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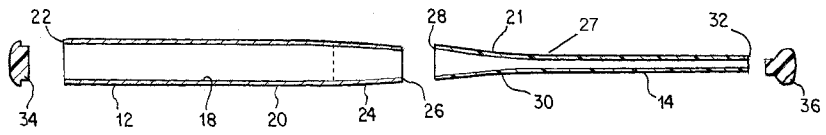
(54) **Title:** TWO-PIECE BALL BAT WITH RIGID CONNECTION



(57) **Abstract:** A two-piece ball bat comprising a hollow barrel attached to a handle by a combination of mechanical interference and a layer of rigid adhesive interposed between the interior surface of the barrel and the exterior surface of the handle at a tapered junction. The rigid adhesive layer prevents any direct contact between the barrel and handle thereby eliminating the need to provide any mating features thereon and reducing complexity and cost of manufacture. In an alternative embodiment, glass shafting beads are added to the rigid adhesive compound to ensure even distribution of the adhesive compound, align the barrel and handle and ensure separation prior to curing.

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TWO-PIECE BALL BAT WITH RIGID CONNECTION

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BACKGROUND OF THE INVENTION

1. Field of the Invention.

[01] This invention relates to a ball bat having a ball bat barrel connected to a bat handle by a combination of mechanical interference and rigid adhesive without the barrel and handle being in direct contact, and a method for making same.

2. Background of the Invention.

[02] Ball bats for baseball and softball generally have a similar shape and comprise a handle, a barrel and a taper that smoothly transitions between the larger circumference barrel and the smaller circumference handle. The handle is sized for a player to easily and securely grip the bat, and usually includes a tape or wrapping to enhance the grip of a player's hands. The barrel is the ball contact portion. The holding and gripping of the bat is a much different purpose than hitting a ball, but many baseball and softball bats are made of a single material, typically aluminum or wood. A single material may present advantages for hitting, for example, but be a poor material for the player's hands to hold and grip, especially upon impact. Conversely, the single material may present advantages for the handle region, but suffer drawbacks in the barrel region. For example, there have been prior art ball bats made entirely of a single composite material, but durability in the barrel region has been a common problem.

[03] To address some of the drawbacks of employing a single material, ball bat makers have designed bats made of more than a single material to provide some advantage to the players such as enhanced performance by reducing energy loss upon impact, desired weight and heft, desired flexibility, and shock attenuation, among other factors. The use of two different materials for the handle and barrel of a ball bat is generally an attempt to capitalize on the advantageous characteristics of each material with the recognition that a single material often means compromising or ignoring the needs of one portion of a bat to gain optimal performance from another portion. Ball bats in which the barrel and handle are made of two different materials have become common on the market. Two-piece ball bats

are usually constructed of an aluminum or aluminum alloy barrel attached to a composite handle. The aluminum barrel provides high strength, durability and low cost of manufacture since the raw materials are less expensive as compared to composites, and involve less labor. Composite handles are advantageous due to their light weight which enables the balance of the bat to be engineered as desired, and greater flexibility to generate more power in the swing by offering the opportunity to customize the stiffness of the bat depending on the player's strength and preferences. A composite handle also tends to damp vibration more than aluminum to reduce any discomfort felt by players when the ball is not hit squarely.

[04] The hyphenated term "two-piece bat" as used throughout this application is intended to refer to just the barrel and handle combination. It is understood that the finished bat may actually comprise more pieces such as the end caps on the barrel and handle, but the hyphenated term refers to the barrel and handle combination. For consistency, the present application describes the ends of the barrel and handle with respect to the junction in the tapered area. The barrel of a ball bat is defined as having a distal end which is the free end at the tip of the bat, and as having a proximate joint end which includes the taper portion that transitions from the barrel circumference to the handle circumference. Similarly, the handle of a ball bat is described as having a distal end which is the free end, and as having a proximate joint end which includes the taper portion. Therefore, the proximate joint ends of both the barrel and handle are the portions that are assembled together. The barrel is a hollow body having an interior circumferential surface and an exterior circumferential surface.

[05] Two-piece ball bats are typically assembled by inserting the handle into the hollow barrel through the distal end of the barrel, and then somehow engaging a portion of the exterior surface of the handle to a portion of the interior surface of the barrel in the taper portions. There are two main approaches to this assembly in the prior art. One approach is to provide some sort of mechanical locking feature on the engaging surfaces of the barrel and handle to join these pieces to another. An example would be to provide exterior threads on the taper portion of the handle, and mating interior threads on the taper portion of the barrel to form a threaded joint. Some of these types of mechanical joints do not require an adhesive of any sort, while some employ a combination of mechanical joints where the barrel and handle are in direct contact with one another and an adhesive. The other main approach is to use an elastomer adhesive to attach the exterior surface of the handle to the interior surface of the barrel in the tapered junction area. An example of this type of assembly is disclosed in

U.S. Patent No. 5,593,158 to Filice et al., in which a castable urethane material adhesively joins the handle and barrel. As most easily seen in FIG. 2 of Filice et al., the barrel and handle of Filice et al. are in direct contact with one another in the narrower portion of the taper area.

[06] Mechanical joints complicate manufacture as they require more manufacturing steps; introduce more quality control factors for fit and finish; increase the chances of mis-assembly; potentially increase tolerance build-up; and may require more assembly steps to complete a ball bat. Higher complexity translates to higher cost with respect to tooling, efficiency and labor.

[07] There is a need for a two-piece ball bat that can be made by simplified manufacturing processes, rapidly assembled to reduce cost while still providing the strength and durability of a metal bat with the advantageous strength, vibration damping and optimization opportunities of a composite handle.

SUMMARY

[08] The two-piece ball bat of the present invention comprises a hollow barrel defining an exterior surface and an interior surface with a free distal end and a tapered joint end. Both ends of the barrel are open in order to receive a handle defining a handle exterior surface. The handle has a free distal end and a tapered joint end, and the tapered joint end of the handle is sized and configured to prevent its passage through the opening in the tapered joint end of the barrel resulting in a junction portion between the two pieces in which they overlap. This junction portion coincides with at least a portion of the tapered areas on both the barrel and handle. The handle is inserted into the hollow barrel through the barrel's free end until the tapered end of the handle engages the tapered interior of the barrel to form the tapered junction. A rigid adhesive is applied along the entire 360° circumference of the tapered interior surface of the barrel, or on the outside of the tapered section of the handle or both. After the handle is inserted, the two pieces are held in place until the adhesive cures. In the finished bat, the rigid adhesive is disposed in the entire circumferential tapered junction between the barrel and handle such that the barrel and handle are not in direct contact for any portion of their lengths.

[09] The rigid connection between the barrel and handle of the present invention maximizes the conservation of collision energy upon impact with the ball to enable better

performance. The combination of the interference fit and the rigid adhesive ensures that less of the collision energy is lost to damping as is the case with elastomeric joints.

[10] In another aspect of the invention, fine glass shafting beads are added to the rigid adhesive to ensure even distribution of the adhesive between the barrel and handle; to ensure separation of the barrel and handle; and to align the joint by the natural tendency of the beads to arrange themselves in a single layer when a normal force is applied due to their spherical shape. The adhesive with glass beads is applied to either or both the barrel interior and the handle exterior prior to assembly. As the tapered junction is formed by the interference fit, the glass beads ensure even coverage of the adhesive in the joint. After curing, the adhesive and glass beads become a composite interposed between the barrel and the handle.

[11] In one aspect of the invention, the barrel is made of a metal to provide the durability and strength necessary for the ball impact area, while the handle is made of a composite to provide opportunities to tune the performance of the bat depending on player's skill level and strength.

[12] In another aspect of the invention, the barrel is made of a composite that is engineered for durability, and the handle is made of a different composite that is engineered for flexibility and bat swing speed performance.

[13] Other configurations, features and advantages of the invention will be, or will become, apparent to one with skill in the art upon examination of the following figures and detailed description. It is intended that all such additional systems, methods, features and advantages be included within this description, be within the scope of the invention, and be protected by the following claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[14] The invention can be better understood with reference to the following drawings and description. The components in the figures are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the invention. Moreover, in the figures, like reference numerals designate corresponding parts throughout the different views. In the drawings:

[15] FIG. 1 is a plan view of a ball bat in accordance with the present invention.

[16] FIG. 2 is an exploded assembly view in cross-section of the ball bat of FIG. 1.

[17] FIG. 3 is a perspective schematic assembly view of the two-piece ball bat.

[18] FIG. 4 is a detailed partial cross-section of the junction area J shown in FIG. 1.

[19] FIG. 5 is a schematic showing a partial cross-section of the junction area of another embodiment of the present invention.

[20] FIG. 6 is a detailed view of the area labeled J' in FIG. 5

[21] FIG. 7 is a flow diagram of the method of assembly of the two-piece bat illustrated schematically in FIGS. 5-6.

DETAILED DESCRIPTION

[22] FIG. 1 shows assembled ball bat 10 comprising a barrel 12 and a handle 14 attached to one another at a taper junction 16. Taper junction 16 is the transition between the larger circumference barrel and smaller circumference handle. FIG. 2 shows in exploded cross-section the components of the ball bat. Specifically that barrel 12 is a hollow body with an interior surface 18 and an exterior surface 20. Along its length barrel 12 has a distal free end 22, a taper section 24, and a proximal joint end 26. Barrel 12 has a larger diameter at its distal free end 22 and a smaller diameter at its proximal joint end 26. Taper section 24 provides a smooth transition between these two circumferences. Exterior surface 20 of the barrel is the ball contact surface. Handle 14 is shown in FIG. 2 to be a hollow body, but could be solid. Handle 14 has an exterior surface 27 and includes along its length, proximal joint end 28, a taper section 30 and a distal free end 32. Joint end 28 of handle 14 has the largest diameter, and distal free end 32 has a smaller diameter. Taper section 30 transitions smoothly between the larger diameter end and the smaller diameter end. The sizing of the distal free end is selected to facilitate a player's grip on the bat. The fully assembled ball bat as shown in FIG. 1 also includes barrel end cap 34 and handle knob 36 as shown in FIG. 2 in the exploded view.

[23] When assembled the two-piece bat comprising the barrel and handle has an overlapping junction region where the taper sections engage one another. The taper sections are sized to provide an interference fit between the handle and barrel. That is, at least a portion of taper section 24 nearest joint end 26, and at least a portion of taper section 30 nearest joint end 28 overlap one another and form junction region J. The dashed vertical line in FIGS. 1 and 2 shows where joint end 28 would be disposed in the assembled bat.

[24] The two-piece bat comprising the barrel and handle are assembled as shown schematically in FIG. 3. First, taper section 24 of barrel 12 and taper section 30 of handle 14 are coated with a rigid adhesive compound A. Handle 14 is then inserted into the opening at distal free end 22 of barrel 12 with handle distal free end 32 inserted first. Distal free end 32

of handle 14 is pulled through the opening at proximal joint end 26 of barrel 12 as seen in dashed lines in FIG. 3. As the handle is pulled through the joint end opening, handle taper region 30 will engage with barrel taper region 24 in an interference fit. As the taper regions engage one another, rigid adhesive A forms a rigid adhesive layer 40 between barrel interior surface 18, and handle exterior surface 27. After the rigid adhesive A cures, rigid adhesive layer 40 prevents direct contact between barrel 12 and handle 14 as seen in FIG. 4 which is a detailed cross-section of the region labeled J in FIG. 1. The barrel and handle are designed to engage one another by the interference fit shown in FIG. 4 through rigid adhesive layer 40. Since there is no direct contact between the barrel and handle, there is no need to provide any mating features on these surfaces thereby reducing complexity and cost of manufacture.

[25] An alternative embodiment bat 10' of the present invention employs a mixture of glass shafting beads in the rigid adhesive compound. The junction area labeled J' in FIG. 5 is shown in more detail in FIG. 6. In this embodiment, glass shafting beads 42 are added to the rigid adhesive so that when the handle and barrel are assembled and the adhesive cured, the resulting rigid adhesive layer 40' is actually a composite of rigid adhesive and glass beads. The assembly process for bat 10' is diagrammed in FIG. 7. In step S1, the glass shafting beads 42 are added to the rigid adhesive compound. The resulting mixture is applied to the interior taper region of the barrel and the exterior taper region of the handle, step S2. The handle is inserted into the barrel as shown in FIG. 3, step S3. The handle is then pulled into engagement with the barrel and tension force applied to center and align the junction, step S4. The assembled barrel and handle are then held together in place while the adhesive cures, step S5. Depending on the properties of the adhesive employed, the curing step may take place at ambient room temperature or encompass heat treatment. The finished bat 10' has the junction structure shown in FIG. 6 in which rigid adhesive layer 40' includes glass beads 42, and prevents direct contact between the barrel and handle.

[26] The mixture of glass shafting beads and rigid adhesive ensures self-alignment of the barrel and handle, and even distribution of the adhesive throughout the junction. As employed in the manufacture of golf clubs, the glass shafting beads help to self-center and align the joint, and ensure that the adhesive is evenly distributed over the joining surfaces and that the joining surfaces are separated from one another by a specific and consistent distance as determined by the diameter of the glass beads. Glass shafting beads are available in

multiple sizes, mostly very fine such as 0.002 inch to 0.020 inch in diameter. The preferred range of sizes for the present invention is between 0.005 inch and 0.010 inch in diameter.

[27] The use of rigid adhesive in the present invention, with or without glass shafting beads, provides a rigid connection that does not damp energy, but rather maximizes the stiffness and liveliness of the joint. For the rigid adhesive, the preferred compounds are epoxy or acrylic based rigid glues. In contrast, elastomer compounds which have been used in ball bat construction serve an isolation function. That is, they are designed to absorb and dissipate energy, not store and return it. The rigid connection of the present invention enhances performance by ensuring that energy from the impact of the ball is returned to the ball instead of dissipated in the bat. The ball bat of the present invention relies on inherent vibration damping characteristics of the composite material of the handle, and the engineering of that handle to reduce sting to the player's hands when the ball is hit. As the vibration wave travels down the barrel and into the handle, the composite handle damps vibration along its entire length to provide comfort to a player's hands. This is a particularly effective approach given that the ball to bat collision is so brief and instantaneous. This collision is largely a local event and occurs so quickly that before the vibration or sting reaches a player's hands, the ball has been hit. The composite handle enables the damping to occur closer to the player's hands so that any damping action takes place after the bat as returned the maximum amount of collision energy to the ball and the ball is no longer in contact with the bat.

[28] The barrel of the present invention is preferably made of an aluminum alloy for durability and strength. It is also possible that a resin with carbon and/or glass fiber composite could be engineered to have similar durability, strength and hardness characteristics as a metal barrel. Such an engineered material for the barrel is within the purview of the present invention, and in this application is referred to as being metal-like. The handle is preferably a composite of curable resin impregnated with carbon and glass fibers which is amenable to tuning and engineering for desired performance characteristics. This engineering is simply a way to tune the conversion of potential energy into kinetic energy when a ball is hit. Potential energy is stored when the ball and bat undergo a physical deformation at collision. That energy is converted to kinetic energy as the ball and bat return to their respective original shapes and the stored energy is released into the energy of the ball's movement away from the bat. With prior art wooden bats, the ball undergoes more

deformation upon impact. With an aluminum or composite barrel, the bat is able to store and release a portion of the potential energy of impact. The composite handle enables the bat designer to change the degree of flexibility in the handle portion to maximize bat speed and strength. A handle portion with optimized flexibility based on the swing speed of the player will enable the bat to return more of the energy of the player's swing to the ball by strong swing energy in the form of handle flex and releasing it by straightening at the moment of impact. Depending on the strength of the player, it may be better to stiffen or increase the flexibility of the handle, and composite enables that type of tuning.

[29] The ball bat of the present invention having a rigid connection between the barrel and handle employing a combination of mechanical interference and a rigid adhesive that prevents direct contact between the barrel and handle results in enhanced performance with reduced complexity and cost of manufacture. Eliminating direct contact between the barrel and handle at the junction eliminates the need to provide any mating features which also eliminates costly manufacturing steps and enables assembly to be greatly simplified. The composite handle provides opportunities to engineer the bat for optimum performance without sacrificing the durability and strength of a metal or metal-like barrel. Interposing a layer of rigid adhesive between the barrel and handle results in a rigid joint that maximizes the distance the ball will travel by ensuring that as much energy from the impact is returned to the ball.

[30] While various embodiments of the invention have been described, it will be apparent to those of ordinary skill in the art that may more embodiments and implementations are possible that are within the scope of the invention.

CLAIMS

What is claimed is:

1. A ball bat comprising:

a hollow barrel defining a barrel exterior surface and a barrel interior surface, said barrel having a free distal end with an opening and a tapered joint end with an opening;

a handle defining a handle exterior surface, said handle having a free distal end and a tapered joint end, said tapered joint end of said handle being sized to prevent passage thereof through the opening in said tapered joint end of said barrel resulting in an overlapping relationship between said barrel and said handle in a tapered junction portion; and

a rigid adhesive layer disposed between said barrel interior surface and said handle exterior surface in said junction portion preventing direct contact between said barrel and said handle.

2. The ball bat of claim 1, wherein said rigid adhesive comprises glass shafting beads added thereto.

3. The ball bat of claim 1, wherein said rigid adhesive is formed of a rigid epoxy adhesive.

4. The ball bat of claim 1, wherein said rigid adhesive is formed of a rigid acrylic adhesive.

5. The ball bat of claim 2, wherein said rigid adhesive is formed of a rigid epoxy adhesive.

6. The ball bat of claim 2, wherein said rigid adhesive is formed of a rigid acrylic adhesive.

7. The ball bat of claim 1, wherein said barrel is metal and said handle is composite.

8. The ball bat of claim 2, wherein said barrel is metal and said handle is composite.

9. A ball bat comprising:

a hollow barrel defining a smooth barrel exterior surface and a smooth barrel interior surface, said barrel having a free distal end with an opening and a tapered joint end with an opening;

a handle defining a smooth handle exterior surface, said handle having a free distal end and a tapered joint end, said tapered joint end of said handle being sized to prevent passage thereof through the opening in said tapered joint end of said barrel resulting in an overlapping relationship between said barrel and said handle in a tapered junction portion; and

a rigid adhesive layer disposed between said barrel interior surface and said handle exterior surface in said junction portion preventing any direct contact between said barrel and said handle.

10. The ball bat of claim 7, wherein said rigid adhesive comprises glass shafting beads added thereto

11. The ball bat of claim 7, wherein said rigid adhesive is formed of a rigid epoxy adhesive.

12. The ball bat of claim 7, wherein said rigid adhesive is formed of a rigid acrylic adhesive.

13. The ball bat of claim 8, wherein said rigid adhesive is formed of a rigid epoxy adhesive.

14. The ball bat of claim 8, wherein said rigid adhesive is formed of a rigid acrylic adhesive.

15. The ball bat of claim 9, wherein said barrel is metal and said handle is composite.

16. The ball bat of claim 10, wherein said barrel is metal and said handle is composite.

17. A method of making a ball bat comprising the steps of:

forming a hollow barrel defining a barrel exterior surface and a barrel interior surface, the barrel having a free distal end with an opening and a tapered joint end with an opening;

forming a handle defining a handle exterior surface, the handle having a free distal end and a tapered joint end, the tapered joint end of the handle being sized to prevent passage thereof through the opening in the tapered joint end of the barrel;

applying a rigid adhesive to at least one of a portion of the barrel interior surface proximate the tapered joint end or a portion of the handle exterior surface proximate the tapered joint end;

inserting the handle into the free distal end opening of the barrel with the tapered joint end of the handle inserted first;

applying a tension force to the handle to cause in an overlapping relationship between the barrel and the handle in a tapered junction portion with the rigid adhesive distributed therebetween;

curing the rigid adhesive to form a rigid adhesive layer disposed between the barrel interior surface and the handle exterior surface in the junction portion to prevent direct contact between the barrel and the handle.

18. The method of claim 17, further comprising the step of adding glass shafting beads to the rigid adhesive.

19. The method of claim 18, further comprising the step of applying a rigid adhesive to the other of a portion of the barrel interior surface proximate the tapered joint end or a portion of the handle exterior surface proximate the tapered joint end.

20. The method of claim 18, wherein said step of forming a barrel employs a metal compound for the barrel, and said step of forming a handle employs a composite for the handle.

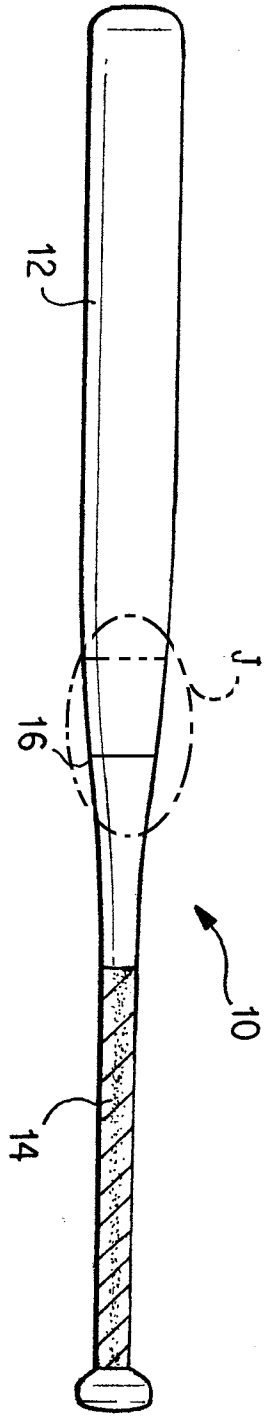

FIG. 1

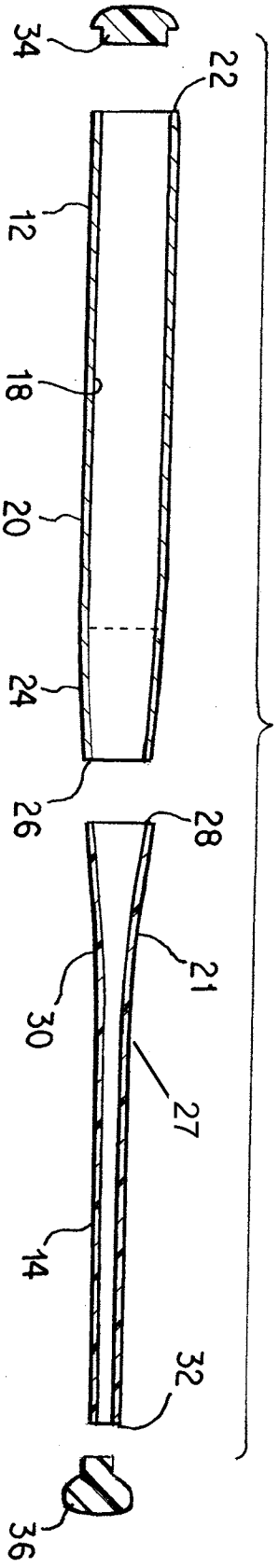

FIG. 2

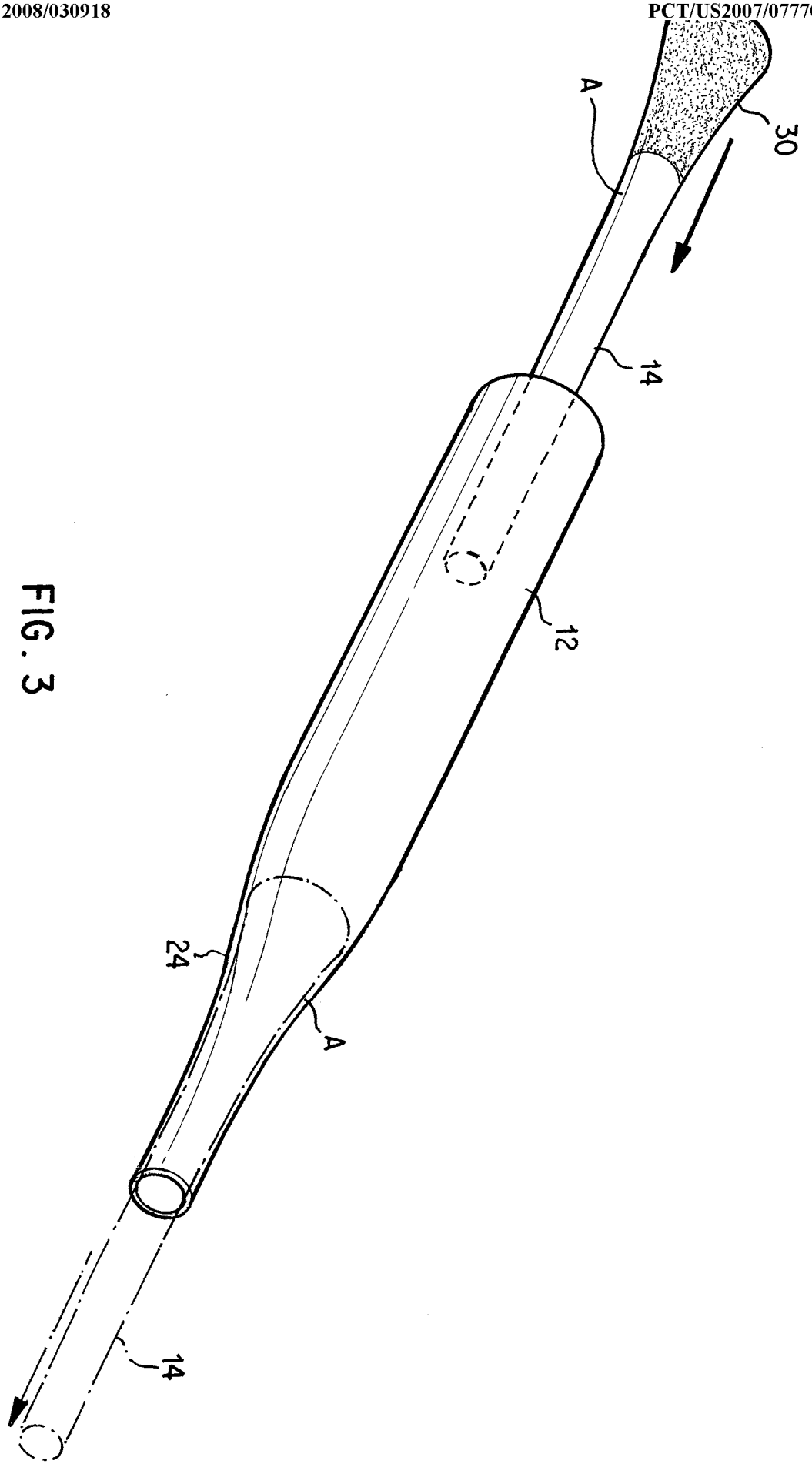

FIG. 3

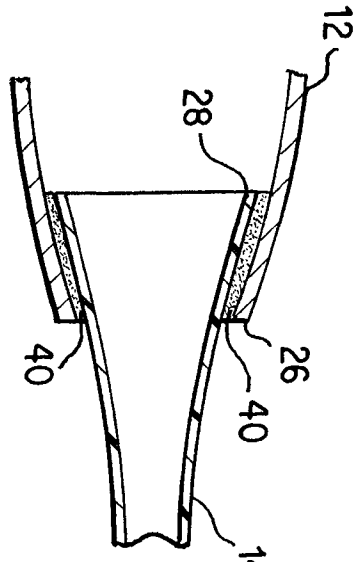

FIG. 4

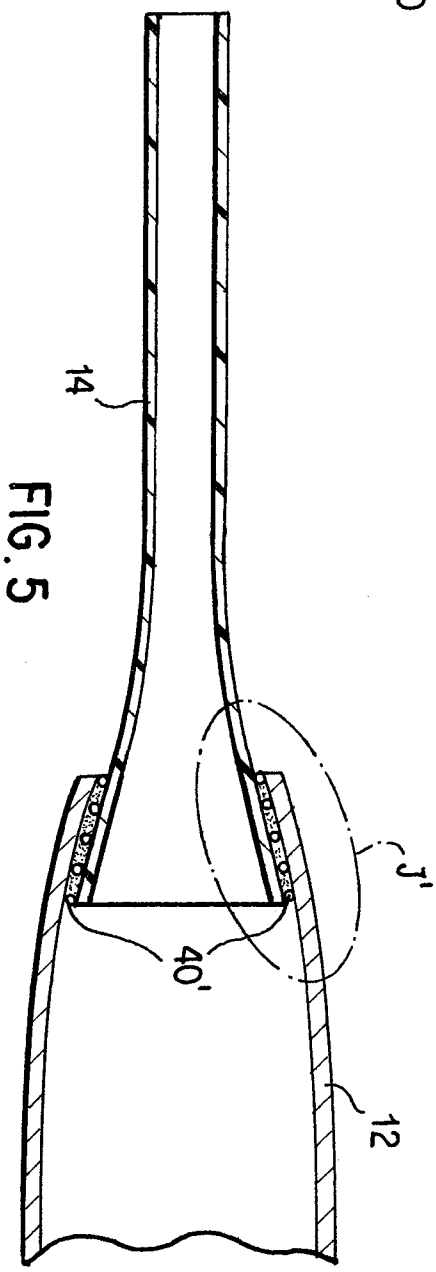

FIG. 5

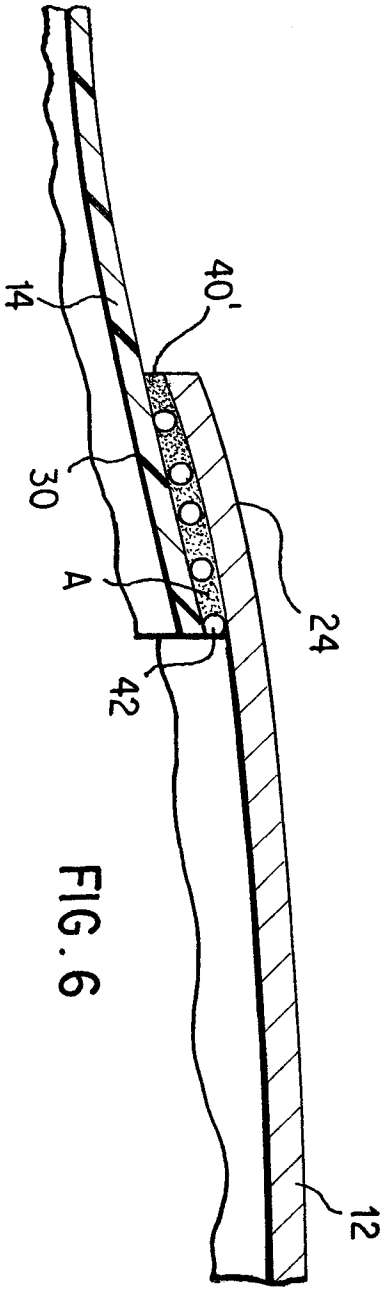

FIG. 6

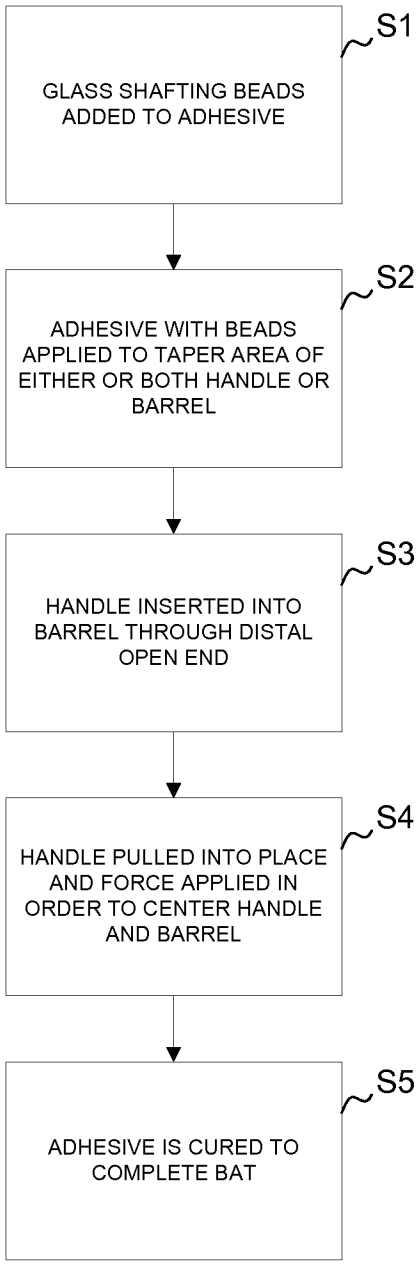
S1
GLASS SHAFTING BEADS ADDED TO ADHESIVE
S2
ADHESIVE WITH BEADS APPLIED TO TAPER AREA OF EITHER OR BOTH HANDLE OR BARREL
S3
HANDLE INSERTED INTO BARREL THROUGH DISTAL OPEN END
S4
HANDLE PULLED INTO PLACE AND FORCE APPLIED IN ORDER TO CENTER HANDLE AND BARREL
S5
ADHESIVE IS CURED TO COMPLETE BAT

FIG. 7