



SAITO FG-11

4-Stroke Gasoline Single Engine Operating instructions

Thanks for buying SAITO FG-11 4-stroke gas-engine exclusively for model airplanes.

In order to avoid misuse, please be sure to read well this instruction manual carefully. If there should be any deficiency, inconvenience, etc. concerning the manufacture, our company will repair them with responsibility.

Any failure or trouble caused by unnecessary disassembly, modification, or other uses than those provided in the instruction manual is not subject to the warranty, however.

Moreover, all responsibilities for the use of the engine, and other obligations and responsibilities based on laws, regulations, etc. are borne by the purchaser and the user, and SAITO SEISAKUSHO CO., LTD. is exempt from any responsibilities.



FG-11 is one of the smallest gas-engine among 4-stroke gas-engines which is designed based on the long seller- Glow engine "FA-62". Taking same devices such as carb, spark plug, ignition system from existing single-gas engines such like "FG-21" "FG-17" "FG-14C", durability, stability, and reliability are given as well.

Notification about treatment of 4-stroke model gas-engine

- ◎ Since valve timing is designed to get high power and high speed, the overlap range is relatively wide. So sometimes fuel get flown back from the carburetor. (It may spatter in the engine room.)
- ◎ Since the oil for lubrication is mixed in the fuel, waste oil from the breather nipple is dirty. Depending on treatment of waste oil, it can be spattered on the plane. (Ref. Section 9)
- ◎ Since lubrication is through breather, sometimes the oil oozes from each joint or commissure however it's no problem on performance.
- ◎ Depending on the quality of the oil, sometimes there can be rust inside the crankcase. But it's no problem on performance as long as there are no abnormal noise or backlash.

Specifications

Bore	Ø27.0mm	Stroke	19.0mm	Disp.	10.9cc
Weight	Body: 465g / Muffler: 50g / Ignition system: 100g / Engine mount: 110g Approx.				
Practical speed	Approx.2,000-9,500rpm	Max on Gnd	Approx.8,500~8,800rpm		
Propeller	12"x8"~13"x8"	Static thrust	APC 13x7 Approx.1.3~1.7kgf (Depend on prop)		
Fuel	Regular gasoline : Oil = 20:1 (Volume ratio)		Applications	4-stroke glow 50-60 class	
Fuel consumption	Approx. 7cc/min (At full throttle 8,800rpm) *Fuel flow varies depends upon prop load. More fuel flow with larger load and less fuel flow with smaller load.				
Battery for ignition system	Voltage:6-8.4V higher than 1,000mA is recommended				
Standard accessories	Engine mount set	1set	Limit gauge (0.1t) for tappet adjustment	1pc	
	Ignition system (w/ sensor)	1set	Spanner for tappet adjusting lock nut	1pc	
	Spark plug [SAITO SP-1] (Attached to engine)	1pc	Hexagonal wrench set	1set	
	Muffler set	1set	Plug wrench	1pc	

1. Propeller

Depending on the airframe, please adopt the standard size in the data and use a reliable product which is generally on the market. (APC13 x 7 is recommended)

Please maintain sufficient balance. Since an imbalanced prop is vibratory and dangerous with lowered performance, please maintain balance with a balancer. Moreover, a cracked prop is dangerous. Make sure to check any time and replace it with a new one if it's cracked.

*Prop and fuel consumption

If the load is large (the diameter & pitch of the prop is large) for the engine characteristics, the air-fuel mixture should be rich. Thus the main needle has to be opened. That is, even if the revolution is low, the fuel consumption is high. Conversely, when the load is small and the revolution is high, the fuel consumption is lowered because the main needle can be closed.

In order to decrease the fuel consumption and prolong the engine life, a propeller should be used whose revolution is maximized when the throttle-valve is fully opened, while using an airframe which enables all flights with about 90% of the output of the propeller. In this case, the throttle valve will be further throttled during horizontal flight. On the contrary, an airframe which can only deliver performance in fully open condition will suffer worsening fuel consumption and life.

Outside dimensions

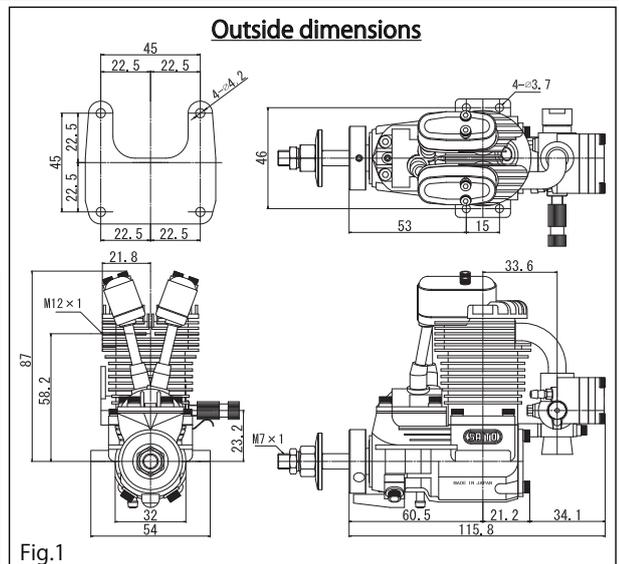


Fig.1

2. Fuel

The fuel is mixture of commercial regular gasoline and reliable oil for 2-stroke. (Unleaded high-octane gasoline is not necessarily required for SAITO engine.)

[Example of oil]

- Klotz KL-200 Original Techniplate
- Deluxe Materials PowerModel 2T-S etc.

For the mixture ratio, please be sure to use "gasoline : oil = 20 : 1" or richer by volume ratio. (ex. 1000ml of gasoline should be mixed with more than 50ml of oil).

Any damage caused by the fuel used, in which the oil ratio is lower than 20:1 ratio, is not warranted.

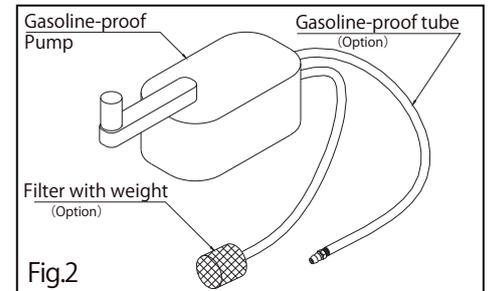
Since gasoline is dangerous material, be careful of its storage, use, and transport enough. (The evaporative emission and exhaust smoke of gasoline have a harmful effect on a human body. Also, if gasoline is leaked, there is danger of fire etc.)

Please note that we take no responsibility for accidents, health damages, etc which occur during storage, use and transport of gasoline.

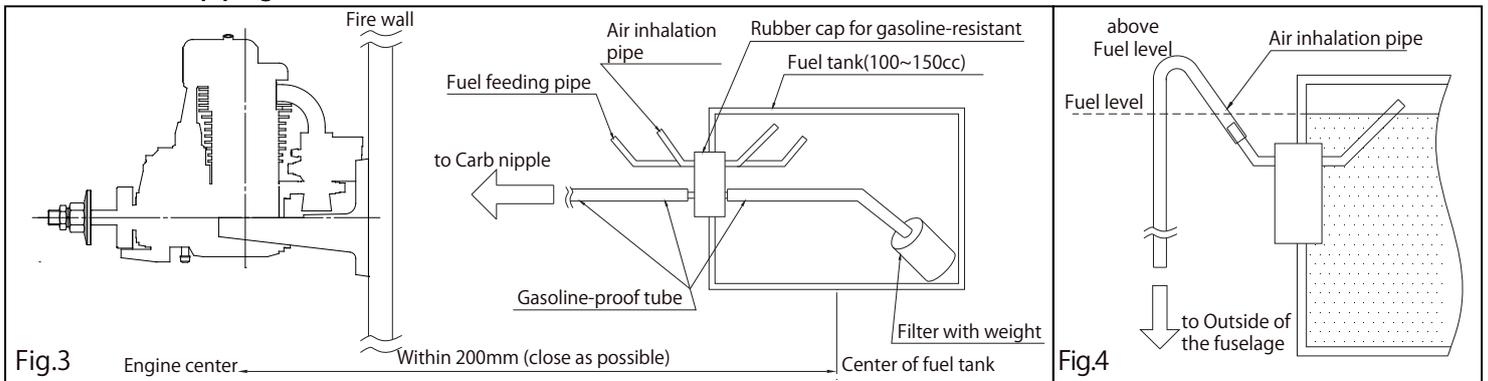
3. Fuel Filter and fuel pump

Since commercial gasoline has many impurities, please be sure to use a reliable filter for the admission port of the gasoline-proof fuel pump (Fig.2), and in the fuel tank as well (Fig.3). Without using a filter, the performance of the carburetor is not delivered, resulting in failures.

Using optional part "Filter with weight" is highly recommended.



4. Fuel tank and piping



For the capacity, refer to the data and select the best of commercial product. Please be sure to use a filter with weight. To avoid entrain any impurities to the carb, piping with "Fuel feeding pipe" and "Air inhalation pipe" (Fig.3) is recommended.

*Please be sure to use "gasoline-proof" products for the tank lid rubber, piping, and tubing. Some of the products for glow fuel can't be used for gasoline. Please check carefully if there're any crack on the piping, tubing, connection, and tank.

All of the connection parts should be bound by thin Nylon strap or wire to avoid fuel leakage or air induction to the fuel line. (If there are any leakages, the performance of the engine decreases dramatically.)

*The tank should be placed within the range of 200mm from the engine center to the tank center. When performing an acrobat with a large change in fuel level or that requiring an excessive movement of throttle, the tank must be placed at a position close to the engine as much as possible.

*When provide "Air inhalation pipe" as Fig.3, arranging the tube above the fuel level (Fig.4) is the effective way of fuel leakage prevention.

5. Spark plug

SAITO SP-1 spark plug is the standard equipment. Dimensions are as follows;

Hexagon width: 8mm Screw size: UNEF 1/4-32

Reach (with a washer): 5.5mm Spark-gap: 0.4-0.5mm

For replacement, please specify "SAITO SP-1".

Since our four cycle engine uses a mixed gasoline, please decide the numbers of flights by yourself and clean the spark plug. Please replace when it is degraded. (Consider the plug as consumable).

6. Ignition system

***Be careful of possibility of electrical shock as it generates high voltage.**

*The unit includes a plastic clip to hold the connectors and spiral tube to protect each wire.

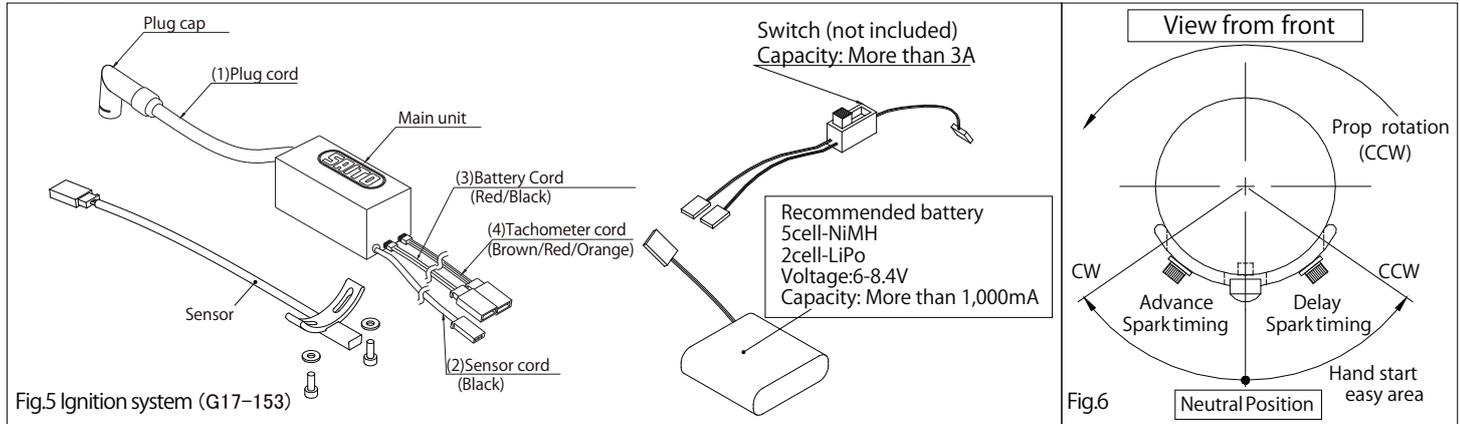
The ignition system is designed to match SAITO 4-stroke gas-engines with automatic advancing system.

However this ignition system is designed to be an anti-noise product, please isolate it completely from the receiver, servo, and battery to avoid a radio-interference trouble. Moreover, it is desirable to utilize a noise filter (line filter). Especially, each switch (for Ignition and for Receiver) should be isolated and set far from each ones.

Caution: A gas-engine generates a noise which has an adverse effect on RC adjustment. Please be sure to carry out a noise check each time while the engine is running before flight. Since a noise which occurs during flight may lead to a large-scale accident, please carry out a noise check without fail. As a simple method, after starting engine you can check by removing the antenna of the transmitter and operate it about 50m away from the airplane. If there is no malfunction, it is normal.

The function of each cord;

- (1) Plug cord (meshed high tension cord)
When you put on the plug cap, insert it to the plug until you can hear clicky sound to avoid coming off during flight. And then pull the plug cap to make sure that it won't come off.
- (2) Sensor cord (Black cord)
Connect with the cord from the sensor attached to the engine.
- (3) Battery cord (Black/Red cord)
Please use the fully charged battery that has adequate spec (6-8.4V, more than 1000mA is recommended.). Between the battery and main unit, make sure to set an ignition switch whose capacity is higher than 3A.
- (4) Tachometer cord (Brown/Red/Orange cord)
Optional on-board tachometer can be attached.



7. Sensor position and Power / Starting easiness

The ignition sensor can be moved to CW (advance the spark timing) or CCW (delay the timing) as Fig.6 shows. At the factory default the sensor is fixed on the center (neutral) position. The reason is related to the methods of engine starting.

- With an electric starter-You can start wherever the sensor is fixed.
- By hand flip (Manual start)-Starting easiness depends on the sensor position.

The factory default is set as you can start by hand flip and also get highest rpm in that range as possible. If you prefer easiness of hand starting, move the sensor to CCW direction to delay the spark timing. But then the maximum rpm will slightly decline. If you prefer power (highest rpm), move the sensor to CW direction. But then you can't start by hand flip but only with starter. In addition by the feature of the ignition system, it heats up with engine running. When you restart the engine by hand flip, you should open the throttle valve slightly while it's hot. And it's better to enlarge the choke without wetting the plug. For safety we recommend to use an electric starter.

8. Carburetor

A carburetor with a pump developed exclusively for our small-size four cycle gasoline engine is mounted, instead of using muffler pressure. Since the carburetor with a pump introduces the air from the air hole shown in the next figure, set it 2mm or more apart from the firewall or drill a hole on the firewall.

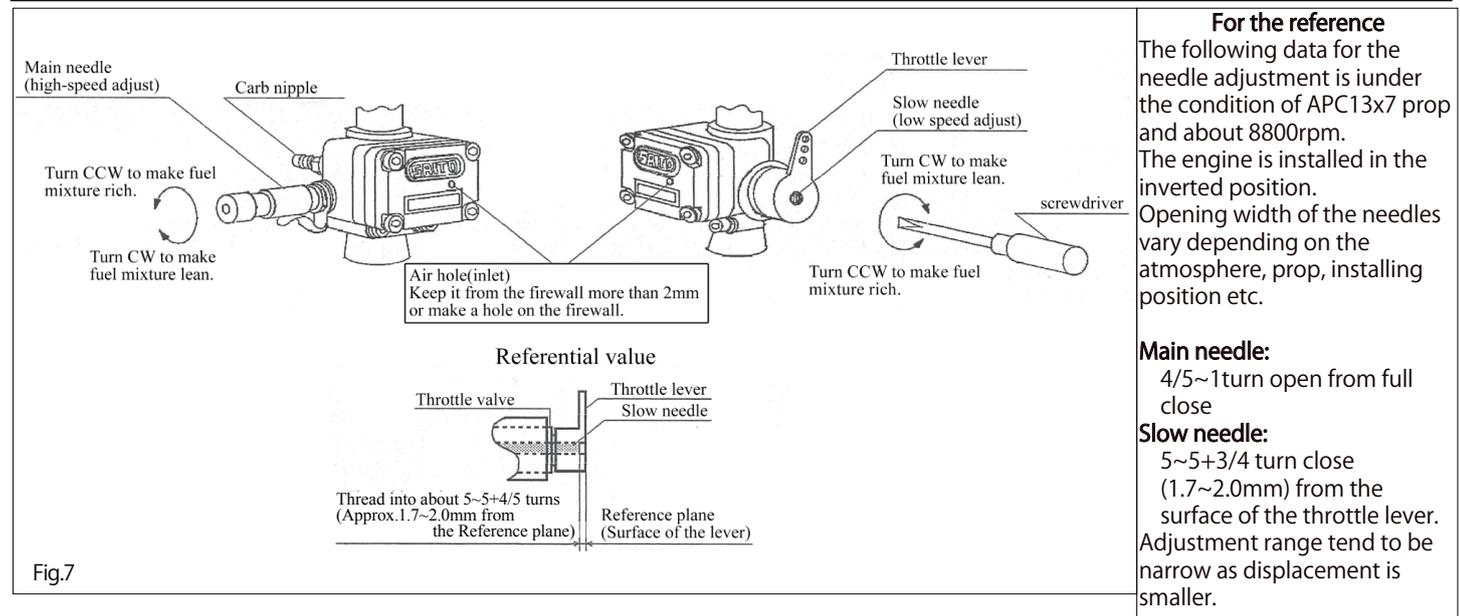
When adjusting the carburetor, refer to Fig.7.

Main needle: To adjust the speed at the time of full open of the throttle valve.

Slow needle: To adjust the speed from the idling to the middle speed.

Turning each needle in clockwise direction, the fuel will become leaner and the rotation speed will increase. Turning it in counterclockwise direction, the fuel will become richer and the rotation speed will decrease.

Note: The carburetor for the gasoline engine is the assembly of very strict and delicate parts. So please make sure to use filtered gasoline. Moreover, DO NOT disassemble by yourself. If there're any troubles regarding carb, please consult the shop from which you bought the engine.



9. Engine mounting, muffler attachment, and breather waste disposal

Inverted installation of the engine is recommended for lubrication however normal or side mounting are possible.

Either way, make sure to use SAITO standard engine mount attached. As a gas-engine generates much heat, SAITO standard mount is designed to release heat effectively and vibration as well. Any other mount which is not enough robust and heat release, might cause troubles by vibration and heat.

Make the firewall robust enough because this part has to endure vibration and torque caused by prop rotation. However, a test bench made of steel that doesn't absorb any vibration can concentrate vibration on the engine and engine mount and there is possibility to break the engine mount in a worst case. Especially with a low load prop, engine tend to generate large vibration that is very dangerous.

Therefore please use a wooden bench robust enough, never use a bench made of steel.

It is preferable to apply some adhesives (such as screw lock) on the tip of each cap screw to avoid looseness when you install the engine.

To ensure that cooling wind passes through the engine and muffler, the cowling should be devised. Also make the air flow outlet larger than the inlet. Building some baffles inside the cowling appropriately will enhance the cooling efficiency. Insufficient cooling may cause engine trouble such as overheat or muffler looseness.

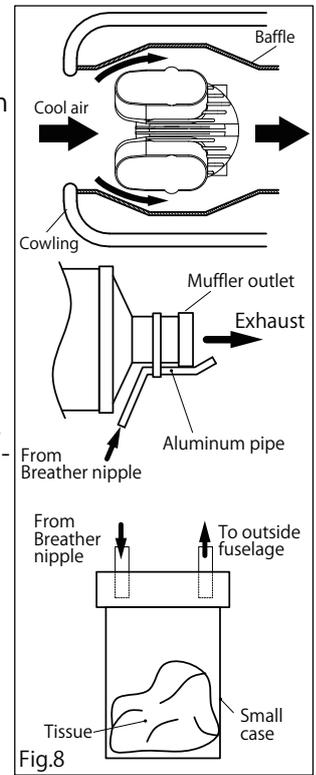
The muffler should be securely tightened up using two spanners. (Adhesives, such as a screw lock agent, are effective against looseness and leakage.)

Muffler right angle manifold (Option) allows muffler to set to the position as you like. Regarding the treatment of the muffler, please refer to Chapter 14.

For breather treatment, attach the gasoline proof tube to the breather nipple and fix the other side of the tube on outside of the cowling. Fix a thin aluminum pipe to the outlet of the tube and bind it to the muffler outlet to diffuse the hot air together with exhaust gas into the air.

And one of the effective way of disposal is to set a brief filter made by a small case and a tissue inside as the Fig.7 shows.

(Please be noted that it might be too much to accumulate for the small case depending on size of the engine.)



10. Preparation for engine start (assuming break-in)

- (1) Mount the engine on a robust and parallelized test bench or on the fuselage. (Either way, the engine should be fixed and immobile.)
- (2) Check whether the throttle valve becomes fully closed and opened certainly.
- (3) Check whether each code of the ignition system is connected certainly.
- (4) Use 100-200cc tank for the test bench, or a tank which has appropriate capacity for the fuselage.
- (5) For piping, only connecting the carburetor with the tank is needed. (Make sure there're no leakage at all the connections.)
- (6) For fuel, prepare a mixed gasoline with a volume ratio of "gasoline : oil" = "20 : 1" or richer than that.
- (7) Prepare a well balanced APC13"x 7" (Approx 8800rpm).
- (8) Prepare an electric starter, also attach a spinner. (This is the standard way of starting engine.)

Note: Please tighten up the prop regularly at least once in ten flights. Especially for a wooden prop, it tends to be compressed so that the nuts are rather easy to be loosen so please confirm carefully that the nuts are tightened adequately.

- (9) As it is difficult to judge clearly the peak condition of 4-stroke engines, prepare a tachometer to prevent over-throttling or overheat.
- (10) Prepare a fuel pump for gasoline. (Be sure to attach a filter to the intake port. It is available as an option.)
- (11) In order to check discharge of the breather, attach a heat-proof and gasoline-proof transparent tube.
- (12) Prepare a thin (-) screw driver for carb adjustment.

Caution: If there's anyone stand in front of the engine, be sure to have them move behind the airplane before starting the engine. Also keep in mind that the exhaust smoke is harmful for health. Keep away one of your arm holding the airplane away from the prop. Once the engine starts, move behind the airplane. Make needle adjustment or other control from rear. If the airplane cannot be fixed, ask your assistant to hold the airplane for safety.

11. Method of starting the engine

The following is the procedure with the engine mounted on the airplane. Fill up the tank with fuel. (Be sure to turn off the switch of the ignition system until just before trying to start up the engine.)

- (1) After confirm that the throttle stick is located at the full-close position, turn on the transmitter switch. Then turn on the receiver switch to check throttle valve and other operation. After that, fully close the throttle valve.
- (2) Open the main needle 1 turn from full close.
- (3) Power on the ignition system.
- (4) Open the throttle valve about 1/4 from the full close position by using the throttle stick. (Starting with excessively opened throttle is dangerous since the airplane jumps forward.)
- (5) Apply the starter to the prop and activate for about 5 seconds to start the engine.

12. Break-in

As Break-in is an important procedure to pull out the maximum performance of the engine, it must be cautiously done. The purpose of break-in is initial lubrication and adjusting of the mobile parts under the condition with rich fuel mixture. Never make the fuel mixture lean. Lean fuel mixture could cause seizure even during idling or low speed running. There's no need to adjust the slow needle at this step as it's already set adequately, so you will adjust only the main needle during break-in.

Procedure;

- (1) After filling up the fuel tank, start the engine as described in the above Chapter 11 and run it for 10 sec in low speed.

- (2) Next, in the condition of (1), fully open the throttle valve, turn back the main needle to make the air-fuel mixture very rich in the range where the engine does not stall (about 4,000 rpm). Operate in this condition with 2 (or more) tanks. (Conduct this step checking the density of the exhaust and the breather's waste oil (inky-black waste oil)).
- (3) Next, after filling up the tank, re-start the engine. With the throttle valve fully opened, throttle the main needle and operate the engine for one tank at 7500 – 8,000 rpm.
- (4) Next, after filling up the tank, re-start the engine. With the throttle valve fully opened, turn the main needle from the rich to the peaks several times. When the peak become stable, open the throttle valve from low speed to high speed several times to check the response. And gradually elongate the time of high-speed operation. Conduct this operation for one tank.
- (5) When the revolution is stabilized at peak, the ground-level break-in is completed. After adjusting the tappet gap in the manner of section "14", adjust the carburetor according to the following section. The running-in is completed by performing some 20 flights in a little rich condition. Subsequently, the flight should be performed in such a rich condition as far as not to influence the flight.

Note: During early stage of flights, take the height high enough to land safely in case the engine stop in the air suddenly. It will reduce the risk of crash or landing accident.

13. Adjustment of carburetor

The principal method of adjustment is the same as that for our glow engine.

In principle, a carburetor is adjusted by first achieving peak (the highest revolution) with the main needle and then set idling (low speed revolution) with the throttle valve and the slow needle. (Unless the peak is certainly achieved, idling adjustment will be difficult and not stabilized.)

- (1) After filling up the fuel tank, start the engine in the manner of Section "11" and then fully open the throttle valve with the throttle stick.
- (2) By turning the main needle depending on the tachometer and the exhaust sound, achieve peak carefully.

Caution: Over closing the main needle is very dangerous because it may cause knocking and propeller nut loosening. Then, turn the main needle CCW immediately to make it rich a little.

- * As for adjusting the main needle in the case of actual flight, setting the peak in the perpendicular attitude with a propeller in the upward direction is recommended if it's possible. In that adjusting, it'll be rich enough in the horizontal attitude so it's more similar to the condition during the actual flight.
- (3) Next, close the throttle valve until the engine operates stably with an idling rotation of around 2000 - 2500rpm, adjusting the slow needle with the (-) screw driver and the throttle valve carefully.
- * Since the richness level of the air-fuel mixture varies corresponding to the nature of the airframe, please adjust it depending on the user's skill.
- Generally, in a scale flight in which the stability of a low-speed zone is considered as important and the engine is operated slowly, adjust the air-fuel mixture to be relatively lean. In an acrobatic flight in which the early stand-up from a low speed is considered as important, adjust the air-fuel mixture to be slightly rich.
- (4) After the idling is set, get the throttle valve slowly fully opened. If the revolution becomes slow or goes up suddenly, adjust carefully until it changes linearly from idling to peak, by fine-tuning with the slow needle.
- (5) After the above adjustment is completed, open the throttle valve from idling to peak quickly. If the revolution does not achieve peak immediately but get delayed as the throttle valve is fully opened, fine-tune the main needle and perform the same process from idling to peak quickly. Repeat this carefully until the response improves.

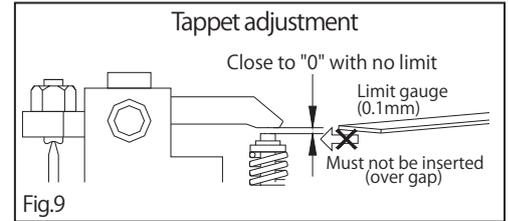
* The key to make the engine last for long life is operating with the slightly rich condition as far as it doesn't effect to the flight. Adjustment is needed depending on the engine attachment direction, the propeller, the fuel, the plug, the climate condition, etc. During flights, please fine-tune so that low speed, medium speed, and high speed match best with the airframe.

14. Normal operation, maintenance, and additional information

- (1) Just after start up the engine, perform warm up running in rich condition for about 1 minute, and just before stop run it at idling for 1 minute to cool down as well.
- (2) When stop the engine after the final flight of the day, be sure to stop by cutting the fuel to remove fuel from the carburetor. And remove the fuel from the tank and reserve it with special care.
- (3) Since the fuel contains more than 5% of oil, sometimes the exhaust valve gets dull by carbon or sludge especially in cold atmosphere. Then turn off the ignition switch and rotate the prop by electric starter. After dilute the oil content by this way, remove the fuel from inside the carb and the engine. It helps the valve to move smoothly.
Or, remove the rocker cover and applying some anti-rust spray to the exhaust valve is effective as well.
- (4) Lubrication for piston, connecting rod, bearing or cam gear is a blow-by lubrication in which the oil in the fuel goes into the crankcase from the clearance between the cylinder and piston. Therefore the engine life is affected by the property of the fuel oil. Please use high quality oil.
- (5) Charge the battery for the ignition system and RC device fully. (Since the ignition system generates high tension, be careful of electrical shock.)
- (6) Since over closing the main needle causes overheating, adjust a little more rich than peak. Over closing leads to knocking or overheat and has an adverse effect on the connecting rod and cam gear. Where the airplane achieves peak completely at the time of ascent should be a proper peak of the engine during flight.
- (7) When connecting the exhaust pipe to the cylinder or attaching the prop nut, apply thin coat of silicon rubber (not excessively) or adhesive on the thread section before tightening. This prevents leakage or loosening.
- (8) Because all of SAITO gas-engines use oil-fuel mixture, there tend to be carbon buildup inside the muffler as shown in the picture. It causes some problems on the exhaust outlet and consequently reduces the power. Therefore cleaning/removing carbon every about 50 flights is recommended. Using a parts cleaning spray is effective way. Actually, it depends on the quality of the oil so when you feel the power loss, please check inside the muffler.
In the case of the picture which had been done more than 70 flights, by removing the carbon buildup, the smoothness of the engine improved dramatically.



- (9) After completing ground break-in or operating the engine for 1 hour, adjust tappet gaps (valve clearances) by following procedure to compensate initial wearing, while the engine is cold (Fig.10).
- Remove the plug and rocker covers from the cylinder.
 - Turn the prop slowly forward by hand until the rocker arm of intake stops. Further turn the prop to bring the piston to the TDC (Top Dead Center) of compression stroke.
 - Use the attached wrench and hexagonal wrench to adjust the gaps indefinitely close to zero within the range compression exists. If the gap is lower than 0, the valve has to be opened at all phases so the compression doesn't occur (then, loosen the screw to reset).
After adjustment, put on the spark plug and turn the prop forward to check if the compression is enough.
 - On checking the gap, securely tighten (but not excessively) the lock nut.



* In the case of the engines for vehicle, small gap is given to tappets to absorb valve elongation. However for SAITO engines, gap becomes larger during operations due to thermal expansion of the cylinder (made of aluminum). Therefore set the gap indefinitely close to zero when the engine is cold.

Note: Occasionally check tappet gap by those procedure. When the attached gauge (limit gauge, $t=0.1\text{mm}$) comes to be inserted, gap has been enlarged beyond the allowable limit. Make an adjustment to lessen the gap. Tappet gap is one of the most important factors in the maintenance of 4-stroke engines. Operating the engine with the tappet gap enlarged excessively will cause poor performance or troubles.

- Occasionally tighten the prop nut and exhaust nut (while it is hot).
- Please notice that our guarantee will not cover any breakage or trouble on the engine caused by user's disassembling or modification.
- Take an extreme care for safety when operating the engine or flying the model airplane not to bother others.
- An engine for a model airplane is not a toy. Handle it with an extreme care.
- Notes for purchasing parts:
Please give orders to the shop you purchased from with "Engine model", "Part No. or part name", and "Quantity".

Optional parts

- Filter with weight [G36-154]
- Spark plug SP-1 [G20-120]
- Tappet adjusting kit [30-161]
- Neoprene tube for gasoline(1m) [G36-155]
- Aluminum spinner nut [50-30]
- Digital tachometer [G17-168]

All specifications and models are subject to change without notice.



<http://www.saito-mfg.com>

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