Sept. 28, 1965 F. G. FIRTH ETAL 3,208,750

BOWLING BALL WITH EPOXY RESIN COVER

Filed March 14, 1960

2 Sheets-Sheet 1

FIG. 1.

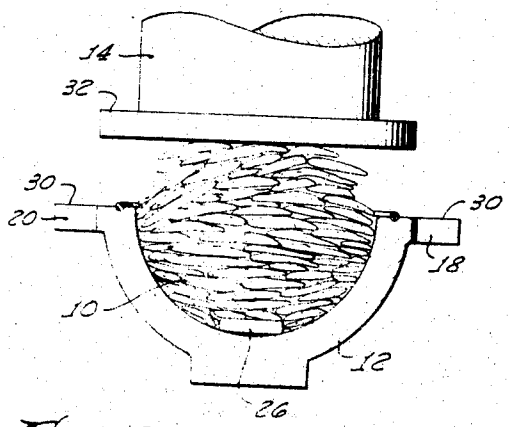


FIG. 2.

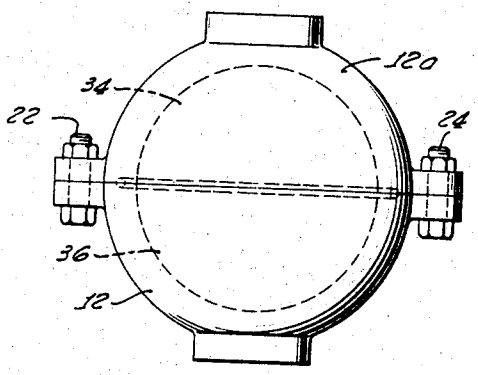
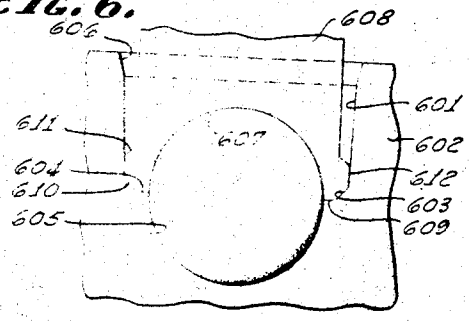


FIG. 6.



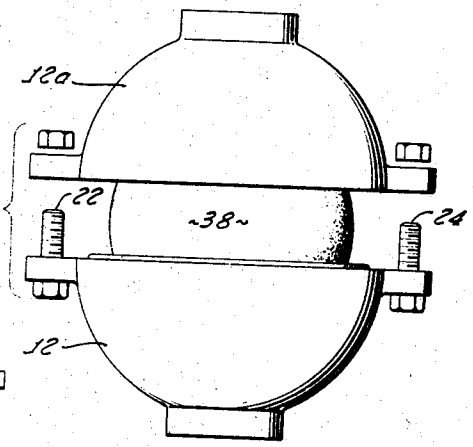


FIG. 3.

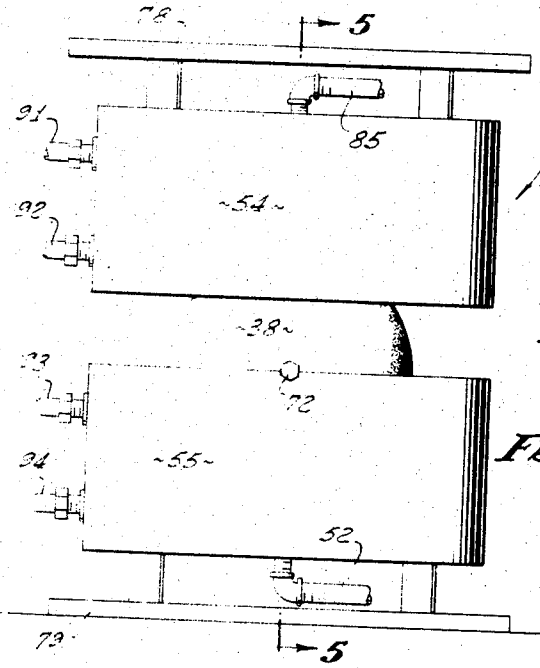


FIG. 4.

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BOWLING BALL WITH EPOXY RESIN COVER

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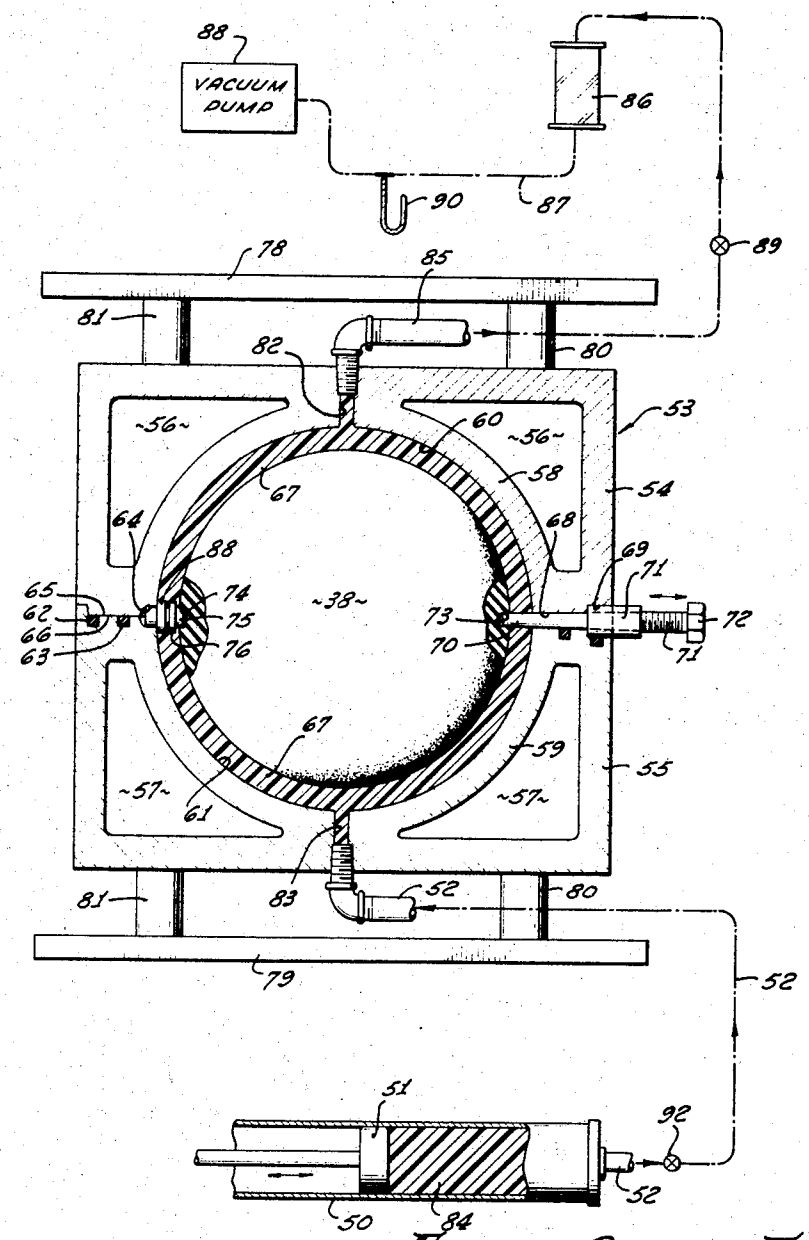


FIG. 5.

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BOWLING BALL WITH EPOXY RESIN COVER

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15 Claims. (Cl. 273—63)

This invention relates to bowling balls and has more particular reference to bowling balls having new and improved construction.

Substantially all of the bowling balls currently in use are composed of a variety of core materials having a covering or outer shell surrounding the core, which coverings are usually hard rubber or phenol formaldehyde. These balls are subject to undue wear in that they tend to chip around the finger holes, have poor abrasion resistance and quickly accumulate bits of dirt on their surface which causes pitting and scarring of the surface. Further, because of their composition these bowling balls almost always have a drab, dark color.

It is, therefore, the principal object of this invention to provide a bowling ball having an outside surface which is able to withstand the shocks to which the ball is subjected in bowling games, which surface is able to withstand abrasion, is smoother than prior balls and does not chip or crack.

It is a further object of this invention to provide a bowling ball which has the ability to repel dirt and retain its smooth appearance.

A still further object of this invention is to provide bowling balls in a variety of pleasing colors which retain their color through repeated use.

It is an additional object of this invention to provide bowling balls having inner cores that are lighter, more cushion-like and thereby provide greater resiliency and tone than found in prior bowling balls.

Other objects will appear as the description proceeds.

To the accomplishment of the foregoing and related ends, said invention then comprises the features hereinafter fully described and particularly pointed out in the claims, the following description setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principle of the invention may be employed.

Referring to the drawings, FIG. 1 is a vertical section or a mold, or die, and of raw material ribbon being placed into the mold.

FIG. 2 is a side view of a completely closed mold.

FIG. 3 is a side view of a partially open mold of the type illustrated in FIG. 2.

FIG. 4 is a partially open view of an additional mold used in the course of manufacturing the ball.

FIG. 5 is a schematic diagram of a molding system using the mold illustrated in FIG. 4.

FIG. 6 is a sectional view of an additional mold used for making the wooden ball cores.

Broadly stated, the present invention comprises a bowling ball comprising at least one core and an epoxy resin cover contiguous with and completely enveloping said core, said epoxy resin having an epoxide equivalent weight in the range of 170 to about 400.

Bowling balls are generally of either two-part or three-part construction. In a ball of two-part construction there is a core and cover; and in a ball of three-part construction there is an inner core, an outer core surrounding and contiguous with the inner core, and a cover contiguous with the outer core and completely enveloping the same.

The bowling balls of the present invention are primarily distinguished by their outer coverings, namely, a covering

of epoxy resin having an epoxide equivalent weight of from about 170 to about 400. Epoxy resins useful in the practice of the present invention are characterized by the presence of two or more oxirane rings on a stable molecule which can be aliphatic, alicyclic or aromatic in nature. Such materials can be exemplified by glyceryl glycidyl ether, dicyclo diepoxy carboxylate and the diglycidyl ether of bisphenol A. Besides the reactive oxirane ring structure there can be present other reactive centers such as hydroxyl, carboxyl or other sites capable of being used in chain extension or cross-linking mechanisms and which may require other condensation agents than catalysts, anhydrides or polyfunctional amines. Typical commercial epoxy resins of varying molecular weights are generally mixtures of polyglycidyl ethers made by the reaction of epichlorohydrin and 2,2-bis(4-hydroxyphenyl)propane in the presence of alkali. The manufacture of epoxy resins applicable to the present invention is described, for example, in U.S. Patents 2,324,483, 2,444,333, 2,500,600 and 2,633,458. The low molecular weight resins of 400 or less epoxide equivalent weight are liquid. We have found that epoxy resins with an epoxide equivalent weight of from about 170 to about 400, and preferably from 170 to 179, have remarkable dimensional stability during cure, and when applied to a bowling ball core material they have outstanding adhesive properties, very little shrinkage and result in a finished ball having an extremely smooth surface with accurate dimensions. These outer covers additionally accept a wide range of fillers and pigments and the finished ball has a hard surface coupled with great toughness and shock resistance.

In applying the epoxy resins to core materials to produce a bowling ball, the resins are incorporated into a formulation designed for this specific end use. Commercial formulators readily know the various additives necessary to obtain a finished or cured product having the requisite color, toughness, dimensional stability, adhesion and abrasion resistance. Although functional end-use properties are determined primarily by the resin itself, a typical formulation could include resin, curing agent (hardener), diluent, filler, resinous modifier and pigment.

The viscosity of epoxy resins can be lowered by the addition of non-reactive or standard reactive diluents. However, the effect of diluent addition is not only the reduction of viscosity. For example, diluents aid in obtaining high filler loadings at lower final viscosity; they can reduce internal strain during cure; and they can lengthen pot life and increase impact resistance. Large excesses of diluent should be avoided, however, as they may degrade desirable physical properties. In the preferred embodiment of our invention we use from about 2 to about 20 parts of reactive diluent per 100 parts of epoxy resin. Typical standard reactive diluents applicable to the present invention are allyl glycidyl ether, butyl glycidyl ether, phenyl glycidyl ether and styrene oxide. Each of these diluents contains an epoxide group which reacts with the hardener, just as does the epoxy group in the resin, and thus makes the diluent an integral chemical part of the cured resin. Non-reactive diluents or solvents are to be avoided in the present formulations as they could cause excessive shrinkage if evaporated from the resin during the cure, and may be fugitive after cure.

The epoxy resins applicable to the present invention are efficiciently cured by the hardeners or curing agents already well known to epoxy formulators. Among these are the aliphatic or aromatic amines, the organic anhydrides, and acidic or basic catalysts. From about 3 to about 100 parts per 100 parts resin of such curing agents as diethylene triamine, triethylene tetramine, tetraethylene pentamine, meta-xylylene diamine, meta-phenylene diamine, diamino diphenyl sulfone, BF_3 amine com-

plexes, phthalic anhydride, hexahydro phthalic anhydride, dodecenyl succinic anhydrid and pyromellitic dianhydride are typical examples of such useful curing agents.

In the preferred embodiment of our invention we use from about 5 to about 70 parts of filler per 100 parts of resin. These fillers not only enable epoxy formulators to reduce costs, but they also contribute to such desirable properties as increased strength, impact resistance, and decreased shrinkage. Among the typical fillers useful in the present formulations are clays, asbestos fibers, glass fibers, nylon fibers, Dacron fibers, Orlon fibers, powdered glass, powdered metals, aluminum oxide, silica and mica. Asbestos short ends are especially useful in the present formulations because of low cost, ease of incorporation, improved reinforcement and the large volume which can be incorporated into the resin mix. Additionally, fillers can also be used as dyes or pigments to impart color to the final product.

Resinous modifiers or flexibilizers can be used in the resin formulations of the present invention in amounts of from 0 to about 100 parts per 100 parts of epoxy resin. These resinous modifiers or flexibilizers either in reaction with the epoxy resins or in solution with them can be used to favorably affect impact resistance, water resistance, heat resistance and flexibility of the final cured product. Additionally, resinous modifiers based on melamine, urea, phenolics, polyamides, propylene glycols, or polyols and polysulfide rubber may act as curing agents for the epoxy resins through reaction with the epoxide groups or the hydroxyl groups.

The purpose of pigments in the epoxy formulations is to develop a pleasing shade on the outside of the ball. A wide variety of pigments are available; they may be of inorganic or organic nature, and may be used in amounts up to 20 parts per 100 parts of epoxy resin depending on the strength of the pigment used. White and pastel shades can be obtained by the use of titanium dioxide, lithopone, zinc oxide and similar other white pigments, alone or in conjunction with iron oxides, carbon blacks, cadmium colors, cobalt colors, and similar materials used in the coloration of paints and plastics.

The following examples are typical formulations useful in producing the covered bowling balls of the present invention:

I

The formulation of this example is composed of Dow epoxy resin 332 cured with a typical amine hardener. Dow epoxy resin 332 is a diglycidyl ether of bisphenol A having an average epoxide equivalent weight of 179.

Dow epoxy resin 332	100.
Diethylenetriamine	8–12 p.h.r. (Parts (wt.) per hundred parts of resin (wt.)).

II

Dow epoxy resin 332	100
Boron trifluoride monoethylamine complex --p.h.r--	3

III

Dow epoxy resin 332	100
Butyl glycidyl ether --p.h.r--	12
Calcium carbonate --p.h.r--	50
Asbestos fibers --p.h.r--	50
Versamid 115 (a polymeric epoxy curing agent made by the condensation of dimerized or trimerized oil fatty acids and ethylene diamine) --p.h.r--	60
Thiokol LP3 (a liquid poly sulfide rubber rubber flexibilizer prepared by the reaction of organic dihalides and sodium polysulfide) --p.h.r--	10
Titanium dioxide --p.h.r--	6
Cadmium-selenium red pigment --p.h.r--	3
Diethylene triamine --p.h.r--	10

As previously stated, the foregoing epoxy resin cover may be applied to a single or double core. The cores used in the present bowling balls may be hard rubber, a mixture of hard rubber and cork and wood flour, wood chips, sawdust or shavings mixed with inorganic fibers and held together with a binder, such as phenol formaldehyde, epoxy resins, polyester resins, melamine, urea formaldehyde, etc.

Referring to FIG. 1, a plurality of hard rubber strips **10**, preheated to a temperature of approximately 140° F., is pressed into a mold **12** by means of a press **14**, a sufficient number of strips being deposited into the mold **12** so as to fill, upon compression, this mold completely, up to its upper surface **30**, with the material used for making the core. The mold, or die, **12** is provided with a flange **16** having slots **18** and **20** for subsequent insertion of bolts **22** and **24** illustrated in FIG. 2. These bolts are used for clamping together two molds, each containing a hemispherical core, on top of each other in the manner indicated in FIG. 2 so as to produce a complete ball core from two hemispherical cores in the course of its manufacture.

When it is desirable to produce hard rubber cores, then a conventional and known composition of hard rubber is used for making strips **10**, such composition usually including in excess of 30% of sulfur and additional hard fillers, such as carbon black, hard rubber dust, barytes ($BaSO_4$), and reclaimed rubber. When such hard rubber stock is used, then ribbon **10**, which may have such size as 5 inches by 16 inches by ⅜ to ⅝ inch thick, is preheated to a temperature from 100–140° F. and mold, or die, **12** is also preheated to a temperature in the order of 100–150° F. prior to its placing under the hydraulic ram **14**. It should also be mentioned here that a high density weight block **26**, or a plurality of such blocks, is placed at the bottom of mold **12**, this block being used as a means for compensating for the reduction in weight in direct vicinity of this block **26**, which takes place when finger holes are subsequently drilled in the ball. The high density block **26** can also be made of hard rubber, in which case its density is increased by increasing the percentage of barytes, or other heavy filler.

The method disclosed in FIGS. 1, 2 and 3 for making the core of the ball is also suitable for making the core of balls which contain a mixture of hard rubber and cork. When cork is used, then the granulated cork, having various sizes from approximately ⅛ to ¾ inch, is mixed with hard rubber prior to making ribbon **10**. In this case, it is often possible to discard the step of making strips of ribbon **10** altogether and using the mixture of hard rubber composition and cork merely as a bulk which is deposited into mold **12** in sufficient amount for filling mold **12** to the hemispheric line **30** of the mold when press **14** is lowered until its flange **32** engages the upper surface **30** of mold **12**. Batches of this type generally are weighed or measured in advance and then deposited into mold **12** so as to produce the desired density, pressure, and compression of the material within the mold, the above parameters determining the final weight of the finished ball.

After two hemispheres of the above type are made in two respective molds **12**, these two molds are used in the manner illustrated in FIG. 2, with one mold acting as a base **12** and the second mold **12*a*** acting as a cover for the second mold. The two identical molds are then tightly clamped together by means of bolts **22** and **24**, or other more convenient means, and this composite mold, holding within it two hemispherical cores **34** and **36**, is placed in any suitable heating medium, such as a steam autoclave, where it is heated from 8 to 13 hours at 245–260° F., depending on the composition of the core. The length of time for producing proper cure is a function of the amount of cork used in the raw materials; the larger the percentage of the cork used, the longer is the time of the cure. After the above period of curing

time, the composite mold **12–12*a*** is taken out of the autoclave and is cooled for a period of from 4 to 8 hours, whereupon the mold is opened, in the manner illustrated in FIG. 3, and the cured core is then taken out of the mold. The two hemispheres **36** and **34** are fused together during the curing step and become a single sphere **38**.

The mold may have a highly polished, plated metallic surface, made of such metal as plated chrome, which facilitates the separation of the molded core from the mold. It is also customary to use mold lubricants or stripping compounds, such as silicone, for preventing any possibility of establishing a bond between the material being molded and the mold, and, in the mold of this type, the chromium-plated surface can be eliminated to reduce the original cost of the mold. The outside diameter of the cured core **38** is made slightly larger than its final diameter; for example, its outside diameter may be in the order of 7 13/16", and it is subsequently turned down on a lathe to a 7¾" to 7½" size.

Referring now to FIGS. 4 and 5, which illustrate a transfer mold apparatus, a piston-cylinder combination **50–51** is connected to an outgoing duct **52**. Duct **52** is connected to an injection mold **53** including an upper half **54** and a lower half **55** each having a hemispherical recess for receiving sphere **38** and synthetic resin which is injected or transferred into the mold **53** by means of piston **50**. Mold **53** is provided with cavities **56** and **57** which surround the hemispherical walls **58** and **59** of the mold. The inner hemispherical concave surfaces **60** and **61** of the mold are polished and then chromium plated for facilitating the removal of the molded balls. Surfaces **60** and **61** are coated with a suitable mold lubricant before injecting the resin into the mold, such as silicone or a soapy solution, both of which prevent the formation of a bond between these surfaces and the injected resin. Mold **53** is provided with two O rings **62** and **63** and a cylindrical recess **64** which is located directly at the two matching surfaces **65** and **66** of the two molds **54** and **55** so that each mold has a semi-cylindrical recess equal to and matching the semi-cylindrical recess in the complementary mold. Accordingly, the recess is located along and on the great circle of core **38**. Mold **53** is also provided with a tapered cylindrical recess **68–69** which is also located on the same great circle and diametrically opposite the location of recess **64**. The recesses **68** and **69** are used for inserting a mandrel, or pin, **70** and a threaded bushing **71** which fits into recess **69**. The outer end of the mandrel is also threaded and is provided with a suitable hexagonal or square head **72** which is used for inserting or screwing in and out the mandrel for engaging core **38** after it has been placed into the lower half **55** of the mold. A bore **74** is also provided at the same great circle of core **38**. Bore **74** is used for inserting a synthetic resin plug **75** which can have a different color than the color of the outer lining **67**. Plug **75** is provided, if so desired, with suitable shoulders **76** and **88**. In practice it has been found that such shoulders are not necessary and, therefore, plug **75** is a straight cylinder of any suitable diameter, and its length is made sufficiently long so as to make it protrude some fraction of an inch beyond the outer surface of the outer lining, or cover, **67** of the ball. Plug **75** is a partially or a completely cured plug made either of the same or compatible resin with respect to the resin used for making the outer cover **67** so that positive adhesion and bonding takes place between the plug and cover **67**. Plug **75** is cured prior to the curing of cover **67** so that it could be machined to the proper outer diameter and, also, so that it can act as a laterial support, or a supporting shaft, for core **38** together with mandrel **68**, the two holding core **38** in a concentric relation with respect to mold **53**. It should be noted here that such concentric relationship is obtained, and the uniformity of the thickness of the outer cover **67**, is insured by the prior turning of core **38** on a lathe to the desired diameter and then by properly controlling the placing and the dimensions of plug **75** and bores **74** and **73**. In one specific example, the outside diameter of core **38** is made in the order of 7.5 inches. Since the standard diameter of the finished ball is 8.594 inches, the thickness of cover in the above example becomes equal to .547 inch. The thickness of wall **67** is not critical and is a function of the physical properties of the synthetic resin used for making the cover. It is also a function of the physical properties of the inner core **38** in that the final properties of the core and the final properties of the cover should match each other as closely as possible in terms of their respective elasticities so that the two could function as a unit. When this is the case, the thickness of the cover can be reduced to a very large extent and made as thin as ⅛ inch.

Proper location of the bores **73** and **74** in the core is accomplished in the manner described below. Plug **75** can then also be used for identifying the location of the axis of the ball which passes through its center of gravity and through the high density weight block **26**. This is accomplished as follows: the ball, after it has been turned down in a lathe, is placed in a mercury bath, the bath having the shape of a concave hemisphere of greater diameter than the diameter of the ball, and the ball places itself at once so that the above axis finds itself in the vertical position. A centering punch is aligned with the vertical position which corresponds to the axis of symmetry of the bath. The punch forms a sliding engagement with the bowl. The punch is struck with a hammer and its cone-shaped sharp top makes a center-punch impression in the ball at the point of the location of the vertical axis passing through the geometric center of the ball and the center of gravity. The center punch mark is then used for properly positioning plug **75** and bores **74** and **73** in concentric relationship with the above axis.

The plug thus is used as a convenient marker for identifying the position of the heavy block, or weight, in the ball for subsequent operations, such as finger holes drilling, and it is also used for placing on the face of the mark all required data, such as the weight, the name of the maker, trademark, etc.

Before proceeding with the further discussion of mold **53**, it should be noted here that cavities **56** and **57** are used alternately, first for heating the mold, with steam as a heating medium, during the curing process, and then, upon the completion of the curing process, for cooling the same mold with water.

The mold is also provided with suitable means for holding the two halves **54** and **55** of the mold in a clamped position with respect to each other, such as plates **78** and **79** and bolts **80** and **81**. The upper half **54** of the mold is provided with a bore **82** and the lower half **55** of the mold is provided with a bore **83**. Bore **83** is connected to pipe **52** which is connected to the piston-cylinder combination **51–50** used for injecting the resinous mixture **84** into the spherical gap between core **38** and the walls **58** and **59** of the mold. High pressure is exerted on piston **51**, and resin **84** is then injected into the mold through pipe **52** and bore **83**. Bore **82**, in the upper half **54** of the mold, is connected to a pipe **85** which connects bore **82** to a sight gauge **86** and then through the pipe **87** to a vacuum pump **88**.

The operation of the mold illustrated in FIGS. 4 and 5 is as follows:

After a fully cured core **38** has been removed from mold **12–12*a***, and after this core has been imparted a true spherical shape in a lathe or a grinder, marked in the mercury bath, and recesses **74** and **73** are drilled at opposite poles, plug **75** is inserted into recess **74** and mandrel **68** is inserted into recess **73**. The ball is then mounted on top of the lower part **55** of the mold. Core **38** then is in concentric position with respect to the lower part **55** of the mold. This position of the mold and of the core is illustrated in FIG. 4. The next step consists

of placing the upper half 54 of the mold on top of the lower part and clamping the two together by means of bolts 80 and 81. The mold is then connected to vacuum pump 88 by opening valves 89 and 90. A manometer 91 is also connected to line 87 for indicating the degree of vacuum obtained through the entire transfer system. After proper vacuum has been reached, valve 92 is opened and resin 84 is injected into the mold by applying pressure to piston 51 whereupon resin 84 is transferred from cylinder 50 into the mold through pipe 52. The injection process is continued until resin 84 also appears in the sight gauge 86 which indicates that mold 53 has been properly filled with resin. Mandrel 68 is withdrawn from its position illustrated in FIG. 5 to the extent that its tip is flush with surfaces 60 and 61 of the mold after the mold has been filled with resin. Since the resin at this instant is at a relatively high pressure, the void formed by the withdrawal of mandrel 68 is immediately filled with resin. At this stage, valves 89 and 92 are closed, piston 51 is disconnected from the source of pressure, and mold 53 is then connected to a source of steam which is circulated through cavities 56 and 67 and steam ducts 91, 92, 93, and 94 illustrated in FIG. 4.

The curing process is carried out at the temperature apropos to the resin, hardener, flexibilizer, diluent, etc., present in the formulation. Hardness of the finished cover is not a direct function of the temperature but of the composition. Those skilled in the art readily know the correct temperature and time necessary to produce a proper cure in an epoxy formulation. For example, the formulation of the foregoing Example III was cured at about 300° F. for about 15 minutes.

After the curing period, the mold is cooled by circulating water through the mold for a period of approximately ten minutes and the mold then is allowed to cool for an additional thirty minutes, whereupon the mold is opened and the ball is removed from the mold. After the removal of the ball from the mold, it is further cooled by immersing it in water at room temperature for approximately 30 minutes.

After the ball is removed from the mold, and completely cooled, it is turned to its proper size in a lathe or a grinder and then subjected to a fine grind, engraving, buffing with wax, and the final polish.

Referring now to FIG. 6, it illustrates the method of making the core from chipped pieces of wood, or sawdust, or wood flour, or wood shavings, which are mixed with such synthetic resin glues as phenol formaldehyde, epoxy resins, polyester resins, melamine, urea formaldehyde, etc.

In order to produce a suitable core made of wood flour, the following proportions of wood flour, asbestos fiber and resin were found to produce a core capable of withstanding very severe impacts and have proper hardness, elasticity and density so as to produce a sixteen-pound ball with an epoxy resin cover.

(1) Wood flour (70 mesh Douglas fir), 60 parts by weight.

(2) Asbestos fibers, 20 parts by weight.

(3) Phenol formaldehyde, 20 parts by weight.

In the above composition, phenol formaldehyde may be replaced with an epoxy resin compounded with urea and melamine. The resins should be in a powdered form, rather than liquid, for proper mixing and subsequent handling of the mixture in the molds.

In making the cores, the ingredients, which are all in a powder form, are thoroughly intermixed prior to their introduction into the molds, or dies, illustrated in FIG. 6, and then preheated to a temperature of 150° F. The mold is also preheated to a temperature of 310° F. by circulating steam through the jackets of the mold. The preheated mixture is then dumped into a slightly convergent cylinder 601 in a stationary die member 602 which terminates in a slanted surface 603 and a horizontal surface 604, the latter interconnecting the cylinder with a concave hemispherical portion 605 of the die. In order to facilitate the introduction of the powder material into the lower die member 602, this member is also provided with a slanting surface 606 which acts as a funnel for the raw materials.

The matching member of the die assembly includes a hemispherical concave portion 607, a cylindrical member 608, or a piston 608, which is provided with a flat surface, or flange, or shoulder, 609, two slanting surfaces 610 and 611, and a ring-shaped surface 612 which interconnects the slanting surfaces 610 and 611. This die member is also preheated to 310° F. by using the circulating steam.

After a proper amount of raw materials has been introduced into the lower die member 602, the upper die member 608 is lowered into the converging portion 606–601 of the die with the result that the raw materials become compressed between the two dies, practically all of the material going into the two hemispherical concave portions 607 and 605 of the die members, and only a small amount being squeezed out sidewise, as is the case in pressure molding. A pressure of 10,000 pounds per square inch is used for compressing the flour. In order to obtain the desired density of the material, a compression ratio of approximately 4 to 1 is used, and this compression ratio can also be varied for obtaining the balls of desired weight.

After the upper die member has been completely lowered into the lower die member, the two die members are held in close position for approximately twenty minutes, at which time partial curing of the material takes place, with phenol formaldehyde or any other suitable synthetic resin binder being used for mechanically binding together the flour, binding the entire compressed mix into a very strong, solid, shock-resisting material. During this curing process, the die members 608 and 602 are kept at a temperature of 310° F. by means of circulating steam.

Such partial curing extends the curing reactions approximately through one inch of the outer crust. Accordingly, in order to obtain complete curing of the ball through its entire body, post curing is required and such post curing may extend over a period of many hours, such as three to eight hours. Post curing for three hours at 170° F. produces satisfactory post curing when the core is made of wood flour and phenol formaldehyde resin. The post curing is conducted in any suitable autoclave after the ball core is removed from the mold.

Accordingly, the partial curing that is conducted while the material is held in the compressed state by the two molds, is reduced to the irreducible minimum which is necessary in order to obtain a reasonably strong ball upon the conclusion of this preliminary curing, or a ball which can be handled quite safely while it is being taken out of the mold, put into an autoclave, etc. Moreover, it is also necessary to have at this stage that amount of preliminary curing which will enable the outer cured crust to hold together in the fully compressed state the uncured central portion of the material without bursting of the ball or undue warpage or expansion in diameter of the ball. All of the above is accomplished with the twenty-minute curing time within the mold.

Other modes of applying the principle of the invention may be employed, provided the features stated in any of the following claims or the equivalent of such be employed.

We, therefore, particularly point out and distinctly claim as our invention:

1. A bowling ball of spherical shape comprising a core and a hard, molded and cured epoxy resin cover in adhesive relationship to said core.

2. A bowling ball of spherical shape comprising a core having at least the outer surface of hard rubber and a surrounding cover of cured and hardened epoxy resin in direct, firmly adhesive contact with said rubber.

3. A bowling ball of claim **2** in which said epoxy resin has an epoxide equivalent weight of from 170 to 400 prior to curing.

4. A bowling ball of claim **2** in which said core includes a center portion of compressed wood particles, and an outer layer of hard rubber.

5. A bowling ball of spherical shape comprising a core having at least the outer surface of fully cured hard rubber and a surrounding cover of cured and hardened epoxy resin in direct firmly adhesive contact with said rubber.

6. The bowling ball of claim **1** in which said core is of molded wood.

7. The bowling ball of claim **1** in which said core is of molded wood including wood flour, asbestos fiber and a resinous binder.

8. A bowling ball of spherical shape having a molded hard rubber core and an epoxy-resin cover applied over said core.

9. A bowling ball of spherical shape having a molded composite hard rubber and cork inner core, an intermediate hard rubber shell, and an epoxy-resin cover applied over said intermediate shell.

10. A bowling ball of spherical shape comprising at least one core and an epoxy-resin cover contiguous therewith and completely enveloping said core, said epoxy-resin prior to curing, having an epoxide equivalent weight of from about 170 to about 400.

11. A bowling ball of spherical shape comprising a molded wood core and a cured epoxy-resin cover contiguous thereto and in adhesive relationship therewith and completely enveloping said core, said epoxy-resin prior to curing, having an epoxide equivalent weight of from about 170 to about 400, and said core consisting essentially of finely divided wood, inorganic fibers and a resinous binder.

12. A bowling ball of spherical shape comprising at least one core and a cured epoxy-resin cover contiguous therewith and completely enveloping said core, said epoxy-resin cover consisting essentially of the cured reaction product of an epoxy resin having an epoxide equivalent weight of from about 170 to about 400, from about 2 to about 20 parts per hundred parts of resin of a standard reactive diluent, from about 5 to about 70 parts per hundred parts of resin of filler, from about 3 to about 100 parts per hundred parts of an epoxy curing agent, from about 0 to about 100 parts per hundred parts of resin of a flexibilizer and from about 0 to about 20 parts per hundred parts of resin of pigment.

13. The bowling ball of claim **12** having a molded and cured core consisting, prior to curing, essentially of finely divided wood, inorganic fiber and a resinous binder.

14. The bowling ball of claim **12** have a molded cured core consisting essentially of hard rubber.

15. The bowling ball of claim **12**, having a molded cured core consisting essentially of hard rubber and cork.

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