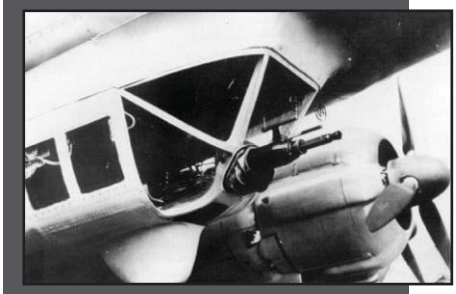
MILE STONES

Early fighter cannon armament

Dr Carlo Kopp



The humble Oerlikon MG FF is without doubt the most important gun of the 1940s era, becoming the basis for the British Hispano HS.404, the German MG FF variants, the Japanese Type 99 series, and later US Colt Mk.12 series.

Cannon armament in fighter aircraft today is taken for granted, with all modern fighters in service, or in development, configured with a rapid fire cannon. While vendor marketing literature often emphasises the 'state of the art' characteristics of the gun in use, the reality is less dramatic. Most current cannon designs intended for airborne use are direct derivatives of 1940s technology weapons.

Prior to the outbreak of World War II, cannon armament was relatively uncommon in fighter aircraft, when machine guns of 7.62 mm (0.30 in) to 15 mm (0.38 in) calibre dominated. Bomber armament was also dominated by machine guns.

Preferred fighter armament mixes during the late 1930s saw the British using mostly the Browning 0.303 Mk.1 and Mk.2, based on the US Browning M1919, the Americans the 0.30 cal AN/M2, another M1919 variant, the Germans mostly the MG15 (7.92 mm), the MG17 (7.92 mm), the MG 131 (13 mm), and the MG 151 (15.1 mm), the French mostly the MAC 1934 and Darne (7.5 mm) and the Russians the ShKAS (7.62 mm). Cannon were scarce, and were mostly 20 mm weapons used to supplement machine gun armament. Most were mounted to fire through the propeller shaft of an inline liquid-cooled V engine.

Without doubt, one weapon dominated the market, and that was the Swiss designed Oerlikon MG FF and its offspring. This 20 mm gun with a drum ammunition feed became the primary weapon of the German Luftwaffe early in the war but also the basis for the French Hispano-Suiza Type 404, or HS.404, which became the primary British 20 mm cannon later in the war. The MG FF also formed the basis for the Japanese Type 2, and the US Navy's HS.404 variant carried later in the war by the F4U-1C Corsair and F8F-1B Bearcat.

There was intensive debate during this period on the merits of cannon versus machine guns. Typically, machine guns delivered a rate of fire of around 1200 up to 2000 rounds per minute, providing for a good probability of a hit in aerial combat but this advantage was offset by the lesser killing power of the small rifle calibre rounds with weights of 9 to 11 gram.

The British reconciled this by standardising on an eight 0.303 calibre gun configuration for the early Hurricane and the Spitfire. This strategy proved quite effective for fighter versus fighter combat but less so in the interception of bombers with heavier structure to penetrate, if damage was to be done to vital systems. There are numerous anecdotes concerning Luftwaffe bombers, which flew on despite being riddled with 0.303 calibre bullet holes.

Several issues arose with early cannon armament. The first was the rate of fire, which was relatively slow compared with that of machine guns, and since the cannon was much heavier, only one or two were typically carried, thus resulting in a much lower aggregate rate of fire with all guns firing. The second was in different ballistic trajectories, which proved especially difficult due to the limitations of early gunsights, which lacked the gyro stabilisation adopted later in the war.

The attraction with cannon was always in the heavier projectiles, which could be filled with explosive to provide much greater damage effect per hit, should a hit occur.

By the end of the Battle of Britain the RAF recognised the value of cannon armament and Spitfires, starting with the Mk.V, were armed with a pair of two Hispano 20 mm guns, and four Browning .303 guns. The World War II Typhoon, initially to be an interceptor, was armed with four Hispanos, as were the Beaufighters and Mosquitos used as night fighters. The success of the Hispano-armed Typhoon in low level strafing led to late-built Hurricanes so armed. By the end of the war, the Tempest and Meteor, and many Spitfire variants carried four Hispanos. While the later Hispano variants were incrementally improved, they remained a derivative of the Oerlikon MG FF. RAF bombers continued to be armed with the Browning .303 gun until the end of the war when some bombers acquired the .50 cal Browning M2 for tail turret installations. It is an open question as to how many more bomber crews would have survived the war had 0.50 cal guns been used instead.

The RAF's initial policy of arming fighters with eight .303 calibre machine guns soon gave way to armament dominated by the Hispano 20 mm gun. The first fighter to use an all cannon armament was the Typhoon I, soon followed by the Tempest V. The much heavier Beaufighters and Mosquitos were armed very early with the Hispano.

The Americans diverged dramatically from the European powers and standardised on the .50 cal Browning M2 machine gun for most fighters used during the war. With armaments varying between four and eight of these guns, it represented a good compromise between the killing power of 20 mm and larger cannon, and the limited 0.30-0.303 cal machine guns. All American bombers used the M2 as a defensive weapon in turrets and flexible mounts. Only the P-38 Lightning and P-39 Airacobra carried a single 20 mm gun, the former nose mounted, the latter firing through the prop shaft. The M2 remained the primary gun used by the US Air Force until the end of the Korean War, when cannon were adopted.

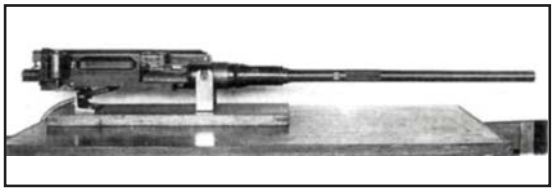
The Russians used the gas-operated ShVAK 20 mm cannon in a number of fighters, but the weapon was considered troublesome and later replaced by the Volkov-Yartsev VYa-23 23 mm gun. The Japanese used the wing mounted Type 1, an MG FF variant, in the A6M2, A6M3 Zeke/Zero, with considerable success, but later replaced it with the Type 99 Mark 2 and 3 cannon, variants of the MG FF F and MG FF L. The widely used Japanese Ho-5 20 mm gun was a re-barrelled Browning M2 derivative.

Germany was by far the most active in the development of new guns for air combat. This partly reflected the well developed munitions industry base, but also the extreme pressures Germany faced in trying to retain its hold on occupied territories in the Mediterranean and later the Eastern Front. As the Allied Combined Bomber Offensive gained momentum, improvements to airborne cannon were well funded and actively encouraged.

The MG FF was initially used in the Bf-109 fighter, firing through the propeller hub. While accurate, its effectiveness was contingent upon a highly skilled pilot. The weapon remained in use until later in the war, especially as part of the Shrage Musik dorsal and ventral gun packs carried by night fighters such as the Do-217 and Bf-110 series.

By the middle of the war the 20 mm gun of choice for fighter applications was the Mauser MG 151/20, a redesign of the 1934 MG 151 15.1 mm machine gun. The 151/20 was used in almost every German fighter type, and often also as bomber defensive armament. It delivered 680 to 740 rounds per minute, with an 800 m/s muzzle velocity and a range of 20 mm round types. These included a 117 g AP round, a 115 g HE round, Armour Piercing Incendiary (API) and incendiary rounds, and the improved HE(M) or 'Minengeschoss' HE round, with a drawn steel casing and larger explosive warload. With better ballistics than the MG FF, the MG 151/20 was far more popular than the earlier gun.

While the MG 151/20 was a major gain over the MG FF family of guns, it required on average nearly twenty hits to kill an Allied heavy bomber. This compelled German industry to do better.



The most widely used German cannon of the war was the Mauser MG 151/20, which became almost ubiquitous on German aircraft.

The Luftwaffe's first 30 mm cannon was the Rheinmetall Borsig MK 101 used in the Hs-129 tank buster. It had a slow rate of fire at 260 rds/min and was replaced by the faster Rheinmetall Borsig MK 103 with 420 rds/min. While the MK 103 had superb muzzle velocity at 860 m/s, at 140 kg it was too heavy for most applications. The weapon was built in the basic version plus the MK 103M, designed to fit between the cylinder banks of the DB-601 and Junkers Jumo 213 engines. The latter was used in the Focke Wulf Ta-152C interceptor, the Do-335 Pfeil interceptor and apparently some late-build Bf-109Ks. Like the MG 151/20, a 'Minengeschoss' HE round was adopted for attacks on bombers.

The weight of the MK 103 was an impediment to its wider use, and the much lighter MK 108 was developed to replace it. With a shorter barrel and many stamped mass production components, the 64 kg Rheinmetall Borsig MK 108 is often regarded as the best 30 mm aerial cannon of the war. While it lacked the muzzle velocity of the longer barrelled MK 103, its higher rate of fire at 660 rds/min and much lower weight made it far more useful.

The MK 103 ended up being widely used, with wing root installations in FW 190 variants, wing and engine installations in Bf-109G/K variants, wing root installations in the highly effective He-219 Uhu night fighter, the Me-163 rocket fighter, the Ju-388 night fighter, Bf-110 night fighters, and a four-gun nose package in the Me-262 jet fighter. The lethality of the MK 103 was demonstrated by continuing high loss rates of night bombers till the end of the war.

The Lightweight Rheinmetall-Borsig MK 108 was the first 30 mm cannon to be widely used on fighter aircraft, equipping variants of the Bf-109, FW-190, He-219, Me-110, Ju-88, Do-217 and Me-262A. It replaced the much earlier MK 101 design.

The biggest innovation during the period was produced by Mauser in the experimental MG 213 20 mm five chamber revolver cannon, intended to replace the MG 151/20. The MK 108, like some other period weapons, was a 'blowback' mechanism, in which energy was transferred to the breech to effect reloading. Earlier weapons like the MG 151/20 were recoil operated, in that, energy from the recoil of a fired round was stored in a spring and then released to load the next round into the chamber, while some like the Hispano and ShVAK were gas operated, using residual gas pressure after firing to effect the reload.

The MG 213 was designed for a 20 mm round but a 30 mm variant known as the MK 213 or MG 213C was also developed. Thankfully, the MG 213 never made it into combat thus sparing allied lives, but it did become the template for a generation of post-war aerial cannon. The RAF's ADEN (Armament Development Establishment / Enfield) 30 mm gun, used in the English Electric Lightning, Folland Gnat, Indian HAL Ajeet, Hawker Hunter, Gloster Javelin, Saab Lansen, Saab Draken, Supermarine Scimitar, CAC Sabre and early Harriers form one example.

The French 30 mm DEFA 550 series, used in the the Dassault MD 450 Ouragan, Dassault Mystere, Mirage III/V, Dassault Etendard and Super Etendard, Sud Aviation Vautour, Mirage F1, French SEPECAT Jaguar, Mirage 2000, IAI Nesher, IAI Kfir, IAI Lavi, Aeritalia G-91Y, Aermacchi MB-326K, and Atlas Cheetah is another MG 213 derivative.

The American 20 mm Pontiac M39, used in the F-86H Saber, F-100 Super Saber, F-101A and F-101C Voodoo, F-5 Freedom Fighter / Tiger II is yet another MG 213 derivative. Worth noting, is that the US Navy Colt-Browning Mk 12 20 mm is a derivative of the HS.404 series, which was used in the F-4D Skyray, F-3 Demon, A-4 Skyhawk, F-8 Crusader, and A-7 Corsair II variants.

A typical rate of fire for an MG 213 derivative is between 1400 to 1700 rds/min for 20 mm, and 1200 to 1800 rds/min for 30 mm types. The GIAT 30M791 delivers 2500 rds/min. This is between 2.5 and 5 times faster than earlier cannon.

The deadly Me-262A turbojet fighter was armed with four lightwieght 30 mm MK 108 guns making it the most heavily armed single seat fighter of WW2. Two exact replicas are being flight tested by the privately funded Me 262 Project in the US. Note the open cannon bay doors (refer Stormbirds.com)

In perspective, World War II led to significant incremental improvements to gas operated, blowback and recoil operated weapons, significant improvements to small calibre cannon shells, and brought in the revolutionary revolver cannon which remains in use today. While cannon were an almost exotic element of fighter armament in 1939, by 1945 they dominated air combat.

Derivatives of the Oerlikon MG FF and Mauser MG 213 played a major role in the subsequent Korean War, Vietnam War, Six Day War and Yom Kippur War, and of course the Falklands War. Vietnam saw the combat debut of modern Gatling guns, and that will be a subject for future Milestones.