

# JIS

**JAPANESE INDUSTRIAL STANDARD**

**Testing Methods for Octane  
Number and Cetane Number**

**JIS K 2280—1986**

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In the event of any doubt arising,  
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## JAPANESE INDUSTRIAL STANDARD

J I S

Testing Methods for Octane Number and  
Cetane Number

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1. Scope

This Japanese Industrial Standard specifies the testing methods for octane number of fuel for spark ignition type engine and cetane number of fuel for compression firing type engine.

Remark: The units and numerical values given in { } in this Standard are in accordance with the conventional units and are Standard value.

2. General Item

Rounding off of numerical values shall be in accordance with JIS Z 8401.

3. Definitions

For the purposes of this Standard following definitions apply:

- (1) octane number The scale indicating antiknock property of fuel for spark ignition type engine, and shall be expressed as follows according to its value.
  - (a) In the Case of Fuel of 100 or Less in Octane Number Taking the octane number of 2,2,4-trimethylpentane of high antiknock property, hereinafter referred to as isooctane, as 100.0 and the octane number of heptane of low antiknock property as 0.0, and by comparing the antiknock property of sample with that of the normal standard fuel which is made by mixing isooctane and heptane, and it is expressed by the volume (%) of isooctane in the normal standard fuel indicating the same antiknock property as that of sample.
  - (b) In the Case of Fuel Exceeding 100 in Octane Number The value shown in Table 1 is expressed by one place of decimal according to the tetraethyl lead concentration (ml) in the isooctane.
- (2) cetane number One of the values expressing the self-firing property of diesel fuel, taking the value of cetane of good firing property as 100, and the cetane number of heptamethylnonane of inferior firing property as 15, and by comparing the firing property of standard fuel made by mixing cetane and heptamethylnonane with that of sample, and from the volume (%) of cetane and heptamethylnonane in the standard fuel indicating the same firing property as that of sample, it is obtained according to the following formula to be expressed by integer.

$$\text{Cetane number} = \text{volume (\% of cetane} + \text{volume (\% of} \\ \text{heptamethylnonane} \times 0.15 \dots\dots\dots (1)$$

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Applicable Standards and Corresponding International Standards: See page 57.

- (3) normal standard fuel The fuel for determining the octane number (or cetane number) of sample.

4. Classification of Testing Methods

The testing methods shall be classified as follows:

(1) Testing Methods for Octane Number

(a) Research Method

(b) Motor Method

Reference: The research method is designated as F-1 or RON, and the motor method, as F-2 or MON in some cases.

(2) Testing Method for Cetane Number

Table 1. Conversion Table from Tetraethyl Lead Concentration in Isooctane to Octane Number

| Tetraethyl lead<br>ml/3.785 l | 0.00   | 0.01   | 0.02   | 0.03   | 0.04   | 0.05   | 0.06   | 0.07   | 0.08   | 0.09   | Tetraethyl lead<br>ml/3.785 l |
|-------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------------------------------|
| 0.0                           | 100.00 | 100.14 | 100.28 | 100.42 | 100.55 | 100.68 | 100.81 | 100.94 | 101.07 | 101.19 | 0.0                           |
| 0.1                           | 101.32 | 101.44 | 101.56 | 101.68 | 101.80 | 101.92 | 102.03 | 102.14 | 102.26 | 102.37 | 0.1                           |
| 0.2                           | 102.48 | 102.58 | 102.69 | 102.80 | 102.90 | 103.01 | 103.11 | 103.21 | 103.31 | 103.41 | 0.2                           |
| 0.3                           | 103.51 | 103.60 | 103.70 | 103.79 | 103.89 | 103.98 | 104.07 | 104.16 | 104.25 | 104.34 | 0.3                           |
| 0.4                           | 104.43 | 104.52 | 104.61 | 104.69 | 104.78 | 104.86 | 104.94 | 105.03 | 105.11 | 105.19 | 0.4                           |
| 0.5                           | 105.27 | 105.35 | 105.43 | 105.51 | 105.59 | 105.66 | 105.74 | 105.82 | 105.89 | 105.97 | 0.5                           |
| 0.6                           | 106.04 | 106.11 | 106.19 | 106.26 | 106.33 | 106.40 | 106.47 | 106.54 | 106.61 | 106.68 | 0.6                           |
| 0.7                           | 106.75 | 106.81 | 106.88 | 106.95 | 107.01 | 107.08 | 107.15 | 107.21 | 107.27 | 107.34 | 0.7                           |
| 0.8                           | 107.40 | 107.46 | 107.53 | 107.58 | 107.65 | 107.71 | 107.77 | 107.83 | 107.89 | 107.95 | 0.8                           |
| 0.9                           | 108.01 | 108.07 | 108.13 | 108.18 | 108.24 | 108.30 | 108.35 | 108.41 | 108.47 | 108.52 | 0.9                           |
| 1.0                           | 108.58 | 108.63 | 108.69 | 108.74 | 108.79 | 108.85 | 108.90 | 108.95 | 109.01 | 109.06 | 1.0                           |
| 1.1                           | 109.11 | 109.16 | 109.21 | 109.26 | 109.31 | 109.36 | 109.41 | 109.46 | 109.51 | 109.56 | 1.1                           |
| 1.2                           | 109.61 | 109.66 | 109.71 | 109.75 | 109.80 | 109.85 | 109.90 | 109.94 | 109.99 | 110.04 | 1.2                           |
| 1.3                           | 110.08 | 110.13 | 110.17 | 110.22 | 110.26 | 110.31 | 110.35 | 110.40 | 110.44 | 110.49 | 1.3                           |
| 1.4                           | 110.53 | 110.57 | 110.62 | 110.66 | 110.70 | 110.74 | 110.79 | 110.83 | 110.87 | 110.91 | 1.4                           |
| 1.5                           | 110.95 | 110.99 | 111.04 | 111.08 | 111.12 | 111.16 | 111.20 | 111.24 | 111.28 | 111.32 | 1.5                           |
| 1.6                           | 111.36 | 111.39 | 111.43 | 111.47 | 111.51 | 111.55 | 111.59 | 111.63 | 111.66 | 111.70 | 1.6                           |
| 1.7                           | 111.74 | 111.78 | 111.81 | 111.85 | 111.89 | 111.92 | 111.96 | 112.00 | 112.03 | 112.07 | 1.7                           |
| 1.8                           | 112.11 | 112.14 | 112.18 | 112.21 | 112.25 | 112.28 | 112.32 | 112.35 | 112.39 | 112.42 | 1.8                           |
| 1.9                           | 112.45 | 112.49 | 112.52 | 112.56 | 112.59 | 112.62 | 112.66 | 112.69 | 112.72 | 112.76 | 1.9                           |
| 2.0                           | 112.79 | 112.82 | 112.85 | 112.89 | 112.92 | 112.95 | 112.96 | 113.02 | 113.05 | 113.08 | 2.0                           |
| 2.1                           | 113.11 | 113.14 | 113.17 | 113.20 | 113.23 | 113.27 | 113.30 | 113.33 | 113.36 | 113.39 | 2.1                           |
| 2.2                           | 113.42 | 113.45 | 113.48 | 113.51 | 113.54 | 113.57 | 113.60 | 113.63 | 113.66 | 113.69 | 2.2                           |
| 2.3                           | 113.72 | 113.75 | 113.77 | 113.80 | 113.83 | 113.86 | 113.89 | 113.92 | 113.95 | 113.97 | 2.3                           |
| 2.4                           | 114.00 | 114.03 | 114.06 | 114.09 | 114.11 | 114.14 | 114.17 | 114.20 | 114.22 | 114.25 | 2.4                           |
| 2.5                           | 114.28 | 114.30 | 114.33 | 114.36 | 114.38 | 114.41 | 114.44 | 114.46 | 114.49 | 114.52 | 2.5                           |
| 2.6                           | 114.54 | 114.57 | 114.60 | 114.62 | 114.65 | 114.67 | 114.70 | 114.72 | 114.75 | 114.77 | 2.6                           |
| 2.7                           | 114.80 | 114.82 | 114.85 | 114.87 | 114.90 | 114.92 | 114.95 | 114.97 | 115.00 | 115.02 | 2.7                           |
| 2.8                           | 115.05 | 115.07 | 115.10 | 115.12 | 115.14 | 115.17 | 115.19 | 115.22 | 115.24 | 115.26 | 2.8                           |
| 2.9                           | 115.29 | 115.31 | 115.33 | 115.36 | 115.38 | 115.40 | 115.43 | 115.45 | 115.47 | 115.50 | 2.9                           |
| 3.0                           | 115.52 | 115.54 | 115.57 | 115.59 | 115.61 | 115.63 | 115.66 | 115.68 | 115.70 | 115.72 | 3.0                           |
| 3.1                           | 115.75 | 115.77 | 115.79 | 115.81 | 115.83 | 115.86 | 115.88 | 115.90 | 115.92 | 115.94 | 3.1                           |
| 3.2                           | 115.96 | 115.99 | 116.01 | 116.03 | 116.05 | 116.07 | 116.09 | 116.11 | 116.14 | 116.16 | 3.2                           |
| 3.3                           | 116.18 | 116.20 | 116.22 | 116.24 | 116.26 | 116.28 | 116.30 | 116.32 | 116.34 | 116.36 | 3.3                           |
| 3.4                           | 116.38 | 116.40 | 116.42 | 116.44 | 116.47 | 116.49 | 116.51 | 116.53 | 116.55 | 116.57 | 3.4                           |
| 3.5                           | 116.59 | 116.61 | 116.63 | 116.64 | 116.66 | 116.68 | 116.70 | 116.72 | 116.74 | 116.76 | 3.5                           |
| 3.6                           | 116.78 | 116.80 | 116.82 | 116.84 | 116.86 | 116.88 | 116.89 | 116.91 | 116.93 | 116.95 | 3.6                           |
| 3.7                           | 116.97 | 116.99 | 117.01 | 117.03 | 117.05 | 117.06 | 117.08 | 117.10 | 117.12 | 117.14 | 3.7                           |
| 3.8                           | 117.16 | 117.17 | 117.19 | 117.21 | 117.23 | 117.25 | 117.26 | 117.28 | 117.30 | 117.32 | 3.8                           |
| 3.9                           | 117.34 | 117.36 | 117.37 | 117.39 | 117.41 | 117.43 | 117.44 | 117.46 | 117.48 | 117.50 | 3.9                           |
| 4.0                           | 117.51 | 117.53 | 117.55 | 117.56 | 117.58 | 117.60 | 117.62 | 117.63 | 117.65 | 117.67 | 4.0                           |
| 4.1                           | 117.68 | 117.70 | 117.72 | 117.74 | 117.75 | 117.77 | 117.79 | 117.80 | 117.82 | 117.84 | 4.1                           |
| 4.2                           | 117.85 | 117.87 | 117.89 | 117.90 | 117.92 | 117.94 | 117.95 | 117.97 | 117.98 | 118.00 | 4.2                           |
| 4.3                           | 118.02 | 118.03 | 118.05 | 118.07 | 118.08 | 118.10 | 118.11 | 118.13 | 118.15 | 118.16 | 4.3                           |
| 4.4                           | 118.18 | 118.19 | 118.21 | 118.23 | 118.24 | 118.26 | 118.27 | 118.29 | 118.30 | 118.32 | 4.4                           |
| 4.5                           | 118.33 | 118.35 | 118.36 | 118.38 | 118.40 | 118.41 | 118.43 | 118.44 | 118.46 | 118.47 | 4.5                           |
| 4.6                           | 118.49 | 118.50 | 118.52 | 118.53 | 118.55 | 118.56 | 118.58 | 118.59 | 118.61 | 118.62 | 4.6                           |
| 4.7                           | 118.64 | 118.65 | 118.67 | 118.68 | 118.70 | 118.71 | 118.73 | 118.74 | 118.76 | 118.77 | 4.7                           |
| 4.8                           | 118.78 | 118.80 | 118.81 | 118.83 | 118.84 | 118.86 | 118.87 | 118.88 | 118.90 | 118.91 | 4.8                           |
| 4.9                           | 118.93 | 118.94 | 118.96 | 118.97 | 118.99 | 119.00 | 119.01 | 119.03 | 119.04 | 119.05 | 4.9                           |
| 5.0                           | 119.07 | 119.08 | 119.10 | 119.11 | 119.12 | 119.14 | 119.15 | 119.17 | 119.18 | 119.19 | 5.0                           |
| 5.1                           | 119.21 | 119.22 | 119.23 | 119.25 | 119.26 | 119.28 | 119.29 | 119.30 | 119.32 | 119.33 | 5.1                           |
| 5.2                           | 119.34 | 119.36 | 119.37 | 119.38 | 119.40 | 119.41 | 119.42 | 119.43 | 119.45 | 119.46 | 5.2                           |
| 5.3                           | 119.47 | 119.49 | 119.50 | 119.51 | 119.53 | 119.54 | 119.55 | 119.57 | 119.58 | 119.59 | 5.3                           |
| 5.4                           | 119.60 | 119.62 | 119.63 | 119.64 | 119.66 | 119.67 | 119.68 | 119.69 | 119.71 | 119.72 | 5.4                           |
| 5.5                           | 119.73 | 119.74 | 119.76 | 119.77 | 119.78 | 119.80 | 119.81 | 119.82 | 119.83 | 119.85 | 5.5                           |
| 5.6                           | 119.86 | 119.87 | 119.88 | 119.90 | 119.91 | 119.92 | 119.93 | 119.94 | 119.96 | 119.97 | 5.6                           |
| 5.7                           | 119.98 | 119.99 | 120.01 | 120.02 | 120.03 | 120.04 | 120.05 | 120.07 | 120.08 | 120.09 | 5.7                           |
| 5.8                           | 120.10 | 120.12 | 120.13 | 120.14 | 120.15 | 120.16 | 120.17 | 120.19 | 120.20 | 120.21 | 5.8                           |
| 5.9                           | 120.22 | 120.23 | 120.25 | 120.26 | 120.27 | 120.28 | 120.29 | 120.30 | 120.32 | 120.33 | 5.9                           |
| 6.0                           | 120.34 | —      | —      | —      | —      | —      | —      | —      | —      | —      | 6.0                           |

## 5. Testing Methods for Octane Number

### 5.1 Research Method

5.1.1 Summary of Testing Method The research octane number test apparatus is operated under the specified conditions, the compression ratio and air-fuel ratio are so regulated as to obtain the standard knock strength of sample at 600 revolutions per minute, the knock strengths of sample and of normal standard fuel of known octane number are compared and the octane number is determined.

5.1.2 Research Octane Number Test Apparatus The apparatus shall be of such construction as shown in Fig. 1, provided with power apparatus, auxiliary equipment and measuring instruments, consisted of single cylinder engine capable of changing compression ratio, and, mounted on the fixing stand executed with a suitable prevention of vibration.

Further, dimensions of each part of engine are shown in Table 2.

(1) Power Apparatus The synchronous motor which carries out starting of engine motion and absorption of power, and is able to maintain at  $600 \pm 6$  revolutions per minute.

(2) Auxiliary Equipment The auxiliary equipment shall be as follows:

(2.1) Ice Tower (refer to Fig. 2)

(2.2) Cooling Liquid Condenser (refer to Fig. 1)

(2.3) Suction Air Heater and Carbureter (refer to Fig. 1 and Fig. 3)

(2.4) Lubricating Oil Filter (refer to Fig. 1 and Fig. 4)

(2.5) Exhaust Gas Pressure Regulating Tank The tank of not less than 250 mm in inner diameter, not less than 270 mm in outer diameter and not less than 28 l in capacity, it may be attached either vertically or horizontally, but the back pressure at the time of measuring shall be as lower as possible in the range of 0 to 2.45 kPa { water column 0 to 250 mm } (refer to Fig. 1).

(2.6) Thermometer

(a) Thermometer for suction air

(b) Thermometer for cooling liquid

(c) Thermometer for lubricating oil

(3) Measuring Instruments The measuring instruments shall consist of knock meter, pickup, and detonation meter.

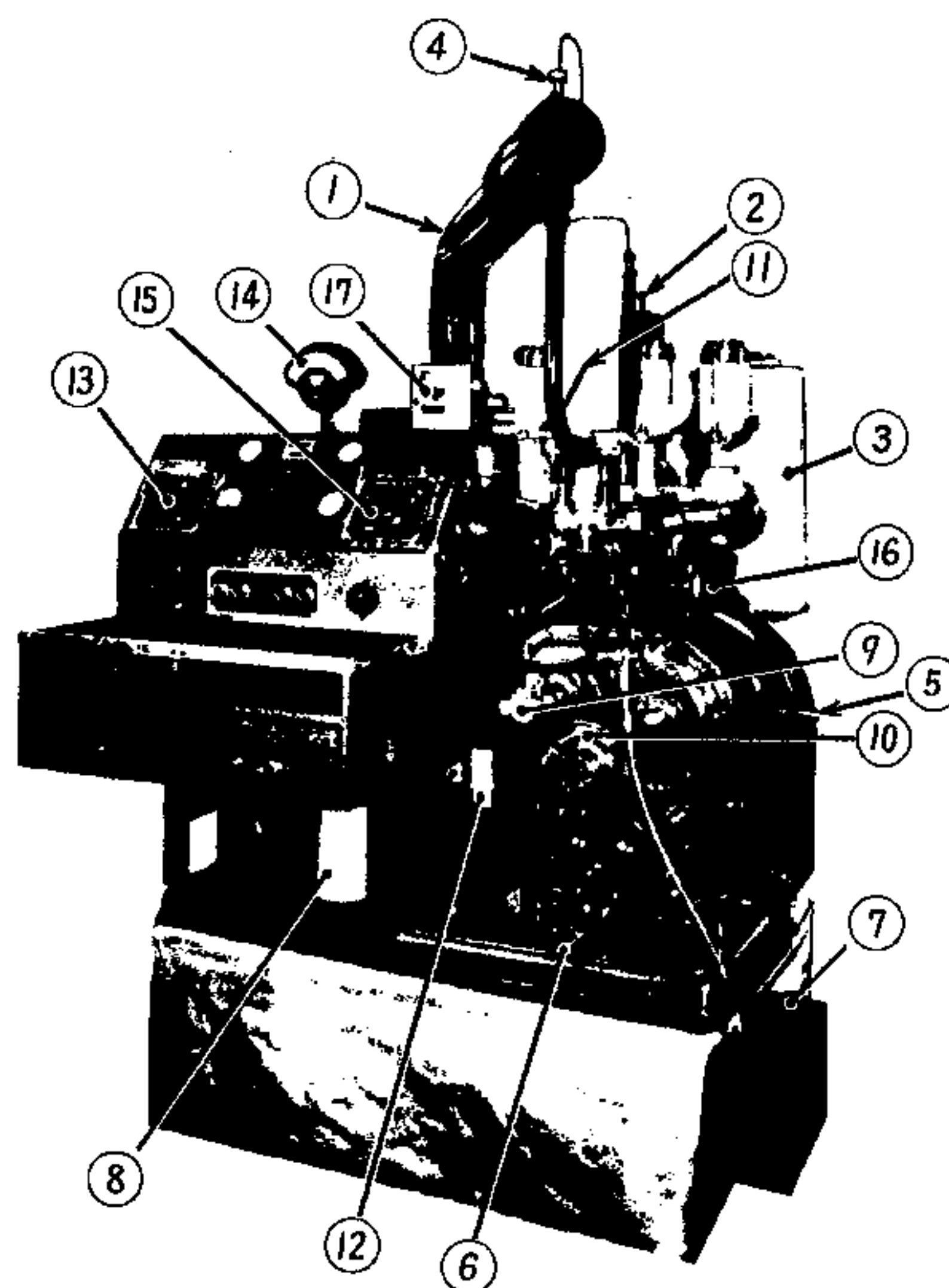
Table 2. Dimensions of Each Part of Engine

| Crank chamber style                               |             | CFR-48* |
|---------------------------------------------------|-------------|---------|
| Compression ratio                                 |             | 4 to 18 |
| Bore of standard cylinder                         | mm          | 83      |
| Stroke mm                                         |             | 114     |
| Exhaust amount ml                                 |             | 612     |
| Valve seat insert, Minimum inner diameter mm      |             | 30      |
| Connecting bar bearing                            | Diameter mm | 64      |
|                                                   | Length mm   | 36      |
| Front part main bearing (excluding thrust washer) | Diameter mm | 76      |
|                                                   | Length mm   | 49      |
| Rear part main bearing                            | Diameter mm | 76      |
|                                                   | Length mm   | 82      |
| Piston pin, floating type, Diameter mm            |             | 32      |
| Length of connecting bar (center to center)       | mm          | 254     |
|                                                   | Width mm    | 41      |
| Face of gear at regulating mm                     |             | 25      |
| Piston ring number of pieces                      |             | 5       |
| Valve opening, minimum diameter mm                |             | 32      |
| Mass of engine (approx.) kg                       |             | 399     |
| Mass of overall equipment (approx.) kg            |             | 1247    |

Note \* CFR is the abbreviation of Cooperative Fuel Research.

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Fig. 1. Research Octane Number Test Apparatus  
(An Example)



- |                                           |                               |
|-------------------------------------------|-------------------------------|
| ① Air induction tube                      | ⑩ Ignition timing scale       |
| ② Cooling liquid condenser                | ⑪ Thermometer for suction air |
| ③ Exhaust gas pressure regulating tank    | ⑫ Ignition coil               |
| ④ Suction air heater                      | ⑬ Detonation meter            |
| ⑤ Handle for compression ratio regulation | ⑭ Knock meter                 |
| ⑥ Lubricating oil drain outlet            | ⑮ Temperature regulator       |
| ⑦ Waste fuel tank                         | ⑯ Micrometer                  |
| ⑧ Lubricating oil filter                  | ⑰ Digital counter             |
| ⑨ Ignition intermitting device            |                               |

Fig. 2. Ice Tower (One Example)

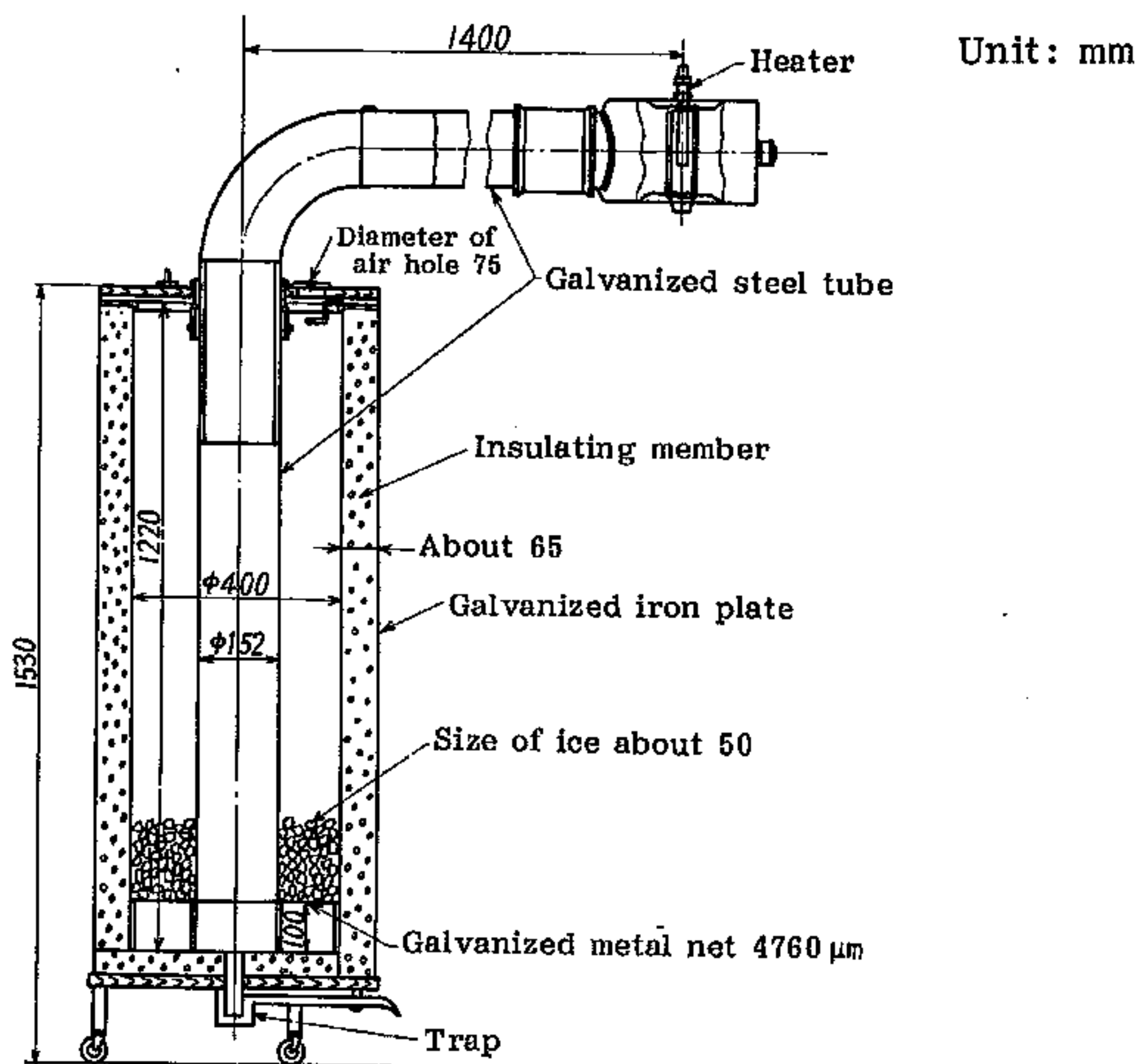


Fig. 3. Carbureter (One Example)

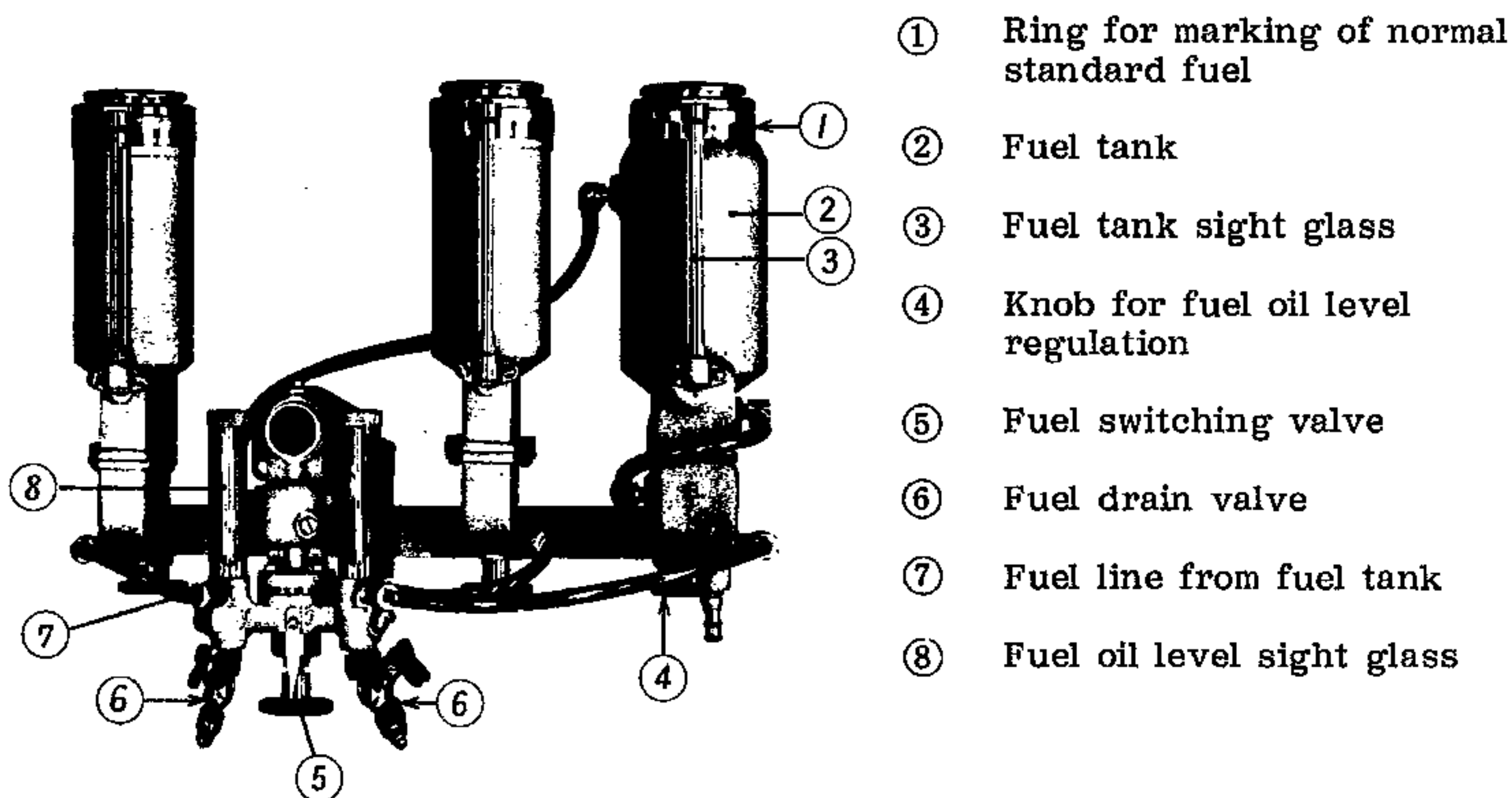
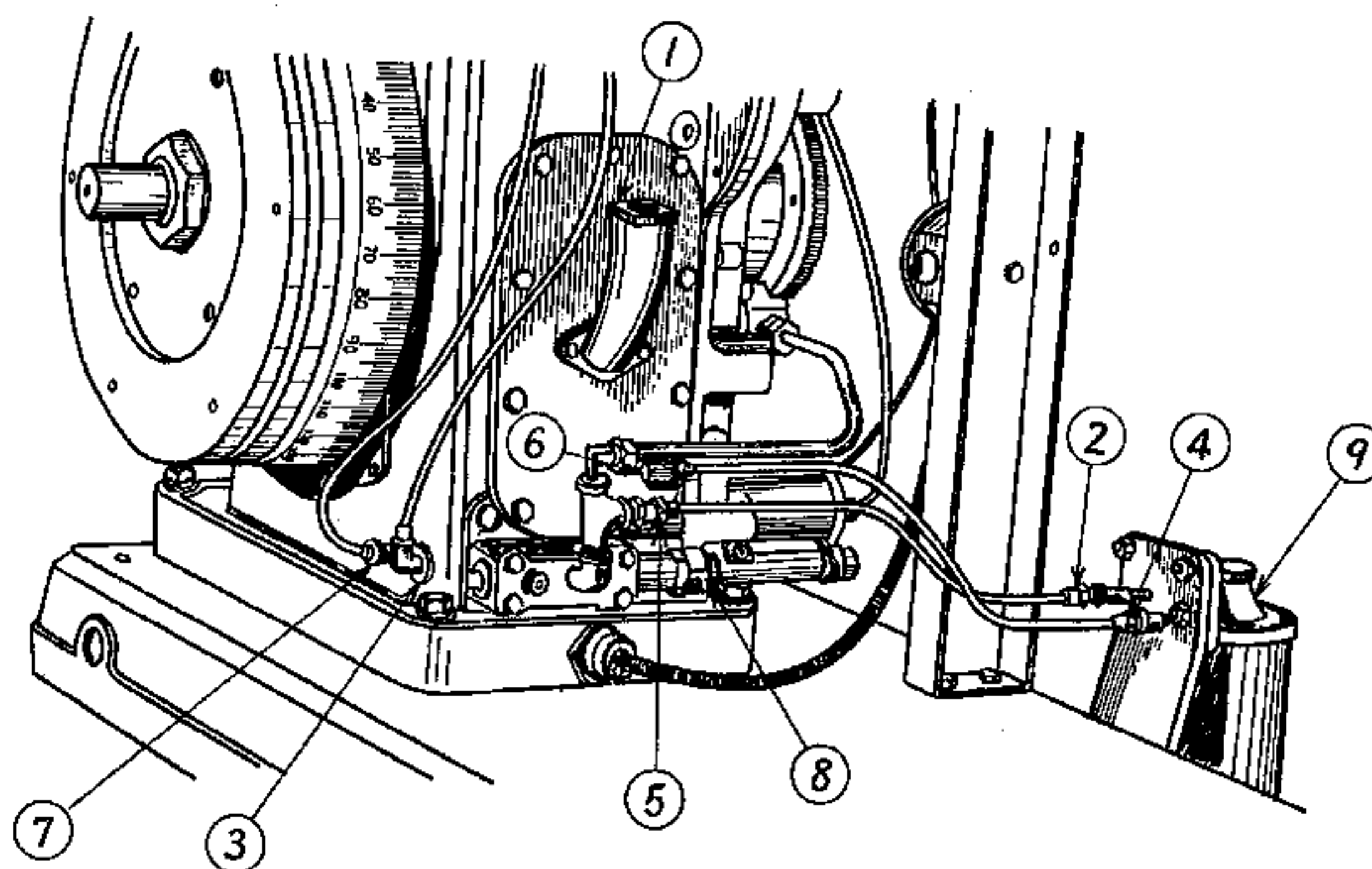


Fig. 4. Lubricating System Figure (One Example)



- |                                                 |                                                  |
|-------------------------------------------------|--------------------------------------------------|
| ① Crank chamber aeration opening                | ⑤ Connecting part of oil-feed pump               |
| ② Lubricating oil filter tube (press-in side)   | ⑥ Tube connecting part                           |
| ③ Connecting tube for lubricating oil manometer | ⑦ Inserting part for lubricating oil thermometer |
| ④ Lubricating oil filter tube (exhaust side)    | ⑧ Lubricating oil pressure regulator             |
|                                                 | ⑨ Lubricating oil filter                         |

#### 5.1.3 Reagents Reagents shall be as follows:

- (1) Isooctane The isooctane accepted by verification of Agency of Industrial Science and Technology, National Research Institute for Pollution and Resources or product complied with ASTM Standard (refer to Reference Table 1).
- (2) Heptane The heptane accepted by verification of Agency of Industrial Science and Technology, National Research Institute for Pollution and Resources or product complied with ASTM Standard (refer to Reference Table 1).

Reference Table 1

| Property                                            | Isooctane        | Heptane          |
|-----------------------------------------------------|------------------|------------------|
| Specific gravity 20/4°C                             | 0.6918 to 0.6921 | 0.6836 to 0.6839 |
| Refractive index ( $n_D^{20}$ )                     | 1.3914 to 1.3917 | 1.3876 to 1.3879 |
| Distillation property                               |                  |                  |
| 50 % distillation temperature (°C)                  | 99.2 to 99.3     | 98.4 to 98.5     |
| 20 to 80 % distillation temperature difference (°C) | 0.02 max.        | 0.02 max.        |
| Octane number (motor method)                        | 100.0 $\pm$ 0.1  | 0.0 $\pm$ 0.2    |

Remark: Those accepted by verification of Agency of Industrial Science and Technology, National Research Institute for Pollution and Resources or products complied with ASTM D 2699 are on the market.

- (3) Toluene Pure toluene No. 1 specified in JIS K 2435 or that equivalent or superior in purity.

5.1.4 Preparation of Standard Fuel The preparation of standard fuel shall be as follows:

- (1) Normal Standard Fuel The preparation shall be as follows:

- (a) In the Case of Octane Number of 100 or Less Prepare by mixing isooctane and heptane at a suitable ratio. For example, for preparation of normal standard fuel of 80 in octane number, mix 80 volume % isooctane and 20 volume % heptane.
- (b) In the Case of Octane Number Exceeding 100 Prepare by adding tetraethyl lead of specified amount to isooctane.

- (2) Fuel for Engine Check It is the fuel used for examining whether the engine is normal or not and shall be prepared as follows:

- (a) Fuel for Checking Toluene Series It is the mixed solution of toluene, isooctane and heptane, and the relation between the mixing rate and the octane number is shown in Table 3.

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Table 3. Fuel for Checking Toluene Series and Its Octane Number

| Octane number | Tolerances | Mixing rate (volume %) |           |         |
|---------------|------------|------------------------|-----------|---------|
|               |            | Toluene                | Isooctane | Heptane |
| 65.2          | $\pm 0.4$  | 50                     | 0         | 50      |
| 75.5          | $\pm 0.3$  | 58                     | 0         | 42      |
| 85.0          | $\pm 0.3$  | 66                     | 0         | 34      |
| 93.4          | $\pm 0.3$  | 74                     | 0         | 26      |
| 96.7          | $\pm 0.2$  | 74                     | 5         | 21      |
| 99.6          | $\pm 0.3$  | 74                     | 10        | 16      |
| 103.3         | $\pm 0.4$  | 74                     | 15        | 11      |
| 108.0         | $\pm 0.8$  | 74                     | 20        | 6       |
| 113.7         | $\pm 0.9$  | 74                     | 26        | 0       |

(b) Fuel for Checking Lead Containing Series The mixed solution of isooctane and heptane added with tetraethyl lead and the relation between its mixing rate and the octane number is shown in Table 4.

Table 4. Fuel for Checking Lead Containing Series and Its Octane Number

| Research octane number | Tolerances | Mixing rate        |                  |                            |
|------------------------|------------|--------------------|------------------|----------------------------|
|                        |            | Isooctane volume % | Heptane volume % | Tetraethyl lead ml/3.785 l |
| 57.5                   | $\pm 0.9$  | 30                 | 70               | 2.0                        |
| 73.4                   | $\pm 0.5$  | 50                 | 50               | 2.0                        |
| 84.1                   | $\pm 0.4$  | 65                 | 35               | 2.0                        |
| 87.5                   | $\pm 0.3$  | 70                 | 30               | 2.0                        |
| 90.8                   | $\pm 0.3$  | 75                 | 25               | 2.0                        |
| 94.1                   | $\pm 0.3$  | 80                 | 20               | 2.0                        |
| 97.1                   | $\pm 0.2$  | 85                 | 15               | 2.0                        |
| 100.1                  | $\pm 0.2$  | 90                 | 10               | 2.0                        |
| 104.0                  | $\pm 0.3$  | 95                 | 5                | 2.0                        |
| 110.5                  | $\pm 0.4$  | 99                 | 1                | 2.0                        |

Remarks 1. The temperature difference between each reagent to be used for preparation shall be within 3 °C.

Remarks 2. Tetraethyl lead is toxic and therefore for its handling sufficient safety countermeasures shall be taken according to Ordinance on Prevention of Tetraalkyl Lead Poisoning.

5.1.5 Operating Conditions The operating conditions shall be as follows:

- (1) Number of Revolutions of Engine It shall be  $600 \pm 6$  revolutions per minute and the maximum variation during the test shall be not more than 6 revolutions per minute.
- (2) Ignition Timing The crank angle is at  $13.0^\circ\text{C}$  before upper dead point and is held always constant.
- (3) Clearance of Ignition Plug  $0.508 \pm 0.127$  mm
- (4) Clearance of Ignition Intermitting Device 0.508 mm
- (5) Clearance of Valve  $0.203 \pm 0.025$  mm

Remark: For measurement of suction valve and exhaust gas valve, after sufficient warming-up the engine, operate under specified conditions by using isooctane, and apply a specified clearance gage between the locker arm button and the valve rod tip to measure.

- (6) Lubricating Oil of Crank Chamber It shall be lando internal combustion engine lubricating oil No. 3 specified in JIS K 2215.
- (7) Pressure of Lubricating Oil The pressure during operation shall be 0.17 to 0.20 MPa  $\{1.8$  to  $2.1$  kgf/cm $^2$  $\}$ .
- (8) Temperature of Lubricating Oil The temperature shall be at  $57 \pm 8.5$  °C.

Remark: Measure with immersing completely the temperature sensitive part of temperature indicator into lubricating oil of crank chamber.

- (9) Temperature of Cooling Liquid It shall be at  $100 \pm 1.5$  °C and the temperature variation during the test, within 0.5 °C.
- (10) Humidity of Suction Air It shall be at 3.56 to 7.12 g H $_2$ O/kg dry air.

Remark: When an ice tower shown in Fig. 2 is used, the air humidity is in this range.

- (11) Temperature of Suction Air It shall be the atmospheric pressure correction temperature  $\pm 1.1^\circ\text{C}$ . Provided that the atmospheric pressure correction temperature shall be the temperature at carburetor inlet measured by means of a mercury-in thermometer and corrected relative to the standard atmospheric pressure according to Table 5.

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Table 5. Correction of Suction Air Temperature, Micrometer Indication and Digital Counter Indication Relative to Atmospheric Pressure

| Atmospheric pressure<br>kPa<br>{mmHg} | Suction air temperature<br>°C | Correction value of micrometer indication | Correction value of digital counter indication | Atmospheric pressure<br>kPa<br>{mmHg} | Suction air temperature<br>°C | Correction value of micrometer indication | Correction value of digital counter indication |
|---------------------------------------|-------------------------------|-------------------------------------------|------------------------------------------------|---------------------------------------|-------------------------------|-------------------------------------------|------------------------------------------------|
|---------------------------------------|-------------------------------|-------------------------------------------|------------------------------------------------|---------------------------------------|-------------------------------|-------------------------------------------|------------------------------------------------|

For obtaining set value of compression ratio, the following correction value shall be subtracted from or added to the value of Table 7 and Table 8.

|  |  |            |       |  |  |       |            |
|--|--|------------|-------|--|--|-------|------------|
|  |  | subtracted | added |  |  | added | subtracted |
|--|--|------------|-------|--|--|-------|------------|

For obtaining compression ratio to be used in Table 7 and Table 8 in order to find approximate octane number the following correction value shall be added to or subtracted from the set value.

|            |      | added | subtracted |            |      | subtracted | added |
|------------|------|-------|------------|------------|------|------------|-------|
| 93.32{700} | 32.2 | 0.047 | 66         | 101.6{762} | 52.2 | 0.001      | 2     |
| 93.99{705} | 33.9 | 0.043 | 60         | 101.9{764} | 52.8 | 0.003      | 4     |
| 94.66{710} | 35.6 | 0.039 | 55         | 102.1{766} | 53.3 | 0.005      | 7     |
| 95.32{715} | 37.2 | 0.035 | 49         | 102.4{768} | 53.9 | 0.007      | 9     |
| 95.39{720} | 38.9 | 0.031 | 44         | 102.7{770} | 54.4 | 0.008      | 11    |
| 96.66{725} | 40.6 | 0.027 | 39         | 102.9{772} | 55.6 | 0.010      | 13    |
| 97.32{730} | 42.2 | 0.023 | 33         | 103.2{774} | 56.1 | 0.011      | 15    |
| 97.99{735} | 43.3 | 0.019 | 28         | 103.5{776} | 56.7 | 0.013      | 17    |
| 98.66{740} | 45.0 | 0.015 | 22         | 103.7{778} | 57.2 | 0.015      | 20    |
| 98.92{742} | 45.6 | 0.014 | 20         | 104.0{780} | 57.8 | 0.016      | 22    |
| 99.19{744} | 46.7 | 0.012 | 17         | 104.3{782} | 58.9 | 0.018      | 25    |
| 99.46{746} | 47.2 | 0.011 | 16         | 104.5{784} | 59.4 | 0.019      | 26    |
| 99.72{748} | 47.8 | 0.009 | 13         |            |      |            |       |
| 99.99{750} | 48.3 | 0.007 | 11         |            |      |            |       |
| 100.3{752} | 48.9 | 0.006 | 9          |            |      |            |       |
| 100.5{754} | 50.0 | 0.004 | 6          |            |      |            |       |
| 100.8{756} | 50.6 | 0.003 | 4          |            |      |            |       |
| 101.1{758} | 51.1 | 0.001 | 2          |            |      |            |       |

(12) Carbureter Venturi, Throat Opening Diameter 14.29 mm

(13) Metering Jet For maintaining the fuel oil level within the specified range, dependent upon the type of suction air tube, the metering jet shown in Table 6 shall be used.

Table 6. Metering Jet

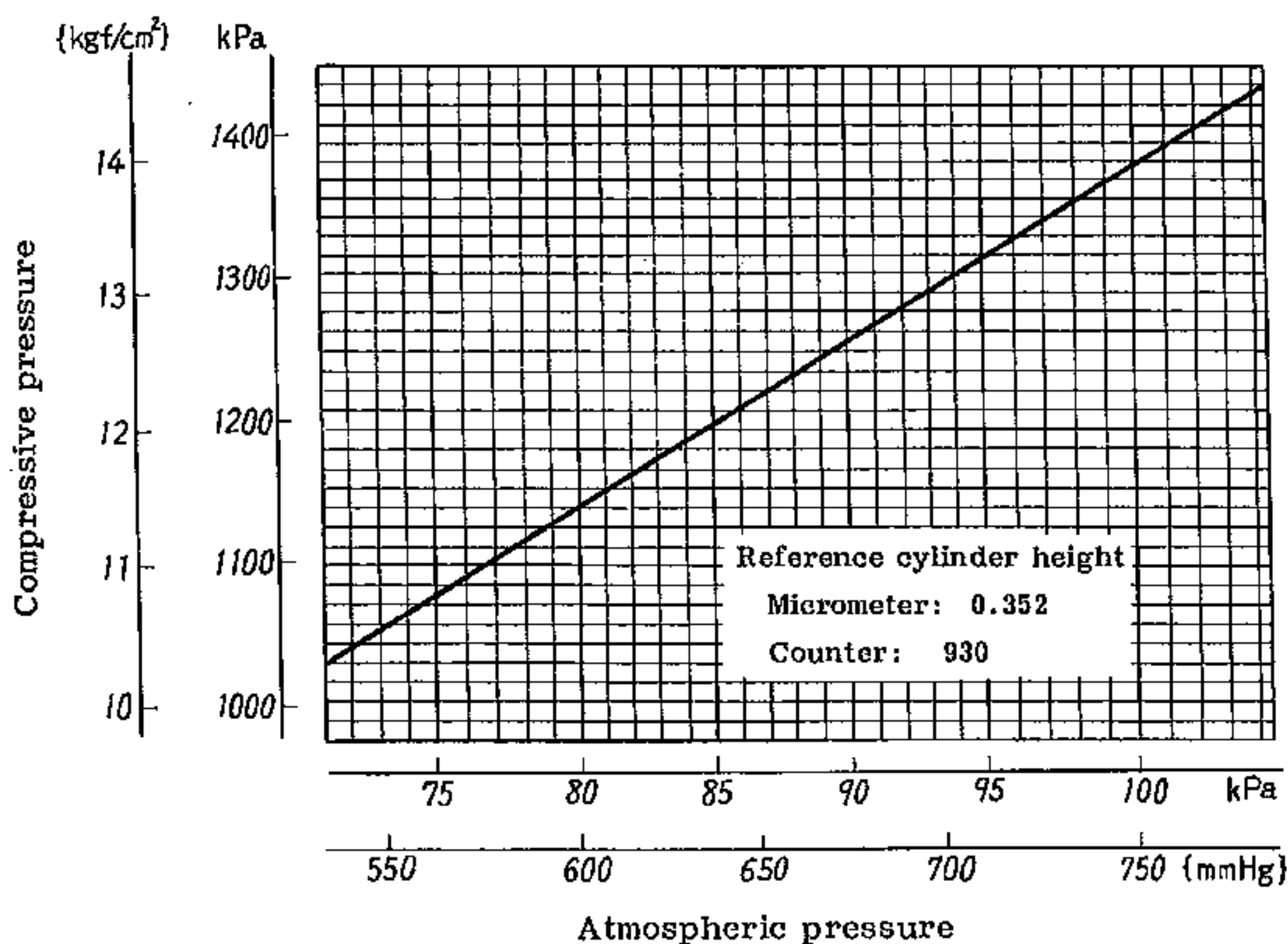
| Suction air tube | Straight tube | Bend tube |
|------------------|---------------|-----------|
| Metering jet No. | 72            | 86        |

(14) Setting of Reference Cylinder Height

- (a) When maintaining temperature of each part of engine at specified operating condition, and at the same time the suction air temperature has reached specified temperature  $\pm 1.1^{\circ}\text{C}$  corresponding to atmospheric pressure correction in Table 5, stop the engine and quickly attach a CFR compression manometer to the pick-up hole.
- (b) Stop the fuel, and rotate the engine without igniting. Regulate the cylinder height so that it corresponds to the compressive pressure shown in Fig. 5.

Remark: In the case of the one with atmospheric pressure correcting device, regardless of the atmospheric pressure at the test time, regulate so that the compressive pressure becomes the value corresponding to 101.3 kPa {760 mmHg}.

Fig. 5. Compressive Pressure to Atmospheric Pressure in Setting Reference Cylinder Height by Means of Micrometer or Digital Counter



- (c) After completion of regulation, regulate the indicator to the following indication without changing cylinder height:

Micrometer indication 0.352

Digital counter indication 930

- (15) Fuel-Air Ratio For sample and normal standard fuel, while adjusting the fuel oil level of carburetor so as to attain the highest knock strength, regulate the fuel-air ratio. The fuel oil level indicating the highest knock strength shall be in the range of 0.7 to 1.7 of oil-level meter.

Remark: In case where the reading of oil-level meter at the time of giving the highest knock-meter indication does not come into this range, the horizontal metering jet (at near the bottom part of sight glass) shall be exchanged with one having other dimension. In the case where the fuel-oil level is too high, the metering jet of larger diameter shall be used, and where the fuel-oil level is too low, the metering jet of smaller diameter.

- (16) Standard Knock Strength Independent of octane number and atmospheric pressure, all measurements of knock shall be carried out at an approximately definite knock strength. This definite knock strength is defined as the standard knock strength. With operating until the temperature of each part of engine becomes constant within the specified temperatures, it shall be regulated to the standard knock strength as follows:

- (a) Prepare the normal standard fuel having the octane number of the same degree as that of sample or fuel for checking and put it into one of fuel tanks of carburetor. When pouring into the fuel tank, at first leave the drain valve opened for a short time, wash the fuel tank and passage. Even after filling in the sight glass, in order to discharge bubbles remaining in the fuel system, instantly open the drain valve to draw out the fuel.

Next, turn the switching valve (⑤ of Fig. 3) to feed the fuel from the above-mentioned tank to engine.

- (b) Obtain the micrometer indication or digital counter indication relative to the octane number of used normal standard fuel according to Table 7 or Table 8. Correct this value by indication correction value in Table 5, relative to the atmospheric pressure at the time of testing, and regulate the cylinder height.

Further, regulate the suction air temperature to the value corresponding to the atmospheric pressure at the time of testing according to Table 5.

Table 7. Setting of Micrometer Indication to Standard Knock Strength

| Research octane number | 0.0   | 0.1   | 0.2   | 0.3   | 0.4   | 0.5   | 0.6   | 0.7   | 0.8   | 0.9   | Research octane number |
|------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------------------------|
| Micrometer indication  |       |       |       |       |       |       |       |       |       |       |                        |
| 40                     | 0.759 | 0.759 | 0.759 | 0.759 | 0.758 | 0.758 | 0.758 | 0.758 | 0.757 | 0.757 | 40                     |
| 41                     | 0.757 | 0.756 | 0.756 | 0.756 | 0.756 | 0.755 | 0.755 | 0.755 | 0.755 | 0.754 | 41                     |
| 42                     | 0.754 | 0.754 | 0.753 | 0.753 | 0.753 | 0.753 | 0.752 | 0.752 | 0.752 | 0.751 | 42                     |
| 43                     | 0.751 | 0.751 | 0.750 | 0.750 | 0.750 | 0.749 | 0.749 | 0.749 | 0.748 | 0.748 | 43                     |
| 44                     | 0.748 | 0.747 | 0.747 | 0.747 | 0.747 | 0.746 | 0.746 | 0.746 | 0.745 | 0.745 | 44                     |
| 45                     | 0.745 | 0.744 | 0.744 | 0.744 | 0.743 | 0.743 | 0.743 | 0.742 | 0.742 | 0.742 | 45                     |
| 46                     | 0.741 | 0.741 | 0.741 | 0.740 | 0.740 | 0.740 | 0.739 | 0.739 | 0.739 | 0.738 | 46                     |
| 47                     | 0.738 | 0.738 | 0.737 | 0.737 | 0.737 | 0.736 | 0.736 | 0.736 | 0.735 | 0.735 | 47                     |
| 48                     | 0.735 | 0.734 | 0.734 | 0.733 | 0.733 | 0.733 | 0.732 | 0.732 | 0.732 | 0.731 | 48                     |
| 49                     | 0.731 | 0.731 | 0.730 | 0.730 | 0.729 | 0.729 | 0.729 | 0.728 | 0.728 | 0.728 | 49                     |
| 50                     | 0.727 | 0.727 | 0.727 | 0.726 | 0.726 | 0.725 | 0.725 | 0.725 | 0.724 | 0.724 | 50                     |
| 51                     | 0.724 | 0.723 | 0.723 | 0.723 | 0.722 | 0.722 | 0.721 | 0.721 | 0.721 | 0.720 | 51                     |
| 52                     | 0.720 | 0.720 | 0.719 | 0.719 | 0.718 | 0.718 | 0.718 | 0.717 | 0.717 | 0.717 | 52                     |
| 53                     | 0.716 | 0.716 | 0.715 | 0.715 | 0.715 | 0.714 | 0.714 | 0.713 | 0.713 | 0.713 | 53                     |
| 54                     | 0.712 | 0.712 | 0.711 | 0.711 | 0.711 | 0.710 | 0.710 | 0.710 | 0.709 | 0.709 | 54                     |
| 55                     | 0.708 | 0.708 | 0.707 | 0.707 | 0.707 | 0.706 | 0.706 | 0.705 | 0.705 | 0.705 | 55                     |
| 56                     | 0.704 | 0.704 | 0.703 | 0.703 | 0.703 | 0.702 | 0.702 | 0.702 | 0.701 | 0.701 | 56                     |
| 57                     | 0.700 | 0.700 | 0.699 | 0.699 | 0.699 | 0.698 | 0.698 | 0.697 | 0.697 | 0.697 | 57                     |
| 58                     | 0.696 | 0.696 | 0.695 | 0.695 | 0.695 | 0.694 | 0.694 | 0.693 | 0.693 | 0.692 | 58                     |
| 59                     | 0.692 | 0.692 | 0.691 | 0.691 | 0.690 | 0.690 | 0.689 | 0.689 | 0.689 | 0.688 | 59                     |
| 60                     | 0.688 | 0.687 | 0.687 | 0.687 | 0.686 | 0.686 | 0.685 | 0.685 | 0.684 | 0.684 | 60                     |
| 61                     | 0.683 | 0.683 | 0.682 | 0.682 | 0.681 | 0.681 | 0.681 | 0.680 | 0.680 | 0.679 | 61                     |
| 62                     | 0.679 | 0.678 | 0.678 | 0.677 | 0.677 | 0.677 | 0.676 | 0.676 | 0.675 | 0.675 | 62                     |
| 63                     | 0.674 | 0.674 | 0.673 | 0.673 | 0.673 | 0.672 | 0.672 | 0.671 | 0.671 | 0.671 | 63                     |
| 64                     | 0.670 | 0.670 | 0.669 | 0.669 | 0.668 | 0.668 | 0.667 | 0.667 | 0.666 | 0.666 | 64                     |
| 65                     | 0.666 | 0.665 | 0.665 | 0.664 | 0.664 | 0.663 | 0.663 | 0.662 | 0.662 | 0.661 | 65                     |
| 66                     | 0.661 | 0.660 | 0.660 | 0.659 | 0.659 | 0.658 | 0.658 | 0.657 | 0.657 | 0.656 | 66                     |
| 67                     | 0.656 | 0.655 | 0.655 | 0.654 | 0.654 | 0.653 | 0.653 | 0.652 | 0.652 | 0.651 | 67                     |
| 68                     | 0.651 | 0.650 | 0.650 | 0.649 | 0.649 | 0.648 | 0.648 | 0.647 | 0.647 | 0.647 | 68                     |
| 69                     | 0.646 | 0.645 | 0.645 | 0.645 | 0.644 | 0.644 | 0.643 | 0.643 | 0.642 | 0.642 | 69                     |
| 70                     | 0.641 | 0.641 | 0.640 | 0.640 | 0.639 | 0.639 | 0.638 | 0.638 | 0.637 | 0.637 | 70                     |
| 71                     | 0.636 | 0.636 | 0.635 | 0.635 | 0.634 | 0.634 | 0.633 | 0.633 | 0.632 | 0.632 | 71                     |
| 72                     | 0.631 | 0.631 | 0.630 | 0.630 | 0.629 | 0.629 | 0.628 | 0.627 | 0.627 | 0.626 | 72                     |
| 73                     | 0.626 | 0.625 | 0.625 | 0.624 | 0.623 | 0.623 | 0.622 | 0.622 | 0.621 | 0.621 | 73                     |
| 74                     | 0.620 | 0.619 | 0.619 | 0.618 | 0.618 | 0.617 | 0.616 | 0.616 | 0.615 | 0.615 | 74                     |
| 75                     | 0.614 | 0.613 | 0.613 | 0.612 | 0.611 | 0.611 | 0.610 | 0.610 | 0.609 | 0.609 | 75                     |
| 76                     | 0.608 | 0.607 | 0.606 | 0.606 | 0.605 | 0.605 | 0.604 | 0.603 | 0.602 | 0.602 | 76                     |
| 77                     | 0.601 | 0.600 | 0.600 | 0.599 | 0.598 | 0.598 | 0.597 | 0.596 | 0.596 | 0.595 | 77                     |
| 78                     | 0.594 | 0.594 | 0.593 | 0.592 | 0.592 | 0.591 | 0.590 | 0.590 | 0.589 | 0.588 | 78                     |
| 79                     | 0.587 | 0.587 | 0.586 | 0.585 | 0.584 | 0.584 | 0.583 | 0.582 | 0.581 | 0.581 | 79                     |
| 80                     | 0.580 | 0.579 | 0.578 | 0.578 | 0.577 | 0.576 | 0.576 | 0.575 | 0.574 | 0.574 | 80                     |
| 81                     | 0.573 | 0.572 | 0.571 | 0.571 | 0.570 | 0.570 | 0.569 | 0.568 | 0.567 | 0.567 | 81                     |
| 82                     | 0.566 | 0.565 | 0.564 | 0.564 | 0.563 | 0.562 | 0.562 | 0.561 | 0.560 | 0.559 | 82                     |
| 83                     | 0.558 | 0.558 | 0.557 | 0.556 | 0.555 | 0.555 | 0.554 | 0.553 | 0.552 | 0.552 | 83                     |
| 84                     | 0.551 | 0.550 | 0.549 | 0.549 | 0.548 | 0.547 | 0.546 | 0.546 | 0.545 | 0.544 | 84                     |
| 85                     | 0.543 | 0.542 | 0.541 | 0.540 | 0.539 | 0.539 | 0.538 | 0.537 | 0.536 | 0.535 | 85                     |
| 86                     | 0.534 | 0.534 | 0.533 | 0.532 | 0.531 | 0.530 | 0.529 | 0.528 | 0.527 | 0.527 | 86                     |
| 87                     | 0.526 | 0.525 | 0.524 | 0.523 | 0.522 | 0.521 | 0.520 | 0.519 | 0.518 | 0.517 | 87                     |
| 88                     | 0.517 | 0.516 | 0.515 | 0.514 | 0.513 | 0.512 | 0.511 | 0.510 | 0.509 | 0.508 | 88                     |
| 89                     | 0.507 | 0.506 | 0.505 | 0.504 | 0.503 | 0.502 | 0.501 | 0.500 | 0.499 | 0.498 | 89                     |

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Table 7. (Continued)

| Research octane number | 0.0   | 0.1   | 0.2   | 0.3   | 0.4   | 0.5   | 0.6   | 0.7   | 0.8   | 0.9   | Research octane number |
|------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------------------------|
| Micrometer indication  |       |       |       |       |       |       |       |       |       |       |                        |
| 90                     | 0.497 | 0.496 | 0.495 | 0.494 | 0.493 | 0.492 | 0.491 | 0.490 | 0.489 | 0.488 | 90                     |
| 91                     | 0.487 | 0.486 | 0.485 | 0.484 | 0.483 | 0.482 | 0.481 | 0.480 | 0.479 | 0.478 | 91                     |
| 92                     | 0.476 | 0.475 | 0.474 | 0.473 | 0.472 | 0.471 | 0.470 | 0.469 | 0.468 | 0.467 | 92                     |
| 93                     | 0.466 | 0.464 | 0.463 | 0.462 | 0.460 | 0.459 | 0.458 | 0.457 | 0.456 | 0.455 | 93                     |
| 94                     | 0.454 | 0.452 | 0.451 | 0.450 | 0.448 | 0.447 | 0.446 | 0.444 | 0.443 | 0.442 | 94                     |
| 95                     | 0.441 | 0.440 | 0.438 | 0.437 | 0.436 | 0.434 | 0.433 | 0.431 | 0.430 | 0.429 | 95                     |
| 96                     | 0.427 | 0.426 | 0.424 | 0.423 | 0.422 | 0.420 | 0.418 | 0.417 | 0.416 | 0.414 | 96                     |
| 97                     | 0.413 | 0.411 | 0.410 | 0.408 | 0.406 | 0.405 | 0.403 | 0.402 | 0.400 | 0.399 | 97                     |
| 98                     | 0.397 | 0.395 | 0.393 | 0.392 | 0.390 | 0.388 | 0.386 | 0.384 | 0.382 | 0.380 | 98                     |
| 99                     | 0.379 | 0.377 | 0.375 | 0.374 | 0.372 | 0.369 | 0.367 | 0.365 | 0.363 | 0.362 | 99                     |
| 100                    | 0.360 | 0.357 | 0.356 | 0.354 | 0.351 | 0.348 | 0.346 | 0.345 | 0.342 | 0.339 | 100                    |
| 101                    | 0.338 | 0.336 | 0.333 | 0.331 | 0.328 | 0.326 | 0.325 | 0.322 | 0.320 | 0.317 | 101                    |
| 102                    | 0.315 | 0.313 | 0.312 | 0.310 | 0.307 | 0.305 | 0.303 | 0.301 | 0.299 | 0.297 | 102                    |
| 103                    | 0.295 | 0.293 | 0.291 | 0.289 | 0.287 | 0.285 | 0.283 | 0.281 | 0.279 | 0.277 | 103                    |
| 104                    | 0.275 | 0.273 | 0.272 | 0.271 | 0.269 | 0.267 | 0.266 | 0.264 | 0.262 | 0.261 | 104                    |
| 105                    | 0.259 | 0.258 | 0.257 | 0.255 | 0.253 | 0.251 | 0.250 | 0.249 | 0.247 | 0.246 | 105                    |
| 106                    | 0.245 | 0.243 | 0.242 | 0.241 | 0.239 | 0.238 | 0.237 | 0.236 | 0.234 | 0.233 | 106                    |
| 107                    | 0.232 | 0.231 | 0.230 | 0.229 | 0.228 | 0.227 | 0.225 | 0.224 | 0.223 | 0.222 | 107                    |
| 108                    | 0.221 | 0.220 | 0.219 | 0.218 | 0.217 | 0.216 | 0.215 | 0.214 | 0.213 | 0.212 | 108                    |
| 109                    | 0.210 | 0.209 | 0.208 | 0.207 | 0.206 | 0.205 | 0.204 | 0.203 | 0.202 | 0.202 | 109                    |
| 110                    | 0.200 | 0.199 | 0.198 | 0.198 | 0.197 | 0.196 | 0.195 | 0.194 | 0.193 | 0.192 | 110                    |
| 111                    | 0.191 | 0.190 | 0.189 | 0.188 | 0.187 | 0.186 | 0.185 | 0.184 | 0.184 | 0.183 | 111                    |
| 112                    | 0.182 | 0.181 | 0.180 | 0.179 | 0.178 | 0.177 | 0.176 | 0.175 | 0.174 | 0.173 | 112                    |
| 113                    | 0.172 | 0.171 | 0.171 | 0.170 | 0.169 | 0.169 | 0.167 | 0.166 | 0.165 | 0.164 | 113                    |
| 114                    | 0.163 | 0.163 | 0.162 | 0.161 | 0.160 | 0.159 | 0.158 | 0.157 | 0.156 | 0.155 | 114                    |
| 115                    | 0.155 | 0.154 | 0.153 | 0.152 | 0.151 | 0.150 | 0.148 | 0.147 | 0.146 | 0.145 | 115                    |
| 116                    | 0.144 | 0.143 | 0.142 | 0.141 | 0.140 | 0.138 | 0.137 | 0.136 | 0.135 | 0.134 | 116                    |
| 117                    | 0.133 | 0.132 | 0.131 | 0.130 | 0.129 | 0.128 | 0.126 | 0.125 | 0.124 | 0.123 | 117                    |
| 118                    | 0.122 | 0.121 | 0.120 | 0.119 | 0.118 | 0.117 | 0.115 | 0.114 | 0.113 | 0.112 | 118                    |
| 119                    | 0.111 | 0.110 | 0.109 | 0.108 | 0.107 | 0.106 | 0.104 | 0.103 | 0.102 | 0.101 | 119                    |
| 120                    | 0.100 | 0.099 | 0.098 | 0.097 | —     | —     | —     | —     | —     | —     | 120                    |