An improved poppet valve system, preferably for use with a paintball marker. The poppet valve system includes a chamber having an inner surface and a piston having a first end and a second end substantially opposite the first end. The first end is positioned for selective contact by a hammer. The piston also includes first and second sealing faces that sealingly engage the inner surface of the chamber when the hammer is not in contact with the piston. A biasing member acts against the second end of the piston. When the hammer contacts the first end of the piston, the hammer overcomes force imparted by the biasing member against the piston in order to disengage the first sealing face from the inner surface of the chamber.
PAINTBALL MARKER WITH AN AIR BALANCED EXHAUST POPPET VALVE WITH BIAS CLOSURE


BACKGROUND OF THE INVENTION

[0002] The present invention relates generally to the field of paintball markers. More particularly, the present invention relates to paintball markers that incorporate the use of a poppet valve to release compressed gas for propelling a paintball.

[0003] A number of conventional paintball markers incorporate the use of an ON/OFF valve, known within the paintball industry as a poppet valve, bang valve or exhaust valve. One such conventional paintball marker is disclosed in U.S. Pat. No. 6,003,504, assigned to NPF Limited and incorporated herein by reference. Another such conventional paintball marker is marketed under the “Tippmann Model 98” brand name. The poppet valve is typically held closed by two forces at one end of the valve, and is opened by being struck by a mechanical hammer at the opposite end of the valve.

[0004] Of the two forces identified above, the first force is applied to the closure face of the poppet valve by the operating pressure of the gas waiting to be released by the poppet valve. This gas is released when the hammer strikes the poppet valve and is used to propel the paintball. This force varies whenever the operation pressure is changed and is a relationship of gas pressure load over surface area of the closure port of the poppet valve. Therefore the force required from the hammer that strikes the poppet valve needs to vary as the operating pressure changes to ensure the same opening travel.

[0005] The second force is applied to the poppet valve by a mechanical spring that acts onto the poppet valve closure face. This spring is present to ensure that, once the valve has been opened by the hammer and the first force is collapsing due to release of the pressure retained by the poppet valve, that the collapsing first-force pressure can also act on the opposite side of the closure face of the poppet valve, without holding the poppet valve open in a free flow situation. The biasing force generated by the second spring force prevents the valve of remaining open and thus ensures the closure of the poppet valve.

SUMMARY OF THE INVENTION

[0006] It is an object of the present invention to develop a poppet valve for use in a paintball marker that substantially reduces and/or eliminates the closing forces applied to the poppet valve from the operation pressure of the paintball marker by ensuring that the poppet valve’s opening and closure force is no longer primarily dependent on the operation pressure that is used to propel the paintball.

[0007] It is another object of the invention to provide a poppet valve for a paintball marker that ensures that the primary closure force is applied by a biasing member.

[0008] The present invention is directed to the reduction of the amount of moving mass required to strike the poppet valve in a paintball marker. This reduction of moving mass results in a reduction in the vibration and the “recoil” of the paintball marker, improving the accuracy of the paintball marker. This is due to the reduction in mass of the respective components that can be made of a lighter construction and alternative materials. Additionally, paintball markers constructed according to the principles of the present invention operate with reduced forces, whether pneumatic or mechanical.

[0009] This present invention can be incorporated within a paintball marker or produced as a conversion, stand alone assembly to be fitted into other paintball markers. The present invention can be applied to any paintball marker that incorporates the use of a poppet valve.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. 1 is a sectional side view of a poppet valve system constructed in accordance with one embodiment of the present invention, wherein the hammer is retracted and the poppet valve is closed;

[0011] FIG. 2 is a sectional side view of the poppet valve system of FIG. 1, wherein the firing hammer is in the forward position;

[0012] FIG. 3 is a front sectional view of the poppet valve system of FIG. 1;

[0013] FIG. 4 is a sectional side view of a poppet valve system constructed in accordance with a second embodiment of the invention;

[0014] FIG. 5 is a sectional side view of a poppet valve system constructed in accordance with a third embodiment of the invention;

[0015] FIG. 6 is a sectional side view of a poppet valve system incorporated into a “blow back” paintball marker;

[0016] FIG. 7 is a sectional side view of a poppet valve system in which a cup seal is used as part of the poppet valve system;

[0017] FIG. 8 is a sectional side view of a poppet valve system in which the o-ring seals have a larger diameter than the corresponding diameter of the shaft to create a piston action;

[0018] FIG. 9 is a sectional side view of a poppet valve system in which the first seal is located within the poppet valve body instead of being located on the shaft; and

[0019] FIG. 10 is a sectional side view of a poppet valve system in which a pneumatic or hydraulic force is used to actuate the poppet valve.

DETAILED DESCRIPTION OF THE INVENTION

[0020] FIGS. 1-6 show various embodiments of poppet valve systems constructed in accordance with the principles of the present invention. In each of the Figures, a source of compressed gas (not shown) is used to supply gas to the chamber 1. This gas can either be regulated or unregulated.

[0021] As shown in FIG. 1, in the “rest” condition gas is received and retained within the chamber 1 and is prevented from escaping through the poppet valve and exiting though a port 10 by a first piston seal 2. Additionally, the pressure within chamber 1 is also acting upon a second piston seal 3.
The first and second seals 2 & 3 are located at opposite ends of a shaft 4. The shaft 4, in combination with the first and second seals 2 and 3, generates two internal sealing faces within chamber 1. The force applied to the sealing face at the first piston seal 2 is related to its surface area within the chamber 1 and the pressure within chamber 1 acting upon it. Substantially the same force is applied to the sealing face corresponding to the second piston seal 3 and is also related to its surface area within the chamber 1 and the pressure within chamber 1 acting upon it.

[0022] The opposite sides of the sealing faces corresponding to the first and second seals 2 and 3 when at rest are at atmospheric pressure. Therefore, the pressure within the chamber 1 is applying little or no force to the shaft 4, and the shaft 4 is in a stable condition. In the event that the surface area of the sealing face corresponding to the first piston seal 2 is increased to be greater than the surface area of the sealing face corresponding to the second piston seal 3 within the chamber 1, the stable condition of the shaft 4 will change, and the shaft 4 will be biased to a closed condition to ensure the sealing face corresponding to the first piston seal 2 is shut against a sealing face within a poppet valve body 5. Preferably the ratio for the surface areas of the two sealing faces should remain within the range of about 1:1 to 8:1. Within this range, it has been found that the force required to open the poppet valve by the moving mass supplied by a hammer 6 is greatly reduced. Although a hammer 6 is used in this particular embodiment of the invention, virtually any type of movable mass can also be used to actuate the poppet valve of the present invention. In addition, systems incorporating gas pressure, liquid pressure, or other mechanisms for amplifying the force against the poppet valve could be used to actuate the valve.

[0023] Additionally, the closure force applied to the shaft 4 against the poppet valve seal face within the poppet valve body 5 is supplied by a biasing member 7. In FIGS. 1 and 2, the biasing member 7 is a mechanical spring in the form of a coil spring. As represented in FIG. 2, the spring force can be adjusted in the case of a mechanical spring by a mechanical adjustment 8 in order to increase the spring compression. Alternatively, the use of shims and/or packing could also be implemented. Instead of a mechanical spring, an air spring could be used and have its pressure adjusted to achieve a different force value to bias the shaft 4 to its closed position. If an air spring is used, it would be understood by one of ordinary skill in the art that the opposite sides of the second sealing face 3 need not necessarily be at atmospheric pressure.

[0024] When a moving mass 6 strikes an end 11 of the shaft 4, this opens the poppet valve, lifting the first piston seal 2 from its seat within the chamber 1. This action permits the gas within chamber 1 to exhaust out the pressure through port 10. At this point, the gas pressure exhausting from chamber 1 is acting on both sides of the sealing face corresponding to the first piston seal 2 and onto the sealing face corresponding to the second piston seal 3 and the primary closure force applied to the shaft 4 is supplied from the opposite side of the sealing face corresponding to the second piston seal 3 by the biasing member 7.

[0025] Because the closing force applied to the poppet valve according to the present invention is primarily supplied by the spring, this force can be substantially reduced or negated. Therefore, the moving mass that is applied to the poppet valve by the hammer to open it can now also be reduced, as it only needs to overcome the closing spring force.

[0026] A third seal 9 may also be used to increase the diameter of the shaft 4 to be similar to the diameter of sealing face corresponding to the first piston seal 2. This aids in quickly closing the poppet valve. Generating an additional piston seal of a similar diameter, with or without seal 9, substantially equivalent to the diameter of the first piston seal 2 to give a servo effect is also advantageous.

[0027] FIG. 4 is a sectional side view of a poppet valve system constructed in accordance with a second embodiment of the present invention. Though similar to the embodiment shown in FIGS. 1 and 2, the system in FIG. 3 shows that the volume in the chamber 1 can be increased by the addition of an extended volume chamber that incorporates a sealing face corresponding to the second piston seal 3.

[0028] FIG. 5 is a cross-sectional view of a poppet valve system according to a third embodiment of the present invention. The embodiment shown in FIG. 5 is similar to the embodiment shown in FIGS. 1 and 2, except that the mechanical biasing member 7 has been replaced with an air spring.

[0029] The system of the present invention can also be applied to what are commonly referred to as “blow back” paintball markers, wherein the hammer 6 is driven forward by a spring to open the poppet valve, releasing the gas which propels the paintball and returning the hammer 6 by the pressure released from the poppet valve, recompressing the spring. This is depicted in FIG. 6.

[0030] In the embodiment shown in FIG. 6, gas exiting the port 10 propels the paintball, while gas exiting a secondary port 12 is directed to the hammer to “blow” it backwards. Again, by using a substantially gas balanced shaft 4 with reduced bias, the hammer mass required to open the poppet valve is reduced. Additionally, a lower strength spring can be used to propel the hammer forward, further reducing vibration, recoil and mechanical wear. This improves the level of accuracy and allows components to be made of a lighter construction.

[0031] FIGS. 7-10 show yet further embodiments of the present invention. In FIG. 7, the poppet valve system incorporates the use of a cup seal as the first piston seal 2. In the poppet valve system of FIG. 8, the first and second piston seals 2 and 3 have a slightly larger diameter than the corresponding diameter of the shaft. This results in the first and second piston seals 2 and 3 being the primary components for creating the piston action, in contrast to FIGS. 1 and 2 where the shaft 4 also substantially contributes to the creation of the piston action. In FIG. 9, a seal is located within the poppet valve body 5 instead of being located on the shaft 4. The other seals in the system could also be arranged in a similar fashion. The poppet valve system of FIG. 10 incorporates the use of either pneumatic or hydraulic forces, wherein an additional seal 13 is located directly on the hammer 6, which can be separate or part of the shaft 4.

[0032] The poppet valve system of the present invention can be used in conjunction with a wide variety of paintball markers having various features. For example but without
limitation, such a poppet valve system can be used with paintball markers of the types described in U.S. Pat. Nos. 6,748,938; 6,615,814; and 6,311,682, each of which is assigned to NPF Limited and incorporated herein by reference in their entirety, as well as United States Published Patent Application No. 2002/0011344, also incorporated herein by reference in its entirety.

While preferred embodiments have been shown and described herein, it should be understood that changes and modifications can be made to the invention without departing from the invention in its broader aspects. Various features of the invention are defined in the following claims.

What is claimed is:

1. A paintball marker, comprising:
   a body;
   a firing chamber for firing a paintball;
   a movable mass positioned within the body;
   a poppet valve positioned within the body and including:
   a chamber, and
   a piston positioned at least partially within the chamber and having first and second sealing surfaces, the piston having a first end positioned for selective contact by the movable mass and a second end substantially opposite the first end, the first and second sealing surfaces being in contact with an inner surface of the chamber when the movable mass is not in contact with the piston; and
   a biasing member acting against the second end of the piston,
   wherein, when the movable mass contacts the first end of the piston, the movable mass overcomes force imparted by the biasing member against the piston in order to disengage the first sealing surface from the inner surface of the chamber.

2. The paintball marker of claim 1, wherein the biasing member comprises a mechanical spring.

3. The paintball marker of claim 2, wherein the mechanical spring is a coil spring.

4. The paintball marker of claim 1, wherein the biasing member comprises an air spring.

5. The paintball marker of claim 1, wherein a cup seal is used to create the first sealing surface.

6. A paintball marker, comprising:
   a body;
   a firing chamber;
   a hammer positioned within the body;
   a poppet valve positioned within the body and including:
   a chamber, and
   a piston positioned at least partially within the chamber and having first and second sealing surfaces, the piston having a first end positioned for selective contact by the hammer and a second end substantially opposite the first end, the first and second sealing surfaces being in contact with an inner surface of the chamber when the hammer is not in contact with the piston;
   wherein, when the hammer contacts the first end of the piston, the first sealing surface is disengaged from the inner surface of the chamber.

7. The blow back paintball marker of claim 6, further comprising a spring for biasing the hammer towards the first end of the piston.

8. The blow back paintball marker of claim 7, wherein gas released from the poppet valve is used to move the hammer away from the piston.

9. The blow back paintball marker of claim 8, further comprising a secondary port for permitting released gas to act against the hammer.

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