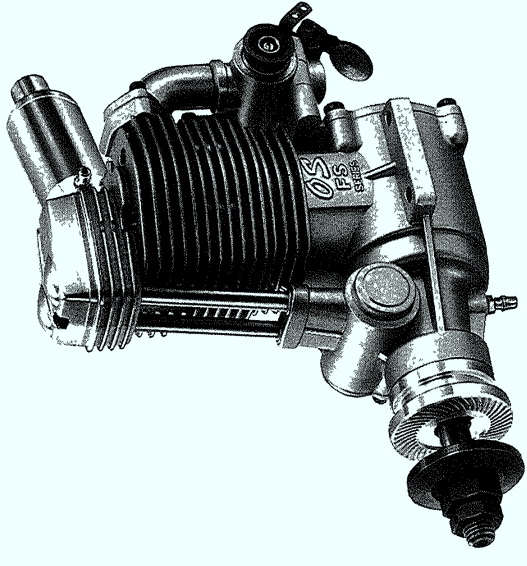


INSTRUCTIONS FOR O.S. FS-91 SURPASS FOUR STROKE CYCLE ENGINE



SPECIFICATIONS

Displacement	14.96 cc (0.913 cu. in.)
Bore	27.7 mm (1.091 in.)
Stroke	24.8 mm (0.976 in.)
Practical R.P.M.	2,000 ~ 11,000 r.p.m.
Output	1.6 BHP/11,000 r.p.m.
Weight	630 g (22.2 oz.)

FUEL TANK

The suggested fuel tank size is 320cc or 12 oz. This will give approximately 12 minutes running time when some part-throttle operation is included. Locate the fuel tank so that the centre line of the tank is 10 to 15mm below the centre line of the needle-valve.

Note: If the model is left unattended with the fuel tank filled, fuel may flow into the carburettor, causing it to "flood" and making the engine difficult to start. Take appropriate action to prevent this.

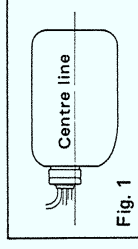


Fig. 1

FUEL

The FS-91 Surpass runs on standard commercially available model glowplug engine fuel. Fuels containing castor-oil and/or synthetic lubricants are acceptable, but for the best performance and reliability, a fuel containing 5 - 15% nitromethane is recommended.

For consistent performance and long engine life, it is advisable to use good quality fuel containing 16 to 20% lubricant.

(The carburettor is adjusted with a fuel containing 20% lubricant when the engine leaves the factory.)

GLOWPLUG

An O.S. Type "F" glowplug is fitted to the engine.

With a four-stroke engine, ignition of the fuel charge takes place at every fourth stroke of the piston instead of every second stroke. Because of this, some conventional two-stroke glowplugs will not suit this engine. For general use, the special O.S. Type F glowplug is recommended.

PROPELLER

The choice of propeller depends on the design and weight of the model and on the type of flying envisaged. Determine the best size and type after practical experiment. As starting points, suggested propellers are listed below.

For stunt models	11x10, 11x11, 12x9½, 12x10, 12x11, 13x9
For scale models	13½x8, 14x7, 15x6, 16x6, 12x8 (3-blade), 12½x7 (3-blade)

IMPORTANT: Before attempting to operate your FS-91 Surpass, please read through these instructions so as to familiarize yourself with the controls and other features of the engine. Also, pay careful attention to the recommendations contained in the "Safety Instructions and Warnings" leaflet enclosed.

INSTALLATION

Use sturdy engine mounting beams: i.e. at least as strong as would be used for a two-stroke engine of 15cc, or greater, displacement. Make sure that these beams are firmly integrated with the airframe, reinforcing the internal surrounding structure as necessary to absorb vibration. Engine installation should be made in such a way that basic maintenance, including the checking and adjustment of valve clearances, can be conveniently carried out. As an aid to aligning the engine on its mounting beams, a simple mounting hole template is supplied with the engine.

As an alternative to horizontal beam mounting, a special O.S. radial motor mount is available, as an optional extra part, for use where firewall mounting is required.

SILENCER ASSEMBLY

Installation procedure is as follows.

1. Screw the exhaust header pipe into the exhaust port until it "bottoms", then unscrew it just sufficiently to achieve the required exhaust outlet angle. Secure the pipe in this position by tightening the locknut firmly against the cylinder head with the wrench supplied.
2. Screw the silencer onto the end of the header pipe and tighten locknut firmly.

Note: It is advisable to apply silicone sealant at the joints to prevent leakage of exhaust gas and loosening of nuts.

CARBURETTOR THROTTLE

The needle-valve and throttle lever locations are interchangeable by reversing the carburettor. This can be done as follows:

Remove the carburettor carefully by unscrewing the two screws which secure both carburettor and choke valve. (See Photo 1.) If it is still hard to remove the carburettor, loosen a little two screws which secure the intake pipe to the cylinder head.

After reversing the carburettor, re-insert it into the intake pipe gently, taking care not to damage the O-ring in the intake pipe by using force.

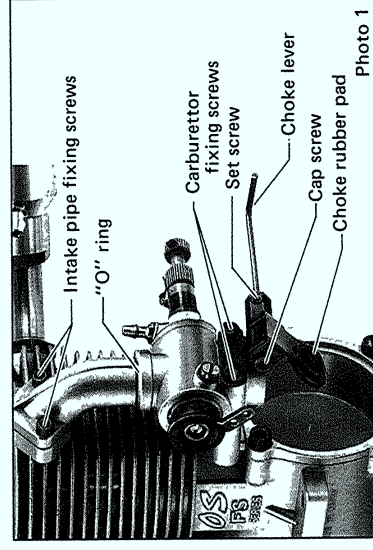


Photo 1

CHOKE VALVE

The FS-91 Surpass is equipped with a spring-loaded choke valve. The choke valve operating lever can be located right or left by transposing the hexagon nut and cap screw. After mounting the engine in the model, secure the L-shaped choke rod by tightening the set-screw. If the rod supplied is too long, reduce it to the required length. If the rod length is more than 40mm (1½ in.) its outer end should be supported to avoid vibration.

CARE AND MAINTENANCE

To ensure that you obtain long life and peak performance from your engine, observe the following.

1. Avoid running the engine under dusty conditions. If necessary, lay a sheet of plywood or hardboard in front and under the nose of the model when starting the engine.
2. Foreign matter in the fuel can cause the carburettor jet to be partially clogged. Therefore:
 - rinse out the fuel tank with methanol or fuel before installing it
 - fit a fuel filter in the fuel delivery tube between tank and carburettor
 - fit a fuel filter to the outlet of your squeeze bottle, or to the pump inlet if you use a manual or electric pump
 - do not leave your fuel container open needlessly
 - check filters periodically and clean them when necessary.
3. Do not leave raw fuel in the engine at the conclusion of a flying session: it may cause corrosion. The best practice is to disconnect the delivery tube from the carburettor while the engine is running. Remaining fuel in the tank should also be drained off.

IMPORTANT: After the engine has run dry, liberally inject corrosion-inhibiting oil or light machine oil into the crankcase, via the breather hole, until excess oil runs from behind the drive washer when the engine is pointed downwards. Rotate the crankshaft to distribute the oil to the bearings, etc. Failure to carry out this procedure may cause internal rusting, resulting in engine malfunction and voiding the warranty.

4. Clean the exterior of the engine with a clean cotton cloth. If this is not done, oil and dirt will burn onto the outside of the engine each time it is run and the engine will soon become blackened.
5. If the engine is not to be used for a while (more than two months) remove the glowplug and rinse out the interior with kerosene (not gasoline), by rotating the crankshaft. Shake out residue, then inject corrosion-inhibiting oil or light machine-oil through the exhaust pipe and breather hole, again rotating the shaft to distribute the protective oil to all working parts.
6. Avoid unnecessary dismantling of your engine.

remove the needle-valve holder from the carburettor, using the wrench supplied, and extract any remaining foreign matter that may have lodged in the location shown in Photo 3.

VALVE CLEARANCE ADJUSTMENT

Valve clearances are correctly set before any O.S. four-stroke engine leaves the factory and, in normal use, will seldom require adjustment. However, if, after a considerable amount of running time has accumulated, a loss of power is detected, or if the engine has to be disassembled or repaired as a result of a crash, valve clearances should be checked and readjusted as necessary. For checking and adjusting the valve clearances, a valve adjusting kit, containing two feeler gauges and two wrenches, is available as an optional accessory.

Note: Valve clearances on this engine must be checked and re-set only WHEN THE ENGINE IS COLD.

1. Remove the rocker cover by unscrewing two Allen screws from the rocker box on top of the cylinder head.
2. Turn propeller until compression is felt, then turn it one quarter turn and stop. Both valves should now be closed.
3. The required valve clearance is between 0.04 mm and 0.10 mm (.0015 to .004 in.) measured between the valve stem and rocker-arm. Use the 0.04 mm (thinner one) and 0.10 mm (thicker one) feeler gauges to check clearance. The 0.04 mm feeler should pass through the gap: the 0.10 mm gauge should not.
4. If the gap is found to be less than 0.04 mm or more than 0.10 mm, carefully slacken the locknut on the rocker-arm with the 5 mm wrench supplied, turn adjusting screw with 1.5 mm Allen key to open or close gap, then retighten locknut.

Finally, re-check gap and readjust if necessary.

IMPORTANT: Incorrect valve clearances may cause difficult starting (due to valve not closing properly) or loss of power (due to valve not opening sufficiently).

NEEDLE VALVE EXTENSION

The needle-valve supplied with this engine is designed to incorporate an extension so that, when the engine is enclosed within the fuselage, the needle-valve may be adjusted from the outside. An L-shaped rod, of 1.6 - 1.8 mm dia. and appropriate length, should be inserted into the needle's centre hole and secured by tightening the set-screw in the needle-valve knob with the small Allen key provided.

PARTS LIST

Code No.	Description	Code No.	Description
45901000	Crankcase	45231100	Camshaft Bearing
45901100	Cam Cover	45960000	Intake Valve Assembly
45902000	Crankshaft	45960010	Exhaust Valve Assembly
46103100	Cylinder Liner	45361000	Rocker Arm Assembly
45903200	Piston	45961400	Rocker Support Assembly
45403400	Piston Ring	45962000	Camshaft
45904000	Cylinder Head (w/Valve Ass'y)	45564000	Cam Follower
45904100	Cylinder Head	45966000	Push Rod
45904200	Rocker Cover	45966100	Push Rod Cover Assembly
45605000	Connecting Rod	45969400	Intake Pipe Assembly
45906000	Piston Pin	45981000	Carburettor Complete
45907000	Cover Plate	45484000	Choke Valve Assembly
45908000	Drive Washer (w/Key)	45825000	Silencer Assembly
29008219	Woodruff Key	71615009	Glow Plug Type "F"
46120000	Thrust Washer	*71901100	Radial Motor Mount
45901000	Safety Propeller Locknut Assembly	*72200060	Valve Adjusting Kit
45913000	Screw Set	*72108100	Flexible Exhaust Pipe 1111A
45914000	Gasket Set	*72108110	Flexible Exhaust Pipe 1111B
26731002	Crankshaft Bearing (Front)	*45910200	Locknut Set for Spinner
29130005	Crankshaft Bearing (Rear)		

*Optional parts

The specifications are subject to alteration for improvement without notice.

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Note: Smaller or larger props than those shown in the list can be used. However, it should be noted that propeller noise will increase as the r.p.m. increases.

For safety, keep your face and other parts of the body well away from the propeller when starting the engine or adjusting the needle-valve while the engine is running. Remember that the propeller turns through a much wider arc with the large sized propellers than this engine is capable of driving. Refer to the "Safety Instructions and Warnings" leaflet enclosed.

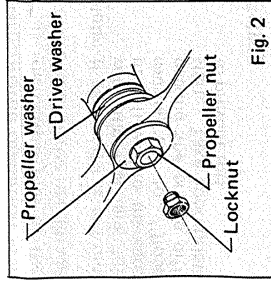
IMPORTANT: Use well balanced propellers and spinners only. An unbalanced propeller or spinner causes vibration and loss of power.

WARNING: There is always a danger, especially with nylon propellers (and depending on engine speed and weather conditions), of the propeller fracturing and a blade flying off and, obviously, this could cause serious injury. Therefore, never crouch over the engine when it is running and keep all onlookers well back and behind the model. If a spinner is used, make sure that the spinner notches are large enough to clear the propeller blades and so do not cut into and weaken the blade roots when the propeller nut is tightened.

There is also a risk, particularly with four-stroke engines, of the propeller flying off if the propeller nut loosens due to detonation or "knocking" when the engine is run too lean or under too heavy a load. Obviously this can also be very hazardous.

To combat this danger, we have developed the special Safety Propeller Locknut Assembly supplied with the FS-91 Surpass. This prevents the propeller from flying off, even if the propeller itself should slip or loosen.

1. Ream the propeller centre hole to 8mm dia. Make sure that the propeller is properly balanced.
2. Fit the propeller sleeve-nut and washer to the propeller, screw onto the shaft and tighten firmly with 14mm wrench supplied.
3. Finally, insert the Safety Propeller Locknut. Tighten Locknut firmly (but not with excessive force) using 12mm wrench. (see Fig. 2)

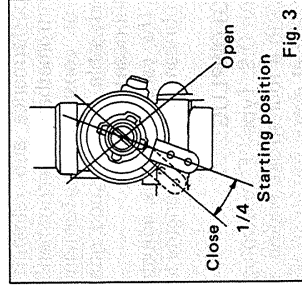


IMPORTANT: Regardless of the type of propeller fixing used, make a habit of always checking the tightness of the propeller before starting the engine. Remember that, especially with wooden propellers, there is a tendency for the material to shrink, or for it to be reduced by the serrated face of the drive hub.

STARTING

It is preferable to use a heavy-duty electric starter, although hand-starting is also possible, as will be explained in a moment.

1. Firstly, fit a spinner so that an electric starter can be used. The O.S. special locknut set for spinner, that is available as an optional part, enables you to fit a spinner securely and easily.
2. Open the throttle so that the throttle-arm is at one-quarter of its full throw. (see Fig. 3)



(a) If a silencer pressurized fuel system is employed, set the needle-valve 2 to 2½ open from the fully closed position.

(b) If a silencer pressurized fuel system is not employed, set the needle-valve 3 to 4 turns open from the fully closed position.

3. Energize the glowplug and apply the electric starter after making sure that the battery leads are properly connected for counter-clockwise rotation. If the power of your starter is insufficient to immediately rotate the engine freely, turn the propeller clockwise ('backwards') until compression is felt, then, with the propeller in this position, try the starter again. This will enable the kinetic

energy of the rotating propeller to assist in carrying the engine through its compression stroke. Also, make sure that your starter battery is in good condition and fully charged.

CAUTION: Never apply an electric starter with the choke closed. Such an action will cause an excess quantity of fuel to be drawn into the cylinder and result in an hydraulic lock that may damage the engine.

4. When the engine starts, keep it running, initially, with the original needle-valve setting while steadily moving the throttle to the fully open position. If the engine slows down because the mixture is excessively rich, close the needle-valve slowly until the engine runs evenly. Then disconnect the battery from the glowplug and close the needle-valve slowly so that revolutions increase. Adjust the needle-valve gradually. Abrupt adjustment of the needle-valve may cause the engine to stop.

The above starting procedure is standard for the FS-91 Surpass. However, the engine may be safely hand started — except when using a lightweight wooden propeller. For safety, be sure to use a "chicken-stick". The procedure is as follows.

1. The propeller should be fixed in such a way that it is positioned horizontally as compression is first felt when turning the propeller counter-clockwise.
2. Open the throttle so that the throttle-arm is at one-quarter of its full throw. (See Fig. 3)
- (a) If a silencer pressurized fuel system is employed, set the needle-valve 2 to 2½ open from the fully closed position.
- (b) If a silencer pressurized fuel system is not employed, set the needle-valve 3 to 4 turns open from the fully closed position.
3. Prime the engine by closing the choke valve and turning the propeller through 4 to 5 revolutions, depending on the length of pipe from tank to carburettor.
4. Turn the propeller counter-clockwise several times so that fuel is drawn well into the cylinder.
5. Gradually turn the propeller counter-clockwise until compression is felt. Leave the prop at this position.
6. Set the throttle at approximately ¼ open.
7. Connect the glowplug battery and, using the chicken-stick, briskly swing the propeller clockwise from the position determined above and from the centre of the right blade. The engine will then bounce smartly in the counter-clockwise direction to the point where ignition and expansion of the charge takes place. If the engine stops, make sure that fuel is reaching the carburettor from the fuel tank, then repeat procedures 3) to 7).
8. Correct priming is the secret of easy hand-starting. When the engine starts, keep it running, initially, with the original needle-valve setting. If it slows down because the mixture is excessively rich, close the needle-valve slowly until the engine runs evenly. Then disconnect the battery from the glowplug and close the needle-valve slowly so that revolutions increase. Adjust the needle-valve gradually. Abrupt adjustment of the needle-valve may cause the engine to stop.
9. To re-start the engine when it is hot, after a run, first try just flipping the propeller, with the throttle in the idling position, after re-energising the glowplug. If the engine does not re-start, re-prime it by closing the choke valve while rotating the propeller once or twice until the cylinder becomes cool enough for restarting.

CAUTION: Do not connect the glowplug to the battery while priming.

Note: Excess fuel in the carburettor may drip into the engine compartment when the choke valve is reopened. Therefore, it is advisable to drill a drain hole in the bottom of the engine bay or cowling and to apply fuelproof paint to the surrounding surfaces to prevent fuel from penetrating the airframe structure.

RUNNING-IN ("Breaking-in")

All internal combustion engines benefit, to some degree, from extra care when they are run for the first few times — known as running-in or breaking-in. This is because the working parts of a new engine take a little time to settle down after being subjected to high temperatures and stress.

However, as O.S. engines are made with the aid of the finest modern precision machinery and from the best and most suitable materials, only a very short and simple running-in procedure is required and can be carried out with the engine installed in the model.

For running-in, use the same sized propeller as you intend for flying your model.

Running-in procedure is as follows:

Start the engine and run it for about 5 seconds at around maximum r.p.m., then open the needle-valve ½ turn to produce a rich mixture for cooler, slower running, and run for 20 seconds at this setting. Keep the throttle fully open, using only the needle-valve to reduce speed. Repeat this procedure, alternately running the engine fast and slow with the needle-valve, but gradually extending the short periods of maximum speed running until two full tanks of fuel are consumed.

Note: Take care to avoid dusty and sandy locations. Dust and grit drawn into the engine will seriously damage its working parts. Following the initial break-in on the ground, the engine should be given a period of moderately rich running in the air. For the first flights, set the needle-valve rich, consistent with adequate take-off power and steady level flight and, if necessary, readjust the throttle trim on the transmitter so that the engine does not stop when the throttle is fully closed.

With each successive flight, close the needle-valve slightly, until, at the end of 10 flights, the needle-valve is set for maximum power. The carburettor can now be adjusted for optimum throttle performance following the instructions given in the next section.

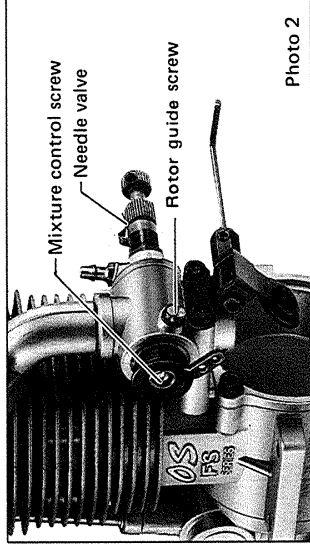
Note: Remember that, while the engine is being run-in and the needle-valve is set on the rich side, the carburettor cannot be expected to show its best response. Therefore, avoid abrupt throttle operation at this stage.

ADJUSTING THE CARBURETTOR

The carburettor of your FS-91 has been factory set for the approximate best result, but the settings may, in some cases, vary slightly in accordance with fuel and climatic conditions.

If the desired throttle response is not obtained after the completion of the running-in period, the carburettor should be re-adjusted as follows.

- **The Needle-Valve:** For adjusting the mixture strength when the throttle is fully open.
- **The Mixture Control Screw:** For adjusting the mixture strength at part-throttle and idling speeds, to obtain steady idling and smooth acceleration to medium speeds.
- **The Throttle Stop Screw:** For establishing the minimum idling speed. (see Photo 3)



1. Set the throttle lever 1/4 open from the fully closed position (see Fig. 3) and start the engine in the usual way. It is preferable to have the throttle only slightly open, to avoid unnecessarily high revolutions when the engine starts.

2. Now open the throttle fully and gradually close the needle-valve until the engine is running at its optimum r.p.m. in the air. The needle-valve setting at this time will be 1/8 to 1/4 open from the maximum r.p.m. setting.

Note: Make sure that the engine is fully "run-in" before operating it continuously at full power. (See RUNNING IN section.)

3. Having set the needle-valve as described above, close the throttle and run the engine at idling speed for approximately 5 seconds, then steadily move the throttle to the fully open position by means of the throttle servo.

(a) If, at this point, the engine hesitates before picking up speed, with a low-pitched exhaust note and an excess of exhaust smoke, it is probable that the idling mixture is too rich. In this case, it will be necessary to turn the mixture control screw clockwise about 45 degrees.

(b) If, on the other hand, the engine hesitates or even appears to cease firing for an instant, before increasing speed, it is probable that the idling mixture is too lean. In this case, it will be necessary to turn the mixture control screw counter-clockwise about 90 degrees then turn it clockwise 45 degrees.

Turn the mixture control screw 30 to 45 degrees at a time in the early stages. When the response improves, turn the mixture control screw 10 to 15 degrees at a time. Carry out adjustments progressively and patiently remembering the symptoms of rich and lean running, quoted above, until the engine responds quickly and positively to the throttle.

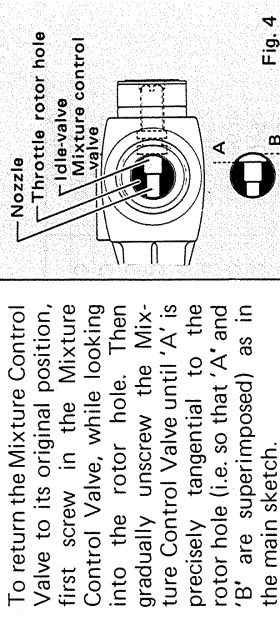
4. The throttle stop screw is for fixing the minimum idling speed. If, after carrying out mixture adjustments, the idling speed is found to be too high, the throttle stop screw should be turned counter-clockwise until the desired idling speed is obtained.

Note: Once the correct carburettor settings have been established, it should be unnecessary to alter them. Such slight needle-valve readjustments as may be required to compensate for variations in atmospheric conditions, will not normally affect the other two controls. Slight readjustments may be necessary for optimum performance if different types of fuel, glow-plugs or propellers are used. In this case, begin by flying the model with the needle-valve approximately 1/8 to 1/4 turn open from the peak r.p.m. as a safety measure, then readjust as necessary.

REALIGNMENT OF MIXTURE CONTROL VALVE

In the course of making carburettor adjustments, it is just possible that the Mixture Control Valve may be inadvertently screwed in or out too far and thereby moved beyond its effective adjustment range.

Its basic setting can be reestablished as follows: The basic (factory) setting is as shown in the main sketch, i.e. with the shoulder portion 'A' exactly at a tangent to the throttle rotor hole.



CARBURETTOR CLEANLINESS

The correct functioning of the carburettor depends on its small fuel orifices remaining clear. The minute particles of foreign matter that are present in any fuel can easily partially obstruct these orifices and upset mixture strength so that engine performance becomes erratic and unreliable.

It is recommended that fuel is passed through a filter when the tank is filled and that a good in-line filter is installed between the fuel tank and carburettor and, furthermore, that this filter is frequently cleaned to remove dirt and lint that accumulates on the filter screen. Finally, occasionally

