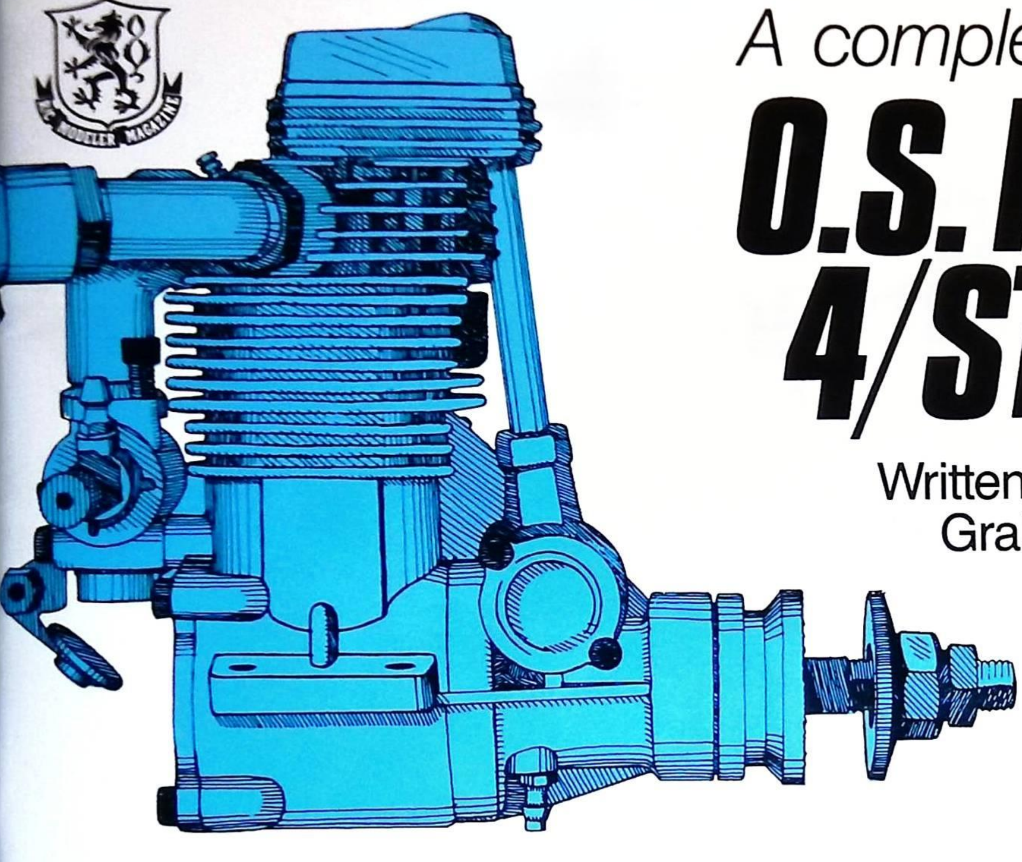
A complete guide to

O.S. MODEL 4/STROKES



Written & illustrated by
Graham C. Rice.

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A complete guide to

O.S. MODEL 4/STROKES

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A complete guide to O.S. MODEL 4/STROKES

An easy to follow step by step stripdown, analysis and rebuild.

INTRODUCTION

It is now more than 14 years since the first introduction of the O.S. model 4-stroke which was to bring with it a revolution in model aircraft thinking.

Although only developing half the torque of the 2-stroke, the 4-stroke has a much longer inlet period, better cylinder filling and produces its maximum available thrust at much lower R.P.M. This makes it ideal for Scale and Sports flying using large propellers. Beginning in 1976, the O.S. FS-60 slowly began to grow in popularity as a pleasant alternative to the 2-stroke because of its more realistic lower pitched exhaust note and its semi scale appearance.

These first 4-strokes had a power rating of about 7 BHP for every 100 CC of engine capacity.

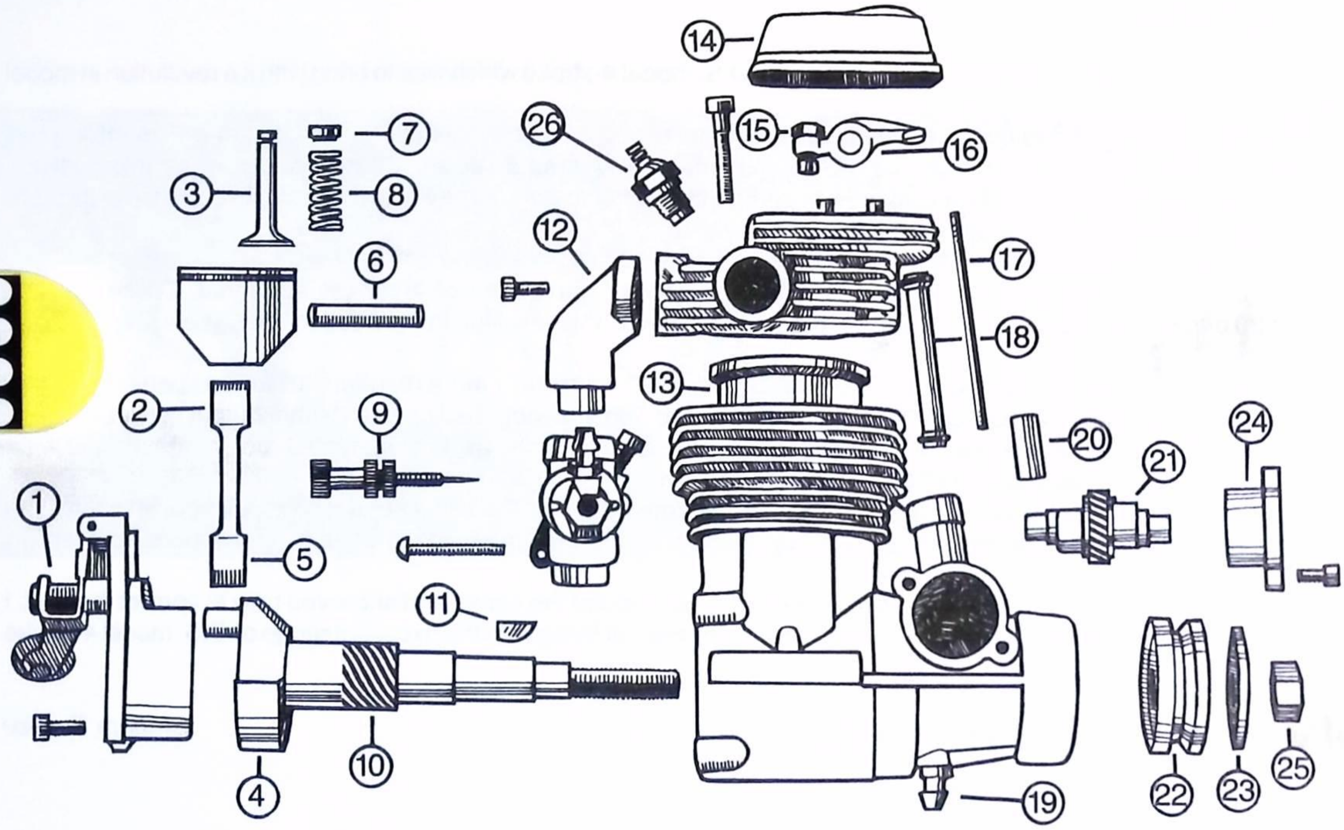
The cries for more horsepower grew louder and in 1982, the second generation of 4-strokes appeared. These engines developed about 30 percent more power but an equally greater noise level, this resulting in the need for these new engines to be fitted with Silencers.

These second generation engines rated about 9 BHP/100 CC. By 1987, with many more refinements such as better breathing and improved combustion chamber design, O.S. 4-strokes aptly named Surpass, obtained an even higher output between 10 and 11 BHP/100 CC. During 1990, we saw the arrival of the FS-120 Surpass S.P. which has a Roots-type Supercharger producing 2 atmospheres of boost. This engine develops between 13.5 and 14.5 BHP/100 CC.

While servicing scores of O.S. 4-strokes over the past 8 years, I came to realize there is a need for a repair booklet containing helpful hints about the function of these engines. As with any precision instrument, a 4-stroke needs careful service from time to time to sustain a good performance over a long life.

When a fault occurs with your favorite 4-stroke, this booklet will help pinpoint the cause and show you how to correct the fault. I hope the hints contained in the following pages, will add to your enjoyment of flying with the excellent range of O.S. model 4-stroke engines.

Graham C. Rice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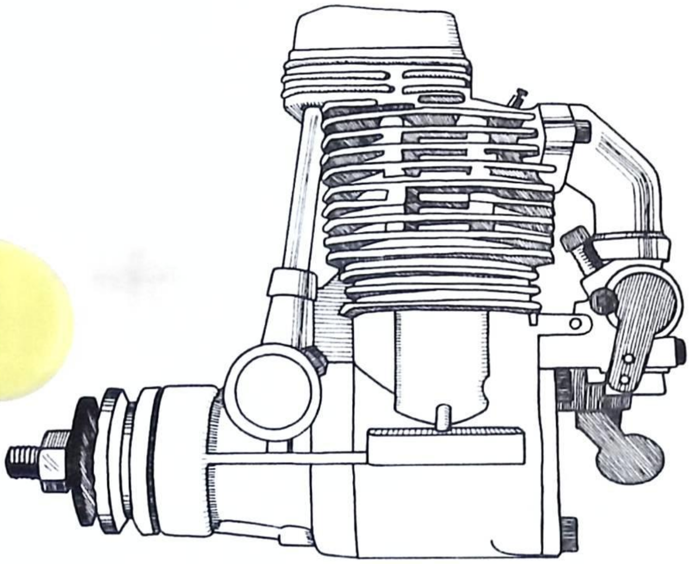
The basic parts of the O.S. FS-48.

1. Spring loaded Carburetor Choke
2. Little End
3. Valve
4. Crankweb
5. Big End
6. Gudgeon Pin
7. Valve Spring Retainer
8. Valve Spring
9. Needle
10. Crossed Helical Gear
11. Woodruff Key
12. Inlet Manifold
13. Cylinder Liner
14. Rocker Cover
15. Tappet Adjuster and Lock Nut
16. Rocker
17. Pushrod
18. Pushrod cover with "O" Rings
19. Crankcase Breather
20. Cam Follower
21. Camshaft
22. Drive Washer
23. Propeller Washer
24. Cam Cover
25. Propeller Nut
26. Glowplug



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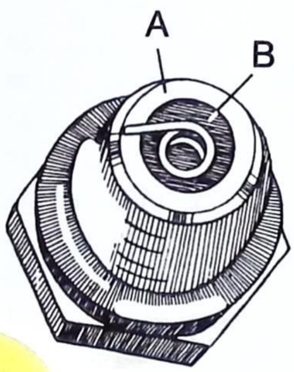
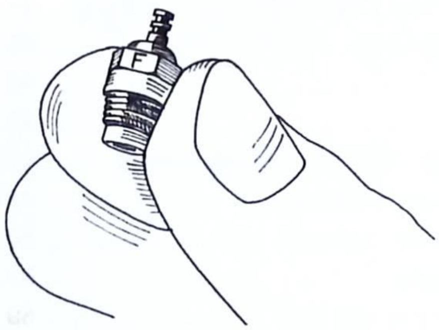


Carbon deposits around the rim (A) indicate oil content and needle setting. The air space around the element (B) promotes cooling and has an effect on the plug's heat rating.

Always use Glowplugs designed for 4-strokes, similar to the O.S. "F".



(1) GLOWPLUGS

Glowplug elements contain various proportions of Platinum, Iridium and Rhodium. The Platinum element, after initially receiving a battery boost for starting, retains sufficient heat between firing by the chemical reaction of the Methanol based gases.

The Glowplug element should be centered in its cavity and the top coil level with the base of the plug, otherwise the Glowplug is slightly retarded in its ignition.

The amount of air space around the element promotes cooling, and has an effect on the plug's heat rating.

When Castor based fuels deposit excessive carbon around the lower rim of the Glowplug, it indicates the use of too high an oil content and or too lean a needle setting.

If the element has a dull matt look, sometimes called frosted, its future life is limited.

Synthetic oils burn clean without the carbon deposit and therefore don't provide a visual guide to the running condition of the engine.

Always use Glowplugs designed for 4-strokes like the O.S. "F" and never use 2-stroke Long reach or Idle Bar plugs.

Early O.S. 4-stroke Heads have a flange at the bottom of the Glowplug cavity and these plugs when tightened will damage the threads in the head.

(2) METHANOL

The advanced ignition characteristic of engines using Glowplugs is ideally suited to the slow burning Methanol which burns well without pre-ignition.

Like high compression 2-stroke racing engines running on straight fuel, 4-strokes are quite sensitive to Methanol containing water. Care should be taken to avoid partly filled containers of Methanol and storage in damp conditions.

(3) NITROMETHANE

Nitromethane is a complex compound which liberates an element of oxygen during combustion. This provides model engines with a very effective form of super charging.

As with Methanol, Nitro needs to be kept free of moisture and stored in a light proof container.

The amount used in 4-strokes varies between 5 and 15 percent of the total fuel.

(4) OIL CONTENT

Using a fuel too high in castor oil content, i.e., 20 percent and over, advances piston compression which can cause pre-ignition.

Early model 4-strokes often pre-ignited causing them to run in reverse, loosening Propeller nuts.

At the introduction of 4-strokes, modelers were given no useful instructions by manufacturers about the type of oil or the percentage to use. They naturally assumed the amount used for their 2-strokes would be suitable.

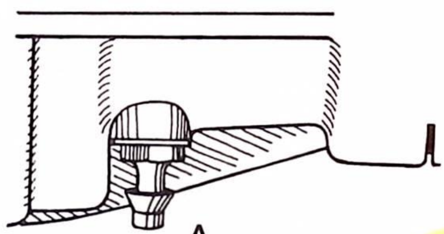
This level of Castor oil has a number of problems. Excessive carbon formation on Valves, sticking Piston rings caused by varnish and Bearing failure due to oil hardening when the engine is not used for long periods.

Carburetor idle can be difficult particularly in cold, humid weather. Many modelers revert to Nitromethane to smooth starting and idle, but Nitromethane creates its own set of problems.

If engines are not adequately flushed out after flying, the Nitric acid formed during the combustion process will later cause corrosion to the Bearings.

However, to some extent, vegetable oils like Castor oil help to neutralize these acids.

(5) CRANKCASE BREATHER



Small amounts of excess oil should drip from the Crankcase Breather (A) during running.

The clearance of this oil performs an important role in preventing a pressure build-up in the Crankcase.

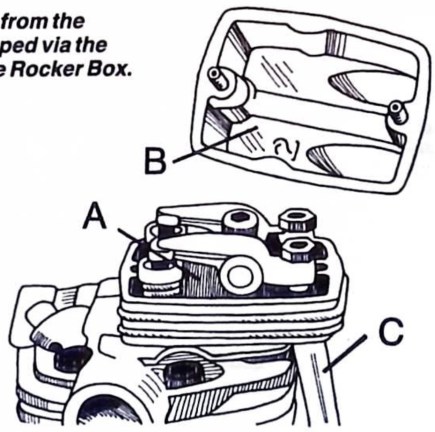
At the end of a day's flying, the Breather is used to inject After-run or Gun oil into the engine as an attempt to curb engine corrosion.

Breathers are constantly being re-located by engine designers in an attempt to help engine after-care.

However, oil injected via the Breather doesn't reach Bearings and Camshaft equipment equally.

On no account should the Breather be used to pressurize a fuel tank.

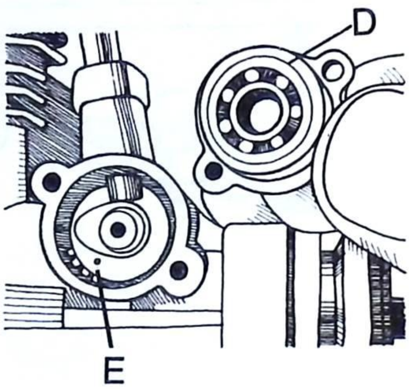
(6) QUALITY OF OIL CHECK



Black metallic sludge from the Camshaft area is pumped via the Pushrod Covers to the Rocker Box.

After removing the Glowplug, use a small Allen key to remove the two screws holding the Rocker Cover.

Engine damage occurs when inadequate lubrication breaks down, increasing metal to metal contact and overheating. These breakdowns are most likely to occur where metal to metal contact is at its heaviest. One such point is between the Camshaft lobe and the head of the Cam follower. Tiny metal flakes combine with the broken down oil to form a black metallic sludge. This sludge acts as a cutting compound and quickly spreads throughout the engine damaging Bearings and Piston Rings.



Examine the Camshaft, Cam followers and Camshaft Bearings. NOTE: The timing mark is not in the timing position.

When this is seen in the Rocker Box (A), or the Rocker Cover (B), it has been pumped by the descending Piston from the Camshaft area via the Pushrod Covers (C) to the Rocker Box.

Using the same Allen key, next remove the Cam Cover (D). Examine the Camshaft, Cam followers and Camshaft Bearings for sludge.

NOTE: The timing mark (E) is not in the timing position. Continue with the strip down.

(7) ROCKER ASSEMBLY

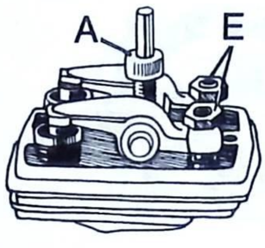
The Rocker Asembly is removed by loosening one central Allen head screw (A).

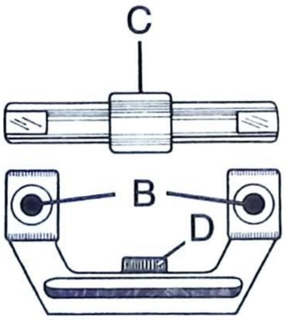
If your engine has the Support Frame Assembly (illust. 2), use your smallest Allen key to loosen the two grub screws first (B), then slide out the Rocker Shaft freeing the Rockers and their Spacer (C). Then remove screw (D).

Loosen the Tappet Retainer Nuts (E) and wind back the Tappet Adjusters.

Next lift out the two Pushrods, which are interchangeable and have hardened dome ends to reduce wear.

One central screw releases the Rocker assembly (A). Loosen the Tappet Retainer Nuts (E) and wind back the Tappet Adjusters.





First loosen the two grub screws (B), slide out the Rocker Shaft holding the Rockers and their Spacer (C). Remove screw (D) to unassemble the Support Frame Assembly. Note which way it assembles.

(8) HEAD REMOVAL

Moving diagonally across the head, slacken all the Head Bolts. Lift the Head releasing the Pushrod Covers (A). Watch for the "O" Rings at both ends of the covers (B).

(9) THE CAM FOLLOWERS

Lift the Cam followers out from the top of their guides before removing the Camshaft. The holes at the top of the Cam followers (E) accept the Pushrods. Next, look carefully at the running faces of the Cam followers.

If a groove is cut in the Cam follower (A), not enough oil is reaching this surface. Add more oil to your fuel or change the type of oil.

Because the surface hardness has been penetrated, this Cam follower should be replaced.

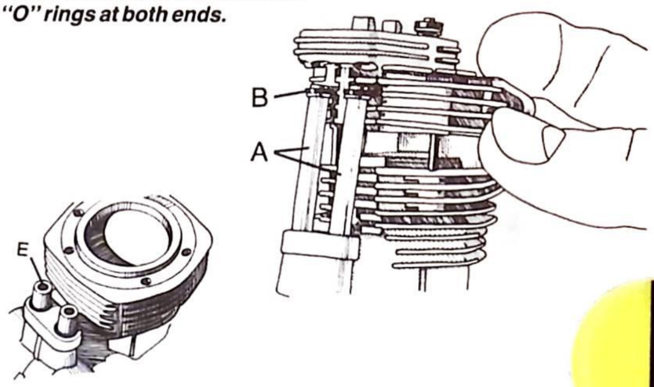
When the Cam follower is working correctly, a close look will reveal a polished area around the edge (B) with a dull spot in the center.

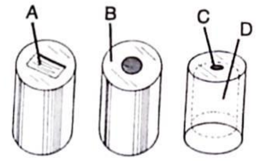
This indicates that the Cam follower is rotating correctly while operating.

Some early Cam followers have a central hole (C) with an inside oil well (D) which is to lubricate the face of the Cam follower.

However, the edges of the hole (C) can break away. This Cam follower should be replaced with the solid type.

Lift the Head to release the Pushrod Covers. Watch for the "O" rings at both ends.

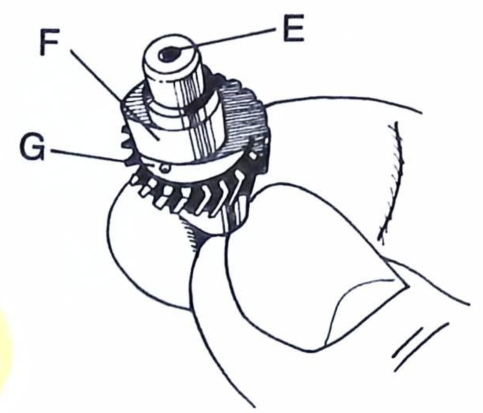




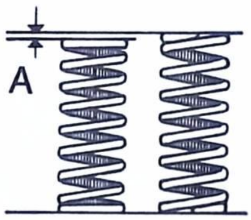
Cam follower damage (A) is due to not enough oil or using an unsuitable oil.

A correctly operating Cam follower has a polished area around its edge (B).

The Cam follower's surface is oiled through hole (C) from its internal oil well (D).



Hole (E) always points towards you when the Camshaft is sitting in its housing. (F) is the Exhaust Cam and (G) is the Camshaft timing mark.



Uneven tension can be due to one spring being slightly compressed.

(10) LOOKING AT THE CAMSHAFT

Hole (E) always points towards you when the Camshaft is sitting in its housing.

The Exhaust Cam Lobe (F) operates the exhaust valve, the inlet Lobe on the other side of the timing gear, the inlet valve.

The small punch mark on the side of the timing gear is the Camshaft timing mark (G).

(11) VALVE SPRING TENSION

Small differences in Valve Spring tension can be felt (while the Valves are attached to the head), by pressing down each Valve in turn.

Uneven Spring tension can be due to one spring slightly compressed (A) or a worn Valve Seat.

Running the engine above its practical operating R.P.M. will wear Valve Seats. Differences in Valve Spring tension greatly affect engine performance and should be attended to immediately.

O.S. Valve Springs look much the same, but there are actually 7 different types used throughout the range of O.S. 4-strokes. It is best to check the computer numbers to be sure of fitting the correct ones.

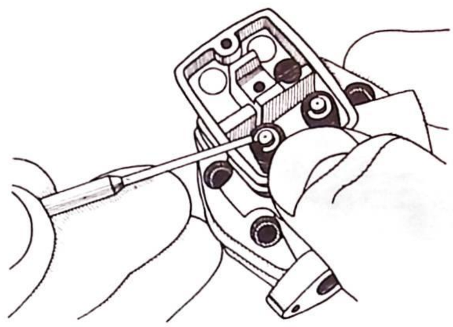
(12) DISMANTLING THE VALVES

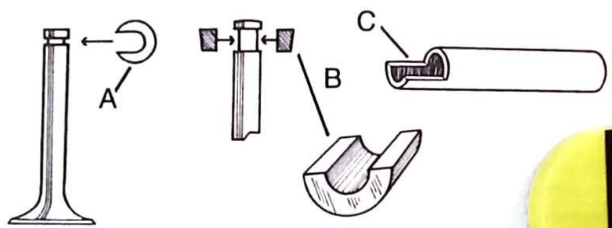
Don't attempt to remove the Valve Springs while the head is attached to the Crankcase.

First, place a finger on the Valve Head underneath and using a thumb nail, press down on the Valve Spring at the same time slide out the "C" shaped Spring Retainer, slowly release the pressure from the Spring.

When the Spring Retainer is below the top of the Rocker Box, a small piece of tubing is needed as a spring depressor to reach down into the Rocker Box.

The O.S. FS-70, 91, 120 Surpass engines use a Split Collet system to retain the Valve Springs. These are much more difficult to assemble and require a special tool.



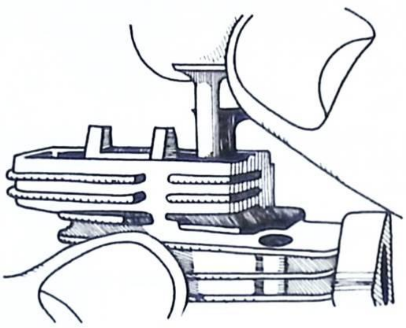


Using a thumb nail, press down on the valve spring and slide out the "C" shaped spring retainer.

The "C" shaped spring retainer (A).

O.S. 70, 91, 120 Surpass engines use a pair of split collets (B).

A small piece of brass tubing about 30mm long, 7mm in diameter with a section of 5mm removed (C), will help as a Spring depressor.



Reverse the two Valves and place them in their respective Guides to test for wear.

(13) VALVE FLOAT

The term valve float means the Cam follower, when operating, is not in contact with the Camshaft lobe.

Over-revving reduces Valve Spring tension and increases the chance of Valve float. To avoid this problem, don't use propellers smaller than those recommended by the manufacturer.

Adjust the propeller R.P.M. to the practical R.P.M. published on the manufacturer's instruction sheet.

Use a tachometer to check ground revs. and allow 10 percent extra for the engine unloading in the air. In power dives always throttle back the carburetor to prevent the engine exceeding its operating R.P.M.

(14) VALVE STEM AND GUIDE WEAR

Reverse the two Valves and place them in their respective guides. Rock each Valve sideways to test for Valve Guide wear. Small amounts of lubrication are pumped up the Valve Guides from the piston cylinder by the motion of the Valves.

Valve Stem and Guide wear is caused by the same condition mentioned in Valve Float.

(15) VALVE CLEANING

Because the Exhaust Valve becomes the hottest, most of the carbon is deposited on it. Carbon collects mainly on the Valve Stem under the head and also a little on the head of the Valve. This can be scraped away using a blunt knife or blade. Care should be taken to avoid scratching around the Valve edge where it seats (A) and also on the bronze seat located in the Head.

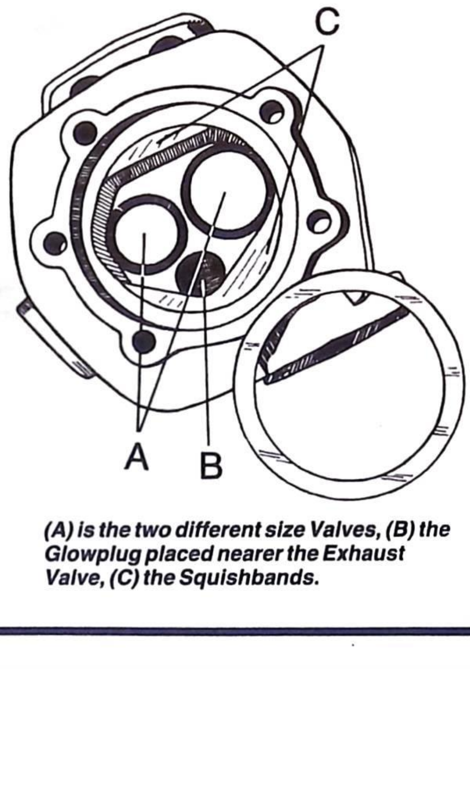
(16) THE HEAD

Early O.S. model 4-strokes have the same diameter Inlet and Exhaust Valves.

In the search for more power, a larger Inlet Valve was introduced to deliver even more mixture to the combustion chamber, but this means the exhaust valve is reduced proportionately. If the Exhaust Valve becomes too small, the power gained from the larger Inlet Valve is substantially offset by the smaller Exhaust Valve being unable to adequately pass the hot Exhaust gases, leading to overheating and increased carbon deposits.

Glowplugs, traditionally placed equally between the Inlet and Exhaust valves, can be repositioned much closer to the hot Exhaust Valve (B) which helps to keep them hotter while idling. As the piston approaches TDC, the mixture is squeezed by the Squishbands (C) from the outside edges of the cylinder towards the ignition zone for more complete burning.

When cleaning, care should be taken not to scratch the Valve Seat.



(A) is the two different size Valves, (B) the Glowplug placed nearer the Exhaust Valve, (C) the Squishbands.

(17) INLET AND EXHAUST VALVE OVERLAP AT IDLE

By leaving the Exhaust Valve open ofter TDC, we use the momentum of the Exhaust gases to create a partial vacuum in the cylinder. As the Inlet Valve is open during this overlap period, Exhaust gas inertia assists the fresh mixture.

However, at idle, the fresh mixture has little momentum and the piston will start to push the mixture back down the Inlet tract as it comes up on the compression stroke.

Similarly, at the late closing of the Exhaust Valve, outgoing Exhaust gases have low inertia at idle and the descending Piston will cause these gases to be reversed back into the cylinder.

Engine designers electing to use a long overlap period between inlet opening and exhaust closing for maximum power gain, can have problems getting a high performance engine to idle properly without reducing the diameter of the Inlet Manifold.

(18) BACKPLATE, DRIVE WASHER, WOODRUFF KEY, PROPELLER WASHER AND NUT

Check for wear in the Drive Washer keyway and also any scraping on the Backplate.

Loose Propeller Nuts allow sideways movement of the Drive Washer resulting in a worn keyway.

As the Camshaft is located at right angles to the Crankshaft and driven by a crossed helical gear, both gears must hold their precise position to ensure correct Cam timing.

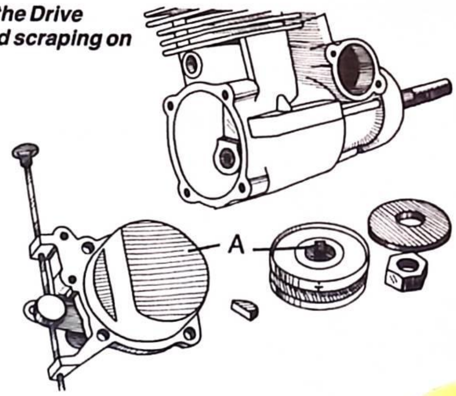
Any rear movement of the Crankshaft will alter the timing.

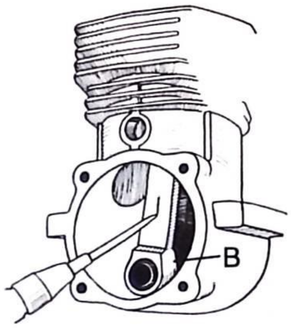
(19) MARKING THE CONROD

Some Conrods are chamfered only on one side. This chamfer is placed next to the Crankweb (B).

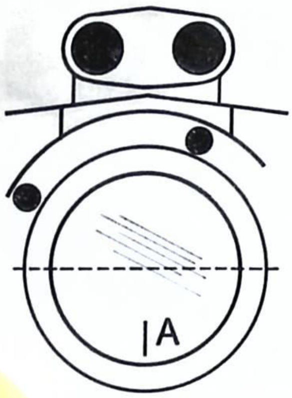
Before removing the Conrod from the engine, mark it with a scriber for correct assembly later.

Check for wear on the Drive Washer keyway and scraping on the Backplate (A).

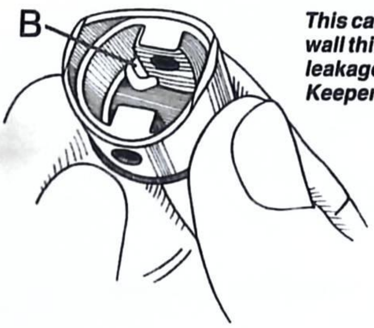




Before removing the Conrod from the engine, mark it with a scriber.



Mark the top of the Piston before removing (A).



This cast block (B) provides a wall thickness to prevent leakage through the Piston Ring Keeper Hole.

(20) MARKING THE PISTON

It is advisable to mark the top of the Piston (A) either fore or aft of the Conrod center line, before extracting the Gudgeon Pin.

A careful look at the inside of O.S. Pistons will reveal a small protruding cast block (B) attached to the base of the Gudgeon Pin boss. This block provides a reasonable wall thickness to prevent leakage of the cylinder pressure through the Piston Ring Keeper Hole.

O.S. 4-stroke engines have no need for Piston Ring Keepers as there are no cylinder ports to catch the ends of the Piston Ring. However, O.S. engines are assembled with this internal cast block always in the same position.

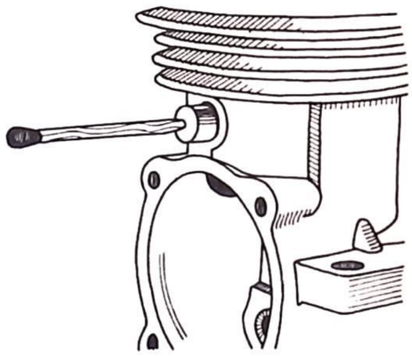
(21) REMOVING GUDGEON PINS

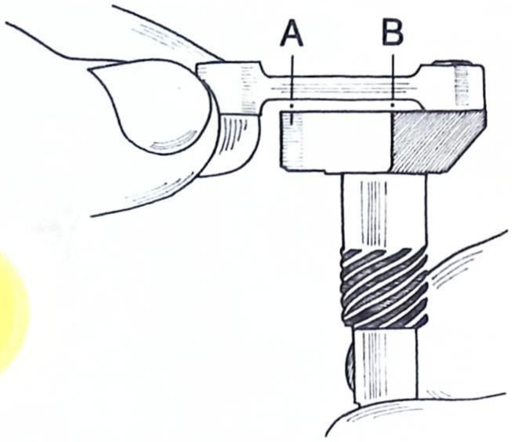
If your 4-stroke has a Gudgeon Pin removal hole in the rear of the Crankcase, the Gudgeon Pin must be extracted through it before the Piston and Conrod can be removed.

To extract the Gudgeon Pin from the Piston, sharpen the end of a match and insert it through the Crankcase hole pressing it into the center of the nylon end pad.

Slowly pull out the Gudgeon Pin. Sometimes only the end pad comes away, then use an unsharpened match to withdraw the Gudgeon.

If the Piston is heavily carboned, the Gudgeon Pin may be difficult to extract due to a layer of carbon deposited around the inner edge of the Piston's Gudgeon Pin hole. This carbon can be carefully removed with the point of a needle. In extreme cases, such as seizure of the Gudgeon Pin to the Piston, it may require a fairly drastic measure such as cutting the Conrod in half using a Hobby Grinder.





A quick check of the distances between (A) and (B) will show large bends.

(22) BENT CONRODS

Hydraulic locks are always possible with 2-strokes and 4-strokes. As fuel enters the 2-stroke Crankcase, a hydraulic lock is less a problem, but because the 4-stroke's direct entry of fuel is into the combustion chamber, excess fuel has no means of release. To prevent bent Conrods, don't over-prime the 4-stroke and make sure the Piston can turn over TDC by hand before connecting the Glowplug battery.

Bent Conrods are a cause of engine vibration.

A quick check of the distances between (A) and (B) will show large bends.

Slight bends are much harder to see and require the use of special dial gauge equipment to locate the bend. Always replace the Conrod if bent, never attempt to straighten it.

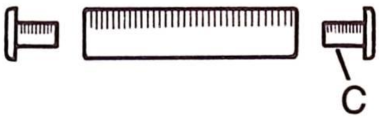
(23) PISTON AND GUDGEON PIN EXAMINATION

The Piston Ring must move freely around its ring groove. Build-up of carbon or varnish should be removed. Again, the use of a match trimmed to fit the Piston Ring groove, some methylated spirits and an old toothbrush will clean the varnish.

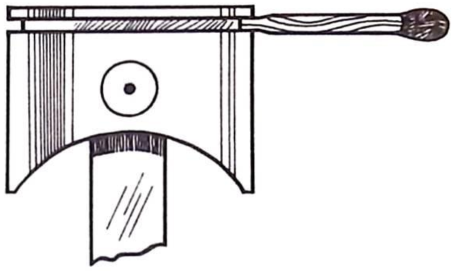
General Piston cleaning can be safely carried out using a small piece of plastic pot scourer mentioned in section 34 about cleaning.

Before starting this operation, read section 27 about handling Piston Rings.

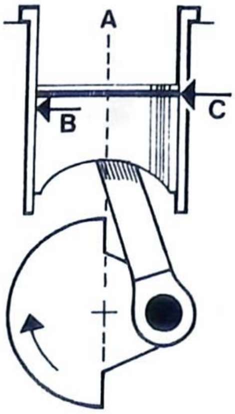
The Gudgeon Pin must not be run without its nylon End Pads (C). These pads seldom give trouble, however, if ill-fitting or worn on the ends, they should be replaced.

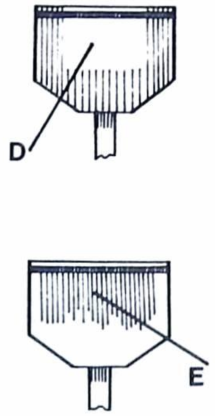


Replace nylon end pads if worn (C).



To remove varnish, use a match to fit the Piston Ring groove.





(24) REAR BEARING WEAR AND PISTON MISALIGNMENT

When the Crankshaft rear Bearing becomes very worn, the engine suffers a misalignment from its center line (A). When this happens, the Conrod takes on a lower angle than normal which increase the Piston sidethrust at (B) and Piston scuffing can be seen at (D).

This added sidethrust upsets the Piston Ring, breaking its seal at (C).

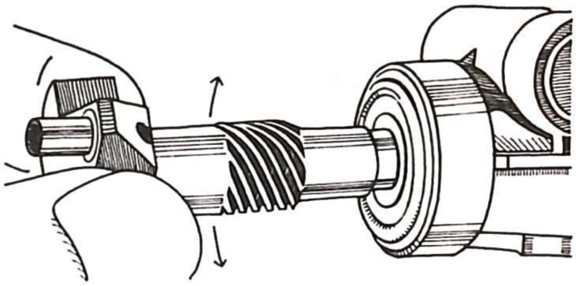
Valuable combustion gases are blown-by the Piston resulting in a coating of varnish below the Ring (E). When this engine is asked to deliver maximum torque, say in a steep climb, its performance is poor.

(25) REMOVING THE CRANKSHAFT

Holding the engine on end, place a block of wood on the end of the Crankshaft, strike the block a sharp blow with a hammer.

(26) FRONT BEARING TEST

Before removing the front bearing from the Crankcase, slide the Crankshaft into the Bearing and move it sideways to feel the Bearing tolerance. This test needs to be carried out on old and new Bearings to gain experience of the correct feel.



Reverse the Crankshaft for the front Bearing test.

(27) HANDLING PISTON RINGS

Model engine Piston Rings are delicate.

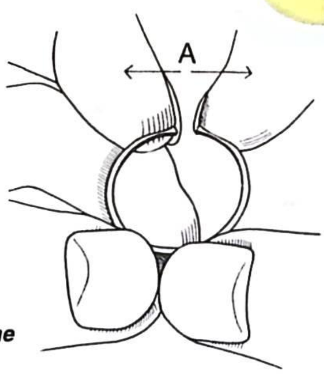
Their removal from the Piston requires careful attention to avoid stretching.

Use your fingernails with an outward movement to ease the Ring from the Piston (A).

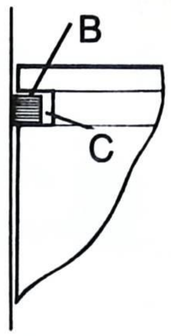
When fitting a Ring, don't rotate and screw the end of the Ring onto the Piston because this gives the Ring a twist which can cause an uneven seal during the compression stroke.

While re-fitting a used Ring, watch for the different color staining on the top and bottom surfaces of the Ring. Place the more stained side towards the top of the Piston.

My experience with 4-stroke Piston Rings is, if correctly run-in they will last at least three years. When a Ring approaches the end of its life, a tar build-up on the surface of the Ring starts to hinder its correct function.



Use your fingernails with an outward movement to ease the Ring from the Piston.



The airspace above (B) and behind (C) the Ring must be kept clear of varnish and carbon.

The tar is embedded into the Ring structure in layers, too fine to be seen with the naked eye and cannot be removed with washing.

As power loss appears quite suddenly with Rings, many modelers mistakenly search for the sudden loss of engine performance in fuel tanks and Carburetors.

(28) RING FUNCTION

Piston Rings don't seal by their own springiness, but rely on the upper cylinder pressure to seal them against the cylinder wall. This function can only happen correctly if the air space above (B) and behind (C) is kept clear of varnish and carbon.

(29) PISTON RINGS AND LUBRICATION

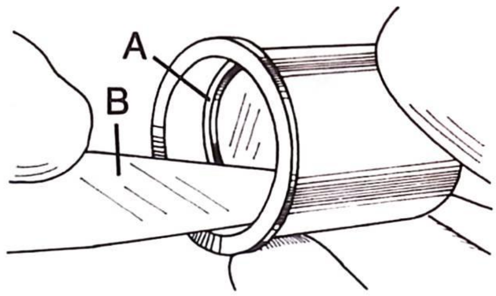
It is by careful design that engine designers elect to use the Ringed Piston for their 4-strokes. As the fuel/oil enters the combustion chamber via the Inlet Valve some of it is blown-by the Piston Ring during the idle strokes.

The oil contained in this mixture is the only lubrication the engine receives for its vital parts, e.g., Bearings and Cam gear.

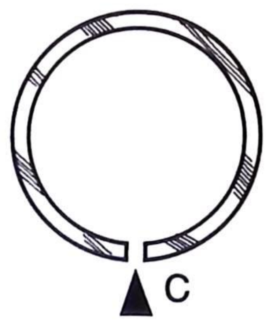
If there is a malfunction of the Piston Ring, and the engine does not receive the correct amount of oil, engine wear is then very rapid.

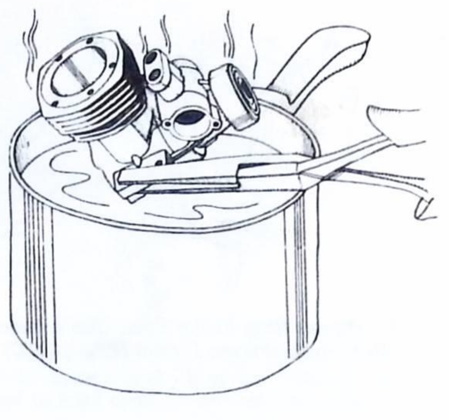
Correct Piston Ring gap plays an important part in the function of the Ring and to check this gap, place the Ring into the liner, about two thirds up the bore (A), push the Piston against the Ring to square it with the bore and use a set of feeler gauges to measure the Ring gap.

Piston Ring gap for an FS.20 is approx. .004 inches (.10mm) and .010 inches (.25mm) for an FS 1.20.

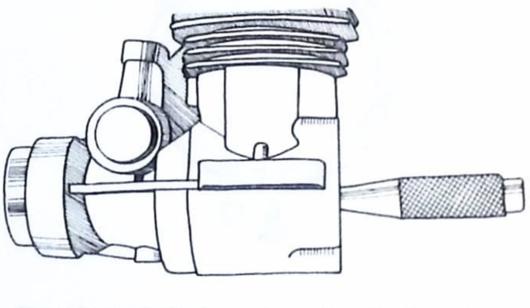


(A) is the Piston Ring in the liner. Use a feeler gauge (B) to measure the Piston Ring gap (C).





Boil enough water to completely cover the Crankcase.



Use a large shafted punch or a length of wooden dowel.

(30) HEATING THE CRANKCASE

I have always considered the most important part of a model engine to be the Crankcase.

The entire performance of all the internal parts rests on the accuracy of its outer casing. Excessive, or uneven heating of Crankcases using ovens or blow torches will quickly shorten the life of an otherwise perfect engine.

The safest way is to boil enough water to completely cover the Crankcase. Reduce the boiling to a simmer and place the Crankcase into the water for 2-3 minutes.

Remove the Crankcase and keep it hot by handling it in a thick rag.

Always fit the Crankshaft with its Bearings COLD, to obtain a maximum expansion difference between the Bearings and the Crankcase.

(31) FRONT BEARING REMOVAL

While the Crankcase is hot, remove the front Bearing using a large shafted flat punch or a length of wooden dowel. The diameter of the punch should be large enough to cover the face of the inner Bearing ring. Tap lightly with the hammer.

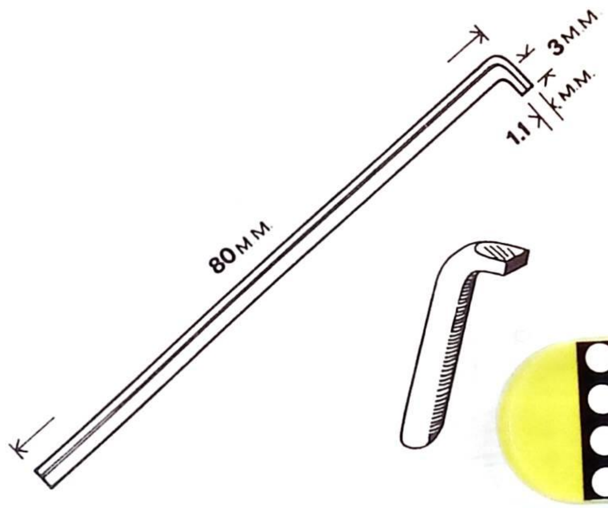
(32) MAKING A SPECIAL PUNCH

Making this special punch will greatly assist you in the removal of all rear Bearings.

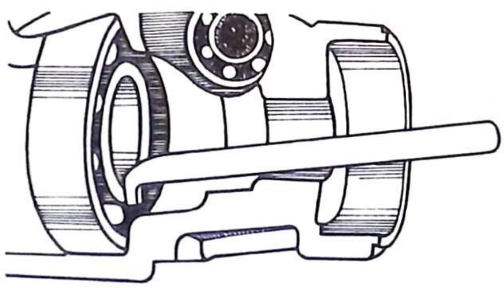
Using some music wire about 4mm in diameter, heat the end of the wire on a gas burner until the wire glows bright red. Bend the end of the wire to a right angle (90 degrees) and allow it to air cool. Grind the end to the measurements on the drawing.

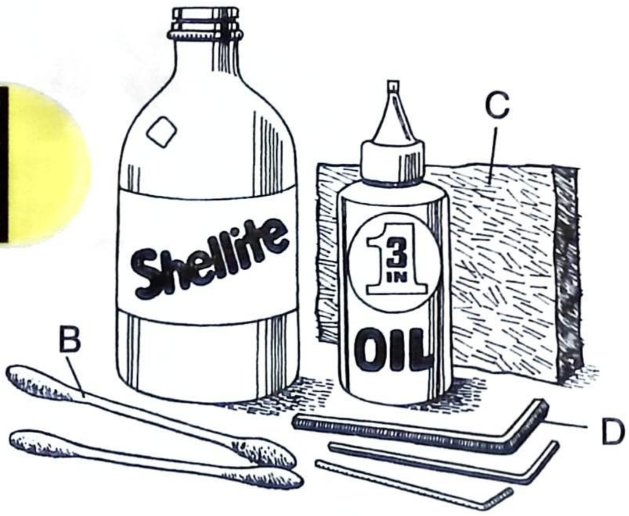
(33) REMOVING THE REAR BEARING

While the Crankcase is still hot, place the toe of the special punch down the gap between the Bearing and the Crankcase. Move the toe to different positions on the Bearing ring at the same time tapping lightly with a hammer.



Place the toe of the special punch down the gap between the Bearing and the Crankcase.





Only simple items are needed to service 4-strokes.

(34) CLEANING EQUIPMENT

Only simple items are needed to service 4-strokes. Cotton swabs (B), for tight corners; a green plastic pot scourer (C), obtainable at most supermarkets; a set of Allen keys (D); some Shellite; 3 in 1 light machine oil and an old toothbrush.

Carbon deposits on Valves can be scraped with a dull blade, the pot scourer dipped in Shellite for Pistons and Heads.

Some light stains or varnish seem to respond to methylated spirits if soaked for a while.

Don't use Petrol, Kerosene or Acetone to clean engine parts. Petrol is dangerous to your health, Kerosene acts as a cutting compound and Acetone attacks any plastic parts on Carburetors.

Nitromethane users should flush their engines with pure Methanol after use, then lubricate all parts with 3 in 1 light machine oil. This will help to reduce the Nitric Acid formed during the combustion process. Some Gun oils are designed to dissolve the brass particles which accumulate in guns.

If you intend long storage of your valuable 4-stroke, you may like to try Mercury Outboard Storage Oil, then seal the engine in a plastic bag after removing as much air as possible.

(35) ABOUT BEARINGS

Occasionally I hear adverse comments from modelers about the loose feel of Japanese Bearings compared to those locally obtainable.

This loose feel is no indication of inferior Bearing quality as O.S. Bearings are very robust and have a good working life.

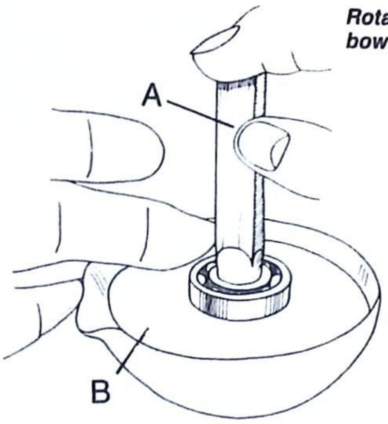
Modelers seeking replacement Bearings from local suppliers must take care to ensure their Bearing choice can handle the R.P.M. and the loads put on them by the engine.

The choice of very high precision Bearings will require equally high precision Bearing housing alignment.

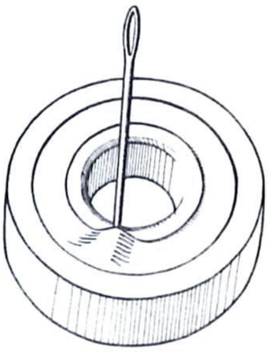
These Bearings are not suitable for many engines and are easily ruined by a simple thing such as an out of balance Propeller.

Excessive amounts of Castor Oil remaining in Bearings while lying idle for a considerable time, will solidify around the Bearing Cage.

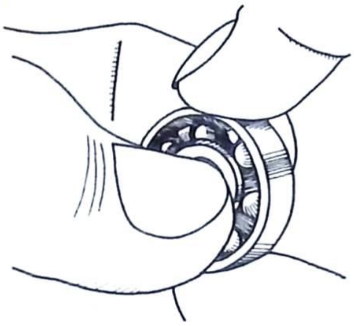
If not noticed before restarting the engine, a broken Bearing Cage is possible. Once the ball bearings lose their precise spacing, considerable engine damage is imminent.



Rotate the Bearing in a bowl of Shellite.



Use a sewing needle as a lever to remove the Dust Covers.



Grip the inner and outer Bearing rings and rock each ring against the other.

(36) CLEANING BEARINGS

Shape one end of a small Balsawood peg (A), and after attaching the Bearing, rotate it in a bowl of Shellite (B).

Small particles of dirt washed from the bearing can be seen in the bottom of a white bowl. Repeat the process a few times until the bowl becomes clean.

If Castor Oil remains in engines for long periods, it will gradually solidify behind the Dust Covers of the Bearings. A way to save these Bearings is to remove their Dust Covers and wash out the offending gum. The Covers cannot be replaced. It is much better for the oil to pass through the Bearing during operation, than to collect behind the Dust Covers where it can eventually result in Bearing failure.

(37) TESTING BEARINGS

After the Bearings are clean, grip the inner and outer rings and rock each ring against the other to test for wear.

Try testing new and used Bearings to acquire some knowledge of fit, and if movement is excessive, replace the Bearing.

Next, place a drop of light machine oil on the Bearing, rotate it, and at the same time feel for smoothness. Worn Bearings often feel rough or gritty and should be replaced.

(38) PURCHASING THE RIGHT PART

O.S. engines have a range of more than ninety different models and a large diversity of spare parts. It is therefore advisable to state the correct factory name of the part and in particular its computer number.

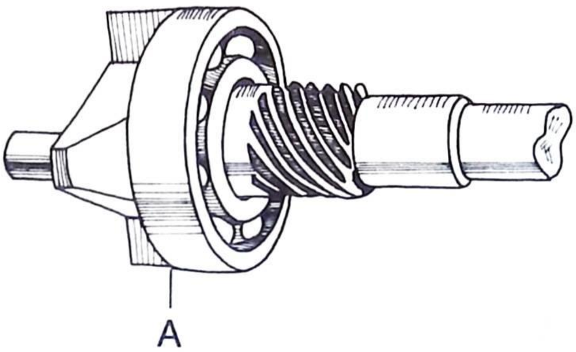
This information is printed on the back of your engine instruction sheet.

An engine purchase date can also be handy as sometimes modifications continue to be carried out on an engine model after its initial release.

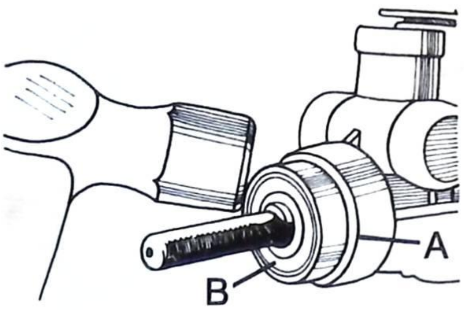
(39) STEP BY STEP ASSEMBLY

The first step is to assemble the Crankshaft with its two Bearings. We start with the rear Bearing. After heating the Crankcase in the pot of boiling water, described in section 30, slide the rear Bearing onto the Crankshaft right up to the Crankweb (A). Make sure it's hard against the Crankweb before pushing the Crankshaft into the heated Crankcase.

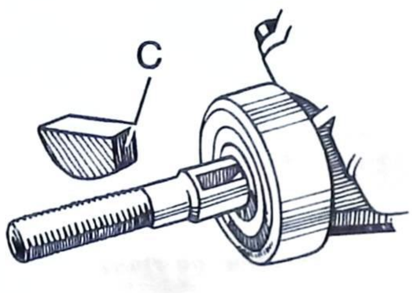
Using the Crankshaft for this operation helps to keep the Bearing aligned correctly as it enters its housing. Apply thumb pressure and push the Crankshaft as far as it will go. Follow up with a block of wood placed on the Crankweb face and tap lightly with a hammer until resistance is felt. This indicates the Bearing is seated firmly in its housing.



Slide the rear Bearing right up to the Crankweb (A).



Tap around the very edge of the Bearing.



If the Woodruff Key has a blunt end (C)!

(40) THE FRONT BEARING NEXT

Before the Crankcase cools, slide the front Bearing on the Crankshaft and up to the front of the Crankcase Bearing housing, by hand.

Then tap around the very edge of the Bearing until it's seated in the final position, i.e, level with the front of the Crankcase (A). Be careful not to strike the Bearing dust cap (B). Lubricate the Bearings with some 3 in 1 oil.

(41) DRIVE WASHER, WOODRUFF KEY, etc.

Turn the Crankshaft so the keyway in the Crankshaft is at 12 o'clock and slide the Woodruff Key into place. If the Woodruff Key has a blunt end (C), place this end next to the Bearing. Slide the Drive Washer on plus a short piece of tubing to act as a spacer, a propeller will do, then the Propeller Washer and tighten the nut.

Rotate the Crankshaft and check for binding in its Bearings. If they're not free, repeat the earlier step with the wooden block on the Crankweb and a tap with the hammer.

Leave the Crankshaft with its spacer in, until we fit the Camshaft.

(42) CONROD, PISTON AND LINER

Push the ringed Piston into the Liner from the bottom leaving the Gudgeon Pin clear (A).

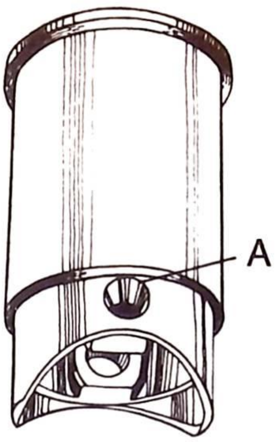
Connect the Conrod to the Big End, watching for the chamfer side on the Conrod Big End Bearing, see section 19. Slide the Liner into the Crankcase aligning the Gudgeon Pin hole opposite the Crankcase hole.

Now line up the Conrod Little End with the Crankcase hole. Fit the Gudgeon Pin and slide the Liner down until its top flange is sitting on the top of the Crankcase.

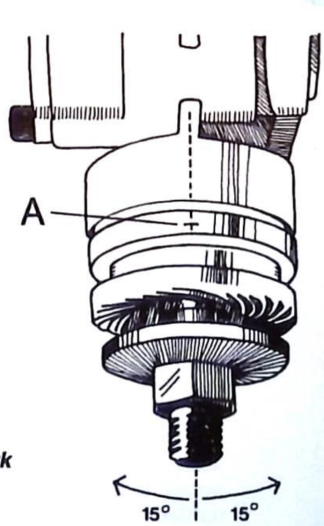
(43) CAMSHAFT TIMING

Before fitting the Camshaft, oil the Camshaft Bearings with some 3 in 1 oil and if you have an FS-20, FS-26, the two Thrust Balls. Make sure the central hole in the end of the Camshaft (E) is pointing towards you, see section 10.

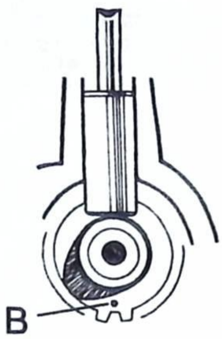
Hold the Crankshaft timing mark steady at the 12 o'clock position (A) and spirally rotate the Camshaft into its housing until the Camshaft timing mark comes to rest at the 6 o'clock position (B). The Camshaft timing is now complete. Close the Camshaft housing with its cover.



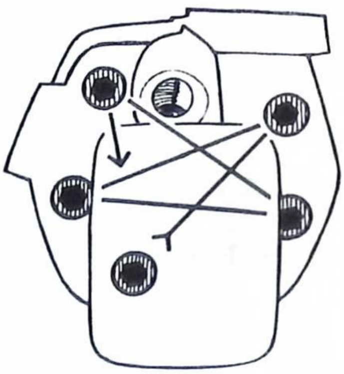
Push the ringed Piston into the Liner from the bottom leaving the Gudgeon Pin hole clear (A).



Hold the Crankshaft timing mark steady at the 12 o'clock position (A).



The Camshaft timing mark comes to rest at the 6 o'clock position (B).



Always tension the Head bolts by moving to opposite sides of the Head as each bolt is tightened.

(44) THE CAM FOLLOWERS

Oil the Cam follower guides and insert the Cam followers, making sure the Cam follower holes which accept the Pushrods are at the top.

(45) HEAD, GASKET AND PUSHROD COVERS

To avoid distorting the Liner, always tension the head bolts by moving to opposite sides of the head as each bolt is tightened. The following order secures the Head correctly —

1. Make sure the Head Gasket is seated.
2. Fit the Pushrod Covers with their "O" rings attached and the Head together, hold in position.
3. Finger tension the Head bolts with an Allen key.
4. Rotate the Pushrod Covers to check that they are seated properly on their "O" Rings.
5. Half tension the Head bolts in the order described.
6. Rotate the Crankshaft and feel for Piston binding.
7. Complete the bolt tensioning, firm but don't over tighten.

(46) PUSHRODS AND FIRING TOP DEAD CENTER (TDC)

Press the Pushrods down into the Pushrod covers to engage the Cam followers. Place a finger on the top of each rod and rotate the Drive Washer timing mark left and right of the 12 o'clock position, see illust. section 43.

If both Pushrods move, rotate the Crankshaft one whole turn to bring the Camshaft lobes to the correct position for Tappet adjustment.

Tappets are always adjusted when the Cam followers are at rest on the back of their Camshaft lobes.

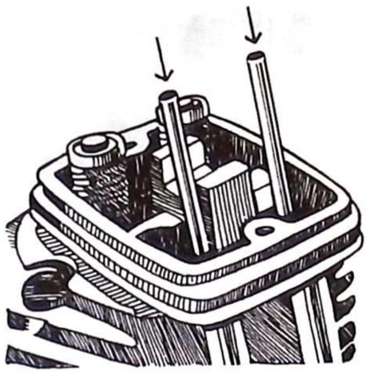
My term for this is the FIRING TDC POSITION.

(47) ROCKER ASSEMBLY

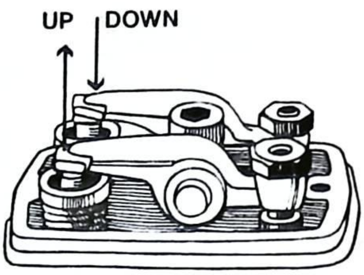
Screw on the Rocker assembly. See section 7 regarding two systems.

Don't over tighten the small grub screw used to secure the "Slide-in" Rocker shaft type.

Next, wind down each Tappet Adjuster until its cup is seated on its respective Pushrod.



Press the Pushrods down into the Pushrod covers to engage the Cam followers.



While rotating the Drive Washer each side of the 12 o'clock position, observe one Rocker rise while the other falls.

(48) FIRING TOP DEAD CENTER POSITION

If you have not completed section 46 then, rotate the Drive Washer timing mark about 15 degrees each side of the 12 o'clock position. If one Rocker rises while the other falls, rotate the Crankshaft one turn to bring the Cam lobes to the FIRING TOP DEAD CENTER position.

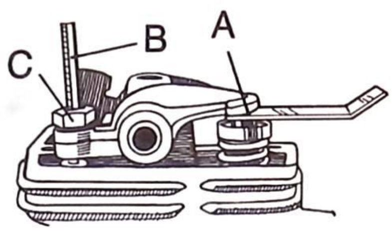
Incorrect Tappet adjustment using the wrong TDC leaves the Cam followers dangerously slack. Instead of the Cam followers being in contact with their Cam lobes, the Cam is free to deliver sledge hammer blows to the surface of the Cam follower, resulting in rapid wear.

(49) ADJUSTING THE TAPPETS

Before adjusting the Tappets, read section 48.

The Tappets should only be adjusted when the engine is COLD. Each engine is supplied with two steel Feeler Gauges. The thickness of the thin gauge is .04mm or .0015 inches and the thick gauge, .10mm or .004 inches.

Slide each Feeler Gauge in turn between the top of the Valve and the Rocker (A) and adjust the Tappet screw with an Allen key (B) until the thick gauge will not pass through the gap, but the thin one will, then tighten the lock nut (C). Use the Feeler Gauges to recheck the gap.



Adjust the gap between the Valve and the Rocker (A) using a small Allen key (B), then secure the lock nut (C).

(50) THE FINAL CHECK

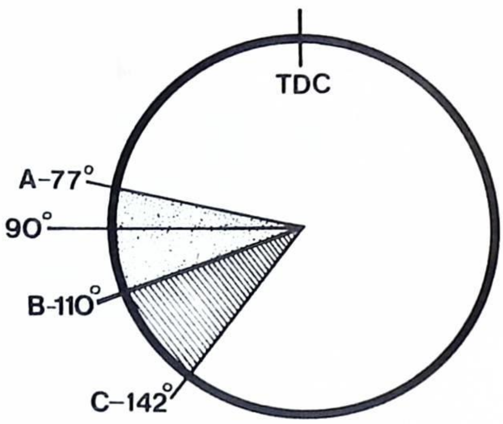
Before finally fitting the Rocker Box Cover, carry out the following visual check.

Let's go back to the Drive Washer timing mark.

Rotate the Crankshaft to the Firing Top Dead Center position explained in section 48.

Remember, when we are at the Firing Top Dead Center position, there is no movement of the Rockers if the Crankshaft is rocked backwards and forwards.

After TDC the Piston starts its descent, the Crankshaft rotating anti-clockwise.



Degrees of anti-clockwise turn of the Crankshaft after ignition at T.D.C.
(B), the Camshaft timing is right.
(A), the Camshaft is advanced one tooth.
(C), the Camshaft is retarded one tooth.

At the 90 degrees position, the Drive Washer timing mark is level with a horizontally cast web which goes from the front of the Crankcase to the engine bearer.

Continue to rotate the Crankshaft slowly for about another 20 degrees, at the same time, looking to see the first sign of movement of the Exhaust Valve Rocker, and STOP.

This position is approximately 110 degrees after TDC as shown on the timing wheel sketch at (B).

This confirms your engine timing and Tappet adjustment is correct.

LET US TAKE THE O.S. 48 SURPASS AS AN EXAMPLE.

It has a 22 tooth Camshaft. If we divide 360 degrees by 22, we find each tooth represents 16.3 degrees of movement.

As the Camshaft turns at half the Crankshaft revolutions, this represents 32.7 degrees of Crankshaft movement for each tooth. The 4-stroke will tolerate only small amounts of advancing or retarding of say 4-6 degrees of Camshaft movement, but will not tolerate 16.3 degrees which represents one tooth out of timing. If the Crankshaft was advanced one tooth, the Rocker would start to move before 90 degrees, or more precisely 77 degrees at position (A). And if the Camshaft is retarded one tooth the Valve would start to open at about 142 degrees of Crankshaft timing, at (C).

The number of teeth on the Camshaft may vary on different models of O.S. 4-strokes, but the general principle outlined above can be used as a final check on all later designs.

(51) 4-STROKE, 2-STROKE INLET/INTAKE COMPARISONS

When we look at the diameter of a 4-stroke Inlet and compare it to its 2-stroke counterpart, we see the 4-stroke is very much smaller.

Let us compare 2 engines of the same capacity, namely the O.S. .61 SF which has an Intake diameter of 11.4mm and an O.S. FS-61 4-stroke Inlet of only 7.2mm.

Perhaps we should ask: if the engines are the same capacity why then aren't their Inlet/Intake diameters the same?

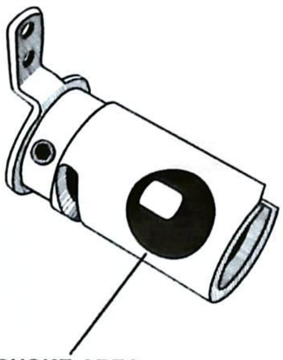
To answer this question, we have to consider not just the Inlet/Intake diameters, but the Valve Inlet/Intake periods of the two engines.

These are very different, the 4-stroke's Inlet Valve is open for 300 degrees of Crankshaft rotation, while the 2-stroke Intake period is about 190 degrees.

The following proportional sum shows that the Inlet/Timing Period of the two engines is approximately the same.

$$\frac{\text{2-stroke Intake diameter in mm}}{\text{4-stroke Inlet diameter in mm}} \times \text{2-stroke timing period in degrees}$$

$$\frac{11.4}{7.2} \times 190 = \text{300 Degrees, 4-stroke Inlet period}$$



(52) CALCULATING THE CORRECT CHOKE SIZE

Efficient carburetor function depends on a high velocity of air flowing through the Choke. The incoming fuel, which is at atmospheric pressure, flows into the Choke where the pressure is slightly below atmospheric due to increased speed of the air.

This air speed and subsequent lowering in atmospheric pressure is mainly caused by the Bore/Choke ratio and the RPM of the engine. If the Choke is too small, then horsepower is limited. When it's too large, poor air-fuel mixing occurs. So selecting the right Choke size is vital for maximum engine performance. To calculate the Bore/Choke ratio expressed as a percentage (%), divide the Bore area by the Choke area and multiply by 100.

The following are typical Bore/Choke percentages of O.S. engines.

2-stroke	suction tank	11% of the Bore*
2-stroke	pressure tank	20% of the Bore*
4-stroke	suction tank (small capacity engine)	3-5% of the Bore*
4-stroke	suction tank (large capacity engine)	7-8% of the Bore*

* Including the deduction for the protruding jet.

(53) CARBURETORS AND IDLE JETS

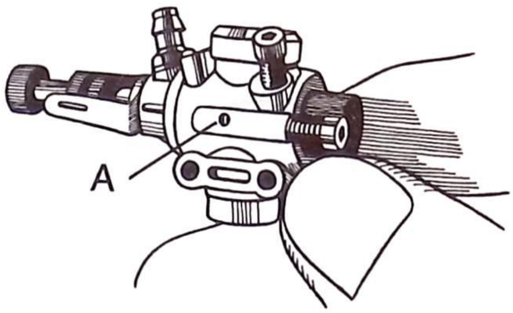
There are basically two types of Carburetors used on O.S. 4-strokes. Both air controlled by a drum and the fuel metered with a Needle Valve assembly.

The FS-.20, .26, .40, .48, .61 use a simple Air Bleed Screw to regulate the idle.

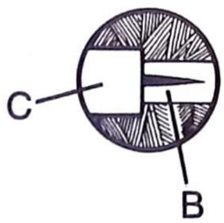
As the drum is rotated to close off the main air supply, the engine draws a much reduced supply of air via the air bleed hole (A). This hole is regulated by the Air Bleed Screw.

The FS-.70, .90, .91, 120 carburetors regulate the fuel using a more precise method of metering. When the barrel rotates closing the main air supply, it moves inwardly, sliding the brass sleeve of the Idle Jet (C) gradually closing the elongated fuel slot (B).

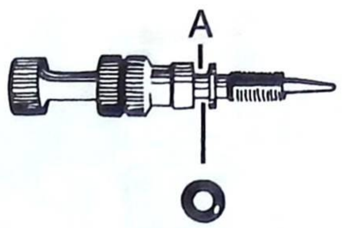
Adjustment to the Idle Jet Screw (illust. section 55B) changes the relative position of the brass sleeve.



A simple Air Bleed Screw closes the air hole (A) to regulate the idle.



The brass sleeve of the Idle Jet (C) gradually closes the elongated fuel slot (B).



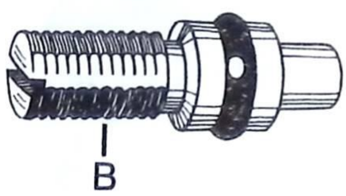
A bend at this point (A), causes the "O" Ring to lose its seal.

(54) NEEDLE VALVES

When a model aircraft crashes, the most accident prone part of a model engines is the Needle of the Needle Valve Assembly.

If the Needle is bent, this is most likely to be at the point where its diameter is smallest, which is at the position of the "O" Ring. A bend at this point causes the "O" Ring to lose its seal. When the engine is set to idle, it is vital that it draws the correct mixture according to the setting of the metering system.

But when the Needle is bent at this point, the "O" Ring seal is broken and air can be drawn down the stem of the Needle Assembly which alters the air/fuel mixture.



Winding the Idle Jet in and out excessively, wears the brass threads (B).

(55) IDLE JET WEAR

If the Idle Jet is wound in and out excessively, the brass threads (B) soon become worn.

When the Idle Jet is set during warm up, it can appear to be working correctly, but in flight due to vibration this brass Idle Jet will begin to slowly turn, altering your idle setting. As you throttle back to idle, the engine may go lean or even stop.

(56) FS-70, FS-90, FS-91 and FS-120 IDLE ADJUSTMENT

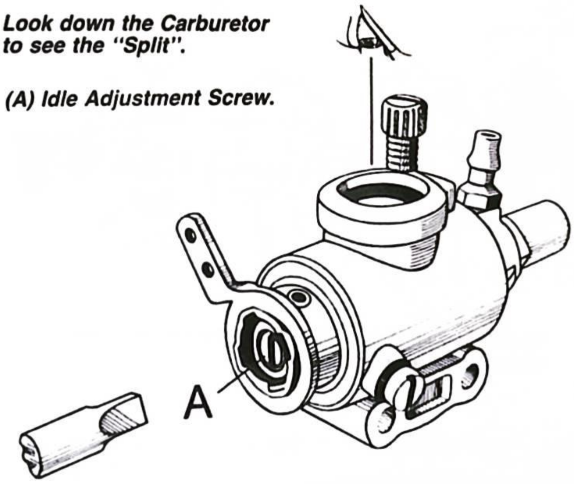
The method used to meter fuel is the same for all four Carburetors. Mechanical adjustment to obtain perfect idle can be done visually. After removing the Inlet Manifold, fully open the Carburetor Barrel. Looking down into the Carburetor, you will see a "Split" in the brass jet through which the fuel mixture is drawn. This "Split" is progressively covered by an outer brass tube, its length being adjusted by the Idle Adjustment Screw (A).

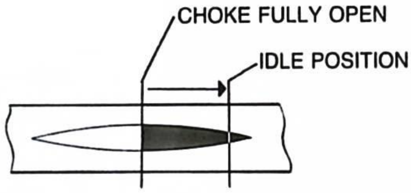
As the Barrel rotates and moves inward to the Idle position, the outer brass tube almost closes off the "Split", so progressively reducing the amount of fuel available to match the reduction in air due to the Barrel closing. Because we cannot see the "Split" when the Barrel is closed, adjustment is made when the Barrel is open. Perfect idle is achieved if we visually set the end of the outer brass tube so it is exactly in the center of the "Split" by turning the Idle Adjustment Screw.

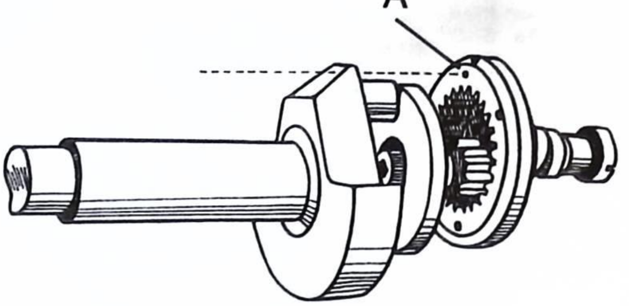
It must be remembered, this method of idle adjustment relies on the correct fuel viscosity. The Idle Jet mechanism is matched to a 15-20% castor oil based fuel. Synthetic oil users may find it necessary to close the "Split" slightly to compenate for the thinner oil.

Look down the Carburetor to see the "Split".

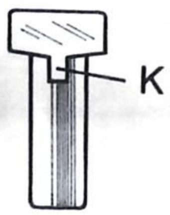
(A) Idle Adjustment Screw.







The timing mark (A) aligns with the center of the Drive Disk Big end slot.



The hammer headed Cam followers are machined on one side (K).

(57) TIMING THE REAR CAM 4-STROKES

There are 4 stages to be carried out to complete the timing of the Rear Cam 4-strokes.

1. If you have an O.S. FS-60 or FS-80, assemble the Camshaft in its Housing, securing it with the left handed screw, but don't tighten it at this stage. Oil all parts and slip in the Cam followers. If you have the FS-90, the Cam followers have hammer shaped heads and these must enter their guides from inside the Cam Housing.

These Cam followers, because they are positioned very close to each other in the Cam Housing, are machined on one side and these machined sides sit together when they are in their guides.

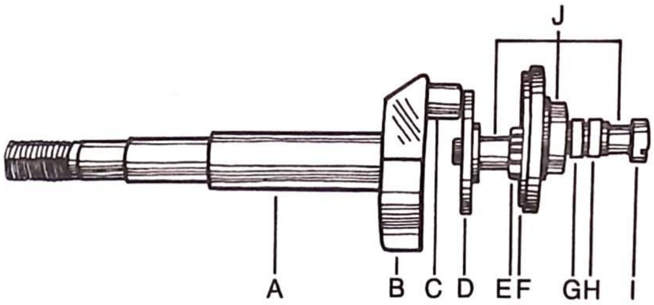
Oil the Cam followers and assemble the Camshaft in its Housing attaching the left handed screw as previously mentioned.

2. Next fit the Rear Housing Gasket, which is quite different in shape from the one on the Front Housing. Next, attach the Cam Housing to the rear of the Crankcase engaging the Pinion Gear on the Drive shaft with the Sun gear on the Camshaft front end. Align the timing mark on the face of the Sun Gear in line with the center of the Big end slot on the Drive Disk (A), both at the 12 o'clock position. The notch cut on the Camshaft rim is opposite the timing mark on the Sun Gear.

3. Before finally fitting the Front Housing, slide the Piston into the Liner with the Conrod attached and slide the liner into the Crankcase, positioning the Conrod in line with the slot in the Drive Disk. Watch for the Conrod chamfer, see section 19.

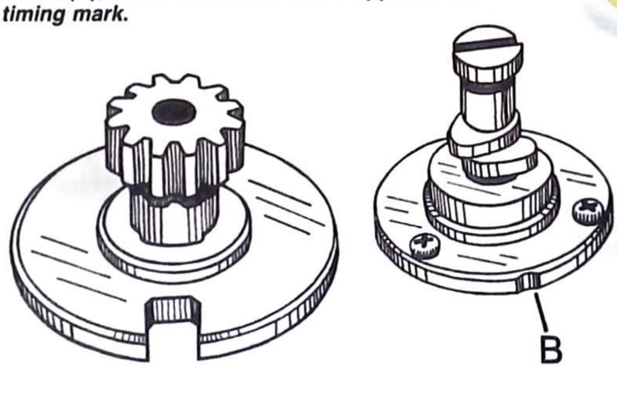
Hold the Drive Disk steady at the 12 o'clock position by using finger pressure on the left hand screw at the rear of the Housing. Position the Big End of the Crankshaft at 12 o'clock and slide in the Front Housing.

4. Tighten the front and rear Housing Screws, bolt a propeller to the Crankshaft and while holding the propeller, tighten the left hand threaded screw on the rear of the Camshaft.

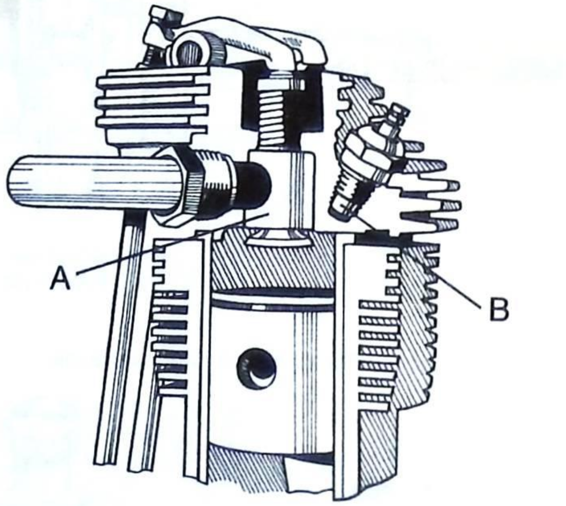


The drive mechanism of the Camshaft for the FS-60, FS-80 and FS-90.

A. Crankshaft	*F. Gear*
B. Crankweb	*G. Inlet Cam*
C. Big end	*H. Exhaust Cam*
D. Drive Disk	*I. L/H Threaded screw*
E. Pinion Gear	*J. Bearings*



Notch (B), on the Camshaft rim is opposite the timing mark.



(A) The FT-120 Valve Bell showing a depressed Exhaust Valve.

(B) Early O.S. 4-strokes had the Glowplug recessed well back from the Cylinder chamber.

(58) THE FLAT TWIN CYLINDER GEMINI FT-120, FT-120 II, FT-160, FT-240, FT-300

First take out the two Glowplugs and inspect each plug to verify the running condition of each Cylinder. See section 1.

Next, remove the two Rocker Covers, loosen the Exhaust and Inlet Manifold retaining nuts and the two screws holding the Inlet Manifold bracket which is attached to the Crankcase. Note the difference between the left and right hand Inlet Manifold tube for later assembly and check the condition of the three "O" Rings in the Inlet Manifold housing mount. Next, lift out the four Spacer Washers (exhaust, 2 copper), (inlet, 2 aluminum) from inside the Head Manifolds.

REMOVING THE ROCKER ASSEMBLY

Choose either the left or right Cylinder and while looking down the Glowplug cavity, rotate the Crankshaft Drive Washer until the Piston comes into view at Top Dead Center. Rotate the Crankshaft Drive Washer either side of TDC a few degrees watching the Rockers for movement. If the Rockers move, that is to say, one up and one down, transfer to the opposite Cylinder and remove the Rocker Assembly using your smallest Allen key.

Care should be taken not to force the two tiny Grub Screws, or use a damaged Allen key. See section 7 for more detail. Loosen the

Tappet Retainer Nuts, wind back the Tappet Adjusters and slide out the Rocker Shaft holding the Rockers and their Spacer. Remove the screw holding the Rocker Shaft Support Frame Assembly to the Head. Note which way it assembles. Now the other Cylinder's Rocker Assembly can be removed, but first rotate the Crankshaft Drive Washer, 360 degrees.

THE HEADS

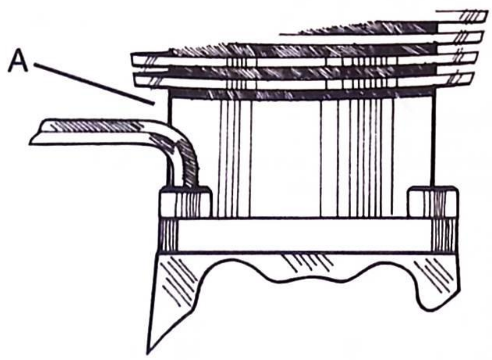
Unscrew all Head Bolts observing there are two different lengths of screws. This will release the Pushrod Covers which contain the Pushrods. Check the condition of the Pushrod Cover "O" Rings.

For information on cleaning Valves and Heads, see sections 11 and 16.

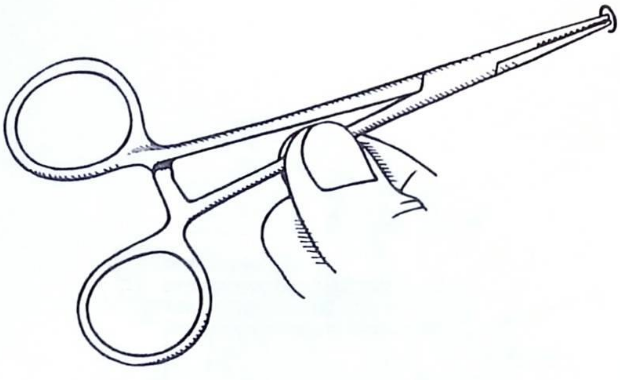
THE CYLINDER BARRELS

The base of each Cylinder Barrel and opposite Crankcase mount should be marked, so on assembly, the Cylinder Barrels align exactly in their original positions. A modification to your Allen key needs to be made so that it will clear the Head Fins. The short leg of the key needs to be shortened using a grinding wheel. Be sure to dip the hot end in water to help retain the key's hardness.

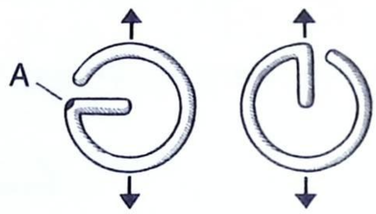
Sometimes Cylinder Barrel screws are very tight and can be quite difficult to remove. Using a small length of steel rod about 2 to 2.5mm in diameter and about 50mm long, insert one end into the head of the screw and strike the other end a sharp blow with a hammer. This has the effect of easing a binding screw, then use your modified Allen key.



(A) A modified Allen key is needed to clear the Head Fins.



Artery Forceps are kept firmly closed by the ratchet locking device.



Tag aligned with Piston motion can prevent wear at point (B).

Concentrating on one cylinder for the moment, first mark the Piston, see section 20, then remove the Cylinder Barrel, Circlips, Gudgeon Pin and Piston.

Circlips are quite common in 2-stroke engines and their removal often presents a problem to modelers. Because of their springy nature, Circlips gripped with pliers are apt to fly any place. Some modelers wrap the engine in a plastic bag to catch the Circlip, but the best method I have found is to purchase a pair of Artery Forceps from a medical supply company. These Forceps, when locked onto the Circlip allow its removal safely. Circlips should be checked for shape and alignment or replaced with new ones.

CIRCLIP PLACEMENT

When the Circlip Tag is placed horizontally, the reciprocating motion of the Piston can cause the Circlip to rotate in its groove, increasing the chances of wear at point (A). Piston motion has no effect, if the Tag is placed vertically.

Now dismantle the other Cylinder. For Piston information and cleaning, see sections 23, 27, 28, and 29.

THE REAR COVERPLATE

Remove all ten Rear Coverplate Screws observing that two of the screws have retainer nuts. Rock the Coverplate slightly to release it. We are now looking at the 24 tooth Pinion Gear and the 48 tooth Camshaft Gear.

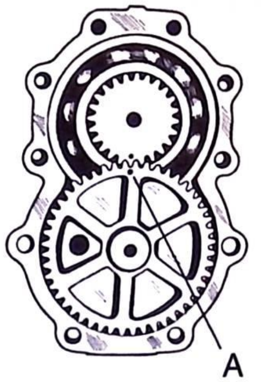
THE TIMING MARKS

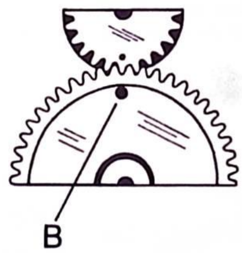
If your engine is the FT-120, then the Pinion timing mark is opposite a tooth and the Camshaft Gear mark opposite a space. However, on the FT-120 II, FT-160, FT-240, and the FT-300, the Pinion timing mark is the same, but the Camshaft Gear mark is directly opposite the 2.5mm hole drilled in the Camshaft Gear face.

Hold the Camshaft Gear face and withdraw the Camshaft from its housing. Use a probe to push the four Cam followers into the Camshaft housing. Replacement of the FT-120 Cam followers due to wear has not been necessary after three years of operation; however, sticking of Cam followers due to corrosion has been found. The sticking is caused by corrosive material building up on the sides of the Cam followers which can be removed using your plastic pot scourer and a little Shellite.

The Camshaft with its Cam lobes rotate at half the Crankshaft revolutions, the front lobe together with the Cam follower, Pushrod and Rocker Arm control in turn the opening and closing of each Exhaust Valve. The rear Cam lobe operates the two Inlet Valves.

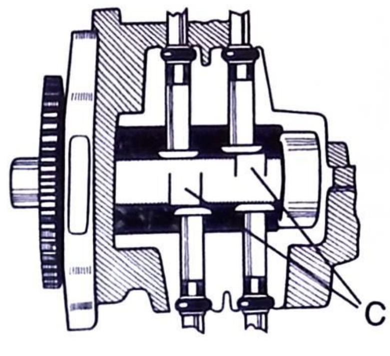
Cam followers are designed to rotate slowly during operation to increase the surface area and so reduce wear. This is achieved by setting the Camshaft lobes (C) slightly off-center with the Cam followers.





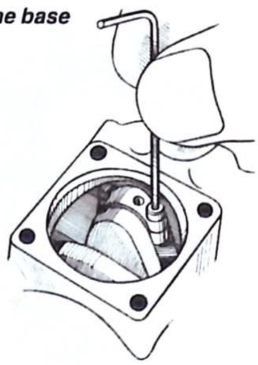
(A) FT-120 timing marks are opposite each other.

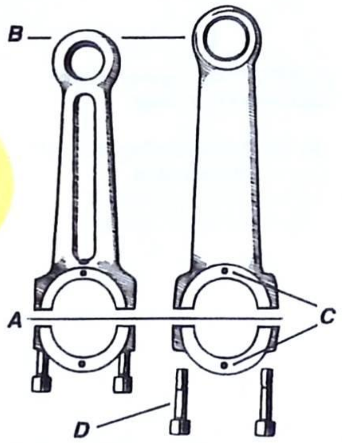
(B) The 2.5mm timing hole in the Camshaft Gear face.



(C) The FT-120 Camshaft Lobes are placed off-center to encourage the Cam followers to rotate.

Access to the Conrod Studs is through the base of the opposite cylinder.





(A) The FT-120 Split Conrod.

(B) The distance between the Conrod Centers of the FT-120 II is much shorter.

(C) Alignment Marks.

(D) The Studs

DISMANTLING THE CONRODS

All O.S. multi-cylinder 4-stroke engines have split Big End Bearings held together by two Studs, one on each side of the Bearing. Access to these Studs in say the left Cylinder, is by rotating the Crankshaft to Bottom Dead Center and removing them through the right hand Cylinder cavity and vice versa. Using the smallest Allen key and first making sure the key is in perfect condition, remove the two Studs. Great care should be taken not to damage the heads of these Studs, otherwise any further stripdown of your engine will be impossible.

Remove one Conrod at a time and examine it. You will see the assembly marks and note the direction the Conrod is fitted in the engine. If the bottom half of the Split Conrod is reversed, that is, the two register marks are not opposite one another, then when the Studs are tightened, the Bearing's running tolerance will not be correct.

Slide off the Drive Washer which is held by a Woodruff Key to the Crankshaft. Use boiling water to ease a tight Washer, see section 30. A light tap with a hammer on the front end of the Crankshaft will release it and the large rear Bearing. Use boiling water to remove the two Crankshaft Bearings. Camshaft Bearings seldom give trouble. They can be left in their housings and cleaned with Shellite, then lubricated. The large rear Crankshaft Bearing of the FT-120, FT-120 II, and FT-160 is subject to heavy loads and poor lubrication on the Coverplate side, and usually needs replacing.

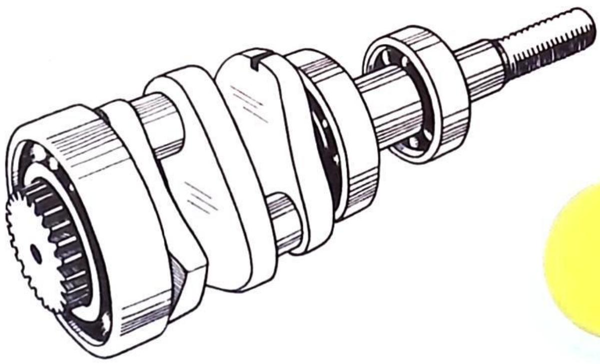
The Pinion Gears on the FT-240 and FT-300 are not part of the Crankshaft but are separate and attached to the rear of the Crankshaft by an alignment key and screw.

ASSEMBLY

After assembling the Crankshaft with its two front bearings, see sections 39 and 40, slide on the large rear Bearing.

Next, assemble the Drive Washer with its Woodruff Key to limit the lateral movement of the Crankshaft while attaching the Conrods. Next, place the larger section of the Conrod into the Crankcase Housing with the split Bearing sitting on the Crankshaft, being sure the Conrod is the right way around. Push the Conrod onto its Bearing, set the Crankshaft at Bottom Dead Center and turn the Crankcase over until the Conrod is coming up from the bottom. Using a pair of tweezers, place the smaller section of the Conrod in position, watching for the alignment marks. Tighten both Studs evenly and firmly, then rotate the Crankshaft to check the freedom of the Big end Bearing.

Next, move to the opposite Cylinder and fit its Conrod the same way. Also be sure to check the freedom of its Big End Bearing. Fit the ringed Piston, Gudgeon and Circlips on one Cylinder, slide on its matching Barrel and finger tighten the four Barrel screws. Move to the opposite Cylinder and complete its assembly, also finger tightening the Barrel screws. The correct seating of the two Cylinder Barrels on the Crankcase is very important. Starting with



The FT-120, FT-120 II and the FT-160 have a one piece Crankshaft with three Bearings.

all eight Barrel screws finger tight, turn the engine Crankshaft to feel the freedom in the Crankshaft, Piston, etc. Gradually cross tighten the Barrel screws feeling the mechanical freedom of the Pistons until all eight Barrel screws are tightened firmly.

CAM FOLLOWERS

The FT-120 Cam followers are assembled from inside the Camshaft Housing, and the FT-120, FT-160, FT-240 and FT-300 can be fitted after the Camshaft is in place.

CAM TIMING

First oil the Camshaft Bearings. Rotate the engine Crankshaft until the Pinion timing mark lines up with the Camshaft timing mark as the Camshaft is fitted. If your engine is the FT-120 II, FT-160, FT-240 or the FT-300, position the Pinion Gear timing mark opposite the 2.5mm drilled hole in the Cam Gear face. Now the Camshaft timing is complete. Carefully attach the Rear Coverplate, making sure the Timing is not disturbed and cross tighten all ten Coverplate screws.

ASSEMBLING THE HEADS

Holding the Pushrod Covers in place and checking that the Head Gasket is seated, fit the Cylinder Head. Finger tighten the Head bolts, then rotate the Pushrod Covers by hand to verify they are seated properly. Cross tension the Head bolts, see section 45 for further information regarding Head tightening. Press the Pushrods down into the Pushrod Covers to engage the Cam followers and complete the assembly of the Rocker Gear, see section 47.

THE TAPPETS

The final operation remaining is to adjust the Tappets on each Cylinder. As previously mentioned in sections 48 and 49, each Cylinder must be set at the FIRING TOP DEAD CENTER POSITION before Tappet adjustment can be carried out.

After adjusting one Cylinder's Tappets, rotate the engine Crankshaft 360 degrees before adjusting the opposite Cylinder. Failure to carry out this operation on the Gemini Flat Twin 4-strokes is likely to lead to a broken Crankshaft when the engine is started.

(59) RUNNING-IN THE ENGINE

The aim of running-in your O.S. 4-stroke is to bed-in the Piston Ring, the Big and Little End Bearings of the Conrod, free up the Bearings and establish running surfaces on the Camshafts, Cam followers and Rockers.

If the engine is to develop and maintain its best power output over a long period of time, then the bedding of the Piston Ring is the most important segment of the running-in process.

While bench running is okay, it is better to simulate actual engine operating conditions by bolting the engine into the model.

Proceed with a small amount of ground running and if the running-in is progressing according to plan, get the model into the air.

Use a balanced Propeller, slightly less in size and pitch than the engine would use under full load, after it has been run-in.

With a rich setting, run the engine in short bursts, then shut the Throttle quickly for a moment, then another short burst and so on.

This has the effect of drawing extra amounts of cool mixture into the engine helping to cool the Piston Ring.

After stopping the engine, test the Cylinder Head temperature. If it's too hot to touch, you have excessive Head temperature. The engine will need further running at an even richer needle setting.

The running-in period is between 1 and 2 hours generally, but your guide is when the engine temperature drops and it can operate on a normal needle setting.

Another guide to engine operating temperature is to observe the short steel Exhaust pipe after running.

At correct operating temperature, this pipe will remain clean and bright, but any bluing of the steel due to heat is a direct indication of excessive engine temperature.

The following should be checked —

1. Too lean a needle setting.
2. Engine not fully run-in.
3. Too low an oil content.
4. Using an unsuitable oil.

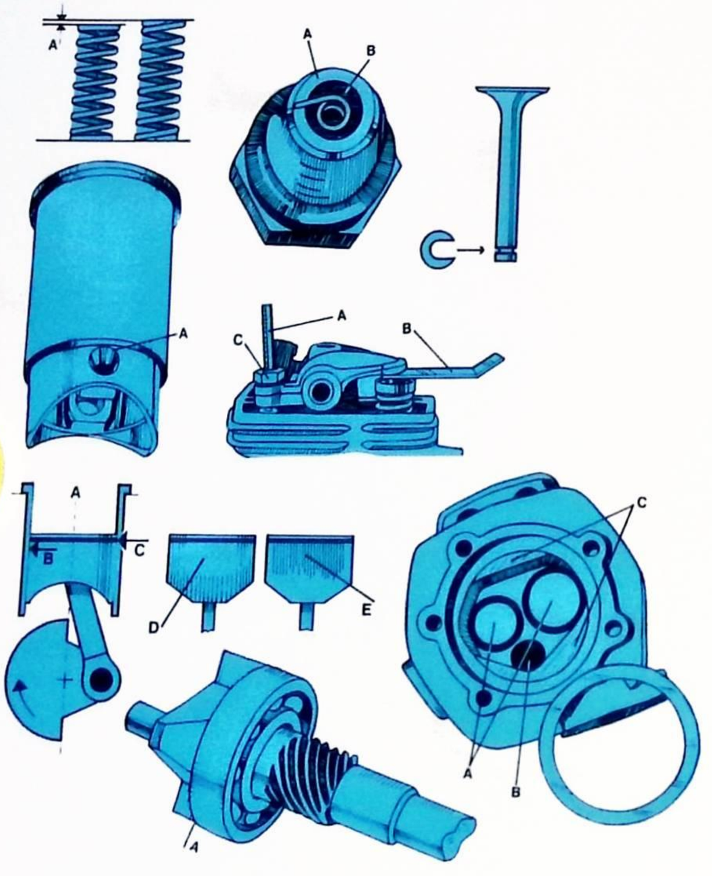
(60) BRAKE HORSEPOWER PER 100CC

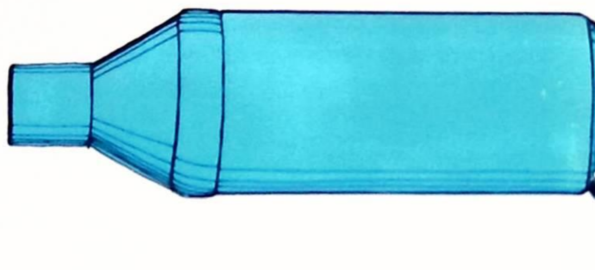
We are all familiar with the term BHP per Litre used by the automotive industry.

It is easy to relate the BHP of different engines by reducing their capacity to a common denominator, e.g., BHP per 100cc.

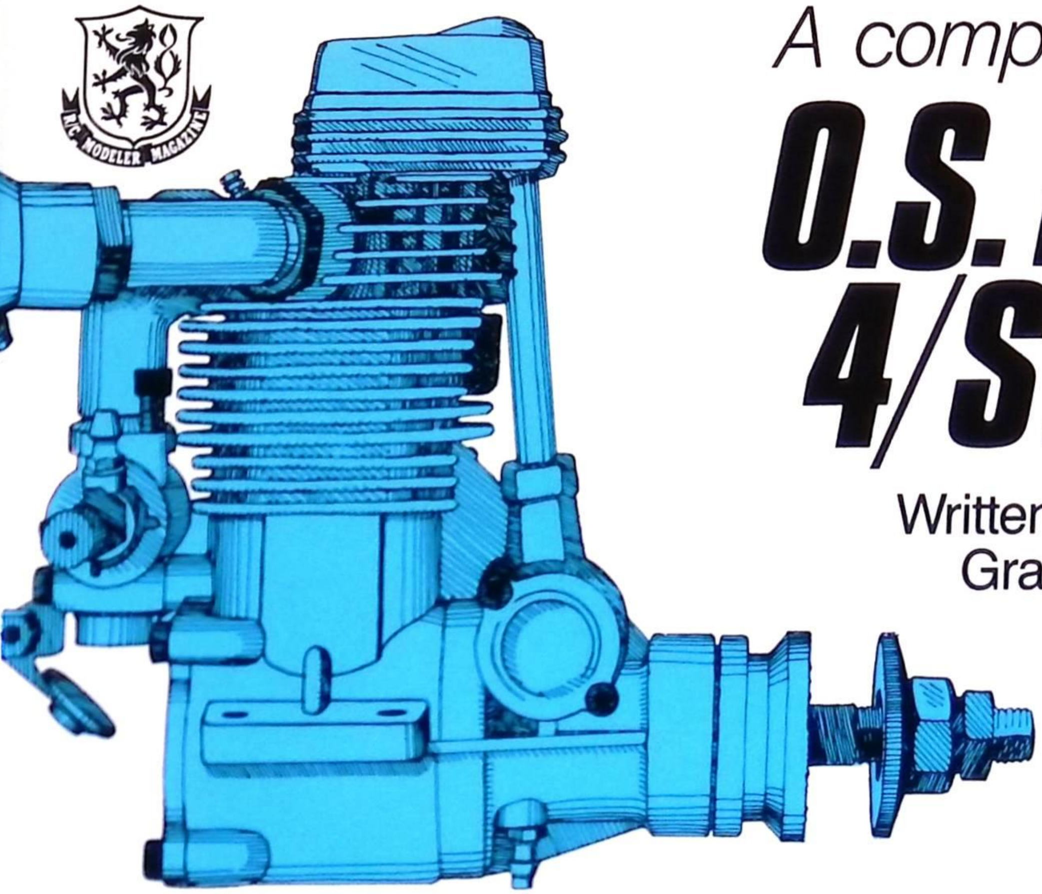
The following table compares the different generations of O.S. 4-strokes

YEAR	ENGINE	BHP/100cc
—	—	15
1990	FS-120 Surpass S.P.	14
—	—	13
—	—	12
1988	Surpass	11
—	Range	10
1982	Second generation	9
—	—	8
1976	FS-60	7





An easy to follow step by step stripdown, analysis and rebuild.



A complete guide to

O.S. MODEL 4/STROKES

Written & illustrated by
Graham C. Rice.

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