Polikarpov I-16

Alors même qu'il travaillait sur le I-15, Nikolai Nikolaevich Polikarpov songea à un monoplan, qui disposerait d'un train rétractable et d'un cockpit fermé. Son obsession majeure fut la vitesse et il s'inspira des Gee Bee R1, de 1932, compacts mais véloces. Le projet, nommé TsKB-12, fut construit sous forme de prototype à partir de juin 1933 et fit l'objet d'une commande dès le 22 novembre, avant même son premier vol. L'appareil avait une construction mixte, avec un fuselage en bois et des ailes métalliques. Il s'agissait du premier chasseur monoplan à train rétractable au monde. Son cockpit était ouvert. Il était construit autour du moteur Wright Cyclone SR-1820-F-3. Les négociations pour le construire sous licence traînèrent et Polikarpov installa à la place un M-22, c'est-à-dire une construction sous licence du Gnome-Rhone Jupiter 9ASB, lui-même une construction sous licence du Bristol Jupiter VI. La puissance passait de 710 hp à 480 hp, mais la vitesse calculée restait supérieure à 300 km/h. Il emportait 225 litres de carburant et était armé de deux mitrailleuses ShKAS de 7,62 mm placées dans les ailes, avec 900 cartouches. Le TsKB-12, doté d'un moteur M-22, effectua son vol inaugural le 30 décembre 1933 avec Valery Chkalov aux commandes. Le deuxième prototype, doté d'un moteur Cyclone, vola pour la première fois en janvier 1934. Les tests étatiques démarrèrent en février et montrèrent une excellente maniabilité. 5 prototypes furent construits, dont le dernier était doté du M-25, le Cyclone construit sous licence. A sa sortie, l'I-16 était le chasseur le plus léger et le plus rapide du monde avec 454 km/h. S'il ne supportait pas les forts facteurs de charge, il avait de très bons taux de roulis (240°/s) et de montée. A son entrée en service en 1934, l'I-16 démontra ses défauts : des armes ayant tendance à s'enrayer (ce qui fut réparé), un pilotage difficile, une mauvaise visibilité. 276 I-16 type 5 et 6 furent vendus aux républicains espagnols, contre un paiement en or, et livrés entre 1936 et 1938. Ils apparurent dans le ciel espagnol en novembre 1936. Leur baptême du feu eut lieu le 13, lorsque 12 I-16 interceptèrent un raid ennemi. Ils engrangèrent 4 victoires, pour la perte d'un d'entre eux. Ils supplantèrent les biplans tels que le He 51, l'Ar 68 et le Cr.32. Les I-16 subirent des pertes lors de l'apparition des Bf 109B en 1937. Il démontra aussi à cette occasion que la structure des ailes avait besoin d'être renforcée, et que l'armement était trop léger. Le type 6 disposait de 3 mitrailleuses, et le Type 10 de 4. Lorsque la guerre civile se termina, le 1er avril 1939, l'I-16 avait subi 187 pertes, dont 112 au combat et 62 par accident. 250 I-16 type 10 furent également fournis à la Chine. La Mongolie utilisa un I-16 pour l'entraînement, et la Pologne un I-16 et 2 UTI-4.

Lors des batailles de Khalkhin Gol, qui virent s'opposer Soviétiques et Japonais en 1939, 112 I-16 furent perdus au combat aérien sur 500 engagés. Un exemplaire du principal opposant, le Ki-27, fut capturé et démontra des capacités supérieures aux avions de chasse Polikarpov, I-16 compris. En 1941, au moment de l'invasion nazie, 1635 avions sur les 4226 des VVS étaient des I-16. Il équipait 57 régiments de chasse. Il devint la cible principale de la Luftwaffe et après 48 h de combat, il n'en restait que 937. Les pilotes russes eurent alors recours au "Taran" (bélier), en se jetant volontairement sur les avions ennemis. Pas moins de 14 avions allemands furent considérés comme détruits dès le premier jour. On estime à 500 le nombre de victoires revendiquées par Taran et certains pilotes survécurent. L'I-16 fut également surclassé par les Bf 109E, puis F. Il fut finalement remplacé en 1943. Plusieurs forces aériennes capturèrent des I-16 : l'Allemagne, l'Espagne, la Finlande (6 I-16 et un I-16UTI), le Japon (1), la Roumanie (1 exemplaire, dont le pilote avait fait défection). Dans le cas de l'Allemagne et de la Finlande, des exemplaires remis en état de vol furent testés. Dans le cas de l'Espagne, ils furent utilisés jusqu'en 1952. 7005 monoplaces et 1639 biplaces furent construits, pour un total de 8644 exemplaires entre 1934 et 1942. Il reçut beaucoup de surnoms : "Ishak" (âne) en Russie, "Mosca" (mouche) pour les républicains espagnols, "Rata" (Rat) pour les Nationalistes, "Siipiorava" (écureil volant) pour les Finnois. Au moins 6 I-16 furent remis en état de vol par Tim Wallis dans les années 1990.

Source : https://aviationsmilitaires.net/v3/kb/aircraft/show/1149/polikarpov-i-16

Version anglaise Wikipédia

The **Polikarpov I-16** (Russian: Поликарпов И-16) is a Soviet single-engine single-seat fighter aircraft of revolutionary design; it was the world's first low-wing cantilever monoplane fighter with retractable landing gear to attain operational status and as such "introduced a new vogue in fighter design".[2] The I-16 was introduced in the mid-1930s and formed the backbone of the Soviet Air Force at the beginning of World War II. The diminutive fighter, nicknamed "***Ishak***" or "***Ishachok***" ("donkey" or "burro") by Soviet pilots, figured prominently in the Second Sino-Japanese War,[3] the Battle of Khalkhin Gol,[3] Winter War and the Spanish Civil War[4][5] – where it was called the ***Rata*** ("rat") by the Nationalists or ***Mosca*** ("fly") by the Republicans. The Finns called the aircraft ***Siipiorava*** "(flying squirrel)".[6]

Design and development

While working on the Polikarpov I-15 biplane, Nikolai Nikolaevich Polikarpov began designing an advanced monoplane fighter. It featured cutting-edge innovations such as retractable landing gear and a fully enclosed cockpit, and was optimized for speed with a short stubby fuselage, and a Wright R-1820 radial engine in a NACA cowling. The aircraft is small, light and simple to build. Full-scale work on the **TsKB-12** prototype began in June 1933, and the aircraft was accepted into production on 22 November 1933, a month before it took to the air. The TsKB-12 was of mixed construction, using a wooden monocoque fuselage and wings employing a KhMA chrome-molybdenum steel alloy wing spar, dural ribs and D1 aluminum alloy skinning on the center and leading edges, with the remaining portions of the wings fabric covered. Another modern feature were the ailerons which ran along almost the entire trailing edge of the wing and also operated as flaps (in the manner of more modern flaperons) by drooping 15°. The cockpit was covered by a 40-centimetre-wide (16 in) canopy which featured an Aldis-type tubular gun sight which could slide back and forth on runners fitted with rubber bungee cords. A 225 L (59.4 US gal) fuel tank was fitted directly in front of the cockpit. The main landing gear is fully retractable by a hand crank. The armament consisted of a pair of 7.62×54mmR (0.30 in) ShKAS machine guns in the wings, mounted on the outboard side of the main gear and 900 rounds of ammunition. These features were proposed at first by Andrei Tupolev; however, the NII VVS was more concerned about the stresses a typical combat aircraft was subjected to in combat, and initially considered the risk too great. However, TsAGI, with the help of the 3rd Design Brigade under the leadership of Pavel Sukhoi and Aleksandr Putylov, eventually convinced NII VVS that what was being proposed was not only feasible, but would enhance the aircraft's performance. The TsKB-12 was designed for the Wright Cyclone SR-1820-F-3 9-cylinder radial engine (rated at 529 kW/710 hp); a license to build this engine under the supervision of the OKB-19 Shvetsov design bureau in the Soviet Union was being negotiated. As the license was not yet approved, Polikarpov was asked to settle for the less powerful M-22 (Soviet-built version of the Gnome-Rhone Jupiter 9ASB, which itself was a licensed version of the Bristol Jupiter VI) with 358 kW (480 hp). This was deemed acceptable because the projected top speed still exceeded 300 km/h (185 mph. The M-22-powered TsKB-12 first took to the air on 30 December 1933 with the famous Soviet test pilot Valery Chkalov at the controls. The second TsKB-12, with a Cyclone engine and three-bladed propeller, flew in January of the following year. Initial government trials in February 1934 revealed very good maneuverability, but the aircraft did not tolerate abrupt control inputs. Thus the TsKB-12 was deemed dangerous to fly and all aerobatics were forbidden. The M-22 version was preferred due to the vibration of the Cyclone-powered aircraft. Pilots commented early on about the difficulty of climbing into the cockpit, a trait that persisted through the I-16's service life. Before continuing test flights the designers had to answer the question of spin behavior. Wind tunnel testing suggested that the TsKB-12, with its short tail, would enter an unrecoverable flat spin, but real-life trials were necessary to confirm this. Since Cyclone engines were rare, it was decided to risk the M-22 prototype for this purpose. On 1 and 2 March 1934, Chkalov performed 75 spins and discovered that the aircraft had very benign stall behavior (dipping a wing and recovering without input from the pilot when airspeed increased) and intentional spins could be easily terminated by placing the controls in the neutral position. The stories of vicious spin behavior of the I-16 perpetuated in modern literature is unfounded (perhaps extrapolated from Gee Bee experience). In fact, the I-16's stablemate, the biplane Polikarpov I-153, exhibited much worse spin characteristics. Service trials of the new fighter, designated **I-16**, began on 22 March 1934. The M-22 prototype reached 359 km/h (223 mph).

The pioneering presence of a complex, triple-strut manually retracted main landing gear design was prone to jamming and required considerable strength from the pilot, who directly operated the rearmost strut's upper end, moved with a manually turned jackscrew running spanwise within the wing structure, to "slide" outwards and inwards on each side to respectively get the main gear retracted and extended, with the main strut (the forward-most of the trio) needing to shorten its length during its retraction to fit the mainwheel into the lower fuselage, performed by the middle-location strut's geometric arrangement and pivot locations.[7] Most of the test flights were performed with the gear extended. On 1 May 1934, the M-22 prototype participated in the flyover of Red Square. Approximately thirty I-16 Type 1 aircraft were delivered, but were not assigned to any VVS fighter squadron. Most pilots who flew the I-16 Type 1 for evaluation purposes did not find the aircraft to have many redeeming characteristics. Regardless of pilot opinion, much attention was focused on the Cyclone-powered aircraft and the M-25 (the license-built Cyclone). On 14 April 1934, the Cyclone prototype was damaged when one of the landing gear legs collapsed while it was taxiing. The third prototype with a Cyclone engine incorporated a series of aerodynamic improvements and was delivered for government trials on 7 September 1934. The top speed of 437 km/h (270 mph) no longer satisfied the Air Force, who now wanted the experimental Nazarov M-58 engine and 470 km/h (290 mph). Subsequently, the M-22-powered version entered production at Factory 21 in Nizhny Novgorod and Factory 39 in Moscow. Because it was the fourth aircraft produced by these factories, it received the designation **I-16 Type 4**. Aircraft fitted with these new engines required a slightly changed airframe, including armor plating for the pilot and changes to the landing gear doors (particularly, the hinged lower mainwheel door)[8] to allow for complete closure. The M-25 fitted I-16, the I-16 Type 5, featured a new engine cowling which was slightly smaller in diameter and featured nine forward-facing, radially-set shuttered openings to control cooling airflow, a redesigned exhaust with eight individual outlet stubs, and other changes. The M-25 was rated at 474 kW (635 hp) at sea level and 522 kW (700 hp) at 2,300 m (7,546 ft). Due to the poor quality of the canopy glazing, the I-16 Type 5 pilots typically left the canopy open or removed the rear portion completely. By the time the Type 5 arrived, it was the world's lightest production fighter (1,460 kg/3,219 lb), as well as the world's fastest, able to reach speeds of 454 km/h (282 mph) at altitude and 395 km/h (245 mph) at sea level. While the Type 5 could not perform the high-G maneuvers of other fighters, it possessed superior speed and climb rates, and had extremely responsive aileron control, which gave it a very good roll rate, which led to precision maneuvers in loops and split-Ss. A total of 7,005 single-seat and 1,639 two-seat trainer variants were produced.

Operational history

Initial service experience revealed that the ShKAS machine guns had a tendency to jam. This was the result of the guns being installed in the wings upside-down to facilitate the fit. The problem was addressed in later modifications. Evaluations from pilots confirmed the experience with prototypes. Controls were light and very sensitive, abrupt maneuvers resulted in spins, and spin behavior was excellent. An aileron roll could be performed in under 1.5 seconds (roll rate over 240 degrees/second). The machine guns were fired via a cable and the required effort, coupled with sensitive controls, made precision aiming difficult. The rear weight bias made the I-16 easy to handle on unprepared airfields because the aircraft was rather unlikely to flip over the nose even if the front wheels dug in. The I-16 was a difficult fighter to fly.

The pilots had poor visibility,[9] the canopy tended to become fouled with engine oil, and the moving portion was prone to slamming shut during hard maneuvers, which caused many pilots to fix it in the open position. The front section of the fuselage, with the engine, was too close to the centre of gravity, and the pilot's cockpit too far to the rear. The Polikarpov had insufficient longitudinal stability and it was impossible to fly the aircraft "hands off".[10]

I-16 in Spanish Republican colors with "Popeye mascot"

Spanish Civil War

At the start of the Spanish Civil War in 1936, Republican forces pleaded for fighter aircraft. After receiving payment in gold, Joseph Stalin dispatched around 475[11] I-16 Type 5s and Type 6s. The first I-16s appeared in Spanish skies in November 1936.[12] The Polikarpov monoplanes had their baptism of fire on 13 November 1936, when twelve I-16s intercepted a Nationalist bombing raid on Madrid. Soviet pilots claimed four air victories and two German Heinkel He 51 pilots were killed. But the Soviets suffered losses too; the group commander collided with an enemy aircraft and another I-16 pilot crash landed.[13] The Polikarpovs immediately began dominating the enemy Heinkel He 51 and Arado Ar 68 biplanes and remained unchallenged until the introduction of the Messerschmitt Bf 109. The arrival of the newest Bf 109Bs and the overwhelming numerical superiority of Nationalist fighters were the primary cause of the heavy I-15 and I-16 combat losses suffered throughout 1937.[14] A number of aviation publications called the new Soviet fighter a "Boeing" due to the incorrect assumption that it was based on the Boeing P-26's design. The Nationalists nicknamed the stubby fighter *Rata* (Rat), while the Republicans affectionately called it *Mosca* (Fly). Combat experience showed that the I-16 had deficiencies; several aircraft were lost after structural failure of the wings which was quickly remedied by reinforced structures. Heavy machine gun bullets could sometimes penetrate the armored backrest and fuel tanks occasionally caught fire in spite of being protected.

The hot Spanish summers required the addition of oil radiators, and dust adversely affected the life of the engines. Although some aircraft accumulated up to 400 hours of flying time, the average life of an I-16 was 87 days, of which one sixth was spent on maintenance. The biggest complaint in service was the light armament of only two 7.62 mm (0.30 in) machine guns. This was urgently addressed with the **Type 6** which added a third ShKAS in the bottom of the fuselage. The four-gun **Type 10** was nicknamed "Super Mosca" or simply "Super". The total number of I-16s delivered to Spain from 1936 to 1938 amounted to 276. When the war ended on 1 April 1939, 187 *Ratas* had been lost in Spain: 112 lost in combat, one shot down by anti-aircraft fire, eleven destroyed on the ground, one force-landed and 62 lost in accidents.[15]

The Far East and battles at Khalkhin Gol

I-16 with Chinese insignia, flown by Chinese pilots and Soviet volunteers

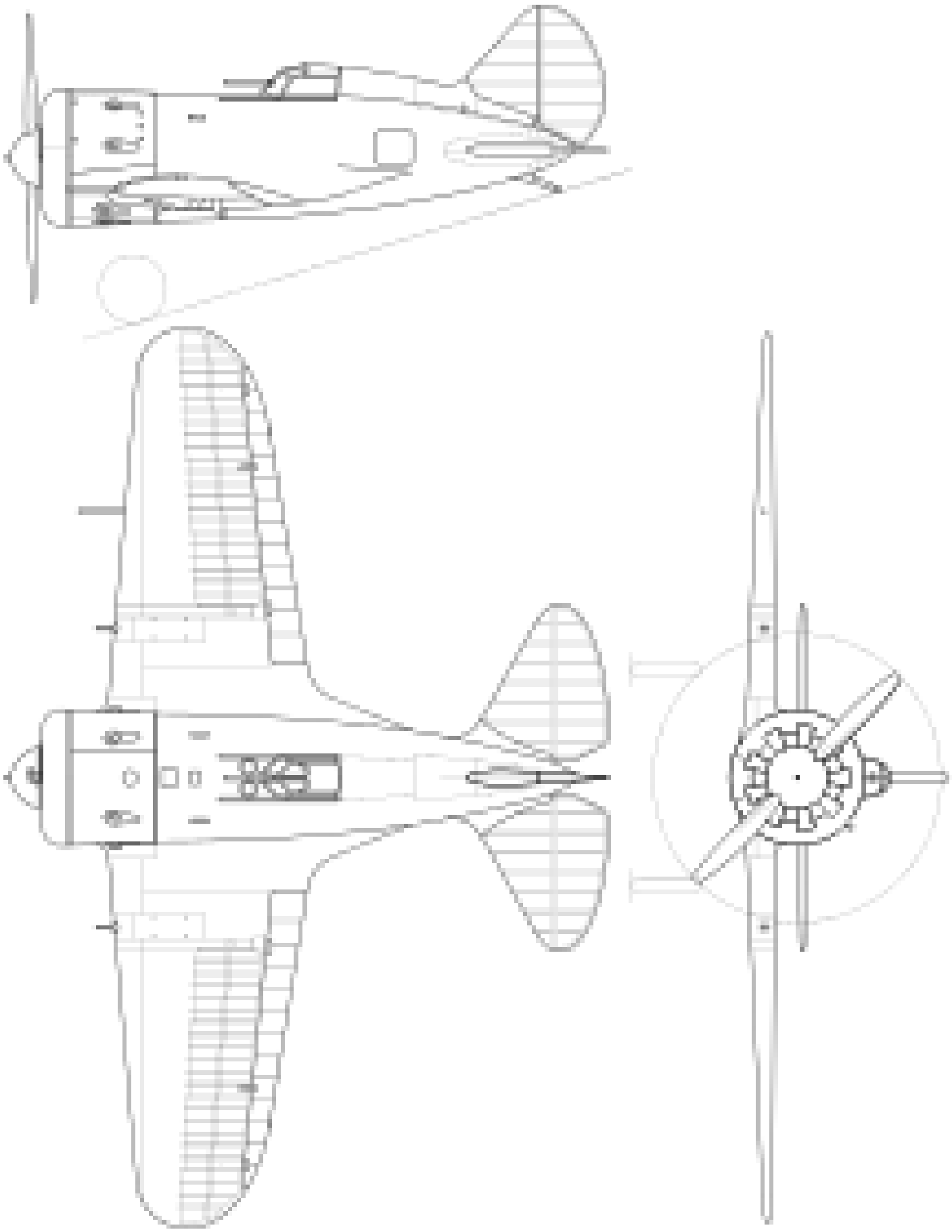
Another 250 **I-16 Type 10s** were supplied to China. This model added a second set of 7.62 mm (0.30 in) ShKAS machine guns, armor behind the pilot, and had a slightly upgraded 560 kW (750 hp) M-25 engine. In 1939, of the 500 I-16s[16] deployed to the fighting at Nomonhan, approximately 112 were lost during the battles of Khalkhin Gol, of which 88 were destroyed in aerial combat, primarily against the all-metal Nakajima Ki-27 Japanese fighters.[17] During test trials in Russia of a captured Ki-27, the aircraft proved superior to the Soviet I-152 (I-15bis), I-153, and the I-16 in aerial combat, as well as having a faster take-off and lower landing speed, requiring shorter airstrips than the I-16, which needed 270 meters to stop and 380 meters for take-off.[18] Further attempts were made to upgrade the firepower of the aircraft using 20 mm (0.79 in) ShVAK cannons, making the I-16 one of the most heavily armed fighters of the period,[19] able to fire 28 rounds of ammunition in three seconds. Pilots loved the results, but the cannons were in short supply, and only a small number of the **I-16 Type 12**, **17**, **27**, and **28** were built. The cannons adversely affected performance, with 360° turn time increasing from fifteen seconds in the Type 5 to eighteen seconds. The **Type 24** replaced the skid with a tailwheel and featured the much more powerful 670 kW (900 hp) Shvetsov M-63 engine. The **Type 29** replaced two of the ShKAS guns with a single 12.7 mm (.50 in) UBS. Ten **Type 17** fighters were supplied to the Chinese Air Force where on 20 May 1940, they effectively shot down a C5M scout-attack plane and three G3M bombers during the Battle of Chongqing.[20][21] Types 18, 24, 27, 28, and 29 could be fitted to carry RS-82 unguided rockets. The first successful use of air-to-air missiles in air combat was on August 20, 1939. A Ki-27 was hit by an RS-82 rocket launched from a distance of about a kilometer. The shot was fired by Captain N. Zvonarev.[22] A 1939 government study found the I-16 had exhausted its performance potential. The addition of armor, radio, battery, and flaps during the aircraft's evolution exacerbated the rear weight distribution problems to the point where the aircraft required considerable forward pressure on the stick to maintain level flight and at the same time developed a tendency to enter uncontrolled dives. Extension and retraction of the landing flaps caused a dramatic change in the aircraft's attitude. Accurate gunfire was difficult.

Soviet Union

VVS pilots at Khalkhyn Gol in front of their I-16 in August 1939.

The pilots nicknamed the aircraft *Ishak* (Russian: *Ишак*, *Donkey*/*Hinny*) because it was similar to the Russian pronunciation of "I-16" ("ee-shestnadtset"). When Operation Barbarossa erupted on 22 June 1941, 1,635 of 4,226 VVS aircraft were I-16s of all variants, fielded by 57 fighter regiments in frontier areas.[23] The main assault delivered by the Luftwaffe's *Luftflotte* 2 (in support of Wehrmacht Army Group Centre) was directed against the Soviet Western Special Military District, that deployed 361 (424 according to other sources) I-16s.[24] During the early phase of the campaign the I-16 bases were the main targets for the German aircraft and after 48 hours of combat, of the 1,635 Polikarpov monoplanes in service on 21 June 1941, only 937 were left.[25] By 30 June the number of I-16s in western front line units had dropped to 873, including 99 that required repairs.[26] To stem the Luftwaffe aerial assault several I-16 pilots adopted the *taran* tactic and sacrificed their lives, ramming German aircraft.[26] Its main opponent in the sky in 1941 was the German Messerschmitt Bf 109.[27] The I-16 was slightly more maneuverable than the early Bf 109s and could fight the Messerschmitt Bf 109E, or *Emil*, on equal terms in turns. Skilled Soviet pilots took advantage of the Polikarpov's superior horizontal maneuverability and liked it enough to resist the switch to more modern fighters. The German aircraft, however, outclassed its Soviet opponent in service ceiling, rate of climb, acceleration and, crucially, in horizontal and diving speed, due to better aerodynamics and a more powerful engine. The main versions of the I-16 had a maximum speed of 450–470 km/h (279–291 mph), while the Bf 109E had a maximum speed of 560–570 km/h (347–353 mph), the more streamlined Bf 109F *Friedrich* could hit 615–630 km/h (372-390plus mph). So German pilots held the initiative and could decide if they wanted to chase their opponents, could attack them from above and behind and then gain altitude for a new attack. Meanwhile, Polikarpovs could only defend each other by forming a defensive circle or via horizontal maneuverability.[27] Moreover, in terms of armament, Messerschmitts had a slight edge on the I-16. The *Emil* carried two wing-mounted 20mm MG FF cannons and two synchronized 7.92 mm MG-17s with a weight of a one-second salvo of 2.37 kg, while the most common version of the I-16 – armed with just two synchronized and two wing-mounted 7.62 ShKAS – could deliver 1.43 kg of bullets each second.[28] Finally, the ammunition storage on a Messerschmitt exceeded that of the I-16, carrying 1,000 rounds for each machine gun (plus sixty drum-housed rounds for each cannon), while the Polikarpov carried just 450 rounds for each ShKAS gun.[29] Around half of all produced I-16s were still in service in 1943, when they were finally replaced. Specially modified I-16s were used in the Zveno parasite aircraft experiments using the Tupolev TB-3 as a mothership. These I-16s carried two 250 kg bombs for dive bombing. This was more than double the bomb load an I-16 could take off with under its own power. Once the bombs were dropped, they could perform as normal I-16s, and could re-attach to the TB-3 for the return journey.[30] The Luftwaffe was known to have captured some I-16 and UTI-4 two-seat trainers (two of which were marked with the *Stammkennzeichen* codes DM+HC and DM+HD) and flown from the *Erprobungstelle Rechlin* central Luftwaffe test facility by Kampfgeschwader 200 (KG 200).[31] The Luftwaffe was not the only air force able to test its fighters against the I-16; the Japanese captured a few I-16s as well,[3] and the Romanian Air Force also got one when a Soviet pilot defected.[32] The Finnish Air Force (FAF) captured some I-16s (along with several other Soviet types). During the Winter War and the Continuation War, the Finns captured six I-16s and one I-16UTI. Two of the captured I-16s and I-16UTIs were put back into flying condition and flight tested.[33]

Specifications (I-16 Type 24)



3-view drawing of Polikarpov I-16

General characteristics

- **Crew:** One
- **Length:** 6.13 m (20 ft 1 in)
- **Wingspan:** 9 m (29 ft 6 in)
- **Height:** 3.25 m (10 ft 8 in)
- **Wing area:** 14.5 m^2 (156 sq ft)
- **Airfoil:** TsAGI R-II (16% at root)[66]
- **Empty weight:** 1,490 kg (3,285 lb)
- **Gross weight:** 1,941 kg (4,279 lb)
- **Powerplant:** 1 × Shvetsov M-63 9-cylinder supercharged air-cooled radial engine, 820 kW (1,100 hp)
- **Propellers:** 2-bladed variable-pitch propeller

Performance

- **Maximum speed:** 489 km/h (304 mph, 264 kn) at 3,000 m (9,800 ft)
- **Range:** 700 km (430 mi, 380 nmi) with drop tanks
- **Service ceiling:** 9,700 m (31,800 ft)
- **Rate of climb:** 14.7 m/s (2,890 ft/min)
- **Time to altitude:** 5,000 m (16,000 ft) in 5 minutes 48 seconds
- **Wing loading:** 134 kg/m^2 (27 lb/sq ft)
- **Power/mass:** 0.43 kW/kg (0.26 hp/lb)

Armament

- 2 × fixed forward-firing 7.62 mm (0.300 in) ShKAS machine guns in upper cowling
- 2 × fixed forward-firing 20 mm (0.787 in) ShVAK cannons in the wings
- 6 × unguided RS-82 rockets *or* up to 500 kg (1,100 lb) of bombs

POLIKARPOV I-16 (GVG / PD)

Source : https://en.wikipedia.org/wiki/Polikarpov_I-16