US 20030024521A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2003/0024521 A1

Smith et al. (43) Pub. Date: Feb. 6, 2003

(54) PNEUMATICALLY OPERATED PROJECTILE LAUNCHING DEVICE

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(21) Appl. No.: **10/254,891**

(22) Filed: **Sep. 24, 2002**

Related U.S. Application Data

(63) Continuation of application No. 09/490,735, filed on Jan. 25, 2000, now Pat. No. 6,474,326, which is a continuation of application No. 08/586,960, filed on Jan. 16, 1996, now Pat. No. 6,035,843.

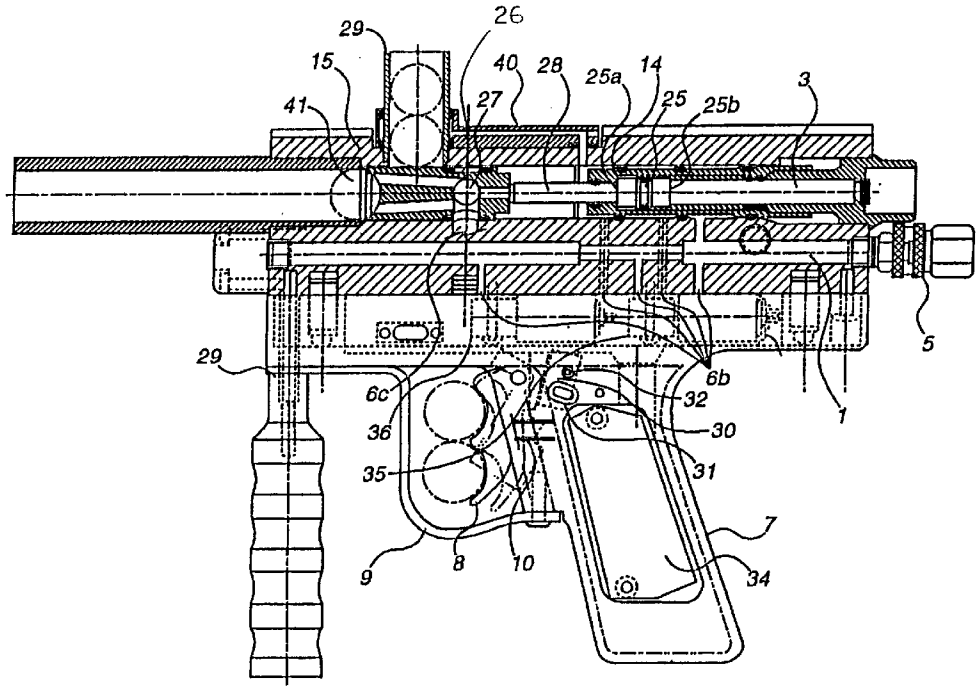
Publication Classification

(51) **Int. Cl.**[7] **F41B 11/00**

(52) **U.S. Cl.** **124/77**

(57) **ABSTRACT**

The pneumatically operated projectile launching device is preferably comprised of three principal elements: a body which houses and interconnects all of the pneumatic components and also houses the electrical power source, a grip mounted to the body which includes an electrical switch that activates a launching sequence, and an electrical control unit housed within both the body and the grip which directs flow between the pneumatic components to load, cock and fire the gun. The body preferably contains a plurality of bores in communication with each other including a bore containing and distribution pressurized gas, a bore containing a compressed gas storage chamber and mechanisms for filling the storage chamber with gas and releasing gas from the storage chamber to fire the projectile, and a bore containing mechanisms for loading and launching the projectile. The electrical control unit preferably includes an electrical power source which activates an electrical timing circuit when the electrical switch is closed, and two electrically operated pneumatic flow distribution devices which are sequentially energized by the electrical timing circuit to enable the loading of a projectile for launching and to release compressed gas from the storage chamber to fire the projectile, respectively. Before the initiation of a launching sequence the compressed gas storage chamber is filled with compressed gas while the projectile launching mechanism is disabled. Filling of the compressed gas storage chamber is preferably accomplished automatically by actuation of the compressed gas filling mechanism. When the electrical switch is closed to initiate the launching sequence the projectile is first loaded into the launching mechanism by electrical timing circuit actuation of the first electrically operated pneumatic flow distribution device. The projectile is then fired when the electrical timing circuit actuates the second electrically operated pneumatic flow distribution device to release gas from the compressed gas storage chamber into the launching mechanism.



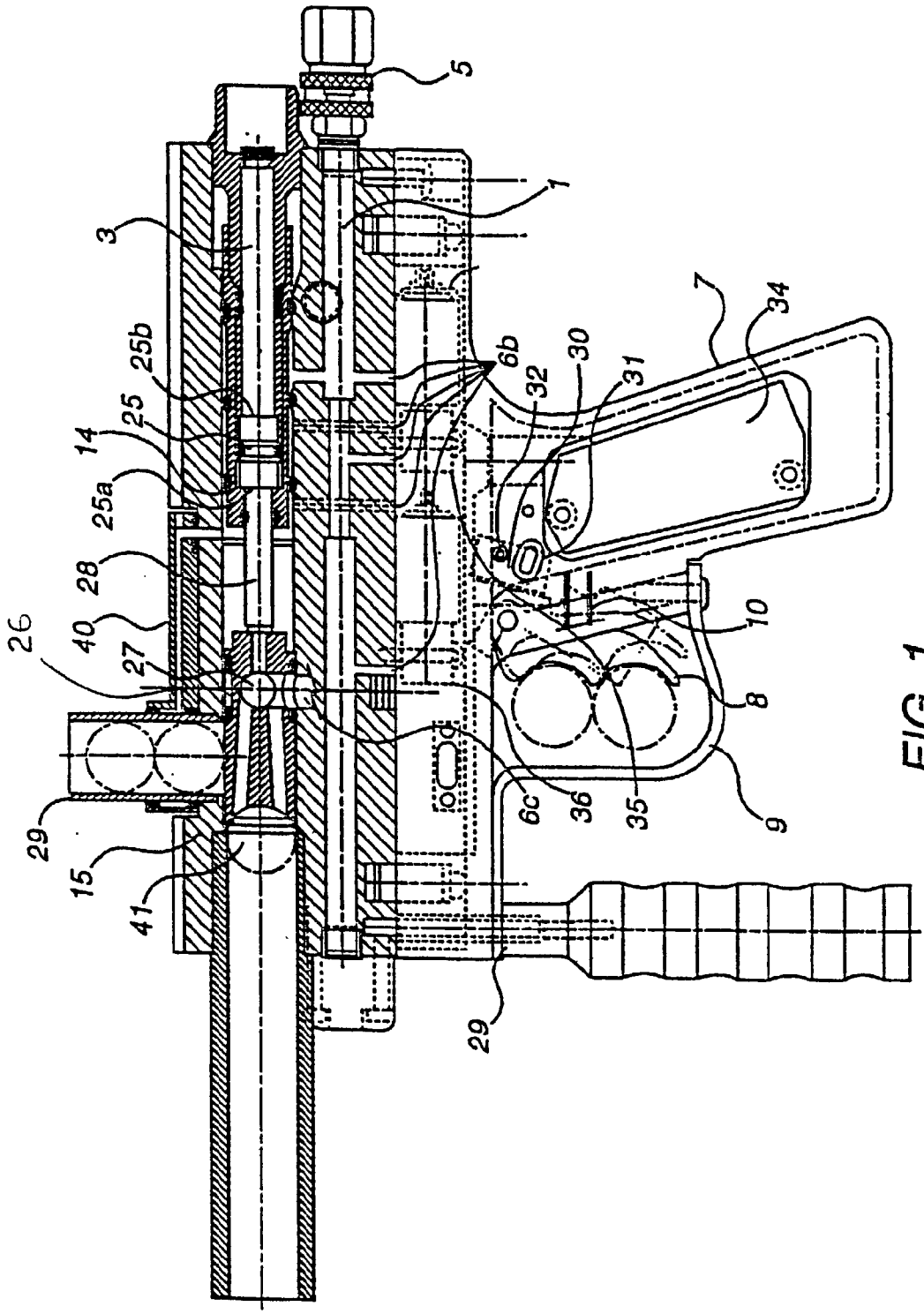

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FIG. 1

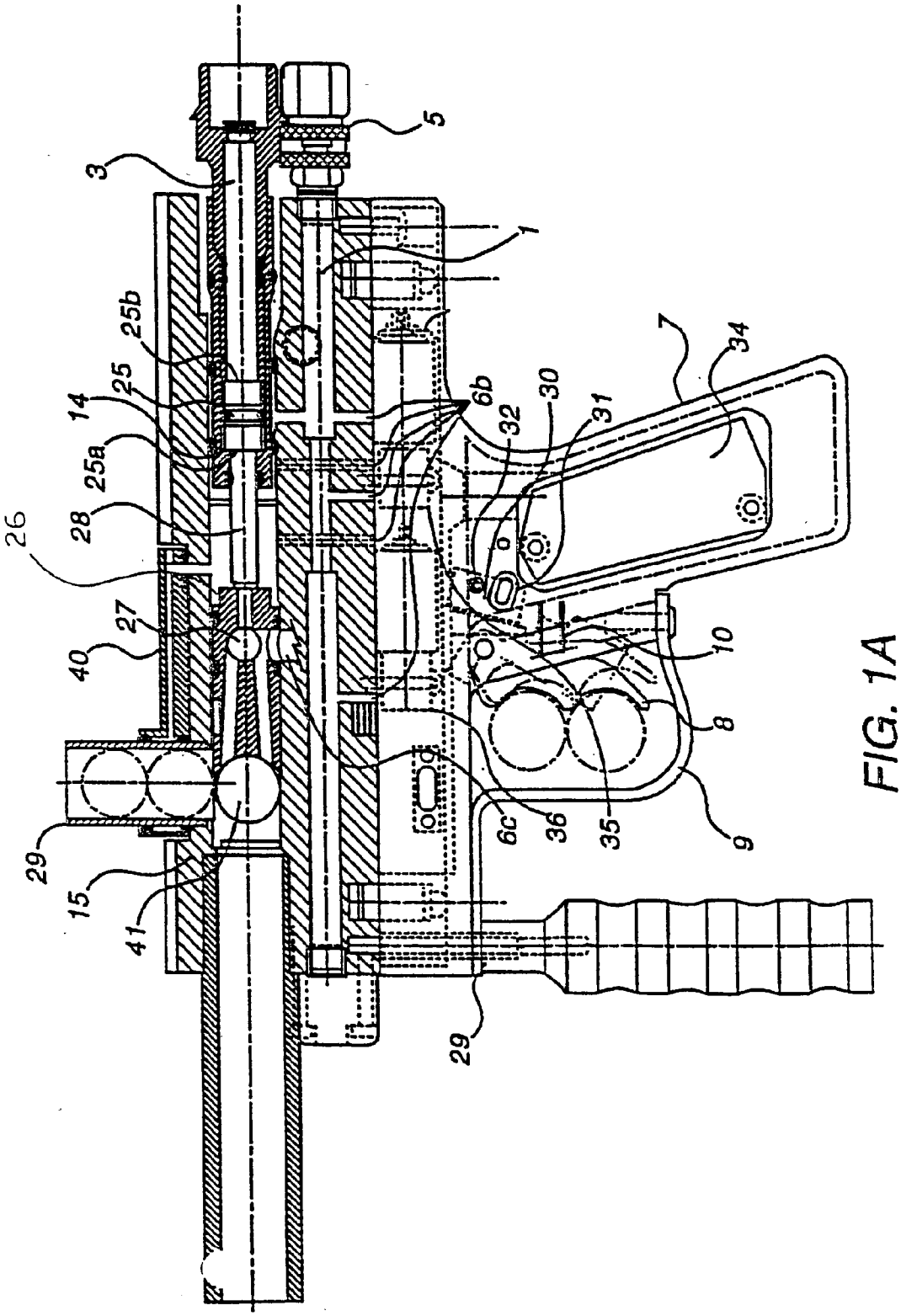
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FIG. 1A

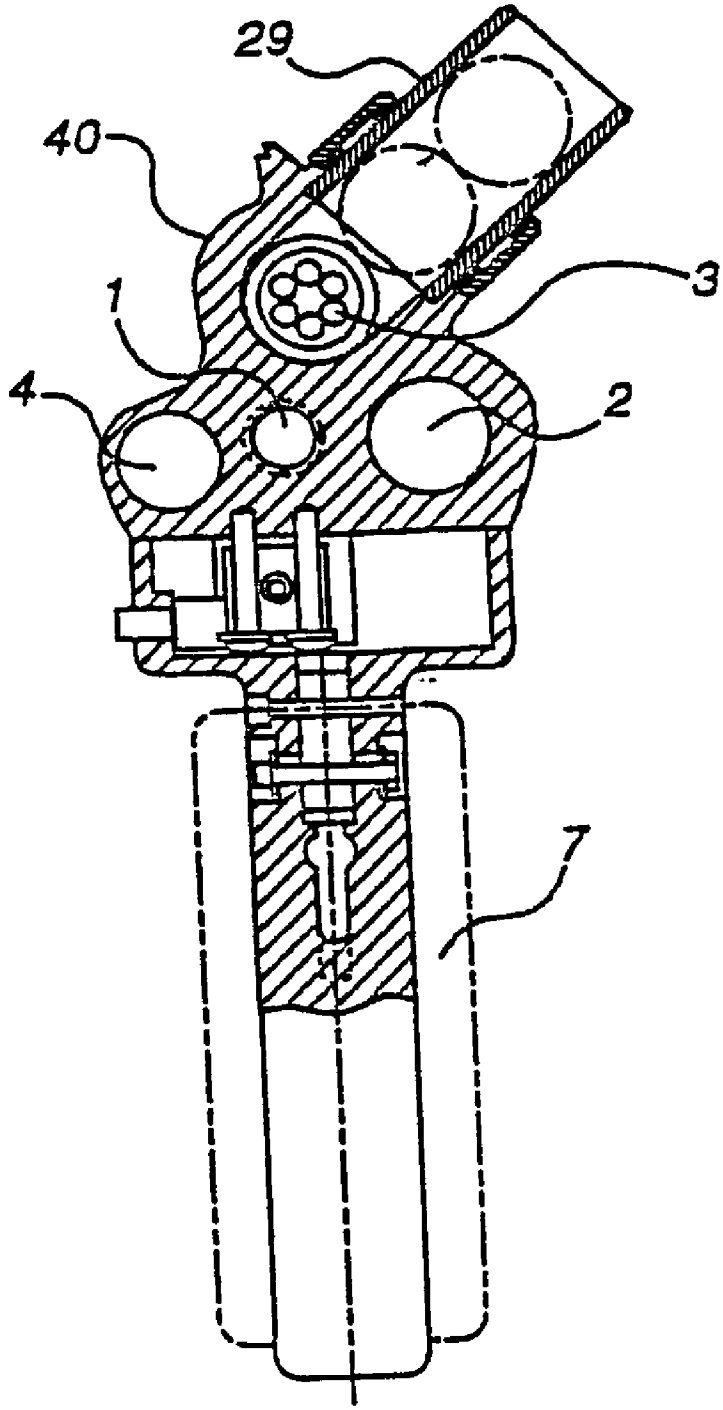

FIG. 2

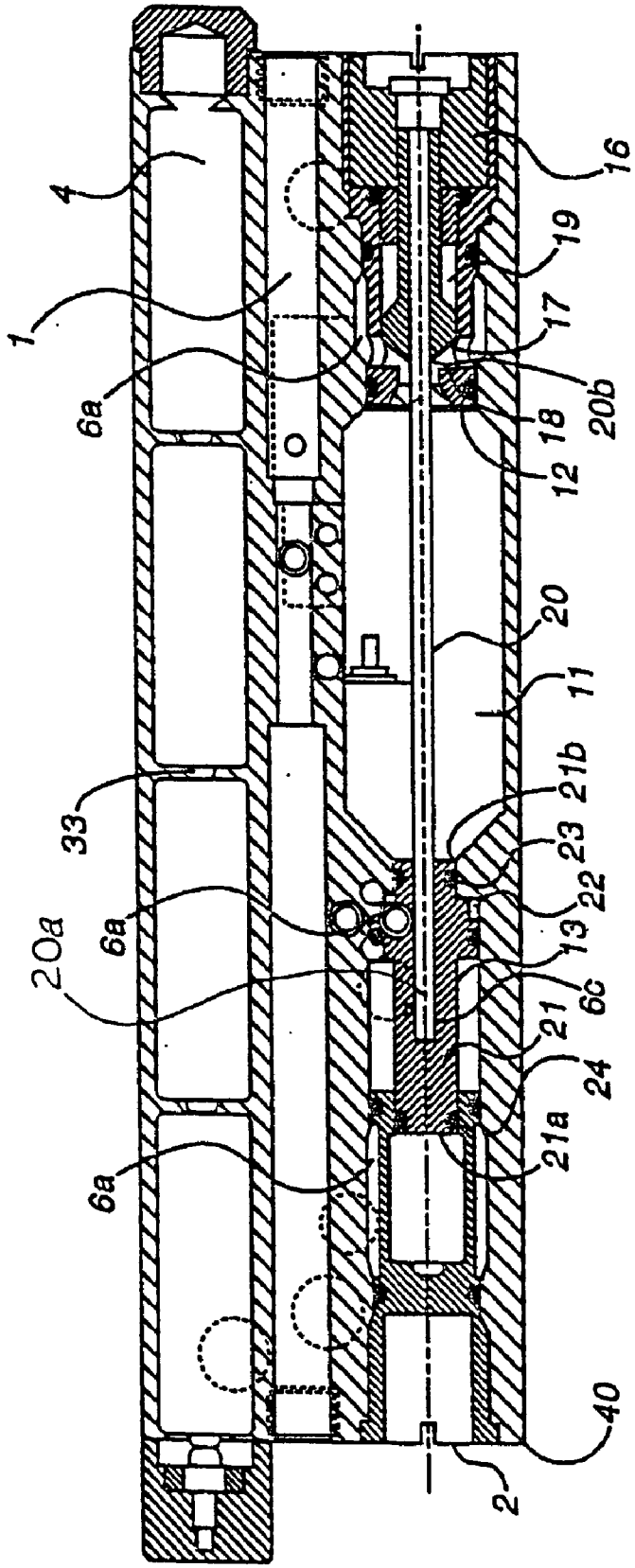
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FIG. 3

PNEUMATICALLY OPERATED PROJECTILE LAUNCHING DEVICE

FIELD OF THE INVENTION

[0001] The present invention relates to a pneumatically operated projectile launching device. A preferred embodiment of the invention is designed for use in the recreational sport of "Paintball" (also known as "Survival" or "Capture the Flag").

BACKGROUND OF THE INVENTION

[0002] The current invention consists of a device for launching a projectile using pneumatic force. Guns using pneumatic force to propel a projectile are well known. In particular, it is well known to use pneumatic force to fire a fragile spherical projectile containing a colored, viscous substance (known as a "paintball") which bursts upon impact with a target. However pneumatically operated guns used in paintball applications (as well as existing pneumatically operated guns in general) suffer from several deficiencies affecting the accuracy of the shot which are eliminated by the present invention.

[0003] Existing pneumatically operated guns invariably use a spring mechanism in some fashion to aid in generating the propellent force necessary to fire the projectile at the desired velocity from the gun. The use of a spring creates a non-linear transformation of energy from a pneumatically stored potential form into kinetic acceleration of the projectile, since the spring releases continuously less energy as it expands from its maximum deformation to its undeformed natural state. In the case of any flexible projectile in general and particularly in the case of paintballs, this non-linear transformation of energy causes some deformation in the shape of the projectile that alters the ballistic forces created upon it in flight, adversely affecting the accuracy with which the projectile can be fired to strike its intended target. The adverse ballistic effects stemming from projectile deformation are particularly felt at the low projectile-velocities required in paintball applications for player safety. Given the spring forces used in the existing state of the art, it is necessary to fire a paintball at the highest pneumatic pressures possible in order to eliminate these adverse ballistic effects. This has caused development of a thicker paintball shell to eliminate paintball breakage within the firing chamber of the gun. This increased thickness has in turn created a problem with paintball breakage as it impacts its target. To eliminate all of these problems without sacrificing player safety, it has become necessary in paintball applications to find a way to minimize projectile deformation at low pneumatic pressure levels, in order to permit the accurate sighting and firing of a low velocity shot.

[0004] The present invention solves all of these problems by eliminating the use of spring mechanisms in the transfer of energy to the projectile during the launching sequence. The invention uses a launching sequence which results in only the application of pneumatic force to the projectile. This creates a linear change in the amount of energy that is applied to the projectile as the pneumatically stored energy undergoes expansion and decompression upon release. This in turn minimizes the physical deformation of the projectile during the launching sequence, increasing the accuracy of the shot. In paintball applications, this linear application of force contributes greatly to increased accuracy, since a non-linear transfer of force at the low pressures required to limit paintball velocities to safe levels exaggerates the adverse ballistic effects on the paintball, due to its low velocity.

[0005] The accuracy of the present invention has been proven through testing at the projectile velocity levels used in paintball applications. Ten shot clusters from a conventional hand held paintball gun that is fired from a target distance of 60 yards typically exhibits an average maximum inaccuracy of 15 inches for projectile velocities in the 290 to 300 feet per second range. The same conventional paintball gun shot under the same conditions from a rigid mount typically exhibits an average maximum inaccuracy of 10 inches. In contrast, the present invention exhibited an average maximum inaccuracy of less than 8 inches when fired from a hand held position, and an average maximum inaccuracy of 4 inches when rigidly mounted.

[0006] The invention also provides increased aiming accuracy through the use of a cam shaped trigger and electrical switch arrangement to initiate the projectile launching sequence. This arrangement minimizes the pull force necessary to engage the switch by contact with the trigger, due to the mechanical advantage provided by the transfer of force through the cam. This in turn minimizes the amount of hand and arm movement experienced upon pulling the trigger, which increases firing accuracy.

[0007] Finally, the present invention also provides a significant accuracy advantage over all prior art spring-loaded guns at all pneumatic operating pressures, due to the minimized recoil experienced after a shot is fired. Typical spring-loaded guns exhibit greater recoil than does the invention, due to the non-linear reaction forces created on the gun body by the expansion of the spring. In contrast, the elimination of spring loading in the present invention eliminates these non-linear forces, minimizing the amount of recoil experienced and thus allowing greater accuracy over all types of existing spring-loaded gun designs in the firing of a shot.

[0008] Accordingly, it is an object of the present invention to provide a projectile launching device that uses only pneumatic force to propel a projectile.

[0009] It is also an object of the present invention to provide a projectile launching device for use in the recreational and professional sport of paintball that uses only pneumatic force to propel the paintball.

[0010] It is also an object of the present invention to provide a projectile launching device which can be aimed and fired with greater accuracy than all types of spring-loaded guns at all pneumatic operating pressures.

[0011] It is also an object of the present invention to provide a projectile launching device for use in the recreational and professional sport of paintball which can be aimed and fired with greater accuracy than existing paintball guns at low pneumatic operating pressures.

[0012] It is also an object of the present invention to provide a projectile launching device that uses electro-pneumatic control to release the pneumatic force that propels the projectile.

[0013] It is also an object of the present invention to provide a projectile launching device for use in the recre-

ational and professional sport of paintball that uses electro-pneumatic control to release the pneumatic force that propels the projectile.

SUMMARY OF THE INVENTION

[0014] The pneumatically operated projectile launching device is preferably comprised of three principal elements: a body which houses and interconnects all of the pneumatic components and also houses the electrical power source, a grip mounted to the body which includes an electrical switch that activates a launching sequence, and an electrical control unit housed within both the body and the grip which directs flow between the pneumatic components to load, cock and fire the gun.

[0015] The body preferably contains a plurality of bores in communication with each other including a bore containing and distributing pressurized gas, a bore containing a compressed gas storage chamber and mechanisms for filling the storage chamber with gas and releasing gas from the storage chamber to fire the projectile, and a bore containing mechanisms for loading and launching the projectile. The electrical control unit preferably includes an electrical power source which activates an electrical timing circuit when the electrical switch is closed, and two electrically operated pneumatic flow distribution devices which are sequentially energized by the electrical timing circuit to enable the loading of a projectile for launching and to release compressed gas from the storage chamber to fire the projectile, respectively.

[0016] Before the initiation of a launching sequence the compressed gas storage chamber is filled with compressed gas while the projectile launching mechanism is disabled. Filling of the compressed gas storage chamber is preferably accomplished automatically by actuation of the compressed gas filling mechanism. When the electrical switch is closed to initiate the launching sequence the projectile is first loaded into the launching mechanism by electrical timing circuit actuation of the first electrically operated pneumatic flow distribution device. The projectile is then fired when the electrical timing circuit actuates the second electrically operated pneumatic flow distribution device to release gas from the compressed gas storage chamber into the launching mechanism.

[0017] The present invention eliminates the use of spring mechanisms in the transfer of energy to the projectile during the launching sequence. The invention uses a launching sequence which results in only the application of pneumatic force to the projectile. This creates a linear change in the amount of energy that is applied to the projectile as the pneumatically stored energy undergoes expansion and decompression upon release. This in turn minimizes the physical deformation of the projectile during the launching sequence, increasing the accuracy of the shot. In paintball applications, this linear application of force contributes greatly to increased accuracy, since a non-linear transfer of force at the low pressures required to limit paintball velocities to safe levels exaggerates the adverse ballistic effects on the paintball, due to its low velocity.

[0018] The accuracy of the present invention has been proven through testing at the projectile velocity levels used in paintball applications. Ten shot clusters from a conventional hand held paintball gun that is fired from a target distance of 60 yards typically exhibits an average maximum inaccuracy of 15 inches for projectile velocities in the 290 to 300 feet per second range. The same conventional paintball gun shot under the same conditions from a rigid mount typically exhibits an average maximum inaccuracy of 10 inches. In contrast, the present invention exhibited an average maximum inaccuracy of less than 8 inches when fired from a hand held position, and an average maximum inaccuracy of 4 inches when rigidly mounted.

[0019] The invention also provides increased aiming accuracy through the use of a cam shaped trigger and electrical switch arrangement to initiate the projectile launching sequence. This arrangement minimizes the pull force necessary to engage the switch by contact with the trigger, due to the mechanical advantage provided by the transfer of force through the cam. This in turn minimizes the amount of hand and arm movement experienced upon pulling the trigger, which increases firing accuracy.

[0020] Finally, the present invention also provides a significant accuracy advantage over all prior art spring-loaded guns at all pneumatic operating pressures, due to the minimized recoil experienced after a shot is fired. Typical spring-loaded guns exhibit greater recoil than does the invention, due to the non-linear reaction forces created on the gun body by the expansion of the spring. In contrast, the elimination of spring loading in the present invention eliminates these non-linear forces, minimizing the amount of recoil experienced and thus allowing greater accuracy over all types of existing spring-loaded gun designs in the firing of a shot.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] FIG. (1) is a side view of the pneumatically operated projectile launching device.

[0022] FIG. (2) is a rear view of the pneumatically operated projectile launching device.

[0023] FIG. (3) is a top view of the body of the pneumatically operated projectile launching device.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0024] The pneumatically operated projectile launching device is preferably comprised of three principal elements: a body which houses and interconnects all of the pneumatic components and also houses the electrical power source; a grip mounted to the body which includes a trigger and an electrical switch that activates the launching sequence; and an electrical control unit housed within both the body and the grip which directs flow between the pneumatic components to load, cock and fire the gun.

[0025] As shown in FIG. (2), the body preferably has three cylindrical pneumatic bores with axes that are preferably parallel to the longitudinal axis of the gun body **40**. The gun body **40** can be made of materials suitable in the art for withstanding the force of the launching sequence such as metal or plastic. The first bore **1** contains compressed gas and is preferably sealed by a removable fitting **5** which is removed to inject the gas. The first bore **1** is preferably in communication with the second bore **2** and the third bore **3** through a series of ported passageways **6***a* and **6***b*, respectively, bored through the interior of the gun body **40**. As shown in FIG. (3), the second bore **2** houses the compressed gas storage chamber **11**, the compressed gas filling mecha-

nism **12** and the compressed gas releasing mechanism **13**. The third bore **3** is also preferably in communication with both the first bore **1** and the second bore **2** through a series of ported passageways **6***b* and **6***c*, respectively, bored through the interior of the gun body **40**. As shown in FIG. **(1)**, the third bore **3** houses the projectile loading mechanism **14** and the projectile launching mechanism **15**.

[**0026**] As shown in FIG. **(3)**, the compressed gas storage chamber **11** is bordered by the interior walls of the second bore **2** and by the compressed gas filling mechanism **12** on one end and by the compressed gas releasing mechanism **13** on the end opposite the compressed gas filling mechanism **12**. The compressed gas storage chamber **11** is filled with compressed gas from the first bore **1** by means of the interconnections **6***a* between the first bore **1** and the second bore **2** when the compressed gas filling mechanism **12** is actuated. The compressed gas storage chamber **11** releases stored gas to the projectile launching mechanism **15** by means of the interconnections **6***c* between the second bore **2** and the third bore **3** when the compressed gas releasing mechanism **13** is actuated.

[**0027**] As shown in FIG. **(3)**, the compressed gas filling mechanism **12** preferably consists of a valve **16** with a metallic or plastic conically or spherically shaped plug **17** which is normally shut against a metallic, plastic, or rubber conically or concavely shaped seat **18** by the loading of a spring **19** when the compressed gas filling mechanism **12** is not in its actuated position. The plug **17** is attached to a second end **20***b* of a metallic or plastic rod-shaped mechanical linkage **20** which opens the valve **16** by compressing the spring **19** when the compressed gas filling mechanism **12** is in its actuated position to create a flow path for compressed gas from the first bore **1** to the compressed gas storage chamber **11**.

[**0028**] As shown in FIG. **(3)**, the mechanical linkage **20** passes through the compressed gas storage chamber **11** and has a first end **20***a* which is attached to the compressed gas releasing mechanism **13**. The compressed gas releasing mechanism **13** preferably consists of a metallic or plastic cylindrical piston **21** which slides along the longitudinal axis of the second bore **2** in a space adjacent to the compressed gas storage chamber **11**. A second end **21***b* of the piston **21** is adjacent to the compressed gas storage chamber **11** and is connected to the first end **20***a* of the mechanical linkage **20**. The second end of the piston **21***b* has a flexible O-ring seal **23** made of rubber or other suitable synthetic sealing materials such as polyurethane that prevents gas leakage out of the compressed gas storage chamber **11**. Compressed gas from the first bore **1** is applied to the second end of the piston **21***b* to actuate the compressed gas releasing mechanism **13** by unseating the O-ring **23** sealing the compressed gas storage chamber **11** to allow stored gas to be released from the compressed gas storage chamber **11** into the projectile launching mechanism **15** by means of the interconnections **6***c* between the second bore **2** and the third bore **3**. The piston **21** contains a notched area **22** adjacent to the O-ring **23** that provides a surface for applying compressed gas pressure from the first bore **1** to unseat the O-ring **23** and actuate the compressed gas releasing mechanism **13**.

[**0029**] The piston **21** has a first end **21***a* opposite the compressed gas storage chamber **11** which is subjected to pneumatic pressure to actuate the compressed gas filling mechanism **12** by transmitting through the mechanical linkage **20** a compression force on the spring **19** that opens the valve **16**. The opening in the valve **16** is formed when the plug **17** is separated from the seat **18** to create a flow path for compressed gas from the first bore **1** to the compressed gas storage chamber **11** by means of the interconnections **6***a* between the first bore **1** and the second bore **2**. Compressed gas from the first bore **1** is applied to the first end of the piston **21***a* to open the valve **16** and actuate the compressed gas filling mechanism **12**. The first end of the piston **21***a* also contains a flexible O-ring seal **24** which prevents actuating pressure leakage into the compressed gas storage chamber **11** when the compressed gas filling mechanism **12** is actuated.

[**0030**] As shown in FIG. **(1)**, the third bore **3** of the gun body **40** houses the projectile loading mechanism **14** and the projectile launching mechanism **15**. The projectile loading mechanism **14** preferably consists of a metallic or plastic cylindrical piston **25** which slides along the longitudinal axis of the third bore **3**. The projectile launching mechanism **15** preferably consists of a metallic or plastic cylindrical bolt **26** which also slides along the longitudinal axis of the third bore **3** and which has a port **27** for receiving released gas from the compressed gas storage chamber **11** to propel a projectile **41** from the gun body **40**. The bolt **26** is connected to the piston **25** by a metallic or plastic rod-shaped mechanical linkage **28**, which moves the bolt **26** to receive the projectile **41** by gravity loading from the projectile feed mechanism **29** when the projectile loading mechanism **14** is actuated.

[**0031**] The projectile loading mechanism **14** is actuated when compressed gas from the first bore **1** is applied by means of the interconnections **6***b* between the first bore **1** and the third bore **3** to a first end **25***a* of the piston **25** which is attached to the mechanical linkage **28**. This compressed gas acts against the piston **25** and the mechanical linkage **28** to drive the bolt **26** back to the cocked position which enables the loading of a projectile **41** into engagement with the bolt **26** from the projectile feed mechanism **29**. The subsequent release of stored gas from the compressed gas storage chamber **11** through the bolt port **27** will drive the projectile **41** from the gun body **40**. After the launching sequence has been completed compressed gas is applied from the first bore **1** to a second end **25***b* of the piston **25** opposite the mechanical linkage **28** to disable the bolt **26** from receiving a projectile **41** by driving the bolt **26** to the shut position.

[**0032**] The second principal element is the grip, shown in FIG. **(1)**. The grip is mounted to the body and preferably houses three principal components, a handle **7**, a trigger **8** and an electrical switch **30**. The handle **7** can be made of any suitable material such as metal or plastic and is preferably shaped with a hand grip to allow the gun to be held in a pistol-like fashion. The metallic or plastic trigger **8** is attached to the handle **7** and preferably has a leading edge shaped to be pulled by two fingers with a cam shaped trailing edge to engage the electrical switch **30**. A trigger guard **9** which prevents accidental trigger displacement is preferably attached to the trigger **8**. A spring **10** preferably returns the trigger **8** to a neutral position after the electrical switch **30** has been contacted to initiate a launching sequence. The electrical switch **30** is preferably a two-pole miniature switch which contains a plunger **31** loaded by a spring **32**.

wherein said one or more solenoid valves are further configured to control an opening of the valve to cause compressed gas to enter the firing chamber from the compressed gas source based on an electronic signal from the electrical circuit.

8. A device according to claim 7, further comprising:

a pneumatic mechanism configured to receive compressed gas from the one or more solenoid valves and to vent compressed gas through the one or more solenoid valves to operate the pneumatic mechanism;

the pneumatic mechanism communicating with the bolt via a mechanical linkage; and

wherein operation of the pneumatic mechanism controls movement of the bolt.

9. A device according to claim 7, further comprising:

a compressed gas storage chamber configured to lie in a fluid path between the compressed gas source and the firing chamber to store compressed gas for the firing operation;

a pneumatic mechanism configured to receive compressed gas from the one or more solenoid valves and to vent compressed gas through the one or more solenoid valves to operate the pneumatic mechanism; and

wherein said pneumatic mechanism is configured to open the valve to release compressed gas from the compressed gas storage chamber into the firing chamber.

10. An electrically-controllable pneumatic projectile launching device, comprising:

a body comprising a trigger;

a bolt configured to be opened by the application of pneumatic force; and

an electronic circuit board mounted in the body, wherein the electronic circuit board initiates a launching operation based on trigger actuation.

11. A device according to claim 10, further comprising:

an electronic valve located in the gun body and configured to receive and selectively distribute compressed gas; and

a pneumatic mechanism located in the gun body, wherein movement of a piston in the pneumatic mechanism is controlled by the selective distribution of compressed gas through the electronic valve based on electrical signals from the electronic circuit board.

12. A device according to claim 11, wherein:

the piston is mechanically coupled to the bolt; and

the pneumatic mechanism is configured to operate the bolt.

13. A device according to claim 11, wherein the pneumatic mechanism is configured to operate a firing valve to launch a projectile from the device.

14. An electronic circuit board for controlling the device of claim 1.

15. A pneumatically operated projectile launching device, comprising:

a body which houses and interconnects pneumatic components and an electrical power source of the device;

a grip mounted to the body, said grip comprising a trigger and an electrical switch that activates a launching sequence of the device; and

an electrical control unit housed within the body, the grip, or both, said electrical control unit configured to direct a flow of compressed gas between the pneumatic components load and fire the device.

16. A device according to claim 15, wherein the electrical control unit comprises a solenoid valve.

17. A device according to claim 16, wherein the device is loaded by directing compressed gas through the solenoid valve to an end of a pneumatic mechanism to open a bolt, wherein the pneumatic mechanism is mechanically coupled to the bolt.

18. A device according to claim 16, wherein the device is fired by directing compressed gas through the solenoid valve to an end of a pneumatic mechanism to open a firing valve.

19. A device according to claim 15, comprising:

a power supply connection configured to receive power from a power supply;

an electrical timing circuit configured to receive electrical power through the power supply connection and to initiate a launching sequence of the paintball gun in response to the actuation of a trigger; and

at least one solenoid valve configured to receive one or more electronic pulses from the electrical timing circuit to launch a paintball from the paintball gun.

20. An electrical control unit according to claim 19, wherein the at least one solenoid valve comprises two three-way solenoid valves.

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