PAINTBALL GUN AND METHOD OF OPERATION

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ABSTRACT

An electro-pneumatically operated paint ball gun operates without the use of a mechanical sear, and includes a pneumatically-operated hammer assembly effective to bump open a discharge valve and fire the gun. A hammer member of the hammer assembly is preferably coupled for reciprocation in unison with a bolt of the paint ball gun. A method of operating the inventive paint ball gun includes pneumatic reciprocation of the hammer member and bolt in unison. The paint ball gun may include a pair of solenoid valves activated alternatingly to flow pressurized gas to the hammer assembly, and to allow an increased cyclic rate of operation for the paint ball gun.
PAINTBALL GUN AND METHOD OF OPERATION

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a Continuation-in-Part of U.S. application Ser. No. 10/965,599, filed 14 Oct. 2004, which is a Continuation of U.S. application Ser. No. 10/452,670, filed 30 May 2003, now U.S. Pat. No. 6,889,682, issued 10 May 2005, and the disclosure of which is hereby incorporated by reference to the extent necessary for a full enabling disclosure of this present invention.

FIELD OF THE INVENTION

[0002] The invention relates to a pneumatic marker or paint ball gun, and to a method of operating such a paint ball gun.

BACKGROUND OF THE INVENTION

[0003] Paint ball guns were originally developed for marking uses such as forestry and cattle ranching, in which frangible projectiles or paint balls were fired against trees to be harvested or cattle to be taken to market, for example. For this reason, the paint ball guns themselves are frequently referred to as “markers.” But, more recently paint ball guns are much more widely used in various recreational environments, such as simulated war games wherein it is the intent to shoot at an opposing player with the paint ball gun, thus marking this opposing player with a particular color of paint from a frangible paint ball.

[0004] Paint ball guns using compressed air or gas for power are well known. Until recently, most paint ball guns were pneumatically powered, mechanically operated guns. The entry of electro-pneumatically operated paint ball guns provided more consistent and better performing guns for the recreational market. An electro-pneumatic paint ball gun provides improved performance with fewer component malfunctions than the earlier mechanical-pneumatic paint ball guns. However, a common problem with the conventional electro-pneumatic paint ball guns is that they use a mechanical sear device to release a hammer. The hammer is spring loaded to a position at which it impacts a valve stem, opening a flow path for high pressure gas to communicate to a paint ball, propelling the paint ball through and from a barrel of the gun. The adjustment of the engagement and release of the mechanical hammer and sear remains an uncertain element of conventional paint ball gun operation, requiring frequent adjustments in order to operate at high cyclic rates.

[0005] One variety or type of conventional paint ball gun is referred to as an “open bolt gun.” In such a paint ball gun, a reciprocating bolt opens and closes the breach of the gun, and in the “ready” condition of the gun, this bolt is open. When the operator of the gun pulls the trigger, the bolt closes under action of a pneumatic ram, and a mechanical sear mechanism is synchronized with the closing of the bolt to open a discharge valve, delivering pressurized gas to the now-closed breach to discharge the paint ball. As can be understood from this explanation, the successful operation of such an open bolt paint ball gun involves a considerable timing challenge in order to achieve high cyclic rates (i.e., high rates of paint ball fire).

SUMMARY OF THE INVENTION

[0006] In view of the deficiencies of the related art, it is an object for this invention to mitigate or eliminate at least one of these deficiencies.

[0007] Specifically, it is an object for this invention to provide a paint ball gun having no mechanical sear for releasing a hammer to discharge pressurized gas for firing a paint gun from the gun.

[0008] Another object for this invention is to provide such a paint ball gun in which a hammer is pneumatically driven in one direction only to discharge the paint ball gun, and is driven in the opposite direction by a controlled pneumatic leakage path using a small excess of pressurized fluid from the paint ball discharge.

[0009] Yet another object for this invention is to provide a paint ball gun in which the pneumatic operation of the gun components is effected using the same pressure level of pressurized gas as is used to discharge the paint ball from the gun.

[0010] In view of the object immediately above, it will be appreciated that an object for this invention is to provide a paint ball gun utilizing a single pressure regulator effecting reduction in gas pressure from the storage pressure of the source to the single operating pressure of the gun.

[0011] Accordingly, one particularly preferred embodiment of the present invention provides a paint ball gun comprising: a body carrying a grip frame with a trigger, and a barrel for discharging a paint ball, a bolt member reciprocating on the body to open and close a breech of the barrel, and a pneumatic hammer assembly including a hammer member operably coupled to the bolt to reciprocate in unison therewith, a pressure regulator receiving high pressure gas from a source thereof and providing a regulated gas pressure for discharge of paint balls from the gun, a discharge valve flowing the regulated gas pressure to the barrel to discharge a paint ball therefrom, and a solenoid valve controllably providing the regulated gas pressure to the pneumatic hammer assembly to controllably operate the discharge valve in response to actuation of the trigger to fire a paint ball from the paint ball gun.

[0012] Additional objects and advantages of the present invention will become apparent to those ordinarily skilled in the pertinent arts upon reading the following detailed description of

[0013] a particularly preferred embodiment of the invention, which illustrates the best mode contemplated for practicing the invention, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. 1 is a side elevation view, partially in cross section, of a paint ball gun embodying the present invention, and shows the paint ball gun in the condition it has immediately preparatory to firing a paint ball;

[0015] FIG. 2 is a side elevation view similar to FIG. 1, and also partially in cross section, and shows the paint ball gun in the condition it has immediately after the moment the trigger is pulled in order to fire a paint ball;
FIG. 3 is a side elevation view similar to FIGS. 1 and 2, also partially in cross section, and shows the paint ball gun in the condition it has at the moment pressurized gas is communicated to a paint ball within the barrel of the gun, thus to fire this paint ball from the barrel;

FIG. 4 is another side elevation view similar to FIGS. 1-3, and is also partially in cross section, and shows the paint ball gun in the condition it has next in sequence after the condition of FIG. 3;

FIG. 4A is an enlarged fragmentary view of a portion of FIG. 3;

FIG. 5 is a side elevation view similar to FIGS. 1-4, also partially in cross section, and shows a second embodiment of paint ball gun embodying the present invention preparatory to firing a paint ball;

FIG. 6 is yet another side elevation view similar to FIG. 5, and is also partially in cross section, and shows the paint ball gun in the condition it has next in sequence after the condition of FIG. 5;

FIG. 7 is yet another side elevation view similar to FIGS. 5 and 6, and is also partially in cross section, and shows the paint ball gun in the condition it has next in sequence after the condition of FIG. 6;

FIG. 8 is yet another side elevation view similar to FIGS. 5, 6, and 7 and is also partially in cross section, and shows the paint ball gun in the condition it has next in sequence after the condition of FIG. 7;

FIG. 9 is a side elevation view similar to FIGS. 1-4, and 5-8 also partially in cross section, and shows a third embodiment of paint ball gun embodying the present invention preparatory to firing a paint ball;

FIG. 10 is yet another side elevation view similar to FIG. 9, and is also partially in cross section, and shows the paint ball gun in the condition it has next in sequence after the condition of FIG. 9;

FIG. 11 is yet another side elevation view similar to FIGS. 9 and 10, and is also partially in cross section, and shows the paint ball gun in the condition it has next in sequence after the condition of FIG. 10;

FIG. 12 is yet another side elevation view similar to FIGS. 9, 10, and 11 and is also partially in cross section, and shows the paint ball gun in the condition it has next in sequence after the condition of FIG. 11;

FIG. 13 is a side elevation view similar to FIGS. 1-4, 5-8, and 9-12, and is analogous to FIGS. 2, 6, and 10. FIG. 13 is also partially in cross section, and shows a fourth embodiment of paint ball gun embodying the present invention including a double-solenoid firing arrangement at some time after a trigger pull, and during the process of firing a paint ball;

FIG. 14 is a side elevation view similar to FIG. 11, and is also partially in cross section, and shows fourth embodiment of the paint ball gun in the condition it has next in sequence after the condition of FIG. 13;

FIG. 15 is yet another side elevation view similar to FIGS. 4, 8, and 12, and is also partially in cross section, and shows the fourth embodiment of paint ball gun in the condition it has next in sequence after the condition of FIG. 14.

FIGS. 16 and 17 are diagrammatic illustrations of alternative embodiments of a double-solenoid firing arrangement which may be employed in any of the other embodiments disclosed herein.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawing Figures in conjunction with one another, and first considering especially FIG. 1, a first embodiment of paint ball gun 10 includes a main body 12, with a grip frame 14 pivotally carrying a trigger 16 and defining a trigger guard 18. A barrel 20 is attached to the main body 12, and defines a breech opening 22a by which a paint ball is received along a feed tube 28, and muzzle opening 22b by which a paint ball is discharged. A gas inlet regulator body 24 is also attached to the main body 12, and provides communication via an inlet 24a (arrowed on FIG. 1) with a source of high pressure gas (not shown in the drawing Figures) for powering the paint ball gun 10.

A paint ball hopper and feeding device (also not seen in the drawing Figures) can be mounted on the top of the main body 12, feeding paintballs 26 into the gun 10 (i.e., into breech opening 22a) via an upper extent of feed tube 28 defining a feed port 30. The feed port 30 opens into a top one 32 of two substantially parallel and vertically spaced bores (i.e., bores 32 and 34) defined by the main body 12. The barrel 20 is received (i.e., threadably attached) at a rear portion thereof into the front of bore 32, and is able to receive and discharge the paint balls 26. A bolt assembly 36 is reciprocally and sealingly received into the rear portion of bore 32, and cooperates with the feed port 30 and with the barrel 20 at breech opening 22a to define a breech chamber 38 in which a paint ball is sealingly received and is held until it is forcefully discharged from the gun 10 by a blast of pressurized gas, viewing FIG. 1, as will be further explained.

The gas inlet regulator 24 provides pressurized gas (i.e., compressed air, nitrogen, or carbon dioxide, for example) into a bore portion 34a. The pressurized gas provided into bore portion 34a is of a singular regulated pressure, as will be further noted below. Also, a front part of the bore portion 34a communicates via a manifold piece 40 (which sealingly closes this bore at the front of the gun 10) with an accumulator chamber 42. The accumulator chamber 42 simply stores a quantity of pressurized gas at the pressure supplied by regulator 24 in order to provide for operation of the gun 10. It is seen that the bore portion 34a also communicates rearwardly to a larger diameter bore portion 34b, which serves also to define an additional gas volume accumulator or chamber 34c, storing a quantity of immediately-available pressurized gas in preparation for a firing operation of the gun 10.

Viewing FIGS. 1-4, and now particularly FIG. 4A, it is seen that a discharge valve assembly 44 is sealingly received in the bore 34a of the bore portion 34b, and includes a seat member 46 movably receiving a poppet valve member 48. The poppet valve member 48 includes an elongate stem portion 50 extending rearwardly through the seat member 46. The seat member 46 also defines a flow
passage 52 communicating via a passage 54 defined by the housing 12 between the bores 32 and 34, to communicate pressurized gas from chamber 34c via a passage 36a of the bolt assembly 36 and to the breech chamber 38 when the poppet valve member 48 is unseated, as will be further explained below. A coil spring 56 yieldably urges the poppet valve member 48 into sealing engagement with the seat member 46.

In order to effect closing of the bolt 36, trapping the paint ball 26 in chamber 38, a pneumatic ram and hammer member 58 (hereinafter referred to simply as a “hammer member”) is received into a cylinder 60 within the aft end portion of bore 34. The hammer member 58 includes a head portion 58a, from which a pin 62 extends through a slot 64 interconnecting respective portions of the bores 32 and 34 to engage with the bolt 36. Consequently, the bolt 36 moves in reciprocation in synchronization with the hammer member 58. A small protrusion 58b of the hammer head portion 58a aligns with and is engageable with the stem 50 of the poppet valve 48 in order to open this poppet valve substantially at the forward extent of travel for the bolt member 36.

Viewing FIGS. 1-4, it is seen that a fluid flow connection (i.e., for the flow of the singular regulated gas pressure from regulator 24) is provided from the manifold piece 40 via a conduit 66 to an inlet port 68 of a singular solenoid valve 70. The solenoid valve 70 includes an outlet port 72, to which the inlet port communicates when the solenoid valve is energized; and a vent port 74 (indicated by the arrowed reference numeral on the Figures) to which the outlet port 72 is connected when the solenoid valve is de-energized. Another conduit 76 communicates the pressurized gas from outlet port 72 to a fitting 78 disposed on the exposed external portion 60a of cylinder 60, and communicates this pressurized gas into the cylinder to act upon hammer member 58.

Further considering the drawing FIGS. 1-4, it is seen that the grip frame 14 houses an electronic assembly 80 including a circuit board 82 upon which is mounted a microprocessor-based control system, indicated with arrowed numeral 84. A battery 80a is provided to power the assembly 80. A switching device 86 (i.e., a microswitch in this embodiment, although the invention is not so limited) is arranged to be activated by rearward movement of the trigger 16 (i.e., by means of an interposed push rod 88) so as to discharge the gun 10, as is further explained below. It is to be noted at this time that while the switching device 86 is depicted in the present embodiment as including or being a micro-switch, the invention is not so limited. For example, another type of electrical contact switch, or an electro-optical switching device may be alternatively employed.

In order to complete this description of the structure seen in FIGS. 1-4, attention is directed to FIG. 4A in which an enlarged view of the discharge valve assembly 44 is presented. It is seen viewing this figure that the valve stem portion 50 includes a portion 50a, which is movably disposed in a bore 90 defined within a spool member 92 sealingly disposed within the bore 34. The spool member 92 defines the seat 46 for the discharge valve assembly 44. The portion 50a of this valve stem defines at least one longitudinally extending groove or slot 94, which establishes a controlled leakage path between the chamber 34c and a chamber 96 defined between the head portion 58a of hammer member 58, and the spool member 92. It will be noted now that this controlled leakage along the stem portion 50 also communicates the chamber 96 to the breach 22a of gun 10.

It will be seen that the operation of the gun 10 is as follows: With a source of high pressure gas connected to the inlet 24a of the gas inlet regulator 24, with a supply of paint balls 26 provided to the feed tube 28, and with the controller 84 energized (i.e., by the on-board battery 80a, for example) the gun 10 is ready for shooting. In preparation for such shooting, the operator can place a first paint ball 26 into the breech chamber 38 by manually grasping and pulling the aft portion 36b of bolt 36 rearwardly to place a paint ball from feed port 30 into chamber 38, preparing the gun 10 so that is in the condition of FIG. 1. In this condition of FIG. 1, the bolt 36 is open, solenoid valve 70 is de-energized, and pressurized gas is provided into chamber 34c (as well as to accumulator 42) via the regulator 24. It will be noted that the gun 10 utilizes a singular regulated gas pressure level. The hammer member 58 is also in its first position (aft position) of FIG. 1. This is the “ready” condition for the gun 10.

Considering FIG. 2, when the trigger 16 is pulled by the operator the control system 84 momentarily energizes solenoid valve 70 (i.e., for a selected time interval sufficient to effect a firing operation of the gun 10), applying pressurized gas to the aft end of hammer member 58. When the solenoid valve 70 later is de-energized, the pressurized gas is vented via vent port 74. Consequently, in response to a trigger actuation the hammer member 58 moves quickly and forcefully forward (refer to FIG. 2—and noting the movement arrows on this figure), driving bolt 36 also forward, so that the bolt 36 closes sealingly trapping the paint ball 26 in chamber 38, and so that the protrusion 58b impacts against the aft end of valve stem 50 (refer to FIG. 3), unseating the poppet valve member 48. Thus, pressurized gas flows from chamber 34c along passages 52, 54, (referring to FIG. 4A) and 36a and to chamber 38, discharging the paint ball 26 along barrel 20 (refer to FIG. 3).

At the same time, a controlled leakage flow of pressurized gas flows from chamber 34c along slot 94 and to chamber 96 (particularly referring to FIG. 4A). This leakage flow of pressurized gas is sufficient to drive the hammer member (and bolt 36) once again rearwardly as is seen in FIG. 4 back to the position seen in FIG. 1 (i.e., because at this time the pressurized gas has been vented from cylinder 60 by operation of solenoid valve 70). As noted, the slot 94 also communicates chamber 96 to chamber 38 (which will be receiving a new paint ball via feed tube 28) and which is now open to ambient through both feed tube 28 (because bolt 36 is open or is opening) as well as via the barrel 20. Consequently, the chamber 96 initially receives a “puff” of pressurized gas while the poppet valve 48 is open, which starts the hammer 58 and bolt 36 into return motion (i.e., leeward motion as seen in FIG. 4), and then after the paintball 26 has been fired from barrel 20, this chamber 96 quickly leaks down substantially to ambient pressure in preparation for another firing operation of the gun 10.

Referring now to FIGS. 5-8, another embodiment (second embodiment) of a paint ball gun according to the present invention is illustrated. In order to obtain reference numerals for us in describing this second embodiment to paint ball gun, features which are the same as or analogous
to those of the first embodiment are referenced on FIGS. 5-8 using the same numeral employed above, and increased by one-hundred (100).

[0043] Considering now FIG. 5, a paint ball gun 110 includes a main body 112, with a grip frame 114 pivotally carrying a trigger 116 and defining a trigger guard 118. A barrel 120 is attached to the main body 112, and defines a breech opening 122a by which a paint ball is received along a feed tube 122b, and muzzle opening 122c by which a paint ball is discharged. A gas inlet regulator body 124 is also attached to the main body 112, and provides communication via an inlet 124a (arrowed on FIG. 5) with a source of high pressure gas (not shown in the drawing Figures) for powering the paint ball gun 110.

[0044] An upper feed tube 128 defines a feed port 130. The feed port 130 opens into a top one 132 of two substantially parallel and vertically spaced bores (i.e., bores 132 and 134) defined by the main body 112. The barrel 120 is received (i.e., threadably attached) at a rear portion thereof into the front of bore 132, and is able to receive and discharge paint balls. A bolt assembly 136 is reciprocally and sealingly received into the rear portion of bore 132, and cooperates with the feed port 130 and with the barrel 120 at breech opening 122a to define a breech chamber 138 in which a paint ball is sealingly received and is held until it is forcefully discharged from the gun 110 by a blast of pressurized gas.

[0045] The gas inlet regulator 124 provides pressurized gas into a bore portion 134a. Again, the pressurized gas provided into bore portion 134a is of a singular regulated pressure. A front part of the bore portion 134a communicates via a manifold piece 140 with an accumulator chamber 142. The bore portion 134a communicates rearwardly to a larger diameter bore portion 134b.

[0046] A discharge valve assembly 144 is sealingly received in the bore 134a, and the bore portion 134b, and includes a seat member 146 movably receiving a poppet valve member 148. The poppet valve member 148 includes an elongate stem portion 150 extending rearwardly through the seat member 146. The seat member 146 also defines a flow passage 152 communicating via a passage 154 defined by the housing 112 between the bores 132 and 134, to communicate pressurized gas from chamber 134c via a passage 136a of the bolt assembly 136 and to the breech chamber 138 when the poppet valve member 148 is unseated, as will be further explained below. A coil spring 156 yieldably urges the poppet valve member 148 into sealing engagement with the seat member 146.

[0047] In order to effect closing of the bolt 136, trapping the paint ball 126 in chamber 138, a pneumatic ram and hammer member 158 (hereinafter referred to simply as a “hammer member”) is received into a cylinder 160 within the aft end portion of bore 134. The hammer member 158 includes a head portion 158a, from which a pin 162 extends through a slot 164 interconnecting respective portions of the bores 132 and 134 to engage with the bolt 136. Consequently, the bolt 136 moves in reciprocation in synchronization with the hammer member 158. An elongate protrusion 158b of the hammer head portion 158a aligns with and is engageable with the stem 150 of the poppet valve 148 in order to open this poppet valve.

[0048] Viewing FIGS. 5-8, it is seen that a fluid flow connection (i.e., for the flow of the singular regulated gas pressure from regulator 124) is provided from the manifold piece 140 via a conduit 166 to an inlet port 168 of a singular solenoid valve 170. The solenoid valve 170 includes an outlet port 172, to which the inlet port communicates when the solenoid valve is energized; and a vent port 174 (indicated by the arrowed reference numeral on the Figures) to which the outlet port 172 is connected when the solenoid valve is de-energized. Another conduit 176 communicates the pressurized gas from outlet port 172 to a fitting 178 disposed on the exposed external portion 160a of cylinder 160, and communicates this pressurized gas into the cylinder to act upon hammer member 158.

[0049] Further considering the drawing FIGS. 5-8, it is seen that the grip frame 114 houses an electronic assembly 180 including a circuit board 182 upon which is mounted a microprocessor-based control system, indicated with arrowed numeral 184. A switching device 186 (i.e., a microswitch in this embodiment) is arranged to be activated by rearward movement of the trigger 116 acting through a push rod 88 so as to discharge the gun 110, as is further explained below.

[0050] In contrast to the first embodiment, in which FIG. 4A depicts valve stem defining at least one longitudinally extending groove or slot 94, and the establishment of a controlled leakage path between the chamber 34c and a chamber 96, the second embodiment does not employ this controlled leakage of pressurized gas to restore the hammer member 158, and the bolt 136, to their respective aft positions. Instead, the second embodiment illustrated in FIGS. 5-8 utilizes an elongate coil spring 100 which is in part disposed about the portion 158a of the hammer member 158 and extends to seat against the spool member 192. This coil compression spring yieldably biases the hammer member 158 and bolt 136 to their first positions seen in FIG. 5.

[0051] The operation of the gun 110 is as follows: with the gun 110 in the condition of FIG. 5, when the trigger 116 is pulled by the operator the control system 184 momentarily energizes solenoid valve 170 applying pressurized gas to the aft end of hammer member 158. The hammer member 158 moves forcefully forward (refer to FIG. 6), driving bolt 136 also forward, so that the bolt 136 closes trapping a paint ball 126 in chamber 138, and so that the protrusion 158b impacts against the aft end of valve stem 150 (refer to FIG. 7), unseating the poppet valve member 148. Thus, pressurized gas flows from chamber 134c along passages 152, 154, and 156a and to chamber 138, discharging the paint ball 126 along barrel 120 (refer to FIG. 7).

[0052] In this embodiment, forward movement of the hammer member 158 and bolt 136 compresses spring 100. After the hammer member 158 bumps open the poppet valve member 148 discharging the paint ball 126, the spring 100 drives the hammer member 158 and bolt 136 back to the positions seen in FIG. 5, preparing the gun 110 for another firing action.

[0053] Turning to FIGS. 9-12, still another embodiment (third embodiment) of a paint ball gun according to the present invention is illustrated. In order to obtain reference numerals for us in describing this second embodiment to paint ball gun, features which are the same as or analogous to those of the first embodiment are referenced on FIGS. 9-12 using the same numeral employed above, and increased by two-hundred (200).
Considering now FIG. 9, a paint ball gun 210 includes a main body 212, with a grip frame 214 pivotally carrying a trigger 216 and defining a trigger guard 218. A barrel 220 is attached to the main body 212, and defines a breech opening 222a by which a paint ball is received along a feed tube 228, and muzzle opening 222b by which a paint ball is discharged. A gas inlet regulator body 224 provides communication via an inlet 224a (arrowed on FIG. 8) with a source of high pressure gas for powering the paint ball gun 210. The upper extent of feed tube 228 defines a feed port 230. A bolt assembly 236 is reciprocally and sealingly received into the rear portion of bore 232, and cooperates with the feed port 230 and with the barrel 220 at breech opening 222a to define a breech chamber 238.

The gas inlet regulator 224 provides pressurized gas at a first regulated gas pressure into a bore portion 234a. However, a front part of the bore portion 234a communicates the first regulated gas pressure via a manifold piece 240 with a second regulator 202, which provides a second (and lower) regulated gas pressure level.

A discharge valve assembly 244 is sealingly received in the bore 234 aft of the bore portion 234a, and includes a seat member 246 movable receiving a poppet valve member 248. The poppet valve member 248 includes an elongate stem portion 250 extending rearwardly through the seat member 246. The seat member 246 also defines a flow passage 252 communicating via a passage 254 defined by the housing 212 between the bores 232 and 234, to communicate pressurized gas at the first regulated gas pressure from chamber 234a via a passage 236c of the bolt assembly 236 and to the breech chamber 238 when the poppet valve member 248 is unseated, as will be further explained below. A coil spring 256 yieldably urges the poppet valve member 248 into sealing engagement with the seat member 246.

In order to effect closing of the bolt 236, trapping the paint ball 226 in chamber 238, a pneumatic ram and hammer member 258 (hereinafter referred to simply as a “hammer member”) is received into a cylinder 260 within the aft end portion of bore 234. The hammer member 258 includes a head portion 258a, from which a pin 262 extends through a slot 264 interconnecting respective portions of the bores 232 and 234 to engage with the bolt 236. Consequently, the bolt 236 moves in reciprocation in synchronization with the hammer member 258. An elongate protrusion 258b of the hammer head portion 258a aligns with and is engageable with the stem 250 of the poppet valve 248 in order to open this poppet valve.

Viewing FIGS. 9-12, it is seen that a fluid flow connection (i.e., for the flow of the second regulated gas pressure from second regulator 102) is provided from a fitting 204 via a conduit 266 to an inlet port 268 of a singular solenoid valve 270. The solenoid valve 270 includes an outlet port 272, to which the inlet port communicates when the solenoid valve is energized; and a vent port 274 (indicated by the arrowed reference numeral on the Figures) to which the outlet port 272 is connected when the solenoid valve is de-energized. Another conduit 276 communicates the pressurized gas from outlet port 272 to a fitting 278 disposed on the exposed external portion 260a of cylinder 260, and communicates this pressurized gas into the cylinder to act upon hammer member 258.

In contrast to the first embodiment, in which FIG. 4A depicts valve stem 50 defining at least one longitudinally extending groove or slot 94, and like the second embodiment described above, the third embodiment of FIGS. 9-12 utilizes an elongate coil spring 200 which is in part disposed about the portion 258a of the hammer member 258 and extends to seat against the spool member 292. This coil compression spring yieldably biases the hammer member 258 and bolt 236 to their first positions seen in FIG. 9.

The operation of the gun 210 is as follows: with the gun 210 in the condition of FIG. 9, when the trigger 216 is pulled by the operator the control system 284 momentarily energizes solenoid valve 270 applying pressurized gas at the second regulated gas pressure to the aft end of hammer member 258. The hammer member 258 moves forcefully forward (refer to FIG. 10), driving bolt 236 also forward, so that the bolt 236 closes trapping a paint ball 226 in chamber 238, and so that the protrusion 258a impacts against the aft end of valve stem 250 (refer to FIG. 11), unseating the poppet valve member 248. Thus, pressurized gas at the first regulated gas pressure flows from chamber 234c along passages 252, 254, and 236a and to chamber 238, discharging the paint ball 226 along barrel 220 (refer to FIG. 11). In this third embodiment, forward movement of the hammer member 258 and bolt 236 compresses spring 200. After the hammer member 258 bumps open the poppet valve member 248 discharging the paint ball 226, the spring 200 drives the hammer member 258 and bolt 236 back to the positions seen in FIG. 5, preparing the gun 210 for another firing action.

Turning to FIGS. 13-15, yet another embodiment (fourth embodiment) of a paint ball gun according to the present invention is illustrated. In order to obtain reference numerals for us in describing this fourth embodiment to paint ball gun, features which are the same as or analogous to those of the first embodiment are referenced on FIGS. 13-15 using the same numeral employed above, and increased by three-hundred (300). As is noted with respect to some elements of the fourth embodiment, component parts differ from the preceding embodiments and these differences are explained below.

Considering now FIG. 13, a double-solenoid valve paint ball gun 310 includes a main body 312, with a grip frame 314 pivotally carrying a trigger 316 and defining a trigger guard 318. A barrel 320 is attached to the main body 312, and defines a breech opening 322a by which a paint ball is received along a feed tube 328, and muzzle opening 322b by which a paint ball is discharged. A gas inlet regulator body 324 provides communication via an inlet 324a (arrowed on FIG. 13) with a source of high pressure gas for powering the paint ball gun 310. The upper extent of feed tube 328 defines a feed port 330. A bolt assembly 336 is reciprocally and sealingly received into the rear portion of bore 332, and cooperates with the feed port 330 and with the barrel 320 at breech opening 322a to define a breech chamber 338.

The gas inlet regulator 324 provides pressurized gas at a first regulated gas pressure into a bore portion 334a. However, a front part of the bore portion 334a communicates the first regulated gas pressure via a manifold piece 340 with a second regulator 202, which provides a second (and lower) regulated gas pressure level.
A discharge valve assembly 344 is sealingly received in the bore 334 aft of the bore portion 334b, and includes a seat member 346 movably receiving a poppet valve member 348. The poppet valve member 348 includes an elongate stem portion 350 extending rearwardly through the seat member 346. The seat member 346 also defines a flow passage 352 communicating via a passage 354 defined by the housing 312 between the bores 332 and 334, to communicate pressurized gas at the first regulated gas pressure from chamber 334c via a passage 336a of the bolt assembly 336 and to the breech chamber 338 when the poppet valve member 348 is unseated, as will be further explained below. A coil spring 356 yieldably urges the poppet valve member 348 into sealing engagement with the seat member 346.

In order to effect closing of the bolt 336, trapping the paint ball 326 in chamber 338, a pneumatic ram and hammer member 358 (hereinafter referred to simply as a “hammer member”) is received into a cylinder 360 within the aft end portion of bore 334. The hammer member 358 includes a head portion 358a, from which a pin 362 extends through a slot 364 interconnecting respective portions of the bores 332 and 334 to engage with the bolt 336. Consequently, the bolt 336 moves in reciprocation in synchronization with the hammer member 358. An elongate protrusion 358b of the hammer head portion 358a aligns with and is engageable with the stem 350 of the poppet valve 348 in order to open the poppet valve.

Viewing FIGS. 13-15, it is seen that a fluid flow connection (i.e., for the flow of the second regulated gas pressure from second regulator 202) is provided from a fitting 204 via a conduit 366 to a respective pair of inlet ports (respectively referenced with the numerals 368a and 368b) of a pair of solenoid valves, which are respectively referenced with the numerals 370a and 370b. The solenoid valves 370a/b each include an outlet port, respectively 372a and 372b. These outlet ports 372a/b are individually connected via respective conduits 376a and 376b each with an intervening check valve 374a and 374b to a T-fitting 378. Consequently, either one of the solenoid valves 370a/b may provide pressurized gas to the T-fitting 378, and to the hammer assembly, as is further explained below. Interposed between the T-fitting 378 and the hammer assembly is a quick exhaust valve (QEV) 379. This QEV 379 normally vents the cylinder 360 to ambient when pressurized gas is not applied to the QEV 379. However, when pressurized gas is provided to the T-fitting 378 via either one of the check valves 374a/b, from either one of the pair of solenoid valves 370a/b, then the QEV 379 closes communication of the cylinder 360 to ambient, and connects the pressurized gas into the cylinder 360 of the hammer assembly 358. On the other hand, once one of the solenoid valves 370a/b is activated, and then is de-activated, the QEV valve 379 vents the pressurized gas from the cylinder 360 immediately to ambient. This quick venting of the pressurized gas from cylinder 360 provides for a faster cyclic operation of the gun 310. It is to be understood that the double-solenoid valve arrangement described with reference to the present disclosure may be employed with any of the embodiments here described, as well as with other embodiments of paint ball gun, such as those which operate with a closed-bolt operation.

The operation of the gun 310 is as follows: FIG. 13 shows the gun in a condition analogous to that of FIG. 10, and some time after the trigger 316 has been pulled. The control system 384 has momentarily energized a selected one of the solenoids valves 370a/b, applying pressurized gas via the respective check valve 376a/b to the T-fitting 379 and to QEV 379. The QEV 379 closes communication of the cylinder 360 to ambient, and communicates the pressurized gas into the cylinder 360 moving the ram 358a to the position seen in FIG. 13, where the ram 358a has just impacted and is about to open the valve 348. The forward movement of the bolt 336 has moved paint ball 326 into the breech and chamber 338 of barrel 320.

Thus, as FIG. 13 shows, pressurized gas at the first regulated gas pressure will flow from chamber 334c along passages 352, 354, and 336a to and chamber 338, discharging the paint ball 326 along barrel 320 as is further explained below. Note that FIG. 13 shows just the initial movement of paint ball 326 into the chamber 338 of the barrel 320. That is, it will be seen that in this fourth embodiment also, forward movement of the hammer member 358 and bolt 336 compresses spring 300. After the hammer member 358 bumps open the poppet valve member 348 discharging the paint ball 326, the spring 300 drives the hammer member 358 and bolt 336 back to the starting positions, not seen in the drawing Figures, but refer to FIG. 9 for illustration of the analogous positions.

FIG. 14 shows the paint ball gun with paint ball 326 being discharged from the barrel 320, while FIG. 15 shows the bolt 336 being moved back toward its open position by action of hammer assembly 358. It is to be noted that the quick opening action of the ram 358a and of the bolt 336 are facilitated in this embodiment because as soon as the activated one of the pair of solenoid valves 370a/b is deactivated, and as soon as communication of pressurized gas from the deactivated solenoid valve 370a/b stops, the QEV 379 opens to vent pressurized gas from the cylinder 360. This quick venting of pressurized gas from the cylinder 360 facilitates rapid return of the ram 358a and bolt 336 to their starting positions, so that another firing cycle of the gun 310 may be started more quickly also. These actions and conditions of a paint ball gun according to the present invention will by now be familiar to the reader.

Importantly, it is to be noted that upon the operator of the gun 310 actuating the trigger 316 a next successive time, the actions described above are repeated, except that the control system 384 actuates the other of the pair of solenoid valves 370. That is, the solenoid valves 370 are alternately activated by the control system 384 in response to successive trigger activations by an operator of the paint ball gun 310. This alternating activation of the solenoid valves 370 permits an improved (i.e., faster) cycle rate of fire for the paint ball gun 310.

Further to the above, FIGS. 16 and 17 each illustrate alternative embodiments of the gun 310 seen in FIGS. 13-15. That is, the embodiments of FIGS. 16 and 17 differ from the fourth embodiment of FIGS. 13-15 only with respect to the plumbing and arrangement of functional flow-control elements disposed in fluid flow communication between a pair of solenoid valves and the hammer assembly 358. Accordingly, the alternative embodiments of FIGS. 16 and 17 are illustrated only schematically, with reference to
FIGS. 13-15 being made if necessary to remind the reader of the physical structure associated with the schematically illustrated elements of FIGS. 16 and 17. In order to obtain reference numerals for use in describing the embodiments of FIGS. 16 and 17, the analogous elements of these Figures are respectively indicated by reference numerals respectively increased by 100 (or by 200) over FIGS. 13-15.

[0073] Viewing FIG. 16, a paint ball gun 410 includes a pair of solenoid valves 470a/b, which are each individually connected via conduits 476a/b to respective quick exhaust valves (QEV) 479a/b. The QEV's 479a/b each communicate to a shuttle valve 478. The shuttle valve communicates pressurized gas from the one of the QEV's 479a/b which is pressurized to the cylinder 460 of a hammer assembly 458, as will be well understood in view of the schematic illustration of FIG. 16. In operation of the embodiment of FIG. 16, dependent on which one of the solenoid valves 470a/b is activated, the pressurized gas is communicated along one of the conduits 476a/b to one of the QEV's 479a/b. The one QEV 479a/b which receives pressurized gas closes communication with ambient, and provides the pressurized gas to the shuttle valve 478. The shuttle valve includes a shuttle member (not seen in the drawing Figures) which moves so as to close communication between the cylinder 460 and the QEV 479 which is not receiving pressurized gas. This movement of the shuttle member also communicates pressurized gas from the one QEV 479 which is receiving pressurized gas to the cylinder 460. Subsequently, when the activated one of the pair of solenoid valves 470a/b is de-activated, the QEV 479 which had been receiving pressurized gas opens communication of the cylinder 460 to ambient. In this way, the pair of QEV's 479a/b dither between providing pressurized gas to, and venting gas from, the cylinder 460. The shuttle valve 478 similarly dithers between communication first one and then the other of the pair of QEV's 479a/b to the cylinder 460.

[0074] Viewing FIG. 17, a paint ball gun 510 includes a pair of solenoid valves 570a/b, which are each individually connected via conduits 576a/b to a shuttle valve 578. The shuttle valve communicates with a quick exhaust valve (QEV) 579. In operation of the embodiment of FIG. 17, dependent on which one of the solenoid valves 570a/b is activated, the pressurized gas is communicated along one of the conduits 576a/b to the shuttle valve 578. This shuttle valve has a shuttle member (not seen in the drawing Figures) which moves so as to close communication between the one conduit 576a/b which is not receiving pressurized gas and the other of the pair of conduits 576a/b. This movement of the shuttle member also communicates pressurized gas from the one conduit 576a/b which is receiving pressurized gas from the activated one of the solenoids 570a/b to the QEV 579. As will be now understood, the QEV 579 closes communication of the cylinder 560 with ambient, and communicates the pressurized gas into the cylinder 560. Subsequently, when the activated one of the pair of solenoid valves 570a/b is de-activated, the QEV 579 opens communication of the cylinder 560 to ambient. In this way, a single shuttle valve 578 and single QEV 579 serve to provide communication of pressurized gas from either of the pair of solenoid valves 570a/b and the cylinder 560, while also providing for rapid venting of the gas from cylinder 560 upon the one activated solenoid valve 570a/b being deactivated.

[0075] In view of the above, it is seen that this invention provides a first embodiment of paintball gun which operates in an open-bolt mode, and in which the gun utilizes only a single pressure regulator, and a single regulated gas pressure, and in which the operation of the hammer member and bolt is entirely effected pneumatically (i.e., by pressurized gas).

[0076] A second embodiment of the present inventive paintball gun similarly operates in open-bolt mode, and has a single pressure regulator, and a single regulated gas pressure, but utilizes a coil compression spring to assist movement of the hammer member and bolt in the rearward direction.

[0077] A third embodiment of the present inventive paintball gun similarly operates in open-bolt mode, but utilizes two series connected pressure regulators, the first providing a first regulated gas pressure which is utilized to discharge a paint ball, and the second providing a second regulated gas pressure, which is utilized to operate a hammer member. This embodiment also utilizes a coil compression spring to assist movement of the hammer member and bolt in the rearward direction.

[0078] Finally, a fourth embodiment of the present inventive paintball gun also operates in open-bolt mode, but utilizes two series connected pressure regulators, and two alternatingly operating solenoid valves, each providing operating gas pressure to a pneumatic hammer assembly, in order to significantly improve the cyclic rate of fire for the paintball gun. This embodiment also utilizes a coil compression spring to assist movement of the hammer member and bolt in the rearward direction.

[0079] While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiments, it is to be understood that the invention is not to be limited to the disclosed embodiments. For example, versions of the first or second embodiments utilizing two pressure regulators is clearly possible, and are within the scope of this disclosure. Similarly, a version of the third embodiment which operates without spring 102 and which is entirely pneumatic is also clearly possible, and is within the scope of this disclosure. Accordingly, this invention is intended to be limited only by the spirit and scope of the appended claims, giving full cognizance to equivalents, and to cover various modifications and equivalent arrangements as is permitted under the law.

What is claimed is:

1. An open-bolt paintball gun comprising: a body carrying a grip frame with a trigger, and a barrel for discharging a paint ball, a bolt member reciprocating on said body between a first open position and a second closed position to open and close a breech of said barrel, a pressure regulator receiving high pressure gas from a source thereof and providing a regulated gas pressure for discharge of a paint ball from said gun, a discharge valve flowing said regulated gas pressure to said barrel to discharge a paint ball therefrom, a pneumatic hammer assembly includes a hammer member operably coupled to said bolt to reciprocate in unison therewith between respective first and second locations, said hammer member in said second location cooperating with and opening said discharge valve, and a solenoid valve controllably providing gas pressure to said
pneumatic hammer assembly to controllably operate said discharge valve in response to actuation of said trigger to fire a paint ball from said paint ball gun.

2. The paint ball gun of claim 1 wherein said bolt and said hammer member reciprocate in unison from a respective first position and first location in which said breech is open to receive a paint ball and said hammer member is spaced from said discharge valve, and in response to a trigger actuation by an operator of said paint ball gun said bolt and hammer member reciprocate to a second position and second location in which said bolt closes said breech to sealingly trap a paint ball therein, and said hammer member engages and opens said discharge valve to flow said regulated gas pressure to said barrel, thereby to fire said paint ball from said barrel.

3. The paint ball gun of claim 2 wherein said hammer member includes a head portion sealingly cooperating with said body to define a variable-volume chamber, and said discharge valve includes a stem portion defining a controlled flow path providing a controlled flow of gas pressure to said variable-volume chamber to move said hammer member from said second position to said first position.

4. The paint ball gun of claim 2 wherein said hammer member includes a head portion defining a spring seat feature, a coil compression spring seating on said spring seat feature of said hammer member and extending to said body, said spring cooperating with said hammer member to bias said hammer member from said second location to said first location.

5. The paint ball gun of claim 1 wherein said pressure regulator is the singular pressure regulator operating said paint ball gun providing said regulated gas pressure, and said solenoid valve and said discharge valve both control flow of said regulated gas pressure to said pneumatic hammer assembly and to said barrel respectively.

6. The paint ball gun of claim 1 wherein said pressure regulator provides a first regulated gas pressure, and further including a second pressure regulator providing a respective second regulated gas pressure, and said solenoid valve flows said second regulated gas pressure to said pneumatic hammer assembly, and said discharge valve flows said first regulated gas pressure to said barrel.

7. The paint ball gun of claim 1 further including another solenoid valve operating alternately with said solenoid valve to flow gas pressure to said pneumatic hammer assembly.

8. The paint ball gun of claim 7 further including another solenoid valve operating alternately with said solenoid valve so that a pair of solenoid valves are provided to individually and alternatingly flow gas pressure to said pneumatic hammer assembly.

9. The paint ball gun of claim 8 further including a quick exhaust valve interposed in fluid flow communication between said solenoid valve and said pneumatic hammer assembly, said quick exhaust valve flowing gas pressure to said pneumatic hammer assembly when said gas pressure is supplied from said solenoid valve, and when said solenoid valve is not providing gas pressure to said quick exhaust valve said quick exhaust valve exhausting gas pressure from said pneumatic hammer assembly to ambient.

10. The paint ball gun of claim 9 further including a check valve interposed in fluid flow communication between said solenoid valve and said quick exhaust valve.

11. The paint ball gun of claim 9 further including a shuttle valve interposed in fluid flow communication between said quick exhaust valve and said pneumatic hammer assembly, said shuttle valve communicating pressurized gas between said quick exhaust valve and said pneumatic hammer assembly, and closing communication from said pneumatic hammer assembly and the other of said solenoid valves which is not activated.

12. The paint ball gun of claim 9 further including a pair of quick exhaust valves each respectively interposed in fluid flow communication between one of said pair of solenoid valves and said pneumatic hammer assembly, and said shuttle valve alternatingly communicating one and then the other of said quick exhaust valves with said pneumatic hammer assembly.

13. A paint ball gun comprising: a body carrying a grip frame with a trigger, and a barrel for discharging a paint ball, a single pressure regulator receiving high pressure gas from a source thereof and providing a singular regulated gas pressure utilized both for discharge of paint balls from said gun and for operation of said gun, said paint ball gun including a discharge valve flowing said single regulated gas pressure to said barrel to discharge a paint ball therefrom, and a solenoid valve receiving said singular regulated gas pressure and controllably providing said singular regulated gas pressure to a pneumatic hammer assembly controllably operating said discharge valve in response to actuation of said trigger to fire a paint ball from said paint ball gun.

14. The paint ball gun of claim 13 wherein said body carries a bolt reciprocating to open and close a breech of said barrel, and said pneumatic hammer assembly includes a hammer member operably coupled to said bolt to reciprocate in unison therewith.

15. The paint ball gun of claim 14 wherein said bolt and said hammer member reciprocate in unison from a mutual first position in which said breech is open to receive a paint ball and said hammer member is spaced from said discharge valve, and in response to a trigger actuation by an operator of said paint ball gun reciprocate to a second position in which said bolt closes said breech to sealingly trap a paint ball therein, and said hammer member reciprocates to a respective second position to engage and operate said discharge valve to flow said singular regulated gas pressure to said barrel, thereby to fire said paint ball from said barrel.

16. The paint ball gun of claim 15 wherein said hammer member includes a head portion sealingly cooperating with said body to define a variable-volume chamber, and said discharge valve includes a stem portion defining a controlled flow path providing a controlled flow of said singular regulated gas pressure to said variable-volume chamber to move said hammer member from said second position to said first position.

17. The paint ball gun of claim 15 wherein said hammer member includes a head portion defining a spring seat feature, a coil compression spring seating on said spring seat feature of said hammer member and extending to said body, said spring cooperating with said hammer member to bias said hammer member from said second position to said first position.

18. The paint ball gun of claim 13 wherein said pressure regulator is the singular pressure regulator operating said paint ball gun providing said regulated gas pressure, and said solenoid valve and said discharge valve both control flow of
said regulated gas pressure to said pneumatic hammer assembly and to said barrel respectively.

19. The paint ball gun of claim 13 further including another solenoid valve operating alternatingly with said solenoid valve to flow gas pressure to said pneumatic hammer assembly.

20. The paint ball gun of claim 13 further including another solenoid valve operating alternatingly with said solenoid valve so that a pair of solenoid valves are provided to individually and alternatingly flow gas pressure to said pneumatic hammer assembly.

21. The paint ball gun of claim 13 further including a quick exhaust valve interposed in fluid flow communication between said solenoid valve and said pneumatic hammer assembly, said quick exhaust valve flowing gas pressure to said pneumatic hammer assembly when said gas pressure is supplied from said solenoid valve, and when said solenoid valve is not providing gas pressure to said quick exhaust valve said quick exhaust valve exhausting gas pressure from said pneumatic hammer assembly to ambient.

22. The paint ball gun of claim 21 further including a check valve interposed in fluid flow communication between said solenoid valve and said quick exhaust valve.

23. The paint ball gun of claim 21 further including a shuttle valve interposed in fluid flow communication between said quick exhaust valve and said pneumatic hammer assembly, said shuttle valve communicating pressurized gas between said quick exhaust valve and said pneumatic hammer assembly, and closing communication from said pneumatic hammer assembly and the other of said solenoid valves which is not activated.

24. The paint ball gun of claim 20 further including a pair of quick exhaust valves each respectively interposed in fluid flow communication between one of said pair of solenoid valves and said pneumatic hammer assembly, and said shuttle valve alternatingly communicating one and then the other of said quick exhaust valves with said pneumatic hammer assembly.

25. A paint ball gun comprising:

a. a gun body defining a first bore for receiving a barrel with a breech end, and also receiving a bolt assembly reciprocating between first and second positions respectively opening and closing said breech end, said gun body further defining a feed inlet opening to the first bore for receiving a paint ball into said barrel breech end;

a second bore defined in said gun body substantially parallel with said first bore, and a passage for communicating pressurized gas from said second bore to said barrel breech end;

a discharge valve disposed in said second bore, including a seat member, and a poppet valve member sealingly engaging in a first position upon said seat member to close communication of pressurized gas from a source thereof to said barrel breech end via said passage, said poppet valve member including a poppet valve stem extending through said seat member rearwardly of said gun;

a pneumatic hammer assembly also disposed in said second bore aft of said discharge valve, and including a cylinder member defining a bore, a hammer member reciprocally and scalingly movable in said cylinder member bore, said hammer member coupling with said bolt assembly to reciprocate in unison therewith, and cooperating with said cylinder member to define a variable-volume chamber having a minimum volume with said hammer member and bolt assembly in a first position, said hammer member in response to receipt of pressurized gas in said cylinder member bore moving axially forwardly of said gun to a second position while also carrying said bolt assembly to a second position closing said barrel breech end, and said hammer member in said second position abutting and unseating said poppet valve member to a second position opening said discharge valve to communicate pressurized gas to said barrel breech end via said passage.

26. A method of providing an open-bolt paintball gun having a high cyclic rate of fire, said method including steps of:

providing a gun body defining a pair of parallel bores disposed adjacent to one another, configuring a first of said pair of bores for holding a barrel for receiving and discharging a paint ball,

disposing in said first bore a reciprocable bolt assembly which in respective first and second positions relative to said main gun body opens and closes a breech of said gun, providing a feed inlet opening to said first bore, and providing a supply of paint balls to said breech via said feed opening;

further providing between said first and second bores a passage for communicating pressurized gas from said second bore to said breech; and providing in said second bore a pneumatic discharge valve including a seat member and a poppet valve member sealingly engaging in a first position upon said seat member to close communication of pressurized gas from a source thereof to said breech via said passage, providing said poppet valve member with a poppet valve stem extending through said seat member, and providing a pneumatic hammer assembly also disposed in said second bore, providing said pneumatic hammer with a cylinder member defining a bore, utilizing a hammer member reciprocally and scalingly movable in said sleeve member bore and cooperating therewith to define a variable-volume chamber having a minimum volume with said hammer member in a first position, coupling said hammer member with said bolt for reciprocation in unison, providing a pneumatic pressure into said variable-volume chamber moving said hammer member and said bolt member axially of said gun to a second position in which said hammer member abuts and unseats said poppet valve to a second position opening said discharge valve to communicate pressurized gas to said breech via said passage and said bolt member in said second position closing said breech to trap a paint ball therein for discharge via said barrel.

27. A paint ball gun comprising: a body carrying a grip frame with a trigger, and a barrel for discharging a paint ball, a bolt member reciprocating on said body to open and close a breech of said barrel, and a pneumatic hammer assembly includes a hammer member operably coupled to said bolt to reciprocate in unison therewith, a first pressure regulator receiving high pressure gas from a source thereof and providing a first regulated gas pressure for discharge of paint.
balls from said gun, a discharge valve flowing said first regulated gas pressure to said barrel to discharge a paint ball therefrom, a second pressure regulator receiving said first regulated gas pressure and providing a second regulated gas pressure, and a solenoid valve actuated in response to movements of said trigger in order to controllably provide said second regulated gas pressure to said pneumatic hammer assembly to controllably operate said discharge valve in order to fire a paint ball from said paint ball gun.

28. The paint ball gun of claim 27 wherein said bolt and said hammer member reciprocate in unison from a mutual first position in which said breech is open to receive a paint ball and said hammer member is spaced from said discharge valve, and in response to a trigger actuation by an operator of said paint ball gun reciprocate to a second position in which said bolt closes said breech to scalenly trap a paint ball therein, and said hammer member reciprocates to a respective second position to engage and operate said discharge valve to flow said first regulated gas pressure to said barrel, thereby to fire said paint ball from said barrel.

29. The paint ball gun of claim 28 wherein said hammer member includes a head portion scalenly cooperating with said body to define a variable-volume chamber, and said discharge valve includes a stem portion defining a controlled flow path providing a controlled flow of gas pressure to said variable-volume chamber to move said hammer member from said second position to said first position.

30. The paint ball gun of claim 28 wherein said hammer member includes a head portion defining a spring seat feature, a coil compression spring seating on said spring seat feature of said hammer member and extending to said body, said spring cooperating with said hammer member to bias said hammer member from said second position to said first position.

31. The paint ball gun of claim 27 further including another solenoid valve operating alternately with said solenoid valve to flow gas pressure to said pneumatic hammer assembly.

32. The paint ball gun of claim 27 further including another solenoid valve operating alternately with said solenoid valve so that a pair of solenoid valves are provided to individually and alternately flow gas pressure to said pneumatic hammer assembly.

33. The paint ball gun of claim 31 further including a quick exhaust valve interposed in fluid flow communication between said solenoid valve and said pneumatic hammer assembly, said quick exhaust valve flowing gas pressure to said pneumatic hammer assembly when said gas pressure is supplied from said solenoid valve, and when said solenoid valve is not providing gas pressure to said quick exhaust valve said quick exhaust valve exhausting gas pressure from said pneumatic hammer assembly to ambient.

34. The paint ball gun of claim 33 further including a check valve interposed in fluid flow communication between said solenoid valve and said quick exhaust valve.

35. The paint ball gun of claim 34 further including a shuttle valve interposed in fluid flow communication between said quick exhaust valve and said pneumatic hammer assembly, said shuttle valve communicating pressurized gas between said quick exhaust valve and said pneumatic hammer assembly, and closing communication from said pneumatic hammer assembly and the other of said solenoid valves which is not activated.

36. The paint ball gun of claim 34 further including a pair of quick exhaust valves each respectively interposed in fluid flow communication between one of said pair of solenoid valves and said pneumatic hammer assembly, and said shuttle valve alternatingly communicating one and then the other of said quick exhaust valves with said pneumatic hammer assembly.

37. A paint ball gun comprising: a body carrying a grip frame with a trigger, and a barrel for discharging a paint ball, a bolt member reciprocating on said body between a first open position and a second closed position to open and close a breech of said barrel, a pressure regulator receiving high pressure gas from a source thereof and providing a regulated gas pressure for discharge of a paint ball from said gun, a discharge valve controllably flowing said regulated gas pressure to said barrel to discharge a paint ball therefrom, a pneumatic hammer assembly including a hammer member reciprocating between respective first and second locations, said hammer member in said second location cooperating with and opening said discharge valve, and a pair of alternatingly-operating solenoid valves each controllably providing gas pressure to said pneumatic hammer assembly to controllably operate said discharge valve in response to actuation of said trigger to fire a paint ball from said paint ball gun.