

OSAKA VACUUM, LTD.



HEAD OFFICE ☒ 6th Floor, Keihan-Yodoyabashi
Building, 6, Kitahama 3-chome, Higashi-ku
Osaka 541, Japan ☎06-2033981
☐ 5222885 OSKVACJ

*Please return to Mark
Bier*

INSTRUCTION MANUAL
FOR
TURBO-MOLECULAR PUMPS,
MODELS TH300 & TH520

OSAKA VACUUM, LTD.

J A P A N



CONTENTS

	<u>Page</u>
1. General	1
1.1 Standard structure of Turbo-Molecular Pump and its basic principle of evacuation	1
1.2 General features of TMP	1
1.3 Warranty	2
2. Construction · Specification of TMP	2
2.1 Construction of TMP	2
2.2 Naming code of TMP	2
2.3 Specifications of TMP	2
3. Selection fo Forepump	2
4. Preparatory Arrangement	3
4.1 Transfer of TMP	3
4.2 Installation of TMP	3
4.3 Vacuum piping	3
4.4 Connection of TMP to Power Supply Unit	4
4.5 Protective circuits	5
4.6 Cooling water piping for water-cooled type TMP	5
4.7 Room temperature, ventilation, etc. for air-cooled type TMP	6
5. Operation of TMP	6
5.1 Lubricating oil	6
5.2 Cooling water for water-cooled type TMP	6
5.3 Roughing and start-up of TMP	6
5.4 Start-up of TMP	7
5.5 Degassing	7
5.6 Shut-down of TMP	7
6. Emergency Measures	8
6.1 Suspension of electric service	8
6.2 Rapid pressure increase or inclusion of foreign matter	8
7. Maintenance of TMP	9
7.1 Abnormality in inlet pressure	9
7.2 Pump oil problem	9
7.3 Vibration	9
7.4 Atmospheric inrush	9
Table 1 Design Specifications of Turbo-Molecular Pump	10
Table 2 List of Accessories of Turbo-Molecular Pump	11
Table 3 Level Control of Lubricating Oil	12
General Terms of Warranty	
Dwg #R4-04737E Sectional drawing of Turbo-Molecular Pump, TH520	
Dwg #R4-04486E Conceptual drawing of lubricating system	



INSTRUCTION MANUAL
FOR
TURBO-MOLECULAR PUMPS,
MODELS: TH300 & TH520

1. General

1.1 Standard structure of Turbo-molecular pump and its basic principle of evacuation

As regards the standard structure of the turbo-molecular pump (hereinafter abbreviated as 'TMP') and its basic principle of evacuation, please refer to the 'Technical Information Bulletin HT001 for Turbo-molecular Pump' herewith accompanied.

1.2 General features of TMP

Some of the important advantages of the TMP are as set forth below:

- 1) While a TMP is in operation, there will be occurred no hydrocarbon backstreaming, which frees the pump inlet from the danger of contamination by oil vapor.
- 2) Rare gases can be pumped out as easily as other common gases can be.
- 3) As is not a gas entrapment pump, the TMP is never subject to the influence of previously pumped gases.
- 4) With sudden atmospheric inrush, working pressure may be temporarily increased and rotational speed may fall, but so far as intruded gas is small in quantity, both will soon recover to normal.

Incidentally, in order to protect the rapidly rotating blades against being damaged by broken fragments of gauge probes or unfastened bolts, nuts or washers, etc., a protection screen is equipped at the pump inlet.

This danger, however, can be averted by not installing a TMP right beneath the opening of the chamber to be evacuated.

- 5) The TMP can be started-up from atmospheric pressure.
- 6) Intaken gas will not be ionized.
- 7) Bypass for roughing is usually unnecessary.

Note: During normal operation, back pressure must be 15 Pa or less.



1.3 Warranty

Osaka Vacuum warrants the quality of the TMP and its accessories in accordance with the conditions of warranty stated in the 'General Terms of Warranty' herein attached. This warranty, however, is not applicable to any handling of the TMP deviated from the operation and maintenance procedure stated in this manual as proper.

Further, this warranty is never given to any cases where the pump is used under special conditions without the approval of the company.

2. Construction · Specification of TMP

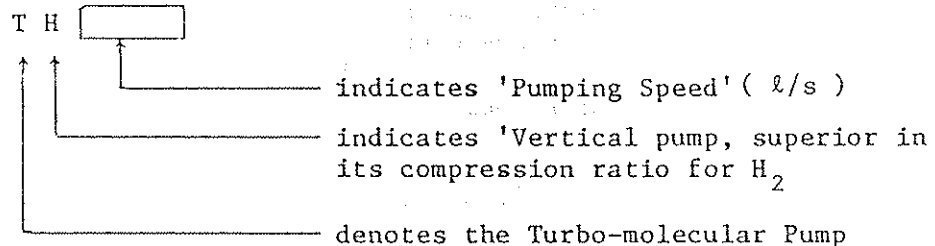
2.1 Construction of TMP

The TMP, as is shown in Fig.1, incorporates an induction motor on its forevacuum side.

The motor requires a power supply unit for its high-speed rotation at the frequency higher than that of commercial power source.

The TMP also needs a forepump for its operation.

2.2 Naming code of TMP



2.3 Specifications of TMP

For the specifications of the TMP, see the attached table #1.

Osaka Vacuum stands ready to help the user of the TMP select its correct model and necessary component parts or modifications to match his most exacting requirements. The engineers of the company will recommend the proper equipment to meet his tailored needs.

3. Selection of Forepump

For selecting a suitable forepump, see the 'Technical Information Bulletin HT001 for Turbo-molecular Pump' herewith accompanied.



4. Preparatory Arrangement

4.1 Transfer of TMP

Note that while a TMP charged with lubricating oil is being transferred, its maximum allowable inclination is 20° from vertical.

Even when a TMP is to be stored with the oil in the sump being emptied, it must not be tilted at more than 45° from vertical.

4.2 Installation of TMP

For installing a TMP, select a strong foundation horizontal with its inclination angle of less than 10° from vertical.

It is necessary to have some space for electric wiring and for piping installation for cooling water.

For a TMP which is integrated with an operation panel, there should be enough room for panel operation.

4.3 Vacuum piping

(1) Inlet side piping

The pipeline to be connected with the chamber to be evacuated shall be made of stainless steel pipe or aluminum alloy.

a. Inlet side piping shall be designed under full contemplation on pipe conductance.

b. Total leakage at the inlet side piping and the chamber shall be minimized to the utmost limit. Oily surface inside the pipeline must be thoroughly cleaned to decrease outgassing rate.

c. Though TMP vibration is very slight, insert a stainless steel bellows coupling between the pump and the chamber in the case where vibration is absolutely impermissible to the chamber. If the chamber itself cause resonance with pumping vibration, remove the TMP-installed frame from the chamber using a bellows coupling, or take some measure to change the specific vibration of the chamber itself.

d. It is recommendable to provide the pipeline or the chamber with a high-vacuum leak valve with the leakage rate of 10^{-10} Pam³/s when it closes.



(2) Forevacuum Piping

For forevacuum piping, use such pipe as of NB25 - 50mm, made of stainless steel pipe, vacuum-resisting rubber hose, flexible tube, or vacuum-resisting vinyl hose.

- a. Unnecessary longer piping must be avoided.
- b. Gasket material must be synthetic rubber.
- c. Devices to be installed at the forevacuum piping are a NB25 - 50 mm manually- or automatically-operated vacuum valve and a gauge adaptor which will be serviceable for testing. The valve is unnecessary when an oil rotary vacuum pump with a valve incorporated is employed as forepump.

(3) Relationship of TMP to Forepump

Install a forepump independently or by using a rubber mount to arrest vibration so as not to be transmitted to the TMP.

4.4 Connection of TMP to Power Supply Unit

Connect the TMP to its applicable power supply unit using a vinyl-insulated-vinyl-sheathed motor cable provided.

For the air-cooled type TMP, connect its fan to the power supply unit using a fan cable, while for the water-cooled type, the fan-cable connector of the power supply must be covered with a blind plug.

If U, V and W phases are indistinguishable after the motor cable being modified by the user, check the TMP's rotational direction. Start-up the TMP at atmospheric pressure for several seconds, and confirm that the pump rotation is clockwise when viewed at from above.

If not, interchange any two leads within the motor cable between the power supply unit and the TMP from among red, white and black leads.

The green and yellow leads are for the thermal protector incorporated in the TMP. When the internal temperature of the TMP increases, the thermal protector will open to turn the power supply off.



4.5 Protective circuits

In order to keep this high-speed rotating machine for oil-free evacuation in good operating condition, it is necessary to provide the pump with such protective circuits as below:

- 1) For the water-cooled type TMP, the protective circuit to automatically shut down the pump when circulating water becomes smaller in amount than specified or when its supply is suspended.
- 2) For both air-cooled and water-cooled type TMP's, in the case of failure of electric supply, the protective circuit not to allow the pump to automatically resume its operation after the power is restored.

4.6 Cooling water piping for water-cooled type TMP

Install cooling water piping to the cooling water inlet and outlet of the TMP. No distinction need be made between inlet and outlet. For the piping, note the following points.

- 1) $\phi 8$ O.D. nipples are provided at the cooling water connection of a TMP. When these nipples are removed, the aperture sockets can accept PF 1/4" male screws.
- 2) Interpose a flowswitch in the midway of cooling water outlet pipeline to let the pump shut down its operation in case of insufficient flux or suspension of supply of cooling water. Never use a pressure switch in place of a flowswitch. Flowswitches are easily procurable on the market. The leading suppliers in Japan, for your information, are Nihon Seiki, Ltd. (Model BN86E) and Yamatake Honeywell Co. (FSI-F).
- 3) Water pressure shall be less than $5 \text{ kg/cm}^2\text{G}$. Use cooling water as clean as possible so that incrustation generated inside the water pipeline may not narrow its flowing passage, though the design affords plenty of area to it. If any foreign matter block that passage, switch the inlet to outlet, and the passage may be restored to the former state. The maximum pressure loss within the TMP is $0.1 \text{ kg/cm}^2\text{G}$.
- 4) Use cooling water of its outlet temperature of 35°C or lower. The water difference between inlet and outlet, though it depends on its flowrate, will be 5°C or lower. Take pertinent anti-freezing measures when required.



- 4.7 Room temperature, ventilation, etc. (for air-cooled type)
Heat will be released by the fins and fan provided at the lower part of the oil sump.

Note the following points while the pump is operating:

- 1) Ambient temperature during operation shall not exceed 32°C.
- 2) Ventilation around the fins and fan shall not be impeded.

5. Operation of TMP

5.1 Lubricating Oil

Please refer to Fig.2 for the TMP oil circulation mechanism.

The mechanism is of simple construction without any special oil pumps. However, oil level, since its control is necessary for oil circulation, shall be periodically checked.

The following points shall be noted in changing lubricating oil:

- 1) Use lubricating oil specified by the company. If any other oil is used, the company's warranty will be invalid.

Note: Oil is specified to each model of the TMP's.

- 2) Inclusion of such foreign matter as dust and metallic powder, etc. in the lubricating oil will shorten service life of bearings. Special attention shall be given to prevent such inclusion.

- 3) See table #3 for amount of oil required.

5.2 Cooling water for the water-cooled type TMP

Never fail to circulate cooling water.

5.3 Roughing and start-up of TMP

1) The TMP with no valve at its inlet

- a. The TMP can be started-up simultaneously with the backing pump (= forepump) when the pressure in the chamber to be evacuated can be pumped down to about 20Pa within 10 minutes.
- b. When the chamber is larger, start-up the backing pump first, and after the chamber pressure reduces to 100Pa or less, start-up the TMP. A vacuum gauge shall be installed on the TMP forevacuum line.

2) For the TMP provided with a valve at its inlet and having another roughing pump separately,

it can be started-up simultaneously with the backing pump.



5.3 Roughing and start-up of TMP - Continued

3) The TMP having an inlet valve but no another roughing pump

- a. When the pressure in the chamber to be evacuated can be reduced down to about 20 Pa within 10 minutes, start up the backing pump first and then open the inlet valve and start up the TMP.
- b. When the chamber is larger, start up the backing pump first, and then open the inlet valve, and after the chamber is pumped down to 100 Pa or less, start up the TMP.

On this occasion, a vacuum gauge must be furnished on the forevacuum line of the TMP.

5.4 Start-up of TMP

Start up the TMP in the following sequence:

- 1) A TMP can be started up and shut down by turning ON and OFF the switch furnished in the power supply unit.
- 2) Rotating speed will then increase, and when a few thousand r.p.m. is attained, lubricating oil will start circulating. See the attached table #3 for oil level variation.
- 3) 95% of the specified rotating speed or more will be reached in 10 to 15 minutes.

5.5 Degassing

The TMP should be degassed together with the chamber to be evacuated when working pressure is 10^{-5} Pa or less.

In degassing the TMP, only its inlet flange shall be heated, and the temperature there shall be maintained below 120°C.

The heater for degassing the inlet flange is available on request as an optional.

5.6 Shut-down of TMP

The TMP shall be shut down in the following manner:

- 1) Stop supplying electric power to the TMP
- 2) Close the forevacuum valve.
- 3) Shut down the backing pump.
- 4) For the water-cooled type TMP, stop circulating cooling water.

For the shut-down time, see the table #1.



5.6 Shut-down of TMP - Continued

The above-mentioned procedure is for maintaining the vacuum inside the TMP. When venting the TMP, introduce gas by degrees and maintain the pressure at 100Pa ~ 1000Pa.

Note: Cleanness of vacuum varies at the time of reoperation, depending on how a TMP is shut-down. The following step of procedure should be taken for the respective operational pressure.

10^{-4} ~ 10^{-5} Pa: Do not introduce or gradually introduce gas from the forevacuum side.

10^{-6} ~ 10^{-7} Pa: Introduce gas by degrees from the high-vacuum side.

Gas to be introduced: Dry air, N₂, or Ar, etc.

6. Emergency Measures

Pertinent measures shall be taken against unexpected occurrences.

6.1 Suspension of electric service

- 1) Immediately close the valve on the forevacuum line.
- 2) Take a proper step so as the TMP not to automatically reoperate after the power is restored.

6.2 Rapid pressure increase or inclusion of foreign matter

- 1) With rapid increase of pressure the TMP will be over-loaded to shut-down. Before reoperation, turn off the switch of the power supply unit to trace its origin. See the attached the 'Operation Manual for Power Supply'.
- 2) Inclusion of such foreign matter as broken fragments of glass, bolts, nuts or others from the inlet, is liable to damage the rotating blades of the TMP.

For Osaka Vacuum TMP, an inlet protection screen is equipped at its pump inlet, and expected decrease in pumping speed by the screen will be 10 ~ 1.7%.

- 3) For the water-cooled type TMP, when cooling water supply is suspended, promptly stop operating the power supply unit.



7. Maintenance

7.1 Abnormality in inlet pressure

The TMP pumping mechanism is very simple, and if the forevacuum pressure is 5Pa or less and the rotor is only rotating at its specified rpm, its evacuation efficiency will be stable.

Nevertheless, when any abnormal inlet pressure is detected, check the following points:

- 1) Check for any leakage in the chamber to be evacuated and the piping on the intake side, using a helium leak detector. When an ionization vacuum gauge is equipped on the inlet side, blow either suitable gas of propane or helium (with its sensitivity coefficient being much dissimilar to air) to the chamber and the piping. Abrupt changes in pressure, if happened, indicate the presence of leakage.
- 2) Check if the internal surface on the inlet side is contaminated.
- 3) Blank the TMP inlet with a stainless steel flange to measure ultimate pressure. If the TMP is normal, the pressure will be $10^{-4} \sim 10^{-5}$ Pa in 1 ~ 2 hours after the pump is started-up and if its flange is heated to degas at 120°C for about 8 hours, the pressure will be $10^{-6} \sim 10^{-7}$ Pa.

With due regard to the above-mentioned, if the TMP is still considered abnormal, contact the company without delay.

7.2 Pump oil problem

- 1) Periodically check during TMP operation that oil is filled up to the specified level on the oil level gauge. See table #3.
- 2) Exchange oil if any organic solvent or others mix in the lubricating oil.

7.3 Vibration

When excessive vibration is observed during operation at the specified rotation speed (e.g. horizontal half amplitude ($\frac{1}{2}P-P$) at center of the TMP is approx. 0.4μ , when the TMP is operated alone), please report to the company. Prolonged operation under such conditions will shorten service life of its bearings.

7.4 Atmospheric inrush

In most cases, even when air is admitted by misoperation during TMP operation, re-starting can be made. If not, contact with the company.



Table 1 Design Specifications of Turbo-molecular Pump

SPECIFICATION	MODEL	TH300	TH520
Pumping speed at 20°C:	N ₂	310ℓ/s	520ℓ/s
	H ₂	320 "	490 "
Ultimate pressure backed by	2-stage oil rotary pump	≤ 1 x 10 ⁻⁷ Pa	
	2-stage oil rotary pump + a Roots pump	≤ 5 x 10 ⁻⁸ Pa	
Permissible back pressure during continuous operation		5 Pa	
Maximum compression ratio:	H ₂	7.8 x 10 ³	
	He	1.0 x 10 ⁵	
	N ₂	> 1 x 10 ⁸	
Start-up time required when outlet pressure being 5 Pa or less		10 ~ 15 min	
Shut-down time required using electric brake by power supply unit		10 ~ 15 min	
Rotational speed		30000 rpm	24000 rpm
Motor output		200W	
Lubricating oil required		250 mℓ	230 mℓ
Cooling water required		≥ 1.5 ℓ/min	
Standard capacity of backing pump		150 ℓ/min	250 ℓ/min
Net weight - Pump only		26 kg	38 kg



Table 2 List of Accessories of Turbo-molecular pumps

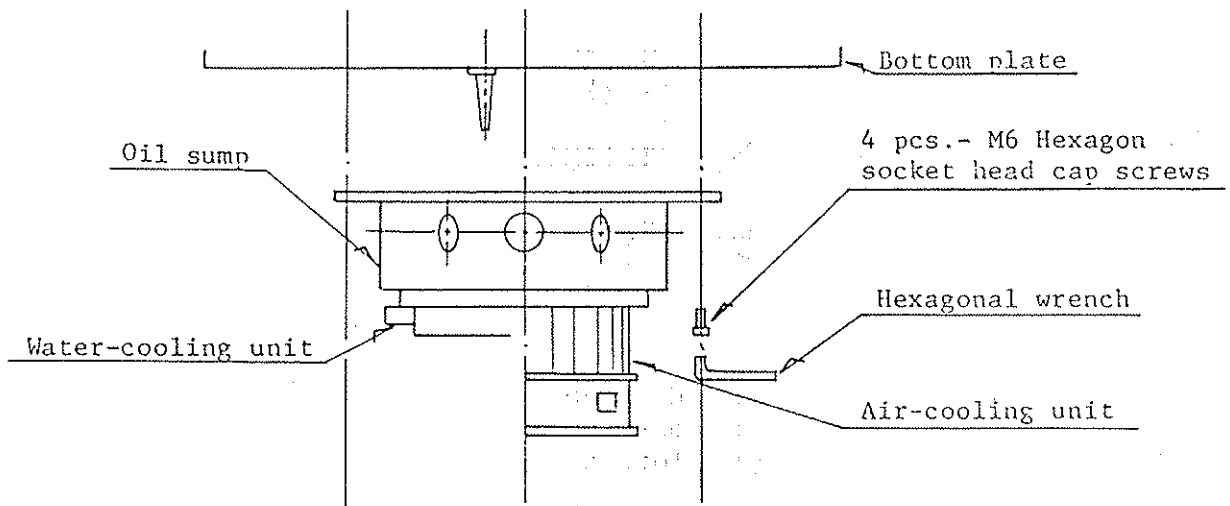
	<u>No. req'd</u>
[Standard Accessories]	
Power supply unit	1 unit
Motor cable, 3m long	1 pce.
Fan cable, 3m long for Air-cooled type TMP only	1 "
Inlet gasket VG: Viton O-ring	1 pce.
CF: Provisional O-ring	1 "
Inlet protection screen	1 "
Provisional inlet flange	1 "
Bolts & eyebolts for provisional flange	1 set
O-ring seat with O-ring for outlet	1 pce.
Blind flange for outlet	1 "
Clamp for outlet	1 "
Transportation leg	1 set
[Optional Accessories]	
Spare parts	
Degassing heater	
Input cable	
Flowswitch	
Others	



Table 3 Level Control of Lubricating Oil

	TH300	TH520
Oil amount req'd during operation	250 ml	230 ml
Oil amount to be replenished after TMP's shut-down for many hours	230 ml	210 ml
Oil level just after shut-down		
Oil level after long shut-down		
Oil level during operation		

Oil replenishment: Detach oil sump in the way illustrated below, and replenish oil as required.



Oil temperature: Approx. 30°C to 40°C, though depending on cooling water temperature for water-cooled type TMP, and on ambient temperature for air-cooled type.

Color phase of oil: Oil being fresh is colorless, but it will change to be light brown in about 100 hour operation.

Precaution: As oil is circulating during operation, oil level lowers, but as far as its deviation from the standard is ± 3 mm or so, there will be no trouble to be caused. During shut-down for many hours, the level rises by degrees. This is because oil incrustated on the upper horizontal surface flows downward. Therefore, it is not an abnormal condition.



GENERAL TERMS OF WARRANTY

Osaka Vacuum, Ltd. hereby guarantees that all product(s) delivered hereunder are in accordance with the specifications, terms and conditions of the contract and are free from all defects in design, materials, and workmanship. The period of warranty is one (1) year from the date of delivery. Should any part or parts of said product(s) prove defective during this period, we agree to repair or replace at our option such defective part(s) as we deem necessary to reduce losses to a minimum.

The warranty stated above is, however, applicable only if the product is properly used, in accordance with the instruction manual or other instructions furnished by us, and is not applicable to any problems,

- 1) Resulting from misuse, improper operation or negligence in maintenance;
- 2) In products repaired or modified by unauthorized persons;
- 3) Due to fire, flood, earthquake, lightning and/or other natural forces beyond the control.

Our liability shall be limited to alterations, repairs and/or replacement of defective part(s) and shall not include any damage or loss resulting from said defects. Our indemnity, whether based on warranty or otherwise, shall in no case exceed the price of the contracted product(s). Minor deviations from specifications, which do not affect performance of the product(s) covered hereby, shall not be deemed to constitute defects of materials, workmanship and/or failure to comply with the specifications referred to herein.

The foregoing warranty does not apply to rubber goods, bulbs and/or other consumable items. This warranty applies only to products stipulated in the specifications, terms and items of the contract. Nothing herein contained shall extend or be construed to extend the original warranty period of one year.

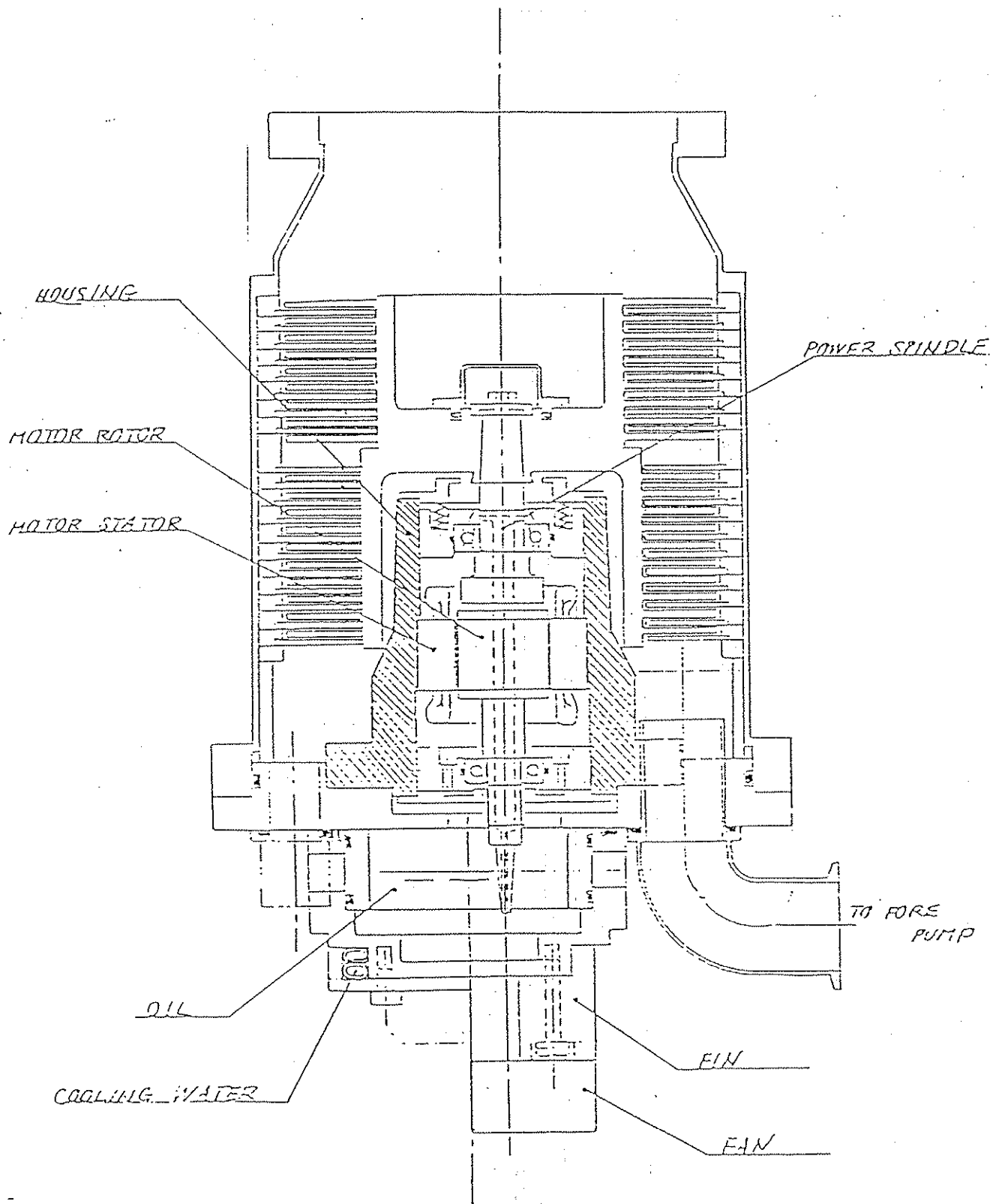


Fig. 1

NO.	DESCRIPTION	MATERIAL	QTY	DWG. NO.	REMARKS
①					TITLE
②					TH570
③	1/2" x 1/2" x 1/2"	S.S.	1		SECTIONAL DRAWING
④	1/2" x 1/2" x 1/2"	S.S.	1		
REV. NO.	DATE	DESCRIPTION	DRA	CHK	APP
CHECKED	APPROVED	DATE	SCALE		OSAKA VACUUM, LTD.
S. G. ...		1971.8.28	1:2.5		
DESIGNED	JOB NO.	NO. OF SET	DWG. NO.		REV.