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Fekete et al.

[11] **3,890,681**

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[54] **APPARATUS FOR NEEDLING TEXTILES**

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[52] **U.S. Cl.** ..... **28/4 R;** 28/72.2 R

[51] **Int. Cl.** **D04h 18/00**

[58] **Field of Search** ..... 28/4 R, 72.2 R

[56] **References Cited**

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2,142,728	1/1939	Kienzle	28/4 R
2,920,373	1/1960	Gresham	28/4 R
2,974,393	3/1961	Hollowell	28/4 R
3,208,125	9/1965	Hall et al.	28/4 R
3,372,447	3/1968	Williams et al.	28/4 R

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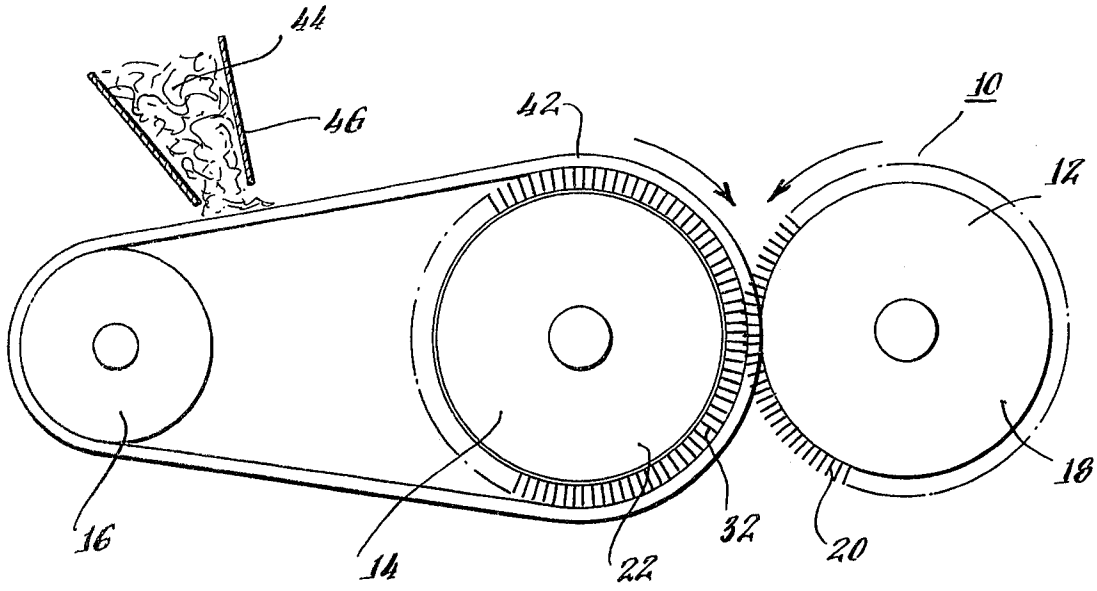
[57] **ABSTRACT**

This invention relates to apparatus for performing so-called "needling" operations on textile goods, which apparatus is characterized by the fact that it comprises a needle support member having a multiplicity of felting needles affixed thereto, the long axes of which are oriented substantially normal to the surface of said member, and an associated backing member to support the textile material against the forces experienced during the needling operation, which backing member has a surface comprising pressure-tolerant, laterally displaceable, elongated members which are affixed at one end to the surface of the backing member and have their long axes oriented substantially normal to the surface of said backing member; said needle support member and said backing member each being so structured as to travel repeatedly along a closed travel path each aggregating 360° of angular change and being so positioned with respect to each other that at least at one point along their paths of travel, portions of said needles reside among said elongated members.

14 Claims, 4 Drawing Figures



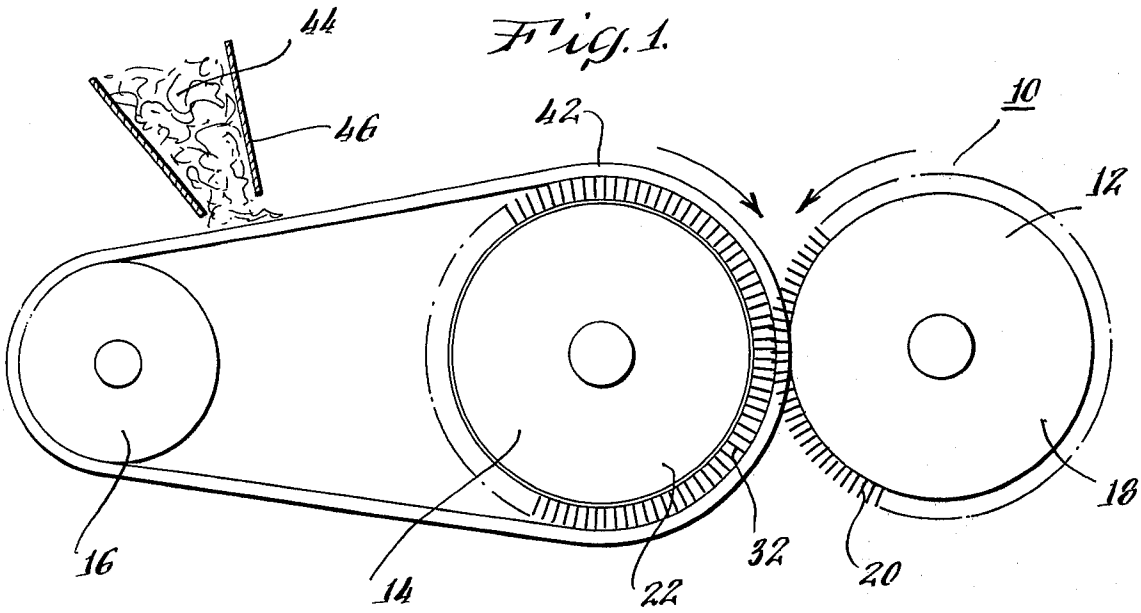


Fig. 1.

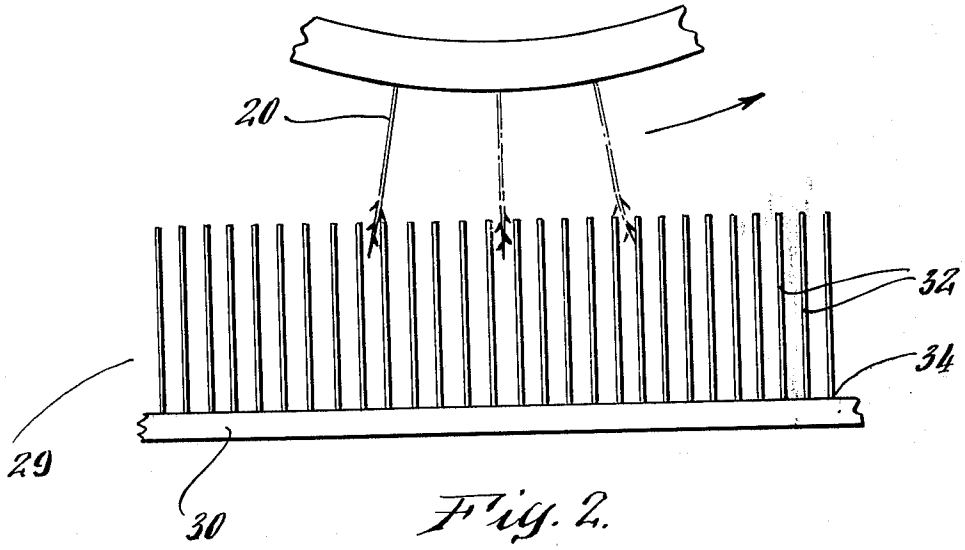
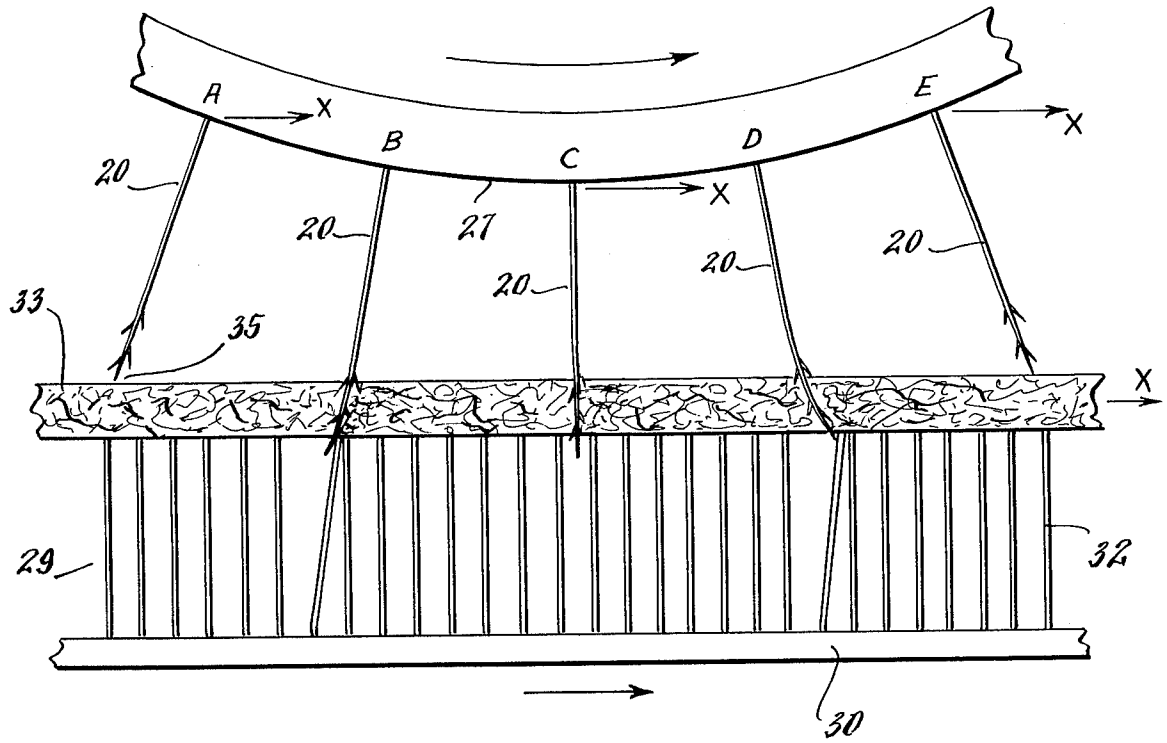


Fig. 2.

Fig. 3.



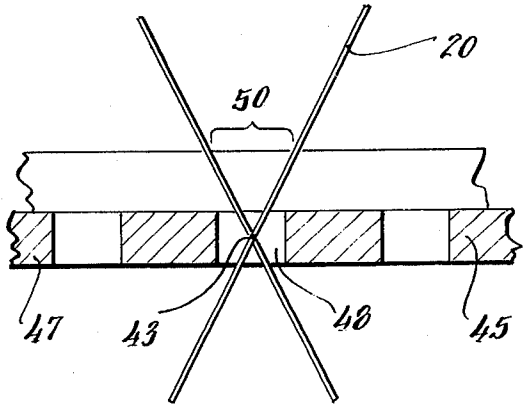


Fig. 3A.

APPARATUS FOR NEEDLING TEXTILES

BACKGROUND OF THE INVENTION

It is well known in the textile arts that it is possible to make a textile product by subjecting a batt of fibers to the repeated plunging action of a multiplicity of so-called "felting" needles, by which, in this context, is meant known per se, long, thin, rod-like structures, usually round or angular in cross-section, having one or more barbs in them, the preponderance of which face toward the pointed end. In this connection, reference is made to the following U.S. Patents: Foster, U.S. Pat. No. 2,322,573; Kopriva et al., U.S. Pat. No. 2,326,038; Foster, U.S. Pat. No. 2,327,416; Foster U.S. Pat. No. 2,349,086; Foster, U.S. Pat. No. 2,391,560; Brown, U.S. Pat. No. 2,678,484; Lauterbach, U.S. Pat. No. 2,857,650; Weickert, U.S. Pat. No. 2,882,585; Lauterbach, U.S. Pat. No. 2,958,113; Foster, U.S. Pat. No. 3,224,067; Zocher, U.S. Pat. No. 3,464,097; Foster U.S. Pat. No. 3,479,708; Zocher, U.S. Pat. No. 3,566,663; Foster, U.S. Pat. No. 3,727,276; and McKew et al., U.S. Pat. No. 3,230,599. The batt of fibers may be supported on a backing scrim, which typically may be an open-weave mesh fabric made in the traditional manner of textile manufacturing. Such a combination, with the fiber batt facing the needle board of the needling machine, is passed beneath the needle board, to which are affixed a multiplicity of needles. In the most widely used types of such machines, the needle board reciprocates upward and downward by means of driven connecting rods, thereby producing the plunging action which, because of the barbed configuration of the needles, causes interlocking entanglement of the fibers with each other and with the backing scrim, thereby giving the textile product structural and mechanical integrity and an acceptable degree of fiber retention. In this connection, reference is made to the following United States Patents which disclose such machines: Stone, U.S. Pat. No. 2,177,604; Walsh, et al., U.S. Pat. No. Re. 21,890; Marshall, U.S. Pat. No. 2,959,509; Chase, U.S. Pat. No. 1,742,133; and Chase U.S. Pat. No. 1,745,739.

Textile products made in accordance with these needling techniques have been found particularly useful in the field of papermakers felts where large numbers of fibers must be incorporated into the felt in order to provide the degree of loft, resiliency, and structural integrity that is required to render them useful in the environment of the papermaking machine. However, the production of needled textile products made by the previously known techniques has been relatively slow and, in addition, the mechanical problems involved in the construction and operation of the associated machinery have been substantial, primarily because of the reciprocal motion and the great weight and inertia attendant to making the apparatus sufficiently strong and rigid to withstand the high forces experienced in the needling operation.

The basis for the premise that reciprocating motion is necessary is that the needles themselves necessarily are very thin, although they must possess sufficient mechanical strength to tolerate the stresses and strains to which they are exposed by virtue of the existence of the barbs and the pressures imparted to the needle shaft during impingement of the needle point and barbs on the fibers and other portions of the textile product being made. In view of this, and the fact that as the textile product is produced it becomes progressively more dense, until the advent of the present invention we believed that it was necessary to cause the needles to enter and be removed from the textile fabric substantially along a linear path; that is, one not involving any significant amount of laterial pressure on the needles, or of angular displacement and flexing of them, between the time the needle point begins to enter the fabric and the time that it leaves the fabric, since the effect would be to cause the constituent material of the needles to fatique through work hardening resulting from such flexing, and ultimately break. Flexing and the angular displacement of the needles would additionally produce undesired tearing and hole-enlarging effects on the associated fabric.

This problem is intensified by the fact that, as noted above, the thrust pressures that must be exerted by the needle in order to provide the desired effects of the needling operation are substantially initially and become progressively greater as the textile product densifies, and this makes it necessary for the textile product to be backed against displacement to ensure that the needles will penetrate the textile product to a predetermined depth. Traditionally, this was achieved by means of a backing plate; that is, a sheet of material, such as heavy gauge steel, having perforations therein corresponding to the position, size, and distribution pattern of the needles on the needle board, whereby the barbs of the needles could be caused to plunge completely through the textile product being fabricated and through the holes in the backing plate. The very nature of such a backing plate meant that the needles must enter it in exactly the same places and configuration each time in order to avoid needle breakage from impingement on the unperforated portions of the backing plate, and it also meant that the potential needle density was limited inherently because of the necessity of preserving sufficient "land" area between the perforations in the backing plate to give the plate enough strength to withstand the forces of needling.

Some attempt has been made to replace such backing plates with other structures, such as belts having "knee-action" plastic filaments projecting therefrom; (in this connection, reference is made to Hollowell, U.S. Pat. No. 2,974,393), but in the textile art, such structures have not to date found wide-spread application primarily because, as the Hollowell reference illustrates, such filament belts were associated with reciprocating needle boards and were merely substitutions for the backing plate. Although they may have permitted greater needle densities than could be achieved with a backing plate, they are inherently suited only to the needling of relatively thin fiber batts because of the limited ability of the "knee-action" filaments to support the fabric against high needling pressures, and they still are substantially restricted to the low production speeds of traditional needle looms because of having reciprocating needle boards, presumably because of all the problems of subjecting the needles to lateral pressures and flexing still being present.

There have been attempts made to process sheet-like goods through the nip formed by associated roll devices wherein protrusions from at least one of the rolls perform work on the material being processed. In this connection, reference is made to the following patents: Harmon et al., U.S. Pat. No. 3,012,290; Harrigan, U.S. Pat. No. 232,962; Gresham U.S. Pat. No. 2,920,373;

Krolik, Jr., U.S. Pat. No. **3,137,611**; Harwood, U.S. Pat. No. **3,038,215**; Mueller U.S. Pat. No. **2,847,086**; Oace, U.S. Pat. No. **3,014,263**; and British Patent Specification No. **20,645.** There have also been similar machines which utilize belt-like structures other than opposing rolls, for substantially the same purposes; (in this connection reference is made to U.S. Pat. Nos. **3,025,585**, Griswold; and U.S. Pat. No. **2,762,433**, Russell). However, none of the aforesaid known references of either type were dealing with needles of the type contemplated by the present invention. Rather, these references deal with devices which were for the purpose of punching perforations in sheet-like material, or embossing it, or performing other such tasks, with penetrating structures that were not long and thin and therefore did not have the kind of mechanical stress problems which are inherent to the needles used in needling as it is known in the textile arts.

Occasionally, attempts have been made to modify textile process machinery to render it more simple structurally and faster than the known per se reciprocating needle looms. Such attempts are illustrated by Kalwaites, U.S. Pat. No. **3,081,501** and Hollowell, U.S. Pat. No. **2,974,393**; but these references also still resort to reciprocating needle board motion as the means for propelling needles into the textile material. Other prior art devices which are more nearly like roll devices so made for the purpose of speeding up the needling process have either not been concerned with the long, thin, and relatively delicate needles contemplated by the present invention, or have tolerated the generation of objectionable relatively wide apertures in materials that are not of a dense nature (in this connection, reference is made to Kalwaites, U.S. Pat. Nos. **3,325,868** and **3,255,496**).

It is believed that needling machines having opposing rolls, one with the needles mounted thereon and the other with a backing surface such as the perforated plate similar to the type previously used as backing plates in reciprocating needle looms, have not been found to be satisfactory because of the practical mechanical problems which would be encountered in such devices. First, there would be the very difficult problem of perfect "registration", or causing each needle to align with a hole exactly in every pass; otherwise, needle breakage would be experienced. Next, if one visualizes the necessity for the needle shafts to pivot angularly about a fictitious point approximately halfway along the axis of each hole as each needle first intercepts, then penetrates, and lastly withdraws from its associated hole as the two pass through arcuate paths through the nip region of the rolls, it will be appreciated that the holes will have to be increasingly larger as the roll diameters decrease, as the depth of needle penetration increases, and as the thickness of the backing plate increases, and this enlargement reduces the possibility for effective backing and therefore increased needle density.

One reference (British Patent Specification No. **450,775**) discloses an apparatus which is an attempt to increase the speed of needling by use of a series of needle boards traveling on an endless belt and opposed by an inclined plane backing plate. The drawbacks of this structure in terms of the lateral stress moments which it places on the needles are apparent from an examination of the apparatus as disclosed since, of course, the entry-withdrawal sequence of the needles effected by the cooperation between the inclined plane bed plate and the endless belt of needles is clearly of such a nature as to cause the relative motion of the needles, due to the raising of the textile product being needled up the incline of the backing plate to the crown and then down it, to be as if the needles were being pivoted through an arc about a fictitious point which moves along their respective shafts. This, apparently, makes such a machine impractical in the long run, as evidenced by the fact that the apparatus has not found wide-spread use in the industry. Furthermore, because of the ribbed configuration of the backing plate substitute which apparently is necessitated by the substantially linear progress of the needles in this arrangement, it is not possible to have a very high needle density which, of course, would help improve the efficiency of needling.

Recognizing the drawbacks of all of the foregoing structures and visualizing the advantages which would result if it were possible to produce a pure roller-type structure, various persons skilled in the art have made attempts from time to time to produce structures that would at once perform needling of the high quality level desired, while, at the same time, simplifying the machinery, speeding up the process time, and avoiding the deleterious effects on the needles themselves. In this connection, reference is made to Hall et al., U.S. Pat. No. **3,208,125**; and Williams et al., U.S. Pat. No. **3,372,447.** It will be noticed that all of these references, however, require the use of internal camming structures which either cause the associated needles to plunge in and out of the roll face, or cause them to be made to cant mechanically, so as to avoid the angular displacement problems noted above, as well as the lateral bending moments imparted by the angular displacement that takes place as the needles first enter and then are withdrawn from the textile material being processed through the course of the material passing through an arc of some dimension. Clearly, such devices are very intricate and expensive, and are subject to extreme and rapid wear, and so are not suited to use on high-speed textile processing machinery.

Accordingly, it is an object of the present invention to provide a new and improved apparatus and method for needling textile materials with a greater number of penetrations per unit time occuring without intolerable adverse effects on the needles or the quality of the textile products so produced.

SUMMARY OF THE INVENTION

The objects of this invention may be achieved through any of its embodiments in which there is utilized an apparatus for needling textile goods comprising a needle support member having a multiplicity of felting needles affixed thereto, the long axes of which are oriented substantially normal to the surface of said member, and an associated backing member to support the textile material against the forces experienced during the needling operation, which backing member has a surface comprising pressure-tolerant, laterally displaceable, elongated members which are affixed at one end to the surface of the backing member and have their long axes oriented substantially normal to the surface of said backing member; said needle support member and said backing member each being so structured as to travel repeatedly through a closed path of travel, and being so positioned with respect to each other that

at least at one point along their paths of travel said needles reside among said elongated members.

DESCRIPTION OF DRAWINGS

FIG. **1** is a schematic drawing of one embodiment of the present invention,

FIG. **2** is a cross-sectional drawing of backing material useful in the practice of a further embodiment of the present invention.

FIG. **3** is a graphic representation of the embodiment of the present invention depicted in FIG. **2** in use, and

FIG. **3***a* is a graphic representation of prior art apparatus.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring first to FIG. **1**, there is illustrated a textile needling machine **10** embodying the present invention, comprising a needle support member **12** and an associated backing member **14.** In this particular embodiment, members **12** and **14** are depicted as rolls. There is also illustrated a carrier roll **16** the purposes of which are hereinafter described, although it will be clear that the use of such a carrier roll with the present invention is optional. The needle roll **12** comprises a roll body **18** of typical, known per se, cylindrical form, to the surface of which is affixed, by known techniques, such as gluing with adhesives, or mechanical affixation, or welding, brazing, or the like, a multiplicity of needles **20** of any of a wide variety of constructions and designs which are known per se in the textile needling art. The associated backing roll **14** comprises a roll body **22,** to the surface of which is affixed a multiplicity of elongated members **32** which have one of their ends affixed to the backing roll body **22** and which are characterized by being able substantially to retain their shape and orientation under the forces delivered to them in their axial direction (which characteristic is referred to herein as "pressure-tolerant"), and yet are laterally displaceable; that is susceptible to being moved from side to side around their fixed ends acting as pivots. So called "card wire", well known in the textile arts, is suitable for this use and possesses the foregoing structural features. It comprises a card wire structure **29** of the type illustrated in FIG. **2** comprising a sheet-like member **30** made from textile goods, rubber, heavy plastic material, and the like, from one surface of which project a multiplicity of cut wire members **32** made from material such as bronze, steel, plastics, synthetic materials, or the like, typically of a diameter of about **0.08** cm, and in length about **2.5** cm, the outermost ends of which occupy a plane substantially parallel to the surface of the supporting back member **30.** The elongated members **32** of such a structure are free to bend or pivot about points **34**; that is, the point at which each emerges from the upper plane of the backing member **30,** so that as portions of a needle **20** penetrate among the members **32,** such portions may move relative to the elongated members **32,** and the elongated members are free to deflect sidewards to give such penetrating portions of the needle freedom to so pass unobstructed. At the same time, the cut wire members **32** are sufficiently rigid to support the pressures imparted by such things as a fabric being processed without substantially losing their shape or orientation, not only against the normal tensions and operationsl forces herein contemplated, but also against the forces applied as the fabric moves through the point of closure between the needle roll **12** and the backing roll **14** wherein the needles **20** on the needle roll **12** are caused to be plunged through and extracted from the fabric being processed. In accordance with the teachings of the present invention, that portion of the needle which is in contact with the felt, the backing material, and the felt travel at the same linear velocity, measured along what has been designated in FIG. **3** as the X axis, at least at the point where the needle roll and backing material are closest.

The foregoing is further illustrated in FIG. **3** where there is shown a graphic illustration of a single needle so positioned relative to the felt **33** and an associated card wire structure **29,** the needle and card wire structure moving from left to right such that at a given position A, the needle **20** begins to enter felt being needle. Position C is the position at which the portion of the needle **20** embedded in felt **33,** the backing material **29** and the felt **33** will be traveling at the same linear velocity along the X axis. The needling sequence continues to position E where the needle **20** is withdrawn completely from the felt **33.** Throughout the needling sequence the cut wire members **32** substantially retain their shape and orientation under the axially oriented or vertical forces imparted during the needling process. In addition, elongated members **32** are susceptible to being moved from side to side around their fixed ends **34** acting as pivots. For example, at position A, the needle tip **35** has begun to penetrate the region occupied by the felt **33.** As the combination continues to move from left to right as shown in FIG. **3,** penetration of the needle **20** through the felt **33** is substantially complete by the time the combination has reached position B at which position the elongated wire member **32** may be caused to bend as a result of the impingement upon wire member **32** by needle **20.** The force imparted upon the needle by the felt will cause the needle **20** to deflect. At position B the angular displacement of the needle **20** relative to the plane of the felt **33** is in a direction opposite that of the direction of movement of felt **33.** The magnitude of the deflecting force on the needle **20** is a function of roll diameter and depth of needle penetration. For example, the force and therefore needle deflection can be reduced by increasing the diameter of the needle roll or the associated backing roll or both rolls. As the sequence continues the end of the needle **20** which extends through felt **33** may impinge upon the bend other elongated wire members **32** and will begin to straighten out such that at position C it will return to its normal orientation. Similarly, the previously deflected wire members **32** will spring back to their normal orientation. As the needling sequence continues past position C to position D, the needle **20** begins to withdraw from the felt **33,** the bending or angular displacement of the needle **20** relative to the plane of the felt **33** now being in the same direction as that in which felt **33** is moving. In addition, the end of needle **20** which extends through felt **33** may impinge upon and bend other elongated wire members **32** and will again begin to straighten out such that at position E it will have sprung back to its normal orientation. Similarly, the previously deflected wire members **32** will spring back to their normal orientation.

At this point, it should be noted that in order to overcome the problems referred to above attendant to using a perforated-type prior art backing plate, the elongated members **32** of the card wire underlying the felt **33**

must be free to move laterally to accommodate the sweep of the needle tip region. The significance of this is illustrated in FIG. 3*a* where it may be seen that if a perforated backing plate where used as in prior art devices, it would be necessary to have the angular displacement of the needles take place about a pivot point **43** that is substantially in the mid-plane **45** of the backing plate **47,** since otherwise, the perforated portion **48** of the backing plate **47** would have to be substantially larger, with a consequent reduction in the ability of the backing plate to withstand the pressure forces imparted during the needling sequence. Not only does this cause an undesired decrease in the effectiveness of the backing member, but also it will be clear that it tends to increase the lateral force moments impartd to the needle and that it further tends to increase the size of the needle holes introduced in the felt **33.** Furthermore, it will be noted that in the prior arrangement depicted in FIG. 3A, of necessity, the dimensions of the flared opening **50** imparted by the angular displacement of the needle **20** in the felt are significantly greater in terms of volumne displacement than are those in the case of the present invention wherein there is no problem regarding registration of needle tips and apertures in a backing plate. In effect, it may be said that the backing member **29** of the present invention provides a system of holes which, unlike those in a backing plate, move to accommodate the angular sweep of the needle tips.

It will be obvious that although not necessary the card wire member can be made to pass through an arcuate path to address the on-coming needles as, for example, by being placed around the circumference of a roll. In the embodiment illustrated in FIG. **1** wherein the elongated members **32** are affixed to a backing roll **14,** the needle roll **12** and backing roll **14** are so positioned with respect to each other that at least a portion of the needles **20** on the needle roll **12** occupy the general region also occupied by the elongated members **32** on the surface of the backing roll **14.** To permit variations in needling depth, one or both of the roll axes are movable so that the rolls may be positioned closer together or farther apart. Obviously, positioning the rolls closer together will also have the effect of increasing the needling "zone", or distance over which needles are inserted into the fabric at any given point in time. Thus, for example, fibers **44** are laid onto the outer surface of a papermakers felt **42** which has been rendered into the form of an endless belt, by a fiber-laying device **46** of any of a multitude of well-known designs such as a carder, batt former, layer combination, or a blown fiber source, and is positioned about the backing roll **14** and, in the case illustrated in FIG. **1,** about a carrier roll **16.** The backing or the carrier roll, or the needle roll, or even an associated slack takeup roll, or any combination of them, may be driven to cause the rolls to revolve and, therefore, the fabric **42** to move. As illustrated, the fabric **42** will be carried through the nip formed between the backing roll **14** and the needle roll **12** such that the needles **20** on the needle roll **12** will be caused to progressively plunge into and through and be extracted from the papermarkers felt **42.** In this manner, it is possible to subject the felt to a substantial number of needling passes in a very short length of time, because experiments have demonstrated that the felt may be run through the needling nip at speeds in excess of about **300** meters per minute.

Furthermore, because the diameters of the elongated members **32** of the card wire structure **29** are small, and since, in terms of needling practice, these diameters are analogous to the "land" areas between the perforated holes on the backing plate of a standard reciprocating needle machine, it is possible to have a much more dense concentration of needles on the surface of the needle roll than can be achieved on a standard needle board. For example, the practical maximum density of needles on a needle board as used in the industry is about **8,303**/sg. meter, whereas experimental machines embodying the present invention have been used having a needle density of **13,830**/sq. meter and it is thought that this density might even be increased. Thus, through the practice of the present invention, it is possible to perform a high-speed needling operation from which the quality of needling and the product produced thereby is very high and is clearly acceptable to meet the standards of such difficult and demanding products as papermakers felts.

It will be apparent that even though various backing roll — needle roll diameter combinations may be operative in the practice of the present invention, it is desirable although not required for both rolls to have large diameters; e.g., on the order of **120** cm or more, since, obviously, the greater the diameter of one or both of these rolls, the less relative movement there is between a given needle point residing in the region of the card wire members **32,** and this further reduces the "working" of the needles through the elimination of lateral moments of force even through it should be understood that the degree of working is smaller diameters is within acceptable limits since there will not be an untoward amount of needle fatigue, bending, or breaking. Accordingly, backing roll — needle roll combinations having smaller diameters may also be used. For example, backing roll — needle roll combinations of as small as **30** cm and **120** cm, respectively, have been shown to be operative in the practice of the present invention. It also may be desirable for the diameter of the backing roll to be equal to the diameter of the needle roll.

EXAMPLE

A machine was constructed having a needle roll **122** cm in diameter, to the surface of which were fitted felting needles which were equilaterally triangular in cross-section, having barbs at the corners of the triangles, to a needle density of **15** needles per **10** sq. cm of roll face. The needles were mounted perpendicular to the roll face. Associated wire rolls were fabricated in two different diameters; one **30** cm, and one **122** cm. On both of these wire rolls the roll face was covered with card wire, the heights of the wire filaments of which were approximately **2.5** cm in length. In this piece of equipment, only the card wire roll was driven by an outside source. The depth of needle penetration was adjusted as desired by changing the center-to-center distance between the rolls.

The felt was positioned about the card wire roll and over a third idler roll which was movable to facilitate taking up slack in the felt. Several felt samples were needled on this machine, using both the **122** cm and the **30** cm wire roll.

It was observed that the rotary motion of this machine allowed relatively high speed needling as compared to a standard reciprocating needle loom. In standard needling procedures used in the manufacture of

papermakers felts it is typical to apply **12.8** g/sq. cm of fibers, and to perform work on felts of this type on a regularly reciprocating needle loom would require **44.5** minutes. It was found that the machine made in accordance with the present invention, having approximately the same number of penetrations per inch as in the aforesaid standard reciprocating needle loom, could be operated at approximately **274.5** m/min., which completely needled the felt in approximately **7.5** minutes. Thus, at a speed of **274.5** m/min. the needling productivity is approximately six times greater.

No particular problems were apparent at **274.5** m/min., from which it is clear that the running speed could be increased significantly. In fact, on this same machine, another run was made at **457.2** m/min.

It was noted that the product of the present invention appeared to have several different characteristics over those produced on standard reciprocating needle looms. For example, one difference was in the apparent size of the holes left in the felt by penetration of the individual needles. Although the needle holes in the felt produced on the machine of the present invention appear slightly larger than those left by reciprocating needle looms, apparently due to the changing angular path followed by the needles during penetration, it was also noticed that the apparent bulk density of the felts produced on the machine made in accordance with the present invention was somewhat less than that produced by a reciprocating needle loom. Without intending to be bound by any theory, it appears that as needles are being pulled out of the felt, they are still under a slight degree of lateral pressure so that the point of the needle may tend to scrape the upper layer as it clears the upper felt surface. Obviously, the degree to which this occurs will be a function of the diameters of the rolls used.

As noted above, both **122** cm and **30** cm wire rolls were used. It was noticed that as the diameter decreased for a given running speed, needle bending and breakage began to occur so that when the **30** cm diameter roll was used, at a relatively high speed, the needling had to be terminated in order to avoid serious damage to the needle roll.

Various empirical measurements were made in the course of utilizing the machine which embodied the present invention, during which it was noted that the maximum load exerted on the rolls at their point of contact with the felt being processed was in the neighborhood of **1.76** kg per linear cm, and that the horsepower requirements were in the neighborhood of **0.0187** norsepower per **30.48** m per minute **2.5** cm of face width.

Based on these experiments, it was estimated that the cost of a loom embodying the present invention would be approximately **60** percent that of a commercially available reciprocating needle loom of the same width.

With respect to the working characteristics of the papermaking felt-type samples produced on machines embodying the present invention, the following table shows the measured vertical flow rate of such felts in liters per minute at various mechanical loadings for various felt thicknesses made both on a reciprocating needle loom and on the machine embodying the present invention.

	Mechanical Loading KG/CM2	Felt Thickness Milimeters	Vertical Flow Rate Liters/Minutes
	17.5	1.45	55.3
Reciprocating	26.3	1.30	44.3
Loom	35.0	1.17	37.1
Sample	43.8	1.09	32.2
	52.5	1.00	28.4
	17.5	1.42	58.3
Present	26.3	1.24	46.2
Invention	35.0	1.14	39.4
Sample	43.8	1.09	34.1
	52.5	1.00	29.1

It should be obvious from the foregoing discussion that even though the embodiments described above are in terms of structures having two opposing rolls or cylinders, it is also possible to practice the present invention in a wide variety of other configurations in which the surface to which the needles are affixed and the surface to which the backing members are affixed travel repeatedly through closed travel paths which, in the aggregate of their constituent flat and arcuate portions, cause the needles and the members to pass through 360° during each revolution, provided that at some point along their paths of travel, at least a portion of the needles reside among the elongated members of the backing members. Included among them are a needle roll in combination with an incline-decline plane carrying an endless belt of card wire as a backing member, or an endless belt of card wire in combination with an endless belt carrying needles, which combination converges at some point along their paths of travel. Obviously, in these embodiments of the invention, the "paths of travel" may not be the true circles as in the case of the needle roll and the backing roll being revolving cylinders, but instead may be elliptical or other geometrically regular or even irregular closed loops in cross-section. It is also within the contemplation of the present invention to have a multiplicity of needle rolls in tandem arrayed around around a common backing roll, whereby several combinations of needle types and/or needling depths may be accommodated sequentially on a given fabric in a single set up.

It is to be understood that the embodiments herein illustrated and discussed, and the terms and expressions which have been employed, are by way of illustration and not of limitation and that there is no intention in using any of them to exclude any equivalents of the features shown or described, or portions thereof, since it will be recognized by those skilled in the arts that this invention may be practiced in a wide variety of forms and embodiments without departing from the spirit and scope of this invention.

We claim:

1. An apparatus for needling textiles comprising

a needle support member which is capable of traveling along a closed travel path and has a multiplicity of felting needles affixed thereto, the long axes of which are oriented substantially normal to the surface of said member,

and a backing member which is capable of traveling along a closed travel path and has a surface comprising pressure-tolerant, laterally displaceable, elongated fabric support members which are affixed at one end to the surface of said backing

member and have their long axes oriented substantially normal to the surface of said backing member;

said closed travel paths each aggregating 360° of angular change and being so positioned with respect to each other that at least at one point along said paths, a portion at least of said needles will reside among said elongated members.

2. The apparatus described in claim **1** wherein said surface of said backing member comprises card wire.

3. The apparatus described in claim **1** in which at least one of said members is a cylinder.

4. The apparatus described in claim **2** in which at least one of said members is a cylinder.

5. The apparatus described in claim **1** in which said needle member and said backing member are cylinders.

6. The apparatus described in claim **5** in which said surface of said backing member comprises card wire.

7. The apparatus described in claim **5** wherein the diameter of said needle-bearing cylinder is at least 122 centimeters and the diameter of said backing cylinder is at least 30 centimeters.

8. The apparatus described in claim **5** wherein the diameter of said needle-bearing cylinder is equal to the diameter of said backing cylinder.

9. The apparatus described in claim **6** wherein the diameter of said needle-bearing cylinder is equal to the diameter of said backing cylinder.

10. A method of needling textiles comprising the steps of moving a fabric through the point of closure between a needle support member having needles affixed thereto the long axes of which are oriented substantially normal to the surface of said support member, and a backing member having pressure tolerant, laterally displaceable elongated fabric support members affixed at one end to the surface thereof, the long axes of which are oriented substantially normal to the surface of said backing member, moving said members along closed travel paths each aggregating 360° of angular change, positioning said members with respect to each other so that at least at one point along said paths, a portion at least of said needles will reside among said members.

11. A method according to claim **10** wherein at least one of said members is a cylinder rotating 360° about it's longitudinal axis.

12. An apparatus for needling textiles comprising

a needle support member which is capable of traveling along a closed travel path and has a multiplicity of felting needles affixed thereto, the long axes of which are oriented substantially normal to the surface of said member,

and a backing member which is capable of traveling along a closed travel path and has a surface comprising pressure-tolerant, laterally displaced, elongated fabric support members which are affixed at one end to the surface of said backing member and having their long axes oriented substantially normal to the surface of said backing member;

said closed travel paths each aggregating 360° of angular change and being so positioned with respect to each other that at least at one point along said paths, a portion at least of said needles will reside among said elongated members, said support member being movable relative to said backing member to control the distance between said needle and backing members and thereby control the depth at which said needles reside among said elongated members.

13. The apparatus described in claim **12** in which at least one of said members is a cylinder.

14. The apparatus described in claim **13** in which said needle member and said backing member are cylinders.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,890,681 Dated June 24, 1975

Inventor(s) Eugene Zoltan Fekete et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 2, Line 19 - Change "substantially" to "substantial".
Col. 5, Line 65 - Change "operationsl" to "operational".
Col. 6, Line 16 - Change "needle." to "needled."
Col. 6, Line 47 - Delete "the".
Col. 6, Line 48 - Change "the" to "and".
Col. 7, Line 18 - Add "art" after "prior".
Col. 12, Line 18 - Change "displaced" to "displaceable".

Signed and Sealed this

twenty-sixth Day of *August 1975*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks

FORM PO-1050 (10-69)

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