The Chinese AR2078A Target Rifle

A User's Manual

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An introduction to one of the finest CO_2 pellet rifles ever produced.

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Flying Dragon Air Rifles

Introduction to the AR2078A

The AR2078A is an evolutionary outgrowth of the QB-78 CO_2 pellet rifle. It is a single-shot bolt-action arm offered in calibers .177 and .22. The AR2078A is optimized for target work and is an exceedingly accurate rifle. Many features differentiate it from the more common QB-78 rifle; these include:

- Heavy target stock with upright pistol grip, rubber butt pad, broad and deep fore-end
- Diopter (peep) style receiver sight with windage and elevation adjustments
- Globe-style front sight with interchangeable aperture and post inserts
- Sprung-pivot trigger shoe providing 2-stage trigger pull
- Alternate adjustable leaf-style rear sight
- Muzzle-end barrel weight
- Gas-release key system
- Bulk fill adaptor

The AR2078A is manufactured by the Shanghai Air Gun Factory (who designate it the Industry Brand AR2078A). In the United States, this rifle is sold under several brand names and model designations including QB-79 and TF-79. It is fitted and finished to higher standards than are applied to QB-78 rifles: its trigger comes well adjusted for target work, the stock has a clear satin finish and the metal parts have a uniform, nearly black, bluing. The compact stock design is well thought out and proves comfortable for large and small shooters, alike. The aperture sites are ideal for short-range basement shooting as well as for serious 10-meter work.

SPECIFICATIONS
Type: single-shot, bolt action
Caliber: .177 standard, .22 available
Muzzle Velocity: 600 fps (.177 caliber) typical within 60° to 80°F
Accuracy: 0.24 inch (6 mm) CTC at 10 meters, typical
Trigger: 2-stage, 3-way adjustable, 1 lb force typical factory setting
Rear Sight: precision Diopter rear adjustable for windage and elevation; optional leaf included
Front Sight: Globe-style hooded sight with interchangeable inserts (aperture and post)
Barrel: target grade steel, weighted, button-rifled, 12 grooves, 21.4 inch (543 mm),
Energy Source: two 12-gram CO_2 Powerlet® cartridges
Stored Energy: typically sufficient for 60 full-power shots
Gas-Release System: receiver opening accepts venting key (included)
Length Overall: 37.8 inch (960 mm)
Length of Pull: 13 in (330 mm)
Weight: 8.8 lb (4 kg)

Setup

Before using your new rifle, inspect it carefully to assure that all parts and accessories are present and that no shipping damage has occurred. Retain the shipping container and packing, in the event that subsequent service is required.

Be certain the *rifle is unloaded*, before doing anything else! Check to see that the *bore is unobstructed*. Be certain the *gas tube cap can be turned by hand*. Verify the bolt, trigger and safety functions.

FITTING THE REAR SIGHT

The rifle is shipped with the rear sight detached. This must be fitted before use.

Use a #1 Phillips-head screwdriver to loosen the single mounting screw of the **Rear Sight**. Position the sight in the grooves on the receiver (breech tub) behind the loading port as shown above. Tighten the mounting screw firmly, using a single hand. *Over-tightening can strip the screw head or damage the sight!*

Slip the small end of the rubber eyecup over the metal eyepiece as shown below. This accessory shades the rear sight and provides a clear sight picture, even in bright sunlight.

ADJUSTING THE SIGHT

The **Diopter Rear Sight** features windage and elevation adjustments with minute-of-angle (MOA) click-stops. Each click provides approximately 0.1 inch of movement at 10 meters.

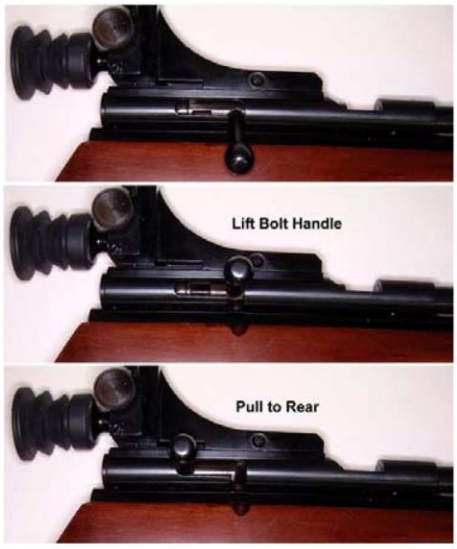
The **Elevation** knob is at the top of the sight. Turn it *clockwise* to *raise* the strike point (about 0.1 inch per click at 10 meters). Rotate it counter-clockwise to lower your shots.

To adjust the **Windage**, use the knob on the right side of the sight. Turn the knob *clockwise* to move the pellet strike to the *right*. Turn it counter-clockwise to move your shots to the left.

Installing CO_2 Cartridges

1. Verify that the **Gas Tube Cap** can be loosened *by hand*, as shown above. *Never* use a tool to rotate this cap. A tight cap indicates dangerously high gas pressure remains within the **Gas Tube**. Refer to venting instructions for more information.

2. Apply the **Safety** by swinging it to the rear as shown above.

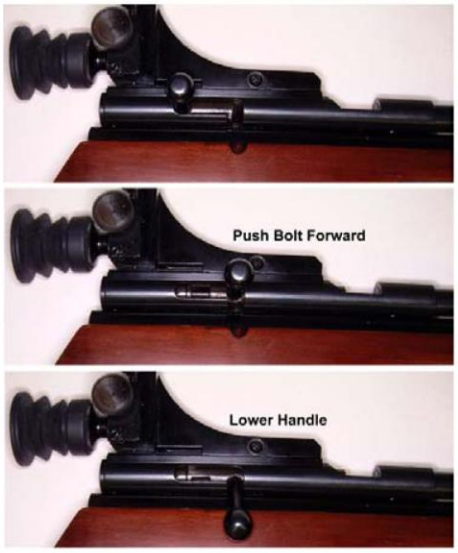


3. Open the **Bolt** as illustrated above. Opening the bolt leaves the loading chamber open to inspection. More importantly, *retracting the bolt prevents dangerous accidental piercing of the rearward-facing CO_2 cartridge*.

4. Unscrew the **Gas Tube Cap** from the **Gas Tube** and set it aside. Slide two **12-gram CO2 cartridges** into the **Gas Tube** back-to-back as shown above. Note, for shorter shooting sessions, load an *empty* cartridge as the rearward-facing (first installed) cartridge. This will give approximately 30 full-power shots.

5. Screw the **Gas Tube Cap** back on fully; this will pierce the forward-facing CO_2 cylinder. When the cap has seated fully hand-tight, back it off a quarter-turn. This will allow the CO_2 to flood the **Gas Tube**. *Do not forget to back off or the forward-facing cartridge will remain sealed* by the **Gas Tube Cap**.

6. Check that the chamber is clear.



7. Close the **Bolt**, cocking the rifle.

8. Release the **Safety**, by rotating forward and out of the trigger guard.

9. *Point the rifle in a safe direction* and pull the trigger. A mild report "pop" verifies the weapon is now charged with CO_2 and is ready for shooting.

Shooting

Basic operation of the rifle is very simple. To fire a pellet:

1. Lift the **Bolt Handle** and pull it fully to the rear to open the breech.

2. Insert a pellet of the proper caliber into the open breech. Make certain the pellet enters *nose-first with the fan-tail skirt to the rear*, as shown.

3. Push the **Bolt Handle** fully forward and rotate it down. This seats the pellet into the rifling and seals the breech. The weapon is ready to fire.

4. Aim at your target, place your trigger finger within the **Trigger Guard** and *squeeze* the **Trigger** gently.

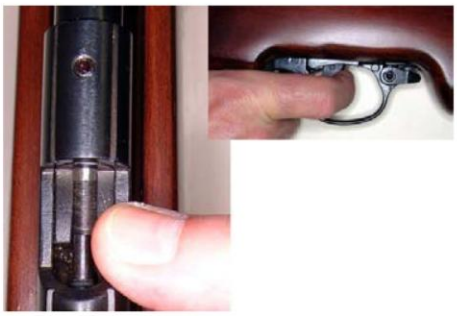
As you become more familiar with the feel of the trigger, you will find it easy to "take up the slack" of the first stage quickly and then concentrate on squeezing against the stiffer resistance of the second stage with more attention.

Engage the **Safety** at any time by rotating it to the rear, into the **Trigger Guard**. This will block the **Trigger** from firing the rifle. Release it by rotating the lever forward as shown above; normal trigger pull action is restored. *Do not depend on the Safety to prevent an accident*. Always point the rifle in a safe direction and keep your finger out of the trigger guard until your target is sighted upon.

Venting Gas from the Rifle

The AR2078A has a unique gas-key system, allowing all gas to be vented from the **Gas Tube** before removing the **Gas Tube Cap**. This is an important safety feature, making it fast and easy to deactivate the rifle.

Remember that the rifle may contain CO2 at *dangerously high pressures*, whenever the **Gas Tube Cap** cannot be easily unscrewed by hand. Always assume gas to be present in this circumstance and take the following actions to clear the weapon:



1. Verify that the **Chamber** is empty, then cock the rifle and fire it in a *safe direction*. It is essential that the chamber be empty as *this procedure vents CO_2 through the barrel*.

If a pellet is found in the chamber, fire it and repeat this step. If a pellet is found lodged in the barrel, engage the **Safety**, leave the Bolt open and dislodge the pellet using a cleaning rod of appropriate caliber.

2. Insert the **Gas-Release Key** into the opening on the left-side of the **Gas Tube** above the **Trigger**.

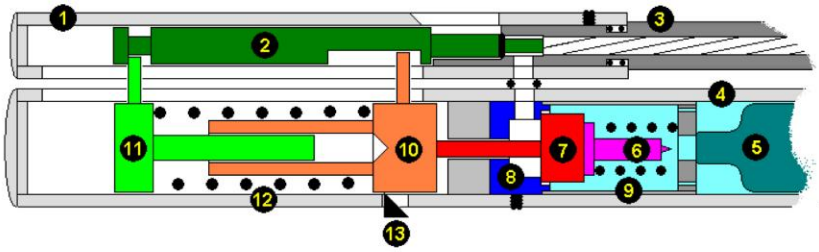
3. Rotate the **Gas-Release Key** 180°. You will hear the hiss of escaping gas. *Point the muzzle in a safe direction before rotating the Gas-Release Key.*

4. Unscrew the **Gas Tube Cap** and remove the expended Powerlets. Dispose of these in a responsible way.

Theory of Operation

The following figures are not scale drawings of the AR2078A parts; they are schematic diagrams intended to explain how the rifle functions. Some artistic liberties have been taken for clarity of explanation.

ARRANGEMENT OF PARTS



The **Breech Tube** (1) contains the **Bolt** (2) and is attached to the **Barrel** (3) by a setscrew and O-rings. It sits atop the **Gas Tube** (4) to which it is screwed. An O-ring seals a gas transfer path between the **Valve Body** (8) contained in the **Gas Tube** and the firing chamber sealed by an O-ring on the **Bolt**.

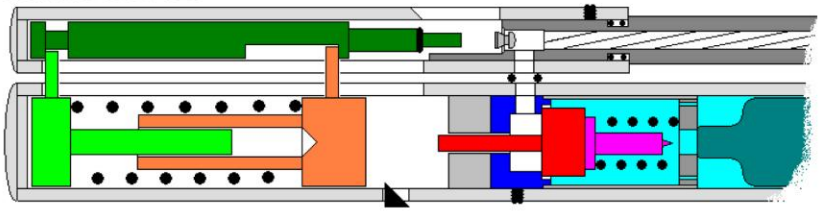
The **Gas Tube** (4) holds two **CO_2 cartridges** (5) back-to-back. The reward-facing cartridge is in front of the **Piercing Pin** (6), the **Valve Stem** (7) and the **Valve Seat** (8). A **Valve Spring** (9) surrounds the **Piercing Pin** and reacts against it and a fixed spacer.

The rear of the **Gas Tube** houses the **Hammer** (10) and **Cocking Piece** (11). These parts are surrounded by the **Hammer Spring** (12), which reacts against both of them. Note that pins are fitted to the **Hammer** and **Cocking Piece**. These pins connect these parts mechanically with the **Bolt**, through facing slots in the **Breech Tube** and the **Gas Tube**.

The spring supported **Sear** (13) protrudes into the **Gas Tube** from the **Trigger Casing Assembly**, screw-mounted to the bottom of the **Gas Tube**. The sear is a cam-like device that can hold the **Hammer** in a rearward position until the **Trigger** causes it to fall away.

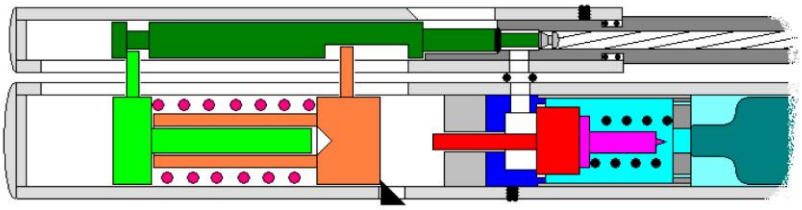
As shown above, the rifle has been fired and the bolt remains closed on an empty chamber. Both the **Hammer Spring** and the **Valve Spring** are in their relaxed (but preloaded) conditions. CO_2 gas fills the front portion of the **Gas Tube** but is blocked from further infiltration by the **Valve Stem** pressed firmly against **Valve Seat** by the **Valve Spring**. The **Hammer** rests upon the **Valve Stem** in this equilibrium.

OPENING THE BOLT



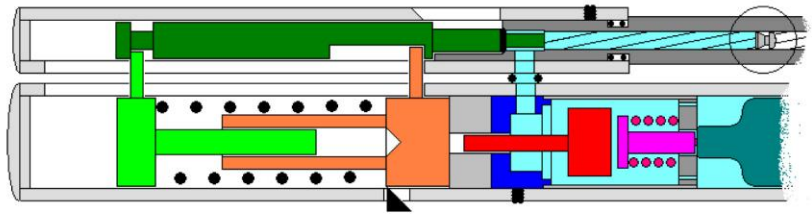
Raising its handle and pulling the **Bolt** (2) to the rear moves the **Hammer** rearward through action of the **Hammer Pin**. The modest compressive preload of the **Hammer Spring** is retained against the bolt through the **Cocking Piece Pin**. With the **Bolt** open, a pellet can be placed in the mouth of the firing chamber.

CLOSING THE BOLT



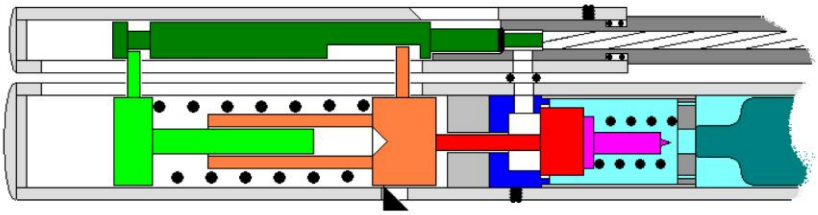
Pushing the **Bolt** forward (and lowering its handle) cocks the weapon and locks the pellet in the firing chamber, ahead of the gas transfer port. The pellet is forced into the Barrel's twisted grooves and the O-ring on the **Bolt** seals the chamber behind it. As the **Bolt** moves forward, the **Hammer** and **Cocking Piece** follow it. Forward motion of the **Hammer** is arrested by the **Sear**, which stops the **Hammer** about 7/16" before it can contact the **Valve Stem**. The **Cocking Piece** moves forward about an inch, compressing the **Hammer Spring**. *The rifle is now ready to fire.*

FIRING THE RIFLE



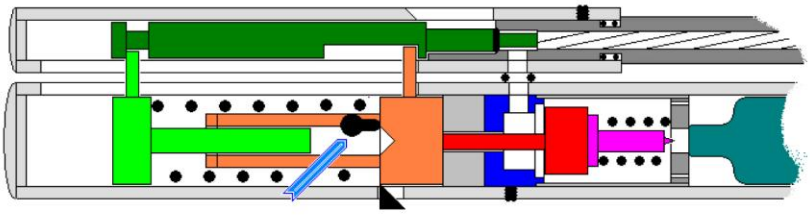
Squeezing the **Trigger** causes the **Sear** to fall, allowing the **Hammer** to move forward rapidly under pressure of the **Hammer Spring**. The **Hammer** impacts the **Valve Stem** and is then arrested by a stop spacer and the back of the **Valve Seat**. The **Valve Stem** continues forward, opening the **Valve Seat** and transfer port to an inrush of CO_2 gas. The **Valve Stem** continues its forward travel, driving the **Piercing Pin** forward and compressing the **Valve Spring**. The pellet is launched by the released gas and starts its journey, spinning down the **Barrel**. The **Piercing Pin** is driven into the welded seal of the rearward-facing CO_2 cartridge, piercing it (if it is still sealed). Note that the foreward-facing CO_2 cartridge is pierced during loading, by a separate piercing pin in the tube cap.

A FEW MILLISECONDS AFTER FIRING



The compressed **Valve Spring** eventually extracts the **Piercing Piece** from the CO_2 cartridge and presses it back against the **Valve Stem**, which is forced back against the **Valve Seat**. This stops the flow of gas just as the pellet is about to exit the **Barrel** and the starting conditions are reestablished.

VENTING CO_2 FROM RIFLE



From the post-fired condition, the **Gas Release Key** may be used to force the **Hammer** forward about 1/8". This vents any remaining gas from the rifle*, through the transfer port and out the barrel*.

About CO_2

Your AR2078A rifle uses two common 12-gram Powerlet® CO_2 cartridges. This is sufficient energy for about 120 full-power shots if used at within a temperature range of about 60 to 80 °F.

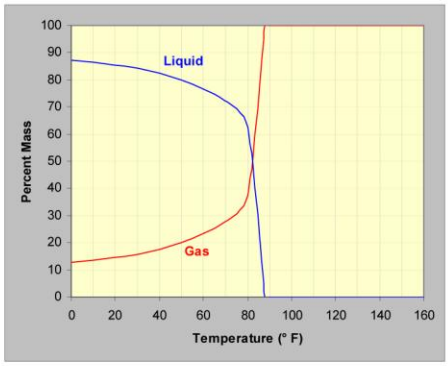
The Powerlet wraps 31.5 grams of deep-drawn steel around 12 grams of liquid and gaseous carbon dioxide (CO_2), locking it in a hermetically sealed vault with a minimum burst-pressure of 7000 pounds per square inch pressure (psi). The bottle is smooth and seamless, providing a precisely controlled 14 cc volume sealed by a pierceable steel plug welded to the bottle's neck.

SECTIONED VIEW OF A POWERLET

The Powerlet contains a considerable amount of energy (over 280 ft-lb or 380 Joule). This is approximately equivalent to two high-velocity .22 long-rifle shells, or one .38 Special (+P) cartridge. To place this in another perspective, the contained energy is sufficient to light a 100-Watt bulb for nearly four seconds. Any one of these equivalents is clearly capable of injuring you; the CO_2 cartridge must be treated with care and respect!

When used near room temperature, it is capable of delivering most of this stored energy as useful muzzle energy. Fifty (slow fired) shots of 600 foot per second (fps) velocity with a 7.1 grain pellet (5.7 ft-lb muzzle energy) is a reasonable expectation.

If the firing pace is slow and deliberate, these shots will exhibit remarkably consistent velocity, owing to the "built-in pressure regulation", provided by thermodynamic interplay between the liquid and gas *phases* of CO_2.



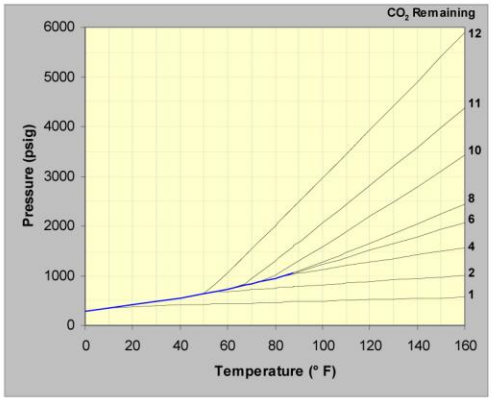
The *critical temperature* of CO_2 is **87.8° F** and this temperature is of particular importance to air-gunners. As shown in the graph above, below this temperature both gas *and liquid* CO_2 coexist in the Powerlet. Above this temperature, only *gas* can be present. The cartridge exhibits a natural pressure-regulating mechanism, but only at temperatures lower than 87.8° F.

At low temperature, the bulk of the entrained CO_2 is in liquid state. As the ambient temperature rises, heat enters the cartridge and some of the liquid boils to gas; the percentage of gas in the mixture increases, as does the pressure. Below 87.8° F, the boiling stops when the pressure reaches the *vapor pressure* determined by the ambient temperature as long as some liquid remains. Above this *critical temperature*, all the CO_2 boils to gas.

When a shot is made, some CO_2 gas exits the cartridge rapidly and the ratio of gas-to-liquid is instantaneously reduced. The loss of gas reduces the pressure within the cartridge, causing some of the liquid to boil or vaporize to "fill the void". This vaporization extracts heat from the mixture, cooling it.

The mixture continues to boil liquid to gas, increasing the pressure while drawing heat from the ambient temperature surroundings. Eventually, the mixture warms back to the ambient temperature and the boiling stops when the pressure reaches the *vapor pressure*. Hence the next shot will be made from exactly the same pressure source. This is the natural *pressure-regulation* mechanism provided by CO_2.

Consider what happens when a mass of CO_2 is sealed in a fixed-volume container. If the mass-to-volume *charge density* is equal to the 0.468 g/cc *critical density*, the pressure within the container will exactly equal the *vapor pressure* for any temperature below the 87.8° F *critical temperature*. If a larger (or smaller mass) of CO_2 is present, the pressure-versus-temperature line will depart from the *saturation line* at a temperature *below* 87.8° F, as shown below.

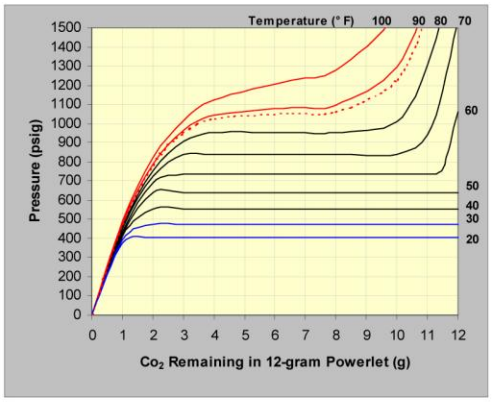


This figure presents the pressure within a Powerlet as a function of temperature with from 1 to 12 grams of CO_2 remaining in the bottle. Note the blue segment partially common to all of these traces; this is the *saturation line*. A CO_2 charge of 6.55 grams remaining in the 14 cc cartridge volume (0.468 g/cc) will exhibit a pressure-versus-temperature curve that follows the *saturation line* all the way to 87.8° F; all other charges depart from the blue line at a *lower* temperature.

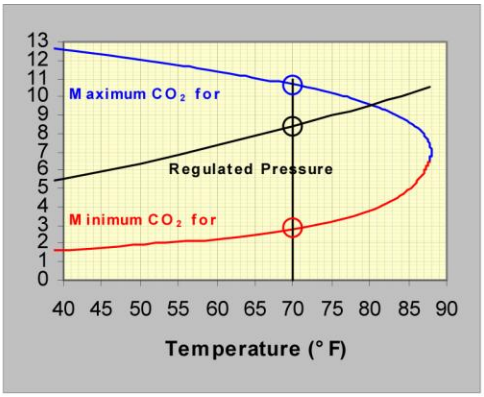
The point of departure from the blue segment is termed the *transition point*, defining a *transition temperature* and a *transition pressure*. Above the *transition temperature*, the CO_2 *behaves as a gas* with pressure rising with increasing temperature. When the Powerlet is essentially full, the slope above the transition point is very steep and pressure rises rapidly with temperature *to potentially dangerous levels*.

When the cartridge is nearly depleted, the transition point marks the end of useful life. This is the point at which all of the *liquid* CO_2 has been consumed.

Re-plotting this data with a different format makes the natural regulation process evident. The following plot presents a family of pressure-versus-mass lines, each for a different ambient temperature. Note the broad constant-pressure (horizontal) segment in each line below the (dotted) 87.8° F curve.



CO_2 regulation is summarized below. Mark the ambient temperature on the horizontal scale and read the corresponding pressure and mass limits directly above it. For example, on a 70° F day, a regulated pressure of 840 psig will be provided as long as the Powerlet holds at least 2.8 grams but not more than 10.6 grams of CO_2. Hence the first few shots will be "hot" until you use 1.4 grams from a new Powerlet. You will "run out of liquid" when 2.8 grams of gas remain in the cartridge.



Flying Dragon Air Rifles

Specializing in QB78 series CO_2 rifles tested for reliability, adjusted for accuracy, polished for smoothness and tuned for maximum performance.

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