

July 28, 1970

3,521,616

RICHARD SHIH-TENG CHANG ET AL
TOY GUN WITH MEANS FOR CONTROLLING THE TRAJECTORY
OF ITS PROJECTILE

Filed June 28, 1968

3 Sheets-Sheet 1

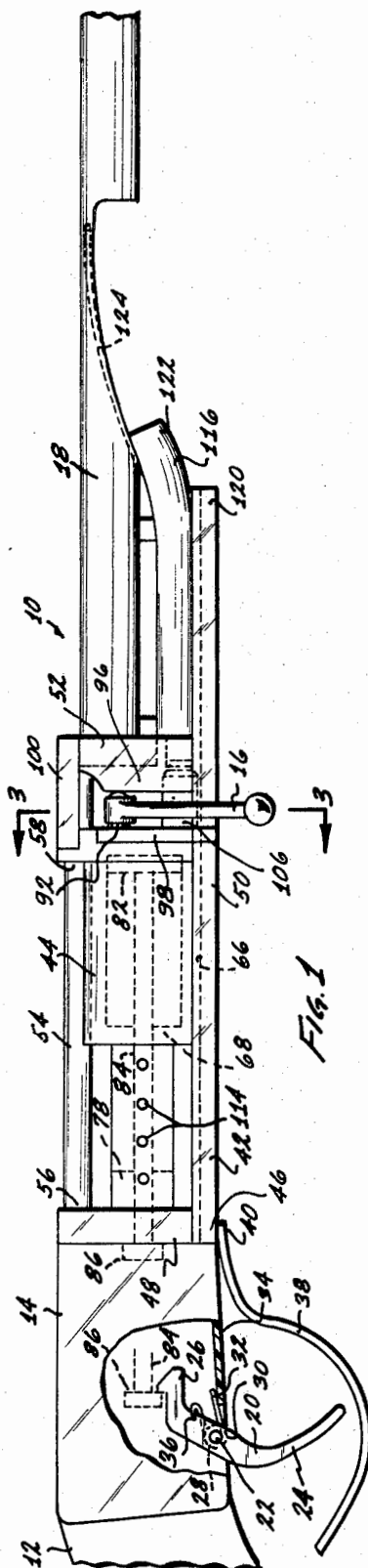


Fig. 1

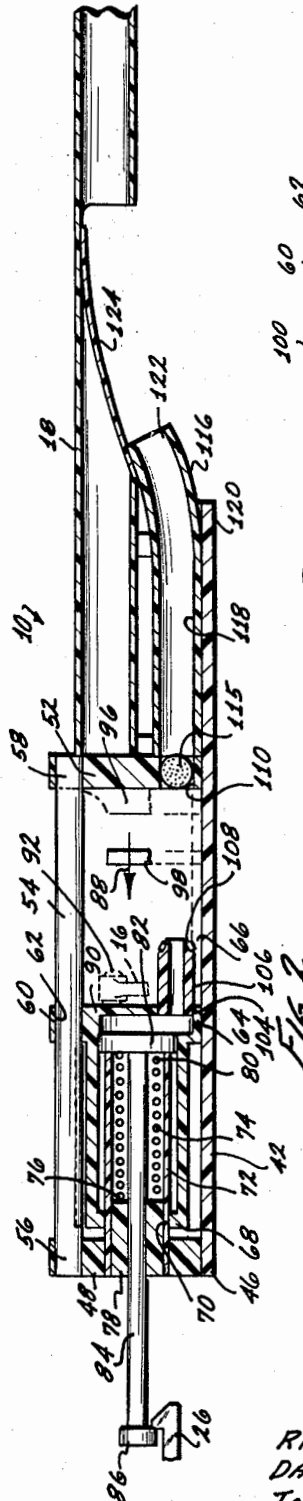


Fig. 2

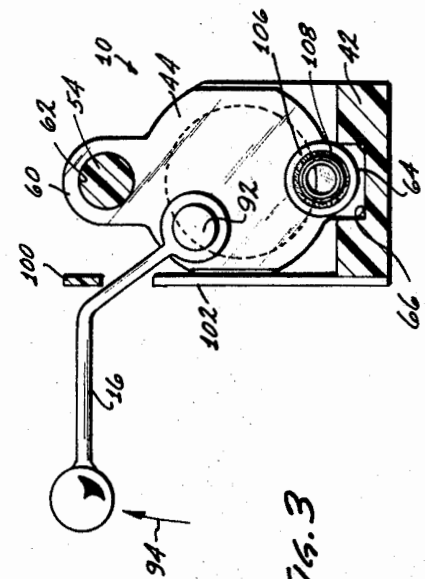


Fig. 3

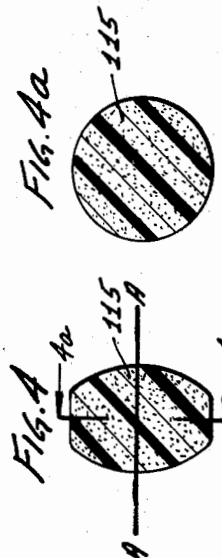
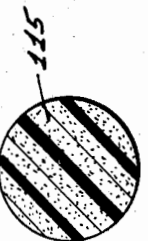


Fig. 4a



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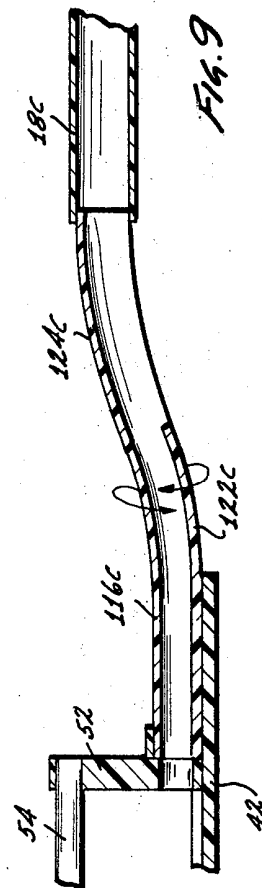
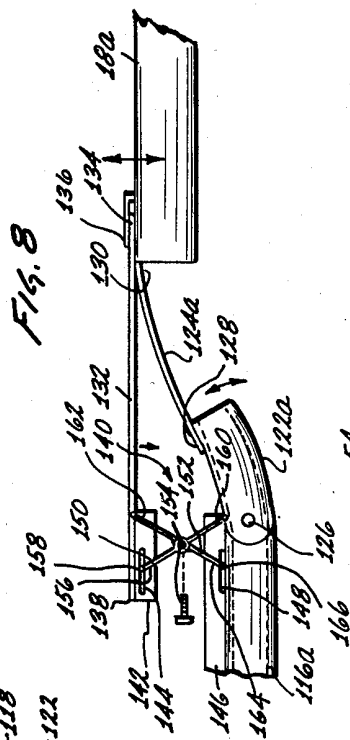
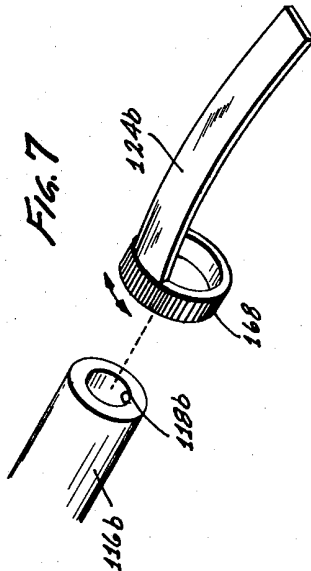
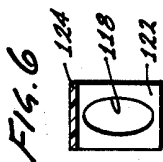
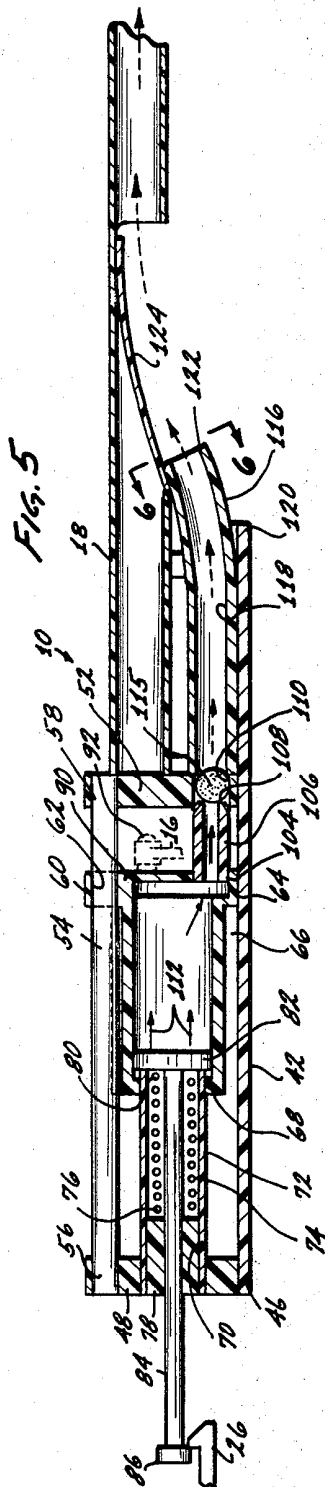
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3 Sheets-Sheet 2

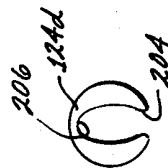


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TOY GUN WITH MEANS FOR CONTROLLING THE TRAJECTORY OF ITS PROJECTILE

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7 Claims

ABSTRACT OF THE DISCLOSURE

A low-density projectile is given an improved trajectory by providing means in a gun toy for spinning the projectile about an axis forming an angle with the initial direction of flight of said projectile.

BACKGROUND OF THE INVENTION

The background of the invention will be set forth in two parts.

FIELD OF THE INVENTION

The invention pertains generally to the field of toy guns and more particularly to such a gun which includes means for controlling the trajectory of a projectile by spinning the projectile about an axis forming an angle with the initial direction of flight of the projectile.

DESCRIPTION OF THE PRIOR ART

Projectile-firing gun toys are known. Such toys have the disadvantage that the projectiles usually have sufficient mass and density to be painful to a child when struck by a projectile fired from such a gun toy.

It is recognized that low-density, light-weight projectiles would minimize injury to a child. The disadvantage with such projectiles, on the other hand, resides in the fact that they have an unsatisfactory trajectory and rapidly fall to the ground when fired from a gun.

SUMMARY OF THE INVENTION

In view of the foregoing factors and conditions characteristic of gun toys, it is a primary object of the present invention to provide a new and useful gun toy not subject to the disadvantages enumerated above and having means for controlling the trajectory of a projectile efficiently, safely and expeditiously.

Another object of the present invention is to provide a new and useful gun toy of the type described having means for spinning a projectile about an axis forming an angle with the initial direction of flight of the projectile.

Yet another object of the present invention is to provide a new and useful gun toy especially designed for firing low-density, light-weight projectiles.

According to the present invention, a projectile-firing gun toy is provided with means for controlling the trajectory of a projectile including means for spinning the projectile about an axis forming an angle with the initial direction of flight of the projectile. A low-density, light-weight projectile is employed and generates a force normal to flight path by spinning. If the magnitude and direction of this force is made to be equal and opposite to the gravitational force, it will prevent the projectile from dropping to the ground too quickly after being fired.

The projectile is given a "reverse" spin about an axis normal to the trajectory by bringing the projectile into engagement with a curved surface having a predetermined curvature as the projectile is forced from a chamber by air pressure.

The features of the present invention which are believed to be novel are set forth with particularity in the

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appended claims. The present invention, both as to its organization and manner of operation, together with further objects and advantages thereof, may best be understood by reference to the following description, taken in connection with the accompanying drawings in which like reference characters refer to like elements in the several views.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial, side-elevational view of a gun toy constituting a first embodiment of the present invention;

FIG. 2 is a partial, cross-sectional view of the gun shown in FIG. 1;

FIG. 3 is an enlarged cross-sectional view taken along line 3—3 of FIG. 1;

FIG. 4 is a cross-sectional view of a projectile which may be used in the gun of FIG. 1;

FIG. 4a is a cross-sectional view taken along line 4a—4a of FIG. 4;

FIG. 5 is a cross-sectional view similar to FIG. 2, but showing certain parts in a different operating position;

FIG. 6 is a cross-sectional view taken along line 6—6 of FIG. 5;

FIG. 7 is an exploded perspective view of a first modified form of the toy of FIG. 1;

FIG. 8 is a side-elevational view of a second modified form of the toy of FIG. 1 showing an adjustable trajectory-controlling means;

FIG. 9 is a cross-sectional view of a third modified form of the toy of FIG. 1;

FIG. 10 is a cross-sectional view of a gun toy constituting a second embodiment of the present invention;

FIG. 11 is an enlarged cross-sectional view taken along line 11—11 of FIG. 10;

FIG. 12 is an enlarged, partial cross-sectional view similar to FIG. 10, but showing certain parts in a different operating position; and

FIG. 13 is a diagram which may be used in calculating the curvature of the trajectory-controlling means used in the gun toys of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring again to the drawings, and particularly to FIGS. 1—6, a gun toy constituting a first embodiment of the present invention, generally designated 10, is shown herein for purposes of illustration, but not of limitation, as simulating a bolt-action, single-shot rifle having a stock 12, a trigger housing 14, a cocking lever 16 and a hollow, cylindrical simulated barrel 18. A trigger 20 is swingably mounted in housing 14 on a pivot pin 22 and includes a finger-engaging portion 24 at one end and a sear 26 at the other end. Trigger 20 is biased to the position shown in FIG. 1 by a torsion spring 28 having a body portion 30 looped about pin 22, a first leg 32 bearing on the bottom wall 34 of housing 14 and a second leg 36 bearing against trigger 20 above pivot pin 22. Trigger 20 is protected by a trigger guard 38 having one end 40 connected to a bottom support member 42 for supporting an air cylinder 44 reciprocally mounted in gun 10 between simulated barrel 18 and trigger housing 14.

Support member 42 includes a rear end 46 which carries an upstanding plate 48, which is affixed to housing 14, and an intermediate portion 50 which carries an upstanding plate 52 to which simulated barrel 18 is affixed.

Gun toy 10 includes a support rod 54 having a first end 56 affixed to plate 48 and a second end 58 affixed to plate 52. Air cylinder includes an upper ear 60 provided with an aperture 62 slidably received by rod 54 and a lower boss 64 slidably received in a rectangular channel 66 provided in support member 42. Air cylin-

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der 44 carries a rear plate 68 provided with an aperture 70 slidably mounting air cylinder 44 on a cylindrical spring guide 72 carried by plate 48 for housing a compression spring 74 having a first end 76 bearing against a cylindrical bearing 78 and a second end 80 bearing against a piston 82. Piston 82 is carried by a piston rod 84 slidably mounted in bearing 78 and carrying a sear-engaging button 86 adapted to engage sear 26 for maintaining piston 82 in the position shown in FIGS. 2 and 5. Piston 82 may be moved to this position by actuating cocking lever 16 to move air cylinder 44 in the direction of arrow 88 (FIG. 2) from the position shown in FIG. 1 to the position shown in FIG. 2. Cocking lever 16 is swingably mounted on the front wall 90 of air cylinder 44 by a pin 92 and is swung upwardly in the direction of arrow 94 (FIG. 3) from its position between front and rear cocking-lever guides 96, 98, respectively, to a position between upper and lower cocking-lever guides 100, 102, respectively, before it is moved rearwardly in the direction of arrow 88 during the cocking operation. Front wall 90 of air cylinder 44 is provided with an aperture 104 in which an air nozzle 106 is mounted. Nozzle 106 includes a tapered end 108 adapted to seat in an aperture 110, provided in plate 52, when air cylinder 44 is moved by cocking lever 16 from the position shown in FIG. 2 to the position shown in FIG. 5 following a cocking operation. Trigger 20 may then be actuated releasing piston 82 for forward travel in the direction of arrows 112 (FIG. 5) forcing air through nozzle 106 from air cylinder 44. This air may be drawn into cylinder 44 through a plurality of apertures 114 provided in spring guide (FIG. 1). A projectile or ball 115 may be placed in aperture 110 before nozzle 106 is moved from its FIG. 2 position to its FIG. 5 position. Pressurized air from air cylinder 44 will then force ball 115 through a gun barrel 116 when gun 10 is fired.

Projectile 115 is shown herein for purposes of illustration, but not of limitation, as having the shape of an oblate sphere and is preferably made from a low-density material such as sponge rubber or the like to minimize the likelihood of a child being injured by gun toy 10. Gun barrel 116 has a bore 118 conforming in shape to projectile 115, as shown in FIG. 6. Bore 118 is slightly smaller than projectile 115 so that it fits snugly therein. Gun barrel 116 is supported by the front portion 120 of support member 42 in fluid communication with nozzle 106 and includes a forward, upwardly-curved portion 122 for directing projectile 114 upwardly into engagement with a substantially flat, slightly curved deflector 124 comprising means for controlling the trajectory of projectile 115. Deflector 124 extends into simulated barrel 18 which has a sufficiently large diameter that it does not in any way interfere with the flight of projectile 115 after it leaves deflector 124. Deflector 124 imparts a reverse spin (counterclockwise as viewed in FIG. 5) to projectile 114 about an axis $a-a$ (FIG. 4) lying substantially normal to the initial direction of flight of projectile 115. Air flow over the top of projectile 115 is then faster than below it, owing to the combined effects of trajectory and spin air flow, resulting in lower pressure above projectile 115. This causes lift overcoming the gravitational pull on projectile 115 giving it a longer flight path before it falls to the ground.

It has been demonstrated that the angular velocity of the spinning projectile may be controlled by the amount of curvature existing in the deflector 124. This will now be explained in connection with FIG. 13 wherein the line L is assumed to be a circular trajectory along which a projectile 115 having a radius R is moving at a constant velocity V_o and an initial angular velocity ω of zero. The center of projectile 115 will be traveling on a radius R_1 through a trajectory angle of θ and will be subjected to a centrifugal force of F_c and a frictional force of F_f . The projectile will gradually acquire an angular velocity (ω) under the influence of the force F_f . Eventually, if the

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condition is allowed to persist long enough, the projectile will reach an equilibrium angular velocity very close to V_o/R . During the angular acceleration period, it can be shown mathematically as follows:

$$F_f = \mu F_o = \mu m \frac{V_o^2}{R_1}$$

$$T = F_f R$$

$$I = \frac{1}{2} m R^2$$

$$I \alpha = I \frac{d\omega}{dt} = T$$

$$\int \frac{d\omega}{dt} = \frac{T}{I} = \frac{\mu m V_o^2 \cdot R}{R_1 \cdot \frac{1}{2} m R^2} = \frac{2\mu V_o^2}{R_1 R}$$

$$\omega = \frac{2\mu V_o^2}{R_1 R} t$$

Assuming:

$$V_o = \text{Constant}$$

$$t = \frac{S}{V_o} = \frac{\theta R_1}{V_o}$$

$$\omega_o = \frac{2\mu V_o^2}{R_1 R} \cdot \frac{\theta R_1}{V_o} = \frac{2\mu V_o \theta}{R}$$

In the above equations, T=torque on projectile 115; I=moment of inertia of projectile 115; t=time; S=distance; α =angular acceleration; and μ =coefficient of friction.

Since the lift force is directionally proportional to ω_o and V, we can relate ω_o to θ from this equation once the other variables are chosen.

This information permits designing a deflector 124 which is adjustable. Such a deflector is shown in FIG. 8 wherein a modified gun barrel 116a includes a curved discharge portion 122a which is swingably connected to the remaining portion of barrel 116a by a pivot pin 126. A deflector plate 124a has a first end 128 connected to the curved portion 122a of barrel 116a and a second end 130 connected to simulated barrel 18a which may be moved up and down by a slide plate 132 having a first end 134 slidably mounted on top of simulated barrel 18a in a retainer 136 and a second end 138 connected to a scissors-type adjusting type mechanism 140 by a bracket 142 having an elongated slot 144 provided therein. The scissors mechanism 140 is connected to gun barrel 116a by a bracket 146 having an elongated slot 148 provided therein and includes a pair of legs 150, 152 connected together by a pivot pin 154. Leg 150 includes an upper end 156 which carries a roller 158 mounted in slot 144 and a second end 160 which bears against curved portion 122a of barrel 116a for moving curved portion 122a downwardly when legs 150, 152 are spread apart. Leg 152 includes an upper end 162 which is connected to slide plate 132 and a lower end 164 which carries a roller 166 mounted in slot 148 so that leg 152 will pull plate 132 and simulated gun barrel 18a downwardly when legs 150, 152 are spread apart.

Gun toy 10 may also be modified as shown in FIG. 7 wherein a gun barrel 116b is provided with a circular bore 118b for receiving spherical projectiles. A deflector 124b may be connected to barrel 116b by a ring 168 which may be rotated on barrel 116b to position the deflector 124b in different planes about barrel 116b. This permits shooting projectiles around corners and the like. For example, the deflector 124 shown in FIG. 5 will impart upward lift to a projectile to prevent it from dropping too rapidly as it leaves gun toy 10. The deflector 124b, on the other hand, could be rotated 180° on barrel 116b from the position shown in FIG. 5 so that the projectile will have a "lift" imparted thereto which supplements gravity causing the projectile to fall to the ground rapidly. The deflector 124b, may, on the other hand, be positioned on barrel 116b 90° from the position shown in FIG. 5 so that the projectile may be shot around corners.

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A further modification of the gun toy 10 is shown in FIG. 9 wherein a modified gun barrel 116c is connected to plate 52 of gun toy 10 in place of the gun barrel 116 and is supported by support member 42. A deflector 124c is fixedly connected to curved portion 122c of gun barrel 116c and is affixed to simulated barrel 18c.

A second embodiment of the present invention is shown in FIGS. 10, 11 and 12 wherein a gun toy 10d includes a pistol grip 12d, a trigger housing 14d, a gun barrel 116d and a deflector 124d. Gun toy 10d also includes a housing 170 provided with a projectile-storage chamber 172 into which a plurality of projectiles 114 may be loaded through an aperture 174 provided in housing 170 beneath a slideable gate 176. Projectiles 114 may be caused to drop into barrel 116d through an aperture 178 provided therein by sliding air cylinder 44d rearwardly to the position shown in FIG. 12 moving a sleeve 180 away from aperture 178. Cylinder 44d may be moved to its FIG. 12 position by moving a cocking-lever 16d rearwardly. Cocking-lever 16d is connected to a piston rod 84d which carries a piston 82d biased to the position shown in FIG. 10 by a compression spring 74d. As piston 82d moves rearwardly, it engages an annular shoulder 182 on cylinder 44d causing it to move rearwardly with piston 82d.

Gun toy 10d includes a trigger 20d which is slidably mounted in a trigger guard 38d and which carries a sear 26d engageable with a button 86d on piston rod 84d, as shown in FIG. 12. Sear 26d is pivotally connected to trigger 20d by a link 184 having a first end 186 connected to sear 26d by a pivot pin 188 and a second end 190 connected to trigger 20d by a pin 192.

Chamber 172 is connected to cylinder 44d by an air pipe 194 which pressurizes chamber 172 for forcing a projectile 114 into barrel 116d through aperture 178 by piston 82d as it moves from its FIG. 10 position to its FIG. 12 position. Air cylinder 44d is normally biased to its FIG. 10 position by a compression spring 196 having one end 198 bearing against a fixed sleeve 200 in housing 170 and a second end 202 bearing against annular shoulder 182. After piston rod 84d has been moved to the position shown in solid lines in FIG. 12, it may be released so that it will move to the broken line position shown therein causing button 86d to engage sear 26d. At this time, spring 196 will force air cylinder 44d forwardly sufficiently to bring sleeve 180 back into closing relationship with aperture 178. Gun toy 10d may then be fired by squeezing trigger 20d releasing piston 82d so that it will pressurize gun barrel 116d forcing a projectile 114 into engagement with the deflector 124d for imparting a spin to projectile 114. Deflector 124d has the cross section shown in FIG. 11 wherein a channel 204 is milled into deflector 124d along the lower surface thereof so that projectile 114 will be spun by contacting the upper, inner surface 206.

Sleeve 180 is adapted to seat against an O-ring 208 when it is in its forward (FIG. 10) position to prevent air from bypassing barrel 116d through aperture 178 when gun toy 10d is fired.

While the particular gun toy shown herein and described in detail is fully capable of attaining the objects and providing the advantages hereinbefore stated, it is to be understood that it is merely illustrative of the pres-

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ently preferred embodiments of the invention and that no limitations are intended to the details of construction or design herein shown other than as defined in the appended claims which form a part of this disclosure.

What is claimed is:

1. In a toy gun for firing a low density projectile the improvement comprising:

a first barrel portion having a muzzle end defining a first projection path and means for projecting a projectile through said first barrel portion;

deflector means defining a surface adjacent and extending a substantial distance along only one side of said projection path, said surface being curved longitudinally of and extending across said first path to present a longitudinally concave surface to and to rollably engage and deflect a projectile issuing from said barrel portion to a second path, whereby a low density projectile is caused to roll along said surface and thereby acquire spin about an axis transverse to said paths.

2. A toy gun as defined in claim 1 including fluid pressure means for projecting a low density projectile through said barrel portion.

3. A toy gun as defined in claim 1 wherein said first barrel portion is provided with a bore of generally oval shape, the minor axis of which is transverse to said paths.

4. A toy gun as defined in claim 1 including a second barrel portion extending about said second path, said second barrel portion being larger than said first barrel portion whereby a low density projectile fitting snugly within said first barrel portion may move freely and loosely through said second barrel portion.

5. A toy gun as defined in claim 1 including adjustable means for changing the curvature of said deflector means.

6. A toy gun as defined in claim 1 wherein said deflector means is mounted on said muzzle end for rotary adjustment about said first projection path.

7. A toy gun as defined in claim 1 including pressurizing means for pressurizing fluid to project a projectile through said first barrel portion;

a projectile storage chamber having an inlet end in fluid communication with said pressurizing means and an outlet end communicating with a breech portion of said first barrel portion through an aperture therein; and

sleeve means for closing said aperture during fluid pressure projection of a projectile through said first barrel portion.

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W. R. BROWNE, Assistant Examiner

U.S. Cl. X.R.

124—30, 41, 51