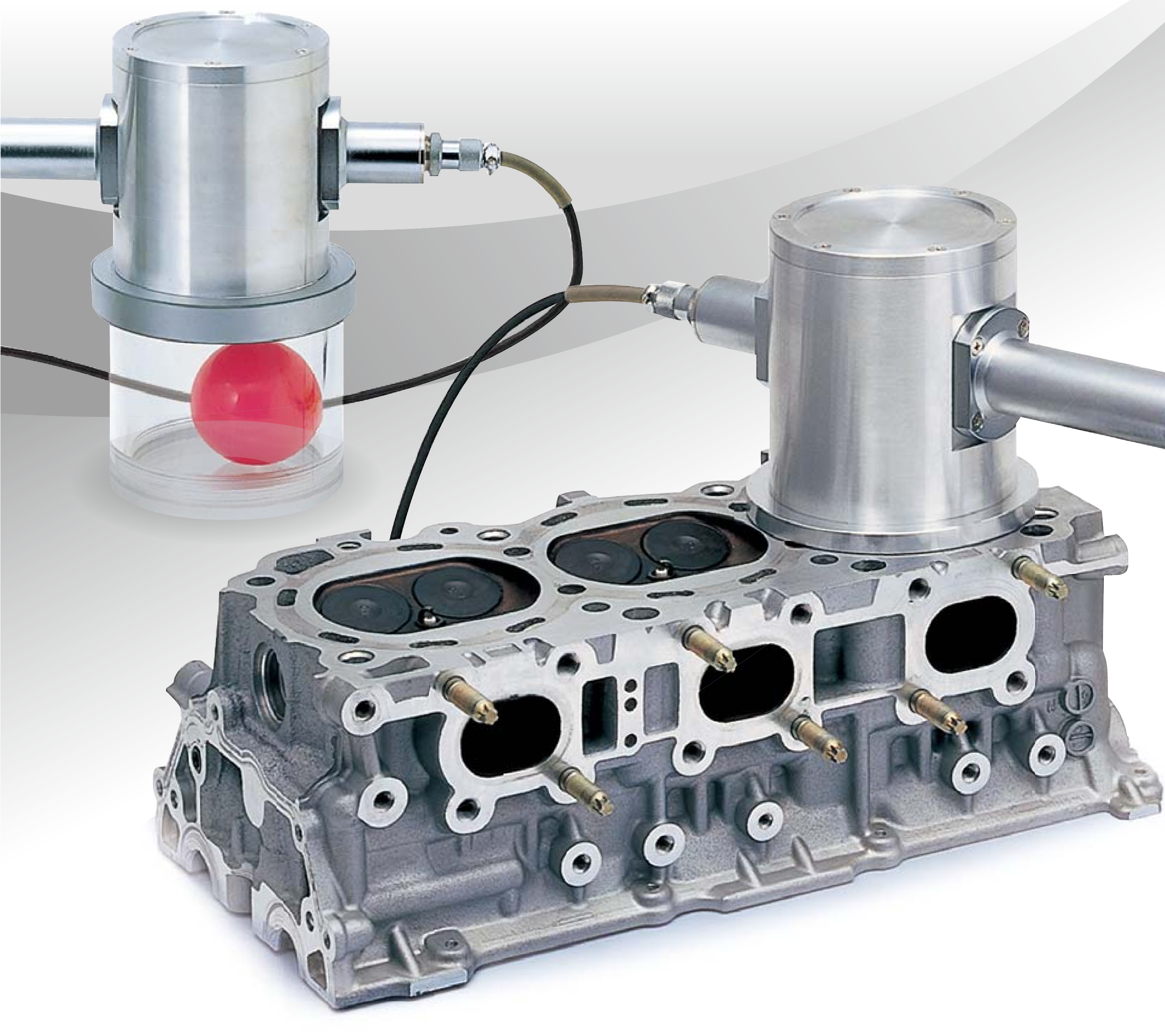
RION

Acoustical Capacity Meter
Acoustical Volume Meter



- **Acoustical Capacity Meter**
  (Combustion Chamber Capacity Meter)
- **Acoustical Volume Meter**

Acoustic Measurement of
Capacity/Volume

Now precision measurement under dry conditions is possible for any shape of object.

Acoustical Capacity Meter

(Combustion Chamber Capacity Meter)

- **Regardless of the shape, the combustion chamber capacity can be measured by simply placing the capacity meter on the combustion chamber cavity of the cylinder head, as shown in the picture.**
- **Instead of using a spark plug of the assembled engine, special adapters are used to connect to the capacity meter so that the combustion chamber capacity can be measured.**
- **In the process of engine manufacturing or maintenance, the combustion chamber capacity can be measured in just two seconds in dry conditions.**

CAPACITY Measurement Method

The target capacity is calculated based on a comparison with a Reference Standard. First, the capacity of the Reference Standard is measured, with the results providing the parameters for measuring the target. Once the calibration process is completed, the target capacity can be measured repeatedly. Currently, to improve measurement precision, two or three Reference Standards are used for calibration. For example, for measuring target capacity of approximately 50 cm^3, a measurement precision at ±0.05 cm^3 can be achieved.

Measurement Principle

When the loudspeaker placed in the sound source chamber is driven by a sinusoidal signal (sine wave) as shown in the right figure, for the capacity V_1 of the sound source chamber and V_2 (the capacity V_0 including space in the attachment plus the capacity V of the object (the combustion chamber in the figure), ultra small changes in volume ($\varDelta V$) and pressure (sound) with the same absolute value, but of opposite phase, will occur inside each chamber.
The degree of change is inversely proportional to the capacity. These pressure changes are detected by electret condenser microphones, and the capacity V_2 is calculated from the ratio of the pressure change. The capacity (V) can be obtained by subtracting V_0 (space in the attachment) from V_2.

$$P \times V^{\gamma} = \text{const.} \quad (\gamma \text{ is the ratio of specific heat for air, approx.1.4})$$

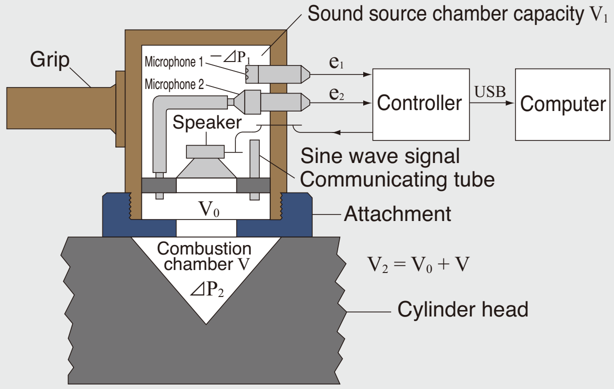
$$\frac{\varDelta P_1}{P_0} = \gamma \frac{\varDelta V}{V_1} \qquad \frac{\varDelta P_2}{P_0} = \gamma \frac{\varDelta V}{V_2}$$

P_0: Pressure in the chamber (atmospheric pressure)
$\varDelta P_1$: Small pressure changes in the sound source chamber
$\varDelta P_2$: Small pressure changes in the space in the attachment and the object

$$V_2 = V_1 \frac{\varDelta P_1}{\varDelta P_2} \ (V_1 : \text{const.}) \qquad V = V_2 - V_0 \ (V_0 : \text{const.})$$

Cross-sectional drawing

- Prior to the measurement, use a few types of reference standards for calibration and obtain the required parameters.
- Measurement is done by attaching the sound source chamber to the object.



Acoustical Volume Meter

- Unlike the conventional method of the Archimedes principle (where the target object is immersed in water), this system allows volume measurement of the target object in dry conditions.
- Even the volume of objects with complex shape can be measured accurately in a short time (approx. two seconds).

VOLUME Measurement Method

The target volume is calculated based on a comparison with a Reference Standard. First, the volume of the Reference Standard is measured, with the results providing the parameters for measuring the target. Once the calibration process is completed, the target volume can be measured repeatedly. Currently, to improve measurement precision, two or three Reference Standards are used for calibration. For example, for measuring target volume of approximately 100 cm^3, a measurement precision at ±0.1 cm^3 can be achieved.

Measurement Principle

When the loudspeaker placed in the sound source chamber is driven by a sinusoidal signal (sine wave) as shown in the right figure, for the volume V_1 of the sound source chamber and V_2 (the volume of space in the attachment plus the space between the measurement enclosure and the object), ultra small changes in volume (ΔV) and pressure (sound) with the same absolute value, but of opposite phase, will occur inside each chamber. The degree of change is inversely proportional to the capacity. These pressure changes are detected by electret condenser microphones and the volume V_2 is calculated from the ratio of the pressure change.
The volume (V) of the object can be obtained by subtracting V_2 from V_0 (space in attachment plus empty space in the measurement chambers).

$$P \times V^{\gamma} = \text{const.}$$ (γ is the ratio of specific heat for air, approx.1.4)

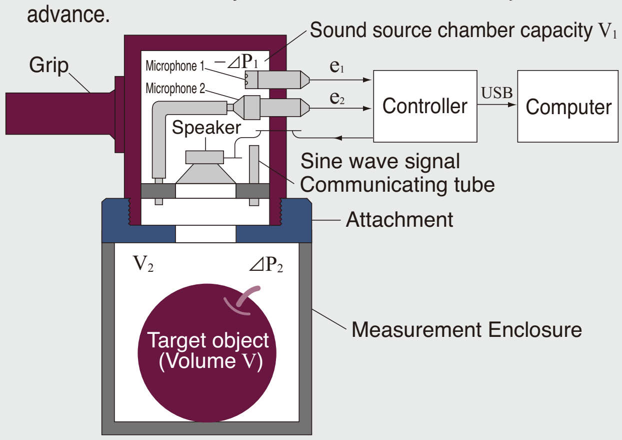
$$\frac{\Delta P_1}{P_0} = \gamma \frac{\Delta V}{V_1} \qquad \frac{\Delta P_2}{P_0} = \gamma \frac{\Delta V}{V_2}$$

P_0: Pressure in the chamber (atmospheric pressure)
ΔP_1: Small pressure changes in the sound source chamber
ΔP_2: Small pressure changes in space in the attachment plus the space between the measurement enclosure and the object

$$V_2 = V_1 \frac{\Delta P_1}{\Delta P_2} \ (V_1 : \text{const.}) \qquad V = V_0 - V_2 \ (V_0 : \text{const.})$$

Cross-sectional drawing

- Prior to the measurement, use a few types of reference stndards for calibration.
- Put the object into the measurement enclosure for measurement.
- To measure the density, measure the mass of the object in advance.



Specifications

	Acoustical Capacity Meter (Combustion Chamber Capacity Meter)	Acoustical Volume Meter
Capacity/ volume measurement: repeat precision	±0.05 cm^3 *1	±0.1 cm^3 *2
Required measurement time	Approx. 2 seconds (When number of analysis points is 1 024. Units: one-second steps)	
Measurement frequency	15 to 99 Hz (variable, depends on the object)	
Numbers of analysis points	256 to 4 096 points (variable, in a power-of-two. Initial value: 1 024 points)	
Reference chamber: acoustic pressure in measurement tank	Approx. 94 to 134 dB (1 to 100 Pa rms)	
Reference chamber: internal dimension, capacity	ϕ90 mm x 91 (H) mm V_1 nealy equal to 570 cm^3	
Controller	Connected to a computer through a USB cable. 54 (H) x 150 (W) x 170 (D) mm, approx.400 g	
Consumption current	5 V, approx. 475 mA (approx. 2.4 VA)	
Available OS	Microsoft Windows 7 Professional 32 bit / 64 bit, 8.1 Pro 32 bit / 64 bit, 10 Pro 32 bit / 64 bit	
Accessories	■ Connection cable, USB cable ■ AC adapter ■ Software (CD-ROM)	■ Connection cable, USB cable ■ AC adapter ■ Software (CD-ROM)
Options	■ Reference standards For calibration, at least two reference standards are needed. 0 to 120 cm^3 (in 5 cm^3 increments) (Manufactured according to the capacity of the object.) ■ Spark plug hole adapter (for assembled engines)	■ Reference standards For calibration, at least two reference standards are needed. ■ Measurement enclosure ・Manufacture the enclosure according to the dimensions of the target object.

*1 When a volume of 50 cm^3 is measured under standard environmental conditions (20 ˚C, 50 %) (for a cylinder head)
*2 When a volume of 100 cm^3 is measured under standard environmental conditions (20 ˚C, 50 %)

JCSS 0197

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This leaflet is printed with environmentally friendly UV ink.

1006-6 1904.P.D