This invention relates to arrows and arrow shafts, and particularly to arrows having grooves in which feathers are interlocked, as well as a method of making such grooves.

Arrows which are provided with feathers for guiding the same in flight have been in use for a number of centuries, but previous ways of attaching the feathers to the arrows have not been completely satisfactory. Attempts have sometimes been made by thread or cord or by glue of the quill of the feather, but such threads or cords do not hold the principal portion of the feather securely to the arrow and also are readily susceptible to damage during use of the arrows. The quill of a feather has been split or ground to provide a flat surface for attachment by gum or other adhesive to the arrow, but such surface for gluing is relatively small, and such feathers therefore have a tendency to become dislodged accidentally. Grooves of generally rectangular cross section have also been produced in arrows, in which the feathers have been split, but again the surface area available for gluing is limited. Darts have been made with undercut grooves, in each of which the quill of a feather may be slipped and glued in place, but such undercut grooves have heretofore been quite expensive to produce, particularly for any considerable length, and split quills do not fit the grooves with any degree of accuracy. Here-fore, to produce an undercut groove in an arrow, it has been necessary to use an end mill or rotating cutter head having an inverted triangular shape, but the cutting operation is relatively slow and time consuming, and in addition leaves numerous loose fibers in the groove, which must be cleaned out by a relatively laborious process. In addition, unless expensive precision machines are used, the production of undercut grooves by an end mill results in an undue amount of rejects, due primarily to pieces of wood splitting off at the edges of the groove. Also, an end mill can produce only an undercut groove in which both sides are inclined at the same angle.

Among the objects of the present invention are to provide a novel arrow shaft and arrow; to provide such an arrow shaft which is provided with grooves, such as undercut grooves, with the material in the bottom and particularly at the sides of the groove tending to have a greater strength than the original wood; to provide an arrow shaft having such grooves which may be asymmetrical rather than symmetrical in cross section; to provide such an arrow having asymmetrical grooves and feathers which are treated so as to interlock in the grooves; to provide a novel method of making grooves, such as undercut grooves, in an arrow shaft; to provide such a method during which the material at the edges of the groove have less tendency to split off; to provide such a method by which an asymmetrical undercut groove may be produced; to provide such a method which leaves a minimum of loose fibers or splinters in the groove; and to provide such an arrow and arrow shaft and such method which will be efficient and effective in operation. The foregoing and additional objects of this invention will become apparent as the description thereof progresses.

In accordance with the present invention, an arrow is provided with a series of radially spaced grooves, such as two or three in number and may extend either longitudinally or spirally of the arrow shaft, which may be undercut and the bottom and sides of which are formed by wood which has been compressed and therefore has a greater strength than the original wood. Such grooves are preferably asymmetrical, that is, one side of the groove slants at a greater angle to the base than the opposite side when the grooves are undercut. In conjunction therewith, a feather is treated, by removing material from its quill, to produce a quill having a flat bottom and the opposite side disposed at an acute angle to the flat bottom, with the narrower side untouched. The removal of material from the quill may be by grinding, cutting, sanding, routing, milling, sawing, or in any other suitable manner. When a feather having such a quill is fitted into an undercut groove having the above configuration, the feather is securely locked within the groove, i.e., against outward pull, and also tends to be retained in the groove against a longitudinal pull. However, a nub may be placed at the end of the arrow so as to further secure the feather against longitudinal pull.

In still further accordance with this invention, a series of radially spaced grooves, such as undercut grooves, are formed in an arrow shaft by effecting a relative longitudinal movement between the arrow shaft and a series of radially spaced tools which have a cross section generally conforming to the desired shape of the groove, but which are rounded at the front, so that during such movement the grooves will be formed primarily by compression of the wood into the bottom and sides of the groove, whereby producing a denser and hence stronger material. Concurrently, the arrow is subjected to inward pressure, along the entire periphery except at the entrance to each of the grooves, so that the wood of the arrow shaft cannot expand outwards and the sides of the groove thus cannot split away during formation of the grooves. The novel apparatus particularly adapted to carry out the method of this invention may include a collet provided with longitudinal slots corresponding to the outer openings of the grooves to be produced and through each of which a tool, as described above, may extend from a supporting chuck in which the tools are mounted and provided with means for pressing the collet against the periphery of the arrow, so as to produce the inward pressure described above. A portion of the material lying within the path of the tool may be severed by a cutting edge formed at the front of the tool, but it will be understood that at least a substantial portion of the groove is formed by the compression of material by the tool while the arrow itself is clamped. The chuck may be rotated to form spiral grooves, and the collet may be stationary and the chuck moved along the collet, or vice versa.

Additional features of this invention will become apparent from the more detailed description which follows, taken in connection with the accompanying drawings, in which:

Fig. 1 is a partly diagrammatic, side elevation of apparatus particularly adapted to carry out the method of this invention;
Fig. 2 is a cross section, on an enlarged scale, of a chuck which forms part of the apparatus of Fig. 1, taken along line 2—2 of Fig. 1;
Fig. 3 is a longitudinal section through the chuck, taken along line 3—3 of Fig. 2;
Fig. 4 is a fragmentary longitudinal section, on a further enlarged scale, illustrating the action of one of a series of tools in forming an undercut groove in an arrow shaft;
Fig. 5 is a transverse section, on a smaller scale than Fig. 4, illustrating the action of a collet and tools in forming a series of equally spaced grooves in an arrow, taken from the position of line 5—5 of Fig. 4;
Fig. 6 is a similar transverse section, taken from the position of line 6—6 of Fig. 4;

Fig. 7 is an enlarged transverse section of an arrow shaft, showing particularly grooves produced in accordance with this invention;

Fig. 8 is a cross section of a feather, illustrating the manner in which the quill of the feather may be treated;

Fig. 9 is a fragmentary cross section, illustrating the manner in which a feather, prepared as in Fig. 8, will fit into an asymmetrical groove in the arrow;

Fig. 10 is a fragmentary side elevation of the rear portion of an arrow provided with grooves and feathers of this invention, with a neck at the rear end of the arrow shown in longitudinal section;

Fig. 11 is a fragmentary longitudinal section, similar to Fig. 4, but showing an alternative type of groove forming tool;

Fig. 12 is a cross section similar to Fig. 5, but showing the tools similar to the tool of Fig. 11;

Fig. 13 is a cross section similar to Fig. 2, but illustrating an alternative arrangement for compressing a collet against the arrow shaft during formation of the grooves;

Fig. 14 is a longitudinal section taken along line 14—14 of Fig. 13;

Fig. 15 is a partly diagrammatic side elevation, similar to Fig. 1, but illustrating apparatus adapted to form spiral grooves in the arrow shaft in accordance with the method of this invention; and

Fig. 16 is an enlarged planar development of a curved cam plate utilized in the apparatus of Fig. 15.

As illustrated in Fig. 1, a cylindrical arrow shaft A, conveniently formed of wood, may be placed in a collet C for movement into a chuck K, to form the desired grooves in the arrow. The chuck K may be supported in a stationary position, in any suitable manner, while the collet C may be mounted on an arm 10, in turn mounted on the end of a piston rod 11, extending from a fluid operated cylinder 12, which may be operated by either air or hydraulic fluid pressure. As in Figs. 1 and 2, the collet C may be generally tubular in form, having an inner diameter corresponding to the outer diameter of arrow A and provided with a series of segments 14, separated by slots 15 and corresponding in number to the number of grooves to be produced in the arrow. Slots 15 may be generally rectangular in cross section and extend to lips 16, at the inner periphery of the collet, each pair of lips 16 being adapted to provide a relatively narrow passage therebetween, preferably located centrally with respect to the corresponding slot 15. As the collet C, with the arrow shaft A disposed therewithin, enters the chuck K and moves to the dotted position of Fig. 1, the collet encounters a series of pressure devices, such as balls 17, which press the segments 14 of the collet inwardly against the arrow shaft, to clamp the arrow securely therein. The bore of the collet is preferably just slightly larger in diameter than the diameter of the arrow shaft A, while the collet is preferably made of sufficiently resilient material and the position of the balls 17 is such that the inner surface of the segments 14 and lips 16 will clamp the arrow securely, with sufficient pressure to prevent any outward displacement of the material of the arrow shaft. There may be two sets of balls 17, as in Fig. 3, one set at the front edge of a series of cutting tools T, also mounted in chuck K, and the other set behind the tools, in the direction of movement of the collet C into the chuck K. The balls 17 may be held in position in passages 18, each of which may be narrowed at the inner end to retain the ball, by set screws 19, which engage the threaded sides of passage 18. It will be noted that the balls 17 are preferably not resiliently mounted, but are adapted to exert a full, solid pressure against the collet, while the balls also may rotate in their socket during passage of the collet C therewithal. The set screws 19 may be provided with concave inner ends, to receive the balls 17, and also may be locked in position by additional set screws 20.

Each tool T may be positioned in a radial slot 21 in chuck K, and locked in place by a set screw 22, which for convenience of adjustment and particularly for measurement for positioning purposes, may extend through a narrower axial slot 23. Each tool T, as in Figs. 3 and 4, may be provided with a relatively narrow depending blade 24, adapted to extend through the space between two of the lips 16 in collect C and having a base 25 corresponding generally in cross sectional shape, as in Figs. 6 and 7, to the groove to be made. The rear portion 26 of the base 25 of the blade, as in Fig. 4, may be inclined slightly upwardly, and the rear side surfaces thereon may be inclined slightly inwardly, to facilitate relative movement of the blade out of the groove, when the collet C and arrow shaft A are moved in a reverse direction after the grooves have been formed. The lower portion 27 of the front or nose of the blade is preferably convex, both laterally and longitudinally, while the upper portion 28 of the nose is preferably concave, so as to form a cutting edge 29. Thus, when the arrow shaft A is positioned in the direction of arrow 30, as in Figs. 4, a groove 30 will be formed, it being understood that the arrow shaft A is clamped tightly by collet C, as will be evident from Figs. 5 and 6. The cutting edge 29 will sever a chip 31 from the upper portion of the groove, chip 31 having a width no greater than the width of the groove at the top which, as indicated previously, is an undercut groove having outwardly tapering sides, while any chip 31 extending from the surface of the arrow will tend to be knocked off when the arrow is pulled out of the collet, through the more solid section rearwardly of the slot 15.

During such movement and because of the clamping pressure by collet C, the lower nose 27 and the sides and bottom of the blade base 25 will compress the material of the wood of the arrow shaft A, into the bottom and sides of the groove, as indicated by the stippling in Figs. 5 and 6. Such compression of the wood into the bottom and sides of the groove will enlarge the groove considerably, relatively speaking, from the shallow channel cut by removal of chip 31, but such compression will not tend to split the undercut sides of the groove away from the arrow shaft, due to the clamping pressure maintained by the collet C. As will be evident, an undercut groove may be made in this manner having any desired cross sectional configuration, such as having equally inclined sides or sides inclined at different angles, as shown, or a different configuration. In addition, the compression of the bottom and particularly the sides of the groove will produce a greater strength of the material at these locations than if the groove were cut without compression of any material. Thus, the material at the sides of the groove is thereby stronger and has less tendency to split off than if the groove were cut. As will also be evident, it is impossible to cut a groove having differently inclined, undercut sides, with a cutter rotating about an axis perpendicular to the longitudinal axis of the groove, since the sides of such a cutter, during rotation, will cut equal distances and at the same inclination on each side, thereby being capable of cutting only a groove having a cross section similar to the lower portion of an isosceles triangle.

As will be evident, when the arrow A and collet C are moved into chuck K for a distance equivalent to the length of the groove desired to be formed, the tools T will form three grooves 36 simultaneously and disposed in equally spaced radial positions about the arrow, as in Fig. 7. Thus, each groove 36 may have a flat bottom 32, one side 33 of greater inclination and an opposite side 34 of lesser inclination. Forming such grooves is particularly adapted to be utilized with feathers treated in accordance with this invention.
As illustrated in Fig. 8, a normal feather F has a quill or rauchis 35 convexly rounded on one side and provided with a concave groove on the opposite side, as shown partly in full lines and partly in dotted lines in Fig. 8, with a series of bars 36 extending in one direction in longitudinal relation, upwardly as shown in Fig. 8, and having a pair of grinding wheels whose peripheral edges are disposed at an angle to each other, so that a prepared quill 38, shown in section in Fig. 8, is formed having a base 39 ground from the quill by one grinding wheel and an angular surface 40 ground from the grooved side of the quill by the other grinding wheel. The remainder of the opposite side of the quill above base 39 is left undisturbed, so that the prepared quill 38 will fit into a groove 30, as in Fig. 9. Thus, the base 39 of the quill will engage the bottom of the groove, the undisturbed side of the quill will engage the undercut side 33 of the groove of greater inclination, and the angular side 40 of the prepared quill will engage the groove side 34 having a lesser inclination. As will be evident, the angular side 40 of the prepared quill is preferably ground at the same angle, as nearly as possible, as the groove side 34 having a lesser inclination, while the groove side 33 is preferably inclined at a tangent to the convex, untouched side of the quill, so that the quill 38 will be securely wedged in the groove 30. Although such angles may be varied, a convenient value for the angle between base 32 and side 33 has been found to be 60° and between base 32 and side 34 has been found to be 70°. As illustrated in Fig. 10, a series of feathers F may be trimmed, as to the shape shown, so that a rear portion of the quill 38 of each will extend onto a conical section 41 provided at the rear end of the arrow shaft A, for engagement with the inside of a conical well in a nock 42, provided with a notch 43 to engage the bow string. Nock 42 may be made of any suitable material, such as plastic, and also may be secured to conical section 41 by a suitable adhesive. As will be evident, the nock 42 prevents any of the feathers F from moving rearwardly out of the slots in the arrow shaft A. It will be understood, of course, that instead of feathers F, any other suitable type of vane may be utilized and such a vane may be formed of any suitable material, such as plastic, cardboard or other material, which may be cut, molded or produced in any other suitable manner. Also, the grooves in the arrow shaft need not have a straight or flat bottom or sides, but one or more of the same may be transversely concave or convex. Also, the groove may be rectilinear, inverted T-shaped, rounded or have any other desired configuration, while the tools T may have a corresponding configuration, and the groove need not necessarily be undercut.

As illustrated in Figs. 11 and 12, and in further accordance with the method of this invention, a series of tools T' may be mounted in a chuck in a manner similar to that described previously, for cutting grooves 30' in an arrow shaft A, while the arrow shaft is clamped tightly by a collet C similar to that described previously. As before, each tool T' is provided with a diamond cutting blade 24' having a base 25' corresponding in cross sectional shape over a substantial portion of its length to the shape of the groove to be formed, with the rear portion 26 of the blade bottom slanting upwardly and the adjacent lateral edges of the blade base slanting inwardly, therefore, so soon as the withdrawal of the tools T' after the grooves have been formed. However, the nose 45 of each tool T' is convex, without the cutting edge described previously, so that the entire groove is formed by compression of material into the sides and bottom of the groove, as indicated by the stippling in Fig. 12. Thus, the nose 45 is convex or rounded on all surfaces so as to merge with the base 25' while pushing material ahead and to each side and also beneath the nose, as the arrow shaft A is moved relatively to the tools T'. The direction of the indicating arrow of Fig. 11. The tools T' of Figs. 11 and 12 operate almost as satisfactorily as tools T of Figs. 3 and 4, although the tools T' tend to leave more debris, such as wood splinters, within the groove, and thus may tend to produce more rejects. Thus, tools T can usually be operated at a faster rate and with fewer rejects than with the tools T', although the latter are generally satisfactory.

In the alternative embodiment of Figs. 13 and 14, a collet C' may be compressed against an arrow shaft A, as in Fig. 13, by a series of roller bearings 48 which extend longitudinally through the inner surface of a chuck K' within slots 49, which may be slightly narrowed at their inner ends, as in Fig. 14. The bearings 48, the outer races of which engage the collet as it moves through the chuck, may be positioned similarly to the balls previously described, such as one set at approximately the front of a series of tools T and another set rearwardly of the tools. Bearings 48 are preferably radially interspaced between tools T, which may be mounted in the chuck in a manner similar to that previously described, such as being disposed within radial slots 21 and held in position by the screws 22. Collect C' may be provided with a series of radially spaced, longitudinally extending, flat lands 50, each of which is engaged by a bearing 48, which rolls thereon during relative longitudinal movement between the chuck and collet. Collet C' may also be provided with radially spaced slots 15' and inwardly extending lips 16 at the inner edges of slots 15', similar to collet C, to accommodate the tools T. The inner edge of each bearing 48 may be mounted on a pin 51 which extends between the legs 52 of a support provided at its outer end with lateral flanges 53, for attachment to the chuck K', as by cap screws 54. Shims 56 may be interposed between each flange 53 and the surface of a flat land 57 on chuck K', so that additional shims may be added or caps may be removed, for adjustment purposes. The outer races of bearings 48, of course, roll with the collet, but are preferably mounted solidly so as to compress the collet tightly against the arrow and thereby prevent any wood front splitting off when tools T are moved through the wood.

The embodiment of apparatus particularly adapted to carry out the method of this invention illustrated in Figs. 15 and 16, adapted to form spiral grooves in an arrow shaft, includes a collet C" which may be mounted on a fixed support, such as including a cross bar 61 and is provided with a series of spiral lands 59' and spiral slots 15", but is otherwise similar to collet C of Fig. 13. A chuck K', similar to the chuck of Figs. 13 and 14, may be mounted for longitudinal movement over collet C" and also for rotational movement, as by being provided with a radial thrust bearing 61 mounted on a cylindrical block 62. Block 62 and chuck K' along with it, may be moved longitudinally by fluid pressure introduced within a cylinder 63, from which extends a piston rod 64 and from the outer end of the latter rods 65, adapted to clear bar 60, extend to block 62. In addition, chuck K' may be provided with a pin 66 provided at its outer end with a roller 67, conveniently a ball bearing roller, which engages a slot 68 in a stationary, arcuate, longitudinally extending cam plate 69, it being noted that, because of the greater distance of cam plate 69 than the outer surface of the arrow shaft A from the axis of rotation, the angularity of slot 68, relative to the outer arcuate cam plate, will be considerably greater, as in the planar development, looking from beneath, of cam plate 69 in Fig. 16, than the angularity of the spiral grooves which
will be produced. An arrow shaft A may be placed in an open top slot 70 in a holder 71, mounted on the end of a pin or rod 72 which extends from a fixed cylinder 73, which may be actuated by air pressure to move the arrow shaft A into collet C' and hold it there, after which fluid may be supplied to the interior of cylinder 63 to move chuck K' along collet C'. As will be evident, as chuck K' is moved longitudinally along collet C', pin 66 will cause chuck K' and tools T with it, to follow a spiral path corresponding to slots 15" to collet C', so that tools T will always be in registration with the collet slots. As will be evident, pin 66 and cam slot 68 will maintain the tools T in alignment with slots 15" in collet C', so that spiral pressure will be formed, but otherwise in a manner similar to that described previously. However, a tool T of Figs. 3 and 4 may be modified by angling the blade 24 and base 25 slightly, to correspond with the angularity of the grooves to be produced. The length of the collet C', the length of slot 68 and cam plate 69 and the angularity of groove 68 may be such that spiral grooves are produced, each of which extend around the arrow, at an angle of approximately 3° to a line extending longitudinally along the surface of the arrow shaft and for any desired distance, such as 3 3/4" to 6", although any other desired angularity or extent of the grooves may be produced. The direction of rotational movement of chuck K', in forming the spiral grooves, is preferably such that, when the feathers are installed, as in Fig. 10, the arrow will be rotated during flight in the conventional counterclockwise direction, when viewed from the position of the archer. If desired, a depression or groove may be formed in the lands 80 or 84, in which the outer races of bearings 48 ride, so as to maintain an accurate alignment between the chuck and collet, particularly when spiral grooves are being formed.

From the foregoing, it will be evident that this invention fulfills to a marked degree the requirements and objects hereinafore set forth. By peripherally clamping the arrow while producing a relative longitudinal movement between the arrow shaft and a series of tools adapted primarily to press material into the sides and bottom of each groove, undercut grooves may be produced quickly on a production basis, without splitting off the wood at the sides of the grooves. By the use of such tools, undercut grooves having sides disposed at different inclinations may be produced, while a cutting edge is provided at the front end of each tool, to sever only a portion of the wood which is to be removed or displaced to form the groove, any tendency to leave chips or splinters in the groove is minimized or avoided. The construction of the tools described is such that the grooves may be produced relatively rapidly and therefore more economically. By using a collet having longitudinal slots, either straight or spiral, the arrow shaft may be clamped securely, with the above advantages. By utilizing a chuck in which the tools may be mounted and which includes members, such as balls or roller bearings, adapted to engage the collet, the collet may be clamped securely against the arrow shaft and particularly when the collet engaging members are adapted to roll, the collet will move relatively readily with respect to the chuck. By providing a solid backing for the collet engaging members, rather than a resilient backing, a sufficient clamping pressure against the arrow shaft will be exerted at all times. By providing spiral grooves in the collet and rotating the chuck in coordination therewith, as by a cam, spiral grooves may be produced in the arrow shaft having any desired cross section shape. By grinding the feather quill to provide a flat base and one inclined side, leaving the other side unground and slightly convex, a feather may be produced having a quill which will be tightly wedged within an undercut groove, particularly a groove having sides corresponding in inclination to the ground side of the quill and to a tangent to the unground side of the quill.

Although certain embodiments of this invention have been described and illustrated, it will be understood that other embodiments may exist and that various changes may be made therein, all without departing from the spirit and scope thereof.

1. An arrow shaft formed of wood and provided with generally longitudinal grooves for receiving feather quills therein, said grooves having undercut sides and the bottom and at least a portion of each side of the inside of each groove being formed of compressed wood which is the same material and has a greater density than the remainder of the cross-section of said shaft and which has the structural characteristics resulting from said grooves having been formed by pushing wood aside and inwardly with a grooving tool moved generally longitudinally along the shaft.

2. An arrow shaft, as defined in claim 1, wherein said grooves are asymmetrical in cross sectional shape.

3. An arrow shaft, as defined in claim 1, wherein said grooves extend spirally around said arrow shaft.

4. A method of forming in a wood arrow shaft a series of radially spaced, generally longitudinal grooves, each groove having two sides and a bottom, which comprises exerting clamping pressure inwardly against the surface of said shaft along the general longitudinal extent of the grooves to be formed, except at the positions of said grooves; and, while said shaft is so clamped, compressing at successive positions along each of said grooves a substantial portion of the wood, occupying the space in which a groove is to be formed, inwardly to the bottom and laterally into at least a portion of each side of said groove.

5. In a method of forming a groove in a wood arrow shaft, as defined in claim 4, including severing a smaller portion of the wood from the cross section of said groove.

6. In a method of forming a groove in a wood arrow shaft, as defined in claim 4, including compressing substantially the entire amount of wood, occupying the space in which said groove is to be formed, into the bottom and sides of said groove.

7. In a method of forming a groove in a wood arrow shaft, as defined in claim 4, wherein said groove is undercut.

8. An arrow comprising a shaft formed of wood and provided with generally longitudinal grooves adjacent one end thereof, the bottom and at least a portion of each side of the inside of each groove being formed of compressed wood which is the same material and has a greater density than the remainder of the cross section of said shaft and which has the structural characteristics resulting from said grooves having been formed by pushing wood aside and inwardly with a grooving tool moved generally longitudinally along the shaft; a head at the opposite end of said shaft; a feather for each groove and having a quill disposed in said groove; and a nock at said one end of said arrow and extending over a portion of each quill.

References Cited in the file of this patent

UNITED STATES PATENTS

1,648,376 Blodgett Nov. 8, 1927
1,842,540 Cowdery Jan. 26, 1932
2,182,951 Sweetland Dec. 12, 1939
2,191,069 Clark Feb. 20, 1940
2,277,743 Crossman Mar. 31, 1942
2,295,684 Paulson Sept. 15, 1942
2,525,332 Alger Oct. 10, 1950
2,562,807 McKenzille July 31, 1951
2,593,745 Gillespie Apr. 22, 1952
2,596,365 Bresnahan May 13, 1952
2,790,473 Roper Apr. 30, 1957

FOREIGN PATENTS

608,756 Great Britain Sept. 20, 1948