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TECHNICAL NOTE 54: DIRECT IMPINGEMENT VERSUS PISTON DRIVE

PURPOSE: To compare the merits of internal and external piston drive systems.

FACTS: The AR-15/M16 and the AR-10 family of rifles employ a unique gas powered operating system patented by Eugene Stoner in the 1950s. This gas operating system works by passing high pressure propellant gasses tapped from the barrel down a tube and into the carrier group within the upper receiver, and is commonly but incorrectly referred to as a “direct impingement” system.

The gas expands within a donut shaped gas cylinder within the carrier. Because the bolt is prevented from moving forward by the barrel, the carrier is driven to the rear by the expanding gasses and thus converts the energy of the gas to movement of the rifle’s parts. The bolt bears a piston head and the cavity in the bolt carrier is the piston sleeve. It is more correct to call it an “internal piston” system.

Most previous semiautomatic rifles use an “external piston” system operating in a gas cylinder mounted outside the receiver, but instead attached to the barrel. Propellant gasses expand within the cylinder and force the piston to the rear. The piston either contacts a rod that and drives a carrier to the rear (FAL), or are part of, connected to, or strike a rod segment that passed around the action to cam and move the bolt (M1, M14, AK- 47, SCAR). In some cases the piston is fixed and the movable cylinder drives the rod (AR-180).

ADVANTAGES AND DISADVANTAGES: The Stoner system provides a very symmetric design that allows straight line movement of the operating components. This allows recoil forces to drive straight to the rear. Instead of connecting or other mechanical parts driving the system, high pressure gas performs this function, reducing the weight of moving parts and the rifle as a whole.

In external piston systems, the path of the operating force is mechanically shifted around the action, resulting in a considerable mass of moving parts moving outside the centerline of the firearm and producing various torques within the system.

There is a common belief that the external piston operated systems are less accurate than the Stoner internal piston system because the operating parts start moving while the bullet

is still in the bore. This is not true: Army Ordnance tests conducted in the 1960s revealed that the bullet is 25 feet out of the bore of the M1 and 15 feet out of the bore of the M14 before any operating part begins to move. It is more likely that the imbalances of the external piston, operating rod, cylinder, and other parts hanging on the barrel produce disruptive vibrations as the bullet exits the bore.

Although movement of the operating parts while the bullet is in the bore isn't apparently a culprit in reducing the accuracy of external piston systems, the inherent accuracy of the Stoner internal piston system has been consistently confirmed in competitive shooting. In all events that allow use of any mechanism the shooter wishes, the Stoner internal piston system is prevailing. Few competitive shooters use the Garand or Kalashnikov systems, and none observed now use the FAL system. In American Service Rifle and NRA competition, the external-piston operated rifles are considered a significant disadvantage.

There is a debate about which system remains cleanest. The internal piston system tends to leave propellant residue in the receivers, while the external piston systems keep the residue outside the action in the cylinder. External piston driven systems, however, tend to allow more external dirt into the action because of the openings required for various connecting members (operating rod, bolt lugs, etc). Comparison tests of the M16 and the M-14 before Desert Storm confirmed the superiority of the Stoner system in sand and dust tests, and recent testing has proven that proper cleaning of either system provides excellent reliability.

ArmaLite concludes that there is no technical advantage to an external piston system employing current ammunition. It will likely, however, provide external-piston systems to the market as customers demand.

As a last note, misuse of the term "direct impingement" to describe the Stoner system is so common that it has confused the issue. A direct impingement system like that of the AG-42 Ljungman or the French MAS-49 rifle taps gas at the barrel and passes it into the receiver in a way similar to the M16, (the source of the confusion) but deposits it into a small, shallow cup or pocket in the carrier. The gas expands there and drives the carrier to the rear with relatively little pneumatic advantage. The addition of the Stoner internal piston system provides significantly more pneumatic advantage to the rifle and little of the blast of escaping gas at the breech end of the gas tube of the earlier rifles.

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