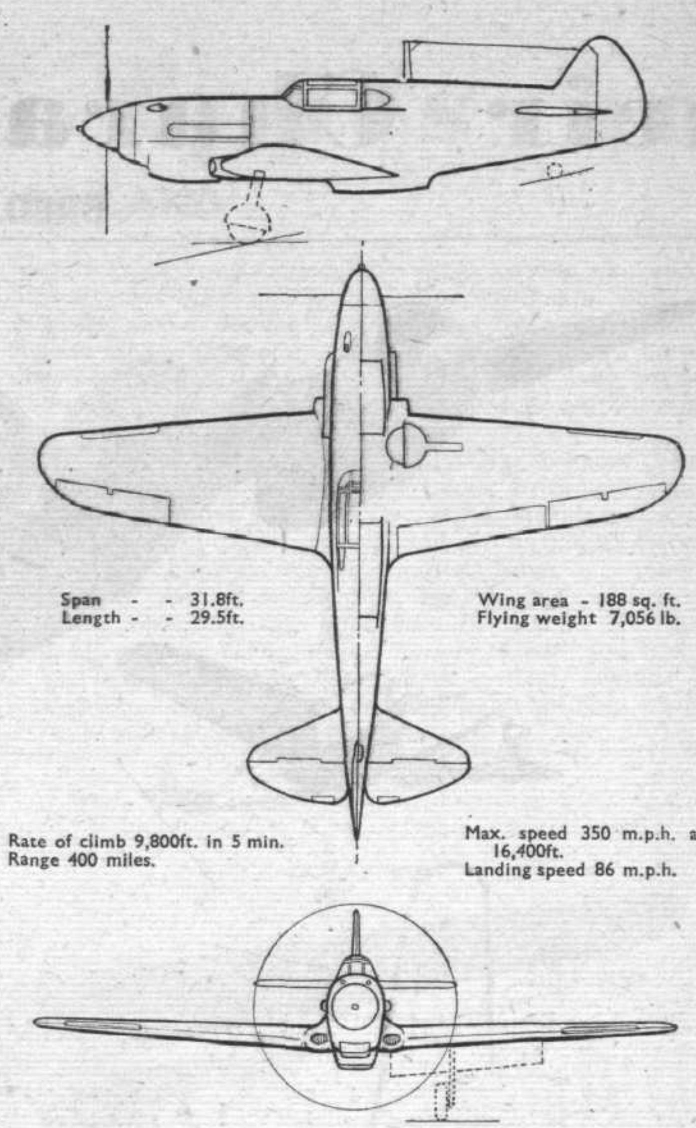
A Russian Fighter

A Review of the Characteristic Features of the Lagg-3, based upon Information from Neutral and Enemy Sources



ONE of the most successful fighter aircraft employed by the Soviet Air Force against the *Luftwaffe* is the Lagg-3. Designed by a team of experts under the leadership of Semen Lavoshkin, one of Russia's top-grade designers, this single-seater fighter has been for some time now in mass production, and acquitted itself well in many combats against Focke-Wulf 190s and Messerschmitts.

The Lagg-3 has already been superseded by further developments, such as the Lagg-4 and 5, and since it is thus a recent ancestor of a notable line of descendants it merits a detailed study of its characteristics.

The Lagg-3 is of all-wood construction, powered with a 12-cylinder V-type engine of 1,100 h.p., and has the following dimensions: wing span, 9.7 m. (31.8ft.); length of 9 m. (29.5ft.); wing area, 17.5 sq. m. (188 sq. ft.); flying weight, 3,200 kg. (7,056 lb.); and wing-loading, 183 kg./m.^{2} (37.4 lb./sq. ft.).

Performance and Structure

With a top speed in horizontal flight of 350 m.p.h. at 16,400ft., the aircraft has a range of 650 km. (400 miles), an endurance of 1½ to 2½ hr., and a service ceiling of 9,000 m. (29,500ft.). Cruising speed at 5,000 m. (16,400ft.) is 450 km./hr. (279 m.p.h.), and landing speed with flaps down 140 km./hr. (86 m.p.h.). The rate of climb is 3,000 m (9,800ft.) in 5 min.

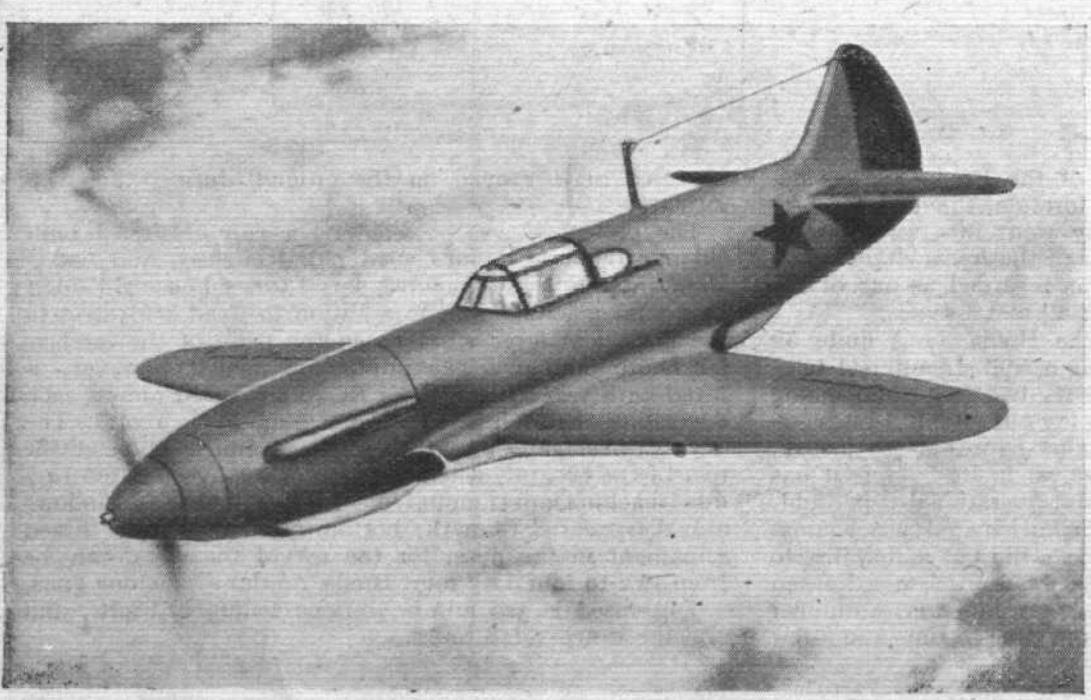
The wooden monocoque fuselage is well streamlined with a smooth-surfaced plywood skin of 5 to 6 mm. (0.19-0.23in.) thickness. The frames are in birch, plywood-sheathed on both sides, and are spaced irregularly from 400 to 500 mm. (15.7-19.6in.), and have a mean cross-section of 10 to 15 by 30 to 50 mm. (0.39-0.59 × 1.18 to 1.96in.). The plywood employed is a 4-ply Russian birch and the bonding used is a phenol-formaldehyde resin, apparently also used as an impregnating medium, as evident from the heavy coating on the whole interior of the fuselage.

The cockpit hood consists of ordinary Plexiglass mounted on welded tubular steel framework, and slides backwards. It is operated by a leather loop above and in front of the pilot's head, and can be locked in three positions: open, shut, or with a gap of about 50 mm. (1.96in.). Windscreens are also of ordinary Plexiglass, and no emergency release is provided. Forward and side visibility is good, but the rearward field of vision appears to be somewhat restricted.

The three-sectional wings are of trapezoidal plan form with rounded tips, the same type of diagonal plywood skin as the fuselage, and fairly closely spaced ribs.

The low wing is of standard Russian Cahi profile with a maximum thickness ratio of 13 per cent. at 32 per cent. of the chord at the wing root. The chord at the wing root is 2,150 mm. (84.6in.), and the length of the outermost rib is about 750 mm. (29.5in.).

The two box-section wing spars are of all-wood construction with flanges of vertically laminated veneer strips 10 to 15 mm. thick (0.39-0.59in.), each strip being built up of phenol-formaldehyde resin-



The Lagg-3 single-seater fighter, powered with an M-105P. liquid-cooled 12-cyl. engine, is armed with a 20 mm. cannon, two 12.7 mm. machine guns and carries six rocket fragmentation bombs underneath the wings.

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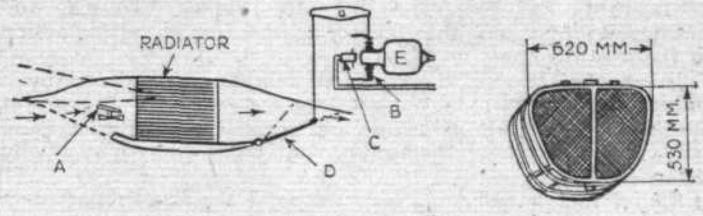
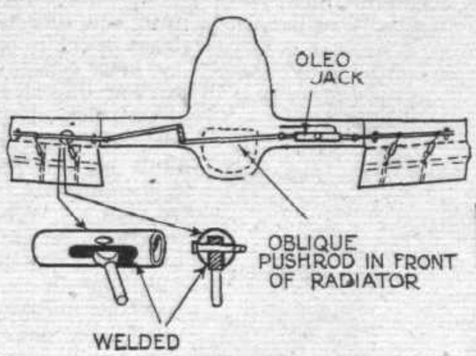
bonded veneers of about 0.2 mm. thickness. Webs of three-ply birch 4.0 mm. thick (0.15in.) are interposed, and the spar sheathed on both sides with 1.5 mm. (0.05in.) three-ply birch. The front spar is 100 mm. thick (3.9in.) and 260 mm. deep (10.2in.) at the wing root, while the corresponding rear spar is 65 mm. thick (2.5in.) and 200 mm. deep (7.8in.). Spar fittings are of welded sheet steel, fitted with eyes for two holding bolts, that for the front spar being 30 mm. in diameter (1.18in.), that for the rear spar 25 mm. (0.98in.).

Exhaust Manifotd.

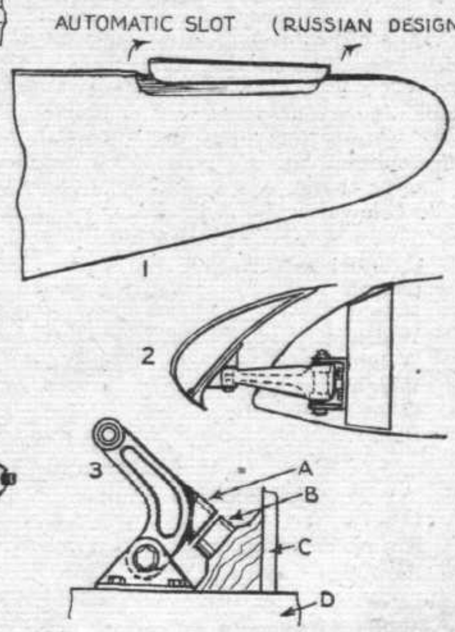


Radiators and Electric Motor: (A) Guide vane with Venturi; (B) Screw; (C) Circuit breaker; (D) Flap; (E) Electric motor.

Wings are equipped with split flaps of duralumin sheet with single piano hinges and operated by pushrods working in duralumin rollers. An accompanying drawing shows how these rods are actuated.

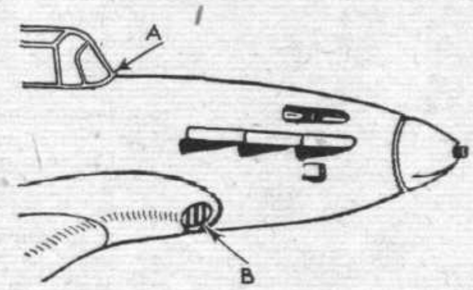


Wing flap arrangement showing the duralumin split flaps operated through a system of levers.



The Undercarriage

The conventionally designed hydraulically operated undercarriage retracts upwards and inwards into pockets in front of the main spar in the centre section. The wheels are light alloy castings with cooling ribs on either side and cross-grooved treaded tyres of 650 x 200 mm. (25.5 x 8.6in.).

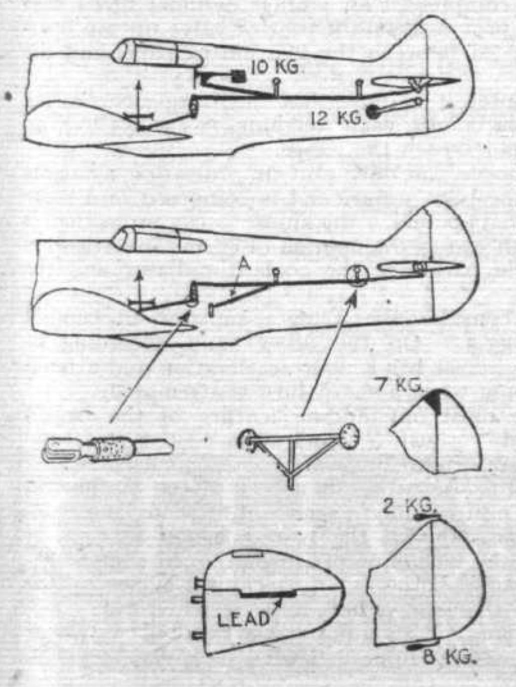


Nose of Lagg-3. (A) Air intake for windscreen de-icing; (B) Induction air intake.

1. Automatic slot. 2. Bearings. 3. Top view: (A) Stop; (B) Rubber buffer; (C) Strut; (D) Spar.

The main shock-absorber legs turn on heavy pivots passing through the main spar, and are secured by riveted flanges. For a better distribution of loads, an auxiliary sheet-metal strut is riveted to the wheel axle and bolted to both wing spars. The conical-shaped pivot itself has two cylindrical bearing surfaces working in bronze bushes, press-fitted into the steel head of the leg, the centre line of the leg at an angle of about 105 deg. with the axis of the pivot. Shock absorbers are oleo-pneumatic, and the wheel is guided by reversed toggle links. When the undercarriage is retracted, spats on the outside of the legs fair them entirely into the wing surface.

The tail wheel is also hydraulically operated and retracts backwards. It is locked in the down position by the action of the hydraulic cylinder; in raising the wheel a locking bar is released by the first inward movement of the retracting strut, and the tail leg drops slightly to allow the wheel to retract. The shock-absorber leg is oleo-pneumatic. To centre the tail wheel after take-off a tapered spring catch is employed which allows the wheel to swivel only under the influence of sufficient lateral force. An electrical undercarriage indicator is provided on the instrument panel, and mechanical indicators are also fitted on the upper wing surfaces.



Varied control balances: (Top) By weights; (Centre) Spring device (A); Horn and mass rudder balances.

The hydraulic system operating the undercarriage gear and wing flaps features a pressure oil tank in front of and to port of the engine, with the coolant tank placed correspondingly to starboard. An engine-driven pump produces the required pressure and is controlled by a pressure governor with a special gauge on the instrument panel.

The control valves on the lower instrument panel are each operated by two push-buttons for dropping and retracting respectively. Several non-return valves are incorporated in the circuit. Hydraulic liquid used is a mixture of 65 per cent. glycerine and 35 per cent. alcohol.

Balancing of Controls

Brakes are pneumatic, supplied from a cylinder placed behind the pilot's seat and of an approximate capacity of 14 litres with combined reducing and distributing valves controlled from the rudder bar. Double hand brakes are fitted, adjustable by means of a lever on the brake handle. The brakes are operated with the right hand, and the distribution of air to port and starboard effected by the action of the rudder bar.

On the Lagg-3 examined by enemy experts, all control surfaces are fabric covered on metal frames, while the tail-fin (integral with the fuselage) and the tailplane (attached to a special spar at the rear of the fuselage) are of wood. The ailerons are of standard design with partial slot effect and lead-weighted leading-edge balance, and have a differential control.

The elevator has two trimming tabs acting also as servo-tabs and, similarly to the ailerons, is operated by pushrods. The rudder is also fitted with trimming tabs and operated by wires running over wooden rollers on the port side of the fuselage.

Since balancing arrangement of the control surfaces differed in three captured types, it is presumed that it presented some difficulty.

In one case two pendulum elevator balance weights were fitted just aft of the pilot and immediately in front of the tail wheel. These weights—one of 10 kg. (22 lb.) and the other

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of 12 to 13 kg. (26.4-28.6 lb.)—are coupled, the rear and heavier weight raising the elevator against the depressing action of the forward one.

In another version the forward weight was replaced by a rudder spring shown in the drawing on page 179, and in yet another case pendulum weights and springs were given up and the control surfaces themselves statically and dynamically balanced.

Again, rudder balancing was in one of the cases reported to be by means of a 7 kg. (15.4 lb.) lead weight on the upper horn balance, while in the second case drop-shaped lead balance weights, one of 2 kg. (4.4 lb.), the other of 8 kg. (17.6 lb.), were fitted above and below the rudder on 20 mm. long (0.78in.) lever arms projecting forward beyond the rudder post.

Power Plant

While later developments, such as the Lagg-5, are equipped with 1,600 h.p. engines, the power plant of the Lagg-3 is the M-105P, a liquid-cooled 12-cylinder V-type engine of 1,100 h.p. employing a boost pressure of about 4 lb. Incidentally, the "P" stands for "pushka," Russian for cannon, signifying the "moteur-canon" type of the engine.

Engine characteristics and performance data are given in the table below:

Engine Data

Cylinder volume	36 litres (7.91 gall.)
Length	2,027 mm. (79.7in.)
Height	960 mm. (37.7in.)
Width	777 mm. (30.3in.)
Weight (dry)	575 kg. (1,267 lb.)
Weight per h.p.	0.523 kg. (1.12 lb./h.p.)
Compression ratio	7:1
Fuel	94 to 95 octane

Performance

	Take Off	Maximum		Cruising	
H.p. ..	1,100	1,100	1,150	900	945
R.p.m. .	2,600	2,700	2,700	2,600	2,600
Altitude	0	2,000	4,000	2,000	4,000
		(6,500ft.)	(13,120ft.)	(6,500ft.)	(13,120ft.)

Cylinder blocks are set at 60 deg. with three valves per cylinder, one exhaust and two inlet. There is a separate overhead camshaft for each cylinder block from which the exhaust valves are operated directly and the inlet valves by tee-section rocker arms.

A two-stage two-speed blower is provided, mechanically controlled from the cockpit and with gear ratios of 7.8:1 and 10:1. The six carburettors are of the pressure type.

Crankcase ventilation is provided by air taken in on one side of the engine and passed right across the crankcase and discharged on the other side through a pipe to the rear. Exhaust manifolds are shaped and arranged to make use of the reaction of exhaust gases similar to the arrangement on Rolls-Royce and Daimler-Benz engines.

Radiator and Airscrew

The engine coolant radiator is underneath the fuselage extending half submerged from the trailing-edge of the wing. The radiator block, 400 mm. long (15.7in.), 620 mm. wide (24.4in.) and 530 mm. deep (20.8in.) is in brass. Coolant temperature is controlled by throttling the air intake, either by means of an electrically operated rear louvre or, in the older systems, by manually actuated, independently working front and back louvres.

The half-moon-shaped oil radiator is similarly of brass and is suspended under the front end of the engine crankcase. Radiator ducts are of relatively small diameter and their total height is about 180 mm. (7.0in.). Cooling air is drawn from under the engine mounting, and the outflow controlled by a throttle. On three Lagg types examined by Finnish engineers this throttle control had been dispensed with and radiator louvres locked in a fixed position.

Induction air scoops fitted with guide valves are placed on either side, near the wing-root fillet at the leading-edge of the wing.

The engine drives a three-bladed, all-metal Wisch-61.P airscrew with hydraulic pitch control over about 35 deg., and constant speed governor. The shaft of the airscrew is bored out to accommodate alternatively a 20 mm. Schwak or 23 mm. W.T. engine cannon, and the diameter of the airscrew is 3,000 mm. (9.8ft.) with a blade width of 260 mm. (10.2in.) and a weight of 132 kg. (291 lb.).

The fuel system comprises five fuel tanks, of which three are in the centre section and one in each outer wing panel. All tanks are made of fairly hard aluminium sheet with gas-welded seams and spot-welded wash plates. Bullet-proofing is provided by a complete rubber sheathing over the whole tank, 10 mm. thick (0.39in.) on the bottom and 5 mm. (0.19in.) on the top and sides. It is interesting to note that this protection is not composed of the usual sponge rubber, but consists of a massive rubber cushioning with no fewer than four layers of tough cord fabric, thus resembling in its composition the appearance of a motor tyre.

Fire Protection and Armament

To reduce fire risk, cooled and filtered exhaust gases are led into the fuel tanks by means of a special two-way cock in front of the pilot's seat, and the air in the tanks is thus replaced by inert combustion gases consisting mainly of nitrogen and a carbon dioxide. It may be of interest to give here a brief description of this installation: A welded steel pipe of 50 mm. clear diameter (1.96in.) leads obliquely from the last exhaust stub on the port side and is continued by a steel tube of approximately 1 m. (39.3in.) length and 15 mm. bore (0.59in.). While in this portion light-alloy material is avoided, presumably because of the high temperature of the exhaust gases, the further extension of the exhaust lead is provided by an aluminium pipe which carries the gases down the fuselage until just before the tail. At the tail are two chambers, one of which is filled with copper shavings and apparently acts as a filter, the other being empty and acts as a trap for condensed water.

From these chambers the gas pipe leads along the starboard side of the fuselage to a three-way pressure-gauge equipped cock; when the latter is in a neutral position the exhaust gases can escape directly into the atmosphere through a pipe in the bottom of the fuselage, otherwise the gas passes into a distributing chamber from which it is led by small-bore pipes to the main fuel tanks. The small tank for inverted flying also receives inert gas through a separate pipe.

In some cases the change-over cock was dispensed with and the continuous gas flow to all tanks controlled by relief valves, and it is feasible that the latter system has been adopted in more current practice.

The armament of the Lagg-3, composed of one cannon and two machine guns, is inferior to that of other fighter types, and has been increased in subsequent versions. The two *Beresin* machine guns mounted above the engine and synchronised to fire through the airscrew are of 12.7in. calibre, and have a muzzle velocity of 840 m/sec. (2,755ft./sec.) and a rate of fire of 700 to 800 r/m. The length of bore is 1,01[illegible] mm. (39.7in.) with an overall length of 1,365 mm. (53.7in.) and a weight of 2,515 kg. (56 lb.).

The 20 mm. (0.78in.) cannon of the Shpitalny-Vladimirov type weighs 40 kg. (88.1 lb.), has a barrel length of 1,700 mm. (64.9in.), and an overall length of 2,155 mm. (84.8in.). The muzzle velocity is 800 m/sec. (2,624ft./sec.), and rate of fire 700 to 800 r/m.

The cannon is mounted between the two cylinder blocks with the long barrel housed in the bore of the airscrew shaft and projecting slightly beyond the spinner. It is a gas-operated, belt-fed type with compressed air storage cylinder fitted next to the cannon and provided with a control valve on top operated by a lever placed between the instrument panel and the reflex sight.

It is of special interest to note that the Lagg-3 carries six rocket fragmentation bombs, each weighing 25 kg. (55 lb.), on special rail racks underneath the wings.

According to reports, the only armour protection available is at the back of the pilot's seat, and is composed of a plate of 9 to 10 mm. (0.35-0.39in.) thickness. No protection is provided underneath and in the opinion of enemy investigators the most vulnerable parts are the coolant radiator and the wing fuel tanks.

Luftwaffe pilots consider the Lagg-3 superior in combat qualities to the Migg-3. On the other hand, according to Finnish pilots the aircraft has a poor acceleration and a tendency to go into a spin when a sharp turn is attempted.

But perhaps the most outstanding feature of the Lagg-3 is its extraordinarily robust "constitution"—the structural strength—and its low weight.

It is impossible to deal with this aspect of the machine in the present review, and we may revert to it at some later date. But it may now be said that the Lagg-3 marks a period of further advance in the technique of Russian wood constructed aircraft, a fact which is borne out by technical evidence from enemy sources. If the Lagg-3 now appears under-armed and perhaps under-powered, it should not be overlooked that it has since been followed by improved versions.