

KES

**Low and Medium Temperature
Detergency Test Procedure
for Evaluating Automoblite
Gasoline Engine oils**

KES T – L329

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1. Purpose

The purpose of this standard shall establish unified test method for evaluating detergency in practical ability of engine oil.

2. Scope of Application

This standard shall stipulate for test method evaluating detergency of automobile gasoline engine oil in low and medium temperature.

3. Meaning of Vocabulary

(1) Detergency

Degree of cleanness of inner engine by accumulation of varnish⁽¹⁾, sludge⁽²⁾ and etc.

Note ⁽¹⁾ Varnish is accumulated material of engine oil which is immovable in a slope and dried one because of not being polished with soft cloth for a long time

⁽²⁾ Sludge is accumulated material of engine oil which is immovable in a slope and polished with soft cloth

(2) Standard oil

Previously made engine oil and conformed one for certain use in evaluating test

(3) Braking

Driving for proper evaluating test holding a harmonious deposition nature test with eliminating primary factor which is not related to quality of engine oil in case of using a new engine or cylinder block for test

(4) Flushing

Driving in a short time for coating a lubricating system with an oil for test before disassembling an engine

4. Equipment of test

Engines for test, fabricating equipment for everything except structure and a kind of measurement equipment are as follows.

4.1 Engine for test

For test, convert the engine being indicated at Figure 1 into the one as follows.

(1) Oil filter

Convert an oil filter case that eliminated oil filter element into dummy filter such like Figure 1.

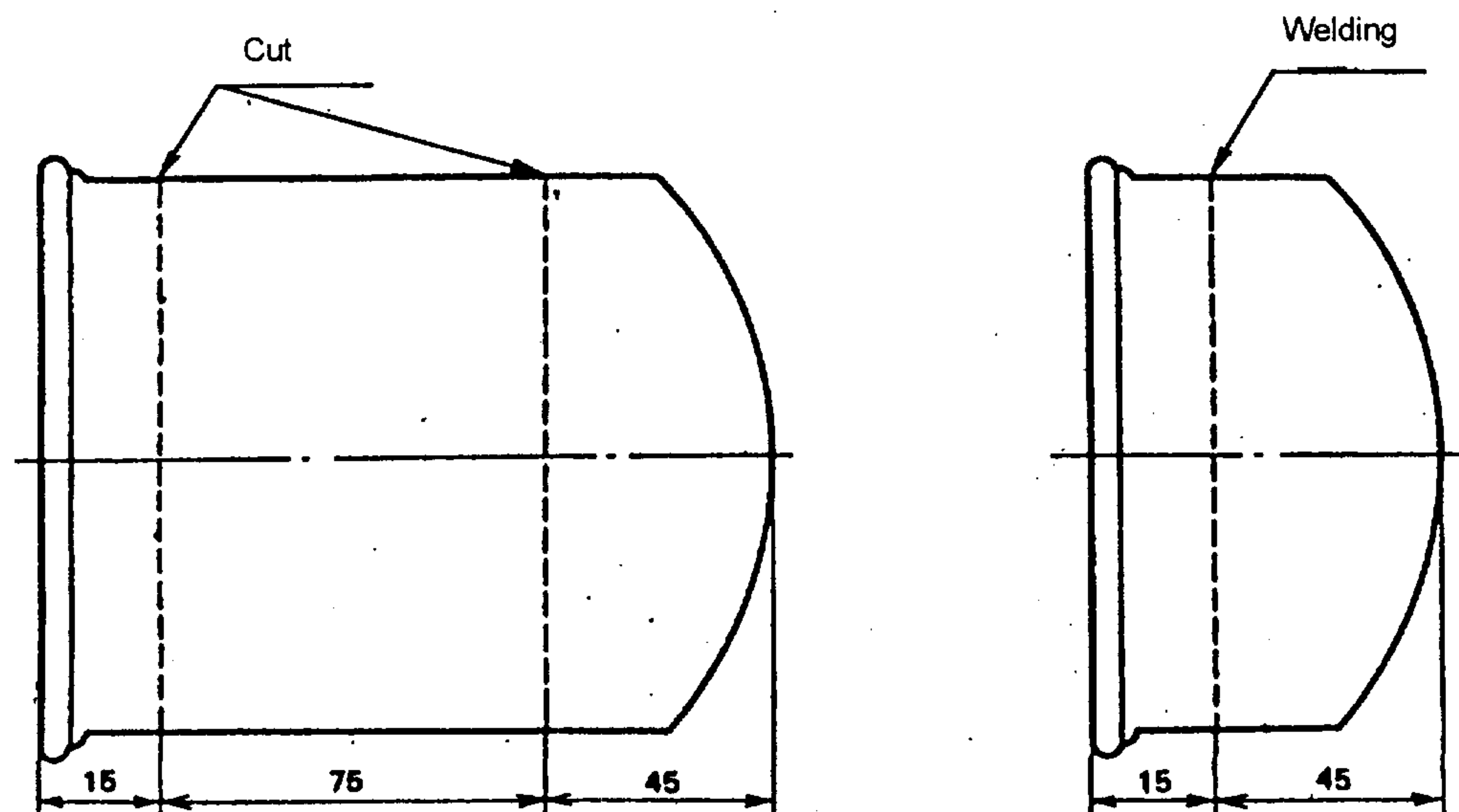


Figure 1. Conversion diagram of oil filter element

(2) Cooling fan

Remove cooling fan

(3) Thermostat

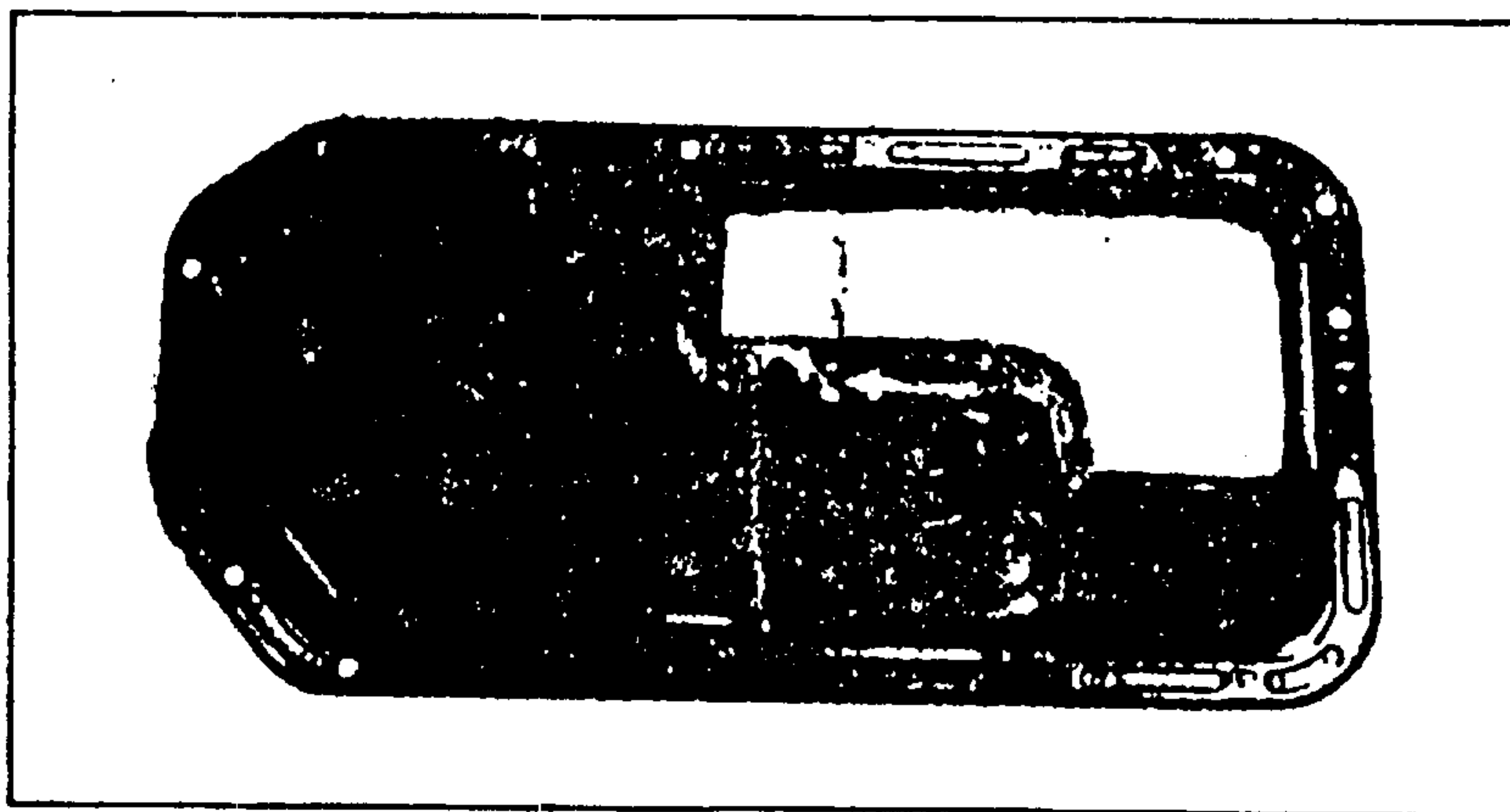
Remove thermostat

(4) Joint Clearance

When propane gas flux of stage III in the table 7 is approached to 40 ± 5 L / min ,cut the cross section of topping and second ring and tune the joint clearance at about 0.65 mm. However, in case that flux of propane gas is not included into regulations, correct the joint clearance.

(5) Oil pan

To be easy to evaluate varnish and sludge, convert oil pan into the one being indicated at Figure 2 and set the quantity of substance of oil pan to 2.5 L.



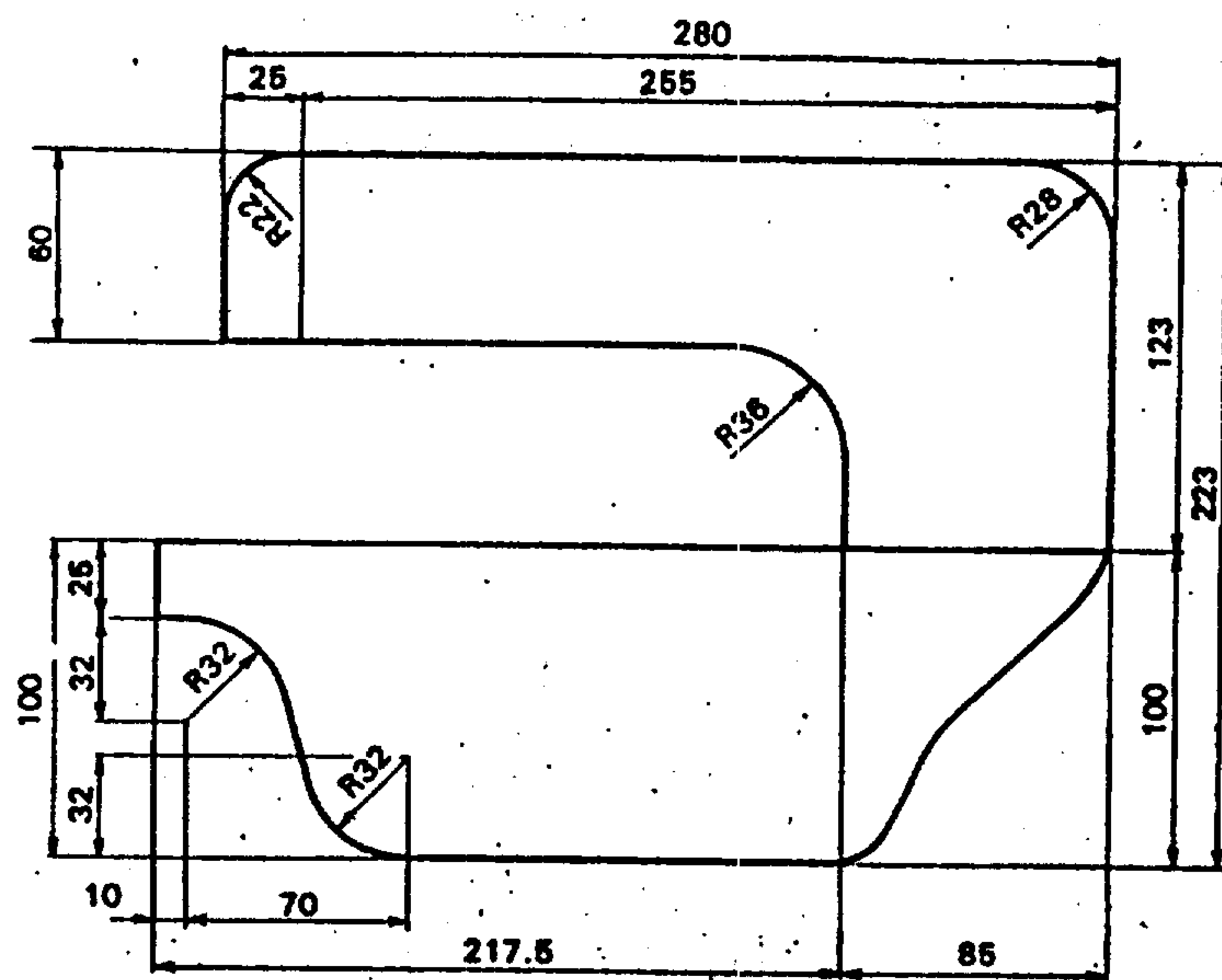


Figure 2. Converted oil fan

(6) Cooling water pump

Take off bypass hose of cooling water pump and fill up the connection hole of cylinder block with a bypass way out of cooling water pump.

(7) Vacuum advance angle apparatus

Take off the hose of vacuum advance angle apparatus and operate it as a level of centrifugal advance angle apparatus.

(8) Rocker Cover

Use a rocker cover that the inside is coated with paint in order to evaluate varnish and sludge easily.

(9) Tappet Cover

Use a tappet cover that the inside is coated with paint in order to evaluate varnish and sludge easily.

(10) Exhaust pipe

Convert the exhaust pipe into the one being indicated at Figure 3.

Unit : mm

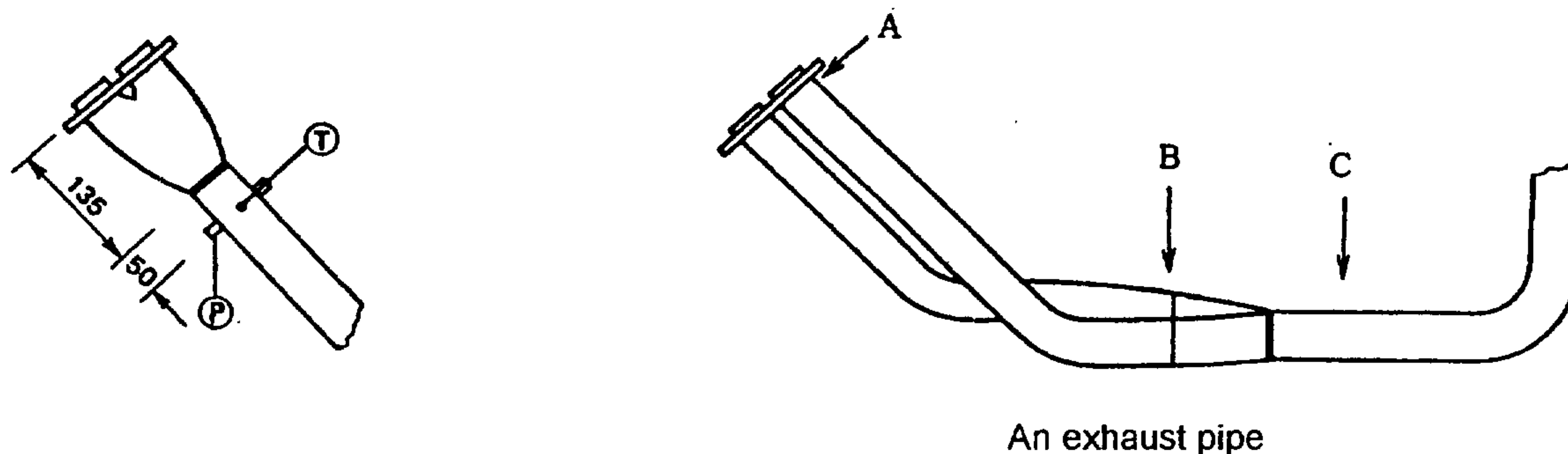


Figure 3 Conversion diagram of the exhaust pipe

Remark Cut this exhaust pipe at points A, B, C and weld the points A, B. In addition to this, set up equipment for measuring exhaust temperature and exhaust pressure at a position of 185 mm to measure temperature and PT 1 / 8 nipple to use exhaust gas sampling.

(11) Conversion of exhaust purification equipment

Convert a exhaust gas recycling device, a time of spark control device, low temperature device and control device for deceleration according to appendix 1.

Do not convert a propane gas reduction device (About a PVV valve).

4.2 An oil pan cooler

To control inner temperature of oil pan, set up a cooler indicated at figure 4.

4.3 A PCV valve cooler

Refrigerate PCV valve in compressed air. In case that compressed air is not suitable for engine body, make a cover indicated at figure 5 and set up the PCV valve in the cover.

4.4 Measuring devices

(1) Propane gas flux measuring device

Use the device indicated at figure 6

(2) PCV valve flux measuring device

Use the device indicated at figure 7.

(3) Inhaled air flux measuring device

Use a Rotor meter or Flow meter to measure inhaled air volume of engine.

Remark Use the Rotor meter that difference of pressure on a part of element is in a limit of 5 ~ 70 mm H₂O.

(4) Measuring and control device

Use devices satisfied with test condition of table 7 and items of measurement at 7.4.5

4.5 A position of taking out temperature and pressure

Taking out devices of input and output cooling water temperature of engine, oil pan visit temperature, exhaust gas temperature, inhaled air temperature, PCV valve temperature, partial pressure of inhalation air, pressure of inhalation air and engine oil pressure refer to appendix 2.

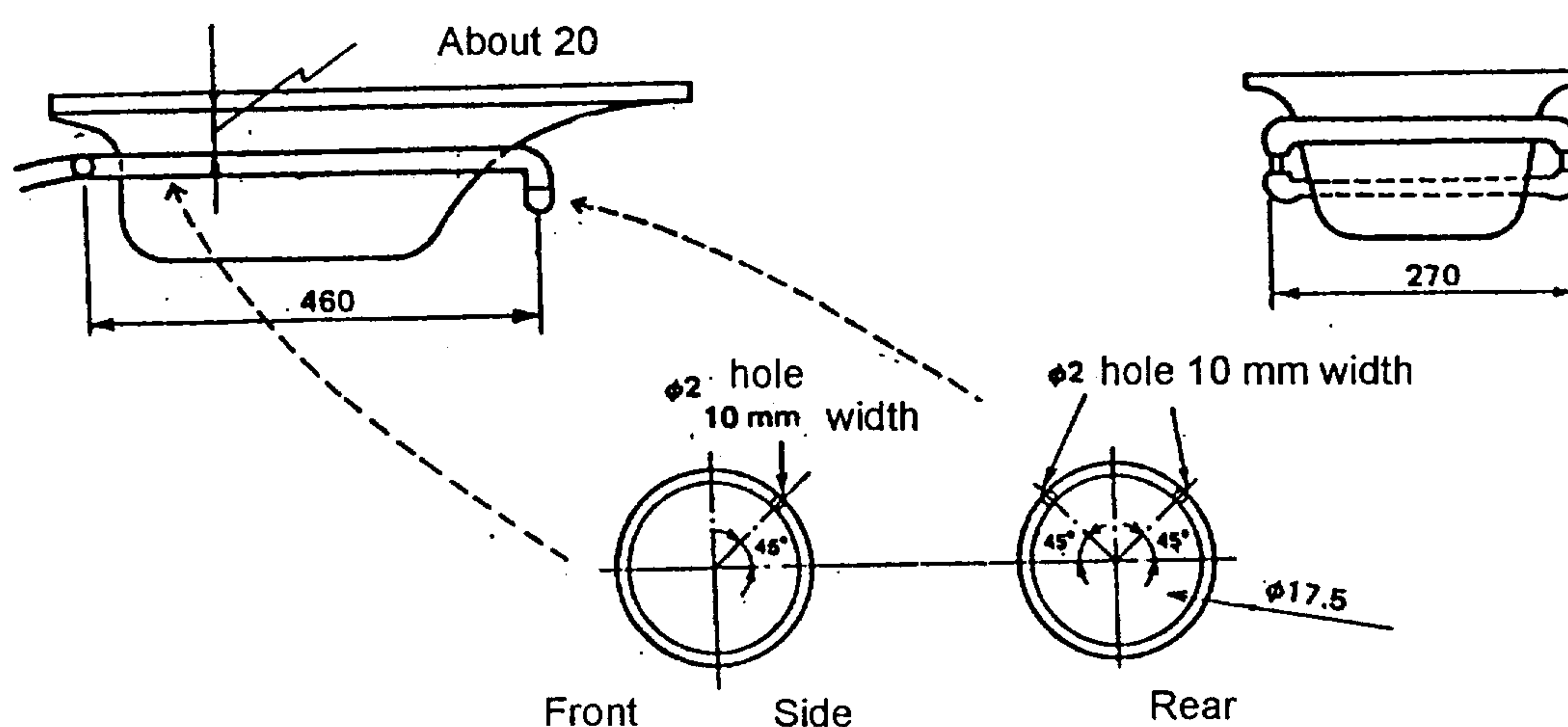


Figure 4 Oil pan cooler

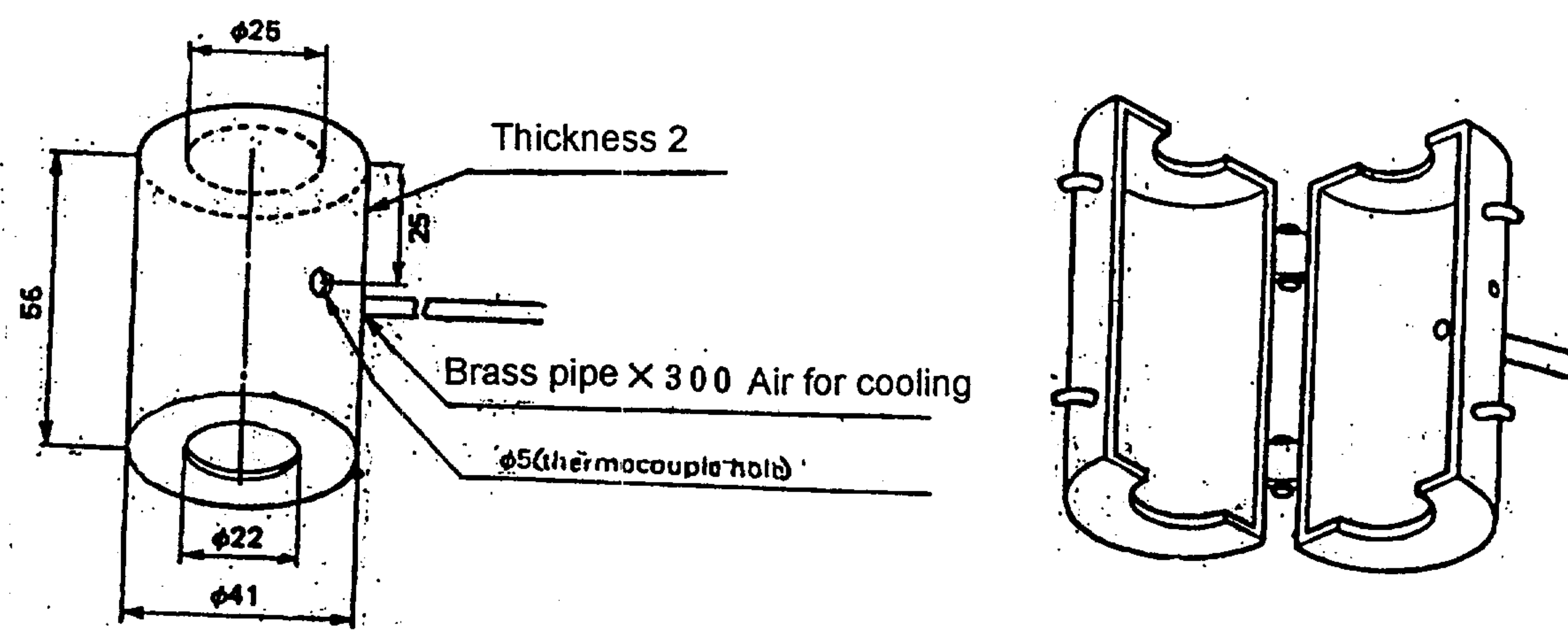


Figure 5 PCV cover for cooling

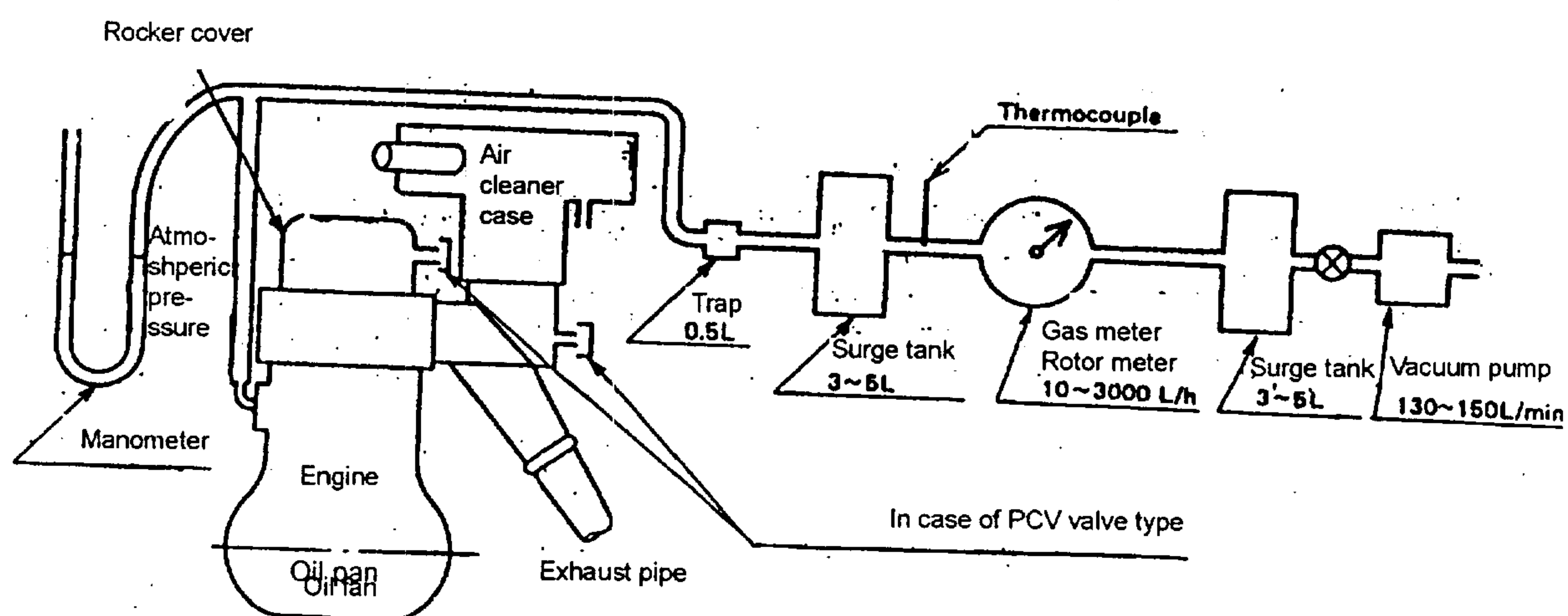


Figure 6 Propane gas flux measuring device(reference)

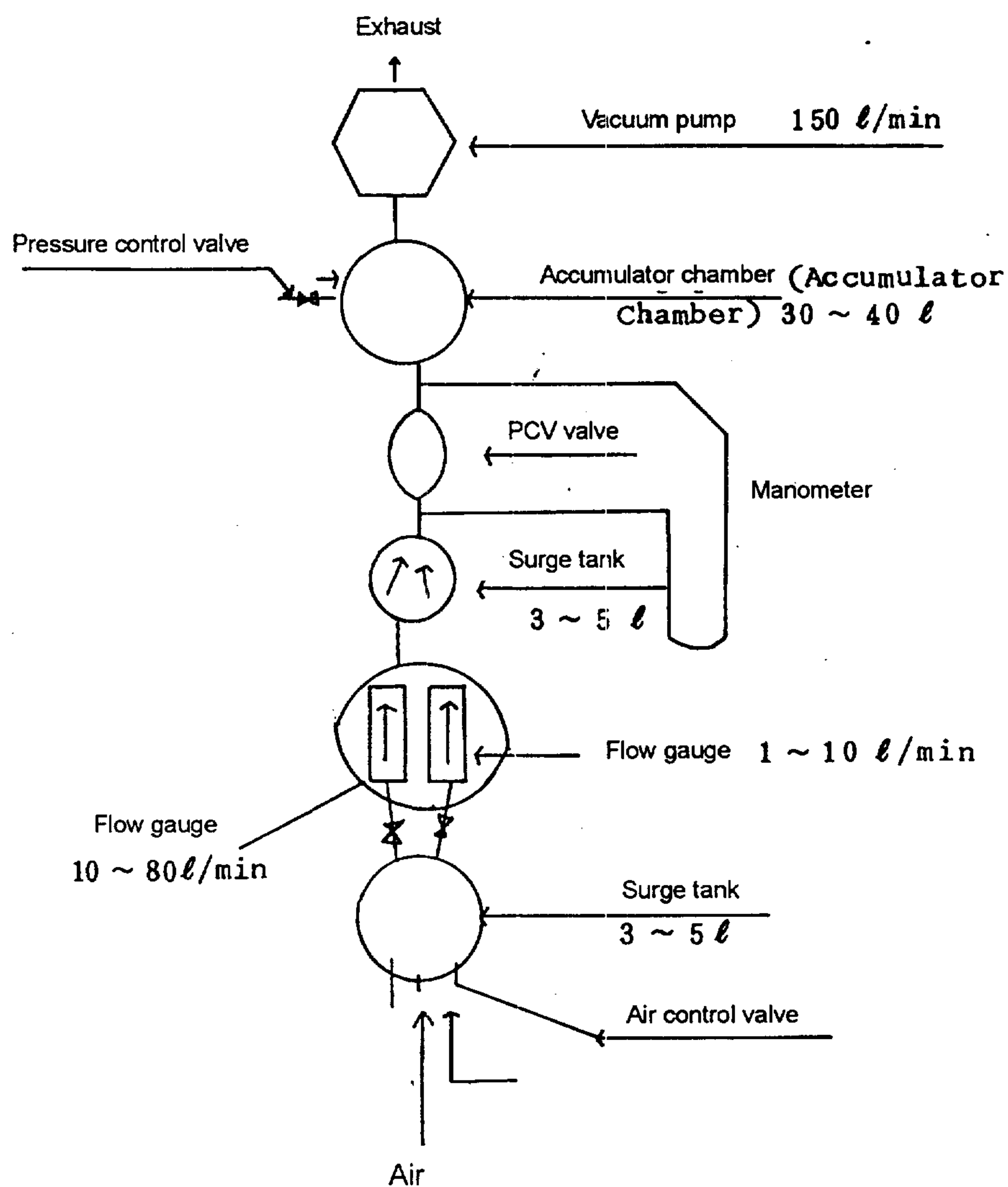


Figure 7 PCV valve flux measuring device

5. Fuel

Use fuel which is N0.2 or so and suitable for gasoline automobile.

For reference, fuel indicated at Table 1 shall be used.

Table 1

Measuring item		Typical value	Test method
Specific gravity (15/4 °C)		—	Specific gravity test method of crude oil and oil products (JIS K 2249)
Real gas mg / 100 mL		Less than 4	Test method of oil product real rubber (JIS K 2261)
Lead vapor pressure Kg f / cm ² { Kpa }		Less than 0.7 { Less than 68.6 }	Test method of oil product vapor pressure (JIS K 2258)
Tetraethyl lead g / 4		0.001	JIS K 2255
Distillation capacity	10 % point (°C)	53 ± 5	Test method of oil product distillation (JIS K 2254)
	50 % point (°C)	100 ± 7	
	90 % point (°C)	165 ± 7	
	Final point (°C)	—	
Sulfur amount (mass %)		Less than 0.3	JIS K 2541
Octane number (Research method)		89 ~ 93	JIS K 2280
Element analysis	Unsaturated compound (Volume %)	10 ~ 20	JIS K 2536
	Aromatic compound (Volume %)	25 ~ 35	

6. Standard oil

- 6.1 When an engine for test is used for the first time, in principle , confirm whether possible to put to the measuring test or not by 7 of putting to the test of standard oil at first.
- 6.2 Standard oils are 2 classes indicated at table 2 and table 3 indicates capacity of several standard oils.

Table 2 A kind of standard oil

A kind applied to a test	Contents	API (reference)
GD 1	In case of bad result of cleanness test	A grade of SC or so
GD 2	Good engine oil for the result of cleanness test	A grade of SD or so

Table 3 General capacity of standard oil

Standard oil		GD 1	GD 2
Item			
Specific gravity (15 / 4 °C)		0.874	0.874
The Flashing point (°C)		220	220
Freezing point ⁽³⁾ (cst) { mm ² / s }	40 °C	63.0	63.0
	100 °C	10.0	10.0
Viscosity index		144	144
Pour point(°C)		- 32.5	- 32.5
Entire acid value (KOH mg / g)		1.10	1.10
Entire base value (KOH mg / g)		1.9	2.8
Lactic acid calcic component(mass %)		0.25	0.36

Note⁽³⁾ 1 cst = 1 mm² / s

Remark Use oil which is satisfied with table 11 about capacity of out of the table 3.

7. Test method

7.1 Preparation of test

7.1.1 braking of a new engine

In case of using a new engine and cylinder block for test, use them that operated braking drive in the condition of being indicated at table 4.

Table 4 The condition of braking drive for a new engine

Step No.	The number of engine rotation (rpm)	Load $\text{kgf} \cdot \text{m}$ ($\text{N} \cdot \text{m}$)	Time of rotation (min)	Cumulative driving time	Oil temperature (°C)	Water temperature (°C)
1	1000	0	60	60	80 ~ 95	80±3
2	1200	1 { 98 }		120		
3	1600	2 {196 }		180		
4	2000	3 {294 }		240		
5	2400	4 {392 }		300		
6	2800	5 {490 }		360		
7	3200	6 {588 }	30	390		
8	3600	7 {686 }		420		
9	4000	8 {784 }		450		
10		10 {980 }		480		

Remark 1. Use the fuel which have capacities indicated at table 1 or which is No 2 for gasoline automobile or so.

2. Use the standard oil GD2 for engine oil.

3. Use an oil filter not as filter element is removed but as it should be regular.

4. Use regular oil pan that oil pan flux is 4 ℓ.

7.1.2 washing accessories

In case of reusing the engine after finishing braking or test, at first disassemble the engine completely and after that wash it clean with an organic solvent(Gasoline for industry, oil ether or a naphtha solvent). Especially wash oil wheel and pump clean. After washing, maintain cleanness of accessories.

7.1.3 Preparation of cylinder

Preparation of cylinder is as follows.

(1) Washing

Remove stored cinders inside and upside of a cylinder carefully.

After that, it is desirable to lift cylinder inner surface again with grinding by a No.350 roughness grinder and stone (by about 50 stroke). In the case that many things are impossible, using equivalent No.400 grinding paper or grinding cloth let the cylinder inner surface be lifted.

(2) Measurement

Measure a caliber of measurement part of movement to 1 / 1000 mm about A and B direction indicated figure 8 and derive caliber difference of up and down direction as a real value of circle for caliber. Measure the real value of circle for caliber at a limit of below 0.03 mm and caliber difference of up and down direction at a limit of below 0.05 mm exactly.

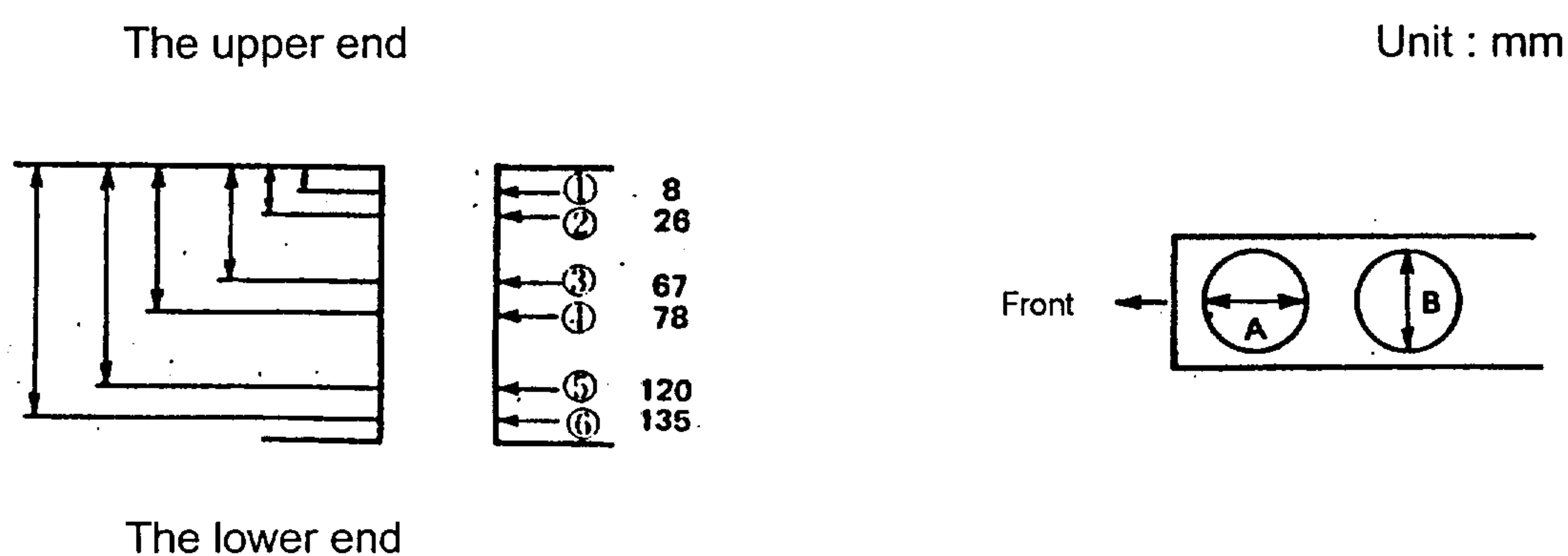


Figure 8 Position of the side of cylinder caliber

7.1.4 cylinder head

Preparation of cylinder head is as follows.

(1) Washing

Remove cinder such as a combustion string using an iron brush.

(2) Measurement in conversion

Measure a caliber indicated at figure 9 to a limit of 1 / 1000 mm about directions of crank axes and tooth angle, and mark the average value of the caliber. Exchange when difference of the outside of diameter of a stick exceed 0.065 at the side of intake and 0.070 mm at the side of exhaust.

After exchange, adjust according to a repair book for engine from the product company.

Unit : mm

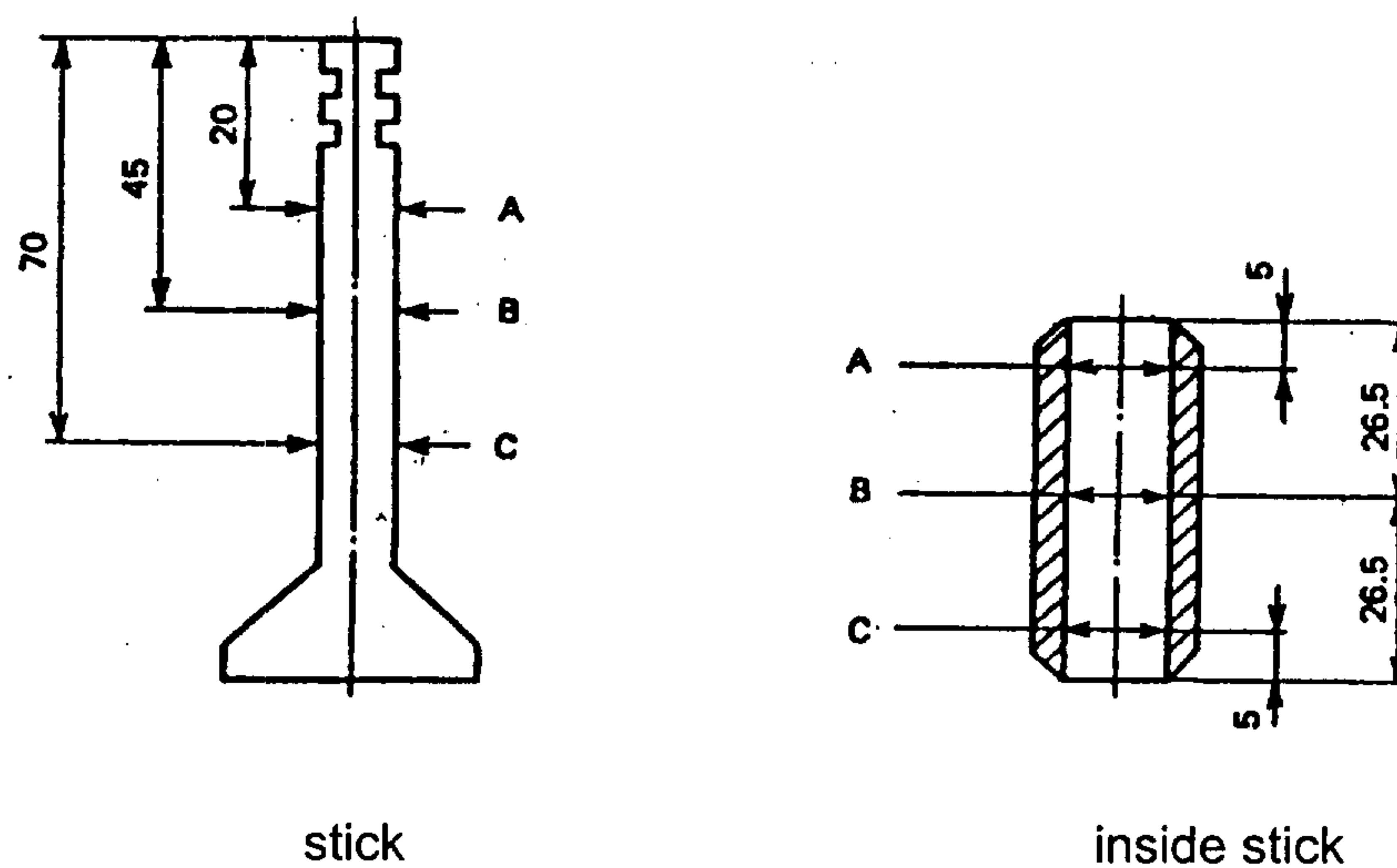


Figure 9 Stick and measurement position of inside stick

(3) Adjustment of valve seat face

Change the side of intake and exhaust into a new one and put it together with valve seat face.

In addition to this, adjust valve seat face according to a engine repair book from the product company when valve seat face as a side face of intake and exhaust is treated unequally due to large width of treatment face.

(4) Valve spring load

Valve spring load is attached load which is 25.8 + 2 kg provided free field is 45.1 mm and attached value is 39 mm.

7.1.5 Arrangement of Spark clearance

Adjust a spark-plug before attachment and spark clearance at 0.7 ~ 0.8 mm.

7.1.6 Preparation of piston

Measure the outside diameter of piston from a position of A indicated at figure 10 to 1 / 1000 mm about right angle direction of piston hose.

A gap of piston must be 0.030 ~ 0.050 mm.

Unit : mm

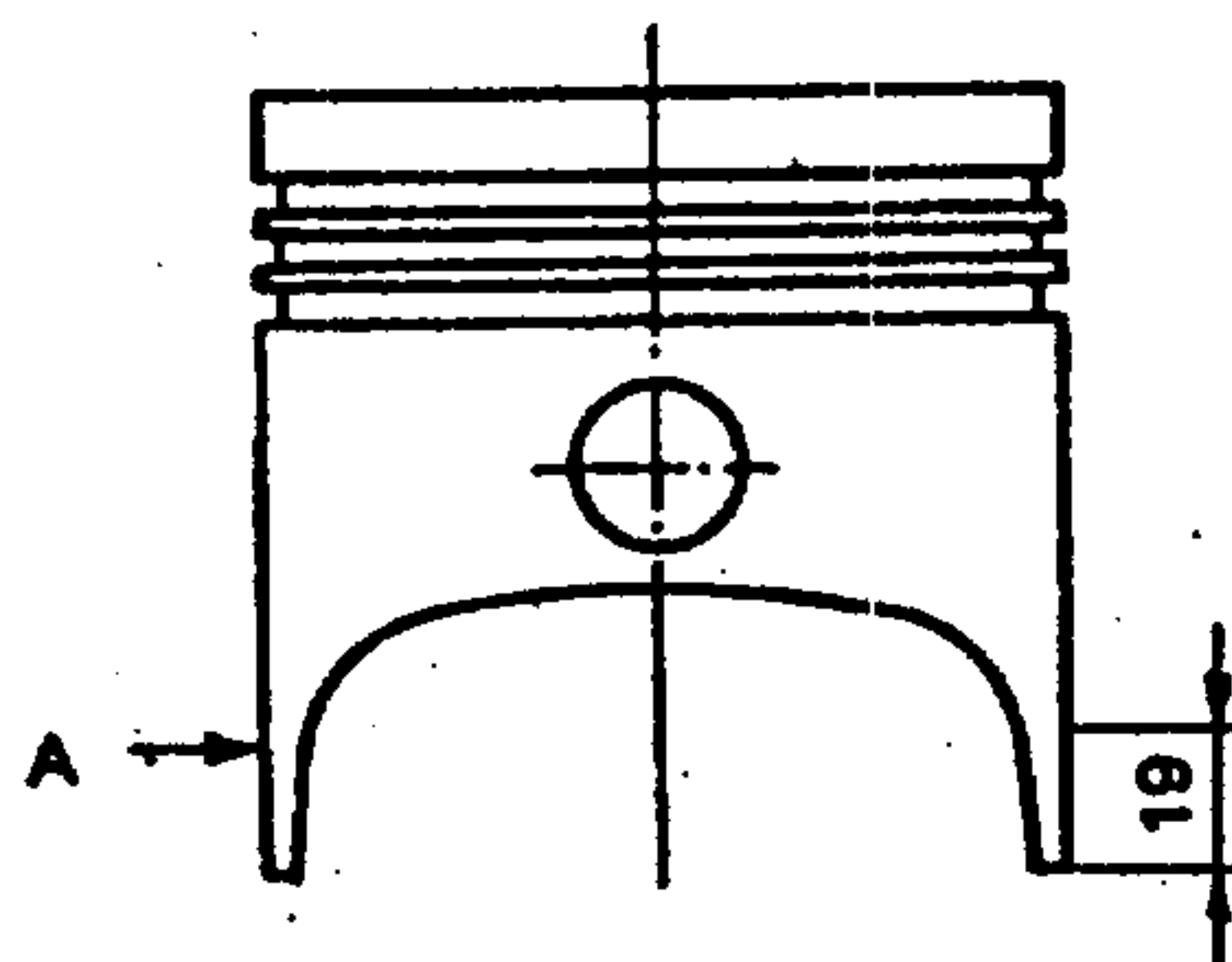


Figure 10 Position of outside of boundary of piston

Remark The gap of piston is difference of smallest value of cylinder caliber measured at the 7.1.3(2).

7.1.7 Preparation of Piston ring

Preparation of Piston ring is as follows.

(1) Cut the cross-section of piston ring to be as follows for the top land clearance at the top ring upper dead point of cylinder in order that amount of propane gas is 40 ± 5 ℓ / min indicated at stage III of table 7.

- (a) Top ring and second ring must be about 0.65 mm.
- (b) Do not adjust the oil ring.

(c) Be careful about secession of flushes for the rest.

(d) Adjust the top land clearance in case that propane gas amount is not included in the regulations.

(2) After cutting, wash it with an organic solvent. Then, record mass to 0.1 mg after drying it for 10 minutes.

7.1.8 Preparation of crank axes

Measure the front and rear of diameter of crank journal and crank pin about key direction or perpendicular direction.

Exchange crank axes in case that real value of circle is over 0.02 mm and difference of front and rear is over 0.02 mm.

7.1.9 Preparation of a bearing

Main bearing oil and crank pin bearing oil can be measured using a pressure gauge.

Position of measurement is the center of a bearing. Oil clearance is required between 0.02 ~ 0.05 mm part of a main bearing and 0.025 ~ 0.066 mm part of a crank pin bearing.

7.1.10 Preparation of exchange components

Use new components indicated at table 5 which is necessary for test. Exchange other components when they are required.

Table 5 Exchange components

The name of an article.	Number
Piston and piston pin	4 groups
Piston ring set	
Intake valve	4 pieces
Exhaust valve	
Crank pin bearing set	1 group
Main bearing set	
Gasket kit engine over hole	
PCV valve	1 piece
Ventilation tube	
Cleaner air element	
Cam axes	
Spark plug	4 pieces
Oil pump relief valve	1 pieces

Remark Indicated components number at additional table 2.

7.1.11 Preparation of PCV valve

Measure and record flux of PCV valve for test. Measuring instruments refer to figure 7.

Flux measurement of PCV valve is as follows. When both end of PCV valve have different pressure by vacuum pump indicated at figure 7, the flux occur and then can be measured by a flow meter in the middle of the figure 7.

Measure flux at 40 mmHg intervals in the range of 50 ~ 500 mmHg and about 130 mmHg pressure difference corresponding to intake pressure of stage II and III.

Measure at 500 mmHg of pressure difference and do it continually to 70 mmHg of pressure difference. Adjustment of pressure difference can be operated by pressure control valve and air control valve.

7.2 Assembly of engine

Assemble exchange components indicated at table 5 and converted components from 4(1) a to k according to engine repair book from the product company

Apply oil for test to every parts of movement of engine.

7.3 Operation before test

7.3.1 Early adjustment

Early adjustment is as follows.

- (1) Just as rocker cover is not attached, fill the upper part of rocker arm assembly with test oil 2.5L slowly and dampen the rocker arm assembly and the rotating upper part of intake and exhaust completely. Fill the valve deck with all of remnant and start the engine until the oil fall enough from returning hole into the crank case.
- (2) Maintain the main oil hole at above 1 kg f / cm^2 during pre-driving with maintaining 800 ~ 850 rpm for some minutes and check whether the oil is cover to the upper hole of rocker arm or not. After that, set up the rocker cover and drive the engine for 30 minutes on the state of unload of 1000 rpm. At this time the temperature of oil is more than $60 \text{ }^{\circ}\text{C}$ and the temperature of engine cooling water outlet is $80 \pm 5 \text{ }^{\circ}\text{C}$. Meanwhile, adjust the time of ignition and intake adjustment bolt to maintain highest value for intake load.
- (3) After 30 minutes, stop the engine and check whether the maximum torque of cylinder head is $11.0 \pm 0.7 \text{ kg f} \cdot \text{m}$ or not.
- (4) Adjust the valve clearance at the side of intake 0.20 mm and the side of exhaust 0.35 mm on the state of stoppage.

- (5) Get rid of a spark plug and measure a compression pressure in a state of an all-open evaporator. The compression pressure must be more than 11.0 kg f / cm^2 at 250 rpm and each pressure difference of cylinder should be less than 1.0 kg f / cm^2 .
- (6) When the measurement of compression pressure is finished, extract test oil from the engine except oil pan drain cock. Although remained oil is just a little, extract the oil at least for 30 minutes and then exchange oil filter for dummy filter.

7.3.2 Flushing

After finishing operation of 7.3.1, flush by injection of new test oil in a deep hole of oil tank of rocker cover and follow the condition of figure 6.

Table 6

Oil	Flux(L)	Load(kgf · m)	Engine rotation number(rpm)	Oil filter	Time(min)
Test oil	2.5	0	1000	Dummy filter	10

7.4 Execution of test

7.4.1 Pre-driving and adjustment of oil level

1 Pre-driving and adjustment of oil level are as follows.

- (1) After flushing stop the engine and extract test oil. After extraction of oil for 30 minutes, set up a drain plug for certain and put the test oil of 25 ℓ in the engine in an error of less than 1g in the way of 7.3.2.
- (2) Drive the engine until temperature of oil approach $50 \text{ }^{\circ}\text{C}$ at unload 100 rpm for 10 minutes.

- (3) After stoppage of engine, turn a crank axes round by hands at about 2 times ,take the first piston to the upper dead point and leave it for 10 minutes. After 10 minutes of stoppage, check a level of the engine oil three times and then record the average position at oil recording stick.
- (4) During a period of remained test, this position is a full level.

7.4.2 Measurement of flux of early propane gas

Measure several things about stages I, II, III in the test condition of table 7 using measuring equipment indicated at figure 6.

- (1) Take a hose away between the tappet cover and the main hold.
- (2) Take a hose away between the air cleaner and the rocker cover.
- (3) Connect a hose of measuring equipment to the position that PCV valve is set up.
- (4) Open a hose connection hole of rocker cover.
- (5) Start the engine and begin to measure when the test condition of table 7 is satisfied.

Adjust a adjustment valve to approach 0 for gauge of gas meter during measurement.

7.4.3 Main driving

Test condition follows table 7. Stage I, II, III for this test is 1cylce and rotate it 48 times.

In addition, the principle of the test is continuous driving and 2 days must be added totally for the case of stoppage.

Table 7 Test condition

Stage	I	II	III
Section			
Rotation number of engine (rpm)	800 ± 20	2500 ± 20	2500 ± 20
Load (kg f / m)	0	1150 ± 0.3	11.0 ± 0.3
Temperature of cooling water (Engine outlet) (°C)	45 ± 2	50 ± 2	80 ± 2
Temperature of cooling water(Engine inlet) (°C)	40 ~ 45	43 ~ 48	73 ~ 78
A visit temperature of oil pan ⁽⁴⁾ (°C)	50 ± 2	80 ± 2	100 ± 2
Air fuel ratio ⁽⁵⁾	10 ± 1	15.5 ± 1	15.5 ± 1
Time of ignition(° BTDC)	16 ± 2	28 ± 1	28 ± 1
Propane gas flux ⁽⁶⁾ (ℓ / min)	—	—	40 ± 5
Exhaust pressure (mmHg)	5.0 ↑	60 ± 12	60 ± 12
Oil pressure (kg f / cm ²)	—	2.5 ~ 4.4	2.5 ~ 4.4
PCV valve temperature (°C)	45	70 ~ 80	70 ~ 80
Test time (min)		120	75
Number of bringing cycle		48	
Previous driving time (h)		192	

Note ⁽⁴⁾ In case of conversion stage III into stage I, Convert 100 ± 2 °C of stage III into 52 °C of stage I in 30 minutes. Then, Do oil pan spray or dipping needed a long time.

⁽⁵⁾ Air fuel ration is a mass ratio obtained at several temperature with the engine intake air amount (m² / h) and the amount of fuel consumption(ℓ / h) measured with flow meter or float meter.

⁽⁶⁾ Yield it using the flux of 27 °C.

Remark 1. PCV valve temperature is reference value.

2. The engine stoppage follows this rules.

- (1) Drive the engine at unload 1000 ± 50 rpm first.
- (2) Open the fuel cock after 3 minutes from this states and supply fuel.
- (3) Turn off the switch for ignition till reaching 1000 ± 50 rpm after 15 minutes.

3. In principle, spark plug must be removed after 24 cycles. However, exchange spark plug in advance when ignition does not occur because of dirt and damage during the test.

4. Open the cock valve of the evaporator completely.

5. Intake air temperature and humidity of engine are recommended following things.

- (1) Intake air temperature 27 ± 3 °C
- (2) Intake air humidity 50 ± 5 %

7.4.4 Supply and picking method of oil

- (1) When 4 cycles test is finished, check oil level up to 12 cycles.
- (2) After the stoppage of the engine, rotate crank axes 2 revolution by hand and leave it for 10 minutes when the first piston is approached the upper dead point of compression stroke.
- (3) After 10 minutes, check the oil level and supply oil to full level.
- (4) Record masses in an error of 1g for supply oil.
- (5) After 16 cycles, check oil level and fill with oil up to full level by repetition of (2) ~ (4) every test completion of 4 cycles. In addition, evaluate amount of necessary new oil by oil check stick.