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HYPERVELOCITY GUN

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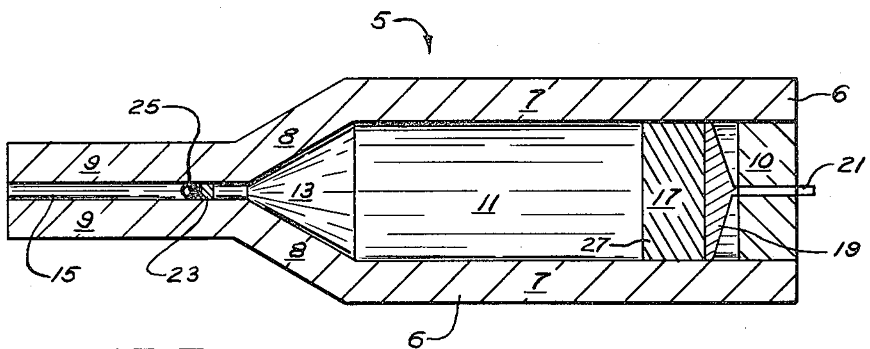

FIG. 1.

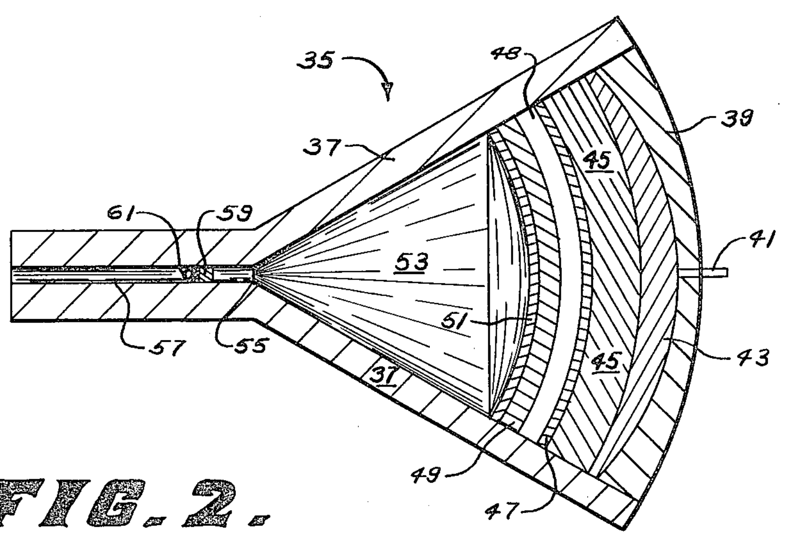

FIG. 2.

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HYPERVELOCITY GUN
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This invention relates to a hypervelocity gun and more particularly to a hypervelocity gun wherein a gas is first shock heated and then adiabatically compressed whereby projectiles may be propelled to hypervelocities.

This hypervelocity gun utilizes chemical energy stored in high explosives to shock heat a gas whereby a high initial gas temperature is created which causes the final gas temperature (after adiabatic compression) to be much greater than has heretofore been achieved. This allows the projectile to be propelled above 30,000 feet per second.

There are at least three types of accelerating devices similar to the present invention which are capable of projecting particles to hypervelocities. These are a high explosive disposable gun, a light gas gun, and a shaped charge. The high explosive, disposable gun has about the same physical size of the present invention. However, its principle of operation is to utilize the high temperatures and pressures of the gas generated from the explosive charge to drive the projectile. Using this technique, projectiles weighing ½ to 1 gram may be driven to velocities of 19,000–12,000 feet per second respectively. Light gas guns under proper conditions, which are usually quite elaborate, may be used to impart velocities to projectiles of about 22,000–28,000 feet per second with occasional velocities measured as high as 30,000 feet per second. Light gas guns are both expensive to build and to operate and therefore their use is limited. A light gas gun has a compression tube down which a piston is driven by a propellant charge whereby the enclosed gas (usually hydrogen or helium) becomes highly compressed storing potential energy. The overall length of the compression tube and launching tube is typically 25 feet. Light gas guns use external heating devices whereby initial gas temperatures on the order of 400° F. may be achieved. Compression of the gas by the piston results in a greatly increased gas temperature; this temperature is the determining factor as to the limiting velocity (velocity of sound in the gas which is a function of temperature) of the projectile to be propelled. The third type of particle accelerating device is the shaped charge which can be used to propel a cloud of microparticles at very high velocities. Relatively large projectiles however are propelled at much slower velocities and have irregular shapes and undeterminable masses.

In accordance with this invention a hypervelocity gun is provided which is based on the principle of shock heatin ga light gas, such as hydrogen or helium, to temperatures on the order of 2700° K., and then, adiabatically compressing the gas to even higher temperatures. The temperatures reached at the end of compression are on the order of 4200° K. and the pressures are about 200 kilobars. This is about four times higher than that which would be obtained if a simple adiabatic compression was used from room temperature. A similar advantage may be seen over compressing the gas from an initial temperature of 400° F. as is done with the light gas gun. Moreover, the overall length of the present invention need not be more than about three feet with a characteristic diameter of about one foot. Its construction and operation are inherently inexpensive and yet it affords a means to produce hypervelocity particles for impact testing.

One object of the present invention is to provide a hypervelocity gun which is both inexpensive to build and to operate.

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Another object of this invention is to provide a hypervelocity gun of compact size and elementary structure.

Another object of this invention is to provide a hypervelocity gun in which a light gas is shock heated before being adiabatically compressed.

Still another object of this invention is to provide a generator wherein high explosives may be used to shock heat and adiabatically compress a light gas thus causing this gas to have a very high potential energy.

Still another object of this invention is to provide a hypervelocity gun capable of projecting particles of known mass above 30,000 feet per second.

Other objects and advantages of this invention will be set forth in the following description of the invention and illustrated in the accompanying drawings wherein similar reference characters relate to similar components and of which drawing:

FIGURE 1 is a side view in section of the hypervelocity gun embodying the present invention.

FIGURE 2 is a side view in section of an alternate embodiment of the hypervelocity gun of the present invention.

Referring now to FIGURE 1 there is shown a hypervelocity gun generally designated 5 with an outer substantially cylindrical housing 6 which may be divided into four areas, the cylindrical compression chamber 7, the converging portion of the combustion chamber 8, the launch tube 9, and the aft end 10. The entire outer housing 6 may be made of steel or aluminum, and when steel is used, preliminary estimates indicate that the walls may be ¼" thick, although it is contemplated that much thicker walls may be used to insure safe operation. The housing 6 defines the space 11 and 13 which is filled with hydrogen, helium or other light gases. The converging portion of the outer housing 8 defines the conical space 13 while the launch tube 9 defines the space 15. Disposed adjacent to the end plate 10 in the space 11 is a high explosive material 17 which may be of suitable material such as Composition "C" and which is ignited by a plane wave generator 19. The generator 19 is ignited by a communicating ignition means 21 which extends through an aperture in the wall 10. Located in the end of the launch tube 9 adjacent to the apex of the space 13 is a sabot 23 and a projectile 25. The sabot 23 may be made of a suitable plastic or metal material.

The operation of the hypervelocity gun may be described in the following manner. The plane wave generator 19 would be used to ignite the back surface of the explosive material 17 which would work progressively toward the front surface 27. The blow off gases as a result of the explosive combustion will move into the space 11 which is occupied by hydrogen or helium gas at some low pressure, for example ¼ atmosphere. These blow off gases will be moving into what amounts to almost a vacuum condition at greater than 5 millimeters per microsecond and accordingly are sufficient to give a strong shock condition. The explosive material 17 would be approximately two inches thick and six inches in diameter to be satisfactory for about a 20 inch compression tube. The blow off gases would shock and compress the hydrogen gas bringing it up to a pressure of about 14 atmospheres and a temperature of about 2500° K. in about 35 microseconds. From this time on in the conical section 13 the adiabatic compression would occur. When the interface between the burned high explosive and the hydrogen reaches a distance of about one inch from the apex of the cone, the sabot 23 and the projectile 25 will start moving down the barrel 9 with a pressure behind them of about 32 kilobars. The hydrogen gas continues to converge down to a distance of approximately ½ inch with a pressure realized in the range of 200 kilobars and a temperature over 4000° K. The hydrogen is able to follow the sabot 23 down the space 15 since the sound velocity in the hot hydrogen is over 15 millimeters per microsecond. The time of acceleration down a 12 inch barrel 9 is about 20 microseconds and the total process from the time the high explosive 17 is ignited until the sabot leaves the barrel is estimated to be about 90 microseconds with velocities in the range of 15 millimeters per microsecond resulting. Without initial shock heating of the gas much lower final gas temperatures result and maximum projectile velocity is greatly reduced as the projectile tends to run away from the gas.

The question always arises as to the maximum acceleration placed upon the sabot 23 as this may cause the sabot **23** and/or the projectile 25 to break up during their travel down the barrel 9. This acceleration has been estimated at 70×10^6 times the acceleration of gravity which a 100 milligram projectile **25** and sabot **23** should be able to withstand.

Referring now to FIGURE 2 a hypervelocity gun generally designated 35 is shown which is comprised of outer housing **37**, with end plate 39, ignition train 41, spherical wave generator 43, and high explosive material 45, and a plate **47**. The hypervelocity gun **35** has an outer housing **37** which is a spherical sector shown here in cross section. The explosive material 45 is ignited such as to drive the plate 47 towards the apex 55 of the spherical sector. The plate **47** is driven forward through the space **48** and impacts a second explosive material 49 whereby said material 49 is greatly compressed and ignited. Compression of the second explosive material 49 by the plate **47** results in a much increased release of energy of explosive material 49 upon ignition which drives the plate **51**. The plate 51 and the outer housing 37 define the spherical sector space 53 which terminates in the apex of the sector 55 and which joins the launch tube 57. Located in the launch tube 57 is a sabot 59 with a projectile 61 disposed thereon.

The operation of this hypervelocity gun is essentially the same as described hereinabove except in this instance a spherical shock and compression wave which converges at the apex 55 is generated as contrasted to the plane shock and compression wave generated in the first embodiment. The hypervelocity gun 35 also utilizes a two stage acceleration system whereby extra energy may be accrued by the compression of the second slab of high explosive 49. In FIGURE 2 a plate is also shown whereby the gas in the space 53 is shocked and compressed, and, it is contemplated that a similar plate might be employed in the hypervelocity gun 5. Performance of the hypervelocity gun 35 might be expected to be similar or better than the gun 5 due to the increased convergence of the second system.

I claim:

1. A hypervelocity gun comprising a housing which is a spherical sector, a barrel disposed at the apex of said sector, a high explosive material disposed adjacent the base at a radius from the apex of said sector, a projectile disposed in said barrel, a fluid material disposed between said projectile and said explosive material, and a means to ignite said explosive material whereby said explosive material generates a spherical shock wave which propagates in said fluid material heating and compressing said fluid, and which adiabatically compresses said fluid propelling said projectile at hypervelocities.

2. The hypervelocity gun as defined in claim 1 wherein a plate is disposed between said high explosive material and said fluid material whereby shock and compression is communicated to said fluid from said explosive material through said plate.

3. The hypervelocity gun as defined in claim 1 wherein a plurality of high explosive materials and plates are provided.

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