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

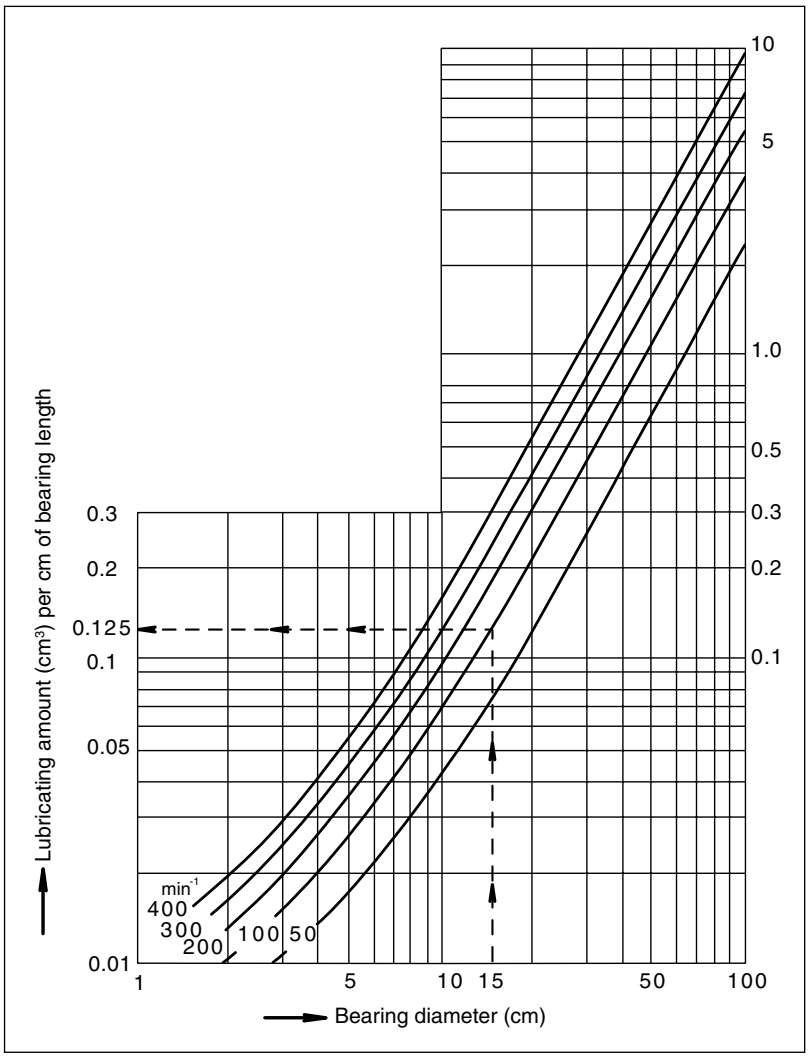
Check every points to be lubricated according to the drawing of main unit.
At the same time, check the type of bearing, size (such as axis diameter and bearing length), rotation speed, lubricating port screw diameter, fixing, and moving.
Then calculate the reference lubricating amount for each lubricating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

Reference lubricating 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) Multi row ball and roller bearing Double of (2)
(4) Sliding surface
Multiply the sliding surface area (cm^2) 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. Lubricating amount depends on load, clearance, sealing condition, atmosphere, property of grease and 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 lubricating amount.

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



In the table on the right, rise from the horizontal axis <15 cm>, and turn left at the intersection with 100/min curve, then the value <0.125> is obtained on the vertical axis. Multiply it by the axial length 18 (cm) to provide 2.25 cm^3. It is the reference lubricating amount.

■Combination plan of distributing valve

Planning is made just by filling the table below:

Bearing number	Bearing designation	Type	Dimension (mm)	Reference lubricating amount (cm^3/4H)	Ratio	Middle unit	Distributing valve	Planned oil (cm^3/4H)
A	B	C	D	E	F	G	H	I

1) Collect the bearings to be lubricated placed closer to the middle to form a bearing group. (The number of bearings is 2 - 16 within the distance approx. 4m from the distributing valve.)
2) Describe the number of bearings in the column A and the designation of bearing in the column B of the table for each bearing group.
3) Describe the abbreviation of bearing type (flat bearing - PL, roller bearing - AF, gear - G, sliding surface - SW) in the column C.
4) Describe the size of bearing in the column D.
5) Describe the reference lubricating amount calculated from the figure (P32) in the column E.
6) Describe the relative ratio of reference lubricating amount within the same group in the column F.
7) Describe the type of distributing valve middle unit according to the ratio.
   Here, the distributing valve is available in MG, MX, M, and MJN series. See the table below showing which series is to be applied.
8) Describe the schematic drawing of distributing valve according to the determined intermediate element type in the column H.
9) Describe the planned lubricating amount sent from the pump to the bearing in the column I.

Pump discharging amount (cm^3/min)	Parent distributing valve	Child distributing valve
-50	MX or M	M or MJN
50-500	MX	M

Memo
If you plan circulating lubrication, contact us.

Ratio	MJN distributing valve	M distributing valve	MX distributing valve
1	5T	10T	25T
1.5		15T	
2	10T, 5S	20T, 10S	50T, 25S
2.5		25T	
3	15T	30T, 15S	75T
3.5		35T	
4	10S	20S	100T, 50S
5		25S	125T
6	15S	30S	150T, 75S
7		35S	
8			100S
10			125S
12			150S

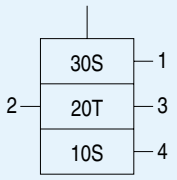
Memo
See the item of distributing valve on the catalogue for discharging amount per port of distributing valve.
Numeric such as 10T and 25S shows discharging amount, and the reference is 1cu.IN./1000 (0.0164 cm^3) per element.
The alphabet T represents a intermediate element with two discharging ports, and S for one discharging port.

Piping plan

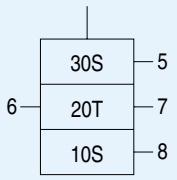
Example of description

Take an planning example of lubrication of plastic molding machine. Assume that there are 18 lubricating points, and grease is used for lubricant. Time unit of lubricating amount is every 4 hours for grease.

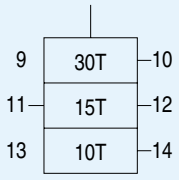
Group A

Bearing number	Designation of bearing	Type	Size (mm)	Reference lubricating amount (cm^3/4H)	Ratio	Intermediate element	Distributing valve	Planned lubricating amount (cm^3/4H)
1	Front pin	PL	ø2005120	1.88	3	30S		2.01
2	Tie rod bush	PL	ø1005 80	0.63	1	20T		0.67
3	Tie rod bush	PL	ø1005 80	0.63	1	20T		0.67
4	Wear plate	SW	ø3005 85	0.64	1	10S		0.67
	Sum			3.78	6			

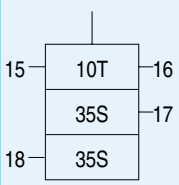
Group B

Bearing number	Designation of bearing	Type	Size (mm)	Reference lubricating amount (cm^3/4H)	Ratio	Intermediate element	Distributing valve	Planned lubricating amount (cm^3/4H)
5	Front pin	PL	ø2005120	1.88	3	30S		2.01
6	Tie rod bush	PL	ø1005 80	0.63	1	20T		0.67
7	Tie rod bush	PL	ø1005 80	0.63	1	20T		0.67
8	Wear plate	SW	ø3005 85	0.64	1	10S		0.67
	Sum			3.78	6			

Group C

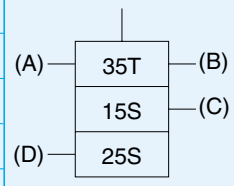
Bearing number	Designation of bearing	Type	Size (mm)	Reference lubricating amount (cm^3/4H)	Ratio	Intermediate element	Distributing valve	Planned lubricating amount (cm^3/4H)
9	Center pin	PL	ø1205100	0.94	3	30T		0.94
10	Center pin	PL	ø1205100	0.94	3	30T		0.94
11	Trunnion pin	PL	ø905 65	0.46	1.5	15T		0.47
12	Trunnion pin	PL	ø905 65	0.46	1.5	15T		0.47
13	Guide rod bush	PL	ø805 50	0.31	1	10T		0.31
14	Guide rod bush	PL	ø805 50	0.31	1	10T		0.31
	Sum			3.42	11			

Group D

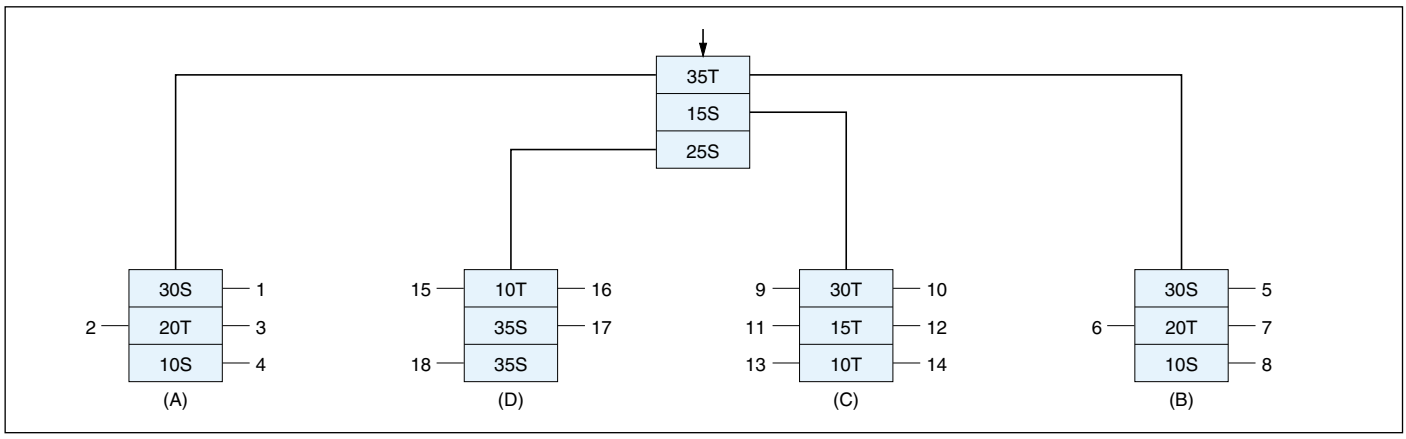
Bearing number	Designation of bearing	Type	Size (mm)	Reference lubricating amount (cm^3/4H)	Ratio	Intermediate element	Distributing valve	Planned lubricating amount (cm^3/4H)
15	Guide rod bush	PL	ø805 50	0.31	1	10T		0.36
16	Guide rod bush	PL	ø805 50	0.31	1	10T		0.36
17	Rear pin	PL	ø2005135	2.12	7	35S		2.51
18	Rear pin	PL	ø2005135	2.12	7	35S		2.51
	Sum			4.86	16			

Summary of group

Enter the sum of reference lubricating amount of group A - D, calculate the lubricating ratio, and make a plan of parent distributing valve.

Group name	Reference lubricating amount (cm^3/4H)	Ratio	Intermediate element	Distributing valve	cm^3/cycle	cm^3/7cycle
A Group	3.78	3.5	35T		0.574	4.018
B Group	3.78	3.5	35T		0.574	4.018
C Group	3.42	3.0	15S		0.492	3.444
D Group	4.86	5.0	25S		0.82	5.74
	15.84	15			2.46	17.22

System diagram



Parent - Child - Grandchild distribution system

When there are more lubricating points, bring them together as a child distributing valve, and bring together some child distributing valves further as a parent distributing valve to form a so-called three-stage configuration of parent - child - grandchild. It applies only to grease use.

In other words, configuration is allowed up to two stages for oil, and up to three stages for grease. It is for ensuring reliable lubrication and alarm operation in the case of blockage.

Piping plan

Investigation

1. Lubricating amount for parent distributing valve to make one cycle (see the system drawing on the previous page) is 0.0164 cm^3 × (35 + 15 + 25) × 2 = 2.46 cm^3, therefore, in order to send total lubricating amount 15.84 cm^3, the number of required cycles is 15.84 cm^3÷ 2.46 cm^3 = 6.4.
   As for parent distributing valve in actual use, 6.4 → 7 cycles can be performed within specified time for finishing in integer times. Assume that the parent distributing valve performs 7 cycles, then the amount of lubricant sent to each distributing valve is as follows:

Group A:	$0.574cm^3 \times 7 = 4.018cm^3$
Group B:	$0.574cm^3 \times 7 = 4.018cm^3$
Group C:	$0.492cm^3 \times 7 = 3.444cm^3$
Group D:	$0.82cm^3 \times 7 = 5.74cm^3$

2. For group A and B, the amount sent from parent distributing valve is 4.018 cm^3. Using the distribution ratio in child distributing valve,

Bearing number:		
1.	(5)	$4.018cm^3 \times 3/6 = 2.01cm^3$
2.	(6)	$4.018cm^3 \times 1/6 = 0.67cm^3$
3.	(7)	$4.018cm^3 \times 1/6 = 0.67cm^3$
4.	(8)	$4.018cm^3 \times 1/6 = 0.67cm^3$

3. For group C, the amount sent from parent distributing valve is 3.444 cm^3. Using the distribution ratio in child distributing valve,

Bearing number:	
9.	$3.444cm^3 \times 3/11 = 0.94cm^3$
10.	$3.444cm^3 \times 3/11 = 0.94cm^3$
11.	$3.444cm^3 \times 1.5/11 = 0.47cm^3$
12.	$3.444cm^3 \times 1.5/11 = 0.47cm^3$
13.	$3.444cm^3 \times 1/11 = 0.31cm^3$
14.	$3.444cm^3 \times 1/11 = 0.31cm^3$

4. For group D, the amount sent from parent distributing valve is 5.74 cm^3. Using the distribution ratio in child distributing valve,

Bearing number:	
15.	$5.74cm^3 \times 1/16 = 0.36cm^3$
16.	$5.74cm^3 \times 1/16 = 0.36cm^3$
17.	$5.74cm^3 \times 7/16 = 2.51cm^3$
18.	$5.74cm^3 \times 7/16 = 2.51cm^3$

Enter the lubricating amount obtained from calculation above in the planned lubricating amount column 1. If it is close to the reference lubricating amount, this system is applicable.

■Determine the following things before making a plan:

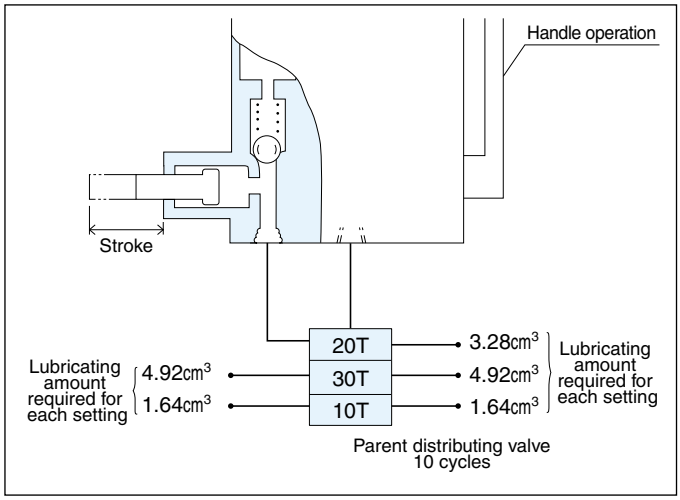
1. Selection of pump (See respective catalogue and drawing for detail.)
   Manually operated pump: KM type (tank capacity 1.6 - 4 ℓ)
   Motor driven Pump : AKA type (tank capacity 2 - 25 ℓ)
   Motor driven Pump : LBP type (drum of 200 ℓ)

2. Selection of control panel (See page 26 - 31 for detail.)
   Motor driven pump control panels all apply multiple count system.

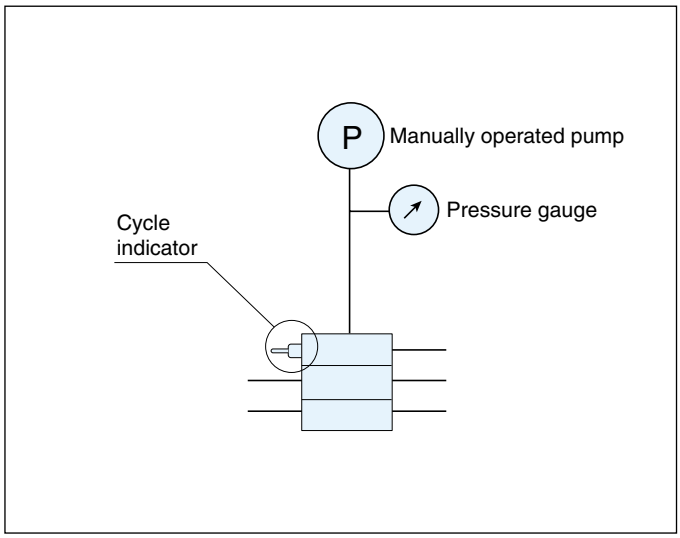
3. When the items above are determined, combination systems are available as follows:
   Manually operated pump + check of lubrication by pump indicator
   Manually operated pump + check of lubrication by watching distributing valve cycle pin –
   (When distributing valve can be checked by sight)
   Motor driven Pump + distributing valve cycle count system

■Manually operated pump system

1. When using KM type manually operated pump
   KM type manually operated pump incorporates "Pump indicator" for checking lubricating amount. When planning a parent distributing valve, provide one more extra discharging port for pump indicator, and connect it to the pump indicator, then lubrication to another discharging port can be known by the motion of indicator. Capacity of indicator is 3.28 cm³ per stroke.



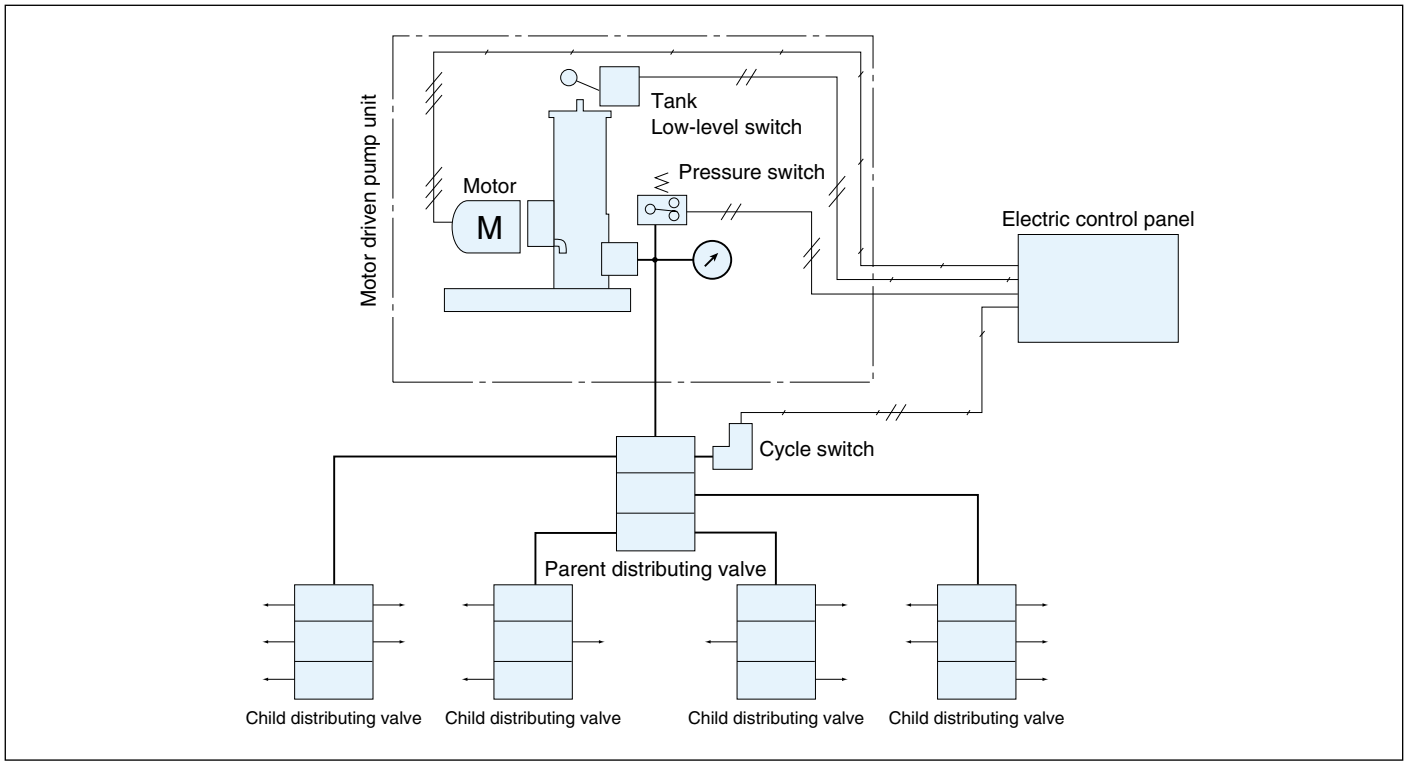
2. When using a manually operated pump other than KM type, choose a parent distributing valve equipped with "Cycle indicator", and count the motion of such indicator by sight to know lubricating amount.



Piping plan

Motor driven pump system

1. Configuration



2. Operation

Lubrication is automatically started by the system timer in the control panel, and lubricating amount is weighed through the motion of parent distributing valve. When it reaches specified amount, lubrication is stopped. In trouble mode, alarm is issued such as lubricating time extension, empty tank, overload and high pressure trouble, and the pump is stopped.

3. Selection of pump

When lubricating amount is rather small, use AKA type pump; when large, use LBP type pump. Choose a pump equipped with pressure switch and low level switch in either case.
See respective catalogue or drawing for detail of pump.

4. Control panel

There are three models available for standard control panel:

(1) EK - 3(T) type.....For mechatronics integration type generally to be combined with AKA-108AK type pump in use
Trouble alarm is displayed comprehensively.

(2) EK - 4(T) type.....Floor-mounted type generally to be combined with AKA-125AK type pump in use
Trouble alarm is displayed individually.

(3) EK - 5(T) type.....Wall type compatible with all AKA models and LBP type pump
Trouble alarm is displayed individually.

■Piping plan

When lubricant is supplied from the pump to supply line → distributing valve → lubricating line → bearing, pressure loss is found in distributing valve and piping.
Rated pressure of the pump is 21MPa for both manually operated and motor driven type, while design reference pressure in planning piping is 17MPa. The difference 4MPa between rated pressure and design reference pressure is a detectable range when distributing valve and piping are blocked.

1. Pressure loss of distributing valve

Lubricant / Distributing valve type	Grease NLGI NO. 0 and 1 Flow rate: 72 cm^3/min or below	Oil 10,000 cst or below Flow rate: 200 cm^3/min or below
MX	1.0MPa	0.8MPa
M, MJN	1.5MPa	1.2MPa

2. Pressure loss of piping

Unit : MPa/m

Flow rate / Piping size	cm^3/min 72	36	24	18	12	8	4
15A, ø18×ø14	0.19	0.16	0.15	0.14	0.13		
10A, ø15×ø11	0.29	0.25	0.22	0.20	0.18		
ø12×ø 9		0.37	0.33	0.30	0.25	0.22	
ø 8×ø 6					0.54	0.50	0.42
ø 6×ø 4						1.10	0.90

- 15A and 10A in the table correspond to STPG370 Sch80.
- Pressure loss in the table is a standard value at 0˚C for centralized lubricating all-purpose grease (lithium base) NO. 1. As for grease No. 2 or special grease such as thermal resistant grease, pressure loss must be calculated each time.

3. Piping material

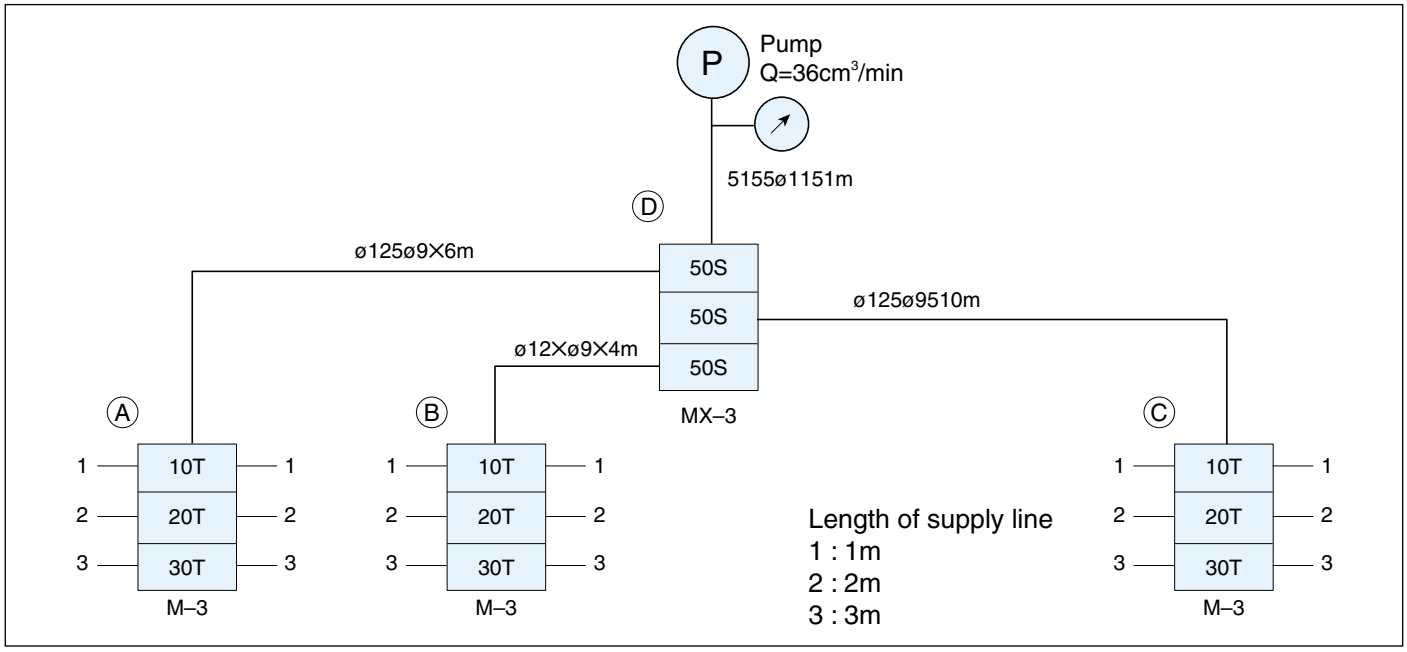
Product name	Standard number	Symbol	Applicable position
Precision carbon steel pipe for hydraulic piping, Class 2	JOHS – 102	OST – 2	General use
Carbon steel pipe for pressure piping, Class 2	JI S G3454	STPG370	For supply line
Seamless copper pipe	JI S G3609	C1221T – 1/2H	For discharge line
Nylon tube			For discharge line
Stainless steel pipe for piping	JI S G3459	SUS304TP	General use

Memo
JOHS-102 represents article 102 of Japan Hydraulic Industry Association Standard.

Choose pipe material which withstands the maximum pressure expected in lubricating system.
Use ordinary hydraulic piping use precision carbon steel pipe class 2 (OST-2) and bite-type joint for supply line.
Use high pressure flexible hose (normal working pressure 21MPa) and swivel joint for moving part.
Use ordinary copper pipe (C1220T-1/2H) for discharge line. Use low pressure flexible hose (normal working pressure 3MPa) to moving point in general. When high pressure is expected due to bearing blockage and etc., use a high pressure flexible hose (normal working pressure 10.5MPa).

Piping plan

Example of calculating system operation pressure



1. Check the pressure loss of lubricant for each piping diameter.
   Applicable lubricant is centralized lubricating grease with NLGI consistency No. 1 (0˚C).
   Pressure loss is as follows:

• Diameter 15 × Diameter 11	0.25MPa/m	Allow for flow rate distribution factor and select	Q = 36 cm³/min.
• Diameter 12 × Diameter 9	0.25MPa/m	Allow for flow rate distribution factor and select	Q = 12 cm³/min.
• Diameter 8 × Diameter 6	0.5 MPa/m	Allow for flow rate distribution factor and select	Q = 8 cm³/min.

2. Calculation of pressure loss

P + D + A → 1

$$\frac{0.25\times1}{\text{ø15}\times\text{ø11–1m}}+\frac{1.0}{\text{MX}}+\frac{0.25\times6}{\text{ø12}\times\text{ø9–6m}}+\frac{1.5}{\text{M}}+\frac{0.5\times1}{\text{ø8}\times\text{ø6–1m}}+\frac{0.5}{\text{Bearing charging pressure}}=5.25\text{MPa}$$

P + D + B → 2

$$\frac{0.25\times1}{\text{ø15}\times\text{ø11–1m}}+\frac{1.0}{\text{MX}}+\frac{0.25\times4}{\text{ø12}\times\text{ø9–4m}}+\frac{1.5}{\text{M}}+\frac{0.5\times2}{\text{ø8}\times\text{ø6–2m}}+\frac{0.5}{\text{Bearing charging pressure}}=5.25\text{MPa}$$

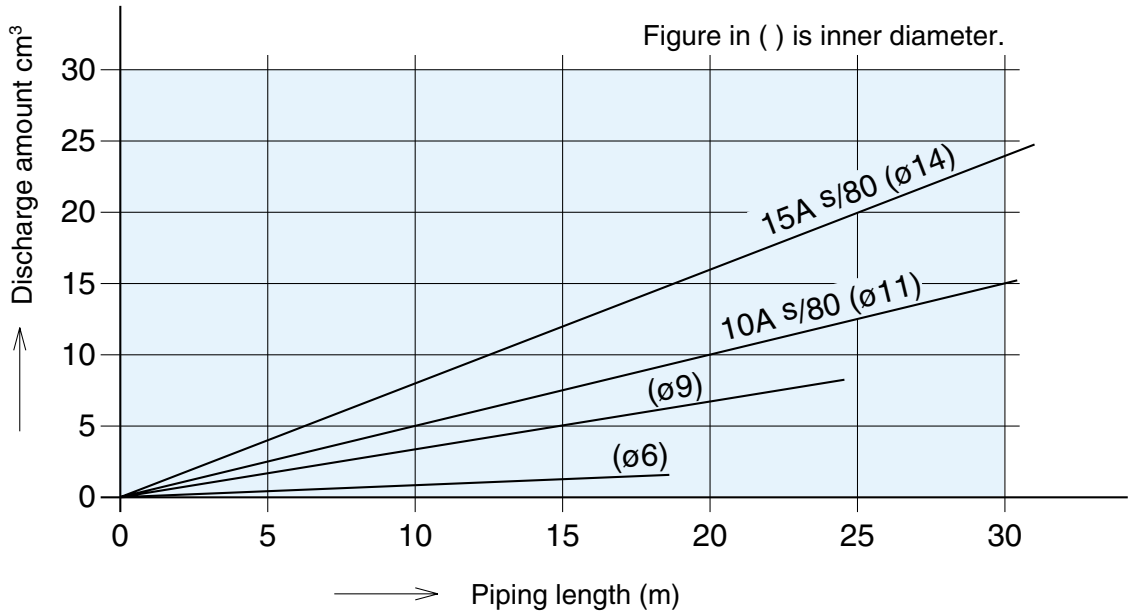
P + D + C → 3

$$\frac{0.25\times1}{\text{ø15}\times\text{ø11–1m}}+\frac{1.0}{\text{MX}}+\frac{0.25\times10}{\text{ø12}\times\text{ø9–10m}}+\frac{1.5}{\text{M}}+\frac{0.5\times3}{\text{ø8}\times\text{ø6–3m}}+\frac{0.5}{\text{Bearing charging pressure}}=7.25\text{MPa}$$

Pump pressure is in the range from 5.25 to 7.25 MPa in this plan.

Detecting the blockage of distributing valve, piping and bearing

Described below is a condition for reliably executing "blockage detection" which is a feature next to "planned lubricating".
In blockage detection of motor driven pump system, change of pressure against normal operation pressure (high pressure) is detected by pressure switch for alarming.
Therefore, it is necessary to make a piping plan so that the pressure rises abruptly at the time of blockage. Pressure change in the piping is determined by the volume in piping and forced amount.
When lubricant is grease, it is assumed that inner piping pressure rises approx. 1 MPa when 1/1000 of piping inner volume is forced in.
In general, the time point when piping inner pressure rises 3 - 5 MPa is detected. Allowable length is indicated in the graph below for each forcing amount (distributing valve discharge amount per operation) and piping size with reference to pressure 5 MPa.



Description of correction mechanism

During the pump being stopped, it is possible that the distributing valve may operate to perform lubrication.

1) Pressure is high inside the piping between the pump and distributing valve immediately after the pump is stopped. This pressure actuates the distributing valve and is discharged to bearing side. Operation amount of distributing valve becomes the larger as the length of piping is the greater.
2) When the ambient temperature rises while the pump is stopped, lubricant in piping expands and actuates the distributing valve and comes out to the bearing side. The greater the change of temperature and volume in piping are, the greater is the operation amount of distributing valve.
3) When KM type manually operated pump and AKA type motor driven pump + standard electric control panel are combined, the amount discharged by "precedent operation" is automatically corrected in next lubrication operation.