A metal bat in which the performance characteristics of an impact of the metal bat with a baseball are the same as or substantially the same as the performance characteristics of a wood bat impacting a baseball. The construction of the metal bat dampens the resilience of the metal bat barrel and reduces the trampoline effect of the bat when impacting the baseball to reduce the exit velocity of the baseball at impact. In addition, the bat speed at the point of impact with a baseball can be decreased by increasing the weight of the bat, preferably at its outer end and adjusting the balance point of the bat toward the outer end.
METAL BASEBALL BAT WITH WOOD BAT PERFORMANCE CHARACTERISTICS

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to developments in baseball bats and more particularly to the construction of a metal baseball bat in which the impact with a baseball is the same as or closer to the ball exit velocity of a wood baseball bat impacting a baseball. The construction of the metal baseball bat of this invention dampens or reduces the trampoline effect of the bat when impacting the baseball and/or decreases bat speed at the point of impact with a baseball by custom designing the bat to impart a prescribed ball exit velocity at impact.

[0003] 2. Description of the Prior Art

[0004] Metal baseball bats have been used extensively in lieu of wood bats in view of the many advantages that a metal bat has as compared to a wood bat. While wood bats are used exclusively in most professional baseball leagues, hollow metal bats have been accepted for use in various nonprofessional baseball leagues, organizations and the like. Metal bats have been used for a number of years by college teams, high school teams, little league teams and various other subprofessional baseball teams.

[0005] In recent developments, metal baseball bats have been provided with improved structural details which have resulted in substantially increased exit velocity of the baseball from the baseball bat upon impacting a pitched baseball with a metal bat. These developments in improving the performance of metal baseball bats have included, for example, reducing the weight of the bat, increasing the diameter of the bat barrel to 2.750 inches in outside diameter, and increasing the trampoline effect by changing the wall thickness and utilizing different materials and placing inserts in the hollow interior. These improvements have resulted in the batted ball traveling at a higher exit velocity and in a longer distance of flight after leaving the bat.

[0006] As a result of the higher exit velocity of the baseball when impacted by a metal bat, the pitcher and fielders have less time to react to the trajectory of the baseball. Pitchers are extremely vulnerable to being hit by a high exit velocity baseball impacted by a metal bat inasmuch as the pitcher is only about sixty feet away from the batter and possibly less than sixty feet depending upon the characteristics of the pitching motion and follow through when delivering a pitch to the batter. The higher exit velocity of the baseball when struck by a metal bat subjects the pitcher to possible injury since the higher exit speed and velocity of the batted ball reduces the time in which a pitcher can react to place the glove in a defensive position in the path of movement of the baseball. Other infielders are similarly subject to the possible dangers of baseballs hit at high exit velocities.

[0007] The following U.S. patents relate to developments in baseball bat constructions:

| Patent Number | Date | Invention
<table>
<thead>
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<tr>
<td>5,727,295</td>
<td>Aug. 16, 2001</td>
<td>disclosed some of the baseball bat structures that have been developed to enhance impact with the baseball including construction of the bat having a maximum diameter of 2.750 inches and unique end caps and weight loads. U.S. Pat. No. 5,114,144 and others disclose a composite baseball bat including a central core having an outer layer of wood veneer impregnated with a resin retaining the core and veneer in assembled relation.</td>
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<tr>
<td>5,114,144</td>
<td>Aug. 16, 2001</td>
<td>While hollow metal bats of aluminum and various other metals and metal alloys are well known and composite bats with a core and external wood veneer are well known as are larger diameter bat barrels, the prior art does not disclose a metal baseball bat which is custom designed to have wood bat performance characteristics, particularly one providing the same or closer to the same ball exit velocity as a wood bat in accordance with the present invention.</td>
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SUMMARY OF THE INVENTION

[0010] In recognition of the potential for injury due to recent developments in metal baseball bats and the tendency for increased hits and runs occurring, regulatory agencies which formulate rules of play have become increasingly concerned about the potential of injury arising from use of high performance metal baseball bats. The regulatory agencies have also expressed the desire to return the incidence of hits, home runs and the like in baseball to a more competitive status resulting from less baseball games in which a higher number of runs are scored. The regulatory agencies also desire to make the game of baseball as safe as possible for the players.

[0011] Accordingly, it is the object of the present invention to construct a metal baseball bat which has structural characteristics to impact the baseball closer to the performance characteristics of a wood bat. In testing high quality wood bats with comparable metal bats, it was surprisingly found that a metal bat with appropriate modifications could be made to have the same, or closer to the same, performance characteristics as a wood bat. When tested on a dynamic hitting machine, such as the Baum bat testing machine, it was discovered that a metal bat swung at 72 miles per hour (mph) at the 5 inch point measured from the barrel end to impact a baseball also traveling at the same 72 mph speed should produce a ball exit velocity of 90-94 mph, or preferably 93 mph. At such ball exit velocity, the metal baseball bat exhibits the same or closer to the same performance characteristics as a baseball bat made from high quality wood. Therefore, the metal baseball bat of the present invention should be adjusted to produce a ball exit velocity, preferably, of 90-94 mph. However, under certain circumstances, the metal baseball bat of this invention can be adjusted to produce a ball exit velocity as high as 98 mph.

[0012] To test a metal baseball bat on a dynamic hitting machine in accordance with this invention, the input target
speeds for bat swing speed and for ball speed are each set at 72 mph, with a 1 mph deviance for test variance. Raw data exit velocities are recorded at four (4) impact test locations on the bat (measured from the barrel end) at 4 inches, 5 inches, 6 inches and 7 inches. Five exit velocity readings at triangle-node sites (three equidistant locations around the circumferences of the bat) are to be recorded at each of the four impact locations. The Wilson A1001NCWA Championship baseball and/or the Diamond D1 Collegiate baseball should be used for the test. The ball shall have a maximum weight of 5.10±0.05 ounces. The maximum circumference of the ball shall be 9.25±0.10 inches. The coefficient of restitution shall be between 0.525 and 0.555 and conducted to ASTM specifications. Before the testing procedure, the baseballs should be stored for 48 hours at a room temperature of 75±30°F. A relative humidity of 65±5%. The testing on the dynamic hitting machine should be conducted in a testing lab or room also maintained at a temperature of 75±30°F and a relative humidity of 65±5%. The ball exit velocity must match the designated velocity in mph, with a 1 mph deviation for test variance, at each of the four impact locations.

[0013] Hence, at the preferred 93 mph ball exit velocity, the ball exit velocity of the metal baseball bat under test must not exceed 93±1 mph at any of the four impact locations, i.e. cannot exceed a maximum of 94 mph. The foregoing test procedures are hereinafter referred to as the "72×72 test".

[0014] In order to achieve a metal baseball bat which will produce the requisite ball exit velocity of 90-98 mph in the 72×72 test, it was discovered that the metal bat barrel should preferably be dampened. Therefore, in accordance with the present invention, such dampening can be accomplished by a number of ways to achieve a 90-98 mph, preferably a 93±1 mph, ball exit velocity under the 72×72 test, including without limitation, filling the interior of the metal baseball bat barrel with pieces of compressible "Styrofoam" expanded plastic or rubber material in the form of blocks or balls or with an expanding foam material or with an inflatable bladder or by thickening the bat barrel wall or by lining the interior of the barrel wall with a mechanical device such as a sleeve or metal spiral or the like.

[0015] Further, in accordance with the present invention, the bat barrel size of the metal baseball bat is reduced to a maximum of 2.625 inches in order to correspond to wood bats, which size reduction also results in a reduction of high exit speed baseballs hit by the bat.

[0016] In addition, in order to provide a metal baseball bat having wood bat performance characteristics, the metal baseball bat according to the present invention has a minimum weight in ounces that is approximately three less than the length of the bat in inches; for example, a 33 inch length bat will have a weight of at least approximately 30 ounces. This weight is without the handle grip wrap.

[0017] Furthermore, it has been discovered that a metal baseball bat can approximate the performance characteristics of a high quality wood bat if the weight and balance point of the bat are moved forward away from the handle in order to decrease the bat speed. The present invention preferably moves this balance point to at least approximately 21 ½ inches from the end of the knob end of the bat.

[0018] It is, therefore, a further object of this invention to provide a metal baseball bat in which the trampoline effect is reduced by varying the wall thickness of the hollow bat, filling the bat barrel with blocks of "Styrofoam" expanded plastic material or expanded foam material or positioning an internal inflatable bladder in the hollow bat barrel or by lining the interior of the barrel wall with a mechanical device or sleeve.

[0019] Still another object of the invention is to construct a metal bat having wood bat performance characteristics in which the weight and balance point of the bat are varied to decrease the bat speed and thus the exit velocity of a baseball when impacted with the bat.

[0020] Thus, the metal bat of this invention reduces the exit velocity of a batted ball to preferably about 93 mph under the 72×72 test, but in the range of 90-98 mph. This exit velocity compares with existing metal bats in which the exit speeds are frequently approximately 105 mph or more. This reduction in exit velocity provides additional time for the pitcher and other fielders to react and move his/her glove to a defensive position.

[0021] These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully herein-after described and claimed, reference being had to the accompanying drawings forming part hereof, wherein like numerals refer to like parts throughout.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] FIG. 1 is a side elevational view of a metal baseball bat constructed in accordance with the present invention.

[0023] FIG. 2 is a schematic plan view of the bat illustrating the impact with a baseball and the balance points of a wood baseball bat, a conventional metal baseball bat and a metal baseball bat constructed in accordance with the present invention.

[0024] FIG. 3 is a schematic plan view of a metal baseball bat constructed in accordance with the present invention illustrating the effect of added weight to the rotational speed of the bat.

[0025] FIG. 4 is a fragmented sectional view of the end of the bat barrel of a metal bat constructed in accordance with the present invention illustrating an end cap with added weight incorporated therein.

[0026] FIG. 5 is a sectional view of the hollow bat barrel of a metal bat constructed in accordance with the present invention illustrating an inflated bladder extending throughout at least the approximate length of the bat barrel.

[0027] FIG. 6 is a sectional view of the hollow bat barrel of a metal bat constructed in accordance with the present invention in which a plurality of "Styrofoam" blocks fill the interior of the bat at least throughout the approximate length of the bat barrel.

[0028] FIG. 7 is a sectional view similar to FIG. 6 illustrating a foam plastic material foamed in situ or otherwise placed within at least the approximate length of the bat barrel.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0029] Although several preferred embodiments of the invention are explained in detail, it is to be understood that
the invention is not limited in its scope to the details of construction and arrangement of components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments and of being practiced or carried out in various ways. Also, in describing the preferred embodiments, specific terminology will be resorted to for the sake of clarity. It is to be understood that each specific term includes all technical equivalents which operate in a similar manner to accomplish a similar purpose.

[0030] The metal baseball bat of the present invention is illustrated in FIG. 1 of the drawings and is generally designated by reference numeral 10. Bat 10 includes a hollow tubular metal bat barrel 12, a handle or hand grip area 14 with a spiral wrapping thereon and a knob 16 on the handle end of the bat. The barrel end 17 of the bat 10 is preferably provided with an end cap 18. This basic structure is that which is found in conventional and existing metal baseball bats.

[0031] One of the structural features of the metal baseball bat 10 of this invention is the reduction in diameter of the bat barrel 12 to a maximum of 2.625 inches to conform to the diameter of the larger wood bats. This reduction in bat barrel size from a previous maximum of 2.750 inches reduces the diameter of the hitting area of the bat and decreases the number of baseballs that are effectively hit by the bat.

[0032] FIG. 2 is a schematic illustration of a typical baseball bat illustrating a baseball 20 impacted by the bat with the ball 20 moving in a trajectory indicated by arrow 22. The balance point of a conventional metal bat is designated by reference numeral 24. The balance point of a conventional wood bat is designated by reference numeral 26. The balance point of the metal bat of the present invention is designated by reference numeral 28 which is closer to the balance point 26 of a wood bat. As indicated, the balance point of the metal baseball bat of this invention is closer to the end cap and spaced further from the knob 16 as compared to the balance point 24 of a conventional metal baseball bat. More specifically, it has been found that a balance point for a metal baseball bat which is at least about 21 1/2 inches from the knob end of the bat provides performance characteristics more like a wood bat. Further, in accordance with this invention, the balance point can be custom designed in the metal bat between about 20 1/2 to about 22 1/2 inches from the knob end of the bat. Thus, with the balance point 28 being further from the handle 14 and knob 16, a batter 30 will have a slower bat speed in view of the increase in the lever arm between the balance point 28 and the hands 32 gripping the handle 14, assuming no change in the weight of the bat.

[0033] FIG. 3 is another schematic illustration of the metal baseball bat of the present invention in which arrow 34 indicates a weight oriented toward the end of the bat barrel 38 with the ball being designated by reference numeral 40 and the trajectory being designated by reference numeral 42. The weight added toward the end of the bat barrel results in a slower bat speed inasmuch as the batter 44 must exert additional force on the handle 14 in order to swing the bat barrel at a predetermined bat speed. This compares to conventional metal bats which have a lighter weight for a given length, for example, a 33 inch bat having a total weight of 28 ounces. In accordance with the present invention, the metal baseball bat must have a weight in ounces of only approximately three less than the length of the bat in inches. For example, a 33 inch bat must have a weight of at least about 30 ounces without grip. The end cap 36 can have weight added if necessary to move the balance point toward the barrel end 17 of the bat.

[0034] FIG. 4 is a fragmental sectional view of a hollow bat barrel 50 having an end cap 52 mounted thereon in a manner disclosed in the prior art. The end cap 52 includes a cylindrical extension 54 having a groove 56 therein which receives an internal rib 58 formed in the inner surface of the end of the bat barrel 50. The inner surface of the bat barrel 50 also includes a shallow groove 60 receiving a reduced diameter portion 62 of the cylindrical sleeve. This structure is a well known end cap and bat barrel construction. Also, the interior of the end cap 52 includes a plurality of a radially extending reinforcements 64 having concavely curved inner edges 66, also as known in the prior art.

[0035] An additional weight 68 of dense material such as polyurethane or the like fills the interior void space of the end cap 52 and projects slightly beyond the inner end of the cylindrical extension 54 on the end cap. The actual volume and weight of the added weight material 68 may vary to provide a desirable shift in the balance point of the hollow metal bat and also to adjust the actual total weight of the bat and barrel. The change in the balance point to move it outwardly from the handle of the bat increases the force necessary to propel the bat barrel at a predetermined bat speed. Likewise, the added total weight at the end of the bat barrel also requires additional force to propel the bat barrel at a predetermined bat speed. Thus, the addition of an added weight 68 to the interior of the end cap or to the interior of the end of the bat barrel results in a slower bat speed as compared to conventional metal bats which include an end cap but do not include additional weight. The configuration of the end cap and the manner of connecting the end cap to the end of the bat barrel may vary depending on the choice of the manufacturer. Further, the weighted material 68 can extend into and engage the inner surface 63 of the bat barrel 50 so as to assist in holding the end cap 52 in place. The added weight material 68 may also vary as to density and total weight in order to obtain the desired maximum bat speed. More specifically, the weighting and balance point will result in a reduced exit velocity of a baseball when impacted by the metal bat of the present invention so that the exit velocity of the baseball will be 90-95 mph, preferably 93±1 mph, when tested in the 72±72 test.

[0036] FIG. 5 illustrates a hollow metal bat barrel which includes an end cap 72 having a reduced weight 74 incorporated therein in the same manner as disclosed in FIG. 4. Positioned internally of the bat barrel is an inflated bladder 76 of resilient flexible material having an inflation valve or other device 78 adjacent the end cap. The bladder 76 directly engages the internal surface of the bat barrel from the end cap down towards the handle of the bat and extends at least throughout the length of the bat barrel. When the bladder is inflated to relatively low pressures, it will exert a force radially outwardly in relation to the wall of the bat barrel which tends to resist inward deformation of the wall of the bat barrel when the bat is impacted with a baseball. This is in contrast to current high performance inflated bladder bats where the internal bladder is under relatively high pressure, and the bladder in effect increases the trampoline effect of the metal bat barrel wall. It has been found that bladders
inflated to pressures up to only about 15 pounds per square inch (above atmospheric pressure) (psi) will increase the resistance to inward deformation of the wall of the bat barrel by an impact with a baseball, thus causing a dampening of the trampoline effect. Preferably, the internal bladder should be pressurized to 8-15 psi, obviously, any known bladder design, construction and inflating gas could be used in accordance with this invention, as well as a plurality of bladders laid end-to-end, or even side-by-side.

[0037] The forces exerted on a baseball when impacted by a metal bat in accordance with the construction illustrated in FIG. 5 reduces the exit velocity of the baseball so that it does not exceed 94 mph, when tested under the 72x72 test.

[0038] The inflated bladder 76 as illustrated in FIG. 5 may be used with an end cap having an added weight or an end cap having no added weight. Also, the configuration and manner of mounting the end cap may vary as well as the pressure inside the bladder, as both previously described. The bladder, when used with a conventional end cap without added weight, reduces the exit velocity of an impacted baseball by reducing the trampoline effect. When an end cap with an added weight is utilized with the internal bladder, the added weight, the changes in the balance point and the reduction in trampoline effect are combined to reduce exit velocity of a baseball impacted by the bat to the prescribed exit velocity.

[0039] FIG. 6 illustrates a bat barrel 80 having a conventional end cap 82 which closes off the bat barrel end 84. A hardenable material 86 fills the end cap 82 and the end of the bat barrel opening 84. The closure material thus forms a weighted end of polyurethane or other weighted material and the volume, and thus the weight, of the material 86 may be varied. FIG. 6 illustrates inserted material 88 filling the bat barrel 80 from the closure material 86 to the handle area and at least throughout the length of the bat barrel. The inserted material 88 is preferably in the form of a plurality of blocks or balls of expanded foam plastic or foam rubber material, such as “Styrofoam”, which is either in a sponge-like or rigid form and can be shoved inwardly from the open end of the bat barrel before final closure of the end of the bat barrel with end cap 82. The blocks of foam plastic or other material are compressed axially inwardly directly against the interior surface of the bat, and exert an outward force on the interior surface of the bat barrel wall. This outward force functions to resist inward deformation on the wall of the bat barrel, thereby reducing the trampoline effect of the bat barrel wall, when impacting a baseball.

[0041] FIG. 7 illustrates a bat barrel 90 having a slightly different but known barrel end structure. The barrel has an inturned end 92 which defines a central opening 94. A closure material 96 in the form of a closure plug is provided for closing the opening 94 with the closure material 96 being varied in volume and weight to obtain a desired weight to length ratio for the bat. The interior of the bat barrel is provided with an expanded plastic material 98 which is in direct contact with the interior wall of the bat barrel and is expanded in situ to fill the interior of the bat at least throughout the length of the bat barrel. The expanded plastic material will resist inward deformation of the bat wall thereby reducing the trampoline effect in a manner similar to the structures illustrated in FIGS. 5 and 6. The resistance to deformation of a bat barrel wall reduces the trampoline effect caused by a return of the deformed bat barrel wall to its original position thereby reducing the exit velocity of a baseball impacted by the bat barrel 90. This construction allows the bat speed to be controlled by adjusting the volume and weight of the closure plug and by using the foamed in situ expanded plastic material 98 to adjust the weight and balance point of the bat and to reduce the trampoline effect by resisting deformation of the bat barrel wall.

[0042] The metal bat barrel of the present invention can be made from any conventional metal baseball bat material, such as aluminum and aluminum alloys, titanium and titanium alloys, or any other material that will provide a solid bat barrel wall and can be made to the total weight of three ounces less than the length in inches of the bat, without the grip wrap, and with a balance point more than about 21 inches from the knob end, and can produce a ball exit velocity of 90-98 mph under the 72x72 test.

[0043] The wall thickness of the metal bat barrel of the present invention may also be uniformly thickened in order to dampen the trampoline effect of the bat barrel wall. More specifically, current standards for wall thickness of metal baseball bats vary the wall thickness from 0.80 to 0.120 inches. In accordance with this invention, the wall thickness of the bat barrel can be increased by about 0.005 inches to about 0.120 inches in order to achieve the damping characteristics of the present invention. While it is preferable to increase the wall thickness throughout the length of the bat, from the top of the knob 16 to the open end 17, the thickness can be confined to the hitting area of the bat, i.e. from the top of the transition zone to the open end 17.

[0044] Further, an increase in the wall thickness can be combined with other mechanisms for damping the metal bat barrel and its trampoline effect, such as by filling the interior of the bat barrel with compressible blocks or balls, with an expanding foam material or with an inflatable bladder, as disclosed in this application. The resultant effect, of course, is to custom design the metal baseball bat to produce the requisite ball exit velocity of 90-94 mph under the 72x72 test and which exhibits performance characteristics which are the same as or closer to the performance characteristics of a baseball bat made from high quality wood.

[0045] The bat barrel diameter in accordance with the present invention is a maximum of 2.625 inches but may be
smaller, such as 2.400 inches. Wall thickness of the bat should be a maximum of 0.160 inches and at or above 0.115 inches. In 72x72 tests comparing the metal bat of this invention with conventional wood bats, a metal bat constructed and in accordance with the present invention obtained approximately the same exit velocity for the baseball as the wood bat. In effect, the metal bat of this invention reduced the ball exit speed and reduced the trampoline effect of the bat barrel wall. One prototype metal bat that tested to the above performance characteristics was constructed of CU 51 alloy. The prototype bat included an external major diameter of 2.625 inches, a length of about 33 inches, a weight of about 30 ounces, a wall thickness of about 0.120 inches, a balance point of about 21.25 inches from the knob end. This bat was comparatively tested with a conventional wood bat having the same dimensions and an existing aluminum bat having a 2.750 diameter, a 33 to 28 length/weight ratio and a balance point of 20.625 inches from the knob end. The metal bat constructed in accordance with the present invention resulted in an exit velocity of an impacted baseball very close to the exit velocity obtained by using a wood bat and substantially less than the exit velocity resulting from an existing 2.750 inch diameter metal bat.

[0046] The metal baseball bat of the present invention should meet the following specifications. First, the length of the bat in inches shall not be more than 3 units greater than the weight of the bat in ounces, without the grip wrap. Second, the bat barrel diameter shall be no greater than 2.625 inches. A certified bat ring (no more than a 1/4 inch thick) with an interior diameter of 2.635 inches must pass completely over the length of the bat. Third, the center of gravity, or balance point, of the bat must be at least 21.5 inches as measured from the end of the bat at the knob end. The ball exit velocity under the 72x72 test must not exceed 93±1 mph.

[0047] The foregoing description should be considered as illustrative only of the principles of the invention. Since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and, accordingly, all suitable modifications and equivalents may be resorted to, falling within the scope of the invention.

What is claimed is as new is as follows:

1. A metal baseball bat comprising a hollow metal bat barrel tapering from an outer barrel end to a reduced diameter handle at a knob end, a closure for the outer barrel end of said barrel, said hollow metal bat barrel having a generally cylindrical barrel wall defining an interior barrel surface, said barrel wall having a resistance to deformation and a resistance to trampoline effect upon ball impact, and mechanical means in direct contact with said interior barrel surface to increase said resistance to deformation and decrease said trampoline effect of said bat barrel when impacted by a baseball.

2. The metal bat as defined in claim 1, wherein the increase in said resistance to deformation and decrease in said trampoline effect of said bat barrel reduces the velocity of a baseball impacted by said baseball.

3. The metal baseball bat as defined in claim 1, wherein said mechanical means reduces the ball exit velocity of a baseball impacted by said metal bat to 90-98 mph when said bat is moving at 72 mph and said ball is moving at 72 mph.

4. The metal baseball bat as defined in claim 3, wherein said ball exit velocity is about 93 mph.

5. The metal baseball bat as defined in claim 1, wherein said outer barrel barrel end includes weight material shifting the balance point of said metal baseball bat to about 65% of the length of the bat from said knob end.

6. The metal bat as defined in claim 1, wherein said means comprises a plurality of foam plastic blocks forced into an open end of the bat barrel to completely fill the bat barrel and resist inward deformation of the bat barrel wall when impacted with a baseball thereby reducing the trampoline effect of the bat barrel wall and reducing exit velocity of a baseball impacted by the wall of the bat barrel.

7. The metal bat as defined in claim 1, wherein said means comprises an expanded plastic foam material substantially completely filling the bat barrel, said plastic being foam in situ and resisting deformation of the bat barrel wall when impacting a baseball to obtain an exit velocity of a baseball impacted by the metal bat barrel to a speed substantially equal to the exit speed of a baseball impacted by a wood bat.

8. The metal bat as defined in claim 1, wherein said means comprises an inflated bladder extending substantially throughout the length of the bat barrel and engaging the internal surface thereof to reduce inward deformation of the bat barrel upon impact with a baseball thereby reducing the trampoline effect.

9. The metal bat as defined in claim 1, wherein said closure for the outer end of the bat barrel includes a weight to provide a length to weight ratio in which the weight in ounces without grip is at least three less than the length in inches to shift the balance point of the bat to a position on the metal bat barrel to substantially coincide with the position of the center of gravity of a wood bat.

10. The metal bat as defined in claim 9, wherein said closure for the outer end of the bat barrel includes an end cap having a cylindrical portion telescoped into the end of the bat barrel, said bat barrel and cylindrical portion of the end cap including a rib and groove engaging surfaces, said cylindrical portion of the end cap defining a cavity filled with an added weight to locate the balance point of the metal bat to a position on the bat barrel more than 21 inches from the end of knob.

11. The metal bat as defined in claim 6, wherein said closure for the outer end of the bat barrel includes an interrupted end on the bat barrel terminating in an opening in the outer end of the bat barrel, a closure plug of resilient material closing the opening extending peripherally of the end turned end of the bat barrel, said closure plug being constructed of weighted material to position the balance point on the metal barrel barrel in substantially the same position as a balance point on a wood bat barrel.

12. A metal baseball bat comprising a hollow metal bat barrel tapering from an outer barrel barrel end to a reduced diameter handle at a knob end, a closure for the outer barrel end of said barrel, said outer barrel metal bat barrel having a generally cylindrical barrel wall and defining a ball hitting zone, said cylindrical barrel wall uniformly thickened in said ball hitting zone by about 0.005 inches to about 0.120 inches in order to resist deformation of said trampoline effect of said bat barrel wall upon ball impact, said bat having an adjusted balance point more than about 21 inches from said knob end.

13. The metal bat as defined in claim 12, and further including a mechanical means in direct contact with an
interior surface of said bat barrel in said hitting zone to further increase said resistance to deformation and trampoline effect.

14. The metal bat as defined in claim 13, wherein said wall thickness and said mechanical means reduce the ball exit velocity of a baseball impacted by said metal bat to 90-98 mph when said bat is moving at 72 mph and said ball is moving at 72 mph.

15. The metal bat as defined in claim 14, wherein said ball exit velocity is about 93 mph.

16. The metal bat as defined in claim 12, wherein said hollow metal bat barrel has a barrel wall uniformly thickened throughout its length.

17. The metal bat as defined in claim 13, wherein said mechanical means comprises a plurality of foam plastic blocks forced into an open end of the bat barrel to completely fill the bat barrel and resist inward deformation of the bat barrel wall when impacted with a baseball thereby reducing the trampoline effect of the bat barrel wall and reducing exit velocity of a baseball impacted by the wall of the bat barrel.

18. The metal bat as defined in claim 13, wherein said mechanical means comprises an expanded plastic foam material substantially completely filling the bat barrel, said plastic being foamed in situ and resisting deformation of the bat barrel wall when impacting a baseball to obtain an exit velocity of a baseball impacted by the metal bat barrel to a speed substantially equal to the exit speed of a baseball impacted by a wood bat.

19. The metal bat as defined in claim 13, wherein said mechanical means comprises an inflated bladder extending substantially throughout the length of the bat barrel and engaging the internal surface thereof to reduce inward deformation of the bat barrel upon impact with a baseball thereby reducing the trampoline effect.

20. The metal bat as defined in claim 1, wherein the length of the bat in inches is not more than 3 units greater than the weight of the bat in ounces, without a grip wrap, said bat barrel having a diameter no greater than 2.625 inches, and said bat having a balance point at least 21.5 inches from said knob end and the ball exit velocity under a 72x72 test no greater than 93±1 mph.

21. A method for custom designing a metal bat to have performance characteristics closer to a wood bat, said bat having a hollow metal bat barrel tapering from an outer barrel end to a reduced diameter handle at a knob end, said outer metal bat barrel having a generally cylindrical barrel wall and defining a ball hitting zone, which comprises selecting said hollow metal bat barrel to have a length in inches no more than 3 units greater than a weight in ounces of said bat and being no greater than 2.625 inches in diameter throughout its length, dampening said generally cylindrical barrel wall in said ball hitting zone to increase resistance to deformation and decrease trampoline effect of said barrel wall and adjusting the center of gravity away from said knob end at least about 21.5 inches from said knob end.

22. The method of claim 21, wherein said dampening reduces the ball exit velocity of a baseball impacted by said metal bat to 90-98 mph when said bat is moving at 72 mph and said ball is moving at 72 mph.

23. The metal baseball bat as defined in claim 1, wherein said mechanical means comprises a sleeve which cooperates with said bat barrel wall to increase said resistance to deformation and decrease said trampoline effect.

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