IMPORTANT
Before attempting to operate your FS-90, please read through this instruction leaflet so as to familiarize yourself with the controls and other features of the engine. Also, please pay careful attention to the recommendations contained in the "Safety Instructions and Warnings" leaflet enclosed.

The O.S. FS-90 is an aircooled, overhead-valve four-stroke cycle engine for model aircraft use. A development of the O.S. FS-60, the world's first quantity-produced four-stroke model aircraft engine, it is famous, but with increased power due to its 50 percent larger displacement. The engine is ideal for scale models, but is also suitable for aerobatic aircraft where local conditions may prohibit the operation of noisier engines. The FS-90 can be installed in any airframe intended for the FS-60, FS-75, as its mounting dimensions are the same and it is only two ounces heavier.

The FS-90 is built to the highest technical standards throughout and has its camshaft, as well as its crankshaft, supported in ball bearings at both ends. Properly cared for, it will have a useful life many times that of ordinary model engines.

INSTALLATION
Use a strong engine mount, at least as firm as is used for two stroke 10 cc engines. Installation should be made in such a way that maintenance, checking and valve tappet adjustment can be done easily.

INSTALLATION OF CHOKE VALVE
The FS-90 is equipped with a spring-loaded choke valve. Insert an L-shaped actuating rod into the hole in the hexagonal part and secure it by tightening the set screw. If the rod length is more than about 40 mm (1 1/2 in.), its outer end should be supported to avoid vibration.

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.

FUEL
The FS-90 runs on standard commercially available model glowplug engine fuels. 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.

GLOW PLUG
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, conventional two-stroke glowplugs do not suit this engine. The special O.S. Type F glowplug supplied is recommended.

PROPELLER
Suggested propeller sizes are 11 x 7~8, 12 x 6~7, 13 x 6~7 or 14 x 5~6. It is not practical to run this engine at high r.p.m. on smaller sized props.

STARTING
It is advisable to use an electric starter for starting, although hand-starting is also possible.

The procedure when using an electric starter is as follows.

1) Open the throttle valve fully and unscrew the needle-valve approximately 5 turns from the fully closed position.
2) It is preferable to use the choke valve for priming, although you can prime the engine through the exhaust pipe if you wish.
3) Close the choke valve and turn the propeller counter-clockwise 2 turns by hand.

CAUTION: Do not turn the propeller more than 2 turns with choke closed, otherwise the engine may suck in too much fuel and become flooded.

4) Turn the propeller counter-clockwise several times so that fuel is drawn well into the cylinder. (When priming through the exhaust pipe, turn the propeller clockwise instead.)

5) Connect the glowplug to the battery and apply the electric starter.

6) When the engine starts, keep it running, initially, with the original needle-valve setting. 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, especially when it is new and insufficiently run-in.

7) To restart the engine when it is hot, after a run, first prime by closing the choke valve while rotating the propeller twice. Initially, the high temperature inside the combustion chamber will turn the liquid fuel into gas and emit it through the exhaust pipe. Therefore, repeat the priming procedure once or twice until the cylinder becomes cool enough for re-starting. (Again, it is possible to prime through the exhaust pipe.)

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

The above starting procedure is standard for the FS-90. However, the engine may be safely hand started – except when using a rather lightweight wooden prop.
peller. For safety, be sure to wear a heavy glove or 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 fully and unscrew the needle-valve approximately 5 turns from the fully closed position.
3) Prime the engine by closing the choke valve and turning the propeller through two revolutions. (Alternatively, prime through the exhaust pipe.)
4) Turn the propeller counter-clockwise several times so that fuel is drawn well into the cylinder. (When priming through the exhaust pipe, turn the propeller clockwise instead.)
5) Gradually turn the propeller counter-clockwise until compression is felt.
6) Connect the glowplug to the battery and flip the propeller clockwise from the center 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 again, make sure that fuel is reaching the carburettor from the fuel tank, then repeat procedures 3) to 6). Correct priming is the secret of easy starting.
7) 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, especially when it is new and insufficiently run-in.
8) To re-start the engine when it is hot, after a run, first prime by closing the choke valve. Initially, the high temperature inside the combustion chamber will turn the liquid fuel into gas and emit it through the exhaust pipe. Therefore, repeat the priming procedure once or twice until the cylinder becomes cool enough for re-starting. (Again, it is possible to prime through the exhaust pipe.)

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

RUNNING-IN ("Breaking-in")
For long life and high performance, your FS-90, like any other engine, requires the correct running-in, or breaking-in, procedure. The same basic rules apply as for a 10 cc two-stroke engine — i.e., when new, the engine must be operated on a very rich needle setting in order to promote cool running and maximum lubrication. It is recommended that initial running-in is done on a bench mount using a 12 x 6 or 13 x 6 propeller.

First, start the engine and run it for about 10 seconds with the needle-valve set for 6,000/7,000 r.p.m., then open the needle-valve to reduce speed to approximately 4,000 r.p.m. and run for 20 seconds at this cooler 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 high speed running until a total of at least 20 minutes running time has been accumulated. For those who do not have a tachometer, the exhaust gas colour can be a help; e.g., as the needle-valve is screwed in, the exhaust gas will turn lighter, from the original grey colour.

Following the initial break-in of 20 minutes minimum on the bench, the engine should be installed in your model and run-in for a further period in the air. For the first flights, have the needle-valve set as rich as possible, consistent with adequate takeoff power and, if necessary, readjust the throttle rotor stop 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 readjusted for optimum throttle performance.

THROTTLE VALVE ADJUSTMENT
The carburettor of your FS-90 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. Remember, also, 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. If, however, the desired throttle response is not obtained after the completion of the running-in period, the carburettor should be re-adjusted as follows.

Three adjustable controls are provided on this carburettor:

I. The Needle-Valve
II. The Mixture Control Screw
III. The Throttle Rotor Set-Screw

![Photo 1]

I. The Needle-Valve is used in the same way as on all model engines, i.e., for adjusting the high-speed mixture strength. Start the engine and, with the throttle fully open, gradually close the needle-valve until it is running at its maximum speed.

CAUTION
Do not close the needle-valve to too "lean" a setting as this will cause the engine to overheat and slow down. Set the needle-valve very slightly to the "rich" side of the peak r.p.m. setting. Make sure that the engine is fully "broken-in" (about 1 hour of total running time in short runs) before operating it continuously at full throttle.

II. The Mixture Control Valve is for adjusting fuel mixture strength at part throttle and idling speeds. Having set the needle-valve as detailed above, close the throttle. The engine should idle continuously and steadily without further adjustment.

a) If, however, the engine begins to idle unevenly, open the throttle. If the engine then hesitates before picking up to full speed, it is probable that the idling mixture is too rich. Check this by closing the throttle again and letting the engine idle for a little longer before again opening up. If the engine now puts out a good deal of smoke and hesitates or even stops, it will be necessary to close the Mixture Control Valve. Do this by turning it clockwise. About 1/3 - 1/4 turn should be sufficient.

b) If instead of being set too rich, the Mixture Control Valve is set too lean, the engine will stop when the throttle is closed, or will lose speed when idling and then cut-out abruptly (without smoking) when the throttle is opened again. In this case, turn the Mixture Control Valve about 1/3 - 1/4 turn counter-clockwise.
Mixture Control Valve adjustment is not critical and, by remembering the symptoms of rich and lean running quoted above, it is a very simple matter to establish the best setting.

III. The Throttle Rotor Set-Screw is for establishing the minimum idling speed. If the engine runs too fast with the throttle closed, the rotor set-screw should be turned counter-clockwise to allow the throttle opening to be reduced.

Subsequent Operation and Care
Once the required carburettor settings have been established, it should be unnecessary to alter them. Such slight needle-valve alterations as may be needed to cope with differences in atmospheric conditions or fuels, do not affect the other two adjustments.

It is important that the carburettor operates under clean conditions. Make sure that fuel is properly filtered before use. We advise fitting a filter in your fuel can and another in the delivery tube between tank and engine, to reduce the risk of the carburettor jet becoming partially clogged and upsetting running adjustments.

Remember to clean the filters occasionally.

Provided that fuel is double filtered in this way, the carburettor should not need any special attention. II. however, it is expected that dirt or fluff has become lodged in the carburettor, it should be dismantled and cleaned by removing the needle-valve assembly using the wrench supplied and washing the part in alcohol or gasoline. (See Photo 2 and 3)

2) Turn propeller until compression is first 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 and 0.10 mm 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 5–6 mm spanner supplied, turn adjusting screw to open or close gap, then re-tighten locknut. 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). Therefore, it is advisable to re-check clearances periodically.

LUBRICATION
All parts of the FS-90 are automatically lubricated by the oil content of the fuel mixture. The nipple located on the rear of the crankcase is the crankcase breather. As some of surplus oil will be emitted from this, fit a short length of silicone tubing of approx. 3.5 mm I.D. to discharge it outside the model.

EXHAUST PIPE ADJUSTMENT
The direction of the exhaust pipe may be altered in accordance with individual installation requirements. The angle is easily adjusted by loosening the nut that secures the exhaust pipe to the cylinder head. Use the special 10 mm spanner supplied.

VALVE CLEARANCE ADJUSTMENT
Valve clearances are correctly set before the FS-90 leaves the factory. However, as the engine becomes properly run-in, the smoothing and polishing of the valve gear surfaces gradually widens the tappet gap. Therefore, when a total running time of about one hour has been accumulated, valve clearances should be checked by using the feeler gauges supplied with the engine.

Note: Valve clearances on this engine must be checked and reset only when the engine is COLD.

1) Remove the rocker cover by unscrewing three Allen screws from the rocker box on top of the cylinder head.

![Photo 4]
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:

Three adjustable controls are provided on this carburettor:

- **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.

To return the Mixture Control Valve to its original position, first screw in the Mixture Control Valve, while looking into the rotor hole. Then gradually unscrew the Mixture Control Valve until 'A' is precisely tangential to the rotor hole (i.e. so that 'A' and 'B' are superimposed) as in the main sketch.

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