ThreeBond
TECHNICAL NEWS

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Coating Devices of Liquid Materials and Applicators of Liquid Gaskets to Joint Surface

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Introduction

As the independent application of liquid gasket is popularized, the mechanization of its coating has been increasingly demanded from various sectors of industries.

The conventional liquid gaskets, which are applied in combination with solid gaskets as an auxiliary means, are mostly of low viscosity type, and hence, can readily be applied manually by using a simple tool such as brush, spatula or roller.

However, liquid gaskets to be used independently require sealing capacity and initial pressure resistance by extension of film, and are mostly of high viscosity type. It is extremely difficult to apply such liquid gaskets manually, resulting in poor productivity. Accordingly, it has been urgently desired in these days to develop an efficient coating device, in order to mechanize the liquid gasket coating process in the mass production line. Whereas the mechanization of other assembling processes has been markedly advanced, that in this field is much delayed. Since liquid gaskets involve a great number of varieties with respect to their applications, such as the organic solvent base, aqueous base, anaerobic base, and silicone base, it is necessary to design the coating device in full consideration of properties of these viscous fluids. Moreover, if types of gasket material, applications, characteristics of the production line and user's intention are taken into consideration, it is inevitable to implement the coating device in highly diversified forms, giving not a standardized one but a number of specialized devices. Because the manufacture of varied kinds of products in small quantities fails to promise a successful business, there are very few manufactures specialized in this field.

Even in the U.S.A., where F.I.P.Gs (formed-in-place gaskets) using silicone-based liquid gaskets alone have been produced from earlier, only a few specialized manufacturers are operating actively, and it seems unlikely that the devices developed by them can be smoothly adopted to the mass production line in Japan.

The scarecity in comprehensive manufacturers of coating devices seems to cause delay in the mechanization. However, cost saving and improved sealing properties associated with the independent application of liquid gasket provide irrestible attraction, and many gasket users are urgently demanding the development of coating devices.

THREE BOND, who has been studying the coating technologies for ten odd years as a specialized manufacturer of liquid gasket material, presents below an outline of coating method for joint surfaces, so as to be helpful to the users.

1. Types and Characteristics of Liquid Gaskets

"Characteristics" covers not all of available data but only those relevant to designing coating devices.

Table 1.

Characteristics \ Type		Volatile		Reactive	
		Organic solvent	Aqueous	Silicone	Anaerobic
Properties	Normal state	Viscous fluid	Viscous fluid	Paste	Paste
	Viscosity (c.p.s.)	2,000 – 10,000	2,000 – 20,000	50,000 – 300,000	40,000 – 200,000
Solidification	Causes	Evaporation of organic solvent	Evaporation of water	Reaction with humidity or moisture	Exclusion of oxygen
	Rate (after being left in air)	Film formed in 3 – 10 min.	Film formed in 5 – 10 min.	Film formed in 3 – 10 min.	Not solidified
Features	Feeding	Low viscosity, pneumatic, pressure tank	ditto.	High viscosity, high pressure pump,, cartridge tank	Non-fluidy, contact with metal prohibited, cartridge tank
	Materials of contacting liquid gasket	Neither dissolved nor corroded by organic solvent	Not corroded by water	Not permeable to water and air	Permeable to air
	Dissolution of solidified gasket	Possible with organic solvent	Impossible	ditto.	ditto.
	Precipitation	Present, in some products	Present	None	None
	Unhardened gasket cleaned by	Organic solvent	Water	Toluol	Organic solvent
	Abrasion of sliding part	Present in some products	None	Present in some products	None
Application Sites	Motorcycles	Lower case, head cylinder (in combination with solid gasket)		Cylinder head	Crank case
	Automobiles	Steering gear box, brake cover, transmission case		Oil pan, oil pump	Transmission case
	Others	Gas meter cover		Wash basin cabinet	Pump case

2. Classification and Features of Coating Devices

Liquid gasket may be applied to the joint surface either in point(s) or in line. Table 2 concerns the line application alone, because the point application may be regarded as a simplified form of the latter. Except for some special cases, the coating devices can be classified into three types given below.

Table 2.

Type	Tracing	Screening	Stamping
General	Gasket material fed from a reservoir through a tube is delivered from a nozzle in the form of string. The nozzle is driven along a joint surface by some means so as to make a line application.	Gasket material is placed on a screen of which area other than patterns to be coated is masked, and squeezed on to a joint surface set below the screen through the latter by means of a spatula-like tools (squeegee).	A box-shaped drum is rotated in a liquid reservoir to form a gasket material film of fixed thickness on its top surface. The film is transferred to a joint surface applied to the top.
Features	Applicable to three-dimensional face, all types of gasket material usable, coating amount readily adjustable, mountable on an automatic line	High coating speed, high dimensional accuracy of pattern to be coated, thin film coating possible, mountable on an automatic line	High coating speed, not limited by complicated geometry or width of area to be coated, thin film coating possible, good maintenability
Applicable gasket material	Solvent, aqueous, silicone, anaerobic	Anaerobic	Solvent, aqueous

Type of automatic coating device	Nozzle drive method provides four types 1. Template type 2. Photoelectric tube type 3. Computer type 4. Disk type	Automatic driving of squeegee	Manual transfer with joint surface held by hand required. Semiautomatic
Types of manual coating device	Hand-gun adapted to joint surface is driven manually. 1. Cartridge gun (Photo 1) 2. Cartridge tank with flow gun (Photo 2) 3. Pressure tank with pencil gun (Photo 3) 4. High pressure pump with flow gun (Photo 4)	Squeegee driven manually	

Tracing type coater

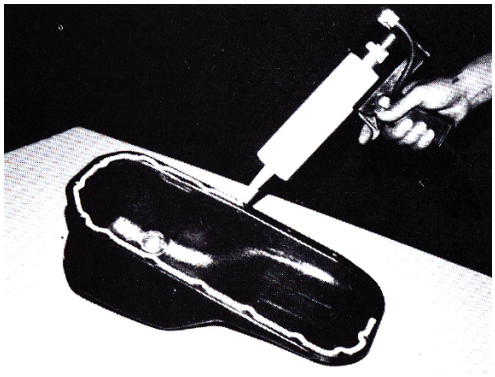


Photo 1. Cartridge gun

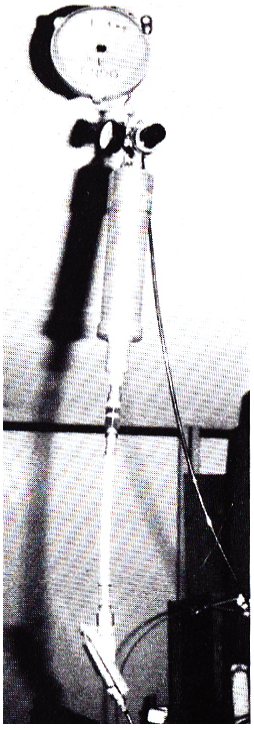


Photo 2. Cartridge tank with flow gun

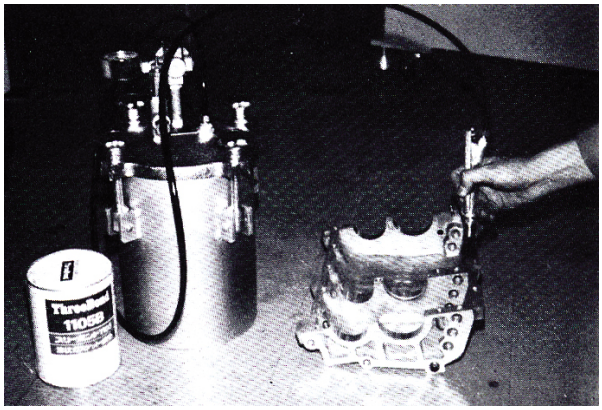


Photo 3. Pressure tank with pencil gun

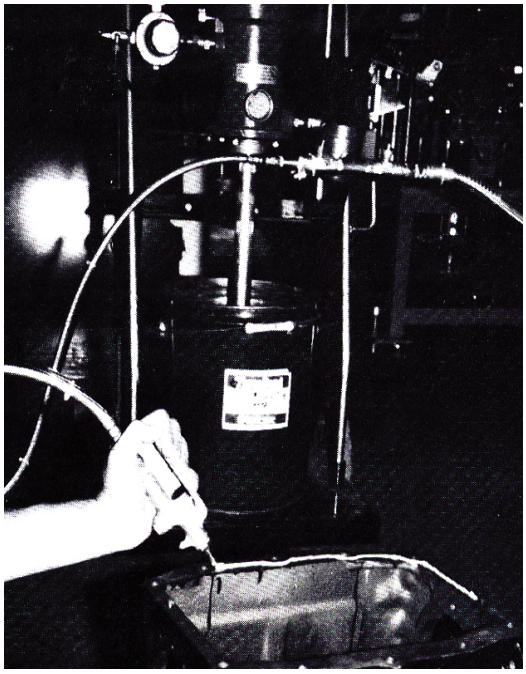


Photo 4. High pressure pump with flow gun

3. Tracing Method

3-1 Construction of Tracing Type Coater

Table 3.

Sections	Standard components	Optional components
Main unit	– Frame…….Casters, levelling bolt – Jig……...Work positioning pin, rough guide – Covers – Hose-hanging arm – Nozzle soaking vessel	Safety cover, shutter, door Work or type detector Work posture detector Work loader and unloader
Nozzle drive unit	– Template type (template, magnet roller, solenoid, universal arm, bevel gear, induction motor) – Photoelectric tube type (Photoelectric tube control unit, lamp, XY table with DC servo motor, nozzle mounting arm) – Computer type (XYZ orthogonal table with DC servo motor, rotary encoder, bellows-type dust cover) – Disk type (disk, spur gear, induction motor)	Template automatic selector
Head unit	– Material on/off valve – Nozzle block with nozzle – Vertical nozzle shift	Flow control valve Shock sensor Nozzle cap
Material feeding unit	– Reservoir (Pressure tank…….pneumatic pressure regulator) (Cartridge tank……pneumatic pressure regulator) (High pressure pump……. pneumatic pressure regulator, material can loader) – Feeding tube (for low pressure…… nylon or teflon tube) (for high pressure……SUS braid teflon tube) – Connecting block or distributer	Residue detector Material regulator Material filter Tank pressure regulator Stirrer
Control unit	– Electric control (Main control panel, auxiliary control panel) (Operation panel) (Starts and emergency stop switch box) – Pneumatic control (Pressure supply cock, three-in-one set) (Pressure switch) (Solenoid valve)	External memory system Constant voltage supply

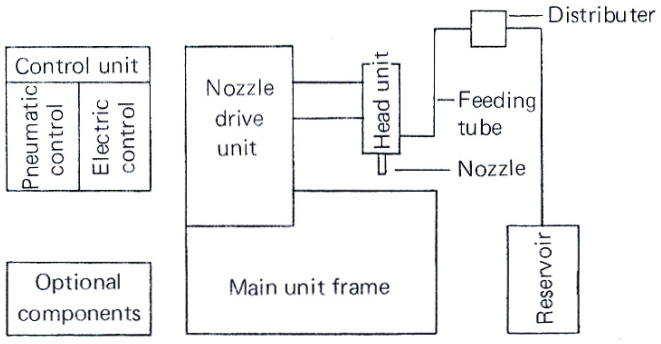


Fig. 1 Construction of tracing type coater

3-2 Classification and Comparison of Nozzle Drive Methods

Table 4.

			Template type	Photoelectric tube type	Computer type	Disk type
General remarks			A magnet roller is driven along an iron template cut in compliance with a pattern to be coated. Gasket material is applied with a nozzle installed at the center of roller. Either outer or inner contour of template is used. (Photo 5)	A live drawing of pattern to be coated is drawn on a sheet of white paper and traced by a photoelectric tube. The resulting signal drives a servo motor installed on an XY table. Coating is made with a nozzle mounted on an arm fixed on the YX table. (Photo 6)	The surface of a work set at the coating position is traced with a nozzle tip so as to store data for moving between specified points. Coating on the work is made by playing back the stored data. (Photo 7)	Nozzle drive for circular arc coating only. A disk with a nozzle filled on its circumference is driven by a motor via gears. (Photo 8)
Specifications	Nozzle drive speed		Max. 4 m/min.	Max. 3 m/min.	Max. 12 m/min.	Max. 12 m/min.
	Partial speed change		Impossible	Impossible	Possible	Impossible
	Locus	Minimum arc	6R	6R	5R	50R
		Discontinuity	Impossible	Possible	Possible	Possible
		Inter section	Impossible	Impossible	Possible	Impossible
		Double lines	Impossible	Impossible	Possible	Possible
		Three-dimensional	Impossible	Impossible	Possible	Impossible
	Pattern change	Method	Plate change	Drawing change	Job No. call	Arm radium change
		Required time	5 min.	3 min.	5 sec.	3 min.
		Type	Not limited	Not limited	20 types (can be increased)	Not limited
	Accuracy		±0.1mm	±0.1mm	±0.1mm	±0.1mm
	Nozzle coverage		Max. 300 x 500 mm	Max. 300 x 400 mm	Max.500 x 1000 mm	Max. 600 mmø
Fatures			High accuracy tracing, low cost, good maintenability	Patterns readily changeable, simultaneous coating of many works possible, low cost.	High speed 3-dimensional coating possible, patterns readily changeable, coating conditions set flexibly	Simple and high reliability, low cost, good maintenability.
Applicatons			Cylinder head cover of motorcycle, FF transmission case and oil pan of automobile	Gas meter counter case, Transmission case of automobile, Condenser calking	Lower case of motor cycle, Buffle plate and oil pan of automobile	Differential gear case, wheel drum fitting and wheel assembly of automobile

Tracing Method

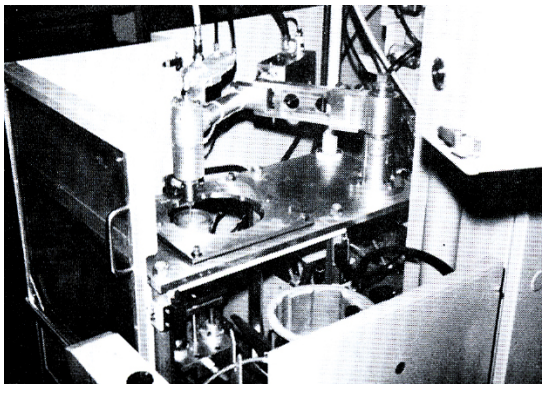


Photo 5. Template type

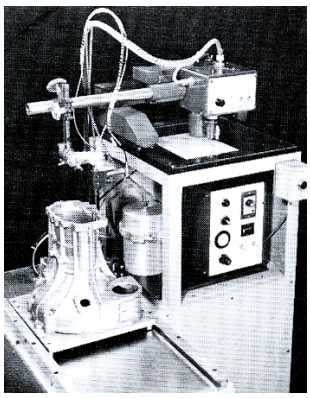


Photo 6. Photoelectric tube type

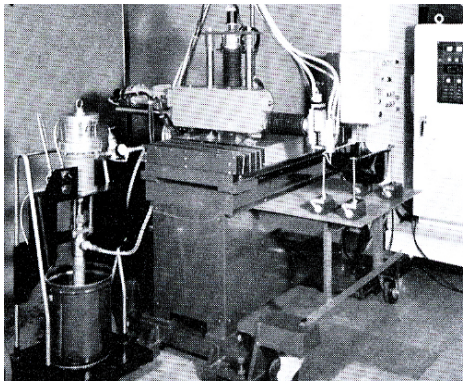


Photo 7. Computer type

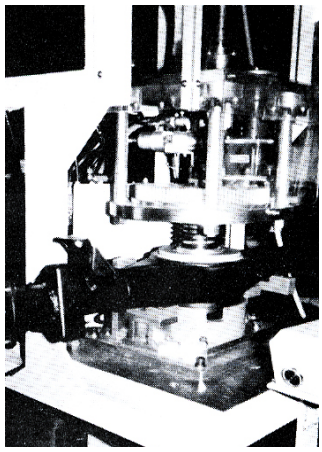


Photo 8. Disk type

3-3 Classification and Features of Feeding Method

The feeding unit which comes to contact with liquid is one of the most important parts in the coating device like the valve. If it is selected or handled wrongly, troubles may occur.

Table 5.

Reservoir		Pressure tank		Cartridge tank		High pressure pump	
Type		Direct feed	Inner container	Plastic	Aluminium	Air pump	Power booster
Illustration		Fig. 2	Fig. 3	Fig. 4	Fig. 5	Photo 9	
Liquid		Low viscosity (10,000 c.p.s. or less) Solvent, aqueous		High viscosity (10,000 – 300,000 c.p.s.) Silicone, anaerobic		High viscosity (10,000 – 300,000 c.p.s.) Solvent, silicone	
Container		20ℓ or less, shape not limited		330cc cartridge		1ℓ – 20ℓ exclusive can	
Pneumatic pressure		0.5 – 7 kg/cm^2		1.0 – 4 kg/cm^2	1.0 – 6 kg/cm^2	1.5 – 5 kg/cm^2	
Liquid pressure		Same as pneumatic pressure		Same as pneumatic pressure		Pneumatic pressure × pressure ratio	
Features		Simple and easy to handle, readily available, tube cleaned readily		Light weight and compact, mounted on head for driving, low cost.		Continuous delivery possible	No pulsation
						High pressure available, large container capacity, low replacing frequency	
Hose	Material	Nylon or teflon		Teflon		High pressure teflon + SUS braid	
	Tolerable pressure	30 – 70 kg/cm^2		30 – 70 kg/cm^2		200 kg/cm^2	
	Length	5m or shorter		1m or shorter		5m or shorter	
	Diameter	1/4" – 1/2"		1/4" – 1/2"		1/4" – 1/2"	
Distributer		Aluminium and brass		ditto.		ditto.	
		When two or more nozzles are used with a distributer, flow control valves for individual nozzles are required.					

Difference between Air Pump and Power Booster

Table 6.

Air pump	Power Booster
Double action, continuous delivery	Single action, intermittent delivery
Constantly pressurized	Pressurized in response to delivery signal
Pulsation at upper and lower dead points	No pulsation
To be used as supply source for flow gun	To be used as supply source for automatic coating device using a nozzle drive unit

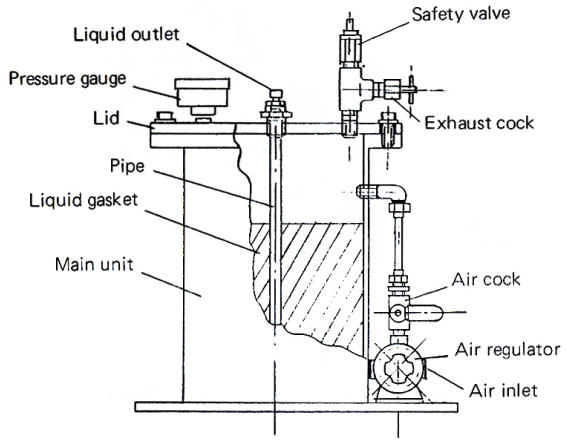


Fig. 2 Direct feed type pressure tank

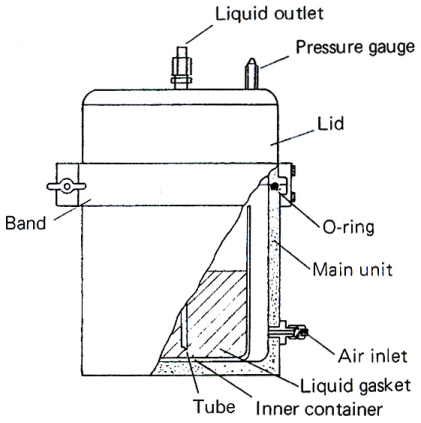


Fig. 3 Inner container type pressure tank

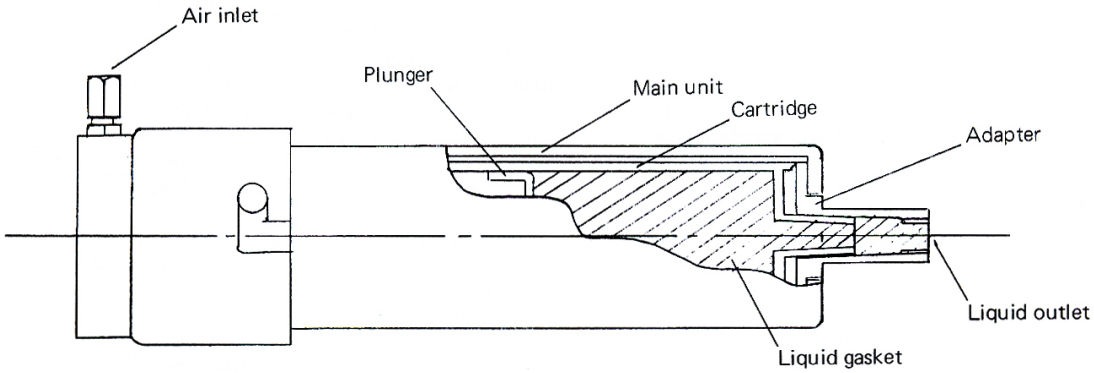


Fig. 4 Plastic cartridge tank

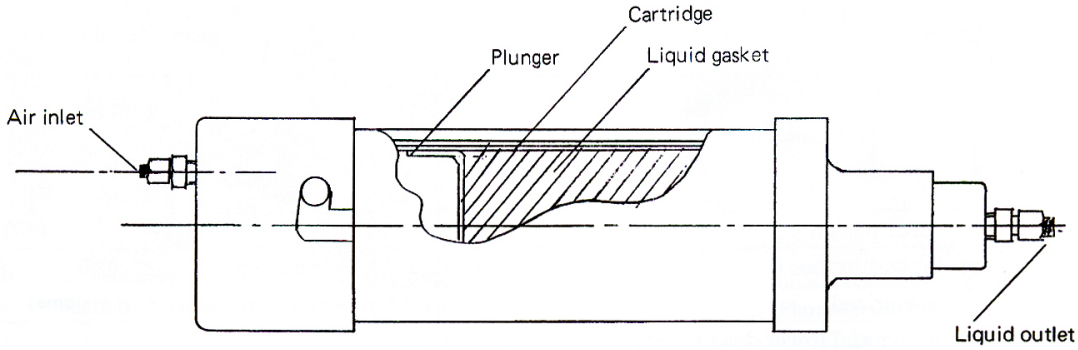


Fig. 5 Aluminium cartridge tank

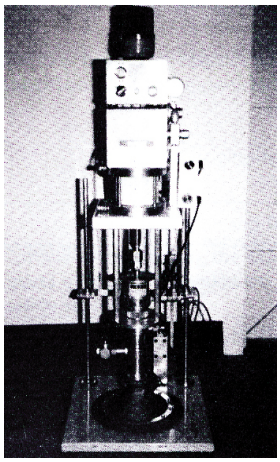


Photo 9. Power booster with residue detector

3-4 Classification and Features of Valve

The valve to control the delivery of liquid gasket is one of most important components of the coating device. Generally three types of valve described below are used.

Table 7.

Type	Pinch valve	Needle valve	Poppet valve
Illustration	Fig. 6	Fig. 7	Fig. 8
Applicable liquid	Low viscosity (10,000 c.p.s.) solvent, aqueous, anaerobic	Low to high viscosity (300,000 c.p.s.) solvent, aqueous, silicone	
Tolerable pressure	5 kg/cm^2 or less	160 kg/cm^2 or less	120 kg/cm^2 or less
		Special version for high pressure available	
Operation	Tube pinched with a tip roller of single or double action air cylinder.	With included double action air cylinder	
		Delivering by rod with drawal	Delivering by rod extrusion
Durability	100,000 times pinching	300,000 strokes (Packing of sliding part to be tightened)	
Delivery adjustment	Tube throttled by included flow control valve	Adjustment of tube resistance at valve seat through stroke control	
Valve seat material	Thin-walled teflon tube	Teflon block	Teflon ring
Features	Comes to contact with liquid only at teflon tube, suited for anaerobic liquid which reacts with metal. Good delivery response, inside cleaned readily.	Valve seat sealed reliably by liquid pressure, suited for high viscosity liquid. Large volume delivery possible with enlarged orifice	When threading occurs, it can be withdrawn to nozzle by suck-back effect. Limited by orifice diameter. Suited for small volume delivery
Precautions for operation	Tube life limited at specified number of pinches. If changed after being broken, cleaning takes time and labor. It is necessary to check the number of pinches with a counter.	Be careful for leakage at packing of sliding part, because of being operated at high pressure. If any leakage occurs, re-tighten immediately. Some grade of liquid gasket may accelerate wear of sliding part.	
	If a speed control (throttle) is provided at each art of operating air cylinder to make operating speed of valve variable, delivery at the beginning and end of coating bead can be adjusted to provide coating at uniform thickness.		

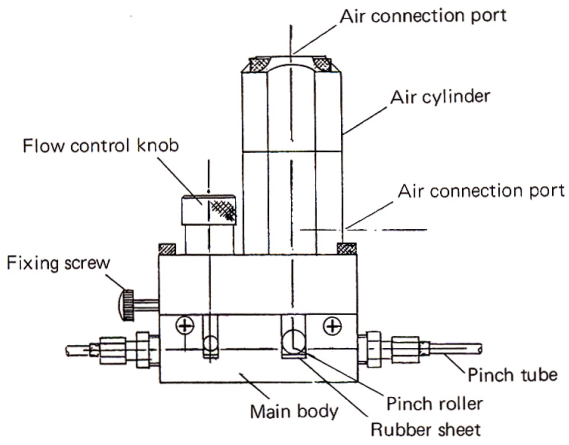


Fig. 6 Pinch valve

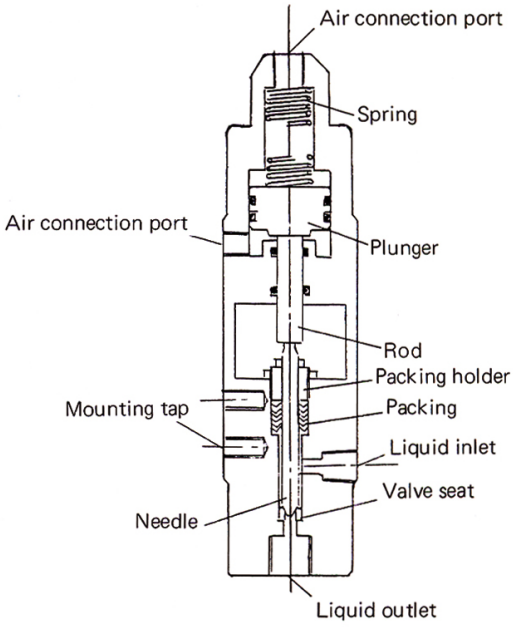


Fig.7 Needle valve

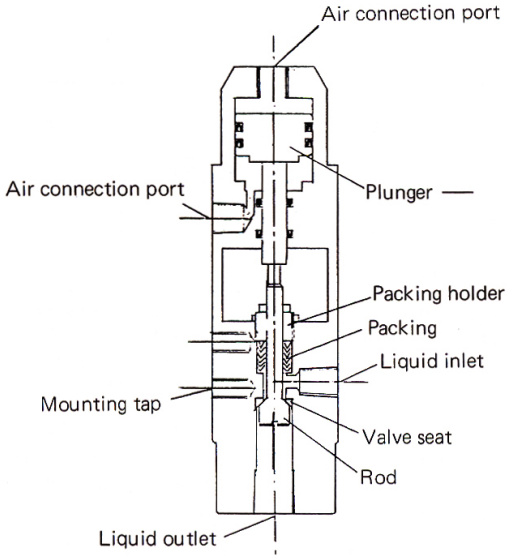


Fig. 8 Poppet valve

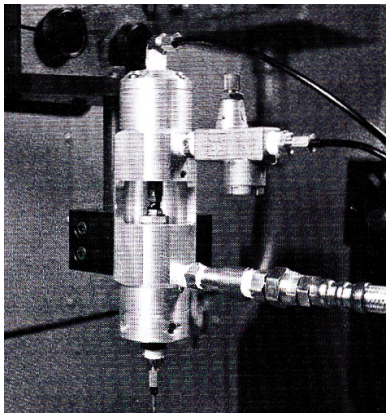


Photo. 10 Poppet valve

3-5 Classification and Features of Optional Components

Optional components described below are used for improving the operability of coating device. But they are not always necessary, and their adoption should be decided in consideration of application purpose and cost.

Table 8.

Section	Item	Description and features
Main unit frame	Safety shutter, safety door, safety cover	To be provided for securing the safety of operators at the nozzle drive unit and active parts of loader and unloader. The adoption is decided in compliance with users' safety standards.
	Work detector	The presence of work in jig is detected by a sensor such as proximity switch or photoelectric switch. In the absence of work, neither loading nor delivering is made.
	Work type detector	Work type is detected, and the pattern for nozzle drive unit is selected depending upon the work type signal.
	Work posture detector	A sensor to check whether or not the work is set at the jig in the proper posture. Mostly, horizontal posture is checked for preventing collision with the nozzle.
	Work loader and unloader	To be provided for the purpose of preventing a part of operator's body from entering the nozzle drive range or facilitating loading and unloading of work. Generally moves horizontally or vertically. Sometimes, an automatic remover to empty the jig is provided.
Nozzle drive unit	Automatic template changer	While the template type unit is inferior with respect to pattern changing, some patterns may be changed automatically, by one of three methods: sliding two templates, inverting two templates, or adding to standard template.
Head unit	Flow control valve	Adjustment of valve stroke provides only limited control of flow. The flow control valve tolerates high pressure, is readily set at the liquid inlet of valve owing its light weight and compact size to be easily adjusted with dial operation.
	Shock sensor	To shut down the nozzle drive unit automatically when the nozzle interferes with work or other object. A switch which is actuated by low load is included.
	Nozzle cap	To cover the nozzle tip when the coating device is put to a long pause, so as to prevent liquid at the nozzle from hardening. Sometimes, solvent may be put into the cap. It should be noted that if the device is put to operation with the nozzle tip capped, the nozzle may come to interfere with work or other objects.
Feeding unit	Residue detector	When liquid content is insufficient, the detector gives alarm with lamp or a buzzer. A proximity switch is used for the pressure tank or cartridge tank. A limit switch is used for the high pressure pump.
	Liquid regulator	To buffer pulsation so as to prevent pressure change at the primary side from being transmitted to the secondary side, when feeding silicone-based liquid with a high pressure pump. The regulator can be used for adjusting delivery. However, as the smaller orifice is readily blocked by dust or solidified liquid, frequent overhauling may be required.
	Liquid filter	To filter out foreign objects and solidified liquid out of liquid with SUS wire net mounted at the pump outlet, when feeding silicone-based liquid with a high pressure pump. It is necessary to clean the filter frequently.
	Tank pressure regulator	The viscosity of viscous fluid varies depending upon the temperature, changing fluid delivery despite constant working pressure. Particularly, in the winter season, the temperature varies at different working periods with the delivery varied accordingly. The regulator is to change the working pressure of liquid supply automatically in response to change in the room temperature for reducing the fluctuation in delivery.
	Stirrer	When precipitation may occur in liquid contained in the pressure tank, liquid is to be delivered while being stirred. Generally, liquid is agitated by turning the stirrer blade in the tank by an air motor mounted at the tank lid.
Control unit	External memory	When a nozzle drive unit of computer type is used, an external memory may be added to the control panel so as to increase the momory capacity for patterns. Either cassette tape or bubble cassette memory is used.
	Constant voltage supply	When a nozzle drive unit of computer type is used, a constant voltage supply is to be used for stabilizing the primary side voltage, so as to eliminate variation on the secondary side. This also prevents secondary voltage from being cut at the time of momentary power failure.

4. Screening Method

The method of screen printing is applied to coating of liquid gasket. This method is applicable only with liquid which does not solidify after having been left for a long period in air. It is used, therefore, exclusively for anaerobic liquid gasket.

4-1 Construction of Screening Type Coater

See Fig. 9 and Photo. 11.

4-2 Standard Specifications for Screening Type Coater

Table 9.

Items	Standard specifications
Power requirements	200V, 3ϕ, 50/60Hz, 10A
Pneumatic pressure	4 – 6 kg/cm^2
Maximum screen frame dimensions	1,000 x 700 mm
Maximum screen dimensions	900 x 600 mm
Maximum coating area	600 x 400 mm
Squeegee drive speed	170 – 115 mm/sec (variable with belt tension)
Squeegee material	Urethane rubber
Squeegee pressure control	Pneumatic with air cylinder
Coating time	10 – 12 sec (including time for loading and unloading)
Screen materials	Nylon-tetron mixed
Screen durability	10,000 operations (dependent upon work geometry)
Screen thickness	0.5 – 1.0 mm
Automatic liquid feeding	Pressurized feeding with cartridge tank (capacity 500cc)
Others	Some work geometry may require a screen protecting means.

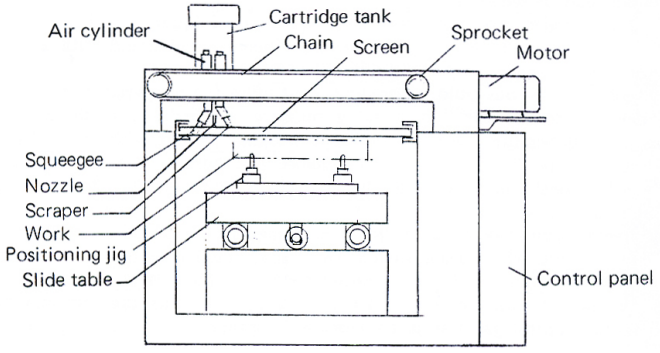


Fig. 9 Construction of screening type coater

Screening Type Coater

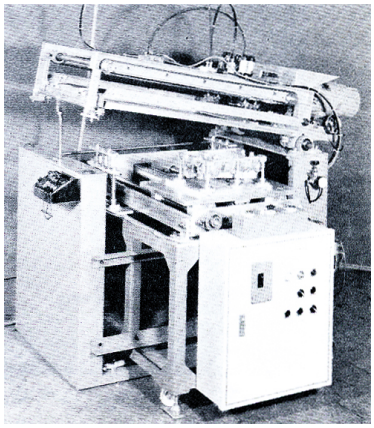


Photo 11. Screening type coater

5. Stamping Method

A work is pressed against uniform coating of liquid gasket formed on the top face of a box-shaped drum so as to coat the work by transfer. This method is suited for creating thin-film liquid gasket of organic solvent or aqueous base on a smooth plane of complicated geometry.

5-1 Construction of Stamping Type Coater

See Fig. 10 and Photo 12.

5-2 General specifications for Stamping Type Coater

Table 10.

Items	Standard specifications
Power requirements	200V, 3ϕ, 50/60Hz, 10A
Maximum drum face dimensions	400 x 500 mm, there are several versions of different drum face dimensions
Maximum tank capacity	90ℓ (minimum liquid requirement 15ℓ)
Drum driving	Electric motor (anti-explosion specifications required for solvent-based liquid)
Drum division	4-division Geneva
Coating face holding time	Max. 12 sec – min. 4 sec, continuously variable
Dividing time	Max. 4 sec – min. 1.5 sec, continuously variable
Thickness of coated film	1.8 – 2.3 mm, adjusted with thickness of collars at both ends of film-making rod
Thickness of transferred film	0.01 – 0.10 mm, variable depending upon nature and viscosity of liquid
Others	− If work face includes a convex area, a concave area is to be provided on the drum face so as to ensure close fitting. − A shutter means is to be provided for preventing solvent from evaporating. − When solvent-based liquid is used, an exhaust duct is to be provided.

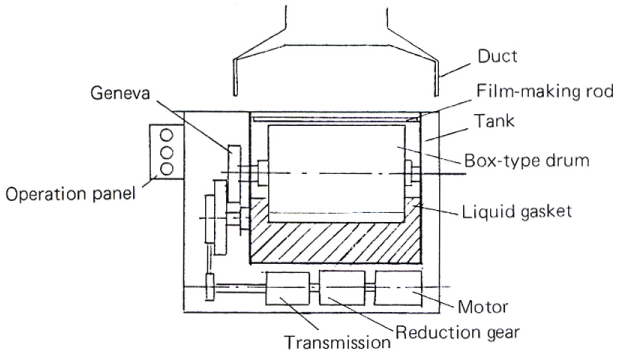


Fig. 10 Construction of stamping type coater

Stamping Type Coater

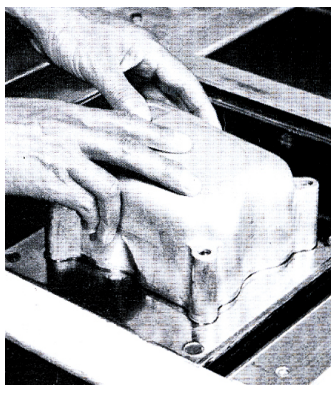


Photo 12. Stamping type coater with a shutter

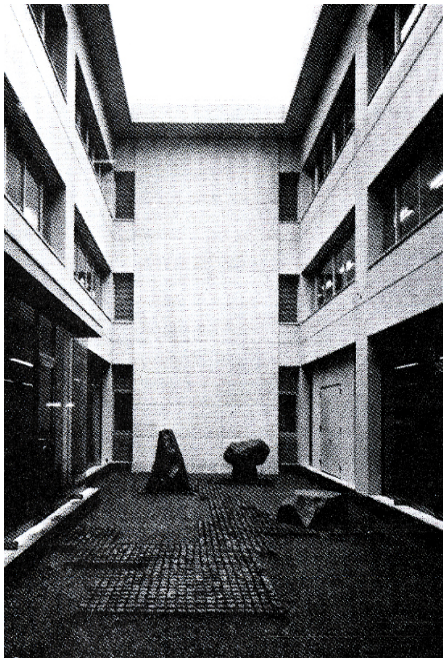
6. Examples of Coater Application

While the coating devices mentioned in the above may be used for coating liquid materials other than liquid gasket, examples of their applications with liquid gasket alone described below.

Table 11.

Coating method	Driving method	Material	Application
Tracing	Template	Anaerobic	Hydraulic control unit
		Silicone	Transmission case, FF transmission case, Flywheel cover, Oil pump case, Rear oil retainer, Oil pan, Thermo case, Transmission rear cover, Brake cover & shim, Water outlet cover, Rear cover, OHC bearing case, Cylinder head cover, Snow-mobile crank case, Corrugated plate of canteen, Room heater blower
	Photo-electric tube	Organic solvent	Transmission case, Condenser caulking
		Silicone	Gas motor counter case
	Computer	Aqueous	Lower case, Upper case (Motorcycle)
		Organic solvent	Asbestos gasket, Lower case
		Silicone	Vertical transmission, Buffle plate, Cylinder block, Oil pan plate, Oil pan, Transmission of light automobile Oil pan for agricultural machine, Gear case, Wash basin cabinet
	Disk	Aqueous	Steering
		Silicone	Differential gear case for automobile, truck and light automobile
Screening		Anaerobic	Transmission case for automobile
Stamping		Aqueous	Lower case for motorcycle Crank case for automobile, Pump case
		Organic solvent	Lower case for automobile, Crank case for motorcycle, Transmission case for automobile, Transmission case for agricultural machine, Outboard engine cover, Gas meter case

THREE BOND Research Laboratory Completed.



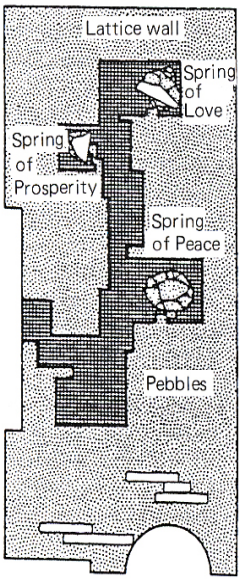
The Research Laboratory which has been in the way of construction at the plot of THREE BOND Co., Ltd. for the purpose of reinforcing the efforts for research and development is completed.

The building is made from ferroconcrete with 3 stories above and 1 story under ground, comprising total floor area about 4,500m^2, which is nearly three times as extensive as the previous research space. The new research facilities involve an engine test room with fully sound-proof construction, an impulse fatigue testing machine and modern analytic instruments.

In addition to the research and development of new products and technical application systems, the Research Laboratory has some auxiliary functions such as the conduction of commissioned or cooperative studies with outside research organizations such as users and universities, technical training of domestic and overseas personnels, and exhibition of production process with plant models for improving users' understanding of quality and performance of our products. The Laboratory is operated through a new system so that it can be utilized 24 hours a day and 365 days a year.

It is recommended to visit the Laboratory at Hachioji whenever you happen to come to Tokyo to utilize its service. Every personnel of the Laboratory would welcome you.

"GARDEN OF CREATION" in the THREE BOND Research Laboratory



We designated this space as "Garden of Creation," intending to symbolically represent the ideal state of mind required for researchers through its configuration.

The invention contributing to the community is derived from the creation, and we believe that indispensable elements for creation are theory, flash of wit and passion.

Lattice Wall – (theory) Well-organized theory is represented by the regular geometrical pattern of lattice.

Pebbles – (flash of wit) Pebbles laid on the ground represent numerous flashes of wit. Each of pebbles has different shape causing free thinking in the part of on-lookers.

Three stones – (passion) Three stones represent;
•spring of love •spring of prosperity •spring of peace
They represents together inexhaustible passion like gushing spring.
Of three stone, two have one each of faces polished so that a triangle of light is formed with the remaining one, "Spring of Peace," at the apex, depicting infinite passion linked up with a beam of light around the peace.

Illumination – (unexpectedness) Lighting an object has an effect of deriving unexpectedness from it.

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