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PIN HAVING DECREASED NECK CHECKING TENDENCIES

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Fig. 1.

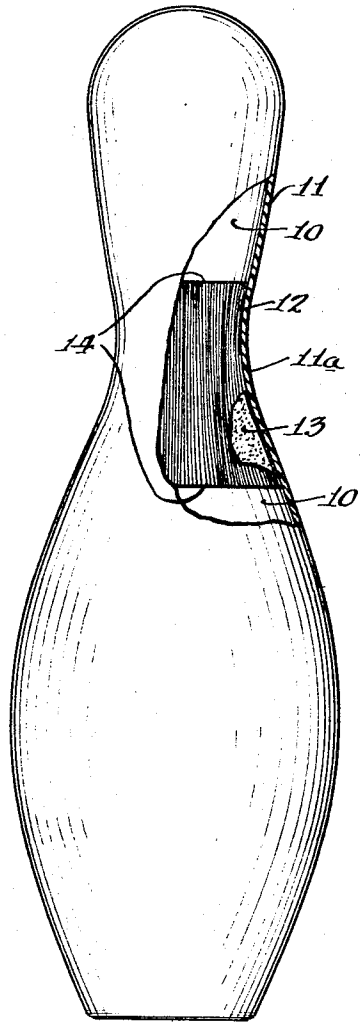
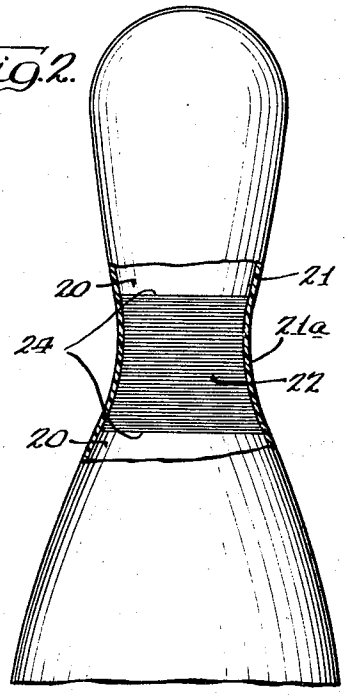


Fig. 2.



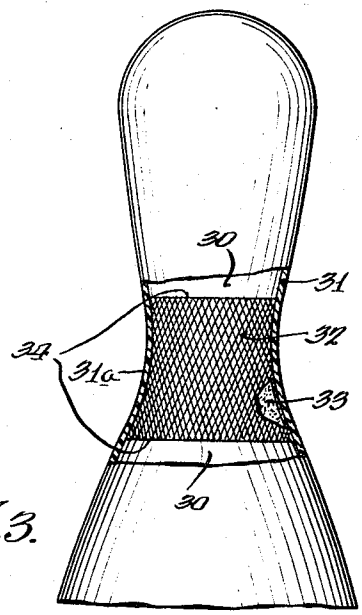


Fig. 3.

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PIN HAVING DECREASED NECK CHECKING TENDENCIES

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5 Claims. (Cl. 273—82)

ABSTRACT OF THE DISCLOSURE

A wood bowling pin with a plastic coating and having decreased neck-checking tendencies by virtue of a skin bonded to the wood surface in the neck region and covered by the plastic coating. The wood surface in the neck has a gradual transition and the bonded skin structure is of high modulus of elasticity and higher tensile strength than the wood so that it bears and withstands compression and tension stresses due to longitudinal bending of the pin under impact.

This application is a continuation-in-part of our application Ser. No. 268,300, filed Mar. 27, 1963, and since abandoned and assigned to the assignee of this invention.

This invention relates to bowling pins and more particularly relates to decreasing neck checking tendencies in bowling pins.

Bowling pins used in such games as Ten Pins and Duck Pins are subjected during use to high stresses generated at or just below the minimum section in the neck of the pin. Such high stresses, together with the natural configuration of the tissue elements of a wood core, may often result in "checking" or failure in the wood core parallel to the wood grains. Such checking is engendered by repeated impact during use of the pin and/or by a single blow of sufficiently high magnitude to initiate check type failures. Once the checks or splitting failures have been started in a pin, their growth or extension into the body of the pin or into the head section of the pin results in complete failure of the pin. Failure of pins due to checking is currently a serious problem and constitutes a prominent cause of shortened pin life.

In games in which bowling pins are used, the action of a pin is appreciably affected by the continuity of the surface of the pin. When neck check failures have progressed sufficiently, the sound or ring of the pin is adversely affected. Such deterioration in sound is well recognized by the bowler as being symptomatic of checked or failed pins in which the reaction of the pin has deteriorated. As a consequence, bowlers rightly refuse to play such pins believing that checked or failed pins may give lower scores. Thus, the proprietor of a bowling establishment must replace such pins, at some expense.

It is a general object of this invention to provide a new and useful bowling pin having a reinforced neck which reduces the checking tendency of the neck region wood.

It is a further object of this invention to decrease the neck checking tendencies in a wood core bowling pin by providing a reinforcing member having a high modulus of elasticity on the core neck laminated or bonded to the wood core surface in the neck region.

Another object of this invention is to provide a plastic coated bowling pin having a hardwood core and to include in such bowling pin a neck reinforcement member secured between the plastic coating of the pin and the outer wood surface of the core neck and contained within the neck region of the pin.

A further object of this invention is to provide such a

pin having a reinforcement member directly on the surface of the core in the neck region by applying to the neck of the core a material having a higher modulus of elasticity than that of the wood of the core and preferably by surrounding the neck with such material.

Other objects include the provision of a bowling pin with such a reinforcement member where the reinforcement member is a circumferentially disposed fiber such as a fiber disposed either spirally or longitudinally or as fabric material surrounding the neck of the core.

It is yet another object to provide a process for making the bowling pin of the foregoing objects by applying to or surrounding the neck of a shaped wood bowling pin core with a reinforcing member in adherence to the wood core surface.

Additional objects will be apparent to those in the art from the following descriptions and drawings in which:

FIG. 1 is a side view of an embodiment of the bowling pin of this invention with cut-away portions to show structure;

FIG. 2 is a side view of another embodiment of the bowling pin of this invention with cut-away portions to show structure; and

FIG. 3 is a side view of still another embodiment of the bowling pin of this invention showing structure by cut-away portions.

While this invention is susceptible of embodiment in many different forms, there is shown in the drawings and will herein be described in detail an embodiment of the invention together with a modification thereof with the understanding that the present disclosure is to be construed as an exemplification of the principles of the invention and is not intended to limit the invention to the embodiments illustrated. The scope of the invention will be pointed out in the appended claims.

Turning now to the drawings, FIG. 1 illustrates a bowling pin of the present invention which includes a hardwood, i.e. maple, core **10**, a reinforcement member **14** surrounding core **10** in the neck region thereof, and a plastic coating **11** applied over the core **10** and the reinforcement member **14**. The reinforcement member includes a reinforcing matrix of high modulus of elasticity, e.g. fabric **12**, and an adhesive, e.g. epoxy resin, of high modulus of elasticity with respect to the modulus of elasticity of the wood of the core.

The coating material **11** may be any suitable coating material, e.g. any of the usual coating materials for bowling pins, nitrocellulose, ethylcellulose, cellulose acetate, cellulose acetate and butyrate, epoxies, urethanes, and the like.

Reinforcement member **14** is a member having a higher modulus of elasticity than the wood core and includes a unidirectional glass fiber fabric **12** which is laid up in four quadrants to surround the neck and secured to the outer surface of the wood core in the neck region by a suitable laminating adhesive such as an epoxied resin adhesive indicated at reference numeral **13**. A large variety of other adhesives, both natural and synthetic, such as polyvinylacetate and phenolic type resins, may also be used. The adhesives, as well as the coating materials, will be apparent to those in the art. Fabric **12** and adhesive **13** (in the cured state) in combination with each other have a higher modulus of elasticity than the wood core.

The unidirectional glass fiber fabric reinforcement member **12** has a modulus of elasticity of approximately 5.0×10^6 p.s.i. which is substantially greater than the modulus of elasticity of maple wood, i.e. approximately 1.6×10^6 p.s.i. Reinforcement member **14** may be considered, as may the other reinforcement members described hereinbelow, as a material laminated between the wood core **10** and the coating material **11**. The tensile

strength of the laminated structure **14** of unidirectional glass fiber **12** and adhesive **13**, secured against the core surface as a stress skin structure, is of the order of about 110,000 p.s.i. while the tensile strength of the wood core is about 15,000 p.s.i. Thus, the reinforcement member carries approximately three times the stress created by bending movements in the pin and is capable of carrying appreciably higher stresses than the wood without failure. Of course, other materials having higher modulus of elasticity, and preferably a higher tensile strength than that of the wood core, including such materials as filaments, fibers of nylon, rayon, polyester products, metals such as high tensile steel and copper wire, very high strength cottom and the like, or combinations thereof, may be laid longitudinally on and laminated to the wood core surface with suitable adhesive at the neck in lieu of the glass fiber reinforcement member **14**. Additionally, a resin having a higher modulus of elasticity can be used alone without including fibers or fabrics or other supplementary reinforcing materials, in which case the reinforcing member consists essentially of the resin, e.g. in its cured state.

In addition, although the reinforcement member **14**, as illustrated in FIG. 1, has 100% of its fiber parallel to the length of the pin, the improvement in decreasing neck checking is not limited to such case. The fibers may be laid up at angles varying from vertical to horizontal. Similarly, various weaves or unwoven mat, roving, yarn or twists may be used. Such other variations may become even more evident with reference to FIGS. 2 and 3.

Turning now to FIGS. 2 and 3, there are shown respectively cores **20** and **30** having reinforcement members **24** and **34** secured or laminated thereto in the neck region and including a suitable adhesive for such lamination, e.g. as shown at **33**. The illustrated bowling pins have substantially uniform plastic coatings **21** and **31**. Reinforcement member **24** includes a nylon strand **22** having a thickness of about .025 inch wound spirally in one layer about core **20** in the neck region. The wound strand is bonded to the core by the adhesive component of member **24**. It is apparent that other configurations, e.g. tape or roving, can be used. The reinforcement member **24** comprises a transverse wrap reinforcement and the true fiber orientation is determined by the lay or form of the material used so that the predominant fiber orientation may be either circumferential or parallel with the axis of the pin. In either instance, and in the use of any neck reinforcement material in accordance herewith, the neck reinforcement material itself may be considered as being circumferential with respect to the core.

Reinforcement member **34** includes a woven sleeve **32** of fiber glass filaments bonded to the core by adhesive material **33**. Of course, other materials such as nylon fabrics, woven nylon or dacron, tesalin form of nylon, or the like may be used.

The reinforcement material usable in accordance herewith, as indicated above, has a higher modulus of elasticity than that of the wood of a core and preferably has a higher ultimate tensile strength than that of the wood of the core with the reinforcement material in its laminated form.

The coating material over the bowling pin is substantially uniform; however, it may be somewhat thinner in the neck region in order to compensate for the presence of the reinforcement member. It is preferred that a sufficient thickness of coating material be provided over the reinforcement member to maintain pleasing appearance of the pin. The remainder of the bowling pin will usually have from about 0.055 to about 0.070 inch of coating material. The thickness of coating material over the pin surface usually varies slightly. The thickness of the reinforcement member may also vary but will usually be substantially less than ⅛ inch and more normally less than 1/16 inch.

In addition, it is to be understood that it is intended that the reinforcement members of the present invention can be used in conjunction with the core over-sizing and densification as described in copending application Ser. No. 268,301, now Patent No. 3,248,115, filed Mar. 27, 1963, entitled "Bowling Pin Having Decreased Neck Checking Tendencies" and assigned to the common assignee of this application. Also, any of the coating methods described in the aforementioned application are adaptable for use in producing bowling pins in accordance herewith.

In accordance with a preferred procedure for making bowling pins in accordance herewith, initially the wood core is turned to proper size, preferably to an external shape generally corresponding to that of the finished bowling pin but of a smaller size sufficient to permit application of the reinforcement member and coating thereto and to permit placement of a pin bottom member to achieve the final pin size. An adhesive or bonding coat of resin having a high modulus of elasticity in its cured state is then applied to the neck region. The reinforcement member is then applied in accordance with the type of reinforcement used under sufficient pressure to assure bonding of the reinforcement with the wood core surface. Longitudinal filament reinforcements are applied as a tape or filament or roving or the like to two or more and preferably all four quadrants of the neck.

The transverse wrap reinforcement is applied by wrapping a filament or tape or roving or the like over the high modulus of elasticity resin around the pin in a spiral direction so that each wind is adjacent the foregoing wind.

The sleeve reinforcement is applied by placing a sleeve of material over the head and on to the neck of the hardwood core and then compressing the sleeve against the adhesive at the core. The sleeve is preferably formable on the core, e.g. by stretching the weave longitudinally on the core or by resiliency of the configuration of weave. In the latter case, the resin, upon curing, prevents slipping or stretching of the weave with respect to the core, the resin being sufficient to impregnate the weave.

In any event, the reinforcement material is applied to a region on the pin which corresponds to the region lying between 3 and 8 inches and preferably between 4 and 7 inches from the top of a regulation ten pins bowling pin. It is especially preferred that the reinforcement material be applied to the core at least in the area from the minimum diameter of the neck to about 1 inch below the minimum diameter. The length of the reinforcement material will usually range between about 2 and 5 inches; a length of 2 to 3 inches may often be sufficient.

After the reinforcement member has been applied to the circumference of the neck portion of the pin, a layer of coating material, e.g. additional epoxy material which is curable at room temperature, is applied to the neck portion of the pin directly over the reinforcement member. The layer of resin may then be cured, the epoxy material being curable in about four hours using moderate oven temperatures, e.g. about 140° F. Of course, other coating materials including the same coating material or materials used in coating the remainder of the pin, can be used if desired, e.g. in cases where additional resin of high modulus of elasticity is not required for the stress skin reinforcing structure, and the curing conditions normally applicable to curing such other resins or materials may be used. However, to preserve the strength of the core wood, such curing conditions are preferably kept below about 160° F. It may be more advantageous to use resin-catalyst combinations as the coating materials and to cure the same with localized heat from lamps, strip heaters, dies or other sources to effect the curing operation in a shorter time, especially for production of pins at mass production rates.

The core with reinforcement in the neck portion is then subjected to a finish coating procedure. Any of the

coating procedures normally used for coating bowling pins may be used in accordance herewith. For example, the pin may be subjected to a plurality of successive dippings in ethyl cellulose lacquer to build up a multilayer coating. The lacquer coating is then cured and the pin is finished in accordance with normal procedures. It may be desirable to machine a portion of the thickness of coating from the neck area to conform the overall outer dimension of the finished pin with regulation size.

In the bowling pin of the present invention, the reinforcement member, which preferably includes a fibrous member and a suitable adhesive, reinforces the core of the pin and has practically no effect on strengthening the coating. It is important that the reinforcement member is a stress skin structure at the core surface. In such construction the reinforcement member provides a high strength, load bearing sheath which reduces the stress carried by the wood core. Stresses which would otherwise be carried by the wood are carried by the sheath.

Thus, the neck portion of the bowling pin is converted to a stress skin structure and the neck may be compared to a hollow core construction wherein the majority of the flexural tension and compression stresses are carried by the skin. It is recognized that if dissimilar materials are laminated together, the material having the greater modulus of elasticity carries the greater stress, approximately in direct ratio between the two modulae of elasticity. Additionally in the present instance, the material having the higher modulus of elasticity is at a greater distance from the neutral axis and would normally be required to carry more of the flexural tension. As a result, the higher modulus of elasticity of the material and the distance of the reinforcement member from the neutral axis are complementary. In the present invention, it is preferred that the reinforcement member be of a sufficient mass or thickness to substantially convert the neck portion of the pin to a stress skin structure wherein the primary stress carrying element in the neck portion is the reinforcement member.

The bowling pins illustrated in FIGS. 1 and 3 having neck reinforcement members consisting of unidirectional glass fiber fabric laid on in quadrants, nylon fiber strand and a glass fiber fabric sleeve respectively, and a control pin of the same construction but without a reinforcement member in the neck, were tested in accordance with a rotating beam fatigue test adapted for testing pin neck fatigue life. The test determines failure in a bowling pin by neck checking due to stresses set up in the pin. Briefly, in accordance with the test procedure, the pin tested is rotated on its longitudinal axis while maintaining a fixed moment (relative to the rotating pin) of 2400 in. lb. so that as the pin rotates, the tension and compression shifts in such a manner to in effect rotate through the pin so that each portion of the neck surface is exposed to tension and compression in each cycle of pin rotation. The number of cycles before neck checking, i.e. failure of the pin, is taken as the test result, indicative of ability of the pin to withstand stresses in the direction of the longitudinal axis. The results of the test were as follows:

Pin sample tested:	Cycles before failure
Control	1,900
FIG. 1	3,000,000
FIG. 3	2,300,000

The above data indicates marked superiority in the present pins in withstanding tension and compression.

In further testing, a set of each of the pins of FIGS. 1 and 3 and a set of control pins of the same construction as used in the fatigue test above were subjected to an accelerated bowling test. Briefly, the test is carried out in cycles and employs an automatic pinsetter, a ball throwing machine and a short length of bowling alley. For each cycle, the ball throwing machine ejects a ball at a preselected speed in a fixed direction into the set of bowling pins at the strike zone. Between hits, the automatic pinsetter sesets the pins with random orientation and random position of pins. The pinsetter automatically returns the ball to the throwing machine after each hit to complete the cycle. The number of cycle before failure of all the pins in the set is recorded.

The results were as follows.

Set of pins tested:	Number of cycles
Control	28,000
FIG. 1	66,000
FIG. 3	70,000

In view of failures of other portions of the pins, e.g., the belly, especially in the pin that was produced in accordance with the present invention, it was not possible to determine the true neck life on every pin of the set. However, it is believed that the comparative results are indicative of the improvements in the present invention in the prevention of neck checking during use.

A series of bowling pins was prepared in which the wood core was grooved in the neck to about the same longitudinal extent as the neck reinforcement members illustrated in the drawings herein and of sufficient depth to receive such members as (1) a vulcanized fiber collar, (2) a phenolic laminate collar, and (3) a nylon collar. Each of the collars was releasably secured in the neck groove of a pin. In actual bowling tests, these pins give negative results. A second series of pins was prepared replacing the above collars with less rigid materials on the assumption that the transition from wood to the reinforcing collar in the first series was too abrupt. In actual bowling tests, these pins also gave negative results. A third series was prepared in which shrinkable plastic end wraps of various fibrous materials were bonded into the grooves, in lieu of the materials of the first two series, to form a hard sheath, bringing the grooved wood pin up to its original contour. In actual bowling tests these pins gave negative results.

In the tests of each series of pins under actual bowling conditions, these pins developed neck checks in a shorter time and in a greater severity than the same wood bowling pins omitting the groove and collar or sheath. The grooves reduce the section or diameter of the pin in the neck, and ball impact forces against the pin induce a longitudinally bending moment in the pin such that stress on the wood in the grooved neck is increased, leading to more rapid and more severe failure through neck checking. Also, a stress raiser effect may have resulted from the abrupt change in section of the wood in the neck of the pin.

The present invention advantageously provides new and useful bowling pins having decreased neck checking tendencies imparted thereto by the incorporation of a reinforcement member in the neck region. In the present pins, the bonding of the higher modulus and higher ultimate fiber strength material to the uninterrupted wood surface of normal transition in the neck, using a bonding material suitable for providing the total stress skin structure with a higher modulus of elasticity than that of the wood of the core to be bonded, results in reduction of the stress carried by the wood so that neck checks are greatly lessened. The reinforcement structure functions to reinforce the neck portion of the core by converting the neck portion to a stress skin structure wherein the reinforcement member is the primary stress carrying element for bearing compression and tension stresses due to longitudinal vibration of the pin resulting from impact by a ball.

We claim:

1. A bowling pin comprising a wood core having a surface of normal gradual uninterrupted transition in the shoulder-neck-head region in the absence of the abrupt surface changes of a groove, a plastic coating covering said core, a skin reinforcement structure circumscribing the neck of the wood core in direct contact therewith

and terminating at the upper extent below the maximum diameter of the pin head and at the lower extent above the pin belly, said reinforcement structure including a reinforcing sleeve and a set adhesive having a higher modulus of elasticity than the modulus of elasticity of said wood core, said adhesive impregnating said sleeve and bonding said skin structure as a stress bearing skin to said surface in the core neck region with the plastic coating of said pin disposed thereover, said skin structure having a sufficiently higher modulus of elasticity and higher ultimate fiber strength than that of the wood of said core to bear the major portion of compression and tension stresses in the pin neck due to bending vibrations of the pin core in the neck resulting from impact by a bowling ball at the belly of the pin, said skin reinforcement structure projecting outwardly from the core surface into said coating, said pin having an appreciably longer neck fatigue life than a similar pin in which the skin structure is absent.

2. The bowling pin of claim 1 wherein said reinforcing sleeve is a long fiber strand disposed spirally around the neck portion of the core.

3. The bowling pin of claim 1 wherein said reinforcing sleeve is a longitudinally disposed fiber.

4. The bowling pin of claim 1 wherein said reinforcing sleeve is a fabric material.

5. The bowling pin of claim 1 wherein said adhesive is an epoxy adhesive.

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