Designing A Series-Flo® Feeder System

DESCRIPTION

The heart of a Trabon® Centralized Lubrication System is the lubricant distribution network. The basic procedure is as follows:

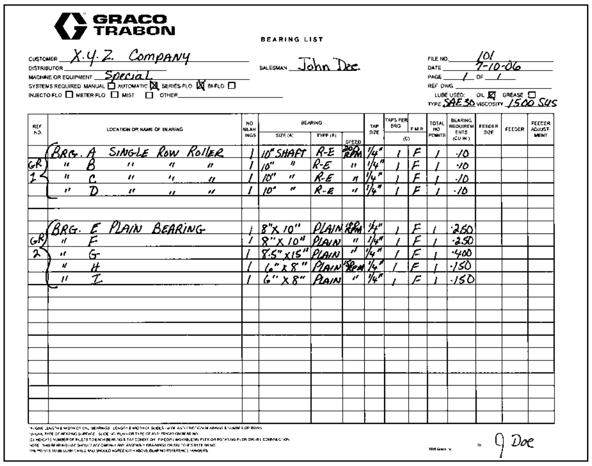
Design Procedures of a Series-Flo System —

1. Select a manual or automatic operation.
2. If automatic, determine the power available for the pump.
   - Pneumatic
   - Hydraulic
   - Mechanical
   - Electric
3. Select the type of control.
   - Visual
   - Machine
   - Timer
   - Count, Single or Multiple
   - Machine Cycle Control
4. Calculate bearing requirements (See Lit. No. 20115).
5. Design secondary divider valve assemblies.
6. Design master divider valve assembly.
7. Determine type and capacity of pump.
8. Select and design the control system.

Note: Parts 5 and 6 will be described in this literature. Other sections are covered in other Application Engineering Literature.

Review and Determine Requirements —

1. Drawing of machine and grouping of lubrication points.
2. A suggested and typical form for the listing of bearings is shown in Figure 1.



GRACO TRABON

BEARING LIST

CUSTOMER: X.Y.Z. Company
DISTRIBUTOR:
MACHINE OR EQUIPMENT: Special
SYSTEMS REQUIRED: MANUAL ☐ AUTOMATIC ☒ SERIES-FLO ☒ BI-FLO ☐
INJECTO-FLO ☐ METER-FLO ☐ MIST ☐ OTHER
SALESMAN: John Doe
FILE NO. 101
DATE 7-10-06
PAGE 1 OF 1
REF DWG
LUBE USED: OIL ☒ GREASE ☐
TYPE SAE 30 VISCOSITY 1500 SUS

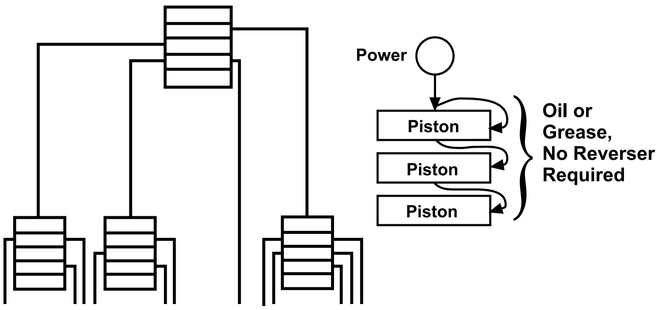
REF NO.	LOCATION OR NAME OF BEARING	NO BEARINGS	BEARING SIZE (A)	BEARING TYPE (B)	SPEED	TAP SIZE	TAPS PER BRG (C)	FMR	TOTAL NO POINTS	BEARING REQUIREMENTS (CU IN)	FEEDER SIZE	FEEDER	FEEDER ADJUSTMENT
	BRG. A SINGLE ROW ROLLER	1	10" SHAFT	R-E	200 RPM	1/4"	1	F	1	.10			
GR	" B " " "	1	10" "	R-E	"	1/4"	1	F	1	.10			
1	" C " " "	1	10" "	R-E	"	1/4"	1	F	1	.10			
	" D " " "	1	10" "	R-E	"	1/4"	1	F	1	.10			
	BRG. E PLAIN BEARING	1	8" x 10"	PLAIN	180 RPM	1/4"	1	F	1	.250			
GR	" F	1	8" x 10"	PLAIN	"	1/4"	1	F	1	.250			
2	" G	1	8.5" x 15"	PLAIN	"	1/4"	1	F	1	.400			
	" H	1	6" x 8"	PLAIN	150 RPM	1/4"	1	F	1	.150			
	" I	1	6" x 8"	PLAIN	"	1/4"	1	F	1	.150			

J Doe

Figure 1. Typical Bearing List

OPERATION

1. Proportioning System.
2. Divider Valve Operation. In a Series-Flo system, the divider valves operate in a sequential manner. Figure 2 illustrates a typical series system. Refer to floppy disk No. 412-C or the Graco web site for divider valve operation.



Typical Series-Flo Feeder Network

The divider valve is self-cycling and no reverser is required. It is made of up to 3 or more valve sections which contain metering pistons. The pistons move progressively back and forth. Each stroke of the piston displaces a measured amount of lubricant.

The total system is made up of a pump package and the distribution network. As long as flow is applied to the divider valves they will divide the lubricant.

The master divider valve, or first tier in the system, receives the full flow of the pump and divides this flow to the secondary divider valves. The secondary divider valves then redivide the lubricant

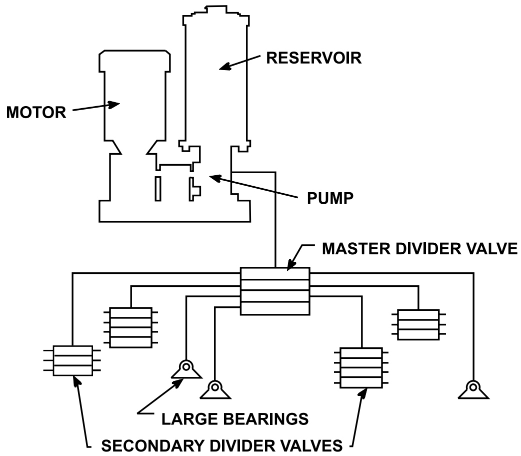
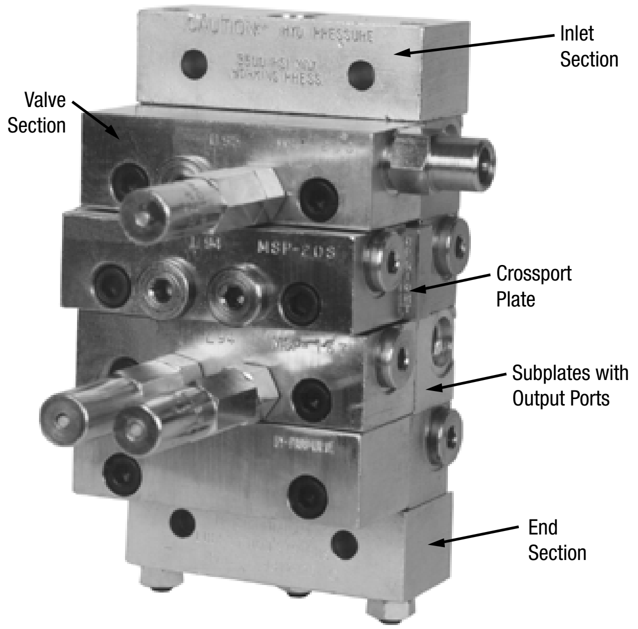


Figure 2. Series System Schematic

and distribute it to the bearing points. The actual amount of lubricant displaced to each outlet during each cycle of the feeder will depend on the diameter of the piston serving that outlet. How the total flow to the divider valve is divided will depend on the size of the pistons in each valve section and the number of valve sections. By combining the output of one or more valve sections (referred to as crossporting) a wide variety of dividing arrangements are available.

There is a number and a letter stamped on each valve section of a series divider valve. The number is the output (for each piston stroke) of that valve section per cycle of the feeder in thousandths of a cubic inch. The letter S or T indicates single or twin outlets. An S valve section is designed to discharge lube to only one point. The T valve section, or twin, must discharge lubricant to 2 bearings or have 2 discharge lines.
Singling and crossporting can be accomplished internally or with an external singling or cross-port kit.

The singling kit converts a T section into an S section. MD feeders are also available; they have a fixed number of discharge outlets (2, 3 or 4).



MJ			MSP			MX & MXP			MGO		
Size		Vol. (In 3) per outlet	Size		Vol. (In 3) per outlet	Size		Vol. (In 3) per outlet	Size		Vol. (In 3) per outlet
5T	–	.005	5T	–	.005	25T	–	.025	150T	–	.150
10T	5S	.010	–	5S	.010	50T	25S	.050	300T	150S	.300
15T	–	.015	10T	–	.010	75T	–	.075	450T	–	.450
–	10S	.020	15T	–	.015	100T	50S	.100	600T	300S	.600
–	15S	.030	–	10S	.020	125T	–	.125	–	450S	.900
–	–	–	20T	–	.020	150T	75S	.150	–	600S	1.200
–	–	–	25T	–	.025	–	100S	.200	–	–	–
–	–	–	–	15S	.030	–	125S	.250	–	–	–
–	–	–	30T	–	.030	–	150S	.300	–	–	–
–	–	–	35T	–	.035	–	–	–	–	–	–
–	–	–	–	20S	.040	–	–	–	–	–	–
–	–	–	40T	–	.040	–	–	–	–	–	–
–	–	–	–	25S	.050	–	–	–	–	–	–
–	–	–	–	30S	.060	–	–	–	–	–	–
–	–	–	–	35S	.070	–	–	–	–	–	–
–	–	–	–	40S	.080	–	–	–	–	–	–

T = Two Outlets S = One Outlet

Crossporting joins two adjacent valve sections combining their capacities.

Example: 15S & 15S yields .060 in ^{3}/cycle
10S & 25S yields .070 in ^{3}/cycle
150S & 150S & 150S yields .900 in ^{3}/cycle

Ratios available are infinite.

Example: 5T & 15S ⟶ 1:6 = .030/.005
10T & 35T ⟶ 1:3.5 = .035/.010
25T & 30T ⟶ 1:1.2 = .030/.025
10T & Crossported 35S & 35S ⟶ 1:14 = .140/.010
30T & 35T ⟶ 1:1.17 = .035/.030

SYSTEM DESIGN

MD Divider Valves —
The **MD-2** is designed to discharge lube to two points, each receiving .040 cubic inches per cycle.
The **MD-3** divider valve is designed to discharge lube to three points. Two points receive .020 cubic inches per cycle and one point receives .040 cubic inches per cycle.
The **MD-4** divider valve is designed to discharge lube to four points. Each point receives .020 cubic inches per cycle.
The **MD-6** divider valve is designed to discharge lube to six points. Each point receives .010 cubic inches per cycle.

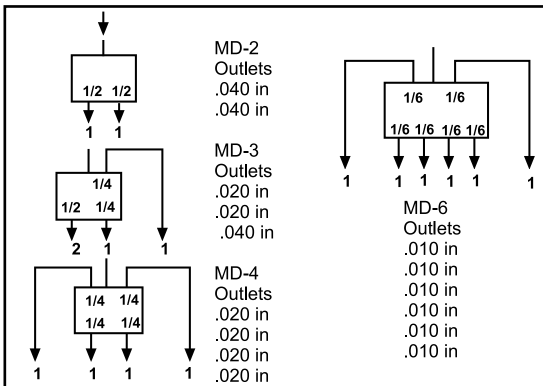


Figure 4. Proportionate Amount

Typical Divider Valve Combinations

Master	Secondary	Type of Application
MJ	MD	Machine Tools Printing, Wire Forging & Packaging Machinery
MSP	MJ, MSP	Machine Tools Textile, Glass, & Can Machinery Mobile Equipment
MX, MXP	MX, MXP, MSP	Cranes, Presses, Steel Mills, etc.
MG	MX	Levellers, Shears, Conveyors, etc.

Note: For small machinery use the smaller series divider valves. Larger Machinery uses the larger series divider valves.

Proportioning —
The proportioning of lubricant in a Series-Flo system depends on the relative size of the outputs in a divider valve. Therefore, to size the outputs correctly one need only know the relative size of the lubricant requirements. This relative size is called "The Basic Ratio."

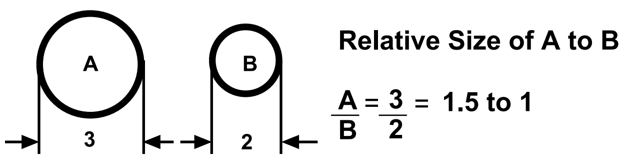


Figure 5. The Basic Ratio

To obtain the basic ratios of a group of bearings, divide the lubricant requirement of each bearing by the smallest lube requirement of the group. Refer to Calculating Lube Requirements, Trabon Application Engineering Lit. No. 20115.

Bearing	Units of Lubricant Required in a Given Time Period	Basic Ratio
A	3	1
B	4	1.33
C	6	2
$A = 3/3 = 1$	$B = 4/3 = 1.33$	$C = 6/3 = 2$

This illustration shows both the relative and actual quantity of lubricant discharged during one complete cycle of the divider valve.

It can be seen in Figure 6 that the total lubricant discharged during one cycle is .150 cubic inches. Conversely, if .150 cubic inches of lubricant is supplied to the inlet of this divider valve it will complete one cycle.

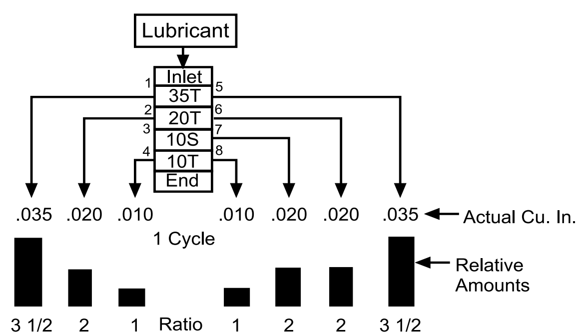
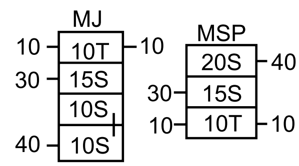


Figure 6. Proportioning

Examples – By multiplying the basic ratio by the divider valve size (5,10,15, 20, etc.) the actual divider valve sections can be determined.

Vol. Req.	Basic Ratio	Basic Ratios	
		X5	X10
.360 In.^{3}	3	15	30
.480 In.^{3}	4	20	40
.120 In.^{3}	1	5	10
.120 In.^{3}	1	5	10



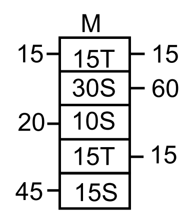
Note: The MSP divider valve would be preferred since three (3) valve sections only are required and no crossporting is necessary.

When a whole number cannot be obtained, use the next higher whole number. In this case the 19.5 ratio requirement will be a 20 size valve section.

Typical Pipe/Tube Connections

	Pump to Master	Master to Secondaries	Bearing Lines
MX	1/2P, 1/2T,3/8T	3/8P, 3/8T	3/8, 1/4P
MX to MSP	3/8P, 3/8T	3/8T	3/8T, 1/4T
MSP	3/8T, 1/4T	1/4T	1/4T, 3/16T
MSP to MJ	3/8T, 1/4T	1/4T, 3/16T	1/4T, 3/16T, 1/8T

Vol. Req.	Basic Ratios	Basic Ratios		
		X5	X10	X15
.100 In.^{3}	1	5	10	15
.130 In.^{3}	1.3	6.5	13	19.5
.300 In.^{3}	3	15	30	45
.400 In.^{3}	4	20	40	60
.100 In.^{3}	1	5	10	15
.100 In.^{3}	1	5	10	15



Note: Use the large pipe and tube sizes for grease applications and the smaller size for oil.

SAMPLE DESIGN PROBLEMS

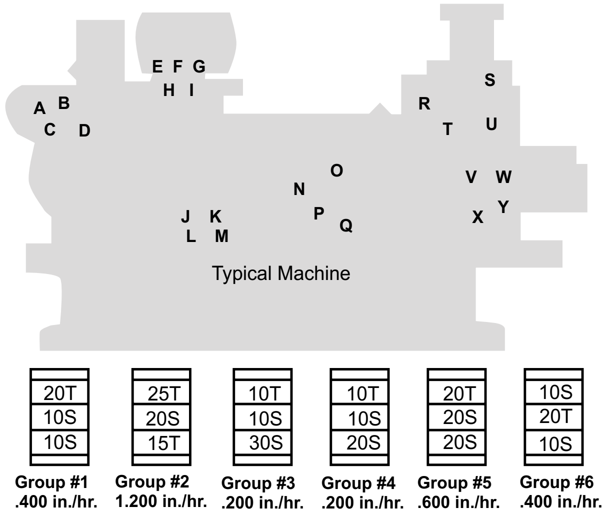
Example A — Design Secondary Divider Valve Assemblies —

1. Group bearings.
2. Calculate volume required (refer to Application Engineering Lit. No. 20115).
3. Design secondary divider valve and master.
4. Use MSP size divider valves. Use replacement film thickness "T". T = .001 inches/hour for oil systems.

The first consideration in designing a divider valve network is to make a machine survey (Figure 7) to determine the location and size of bearings. Following is an example problem and illustration showing a basic design using MSP divider valves in the system. Also refer to the "Bearing List" (Figure 1) form for a description of each bearing.

1. Group 1 illustrates four single row roller bearings (see Example A).
2. Group 2 illustrates five plain bearings (see Example A).
3. Groups 3 through 6 are not detailed; however, total volume and MSP divider valve is shown (see Example B).

Figure 7. Machine Survey



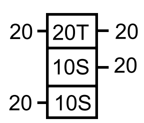
Lube points in a group are generally located close to each other and/or are located on a moving machine member.

Group 1 — Single Row Roller Bearings — Vol = $D^2R \times T$

	Dia.^{2} x Rows = Area			A x T = Volume/Hr.
A.	$(10)^2$	1	100 in.^{2}	100 x .001 = .100
B.	$(10)^2$	1	100 in.^{2}	100 x .001 = .100
C.	$(10)^2$	1	100 in.^{2}	100 x .001 = .100
D.	$(10)^2$	1	100 in.^{2}	100 x .001 = .100
				Total = .400 Cu. in/hr.

MSP System —

Vol./Hr.	Basic Ratio	x10	x 20
.100	1	10	20
.100	1	10	20
.100	1	10	20
.100	1	10	20



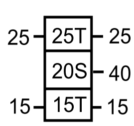
Group 1 — Secondary

Group 2 — Plain Bearings — Vol. = $\pi DL \times T$

	Dia. x L x π = Area				A x T = Volume/Hr.
E.	8	10	3.14	250 in.^{2}	250 x .001 = .250
F.	8	10	3.14	250 in.^{2}	250 x .001 = .250
G.	8.5	15	3.14	400 in.^{2}	400 x .001 = .400
H.	6	8	3.14	150 in.^{2}	150 x .001 = .150
I.	6	8	3.14	150 in.^{2}	150 x .001 = .150
					Total = 1.200 cu. in./hr.

MSP System —

Vol ./Hr.	Basic Ratio	x 10	x 15
.250	1.67	16.7	25
.250	1.67	16.7	25
.400	2.67	26.7	40
.150	1	10	15
.150	1	10	15



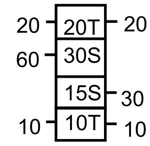
Group 2 — Secondary

Example B – Design Master Feeder Assembly —

1. List volume required for groups.
2. Design master divider valve — consider each secondary divider valve as a lubrication point with the total volume required equal to the total of all the points served by the secondary.

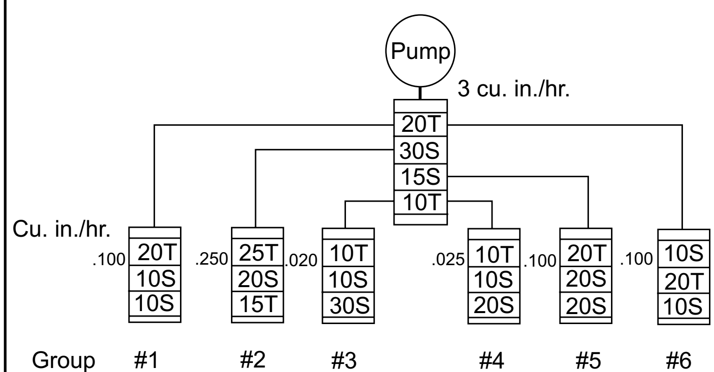
MSP System —

Group	Vol/Hr.	Basic Ratio	x 10
1	.400	2	10 = 20
2	1.200	6	10 = 60
3	.200	1	10 = 10
4	.200	1	10 = 10
5	.600	3	10 = 30
6	.400	2	10 = 20



Master Feeder

NOTE: Series Progressive divider systems designs should be limited to the use of one or two stages only. The use of a third tier of dividers is not recommended.



Cycles/hr. = $\frac{\text{Required output/hr}}{\text{Output Cycle}}$ $\frac{.100 \text{ Cu. in./hr.}}{.020 \text{ Cu. in./Cycle}}$ = 5 Cycles/hr.

$\frac{.100}{.020}$	$\frac{.250}{.025}$	$\frac{.020}{.010}$	$\frac{.025}{.010}$	$\frac{.100}{.020}$	$\frac{.100}{.020}$
5	10	2 Cycles/hr.	2.5	5	5

Master = $\frac{\text{Group \#1 Volume Required/hr.}}{\text{Output/Cycle to Group \#1}}$ $\frac{.400}{.020}$

Figure 8. Final System Calculations

This system will require 3 cubic inches per hour of lube which can be discharged in several ways. Example: An ALS-25 pump, set at approximately .100 cubic inches per cycle could be operated 30 times per hour. 30 cycles/hour x .1 cubic in/cycle = 3 cubic in./hr.

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