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(71) Applicant(s)

Heinrich Lippert GmbH

(72) Inventor(s)

Theo Arnold

(74) Agent/Attorney

COLLISON CO

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(71) Anmelder (*für alle Bestimmungsstaaten ausser US*): HEINRICH LIPPERT GMBH [DE/DE]; Eschelbronner Strasse 35, D-74925 Epfenbach (DE).

(72) Erfinder; und
(75) Erfinder/Anmelder (*nur für US*): ARNOLD, Théo [FR/FR]; 18, rue Durrenbach, F-68830 Oderen (FR).

(74) Anwalt: KEIL & SCHAAFHAUSEN; Eysseneckstrasse 31, D-60322 Frankfurt am Main (DE).

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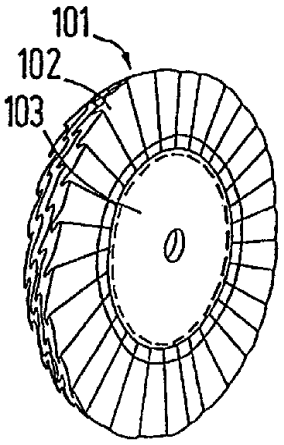
(54) Title: TOOL FOR MECHANICALLY TREATING SURFACES

(54) Bezeichnung: WERKZEUG FÜR DIE MECHANISCHE OBERFLÄCHENBEHANDLUNG

(57) Abstract

The invention concerns a tool for mechanically treating the surface of an object by rubbing, e.g. brushing, polishing, burnishing, cleaning, wetting or drying, the tool consisting of a fibre non-wovein which has been cut to size and processed. In order to improve the properties of the tool, the non-woven is manufacture, by an exclusively mechanical process, as a flexible, random-fibre non-woven which allows the object to be inserted into it and at least partly enclosed by it under the pressure used, the non-woven having a mechanical strength of 150-500 N/50 mm, preferably at least 300 N/50 mm, and a mean elongation at rupture of 50-150 %, preferably 80-100 %, when determined in accordance with DIN 53857/2.



(57) Zusammenfassung

Die Erfindung bezieht sich auf ein Werkzeug für die mechanische Oberflächenbehandlung eines Gegenstandes durch Reiben, z.B. zum Bürsten, Polieren Glänzen, Reinigen, Benetzen oder Abtrocknen, das aus einem zugeschnittenen und verarbeiteten Vlies aus Fasern besteht, wobei zur Verbesserung der Eigenschaften des Werkzeugs das Vlies mittels eines ausschließlich mechanischen Verfahrens als flexibles, das Eintauchen und wenigstens bereichsweise Umhüllen des Gegenstandes unter dem Behandlungsdruck zulassenden Wirrfaservlies mit einer mechanischen Festigkeit von 150 - 500 N/50 mm, vorzugsweise mindestens 300 N/50 mm, und einer mittleren Bruchdehnung von 50 - 150 %, vorzugsweise 80 - 100 %, nach DIN 53857/2 hergestellt worden ist.

Tool for mechanical surface treatment

The invention relates to a tool implemented for the mechanical surface treatment by friction of an object, for example, for brushing, polishing, shining, cleaning, wetting or drying, which comprises a cut and processed fleece of fibers.

The mechanical surface treatment is applied in particular for working numerous products comprising metal, wood, stone, glass, leather, synthetic material and the like, such as for example kitchen utensils, flatware/instruments, armatures, notches, grooves/frames of doors/windows, profile rods, industrial parts, jewelry and musical instruments as well as further for the maintenance and care of floors, walls, glass panes, tiles and the like.

In polishing the surface treatment takes place for example in several steps with the graduated use of different tools or tool configurations which generate an increasingly finer surface through selected graduation. These tools comprise for example polishing rings or disks which are composed of several layers of woven textiles and in general are disposed on a common axis of rotation respectively on a clamping ring. For polishing rings the textile cut into strips is folded, placed annularly about a core comprising cardboard rings or respectively flanges or a metal clamping ring and fastened thereon or therewith. For polishing disks layers of textiles cut to size are placed one above the other and therein rotated for example by an angle of 30°, sewn and held together by cardboard flanges affixed thereon. The textile used for this purpose is in general, but for polishing in particular, a cotton textile. But for the first polishing procedures a textile comprising more rigid fibers, for example sisal, can also be used. Specific polishing rings or respectively disks, can also be fabricated from a mixture of cotton and sisal textile. The polishing rings, respectively disks, can potentially be impregnated with a resin serving as a bonding means in order to increase their strength.

It has been necessary for many years to bias the textiles comprising cotton or other nonmixed or mixed fiber materials before cutting them to size and processing them

into folded rings. By this is understood the oblique placement of warp and weft threads to a cutting edge which extends obliquely to the original selvedge. For this procedure a special reversing machine is required which sews together the edges of the textile forming a tube. Subsequently the textile tube is helically cut open into webs (biased) and rolled up to form bales. The threads form an angle of 45° at the periphery of the folded rings. The problem of fraying of the folded rings is intended to be counteracted by means of the biasing (cf. Journal L'Usine Nouvell, March 1961, "Techniques modernes de Bufflage et de Pollisage").

Due to the folding into pleats of the textile strips the polishing ring is automatically ventilated during the rotation; it receives the requisite pliability in order to enwrap better the part to be polished and forms honeycombs at the periphery which hold the polishing paste. Polishing pastes are always required when polishing surfaces due to their grinding and lubricating capability.

Conventional polishing tools, however, have economic as well as also technical disadvantages. These are in particular the following:

- impeded procurement of goods on the world markets due to bureaucratic regulation of import quotas by the European Union with respect to cotton textiles,
- strong fluctuations of the quotations on the stock market of world market prices of the raw material cotton,
- lacking production capacities in Europe due to high wages,
- difficult manufacture of mixed textiles due to the yarn production process,
- technical necessity of biasing as an additional work step which cannot be automated with disturbing side effects of hard and broad bias seams which impair the production process as well as also the quality of the surface treatment,
- considerable textile waste which cannot be worked up,
- non-uniform wear of the grinding rings respectively disks due to fraying of the textile,
- frequent tool change due to limited service life of the grinding rings respectively disks.

Polishing tools comprising fleece are rarely used. FR 1 426 721 describes in this regard, for example, a polishing or grinding material comprising fleece which comprises synthetic permanently undulated filaments. In the process an adhesive substance with or without grinding particles is applied onto the filaments while tension is applied to them. When the tension is relaxed the fibers become interlaced and are subsequently thermofixed. The fleece obtained in this way is cut into an annular polishing tool and processed. FR 2 310 838 also discloses polishing rings which comprise several layers of fleece. The fibers arranged nonsystematically of this fleece are connected at their points of intersection by means of a resin.

In spite of some improvements relative to textile rings and disks, such fleece polishing rings respectively disks nevertheless still have the following disadvantages:

- high waste component which cannot be utilized due to the bonding means,
- low fleece density due to the limited penetration capability of the bonding means (filter effect),
- insufficient mechanical strength resulting therefrom with correspondingly lower service life,
- limited possibilities of application because the distribution of the bonding means is not uniform and thereby differing erratic results are obtained,
- insufficient heat stability leading to undesirable smearing effect,
- restricted production capability of fiber mixtures due to differing adhesion and bonding capability of the bonding means on the different types of fiber materials, and
- undesirable stiffening of the fibers through the bonding means.

EP-A-0 178 577 discloses a felt body, in particular felt ring, provided with grinding or polishing paste for polishing and grinding work, which for the firm integration of the grinding respectively polishing grains into the felt comprises at least 35% wool or similar hair elements and in which in hollow spaces of the random-fiber felt are enclosed grinding respectively polishing grains of a grain size less than 1000 µm. The felt body is to be treated with a stiffening means with the fraction of stiffening

additives to the felt body being at least 40%. As stiffening additives serve for example water-soluble thermoplastic additives with a dry content of 20 to 50% polyvinyl acetate dispersions. The stiffness of the felt body achieved hereby makes it unsuitable for many applications.

It is the task of the present invention to create a tool of the above described type which while avoiding the previously cited disadvantages has reliable applicability, in particular also for objects with uneven surfaces, while being simple to manufacture and having a long service life.

According to one form of the invention there is provided a tool for the mechanical surface treatment of an object by friction, for example for brushing, polishing, shining, cleaning, wetting or drying of the surface of the object, which includes a cut-to-size and processed fleece of fibers, characterized in that the fleece is an exclusively mechanical solidified, flexible random-fiber fleece free of binding agents and permitting at the treatment pressure immersion and, at least in parts, envelopment of the object, with a mechanical strength of 150-500 N/50 mm, and a mean elongation at rupture of 50 -150%, according to DIN 53 857/2.

Thus, the manufacturing is free of bonding means, i.e. without application of such means as would lead to a stiffening of the fibers impairing the flexibility of the fleece.

Hereby a significant technical and economic advance in the field of surface treatment by friction is achieved. Tools according to the invention entail the following advantages:

- independence from unstable raw material prices since the fleece according to the invention can also be produced of artificial or synthetic fibers;
- reusable waste since neither a textile structure nor bonding means are present;
- expanded options for fiber mixing since yarn production is omitted;
- omission of the working step of biasing;

- accordingly better processibility and application capability due to the omission bias seams;
- production processes which are simple to automate;
- no fraying and thus uniform radial wear;
- consequently greater service and thus tool change times;
- increased quiet running due to better true running,
- less and more readily removable abraded particles and thereby greater cleanliness and reduced danger of smouldering fire at the work place; and
- due to the flexibility of the bonding means-free and therefore not rigidiified random fiber fleece good immersion behaviour for uneven objects which upon immersion are enveloped by the fleece. The flexibility is preferably such that an immersion depth of up to at least 50mm can be achieved.

Depending on the requirements and consumption, the grinding respectively polishing paste can be added separately during the surface treatment; the necessity of keeping the grinding respectively polishing grains in the fiber fleece becomes superfluous.

Flexibility and immersion behaviour of the tool can be further optimized. In a preferred form of the invention the fleece has a drop capability, i.e. a drop co-efficient D according to DIN 54 306 between approximately 70 and 90%.

In an advantageous embodiment of the invention the mechanical fleece formation process is carried out either through the needling process known per se or by means of a liquid and/or gas jet whereby a surprisingly durable random-fiber fleece, especially suitable for the application purpose according to the invention, is generated, which especially well meets the requirements made of a tool for the mechanical surface treatment by friction while having a long service life.

As the liquid can therein be used preferably water and/or as the gas, preferably air. As is the case with the needle technique, both methods lead to a bonding means free fiber composite wherein the use of water as the

liquid entails the advantage that the water completely evaporates during drying.

In a preferred form of the invention the fleece includes natural, artificial or synthetic fibers and/or such fibers which are filled with mineral substances which are present in the fleece (11) mixed or non-mixed.

As natural fibers of plant origin, for example cotton, linen, hemp or sisal lend themselves as possible choices, as natural fibers of animal origin, wool, mohair and silk, as artificial fibers viscose, mineral, ceramic, carbon and metal fibers, and as synthetic fibers those comprising polyester, polyamide, polypropylene, polyimide, acrylic and aramide. Of advantage is the use of fibers which are filled with mineral substances. The wear of the material can thereby be improved. Through the abrasive action of such fibers, the polishing effect of the fleece is influenced positively.

In a preferred form of the invention the fleece includes a fraction of bond fibers which connect under the influence of heat at their cross-over points.

A further mechanical strengthening of the fiber structure can be achieved without needing to use a liquid curable bonding means which would lead to an undesirable stiffening of the fibers. Through such thermofixation the flexibility of the individual fibers is not impaired. The bond fibers have a lower melting point than the remaining fibers.

In a preferred form of the invention the fleece includes a fraction of shrink fibers which contract under the influence of heat and remain in the shrunken state after cooling.

When using a fraction of shrink fibers which contract under the influence of heat and remain in this state even after cooling, additional densification of the fiber structure and a concomitant increase of the mechanical strength can be attained.

In a preferred form of the invention the fibres forming the fleece are cross-cut fibers whose length is between approximately 10 and 100 mm and whose titer between 0.02 and 150 dtex.

Furthermore, within the scope of the inventive concept, it is of advantage if density and thickness of the fleece in the fleece forming process by liquid jet stream, are determined by the pressure, regulatable between approximately 5 and 230 bars, of the liquid used.

The nozzles generating the liquid jet used for the fleece production have therein preferably a diameter between approximately 80 and 140 x 10^{-6} m.

In a preferred form of the invention the fleece has a GSM between approximately 50 and 500 g/m^2 or the density of the fleece is between approximately 0.1 and 0.5 g/cm^3.

In a preferred form of the invention the thickness of the fleece is between approximately 0.3and 5.0mm.

In a preferred form of the invention the fleece is implemented in single or multiple layers as folded ring, flat disk, pad, roll, cylinder, tape or brush.

In a preferred form of the invention the fleece has the form of a ring including at least one strip cut to size from at least one layer of fleece, which is folded, placed radially about a solid core and secured there (Figure 2a) respectively that the fleece in the form of a ring including at least one strip cut to size from at least one layer of fleece, which is folded in the form of waves and/or gathered and held together by a clamping ring (Figure 2c) or respectively that the fleece in the form of a ring includes at least two disks cut to size from at least one fleece layer and placed one on top of the other held together by center pieces and/or quilted seams (Figure 2d) or respectively that the fleece in the form of individual strip segments of single or multiple layers formed into leaves is fastened on a round, cylindrical, conical or plate-form core (Figure 2e) or respectively that the, for example, folded fleece is fastened on a belt-form continuous support which, similar to a driving belt, can be driven by pulleys (Figure 2f and 2g) or respectively that the fleece in the form of a strip folded in several layers or individual

single or multi-layered strip segments formed into leaves, is fastened on a belt-form continuous support (Figure 2f and 2g).

It is also possible that the fleece in the form of a ring comprises at least one strip cut to size from at least one layer of fleece, which is folded in the form of waves, placed about a solid core and secured there.

In a preferred form of the invention the finished and potentially already mounted fleece (11) is subsequently provided [with means] for the purpose of reducing the wear or the flammability or for the purpose of improving the paste adhesion, the abrasive bahvior, the surface attack, service life, liquid absorption, liquid repelling capability, antistatic effect or the like.

In order to adapt the tool for varying application purposes, it is further suggested with the invention that the finished and potentially already mounted fleece be provided subsequently with corresponding substances for the purpose of reducing the wear or flammability or for the purpose of improving the paste adhesion, of the abrasive behaviour, of the surface attack, service life, absorption of liquid, capability to repel liquids, antistatic effect or the like, without significant change of the mechanical bonding of the fibers in the fleece.

Further goals, characteristics, advantages and application possibilities of the invention are evident in the following description of embodiment examples in conjunction with the drawings. Therein all described and/or graphically represented characteristics by themselves or in any combination form the subject matter of the invention even independently of their summary in the claims or their referral back.

In the Figures show:

Fig. 1 schematically an embodiment example of the manufacturing process for the fleece according to the invention,

Fig. 2a to 2d oblique views of different embodiments of polishing rings and disks,

Fig.. 2e oblique view of a polishing ring with leaves,

Fig. 2f and 2g oblique view of belt-form tools,

Fig. 3a and 3b views of two used polishing rings, wherein one is of a conventional type (Fig. 3a) and the other of the type according to the invention (Fig. 3b), and

Fig. 4a and 4b views analogous to Fig. 3a and 3b of other disk-form tools.

According to Figure 1 a production line 10 for a fleece 11 according to the invention produced free of bonding means through liquid jets, comprises for example the following essential facilities: opener with mixing chamber 20 for fiber balls for the production of a loose homogeneous bulk material, weighing dosing device 30, carding machine 40, spreading machine 50, jet installation 60 for the mechanical bonding of the fibers to form a random-fiber fleece 11, drying oven 70 and winder 80. In the case of a production line operating according to the needling process, instead of the jet installation 60, a needle machine is used.

The fiber bales are opened in the opener 20. These are preferably cross-cut fibers of a natural, artificial or synthetic type with a length between approximately 10 and 100 mm and a titer between approximately 0.02 and 150 dtex. The opener 20 with its adjoining mixing chamber can process fibers of the same or of a different type. In the mixing chamber identical fibers can be produced in homogenized form respectively mixtures of different fiber types can be produced. Accordingly, one or several identical bales or several nonidentical bales are used.

The weighing dosing device 30 supplies the carding machine 40 which converts the loose fibers into a card web in which the fibers have been aligned in the same direction. The GSM of the card web is given and regulated by the quantity of the fibers supplied by the weighing dosing device 30. This can vary for example between approximately 5 and 10 g/m^2. The card web is subsequently arranged in layers on a conveyor belt by means of the spreading machine 50, which [layers] together form a fiber fleece 51. The GSM of the fiber fleece 51 is between approximately 50 and 500 g/m^2. The fiber fleece 51 subsequently passes through the jet installation 60, or alternatively

the needle machine, for the production of a random-fiber fleece 11 free of bonding means. The liquid jet process is more cost-effective up to approximately a GSM of 150 g/m^2; above that the needle process is more cost-effective. The fleece production process by means of liquid jet is known per se for example from FR 1 460 513. The jet installation 60 comprises two rows of injection nozzles 61 which act with high pressure upon the front side respectively the back side of the fiber fleece 51 for generating the random-fiber fleece. Depending on the desired bonding strength, a single row of nozzles suffices. The openings of the injection nozzle 61 can have a diameter of approximately 80 to 140 x 10^{-6} m and are fed with water whose pressure is between approximately 5 and 230 bars. They are disposed perpendicularly to the fiber fleece 51 placed on a metal sieve 62. In order to drain excess water from the fiber fleece 51, below the metal sieve 62 in each instance opposing the injection nozzles 61, suction mechanisms 63 are disposed. The water jets penetrate the fiber fleece 51 and interlace the fibers with one another to form a formed solid areal body. In this process the flat structure of for example a thickness of 2 cm, is densified to form a 1 mm thick fleece 11. The thickness can be reduced in the random-fiber fleece forming process in a ratio of approximately 10:1 to 50:1. The possible thicknesses of a fleece 11 usable within the scope of the present invention are for example between approximately 0.3 and 5 mm. The strong reduction of the thickness leads to a marked increase of the density of the fleece 11, which subsequently is for example between approximately 0.1 and 0.5 g/cm^3. Apart from the initial GSM of the fiber material, the density is significantly determined by the jet pressure. The fleece 11 passes subsequently through the dryer 70 in which the remaining moisture is removed. The dryer 70 can for example be a hot-air fan, drum, high frequency or microwave dryer. After being dried, the fleece 11 is rolled up with the winder 80.

In the following by example process parameters are specified in detail for the production of a fleece 11 for tools comprising 100% viscose with a GSM of 200 g/m^2 and 1.7 dtex fibers:

- carding:

  production of three fiber card webs at 140 + 120 + 90 g/m^2 and

- jet bonding:
  - first side: pressure of 70 bars
  - second side: pressure of 110 bars.

The fleece 11 produced in this way has very good mechanical properties and, due to the process, high mechanical fiber cohesion which rests on hydrogen bridge bonding. The fleece 11 can be processed like a conventional textile.

The tools forming the subject matter of this invention are produced using the novel fleece material. The production process is simplified inter alia thereby that the biasing is omitted. Tools of high quality are formed since the random-fiber fleece produced and used according to the invention has good capabilities for taking up grinding paste and durable grinding paste adhesion capability. The surface quality achieved with them is improved because hard bias seams are absent. The service life is increased due to uniform low wear.

Figures 2a to g show different tools in folded ring form (Fig. 2a to c), in flat disk form (Fig. 2d), in leaf disk form (fig. 2e), and in web form (Fig. 2f and 2g). A ring 101 (fig. 2a) comprises for example a folded fleece strip 102 which is placed flat in several layers about a core and secured with two affixed cardboard flanges 103. This type of workup is distinguished by high adaptation ability to various contours of the item to be worked, effective self-ventilation when rotated, good surface attack and optimum envelopment. The folded ring 110 shown in Figure 2b is fabricated of several superjacent fleece strips 111 folded in the form of waves, which strips are placed about a core and secured between two affixed cardboard rings 112. This type of workup has good dimensional stability and high strength. The folded ring 120 depicted in Figure 2c comprises a fleece strip 121 which is wound in several layers and gathered by constriction as well as fixed with a clamping ring with metal hook 123. This type of workup has good self-ventilation, high dimensional stability and effective surface attack. The flat disk 130 depicted in Figure 2d comprises two individual disks 131 cut to size, which are placed one on top of the other and connected by means of concentric quilting seams 132. The center is reinforced by cardboard flange 133 sewn or affixed thereon.

The tool 140 depicted in Figure 2e comprises individual fleece leaves 141 which

are fastened on one side on a round, cylindrical, conical or plate-form core 142 preferably by gluing but also by quilting or riveting individually or in packets 143 which can also be folded in the form of a U 144 and be disposed with or without an interval 145 between them.

The tools 150 and 160 depicted in Figures 2f and 2g comprise a belt-form continuous support 151 or 161 respectively, on which a fleece strip 152 folded into several layers (Figure 2f) or individual fleece leaves 162 or fleece leaf packets 163 which can also be folded in the form of a U 164, are fastened by quilting 165 and/or gluing and/or riveting (Fig. 2g).

Figures 3a and 3b show two polishing rings after they have been used. Both rings have the configuration of Figure 2c wherein the first (Figure 3a) has been fabricated conventionally from a cotton textile and the second (Figure 3b) from a cotton fleece according to the invention. Noticeable is the uniform radial wear of the second ring in comparison with the first. In a random-fiber fleece produced by means of needling or liquid jet the radial wear is uniform in contrast to a woven material. Due to this property the second ring can be used for a longer time than the first whose irregular frayed contour impaires the polishing quality.

These different characteristics are also evident in the representations of Figures 4a and 4b which show two used layers of a multi-layer flat disk according to Figure 2d. The first layer (Figure 4a) was produced in conventional manner from cotton textiles and the second layer (Figure 4b) according to the invention from a cotton fleece. It is evident that the first layer (Figure 4a) shows marked evidence of wear in the form of strong fraying which leads to a complete change of geometry while the second layer (Figure 4b) shows only light regular fraying.

The invention is not limited to the embodiments described and shown as examples, but can be variously modified within the scope of expert knowledge without deviating from the inventive concept.

Throughout this specification and the claims that follow unless the context requires otherwise, the words "comprise" and "include" and variations such as "comprising" and "including" will be understood to imply the inclusion of a stated integer of group of integers but not the exclusion of any other integer or group of integers.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. Tool for the mechanical surface treatment of an object by friction, for example for brushing, polishing, shining, cleaning, wetting or drying of the surface of the object, which includes a cut-to-size and processed fleece of fibers, characterized in that the fleece (11) is an exclusively mechanical solidified, flexible random-fiber fleece free of binding agents and permitting at the treatment pressure immersion and, at least in parts, envelopment of the object, with a mechanical strength of 150-500 N/50 mm, and a mean elongation at rupture of 50 -150%, according to DIN 53 857/2.

2. Tool as stated in claim 1, characterized in that the fleece (11) has a drop capability, i.e. a drop co-efficient D according to DIN 54 306 between approximately 70 and 90%.

3. Tool as stated in one of the preceding claims, characterized in that the fleece (11) includes natural, artificial or synthetic fibers and/or such fibers which are filled with mineral substances which are present in the fleece (11) mixed or non-mixed.

4. Tool as stated in one of the preceding claims, characterized in that the fleece (11) includes a fraction of bond fibers which connect under the influence of heat at their cross-over points.

5. Tool as stated in one of the preceding claims, characterized in that the fleece (11) includes a fraction of shrink fibers which contract under the influence of heat and remain in the shrunken state after cooling.

6. Tool as stated in one of the preceding claims, characterized in that the fibers forming the fleece (11) are cross-cut fibers whose length is between approximately 10 and 100 mm and whose titer between 0.02 and 150 dtex.

7. Tool as stated in one of the preceding claims, characterized in that the fleece (11) has a GSM between approximately 50 and 500 g/m^2 or the density of the fleece (11) is between approximately 0.1 and 0.5 g/cm^3.

8. Tool as stated in one of the preceding claims, characterized in that the thickness of the fleece (11) is between approximately 0.3and 5.0mm.

9. Tool as stated in one of the preceding claims, characterized in that the fleece (11) is implemented in single or multiple layers as folded ring, flat disk, pad, roll, cylinder, tape or brush.

10. Tool as stated in claim 12, characterized in that the fleece (11) has the form of a ring (101) including at least one strip (102) cut to size from at least one layer of fleece, which is folded, placed radially about a solid core and secured there (Figure 2a) respectively that the fleece (11) in the form of a ring (110) including at least one strip (111) cut to size from at least one layer of fleece, which is folded in the form of waves and/or gathered and held together by a clamping ring (Figure 2c) or respectively that the fleece (11) in the form of a ring (130) includes at least two disks cut to size from at least one fleece layer and placed one on top of the other held together by center pieces (133) and/or quilted seams (132) (Figure 2d) or respectively that tne fleece (11) in the form of individual strip segments of single or multiple layers formed into leaves (141) is fastened on a round, cylindrical, conical or plate-form core (142) (Figure 2e) or respectively that the, for example, folded fleece (11) is fastened on a belt-form continuous support (151, 161) which, similar to a driving belt, can be driven by pulleys (Figure 2f and 2g) or respectively that the fleece (11) in the form of a strip (152) folded in several layers or individual single or multi-layered strip segments formed into leaves (162), is fastened on a belt-form continuous support (161) (Figure 2f and 2g).

11. Tool as stated in one of the preceding claims, characterized in that the finished and potentially already mounted fleece (11) is subsequently provided [with means] for the purpose of reducing the wear or the flammability or for the purpose of improving the paste adhesion, the abrasive bahvior, the surface attack, service life, liquid absorption, liquid repelling capability, antistatic effect or the like.

12. Tool for the mechanical surface treatment of an object by friction substantially as hereinbefore described with reference to the accompanying drawings.

Dated this 12th day of November 1998

HEINRICH LIPPERT GmbH
By their Patent Attorneys
COLLISON & CO

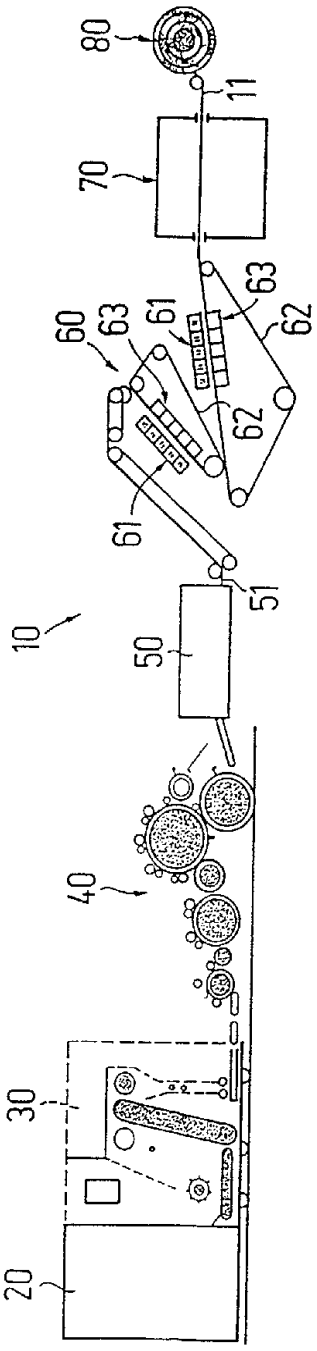


FIG.1

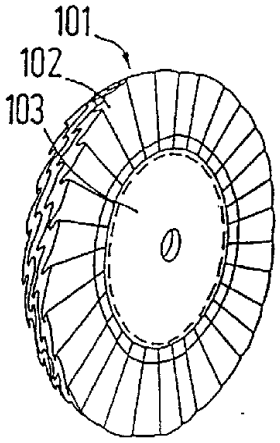


FIG. 2a

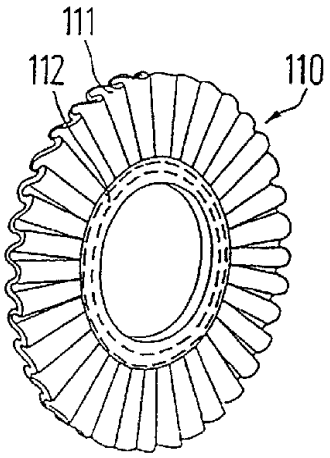


FIG. 2b

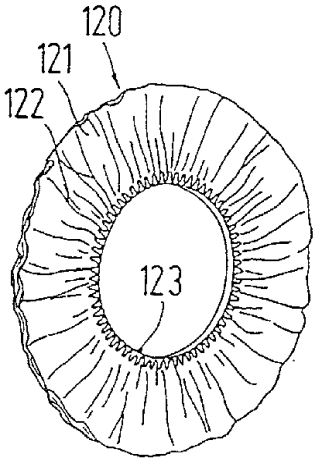


FIG. 2c

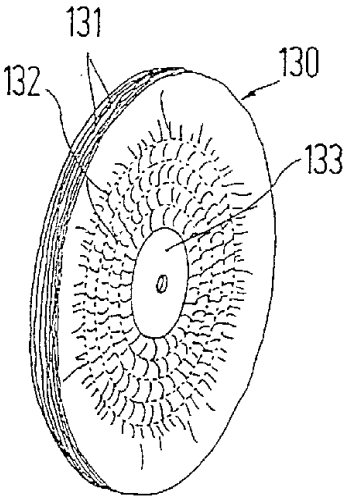


FIG. 2d

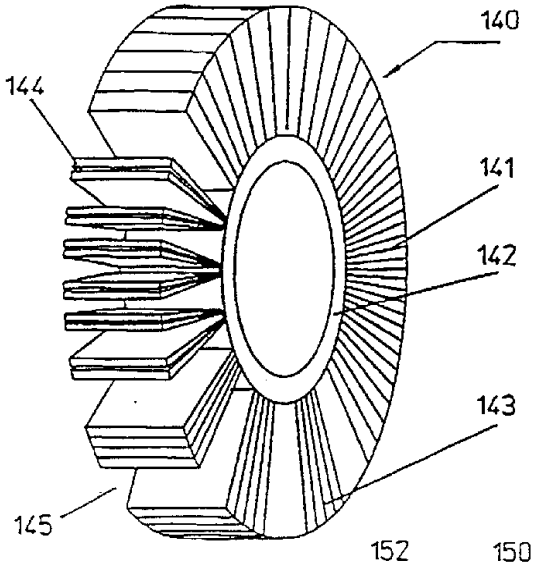


Fig. 2e

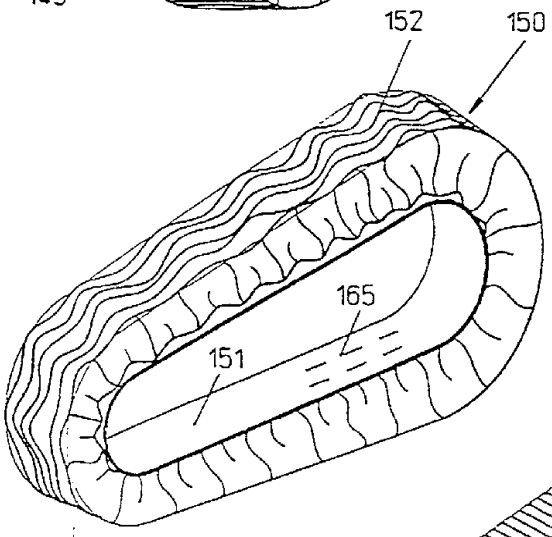


Fig. 2f

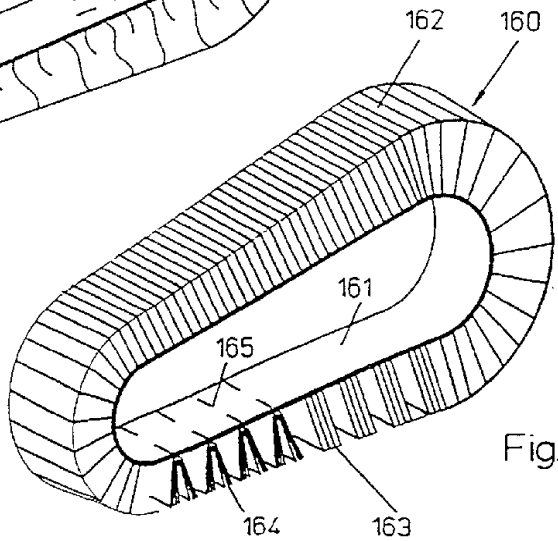


Fig. 2g

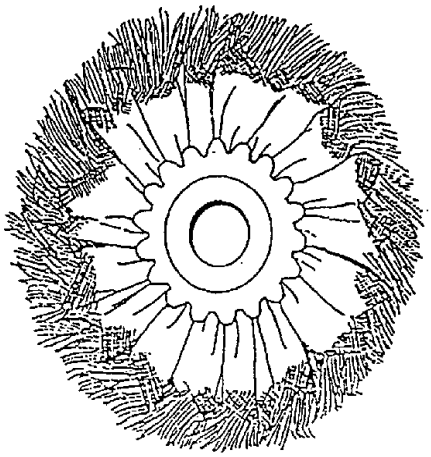


FIG.3a

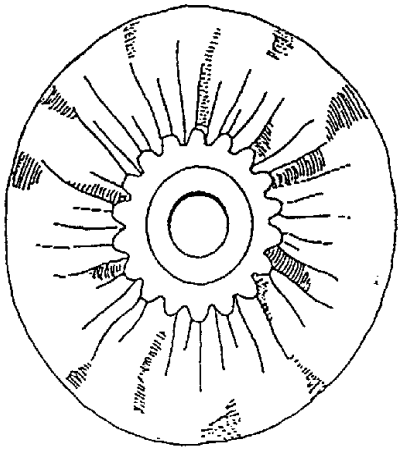


FIG.3b

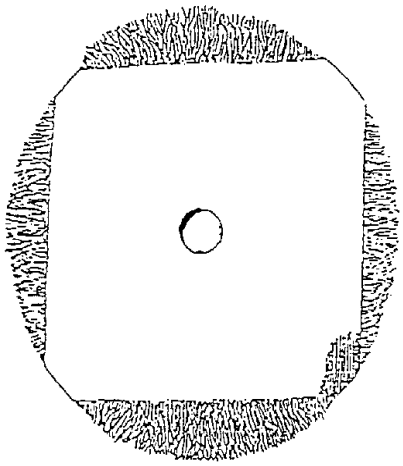


FIG.4a

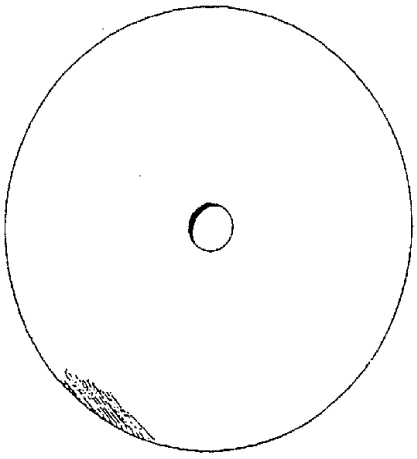


FIG.4b