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TOY CAP GUN HAVING A PARABOLIC GAS EXPANSION CHAMBER

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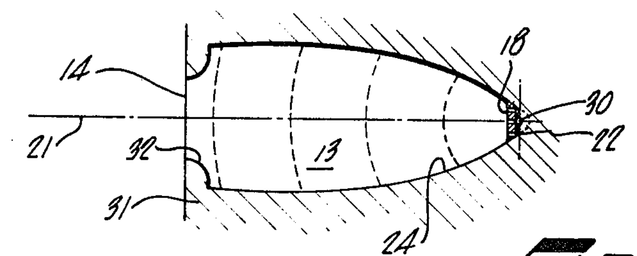

FIG. 1

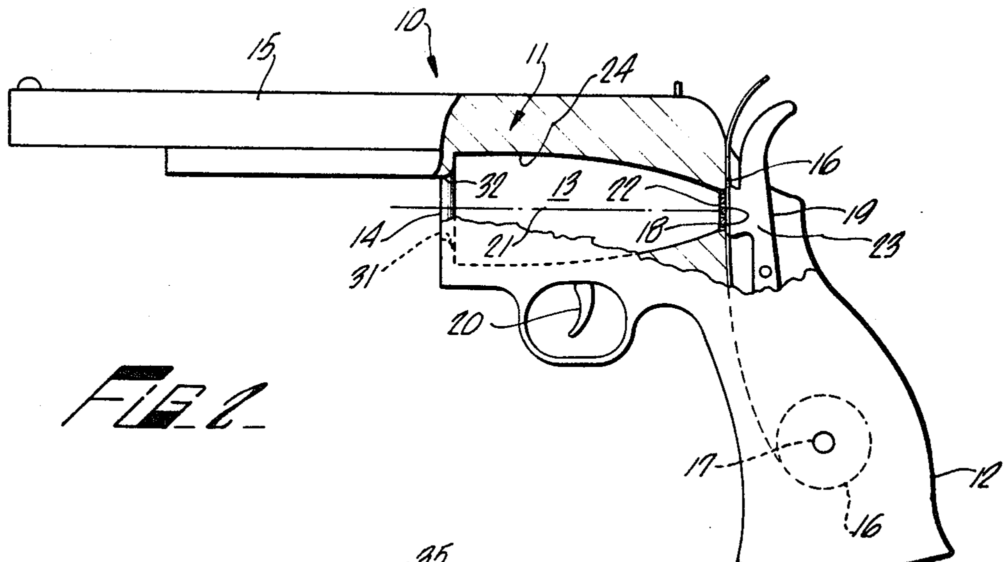

FIG. 2

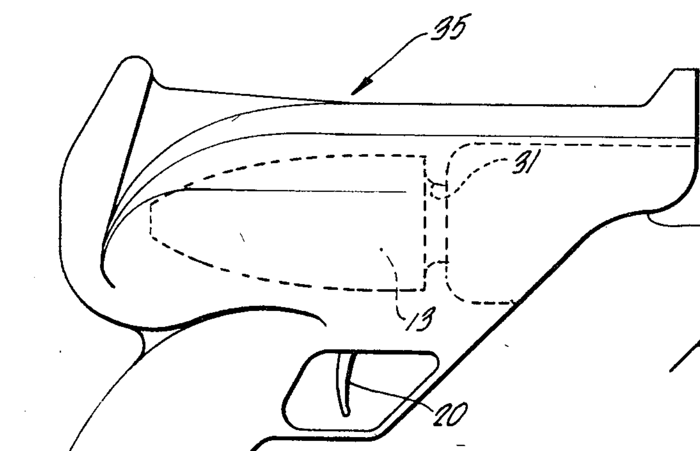

FIG. 3

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TOY CAP GUN HAVING A PARABOLIC GAS EXPANSION CHAMBER

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ABSTRACT OF THE DISCLOSURE

A toy cap gun having a perforated striking anvil, a hammer and a parabolic gas expansion chamber, the anvil forming a boundary of the chamber adjacent the focus of the chamber. Acoustic energy produced by detonating a percussion cap between the anvil and the hammer is communicated to the chamber and is there controlled to closely resemble the sound of a gunshot and to produce shock waves.

Background of the invention

Field of the invention.—This invention relates to toy cap guns and, more particularly, to toy cap guns having a parabolic expansion chamber to which gases from the explosion of a percussion cap are introduced for focusing of the sound and shock waves produced by the explosion.

Description of the prior art.—Presently available toy cap guns are very inefficient in the utilization of energy derived from the explosion of a percussion cap. Existing percussion cap guns are characterized by a serrated hammer which strikes against a flat anvil on which the cap is supported. The expanding gases produced by explosion of the cap are required to follow paths between the opposing surfaces of the anvil and the hammer to escape and create an audible noise. In following these paths, the speed of the escaping gas is greatly reduced due to surface drag against the hammer and the anvil. As a result, the volume of sound produced in existing percussion cap pistols is appreciably less than that theoretically produced by the cap.

A further characteristic of existing percussion cap pistols is that the sound waves generated by explosion of the cap are not directed to the areas where they can best simulate the sound of a gunshot. The sound waves must propagate in a plane between the hammer and the anvil and, since the sides of the anvil are usually bound by guide rails to guide the strip of caps, the bulk of the energy of detonation is either directed upward or downward. Since the waves directed downward are almost entirely absorbed in the gun mechanism, only the upwardly directed sound waves can effectively be heard. As a result, the play value of a conventional existing toy percussion cap pistol is less than optium because the person at whom the pistol is aimed in play does not readily hear the report of the cap's explosion.

Moreover, the report produced by operation of an existing toy cap pistol does not accurately reproduce the sound of the gunshot it intended to simulate because the sound frequency spectrum of an exploding percussion cap varies considerably from that of an explosion emanating from the gun barrel of a pistol.

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Summary of the invention

A cap gun constructed according to this invention closely simulates the sound of an actual gunshot, preferably that of a pistol shot. The gun includes an expansion chamber for controlling the gases produced in the explosion of a percussion cap and a perforated anvil upon which the cap is supported during its explosion, the anvil forming a boundary of the expansion chamber.

Sound waves created by striking a hammer against a percussion cap supported on the anvil are communicated to the chamber through the perforations in the anvil. The chamber is configured to direct the acoustic energy of the cap detonated in a desired direction with a minimum of energy loss in the gun structure. The configuration of the expansion chamber preferably is such that its resonant frequency is close to that of the predominant frequency of a gunshot. Accordingly, the sound produced by the explosion of a percussion cap in the present gun closely simulates the sound of an actual gunshot.

The initial expansion of the gases produced in the detonation of a percussion cap occurs at supersonic velocities, thereby generating a shock wave. This shock wave is optimized in the expansion chamber of the present gun and is directed from the gun in the same direction as the direction of audible sound propagation. This shock wave can be felt within a relatively large distance from the gun. The shock wave is felt as a harmless physical impact upon a person at whom the gun may be aimed, and if such person is standing reasonably close to the gun, he feels the impact of the shock wave before he hears the sound of the cap detonation. Accordingly, the play value of the present gun is appreciably enhanced over that of existing toy cap guns.

Generally speaking, the invention provides a percussion cap gun which includes a body. A perforated striking anvil is mounted on the body for receiving a percussion cap. A hammer is mounted on the body for movement into engagement with the anvil with a force sufficient to detonate a percussion cap supported on the anvil. The body adjacent the anvil defines a chamber for the expansion of gases produced in the detonation of a cap, the chamber having an opening to the exterior of the body at a location spaced from the anvil. The anvil defines a portion of the boundary of the chamber. Thus, detonation gases are introduced into the chamber through the anvil, which gases expand in the chamber to produce sound waves. The walls of the chamber are arranged to direct the sound waves to the chamber opening. Also, the chamber walls are arranged so that, as the sound wave fronts move toward the opening, they have essentially only grazing incidence with the chamber walls.

Brief description of the drawings

FIG. 1 is an outline in cross-section of a detonation gas expansion chamber in a gun constructed according to this invention;

FIG. 2 is an elevation, partly in cross-section, of the gun; and

FIG. 3 is an elevation of another form of the gun.

Description of the preferred embodiments

As shown in FIG. 1, a percussion cap gun **10** constructed according to this invention includes a body **11** defining a handle **12**. The body defines an internal chamber **13** having an open end **14** at the end of the chamber which corresponds to the discharge end of an actual gun which gun **10** is intended to simulate. Gun **10** is constructed in the style of a western six-shot revolver, and thus has a false barrel **15**; chamber **13** is defined within the portion of the body which simulates the revolving cartridge holder of an actual revolver.

In a manner similar to the construction of conventional percussion cap guns, the interior of handle **12** is made hollow to receive a roll **16** of percussion caps, such caps normally being manufactured in the form of a pair of strips of paper laminated together and having small quantities of impact detonating explosive disposed between the paper strips at regular intervals along the strips. Cap roll **16** preferably is loosely supported on a pin **17** within the gun handle. The strip of caps is led from the roll past a striking anvil **18** mounted on the gun body adjacent a hammer member **19**, the anvil being located between chamber **13** and the hammer member.

The hammer member is a part of a cap strip advancing and cap detonating mechanism of the gun, which mechanism also includes a trigger **20**. The advancing and detonating mechanism may be of conventional construction. A suitable cap strip advancing and cap detonating mechanism is illustrated in U.S. Patent 2,855,714. Regardless of the specific type of mechanism used, hammer member **19** is mounted, preferably pivotally, on the gun body for movement into engagement with the anvil with sufficient force to detonate a cap supported on the anvil. Detonating motion of the hammer member toward the anvil is produced by operation of trigger **20**.

As shown in FIG. 2, chamber **13** is elongated along a line **21** parallel to the length of barrel **15**. Anvil **18** is located at the end of the chamber opposite from the chamber open end and actually forms a portion of the boundary of the chamber. Preferably, the anvil is centered on line **21** and is generally normal to the length of the chamber. Also, as shown, the anvil is provided with perforations **22** through it communicating the cap supporting surface of the anvil with the chamber. The hammer member has a hammer head **23** which is sized to cover all of the anvil perforations when it is in the position depicted. Therefore, when a cap supported on the anvil is detonated by forceful engagement of the hammer head with it, the gases produced by the detonation follow the path of least resistance through the anvil perforations into the chamber.

The perforations in the anvil are as large and as many as possible consistent with rigidity of the anvil itself. If the anvil is too heavily perforated, it will yield undesirably under the impact of the hammer. If the yield of the anvil is too great, i.e., if the anvil absorbs too large a fraction of the energy of the hammer, a cap supported on the anvil may not receive sufficient energy to produce detonation. Consistent with these criteria, the anvil perforations are made as large as possible to produce the least possible resistance to the passage of the detonation gases into the chamber.

Manifestly, the anvil has a finite thickness. Thus, perforations **22** direct the detonation gases into the chamber along lines generally parallel to line **21**.

Obviously, the detonation of a percussion cap produces acoustic energy as the gases produced by the detonation compress the adjacent air during their expansion. Because of the construction of the anvil and the hammer of gun **10**, the detonation gases do not begin to expand appreciably until they enter chamber **13**. As they enter the chamber and expand therein, they produce sound waves which travel along the chamber and out the opening. The walls **24** of chamber **13** between the anvil and opening **14** are arranged to focus these sound waves to propagation along lines parallel to line **21** with the minimum loss of the energy embodied in such sound waves. Moreover, the chamber has dimensions which are selected so that the chamber has a resonant acoustic frequency which approximates the predominant frequency in the acoustic energy spectrum of an actual gunshot, preferably an actual pistol shot. As a result, gun **10** operates to simulate the sound

of a true gunshot with a fidelity and loudness heretofore unknown.

Chamber **13** preferably is symmetrical about line **21**. Preferably, the configuration of the chamber is basically that of a truncated paraboloid, a paraboloid being the surface formed as a parabola is rotated about its axis of symmetry. A paraboloid configuration of chamber **13** is preferred because such a configuration results in a maximum angle of incidence between the chamber walls and the fronts of sound waves moving along the chamber axis. Where the angle of incidence is 90°, as where a sound wave propagates in a direction parallel to a reflective surface, a minimum amount of the energy in the acoustic wave is transferred to the reflective surface. The configuration of chamber **13** is such that the angle of incidence at any point along the length of the chamber with a sound wave moving along the chamber axis is as high as possible. Preferably the angle of incidence, as described above, between sound waves moving along line **21** and the walls of the chamber is between about 85° and about 90°. Thus, sound waves originating at the anvil make only grazing reflective contact with the chamber walls, and a minimum of acoustic energy in the waves is lost in the chamber. As a result, the sound heard by a person standing in front of gun **10** is as loud as possible, and is considerably louder than the sound heard as a result of the operation of an existing percussion cap gun.

It has been found that an effective parabolic detonation gas expansion chamber for gun **10** is a chamber which has a maximum diameter of approximately 1.25 inches adjacent chamber opening **14**, a minimum diameter of about 0.375 inch adjacent anvil **18**, and a length of about 2.875 inches. Such a chamber configuration is illustrated in FIG. 1.

As shown in FIG. 1, it is preferred that the paraboloid defining the configuration of chamber **13** have its focal point **30** located outside the chamber adjacent the side of the anvil opening toward the hammer member; the paraboloid is thus truncated by the anvil. More specifically, it is preferred that the focal point of the chamber paraboloid be in the plane defined by the cap supporting surface of the anvil. Since the focal point of the paraboloid is outside chamber **13**, the gases and sound waves entering the chamber through the anvil are travelling in the desired direction. Thus, the chamber configuration functions to maintain this direction and to propagate the sound waves into a flat plane at the open end of the chamber. The chamber configuration described above accomplishes these purposes effectively.

The use of long, narrow chamber configurations should be avoided, as should the use of short, wide configurations. Long, narrow configurations produce excessive losses of acoustical energy due ot the same effects which cause pressure losses in fluids flowing through pipes. Short, wide paraboloids do not produce the desired sound directionality; moreover, such paraboloids do not permit grazing incidence acoustical reflection, and therefore a significant portion of acoustic energy is absorbed by the reflector.

It was mentioned above that chamber **13** is a tuned chamber. The length of chamber **13** is selected relative to its diameter so that the chamber has a resonant acoustical frequency in the range of from 800 to 1000 cycles per second, and preferably of about 900 cycles per second. The acoustic spectrum of an actual pistol shot has a peak at about 900 cycles per second, whereas the predominant frequency in the audible spectrum of the sound produced by detonation of a toy percussion cap is about 2000 cycles per second. Thus, a gun according to this invention preferably has a chamber about 3 inches long, and the ratio of chamber length to chamber diameter preferably is about 2.3:1. Such a gun realistically simulates both the loudness and the tone of an actual pistol shot, notwithstanding that the sound produced by a percussion cap per se has a much different tone.

The initial expansion of the gases produced by detonation of the explosive charge in a percussion cap occurs at velocities which are several times greater than the speed of sound in air. Because hammer head **23** completely covers the truncated end of chamber **13** over anvil **18**, the gases produced upon detonation of a percussion cap supported on the anvil are forced to enter the chamber. The initial expansion of these gases in the chamber produces a shock wave which travels down the chamber and out open end **14**. This shock wave can be felt by a person standing within about thirty feet of the gun and in front of the gun. If the person is standing within about 10 feet of the gun, he feels the shock wave before he hears the report of the cap detonation. If the person is standing in the range of from about ten feet to about twenty feet of the gun, he feels the shock wave at about the same time that he hears the report of the detonation.

It has been found that where the parabolic curvature of chamber **13** extends entirely to the open end of the chamber, i.e., where the diameter of opening **14** is the maximum diameter of the chamber, the accuracy of shooting the shock wave at an intended target is related to the accuracy with which a percussion cap is centered on the anvil. In order to minimize the effect of erratic placement of a cap on the anvil, such positioning variations being common with existing repeating-action cap strip advancing mechanisms, chamber **13** is provided adjacent its open end with a shock wave focusing nozzle **31**. Preferably, as shown in FIGS. 1 and 2, the nozzle is of volute configuration and is defined by a surface **32** which is essentially normal to the chamber axis at the maximum diameter of the chamber and curves into parallelism with the chamber axis at the chamber open end. Preferably the nozzle is shaped to reduce the 1.25 inch maximum diameter of the chamber described above to about 1.0 inch at open end **14**.

Without the nozzle described above, it was found that the shock wave would vary over an area one foot in radius on a target located ten feet from the gun. With a gun equipped with the shock wave focusing nozzle described above, however, the shock wave was found to be concentrated in an area 3 inches in diameter twenty feet from the gun, and that the shock wave consistently hit a target twenty feet from the gun within a few inches of the aiming point. At this range, the force of the shock wave is sufficient to move or tip over light targets made of plastic or paper. The provision of the shock wave focusing nozzle at the mouth of chamber **13** does not detract from the loudness of the sound produced by the gun.

Barrel **15** of gun **10**, in cooperation with the remaining structure of the gun, makes it impossible for a child using gun **10** to place the gun in contact with his head so as to seal the open end of chamber **13** against his ear. Thus, it is not possible for a child to use the gun in a manner which may produce permanent or semipermanent damage to his or another's hearing. Gun **35**, shown in FIG. 3, has a futuristic appearance, but like gun **10** is shaped, as at **36**, adjacent the opening of chamber **13** to the exterior of the gun in a manner which prevents a child from sealing the chamber opening against this ear. As a result, guns **10** and **35** are safe both as to their users and to persons at whom the gun may be pointed.

As shown in FIG. 3, where nozzle **31** is located intermediate the passage between the anvil and the exterior of the gun, the diameter of the passage between the nozzle and the exterior of the gun is enlarged to the greatest extent possible to minimize loss of acoustical energy to the greatest extent possible. Preferably the transition from the nozzle to the enlarged diameter of the passage is a sharp step as shown in FIG. 3.

The guns described above, as already noted, have several features not found in existing percussion cap guns. The sound produced by the detonation is directionalized to be loudest in the direction in which the gun is pointed. Also, the acoustic energy produced by the detonation of

the cap is handled efficiently in the gun to increase the loudness of the gun report, the tone of which is regulated so that the audible report of the gun closely simulates the sound of an actual gunshot. Moreover, the gun is configured so that detonation of a percussion cap produces a directionalized shock wave. All these features result in the provision of a gun which has a play value significantly higher than existing percussion cap guns.

It should be realized that the features and improvements provided by this invention are not restricted to repeating-action toy pistols. These features may be incorporated into a single shot toy pistol or rifle. Where the invention is used in a toy rifle, it is within the scope of the invention that the proportions of the detonation gas expansion chamber be modified from those given above by way of example so as to have a resonant frequency according with the predominant frequency of the sound of an actual rifle shot.

What is claimed is:

1. A percussion cap gun comprising a body, a perforated striking anvil mounted on the body for receiving a percussion cap, a hammer mounted on the body for movement thereof into engagement with the anvil sufficiently forcefully to detonate a percussion cap supported on the anvil, and a chamber defined by the body adjacent the anvil and having an open end spaced from the anvil, the anvil forming a portion of the boundary of the chamber so that gases from the detonation of a percussion cap supported on the anvil are introduced into the chamber for expansion thereof in the chamber to produce sound waves, the chamber being configured concave from the anvil toward the open end to direct the sound waves from the anvil toward the chamber open end, the chamber walls being arranged so that the fronts of sound waves moving toward the open end have essentially only grazing incidence upon the walls.

2. A gun according to claim **1** wherein the chamber has a truncated paraboloid configuration symmetrical about a line extending along the length of the chamber between the anvil and the center of the chamber open end.

3. A gun according to claim **2** wherein the length of the paraboloid is about 2.3 times the maximum diameter of the chamber.

4. A gun according to claim **2** wherein the paraboloid is truncated by the anvil.

5. A gun according to claim **4** wherein the anvil is disposed in a plane substantially normal to the paraboloid axis.

6. A gun according to claim **4** wherein the paraboloid has its focus located externally of the chamber.

7. A gun according to claim **6** wherein said focus is located substantially coincident with the surface of the anvil with which the hammer is engageable.

8. A gun according to claim **1** wherein the chamber has a resonant acoustical frequency in the range of from about 800 to about 1000 cycles per second.

9. A gun according to claim **8** wherein the said resonant frequency is about 900 cycles per second.

10. A gun according to claim **1** wherein the expansion of detonation gases in the chamber produces a shock wave which moves along the chamber toward the chamber open end, and including a nozzle defined by the body at the chamber open end for focusing said shock waves, the nozzle being configured so that the chamber open end has a diameter less than the maximum diameter of the chamber.

11. A gun according to claim **10** wherein the nozzle is of volute configuration and includes a surface extending circumferentially of the chamber open end and curving at the chamber maximum diameter from substantially normal to a line between the anvil and the chamber open end about which the chamber is symmetrical to substantially parallel to said line at the chamber open end.

12. A gun according to claim **11** wherein the diameter of the chamber at said open end is approximately four-fifths of the maximum diameter of the chamber, which maximum diameter is located immediately adjacent the volute toward the anvil.

13. A gun according to claim **12** wherein the chamber has a truncated paraboloid configuration, the chamber being truncated by the anvil, the anvil being disposed substantially normal to said line, the chamber having a minimum diameter of about 0.375 inch adjacent the anvil and a maximum diameter of about 1.25 inches, and a length between said diameters of about 2.875 inches.

References Cited

UNITED STATES PATENTS

738,585	9/1903	Wenzel	42—57
2,983,064	5/1961	Hirsch et al.	42—58

BENJAMIN A. BORCHELT, *Primary Examiner*.