Maxi-Flo® System

DESCRIPTION

The Graco® Maxi-Flo® System consists of the compact Maxi-Flo pump/control package and Trabon MJ Divider Valves to provide positive, automatic, centralized series lubrication for low pressure applications. Designed for machinery requiring oil lubrication, the self-contained, easy to install package includes a reservoir, electrical motor driven positive displacement pump, and a choice of three control modes.

The amount of lubricant supplied to the system is adjustable and can be controlled by a timed cycle, a stroke count cycle (machine operation), or wired directly to the machine control system.

The MJ Divider Valve, the heart of the Maxi-Flo system, contains precision match honed pistons of different diameters to accurately meter oil in various quantities. The series progressive design and operation of the MJ Divider Valves provide positive displacement of lubricant to all points at all times. Variations in viscosity due to changes in temperature or types of lubricant will not affect the positive delivery of oil to the lube points.

SYSTEM OPERATION

In a Maxi-Flo system the divider valves operate in a sequential manner (See Figure 1). Figure 2 illustrates a typical system. Refer to engineering slide card No. 412-C.

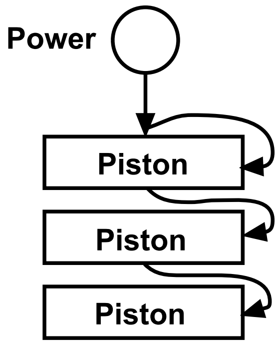


Figure 1

The divider valve is self-cycling and no reverser is required. It is made up of 3 or more intermediate sections which contain metering pistons. The pistons move progressively back and forth.

The system consists of a Maxi-Flo pump and MJ Series Divider Valves. MJ Divider Valves are positive displacement, Series-Flo type. Each valve piston must complete its stroke, dispensing a measured amount of lubricant to the location it serves before the inlet flow is ported to the next valve position.

The master divider valve, or first divider valve in the system, receives the full flow of oil from the pump, and divides it to the secondary divider valves. The secondary divider valves then re-divide the oil to the bearing points. The actual amount of oil necessary to satisfy each lubrication point determines the size of the piston serving that outlet. The size of the pistons and the number of intermediate sections determine the total flow as well as the distribution of oil. A wide variety of arrangements are possible by combining the output of one or more intermediate sections (referred to as crossporting).

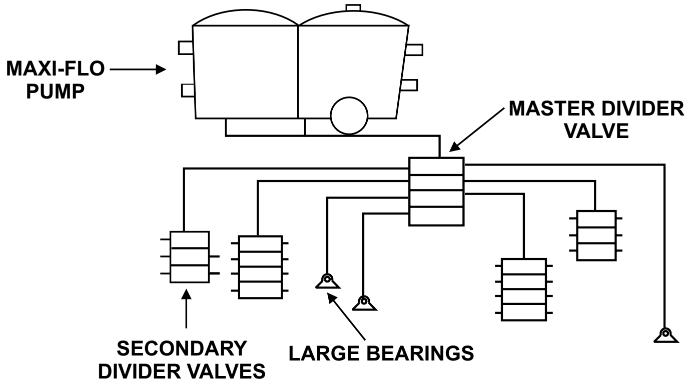


Figure 2 Typical Maxi-Flo System

There is a number and a letter stamped on each intermediate section of the divider valve. The number is the output (for each position stroke) of that intermediate section per cycle of the divider valve in thousandths of a cubic inch., The S or T indicates single or twin outlets. An S intermediate section is designed to discharge oil to only one point. The T intermediate section, or twin, discharges oil to two points.

Singling and crossporting can be accomplished internally (intermediate sections can be ordered as singles or twins), or with an external singling or crossporting bar.

MJ Divider Valve		
Size		Volume (in^3) Per Outlet
5T		.005
10T	5S	.010
15T		.015
	10S	.020
	15S	.030

T = Two Outlets S = One Outlet

Figure 3

Crossporting joins two adjacent intermediate sections, thus combining their capacities.

Example: 15 S & 15 S yields .060 cu.in./cycle
10 S & 10 S yields .040 cu.in./cycle

A wide range of ratios are available.

Example:

5T & 15S ⟶ $\frac{0.030}{0.005}$ = 1:6

10T & 15S ⟶ $\frac{0.030}{0.010}$ = 1:3

10T & 15T ⟶ $\frac{0.015}{0.010}$ = 1:1.5

15S Sections ⟶ $\frac{0.060}{0.005}$ = 1:12

SYSTEM DESIGN

Proportioning—

The proportioning of oil in a Maxi-Flo system depends on the relative size of the pistons in a divider valve. Therefore, to size the pistons correctly one need only know the relative size of the oil requirements. This relative size is called "The Basic Ratio."

Relative Size of A to B

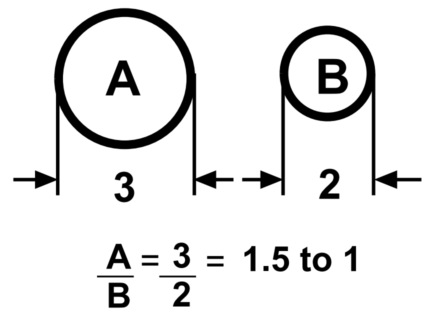


Figure 4 The Basic Ratio

To obtain the basic ratios of a group of bearings, divide the lubricant requirements of each bearing by the smallest oil requirements of the group. (Refer to calculating lube requirements, Trabon Application Engineering Lit. No. L20115.)

Example:

Bearing	Unit of Oil Required in a Given Time Period	Basic Ratio
A	2	1
B	3	1.5
C	4	2
A = 2/2 =1	B = 3/2 = 1.5	C = 4/2 = 2

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

It can be seen in Figure 5 that the total oil discharged by the divider valve during one cycle is .080 cubic inches. Conversely, if .080 cubic inches of oil is supplied to the inlet of this divider valve it will complete one cycle.

(One cycle equals Ts x 2)
(Where Ts = total of intermediate section sizes)

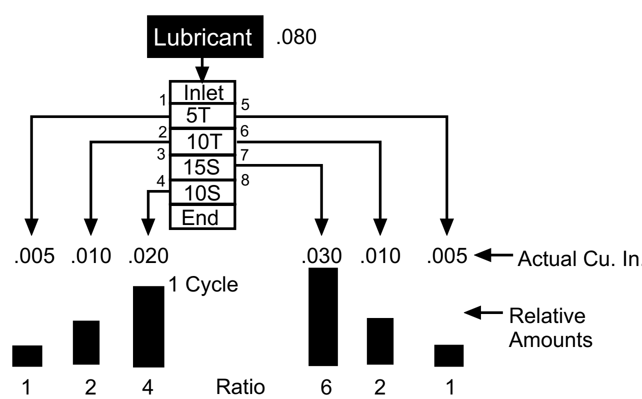


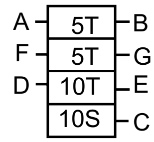
Figure 5 Proportioning

Examples:

By multiplying the basic ration by the smallest intermediate section capacity (5) the actual section size can be determined.

Bearing Designation	Calculated Bearing Req. Cu.In./Hr.	Design Volume Cu.In./Hr. See Note (1)	Basic Ratio	Basic Ratio x5
A	.002	.010	1.0	5
B	.005	.010	1.0	5
C	.040	.040	4.0	20
D	.020	.020	2.0	10
E	.020	.020	2.0	10
F	.002	.010	1.0	5
G	.010	.010	1.0	5
Total Design Volume Cu.In./Hr.		.120		

"MJ" Divider Valve Assembly



Note: In systems where central pressure signaling is desired the following is recommended:

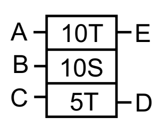
If the oil to be used in the system is less than 2000 SUS (actual), substitute .010 cubic inches per hour (design volume) for all bearings where the calculated volume is less than .010 cubic inches per hour. If using oil above 2000 SUS (actual), substitute .005 cubic inches per hour (design volume) for all bearings where the calculated volume is less than .005 cubic inches per hour. Oils with viscosities less than 300 SUS (actual) are not recommended.

When a whole number cannot be obtained, use the next higher whole number. In this case the 18.5 ratio requirement will be a 10 S size intermediate section, thus providing .020 cubic inches per cycle.

DESIGNING A MAXI-FLO SYSTEM

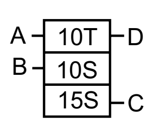
Bearing Designation	Calculated Bearing Req. Cu.In./Hr.	Design Volume Cu.In./Hr. See Note (1)	Basic Ratio	Basic Ratio x5
A	.100	.100	2	10
B	.185	.185	3.7	48.5
C	.050	.050	1	5
D	.050	.050	1	5
E	.100	.100	2	10
Total Design Volume Cu.In./Hr.		.120		

"MJ" Divider Valve Assembly



Bearing Designation	Calculated Bearing Req. Cu.In./Hr.	Design Volume Cu.In./Hr. See Note (1)	Basic Ratio	Basic Ratio x5
A	.020	.020	4	5
B	.040	.040	2	10
C	.060	.060	3	15
D	.020	.020	1	5
Total Design Volume Cu.In./Hr.		.140		

"MJ" Divider Valve Assembly



The design procedure for a Maxi-Flo centralized lubrication system is as follows:

1. Survey machine (See Figure 6 machine survey) and group bearings
2. Determine type of Maxi-Flo pump best suited for the application
    - Time Controlled
    - Stroke Controlled
    - Remote Controlled (Refer to Graco Product Specs and Ordering Lit.)
3. Calculate bearing requirements (Refer to Lit No. L20115)
4. Design secondary divider valve assemblies
5. Design master divider valve assembly
6. Determine total system oil requirement in cubic inches per hour

DESIGN PROBLEM

MJ Divider Valves are to be used with a .001 cu.in/hour oil film replacement rate. A SAE 30wt oil is to be used in the system, and a central pressure signal is desired. The Maxi-Flo time control unit has been selected to supply the system.

The machine contains 25 lubrication points which have been grouped. Lube volumes have been assigned to groups 3—6. (See Figure 6 machine survey). Groups 1 and 2 are contained on machine bearing list Figure 6, and will be used as the example for designing the divider valves.

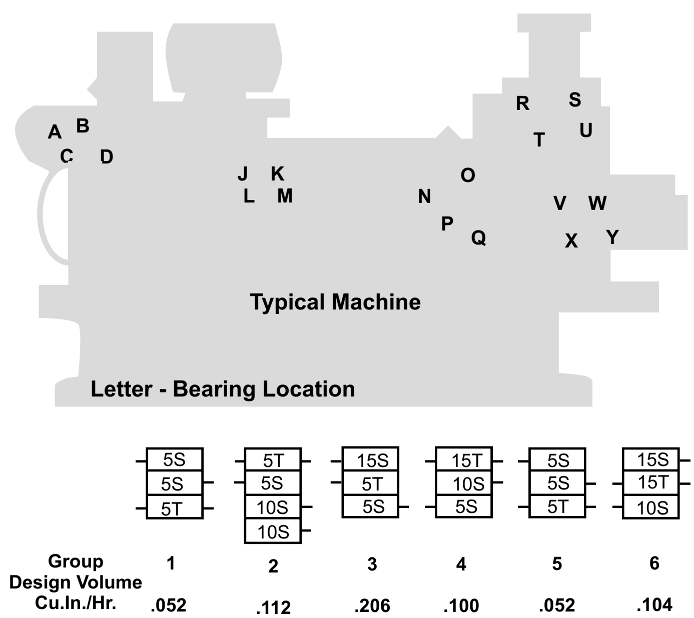
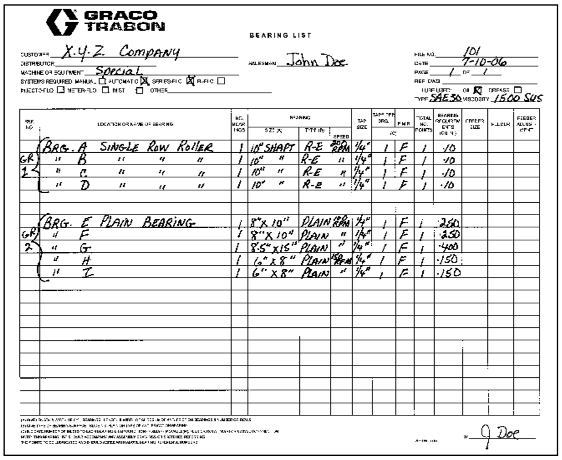


Figure 6 Machine Survey

DESIGN PROBLEM (Continued)



GRACO TRABON

BEARING LIST

CUSTOMER X.Y.Z. Company
MACHINE OR EQUIPMENT Special
SALESMAN John Doe
FILE NO. 101
DATE 7-10-06
PAGE 1 OF 1
LUBE USED: OIL [X]
TYPE SAE30 VISCOSITY 1500 SUS

REF. NO.	LOCATION OR NAME OF BEARING	NO. BEARINGS	SIZE	TYPE	SPEED	TAP SIZE	TAPS PER BRG.	FMR	TOTAL NO. POINTS	BEARING REQUIREMENTS
GR 1	BRG. A SINGLE ROW ROLLER	1	10" SHAFT	R-E	200 RPM	1/4"	1	F	1	.10
	" B " " "	1	10" "	R-E	"	1/4"	1	F	1	.10
	" C " " "	1	10" "	R-E	"	1/4"	1	F	1	.10
	" D " " "	1	10" "	R-E	"	1/4"	1	F	1	.10
GR 2	BRG. E PLAIN BEARING	1	8"x10"	PLAIN	100 RPM	1/4"	1	F	1	.250
	" F	1	8"x10"	PLAIN	"	1/4"	1	F	1	.250
	" G	1	8.5"x15"	PLAIN	"	1/4"	1	F	1	.400
	" H	1	6"x8"	PLAIN	150 RPM	1/4"	1	F	1	.150
	" I	1	6"x8"	PLAIN	"	1/4"	1	F	1	.150

Figure 7 Machine Bearing List

Given the above information, the next step is to design the secondary divider valves.

Design Secondary Divider Valves —

1. Group 1 illustrates four single roller bearings (See Figure 7).
2. Group 2 illustrates five plain bearings (See Figure 7).
3. Group 3 thru 6 are not detailed; however total design volumes (cu.in./hr.) and MJ divider valves are shown.

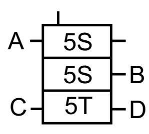
Group 1 —
Single row roller bearings — Vol = $D^2R \times T^*$

Brg.	Dia.² x Rows = Area	A x T* = Vol./Hr
A	(4) X 1 = 16 In²	16 X .001 = .016 Cu. In./Hr.
B	(4) x 1 = 16 In²	16 x .001 = .016 Cu. In./Hr.
C	(3) x 1 = 9 In²	9 x .001 = .009 Cu. In./Hr.
D	(3) x 1 = 9 In²	9 x .001 = .009 Cu. In./Hr.

*T = .001 cubic inches/hour oil film replacement rate.

Bearing Designation	Calculated Bearing Req. Cu.In./Hr.	Design Volume Cu.In./Hr. See Note (1)	Basic Ratio	Basic Ratio x5
A	.016	.016	1.6	8.0
B	.016	.016	1.6	8.0
C	.009	.010	1	5
D	.009	.010	1	5
Total Design Volume Cu. In./Hr.		.052		

“MJ” Divider Valve Assembly



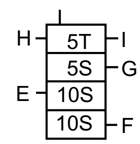
Group 2 —
Plain Bearings — Vol = π DL x T*

Brg.	Dia. x L x = Area	A x T* = Vol./Hr
E	3 X 4 X 3.14 = 38.0 In.	38.0 x .001 = .038 Cu. In./Hr.
F	3 x 4 x 3.14 = 38.0 In.	38.0 x .001 = .038 Cu. In./Hr.
G	2 x 2.5 x 3.14 = 16.0 In.	16.0 x .001 = .016 Cu. In./Hr.
H	1 x 2 x 3.14 = 6.0 In.	6.0 x .001 = .006 Cu. In./Hr.
I	1 x 2 x 3.14 = 6.0 In.	6.0 x .001 = .006 Cu. In./Hr.

*T = .001 cubic inches/hour oil film replacement rate.

Bearing Designation	Calculated Bearing Req. Cu.In./Hr.	Design Volume Cu.In./Hr. See Note (1)	Basic Ratio	Basic Ratio x5
E	.038	.038	3.8	19
F	038	.038	3.8	19
G	.016	.016	1.6	8
H	.006	.010	1	5
I	.006	.010	1	5
Total Design Volume Cu. In./Hr.		.112		

“MJ” Divider Valve Assembly

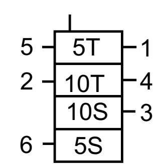


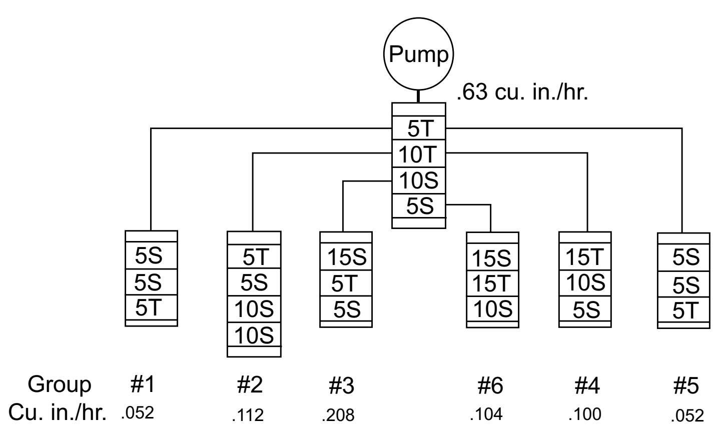
Design Master Divider Valve —

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

Group No.	Design Volume Cu.In./Hr.	Basic Ratio	Basic Ratio x5
1	.052	1.0	5
2	.112	2.1	10
3	.208	4.0	20
4	.100	1.9	10
5	.052	1.0	5
6	.104	2.0	10
Total Design Volume Cu. In./Hr. See Note (2)	.628		

Master “MJ” Divider





Note: Do not third state Maxi-Flo systems

DESIGN PROBLEM (Continued)

Maxi-Flo Pump Settings —
(For units having 115 V 60 Hz service only)

Time Control —
The time control unit Part No. 563379 (521-500-910) was selected to supply the example system, therefore set the Solid State Timer for "on" time required. See Lit. No. L13110.

Note: In systems where central pressure signaling is required the pump should not be set for less than .120 cubic inches per hour.

Stroke Control —
If stroke control unit Part No. – (521-500-420) is selected to supply system, first determine electrical connections to machine cycle control. Second, determine the average machine cycles per min. (SPM). Third, determine the system design volume per hr. (Dv). Fourth, using the following formula, calculate the pump stroke setting (Ssc).

Formula #1

$$Ssc = \frac{(*0.06) \times (SPM) \times (B)}{Dv}$$

Where:

Ssc = **Calculated** stroke setting for pump counter

SPM = Average machine strokes per minute

Dv = System design volume, cubic inches per hour

A = *8.33 x Dv

B = *60 - A

*Constants

Should the calculated stroke setting fall between stroke increments of the pump counter, it is necessary to calculate the actual output delivered at both the higher and lower stroke settings and choose the appropriate setting. Use the following formula to determine the outputs at both settings.

Formula #1

$$\text{Output (cu.in)} = \frac{(*3.6) \times (SPM)}{Ssa + C}$$

Where:

Output = Actual pump output, cubic inches per hour

SPM = Average machine strokes per minute

Ssa = Actual stroke setting for pump counter

C = (*0.5) x (SPM)

*Constants

Example:

A machine requires 2.77 cu.in. of lubricant per hr. to satisfy the lube system. The machine averages 30 strokes per min. when in operation. To determine the proper stroke setting, use Formula #1, as above and proceed as follows:

$$\frac{(0.06) \times (SPM) \times (B)}{Dv}$$

Solve for B

A = 8.33 x Dv

= 8.33 x 2.77

= 23.07

B = 60 - A

= 60 - 23.07

= 36.93

$$Ssc = \frac{(0.06) \times (30) \times (36.93)}{2.77}$$

Ssc = 24 Required stroke setting to satisfy system requirements

The calculated stroke setting of 24 is between the 16 and 32 settings on the stroke counter. Therefore, outputs at the 16 and 32 stroke settings must be calculated to determine which setting would be more appropriate to use. Outputs can be determined by using Formula #2, as follows:

$$\text{Output (cu.in.)} = \frac{3.6 \times SPM}{Ssa + C}$$

Solve for C

C = 0.5 x SPM

= 0.5 x 30

= 15

32 Stroke Setting

$$\text{Output (cu.in.)} = \frac{3.6 \times 30}{32 + 15}$$

$$\text{Output (cu.in.)} = \frac{180}{47}$$

Output = 2.298 cu.in./hr @ 32 strokes setting

16 Stroke Setting

$$\text{Output (cu.in.)} = \frac{3.6 \times 30}{16 + 15}$$

$$\text{Output (cu.in.)} = \frac{180}{31}$$

Output = 3.484 cu.in./hr @ 16 stroke setting

The lube system requirement was 2.77 Cu.In./Hr. If the 32 stroke setting were selected (2.298 Cu.In./Hr.), the system would receive 17% **less** lubrication than required. If the 16 stroke setting was selected (3.484 Cu.In./Hr.). the system would receive 26% **more** lubrication than required. A decision can now be made s to which stroke setting would be more appropriate for the particular application.

Note:
The pump volume can be increased by lowering stroke settings and decreased by increasing stroke setting.

REMOTE CONTROL

If remote control pump unit, Part No. 563376 (521-500-430) is selected the following recommendations for pump setting should be followed:

To determine total pump run time per hour, divide the total system design volume (cu.in. pr hr.) by the pump delivery rate per minute (.120 cu.in./min.).

In the example, the total design volume is .628 cu.in./hr. thus, .628 ÷ .120 = 5.22 minutes/hour. It is recommended that one quarter of the total design volume be supplied to the system every 15 minutes therefore, the remote control should provide 1.3 min. (78 sec.) of "on" time every 15 minutes.

Note:
In systems where central pressure signaling is desired the pump "on" time should not be less than .5 min. (30 sec.) per each cycle time.

INSTALLATION

Because of the low volume capabilities of the Maxi-Flo system, it is recommended that 1/8" O.D. (.020 wall) copper/nylon tubing be used throughout the system, from the pump to master divider valves, master divider valves to secondary divider valves, and secondary divider valves to lube points.

Hose should be used only when absolutely necessary. A 3/16" inside diameter L.V.E. (low volumetric expansion) hose is recommended.

All divider valve assemblies should be centrally located to the lube points they serve to provide the shortest feed lines possible.

As in any lube system all air should be removed from the Maxi-Flo system for effective oil delivery to lube points (see Lit. No. L30103). Installation of Graco manual reset indicators Part No. – (509-931-000) in working outlet of divider valves is recommended in order to facilitate system troubleshooting.

Contact us today!

To receive product information or talk with a Graco representative, call **800-533-9655** or visit us online at **www.graco.com.**