

Piping plan

In order to make full use of centralized lubricating system, appropriate equipment must be selected, as well as appropriate piping design must be applied.

Selecting a distributing valve

Check every point to be lubricated according to the drawing of main unit. At the same time, check the type of bearing, size (such as axis diameter and bearing length), rotation speed, lubricating point screw diameter, fixing, and moving. Then calculate the reference lubricating amount for each lubricating point by use of the figure below.

Reference lubrication amount

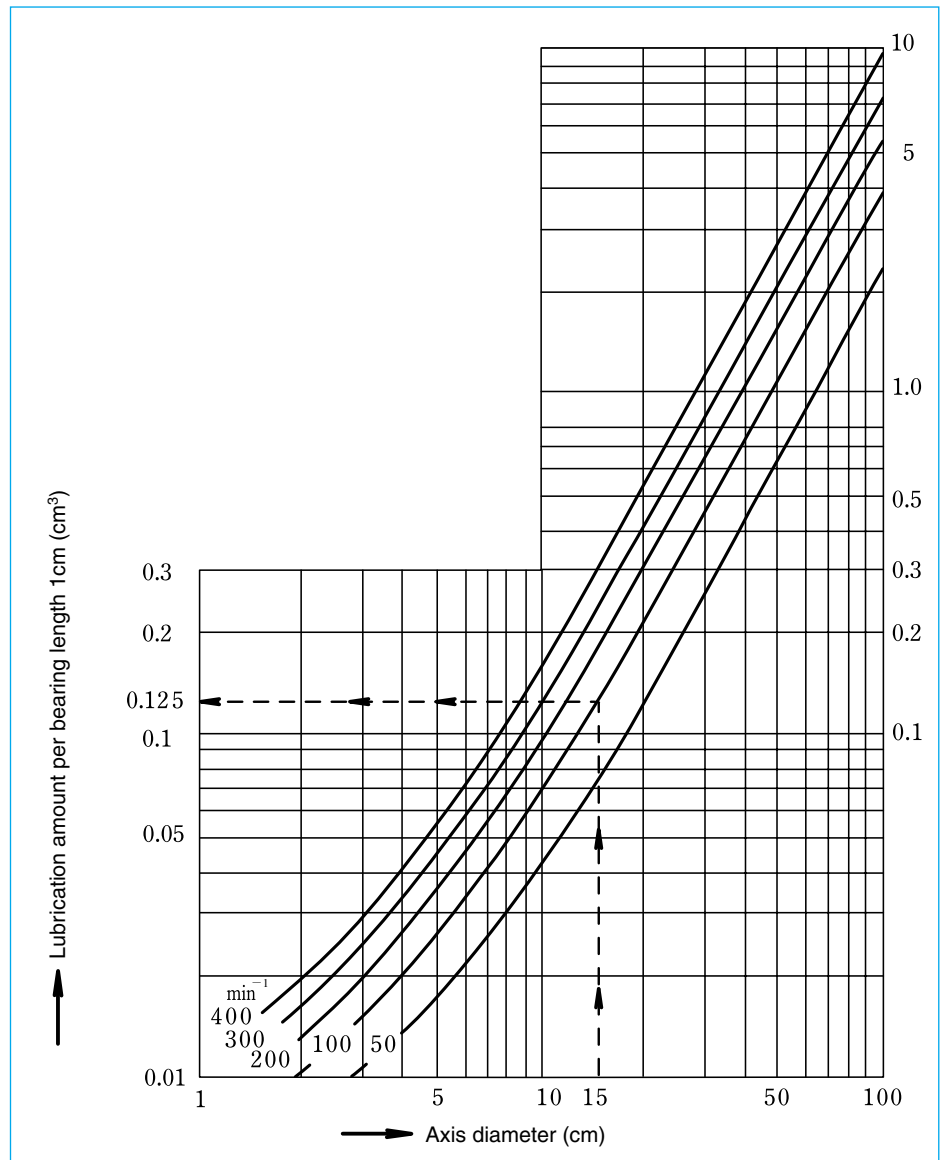
- (1) Plain bearing
Multiply the value obtained from the table by the length of bearing (cm).
- (2) Single row ball and roller bearing
Multiply the value obtained from the table by 2.5.
- (3) Double of multi row ball and roller bearing (2)
- (4) Sliding surface
Multiply the sliding surface area (cm²) by 0.0025 irrespective of the table.

* The table on the right shows the case where unit is lubricated once every four hours with all-purpose grease. Lubrication amount depends on load, clearance, sealing condition, atmosphere, property of grease, etc. even if the size and rotating speed of bearing are the same. When operation is actually started, observe the condition of lubrication well enough, and adjust the lubrication amount.

[Example]

What is the reference oil amount for flat bearing of axis diameter 150, axial length 180 mm, and rotating speed 100/min⁻¹?

On the figure on the right, rise from the horizontal axis <15 cm>, and turn left at the intersection with 100/min⁻¹ curve, then the value <0.125> is obtained on the vertical axis. Multiply it by the axial length 18 (cm) to provide 2.25 cm³. It is the reference lubrication amount.



● Selection of distributing valve

When reference lubrication amount is obtained for each lubricating point, make a plan about what operation interval is to be set on the system. Any lubricating interval can be set as for motor driven grease pump. As for manually operated grease pump, take a lubricating interval as long as possible. Determine the size and quantity of distributing valve based on the plan. Discharging amount can be adjusted independently for each distributing valve, therefore unify to one type unless lubrication amount is significantly different.

■ Discharging amount table of distributing valve

Type	Specification	Stroke discharge amount/cm ³	Adjusting amount per rotation of adjusting screw/cm ³
DV-30		0.2 to 1.2	0.06
DV-40		0.6 to 2.5	0.10
DV-50		1.2 to 5.0	0.15
DV-60		3.0 to 14.0	0.68
DW-20		0.15 to 0.6	0.04
DW-30		0.2 to 1.2	0.06
DW-40		0.6 to 2.5	0.10
DW-50		1.2 to 5.0	0.15

Note) DW type distributing valve is double discharging type. Discharging amount shown above is obtained from every discharging port by lubrication of two times (one cycle). (Discharging port is placed on two positions, i.e. on the front and at the bottom, discharging in turn.)

■ Determining a pump and piping

Lubricating range afforded by one pump is not restricted theoretically, however, it is necessary to apply some restriction to the range where a handle can be operated easily for manually operated pump, and to pressure and operation time for motor driven pump.

Plan the pump pressure below 17MPa allowing a margin for operation condition (summer and winter) and error by design. Pressure 5MPa and differential pressure 3MPa required for lubricating distributing valve are reserved, therefore allowable pressure loss of main supply line is determined as a difference of pump pressure. In view of convenience in checking lubrication, time required for single lubrication cannot be made very long. Reference values are as shown on the right.

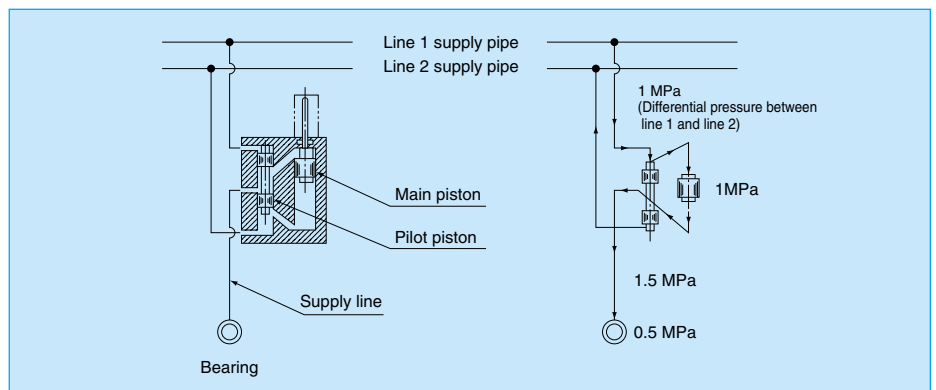
● Design standard

- Allowable pressure loss of main supply line
 - Loop type : 12MPa
(from pump outlet to main supply line return port)
 - End type : 9MPa
(from pump outlet to the end of main supply line)
 - Lance type : 9MPa
(from pump outlet to the end of main supply line)
Except that UE-04A applies 7MPa.
- Time required for lubricating :
Within 5 minutes (within 8 minutes at the maximum) ... Motor driven pump
Handle operation within 25 times ... Manually operated pump

■ Structure of distributing valve and pressure required for lubrication

Shown below is the simplified structure of distributing valve. The pilot piston is operated by the differential pressure of line 1 and line 2, and the main piston is operated by the pressure of line 1 or line 2 after the operation of pilot piston. In order that lubrication is performed reliably, the pressure required for operating distributing valve must work on every distributing valve. Pressure required for distributing valve operation is as follows:

Pressure required for distributing valve pilot piston operation		1MPa (Differential pressure)
Pressure required for distributing valve main piston operation...*1	1MPa	
Lubricating line pressure loss...*2	1.5MPa	
Pressure required for charging bearing	0.5MPa	
Safe pressure (guaranteed lubrication pressure)...*3	2MPa	2MPa (Differential pressure)
Total	5MPa	3MPa (Differential pressure)



- *1 It depends on the type of distributing valve. See the specification of distributing valve. 1MPa in description is a standard value except for DW-20 type.
- *2 Pressure loss of supply line is assumed at 1.5MPa, but it depends on applicable grease, temperature, piping diameter, length, etc. See the table 2 on page 49 and progressive system on page 52.
- *3 Safe pressure is applied in order to guarantee the operation of distributing valve.

Piping plan

Determining distributing valve layout and piping system

Enter the lubricating point to the drawing, and prepare the layout of distributing valve.

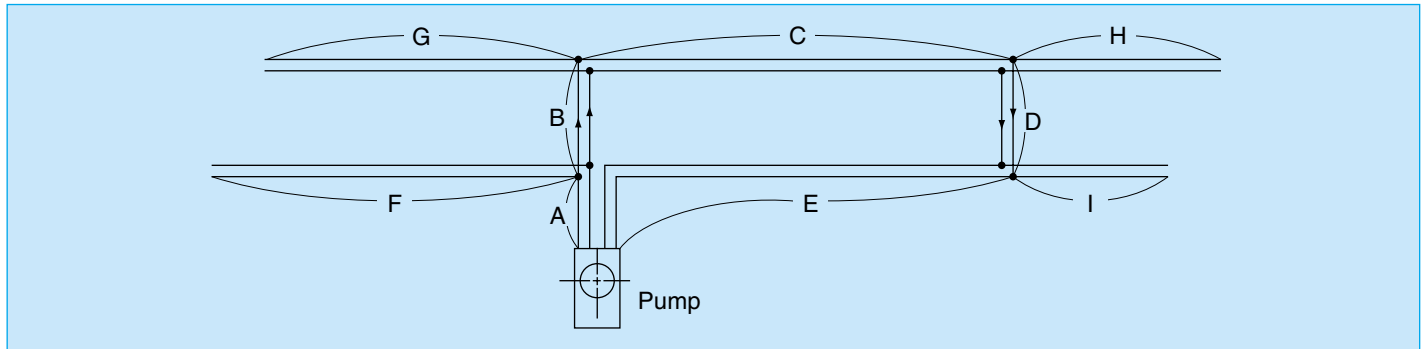
In addition, determine the position of pump in consideration of pump characteristics and maintenance.

(Center is preferable if possible in view of piping plan.)

Piping system is available in three types, i.e. loop type, end type, and lance type.

See the item of system in General (page 2 to 11) and determine which system to take.

Loop type piping plan



Length of loop = A + B + C + D + E ... Length relating to pressure (main line)

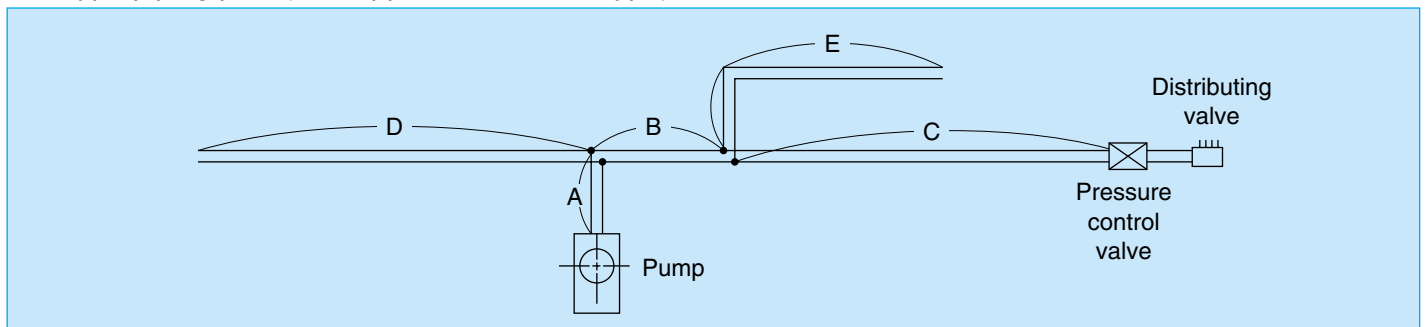
Piping branch length is respectively as follows if the size is the same as main line:

$$F \leq \frac{1}{2} (B + C + D + E) \quad G \leq \frac{1}{2} (C + D + E)$$

$$H \leq \frac{1}{2} (D + E) \quad I \leq \frac{1}{2} E$$

In addition, when piping different in size is to be used, make a plan so that the pressure loss between the branch point and the end of branch line is below 1/2 of pressure loss between the branch point and the pump return port.

End type piping plan (also applicable to lance type)



Piping length = A + B + C ... Main line

The length relating to pressure is (A + B + C) × 1.5 ... Including remaining pressure on opening side

The length of branch piping is respectively as follows when it has the same size as main line:

$$D < (B + C) \quad E < C$$

In addition, in using piping different in size, make a plan so that the pressure loss between the branch point and the end of branch is below the pressure loss between the branch point and the pressure control valve according to the table 1 on next page.

Install one or more distributing valve in principle beyond the pressure control valve.

■ Main supply line pressure loss and discharge line pressure loss

Pressure loss of grease in the piping depends on flow rate per hour, temperature, type of grease, pipe bore, etc.

Table 1 Pressure loss of main line and branch line (Nominal diameter 10 and 14 refer to copper pipe, and others refer to STPG370 SCHEDULE 80.)

Unit MPa · m

Nominal diameter		OD (mm)	ID (mm)	U-5	U-45	U-40	U-30	U-25 UE-225	UE-108	UE-04	FB-42A FB-62A	FB-4A FB-6A
A	B											
φ10		10.0	7.2							0.50		
φ14		14.0	10.0						0.30	0.27		
8	1/4	13.8	7.8						0.48	0.42		
10	3/8	17.3	10.9				0.37	0.32	0.26	0.23	0.33	0.41
15	1/2	21.7	14.3		0.31	0.26	0.23	0.19	0.16	0.14	0.20	0.25
20	3/4	27.2	19.4	0.21	0.18	0.15	0.13	0.11	0.09		0.12	0.14
25	1	34.0	25.0	0.13	0.12	0.10	0.08	0.07				
32	1 1/4	42.7	32.9	0.08	0.07	0.06	0.05	0.05				
40	1 1/2	48.6	38.4	0.06	0.05							
50	2	60.5	49.5	0.04								

Remarks

- These values apply to concentrated lubricating grease NLGI consistency number #1 at 0°C (apparent viscosity below 5,500 poise at shearing speed 1/sec and apparent viscosity below 1,000 poise at shearing speed 10/sec). Values in the table may not be applicable to grease other than lithium soap grease, urea base thickening agent, non-soap thickening agent, base oil other than mineral oil and grease containing special additive.
- When grease in use is identified, place the manufacturer's shearing factor - apparent viscosity table upon the pressure loss table (page 53) for calculating pressure loss.
- Reduced to 60% of the table for grease #0, and increased to 250% of the table for grease #2.
- Change by temperature is 70% at 15°C, 50% at 25°C, and 150% at -5°C.
- Distributing valve operates in parallel with flow rate in the discharge line, therefore the pump discharging quantity is dispersed after the distributing valve.
Grease in the discharge line (copper pipe) is assumed to have flow rate about 10cm³/min, and pressure loss is as follows:

Table 2 Pressure loss in discharge line (copper pipe) NLGI consistency #1

Nominal diameter	OD (mm)	ID (mm)	Pressure loss (MPa · m)	Maximum piping length (m)
φ6	6	4.4	0.90	3
φ8	8	6.4	0.45	6
φ10	10	8.0	0.30	10

In general, intend at 1/2 or below of maximum piping length in planning.

Change of pressure loss by temperature is the same as described in remarks of table 1.

Piping plan

Time required for lubricating

Time required for lubricating is calculated as follows:

$$T = \frac{V_1 + V_2 + V_3 + V_4 \text{ (or } V_5)}{Q} \text{①}$$

T : Time (min)

Q: Pump discharging amount cm³/min.....(table 3) V₃: Hydraulic switch valve and pressure control valve loss (operation lubricant amount).....(table 5)

V₁: Sum of distributing valve discharging amount.....(table 4) V₄: For 10MPa) Amount required for pressure rise (compression amount)

V₂: Sum of distributing valve loss (operation lubricant amount)(table 4) V₅: For 21MPa) Piping between pump and distributing valve of one line (single line).....(table 6)

Table 3
Q: Pump discharging amount

Type	50Hz (cm ³ /min)	60Hz (cm ³ /min)
UE-04AN	21	25
UE-108AL	30	36
UE-225AL (N)	64	76
U-25AL (E.N)	60	72
U-30AL (E.N)	120	144
U-40AL (E.N)	195	234
U-45AL (E.N)	390	468
U-5AL (E)	585	702

Table 4
V₁: Distributing valve discharge
V₂: Distributing valve loss

Type	V ₁ per port (per two ports as for DW) cm ³	V ₂ per port (per two ports as for DW) cm ³
DV-30	0.2 to 1.2	0.50
DV-40	0.6 to 2.5	0.55
DV-50	1.2 to 5.0	0.63
DV-60	3.0 to 14.0	0.63
DW-20	0.15 to 0.6	0.17
DW-30	0.2 to 1.2	0.20
DW-40	0.6 to 2.5	0.20
DW-50	1.2 to 5.0	0.20

Table 5
V₃: Loss at hydraulic switch valve or pressure control valve

Type	V ₃ loss (cm ³)
UE-108AL, UE-225AL (LRV-6)	0.9
UE-04AN, UE-108AN, UE-225AN (LRV-7)	0.9
U-25, 30, 40, 45AL (E,N) (HV03)	1.5
U-25, 30, 40, 45AE (PV-2E)	1.5
U-5AL (RV-3)	17.0

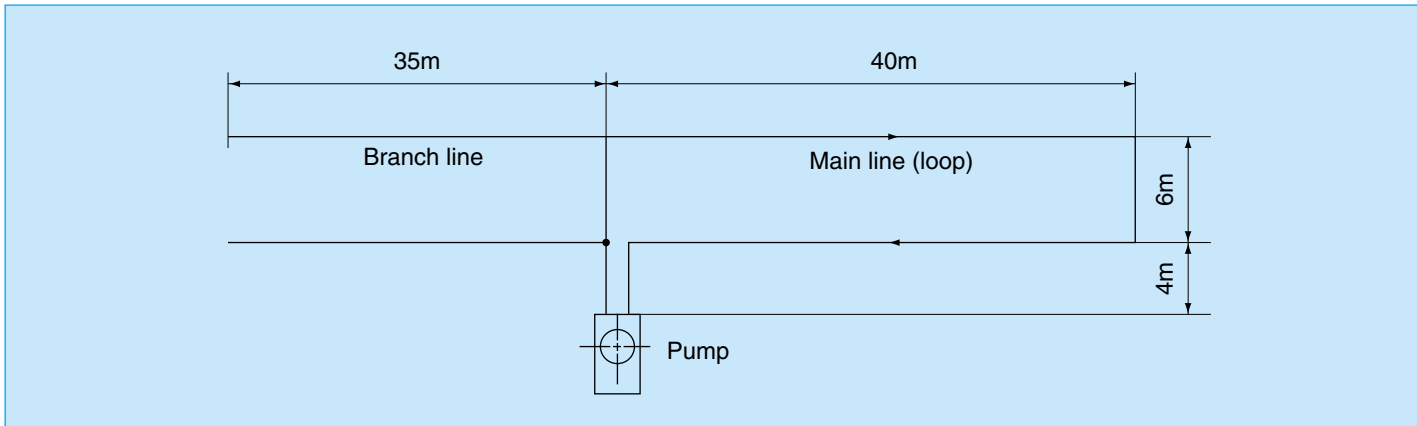
Table 6
V₄: Amount required for pressure rise at system pressure 10MPa
V₅: Amount required for pressure rise at system pressure 21MPa

Nominal diameter		OD (mm)	Wall thickness (mm)	ID (mm)	Volume (cm ³ /m)	V ₄ Compression amount (cm ³ /m)	V ₅ Compression amount (cm ³ /m)
A	B						
φ10		10.0	1.4	7.2	40.7	0.13	0.24
φ14		14.0	2.0	10.0	78.5	0.26	0.47
8	1/4	13.8	3.0	7.8 (9.4)	47.8 (69.4)	0.16 (0.23)	0.29 (0.42)
10	3/8	17.3	3.2	10.9 (12.7)	93.3 (126.7)	0.31 (0.42)	0.56 (0.76)
15	1/2	21.7	3.7	14.3 (16.1)	160.6 (203.6)	0.53 (0.67)	0.96 (1.22)
20	3/4	27.2	3.9	19.4	295.6	0.98	1.77
25	1	34.0	4.5	25.0	490.9	1.62	2.95
32	1 1/4	42.7	4.9	32.9	850.1	2.81	5.10
40	1 1/2	48.6	5.1	38.4 (34.4)	1158.1 (929.4)	3.82 (3.07)	6.95 (5.58)
50	2	60.5	5.5 (8.7)	49.5 (43.1)	1924.4 (1459.0)	6.35 (4.81)	11.55 (8.75)

Note) Value in () refers to SCHEDULE 40 or 160.

[Ex] What is the piping diameter in the condition below?

- Distributing valve DW—54 × 5 20 ports
- DW—46 × 10 60 ports
- DW—38 × 50 400 ports
- Grease #1 Minimum temperature 0°C
- Area 50Hz Piping system loop



Length of loop = (40m + 6m + 4m) × 2 = 100m
 Length of branch line = 35m × 2 = 70m
 Assume pump pressure = 17MPa and reversing pressure = 5MPa.
 Pressure loss at the loop is 17MPa - 5MPa = 12MPa

Then determine the diameter of main line by use of table 1 so that pressure loss in the loop is within 12MPa.

- For U—25AL, 0.11 × 100 = 11MPa (wall thickness 3.9mm) for main line 20A.
- For U—30AL, 0.08 × 100 = 8MPa (wall thickness 4.5mm) for main line 25A.
- For U—40AL, 0.1 × 100 = 10MPa (wall thickness 4.5mm) for main line 25A.
- For U—45AL, 0.12 × 100 = 12MPa (wall thickness 4.5mm) for main line 25A.
- For U—5 AL, 0.08 × 100 = 8MPa (wall thickness 4.9mm) for main line 32A.

Then investigating in terms of lubricating time, from the formula ①,

$$T = \frac{V_1 + V_2 + V_3 + V_5}{Q} \dots\dots\dots \text{Planning at (T normally within 5 min, maximum within 8 min)}$$

In case of U—25AL

$$Q = \text{From the table 3} = 60\text{cm}^3/\text{min (50Hz)}$$

$$V_1 = [(5 \times 20) + (2.5 \times 60) + (1.2 \times 400)] \times \frac{1}{2} = 365 \text{ cm}^3 \text{ * (distributing valve discharge)}$$

$$V_2 = [(0.2 \times 20) + (0.2 \times 60) + (0.2 \times 400)] \times \frac{1}{2} = 48 \text{ cm}^3 \text{ * (distributing valve loss)}$$

$$V_3 = \text{From the table 5 (HV03)} = 1.5 \text{ cm}^3$$

Assume that the branch line has the same size as main line, and connection line with the distributing valve is 10A (wall thickness 3.2 mm), and total length is 75m, then refer to the table 6.

$$V_5 = [1.77 \times (100+70)] + (0.56 \times 75) = 342.9\text{cm}^3$$

$$T = \frac{365 + 48 + 1.5 + 342.9}{60} = 12.6 \approx 13\text{min} > 5\text{min}$$

Therefore, capacity of U-25AL pump is insufficient.

In case of U—40AL

$$Q = 195 \text{ cm}^3/\text{min}$$

$$\left. \begin{array}{l} V_1 = 365 \text{ cm}^3 \\ V_2 = 48 \text{ cm}^3 \\ V_3 = 2.7 \text{ cm}^3 \end{array} \right\} \text{The same as U—25AL described above.}$$

Note) This calculation is for judging the capacity of pump. DW type distributing valve is used in this example, and 1/2 is multiplied in order to calculate the time used for lubricating by line 1 or line 2 (half cycle lubricating).
 Actually, double times of the calculation above is required for supplying single specified amount to every lubricating point.
 In other words, when one cycle is completed by line 1 and line 2, single lubrication is completed for every point.

Piping plan

$$V_5 = [2.95 \times (100 + 70)] + (0.56 \times 75) = 543.5 \text{ cm}^3$$

$$T = \frac{365 + 48 + 1.5 + 543.5}{195} = 4.9 \text{ min} < 5 \text{ min}$$

Therefore, capacity of U-40AL pump is sufficient.

In view of lubricating time, it is not necessary to use U-5AL.

Use of progressive distributing valve

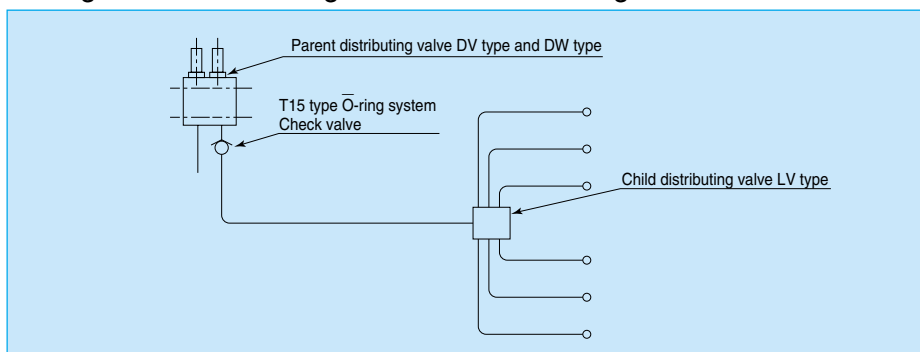
The most orthodox way is to use distributing valve of one port for one lubricating point and distributing valve of three ports for three lubricating point, while progressive (DV type or DW type + LV type) distributing valve system is effective in the case below.

In this case, employ a system in which pressure above 10MPa works on parent distributing valve in order to guarantee operation of distributing valve sufficiently.

(See page 11 of system edition and page 32 of equipment edition.)

- (1) When bearing of the same size is concentrated.
- (2) When 4 - 8 lubricating point are deviated from another lubricating point and piping.
- (3) When it is difficult to check the operation of distributing valve because of inside piping or when parent and child are connected with a hose because piping space is limited (two lines for DV and DW type, one line for LV type).

Progressive distributing valve connection diagram



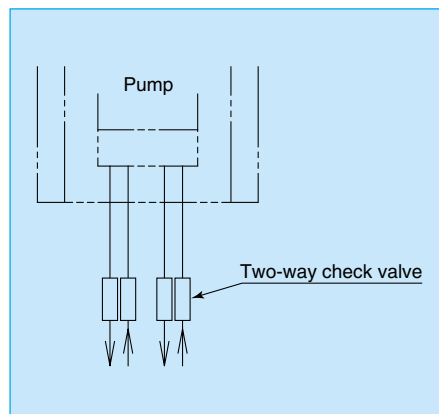
Use an equivalence to copper tube of diameter 10 to 8 mainly in piping between parent and child, and use copper tube of diameter 6 in piping between child distributing valve and bearings.

Rising piping and backflow check

In piping to lubricating points placed higher than pump position, such as blast furnace, air heating furnace, crane or conveyor, grease in rising part of piping flows back into the tank.

Two types of method to prevent backflow are available as follows:

- (1) Method of installing two-way check valve in the vicinity of pump outlet and return port (opening pressure 0.45 MPa). Two-way check valve is installed both at the outlet and return port, and pressure loss is 0.9 MPa. Further, pressure loss generated by passing through a thin hole inside the two-way check valve and pressure loss in neighboring piping must be considered.

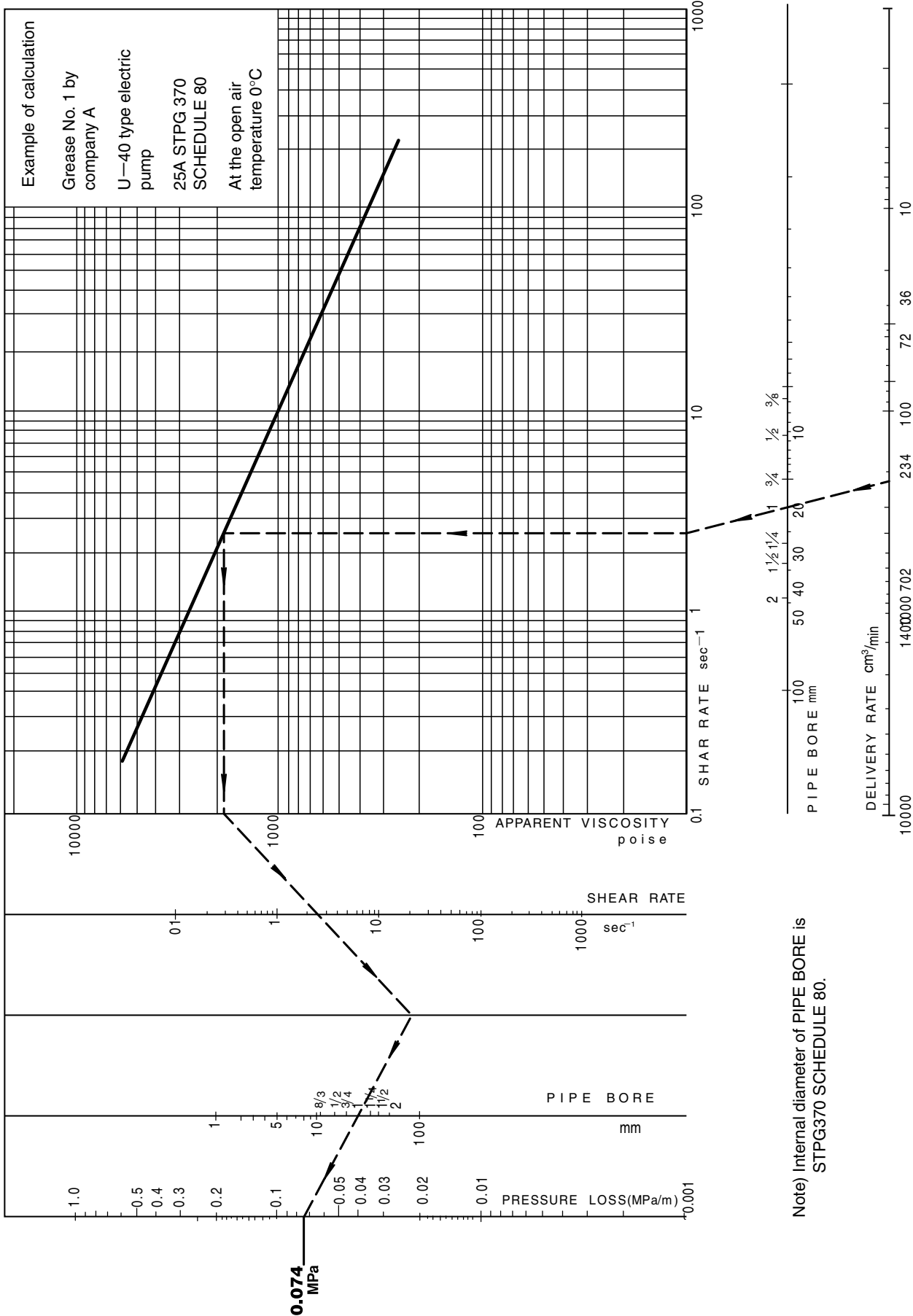


Note

- (1) In piping between parent and child, choose a place where damage of piping can be checked as easily as possible.
- (2) The length of piping between parent and child should be 10m at the maximum.
- (3) Pressure required for operation of child distributing valve is 1.2 MPa.
- (4) Install a check valve at the discharging port of parent distributing valve. Opening pressure of check valve is 0.4 MPa.
- (5) Pressure required for operation of parent distributing valve is standard system plus pressure loss of (2) (3) and (4) above.

- (2) Method of using pump unit incorporating backflow check mechanism. Only an open line in pump unit is equipped with backflow check mechanism, therefore pressure loss is only 0.45 MPa, which enables high efficiency, and piping cost is low. Backflow check pressure is normally 0.45 MPa. When height is more than 45m, valve is required which has a pressure capacity corresponding to the head.

Pressure loss diagram

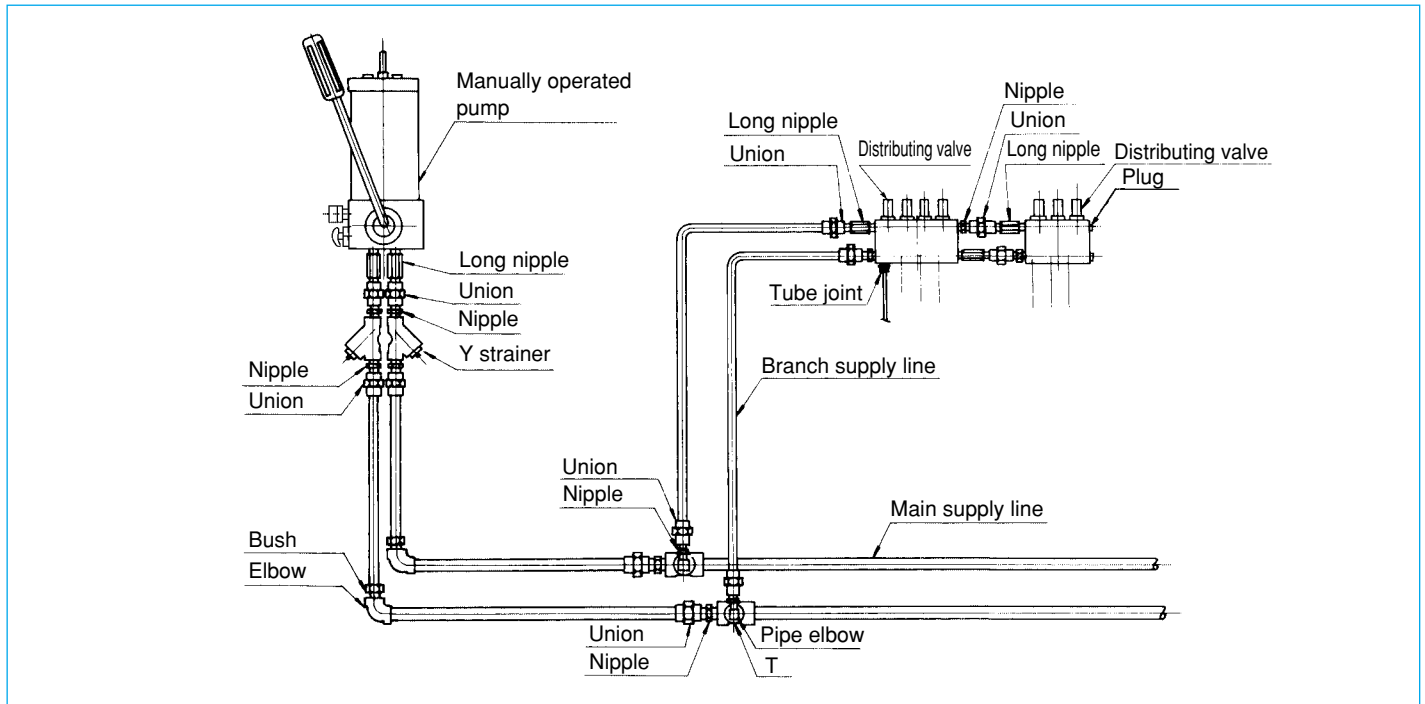


Note) Internal diameter of PIPE BORE is STPG370 SCHEDULE 80.

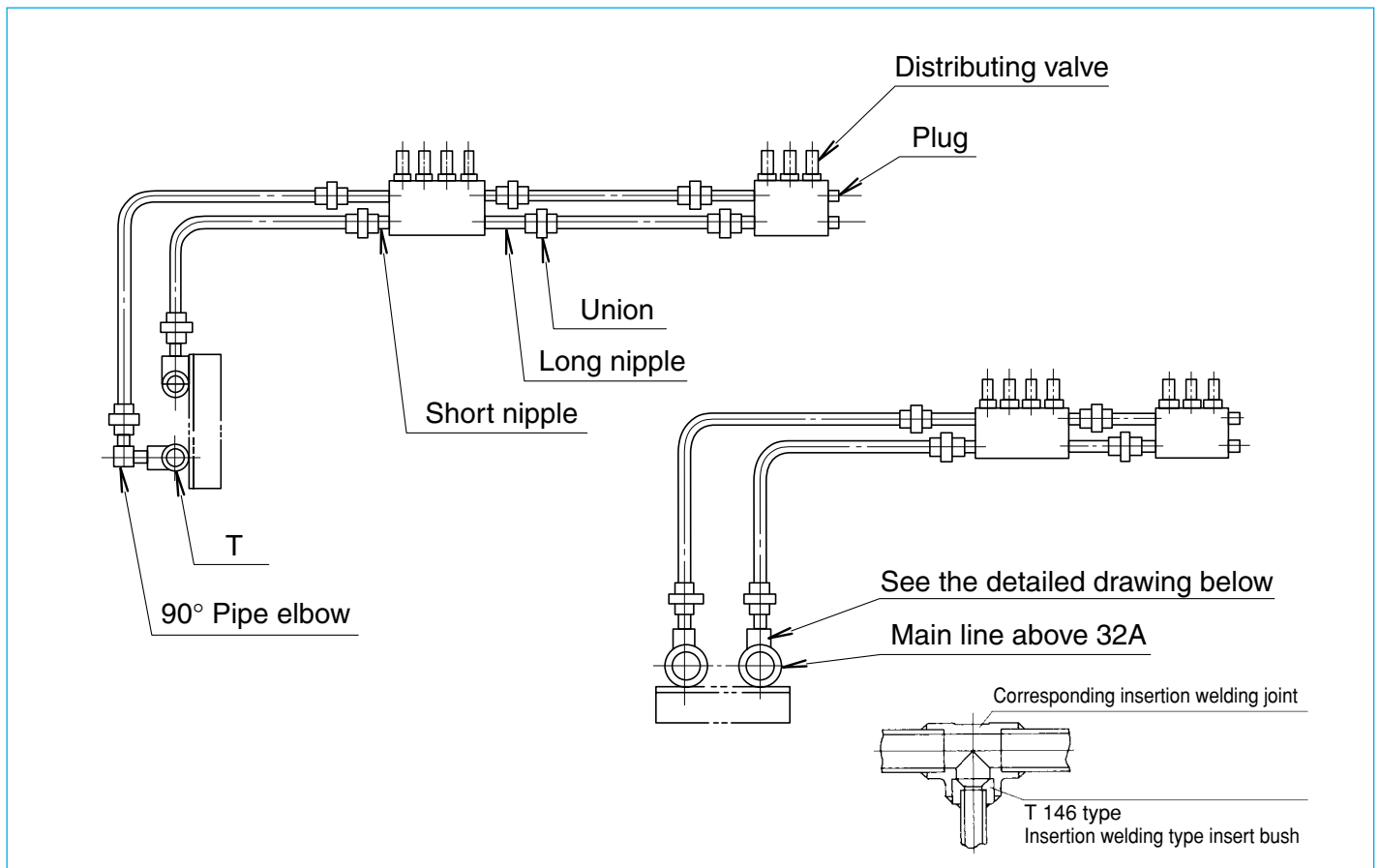
Piping plan

Example of piping procedure

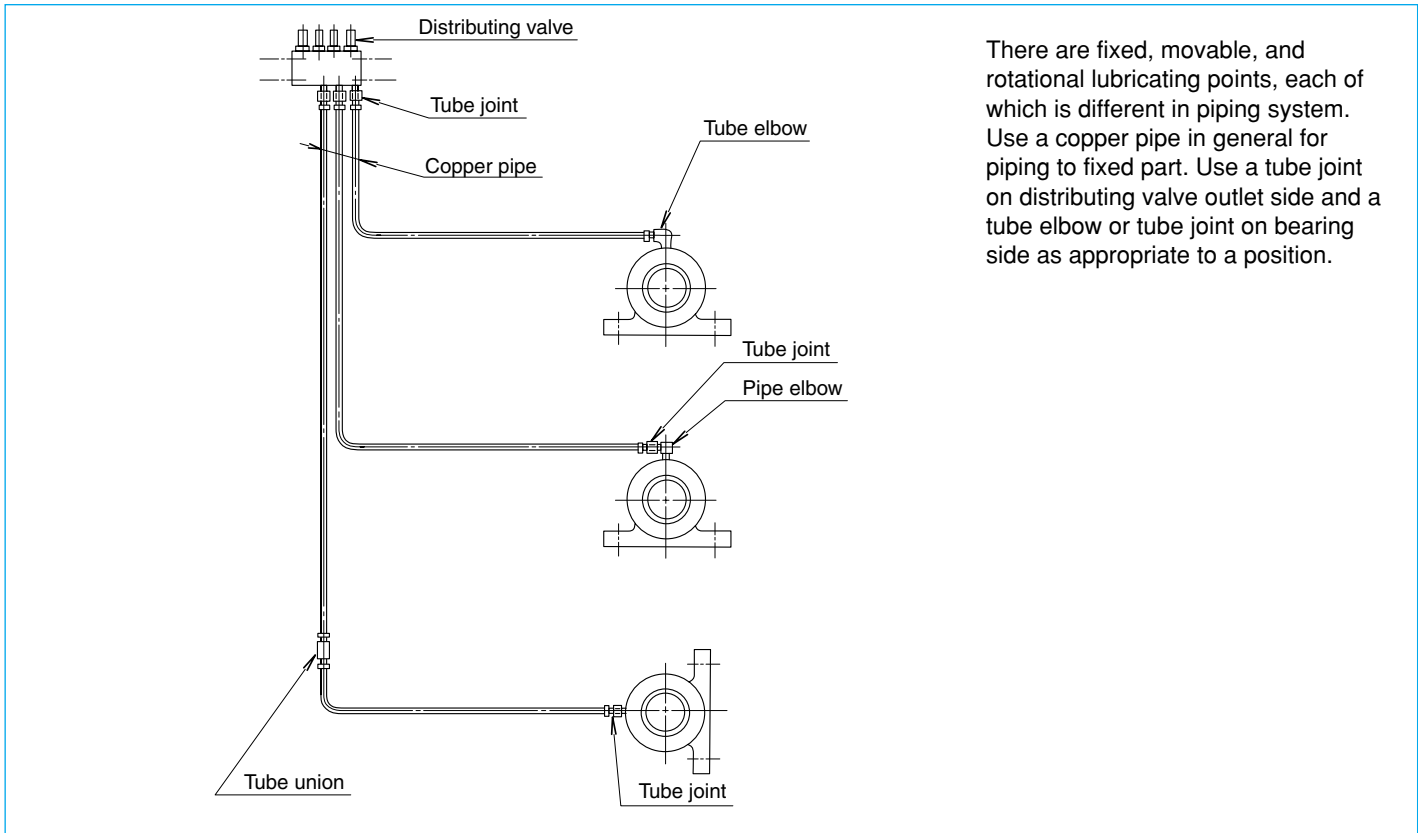
- Example of piping A (Manually operated pump: Example of using steel pipe screwed fitting)



- Example of piping B (Lead portion of branch line and distributing valve connection)

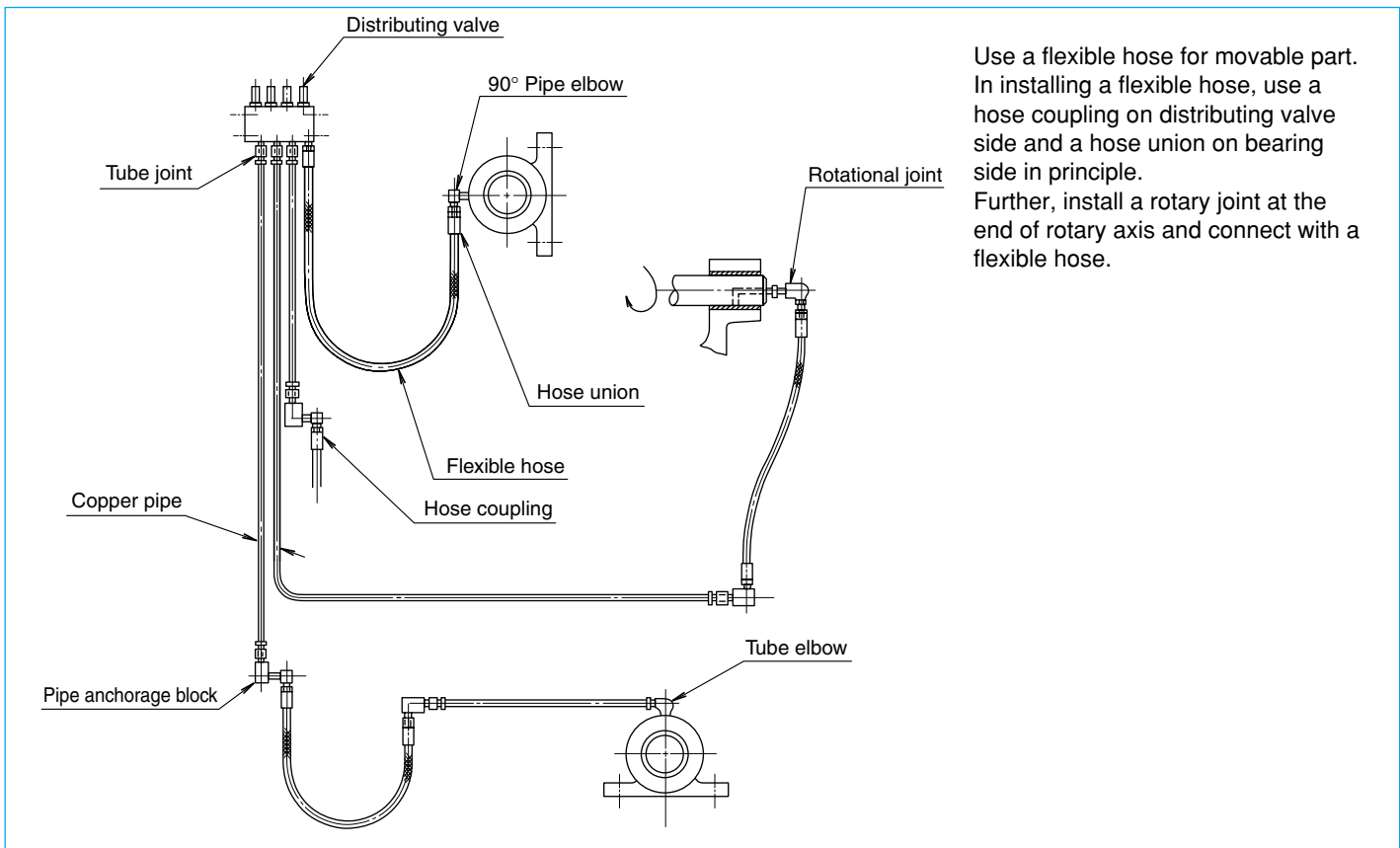


● Example of piping C (Discharging line < Distributing valve → Bearing > Piping procedure... Lubricating point fixed)



There are fixed, movable, and rotational lubricating points, each of which is different in piping system. Use a copper pipe in general for piping to fixed part. Use a tube joint on distributing valve outlet side and a tube elbow or tube joint on bearing side as appropriate to a position.

● Example of piping D (Discharging line < Distributing valve → Bearing > Piping procedure..... Moving/Rotation point)



Use a flexible hose for movable part. In installing a flexible hose, use a hose coupling on distributing valve side and a hose union on bearing side in principle. Further, install a rotary joint at the end of rotary axis and connect with a flexible hose.