Text and Reference Books No. 55
September 1990

INSTRUCTION MANUAL FOR PRACTICAL TRAINING ON THE GASOLINE ENGINE IN THE WORKSHOP

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PREFACE

This text book has been compiled for the SEAFDEC workshop trainees who are studying various aspects of the Internal Combustion Engine. There are two separate engineering fields associated with the Internal Combustion Engine, one is centered around theory and the other is practice.

In other words, knowing about or understanding the principles of an engine are one thing, handling or operating, and repairing it are quite another.

A good practical engineer, should be skillful and proficient in the operation, repair and maintenance of an engine. This book is provided as a supplement to the students' course work, lectures and practical demonstrations to enhance their understanding of the engine. Although many technological advances have been made in other fields, the fundamentals of the Internal Combustion Engines are, as yet, unchanged.

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June 1990

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1. ON THE PRACTICAL TRAINING WITH ENGINES

What do you suppose is meant by "understanding" an Internal Combustion Engine?

If you should ever arrive at a thorough understanding of the Internal Combustion Engine the prospects of a brilliant engineering career will open up before you.

However, because the Internal Combustion Engine is the kind of system which integrates almost all aspects of technology, including thermodynamics, gaining a thorough understanding may be asking a little too much of one person.

The following figure helps to show the variety of branches of engineering which form the various components of the Internal Combustion Engine.

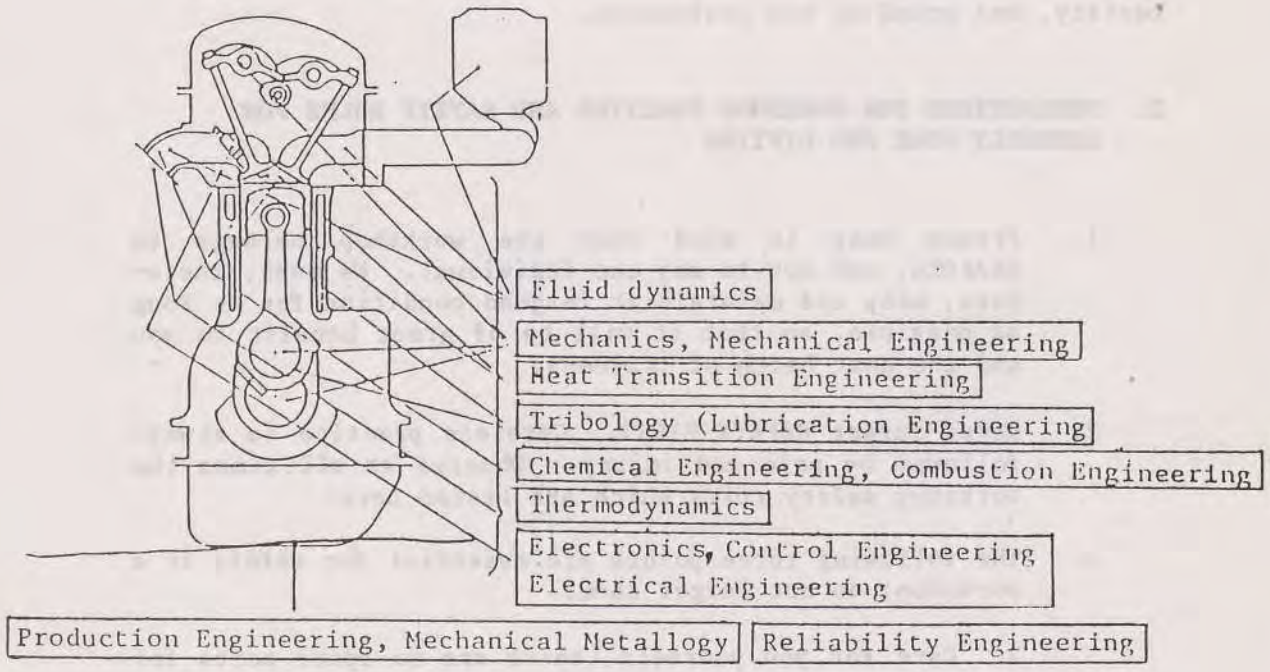


Fig. 1. I.C. Engine and its related Engineering Systems

Learning about the various aspects of the I.C. Engine will provide you with many valuable skills which can equally be applied to a wide range of important areas in our modern technological world.

It is best that trainees learn both the theory and the practice which are essential for a good engineer and the old adage "practice makes perfect" holds true here.

To do this, one of the first prerequisites is that you learn to take good notes and to file the information that you are given. This information will accumulate over the years.

As easily acquired knowledge is equally easy to lose, this information should also be simple to retrieve and classified according to its purpose.

Keeping a good note book is a practical contribution towards becoming a good engineer who will be of benefit to society, and proud of his profession.

2. PRECAUTIONS FOR WORKSHOP PRACTICE AND SAFETY RULES FOR ASSEMBLY WORK AND LIFTING

1. Please keep in mind that the workshop belongs to SEAFDEC, and not to any one individual. We must, therefore, keep and maintain it in good condition for as long as possible, so that it will be of great benefit to you and the next batch of trainees.

2. Never forget SAFETY FIRST. Careless practice is always followed by pain and injury. Observe at all times the workshop safety rules which are listed here:

3. The following three points are essential for safety in a workshop; do not forget them:

    1. Care for you yourself (there are no spare parts for your body)

    2. Care for your colleagues, partner, your group, and the person nearest to you.

    3. Care for the tools you use.

4. In order to keep the workshop, especially the engine and tools, in good condition you must always clean them during and after practice. If otherwise your practical experience will not be qualified and you may cause an accident. Besides which tidiness shows good working habits.

5. Do not touch the machines or tools if you have not had any previous experience with them. Never practice alone. Never touch any machine while it is running (unless it is required that you do so). Take care that your clothing does not get caught in the machinery. Refrain from practical work after taking certain medicines. Do not operate any machine or tool that is not required for your practice purposes as it may cause you, the instructor and workshop monitor and/or other trainees unnecessary trouble.

6. Smoking is strictly prohibited during workshop practice, except during the break periods and/or in the smoking area.

7. Listen and carefully observe all the instructions and cautions given by the instructors or the assistants.

8. As previously mentioned, keep a record or note book of all practical procedures to improve your engineering skills. This record will become a valued possession, a reference manual of all you have learned. It will help you revise, and should become a storehouse of information you will be able to refer to time and again.

2.1 Workshop Safety Rules (Assembly work)

Some people say "Accidents will happen!" But safety experts do not agree. They say "accidents are caused by careless actions, by inattention to the job, and by using damaged or incorrect tools". "Fewer or no-accidents occur in a shop that is kept neat and clean".

To prevent those accidents, follow these safety rules:

1. Work quietly and give full attention to the job in hand.

2. Keep your tools and equipment under control.

3. Never indulge in prankish play or in other silly activities. You may cause yourself or someone in the vicinity serious injury.

4. Don't carry sharp objects, such as a screwdriver, in your pocket. You may hurt or stab yourself or damage clothing and upholstery.

5. Make sure that you are properly dressed for the job. Dangling sleeves or ties can be caught by rotating machinery. You will be in grave danger by being careless.

6. Don't wear sandals or slippers. Wear full leather shoes with nonskid rubber heels and soles. Safety shoes are the best for the workshop.

7. Wipe excess oil and grease off your hands and tools so that you can get a good grip on tools or machine parts.

8. If you spill oil or grease or any liquid on the floor, clean it up immediately so that no one can slip and fall.

9. Be careful to work in collaboration with your colleagues, give a signal or tell them before you abruptly move or rotate any parts of machinery otherwise you may cause injury to your colleagues.

10. Never position yourself near the loading wire and rope or stand under a heavy weight such as a hoist or crane.

11. Although all moving parts on a machine or other workshop equipment must be provided with guards, never position yourself or stand in the same plane as that of high speed rotating body and do not touch the rotating body.

12. Use SEAFDEC Workshop's equipment and tools with as much care as if they were your own.

13. Clear away any pieces of equipment from the work area which may obstruct your work.

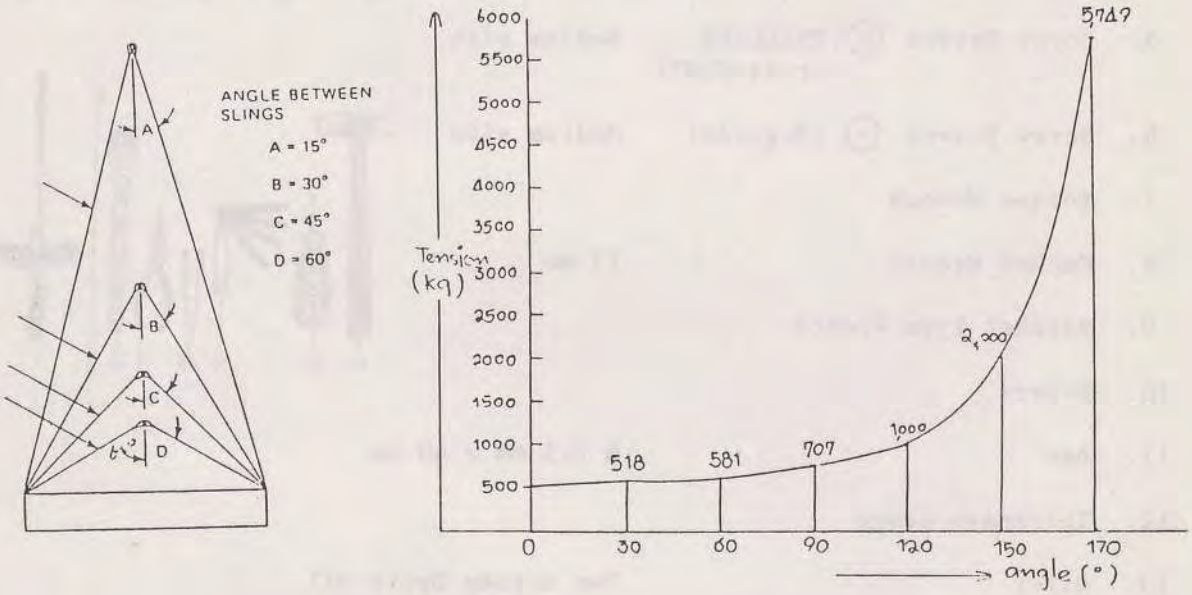
14. Use extreme care while making adjustments on the engine or equipment while it is running, keep your hand away from moving parts.

Note: According to my experience, a skilled mechanic or engineer never suffers an injury when the quality of work is excellent and his working suit is neat.

2.3 Safety Rules for Lifting

A high percentage of injuries and accidents occur while the engine is being removed, during cleaning or installing parts.

When it is necessary to remove components or transfer the weight, the slings or chains must be fastened at an angle to the object to be lifted. Please note that with an increase in angle the force on the slings increases and may eventually exceed the load capacity of the slings.

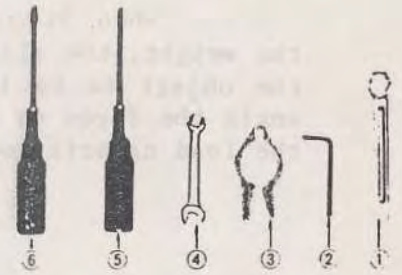


The greater the angle between the slings, chains, or ropes used when lifting a piece of equipment the greater the strain on them and the stronger they must be.

3. TOOLS (To be prepared before practice)

Ref. No.	Descriptions	Remarks
1.	Spanner	19 mm
2.	Key Wrench (Hex-Head wrench or Allen wrench)	R-04
3.	Piston Ring Band (Ring compressor)	
4.	Spanner	8 x 10 mm
5.	Screw Driver ⊕ (PHILLIPS cross-SLOT)	Medium size
6.	Screw Driver ⊖ (Regular)	Medium size
7.	Torque Wrench	
8.	Socket Wrench	12 mm
9.	Ratchet Type Wrench	
10.	Pliers	
11.	Bar	ϕ 7.5 mm x 40 mm
12.	Thickness Gauge	
13.	Oiler	Two Stroke Cycle oil
14.	Wooden Hammer	

Tools



Measurement tools (To be prepared before practice)

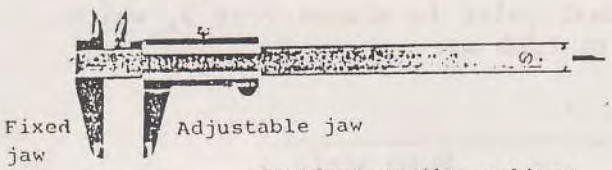
Micrometer ---------- 1
Dial gauge with stand ------ 2
Cylinder gauge ---------- 1

4. MEASURING TOOLS

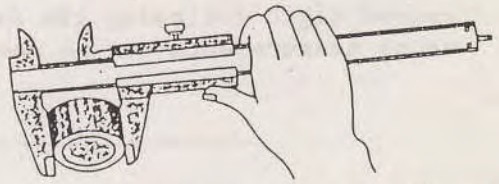
There are numerous types of measuring tools used during engine assembly work. This chapter will deal with methods for using some of the most frequently encountered types.

1. Vernier calipers

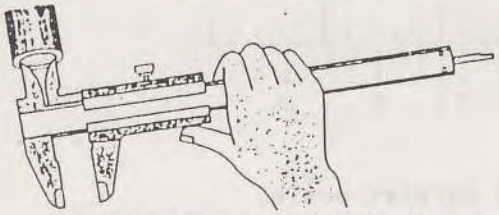
As shown in the figure below vernier calipers consist of two jaws. One jaw is fixed to the beam and the other to the vernier which slides along the beam. The vernier of the tool, accurate to 0.02 mm, has 19 mm scale graduated fractional parts in 20 equal divisions. This tool can measure internal diameters, external diameters, and depth. Also, dimensions can be measured within an accuracy of 1/20 mm (0.05 mm), as illustrated in the following examples.



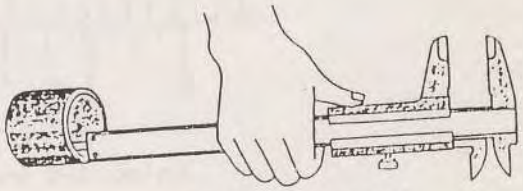
Standard vernier caliper



Measurement of outer diamenters



Measurement of inside diameters



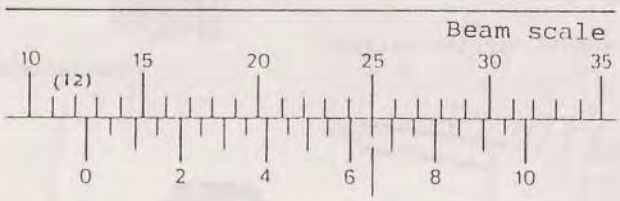
Depth measurement

- Reading vernier calipers

If, for example, we consider the two scales of the caliper which overlap each other, as shown in the diagram below, the following procedures should be undertaken to obtain a reading:

1. Read the beam scale just before the 0 of the vernier scale ..... 12 mm
2. Read that graduation on the vernier scale which exactly coincides with a graduation on the beam scale ..... 0.65 mm (In this example, 25 on the beam scale coincides with the vernier scale 65).
3. Add items (1) and (2)
   The reading is therefore 12.65 mm

Thus, when reading standard vernier calipers, the second digit following the decimal point is always 0 or 5, which means measurements can be made to 1/20 mm.



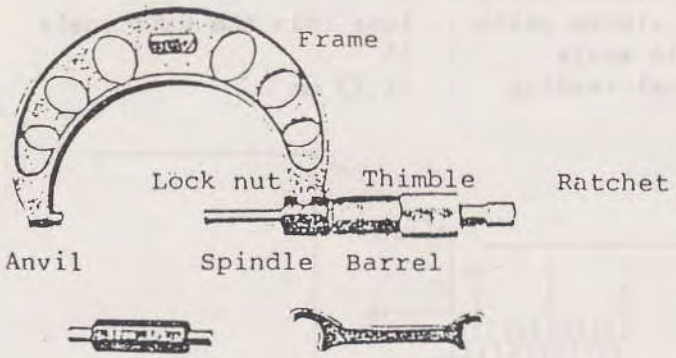
Coincided point vernier scale

2. Micrometer

The micrometer is designed for external measurements to an accuracy of 0.01 mm.

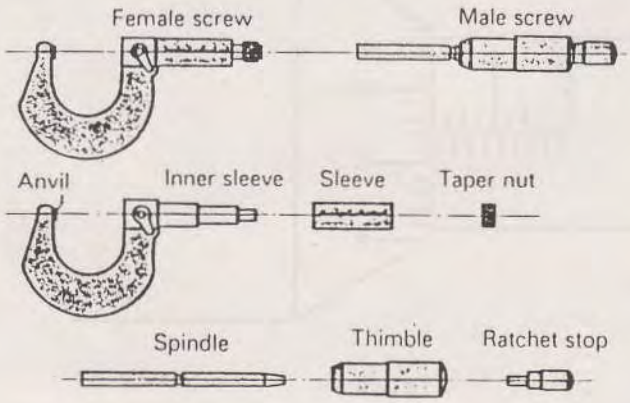
- Operating principle:

If the screw is turned one complete revolution, it traverses one pitch into a fixed nut. Similarly, if the screw were revolved only half a turn, it would traverse half a pitch. The micrometer is based on this principle and is a measuring instrument which can precisely indicate the distance a screw traverses. The various parts of a micrometer are shown in the following diagram. The micrometer consists of a frame, an anvil, a spindle, a barrel, a thimble, a ratchet, and a lock nut.



- Reading micrometer

The micrometer spindle has an 0.5 mm pitch screw. The thimble moves simultaneously with the spindle. The circumference of the thimble is divided into 50 equal graduations. Therefore, one complete revolution of the thimble moves the spindle by one pitch, i.e. 0.5 mm. Since the thimble has 50 equal graduations, 1 graduation would therefore be equal to 0.5 x 1/50 = 1/100 mm, which is 0.01 mm. The micrometer sleeve has two scales; the upper scale has 1 mm graduations and the lower one has 0.5 mm graduations. When taking micrometer readings, first read the upper 1 mm sleeve scale and then the lower 0.5 mm scale. Finally read the 0.01 mm thimble scale.



- Example A (Fig. A)
  Upper sleeve scale : 11
  Lower sleeve scale : less than the half scale
  Thimble scale : 13
  ∴ Final reading : 11.13 mm

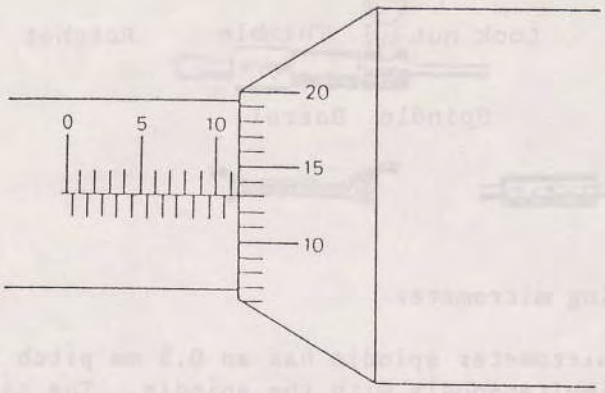


Fig. A.

- Example B (Fig. B)
  Upper sleeve scale : 8
  Lower sleeve scale : exceeds the half mm (0.5 mm)
  Thimble scale : 7
  ∴ Final reading : 8.57 mm

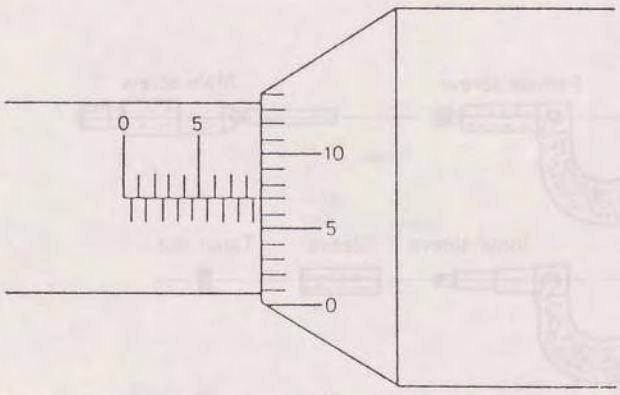


Fig. B.

In Figs. C and D the minimum reading is 0.01 mm. However, if a small gap is still observed, a reading to 0.001 mm can be made depending on the skill of the reader. Although there are minor variations among the different types of micrometers, for a typical 0-25 mm micrometer one graduation of the thimble scale is approximately equal to 5 times the sleeve baseline thickness (See Fig. D).

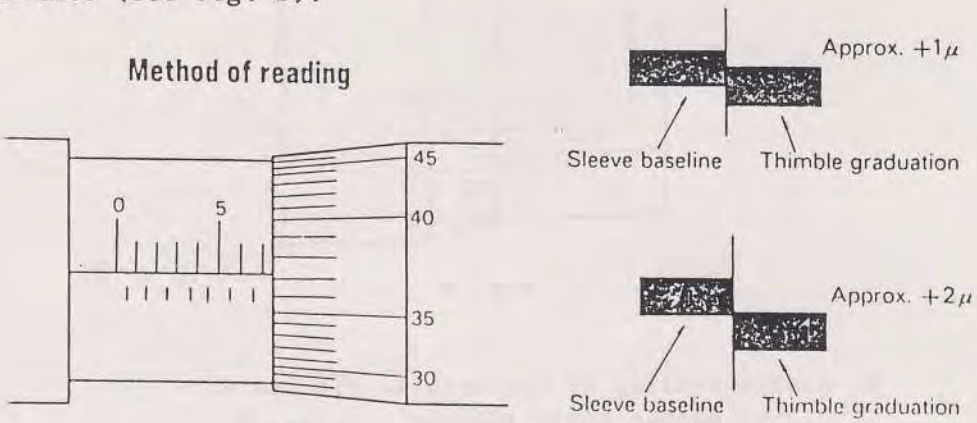


Fig. C Fig. D

- How to read the micrometer

As you become more experienced in using the micrometer, it becomes much easier to apply your skill and judgement. In Fig. C, for instance, the reading would be:

Sleeve scale reading	:	7 mm
Thimble scale reading	:	37
Approximate reading from judgement	:	3/10
∴ Final micrometer reading	:	7.373 mm

Thus, by using an educated guess, measurement can be made to 1/1000 mm. However, to precisely measure to 1/1000 mm, other types of micrometers such as the vernier or micron micrometers, which have minimum graduations of 1/1000 mm, should be used.

- Micrometers with a vernier scale (Vernier Micrometer)

In order to make readings to 1/1000 mm note the graduations on the sleeve above the baseline, as shown in Fig. E. To read the micrometer first read the 1 mm and 0.5 mm graduations and then the 0.01 mm thimble graduations. Finally, instead of guessing, read the 1/1000 mm graduation on the vernier scale which coincides with a graduation on the thimble scale.

Method of reading

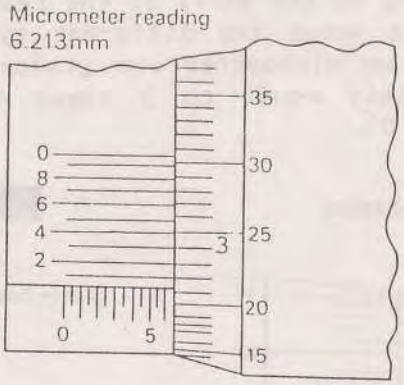


Fig. E

- Sample reading of the Vernier Micrometer
  0.5 mm sleeve scale reading 6
  0.01 mm thimble scale reading 21
  0.001 mm vernier scale reading 3
  Final micrometer reading ..... 6.213 mm

3. Dial gauge (Dial type indicator)

The dial gauge is an instrument which magnifies and displays small movements exerted on the measuring tip. Readings are made on a graduated dial. This gauge can measure continuously and is therefore very widely used for checking the accuracy of machine tools, setting up machining operations, checking slot depths, and checking the eccentricity of cylindrical objects. Its popularity is further enhanced because it is as easy to read as an ordinary watch.

- Structure of the dial gauge (Figs. F and G)

The dial gauge has a spindle (S), a portion of which has been machined into a rack. When the spindle moves vertically it turns the first pinion (a) meshing with the rack, as well as larger gear (b), which is on the same shaft as the first pinion. The larger gear turns the second pinion (c) which activates the dial gauge pointer.

Usually, the large and the small gears have a diameter ratio of 10:1. Therefore, even if the spindle movement is minute, it can be magnified to give substantial movement to the second pinion and the dial gauge pointer.

The second pinion also meshes with another larger gear (d), which is coaxially connected with the coil spring (h). This spring prevents the entire sequence of gears from backlashing.

The spindle is also loaded with a helical spring (e), which ensures that the spindle tip is always pressed against the object being measured.

- Reading the dial gauge:

Referring to Fig. G, first read the pointer of the smaller dial. The pointer of the smaller dial moves one graduation when the pointer of the larger dial makes one complete revolution. This means that 1 graduation on the smaller dial is equal to 1 mm.

In this case, the reading is .... 8.00 mm - (1) Next, read the hand of the larger dial which has graduations of 1/100 mm; .... 0.15 mm - (2). By adding items (1) and (2), the final reading for this example is 8.15 mm.

Thus, with this instrument even small measurements can easily be made. It is therefore used to make measurements of valve clearances, flywheel run-out, cylinder I.D., etc.

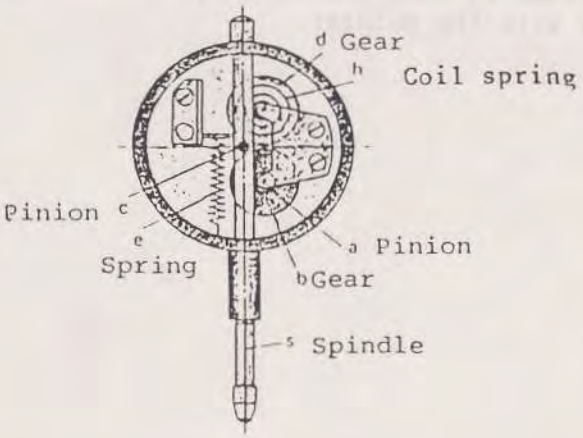


Fig. F

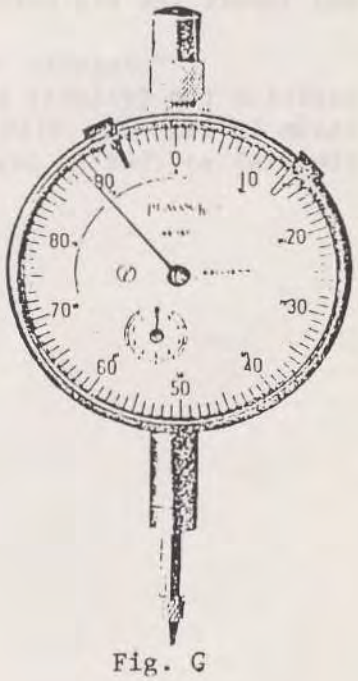


Fig. G

4. Cylinder gauge

A typical cylinder gauge set is shown in Fig. H. This set can be used to measure the bores of different sizes of cylinder liners by merely changing the tip.

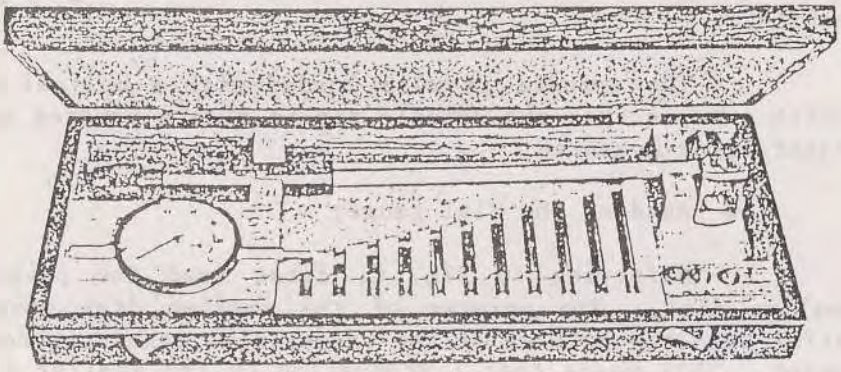


Fig. H

- Setting up the cylinder gauge

Insert the dial gauge into the bar allowing the pointer to turn approximately two revolutions, tighten it in this position.

Measure the bore of the liner using a vernier caliper and insert the tip corresponding to the measurement in the bar.

Precisely set this dimension on a micrometer and position the cylinder gauge squarely with the micrometer face, as shown in Fig. K. With the gauge in this position set the '0' on the dial so that it coincides with the pointer.

Note: The larger dial of the gauge can be moved freely.

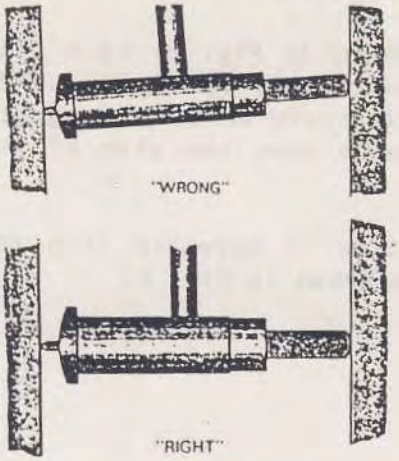


Fig. I

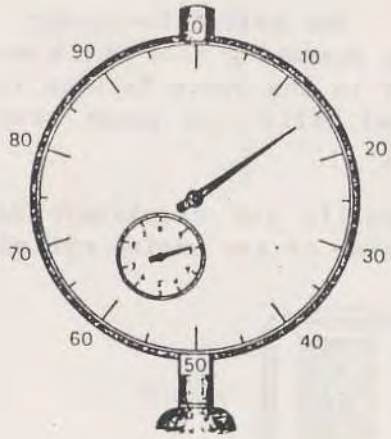


Fig. J

- Using the cylinder gauge

To measure the liner bore with a cylinder gauge, position the cylinder gauge squarely in the liner, as shown in Fig. K (similar to the setting up operation), and take the dial reading. If, for example, the pointer moves to the left (anti-clockwise) of 0, as shown in the figure, read this as "+", whereas if the pointer moves to the right (clockwise) read it as "-". A "+" reading indicates abrasion of the liner, whereas a "-" indicates a smaller bore due to the trapping of foreign objects such as dust particles when the liner was inserted or a deformation in the liner.

Note:
Zero Point Adjustment:
Set the "0" (Zero) on the large dial (the figure to be read by red pointer) so that it coincides with the pointer by turning the outer case. The gauge bar should make a right angle at this time.

Fig. K

5. Deflection gauge. (This gauge is used only for large diesel engines).

The deflection gauge, as shown in Fig. 0, is a dial gauge type measuring tool which measures on a 1/100 mm scale. It is mounted in the space between the crankshaft arms by a magnet. The size of deflection gauge used depends upon the size of the crankshaft.

Usually the crankshaft deflection is measured from the flywheel side of the engine cylinder as shown in Fig. 1.

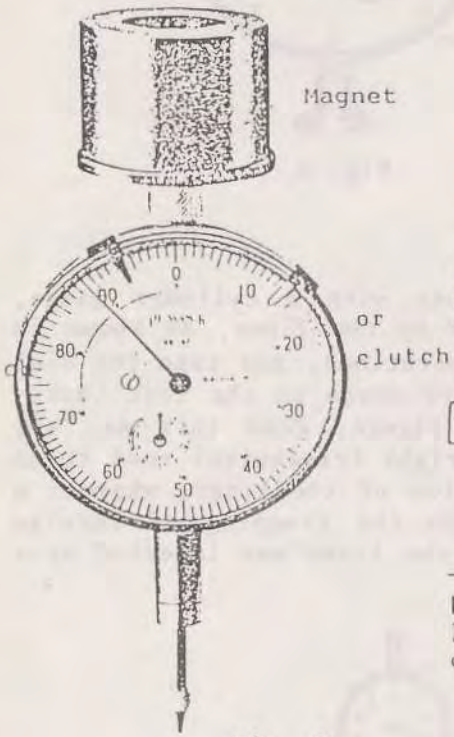
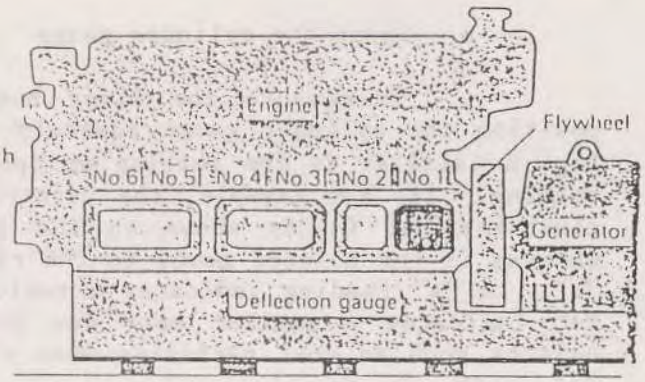


Fig. 0



Note:
Permissible deflection is within 1/10,000 of a cylinder stroke.

Fig. 1

Note: Permissible deflection is within 1/10,000 of a cylinder stroke.

(1) Remove the cylinder side cover nearest the flywheel side and mount the deflection gauge between the crank arms as shown in Fig. 2

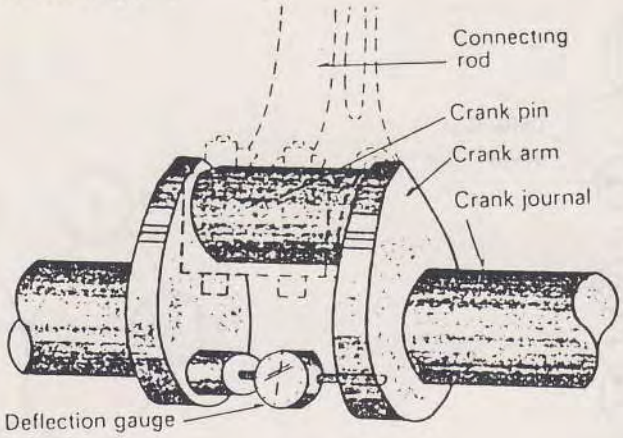


Fig. 2

Note: Mount the gauge from the cylinder side cover opening on the exhaust manifold side.

(2) Position the crank-pin for the measurement of deflection according Fig. 3 below.

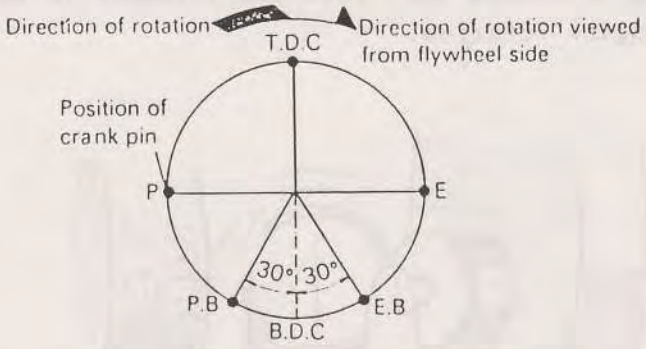
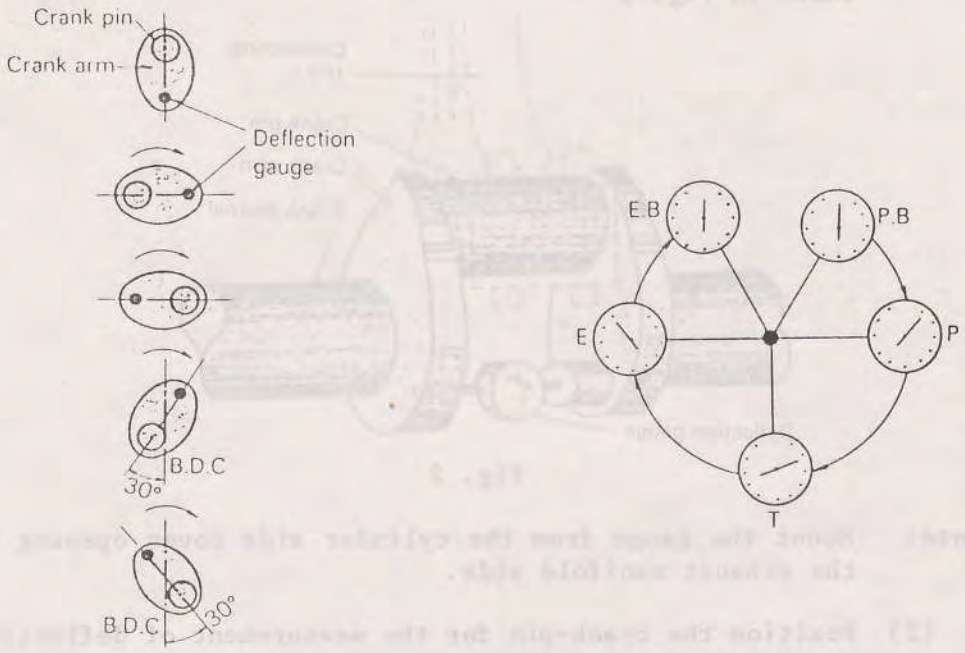


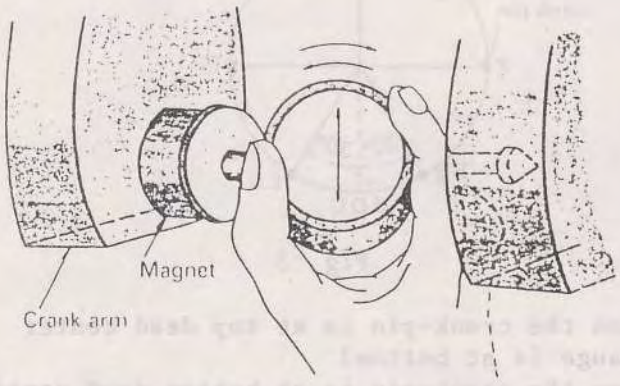
Fig. 3

T.D.C - When the crank-pin is at top dead center (Gauge is at bottom)
B.D.C - When the crank-pin is at bottom dead center
P - When the crank-pin is on the fuel pump side (Gauge is on exhaust manifold side)
E - When the crank-pin is on the exhaust manifold side (Gauge is on fuel pump side)
P.B. - When the crank-pin is 30° past B.D.C. on the fuel pump side
E.B. - When the crank-pin is 30° before C (on the exhaust manifold side)

(3) Sequence of deflection measurements:



Note: Using a turning bar, turn the flywheel in the direction of engine rotation.



Note: Set the deflection gauge pointer to zero in the B. position. (Use a torch to illuminate the gauge)

(4) Measurement recording table

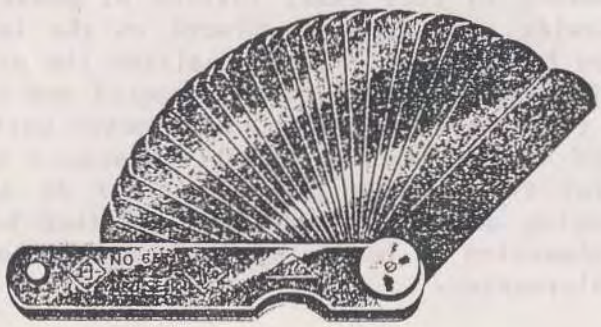
	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	Remarks
P.B.	0	0	0	0	0	0	Set to zero
P							
T							
E							
E.B.							

6. Thickness gauge

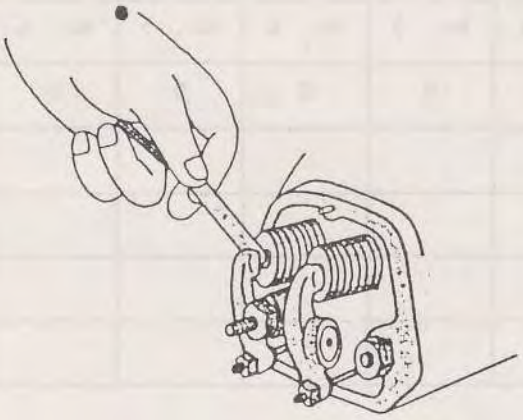
A thickness gauge consists of a number of calibrated steel sheets of defined thicknesses, and is used to measure the clearance between conjugate surfaces. This gauge is sometimes called a filler gauge.

- How to use the gauge

Insert the different feelers of the gauge in the clearance to be measured. Select the best fitting gauge. Read the thickness of the feeler to find the size of the clearance. Also, to adjust the clearance to a given dimension, as in setting the valve clearance, first select the appropriate feeler from the gauge stack, and then, with this feeler in position, adjust the clearance with the adjust screw. Other types of clearance gauges can also be used in the same way.



Feeler gauge



Using a thickness gauge to check the valve clearance.

Note: When using a thickness gauge it is advisable to use the minimum number of feelers to build up a given dimension since the accuracy of measurement is reduced as the number of feelers used is increased.

7. Inside micrometer

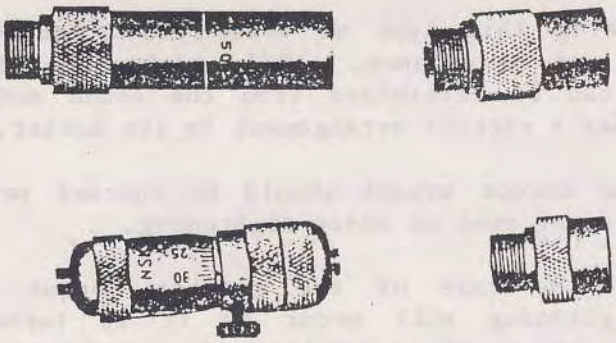
This instrument is used for measuring internal diameters such as cylinder liners; camshaft bushes; and tappet holes which cannot be measured with a cylinder gauge.

How to use this micrometer

Use this instrument in the same manner as a micrometer. However, in this case, instead of measuring the object from the outside, the gauge is placed on the inside surface of the object to be measured. First position the nibs of the gauge inside the internal diameter to be measured and continue to move the jaws in the same way as with a micrometer until the nibs have been extended to the maximum possible distance inside the bore. At this point the movable jaw will start to slip and make a ratchet stopping noise. The reading can then be taken. For a detailed explanation of how to read the instrument, refer to the section on micrometers.

There are inside caliper-type micrometers which can measure to 1/1000 mm and are similar to the special micrometers discussed in the micrometer section.

Inside micrometer



Note: The gauge should be straight when it is positioned in the object being measured.

8. Torque wrench

This tool measures the tightening torque applied to a thread, on a scale (kg-cm, lb-ft). By using this wrench, bolts or nuts can be tightened to a specified torque. To assure accurate tightening of nuts and bolts, you must use a torque wrench.

Ordinary Torque Wrench

This tool has a graduated indicator plate fixed on to the arm of the wrench. The torque applied is indicated by a pointer on this plate.

Ratchet Torque Wrench

By using this type of wrench the required tightening torque can be set in advance. While tightening the thread the preset limit can be determined from the sound and feel of the wrench which has a ratchet arrangement in its socket.

Note:

- The torque wrench should be checked periodically to prevent over or under tightening.
- In the case of the ratchet torque wrench, over tightening will occur if it is turned after the ratchet sound is audible. To prevent over tightening, stop the tightening when the ratchet sound is heard.

5. ENGINE FOR PRACTICE (2 Cycle Gasoling Engine)

The engine used for practical experience is a two stroke cycle gasoline engine, T-200 type of Mitsubishi Heavy Industries Co., Ltd. Japan. One engine is provided for every two trainees in the SEAFDEC Engineering Workshop.

5.1 Practice Engine's specifications

5.1.1 Specifications

ITME / MODEL	T 200 P
Type	Forced air-cooled 2-stroke cycle engine
No. of cylinders-Bore x Stroke (mm)	1 - O 39 x 34
Displacement (cc)	40.6
Compression ratio	8.5
Fuel	Gasoline mixed with 2 cycle oil (20:1)
Continuous rated output (PS/rpm)	1.4/6000
Max. output (PS/rpm)	- 2.0-
Max. torque (kg m/rpm)	0.24/5000
Dry weight (kg)	3.5
Rotating direction (as viewed from output shaft side)	Counterclockwise
Method of starting	Recoil starter
Carburetor	Float Piston Valve Type
Air cleaner	Semi-wet polyurethane foam
Method of ignition	Magneto ignition (Contact breaker type)
Spark Plug	NGK : BM-6A
Fuel tank capacity ( )	1.0
Method of fuel feed	Gravity System
Specific fuel consumption (g/PS.h)	410
Idle set revolution (rpm)	2000 - 2400 (Float type)

Explanation of serial number designation

T 200 P Z C 01

- 01 — Special specifications.....Customer code No.
- C — Detail specification.....C:inverse, D: with diaphragm type, G: with speed governor
- Z — P.T.O.....Power output mechanism; opposite side of fan
- P — Rotation....P: counterclockwise; direct connection, M: clockwise; direct connection (viewed from flywheel side)
- 200 — Output.... Output multiplied by one hundred (first digit of decimal point is changed as a model change No.)
- T — Major distinction....Two stroke cycle engine initial sign (TWO cycle engine)

TIGHTENING TORQUES

Descriptions	Screws, Bolts and Nut's Size	Tightening Torque (Kg.m)
• Flywheel	M8, Nut	1.0 - 1.3
• Pulley (Recoil Starter)	M8, Nut	1.0 - 1.3
Air Cleaner Cover	M5, Screw	0.15 - 0.2
Muffler	M5, Nut	0.5 - 0.6
Others	M4	0.2 - 0.3
	M5	0.3 - 0.4

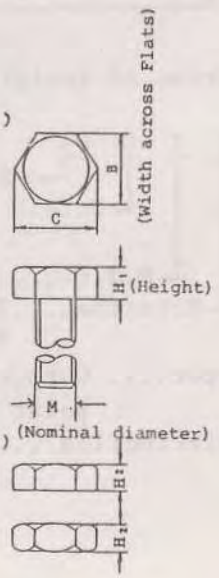
• - Marked, item requiring the use of a torque wrench.

	Bolt or Machine screw A : Diameter B : Length A x B (Ex. A = 4 mm, B = 6 mm M 4 x 6
	A : Indicate from outer diameter
	A : Indicate from inner diameter

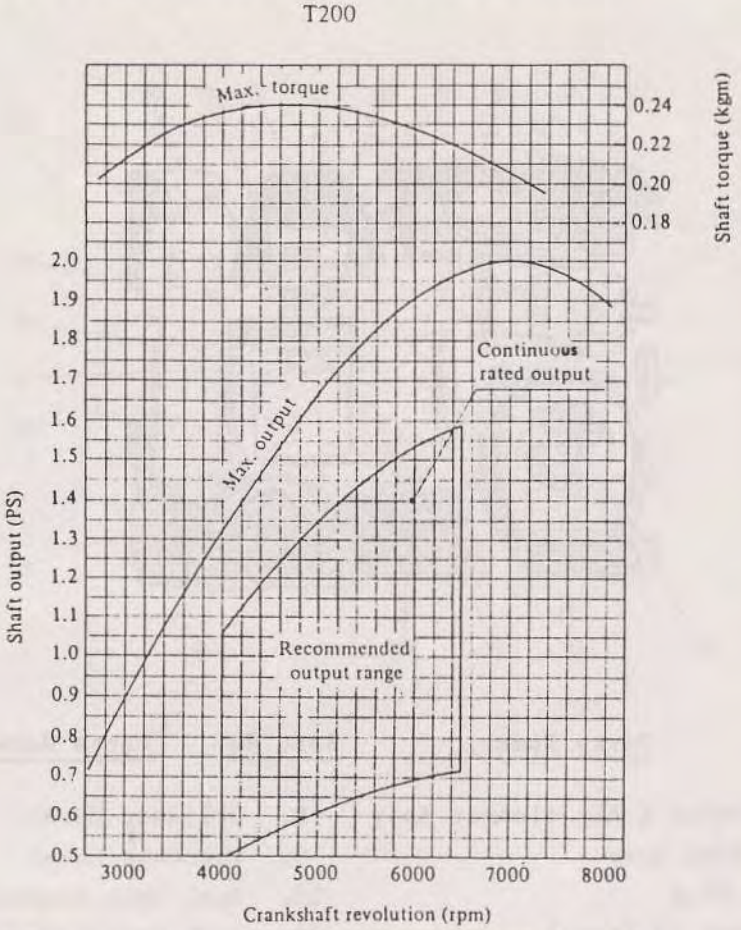
* - Indication of dimension for Bolt Screw, Washer and Nut.

Metric M-screw Threads (Reference)

M	Pitch	Tapped hole	Coarse screw thread Bolt B	Bolt C	Bolt H1	Nut B	Nut C	Nut H2	Fine M	Fine Pitch
3	0.5	$3.2^{+0.12}_{0}$	5.5	6.4	2	5.5	6.4	2.4		
4	0.7	$4.8^{+0.12}_{0}$	7	8.1	2.8	7	8.1	3.2		
5	0.8	$5.3^{+0.12}_{0}$	8	9.2	3.5	8	9.2	4		
6	1.0	$6.4^{+0.15}_{0}$	10	11.5	4	10	11.5	5		
8	1.25	$8.4^{+0.15}_{0}$	13	15	5.5	13	15	6.5		
10	1.5	$10.5^{+0.18}_{0}$	17	19.6	7	17	19.6	8	10	1.25
12	1.75	$13^{+0.18}_{0}$	19	21.9	8	19	21.9	10	12A 12	1.25 1.5
14	2.0	$15^{+0.18}_{0}$	22	25.4	9	22	25.4	11	14	1.5
16	2.0	$17^{+0.18}_{0}$	24	27.7	10	24	27.7	13	16	1.5
18	2.5	$19^{+0.21}_{0}$	27	31.2	12	27	31.2	15	18	1.5
20	2.5	$21^{+0.21}_{0}$	30	34.6	13	30	34.6	16	20	1.5
22	2.5	$23^{+0.21}_{0}$	32	37	14	32	37	18	22	1.5
24	3.0	$25^{+0.21}_{0}$	36	41.6	15	36	41.6	19	24 24A	1.5 2



5.1.2 Performance curve of T-200 engine



This performance curve is based upon B8013 in JIS.

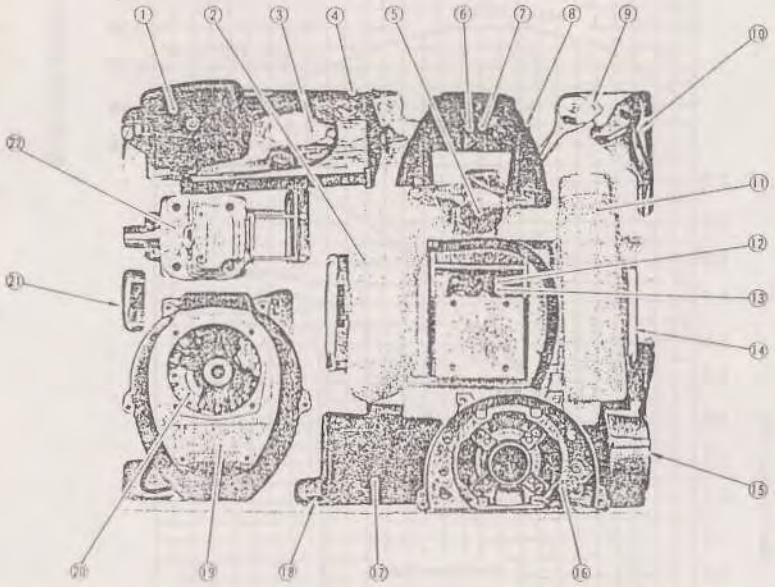
(1) Max. output is the output produced when the throttle valve of the carburetor is fully opened and when the engine has been completely run in.

(2) Continuous rated output is the output level which can be continuously maintained. It is the highest level recommended by the manufacturer for engine efficiency and fuel economy.

(3) Max. torque is the drive torque at the time when maximum output is produced.

(4) Recommended output range is the range in which the engine can be used with stability. It is the most advantageous working range from the standpoint of economy, durability and maintenance.

5.2 Engine Parts



Ref. No.	Parts Name	Ref. No.	Parts Name
1.	Carburetor & Air cleaner Assy	8.	Cylinder Cover
2.	Fuel Tank Assy	9.	Throttle Lever
3.	Spark Plug	10.	Fuel Tank Bracket
	Tool Set (3 items)	11.	Fuel Container
	Contact Breaker	12.	Spare Parts (Packings,
	Stop Switch		Piston Ring)
	Key	13.	Packing (Cylinder)
	Packing (Rubber Sheet)		Packing (Recoil Starter)
4.	Fuel Tank Band Assy		Packing (Crank Case)
5.	Crankshaft & Piston Assy	14.	Engine Frame
6.	Spare Parts (Screws)	15.	Recoil Starter Assy
7.	Screws (M4 x 8) 1 pc.	16.	Crank case Assy
	(M4 x 10) 2 pcs.	17.	Muffler
	(M5 x 12) 4 pcs.	18.	Muffler Cover
	(M5 x 20) 4 pcs.	19.	Fan Case
	(M6 x 12) 4 pcs.	20.	Flywheel Magnetto Assy
	(M6 x 20) 4 pcs.	21.	Starter Pulley
	Bolts (M5 x 20) 4 pcs.	22.	Cylinder Assy

5.3 Principle of a two-stroke cycle engine

Since the two-cycle engine uses the crankcase for storing a reserve charge of the fuel-air mixture for the next stroke, it cannot be used solely as an oil storage compartment for lubricating the engine. Instead, lubrication is supplied by a specific quantity of oil mixed with the gasoline at the time the engine is refueled. Two-cycle engines have a sealed crankcase, but no oil sump (Fig. 5.3.1).

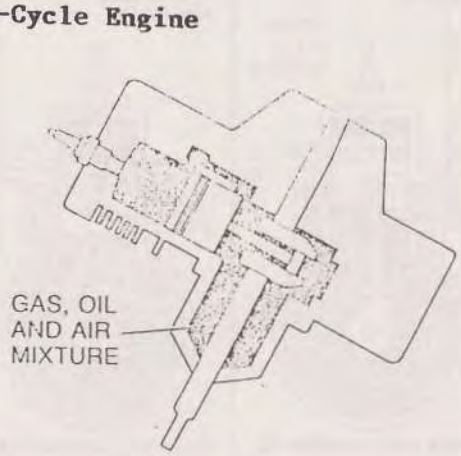


Fig. 5.3.1 A two-stroke cycle engine is lubricated at any position in the cycle because it is lubricated by special oil mixed with the fuel.

Here is how a two-stroke cycle engine works. It is designed to complete all the actions (a cycle) as described in the working of a four-stroke cycle engine, but it completes them during one revolution of the crankshaft. The operating principle of a two-stroke cycle engine is shown in Fig. 5.3.2. The two strokes are:

a. Stroke 1 -- Compression and Intake

b. Stroke 2 -- Power and Exhaust

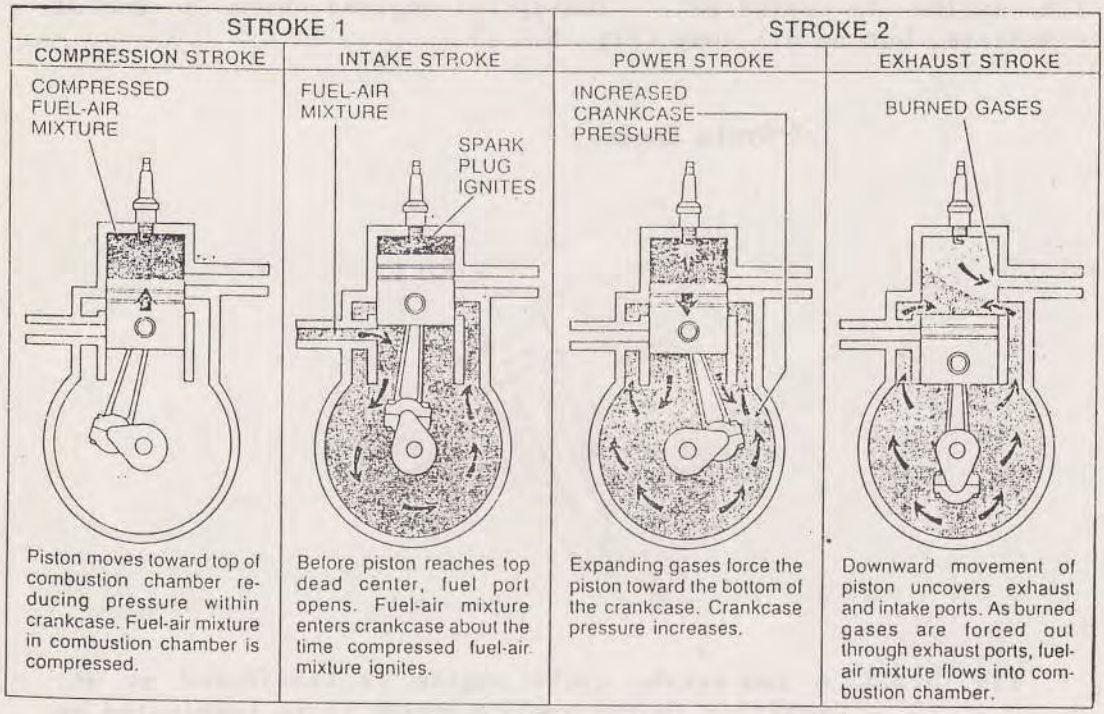
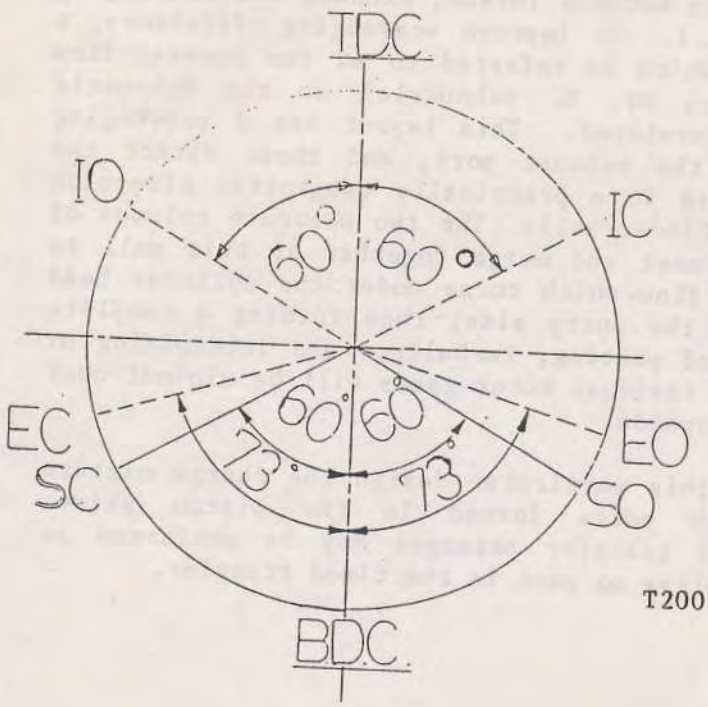


Fig. 5.3.2 The operating principle of a two-stroke cycle engine.

5.4 Valve diagram



Intake open	BTDC 60°
Intake close	ATDC 60°
Scavenging open	BBDC 60°
Scavenging close	ABDC 60°
Exhaust open	BBDC 73°
Exhaust close	ABDC 73°

T200 engine's valve diagram

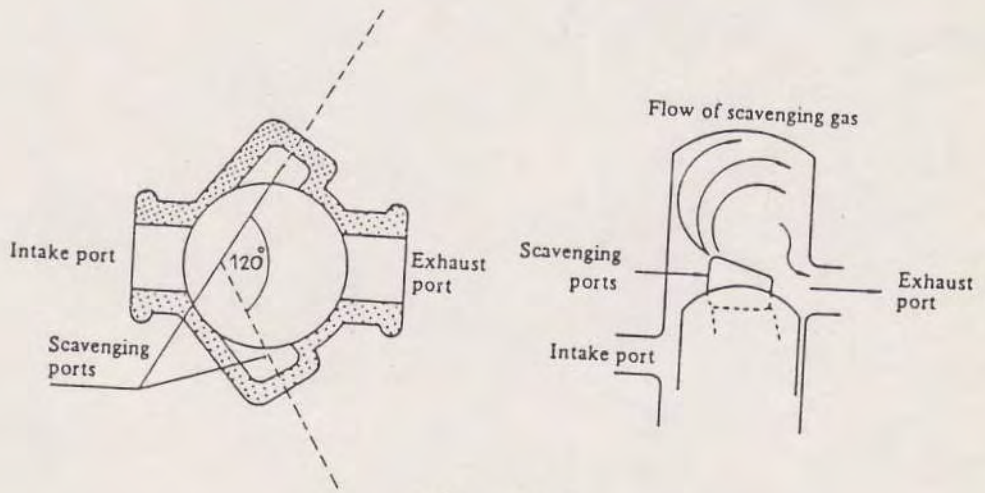
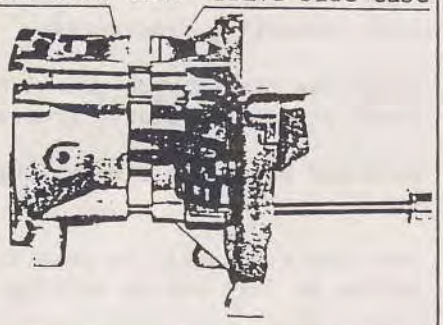
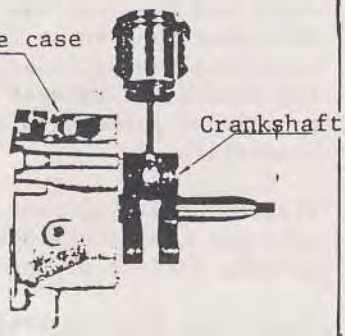
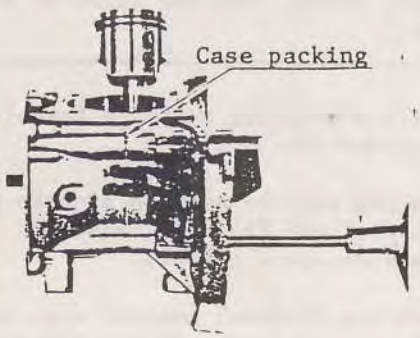
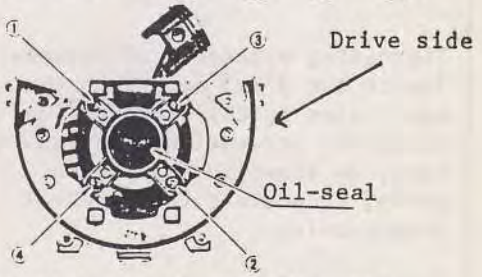


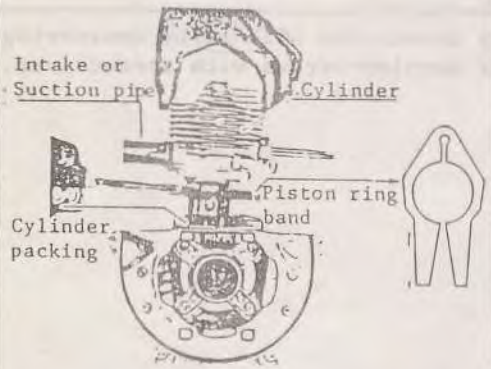
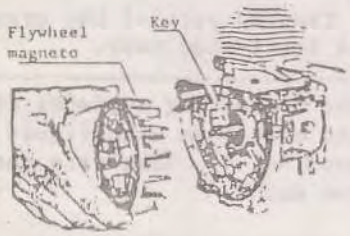
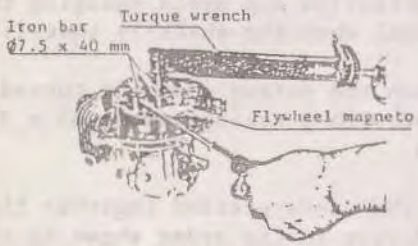
Fig. 5.4.1

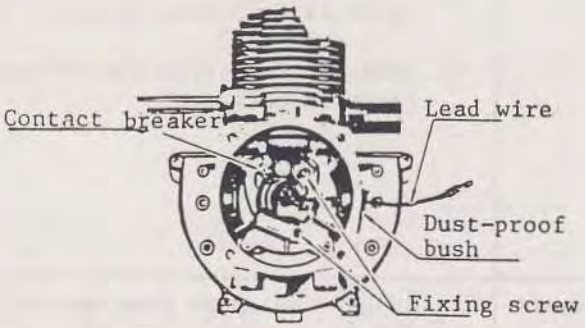
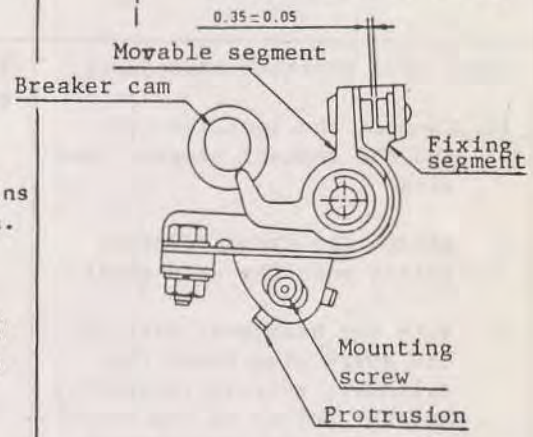
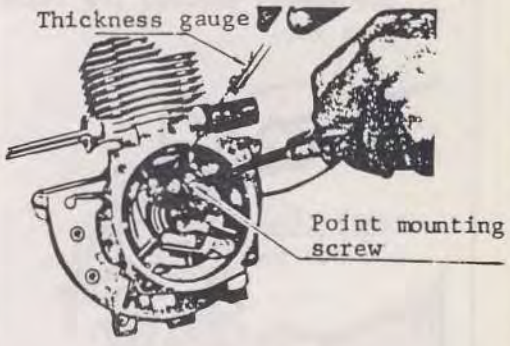
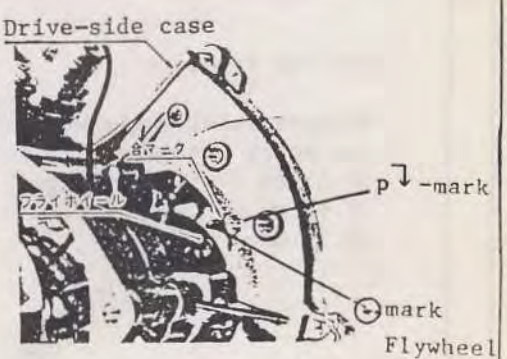
The T-200 engine employs a reverse-flow scavenging system. The relationship between intake, exhaust and scavenging is as shown in Fig. 5.4.1. To improve scavenging efficiency, a loop-scavenging system which is referred to as the reverse-flow or (after its inventor, Dr. E. Schnuerle) as the Schnuerle scavenging system was developed. This layout has a scavenging port on each side of the exhaust port, and these direct the scavenging charge mixture in a practically tangential direction towards the opposite cylinder wall. The two separate columns of the scavenging mixture meet and merge together at this wall to form one inward rising flow which turns under the cylinder head before flowing down on the entry side, thus forming a complete loop. With this form of porting, turbulence and intermixing of fresh fuel mixture with residual burnt gases will be minimal over a wide range of piston speeds.

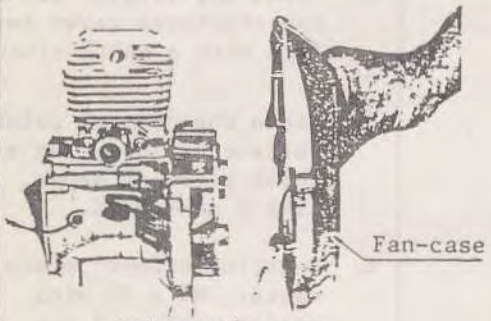
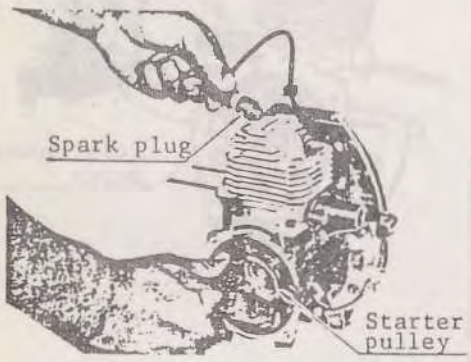
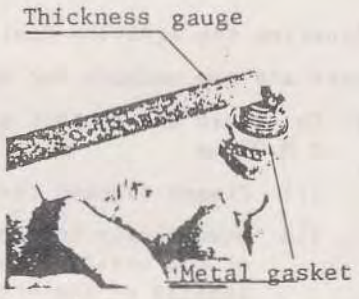
Note that in this particular design the charge mixture is transferred through ports formed in the piston skirt. Alternatively, extended transfer passages may be preferred so that the piston skirt plays no part in the timed transfer.

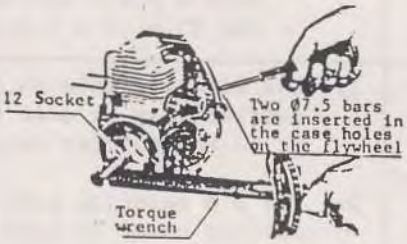
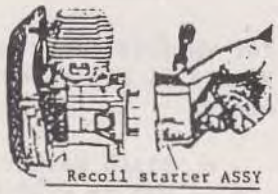
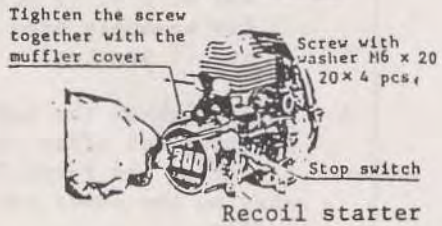
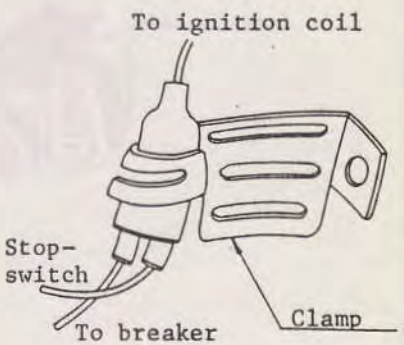
6. Engine Assembly Sequence

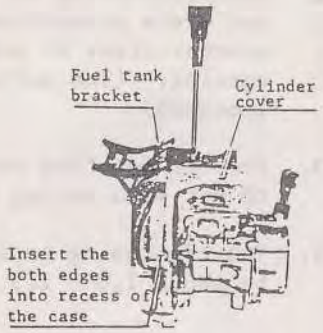
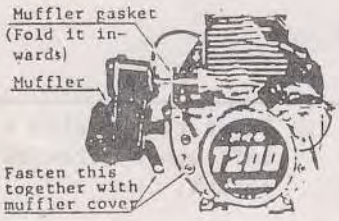
	Assembly procedures	Tools	Caution
1	Starter-side case Drive-side case 	(+) Screw-driver	Separate crank-case ASSY (16) by unscrewing the four machine-screws with screwdriver.
2	Insert crankshaft (5) into starter side case 	Lubricating	1. Wash crankshaft & piston ASSY (5) and oil each moving part. 2. Insert crankshaft with care so that the oil seal may not be damaged. 3. Don't hammer on the crankshaft when the shaft is inserted. 4. Take care not to damage the piston. 5. Insert the crankshaft completely. 6. Put the tapered part of the crankshaft into the drive-side case.
3	Place crank case packing (13) on the joint-surface of the starter-side case, and install the drive side case 	(+) Screw-driver Plastic-Tipped hammer	1. Clean the connecting surfaces of the cases and coat them with liquid seal or three-bond No. 4. Take care not to apply too much. 2. Pay attention and avoid damaging the oil-seal when the shaft is installed. 3. Tighten the screws (Machine turned screws with a spring washer M5 x 35 x 4 pcs.) 4. With the cases pressed together, tighten the screws in the order shown in the Figure below ((1) → (2) → (3) → (4))  5. Check that the crankshaft turns smoothly after tightening the screws.

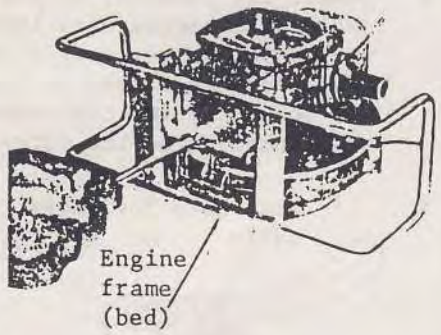
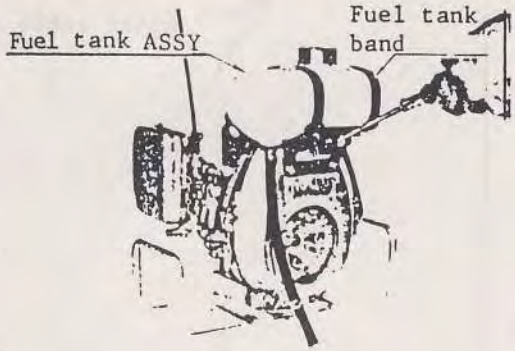
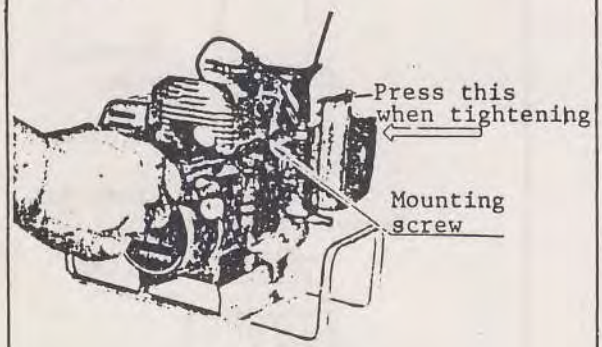
	Assembly procedures	Tools	Caution
4	 Further Practice Check and measure the valve timing: Intake open ( ) BTDC close ( ) ATDC Exhaust open ( ) BBDC close ( ) ABDC	Key Wrench Ring (Band) Compressor Oil	1. Oil the inner surface cylinder of the cylinder and piston ring. 2. Cylinder installing procedures: 1) Align the piston ring gap with the knock pin on the piston groove. 2) Hold and press the ring by the ring-band. 3) Turn the crankshaft to position the piston at full bottom setting. 4) Place the cylinder on the piston, with the intake pipe positioned on the left when viewed from the drive-side, and then tap the cylinder top with your hand so as to insert the ring into the cylinder. Check that the intake and exhaust ports are positioned perpendicular to the crankshaft.
5	Install flywheel magnet to crank-shaft after fitting the key onto crankshaft   Tightening procedure of Flywheel: Insert two ϕ 7.5 bars into the cast holes on the flywheel, and place the screwdriver between the bars, as shown in the Figure above, to prevent the flywheel from turning. Tightening torque 130 kgf. cm. = 9.4 Lb. ft.	Torque wrench 12 Socket Screwdriver Bar (ϕ 1.5)	5) Dismount the ring-band and press the cylinder completely down into the joining surface of the case. 6) Check that the crankshaft can be rotated smoothly when the cylinder is pressed down. 7) Tighten the bolt with the packing holes correctly aligned. 3. Tighten the bolts using a Hexagon socket head cap screw M5 x 20 x 4 pcs. 1. Install a woodruff key into keyhole on the crankshaft. 2. Clean the tapered portion of both the crankshaft and flywheel magneto. (Don't use woolen waste cloths). 3. Insert the flywheel magneto with the key and keyway aligned. If the key and key-way are not properly aligned, the wood-ruff key may become detached from the case-side. 4. Use an M8, plain and spring washer and nut. 5. First install the plain washer, and then the spring washer.

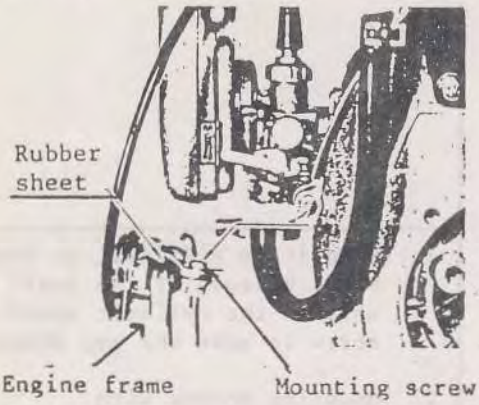
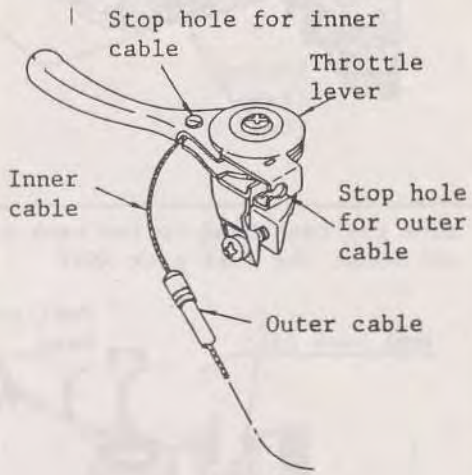
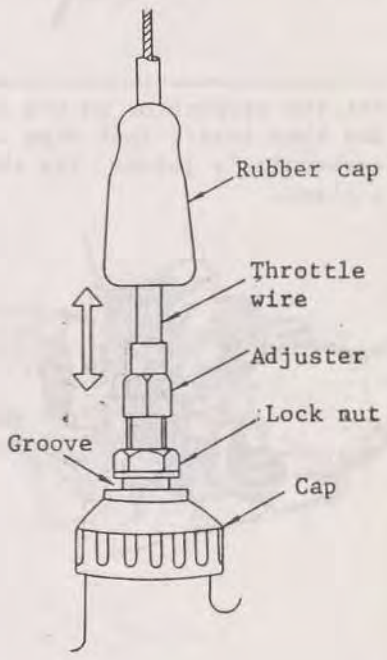
	Assembly procedures	Tools	Caution
6	Install contact breaker (3) on the starter-case and adjust the ignition timing 1. Breaker installation: 1) Pass the lead wire through the hole in the case and insert the dust-proof bush. 2) Mount the Contact breaker body & Condenser body.  3) The lead wire clamp and contact breaker are fastened together with screws. 4) Insert the contact contact breaker knock pins and condenser into the case-hole and fasten. 2. Adjusting the ignition timing: There are two methods for adjusting (14) timing 1) To adjust the contact gap to be within 0.35 ± 0.05 mm 1.1 Finger tighten the mounting screw. 1.2 When slowly turning the crankshaft stop at the position showing the maximum opening of the breaker point gap. 1.3 Place a screw driver between the protrusion and mounting screw, and then adjust the gap to be within 0.35 ± 0.05 mm by moving the fixing segment. 1.4 Firmly tighten the mounting screw to maintain the adjustment 1.5 The above procedures enable the ignition timing to be 25 ± 3° (B.T.D.C) 2) To align the matching mark for ignition timing 2.1 Align the p⌐ -mark on the drive-side case with the red-mark ⊖ on the flywheel and when in this position, adjust the contact point so that is starts to open its gap when a screwdriver ⊖ is placed between the protrusion and mounting screw. 2.2 Confirm that the opening of the contact point is correctly positioned by turning the flywheel. 2.3 The above procedures enable the ignition timing to be 25° ± 3° B.T.D.C.		1. Firmly install the dust-proof bush in the crank-case. 2. Clean any surplus oil on the thickness gauge surface with a waste cloth. 3. Clean the contact point surface by inserting a thick piece of paper, like a name card. 4. Mounting screws; plain washer, M4 x 10 with spring washer, 2 pcs.   

	Assembly procedures	Tools	Caution
7	Mounting the fan-case (19) onto the drive-side case  	(+) Screw-driver	1. Use M5 x 10 x 4 pcs mounting screws without washers. 2. The ignition coil is incorporated inside the fan-case so that the gap between the Flywheel magneto outer surface and ignition coil core is about 0.4 - 0.5 mm. This gap is called the air-gap on the ignition coil.
8	Spark plug checking procedures: 1. Connect the ignition coil and the contact breaker lead wire 2. Attach the recoil-starter pulley onto the crankshaft 3. With the hexagonal part of the spark plug touch the cylinder, quickly rotate the starter pulley in the direction of arrow, and observe the sparks between the spark plug gap.  Further Practice Measure wheel angle when the point gaps are: ;0.35 mm --- ( ) deg ;0.45 mm ( ) ;0.25 mm ( )	Thickness gauge	1. Adjust the spark plug gap to about 0.7 mm. 2. Check that the metal gasket is firmly attached to the spark plug. 

	Assembly procedures	Tools	Caution
9	Installing the recoil starter pulley (21) 1) Tap the claw parts of the starter pulley (21), which is screwed on the crankshaft, with plastic hammer and tighten the starter pulley in the direction shown.  2) Fix the starter pulley tightly with an M8 nut  	Screwdrive 12 socket wrench Torque wrench Plastic hammer 0 7.5 bars	1. Don't hammer the claws too much when the starter pulley is tightened. 2. When tightening an M8 nut, do not place screwdriver on the starter claws to prevent it turning. (The pulley may be loosened) 3. For the mounting nut use an M8 nut with spring washer. 4. The tightening torque should be about 1.0 - 1.3 kg. m.
10	Installing the recoil-starter packing (13) and the recoil starter (15) 1. Install the stop switch in the upper right position and fix with the screw 2. Connect the lead wires of the stop switch and fix the terminal with the clamp   Recoil starter	(+) Screw-driver	1. First temporarily tighten the left upper screw of the four screws. 2. Mount a plain screw washer., and spring washer. 

	Assembly procedures	Tools	Caution
11	Install fuel tank bracket (10) and cylinder cover (8). ⌖ The upper mounting hole on the tank bracket is used for tightening the cylinder cover  	(+) Screw-driver	1. Insert the high tension cord dust-proof bush into the notched portion on the fan case. Insert the contact breaker dust-proof bush into the notched portion on the cylinder cover. 2. Insert both edges of the cylinder cover into the recess provided on the drive-side of the case. 3. Mounting screws: o A cylinder cover mounting M5 x 12 x 1 pc. screw with plain washer o Fuel tank bracket mounting with a plain spring washer and M5 x 12 x 2 pcs. screws
12	Installation of the muffler (17), Muffler cover (18), and spark plugs (3).   	(+) Screw-driver 8 mm spanner 19 spoon-type spanner	1. The mounting hole on the lower muffler stay is used to fasten it to the muffler cover. 2. The 6 ϕ mounting hole on the muffler cover is used to fasten the cover onto the recoil starter. 3. Screws used when mounting the muffler o Spring washer and M5 nut x 2 pcs. o Plain washer, with spring washer and M5 x 12 x 1 pc. screw For muffler cover mounting use an M4 x 8 (1 pc) screw and plain washer o Plain washer, spring washer, and M5 x 12 (1 pc) screw (is commonly used on the recoil starter) 4. Fully tighten the muffler mounting nut after temporarily inserting the screw for the stay on the lower part of the muffler.

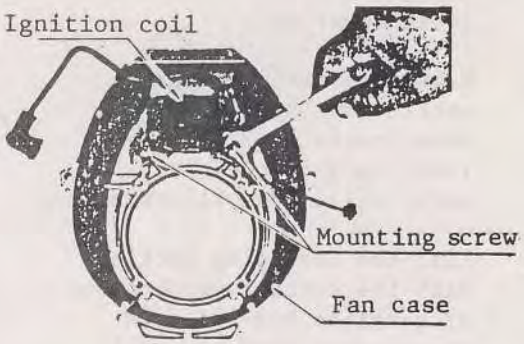
	Assembly procedures	Tools	Caution
13	Mounting the engine onto the engine frame (14).  	⊕ Screw-driver	1. Install the bottom fan case in the notched part of the engine frame. 2. Use mounting screws M6 x 16 x 4 pcs. with spring washer.
14	Hook the tank band to the tank bracket, and mount the fuel tank ASSY  		1. When it is difficult to hook the band, because of the small gap, unscrew the cylinder cover mounting screw to make the gap wider. 2. Mounting screws with o Washer, M5 x 40 x 1 pc. M5 nut x 1 pc. o These screws are set on the tank band. 3. Do not over tighten the band fastening screw.
15	Fit the carburetor on the intake pipe, and then insert fuel pipe into the carburetor's joint. Fix the pipe with a clamp.  	⊖ Screw-driver. Pliers	1. Firmly press the carburetor onto the intake pipe, then fasten the carburetor band. (To prevent the suction of secondary air). 2. Position the nob on the pipe clip on the clean air side using the pliers (This will prevent interference with the fuel cock lever).

	Assembly procedures	Tools	Caution
16	Installing the throttle wire to the throttle lever and the throttle lever on the engine frame: 1) Place the rubber sheet (3) between the throttle lever and the engine frame and fix them with a mounting screw.  2) Adjusting the play on the throttle wire. To properly control the throttle valve opening, adjusting the play on the throttle wire is important. Adjustment procedures: 1 Set the throttle lever in the slow speed position. 2 Loosen the lock nut 3 Adjust the play with the adjuster. When the adjuster is turned upwards, the play becomes small and if downwards, larger. Confirm the actual amount of play by moving the outer cable of the throttle wire up and down with fingers. The amount of play on the wire should be between 0.5 - 1.0 mm 4 After adjusting the play, fix the wire with a lock-nut and insert the rubber cap into the groove.	⊕ Screw-driver 8 spanner	Throttle wire installation o Insert the terminal of the inner cable of throttle wire into the stop hole on the lever's opposite side and then thread it through the stop hole for the outer cable while pulling on the outer cable.  

Installation of Ignition coil

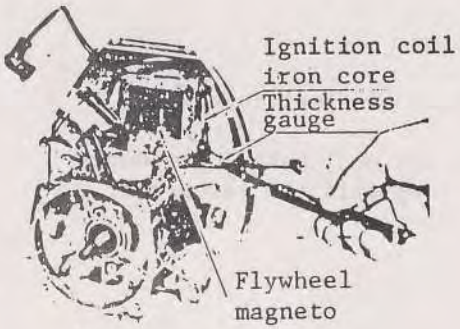
The ignition coil has been installed in the fan case so that the gap between the outer circumference of the flywheel and ignition coil is adjusted to between 0.4 - 0.5 mm. However, when replacement is required, it should be performed according the following procedures:

1) Installing the ignition coil into the fan case. Temporarily insert the fastening screw or finger tighten the fixing screw to the extent that the coil can be moved by hand.

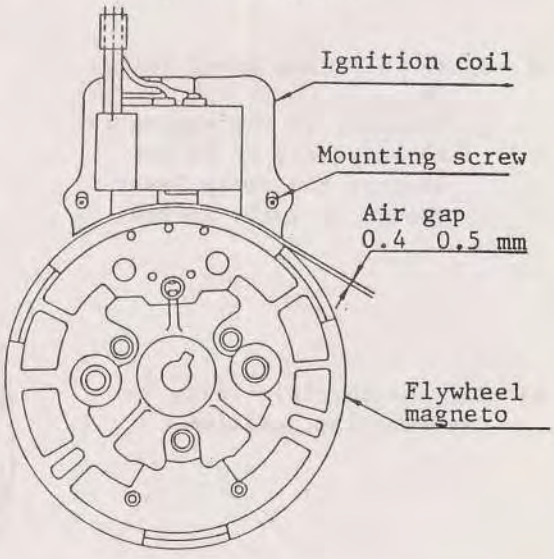


2) Adjust the air gap to between 0.4 - 0.5 mm by measuring the slotted hole on the ignition coil with a thickness gauge.

   o The measuring should be done at the point where the magnetic steel (Magnet) is embedded.



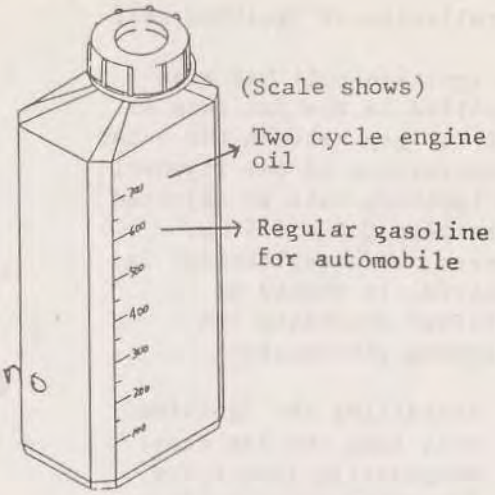
3) After the gap has been adjusted, firmly tighten the ignition coil, and measure and again check that the gap remains between 0.4 - 0.5 mm.



7. Operation

The operation of the assembled engine should be performed as follows:

1. Preparation for operation



- Supply the tank with fuel

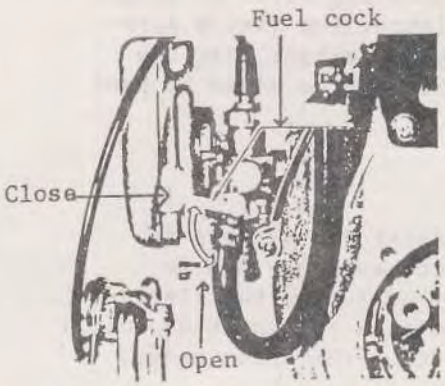
  The fuel used is a mixture of gasoline (regular class for automobiles) with two cycle motor oil.

- Using a plastic measuring bottle make a mixture whose ratio is 20 (gasoline) to 1 (two cycle motor oil). See illustration.

- Fill the measuring bottle with the correct proportions of gasoline and oil, and shake until they are well mixed together.

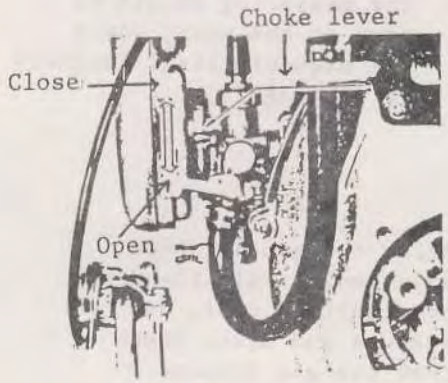
2. Starting

1) Open the fuel cock.



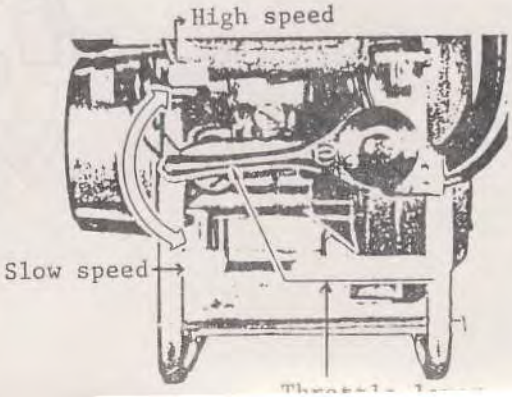
   - It will take 1-2 minutes to fill the carburetor.

2) Close the choke lever fully.



   - However, if the engine is already warm or in hot weather the choke lever should be fully opened.

3) Set the throttle lever in the starting position.



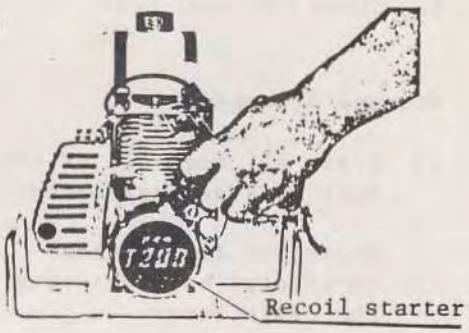
4) Pull sharply on the recoil starter.

- o After starting the engine, open the choke gradually up to its full position while observing the engine's condition.

(Caution)

If the engine won't start the cause may be excessive suction of fuel.

In this case, dismount the spark plug and close the fuel cock, and then pull the recoil starter with both the choke and throttle valve fully opened. Then remount the spark plug and open the choke to restart engine.

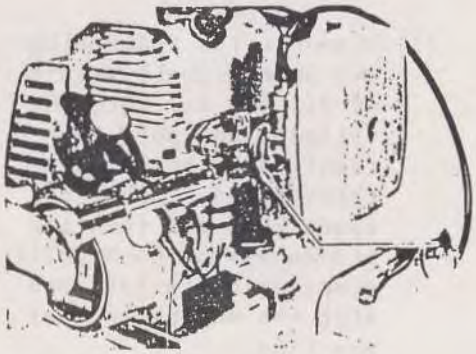


3. **Operation**

1) After the engine has started, allow it to warm up before operating at the required speed.

The slow or idling speed can be adjusted by turning the idle speed adjusting screw.

- o Screw is turned clockwise --- faster or idling speed increases,
- o Screw is turned anti-clockwise --- slower or idling speed decreases.



(Caution while operating)

1. Do not increase speed rapidly or run the engine at high speeds without loading.
2. Never run an engine in a closed space where there is no ventilating system.
3. Do not touch the muffler cover or cylinder while the engine is running to avoid getting burnt.
4. Do not touch the flywheel while in operation.

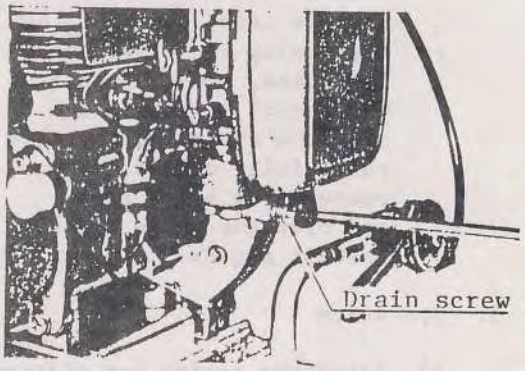
4. Stop Engine

1. Slow down the engine speed by moving the throttle lever to the slow speed position.

2. Press the stop switch until the engine has stopped completely.

3. Close the fuel cock.

5. Storage of engine



1) Drain all fuel out of the fuel tank and carburetor.

   Drain the fuel in the carburetor by unscrewing the drain screw.

2) Clean the whole outer surface of the engine with an oil-dampened cloth.

3) Dismount the spark plug and pour a small amount of oil (10 cc) into the cylinder and pull the recoil starter two or three times. Mount the spark plug and turn the crankshaft by hand until compression is felt and stop the engine in that position.

4) Store the engine in a dry place.

6. When the engine is to be stored in the original packing case.

1) Wipe and clean the all parts of the engine because the styrene foam case liner may be dissolved in gasoline or oil

2) Coat the following parts with oil and wrap them in plastic before storage; cylinder, crankshaft-piston assembly, flywheel magneto bearing parts, screws.

8. STRUCTURE AND MAINTENANCE STANDARDS

8.1 Crankcase

The crankcase is made of diecast aluminium. In general the compression ratio in the crankcase is between 1.3 - 1.5. The crankcase should be completely airtight because the air-fuel mixture sucked through the intake port is compressed before being fed to the combustion chamber.

Case knock pins are used to mount the fan case therefore mounting work can be easily and accurately performed during an overhaul. Because the three cases are in one machined unit, the whole case assembly should be replaced when any one section needs replacing.

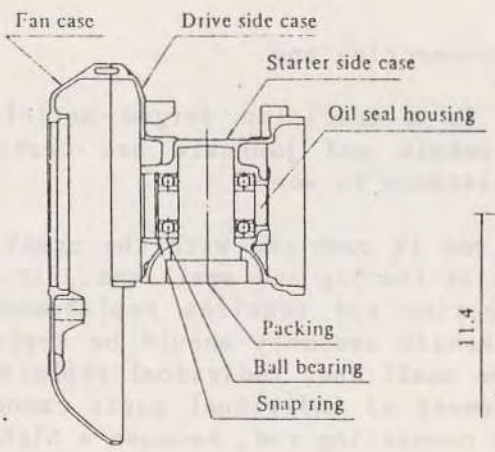


Fig. 1

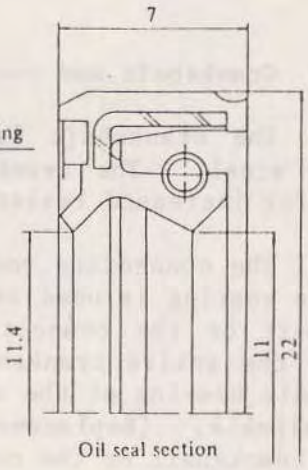


Fig. 2

	Drive side	Starter side
Ball bearing	# 6202	←
Oil seal	TC 15 35 7	TC 12 22 7
Case tightening torque .... (M5 pan head screw) 0.4-0.5 kg.m		

(Reference)	Material grade	Inside diameter	Outside diameter	Width
o Ball bearing # 6202 ⟹		15	35	11
o Oil seal ⟹	TC	12	22	7

8.2 Crankshaft and connecting rod

The crankshaft is a precision forged article made of blister steel. The crankpin and journals are carburized and ground for increased resistance to wear.

The connecting rod is combined with the crankshaft, and a needle bearing is used at its big and small end. If either the crankshaft or the connecting rod requires replacement for any reason, the entire crankshaft assembly should be replaced. For the needle bearing at the small end, individual replacement parts are available. (Replacement of individual parts cannot be made on the crankshaft or the connecting rod, because a high degree of accuracy required).

(1) Runout of crankshaft end

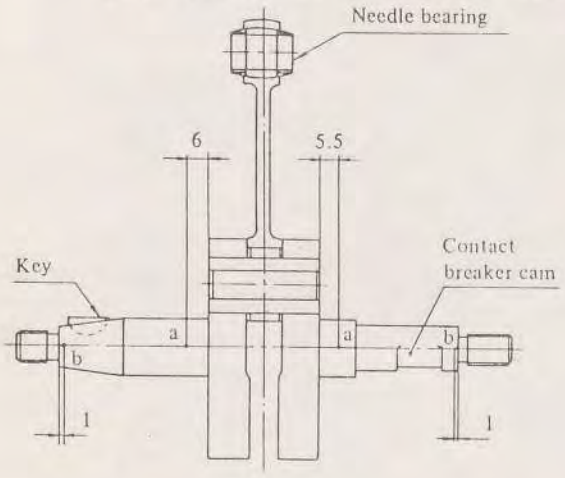


Fig. 3

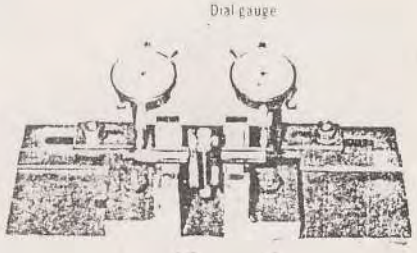


Fig. 4

The runout should be within the values shown in the following table when the crankshaft is rotated, as supported at a' and a' as shown in Fig. 3.

Standard dimension	b	0.05 Max.
	b'	0.05 Max.
Allowable limit	b	0.06
	b'	0.06

The crankshaft assembly should be replaced if the allowable limit is exceeded.

(2) Clearance between crankshaft and connecting rod big end (Fig. 5)

Measuring tool: Feeler gauge

Fig. 5

Standard dimension	0.16 - 0.35 L
Allowable limit	0.55

Push the connecting rod in either direction and insert a feeler gauge into the clearance on the opposite side. Take four separate readings. Replace the crankcase assembly if the clearance exceeds the allowable limit at any of the four points.

(3) Clearance between hole in connecting rod big end and crankpin (Fig. 6)

Measuring tool: Dial gauge

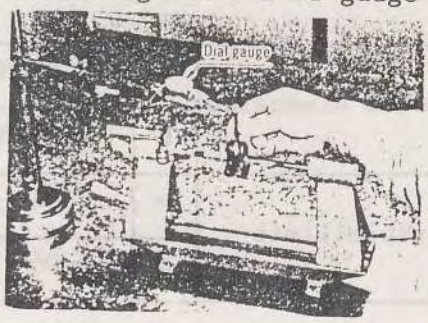


Fig. 6

Standard dimension	0 - 0.025 L
Allowable limit	0.05

Fix the crankshaft. Fit a dial gauge to the connecting rod small end, and read the dial gauge with the connecting rod moved in the longitudinal direction. Replace the whole crankshaft assembly if the dial gauge reading exceeds the allowable limit.

(4) Clearance between hole in connecting rod small end and piston pin (Fig. 7, Fig. 8)

Measuring tool: Cylinder gauge

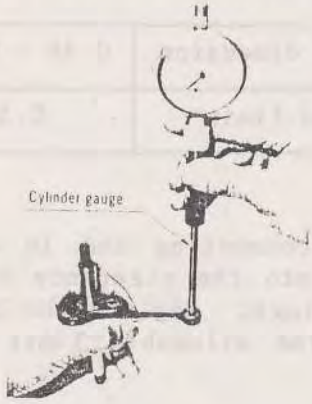


Fig. 7

Measuring tool: Micrometer

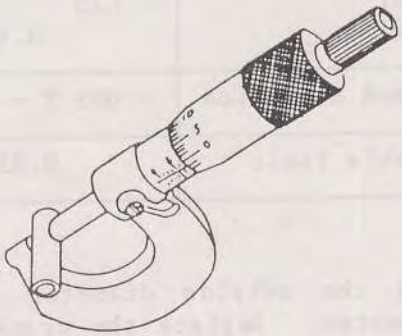


Fig. 8

Standard dimension	0.001 L - 0.023 L
Allowable limit	0.05

Measure the inside diameter of the hole in the connecting rod small end with a cylinder gauge and measure the outside diameter of the piston pin with a micrometer. If the difference between these values exceeds the allowable limit, replace the needle bearing, piston and piston rings set.

(5) Clearance between crankshaft and main bearings (Fig. 9)

Measuring tool: Micrometer

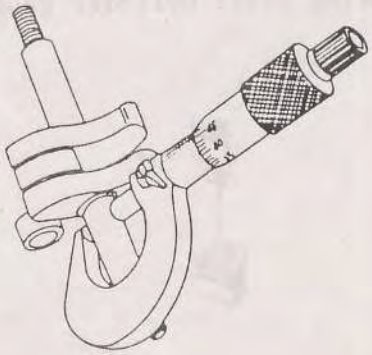


Fig. 9

Crankshaft journal dimension	$^{-0.005}_{015}$ $^{-0.012}$
Standard dimension	0.003 T - 0.012 L
Allowable limit	0.05

Measure the outside diameter of each crankshaft journal with a micrometer. Replace the crankshaft assembly and main bearings if the fitting clearance to the main bearing exceeds the allowable limit.

8.3 Cylinder

The cylinder is of aluminium and diecast together with the cylinder head into a solid body to increase heat conductivity and to reduce its weight. The inside cylinder surface is porous chrome plated (channel type) for improving the durability of the cylinder.

(1) The cylinder head section forms part of a sphere, and the cooling fins are placed in position to allow good airflow and provide a large cooling effect.

The relationship between intake, exhaust and scavenging is shown in section 5.4. The valve timing is shown below.

(2) Cylinder bore

Measuring tool: Cylinder gauge

Fig. 10

Measure the bore with a cylinder gauge. (Fig. 10)

Standard dimension	ϕ 39 $^{+0.02}_{0}$
Allowable limit	Until plating exfoliates

8.4 Piston and piston rings

The piston is made of special aluminium alloy to reduce its weight and for reducing the bearing load during operation. In a 2-stroke cycle engine, the scavenging ports open up before termination of the exhaust stroke so that the air-fuel mixture pressurized in the crankcase is fed into the combustion chamber and discharge of exhaust gas is enabled. Therefore, a semi-spherical form is used for the piston crown to facilitate the flow of exhaust and scavenging air.

Piston rings are positioned with knock pins so that their open ends will not be caught by the ports in the cylinder. A slip-out of the piston pin is prevented by the stop rings provided on both right and left sides. (Fig. 11)

The piston rings are made of special cast iron and are surface treated by parkerizing for improving resistance to wear.

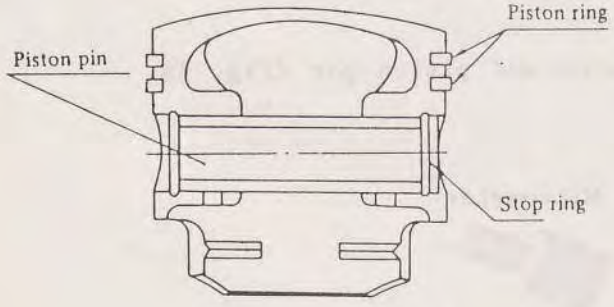


Fig. 11

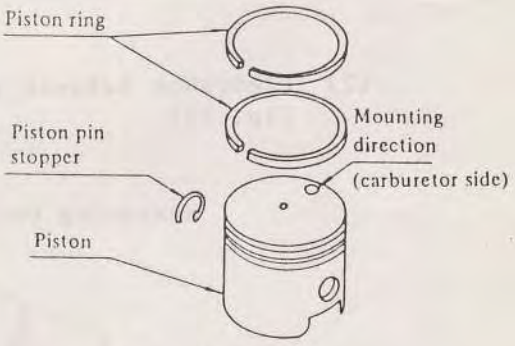


Fig. 12

(1) Clearance between piston and cylinder (Fig. 13). Measure the maximum diameter of the piston with a micrometer and calculate the difference (called piston clearance) to the maximum cylinder bore. Replace the piston assembly if this clearance exceeds the allowable limit.

Measuring apparatus: Micrometer

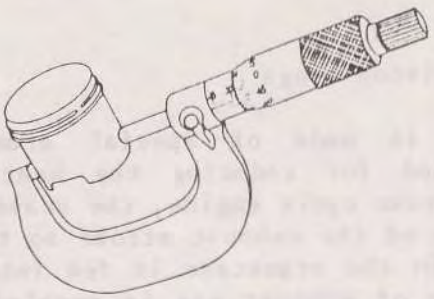


Fig. 13

Piston pin outside diameter	ϕ 39 $^{-0.035}_{-0.050}$
Standard dimension	0.035 L - 0.07 L
Allowable limit	0.1

(2) Clearance between piston and piston pin (Fig. 14, Fig. 15)

Measuring tool: Micrometer

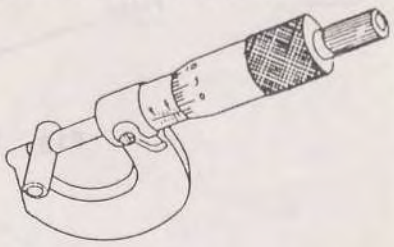


Fig. 14

Measuring tool: Cylinder gauge

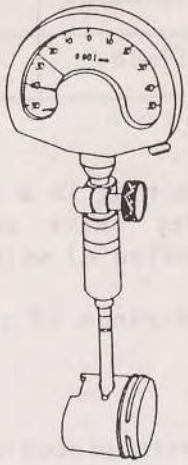


Fig. 15

Standard dimension	0.099 T - 0.007 L
Allowable limit	0.05

Measure the piston pin hole inside diameter with a cylinder gauge and measure the piston pin outside diameter with a micrometer. Replace the piston and piston pins set if the fitting clearance exceeds the allowable limit.

(3) Clearance between open ends of piston rings (Fig. 16)

Measuring tool: Feeler gauge

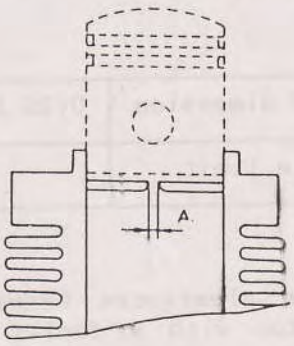


Fig. 16

Standard dimension	0.1 - 0.3 L
Allowable limit	0.7

Fit the piston ring in a horizontal position (using a piston) into the cylinder skirt and measure the clearance between the open ends (dimension A) with a feeler gauge.

Replace piston rings if this clearance exceeds the allowable limit.

(4) Clearance between piston ring and ring groove (Fig. 17)

Measuring tool: Feeler gauge

Fig. 17

Standard dimension	0.05 L - 0.09 L
Allowable limit	0.15

Measure the clearances between piston rings and ring grooves in the piston with a feeler gauge. Replace the piston and rings if any clearance exceeds the allowable limit.

8.5 Recoil starter

A recoil starter (Fig. 18) is mounted in a case for the purpose of increasing the work efficiency and safety. When the starter rope, which is wound on the reel by the tension of the spiral spring, is pulled the ratchet linked with the reel opens, causing the starter pulley to turn.

(1) Bind screw tightening torque is 0.35 kg.m.

(2) Apply a small amount of quality grease to the reel.

(3) Recoil starter disassembling and reassembling procedures are shown in the following table.

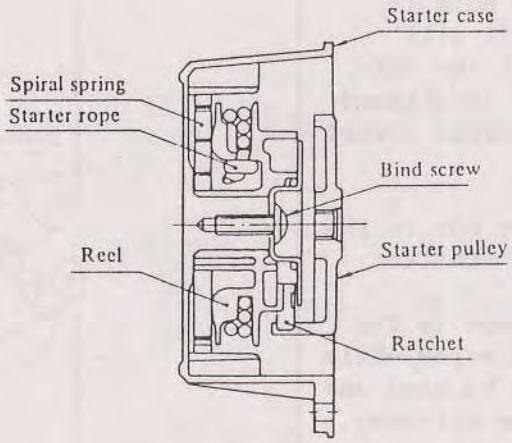
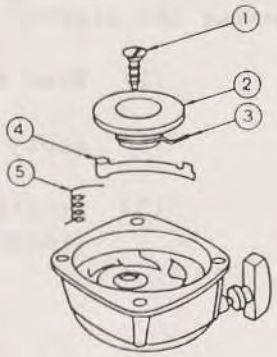
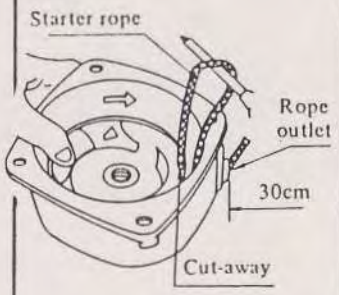
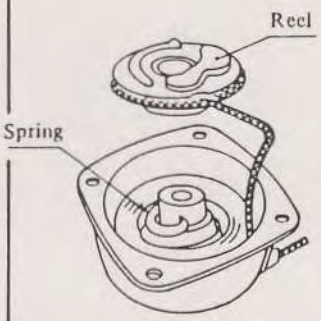
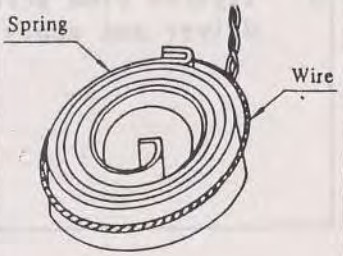
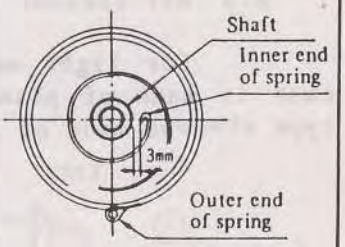
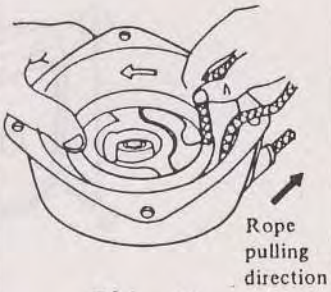


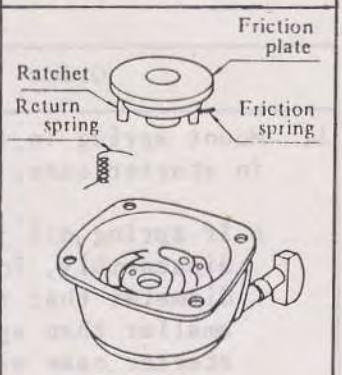
Fig. 18

DISASSEMBLING PROCEDURE OF THE RECOIL STARTER

Order	Tool	Illustration
1. Remove bind screw. 2. Dismount friction plate 2, friction spring 3 and ratchet 4 at the same time. 3. Remove return spring 5. (Fig. 19) 4. Pull out about 30 cm of the starter rope and hold it by hand so that it will not return until the cut-away in the reel is aligned with the starter rope outlet. (Fig. 20). 5. Pull starter rope out to the inside of recoil starter. 6. Rewind starter rope in the direction of the arrow while applying a brake by hand and making use of the cut-away, until rotation stops. 7. When the reel only needs to replaced slowly remove it from the starter case while lightly turning first clock-wise then counter-clockwise to release it from the spring. Note: Do not suddenly remove the reel. The spring may jump out of position.	+ screwdriver	 Fig. 19  Fig. 20  Fig. 21

REASSEMBLING PROCEDURE OF THE RECOIL STARTER

Order	Tool	Illustration
1. Mount spring in its position in starter case. o If spring did jump out during disassembly, form a ring of a diameter that is slightly smaller than spring seat in starter case with the wire, then rewind the spring into it. (Fig. 2)		 Fig. 22
2. Adjust from the inner end of spring so that it comes to a position about 3 mm from shaft so that the reel hook positively catches on the spring. (Fig. 23)	Long nose pliers	 Fig. 23
3. Wind the starter rope on reel in the direction of arrow, and take it out of cut-away in reel when 3½ turns have been completed. (Fig. 24)		 Fig. 24
4. Mount the reel and spring with inner end of spring suitably matched with spring catch of reel.		
5. Hold the starter rope and wind it on reel by three turns in the direction of arrow. Hold reel so that it will not reverse, and pull rope out in the direction of arrow (⇒). (Fig. 25)		 Fig. 25
Note: Do not quickly return the rope, as the reel may jump out of the case.		
6. Mount return spring.		

Order	Tool	Illustration
7. Hook friction spring on protrusion (small) of rachet and mount it together with friction plate. (Fig. 26) 8. Tighten bind screw (with screw driver and apply lock cement).	Screwdriver	 Fig. 26

8.6 Air cleaner (Fig. 27)

For light weight and ease of handling the air cleaner case is made of plastic resin which is filled with a semi-wet type element made of polyurethane foam.

T200P

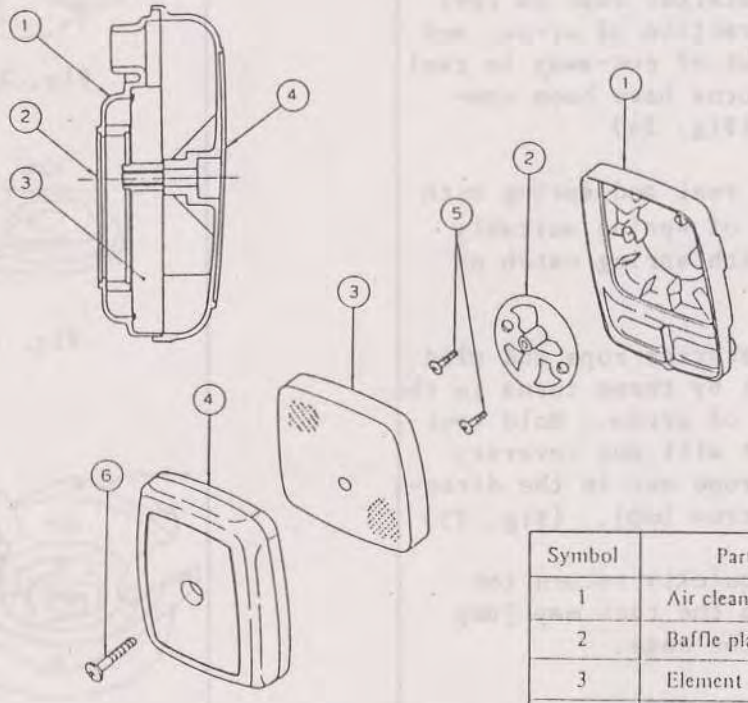


Fig. 27

Symbol	Part Name
1	Air cleaner case
2	Baffle plate
3	Element
4	Air cleaner case cap
5	Screw (M4 x 16)
6	Screw (M5 x 25)

8.7 List of maintenance standards

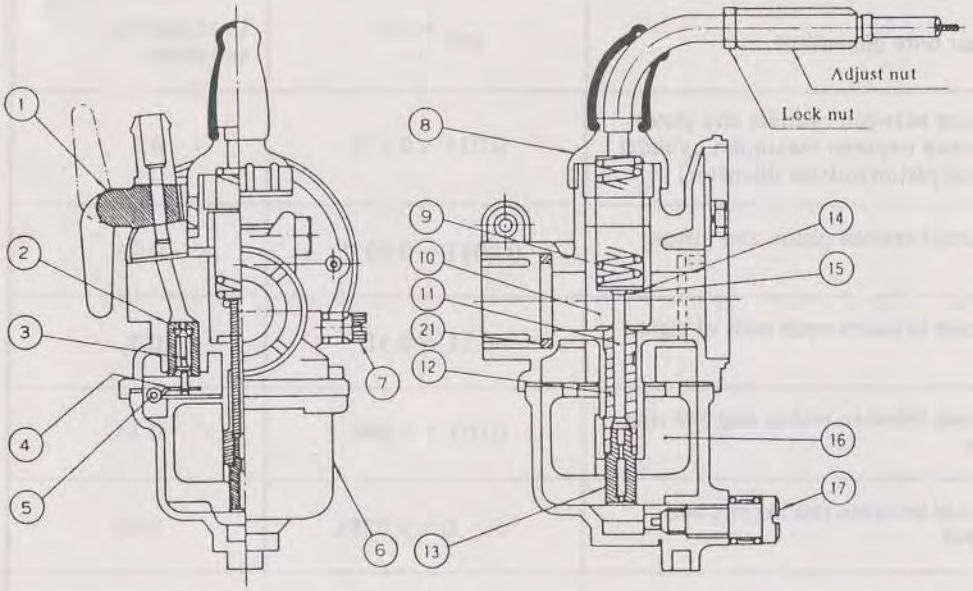
Servicing Item	Standard dimension	Allowable limit
Cylinder bore dimension	$\phi 39\ ^{+0.02}_{0}$	Until plating exfoliates
Clearance between cylinder and piston (difference between maximum cylinder bore and piston outside diameter)	0.035 ~ 0.07L	0.1
Clearance between piston and piston pin	0.009T ~ 0.007L	0.05
Clearance between open ends of piston rings	0.1L ~ 0.3L	0.7
Clearance between piston ring and ring groove	0.05L ~ 0.09L	0.15
Clearance between rod big end and crankpin	0 ~ 0.025L	0.05
Clearance between rod small end and piston pin	0.001L ~ 0.023L	0.05
Axial play of crankshaft	0.01L ~ 0.20L	0.5
Clearance between crankshaft and main bearing	0.003T ~ 0.012L	0.05
Clearance between crankshaft and side face of rod big end	0.16L ~ 0.35L	0.55
Runout of end of crankshaft	0.05 Max.	0.06
Spark plug electrode gap	$0.7\ ^{0}_{-0.1}$	0.8

Note: Replace parts when the allowable limit is exceeded, except for spark plug, the electrode gap of which is adjustable.

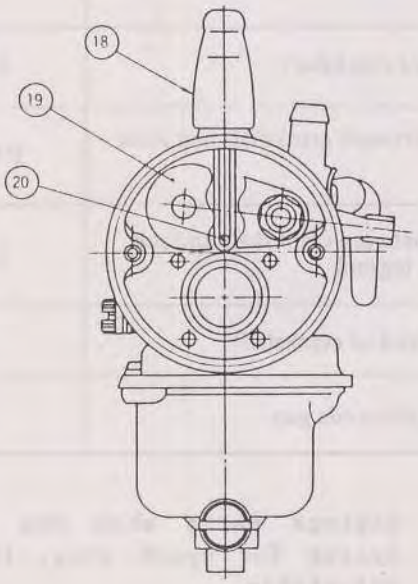
8.8 Carburetor and adjusting procedures

(1) Description of components

Float type carburetor (T200P)



Symbol	Part Name
1	Fuel cock
2	Needle valve seat
3	Needle valve
4	Float arm
5	Float arm pin
6	Float chamber body
7	Slow stop screw
8	Mixing chamber cap
9	Throttle spring
10	Throttle valve
11	Jet needle
12	Needle jet
13	Main jet
14	Needle clip plate
15	Needle clip
16	Float
17	Drain screw
18	Rubber cap
19	Choke valve
20	Air vent hole
21	Rubber packing



(2) Operation of carburetor

The carburetor is the device which breaks down the gasoline into very fine particles using the venturi principle. It mixes air and fuel to a suitable air-fuel ratio and supplies the required mixture to meet the variable operating demands of an engine.

Float type carburetor (T200P)(Fig. 31, Fig. 32)

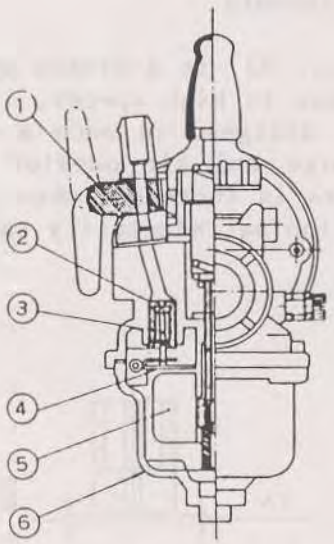


Fig. 31

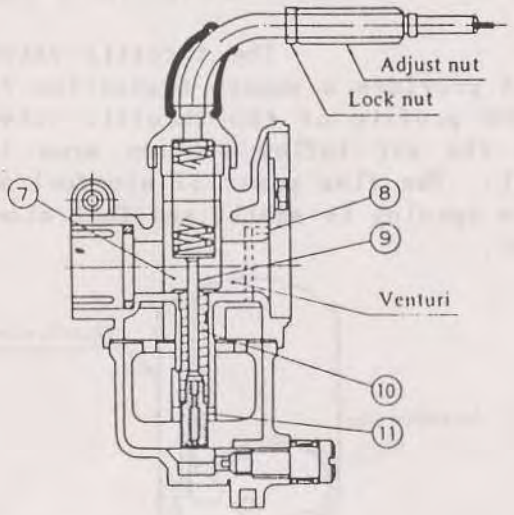


Fig. 32

(a) The fuel intake flows by gravity into the float chamber (6) through the clearance between needle valve (3) and valve seat (2) from fuel cock (1).

(b) When the fuel begins to accumulate in the float chamber, float (5) begins to float upwards and pushes up float arm (4) thus reducing the clearance between the needle valve and needle seat until finally the needle valve contacts the needle seat to stop the inflow of fuel. In this way the fuel in the float chamber is always kept at a fixed level.

The movement of air in the float chamber is controlled by air vent hole (8).

(c) A measured amount of fuel at main jet (11) is sucked in by the negative pressure created in the venturi through the up and down motion of the throttle valve (7). It then flows through the clearance between jet needle (9) and needle jet (10), and is ejected out of the needle jet to mix with air before being sucked into the crank-case.

(3) Carburetor's Main parts and adjusting procedure

(a) Throttle valve and jet needle

The throttle valve (Fig. 23) is a piston type which provides a smooth transition from low to high speeds. The bottom profile of the throttle valve is designed in such a way that the air inflow section area is large and air outflow is small. The flow power of air-fuel mixture is increased when the valve opening is small, and fuel atomization satisfactorily takes place.

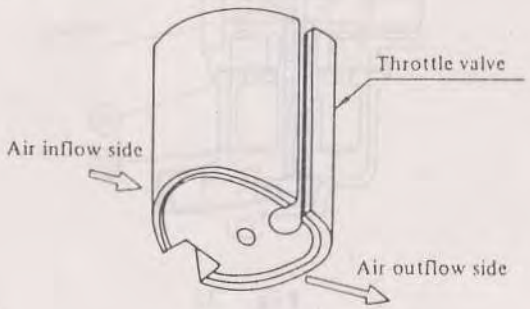


Fig. 33

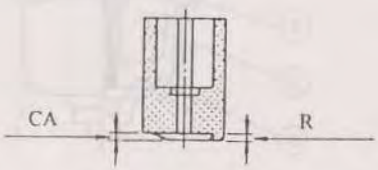


Fig. 34

- The cut-away (CA) and recess (R) are matched on each throttle valve to stabilize the fuel flow rate when the engine is idling. (Fig. 34)

	T200P
CA	0.75
R	1.5

- The supply rate of air-fuel mixture to the combustion chamber is controlled by adjusting the opening of the throttle valve. Not only is the suction airflow controlled but, at the same time, the amount of fuel injected from the needle jet is also controlled by the jet needle which responds to the opening of the throttle valve.

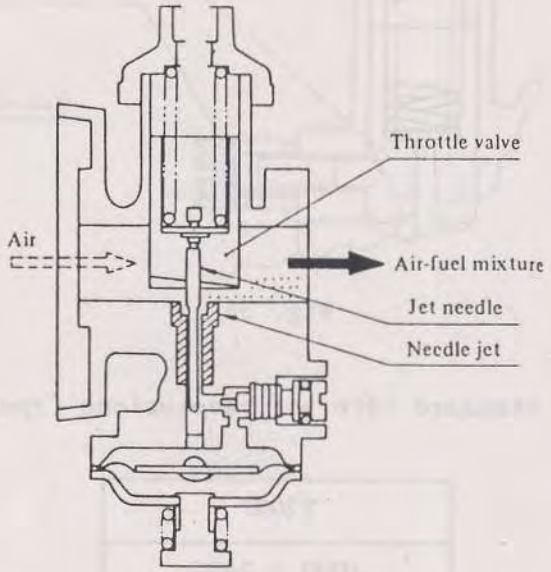


Fig. 35

(a)-1 Adjustments made to the throttle valve to maintain idling speed of engine.

1. Throttle valve and throttle adjust screw

Adjust the throttle valve opening when the engine is idling with the throttle adjust screw (stop screw).

Revolutions increase when turned clockwise.

Revolutions decrease when turned counter-clockwise.

Note: The engine may stall if the revolutions are over decreased.

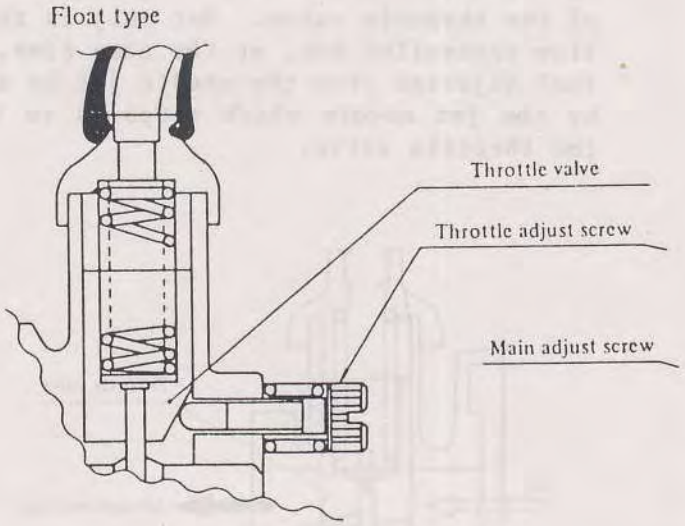


Fig. 36

Standard idle set revolutions (rpm)

T200P
2000 - 2400

(b) Jet needle (Fig. 37)

There are five grooves (float type) on the head of the jet needle. Setting is usually made in the fourth groove (float type). Further readjustment is not usually required because matching is automatically made with the engine so that the optimum air-fuel mixture is obtained in this position.

When the clip is set in an upper groove ... The clearance between jet needle and needle jet becomes less and the air-fuel mixture becomes poor.

When the clip is set in a lower groove ... The clearance between jet needle and needle jet becomes large and the air-fuel mixture becomes rich.

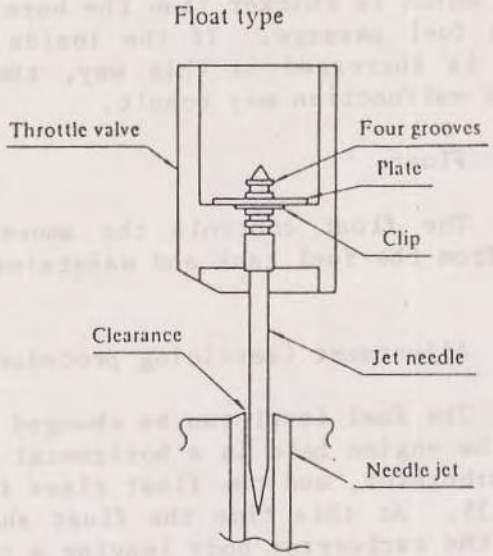


Fig. 37

(b)-1 Main jet (float type) (Fig. 38)

A hole for metering the optimum flow rate of fuel for the engine is bored into the main jet. The measured amount of fuel from main jet is further metered by the jet needle to match the required engine load.

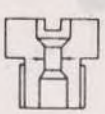


Fig. 38

Adjustments (servicing procedure) of jet needle

Cleaning should be undertaken when the fuel passage becomes plugged with foreign matter. If the main jet is to be removed from the carburetor body, care should be taken to avoid damaging the slotted groove. Also never attempt to thread a wire or similar object which is thicker than the bore through the bore hole to clean the fuel passage. If the inside surface diameter of the bore hole is increased in this way, the fuel flow rate changes and engine malfunction may result.

(c) Float

The float controls the amount of fuel as it flows by gravity from the fuel tank and maintains it at a certain constant level.

Adjustment (servicing procedure) of float:

The fuel level can be changed by adjusting the float arm. With the engine held in a horizontal position fuel is supplied to the carburetor, and the float rises to stop the flow, as shown in Fig. 39. At this time the float should be parallel to the surface of the carburetor body leaving a clearance of 3 mm between the float and the surface of float chamber packing. (4 mm, when the packing is removed). The arm should not be in contact with only one side.

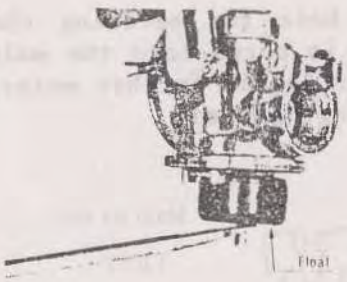


Fig. 39

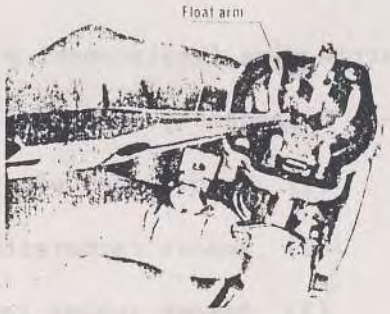


Fig. 40

Note: Arm adjustment is undertaken using long nose pliers in the forked part, as shown in Fig. 40.

(d) Float valve

The float valve operates in response to the vertical motion of the float to release fuel into the float chamber. The float valve motion, which is synchronized with the float arm movement, controls the fuel flow rate.

(d)-1 Adjustment (servicing procedure of a float valve)

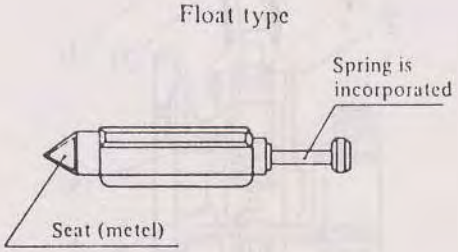


Fig. 41

It is essential for the carburetor's function that the action of the float valve is smooth and that it forms an airtight seal when the valve is fully closed. If the seat of the valve is damaged by foreign matter or if stepped wear occurs after being in use for a long period of time, then overflow will occur, resulting in engine malfunctions. At this stage the float valve should be replaced.

(e) Throttle wire (replacement procedures)

(e)-1 Disassembly of throttle wire

(1) Remove fuel pipe on carburettor.

(2) Remove carburettor (with spanner).

(3) Remove rubber cap (1) from mixing chamber cap (2).

(4) Remove mixing chamber cap, then pull out throttle wire together with spring (3), throttle valve (5), and jet needle (6), from the body.

(5) Remove inner wire from throttle valve (5) (simultaneously, the spring and mixing chamber cap will be removed).

(6) Pull out rubber cap from L-type pipe (4).

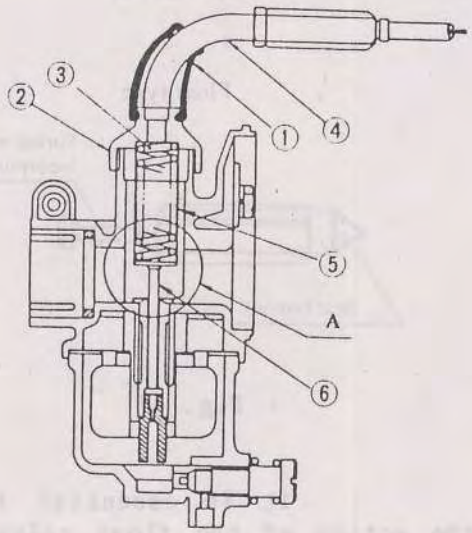


Fig. 42

(e)-2 Assembly of throttle wire

(1) Insert rubber cap to L-type pipe.

(2) Pass wire through mixing chamber cap and spring, and hang the end on the throttle valve.

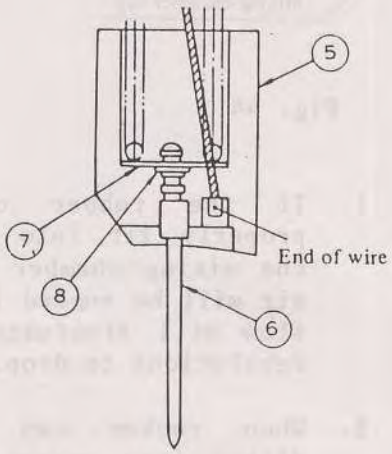


Fig. 43

Note: Make sure that plate (7) is on clip (8). If it is upside down, engine will not work properly.

(3) Insert the assembly consisting of throttle valve, spring and mixing chamber cap into the body of carburetor.

(4) Tighten mixing chamber cap securely (with pliers). (Recommended tightening torque: 0.4 - 0.5 kg.m)

(5) Fit rubber cap snugly into mixing chamber cap.

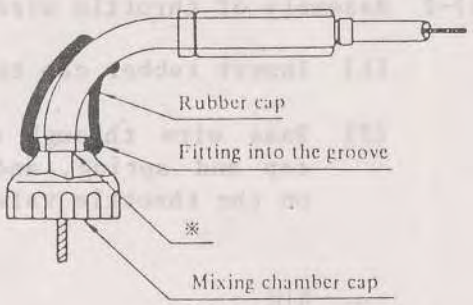


Fig. 44

Note: 1. If the rubber cap does not properly fit into the groove on the mixing chamber cap, secondary air will be sucked in and the fuel flow will fluctuate, causing the revolutions to drop.

2. When rubber cap is correctly fitted into groove, no clearance should exist between the stepped portion on the L-type pipe and mixing chamber cap.

3. Adjust the play on the throttle wire (See: Assembly sequence)

(e)-3 Installation of Carburetor

Note: When tightening the Band, securely press the Carburetor onto Intake flange. If there is any space left between the rubber packing inside the Carburetor and the Intake flange, the intake of secondary air will cause defects in the starting action. (Recommended tightening torque: 0.5 - 0.6 kg/m)

8.9 Carburetor troubleshooting

Trouble phenomenon		Probable cause	Remedy
Starting failure	Fuel is not sucked into the cylinder.	Plugged fuel cock	Clean
		There is a clearance between rubber packing inside of carburetor and intake flange	Carry out assembly once again.
		Failure in full closing of choke	Fully open choke.
		Faulty operation of float valve (needle valve)	Disassemble and clean or replace.
		Fuel passage plugged with dust, or other substances formed in deteriorated gasoline	Disassemble and clean or replace.
		Plugged main jet (float)	Disassemble and clean.
	Fuel is sucked at an excessive rate.	Extraordinary high level of fuel (float)	Adjust.
		Dust accumulated between float valve and seat	Disassemble and clean.
		Plugged air cleaner	Disassemble and clean.
		Mismatched groove of jet needle	Carry out assembly once again.
Idling is unstable.		Rubber Cap not securely fitted	Fit securely.
		Float valve fouled	Disassemble and clean.
		Faulty adjustment of throttle adjust screw	Adjust.
		Faulty position of jet needle	Carry out assembly once again.

Carburetor troubleshooting

Trouble phenomenon		Probable cause	Remedy
Disorder at high speed	Revolutions cannot be increased (engine stalls or a strange sound is produced) or revolutions are unstable even when they can be increased.	Insufficient opening of Choke Valve	Move choke lever to open position.
		Worn float valve	Replace parts.
		Plugged main jet (float)	Disassemble and clean.
		High fuel level (float)	Adjust.
		Incorrect play on throttle wire	Adjust.
		Plugged fuel cock (float)	Clean
	Engine stalls or erratic revolutions occur during the running but they stop occuring for a short period of time after the engine is restarted.	Plugged fuel cock filter net (float)	Disassemble and clean.
		Faulty ventilation of fuel tank cap	Disassemble and clean.
Faulty acceleration		Plugged main jet (float)	Clean. (Refer to p. 30)
		Plugged needle jet	Clean.
		Low level idling revolution	Readjust.
Overflow occurs.		Worn float valve	Replace.
		Faulty operation of float valve	Clean.
		Faulty float valve	Clean or replace parts.
		Excessive fuel level height. (float)	Adjust.

8.10 Flywheel Magneto, Spark Plug and Adjusting Procedures

The flywheel magneto is included in the ignition unit with the generating coil, contact breaker and the flywheel.

Carry out inspection, adjustment and servicing of these parts in accordance with the instructions given below.

(1) Flywheel

Magnetic steel used for power generation is cast into a flywheel of which the cooling fan is an integral part. As this part has several important functions, care should be taken not to drop or damage it when disassembling and reassembling.

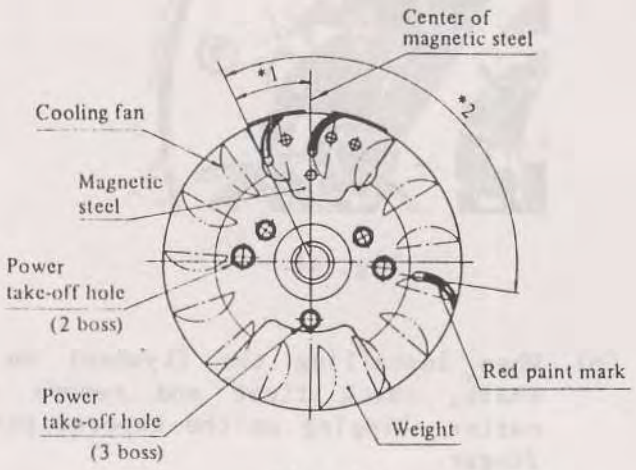


Fig. 45

		Point	
* mark each angle	* 1	33° ± 30'	
	* 2	128°	
Power take-off hole	2 boss	M 8 x 2	
	3 boss	M 6 x 3 (T200 special spec.)	

Note: The red paint mark on the flywheel shows the matching point for ignition timing. (On the opposite or facing side an embossed mark is cast on the drive side case).

Remarks for adjustment

(a) If a deformed cooling fan is mounted, the flow of air will be affected and an unbalanced force will be applied which may result in main bearing damage.

Therefore, no damaged or deformed flywheel must be used.

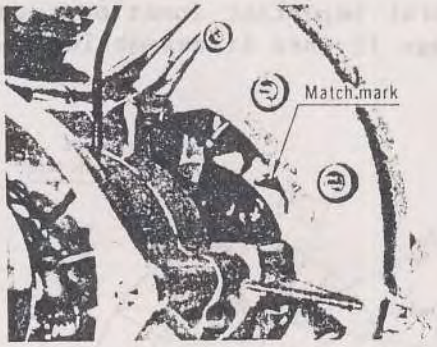


Fig. 46

(b) When installing the flywheel on the crankshaft, check first and remove any foreign matter clinging on the tapered part with your finger.

(c) Tightening torque for flywheel.

1.0 - 1.3 kg.m

(2) Ignition coil (Fig. 47)

The ignition coil is perfectly moisture proof because is has been impregnated with epoxy resin and the outside has been covered with a case of phenol resin. Primary wire (low voltage wire) and secondary wire were both wound on the core of laminated silicon steel plate coil. The primary wire (0.4 to 0.7 mm x 300 turns) is connected to the contact breaker and stop switch, and the secondary wire (0.05 to 0.07 mm x 10,000 turns) is connected to the spark plug cap.

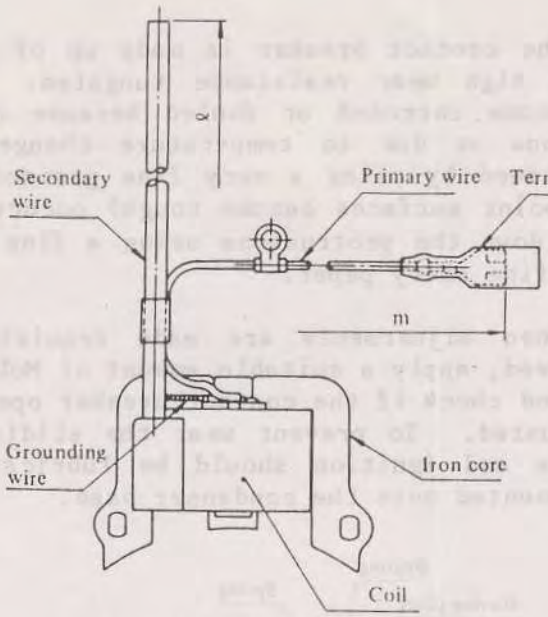


Fig. 47

Check the soldered points on the grounding and primary wires when inspecting the ignition coil. Measure the sparking performance with a coil tester, and replace the coil if the spark length is less than the specified value.

Three-needle sparking performance (at normal temperature):

	Specification
Point	7 mm / 500 rpm
	8 mm / 1,000 rpm

(3) Contact breaker (Fig. 48)

The contact breaker is used to generate high voltage in the secondary coil by interrupting the primary current generated in the ignition coil during the revolutions of the fly-wheel.

The contact breaker is made up of a fixed and a moving piece of high wear resistance tungsten. On occasions these points become corroded or fouled because of poor engine storage conditions or due to temperature change. The point surfaces are cleaned by using a very fine grained emery paper. If transition (point surfaces become rough) occurs on the point surfaces, grind down the protrusions using a fine file and then finish with the fine emery paper.

When adjustments are made requiring the moving piece to be removed, apply a suitable amount of Molykote GP Paste to the bearing and check if the contact breaker operates smoothly when it is remounted. To prevent wear the sliding surfaces on the moving piece and ignition should be lubricated by an oil moistened felt mounted onto the condenser base.

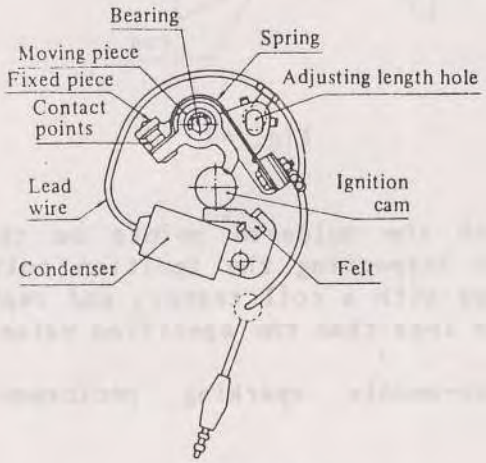
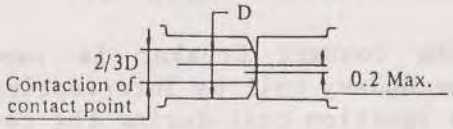


Fig. 48

Deviation and location of contact point

Deviation = within 0.2 mm in every direction

Location = within 2/3 at the center of diameter



(1) Adjusting procedure (See; Assembly sequence)

(4) Condenser (Fig. 49)

The condenser, when employed in an ignition system, performs a double function, it (1) prevents arcing at the primary contacts and (2) speeds up the collapse of the magnetic field.

When pieces of tin foil face one another with only a small gap between an electrical action takes place, and the ability to store electricity in the space between these foils is produced. In the condenser a tin or aluminium foil strip is wound round a cylinder with a thin papers sandwiched between the layers to prevent direct contact before being enclosed in a vibration proof metal case.

A condenser cannot be disassembled or repaired, therefore, first check if there are any problems in the lead wires on the outside of the case, and replace the condenser if it is faulty. To check the condenser for internal abnormalities use the following measuring instruments:

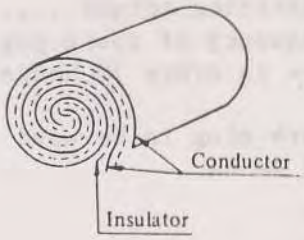
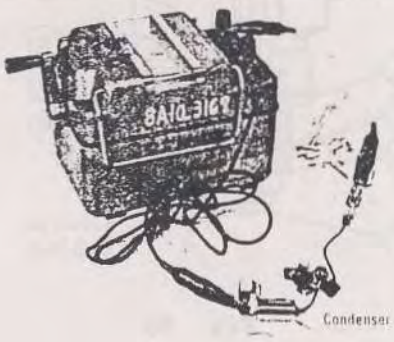


Fig. 49

Insulation resistance meter with 1,000 V capacity	10 M
Condenser capacity	0.22 F



Measurements are taken by using a condenser capacity test insulation resistance tester and a condenser capacity tester. The condenser should be replaced if any of the measured values are less than those shown in the above table.

(5) Spark plug (Fig. 50)

The spark plug ignites the air-fuel mixture, after if has been sucked into the cylinder, with a spark generated between its center electrode and grounding electrode. Starting failure and reduced power output will be noticed if the electrodes are burnt or an excessive amount of carbon has collected on the electrode surfaces.

The spark gap should be adjusted to the values stated below:

(1) Spark gap ..... $0.7^{0}_{-0.1}$
(allowable limit 0.8)

(2) Tightening torque ..... 1.2 kg.m
Frequency of spark gap should be checked once in every 50 hours of operation.

(3) Spark plug to be used
NGK BM-6A

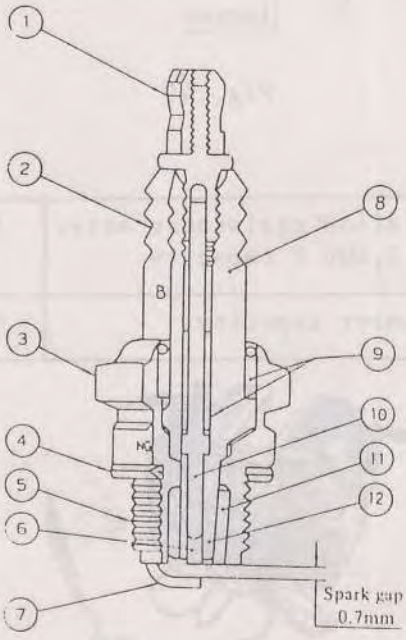


Fig. 50

Spark Plug Parts Name

Symbol	Part Name	Structure
1.	Terminal nut	For inserting spark plug cap.
2.	Rib	Eliminates flash over.
3.	Metal shell	Hexagon head mounting.
4.	Gasket	Tighten with regular mounting torque. This gasket provides a seal against combustion gas leakage.
5.	Mounting screw	On the cylinder head. Its dimension is M 14 mm
6.	Center electrode	These electrodes are cast in a special alloy to resist chemical corrosion and spark consumption.
7.	Grounding electrode	
8.	Insulator (head)	High alumina insulator with special properties such as voltage and corrosion resistance, mechanical strength, thermal conductivity and thermal shock resistance.
9.	Filler powder	This powder with its high mechanical strength prevents leakage under high pressure.
10.	Copper core	A copper core is inserted into the center electrode to encourage thermal conductivity.
11.	Gas circulation	The space in which the gas circulates has major influence on temperature of spark plug.
12.	Insulator (leg)	A high alumina insulator, same as 8

(6) Adjustment of ignition coil air gap

The air gap is the clearance between the ignition coil and outer circumference of the flywheel which directly affects startability. Any necessary adjustments have already been made by the manufacturer.

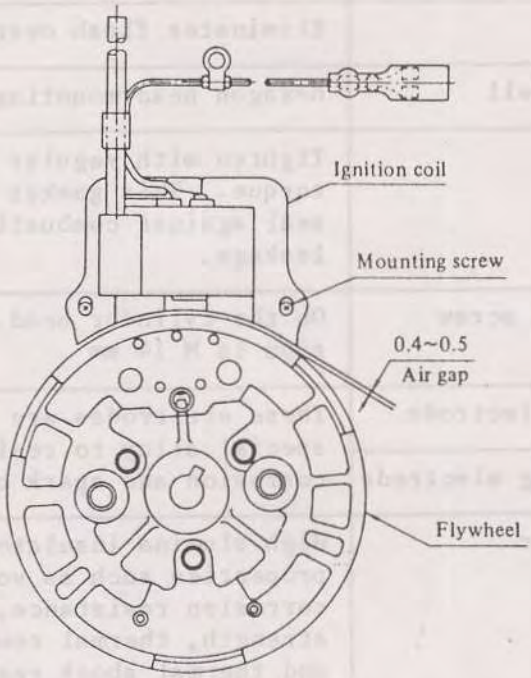


Fig. 51

9. INSPECTION AFTER DISASSEMBLY

9.1 General

(1) Check each sliding and rotating portion (piston, piston ring, cylinder, crankshaft, bearing, oil seal etc.) for abnormalities by following instructions in the check point table below.

Check point	Piston	Piston ring	Crankshaft assy	Cylinder	Oil seal	Bearing
Output shortage (Defective compression)	• Abrasion • Seize • Scratch	• Abrasion (wear) • Sticking		• Carbon deposits • Plugged pulse hole (Defective maintenance)	• Abrasion of lip • Protrusion	
Internal abnormal noise	• Tapping noise (Abrasion)		• Abrasions on pin and both ends of rod			• Abrasion (wear)

(2) Clean the outside of carburetor with gasoline, and overhaul and that each part is in good working order. When reassembling, rinse the inner parts with clean gasoline and air dry. (Do not use waste cloth).

(3) Do not clean electrical parts. Just wipe with a dry cloth and allow to dry.

(4) Clean all other parts with a cleansing oil.

9.2 Carbon removal, cleaning and inspection

(1) Cylinder (Fig. 52)

Remove carbon deposited in combustion chamber and exhaust system using a ⊖ screwdriver or other suitable means. Take care not to damage the aluminium surfaces or chrome plated sections.

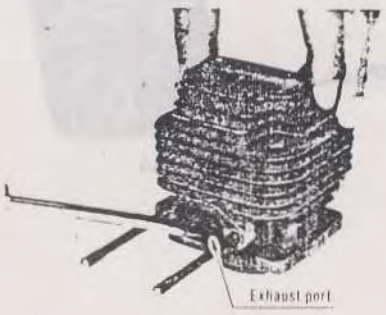


Fig. 52

(2) Piston (Fig. 53)

Remove carbon deposited on cylinder head and ring grooves. Repair any damage found such as seizing or scratches with fine sandpaper (#400). If the seizing or scratches are considerable, replace the piston.

Fig. 53

(3) Muffler (Fig. 54)

Remove carbon which has been deposited in the exhaust passage of cylinder and tail pipe. It a considerable amount of carbon deposit is present use a thick wire. The alternative is to burn the outside of muffler with torch lamp. When doing this be sure to remove the gasket.

Fig. 54

(4) Ignition plug (Fig. 55)

Remove the carbon which has accumulated on the electrode and insulator with a small screw driver. The insulator should be cleaned until the plate surface is revealed. Adjust the clearance between electrodes after cleaning.

a. Standard clearance: 0.6 - 0.7 mm

b. When replacing ignition plug, use NGK BM6A.

Fig. 55

(5) Cleaning of air cleaner

Wash the air cleaner element in gasoline, firmly squeeze it dry, immerse it in engine oil, firmly squeeze again and then mount it in its case. (See assembly procedure)

(6) Repairing and cleaning the contact breaker

When necessary adjust the transition or any deviation in the transition of contact point using a fine sandpaper or oilstone. Wash the contact point only in gasoline, blow dry and wipe with cardboard.

If insufficient finishing is left on the contact point, there will be no spark. Care should be taken to ensure a smooth finish on the point surface.

(7) Cleaning of fuel filter

The filter is placed in the discharge port of fuel tank and can be removed by pulling on the fuel pipe. Clean the filter with gasoline.

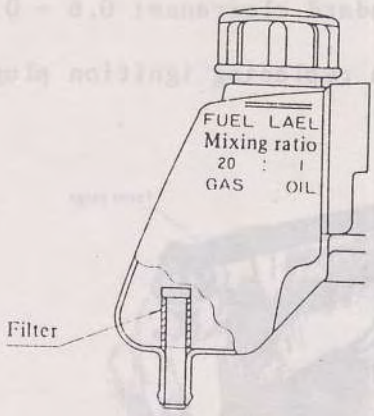


Fig. 56

10. PERIODICAL INSPECTION AND MAINTENANCE

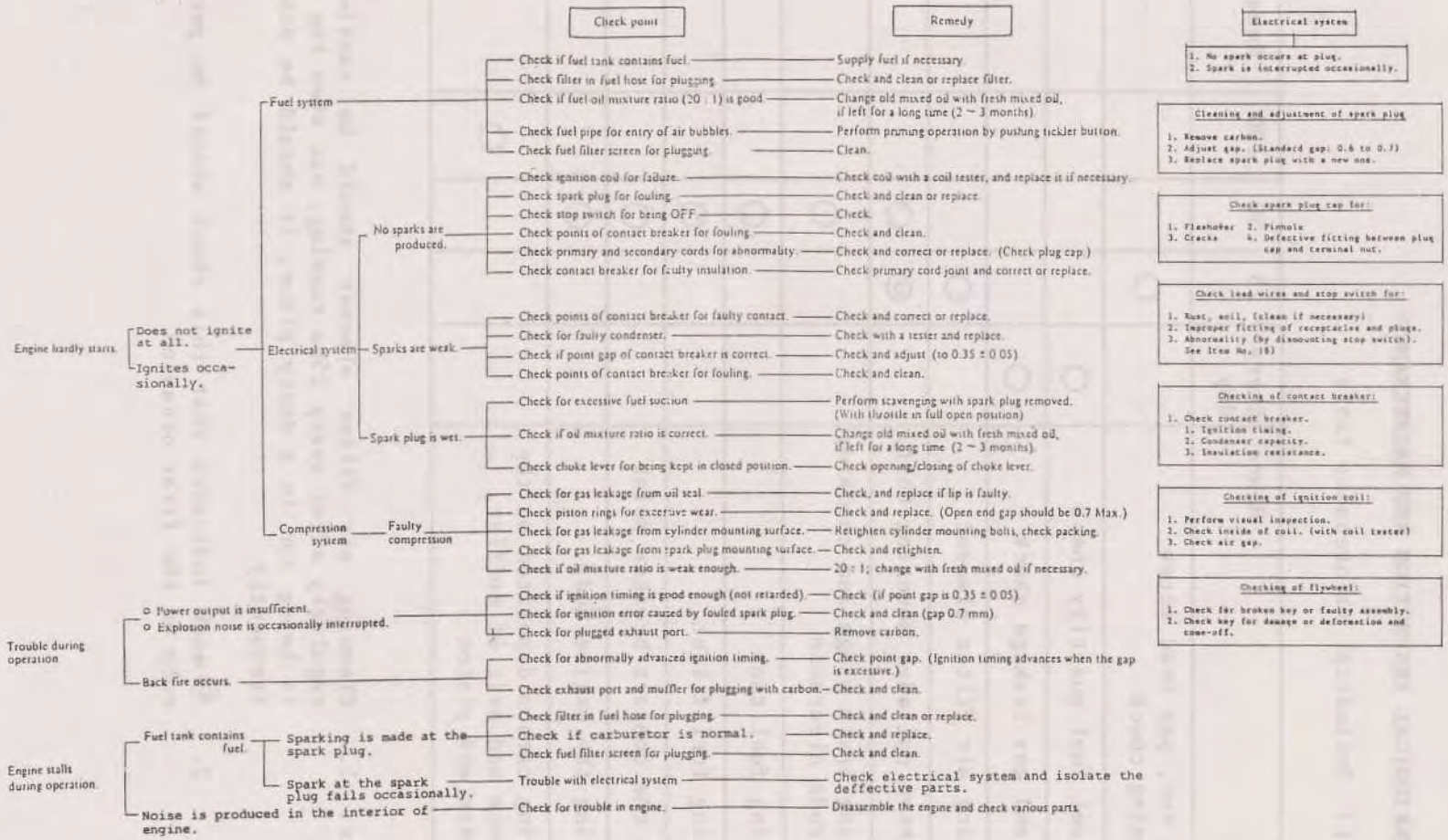
(1) Periodical maintenance table

Item \ Hours	Every-day	25	50	100	Remarks
Bolt, nut, pan head screw loosening check		○			
Residual fuel quantity check	○				
Fuel and gas leakage check	○				
Cleaning air filter element		○			
Retighten cylinder mounting bolt		◎	○		
Cleaning spark plugs and checking electrode clearance			○		
Cleaning fuel tank			○		
Cleaning fuel filter			○		
Check the contact breaker point			○		
Cleaning the engine body			○		
Removing carbon deposited on the entrance and exit of muffler, cylinder and piston				○	

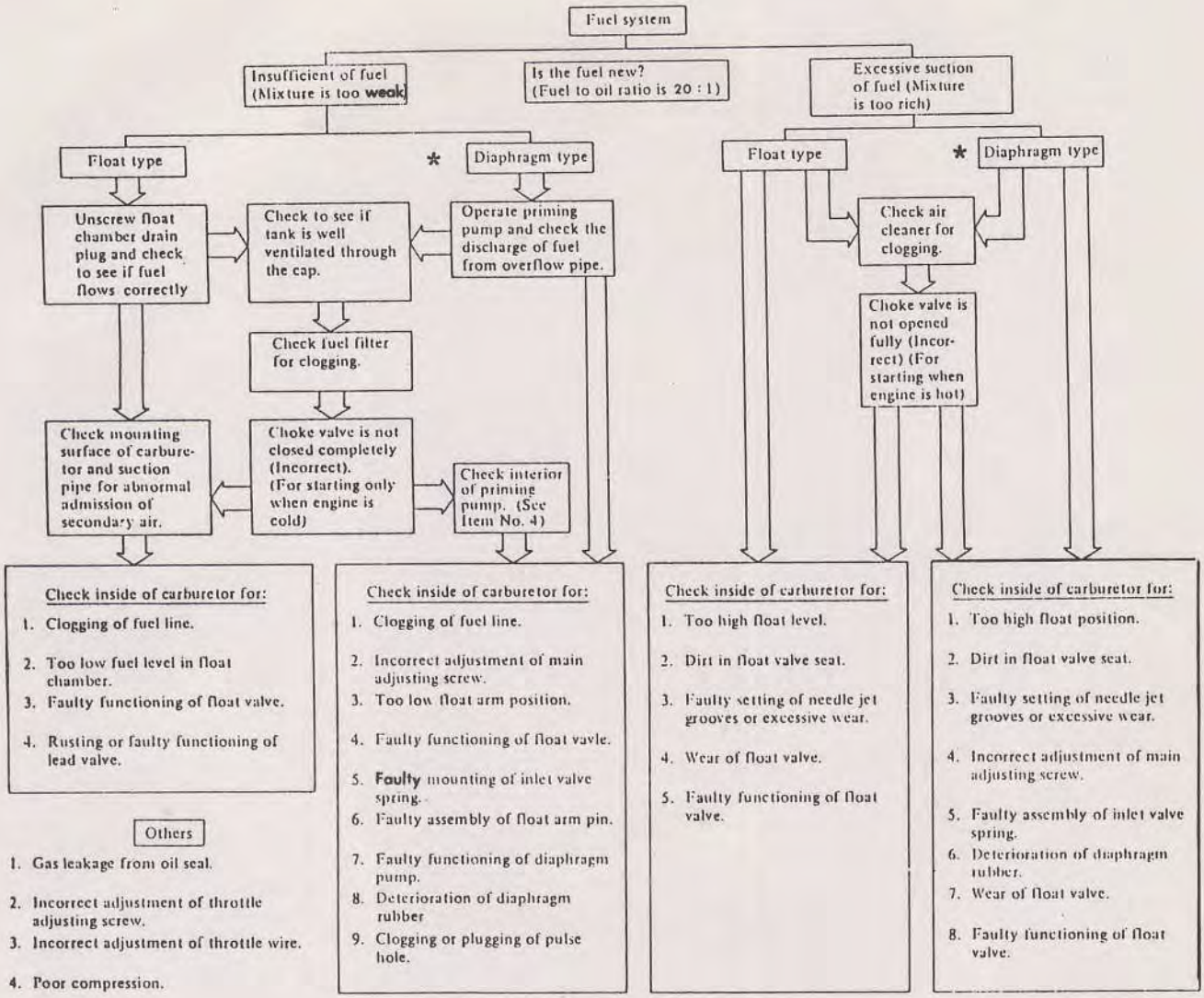
Note: 1. Cleaning air filter element should be carried out regularly after every 25hs running, but when the engine is being run in a dusty place, it should be done more frequently.

2. ◎ mark indicates that this check should be performed only on the first occasion.

11. TROUBLESHOOTING PROCEDURE (1)



TROUBLESHOOTING PROCEDURES (2)



Note: * Diaphragm type is not used for T200 Engine