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MULTIPLE PISTON TWO-STAGE LIGHT GAS LAUNCHER

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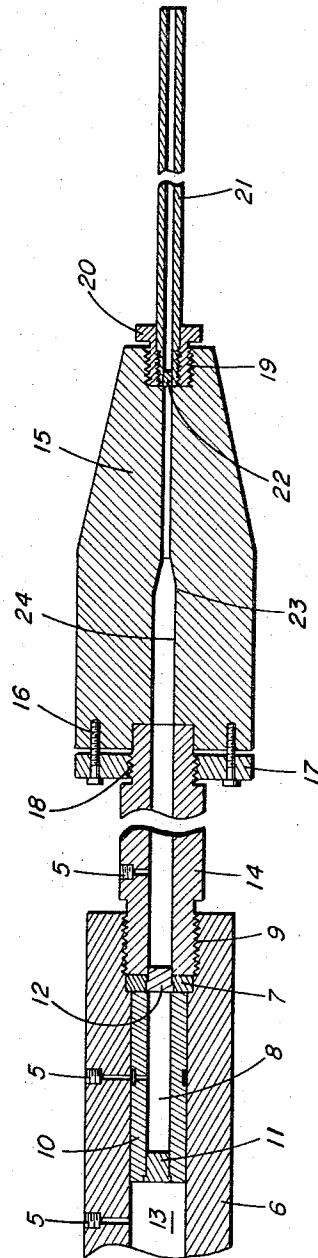
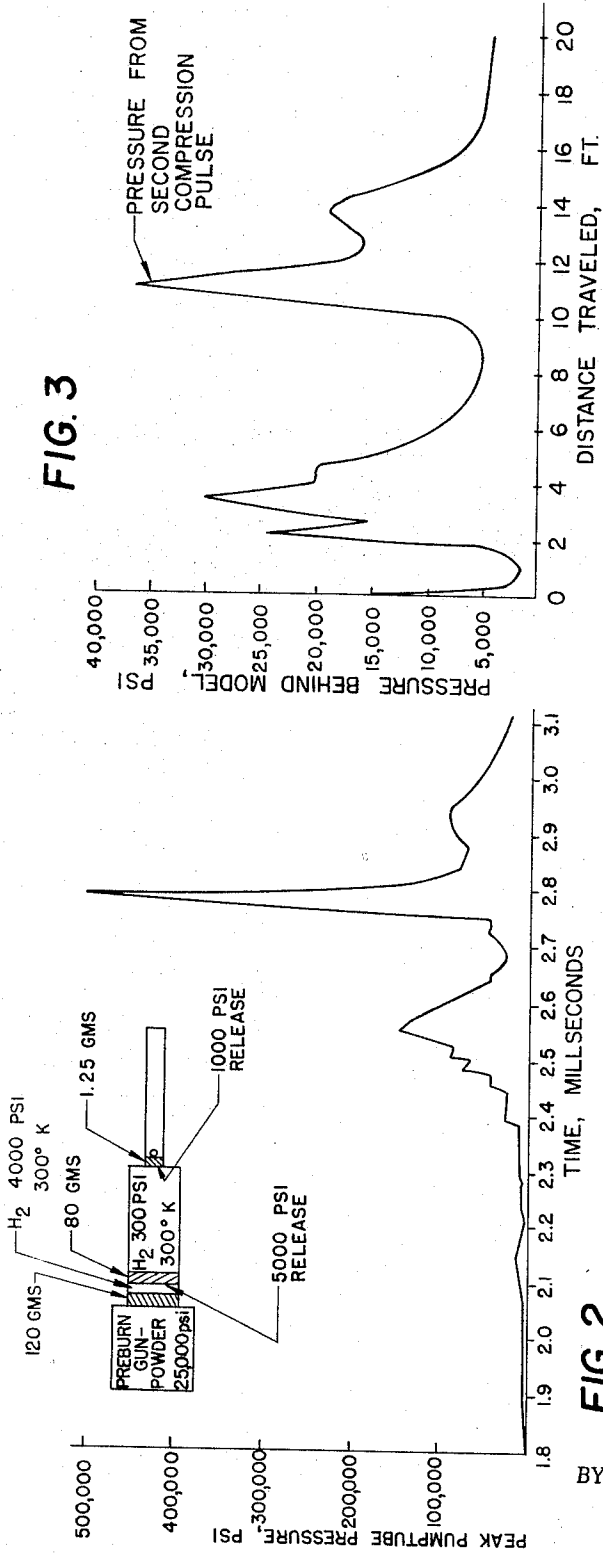


FIG. 2

FIG. 1

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**MULTIPLE PISTON TWO-STAGE LIGHT
 GAS LAUNCHER**

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 4 Claims. (Cl. 89-8)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

The present invention relates generally to projectile launchers. More particularly, the invention relates to a light, gas projectile launcher capable of firing projectiles which reach velocities greater than those presently attainable using similar launchers available in the prior art.

In the conventional two stage gas launchers presently available the driver gas for the projectile is brought to its final high pressure, high temperature state through the use of a single moving piston. This piston travels down a tube called a pump tube and the pump tube normally contains a low molecular weight driver gas, such as hydrogen or helium, at low pressures. As the piston travels the length of the pump tube it compresses the gas in front of it, raising the temperature and pressure of the gas. Attached to the downstream end of the pump tube is a barrel containing a projectile which is driven by this compressed gas.

Once the projectile starts to move down the barrel, the pressure behind it will diminish unless the pressure of the gas in the pump tube continues to increase. The rate of increase of the gas pressure in the pump tube, in order to increase the projectile velocity as it travels down the barrel, should be sufficiently high to prevent a decrease in pressure behind the projectile during its travel down the barrel. However, if the rate of increase of pressure in the pump tube is too high, the model will be accelerated too rapidly and cause the model to break up.

When the projectile is at the entrance of the barrel, the pressure in the pump tube should rise slowly. Later, as the projectile is further away and is moving faster, the pressure should rise more rapidly. If the piston is light and is moving at relatively high speeds in the pump tube, the projectile will feel the rapidly increasing pressure before it has moved very far down the barrel at a magnitude which will destroy the projectile. This situation may be corrected somewhat by decreasing the piston velocity, but this decrease in piston velocity may mean that the pressure behind the projectile, upon reaching the end of the barrel, will be too low. A heavy piston moving at slow to moderate velocities has been the best compromise between these two unsatisfactory methods of operation and has given the best overall results insofar as attaining maximum projectile velocities is concerned.

The invention to be described has been designed to overcome the above shortcomings in the operation of the single piston gas launcher. The present invention includes a multiple piston gas driving device capable of controlling the pump tube pressure in such a manner as to maintain a pressure behind the projectile throughout a substantial portion of its barrel travel and heretofore unobtainable using prior art single piston launchers.

Accordingly, it is an object of the present invention to provide a new and improved projectile launcher.

Another object of the invention is to provide a multiple piston gas launcher for firing projectiles, said projectiles attaining velocities greater than those presently attainable using prior art gas launchers.

Still another object of the invention is to provide a

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new and improved projectile launcher without substantially modifying the overall design of and increasing the production cost of gas launchers presently available.

Other objects and attendant advantages of the present invention will become more fully apparent in the following description of a preferred embodiment thereof wherein:

FIG. 1 is a cross-sectional view of the two stage projectile launcher of the present invention;

FIG. 2 is a graph of the variation of peak pump tube pressure with time for the values of pressure and weights given in the example given in FIG. 2; and

FIG. 3 is a graph of the variation of pressure behind the projectile with distance traveled by the projectile down the barrel.

Referring now to FIG. 1 there is shown a chamber sleeve adapter 10 surrounding a pressurized hydrogen gas filled chamber 8 and having pistons 11 and 12 mounted at the respective ends thereof. A coaxial outer housing 6 surrounds the sleeve adapter 10, and an explosion chamber 13, shown in a cutaway section at the left hand end of the sleeve adapter 10, serves as the driving means for the two pistons 11 and 12.

A pump tube 14 containing hydrogen gas is securely fixed to one end of the housing 6 by threads 9, and the piston 12 nearest the barrel 21 has a portion thereof extending axially within the pump tube 14. An annular seal 7 between the adapter 10 and pump tube 14 has a rear portion thereof which engages and retains the piston 12 in the position shown in FIG. 1 before firing. Since the gas pressure in explosion chamber 13 is at least as great or greater than the gas pressure in chamber 8, the force exerted on piston 11, if any, will be toward the projectile 22. For this reason a rear, axial segment of piston 11 having an increased diameter engages sleeve 10 to prevent any movement of piston 11 toward piston 12 before firing.

The gun barrel 21 having a projectile 22 slideably engaged therein is coupled via transition section 15 to the end of the pump tube 14, and the transition section 15 has a hollow section 24 which is effectively only an extension of the pump tube 14, which extension tapers at 23 to the diameter of the gun barrel 21. Transition section 15 is secured to the pump tube 14 by the screws 16, and these screws extend through annular member 17 which is threaded at 18 on the end of the pump tube 14.

The barrel 21 is threaded in the hollow screw member 20 and the latter is in turn threaded in the right hand end of the transition section 15.

A separate gas passage 5 is provided for the explosion chamber 13, the chamber 8 between pistons 11 and 12, and the pump tube 14.

Operation

The two pistons 11 and 12 are initially separated by the chamber 8 containing hydrogen at a pressure higher than that of the hydrogen in the pump tube 14. This gas provides for the separation of the pistons as they travel down the pump tube 14, and the time of arrival of the two pistons at the end of the pump tube may be varied by either varying the pressure of the hydrogen in the chamber 8 or the distance between the pistons 11 and 12.

Once an explosion takes place in chamber 13 sufficient to drive the pistons 11 and 12 towards the projectile 22 in barrel 21, the hydrogen in the pump tube 14 which propels the projectile 22 is compressed a first time by the right hand piston 12 and a second time by the left hand or trailing piston 11. The second compression produced by the trailing piston 11 transmits a compression wave up the barrel 21 which catches up to the pro-

jectile and provides an extra push necessary to increase the velocity of the projectile as it travels down the barrel. It is possible that a relatively long barrel will be required for the double piston operation since the second pressure pulse may occur after the first pulse is nearly expended. The double piston technique does not provide a constant pressure for the projectile 22 but this condition is at least approached by providing the extra push near the end of the projectile travel.

The pistons 11 and 12 mounted at separate ends of chamber 8 can be made of Lexan or some other material sufficiently pliable to enable the rear segments thereof having enlarged diameters to travel down the pump tube 14 once an explosion takes place in chamber 13. The sections of increased diameter act as a seal during the piston travel down the pump tube and this insures maximum compression of the hydrogen gas in the pump tube 14.

Once an explosion takes place in the combustion chamber 13, the front or right hand position 12 maintains its prefire position until a pressure is built up between the pistons sufficient to drive the front piston 12 towards the projectile 22. When the front piston 12 approaches the transition section 15 it is met with its own reflected shock wave and is repelled thereby. However, the back piston 11 continues to travel against the repelling force of the pressure between it and the front piston 12 and drives the front piston 12 against its repelling shock wave toward the tapered section 23 of the transition section 15. It is this latter boost by the back piston 11 that serves to increase the pressure on and velocity of projectile 22.

For the example of pressures and weights used with the double piston gun in FIG. 2, a graph of peak pump tube pressure v. time is shown up to 3.1 milliseconds after firing. The peak pump tube pressure of approximately 500,000 p.s.i. occurs at approximately 2.8 milliseconds after firing in the chamber 13.

In FIG. 3 there is shown a graph of pressure behind the projectile model as a function of distance traveled down the barrel 21 in FIG. 1. An initial peak pressure of approximately 30,000 p.s.i. is reached when the projectile has traveled four feet down the barrel 21. However, a maximum peak pressure from the second compression pulse due to the rear piston 11 occurs when the projectile has traveled approximately eleven feet down the barrel 21.

A gun of the type illustrated in FIG. 1 and having only a single piston was operated with a maximum velocity capability for launching a .250-inch soft aluminum sabot sphere of 21,750 feet per second. The same gun, when operated as a double piston gun, produced velocities up to 22,900 feet per second with the same projectile. However, the above velocities were attained using a barrel length of 240 calibers. When the barrel length was increased up to 480 calibers, velocities of approximately 26,700 feet per second were obtained for double piston operation using the same sabot sphere.

Obviously many structural modifications can be made in the embodiment of FIG. 1 without departing from the spirit and scope of this invention. It should therefore be understood that the invention described above is limited only by way of the following appended claims.

We claim:

- 1. A multiple piston two-stage gas launcher including:
 - (a) a barrel to engage a projectile to be fired therefrom,
 - (b) a pump tube joined to one end of said barrel,
 - (c) a piston chamber joined to one end of said pump tube,
 - (d) said pump tube and said piston chamber being maintained under fluid pressure,
 - (e) a first piston slidably disposed within said chamber and located at one end of said chamber adjacent the

juncture of said piston chamber with said pump tube, (f) a second piston slidably disposed within said piston chamber at the other end thereof and spatially separated from said first piston as a result of the fluid pressure within said piston chamber,

(g) means including an explosion chamber adjacent one end of said piston chamber adjacent said second piston for driving said second piston toward said projectile thereby also driving said first piston toward said projectile creating a first compression wave resulting from movement of said first piston that initiates projectile movement in the barrel and a second compression wave resulting from movement of said second piston that further increases the velocity of said projectile,

(h) said spatially separated pistons having an axial segment thereof with a diameter larger than the diameter of the pump tube through which they travel whereby said axial segment acts as a seal during travel down said pump tube,

(i) the gas pressure in said explosion chamber is greater than the gas pressure in said piston chamber,

(j) an annular seal between said piston chamber and said pump tube, and

(k) said axial segments of said pistons extending into engagement with sections of said piston chamber and seal respectively, said last named sections having an inside diameter greater than the inside diameter of said piston chamber and said pump tube whereby said pistons are restrained from movement toward said projectile before firing.

2. The launcher of claim 1 wherein

(a) said spatially separated pistons engage said piston chamber before firing and are separated by hydrogen at a pressure higher than the hydrogen pressure in the pump tube whereby the times of arrival of said piston at the end of said pump tube can be regulated either by varying the distance or pressure between pistons.

3. The launcher of claim 2 which further includes:

(a) a transition section coupling said pump tube to said barrel and having means for receiving said pistons after firing and restraining further movement of said pistons, and

(b) an open passage between said receiving means and said barrel for allowing compression waves to reach said projectile.

4. The launcher of claim 3 wherein:

(a) the piston chamber contains hydrogen gas at approximately 4,000 p.s.i. and the pump tube contains hydrogen gas at approximately 300 p.s.i.;

(b) said piston nearest said barrel being approximately 80 grams and said other piston being approximately 120 grams;

(c) said piston nearest said barrel having a release pressure of approximately 5,000 p.s.i.; and

(d) said projectile being approximately 1.25 grams with a release pressure of approximately 1,000 p.s.i.

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