool 15 to turn together with the hanging tool 15 by a predetermined angle.

[0181] Next, a fifth embodiment will be described with reference to FIGS. 13(a) to 16.

[0182] In the support structure A for rotating the die in the third embodiment, the die is made rotatable while preventing leakage of the resin by the lapping between the expansion portion 41 and the inner peripheral surface of the recessed portion 32. In addition, no seal member for preventing leakage of the resin is required. However, in this attachment structure, for example, when a rotational force is applied to the die from one end thereof for rotating the die, the axes of the die 2 and the resin inflow port 21 are inclined relative to the axis of the resin supply port 31 as illustrated in FIGS. 13(a) and 13(b). As a result, the end of the upper surface of the expansion portion 41 partially makes contact with the flange 51 or the recessed portion inner peripheral surface 32b, which may cause seizure. The rotation may be performed by uniformly applying force so as to prevent the die and the resin inflow port 21 from being inclined. However, limitation to such a rotation applying mechanism causes poor usability, cost increase, and reduction in the flexibility of design.

[0183] In view of the above, in the present embodiment, as illustrated in FIGS. 14(a) and 14(b), a support structure A is configured in such a manner that a cylindrical portion 4a (joint tube 40) and an expansion portion 41 having an outer peripheral surface 41a whose diameter expands on the tip of the cylindrical portion 4a are provided in a resin inflow port 21, a holding body 7 which has a recessed portion 32 which coaxially receives the expansion portion 41 is provided in a resin supply port 31, and a cylindrical support portion 70 having an inner peripheral surface which relatively rotatably supports the outer peripheral surface of the cylindrical portion 4a is provided continuous with the inner surface of the recessed portion 32 in a region on the tip side of the holding body 7. The cylindrical portion 4a is composed of the joint tube 40 which constitutes the resin inflow port 21. The expansion portion 41 is integrally formed with the outer periphery of the tip of the joint tube.

[0184] The holding body 7 includes a flange 51 which is formed on the outer periphery of the tip of a resin supply tube 50 which constitutes the resin supply port 31 and a holding cylinder 52 which is disposed in a protruding manner on the tip surface of the flange 51 and has the recessed portion 32 and the cylindrical support portion 70 continuous with the recessed portion 32. The holding cylinder 52 is a holding fitting made of metal in which a recessed groove 52c which receives the flange 51 so as to be fitted thereto is formed on a surface on the base end side and a through hole 52d which corresponds to a bolt insertion hole 51d of the flange 51 is formed to communicate with the bolt insertion hole 51d in the axial direction.

[0185] A bearing member 71 is interposed between the outer peripheral surface of the cylindrical portion 4a and an inner peripheral surface 70a of the cylindrical support portion 70. Also, a bearing member 72 is interposed between an outer surface 41c of the expansion portion 41, the outer surface 41c facing the base end side of the expansion portion 41, and an inner surface 32c of the recessed portion 32, the inner surface 32c facing the base end side of the recessed portion 32 and being opposed to the outer surface 41c. A sufficient pressure joining force acts in this portion by the self-weight of the die. Thus, the existence of the bearing member 72 makes it possible to reliably prevent seizure. In the present embodiment, the bearing members 71, 72 are composed of a single member. However, the bearing members 71, 72 may be composed of separate members. The bearing members 71, 72 are preferably bushes (slide bearings) made of a material that is heat resistant and not likely to cause seizure (metal or the like).

[0186] A seal member 73 which surrounds a resin flow path is disposed between an outer surface 41d of the expansion portion 41, the outer surface 41d facing the tip side of the expansion portion 41, and an inner surface 32d (the tip surface of the flange 51) of the recessed portion 32, the inner surface 32d facing the tip side of the recessed portion 32 and being opposed to the outer surface 41d. In the present embodiment, an annular groove 41e is formed on the outer surface 41d of the expansion portion 41 and the annular seal member 73 is engaged with and thereby attached to the annular groove 41e. However, a similar annular groove to which the seal member 73 is attached may, of course, be formed on the inner surface 32d of the recessed portion 32.

[0187] A molten resin flows from the resin supply port 31 to the resin inflow port 21 (joint tube 40). The seal member 73 prevents the molten resin from leaking out to the outside. The seal effect of the seal member 73 does not change even when the resin inflow port 21 rotates relative to the resin supply port 31. As also illustrated in FIG. 14(b), the seal member 73 is composed of one called “C-ring”, made of metal, for example, Inconel, and durable against a high temperature of several hundred degrees. In the drawing, DA denotes the outer diameter of the C-ring. The C-ring is fitted into the annular groove 41e having an outer diameter (inner diameter on the outer side) of D, a depth of G, and a width of W.

[0188] The holding cylinder 52 with the bearing members 71, 72 attached to the inside thereof is fixed to the flange 51 with the bolt 33 which passes through the bolt insertion hole 51d and the through hole 52d, the washer 34, and the nut 35 with the holding cylinder 52 attached to the outer peripheral part of the expansion portion 41 with the seal member 73 attached to the outer surface thereof and the outer peripheral part of the cylindrical portion 4a. Accordingly, there is maintained in a stable attitude in which the expansion portion 41 is inseparably locked inside the formed recessed portion 32 and the outer peripheral surface of the cylindrical portion 4a is supported by the cylindrical support portion 70 with the bearing member 71 interposed therebetween.

[0189] In the present embodiment, the outer peripheral surface 41a of the expansion portion 41 is parallel to the outer peripheral surface of the cylindrical portion 4a and formed in a flange shape. Further, the recessed portion 32 has the inner peripheral surface 32b which is parallel to the outer peripheral surface 41a of the expansion portion 41. The cylindrical support portion 70 has the inner peripheral surface 70a whose diameter decreases in a stepwise manner continuously with the recessed portion 32, the inner peripheral surface being parallel to the outer peripheral surface of the cylindrical portion 4a. As described above, the present invention has a structure capable of supporting the cylindrical portion 4a by the cylindrical support portion 70 to achieve rotation of the die 2 in a stable attitude without causing axial deflection as a whole. Further, a gap can be formed between the outer peripheral surface 41a of the expansion portion 41 and the inner
peripheral surface 32b of the recessed portion 32. Thus, it is easy to perform assembly between the resin inflow port 21 and the resin supply port 31, specifically, assembly for attaching the holding cylinder 52 to the outer peripheral part of the expansion portion 41 and the outer peripheral part of the cylindrical portion 4a.

[F0190] FIG. 15 illustrates a modification in which the expansion portion 41 has an outer peripheral surface 41a whose diameter expands toward the tip of the resin inflow port 21 in a fan shape. A recessed portion 32 has an inner peripheral surface 32b whose diameter decreases toward the tip. The recessed portion 32 receives the expansion portion 41 inside thereof to allow the outer peripheral surface 41a of the expansion portion 41 to abut on the inner peripheral surface 32b to thereby lock the expansion portion 41 relatively rotatably in the circumferential direction as well as inseparably in the axial direction. The outer peripheral surface 41a of the expansion portion 41 is formed in a conical surface. The inner peripheral surface 32b of the recessed portion 32 is formed in a conical hole surface which faces the outer peripheral surface 41a in parallel thereto. Accordingly, the outer peripheral surface 41a and the inner peripheral surface 32b are closely joined to each other throughout the entire circumferences and the entire surfaces. In addition, a sufficient pressure joining force acts between the outer peripheral surface 41a and the inner peripheral surface 32b by the self-weight of the die. Thus, even if a resin flows into a gap 13 between the tip surface of the expansion portion 41 and the tip surface of the flange 51, the resin does not leak out. Thus, it is possible to omit the seal member 73.

[F0191] The outer peripheral surface whose diameter expands in a fan shape may be a curved surface whose diameter expansion ratio varies, for example, an outwardly convex spherical surface in addition to the conical surface whose diameter expands at a constant ratio along the axial direction as described above. Similarly, the inner peripheral surface of the recessed portion may be formed in a curved surface whose diameter reduction ratio varies, for example, an inwardly convex spherical surface in addition to the conical hole surface whose diameter decreases at a constant ratio as long as the diameter of the inner peripheral surface decreases toward the tip. In curved surfaces other than a conical surface or a conical hole surface, it is difficult to have a sufficient machining accuracy. Thus, when such curved surfaces are employed, it is preferred to set the outer peripheral surface of the expansion portion to have a smaller curvature along the axial direction than the inner peripheral surface of the recessed portion without setting the curved surfaces parallel to each other. Further, it is more preferred that only the outer peripheral surface of the expansion portion be formed in a curved surface other than the conical surface, for example, an outwardly convex spherical surface and the inner peripheral surface of the recessed portion be formed in a conical hole surface having a constant diameter reduction ratio.

[F0192] In the above embodiment, the expansion portion 41 is provided in the resin inflow port 21 and the holding body 7 is provided in the resin supply port 31 as the support structure A. However, as illustrated in FIG. 16, conversely, a similar holding body 7 may be provided in the resin inflow port 21 and a similar expansion portion 41 may be provided in the resin supply port 31. In this case, as illustrated in FIG. 16, the holding body 7 on the die is supported on the outer peripheral surfaces of the expansion portion 41 and a cylindrical portion 3a (resin supply tube 50) on the resin supply means 8 inseparably in the axial direction as well as turnably in the circumferential direction. Accordingly, when rotating the die, the die is supported in a stable attitude without causing inclination of the axis thereof.

[F0193] The embodiments of the present invention have been described above. However, the present invention is not limited at all to these embodiments. It is needless to say that the present invention can be carried out in various forms without departing from the scope of the invention.

1: A nonwoven fabric manufacturing apparatus comprising:

- a die having a nozzle row, the nozzle row extruding a thermoplastic resin;
- a resin supply means supplying the thermoplastic resin to the die;
- a hot air supply means supplying hot air to the thermoplastic resin extruded from the nozzle row of the die to draw the thermoplastic resin into fibers; and
- a collector having a conveyor belt, the collector collecting the thermoplastic resin that has been drawn into fibers to form a web by the self-fusion property;

wherein the die is disposed in such a manner that the angle of the die can be changed in a direction inclined relative to a width direction of the web that is perpendicular to a moving direction of the conveyor belt so that a width dimension of the web to be formed can be adjusted to a dimension corresponding to the angle of the die.

2: The nonwoven fabric manufacturing apparatus according to claim 1, wherein a resin inflow port of the die is turnably attached to a resin supply port of a resin supply means so that the angle of the die can be changed by adjusting a turning angle of the attachment.

3: The nonwoven fabric manufacturing apparatus according to claim 2, wherein an attachment structure between the resin inflow port of the die and the resin supply port of the resin supply means is a butt connection structure between flanges and the flanges can be fixed to each other with changing an angle therebetween.

4: The nonwoven fabric manufacturing apparatus according to claim 3, wherein the flanges can be fixed to each other with changing the angle therebetween using a quick coupling.

5: The nonwoven fabric manufacturing apparatus according to claim 1, wherein the die is provided with slits as the hot air supply means through which hot air is blown out from both sides across the nozzle row.

6: The nonwoven fabric manufacturing apparatus according to claim 1, wherein the collector includes a mesh-like conveyor belt and a suction box that sucks air on an upper surface of the belt from a rear surface of the belt, and at least a suction unit of the suction box that faces the die across the conveyor belt is disposed in such a manner that the angle thereof can be changed to a direction inclined relative to the width direction that is perpendicular to the conveyor belt moving direction.

7: The nonwoven fabric manufacturing apparatus according to claim 6, further comprising an interlocking mechanism that changes at least the angle of the suction unit of the suction box in interlocking with angle change of the die.

8: A nonwoven fabric manufacturing apparatus in which a resin inflow port of a die having a nozzle row that extrudes a thermoplastic resin is turnably attached to a resin supply port of a resin supply means, wherein
an expansion portion having an outer peripheral surface whose diameter expands toward a tip in a fan shape is provided in one of the resin inflow port and the resin supply port,
a recessed portion is provided in the other one of the resin inflow port and the resin supply port, the recessed portion having an inner peripheral surface whose diameter decreases toward a tip and receiving the expansion portion inside thereof to allow the outer peripheral surface to abut on the inner peripheral surface to lock the expansion portion relatively rotatably in a circumferential direction as well as inseparably in an axial direction, and the resin inflow port of the die is turnably attached to the resin supply port of the resin supply means by a support structure that includes the expansion portion and the recessed portion.

9: The nonwoven fabric manufacturing apparatus according to claim 8, wherein the expansion portion is formed on an outer periphery of a tip of a joint tube that constitutes the resin inflow port or an outer periphery of a tip of a resin supply tube that constitutes the resin supply port.

10: The nonwoven fabric manufacturing apparatus according to claim 8, wherein the recessed portion includes a flange that is formed on an outer periphery of a tip of a resin supply tube that constitutes the resin supply port or an outer periphery of a tip of a joint tube that constitutes the resin inflow port and a holding cylinder that is disposed in a protruding manner on a tip surface of the flange and has the inner peripheral surface.

11: The nonwoven fabric manufacturing apparatus according to claim 8, wherein the outer peripheral surface of the expansion portion is formed in a conical surface and the inner peripheral surface of the recessed portion is formed in a conical hole surface that faces the outer peripheral surface in parallel thereto.

12: A nonwoven fabric manufacturing apparatus in which a resin inflow port of a die having a nozzle row that extrudes a thermoplastic resin is turnably attached to a resin supply port of a resin supply means, wherein
one of the resin inflow port and the resin supply port includes a cylindrical portion and an expansion portion having an outer peripheral surface whose diameter expands on a tip of the cylindrical portion,
a holding body is provided in the other one of the resin inflow port and the resin supply port, the holding body having a recessed portion receiving the expansion portion inside thereof to lock the expansion portion relatively rotatably in a circumferential direction as well as inseparably in an axial direction,
a cylindrical support portion is provided in a region on a tip of the holding body, the cylindrical support portion having an inner peripheral surface that is continuous with an inner surface of the recessed portion and relatively rotatably supports an outer peripheral surface of the cylindrical portion, and
the resin inflow port of the die is turnably supported with respect to the resin supply port of the resin supply means by a support structure that includes the expansion portion and the holding body.

13: The nonwoven fabric manufacturing apparatus according to claim 12, wherein a bearing member is interposed between the outer peripheral surface of the cylindrical portion and the inner peripheral surface of the cylindrical support portion.

14: The nonwoven fabric manufacturing apparatus according to claim 12, wherein a bearing member is interposed between an outer surface of the expansion portion, the outer surface facing a base end side of the expansion portion, and an inner surface of the recessed portion of the holding body, the inner surface facing a base end side of the recessed portion and being opposed to the outer surface of the expansion portion.

15: The nonwoven fabric manufacturing apparatus according to claim 12, wherein a seal member surrounding a resin flow path is disposed between an outer surface of the expansion portion, the outer surface facing a tip side of the expansion portion, and an inner surface of the recessed portion of the holding body, the inner surface facing a tip side of the recessed portion and being opposed to the outer surface of the expansion portion.

16: The nonwoven fabric manufacturing apparatus according to claim 12, wherein the cylindrical portion is composed of a joint tube that constitutes the resin inflow port or a resin supply tube that constitutes the resin supply port, and the expansion portion is formed on an outer periphery of a tip of the joint tube or an outer periphery of a tip of the resin supply tube.

17: The nonwoven fabric manufacturing apparatus according to claim 12, wherein the holding body includes a flange that is formed on an outer periphery of a tip of a resin supply tube that constitutes the resin supply port or an outer periphery of a tip of a joint tube that constitutes the resin inflow port and a holding cylinder that is disposed in a protruding manner on a tip surface of the flange and has the recessed portion and the cylindrical support portion continuous with the recessed portion.

18: The nonwoven fabric manufacturing apparatus according to claim 12, wherein the outer peripheral surface of the expansion portion is parallel to the outer peripheral surface of the cylindrical portion, and the holding body includes a recessed portion having an inner peripheral surface parallel to the outer peripheral surface of the expansion portion and a cylindrical support portion having an inner peripheral surface whose diameter decreases in a stepwise manner continuously with the recessed portion, the inner peripheral surface being parallel to the outer peripheral surface of the cylindrical portion.

19: A nonwoven fabric manufacturing method comprising: preparing a nonwoven fabric manufacturing apparatus, the apparatus includes
a die having a nozzle row, the nozzle row extruding a thermoplastic resin,
a resin supply means supplying the thermoplastic resin to the die,
a hot air supply means supplying hot air to a thermoplastic resin extruded from the nozzle row of the die to draw the thermoplastic resin into fibers, and
a collector having a conveyor belt, the collector collecting the thermoplastic resin that has been drawn into fibers to form a web by the self-fusion property;
disposing the die in such a manner that the angle of the die can be changed in a direction inclined relative to a width direction of the web that is perpendicular to a moving direction of the conveyor belt; and
adjusting a width dimension of the web to be formed to a dimension corresponding to the angle of the die by changing the angle of the die.