A button for attaching an abrasive article to a back-up pad can include a body having a lower plate, and a hub extending from the lower plate. The hub is configured to engage an abrasive article installed over the hub at least partially along the height of the hub to prevent the abrasive article from rotating relative to the hub. The body can also include a post extending from the hub. The post can include at least one helical thread extending outwardly along the post. Further, the post can include a height, HP, and the at least one helical thread includes a thread lead, L, that is \( \geq 0.5 \, \text{HP} \).
FIG. 7
BUTTON FOR ATTACHING AN ABRASIVE ARTICLE TO A BACK-UP PAD

FIELD OF THE DISCLOSURE

[0001] The present disclosure is directed to an abrasive article and to a button for attaching an abrasive article to a back-up pad.

BACKGROUND

[0002] Abrasive articles can be quite useful for smoothing surfaces, polishing surfaces, removing material from surfaces, for cleaning surfaces, etc. Certain types of abrasive articles are configured in the shape of a wheel. During use, these abrasive wheels are rotated to create a moving surface on the abrasive wheel that can be placed in contact with another surface in order to alter a characteristic of that surface. In order to rotate an abrasive wheel, the abrasive wheel is typically mechanically coupled to a shaft of a motor via a tool holder, e.g., a chuck, that can be tightened to engage a portion of the abrasive wheel.

[0003] In response to changes in the abrasives industry, new ways to connect abrasive articles may be desirable.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] Embodiments are illustrated by way of example and are not limited in the accompanying figures.

[0005] FIG. 1 includes a view of an abrasive article assembly in accordance with a particular embodiment.

[0006] FIG. 2 includes a partially exploded view of an abrasive article assembly in accordance with a particular embodiment.

[0007] FIG. 3 includes a fully exploded view of an abrasive article assembly in accordance with a particular embodiment.

[0008] FIG. 4 includes a view of a button for attaching an abrasive article to a back-up pad in accordance with a particular embodiment.

[0009] FIG. 5 includes a plan view of a button for attaching an abrasive article to a back-up pad in accordance with another particular embodiment.

[0010] FIG. 6 includes a view of a button for attaching an abrasive article to a back-up pad in accordance with yet another particular embodiment.

[0011] FIG. 7 includes a plan view of a button for attaching an abrasive article to a back-up pad in accordance with yet another particular embodiment.

[0012] FIG. 8 includes a view of a lower plate for a button for attaching an abrasive article to a back-up pad in accordance with a particular embodiment.

[0013] FIG. 9 includes a view of an abrasive article in accordance with a particular embodiment.

[0014] FIG. 10 includes a view of an abrasive article in accordance with a particular embodiment.

[0015] Skilled artisans appreciate that elements in the figures are illustrated for simplicity and clarity and have not necessarily been drawn to scale. For example, the dimensions of some of the elements in the figures can be exaggerated relative to other elements to help to improve understanding of embodiments of the invention. The use of the same reference symbols in different drawings indicates similar or identical items.

DETAILED DESCRIPTION

[0016] The following description in combination with the figures is provided to assist in understanding the teachings disclosed herein. The following discussion will focus on specific implementations and embodiments of the teachings. This focus is provided to assist in describing the teachings and should not be interpreted as a limitation on the scope or applicability of the teachings. As used herein, the terms “comprises,” “comprising,” “includes,” “including,” “has,” “having,” or any other variation thereof, are intended to cover a non-exclusive inclusion. For example, a process, method, article, or apparatus that comprises a list of features is not necessarily limited only to those features but can include other features not expressly listed or other features that are inherent to such process, method, article, or apparatus. Further, unless expressly stated to the contrary, “or” refers to an inclusive-or and not to an exclusive-or. For example, a condition A or B is satisfied by any one of the following: A is true (or present) and B is false (or not present), A is false (or not present) and B is true (or present), and both A and B are true (or present).

[0017] The use of “a” or “an” is employed to describe elements and components described herein. This is done merely for convenience and to give a general sense of the scope of the embodiments of the disclosure. This description should be read to include one or at least one and the singular also includes the plural, or vice versa, unless it is clear that it is meant otherwise. Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this disclosure belongs. The materials, methods, and examples are illustrative only and not intended to be limiting.

[0018] Referring initially to FIG. 1, an abrasive article assembly is illustrated and is generally designated 100. As illustrated, the abrasive article assembly 100 can include a back-up pad 102 and an abrasive article 104 coupled to the back-up pad 102. The back-up pad 102 can include a housing 110 that defines a proximal end 112 and a distal end 114. The housing 110 can include a threaded bore (not shown) that extends into the housing 110 from the proximal end 112. The threaded bore can be sized and shaped to receive a threaded post of a button, described in detail below.

[0019] A shank 116 can extend from the distal end 114 of the housing 110. The shank 116 can be received and clamped within a drill chuck (not shown) or some other rotating tool. Thus, as the drill chuck rotates, the shank 116 will rotate, and can cause the entire abrasive article assembly 100 to rotate. The rotating abrasive article assembly 100 can be moved across a surface to be finished in order to abrade the surface, to smooth the surface, to polish the surface, to clean the surface, etc.

[0020] FIG. 1 indicates that the abrasive article 104 can include an upper surface 120, a lower surface 122, and an outer peripheral surface 124. In a particular aspect, the abrasive article 104 can be a non-woven abrasive article 104.

[0021] In one non-limiting, exemplary embodiment the non-woven abrasive article 104 can include a support, at least one polymeric binder, and abrasive particles. In one aspect, the support can include one or more nonwoven layers. Each nonwoven layer can include a plurality of fibers. The fibers can be bonded to each other by a polymeric binder, such as one derived from a latex. The fibers can include natural fibers, inorganic fibers, such as fiberglass, synthetic fibers, such as
polyester fibers, polyamide fibers, or other suitable synthetic fibers, or any combination thereof.

[0022] The abrasive particles can have a Mohs hardness of at least about 8.0, such as at least about 8.5, even at least about 9.0. In particular, the abrasive particles 108 can include superabrasive particles, such as diamond, cubic boron nitride, boron carbide, silicon carbide, or any combination thereof. The abrasive particles can have a size of between about 10 microns and about 1000 microns, such as between about 50 microns and about 500 microns, particularly between about 100 microns and about 200 microns.

[0023] The one or more polymeric binders can include a curable polymeric binder. The curable polymeric binder can include a polyurethane resin, a phenolic resin, polyester resin, or any combination thereof. Further, the curable polymeric binder can include a blocked resin. Polymeric binder can be a strong and flexible polymeric binder in order to hold the support together during abrading while allowing the support to be flexible enough to conform to the shape of the workpiece. In a particular embodiment, the polymeric binder can be located between the fibers and the abrasive particles.

[0024] In another aspect, the polymeric binder can include another polymeric binder, such as a phenolic resin, an epoxy resin, a formaldehyde-urea resin, or any combination thereof. The other polymeric binder can include a binder that bonds without significant curing and this binder can be used bond the abrasive particles to the support and to permit additionally processing of the abrasive article.

[0025] In an embodiment, the one or more polymeric binders can be formed from binder formulations that can further include components such as dispersed filler, solvents, plasticizers, chain transfer agents, catalysts, stabilizers, dispersants, curing agents, reaction mediators, or agents for influencing the fluidity of the dispersion. In addition to the above constituents, other components can also be added to the binder formulation, including, for example, anti-static agents, such as graphite; carbon black, and the like; suspending agents, such as fumed silica; anti-loading agents, such as metal stearate, including zinc, calcium, or magnesium stearate; lubricants such as wax; wetting agents; dyes; fillers; viscosity modifiers; defoamers; or any combination thereof.

[0026] In one particular embodiment, the non-woven abrasive article 104 can have an open structure. Specifically, the open structure can include voids located between the fibers. The open structure can be at least about 25% open volume, such as at least about 40% open volume, such as at least about 55% open volume. Additionally, the open structure can be not greater than about 99% open volume, such as not greater than about 95% open volume, even not greater than about 90% open volume.

[0027] In an embodiment, the non-woven abrasive article 104 can have a hardness of 20 kgf/25% compression to 90 kgf/25% compression, such as 30 kgf/25% compression to 80 kgf/25% compression, even 40 kgf/25% compression to 70 kgf/25% compression as measured by applying a force with a 25.4 mm semi-spherical probe to compress the abrasive article by 25% along the thickness direction. In a particular embodiment, the hardness can be 50 to 60 kgf/25% compression.

[0028] FIG. 2 and FIG. 3 indicate that the abrasive article 104 can be removed from the back-up pad 102. Further, FIG. 2 and FIG. 3 indicate that the abrasive article 104 can include a central bore 126 extending through the abrasive article 104 along a central axis 128. The abrasive article assembly 100 can include a button 130 that can be used to connect the abrasive article 104 to the back-up pad 102. Specifically, a threaded post that extends from the button 130, and is described in detail below, can fit into and engage the threaded bore (not shown) formed in the housing 110 of the back-up pad 102.

[0029] FIG. 4 illustrates details of the button 130. As depicted, an embodiment of the button 130 can include a lower plate 132. The lower plate 132 can be generally flat and disk-shaped. The lower plate 132 can include an outer diameter, O_d, which can be ≤50% O_d, such as ≤45% O_d, ≤40% O_d, ≤35% O_d, or ≤30% O_d. Further, O_d can be ≥15% O_d, such as ≥15% O_d, ≥20% O_d, or ≥25% O_d. It will be appreciated that the O_d can be within a range between and including any of the percentages noted above relative to the O_d.

[0030] For example, O_p can be ≤50% O_d and ≥10% O_d, such as ≤50% O_d and ≥15% O_d, ≤50% O_d and ≥20% O_d, or ≤50% O_d and ≥25% O_d. In another aspect, O_p can be ≥5% O_d and ≥10% O_d, such as ≥45% O_d and ≥15% O_d, ≥5% O_d and ≥20% O_d, or ≥5% O_d and ≥25% O_d. O_p can be ≤40% O_d and ≤10% O_d, such as ≤40% O_d and ≤15% O_d, ≤40% O_d and ≤20% O_d, or ≤40% O_d and ≤25% O_d. O_p can be ≥35% O_d and ≥10% O_d, such as ≥35% O_d and ≥15% O_d, ≥35% O_d and ≥20% O_d, or ≥35% O_d and ≥25% O_d. O_p can be ≤40% O_d and ≤10% O_d, such as ≤40% O_d and ≤15% O_d, ≤40% O_d and ≤20% O_d, or ≤40% O_d and ≤25% O_d. O_p can be ≥35% O_d and ≥10% O_d, such as ≥35% O_d and ≥15% O_d, ≥35% O_d and ≥20% O_d, or ≥35% O_d and ≥25% O_d. O_p can be ≤40% O_d and ≤10% O_d, such as ≤40% O_d and ≤15% O_d, ≤40% O_d and ≤20% O_d, or ≤40% O_d and ≤25% O_d. O_p can be ≥35% O_d and ≥10% O_d, such as ≥35% O_d and ≥15% O_d, ≥35% O_d and ≥20% O_d, or ≥35% O_d and ≥25% O_d. O_p can be ≤40% O_d and ≤10% O_d, such as ≤40% O_d and ≤15% O_d, ≤40% O_d and ≤20% O_d, or ≤40% O_d and ≤25% O_d. O_p can be ≥35% O_d and ≥10% O_d, such as ≥35% O_d and ≥15% O_d, ≥35% O_d and ≥20% O_d, or ≥35% O_d and ≥25% O_d. O_p can be ≤40% O_d and ≤10% O_d, such as ≤40% O_d and ≤15% O_d, ≤40% O_d and ≤20% O_d, or ≤40% O_d and ≤25% O_d. O_p can be ≥35% O_d and ≥10% O_d, such as ≥35% O_d and ≥15% O_d, ≥35% O_d and ≥20% O_d, or ≥35% O_d and ≥25% O_d. O_p can be ≤40% O_d and ≤10% O_d, such as ≤40% O_d and ≤15% O_d, ≤40% O_d and ≤20% O_d, or ≤40% O_d and ≤25% O_d. O_p can be ≥35% O_d and ≥10% O_d, such as ≥35% O_d and ≥15% O_d, ≥35% O_d and ≥20% O_d, or ≥35% O_d and ≥25% O_d.

[0031] A hub 134 can extend from the lower plate 132. The hub 134 can include a proximal end 136 and a distal end 138. In one aspect, the hub 134 is configured to fit into and engage the abrasive article 104 when the abrasive article 104 is installed over the hub 134 such that the hub 134 fits into the similarly sized and shaped central bore 126 of the abrasive article 104. The hub 134 is configured to engage the abrasive article 104, e.g., the inner wall of the central bore 126, at least partially along a height of the hub 124 in order to engage the abrasive article 104 and to prevent the abrasive article 104 from rotating relative to the hub 134.

[0032] When the hub 134 is disengaged from the back-up pad 102 and removed from the abrasive article 104, the hub 134 can include a height, H_y, and the bore 126 within the abrasive article 104 can include a height, H_y. In a particular aspect, H_y≤0.99 H_y. Moreover, H_y≤0.98 H_y, such as ≤0.97 H_y, ≤0.96 H_y, ≤0.95 H_y, ≤0.94 H_y, ≤0.93 H_y, ≤0.92 H_y, ≤0.91 H_y, or ≤0.90 H_y. In another aspect, H_y≥0.80 H_y, such as ≥0.81 H_y, ≥0.82 H_y, ≥0.83 H_y, ≥0.84 H_y, or ≥0.85 H_y. H_y can be within a range between and including any of the values of H_y described herein.

[0033] For example, H_y can be ≥0.99 H_y and ≥0.80 H_y, such as ≥0.99 H_y and ≥0.81 H_y, ≥0.99 H_y and ≥0.82 H_y, ≥0.99 H_y and ≥0.83 H_y, ≥0.99 H_y and ≥0.84 H_y, or ≥0.99 H_y and ≥0.85 H_y. H_y can be ≥0.98 H_y and ≥0.80 H_y, such as ≥0.98 H_y and ≥0.81 H_y, ≥0.98 H_y and ≥0.82 H_y, ≥0.98 H_y and ≥0.83 H_y, ≥0.98 H_y and ≥0.84 H_y, or ≥0.98 H_y and ≥0.85 H_y. In another aspect, H_y can be ≥0.81 H_y and ≥0.82 H_y, ≥0.83 H_y, ≥0.84 H_y, or ≥0.85 H_y. H_y can be within a range between and including any of the values of H_y described herein.
\[\leq 0.95\ H_p\ and\ \leq 0.84\ H_p\ or\ \leq 0.95\ H_p\ and\ \leq 0.85\ H_p.\ \] 
\[H_p\ can\ be\ \leq 0.94\ H_p\ and\ \leq 0.80\ H_p,\ such\ as\ \leq 0.94\ H_p\ and\ \leq 0.81\ H_p,\ \leq 0.94\ H_p\ and\ \leq 0.82\ H_p,\ \leq 0.94\ H_p\ and\ \leq 0.83\ H_p,\ \leq 0.94\ H_p\ and\ \leq 0.84\ H_p,\ or\ \leq 0.93\ H_p\ and\ \leq 0.85\ H_p.\]

[0035] \[H_p\ can\ also\ be\ \leq 0.93\ H_p\ and\ \leq 0.80\ H_p,\ such\ as\ \leq 0.93\ H_p\ and\ \leq 0.81\ H_p,\ \leq 0.93\ H_p\ and\ \leq 0.82\ H_p,\ \leq 0.93\ H_p\ and\ \leq 0.83\ H_p,\ \leq 0.93\ H_p\ and\ \leq 0.84\ H_p,\ or\ \leq 0.93\ H_p\ and\ \leq 0.85\ H_p.\]

[0036] Since \(H_p\) can be less than \(H_p\) before the button 130 is installed through the abrasive article 104 and engaged with the back-up pad 102, when the button 130 is engaged with the back-up pad 102 and the abrasive article 104 is captured between the lower plate 132 and the proximal end 112 of the back-up pad 102, the abrasive article 104 can be compressed between the lower plate 132 of the button 130 and the proximal end 112 of the back-up pad 102 such that the height of the bore when engaged, \(H_p\), is equal to \(H_p\).

[0037] In a particular aspect, the button 130 can be configured to apply a compressive force on the abrasive article, \(C_p\), wherein \(C_p\) can be \(\leq 5\ lbs,\ \leq 7\ lbs, \leq 8\ lbs, \leq 9\ lbs,\ or \leq 10\ lbs.\) Further, \(C_p\) can be \(\leq 50\ lbs,\ \leq 40\ lbs, \leq 30\ lbs, \leq 20\ lbs,\ or \leq 15\ lbs.\) Moreover, \(C_p\) can be within a range and including any of the values of \(C_p\) described herein.

[0038] For example, \(C_p\) can be \(\leq 5\ lbs,\ \leq 50\ lbs,\ \leq 40\ lbs, \leq 30\ lbs, \leq 20\ lbs,\ or \leq 15\ lbs.\) Further, \(C_p\) can be \(\leq 50\ lbs,\ \leq 40\ lbs, \leq 30\ lbs, \leq 20\ lbs,\ or \leq 15\ lbs.\) Moreover, \(C_p\) can be \(\leq 5\ lbs,\ \leq 40\ lbs, \leq 30\ lbs, \leq 20\ lbs,\ or \leq 15\ lbs.\) Further, \(C_p\) can be \(\leq 50\ lbs,\ \leq 40\ lbs, \leq 30\ lbs, \leq 20\ lbs,\ or \leq 15\ lbs.\)

[0039] The hub 134 can have a cross-sectional shape, or an end shape, perpendicular to the central axis 128 that includes a convex polygon having at least three vertices. For example, the cross-sectional shape of the hub can be selected from the group of shapes including: triangle, square, pentagon, and hexagon. In another aspect, the hub 134 can have a cross-sectional shape, or end shape, perpendicular to the central axis 128 that includes a concave polygon having at least six vertices. In this aspect, the cross-sectional shape of the hub 134 can be selected from the group of shapes including: concave hexagon, concave octagon, concave decagon, and concave dodecagon. In still another aspect, the hub 134 can have a cross-sectional shape, or end shape, perpendicular to the central axis 128 that includes a regular star polygon having at least ten vertices. The at least ten vertices can be selected from the group that includes: 10, 14, 18, 22, and 26 vertices.

[0040] In another aspect, the distal end 138 of the hub 134 includes a surface area, \(A_{hub}\), and the upper surface 120 of the abrasive article 104 can also include a surface area \(A_{surf}\). In this aspect, \(A_{hub}\) can be \(\geq 10.0\%\ A_{surf}\), such as \(\geq 7.5\%\ A_{surf}, \geq 5.0\%\ A_{surf}, \geq 4.0\%\ A_{surf},\ or \geq 3.0\%\ A_{surf}.\) Further, \(A_{hub}\) can be \(\geq 5.0\%\ A_{surf},\ such as \geq 7.5\%\ A_{surf}, \geq 5.0\%\ A_{surf}, \geq 4.0\%\ A_{surf},\ or \geq 3.0\%\ A_{surf}.\) Moreover, \(A_{hub}\) can be \(\geq 1.25\%\ A_{surf},\ \geq 1.5\%\ A_{surf},\ \geq 1.75\%\ A_{surf},\ \geq 2.0\%\ A_{surf},\ or \geq 2.5\%\ A_{surf}.\) In yet another aspect, \(A_{hub}\) can be \(\geq 5.0\ H_p\), \(\geq 6.0\ H_p,\ \geq 7.0\ H_p,\ \geq 8.0\ H_p,\ \geq 9.0\ H_p,\ \geq 10.0\ H_p,\ \geq 11.0\ H_p,\ \geq 12.0\ H_p,\ or \geq 13.0\ H_p.\)
[0046] FIG. 4 also shows that the button 130 can include a guide post 160 extending from the distal end 154 of the engagement post 150. The guide post 160 can facilitate insertion of the button 130 into the back-up pad 102 during assembly.

[0047] FIG. 5 illustrates another aspect of a button 500 that can be used to engage an abrasive article to a back-up pad. In this aspect, the button 500 can include a body that has a generally disc-shaped lower plate 502. A twisted hub 504 can extend from the disc-shaped lower plate 502. The twisted hub 504 can include a proximal end 506 and a distal end 508. A threaded engagement post 510 can extend from the distal end of the hub 504. Moreover, a guide post 512 can extend from the engagement post 510.

[0048] In this aspect, the twisted hub 504 is twisted along a height of the hub 504 so that the distal end 506 of the hub 504 is rotated with respect to a proximal end 508 of the hub by an angle, α. In a particular aspect, α can be ±5.0°, such as ±6.0°, ±7.0°, ±8.0°, ±9.0°, or ±10.0°. Further, α can be ±30.0°, such as ±32.5°, ±20.0°, ±15.0°, or ±12.5°. α can also be ±10.0° and ±12.5°. α can be ±30.0° and ±30.0°, such as ±32.5° and ±20.0°, ±30.0° and ±15.0°, or ±30.0° and ±12.5°. α can be ±60.0° and ±30.0°, such as ±62.5° and ±20.0°, ±60.0° and ±15.0°, or ±60.0° and ±12.5°. α can be ±30.0° and ±30.0°, such as ±32.5° and ±20.0°, ±30.0° and ±15.0°, or ±30.0° and ±12.5°. α can be ±70.0° and ±30.0°, such as ±72.5° and ±20.0°, ±70.0° and ±15.0°, or ±70.0° and ±12.5°. α can be ±80.0° and ±30.0°, such as ±82.5° and ±20.0°, ±80.0° and ±15.0°, or ±80.0° and ±12.5°. α can be ±90.0° and ±30.0°, such as ±92.5° and ±20.0°, ±90.0° and ±15.0°, or ±90.0° and ±12.5°. Moreover, α can also be ±10.0° and ±12.5°, ±10.0° and ±15.0°, or ±10.0° and ±12.5°.

[0050] Accordingly, the hub 504 is configured to impart a force, e.g., a twisting or rotational force, on an abrasive article installed on the hub 504 during use in order to cause the abrasive article to rotate over an angle, A, with respect to the hub 504 and to move linearly toward the lower plate 502. It can be appreciated that multiple abrasive articles can be installed over the hub 504 to create a stack of like, or different, abrasive articles. The twisting of the abrasive articles, and liner motion associated therewith, can cause the abrasive articles to tighten against the lower plate.

[0051] In a particular aspect, the angle of rotation, A, can be ±5°, such as ±4°, ±3°, ±2°, or ±1°. Further, A can be ±0.1°, such as ±0.25°, ±0.5°, or ±0.75°. A can also be within a range between and including any of the values of A described herein.

[0052] For example, A can be ±5° and ±0.1°, such as ±5° and ±0.25°, ±5° and ±0.5°, or ±5° and ±0.75°. A can be ±4° and ±0.1°, such as ±4° and ±0.25°, ±4° and ±0.5°, or ±4° and ±0.75°. A can be ±3° and ±0.1°, such as ±3° and ±0.25°, ±3° and ±0.5°, or ±3° and ±0.75°. A can be ±2° and ±0.1°, such as ±2° and ±0.25°, ±2° and ±0.5°, or ±2° and ±0.75°. A can be ±1° and ±0.1°, such as ±1° and ±0.25°, ±1° and ±0.5°, or ±1° and ±0.75°.

[0053] In a particular aspect, the button 504 can include an overall height, H, and D can be ±20.5% H, such as ±10.0% H, ±75% H, or 100% H. Further, D can be ±5.0% H, such as ±4.5% H, ±4.0% H, ±3.5% H, ±3.0% H, ±2.5% H, or ±2.0% H. D can also be within a range between and including any of the values of D described herein.

[0054] For example, D can be ±0.25% H, ±0.5% H, ±1.0% H, ±2.5% H, ±4.0% H, ±4.5% H, ±5.0% H, or ±6.0% H. D can be ±0.25% H, ±0.5% H, ±1.0% H, ±2.5% H, ±4.0% H, or ±5.0% H. D can be ±0.25% H, ±0.5% H, ±1.0% H, ±2.5% H, ±4.0% H, or ±5.0% H. D can be ±0.25% H, ±0.5% H, ±1.0% H, ±2.5% H, ±4.0% H, or ±5.0% H. D can be ±0.25% H, ±0.5% H, ±1.0% H, ±2.5% H, ±4.0% H, or ±5.0% H. D can be ±0.25% H, ±0.5% H, ±1.0% H, ±2.5% H, ±4.0% H, or ±5.0% H. D can be ±0.25% H, ±0.5% H, ±1.0% H, ±2.5% H, ±4.0% H, or ±5.0% H. D can be ±0.25% H, ±0.5% H, ±1.0% H, ±2.5% H, ±4.0% H, or ±5.0% H.

[0055] Referring now to FIG. 6, another aspect of a button for attaching an abrasive article to a back-up pad is illustrated and is generally designated 600. As indicated in FIG. 6, the button 600 can include a body 602. The body 602 can include a lower plate 604. A hub 610 can extend from the lower plate 604. The hub 610 can include a center portion 612 and a plurality of fins 614 can extend radially outward from the center portion 612 of the hub 610. Each fin 614 can include a proximal end 616 and a distal end 618. The proximal end 616 of each fin 614 can extend from and be attached to (or integrally formed with) the lower plate 604. In this aspect, the fins 614 are configured to extend at least partially through an abrasive article installed on the hub 610 and to prevent the abrasive article from rotating relative to the hub 610. Each fin 614 is integrally formed with, or rigidly connected to, the lower plate 604 and can transmit a torque from the lower plate directly to an abrasive article installed over the fins 614 so that as the lower plate 604 rotates the abrasive article rotates therewith. As described below, an abrasive article can be formed with an opening at or near a center of the abrasive article and the opening can be sized and shaped to fit over the hub 610.

[0056] FIG. 6 further illustrates that an engagement post 620 can extend from the hub 610, e.g., from a distal end 618 of the hub 610 and fins 614. The engagement post 620 can include a proximal end 622 and a distal end 624. The engagement post 620 can also include at least one helical thread 626 that can extend along a height of the post 620 from the proximal end 622 and the distal end 624. As illustrated, a guide post 630 can extend from the distal end 624 of the engagement post 620.

[0057] FIG. 6 also indicates that each fin 614 can include at least one post 632 extending from the distal end 618 of each fin 614. The button 600 can also include an upper plate 640 formed with a central bore 642 that is configured to fit over the guide post 630 and the engagement post 620. The upper plate 640 can also include a plurality of lateral bores (not shown) and lateral bore can be configured to align with a respect post 632 on each fin 614. The upper plate 640 is configured to be installed over the posts 632 such that each lateral bore engages and receives a respective post 632, e.g., in a snap fit. Further, the upper plate 640 is configured to be installed between an abrasive article and a back-up pad. The upper plate 640 is configured to compress the abrasive article against the lower plate 604 when the engagement post 620 is threadably engaged with the back-up pad.

[0058] In a particular aspect, the hub 610 can include at least three fins, at least four fins, at least five fins, at least six
fins, at least seven fins, or at least eight fins. Further, as best illustrated in FIG. 7, each fin 614 can be twisted along a height of the fin 614 so that the distal end 618 of the fin is rotated with respect to the proximal end 616 of the fin by an angle β, and β can be ±5°, such as ±6°, ±7°, ±8°, ±9°, or ±10°. Further, β can be ±30°, such as ±25°, ±20°, ±15°, or ±12.5°. In another aspect, β can be within a range between and including and of the values of β described herein.

[0059] For example, β can be ±5° and ±30°, such as ±5° and ±25°, ±5° and ±20°, ±5° and ±15°, or ±5° and ±12.5°. β can be ±6° and ±30°, such as ±6° and ±25°, ±6° and ±20°, ±6° and ±15°, or ±6° and ±12.5°. β can be ±7° and ±30°, such as ±7° and ±25°, ±7° and ±20°, ±7° and ±15°, or ±7° and ±12.5°. β can be ±8° and ±30°, such as ±8° and ±25°, ±8° and ±20°, ±8° and ±15°, or ±8° and ±12.5°. β can be ±9° and ±30°, such as ±9° and ±25°, ±9° and ±20°, ±9° and ±15°, or ±9° and ±12.5°. Moreover, β can be ±10° and ±30°, such as ±10° and ±25°, ±10° and ±20°, ±10° and ±15°, or ±10° and ±12.5°.

[0060] FIG. 8 illustrates a particular aspect of a lower plate, designated 800, that can be used with any of the buttons described herein. As depicted in FIG. 8, the lower plate 800 can include a series of regularly spaced undulations 802 extending from the lower plate 800 in the same direction that a hub (not shown) would extend from the lower plate 800 or toward the hub (not shown). Each undulation 802 can include an arch shape having a peak 804 and a base 806. The peak 804 of each arch can be spaced from the base 806 of each arch at a distance DP.

[0061] When used as part of a button that includes an overall height, Hax, Dax, and wherein Dax can be 0.25% Hax, such as 0.5% Hax, 0.75% Hax, or 1.0% Hax. Further, Dax can be ±5% Hax, such as ±4.5% Hax, ±4.0% Hax, ±3.5% Hax, ±3.0% Hax, ±2.5% Hax, or ±2.0% Hax. In another aspect, Dax can be within a range between and including any of the values associated with Dax herein.

[0062] For example, DP can be ±0.25% Hax and ±5.0% Hax, such as ±0.25% Hax and ±4.5% Hax, ±0.25% Hax and ±4.0% Hax, ±0.25% Hax and ±3.5% Hax, ±0.25% Hax and ±3.0% Hax, ±0.25% Hax and ±2.5% Hax, or ±0.25% Hax and ±2.0% Hax. In another aspect, DP can be ±0.5% Hax and ±5.0% Hax, such as ±0.5% Hax and ±4.5% Hax, ±0.5% Hax and ±4.0% Hax, ±0.5% Hax and ±3.5% Hax, ±0.5% Hax and ±3.0% Hax, ±0.5% Hax and ±2.5% Hax, or ±0.5% Hax and ±2.0% Hax. Dp can be ±0.75% Hax and ±5.0% Hax, such as ±0.75% Hax and ±4.5% Hax, ±0.75% Hax and ±4.0% Hax, ±0.75% Hax and ±3.5% Hax, ±0.75% Hax and ±3.0% Hax, ±0.75% Hax and ±2.5% Hax, or ±0.75% Hax and ±2.0% Hax. Dp can be ±1.0% Hax and ±5.0% Hax, such as ±1.0% Hax and ±4.5% Hax, ±1.0% Hax and ±4.0% Hax, ±1.0% Hax and ±3.5% Hax, ±1.0% Hax and ±3.0% Hax, ±1.0% Hax and ±2.5% Hax, or ±1.0% Hax and ±2.0% Hax.

[0063] In a particular aspect, the undulations 802 are configured to impart prints in at least one abrasive article installed on a hub extending from the lower plate 800 on a button when the button is engaged with a back-up pad.

[0064] FIG. 9 illustrates another exemplary abrasive article 900. As illustrated, the abrasive article 900 includes a body 902 formed with a bore 904 at or near a center of the abrasive article 900. The bore 904 can be sized and shaped to fit over a hub that is formed with multiple fins, e.g., the hub shown in FIG. 6 and FIG. 7. As such, the bore 904 can include a central opening 906 with multiple branches 908 extending radially outward therefrom. Depending on the number of fins, the bore 904 can include three branches, four branches, five branches, six branches, seven branches, eight branches, etc.

[0065] FIG. 10 depicts yet another exemplary abrasive article 1000. In lieu of removing material from the body 1002 of the abrasive article 1000 to form a passageway for the fins to fit through, as illustrated in FIG. 9, the body 1002 of the abrasive article 1000 may be cut with multiple slits 1004 that correspond to the number of fins. Accordingly, when the fins are fitted through the slits, the material of the abrasive article 1000 can expand around the fins to accommodate the fins. Alternatively, the flaps 1006 created between adjacent slits 1004 can bend along a central axis in the same direction that a button having fins is inserted through the abrasive article 1000 (e.g., into the page on which FIG. 10 is illustrated).

[0066] With the configuration described herein, the button for attaching an abrasive article to a back-up pad provides a relatively user friendly way to quickly attach an abrasive article to a back-up pad. Further, as easily as the abrasive article is attached, it can be just as easily detached. The button includes an engagement post having a thread lead that allows the engagement post to be engaged with a back-up pad with fewer than 2 revolutions of the button and abrasive tool. An abrasive article (e.g., a non-woven abrasive article) may be compressed between the button and the back-up pad, in order to provide substantial gripping force on the abrasive article during use. The back-up pad can be engaged with a rotating tool holder, such as a drill chuck.

[0067] The button may be disengaged from the back-up pad, removed from the abrasive article, installed in a new abrasive article, and re-engaged with the back-up pad for further use. Alternatively, the button can be removed from the abrasive article, the abrasive article can be flipped over, the button can be re-installed in the abrasive article, and the button can be re-engaged with the back-up pad for further use of the abrasive article. As such, a previously un-used side of an abrasive article can be used and full use may be made of the abrasive article—unlike abrasive articles having buttons that are glued or otherwise fixed thereto.

[0068] The hub of a button may be formed with a twist and during use the twist may cause the abrasive article installed thereon to move to a lower plate and further increase the gripping force on the abrasive article. Multiple abrasive articles having the same or different abrasive characteristics can be installed on a single hub in any stack order desired by a user. After use, the abrasive articles can be re-stacked in any other order for further use. A lower plate of a button can be formed with undulations and these undulations can impart prints on the working surface of the abrasive article placed on the button.

[0069] The button may be formed with fins and the abrasive article may be formed with slits corresponding to the number of fins in a relatively simple and efficient cutting operation that only cuts the abrasive article without removing any of the abrasive article.

[0070] Note that not all of the activities described above in the general description or the examples, if provided, are required, that a portion of a specific activity may not be required, and that one or more of the activities described in this specification, if provided, may be performed in addition to those described. Still further, the order in which activities are listed is not necessarily the order in which they are performed. Certain features that are, for clarity, described herein in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features that are, for brevity, described in
the context of a single embodiment, can also be provided separately or in any subcombination. Further, reference to values stated in ranges includes each and every value within that range.

[0071] Benefits, other advantages, and solutions to problems have been described above with regard to specific embodiments. However, the benefits, advantages, solutions to problems, and any feature(s) that can cause any benefit, advantage, or solution to occur or become more pronounced are not to be construed as a critical, required, or essential feature of any or all the claims. The specification and illustrations of the embodiments described herein are intended to provide a general understanding of the structure of the various embodiments. The specification and illustrations are not intended to serve as an exhaustive and comprehensive description of all of the elements and features of apparatus and systems that use the structures or methods described herein. Separate embodiments can also be provided in combination in a single embodiment, and conversely, various features that are, for brevity, described in the context of a single embodiment, can also be provided separately or in any subcombination. Further, reference to values stated in ranges includes each and every value within that range. Many other embodiments can be apparent to skilled artisans only after reading this specification. Other embodiments can be used and derived from the disclosure, such that a structural substitution, logical substitution, or another change can be made without departing from the scope of the disclosure.

[0072] Accordingly, the disclosure is to be regarded as illustrative rather than restrictive.

1. -3. (canceled)

4. An abrasive tool comprising:
   a back-up pad comprising a central bore having at least one internal thread extending inwardly from an inner wall of the central bore;
   at least one abrasive article formed with a central bore; and
   a button for removably attaching the abrasive article to the back-up pad, wherein the button comprises:
   a body, comprising:
   a lower plate;
   a hub extending from the lower plate, wherein the hub includes a center portion and a plurality of fins extending radially outward from the center portion, wherein the fins are configured to extend along at least one partial length through the at least one abrasive article installed on the hub and to prevent the at least one abrasive article from rotating relative to the hub;
   and
   a post extending from the hub, wherein the post includes at least one helical thread extending outwardly along the length of the fin so that a distal end of the fin is rotated with respect to a proximal end of the fin by an angle, B, that is \( \geq 30^\circ \).

5. -7. (canceled)

8. The abrasive tool of claim 4 wherein the hub comprises at least three fins.

9. The abrasive tool of claim 8 wherein each fin is twisted along the height of the fin so that a distal end of the fin is rotated with respect to a proximal end of the fin by an angle, B, that is \( \geq 5.0^\circ \).

10. The abrasive tool of claim 9 wherein \( B \geq 30^\circ \).

11. The abrasive tool of claim 4 further comprising at least one post extending from each fin and an upper plate, wherein the upper plate includes a central bore and a plurality of lateral bores, wherein the upper plate is configured to be installed over the post and each of the lateral bores is configured to receive and engage a respective post.

12. The abrasive tool of claim 11 wherein each lateral bore engages a respective post in a snap fit.

13. The abrasive tool of claim 11 wherein the upper plate is configured to be installed between the at least one abrasive article and the backup plate, wherein the upper plate is configured to compress the at least one abrasive article when the post is engaged with the backup plate.

14. -21. (canceled)

22. The abrasive tool of claim 4 wherein the lower plate is disc shaped and comprises an outer diameter, \( L \), and the abrasive article comprises an outer diameter \( O \), and \( O \leq 50\% \ L \).

23. The tool of claim 22 wherein \( O \leq \leq 10\% \ L \).

24. The abrasive tool of claim 4 wherein a distal end of the hub includes a surface area, \( A_{HAAD} \), and an upper surface of the abrasive article comprises a surface area \( A_{USHA} \) and \( A_{HADE} \leq 10\% A_{USHA} \).

25. The abrasive tool of claim 4 wherein \( A_{HADE} \leq 0.5\% A_{USHA} \).

26. -27. (canceled)

28. The abrasive tool of claim 4 wherein the hub is configured to impart a force on the at least one abrasive article during use in order to cause the at least one abrasive article to rotate over an angle, A, and move linearly toward the lower plate over a distance, D.

29. The abrasive tool of claim 28 wherein \( A = \leq 5^\circ \).

30. -32. (canceled)

33. The abrasive tool of claim 4 wherein the hub is twisted along the height of the hub so that a distal end of the hub is rotated with respect to a proximal end of the hub by an angle, \( \alpha \), that is \( \geq 5.0^\circ \).

34. -35. (canceled)

36. The abrasive tool of claim 4 wherein the lower plate comprises a series of regularly spaced undulations extending from the lower plate toward the hub.

37. The abrasive tool of claim 36 wherein the undulations are configured to impart pleats in the at least one abrasive article installed on the hub of the button when the button is engaged with a back-up pad.

38. -39. (canceled)

40. A button for attaching an abrasive article to a backup pad, the button comprising:
   a body, comprising:
   a lower plate;
   a hub extending from the lower plate, wherein the hub includes a center portion and a plurality of fins extending radially outward from the center portion, wherein the fins are configured to extend along a partial length through the at least one abrasive article installed on the hub and to prevent the at least one abrasive article from rotating relative to the hub;
   and
   a post extending from the hub, wherein the post includes at least one helical thread extending outwardly along the height of the fin so that a distal end of the fin is rotated with respect to a proximal end of the fin by an angle, \( \beta \), that is \( \geq 5.0^\circ \).

41. The button of claim 40 wherein the hub comprises at least three fins.

42. The button of claim 41 wherein each fin is twisted along the height of the fin so that a distal end of the fin is rotated with respect to a proximal end of the fin by an angle, B, that is \( \geq 5.0^\circ \).
43. The button of claim 40, wherein the lower plate comprises a series of regularly spaced undulations extending from the lower plate toward the hub.

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