April 21, 1959 B. WEICKERT 2,882,585

FELTING NEEDLE

Filed Jan. 24, 1956

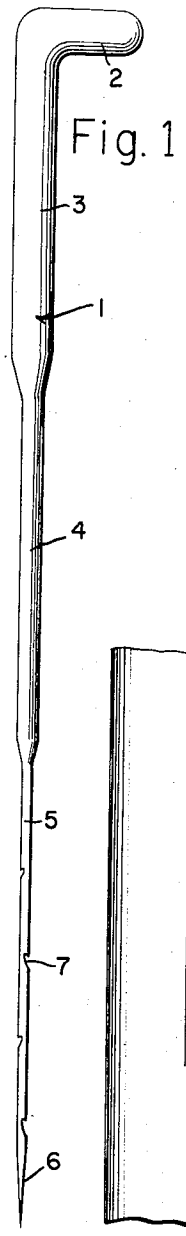


Fig. 1

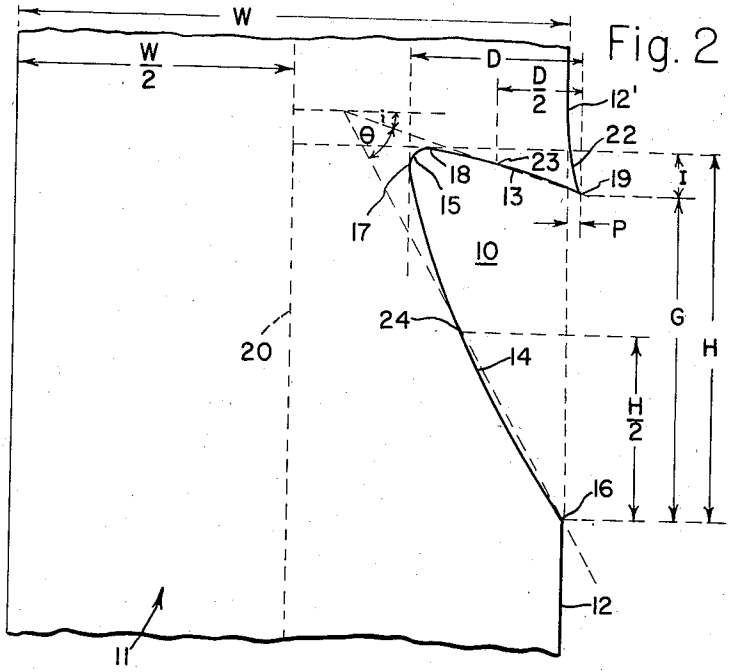


Fig. 2

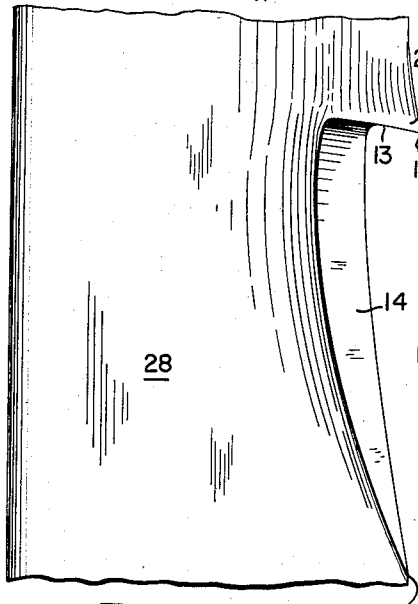


Fig 3.

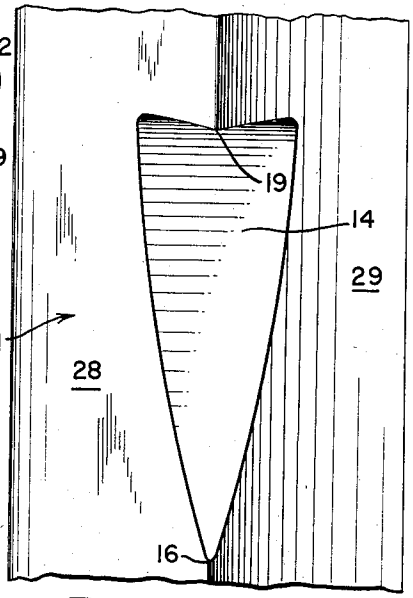


Fig. 4

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United States Patent Office 2,882,585 Patented Apr. 21, 1959

2,882,585

FELTING NEEDLE

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Application January 24, 1956, Serial No. 560,936

8 Claims. (Cl. 28—4)

This invention relates to felting needles, concerning particularly a configuration of needle especially suited to production of coherent articles from batts or other assemblages of fibrous material.

Needles with barbs or similar profile irregularities are known to be adapted to engagement and displacement of fibers upon reciprocation through textile material. Recently such needles have been used to compact non-woven assemblages of fibers or filaments of synthetic origin. Repeated needling of a fibrous batt or like assemblage with conventional felting needles, if at all efficacious, often tends to disrupt the forming structure before occurrence of the desired degree of coherence or compaction.

A primary object of the present invention is provision of an improved felting needle. A particular object is configuration of the fiber-engaging portion of a felting needle for beneficial, rather than detrimental effect upon fibrous material repeatedly needled therewith. Other objects of this invention, together with means and methods for attaining the various objects, will be apparent from the following description and the accompanying diagrams.

Figure 1 is a schematic representation of a needle of the present invention viewed in a direction normal to the longitudinal axis of the needle. Figure 2 is an enlarged representation of part of a needle of this invention, including a fiber-engaging portion thereof in profile. Figure 3 is a view of the same part of a needle of this invention with the fiber-engaging portion rotated slightly from profile position toward the viewer. Figure 4 shows the same fiber-engaging portion head-on, that is rotated 90° toward the observer from the position of Figure 2.

In general, the objects of the present invention are accomplished by means of a felting needle having a notch-like indentation with roof and inner wall defining a moderate acute notch angle, the roof inclining from an internal peak outward at a slight angle to a normal with respect to the longitudinal axis of the needle and terminating at an external corner substantially aligned with the adjacent exterior of the needle, with the deepest wall indentation located transversely opposite the outwardly sloping roof part. The invention comprehends such a needle having a polygonal transverse cross section in which the roof of the indented configuration is inclined at an angle of about 12½° ± 5° to a normal with respect to the longitudinal axis and with the wall sloping at an acute angle of at least 45° to the roof, a curved connecting surface extending from the peak of the roof to the innermost indentation of the wall a distance less than the length of the substantially uniformly inclining roof from peak to corner.

Figure 1 shows felting needle **1** in ordinary operating position, i.e., oriented with its longitudinal axis vertical. L-shaped end **2** extends at a right angle from butt **3**, which narrows to shank **4** and then to blade **5**, finally terminating in pointed end **6**. Spaced along the edges of the blade are notches **7**, which are so small in this view as to indicate merely the general indented configuration. In transverse cross section from the butt end through the shank, the needle is circular, becoming polygonal at the blade.

The profile of a fiber-engaging portion of a felting needle of this invention appears in Figure 2. The longitudinal regularity of exterior edges **12** and **12'** of needle **11** is interrupted by notch **10** outlined by roof **13** and wall **14**, which are joined by curved apex **15**. The wall slopes inward toward longitudinal axis **20** of the needle from base point **16** on edge **12** to deepest indentation **17**. The roof inclines outward from internal peak **18** to external corner **19**, which terminates protrusion **22** extending beyond the regular line of the exterior by distance P measured in a direction transverse to the longitudinal axis. The transverse separation of the corner from the deepest indentation appears as depth D on this view. Height H of the notch, being the separation of the peak of the roof from the base of the wall, measured in a direction parallel to the longitudinal axis, exceeds gap G, which is the longitudinal separation of the corner of the roof from the base.

Transverse mid-point **23** of the roof, being the intersection of the roof with bisector $D/2$ of the notch depth, defines with the corner of the roof one side of inclination angle i of the roof, which provides the departure of the roof a distance I (the inclination itself) from a normal to the longitudinal axis. The same two points also define one side of notch angle θ, whose other side is defined by the base point and longitudinal mid-point **24** of the wall (i.e., its point of intersection with $H/2$). The mentioned mid-points are so selected and the angles accordingly defined accurately with the aid of the fixed corner and base point for precision of notch specification.

Both roof and wall surfaces are predominantly straight in profile, those in the illustration being slightly concave. In general, they also will be predominantly straight in the dimension perpendicular to the plane of the profile; however, curvature in that direction is not particularly objectionable, and allowance for it can be made by considering the view of Figure 2 as best representing the appearance of a central longitudinal cross section (i.e., through the axis of the needle and bisecting the notch longitudinally into halves usually mirror images of one another), section lines being omitted from the drawing in the interest of clarity.

Figure 3 depicts an indented portion of a preferred needle of this invention, conforming in all material respects to that schematized in Figure 2, rotated slightly (about 30°) about the longitudinal axis to bring the notch around further toward the viewer. Unlike the roof, substantially all of whose interior is hidden behind the inclined edges and corner thereof, the wall appears as a surface, rather than merely a line. The angle of inclination of the illustrated needle is about 12½°, and the notch angle is about 70°. The most deeply indented extent of the wall is exposed, though not separately identified, to one side of the near edge of the roof. As suggested by shading, the near edges of both the roof and the wall are lipped outward slightly from visible exterior face **28** of the needle, i.e., bulged toward the viewer. The blade of the needle has a triangular transverse cross section.

Figure 4 shows the same fiber-engaging portion as in Figure 3, conforming also to Figure 2, from the front of the notch, i.e., viewed head-on. This reveals exterior face **29** at the same angle as the face previously visible. Rounding of the notch apex is minimized in this view, of course, and the roof from the peak to the visible corner is completely hidden from view. Extremes of the deepest indentation are visible, through not too apparent, flanking the roof, but the centralmost part of the identation is hidden also inasmuch as a line projected through it in

a direction normal to the longitudinal axis intersects the roof itself.

The notch-like configuration of the needle of this invention is not difficult to manufacture. When the needle itself is composed, as it usually is, of steel or similar metal, a conventional upsetting method suffices. A male die conforming to the desired indentation is impressed upon a needle blank with sufficient force to swage a notch accurately. As a practical matter, the notch apex so produced will be somewhat rounded, through appearing relatively sharp to the unaided eye. Slight resulting lipping of the edges is not objectionable, but care should be taken to prevent excessive protrusion or undue sharpness of the corner, which would have an adverse effect upon the structure of the needled fiber assemblage; a positive way of controlling this is to include a corresponding female surface at one edge of the die. Although swaging has a beneficial effect upon the strength of the needle, not weakening it as do methods that involve complete removal of material from the needle blank during formation of the notch (e.g., cutting, grinding, or etching), a combination of methods may be used for optimum notch formation. The needle may be composed of non-metallic materials, e.g., ceramic or palstic, in which the notch-like fiber-engaging configuration may be recessed in similar manner or provided by injection molding or other method. In transverse cross section the needles usually are polygonal, most frequently triangular or square, the exterior faces being milled or planed from round blanks or produced in other conventional manner. The indentations are located most conveniently along the edges of intersecting faces, although they may extend clear across one or more faces if desired.

In actual practice the superiority of the fiber-engaging configuration of the needle of this invention soon becomes apparent. Needles of otherwise like configuration in which the deepest indentation is separated longitudinally further from the peak of the roof than the corner it must be reciprocated many more times to attain the same coherence or compactness of structure in the needled fiber assemblage. Needles in which the peak of the roof is transversely nearer the corner than it is to the deepest indentation are subject to similar operational disadvantage.

The most satisfactory inclination of the roof of the fiber-engaging indentation will vary somewhat with the exact location of the above features but in no event will exceed about 20° from a normal to the longitudinal axis. Like excessive protrusion of the corner, excessive roof inclination has a deleterious effect upon the needled structure, and a range of from about 10° to 15° has proved very effective upon batts of synthetic organic fibers, including those composed of cellulosics, polyacrylic, polyamide, or polyester compositions. The roof and wall together form a notch angle adequate to admit fibers without difficulty, being also effective to retain the fibers until the direction of movement of the needle reverses; any moderate acute angle is suitable, about 45° being a reasonable operating minimum.

The fiber assemblage for needling may consist of staple fibers, continuous filaments, or a mixture of the two, the fiber or filaments being arranged individually in completely random initial orientation or in some ordered arrangement. In ordinary use, the illustrated preferred needle of this invention whose notch would accommodate a maximum of about one hundred of the fibers being needled (i.e., filled flush with the exterior of the needle) will be found to engage and displace about one-tenth that many in or through a conventional batt composed of staple fibers. The roof length from peak to corner most suitably is equivalent in length to about a half dozen average diameters, the roof being absolutely longer the larger the average diameter of the fibers, of course. For optimum effect upon the needled structure both the inclination of the roof and any protrusion of the corner should not exceed about two fiber diameters (each). In general, it is preferable that the corner of the notch roof not protrude at all beyond the regular exterior of the needle.

As a practical matter, the gage of the needle is determined largely by the material to be needled with it, depending upon the diameter and resilience of the component fibers as well as upon the general thickness and density of the batt or other assemblage of fibrous material, whether non-woven, woven, or knitted. It is generally desirable to use as small a needle as is commensurate with a reasonably low rate of needle breakage so as to secure maximum needling density with minimum needle marking of the surface or tearing or other adverse dislocation of the interior of the needled article. Needling densities on the order of thousands of penetrations per square inch of the needled article are permissible with the needles of this invention, while the improved needling efficiency provided by the prescribed fiber-engaging configuration ensures high degrees of compaction at lower needling densities.

For optimum performance a needle of usual metallic composition having customary triangular or tetragonal transverse cross section will have a notch depth, which is the transverse distance from the corner of the roof to the deepest indentation (i.e., measured in a direction normal to the longitudinal axis), amounting to no more than about one-third its least transverse dimension. Of course, the longitudinal separation of the peak of the roof and the deepest indentation does not exceed the roof inclination (i.e., distance from peak to corner, measured parallel to the longitudinal axis), which in such needles is expressible as about one-fourth the notch depth. The gap between the corner of the roof and the base of the notch is on the order of several times the notch depth, while any protrusion of the corner is limited to about one-tenth the notch depth. Selection of proper gage and conformation of needle for a particular material to be needled is within ordinary operative skill in the light of the above teachings.

The claimed invention:

1. A felting needle having a notch-like indentation with tangents to both roof and inner wall converging to define a moderate acute angle, the roof inclining from an internal peak outward at a slight angle to a normal with respect to the longitudinal axis of the needle and terminating at an external corner substantially aligned with the adjacent exterior of the needle, with the deepest wall indentation located transversely opposite the outwardly sloping roof part.

2. A felting needle of predominantly uniform transverse cross section characterized longitudinally by a recessed portion with roof and inner wall together defining a moderate acute angle, the roof inclining outwardly from an internal peak at an actue angle of at most about 20° with respect to a normal to the longitudinal axis of the needle and terminating at an external corner with at most a slight protrusion beyond the adjacent exterior surface of the needle, with the innermost indentation of the wall and a part located between the internal peak and the external corner of the outwardly sloping roof intersecting a common normal with respect to the longitudinal axis.

3. A felting needle of polygonal transverse cross section and characterized by an indented fiber-engaging portion with tangents to both inclining roof and sloping inner wall converging to define an acute angle in a longitudinal plane, the roof inclining, at a slight angle with respect to a normal to the longitudinal axis of the needle, from an internal peak located at most halfway, in distance normal to the longitudinal axis, from the innermost indentation of the wall to the outermost corner of the roof, that outermost corner lying substantially flush with adjacent exterior surfaces of the needle and

that inner indentation lying transversely opposite the outwardly inclining roof.

4. A polygonal felting needle recessed at intervals therealong into notch-like outline characterized by inclining roof and sloping wall together defining a moderate acute notch angle and separated by a connecting surface terminating at the peak of the roof and at the innermost extent of the wall, the roof terminating externally in a corner having at most a slight protrusion beyond adjacent exterior longitudinal surfaces of the needle and lying with respect to the longitudinal axis at least half as far from the peak of the roof as from the innermost extent of the wall, with the innermost extent of the wall located at such a position longitudinally that a normal projected from the longitudinal axis through the innermost extent of the wall passes also through the outwardly inclining roof at a point between the peak and corner of the roof.

5. A polygonal felting needle characterized longitudinally by indented configuration, with roof inclined at an angle of about 12½°±5° to a normal with respect to the longitudinal axis and wall sloping downwardly from the innermost indentation at an acute angle of at least 45° to the roof and with a curved connecting surface extending from the peak of the roof to the innermost indentation of the wall, the roof inclining substantially uniformly to terminate in an external corner located farther along the roof from the peak than the innermost indentation is distant from the peak along the connecting surface.

6. A polygonal felting needle characterized longitudinally by recessed notch-like fiber-engaging configuration defined by a roof inclined at an angle of at most about 20° to a normal with respect to the longitudinal axis, a wall sloping at an acute angle to the roof and forming therewith an opening more than two times as great in longitudinal extent as the deepest indentation is in transverse extent, and a curved surface extending from the peak of the roof to the innermost end of the wall, the roof terminating in an external corner substantially flush with the adjacent exterior surfaces of the needle, the peak of the roof being located at least halfway, in direction normal to the longitudinal axis, from the external corner to the innermost end of the wall, and the innermost end of the wall being transversely opposite a part of the roof located between the peak and the external corner of the roof, in direction parallel to the longitudinal axis.

7. A metallic felting needle of substantially triangular transverse cross section characterized by a plurality of recessed longitudinally notch-like fiber-engaging portions, each having a sloping side wall with deepest indentation at most one-third of the least transverse extent of the needle taken through the deepest indentation, with a roof inclining from an internal peak to an external corner sufficiently aligned longitudinally with the exterior of the needle that the corner protrudes at most one-tenth the transverse extent of the needle, with the roof and the side wall joined by a connecting surface at the apex of the notch, the peak of the roof being located transversely at most halfway from the deepest indentation to the external corner of the roof and longitudinally from the deepest indentatioon of the notch at most a distance equal to the longitudinal distance from the peak to the external corner of the roof, the longitudinal separation of the peak from the external corner of the roof being about one-fourth the transverse separation of the corner from the innermost indentation, and the longitudinal separation of the corner of the roof from the base of the wall being more than two times the deepest transverse indentation of the wall.

8. A felting needle characterized by a plurality of recessed notch-like portions, each adapted to engage fibers upon longitudinal movement of the needle in one direction and to release the engaged fibers upon opposite longitudinal movement of the needle and bounded by a wall sloping inwardly from the base of the notch at the needle exterior to an innermost indentation and a roof inclined from a corner at the needle exterior to an internal peak, said innermost indentation and internal peak being joined by a connecting surface, the wall and the roof together defining in a central longitudinal plane a moderate acute angle, a line common to both the external corner and the base completing a triangle of area sufficient to circumscribe about a hundred average fiber transverse cross sections, the inclination of the roof measured from the peak to the external corner in a direction parallel to the longitudinal axis being equivalent to at least about twice the average fiber diameter, and the distance in the same direction between the peak of the roof and the innermost indentation of the wall measuring at most as much as the inclination, the outwardly inclined roof portion having a length equivalent to at least about a half dozen fiber diameters, the external corner of the roof being substantially flush with the exterior of the needle so as to protrude beyond the regular exterior of the needle at most a transverse distance equivalent to twice the fiber diameter.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,882,585 April 21, 1959

Bernhard Weickert

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 24, for "palstic" read -- plastic --; line 63, for "some ordered" read -- some more ordered --.

Signed and sealed this 11th day of August 1959.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents