

Two of the four 20 mm guns in the Gloster Meteor. Attention is drawn to (A) the gun barrels, with their blast tubes removed, (B) pneumatic cocking valves, (C) link chutes, (D) case chutes, (E) rear mountings and adjusters.



is considered less reliable, due to the risk of mechanical seizure caused by solid residues in the powder gases; but it is lighter and will normally allow a high rate of fire. German experts hold the view that the gas-operated airborne gun deserves preference for all purposes because of its low weight and because of the smaller number of moving parts; and they consider as exceptional the mass-locking system preferred in the case of the M.K.108 and M.K.112 weapons.

Rate of fire is directly related to muzzle velocity. On our assumptions, the greater propellant charge needed for high muzzle-velocity demands a longer cartridge case, and, consequently, increased stroke of the breech-block and a longer breech; also, a longer barrel is needed, and the recoil is higher. High muzzle-velocity, therefore, increases the reciprocating masses and thus slows the rate of fire. In addition, the gun with the higher muzzle-velocity is longer and heavier; the larger ammunition requires more stowage space and is heavier; and a more substantial mounting is needed.

For a 20 mm aircraft shell-gun (with mechanically locked breech and recoil-operated mechanism), a 50 per cent increase in muzzle velocity reduces the shell's time of flight over 1,000 yards by 20 per cent, while the trajectory is flatter and the impact penetration greater. But this is achieved at the cost of a gun weighing not less than two-and-a-half times as much, of twice the length, and firing at half the speed. The cartridge is longer by 44 per cent.

In general, the trend in air combat is to rely on moderate muzzle velocities. With fixed-gun installations, the flying speed adds to the muzzle velocity: as modern interceptors have high speeds, especially with power-boost during attack, sufficiently flat trajectories result, particularly at high altitudes. Moreover, a deficient muzzle velocity can be compensated by automatically computing sights. A deficiency in fire density, however, compels us to multiply the weapon installation, and this is usually an unacceptable remedy.

**Methods of Use.**—Interception can be accomplished by four methods of discharging projectiles:—

- (a) *Single shot*: automatically triggered, or guided, or directed.
- (b) *Burst*: i.e., a sequence of several projectiles.
- (c) *Salvo*: i.e., simultaneous discharge of several projectiles.
- (d) *Salvo-burst*: a combination of (b) with (c).

Destruction of the target is effected either by a direct hit (or hits), or by nearby detonation. In the latter case, however, it must be realized that the lethal range of even the very effective German 88 mm Flak shell (with time fuze) was actually less than five yards distance from the target, and that the lethal sphere formed by a detonating 3.7in A.A. shell has a diameter of only about 50 feet, effective during about one-fiftieth of a second.

The alternative between splinter and blast action has been referred to in an earlier instalment of this article. Explosive shrapnel, i.e., the ejection of small, separate explosive missiles from a detonating shell is possible, and was eagerly studied in Germany; but its operational effectiveness has yet to be established.

A modern trend is towards *single-shot action* by means of substantial-sized guided or directed, homing, air-to-air missiles which produce lethal spheres large enough to destroy an enemy even with the aid of proximity fuzes, and which can be discharged over ranges exceeding one mile without proper taking of aim. The operational similarity to the naval torpedo is obvious.

The traditional but by no means obsolete method is action

by *salvo-bursts*, from weapon batteries firing at high rate over ranges not exceeding about 1,000 yards. The probability of a hit is not related to the single-round dispersion, i.e., the difference between aiming point and average point of impact; burst-dispersion alone is essential. The former characteristic is more usually found in salvo fire; in bursts, projectiles follow each other and cause departure deflections not present in single-shot fire. Moreover, apart from effects of barrel vibration, etc., the target and the attacker move whilst the actual projectiles are under way. Since a modern bomber easily covers 300 yards during one second, range and bearing are subject to considerable variations.

*Salvo* fire from rocket batteries offers good prospects for the use of small, supersonic rocket or ramjet missiles. If the nose of the fuselage is available for such "honeycomb" batteries as in the Natter (illustrated in Part V), full benefit can be derived, but with launching devices distributed along a wing the fire-density produced might not be good enough. For supersonic interceptors having automatically triggering sights, salvo fire of rockets should be satisfactory. In such aircraft a prone position of the pilot in the nose of the fuselage might be preferred.

As to *salvo-bursts*, it must first be remembered that the "curve of pursuit" is the shortest path along which an interceptor can get into position to open fire. Fixed-gun installations compel the interceptor to follow something approaching a "ramming course"; thus the axis of the interceptor must point towards the target or, in view of the target's motion during the time of flight of the projectiles, towards the point which the target will reach when the projectiles complete their flight. The "lead" required for the relative movement during projectile flight may be considerable. If the target proffers defensive fire, the curve of pursuit will be adhered to solely during the short interval between taking aim and firing; this may be anything between, say, three and six seconds, and during it the interceptor is helplessly exposed.

Operational experience indicates that, when the target is not fired at from directly aft or whilst moving in the same vertical plane as the interceptor, the probability of hits is much reduced ("lead dispersion"). Angles exceeding 20 deg in flight courses can give prospects of destruction only with the aid of automatically computing (i.e., gyro-monitored) sights. However, in an attack from above or below, at an angle of less than 30 deg, whilst flying on the same course as the target, the latter presents a larger area, and the chances of a hit are greater.

Automatically computing sights (first suggested and experimented with during the First World War, by this country) are a necessity for an interceptor. They must at least provide the angle of deflection (or lead), while automatic ranging, also, is most desirable. All this was included in German Luftwaffe experimental devices, upon which the German experts set high hopes. The final (and, for total air defence, absolutely necessary) development is an automatically triggering ("blind-aiming") sight, in combination with radar stalking. It is hard to see how, otherwise, night