DCS GUIDE
I-16 ISHAK SERIES 24

By Chuck

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Special thanks to Paul "Goldwolf" Whittingham for creating the guide icons.

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The **Polikarpov I-16** (Russian: Поликарпов И-16) was a russian 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.“ 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, the Battle of Khalkhin Gol and the Spanish Civil War – where it was called the Rata ("Rat") by the Nationalists or Mosca ("Fly") by the Republicans.

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 was 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. The main landing gear was fully retractable by a hand crank, which at the time was a major improvement over the existing fixed undercarriages on biplanes.

Nikolai Nikolaevich Polikarpov
(1892-1944)

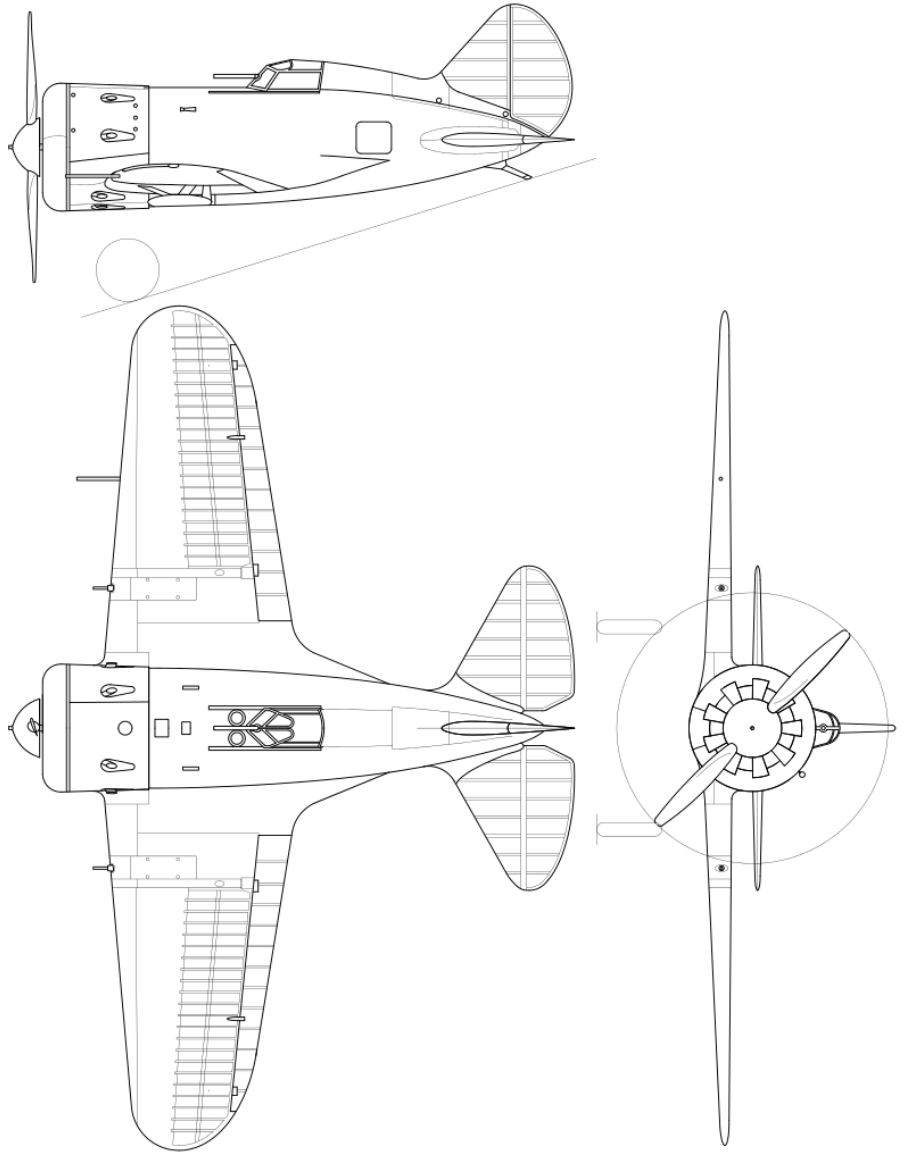
The TsKB-12 was designed for the Wright Cyclone SR-1820-F-3 9-cylinder radial engine (rated at 529 kW/710 hp); a license to build this engine under the supervision of the OKB-19 Shvetsov design bureau in the Soviet Union was being negotiated. As the license was not yet approved, Polikarpov was asked 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 March 1 and 2, 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.

Service trials of the new fighter, designated I-16, began on 22 March 1934. 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. 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, 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".

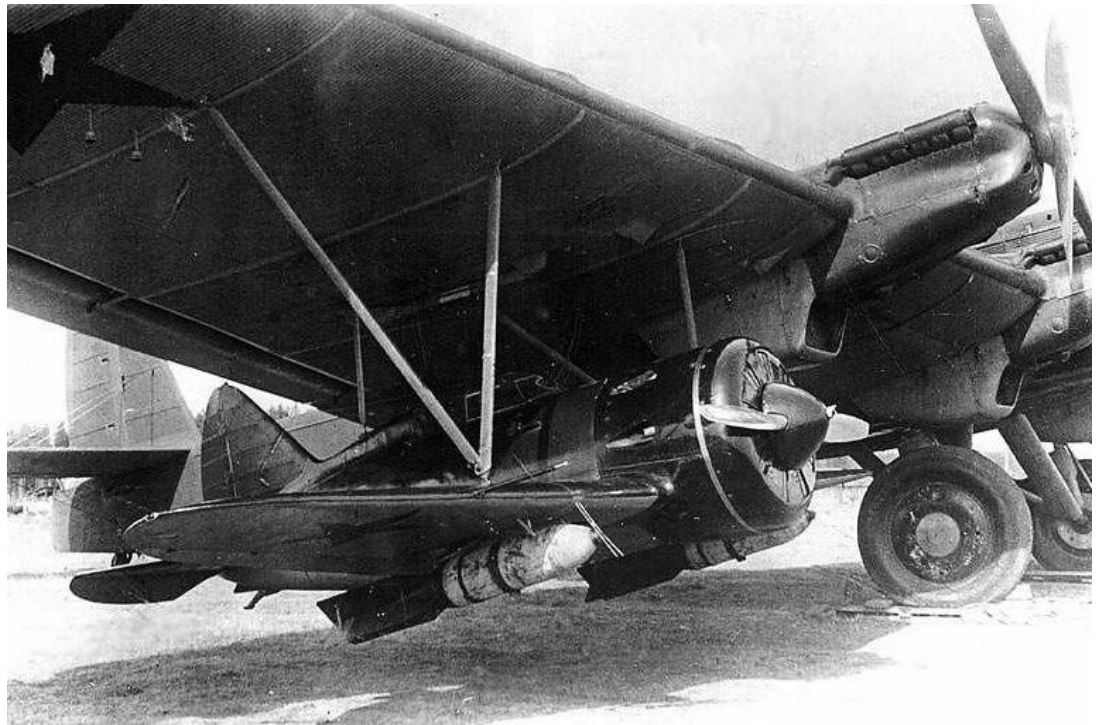


PART 1 – INTRODUCTION

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 I-16 Type 5s and Type 6s. The first I-16s appeared in Spanish skies in November 1936. 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 Mosca's main opponent in the sky in 1941 was the German Messerschmitt Bf109. 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.

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. The I-16 had a more durable engine than the liquid-cooled engine of the Bf 109. Around half of all produced I-16s were still in service in 1943, when they were finally replaced. Interestingly, specially modified I-16s were used in the Zveno parasite aircraft experiments using the Tupolev TB-3 as a mothership.

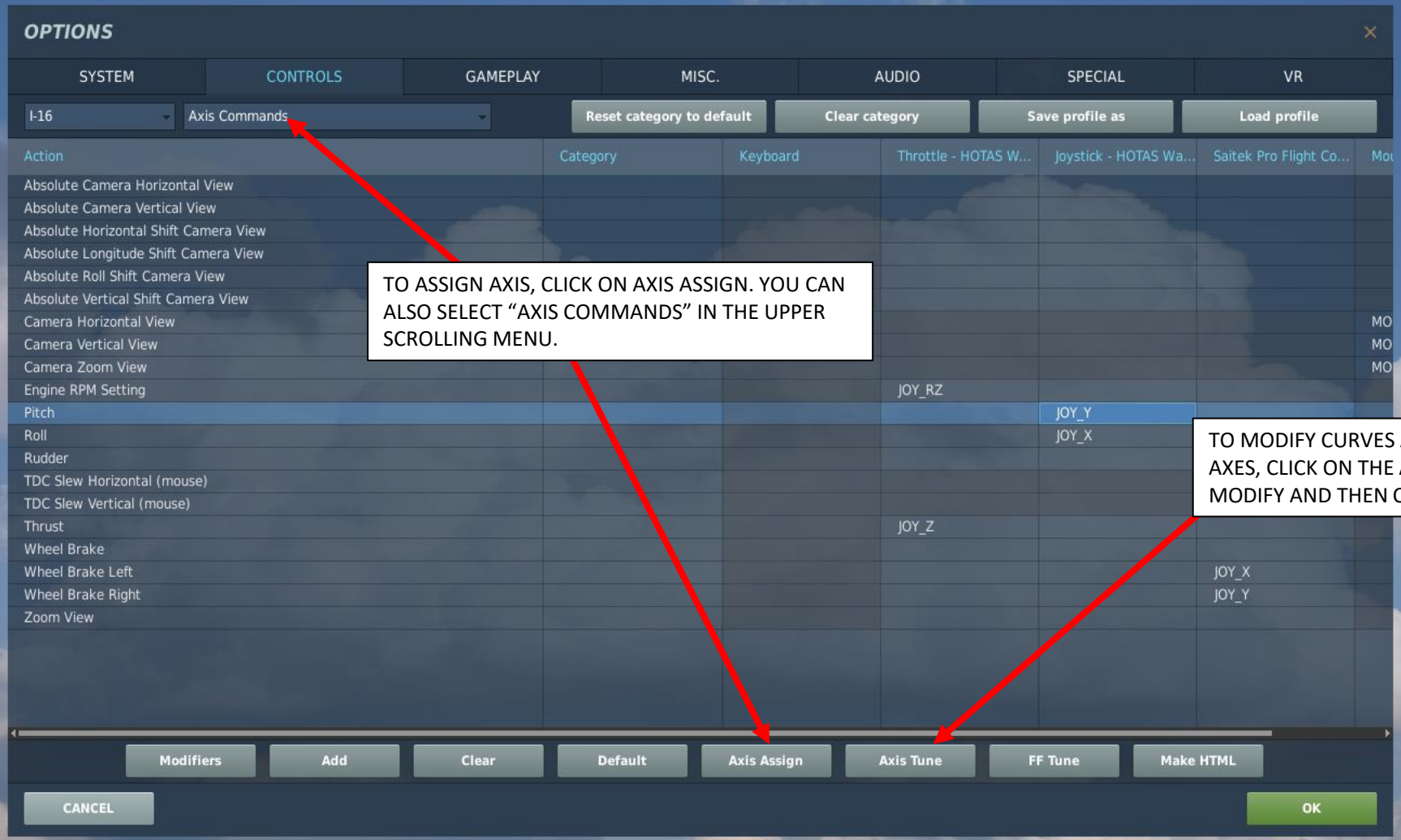


Overall, the history of the I-16 is a fascinating one. It is the perfect example of the bridge between the World War I biplanes and the World War II monoplane fighters. In hindsight, the I-16 made me develop an appreciation for certain aircraft systems that I have always taken for granted. For instance, the lack of trim controls and the longitudinal instability of the aircraft showcase the importance trimming an aircraft in most phases of normal flight. Managing your airspeed during the approach is all the more critical since excessive speed will make the deployment of the landing gear very difficult.

The I-16 may seem outclassed by most aircraft in DCS, but it is one of the toughest aircraft to fly and one of the most rewarding to master. Aerodynamically speaking, it's an interesting beast to tame that will always keep you on your toes. Even if the Ishak looks a bit barebones in comparison to late World War II aircraft, keep in mind that the I-16's design was revolutionary at the time and kickstarted the race to master the skies.

When flying the I-16, one must keep in mind that the lack of trim control surfaces means that at least one hand will always be busy keeping the aircraft at the desired attitude. This is why I suggest that you map as many controls as you can on your joystick and throttle since clicking on switches and levers in the cockpit can be very difficult since you will need to switch hands to use the mouse when you are flying.

CONTROL	FUNCTION
Communication Menu (“\”)	Used to communicate on the radio
Cannon Fire Button (Spacebar)	Fires machine guns
Landing Gear Handle – Down (“LSHIFT + G”)	Landing gear crank deploys the undercarriage
Landing Gear Handle – Up (“LCTRL + G”)	Landing gear crank retracts the undercarriage
Motor Cooling Flaps – Decrease (“RWIN + N”)	Closes engine cowl louvres
Motor Cooling Flaps – Increase (“RALT + N”)	Opens engine cowl louvres
Oil Radiator Flaps – Decrease (“RWIN + M”)	Closes engine oil radiator flaps
Oil Radiator Flaps – Increase (“RALT + M”)	Opens engine oil radiator flaps
Supercharger Switch – High (“RALT + S”)	Shifts supercharger into second/high gear
Supercharger Switch – Low (“RWIN + S”)	Shifts supercharger into first/low gear
Weapon Release Button (“RALT + Spacebar”)	Fires rockets
Wing Flaps Handle – Down (“LSHIFT + F”)	Deploys flaps
Wing Flaps Handle – Up (“LCTRL + F”)	Retracts flaps
Zoom In Slow (Numpad*)	Zoom In
Zoom Out Slow (Numpad/)	Zoom Out



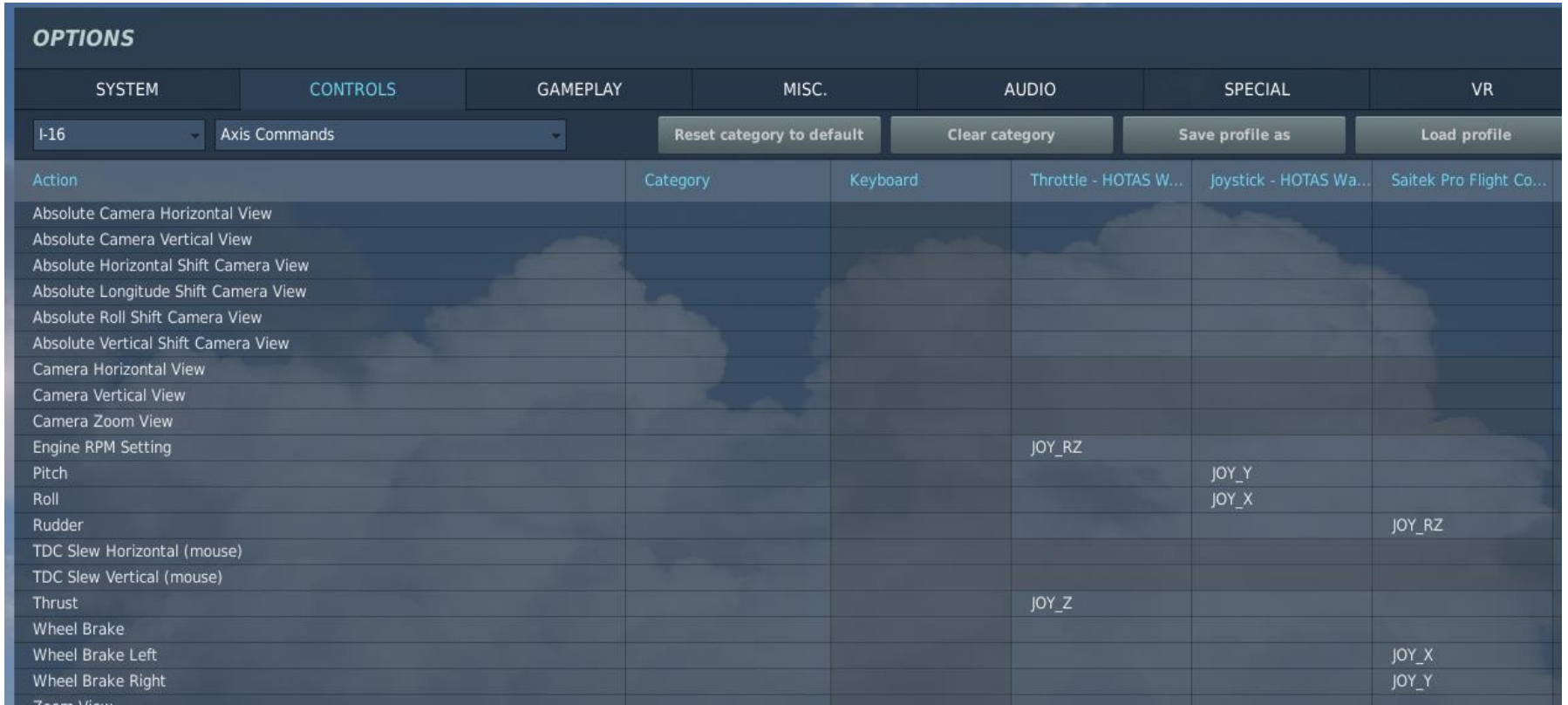
TO ASSIGN AXIS, CLICK ON AXIS ASSIGN. YOU CAN ALSO SELECT “AXIS COMMANDS” IN THE UPPER SCROLLING MENU.

TO MODIFY CURVES AND SENSITIVITIES OF AXES, CLICK ON THE AXIS YOU WANT TO MODIFY AND THEN CLICK AXIS TUNE

PART 2 – CONTROLS SETUP

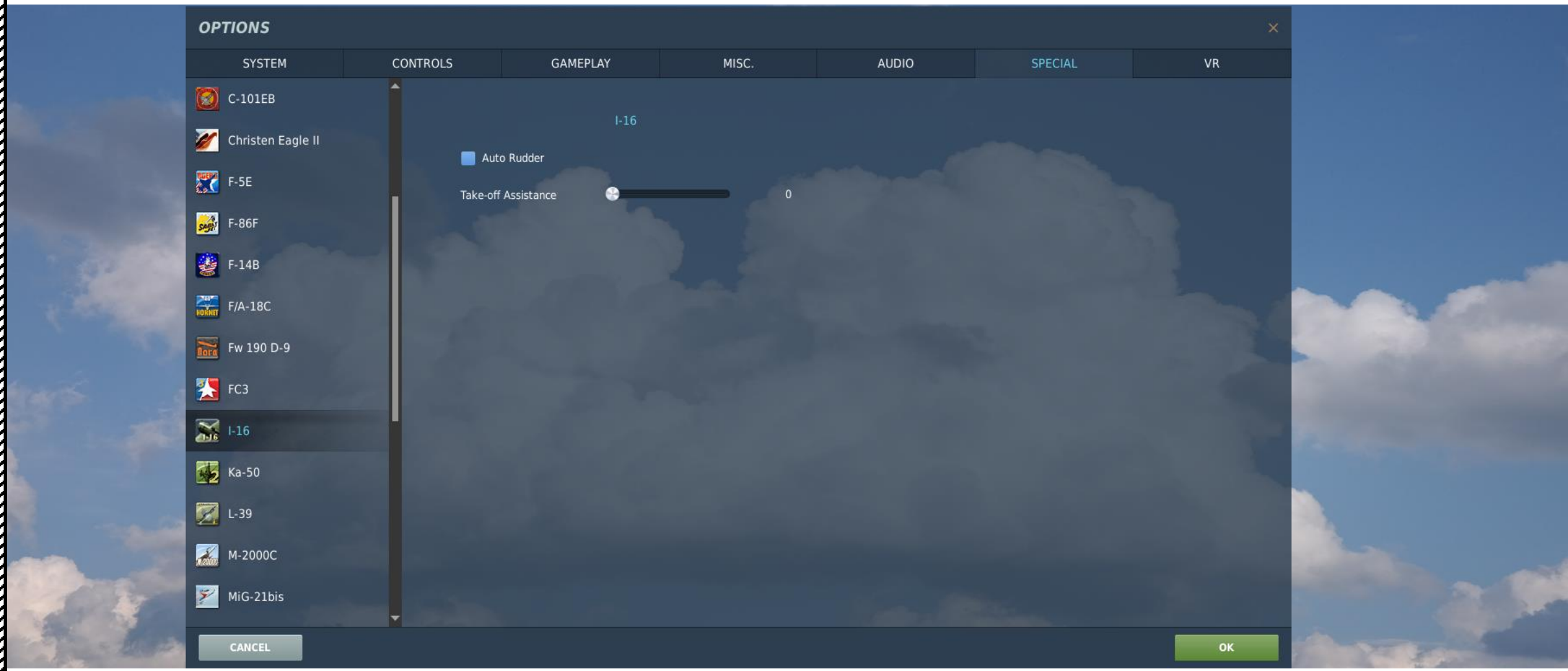
Bind the following axes:

- ENGINE RPM SETTING – CONTROLS RPM
- PITCH, ROLL, RUDDER (DEADZONE AT 5, SATURATION X AT 100, SATURATION Y AT 100, CURVATURE AT 15)
- THRUST – CONTROLS MANIFOLD PRESSURE
- WHEEL BRAKE LEFT/RIGHT



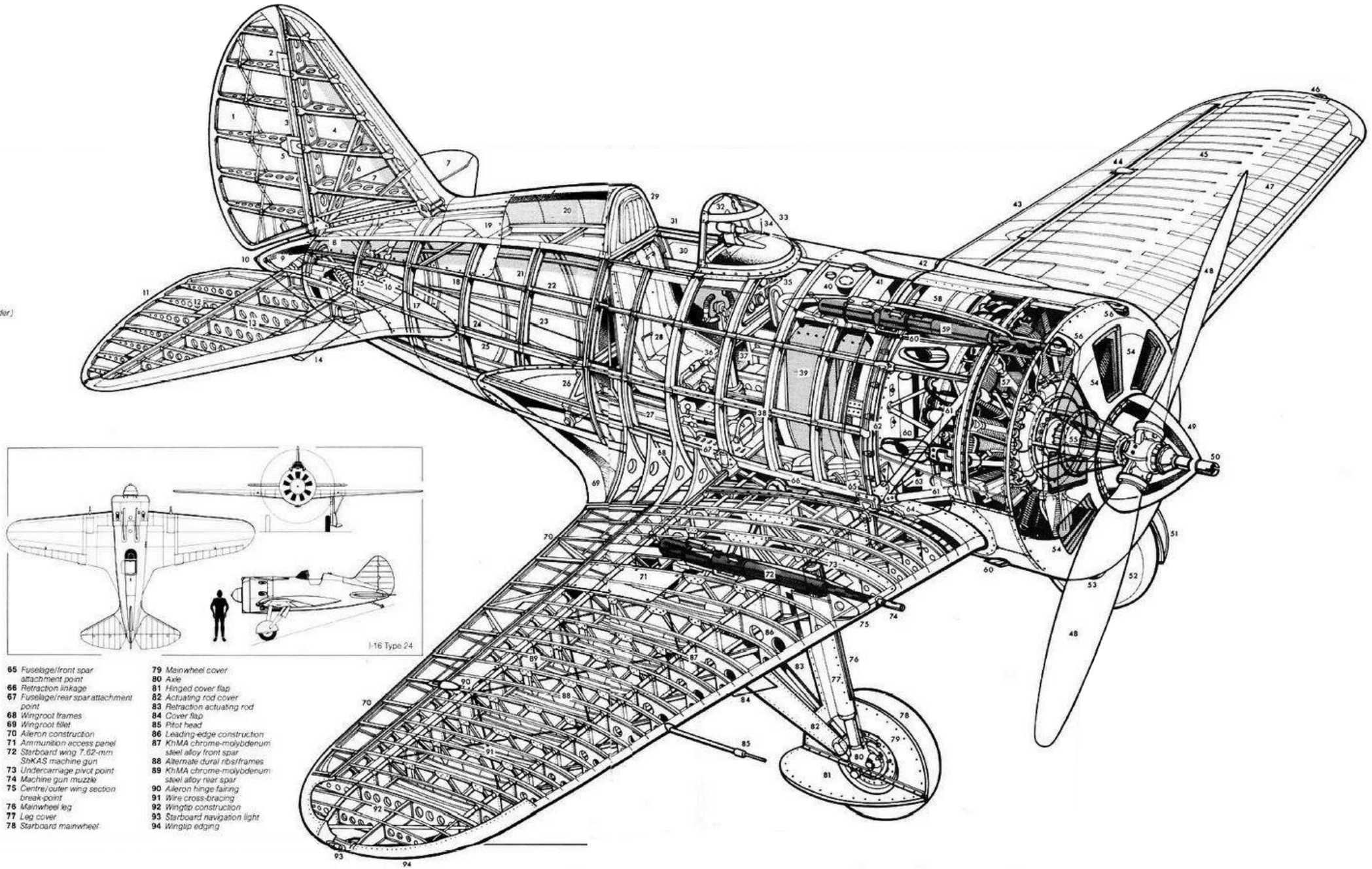
Action	Category	Keyboard	Throttle - HOTAS W...	Joystick - HOTAS Wa...	Saitek Pro Flight Co...
Absolute Camera Horizontal View					
Absolute Camera Vertical View					
Absolute Horizontal Shift Camera View					
Absolute Longitude Shift Camera View					
Absolute Roll Shift Camera View					
Absolute Vertical Shift Camera View					
Camera Horizontal View					
Camera Vertical View					
Camera Zoom View					
Engine RPM Setting			JOY_RZ		
Pitch				JOY_Y	
Roll				JOY_X	
Rudder					JOY_RZ
TDC Slew Horizontal (mouse)					
TDC Slew Vertical (mouse)					
Thrust			JOY_Z		
Wheel Brake					
Wheel Brake Left					JOY_X
Wheel Brake Right					JOY_Y

In the “SPECIAL” tab, make sure that Take-Off Assistance is set to 0 and that Auto Rudder is unchecked.



Braking is done by pressing the wheel brake pedals. Braking can be done by using both the wheel brakes and using the rudder pedals; the tailwheel is mechanically linked to the rudder, which makes taxiing easier.

PART 3 – COCKPIT & GAUGES

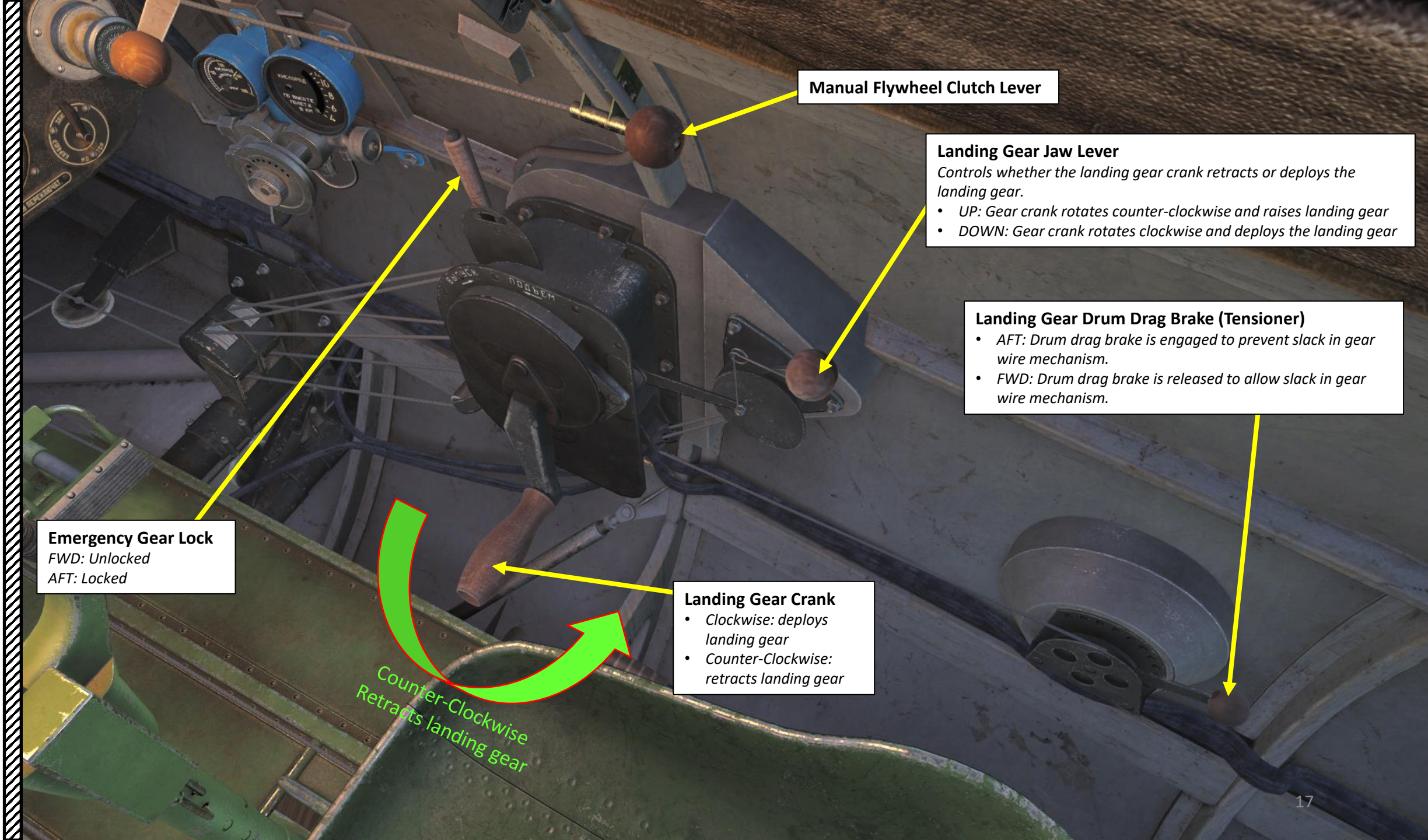


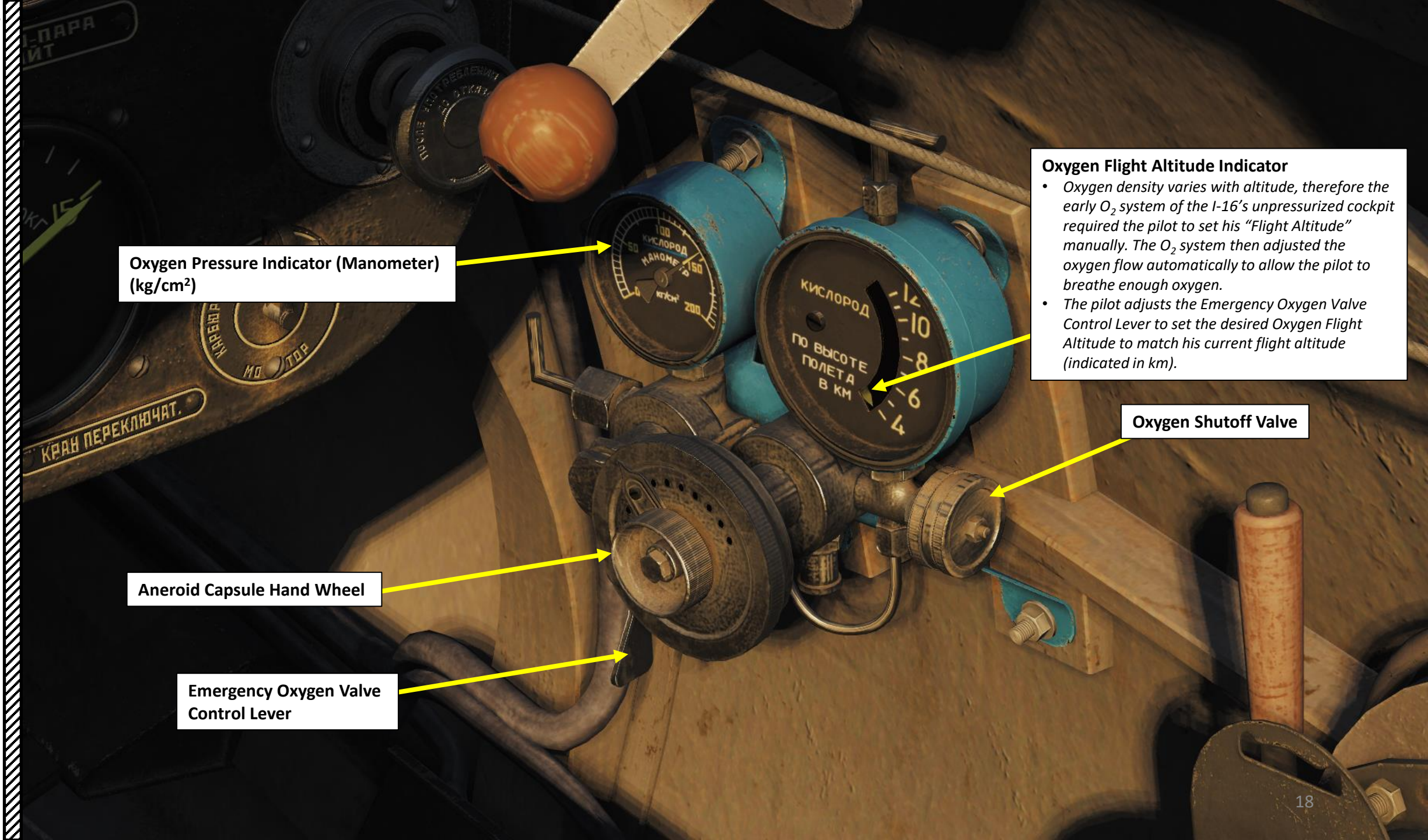
Key to Polikarpov I-16 Type 10

1 Rudder construction
2 Rudder upper hinge
3 Rudder post
4 Fin construction
5 Rudder lower hinge
6 Fin auxiliary spar
7 Port tailplane
8 Rudder actuating mechanism
9 Tail cone
10 Rear navigation light
11 Elevator construction
12 Elevator hinge
13 Tailplane construction
14 Tailskid
15 Tailskid damper
16 Control linkage (elevator and rudder)
17 Tailplane fillet
18 Fuselage half frames
19 Fin root fairing
20 Dorsal decking
21 Fuselage monocoque construction
22 Main upper longeron
23 Rudder control cable
24 Elevator control rigid rod
25 Main lower longeron
26 Control linkage crank
27 Seat support frame
28 Pilot's seat
29 Headrest
30 Cockpit entry flap (port)
31 Open cockpit
32 Rear-view mirror (optional)
33 Curved one-piece windshield
34 Tubular gunsight (PBP-1 reflector sight optional)
35 Instrument panel
36 Undercarriage retraction handcrank
37 Control column
38 Rudder pedal
39 Fuselage fuel tank, capacity 96 Imp gal (255 l)
40 Fuel filler caps
41 Ammunition magazines
42 Machine-gun fairing
43 Split-type aileron (landing flap)
44 Aileron hinge fairing
45 Fabric wing covering
46 Port navigation light
47 Aluminium alloy leading-edge skin
48 Two-blade propeller
49 Conical spinner
50 Hucks-type starter dog
51 Hinged mainwheel cover
52 Port mainwheel
53 Lip intake
54 Adjustable (shuttered) cooling apertures
55 Propeller shaft support frame
56 Machine gun muzzles
57 750 hp M-25V radial engine
58 Oil tank
59 Starboard synchronized 7,62-mm ShKAS machine gun
60 Exhaust exit ports
61 Engine bearers
62 Firewall/bulkhead
63 Centre-section trussed-type spar carry-through
64 Wheel well
65 Fuselage/front spar attachment point
66 Retraction linkage
67 Fuselage/rear spar attachment point
68 Wingroot frames
69 Wingroot fillet
70 Aileron construction
71 Ammunition access panel
72 Starboard wing 7,62-mm ShKAS machine gun
73 Undercarriage pivot point
74 Machine gun muzzle
75 Centre/outer wing section break-point
76 Mainwheel leg
77 Leg cover
78 Starboard mainwheel
79 Mainwheel cover
80 Axle
81 Hinged cover flap
82 Actuating rod cover
83 Retraction actuating rod
84 Cover flap
85 Pitot head
86 Leading-edge construction
87 KhMA chrome-molybdenum steel alloy front spar
88 Alternate dural ribs/frames
89 KhMA chrome-molybdenum steel alloy rear spar
90 Aileron hinge fairing
91 Wire cross-bracing
92 Wingtip construction
93 Starboard navigation light
94 Wingtip edging


Seat Adjustment Lever

PART 3 – COCKPIT & GAUGES


Manual Flywheel Clutch Lever
Landing Gear Jaw Lever
Controls whether the landing gear crank retracts or deploys the landing gear.
• UP: Gear crank rotates counter-clockwise and raises landing gear
• DOWN: Gear crank rotates clockwise and deploys the landing gear
Landing Gear Drum Drag Brake (Tensioner)
• AFT: Drum drag brake is engaged to prevent slack in gear wire mechanism.
• FWD: Drum drag brake is released to allow slack in gear wire mechanism.
Emergency Gear Lock
FWD: Unlocked
AFT: Locked
Landing Gear Crank
• Clockwise: deploys landing gear
• Counter-Clockwise: retracts landing gear
Counter-Clockwise
Retracts landing gear



Oxygen Pressure Indicator (Manometer) (kg/cm²)

Aneroid Capsule Hand Wheel

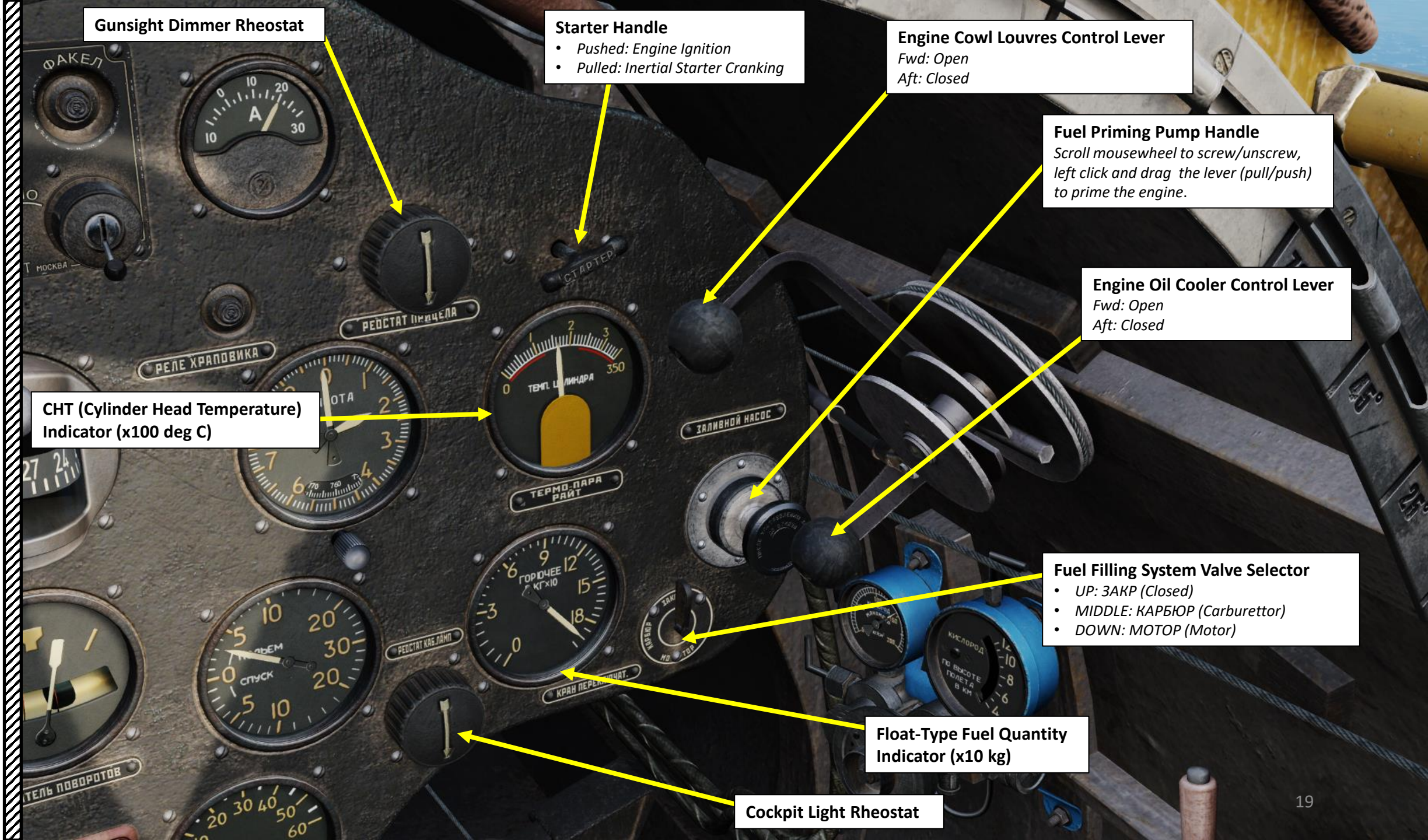
Emergency Oxygen Valve Control Lever

Oxygen Shutoff Valve

Oxygen Flight Altitude Indicator

- *Oxygen density varies with altitude, therefore the early O_2 system of the I-16's unpressurized cockpit required the pilot to set his "Flight Altitude" manually. The O_2 system then adjusted the oxygen flow automatically to allow the pilot to breathe enough oxygen.*
- *The pilot adjusts the Emergency Oxygen Valve Control Lever to set the desired Oxygen Flight Altitude to match his current flight altitude (indicated in km).*

PART 3 – COCKPIT & GAUGES



Gunsight Dimmer Rheostat

Starter Handle
- *Pushed: Engine Ignition*
- *Pulled: Inertial Starter Cranking*

Engine Cowl Louvres Control Lever
Fwd: Open
Aft: Closed

Fuel Priming Pump Handle
Scroll mousewheel to screw/unscrew, left click and drag the lever (pull/push) to prime the engine.

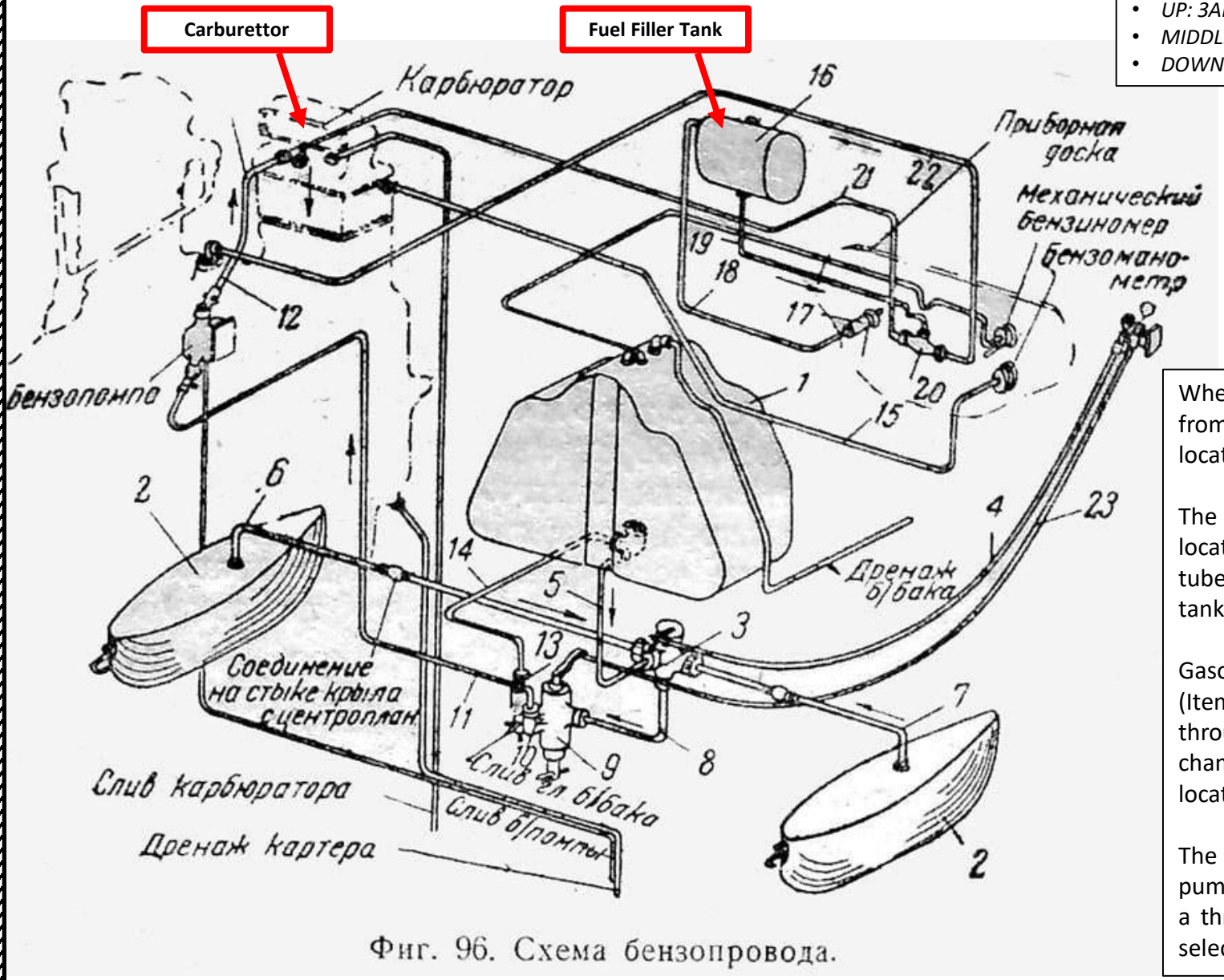
Engine Oil Cooler Control Lever
Fwd: Open
Aft: Closed

CHT (Cylinder Head Temperature) Indicator (x100 deg C)

Fuel Filling System Valve Selector
- *UP: ЗАКР (Closed)*
- *MIDDLE: КАРБЮР (Carburettor)*
- *DOWN: МОТОР (Motor)*

Float-Type Fuel Quantity Indicator (x10 kg)

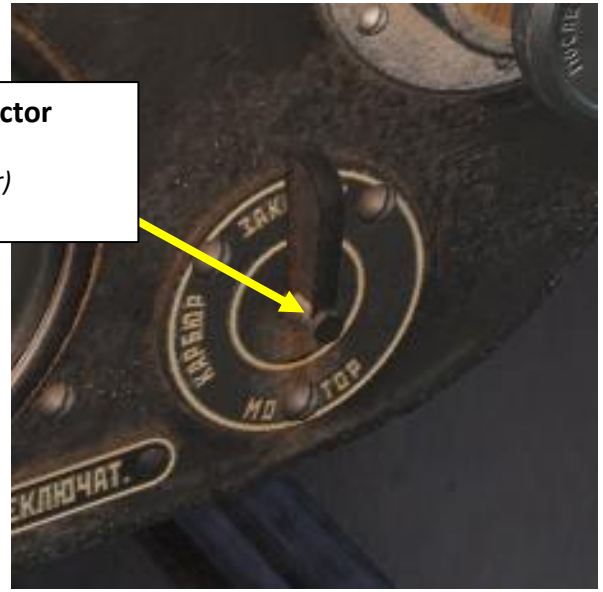
Cockpit Light Rheostat



Фиг. 96. Схема бензопровода.

Fuel Filling System Valve Selector

- *UP: ЗАКР (Closed)*
- *MIDDLE: КАРБЮР (Carburettor)*
- *DOWN: МОТОР (Motor)*



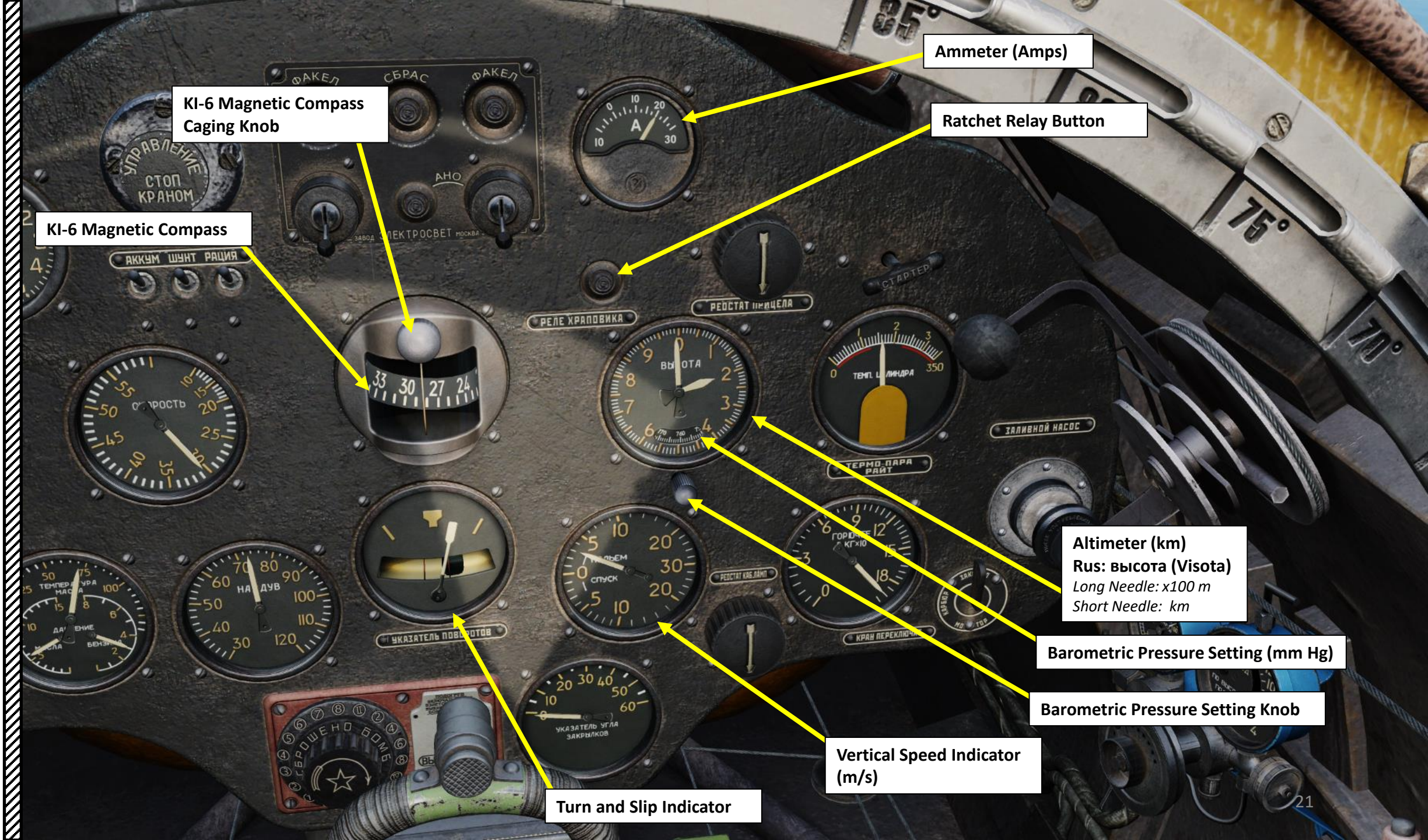
When starting the engine, fuel is supplied under pneumatic pressure from a special filler tank (Item #16) with a capacity of 4 liters, which is located in the upper part of the fuselage behind the gasoline tank.

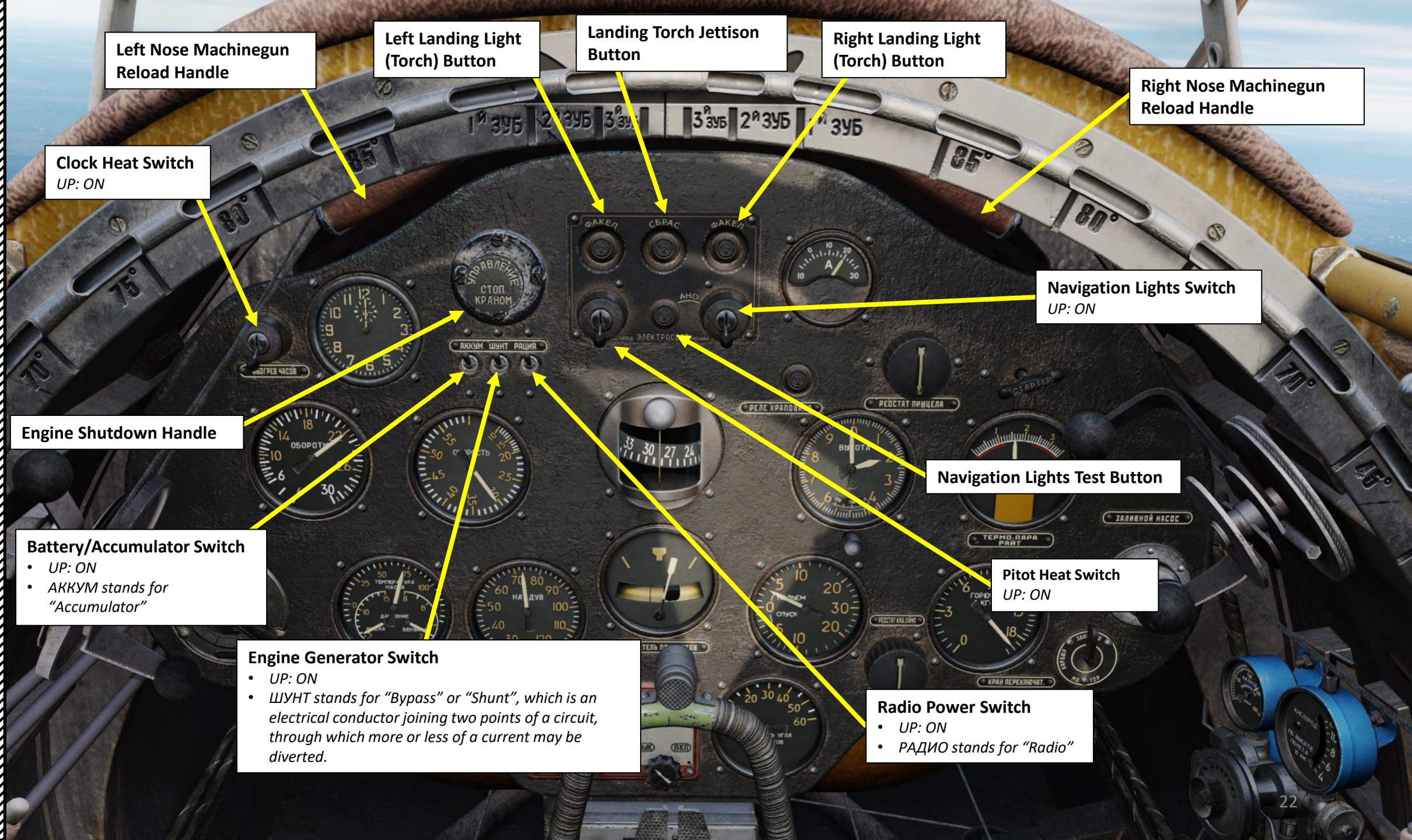
The pressure in the tank is created by a special air pump (Item #17), located on the right side of the instrument panel, through a copper tube (Item #18) with a section attached to the upper fitting of the tank.

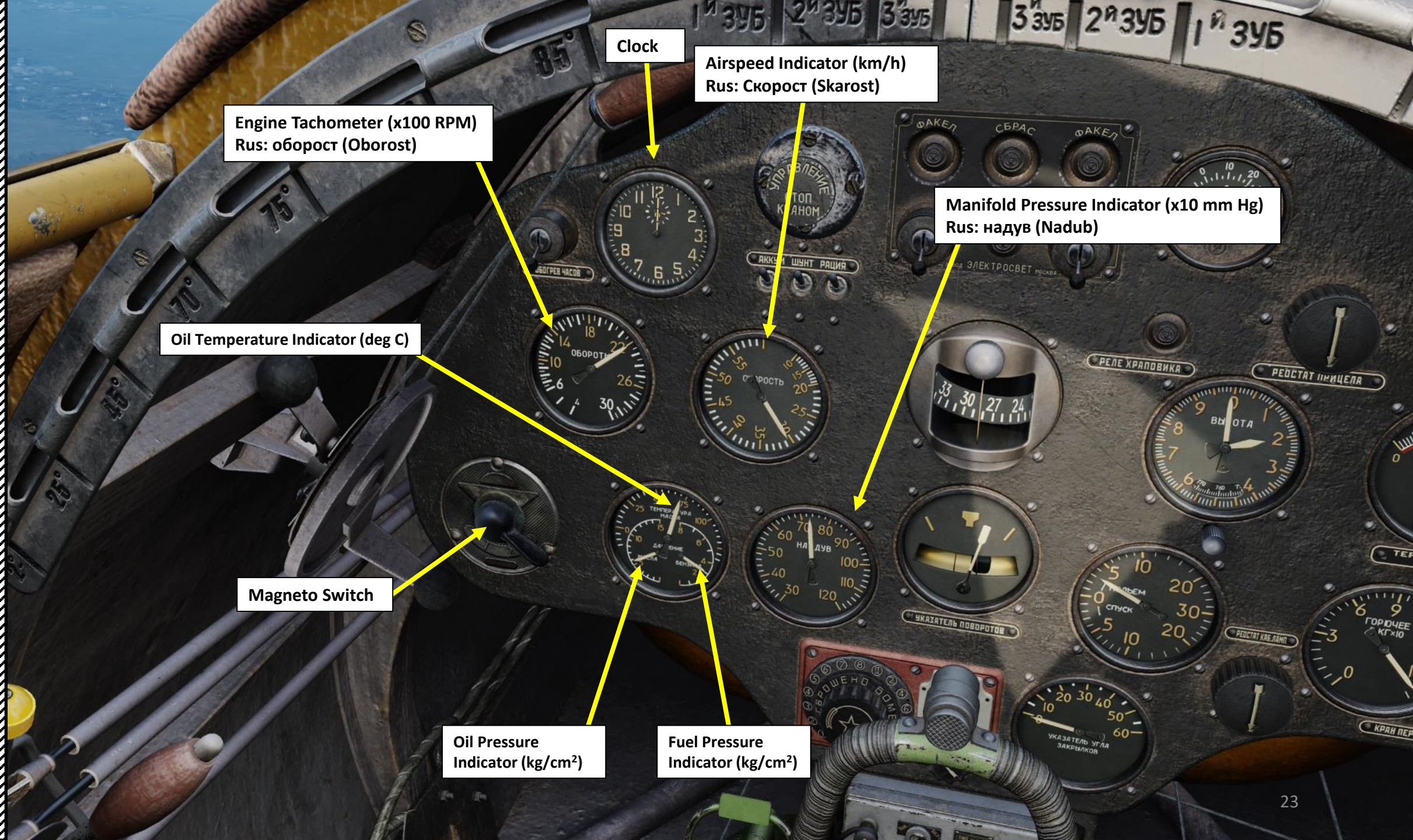
Gasoline flows through the lower fitting of the tank and the tube (Item #19) enters the three-way valve (Item #20), which is connected through pipes (Item #21 and #22) to the carburettor and the impeller chamber of the motor. A fitting for connecting the motor fill tube is located on the first cylinder.

The pressure created in the tank before the engine is started by the pump makes it possible to fill the carburettor and the engine through a three-way valve. The fuel filling system valve is controlled by the selector switch in the cockpit.

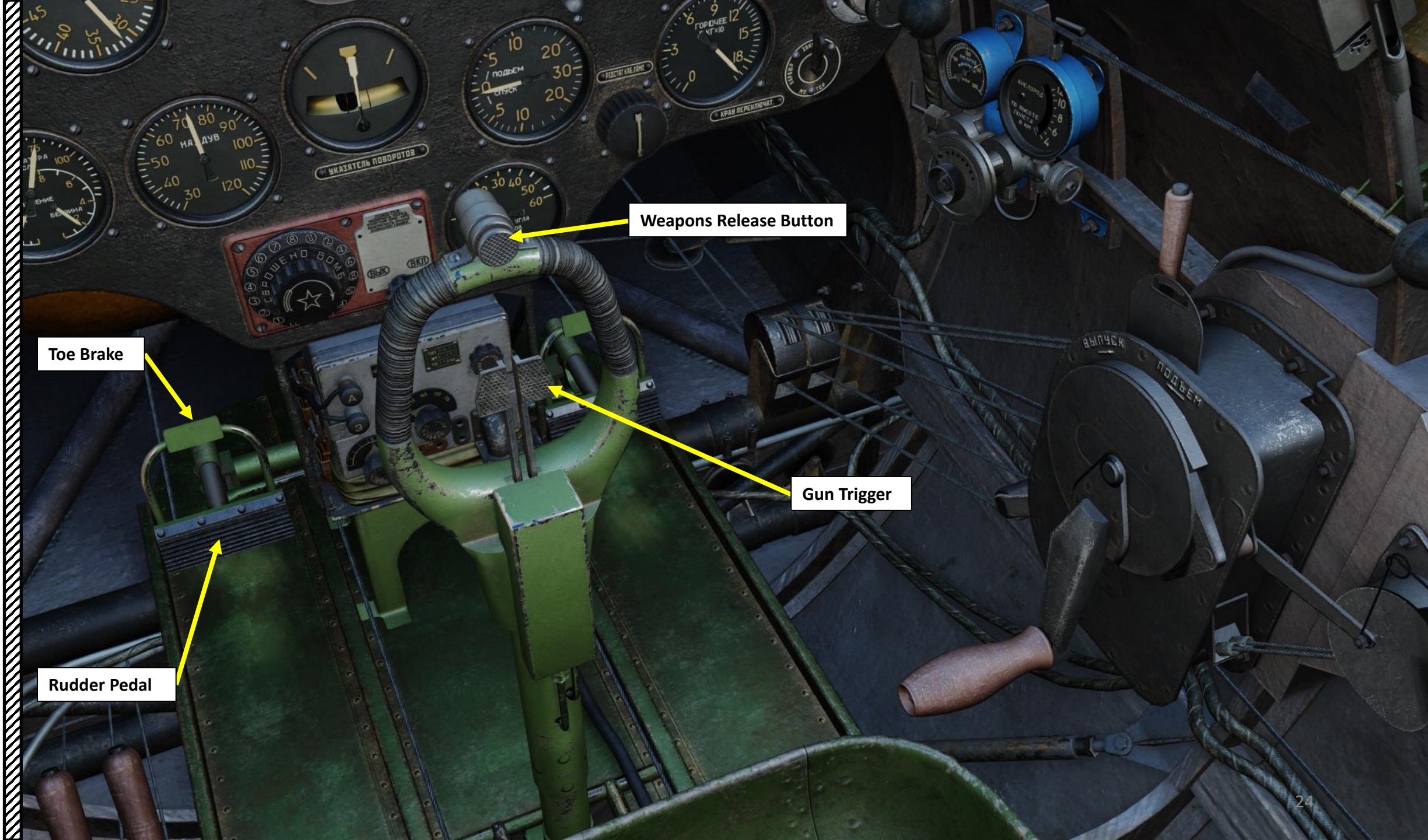
PART 3 – COCKPIT & GAUGES

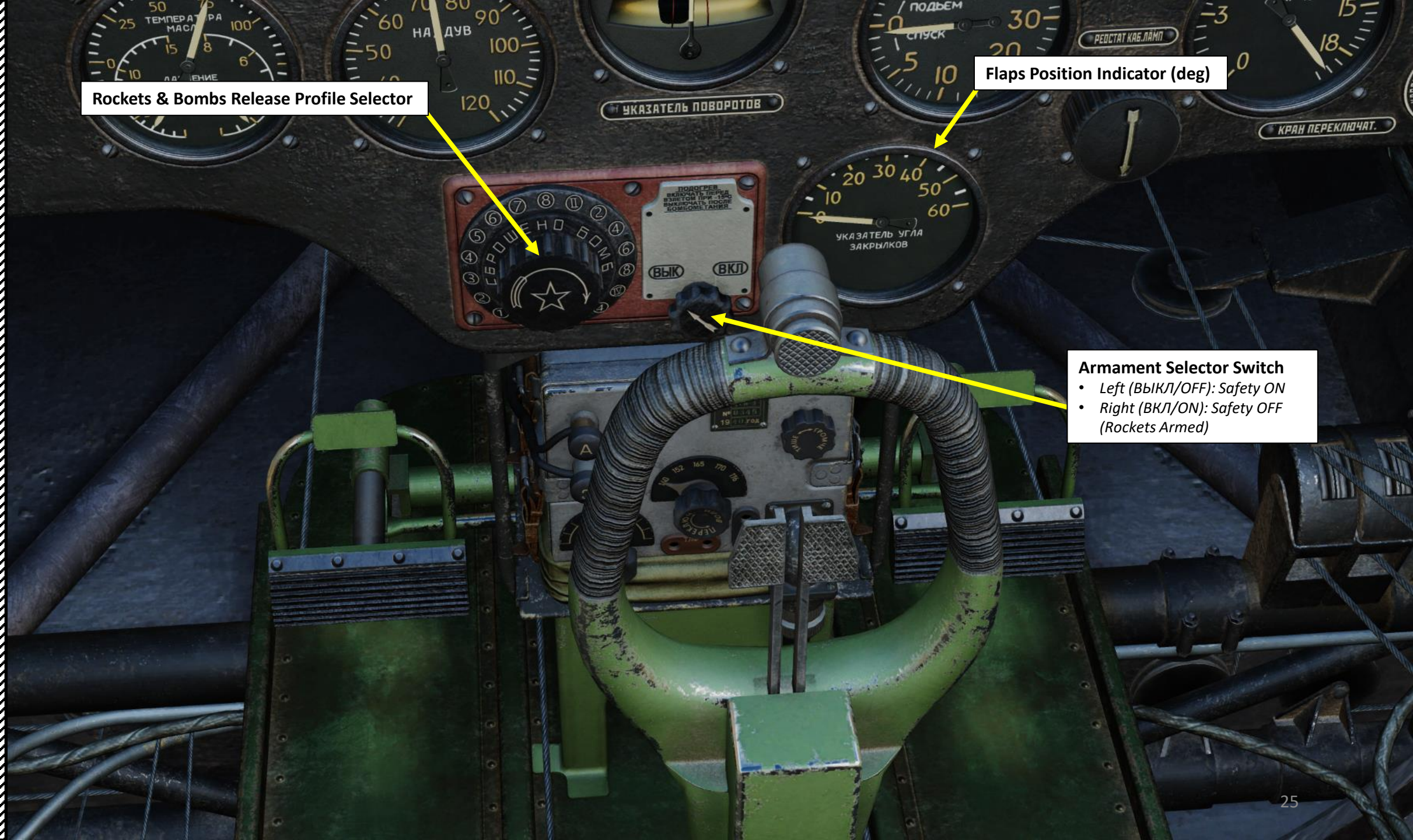



Left Nose Machinegun Reload Handle
Left Landing Light (Torch) Button
Landing Torch Jettison Button
Right Landing Light (Torch) Button
Right Nose Machinegun Reload Handle
Clock Heat Switch
UP: ON
Navigation Lights Switch
UP: ON
Engine Shutdown Handle
Navigation Lights Test Button
Battery/Accumulator Switch
• UP: ON
• АККУМ stands for "Accumulator"
Pitot Heat Switch
UP: ON
Engine Generator Switch
• UP: ON
• ШУНТ stands for "Bypass" or "Shunt", which is an electrical conductor joining two points of a circuit, through which more or less of a current may be diverted.
Radio Power Switch
• UP: ON
• РАДИО stands for "Radio"

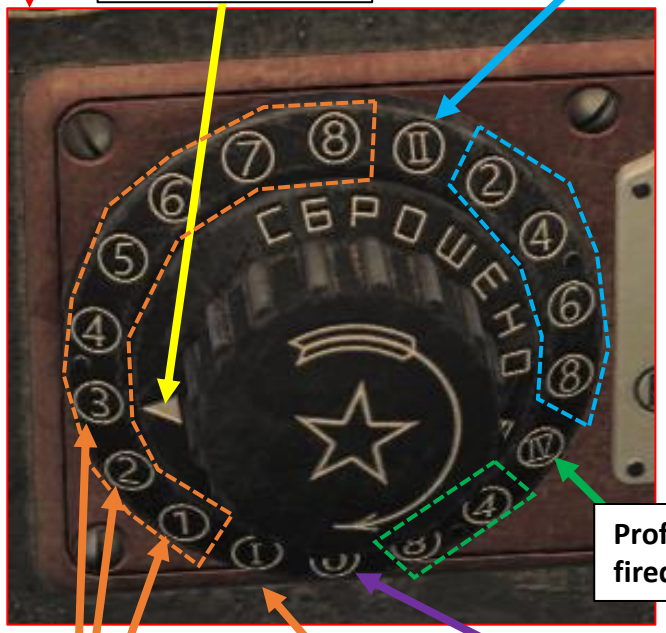

Clock
Airspeed Indicator (km/h)
Rus: Скорост (Skarost)
Engine Tachometer (x100 RPM)
Rus: оборост (Oborost)
Manifold Pressure Indicator (x10 mm Hg)
Rus: надув (Nadub)
Oil Temperature Indicator (deg C)
Magneto Switch
Oil Pressure Indicator (kg/cm²)
Fuel Pressure Indicator (kg/cm²)

PART 3 – COCKPIT & GAUGES



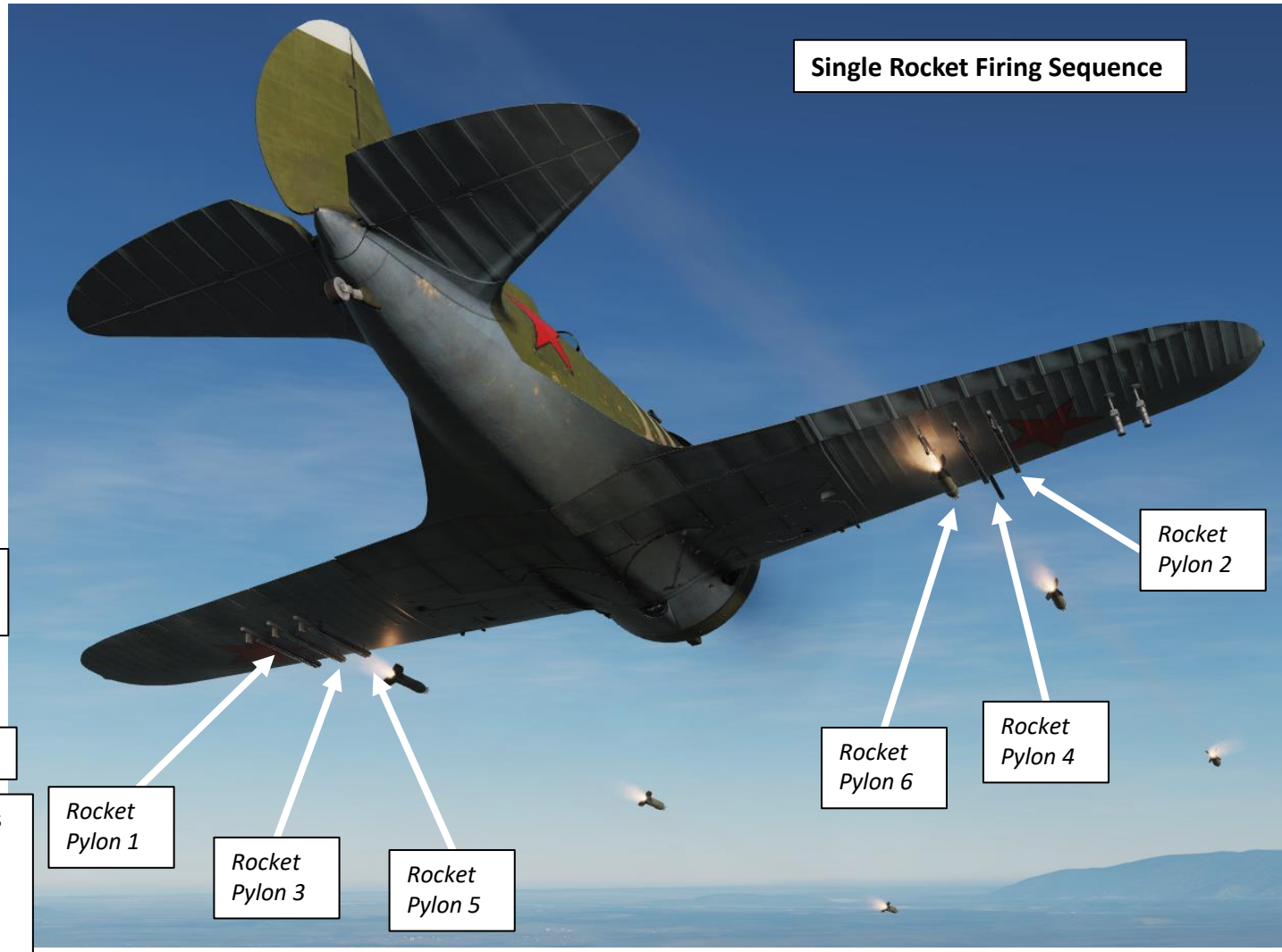

Rockets & Bombs Release Profile Selector
Flaps Position Indicator (deg)
Armament Selector Switch
• Left (ВЫКЛ/OFF): Safety ON
• Right (ВКЛ/ON): Safety OFF (Rockets Armed)
УКАЗАТЕЛЬ ПОВОРОТОВ
УКАЗАТЕЛЬ УГЛА ЗАКРЫЛКОВ
ВЫК
ВКЛ
РЕОСТАТ КАБЛАМП
КРАН ПЕРЕКЛЮЧАТ.

PART 3 – COCKPIT & GAUGES

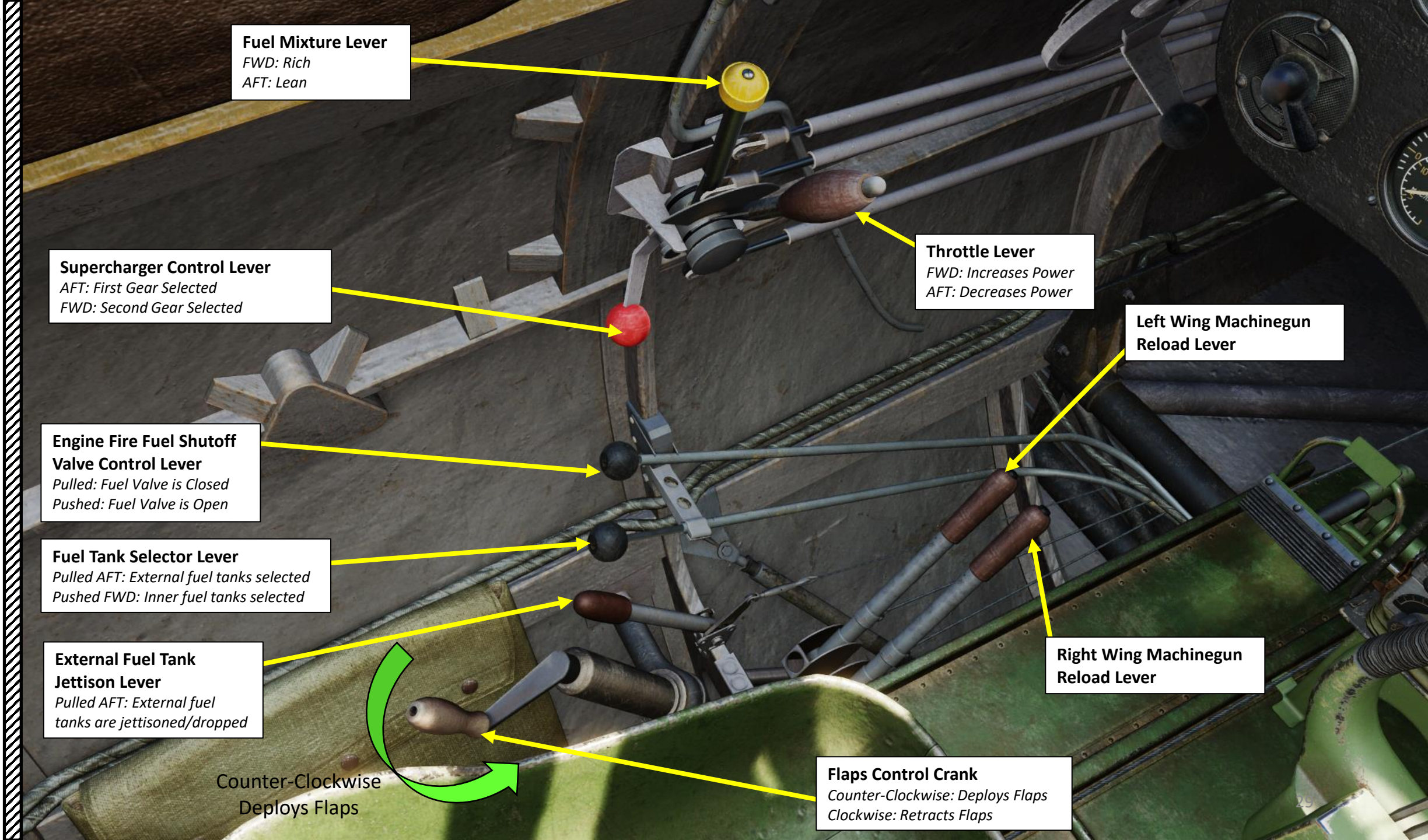


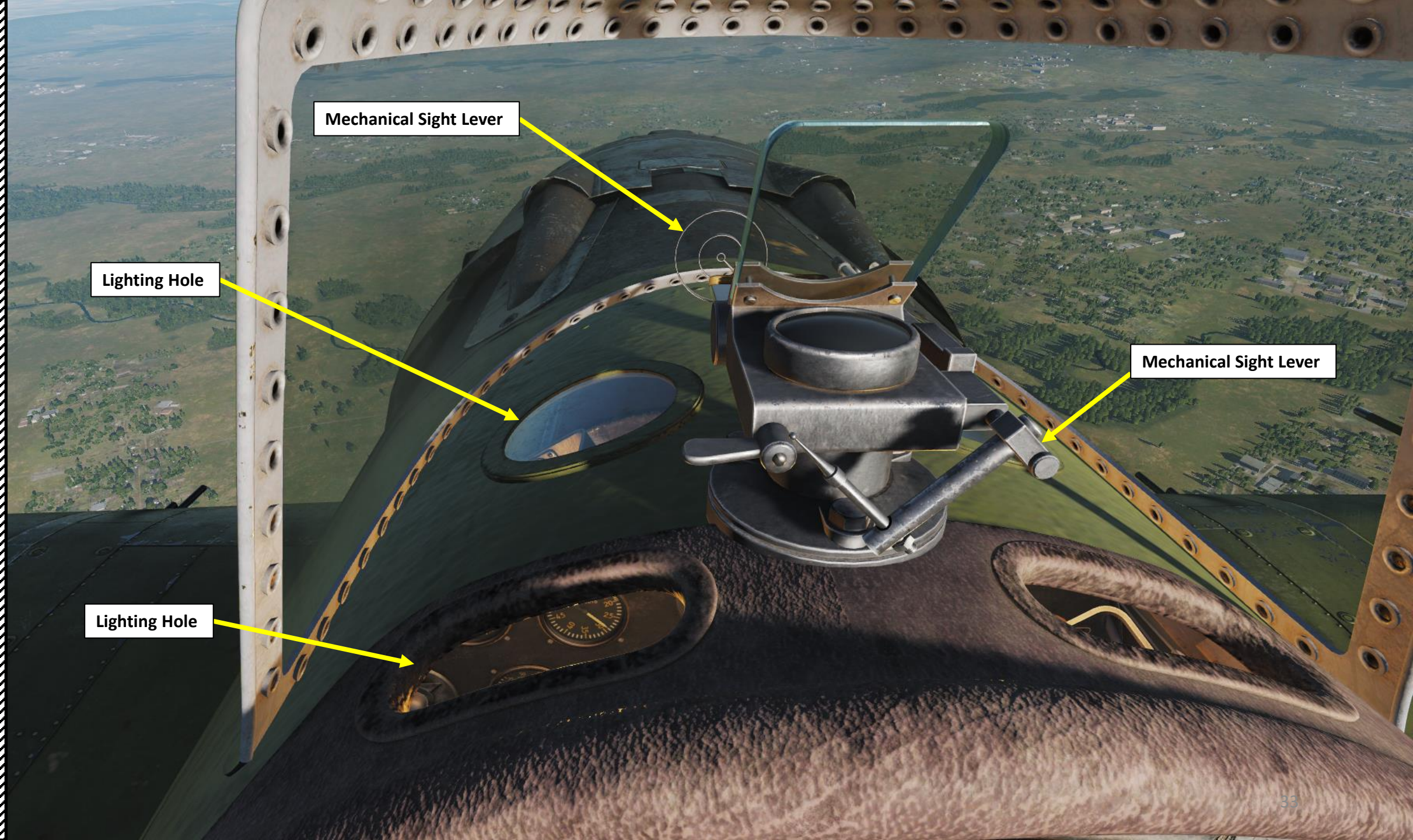
Each time the Weapons Release button is pressed, the selector indicator increments clockwise. These arabic numerals can be seen as the number off rockets or bombs expended so far. Roman numerals represent "release profiles" (i.e. how many bombs/rockets are fired per Weapons Release button press.

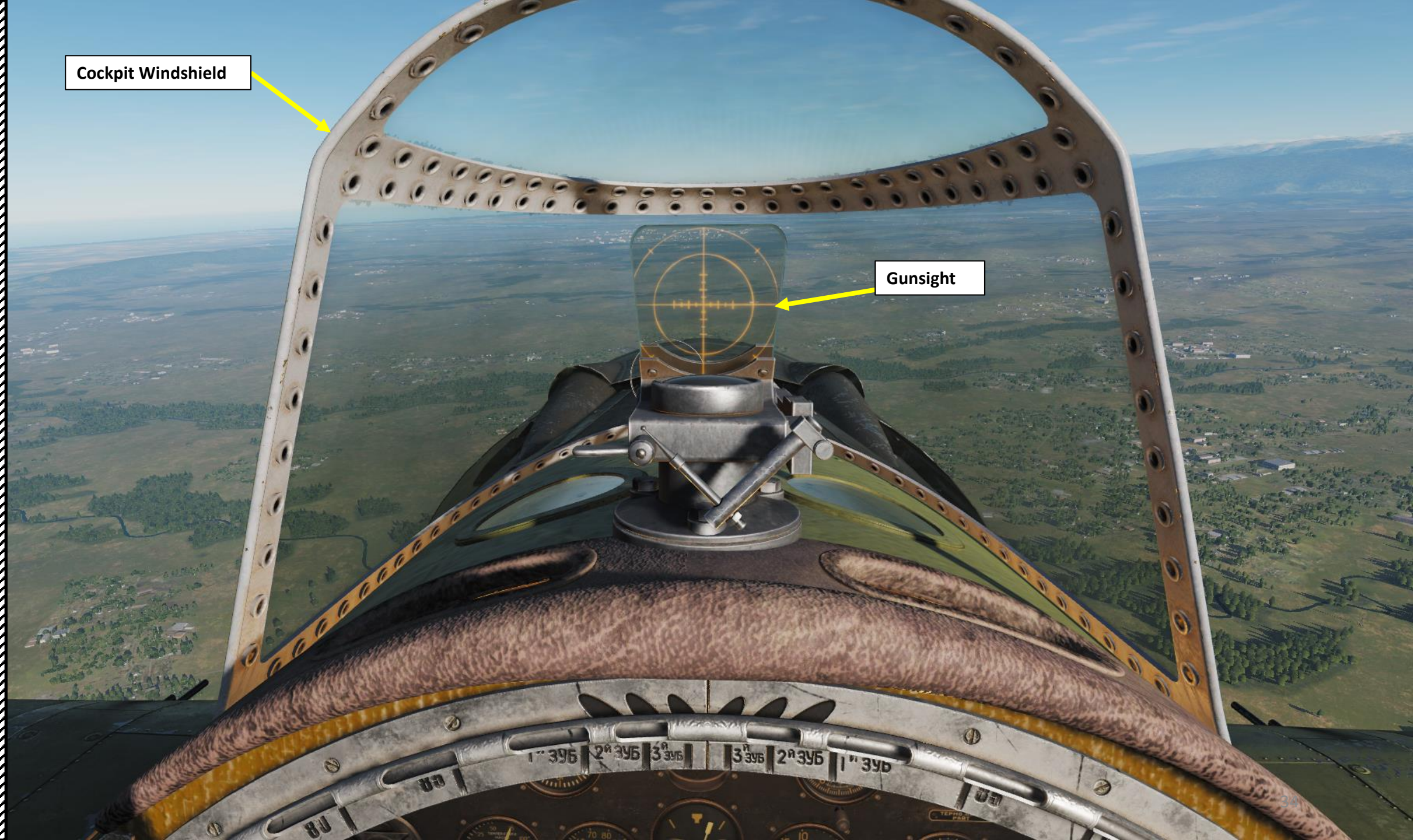
As an example, setting your Selector Indicator triangle to "I" and then firing a rocket will fire a single rocket. The Selector will then automatically go to "1", which means one rocket has been fired. If you fire another rocket, the Selector will go to "2", meaning two rockets have been fired.



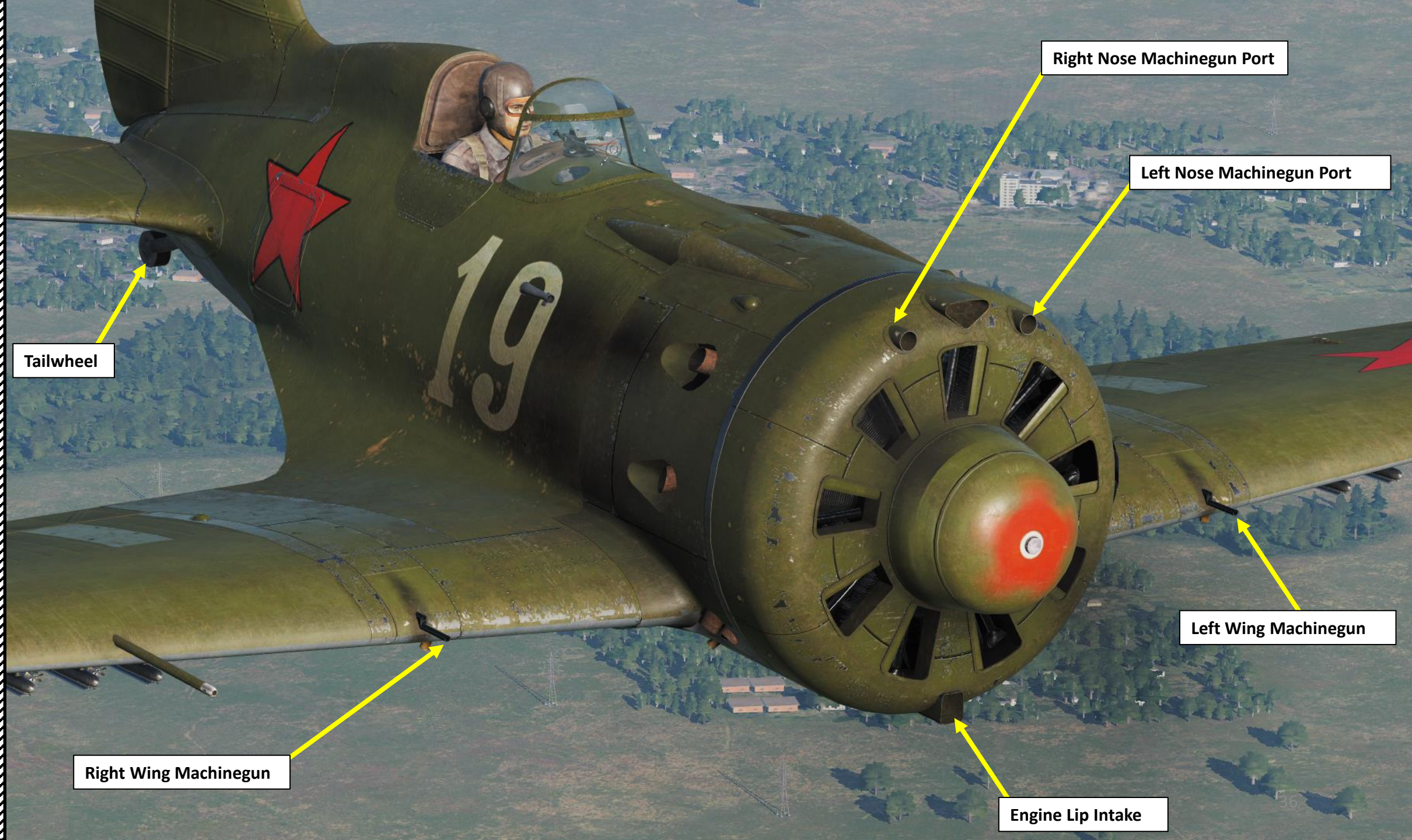

Engine Boost Augmentation Lever
AFT: OFF
FWD: ON
Engine RPM Control Lever
AFT: Decreases RPM
FWD: Increases RPM


Fuel Mixture Lever
FWD: Rich
AFT: Lean
Throttle Lever
FWD: Increases Power
AFT: Decreases Power
Supercharger Control Lever
AFT: First Gear Selected
FWD: Second Gear Selected
Left Wing Machinegun Reload Lever
Engine Fire Fuel Shutoff Valve Control Lever
Pulled: Fuel Valve is Closed
Pushed: Fuel Valve is Open
Fuel Tank Selector Lever
Pulled AFT: External fuel tanks selected
Pushed FWD: Inner fuel tanks selected
External Fuel Tank Jettison Lever
Pulled AFT: External fuel tanks are jettisoned/dropped
Right Wing Machinegun Reload Lever
Counter-Clockwise
Deploys Flaps
Flaps Control Crank
Counter-Clockwise: Deploys Flaps
Clockwise: Retracts Flaps


Mechanical Sight Lever
Lighting Hole
Mechanical Sight Lever
Lighting Hole


Cockpit Windshield
Gunsight


Gunsight Sun Filter


Right Nose Machinegun Port
Left Nose Machinegun Port
Tailwheel
Left Wing Machinegun
Right Wing Machinegun
Engine Lip Intake

Landing Lights (Torch)
Only available if equipped via the Mission Editor

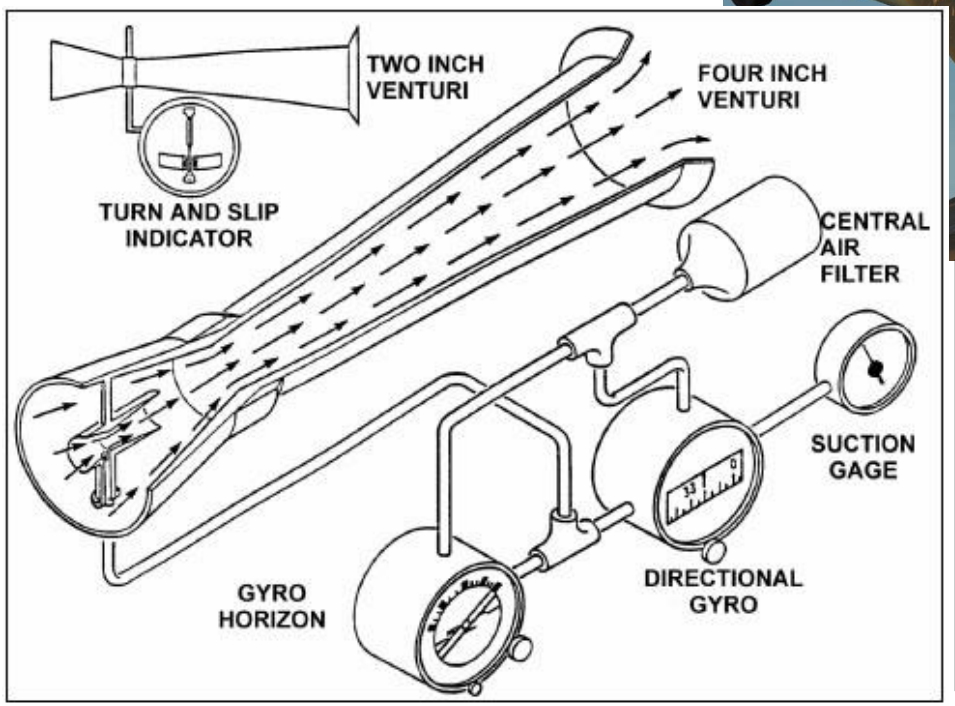


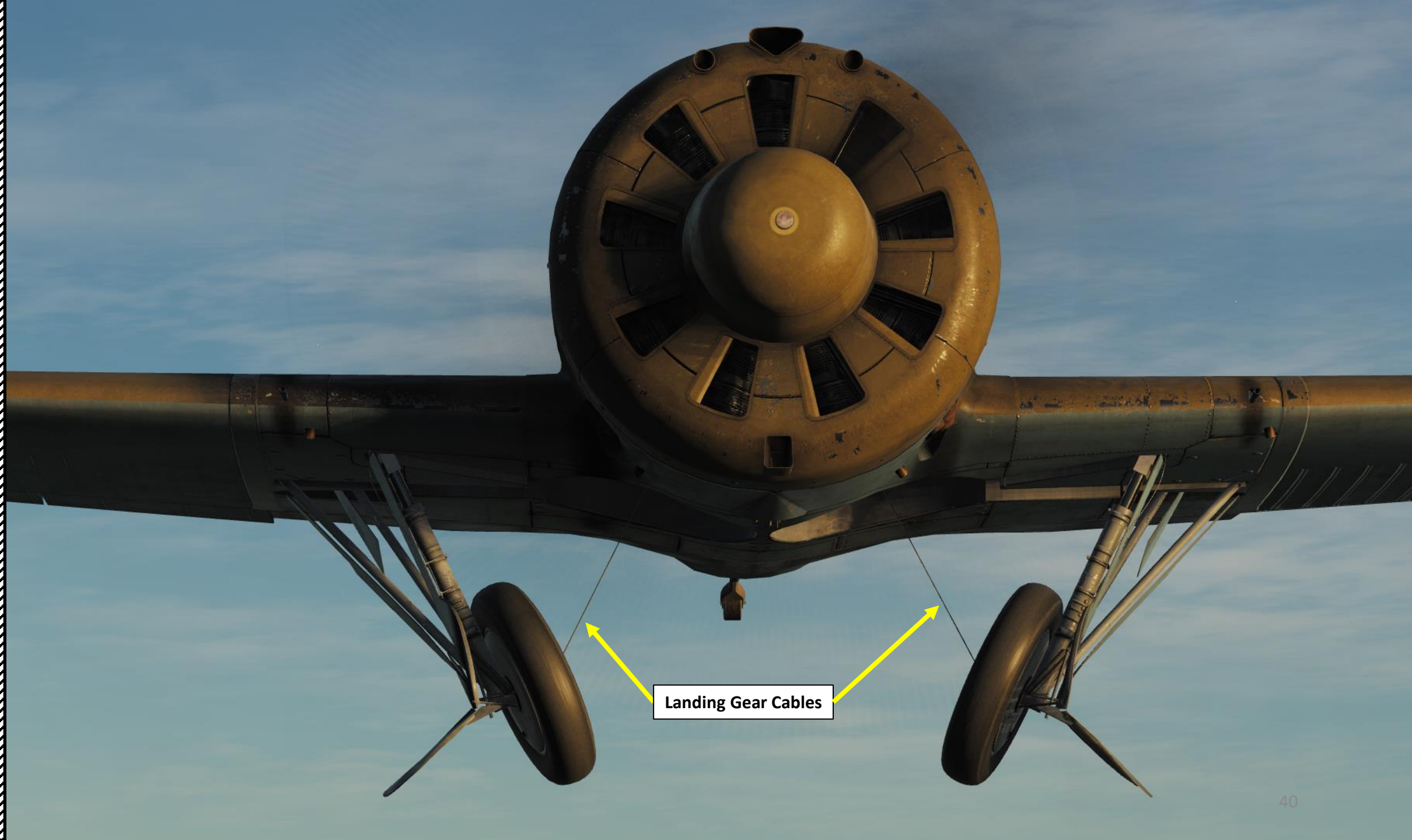
FIGURE 12-1. Venturi system for providing airflow through gyro instruments.

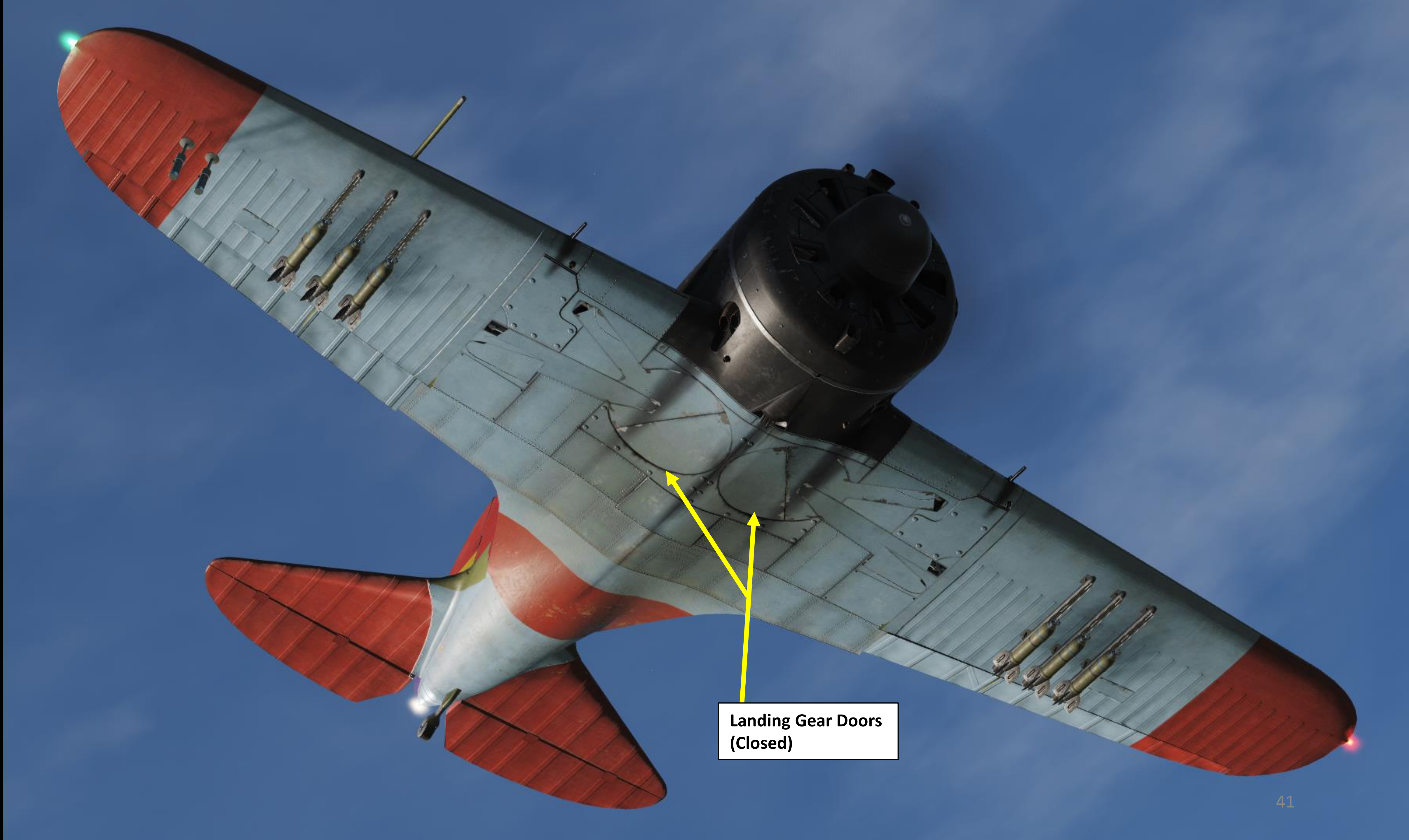
Vacuum Gyro System Venturi Tube

The velocity of the air rushing through a venturi can create sufficient suction to spin instrument gyros. A line is run from the gyro instruments to the throat of the venturi mounted on the outside of the airframe. The low pressure in the venturi tube pulls air through the instruments, spins the gyros, and expels the air overboard through the venturi. This source of gyro power is used on many simple, early aircraft.

The advantages of a venturi as a suction source are its relatively low cost and its simplicity of installation and operation. It also requires no electric power. But there are serious limitations. A venturi is designed to produce the desired vacuum at approximately 100 mph at standard sea level conditions. Wide variations in airspeed or air density cause the suction developed to fluctuate. Airflow can also be hampered by ice that can form on the venturi tube. Additionally, since the rotor does not reach normal operating speed until after takeoff, pre-flight operational checks of venturi powered gyro instruments cannot be made. For these reasons, alternate sources of vacuum power were developed.

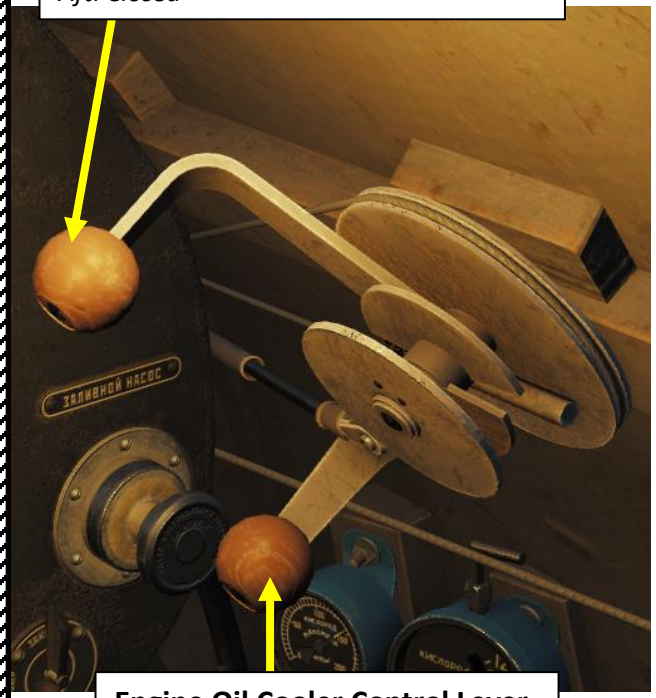

Landing Gear Position Mechanical Indicator (Spring)


Landing Gear Cables


Landing Gear Doors (Closed)

Engine crankcase air breather port
Part of the engine crankcase breathing system, which comes from the oil air separator. After high G manoeuvres, a significant amount of oil can come out of this port.

Engine Cowl Louvres Control Lever
Fwd: Open
Aft: Closed



Engine Oil Cooler Control Lever
Fwd: Open
Aft: Closed

Engine Cowl Louvres Closed

Engine Cowl Louvres Open

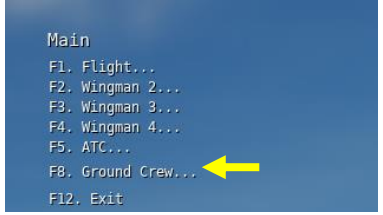

Navigation Light (Green)
Pitot Tube
Navigation Light (White)
Navigation Light (Red)
CM 225

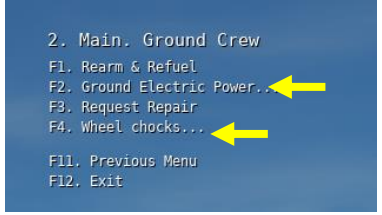
Fuel Tank
Capacity: 260 Liters / 421 lbs / 191 kg

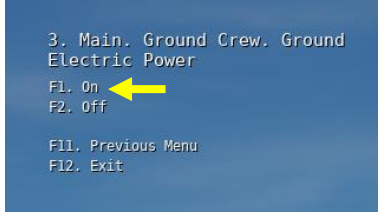
Float-Type Fuel Quantity Indicator (x10 kg)

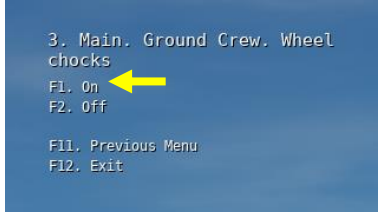
BEFORE START

1. Connect external ground power
   a) Make sure your canopy is open to communicate to the ground crew
   b) Press “\” (communication menu binding) to contact ground crew
   c) Press “F8” to select “Ground Crew”
   d) Press “F2” to select “Ground Electric Power”
   e) Press “F1” to “Connect Ground Power”.
2. Install wheel chocks
   a) Make sure your canopy is open to communicate to the ground crew
   b) Press “\” (communication menu binding) to contact ground crew
   c) Press “F8” to select “Ground Crew”
   d) Press “F4” to select “Wheel Chocks”
   e) Press “F1” to “Install Wheel Chocks”.



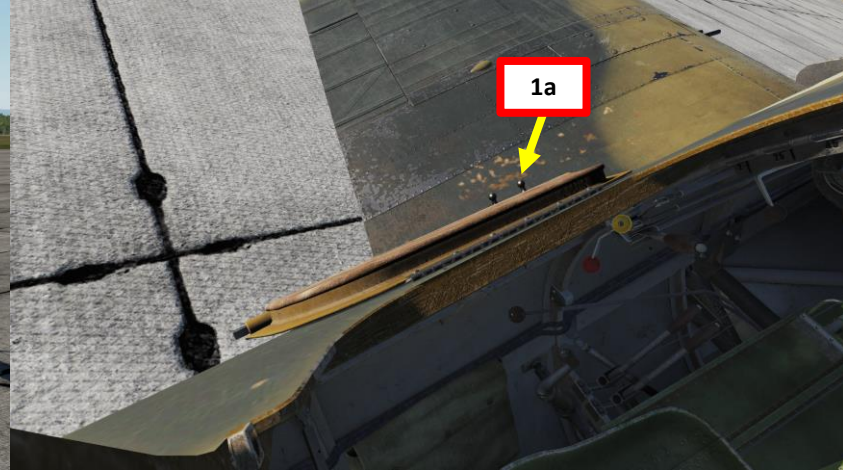


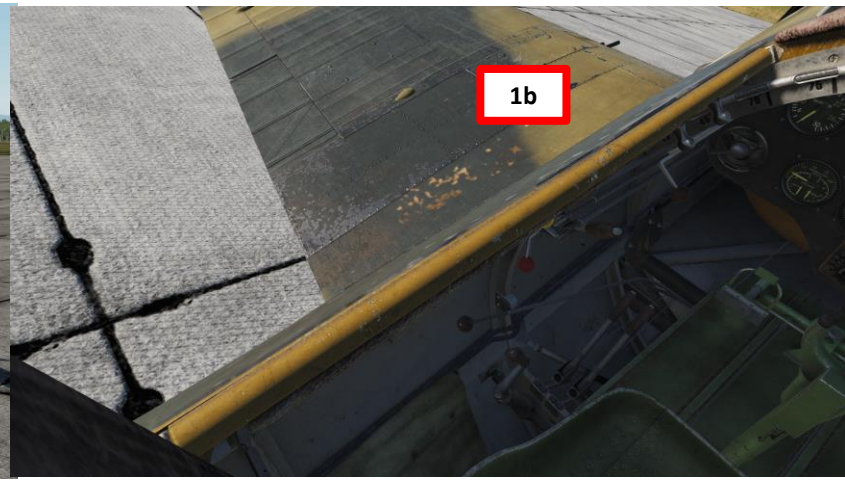


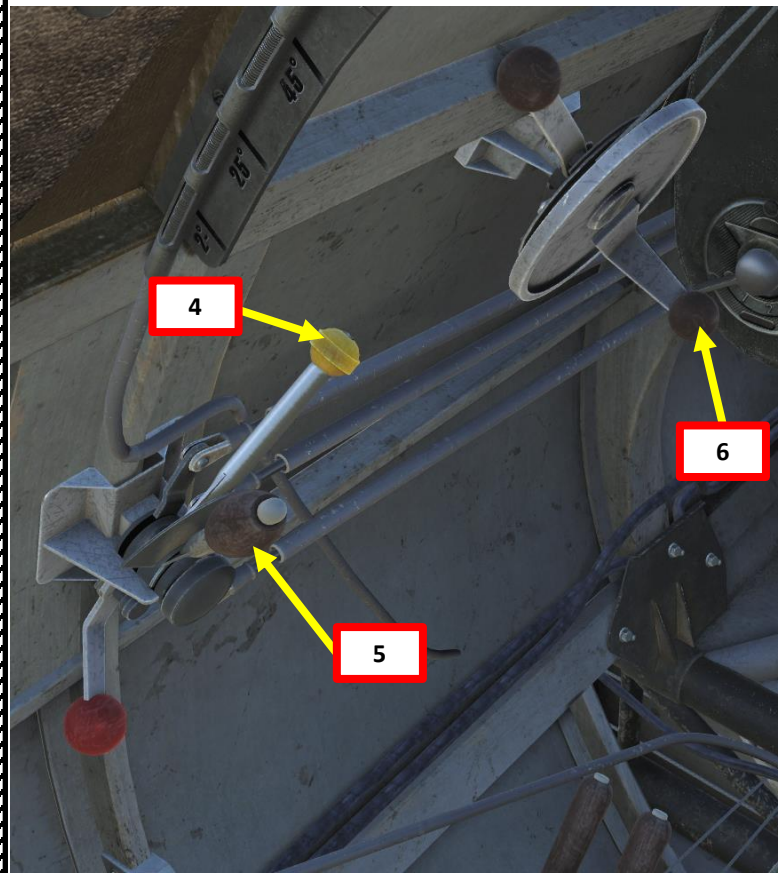


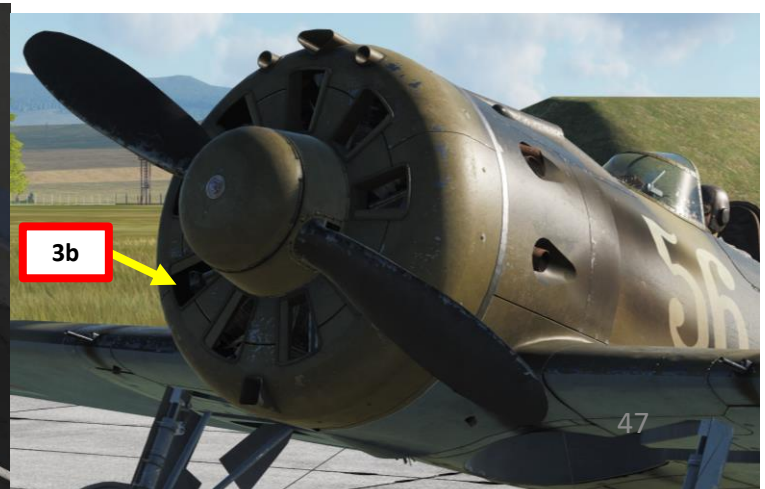
ENGINE START

1. Close cockpit side doors (LCTRL+C)
2. Oil Radiator Flaps Lever – Open (FWD)
3. Engine Cowl Louvres Lever – Open (FWD)
4. Mixture Lever – Fully Rich (FWD)
5. Throttle – Cracked Open (1 inch FWD)
6. Engine RPM Control Lever – Fully Forward



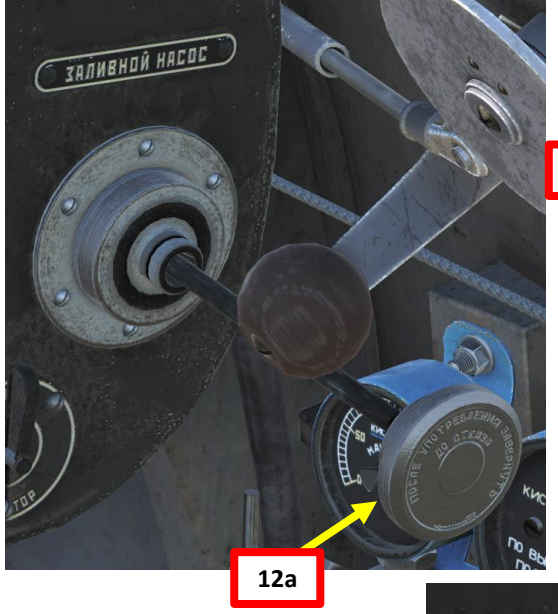


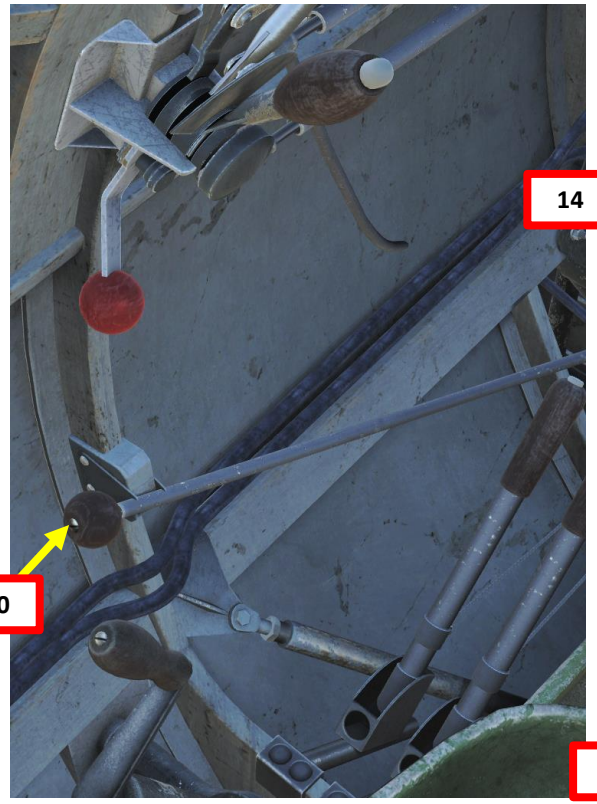


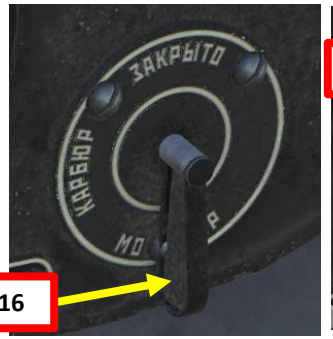


ENGINE START

7. Battery/Accumulator (*АККУМ*) Switch – ON (UP)
8. Engine Generator Bypass/Shunt (*ШУНТ)* Switch – ON (UP)
9. Radio (*РАДИО)* Switch – ON (UP)
10. Engine Fire Fuel Shutoff Valve Lever – Open (Pushed FWD)
11. Unlock Primer Lever by rotating the lever counterclockwise to STOP position (Scroll mousewheel)
12. Prime the engine five times (Left click and hold lever, then drag it back and forth five times)
13. Lock the Primer Lever by rotating the lever clockwise (Scroll mousewheel)
14. Set Fuel Filling System Valve Selector to MIDDLE position (*КАРБЮР*, Carburettor) for 3 seconds
15. Confirm that Fuel Pressure indicator increases to approx. 1 atmosphere (1.03 kg/cm^2)
16. Set Fuel Filling System Valve Selector to DOWN position (*МОТОР*, Motor) for 3 seconds
17. Set Fuel Filling System Valve Selector to UP position (*ЗАКР*, Closed)

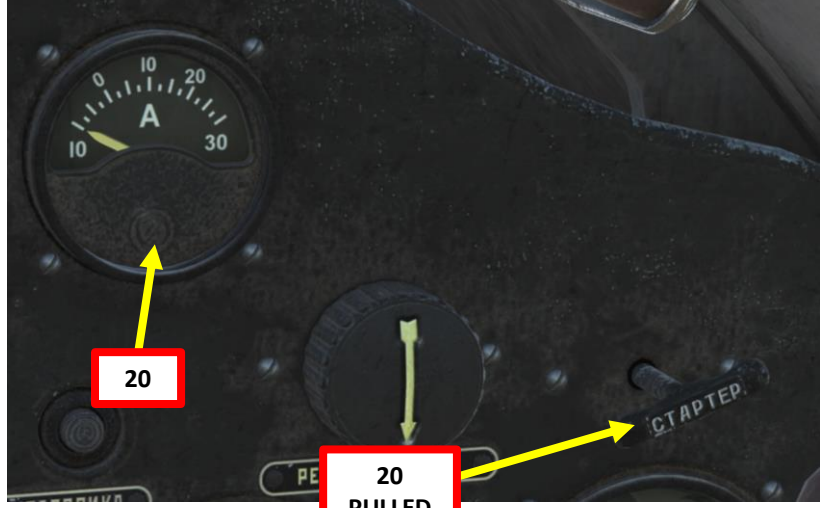


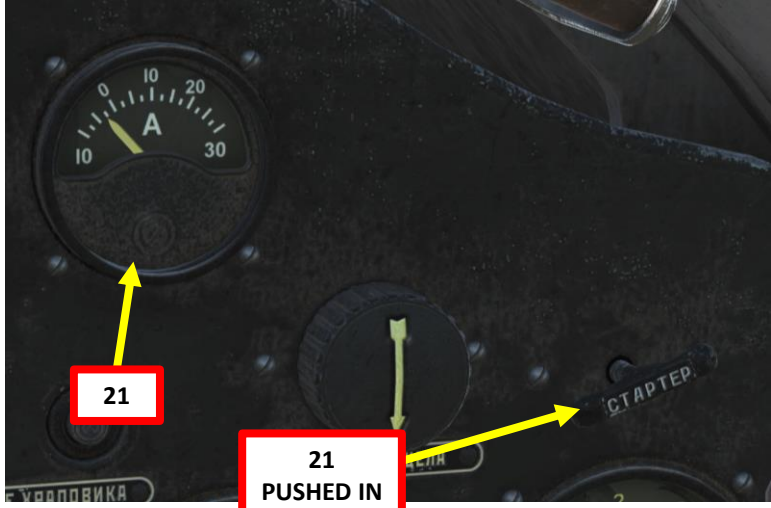


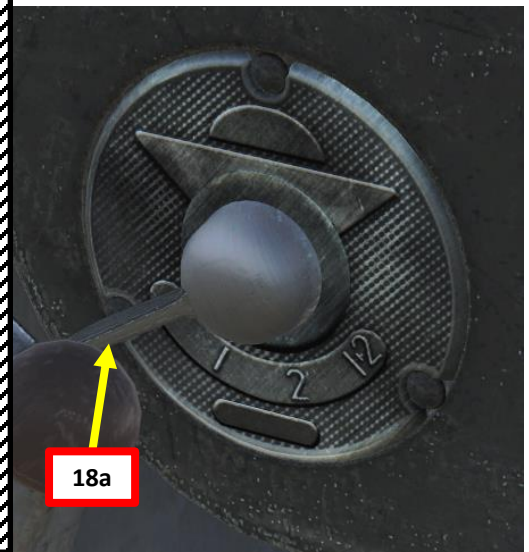


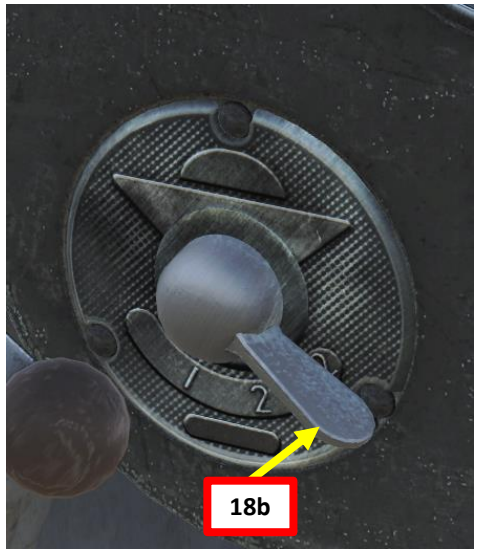
ENGINE START

18. Magneto Switch – 1+2 (Fully Right)
19. Hold Wheel Brakes
20. Pull Inertial Starter handle AFT (Right Click and hold) and hold it
    - 8-10 sec during summer
    - 10-12 sec during winter
21. Immediately Push the Inertial Starter handle FWD (Left Click and hold) until engine starts. You will see the Amperage decrease while the starter is cranking.
22. When engine starts, release Inertial Starter handle. If engine fails to start, repeat steps the two previous steps.
23. Verify that oil pressure, oil temperature, and fuel pressure increase.





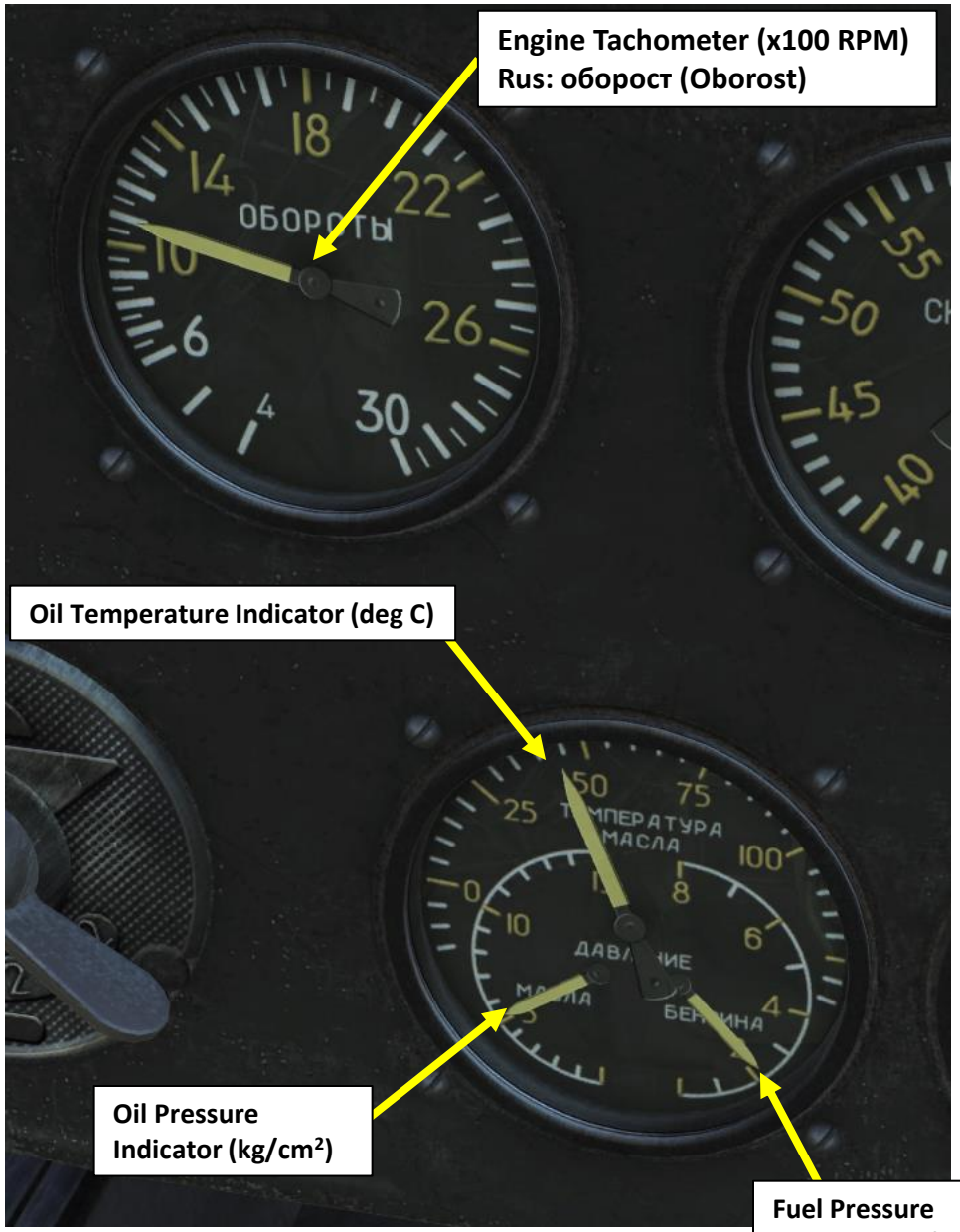




ENGINE WARM-UP

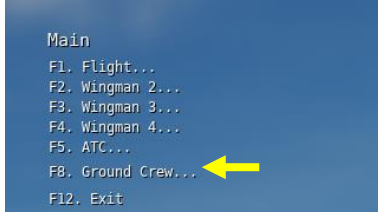
1. Hold Wheel Brakes
2. Adjust throttle to reach a RPM between 1100 and 1200 (IDLE range).
3. Wait until engine oil warms up to at least 50 deg C. You can close the Engine Cowl Louvres and Oil Radiator flaps momentarily to speed up the engine warm-up.
4. Make sure CHT (Cylinder Head Temperature) does not exceed 210 deg C.
5. Increase throttle and release wheel brakes to start taxiing when engine is warmed up

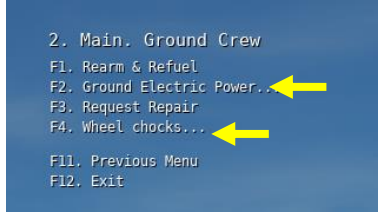
Note: *Attempting a takeoff with low oil temperature can lead to dire consequences. Waiting for proper engine warm-up is often overlooked by virtual pilots and the Shvetsov M-63 engine leaves no room for error when engine temperatures are concerned.*

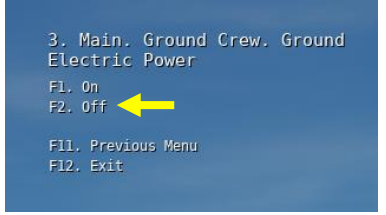


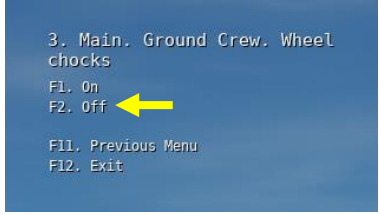
AFTER START

1. Disconnect external ground power
   a) Make sure your canopy is open to communicate to the ground crew
   b) Press “\” (communication menu binding) to contact ground crew
   c) Press “F8” to select “Ground Crew”
   d) Press “F2” to select “Ground Electric Power”
   e) Press “F2” to “Disconnect Ground Power”.
2. Remove wheel chocks
   a) Make sure your canopy is open to communicate to the ground crew
   b) Press “\” (communication menu binding) to contact ground crew
   c) Press “F8” to select “Ground Crew”
   d) Press “F4” to select “Wheel Chocks”
   e) Press “F2” to “Remove Wheel Chocks”.









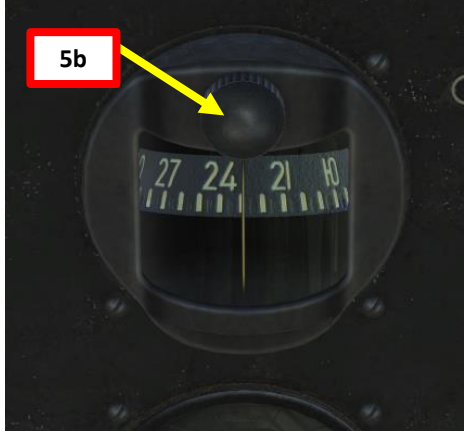
TAXI PROCEDURE

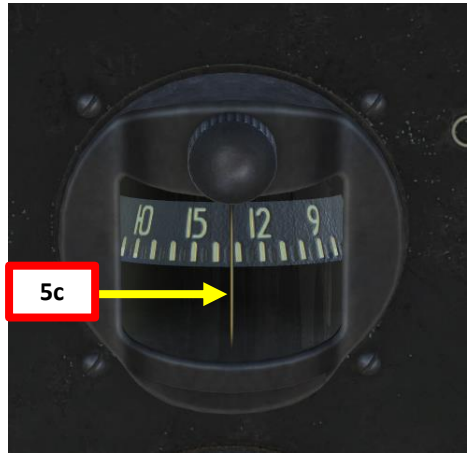
1. Ensure engine oil temperature is above 50 deg C and CHT (Cylinder Head Temperature) is below 210 deg C.
2. Set throttle to 1200 RPM, set your control stick fully aft, release wheel brakes and start taxiing. Reduce throttle as required to maintain a safe taxi speed.
3. To execute a turn, apply wheel brake in the direction of the turn. Since the tailwheel is mechanically linked the tailwheel, you can also apply rudder input in the desired direction.
4. When lined up on the runway, ensure side doors are closed.

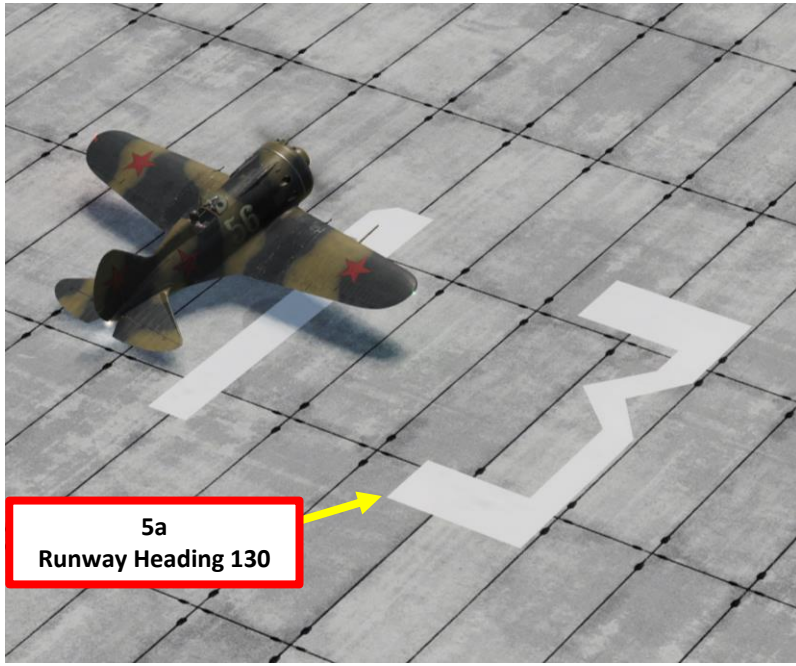
Note: *During taxi, keep the control stick pulled completely AFT and try to keep the rudder centered to ensure that the tailwheel remains straight.*

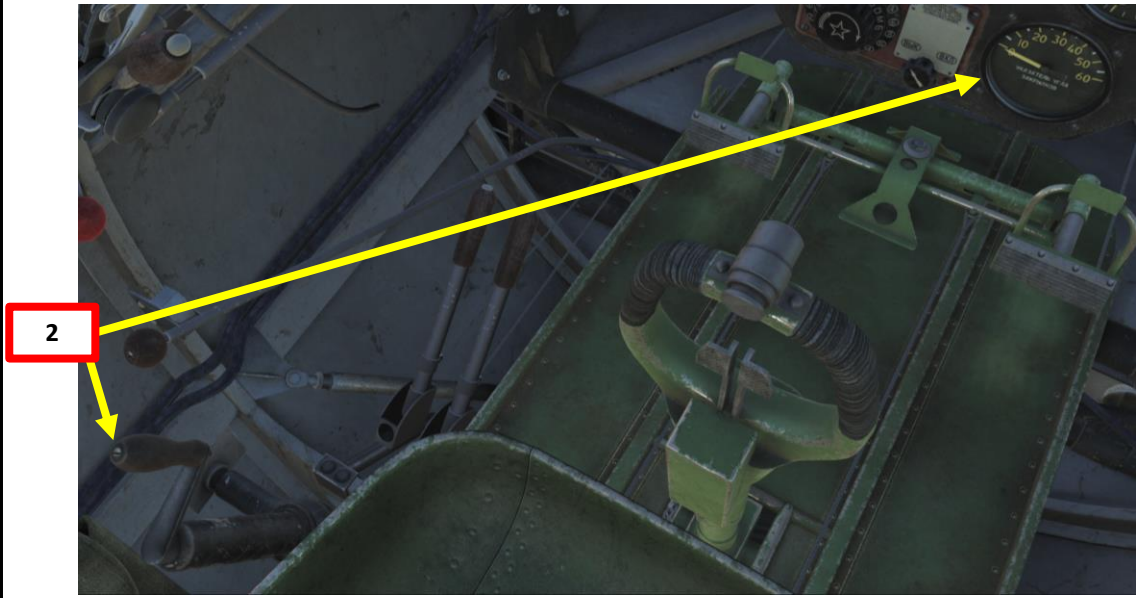
TAKEOFF PROCEDURE

1) Ensure RPM Control lever is fully forward, Engine Cowl Louvres and Oil Radiator Flaps are fully open (FWD)
2) Flaps – UP
3) Set Pitot Heat Switch – ON (UP)
4) Set Navigation Lights Switch – ON (UP)
5) Set Magnetic Compass heading to Runway Heading using the Compass Caging Knob
6) Pull stick fully back and center rudder pedals to ensure that tailwheel remains straight.
7) Release wheel brakes and slowly throttle up to 3/4 of the full throttle travel. Compensate engine torque with small right rudder input. With the engine's slow response time, the slower your increase the throttle, the better control you will have over the acceleration and engine torque of the aircraft.
8) Release control stick to center position as aircraft gains speed and tailwheel leaves the ground.
9) Rotate when reaching 170 km/h.
10) Once in the air, press the wheel brake lever to stop the wheels from spinning before retracting the landing gear.





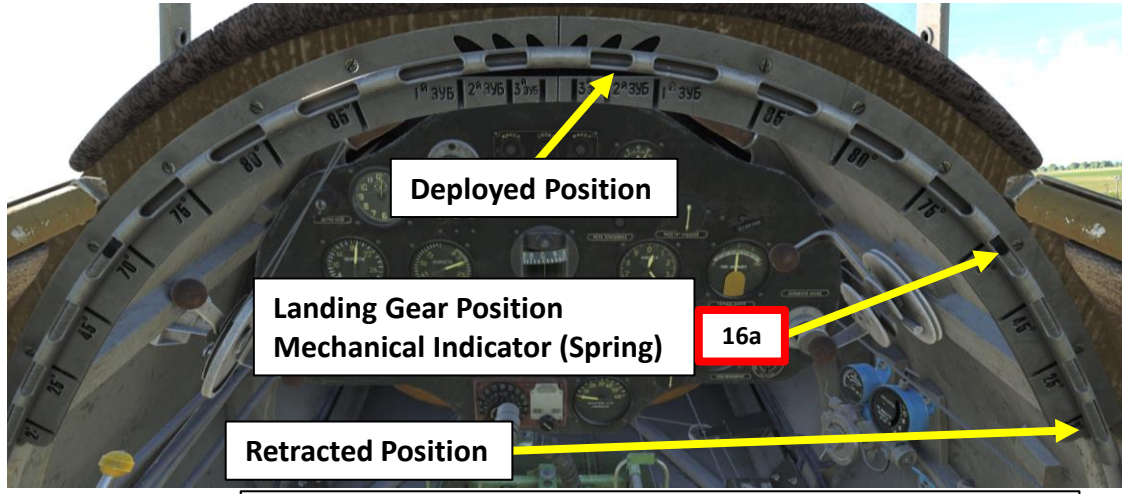


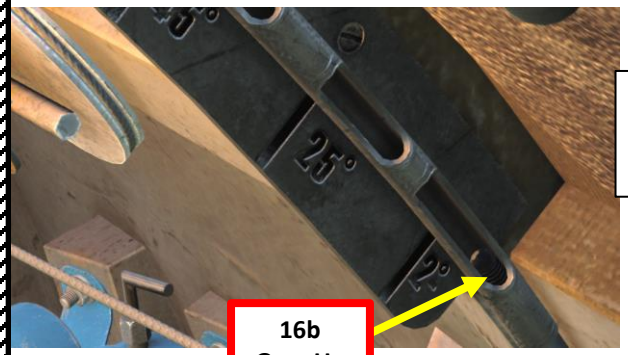


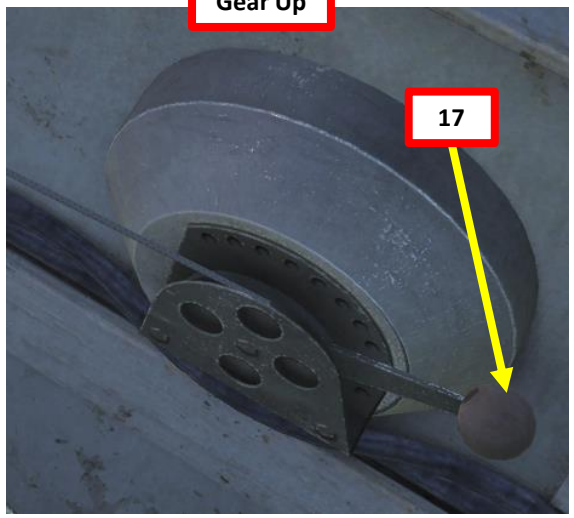
TAKEOFF PROCEDURE

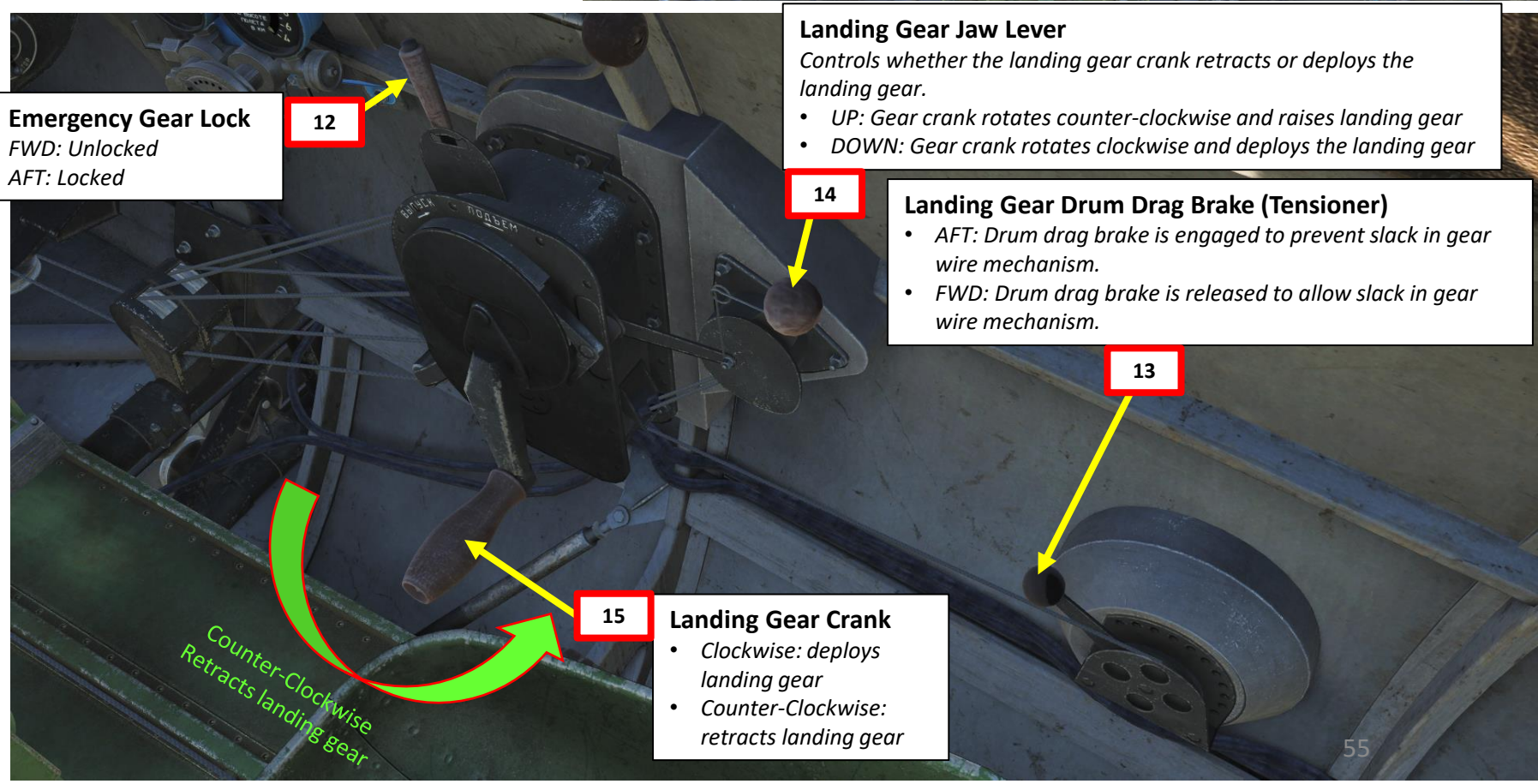
RETRACTING THE LANDING GEAR

11) As you climb, adjust throttle to keep an airspeed at 200 km/h or below to ensure the landing gear retraction will not be hampered by the speed of the air stream.
12) Emergency Gear Lock Lever – FWD (Unlocked)
13) Landing Gear Drum Drag Brake (Tensioner) Lever – FWD (Released)
14) Landing Gear Jaw Lever – UP (Gear crank rotation will raise the landing gear)
15) Turn Landing Gear Crank counter-clockwise (hold “LCTRL+G” binding) for 43 rotations.
16) Monitor the position of the landing gear
17) Once landing gear is up, set the Landing Gear Drum Drag Brake (Tensioner) Lever to AFT (Engaged)







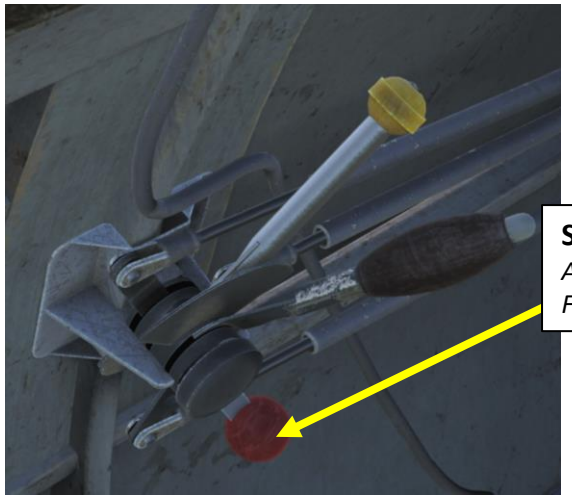


TAKEOFF PROCEDURE

VIDEO DEMO:
https://youtu.be/NRzjddPJQcI

CLIMB CHECKS

1) Your climb speed should be set to 200 km/h
2) Adjust Manifold Pressure to 750 mm Hg
3) Adjust RPM control lever to 2200 (MCP, Maximum Continuous Power)
4) Above 3000 m (10000 ft), set Supercharger Lever from first gear to second gear (from AFT to FWD)
5) Above 3000 m (1000 ft), Open Oxygen Shutoff Valve and regulate oxygen with the Aneroid Capsule Hand Wheel



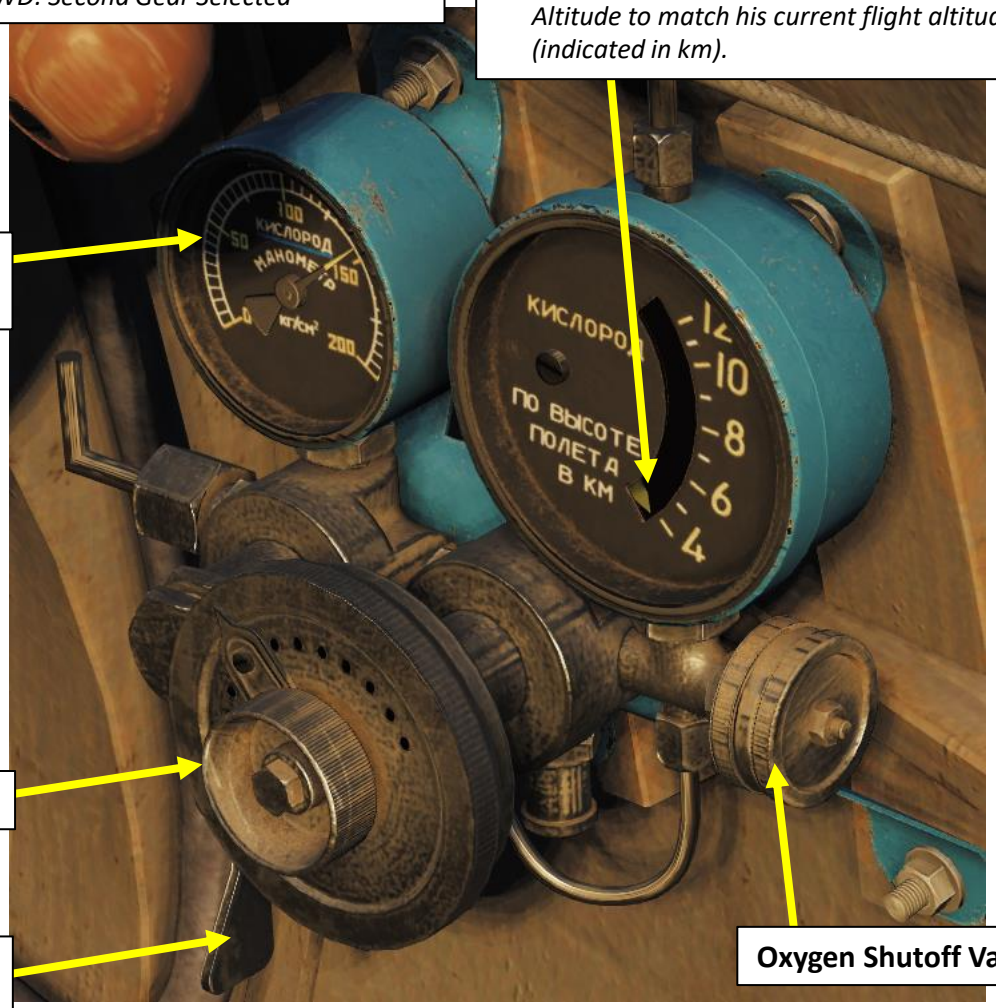
Supercharger Control Lever
AFT: First Gear Selected
FWD: Second Gear Selected

Oxygen Flight Altitude Indicator

- *Oxygen density varies with altitude, therefore the early O_2 system of the I-16's unpressurized cockpit required the pilot to set his "Flight Altitude" manually. The O_2 system then adjusted the oxygen flow automatically to allow the pilot to breathe enough oxygen.*
- *The pilot adjusts the Emergency Oxygen Valve Control Lever to set the desired Oxygen Flight Altitude to match his current flight altitude (indicated in km).*

CRUISE CHECKS

1) Make sure you always keep a hand on your stick since there are no trim controls on the I-16
2) Adjust Manifold Pressure to 500 mm Hg (Best Economy Power Setting)
3) Adjust RPM control lever to 1800 Hg (Best Economy Power Setting)



Oxygen Pressure Indicator (Manometer) (kg/cm²)

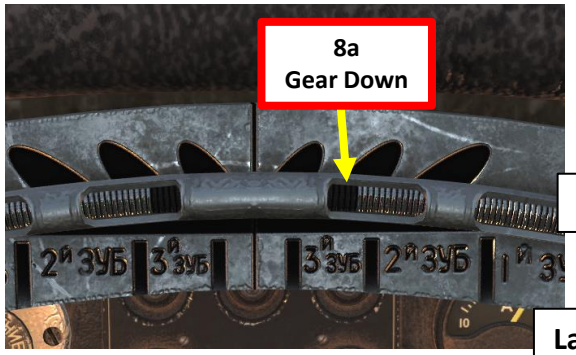
Aneroid Capsule Hand Wheel

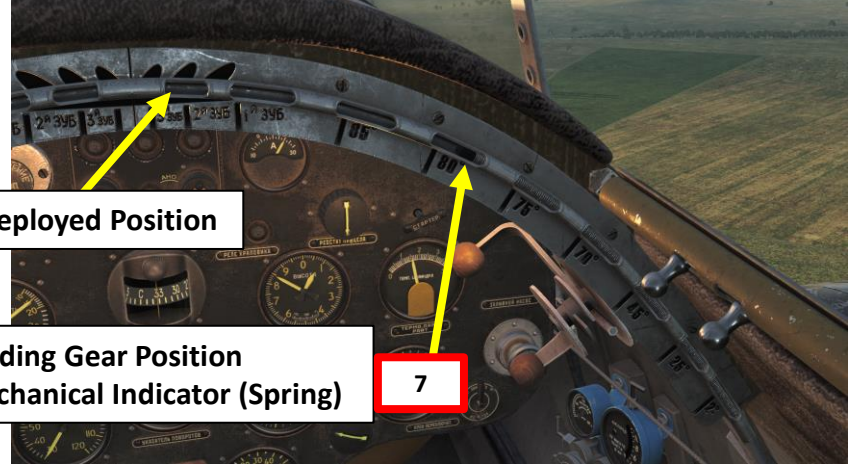
Emergency Oxygen Valve Control Lever

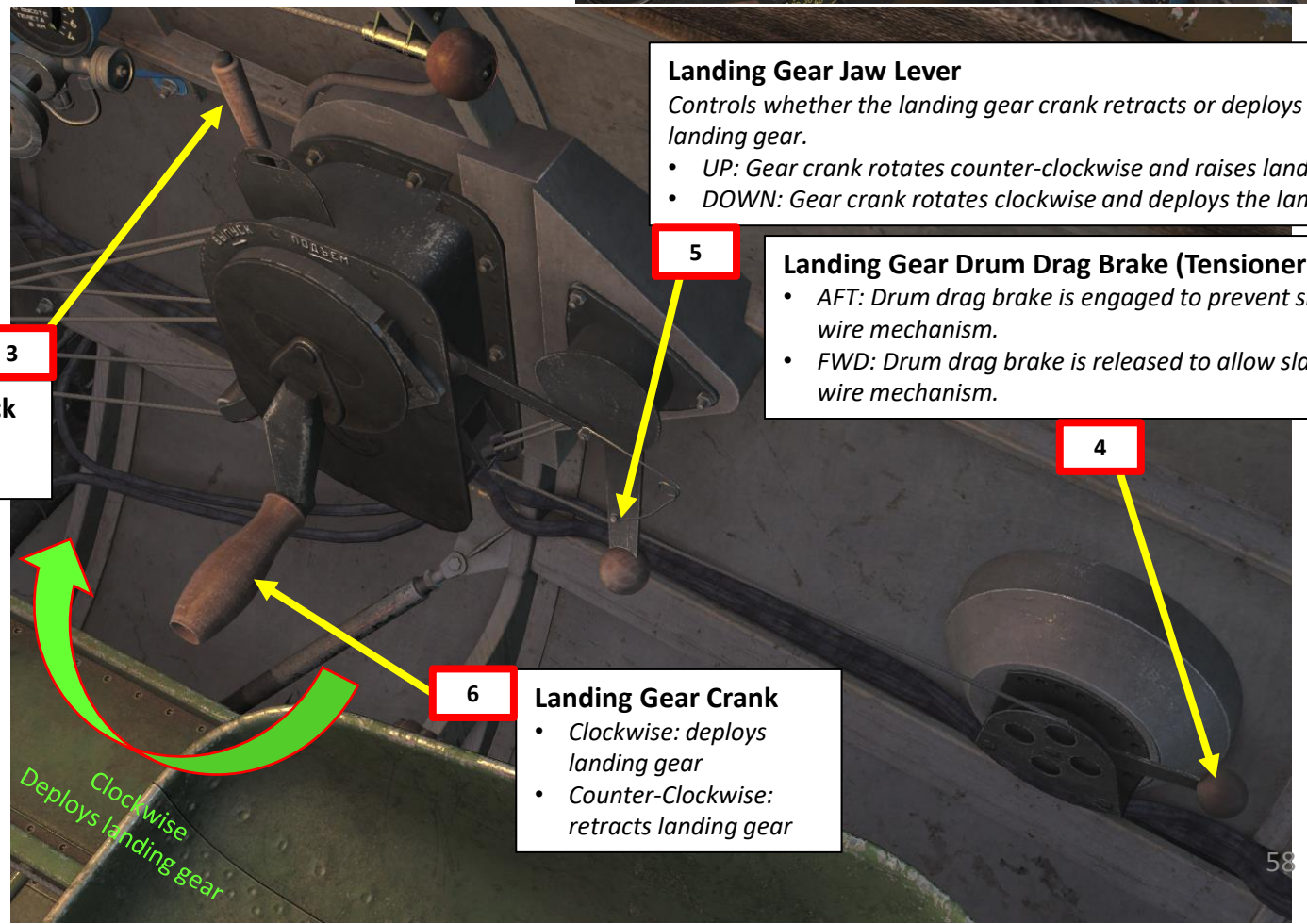
Oxygen Shutoff Valve

LANDING PROCEDURE

1) Ensure RPM Control lever is fully forward and Engine Cowl Louvres and Oil Radiator Flaps are fully closed (AFT) to prevent overcooling of the engine
2) Reduce throttle to maintain an airspeed of 200 km/h or below (180-200 km/h range) to ensure the landing gear deployment will not be hampered by the speed of the air stream.
3) Ensure Emergency Gear Lock is FWD (Unlocked)
4) Landing Gear Drum Drag Brake (Tensioner) Lever – AFT (Engaged)
5) Landing Gear Jaw Lever – DOWN (Gear crank rotation will deploy the landing gear)
6) Turn Landing Gear Crank clockwise (hold "LSHIFT+G" binding) for 43 rotations. Make sure you are at least 60 seconds away from the airport when you start deploying the undercarriage: it's a long process.
7) Monitor the position of the landing gear
8) Once landing gear is down, set Emergency Gear Lock Lever – AFT (Locked)

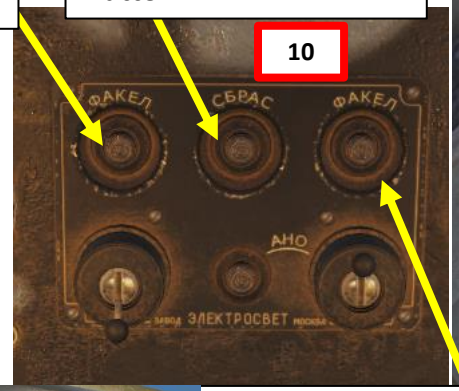


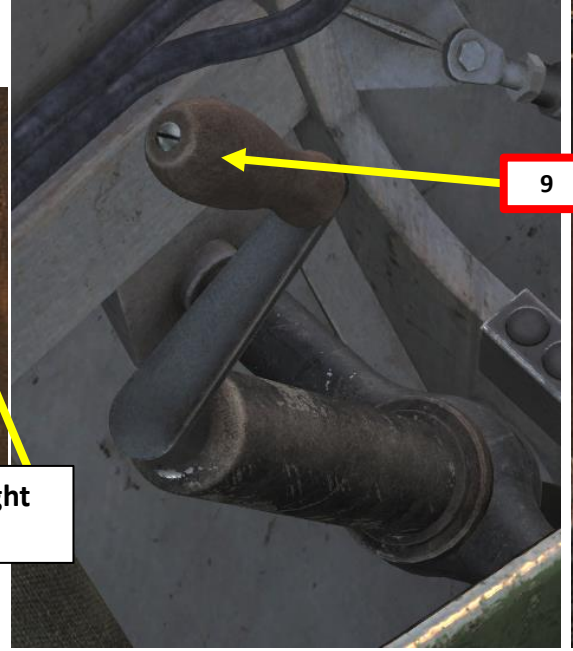


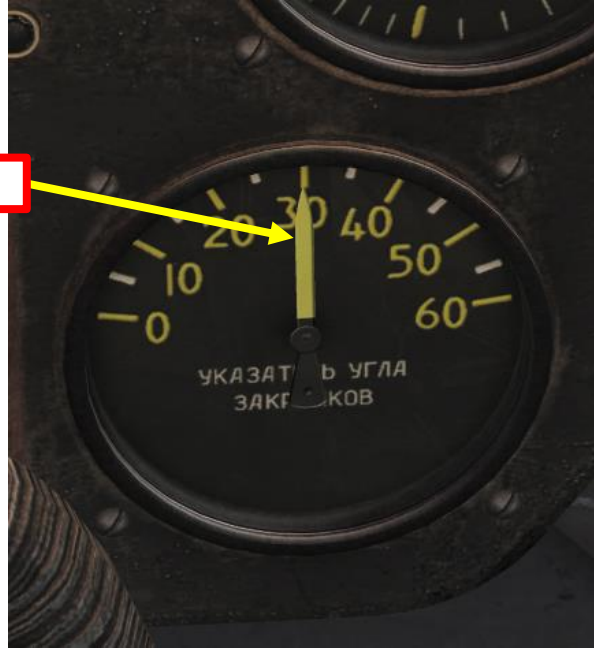


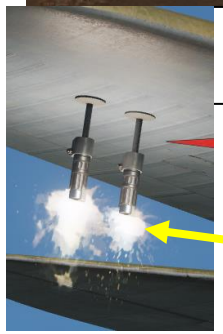
LANDING PROCEDURE

9) Deploy flaps as required. 30 deg of flaps will reduce the aft stick force required to stay level, but many pilots land with flaps fully retracted to avoid bouncing during touchdown. Flap setting recommendations vary from source to source.
10) You can use your landing torches to illuminate the runway, but make sure they are equipped via the mission editor
11) Aim for a 140 km/h speed on touchdown. Make sure you land with a three-pointer attitude and touch the ground as smoothly as possible. Don't hesitate to extend your landing to make sure the aircraft wheels barely graze the runway as you slow down.
12) Once on the ground and decelerating, pull your stick fully aft and use minimal rudder inputs since your tailwheel is mechanically linked to your tailwheel.
13) The aircraft should be able to slow down by itself without having to apply much brake pressure





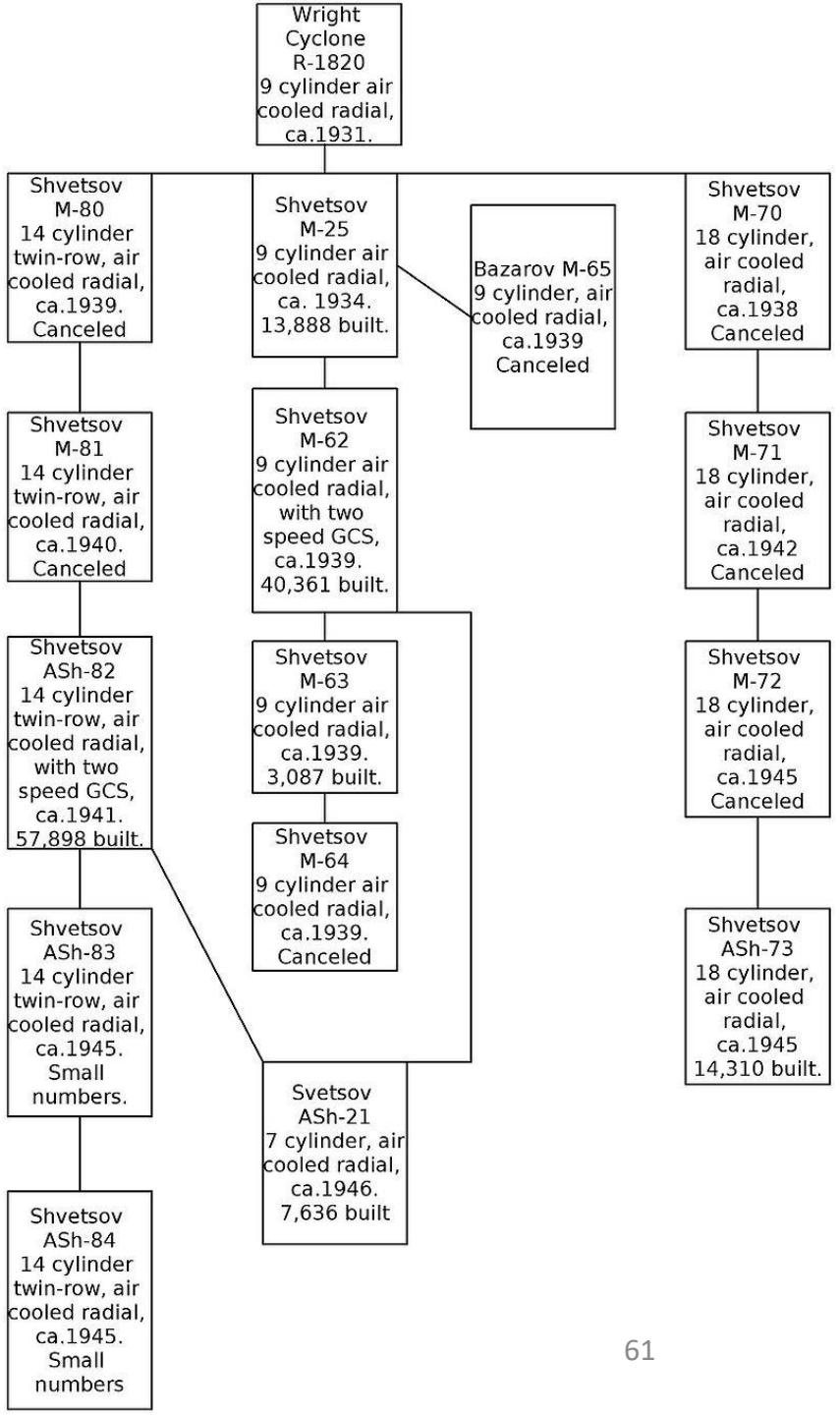




SHVETSOV M-63 ENGINE

The I-16 Series 24 is powered by a Shvetsov M-63 nine-cylinder, air-cooled radial engine.

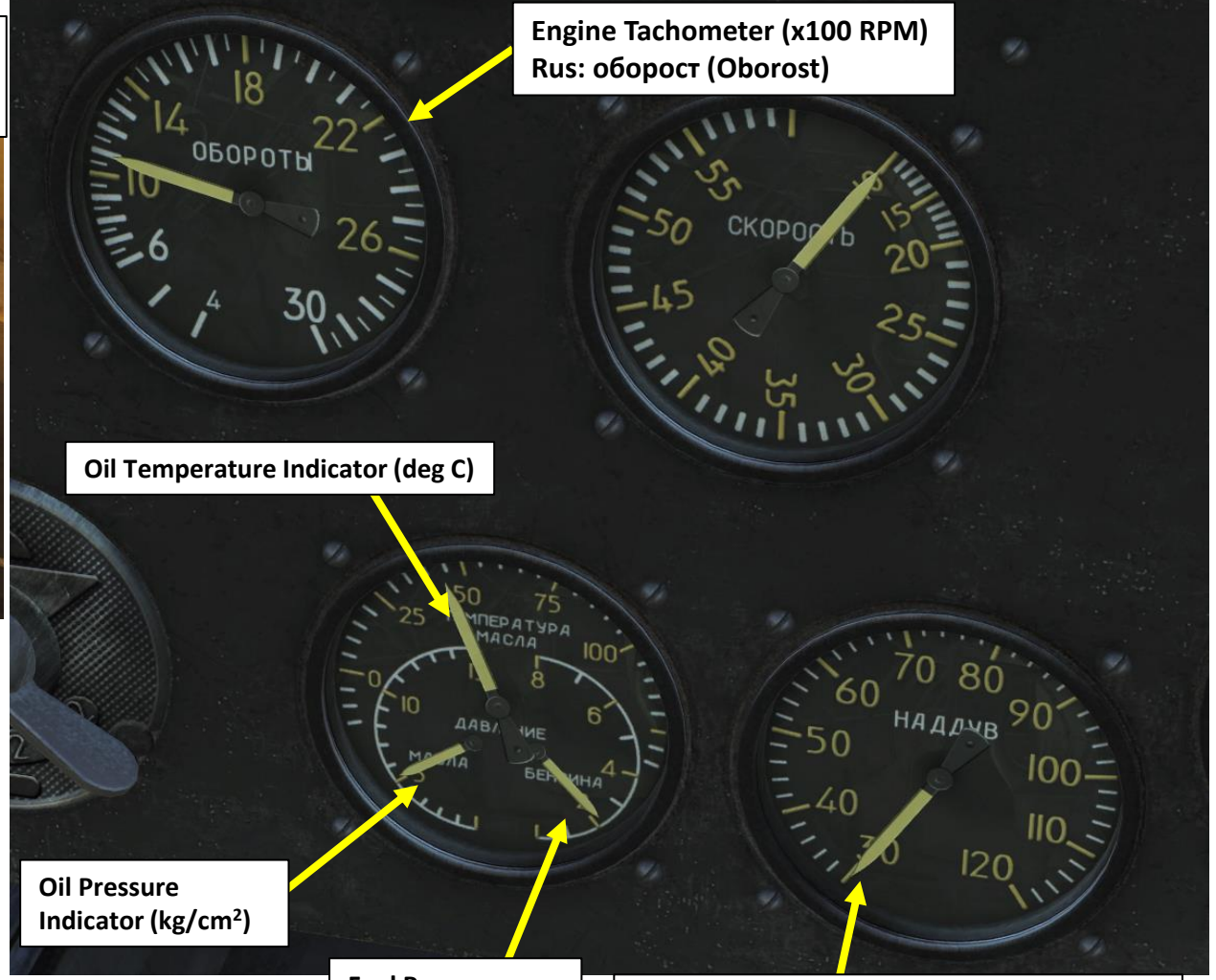
The ASh-62 (designated M-62 before 1941) was a development of the Wright R-1820 Cyclone that had been built in Russia under licence as the Shvetsov M-25, the main improvements including a two-speed supercharger and a more efficient induction system. Power was increased from the Cyclone's 775 hp to 1,000 hp. First run in 1937, licensed versions are still in production by WSK "PZL-Kalisz" in Poland (as of 2017). The M-63 installed on the Series 24 was an improved version of the M-62 with the power output increased to 821 kW (1,100 hp) at 2,300 rpm for takeoff and 671 kW (900 hp) at 2,200 rpm at 4,500 m (14,764 ft) due to a higher compression ratio of 7.2:1 and a higher redline.



CHT (Cylinder Head Temperature) Indicator (x100 deg C)

Engine Cowl Louvres Control Lever
Fwd: Open
Aft: Closed

Engine Oil Cooler Control Lever
Fwd: Open
Aft: Closed



Engine Tachometer (x100 RPM)
Rus: оборост (Oborost)

Oil Temperature Indicator (deg C)

Oil Pressure Indicator (kg/cm²)

Fuel Pressure Indicator (kg/cm²)

Manifold Pressure Indicator (x10 mm Hg)
Rus: надув (Nadub)

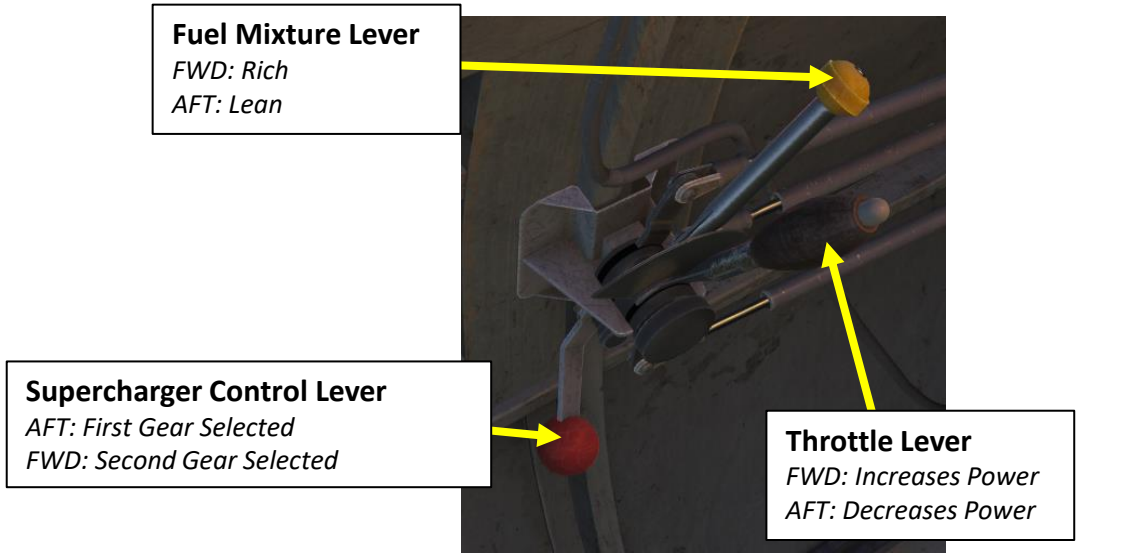
The I-16 had manual engine cowl louvre and oil radiator controls. One of the challenges of operating an air-cooled radial engine is to ensure that it does not overheat and that it does not overcool either. This is why the oil temperature, oil pressure and CHT (Cylinder Head Temperature) gauges must be within safe parameters at all times. Scan your instrument panel regularly. The engine limitations are listed in the table on the next page.

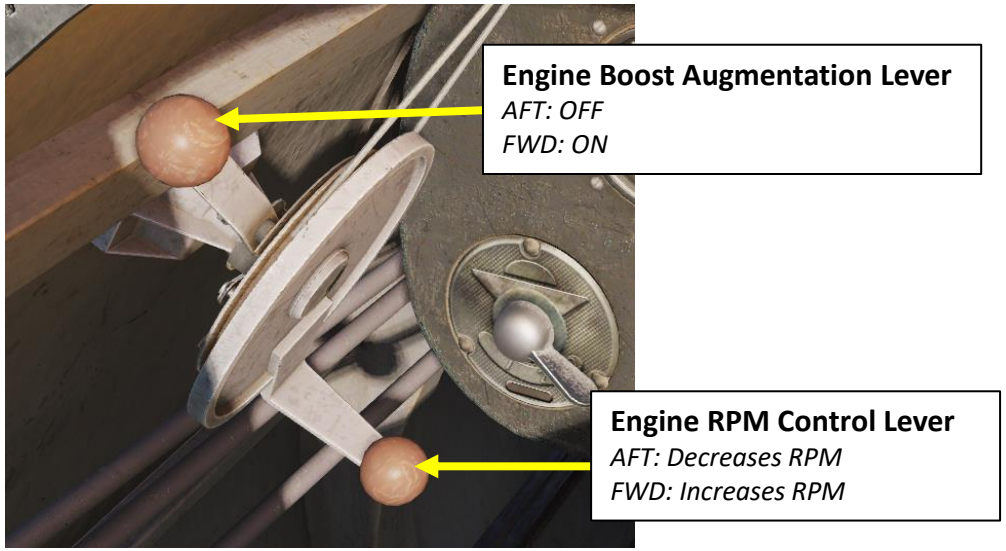
If engine overheats, you can:

1. Enter a dive to increase airspeed and airflow to the engine intake.
2. Reduce throttle and RPM
3. Decrease rate of climb
4. Open up the engine cowl louvres and oil radiator flaps

CHECK YOUR ENGINE TEMPERATURES EVERY 30 SECONDS OR SO. IT WILL SAVE YOUR LIFE.

Take note that there is an "Boost Augmentation" lever, which can be considered as a WEP (War Emergency Power) control. It basically increases the manifold pressure to provide additional power in emergency situations. **DO NOT use the Boost Augmentation for more than 5 minutes.**





ENGINE LIMITATIONS

Power Setting	RPM	Manifold Pressure (mm Hg)
Best Economy Power	1800	500
MCP (Maximum Continuous Power)	2200	-
Take-Off (4 minutes)	2300	-
Emergency Power (5 minutes)	2300	910+ Do not stay above 910 for more than 5 minutes
30-Second Power / Overspeed (30 sec)	2350	-
Oil Temperature (deg C)	• Normal Range: 60-75 deg C • Always keep below 85 deg C (max 3 minutes at 85 deg C)	
CHT (Cylinder Head Temperature) (deg C)	• Always keep above 120 deg C • On Takeoff: Do not exceed 235 deg C for more than 5 minutes • Normal operation: Do not exceed 235 deg C for more than 15 minutes	

SUPERCHARGER BASICS

A **supercharger is an engine-driven air pump or compressor that provides compressed air to the engine to provide additional pressure to the induction air so the engine can produce additional power.** It increases manifold pressure and forces the fuel/air mixture into the cylinders. The higher the manifold pressure, the more dense the fuel/air mixture, and the more power an engine can produce.

With a normally aspirated engine, it is not possible to have manifold pressure higher than the existing atmospheric pressure. A supercharger is capable of boosting manifold pressure above 30 "Hg (762 mm Hg). For example, at 3000 m (10000 ft) a typical engine may be able to produce 75 percent of the power it could produce at mean sea level (MSL) because **the air is less dense at the higher altitude**. The supercharger compresses the air to a higher density allowing a supercharged engine to produce the same manifold pressure at higher altitudes as it could produce at sea level.

Thus, an engine at 3000 m MSL could still produce 25” Hg (635 mm Hg) of manifold pressure whereas without a supercharger it could produce only 22 "Hg (558 mm Hg). Superchargers are especially valuable at high altitudes (such as 18,000 feet, or approx. 5.5 km) where the air density is 50 percent that of sea level. The use of a supercharger in many cases will supply air to the engine at the same density it did at sea level. With a normally aspirated engine, it is not possible to have manifold pressure higher than the existing atmospheric pressure.

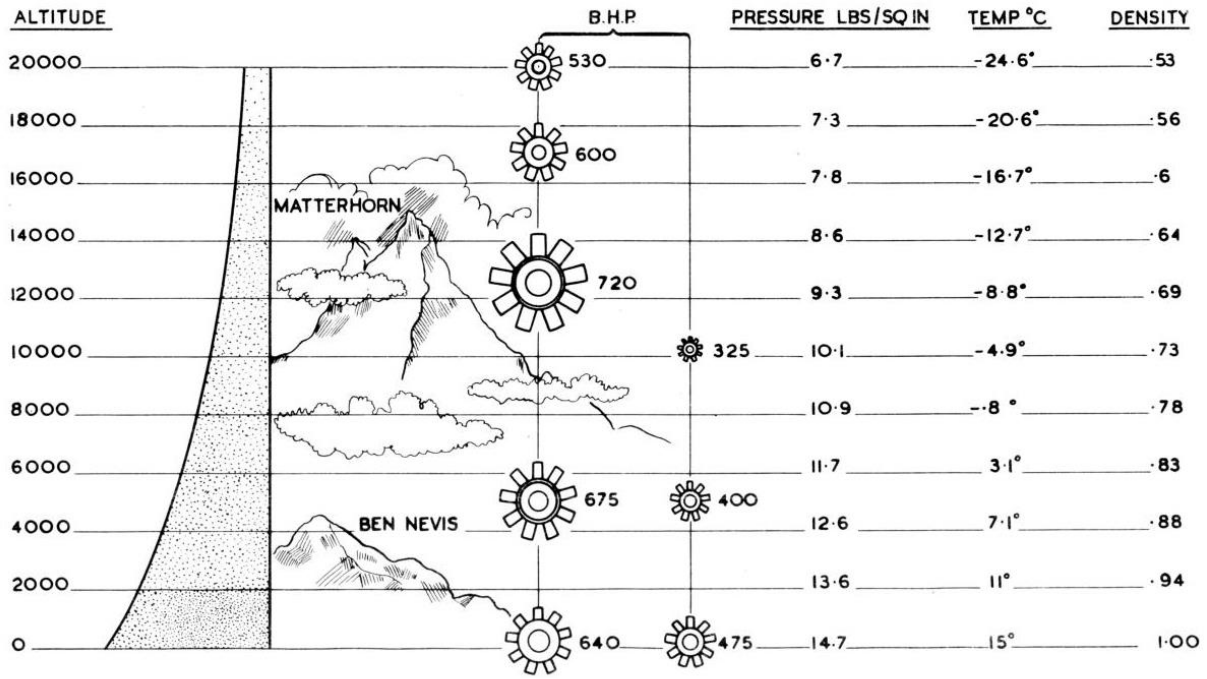
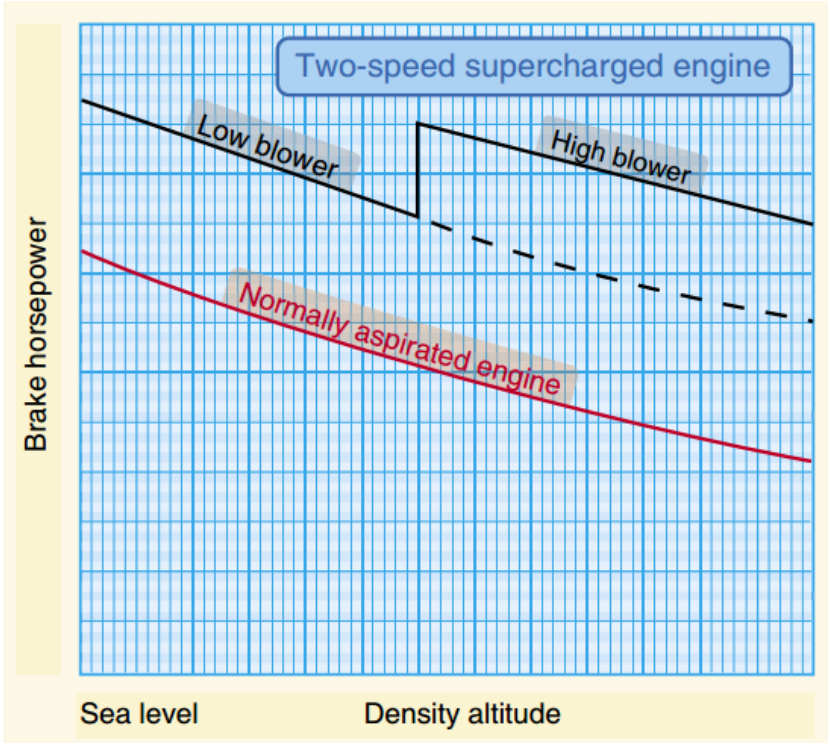


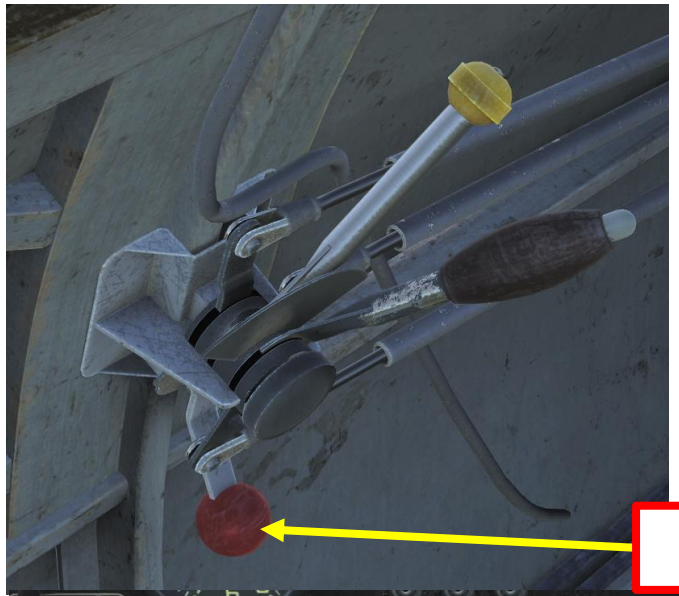
DIAGRAM SHOWING ATMOSPHERIC AND POWER VARIATIONS



SUPERCHARGER OPERATION

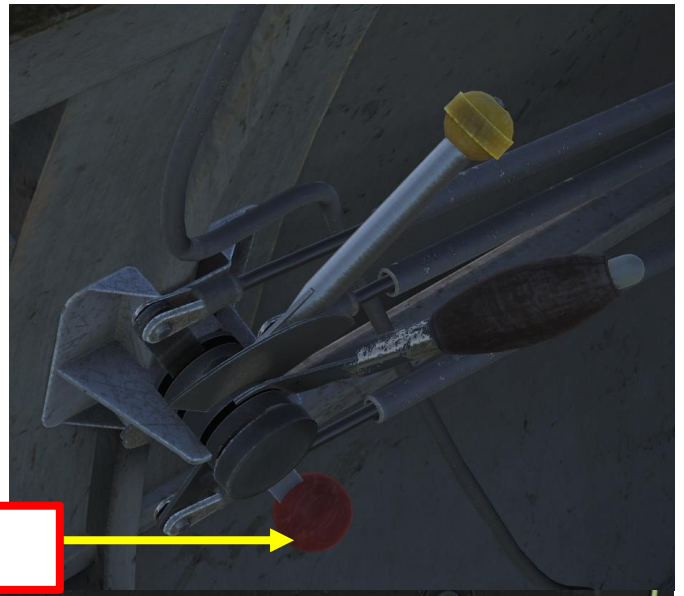
- **FIRST GEAR = LOW BLOWER = LOW MANIFOLD PRESSURE = USED BETWEEN 0 AND 3000 M.**
- **SECOND GEAR = HIGH BLOWER = HIGH MANIFOLD PRESSURE = USED AT 3000 M OR HIGHER.**

- The gear-driven supercharger mounted on the Shvetsov engine has a two-stage compressor that raises air pressure at the entrance to the engine cylinders in order to increase both the coefficient of admission and engine power, as well as to maintain a constant air pressure at the entrance to the cylinders during increases in altitude. The supercharger works in either low or high blower mode, selection of which is manually set by the pilot.



SUPERCHARGER IN FIRST GEAR
ALTITUDE: 3000 M

SUPERCHARGER IN SECOND GEAR
ALTITUDE: 3000 M



MANIFOLD PRESSURE INCREASE

FUEL SYSTEM OVERVIEW

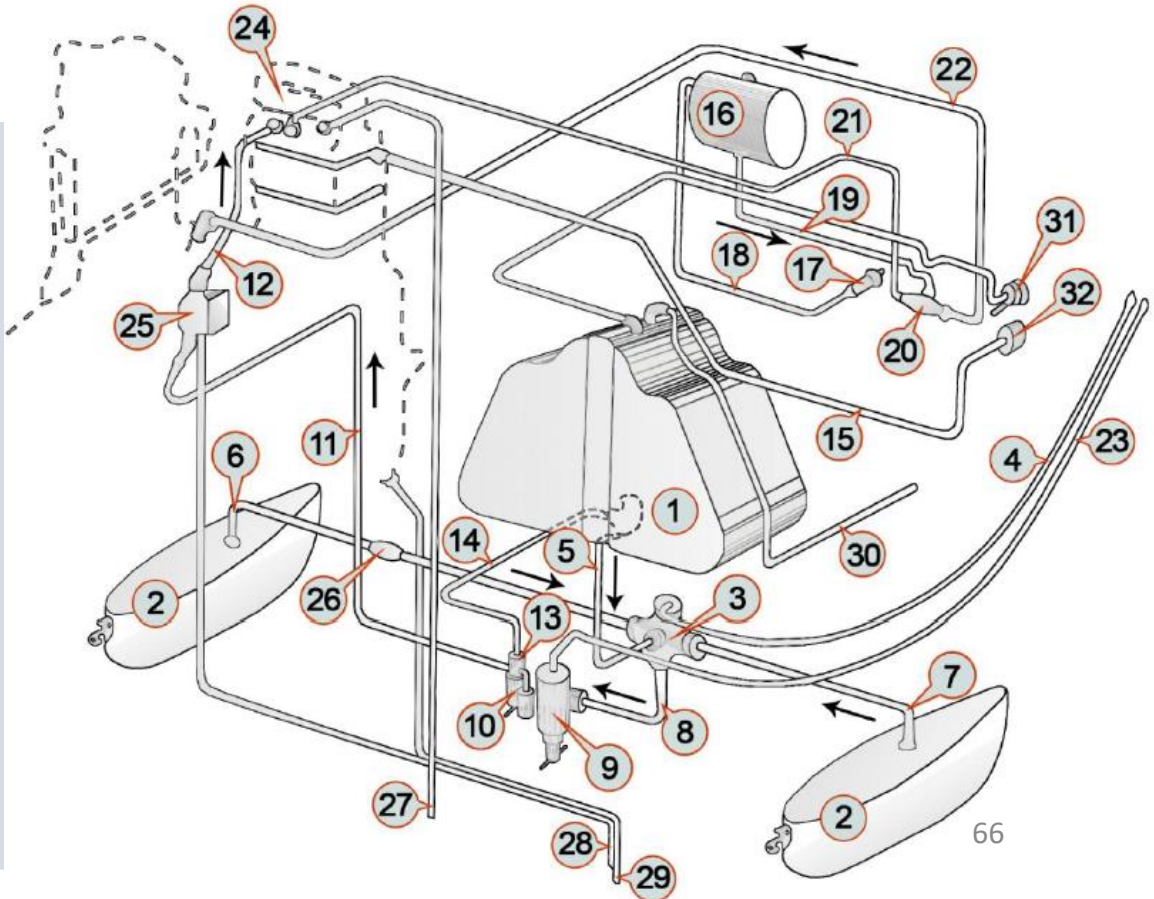
The aircraft is equipped with one fuselage fuel tank. A tank with a capacity of 260 liters, covered with a protector, is installed between frames No. 1 and 4 of the fuselages (behind the pilot's dashboard).

If necessary, two external fuel tanks with a capacity of 93 liters each can be added. At the same time, the fuel is first consumed from the suspended gas tanks, then from the central one. Tanks are switched manually from the cockpit.

When the engine is started, fuel is supplied under the pressure from a special 4-liter filler tank, which is located in the upper part of the fuselage behind the gasoline tank. The pressure in the reservoir is created manually by an air pump located on the right side of the instrument panel. The tank's pressure created by the pump makes it possible to fill the carburetor and engine before starting through a three-way valve.

Float-Type Fuel Quantity Indicator (x10 kg)

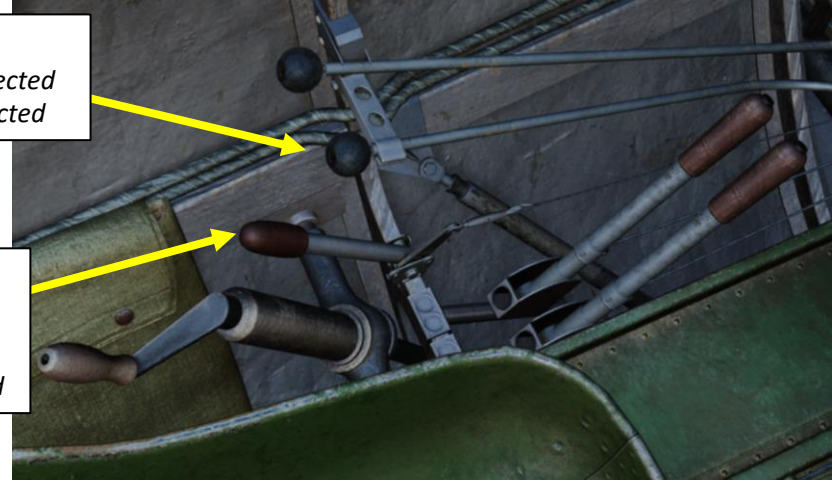
1. Central fuel tank;
2. Hanging tanks;
3. Manifold;
4. Manifold control rod;
5-7. Gas pipelines that are connecting fuel tanks to a manifold;
8. Fuel line from the manifold to the fuel filter;
9. Fuel filter;
10. Fuel fire shutoff handle;
11 The pipeline between the fuel fire shutoff handle and the gas pump;
12. The pipeline from the fuel pump to the carburetor;
13. Fuel drain cock from the central tank;
14. Fuel drain line from the central tank;
15. Fuel pressure gauge pipeline;
16. Filling tank;
17. Air pump for pressurizing the filling tank;
18. The tube connecting the air pump to the filler tank;
19. Fuel supply line from the filler tank to the three-way tap;
20. Three-way tap;
21. The gas line that connects the filler tank with the carburetor;
22. The gas line that connects the filler tank with the engine;
23. Flexible control rod for fuel fire shutoff handle;
24. Carburetor;
25. Fuel pump;
26. Connections of the aircraft fuel line with the external fuel tanks;
27. Carburetor's fuel drain pipe;
28. Fuel pump's drain pipe;
29. Crankcase drain pipe;
30. Drainage tube of the central tank;
31. Fuel remaining indicator (gas meter);
32. Fuel pressure indicator (three-pointer indicator).

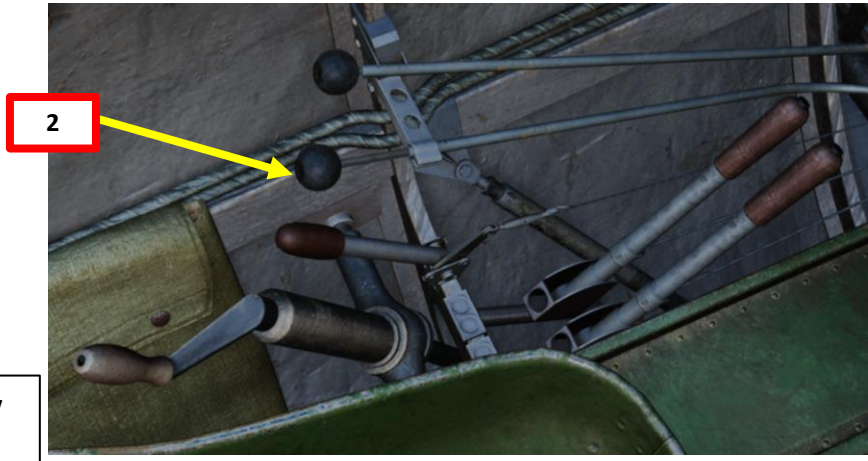


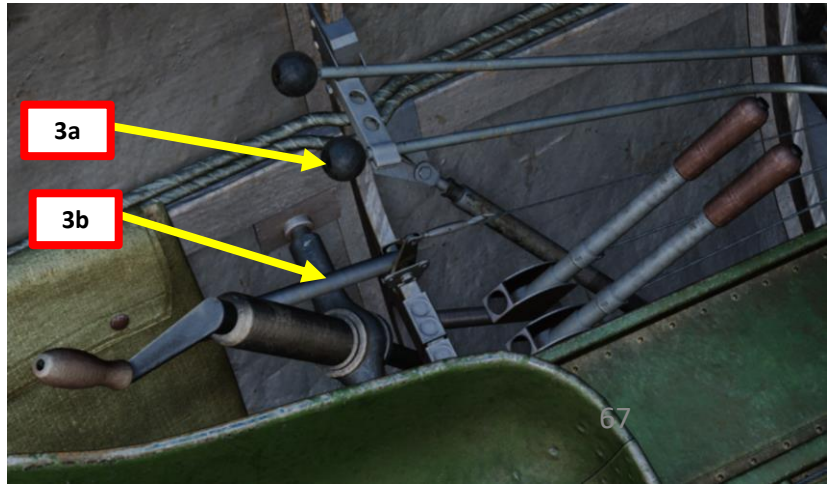
EXTERNAL FUEL TANK OPERATION

- The I-16 can equip two external fuel tanks of 93 Liters each.
- There is no external fuel tank quantity indicator. You know the tanks are dry once the engine starts running rough.

1. To consume fuel from the inner fuel tanks, set Fuel Tank Selector Lever FWD.
2. To consume fuel from the external drop tanks, set Fuel Tank Selector Lever AFT.
3. To jettison external fuel tanks:
    a) Set Fuel Tank Selector Lever FWD to consume fuel from the inner tanks.
    b) Pull External Fuel Tank Jettison lever AFT.
    c) Once fuel tanks are jettisoned, push External Fuel Tank Jettison lever FWD.







The I-16 is a very nimble aircraft. Here are some important aspects to keep in mind when flying the Ishak:

- Fighting in the horizontal plane is the best way to increase your survivability. Most aircraft will outperform you in the vertical plane,
- Negative G maneuvers will starve the engine of fuel and cause it to cut out. Instead of performing negative G maneuvers, perform a Split S instead.
- The absence of trim controls will force you to keep a steady hand on your controls at all times.
- Spins are vicious in the I-16 but easy to recover from using standard spin recovery techniques.

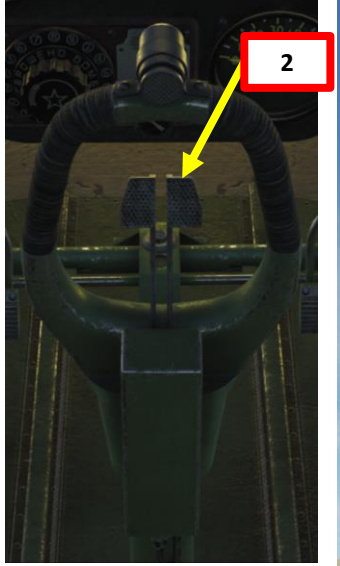
Aerodynamic Data	
Maximum Speed	525 km/h at 3000 m
Range	700 km (378 nm)
Service Ceiling	9700 m (31,800 ft)
Maximum Rate of Climb	14.7 m/s (2,890 ft/min)
Time to Altitude	5,000 m (16,000 ft) in 5 minutes 48 sec
Optimal Glide Speed	185-195 km/h

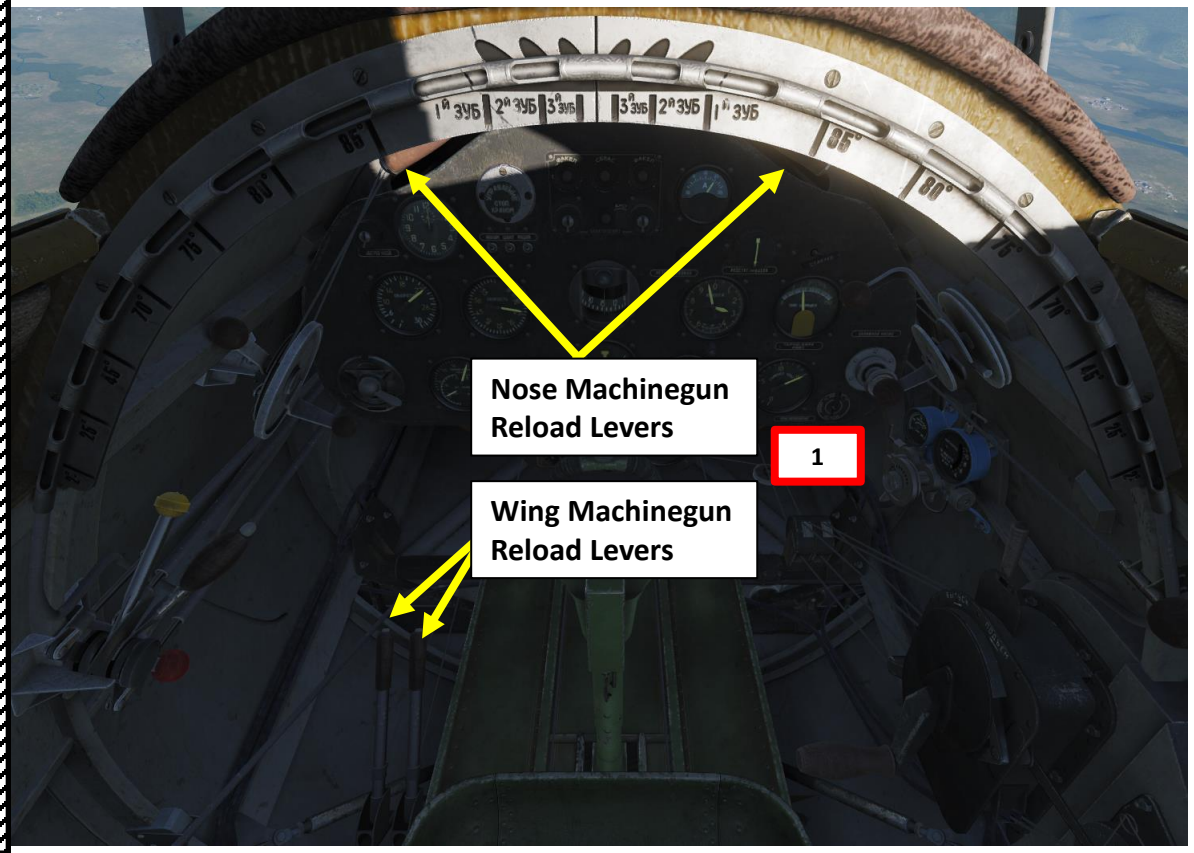
ARMAMENT OVERVIEW

- 4 x ShKAS 7.62 mm Machineguns
  - Wing guns: 2 x 900 rounds
  - Nose guns: 2 x 500 rounds
- 6 x RS-82 Rockets
- 2 x FAB-100SV (100 kg) Bombs

WEAPON EMPLOYMENT (MACHINEGUNS)

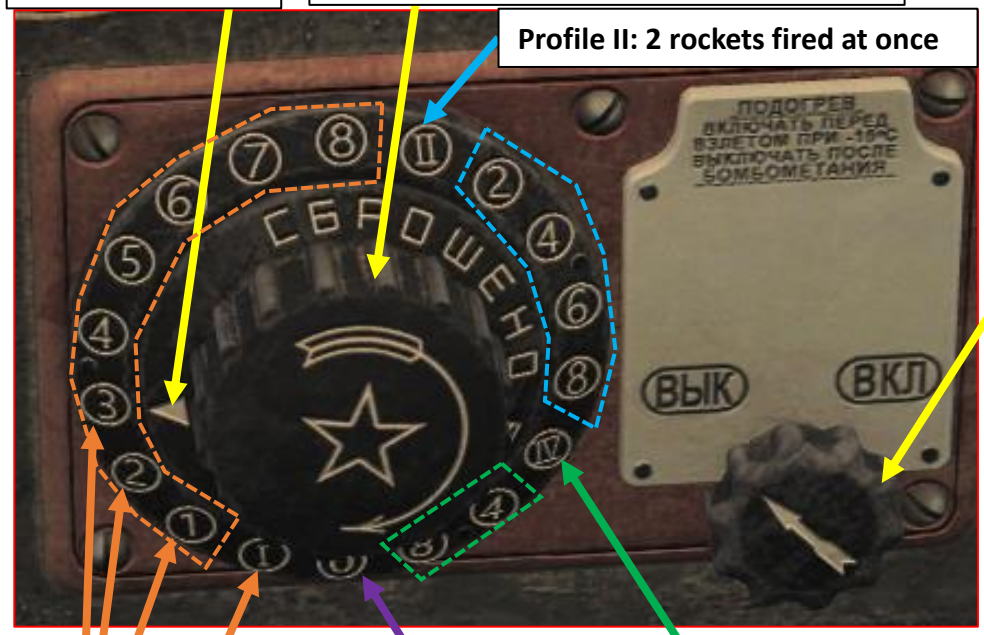
1. Reload nose cannons and wing cannons by pulling the reload levers
2. Fire by using the “CANNON FIRE” button (SPACEBAR key) .



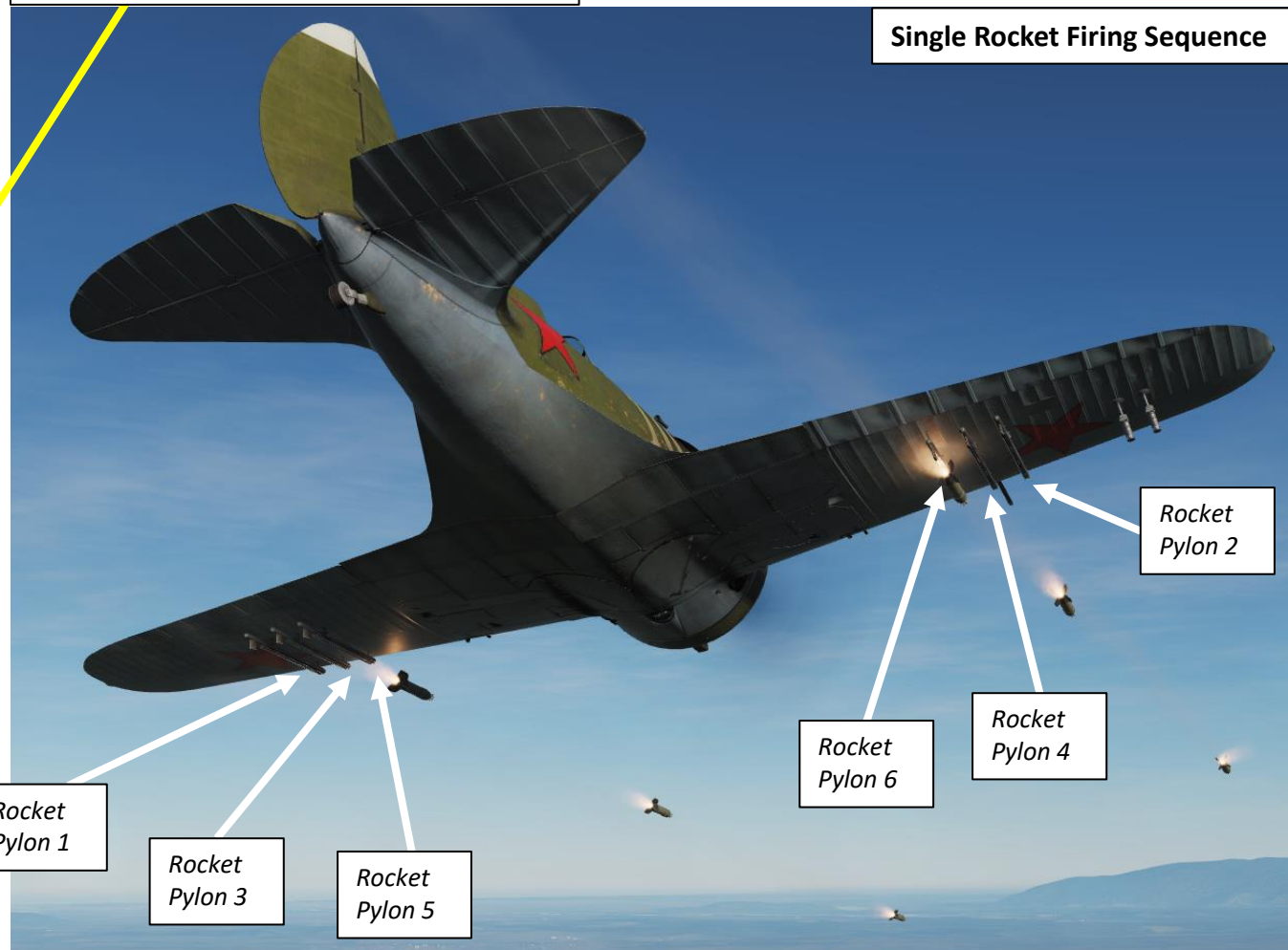


WEAPON EMPLOYMENT (ROCKETS)

1. Set Armament Selector Switch to the Right position (*ВКЛ/ON)*
2. Select desired rocket release profile (either I, II, or IV)
3. Fire by using the “WEAPONS RELEASE” button (RALT + SPACEBAR binding)



Armament Selector Switch
- *Left (ВЫКЛ/OFF): Safety ON*
- *Right (ВКЛ/ON): Safety OFF (Rockets Armed)*



Each time the Weapons Release button is pressed, the selector indicator increments clockwise. These arabic numerals can be seen as the number off rockets or bombs expended so far. Roman numerals represent “release profiles” (i.e. how many bombs/rockets are fired per Weapons Release button press.

As an example, setting your Selector Indicator triangle to “I” and then firing a rocket will fire a single rocket. The Selector will then automatically go to “1”, which means one rocket has been fired. If you fire another rocket, the Selector will go to “2”, meaning two rockets have been fired.

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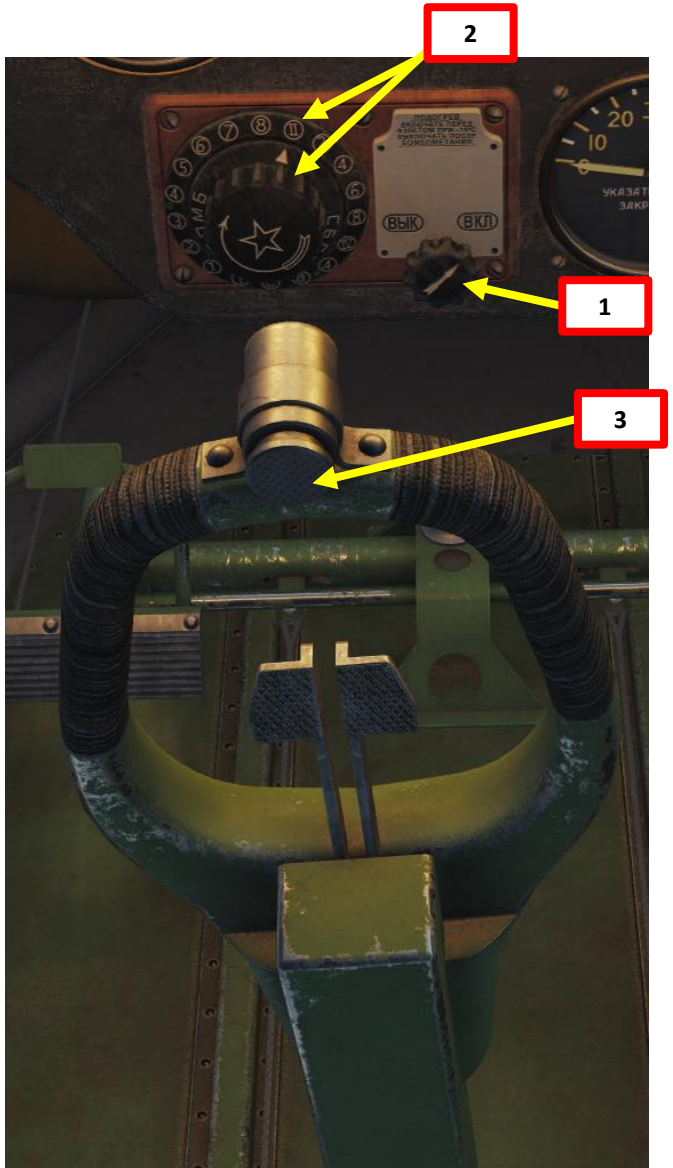
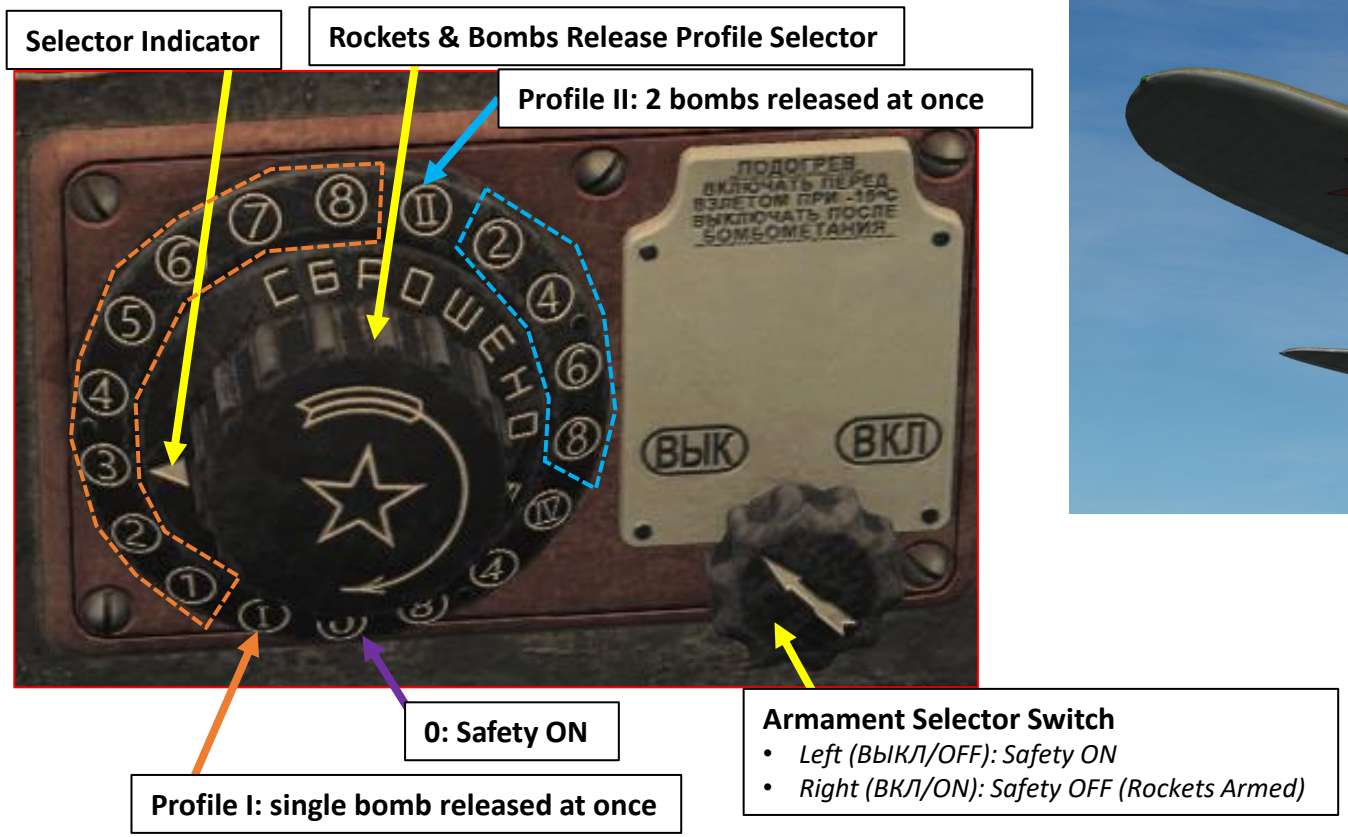


WEAPON EMPLOYMENT (BOMBS)

1. Set Armament Selector Switch to the Right position (*ВКЛ/ON)*
2. Select desired rocket release profile
   a) Either “I” (single drop) or “II” (dual drop) if only bombs are equipped
   b) “6” if both bombs and rockets are equipped.
      - If “6” is selected in the “Profile I” section, this profile will drop a single bomb first.
      - If “6” is selected in the “Profile II” section, this profile will drop both bombs first.
      - After bombs are away, you have to manually move the selector back to starting position in order to fire the rockets.
3. Fire by using the “WEAPONS RELEASE” button (RALT + SPACEBAR binding)



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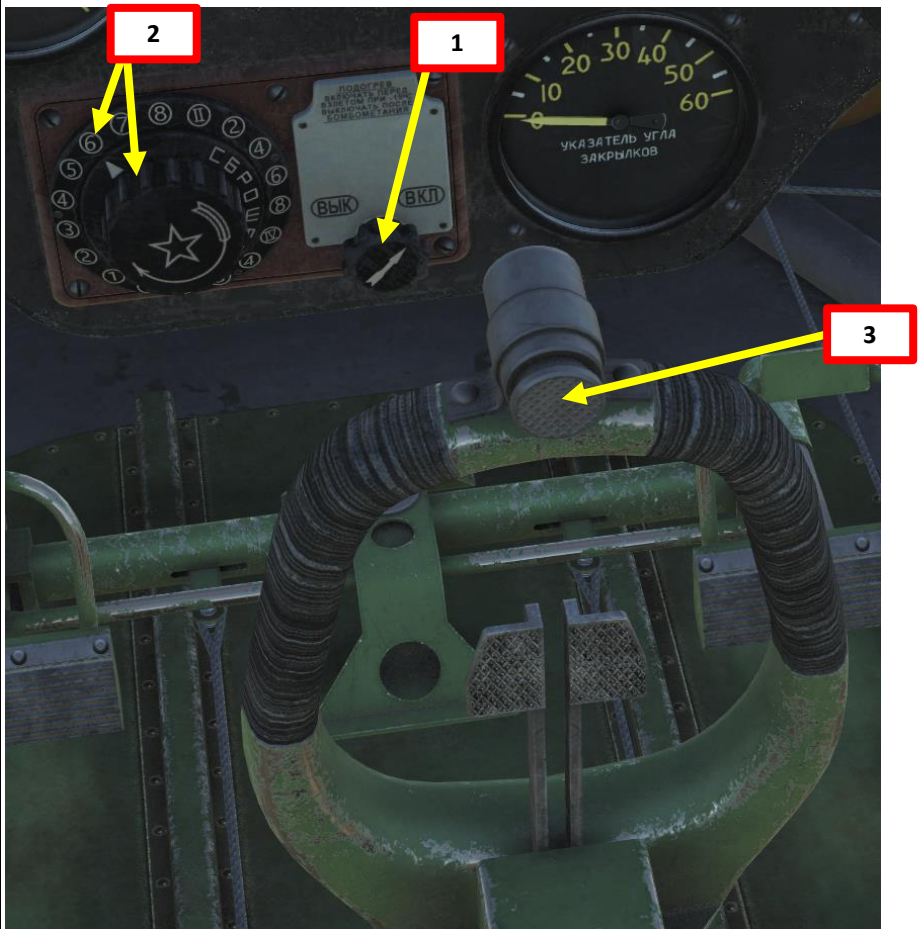

Taming taildraggers is much more difficult than meets the eye, especially during the takeoff and landing phase. Here is a useful and insightful essay on the art of flying taildraggers wonderfully written by *Chief Instructor*. I highly recommend you give it a read.

Link: https://drive.google.com/open?id=0B-uSpZROuEd3V3Jkd2pfa0xRRW8

TAMING TAILDRAGGERS

Essay by Chief Instructor (CFI)

PART 1

Why taildraggers are tricky and how to overcome it

What do I know about it? Well, I have spent a significant proportion of my professional flying career teaching both experienced and novice pilots how to fly and handle tail-dragging aircraft. This amounts to several thousand hours of tailwheel training alone, though who's counting! These aircraft include among them modern high performance aerobatic aircraft and a variety of more vintage types from DH Tiger Moths, to Harvards. I can't recall off the top of my head exactly how many students I've worked with over the years, but it's well over 200! Best of all, they have all gone on to fly extensive tailwheel ops in a variety of types and to the best of my knowledge, only 2 of them have crashed anything since!

As a significant number of pilots here are expressing difficulties with tailwheel handling,

RESOURCES

I-16 TECHNICAL DESCRIPTION
http://www.airpages.ru/po/i16_08.shtml
http://www.airpages.ru/po/i16_fuel.shtml
http://www.airpages.ru/po/i16_oil.shtml
http://www.airpages.ru/po/i16_9.shtml
http://www.airpages.ru/po/i16_010.shtml

MYRIAD RESEARCH - TEST PILOT DAVE MORSS
http://www.ksql.com/myriad/warbirds_poly.htm

OCTOPUSG QUICK GUIDE
https://drive.google.com/open?id=19wvNzHXv4UkN7V6Qu_aJ4c_YpDNnChxa

AIR COMBAT LIBRARY – LEARN TO FLY THE IL-2 BATTLE OF MOSCOW I-16 SERIES 24
https://youtu.be/U9VLCERaCvk

GRIM REAPERS – I-16 ISHAK TUTORIAL PLAYLIST
https://www.youtube.com/watch?v=Vxxt8bi8_bQ&list=PL3kOAM2N1YJcS0_JWEcUOq6-ARHK8yZHG

IL-2 BATTLE OF MOSCOW – I-16 DOCUMENTARY
https://youtu.be/-Ah8PtBnHO8

I-16 FIGHTER PLANE DOCUMENTARY – WEAPONS OF VICTORY
https://youtu.be/cL8BYAY_9d8


digital combat series
19
Chuck_Owl
OctopusG
INSTANT ACTION
CREATE FAST MISSION
MISSION
CAMPAIGN
MULTIPLAYER
LOGBOOK
ENCYCLOPEDIA
TRAINING
REPLAY
MISSION EDITOR
CAMPAIGN BUILDER
EXIT
AV8BNA
2.5.x Dev
Bf 109 K-4
C-101
CA
Caucasus
China Asset Pack
Christen Eagle II
DCS-SRS
2.0.7.1
F-14B
EA
F-16C
EA
F-5E
F-86F
F/A-18C
EA
FC3
Fw 190 A-8
Fw 190 D-9
I-16
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