Abstract: An electronic paintball marker has a breech having an opening that receives a paintball to be fired, the paintball having substantially two positions within the breech, a loaded position and a firing position, and a bolt with two corresponding rearward and forward positions that moves the paintball between the loaded and firing positions. The marker also has a sensor in communication with an electronic controller and positioned to detect a paintball in the loaded position within the breech, wherein, when the sensor detects the paintball in the loaded position, the sensor sends a detection signal to the electronic controller which in turn allows the bolt to move from the rearward to the forward position. Finally, the marker has a trigger that sends a firing signal to the electronic controller, the firing signal initiating a firing sequence comprising the sensor detecting a paintball within the breech, the electronic controller moving the valve from the closed state to the open state, and firing the paintball.
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ELECTRONIC PAINTBALL MARKER

FIELD OF INVENTION

The present invention is directed to an electronically controlled paintball marker. In particular, it relates to a paintball firing control system.

BACKGROUND

In recent years, the popularity of the combat game known as “Paintball” has increased dramatically. In one form of this game, players use a paintball marker (gun) that gas-propels rounds of ammunition called paintballs in an attempt to “paint” another player. The paintballs are usually a spherical gelatin or similar shell filled with a non-toxic, water-soluble, biodegradable paint. Striking another player with one of these balls ruptures the ball and paints the player, which provides dramatic evidence of the hit, without substantially injuring the player.

A typical firing cycle of a paintball marker begins by a user manually cocking a bolt in the breech of the marker rearwardly, opening a hole in the breech through which a paintball falls. Once the paintball is in the breech, the bolt slides forward to contact the paintball. When the trigger is pulled, a valve opens and releases compressed gas through the bolt into the breech, which forces the paintball out of the marker’s barrel.

Paintball markers have been developed that are automatic, i.e. fire repeatedly when the trigger is held back without manual recocking. These automatic markers increase a marker’s rate of fire, but have also created a problem known as “ball chop.” Ball chop occurs when the bolt moves forward towards the paintball while the paintball is only partially within the breech. This results in the paintball being crushed in the breech, which fouls the paintball marker. This breakage often entirely disables the marker, effectively ending a player's game.
Some markers have been designed to overcome the ball chop problem. Optical and mechanical sensors have been added to paintball markers to detect the presence of a paintball within the breech in conjunction with sensors that detect the position of the bolt relative thereto. A logic circuit works in concert with the sensors to prevent the bolt from being in a position that damages a paintball within the breech.

These solutions employ multiple sensors that detect the bolt and paintball position, are disadvantageously positioned within the breech, or are driven by logic circuits that are not suitable for all paintball markers.

It is therefore an object of the present invention to provide an automatic paintball marker that eliminates ball chop while allowing for faster firing and uses fewer sensors.

To that end, the inventive electronic paintball marker comprises a breech having an opening that receives a paintball to be fired, the paintball having substantially two positions within the breech, a loaded position and a firing position;

a bolt that reciprocates between rearward and forward positions to move the paintball between the corresponding loaded and firing positions;

a valve in communication with a source of compressed gas and the breech, the valve having an open and closed state, the valve’s state controlled by an electronic controller, the valve’s open state releasing compressed gas from the source of compressed gas into the breech for firing a paintball, the valve’s closed state preventing said firing;

a sensor in communication with the electronic controller and positioned to detect a paintball in the loaded position within the breech, wherein, when the sensor detects the paintball in the loaded position, the sensor sends a detection signal to the electronic controller which in turn allows the bolt to move from the rearward to the forward position; and
[0016] a trigger that sends a firing signal to the electronic controller, the firing signal initiating a firing sequence comprising the sensor being activated to detect the paintball within the breech, the electronic controller moving the valve from the closed state to the open state, and firing the paintball.

[0017] BRIEF DESCRIPTION OF THE DRAWING(S)
[0018] Figure 1 is a schematic illustration of a first embodiment of the paintball marker showing the bolt in the rearward position.
[0019] Figure 2 is a schematic illustration of a first embodiment of the paintball marker showing the bolt in the forward position.
[0020] Figure 3 is a schematic illustration of a first embodiment of the paintball marker showing a paintball immediately after the compressed gas has been released into the breech.
[0021] Figure 4 is a schematic illustration of a second embodiment of the paintball marker showing a paintball immediately after the compressed gas has been released into the breech.
[0022] Figure 4A is a schematic illustration of a third embodiment of the paintball marker showing the bolt in the forward position.
[0023] Figure 5 is a schematic illustration of a fourth embodiment of the paintball marker showing the bolt in the rearward position.
[0024] Figure 5A is a schematic illustration of a fourth embodiment of the paintball marker showing a paintball immediately after the compressed gas has been released into the breech.
[0025] Figure 6 is a schematic illustration of a fifth embodiment of the paintball marker showing the bolt in the rearward position.
[0026] Figure 6A is a schematic illustration of a fifth embodiment of the paintball marker showing a paintball immediately after the compressed gas has been released into the breech.
[0027] Figure 7 is a schematic illustration of a sixth embodiment of the paintball marker showing the shutter gate in the closed position.
[0028] Figure 7A is a schematic illustration of a sixth embodiment of the paintball marker showing the shutter gate in the open position and a paintball exiting the barrel.

[0029] DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

[0030] A paintball marker is usually a futuristic "gun-shaped" device having one or two grips for firing, a barrel from which a paintball is discharged, and a trigger for activating the marker to fire the paintball. The actual body and shape of the marker is not shown in the Figures because the invention discussed herein relates to only several components of a marker, and not the body of the marker itself. It should be understood that the invention herein could be adapted for use in almost any paintball marker body.

[0031] Figure 1 shows an electronic paintball marker 10 comprising at least one electronic controller 32, typically a microprocessor, that can receive electronic signals from marker components and also control many marker functions. In the Figures, these electronic signals and control function relationships are shown by lines connecting components with the controller 32.

[0032] SIGNALS TO AND FROM THE CONTROLLER

[0033] The controller 32 can receive a signal from the trigger 50, bolt 16, valve 34, sensor 20, and shutter gate 70, all of which are actuated as discussed below. Although the Figures show one central controller 32, there could be multiple controllers that control and receive signals from the components, or the controllers could be integral with the components themselves and not separate as shown. The controller is not limited to receiving only these signals, and it can also control more functions than those described.

[0034] Pulling the trigger 50 sends a signal to the electronic controller 32 that reflects a player's desire to fire the marker 10. When the signal is received by the electronic controller, a firing sequence is initiated, the final step in which, in normal operation, is the firing of the paintball. The firing sequence(s) will be
discussed in greater detail after the other sensors and components are introduced.

[0035] The bolt 16 optionally sends a signal to the controller to indicate its position in the breech 12. The bolt has two positions in the breech 12, a rearward position shown in Figure 1 and a forward position shown in Figure 2. During automatic firing, the bolt reciprocates between these positions rapidly with each firing of a paintball 14 from the marker 10.

[0036] The valve 34 may also send a signal to the controller 32 indicating its state as open or closed. When the valve 34 is opened, gas from a source of compressed gas 26, such as CO2 air tank or similar tank as is known in the art of paintball sports, travels through channel 27 through the valve 34, then through channel 28 and into the breech 12. This compressed gas drives the paintball 14 out of the barrel 17 in direction designated by A (see Figure 7A showing a paintball 14 leaving the barrel 17). The Figures show an aperture 28a in the bolt that allows the compressed gas into the breech to fire the paintball, however, the compressed gas could be directed around the bolt 16 into the breech 12, or from a separate chamber (not shown) and into the breech, as shown in U.S. Publication No. 2004/0144377 to Dobbins, herein incorporated by reference. When the valve 34 is closed, the marker 14 cannot fire.

[0037] In a first embodiment shown in Figures 1-3, once the trigger 50 is actuated, a firing signal is sent to the electronic controller. The electronic controller activates a sensor 20 that detects a paintball 14 within the breech 12 and sends a corresponding signal to the controller. The sensor 20 may send a paintball detected signal, paintball absent signal, or either one of the two depending on whether a paintball 14 is present. In a preferred embodiment, the sensor 20 sends a paintball detected signal to the controller 32 when it detects the paintball 14 within the breech 12.

[0038] When the sensor sends a signal to the electronic controller 32 that a paintball has been detected within the breech 12, the electronic controller 32 can send a signal to actuate the bolt 16 from the rearward to the forward position. If no such signal is detected, the electronic controller 32 will not move the bolt 16
from the rearward to the forward position, since such movement could crush a paintball 14 that is falling from the feed tube 22, or drive the bolt 16 forward with no paintball 14 within the breech 12, resulting in a non-fire.

[0039] Figure 4 shows a second embodiment of the marker 10 showing a firing sensor 20a located forward of sensor 20 within the breech 12 or barrel 17. The firing sensor is preferably an optical sensor (see below) that detects the paintball 14 as it passes after the paintball is fired. Once the paintball 14 is detected by the firing sensor 20a, the sensor 20a sends a corresponding signal to the controller 32.

[0040] The controller 32 receives the signal from the firing sensor and then sends a signal to actuate the bolt 16 from the forward to the rearward position to reload another paintball 14 into the breech 12 through an opening between the feed tube 22 and the breech 12. By waiting for the paintball 14 to pass the firing sensor 20a before moving the bolt from the forward to the rearward position, the marker 10 insures that it will not load a second paintball 14 into the breech 12 if the first paintball 14 did not fire. It further automates a process that demands precision timing.

[0041] Figure 4A shows a third embodiment of the marker 10 with a forward sensor 20d that detects the paintball 14 in a firing position (as opposed to the paintball loading position shown in Figure 1), and sends a corresponding signal to the controller 32. Upon receipt of the signal, the controller 32 sends a signal to open the valve 34 to release compressed gas into the breech 12 to fire the paintball 14. Thus sensor 20d could also be a mechanical sensor that protrudes slightly into the breech to serve a second purpose as a detent that holds a paintball 14 in place. This slight “holding” is overcome when the paintball 14 is fired, and just prevents the paintball 14 from falling down the barrel 17 when the marker 10 is pointed downward.

[0042] Although the embodiments shown in Figures 4 and 4A show the firing and forward sensors 20a, 20d used in conjunction with sensor 20, these sensors 20a, 20d could be used alone or in combination with each other to decrease the chance of a misfire in a paintball marker.
Figures 5, 5A, 6, and 6A show fourth and fifth embodiments of a sensor located on or within the bolt 16 that detects a paintball 14 and sends a corresponding signal to the controller 32. The controller 32 responds to this signal in a similar manner as described in the first embodiment, that is, by moving the bolt 16 to the forward position, opening the valve 34, and returning the bolt 16 to the rearward position.

The fourth embodiment sensor 20b in Figures 5 and 5A is preferably an optical sensor located on a lower half of a front face 16a of the bolt 16. The reason for this location is that the sensor 20b will detect the paintball 14 as it nears the bottom surface 12a of the breech 12. When the paintball 14 is in this position, it is less likely to be crushed or cause a jam as the bolt 16 moves forward.

The fifth embodiment sensor 20c in Figures 6 and 6A is a mechanical sensor 20c that is activated by contact with the paintball 14 in the loaded position (Figure 6), and sends a corresponding signal to the controller 32. The mechanical sensor 20c is preferably located on a front face 16a of the bolt 16, that is, facing toward the barrel 17. Once the marker 10 is fired (Figure 6A), the sensor 20c will no longer detect a paintball, and the controller will automatically move the bolt 16 to the rearward position for reloading another paintball 14 into the breech 12.

Generally, the sensors can be one of several types. A mechanical sensor requires contact of the paintball on the sensor to initiate the sequence. A mechanical sensor system must be adjusted when using paintballs of different weights and is not as accurate as an optical sensor. Further, piezoelectric sensors can be problematic in certain paintball situations, because the marker is often held at different angles and the paintball will not always contact the sensor with the same force. The mechanical or piezoelectric sensor 20 and 20c shown in Figures 6 and 6A does not have this detection problem because it is preferably activated by contact, not weight. Optical sensors, which do not suffer from this weight problem, are preferred for the embodiment shown in Figures 1-5, 7 and 7A. Optical sensors may use infrared light to detect the ball, and may comprise
an emitter and a detector that form a light beam, the sensor being activated when an paintball 14 crosses the light beam. The emitter and detector may be positioned as required to detect a paintball within the breech or barrel. Or an optical sensor may detect a paintball when light emitted from the sensor is reflected back on the sensor.

[0047] Figures 7 and 7A show a sixth embodiment sensor 20 (although it should be understood that any of the previous sensors or combinations thereof could be used) that works with a shutter gate 70 in communication with the controller 32. The shutter gate 70 is closed (Figure 7) when the paintball is detected by the sensor 20, and open (Figure 7A) for loading in direction B when the sensor does not detect a paintball 14 in the breech. In this embodiment, the bolt 16 need not move between the rearward and forward position to block the opening between the feed tube 22 and the breech 12, since the shutter gate 70 blocks such opening. A variant shutter gate 70 could be an iris gate.

[0048] FIRING SEQUENCE

[0049] The firing sequence that is initiated by pulling the trigger 50 will now be described. Generally, the firing sequence comprises the sensor 20 being activated to detect a paintball 14 within the breech 12, the electronic controller 32 moving the valve 34 from the closed state to the open state, and firing the paintball 14. However, this firing sequence can involve more, and also sequential, steps in two types of markers called open bolt and closed bolt markers.

[0050] An open bolt marker is so-named because before the firing sequence is initiated, the bolt 16 is in the rearward position, which leaves the breech “open” to loading a paintball 14 from the feed tube 22 through the hole in the breech. In an open bolt marker, the firing sequence comprises the sequential steps of:

[0051] (a) the sensor 20 being activated (directly from a signal from the trigger 50 or through the controller 32) to detect the paintball 14 within the breech 12 and if such detection occurs, sending a detection signal to the electronic controller 32 to allow the electronic controller 32 to carry out step (b);
(b) the electronic controller 32 moving the bolt 16 from the rearward position (Figure 1) to the forward position (Figure 2); and
(c) the electronic controller 32 moving the valve 34 from the closed position to the open position to fire the paintball 14.
An additional step may be (d) the controller 32 returning the bolt to the rearward position.

A closed bolt marker by contrast, begins with the bolt 16 in the forward position, which blocks the hole in the breech between the feed tube 22 and the breech 12 before the firing sequence is initiated. In such a closed bolt marker, the firing sequence comprises the sequential steps of:
(a) the electronic controller 32 moving the bolt 16 from the forward position to the rearward position;
(b) the sensor 20 being activated (directly from a signal from the trigger 50 or through the controller 32) to detect the paintball 12 within the breech, and if such detection occurs, sending the detection signal to the electronic controller 32 to allow the electronic controller 32 to carry out step (c);
(c) the electronic controller 32 moving the bolt 16 from the rearward position to the forward position; and
(d) the electronic controller 32 moving the valve 34 from the closed position to the open position to fire the paintball 14.

ACTUATION OF COMPONENTS

Although the application mentions that the electronic controller 32 controls the movement of several components in the marker 10, it does so using one or more actuators (not shown).

The controller 32 controls the operation of the valve 34 and shutter gate 70 through the actuator that moves the components between an open and closed state.
The bolt 16 is reciprocated between the rearward position (Figure 1) and forward position (Figure 2) using one of several types of actuators or combinations thereof. In a preferred embodiment, the actuator is an electronic motor that reciprocates the bolt. Other actuators may use magnets, solenoids, and/or
electromagnets to reciprocate the bolt using electronic, magnetic and/or electromagnetic forces. Other markers, such as that shown in U.S. Publication No. 2004/0144377 to Dobbins, herein incorporated by reference, show a bolt that reciprocates using the compressed gas. Finally, the bolt can reciprocate using a spring.

*     *     *
CLAIMS

What is claimed is:

1. An electronic paintball marker comprising:

   a breech having an opening that receives a paintball to be fired, the paintball having substantially two positions within the breech, a loaded position and a firing position;

   a bolt that reciprocates between rearward and forward positions to move the paintball between the corresponding loaded and firing positions;

   a valve in communication with a source of compressed gas and the breech, the valve having an open and closed state, the valve's state controlled by an electronic controller, the valve's open state releasing compressed gas from the source of compressed gas into the breech for firing a paintball, the valve's closed state preventing said firing;

   a sensor in communication with the electronic controller and positioned to detect a paintball in the loaded position within the breech, wherein, when the sensor detects the paintball in the loaded position, the sensor sends a detection signal to the electronic controller which in turn allows the bolt to move from the rearward to the forward position; and

   a trigger that sends a firing signal to the electronic controller, the firing signal initiating a firing sequence comprising the sensor being activated to detect the paintball within the breech, the electronic controller moving the valve from the closed state to the open state, and firing the paintball.

2. The electronic paintball marker of claim 1 wherein the sensor is an optical sensor.

3. The electronic paintball marker of claim 2 wherein the bolt comprises the optical sensor.

4. The electronic paintball marker of claim 3 wherein the optical sensor is located on a face of the of the bolt coaxial with the breech.
5. The electronic paintball marker of claim 2 wherein the optical sensor is located in a lower portion of the bolt.

6. The electronic paintball marker of claim 2 wherein the optical sensor is located on a bottom surface of the breech.

7. The electronic paintball marker of claim 1 wherein the electronic controller reciprocates the bolt between the two positions.

8. The electronic paintball marker of claim 7 wherein the bolt reciprocation is carried out using a motor.

9. The electronic paintball marker of claim 7 wherein the bolt reciprocation is carried out using an electromagnetic field.

10. The electronic paintball marker of claim 7 wherein the bolt reciprocation is carried out using the compressed gas.

11. The electronic paintball marker of claim 7 wherein the bolt reciprocation is carried out using a spring.

12. The electronic paintball marker of claim 7 wherein the bolt reciprocation is carried out using a motor, an electromagnetic field, compressed gas, a spring, or combinations thereof.

13. The electronic paintball marker of claim 1 wherein the firing sequence is an open bolt firing sequence comprising the sequential steps of:
   (a) the sensor being activated to detect the paintball within the breech, and if such detection occurs, sending the detection signal to the electronic controller to allow the electronic controller to carry out step (b);
the electronic controller moving the bolt from the rearward position to the forward position; and
(c) the electronic controller moving the valve from the closed position to the open position to fire the paintball.

14. The paintball marker of claim 13 wherein the sensor is activated by a direct signal from the trigger.

15. The paintball marker of claim 13 wherein the sensor is activated by a signal from the controller.

16. The electronic paintball marker of claim 13 wherein the firing sequence further comprises the step of:
(d) the electronic controller moving the bolt to the rearward position.

17. The electronic paintball marker of claim 1 wherein the firing sequence is a closed bolt firing sequence comprising the sequential steps of:
(a) the electronic controller moving the bolt from the forward position to the rearward position;
(b) the sensor detecting the paintball within the breech, and if such detection occurs, sending the detection signal to the electronic controller to allow the electronic controller to carry out step (c);
(c) the electronic controller moving the bolt from the rearward position to the forward position; and
(d) the electronic controller moving the valve from the closed position to the open position to fire the paintball.

18. The paintball marker of claim 17 wherein the sensor is activated by a direct signal from the trigger.
19. The paintball marker of claim 17 wherein the sensor is activated by a signal from the controller.

20. The electronic paintball marker of claim 1 wherein the sensor is an infrared sensor.

21. The electronic paintball marker of claim 1 wherein the bolt has an aperture therethrough in communication with the valve, the aperture allowing passage of the compressed gas therethrough to fire the paintball.

22. The electronic paintball marker of claim 1 wherein when the sensor does not detect a paintball, the sensor sends a paintball absent signal to the electronic controller that in turn sends a signal to move the bolt to the loaded position.

23. The electronic paintball marker of claim 18 wherein the electronic controller will not send the signal to move the bolt to the firing position unless the sensor senses a ball in the loaded position within the breech.

24. The electronic paintball marker of claim 1 wherein the electronic controller activates a solenoid that moves the bolt from the firing to the loaded position.

25. The electronic paintball marker of claim 1 wherein the bolt comprises the sensor and wherein the sensor is a mechanical sensor.

26. The electronic paintball marker of claim 1 further comprising:
   a fired detection sensor that detects a paintball after the initiation of the firing sequence;
   wherein when the paintball is fired, the fired detection sensor detects the fired paintball and sends a fired signal to the electronic controller, and in
response to the fired signal, the electronic controller actuates the bolt into the rearward position.

27. The electronic paintball marker of claim 1 further comprising:
   a forward detection sensor that detects a paintball in the firing position;
   wherein when the paintball is in the firing position, the forward detection sensor sends a firing signal to the electronic controller, and in response to the firing signal, the electronic controller moves the valve from the closed to the open state.

28. The electronic paintball marker of claim 23 wherein the forward detection sensor protrudes into the breech slightly to serve as a detent that holds the paintball in place in the firing position, said holding being overcome when the paintball is fired and the paintball is driven from the breech.

29. A bolt for use in a paintball marker comprising a sensor for detecting a paintball.

30. The bolt of claim 29 wherein the sensor is an optical sensor.

31. The bolt of claim 29 wherein the sensor is a mechanical sensor.

32. An electronic paintball marker comprising:
   a breech that receives a paintball to be fired;
   a shutter gate movable between an open and a closed position, the shutter gate allowing passage of a paintball to the breech in the open position, the shutter gate prohibiting passage of the paintball to the breech in the closed position;
   a valve in communication with a source of compressed gas and the breech, the valve having an open and closed state, the valve's open state releasing
compressed gas from the source of compressed gas into the breech which fires the paintball, the valve’s closed state preventing said firing;

- a sensor in communication with an electronic controller positioned to detect a paintball within the breech;

- wherein, when the sensor detects the paintball in the loaded position, the sensor sends a signal to the electronic controller that moves the shutter gate into the closed position and the firing sequence can be initiated, the firing sequence comprising moving the valve from the closed to the open state.

33. An electronic paintball marker comprising:

- a breech having an opening that receives a paintball to be fired, the paintball having substantially two positions within the breech, a loaded position and a firing position;

- a bolt that reciprocates between rearward and forward positions to move the paintball between the corresponding loaded and firing positions;

- a valve in communication with a source of compressed gas and the breech, the valve having an open and closed state, the valve’s state controlled by an electronic controller, the valve’s open state releasing compressed gas from the source of compressed gas into the breech for firing a paintball, the valve’s closed state preventing said firing;

- a forward detection sensor that detects a paintball in the firing position; and

- a trigger that sends a firing signal to the electronic controller, the firing signal initiating a firing sequence comprising the sensor detecting a paintball within the breech, the electronic controller moving the valve from the closed state to the open state, and firing the paintball;

- wherein when the paintball is in the firing position, the forward detection sensor sends a firing signal to the electronic controller, and in response to the firing signal, the electronic controller moves the valve from the closed to the open state.