FISHER®

UNIVERSAL VALVE SIZING RULE

INSTRUCTION MANUAL

FISHER GOVERNOR COMPANY

INTRODUCTION

The importance of correct sizing cannot be over-emphasized in the selection of control valves. The most expensive and sensitive controller is of little value if the final control element, the control valve, is not correctly sized and cannot make the necessary changes in flow to maintain the desired control point.

Sizing slide rules have been available for years to help in the selection of the proper size valves but none can compare with the highly versatile and extremely accurate Fisher Universal Valve Sizing Rule (Copyright 1967). This rule has been designed specifically to include the Universal Gas Sizing Equation, a unique equation that considers the geometry of the valve configuration by use of a C_1 value (C_g/C_v ratio) as one of the sizing parameters. This one parameter is a most important advancement since it is the "key" to accurate sizing of high pressure recovery valves such as butterfly valves, ball valves, Vee-Ball valves, and flow close angle valves which have a C_1 value appreciably less than 35. Yet conventional globe bodies ($C_1 = 35$) can be sized as easily on the Universal Rule as on previous models. Use of the Universal Valve Sizing Rule in conjunction with published tables of sizing coefficients and other technical data will enable the proper selection of *any* style valve for *any* fluid application.

The equations on which the Universal Rule is based are as follows:

Gas Flow

$$Q = \sqrt{\frac{520}{GT}}\; C_g\; P_1\; \mathrm{SIN}\left[\frac{3417}{C_1}\sqrt{\frac{\Delta P}{P_1}}\right]_{DEG} \qquad (1)$$

This form of the Universal Gas Sizing Equation is slightly different from the form presented in Fisher Technical Manual TM-15. The parameter C_2, a correction factor for variation in specific heat, is not included since it is negligible in most control valve sizing problems. The other variation in the forms of the Universal Gas Sizing Equation is the substitution of the gas sizing coefficient, C_g, for the product $C_1 C_v$ (from the definition of C_1).

Steam and Vapor Flow

$$Q_s = 1.06\sqrt{d_1\; P_1}\; C_g\; \mathrm{SIN}\left[\frac{3417}{C_1}\sqrt{\frac{\Delta P}{P_1}}\right]_{DEG} \qquad (2)$$

This is a form of the Universal Gas Sizing Equation that is directly applicable to the sizing of *all* vapors, including steam under *any* pressure conditions.

$$Q_s = \frac{C_s \ P_1}{1+0.00065 t_{sh}} \ \text{SIN} \left[\frac{3417}{C_1} \sqrt{\frac{\Delta P}{P_1}} \right]_{DEG} \qquad (3)$$

This equation is provided on the slide rule to give a simplified method of sizing valves for steam service. The equation is based on the assumption that the factor for converting air flow in scfh to steam flow in 1b/hr is a constant. Equation No. 3 should be used *only* when the steam inlet pressure is *1000 psig or less.*

Liquid Flow

$$Q_l = C_v \sqrt{\frac{\Delta P}{G_l}} \qquad (4)$$

This equation is the liquid sizing equation for control valves. It is based on water at 60°F with a correction factor provided for liquids with a specific gravity other than 1.0. A viscosity correction is not provided on the slide rule but a procedure is included in the Fisher Valve Sizing Coefficient Bulletin AL-10 and Continental Technical Data Bulletin 141.05. Use this procedure if viscosity enters into the problem.

Explanation of Terms Used in Equations

- C_1 = C_g/C_v (see table on Page 2)
- C_g = gas sizing coefficient
- C_s = steam sizing coefficient
- C_v = liquid sizing coefficient
- d_1 = density of steam or vapor, lbs/ft^3
- G = gas specific gravity (air = 1.0)
- G_l = liquid specific gravity (water = 1.0)
- P_1 = valve inlet pressure, psia (P_1 scale on slide rule is graduated in psig for convenience)
- ΔP = pressure drop across valve, psi
- Q = gas flow rate, scfh
- Q_l = liquid flow rate, gpm
- Q_s = steam or vapor flow rate, 1b/hr
- T = absolute temperature of gas at valve inlet, Deg. Rankine (TEMP scale on slide rule is graduated in degrees Fahrenheit for convenience)
- t_{sh} = degrees of superheat, °F

Representative C_1 Values

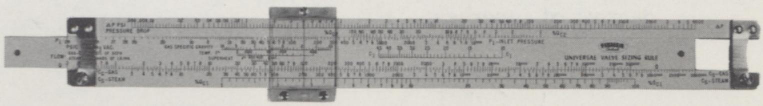
Body Design	Body Style	Description	Flow Direction	Representative C_1
"A"	Globe	Single Port	Open	35.0
"A"	Globe	Double Port	Normal	35.0
"AA"	Angle	Specs. B & D	Open	35.5
"AA"	Angle	Specs. B & D	Close	30.5
"AA"	Angle	Specs. C & E	Close	17.5
"BF"	Globe	Single Port	Open	32.0
"D"	Globe	Any Valve Plug	Open	30.0
"D"	Globe	Micro-Form	Close	21.5
"D"	Globe	Micro-Flute	Close	24.0
"DA"	Angle	Micro-Form	Close	18.5
"DA"	Angle	Micro-Flute	Close	22.5
"DBQ"	Globe	Single Port	Open	33.0
"DBAQ"	Angle	Single Port	Open	34.5
"GS"	Globe	Single Port	Open	35.0
"IC"	Globe	Single Port	Open	33.5
"U"	150 & 300 lb.	Vee-Ball Valve	....	22.0
V25	Ball	Hi-Ball	....	20.0
461	Angle	Single Port	Close	18.0

Note: The representative C_1 value for Fisher valve bodies not listed above is 35.0. C_1 values for Continental Equipment Company butterfly valves are shown in their Technical Data Bulletin 141.05.

Procedure for Gas Sizing

A. To determine the gas sizing coefficient, C_g, and required valve size when the known values are inlet pressure, outlet pressure, flow rate, specific gravity and flowing temperature, proceed as follows. (The valve body style under consideration must also be known.)

1. Determine the pressure drop (inlet pressure minus outlet pressure) and move hairline to this value on $\triangle P$ scale. For this procedure, use the side of the rule on which the title "Universal Valve Sizing Rule" appears.



Use this side of sizing rule.

2. Move the slide to position the inlet pressure on P_1 scale under the hairline.
3. Move the hairline to the appropriate C_1 value on C_1 scale. Determine the representative C_1 value for the desired body style from the tabulation on Page 2 of this booklet.
4. Read the percent of critical flow under the hairline on $\%Q_{C1}$ scale.
   a. If the value read on $\%Q_{C1}$ scale is 100 or less, subcritical flow is indicated. Move the hairline to this value on $\%Q_{C2}$ scale.
   b. If the hairline is beyond 100 on $\%Q_{C1}$ scale, critical flow is indicated. Move the hairline to 100 on $\%Q_{C2}$ scale.
5. With the hairline positioned properly on $\%Q_{C2}$ scale as outlined in Step 4a **or** 4b, move the slide to position the inlet pressure on P_1 scale under the hairline.
6. Move the hairline to index (1) on GAS SPECIFIC GRAVITY scale.
7. Move the slide to position the proper value of specific gravity under the hairline.

   Note: Steps 6 and 7 may be omitted if gas has a specific gravity of 1.0.
8. Move the hairline to index (60°F) on TEMP scale.
9. Move the slide to position the proper value of gas temperature under the hairline.

   Note: Steps 8 and 9 may be omitted if gas temperature is 60°F.
10. Move the hairline to the flow rate (thousands of scfh) on FLOW-Q scale. Read the required gas sizing coefficient under the hairline on C_g-GAS scale.
11. From the gas sizing coefficient table for the desired body and valve plug style, locate the coefficient equal to or higher than the required C_g determined in Step 10. This will give the valve size and percent of total travel required to pass the given flow.

    Note: Since the C_1 value used in the above procedure was a representative figure, it is recommended that the exact C_1 be determined, once the valve size is established, by dividing the C_g by C_v at the same valve travel. If there is a chance that a smaller or larger valve might be required if the exact C_1 value were used in sizing, rework the problem on the slide rule.

B. To determine the gas flow rate when the valve style, valve size and pressure conditions are known, proceed as follows:

1. Follow the procedure of Steps 1 through 9 in section A above.
2. Move the hairline to the proper sizing coefficient (determined from published tables) on C_g-GAS scale. Read the flow rate (thousands of scfh) under the hairline on FLOW-Q scale.

Gas Sizing Example 1 — Globe Body

Given:

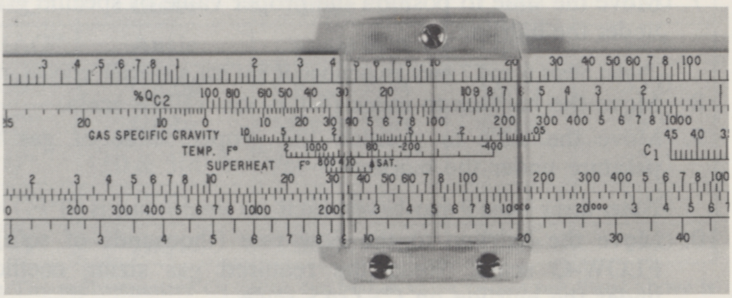
INLET PRESSURE	100 psig
OUTLET PRESSURE	90 psig
SPECIFIC GRAVITY	1.2
GAS TEMPERATURE	200°F
FLOW RATE	10,000 scfh
VALVE STYLE	Single Port Design "A", Flow Tends to Open, Throttle Plug Valve Plug

Required: Valve Size

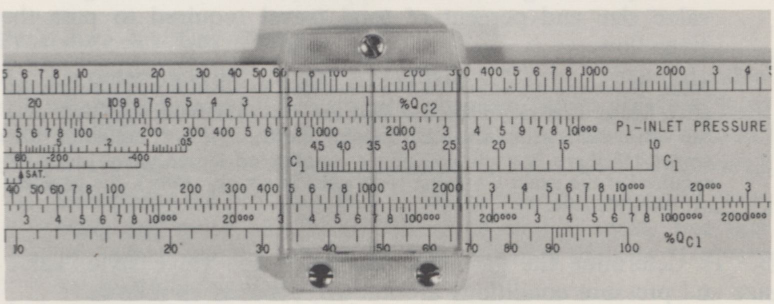
1. The pressure drop is 10 psi (100 — 90). Move the hairline to 10 psi on △P scale. Use side of rule on which title "Universal Valve Sizing Rule" appears.
2. Move the slide to position the inlet pressure of 100 psig on P_1 scale under the hairline.

△P

P_1

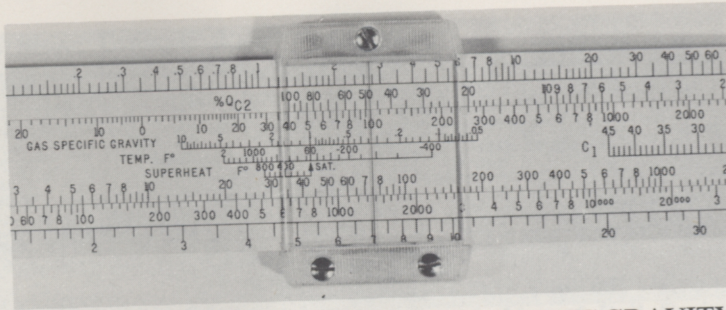


3. From the table of representative C_1 values on Page 2, pick a value of 35.0 for a single port Design "A" body. Move the hairline to 35.0 on C_1 scale.

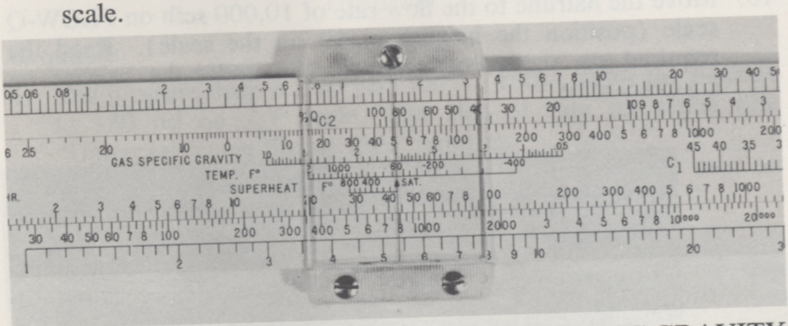


4. Under the hairline on $\%Q_{C1}$ scale, read 48. Move the hairline to 48 on $\%Q_{C2}$ scale.
5. Move the slide to position the inlet pressure of 100 psig on P_1 scale under the hairline.

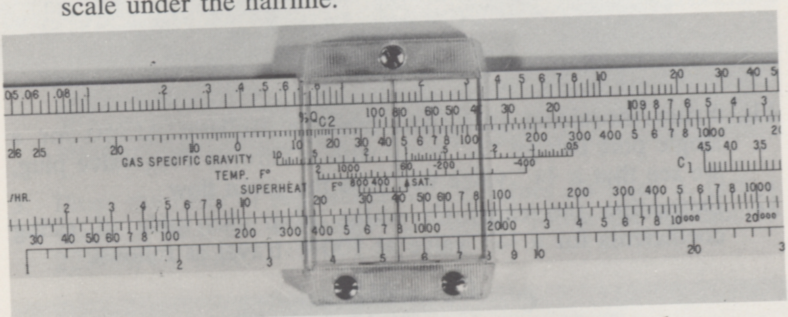
P1



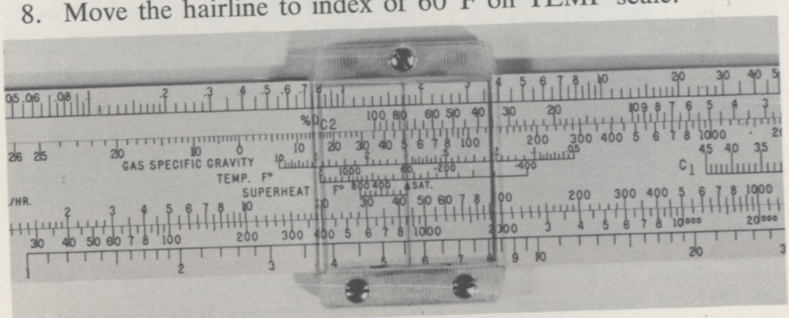
6. Move the hairline to index of 1 on GAS SPECIFIC GRAVITY scale.



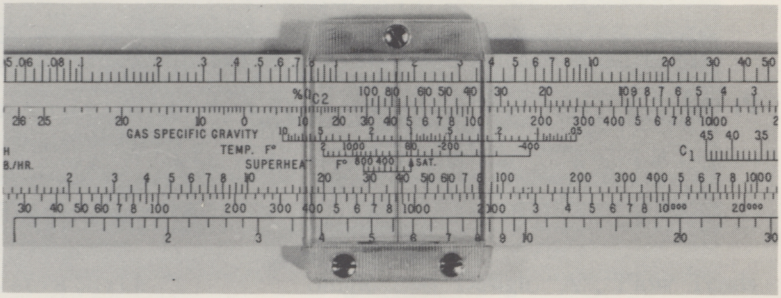
7. Move the slide to position 1.2 on GAS SPECIFIC GRAVITY scale under the hairline.



8. Move the hairline to index of 60°F on TEMP scale.

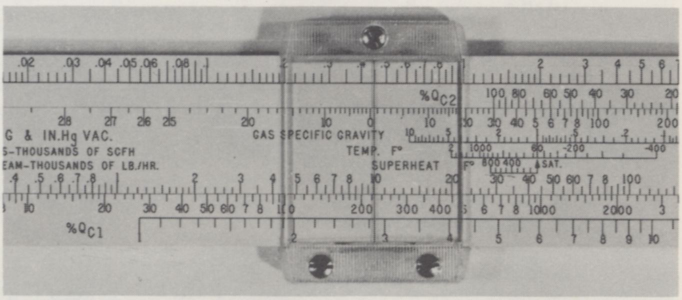


9. Move the slide to position 200°F on TEMP scale under the hairline.



10. Move the hairline to the flow rate of 10,000 scfh on FLOW-Q scale (position the hairline at 10 on the scale). Read the required gas sizing coefficient of 224 under the hairline on C_g-GAS scale.

C_g



11. From the sizing coefficient table in Bulletin AL-10 for a single port Design "A" body with a Throttle Plug valve plug, we see that a ¾″ valve will pass the given flow.

12. Determine the exact C_1 value from the table of sizing coefficients for a ¾″ valve at 100% travel as follows:

$$C = \frac{C_g}{C_v} = \frac{241}{6.39} = 37.7$$

Rework the problem using 37.7 instead of the representative C_1 value of 35.0. The new required C_g is 235 and a ¾″ valve will still do the job.

Gas Sizing Example 2 — Vee-Ball Valve

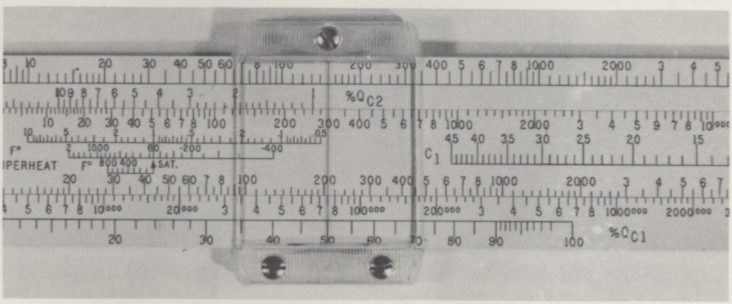
Given:

Inlet Pressure	300 psig
Outlet Pressure	150 psig
Specific Gravity	1.0
Gas Temperature	60°F
Flow Rate	1,000,000 scfh
Valve Style	300 lb. Design "U" Vee-Ball Valve to be Installed with Vee of Ball Facing Upstream
Required:	Valve Size

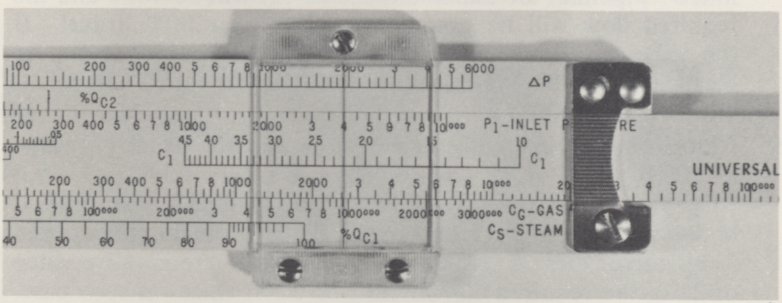
1. The pressure drop is 150 psi (300 — 150). Move the hairline to 150 psi on $\triangle P$ scale. Use side of rule on which title "Universal Valve Sizing Rule" appears.
2. Move the slide to position the inlet pressure of 300 psig on P_1 scale under the hairline.

$\triangle P$

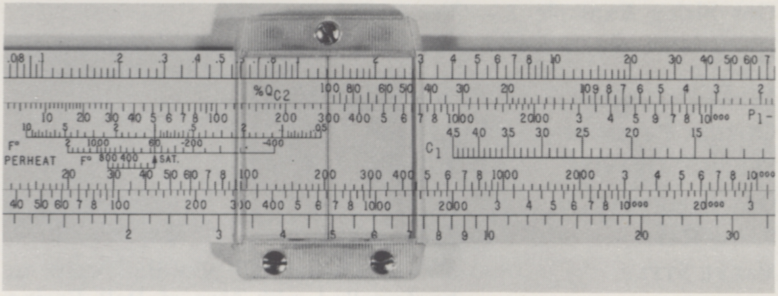
P_1



3. From the table of representative C_1 values on Page 2, pick a value of 22.0 for a Design "U" body. Move the hairline to 22.0 on C_1 scale.

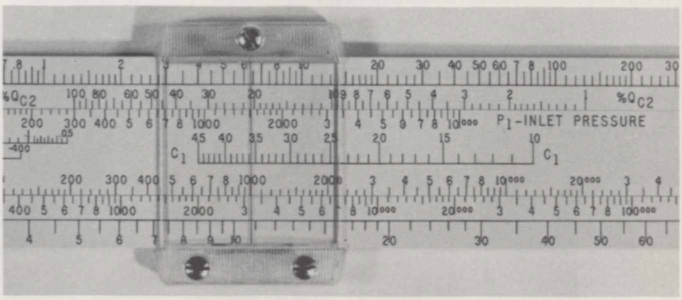


4. Note that the hairline is beyond 100 on $\%Q_{C1}$ scale. This indicates that critical flow exists. Move hairline to 100 on $\%Q_{C2}$ scale.
5. Move the slide to position the inlet pressure of 300 psig on P_1 scale under the hairline.



6. Since specific gravity is 1.0 and gas temperature is 60°F, no corrections are necessary.
7. Move the hairline to the flow rate of 1,000,000 scfh on FLOW-Q scale (position the hairline at 1000 on the scale). Read the required gas sizing coefficient of 3200 under the hairline on C_g -GAS scale.

FLOW
C_g



8. From the sizing coefficient table in Bulletin L-22 for a 300 lb. Design "U" Vee-Ball valve (Vee facing upstream), we see that a 3″ valve will handle the flow. If the valve will be installed in a 3″ pipeline, the maximum coefficient will be 4670 and the required flow will be passed at slightly over 80% travel. If the valve is to be installed in a 4″ pipeline, the maximum coefficient will be 4460; in a 6″ pipeline, the maximum coefficient will be 4200.
9. Note from the sizing coefficient table that the exact C_1 value at 100% travel is 18.4 when line size equals body size, 19.6 when line to body size ratio is 1.5 : 1, and 21.4 when line to body size ratio is 2 : 1 and over. If the problem is reworked using one of these C_1 values instead of the representative value of 22.0, the required C_g will still be 3200 since, in each case, critical flow exists.

Gas Sizing Example 3 — Butterfly Valve

Given:

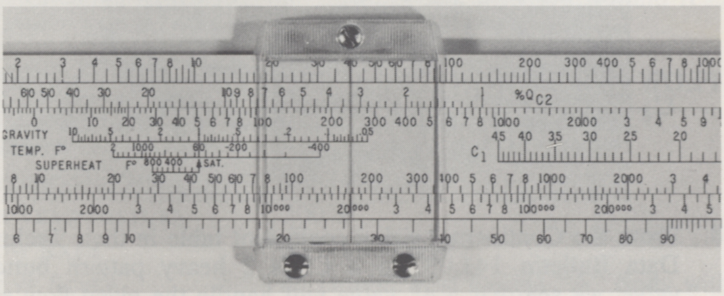
INLET PRESSURE	240 psig
OUTLET PRESSURE	200 psig
SPECIFIC GRAVITY	1.0
GAS TEMPERATURE	60°F
FLOW RATE	1,400,000 scfh
VALVE STYLE	Continental Equipment Company Heavy Pattern Butterfly Valve, Class 2, 60° Angle of Opening

Required: Valve Size

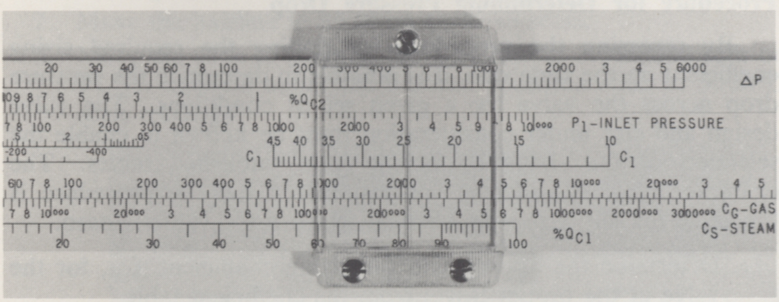
1. The pressure drop is 40 psi (240 — 200). Move the hairline to 40 psi on $\triangle P$ scale. Use side of rule on which title "Universal Valve Sizing Rule" appears.
2. Move the slide to position the inlet pressure of 240 psig on P_1 scale under the hairline.

$\triangle P$

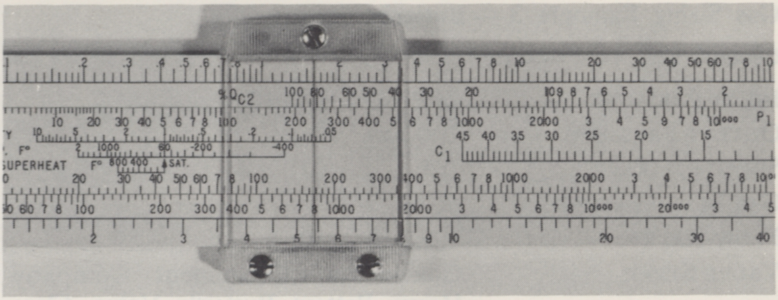
P_1



3. From Continental Technical Data Bulletin 141.05, select the C_1 value of 24.7 for a Class 2 heavy pattern butterfly valve with 60° angle of opening. Move the hairline to 24.7 on C_1 scale.

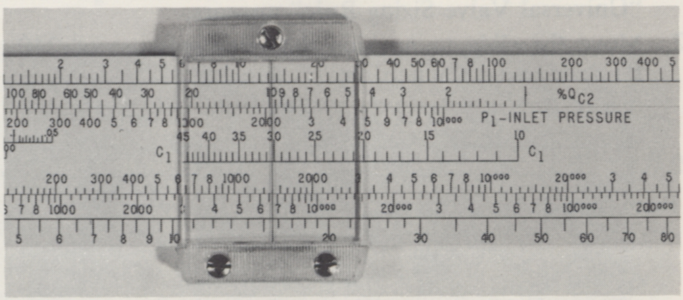


4. Under the hairline on $\%Q_{C1}$ scale, read 82. Move the hairline to 82 on $\%Q_{C2}$ scale.
5. Move the slide to position the inlet pressure of 240 psig on P_1 scale under the hairline.



6. Since specific gravity is 1.0 and gas temperature is 60°F, no corrections are necessary.
7. Move the hairline to the flow rate of 1,400,000 scfh on FLOW-Q scale (position the hairline at 1400 on the scale). Read the required gas sizing coefficient of 6700 under the hairline on C_g-GAS scale.

FLOW
C_g



8. From the Continental sizing coefficient table in their Technical Data Bulletin 141.05 for a Class 2 heavy pattern butterfly valve, we see that a 4″ valve will handle the given flow since it has a C_g of 6940 at 60° angle of opening.

Procedure for Determining Pressure Drop

By reversing the procedure for finding the required sizing coefficient on the slide rule, it is possible to determine the pressure drop across the valve for a given set of conditions. The valve design and size under consideration must be known to enable the selection of the sizing coefficient from published tables. The example below considers a gas installation but the procedure is the same for any sizing problem in which a C_1 value is used.

1. Determine the appropriate gas sizing coefficient, C_g, for the valve at the proper travel from the coefficient table.
2. Move the hairline to this C_g value on C_g-GAS scale.
3. Move the slide to position the flow rate on FLOW-Q scale under the hairline.
4. Move the hairline to the gas temperature on TEMP scale.

5. Move the slide to position the index (60°F) on TEMP scale under the hairline.
6. Move the hairline to the specific gravity on GAS SPECIFIC GRAVITY scale.
7. Move the slide to position the index (1) on GAS SPECIFIC GRAVITY scale under the hairline.
8. Move the hairline to inlet pressure on P_1 scale and read the value on $\%Q_{C2}$ scale under the hairline. *Do not attempt to determine the pressure drop at critical flow since the procedure is valid only for sub-critical flow.* Thus, if the value read on $\%Q_{C2}$ scale is *90 or higher,* the pressure drop cannot be determined accurately and the procedure should be terminated at this point. If the value read on $\%Q_{C2}$ scale is *less than 90,* move on to Step 9.
9. Move the hairline to $\%Q_{C1}$ scale and position it at the value obtained from $\%Q_{C2}$ scale.
10. Move the slide to position the C_1 value on C_1 scale under the hairline. Determine C_1 from sizing coefficient table; if not listed, divide C_g by C_v at the same travel.
11. Move the hairline to the inlet pressure on P_1 scale and read the pressure drop on $\triangle P$ scale under the hairline.

Example Problem To Determine Valve Pressure Drop

Given:

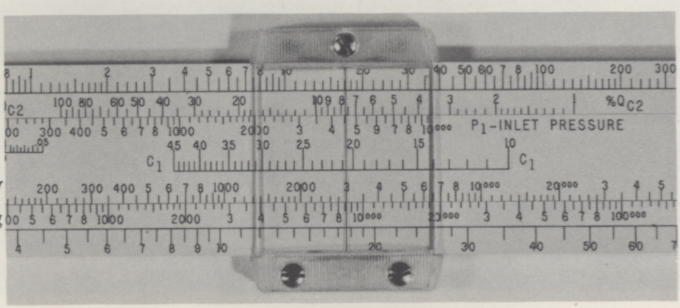
INLET PRESSURE	750 psig
SPECIFIC GRAVITY	0.8
GAS TEMPERATURE	500°F
FLOW RATE	3,000,000 scfh
VALVE STYLE	4″ Double Port Design "A" Body with Quick Opening Valve Plug

Required: Valve Pressure Drop

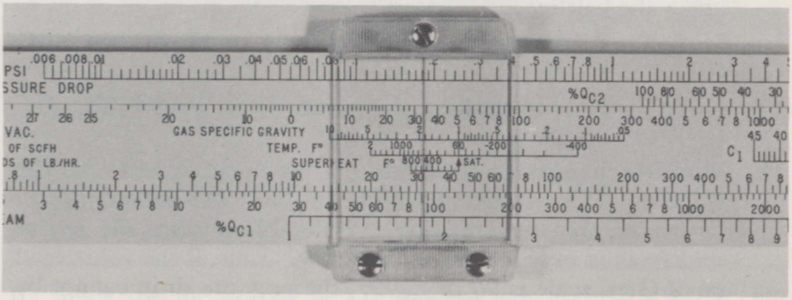
1. The C_g from coefficient table is 8520.
2. Move the hairline to 8520 on C_g-GAS scale.
3. Move the slide to position the flow rate of 3,000,000 scfh on FLOW-Q scale under the hairline (position slide at 3000 Q scale reading).

FLOW

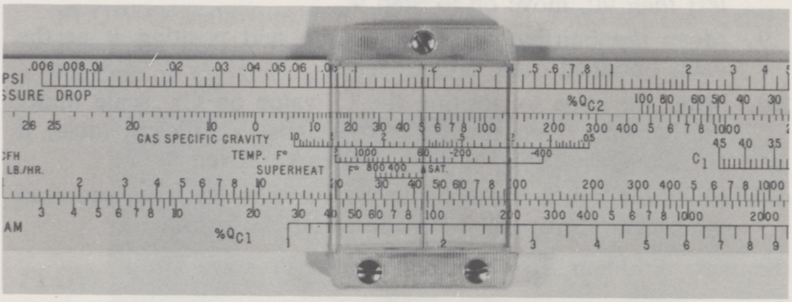
C_g



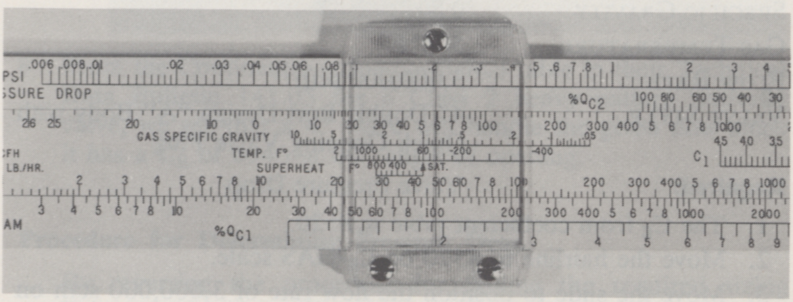
4. Move the hairline to 500°F on TEMP scale.



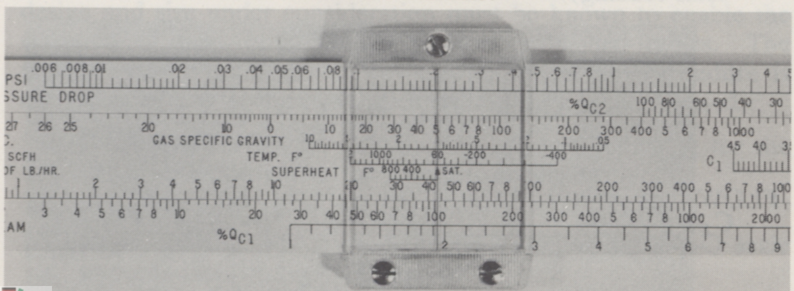
5. Move the slide to position the index (60°F) on TEMP scale under the hairline.



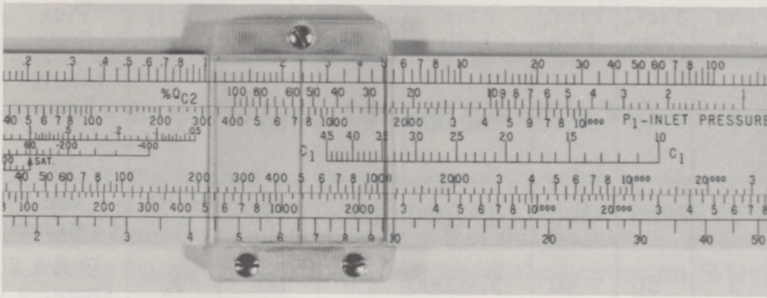
6. Move the hairline to 0.8 specific gravity on GAS SPECIFIC GRAVITY scale.



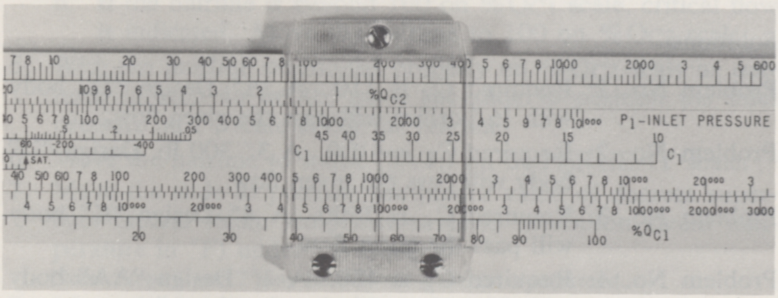
7. Move the slide to position the index (1) on GAS SPECIFIC GRAVITY scale under the hairline.



8. Move the hairline to 750 psig inlet pressure on the P_1 scale and read 56 on $\%Q_{C2}$ scale under the hairline.

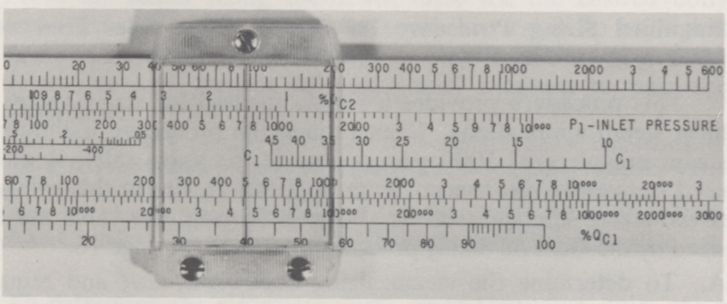


9. Move the hairline to 56 on $\%Q_{C1}$ scale.
10. Move the slide to position 35 on C_1 scale under the hairline.



11. Move the hairline to 750 psig on P_1 scale and read the pressure drop of 91 psi under the hairline on $\triangle P$ scale.

$\triangle P$



Additional Gas Sizing Examples

Problem No.	Inlet Pres., Psig	Outlet Pres., Psig	Flow Rate, Scfh	Sp. Gr.	Gas Temp., °F	Valve Body Style	Valve Plug Style
1	520	360	50,000	1.1	60	"D"	Micro-Form (Flow Opens)
2	700	300	4,000,000	0.6	0	300 lb. "U"	Vee Upstream
3	50	40	300,000	1.0	60	"K"	Quick Opening
4	10″ Hg. Vac.	15″ Hg. Vac.	3,500	1.0	60	"AA"	Contoured (Flow Opens)

Solutions:

Problem No. 1: Required C_g is 110. A ½″ Design "D" body with ½″ orifice will pass the given flow.

Problem No. 2: Required C_g is 4100. A 3″ 300 lb. Design "U" body will pass the given flow.

Problem No. 3: Required C_g is 7500. A 4″ Design "K" body will pass the given flow.

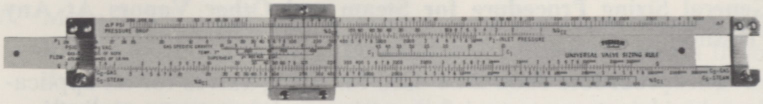
Problem No. 4: Required C_g is 480. A 1″ Design "AA" body with 1″ orifice will pass the given flow.

Simplified Sizing Procedure for Steam When Inlet Pressure is 1000 psig or Less

This procedure provides a simple method for sizing valves for most steam applications. Even though the procedure is limited to steam pressures of 1000 psig or less at the valve inlet, it will be used frequently since most steam applications are in this category. If the steam inlet pressure is above 1000 psig, the valve must be sized by the General Sizing procedure outlined on Page 16.

A. To determine the steam sizing coefficient, C_s, and required valve size when the known values are inlet pressure, outlet pressure, flow rate and steam state, proceed as follows. (The valve body style under consideration must also be known.)

1. Determine the pressure drop (inlet pressure minus outlet pressure) and move the hairline to this value on △P scale. For this procedure, use the side of the rule on which the title "Universal Valve Sizing Rule" appears.



Use this side of sizing rule.

2. Move the slide to position the inlet pressure on P_1 scale under the hairline.
3. Move the hairline to the appropriate C_1 value on C_1 scale. Determine the representative C_1 value for the desired body style from the tabulation on Page 2 of this booklet.
4. Read the percent of critical flow under the hairline on $\%Q_{C1}$ scale.
   a. If the value read on $\%Q_{C1}$ scale is 100 or less, sub-critical flow is indicated. Move the hairline to this value on $\%Q_{C2}$ scale.
   b. If the hairline is beyond 100 on $\%Q_{C1}$ scale, critical flow is indicated. Move the hairline to 100 on $\%Q_{C2}$ scale.
5. With the hairline positioned properly on $\%Q_{C2}$ scale as outlined in Step 4a **or** 4b, move the slide to position the inlet pressure on P_1 scale under the hairline.
6. Move the hairline to index (SAT.) on SUPERHEAT scale.
7. Move the slide to position the proper value of degrees superheat (actual steam temperature minus saturation steam temperature in °F) under the hairline.

Note: Steps 6 and 7 may be omitted if steam is saturated.

8. Move the hairline to the flow rate (thousands of 1b/hr) on FLOW-Q scale. Read the required steam sizing coefficient under the hairline on C_s-STEAM scale.
9. From the steam sizing coefficient table for the desired body and valve plug style, locate the coefficient equal to or higher than the required C_s determined in Step 8. This will give the valve size and percent of total travel required to pass the given flow.

Note: Since the C_1 value in the above procedure was a representative figure, it is recommended that the exact C_1 be determined, once the valve size is established, by dividing the C_g by C_v at the same valve travel. If there is a chance that a smaller or larger valve might be required if the exact C_1 value were used in sizing, rework the problem on the slide rule.

B. To determine the steam flow rate when the valve style, valve size, steam state and pressure conditions are known, proceed as follows:

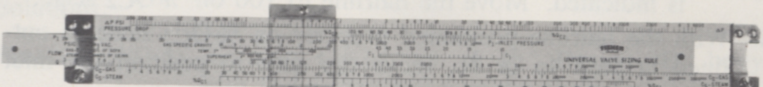
1. Follow the procedure of Steps 1 through 7 in section A above.
2. Move the hairline to the proper sizing coefficient (determined from published tables) on C_s-STEAM scale. Read the flow rate (thousands of 1b/hr) under the hairline on FLOW-Q scale.

General Sizing Procedure for Steam and Other Vapors At Any Pressure

This procedure should be used for sizing valves for all applications involving vapors and it must be used for steam applications where the inlet pressure exceeds 1000 psig. It may also be used for sizing valves for steam service where the inlet pressure is less than 1000 psig but the simplified procedure outlined on Page 14 will generally be used to size valves in this category.

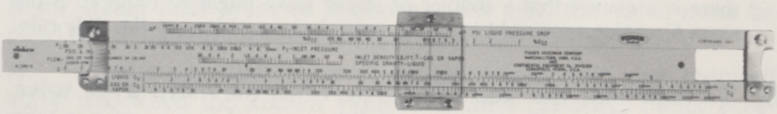
A. To determine the sizing coefficient, C_g, and required valve size when the known values are inlet pressure, outlet pressure, flow rate (1b/hr) and vapor density at valve inlet, proceed as follows. (The valve body style under consideration must also be known.)

1. Determine the pressure drop (inlet pressure minus outlet pressure) and move the hairline to this value on $\triangle P$ scale. For this procedure, start on the side of the rule on which the title "Universal Valve Sizing Rule" appears.



Start procedure on this side of sizing rule.

2. Move the slide to position the inlet pressure on P_1 scale under the hairline.
3. Move the hairline to the appropriate C_1 value on C_1 scale. Determine the representative C_1 value for the desired body style from the tabulation on Page 2 of this booklet.
4. Read the percent of critical flow under the hairline on $\%Q_{C1}$ scale.
   a. If the value read on $\%Q_{C1}$ scale is 100 or less, sub-critical flow is indicated. *Turn the slide rule to the reverse side* and move the hairline to this value on $\%Q_{C2}$ scale.
   b. If the hairline is beyond 100 on $\%Q_{C1}$ scale, critical flow is indicated. *Turn the slide rule to the reverse side* and move the hairline to 100 on $\%Q_{C2}$ scale.



Finish procedure on this side of sizing rule.

5. With the hairline positioned properly on $\%Q_{C2}$ scale (on COPYRIGHT 1967 side of rule) as outlined in Step 4a **or** 4b, move the slide to position the inlet pressure on P_1 scale under the hairline.

6. Move the hairline to the proper value of vapor density on INLET DENSITY scale. Determine the density of steam from the curves on Page 20. Note that the pressure curves are in absolute pressure (psia), so it will be necessary to add 14.7 to the inlet pressure (if given in psig) before using the curves. The density of other vapors should be obtained from engineering reference manuals.
7. Move the slide to position the reference density, 1.0, (at arrow on INLET DENSITY scale) under the hairline.
8. Move the hairline to the flow rate (thousands of 1b/hr) on FLOW-Q scale. Read the required sizing coefficient under the hairline on C_g-GAS OR VAPOR scale.
9. From the gas sizing coefficient table for the desired body and valve plug style, locate the coefficient equal to or higher than the required C_g determined in Step 8. This will give the valve size and percent of total travel required to pass the given flow.

Note: Since the C_1 value in the above procedure was a representative value, it is recommended that the exact C_1 be determined, once the valve size is established, by dividing the C_g by C_v at the same valve travel. If there is a chance that a smaller or larger valve might be required if the exact C_1 value were used in sizing, rework the problem on the slide rule.

B. To determine the steam or vapor flow rate when the valve style, valve size, vapor density at valve inlet and pressure conditions are known, proceed as follows:

1. Follow the procedure of Steps 1 through 7 in section A above.
2. Move the hairline to the proper sizing coefficient (determined from published tables) on C_g-GAS OR VAPOR scale. Read the flow rate (thousands of 1b/hr) under the hairline on FLOW-Q scale.

Steam Sizing Example — Butterfly Valve

Given:

INLET PRESSURE	200 psig
OUTLET PRESSURE	170 psig
STEAM STATE	Saturated
FLOW RATE	20,000 lb/hr
VALVE STYLE	Continental Equipment Company Heavy Pattern Butterfly Valve, Class 2, 90° Angle of Opening

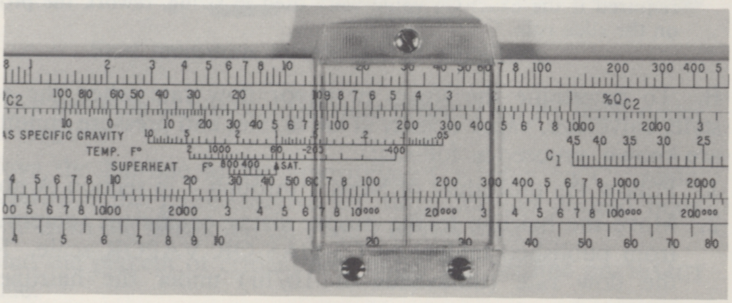
Required: Valve Size

Solution A — Simplified Procedure

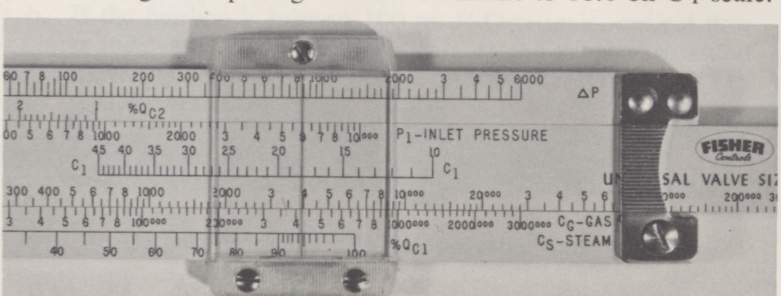
1. The pressure drop is 30 psi (200 — 170). Move the hairline to 30 psi on $\triangle P$ scale. Use side of rule on which title "Universal Valve Sizing Rule" appears.
2. Move the slide to position the inlet pressure of 200 psig on P_1 scale under the hairline.

$\triangle P$

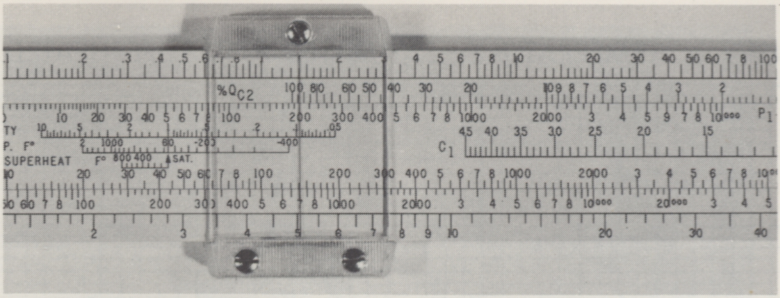
P_1



3. From Continental Technical Data Bulletin 141.05, select the C_1 value of 18.0 for a Class 2 heavy pattern butterfly valve with 90° angle of opening. Move the hairline to 18.0 on C_1 scale.

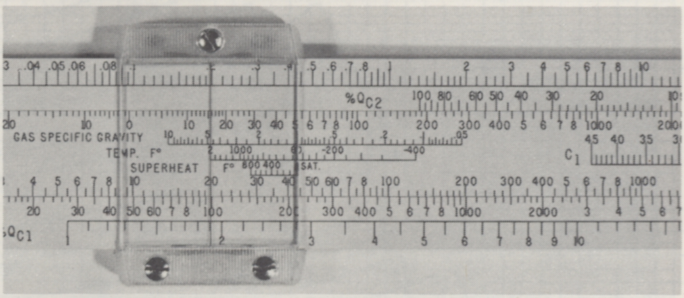


4. Under the hairline on $\%Q_{C1}$ scale, read 94.5. Move the hairline to 94.5 on $\%Q_{C2}$ scale.
5. Move the slide to position the inlet pressure of 200 psig on P_1 scale under the hairline.



6. Since the steam is saturated, no correction is necessary for superheat temperature.
7. Move the hairline to the flow rate of 20,000 1b/hr on FLOW-Q scale (position the hairline at 20 on the scale). Read the required steam sizing coefficient of 99 under the hairline on C_S-STEAM scale.

FLOW
C_S

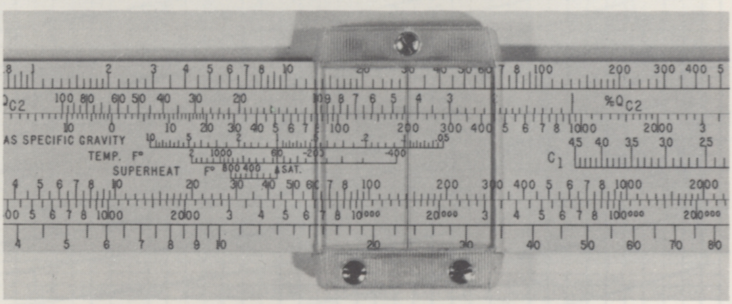


8. From the Continental steam sizing coefficient table in their Technical Data Bulletin 141.05 for a Class 2 heavy pattern butterfly valve, we see that a 2″ valve will handle the given flow since it has a C_S of 101 at 90° angle of opening.

Solution B — General Procedure

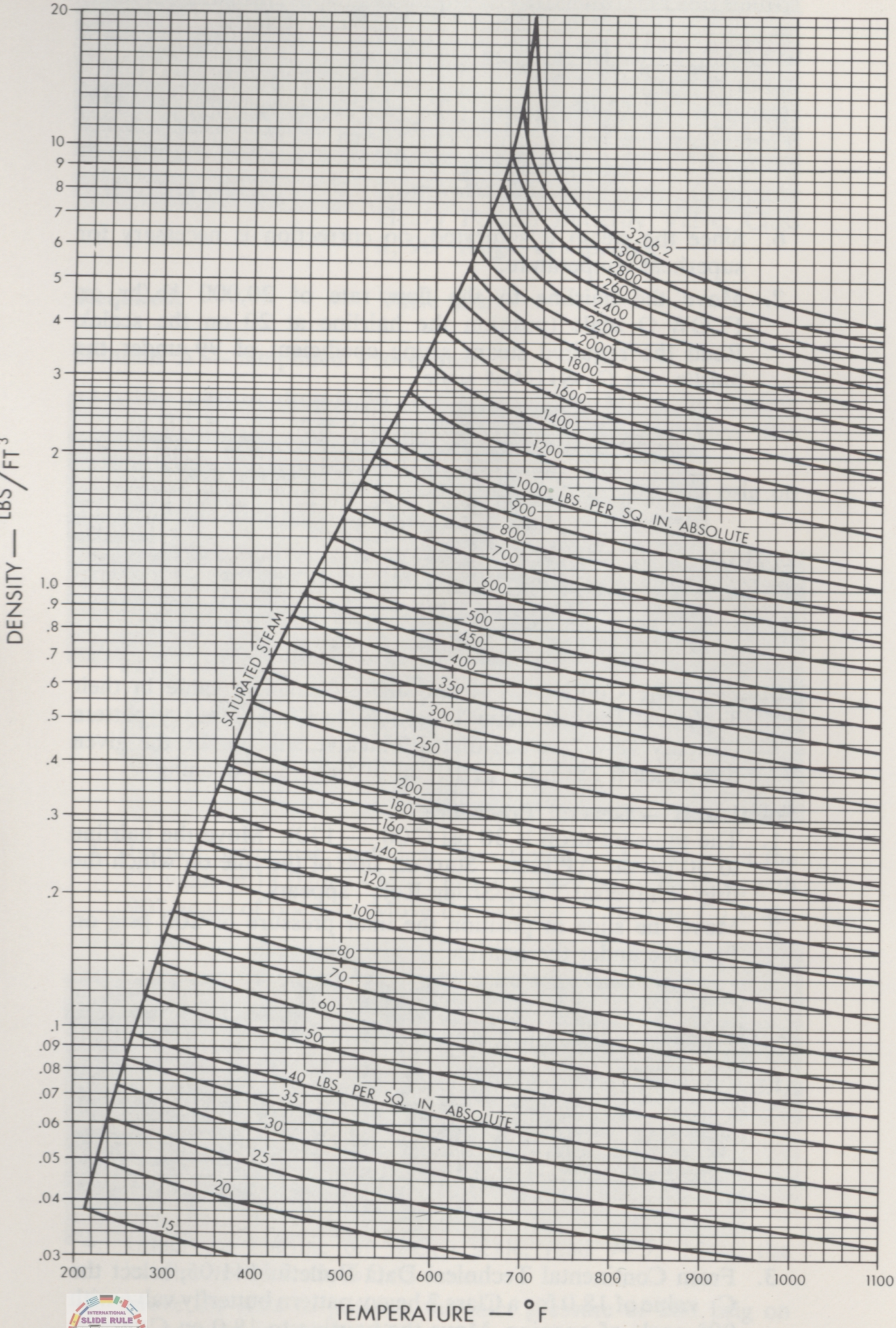
1. The pressure drop is 30 psi (200 — 170). Move the hairline to 30 psi on △P scale. Start on side of the rule on which the title "Universal Valve Sizing Rule" appears.
2. Move the slide to position the inlet pressure of 200 psig on P_1 scale under the hairline.

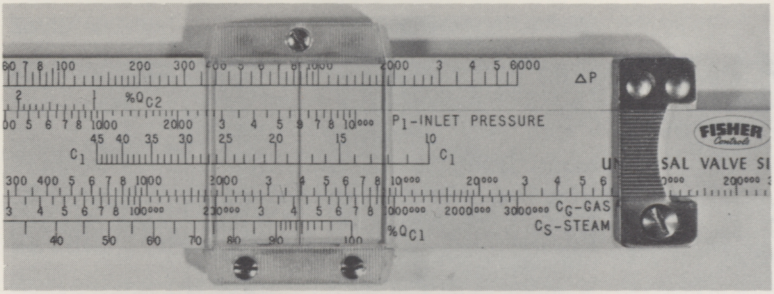
△P
P_1



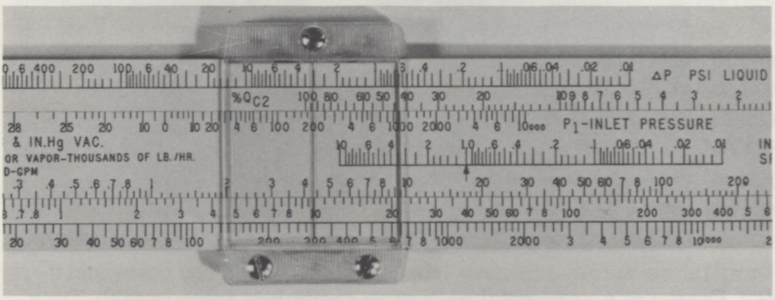
3. From Continental Technical Data Bulletin 141.05, select the C_1 value of 18.0 for a Class 2 heavy pattern butterfly valve with 90° angle of opening. Move the hairline to 18.0 on C_1 scale.

DENSITY vs. TEMPERATURE—SATURATED AND SUPERHEATED STEAM

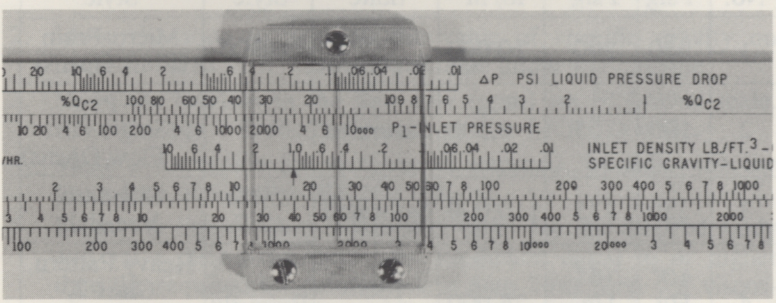




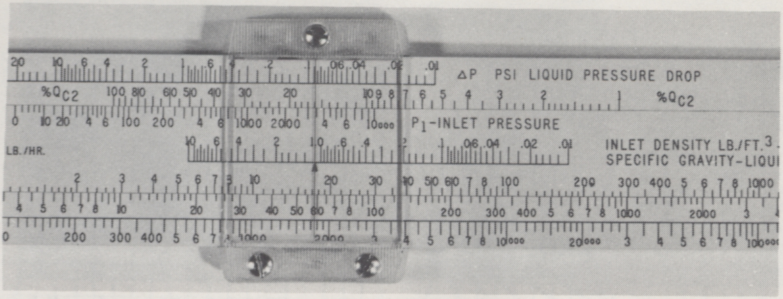
4. Under the hairline on $\%Q_{C1}$ scale, read 94.5. *Turn the slide rule to the reverse side* and move the hairline to 94.5 on $\%Q_{C2}$ scale. (Stay on Copyright 1967 side of rule for remainder of procedure.)
5. Move the slide to position the inlet pressure of 200 psig on P_1 scale under the hairline.



6. From the density versus temperature curves on Page 20, determine the density of the steam at the inlet pressure of 200 psig. Note that the pressure curves are in absolute pressure (psia), so it will be necessary to add 14.7 to the 200 psig. Locate the point at which 214.7 psia intersects the saturated steam line. From this point, proceed horizontally to the left to read the inlet density of 0.46 lbs/ft^3. Move the hairline to 0.46 on INLET DENSITY scale.



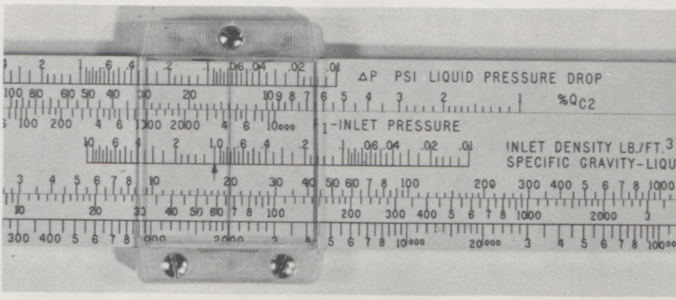
7. Move the slide to position 1.0 on INLET DENSITY scale under the hairline.



8. Move the hairline to the flow rate of 20,000 lb/hr on FLOW-Q scale (position the hairline at 20 on the scale). Read the required vapor sizing coefficient of 2000 on C_g-GAS OR VAPOR scale.

FLOW

C_g



9. From the Continental gas sizing coefficient table in their Technical Data Bulletin 141.05 for a Class 2 heavy pattern butterfly valve, we see that a 2″ valve will handle the given flow since it has a C_g of 2012 at 90° angle of opening.

Additional Steam Sizing Problems

Problem No.	Inlet Pres., Psig	Outlet Pres., Psig	Flow Rate, lb/hr	Steam State	Valve Body Style	Valve Plug Style
1	950	200	20,000	400° Superheat	"DBQ"	Micro-Form (Flow Opens)
2	100	65	8,500	Saturated	"A"	V-Pup (Single Port Flow Opens)
3	250	175	110,000	Saturated	150 lb. "U"	Standard Vee-Ball
4	10″ Hg. Vac.	16″ Hg. Vac.	26,000	150° Superheat	Butterfly	Heavy Pattern, Class 2, 60° angle of opening

Solutions:

Problem No. 1: Required C_S by simplified procedure is 26. A 2″ Design "DBQ" body with 1″ orifice will pass the given flow.

Problem No. 2: Required C_S by simplified procedure is 91. A 2½″ Design "A" body will pass the given flow.

Problem No. 3: Required C_S by simplified procedure is 420. A 4″ 150 lb. Design "U" body will pass the given flow.

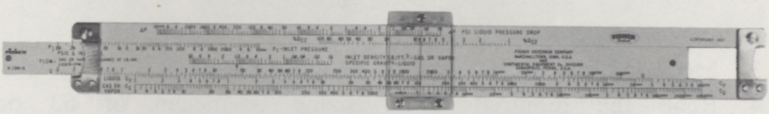
Problem No. 4: Required C_S by simplified procedure is 3000. A 12″ heavy pattern Continental Class 2 butterfly valve at 60° angle of opening will pass the given flow.

Procedure for Liquid Sizing

Scales for liquid sizing are based on water at 60°F. A correction scale is included for liquids with other specific gravities. A correction for viscosity is not included on the slide rule but a separate publication, Fisher Bulletin AL-10, contains a viscosity correction nomograph that should be used when viscosity affects liquid sizing.

A. To determine the valve size when the inlet pressure, outlet pressure, specific gravity and flow rate are known, proceed as follows:

1. Determine the pressure drop (inlet pressure minus outlet pressure) and move the hairline to this value on △P scale. For this procedure, use the side of the rule on which "Copyright 1967" appears.



Use this side of sizing rule.

2. Move the slide to position the value of specific gravity on LIQUID SPECIFIC GRAVITY scale under the hairline.
3. Move the hairline to the flow rate (gpm) on FLOW-Q scale. Read the liquid sizing coefficient on C_V -LIQUID scale.
4. Make a correction for viscosity, if required, by following the procedure outlined in Bulletin AL-10.
5. From the liquid sizing coefficient table for the desired body and valve plug style, locate the coefficient equal to or higher than the required C_V determined in Step 3 (or Step 4 if viscosity correction was made). This will give the valve size and percent of total travel required to pass the given flow.

B. To determine the flow rate when the valve style, valve size, specific gravity and pressure conditions are known, proceed as follows: (Assume no viscosity correction is required.)

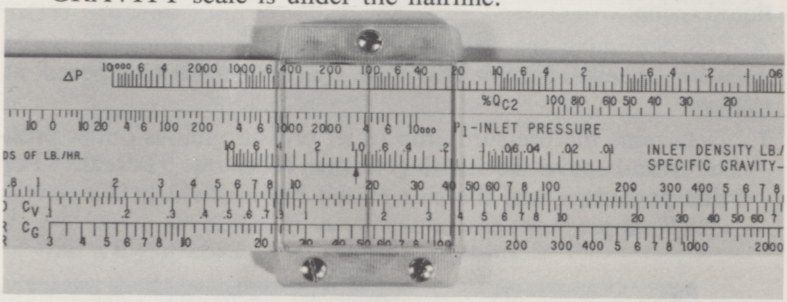
1. Follow the procedure of Steps 1 and 2 in section A above.
2. Move the hairline to the proper sizing coefficient (determined from published tables) on C_V-LIQUID scale. Read the flow rate (gpm) under the hairline on FLOW-Q scale.

Liquid Sizing Example

Given:

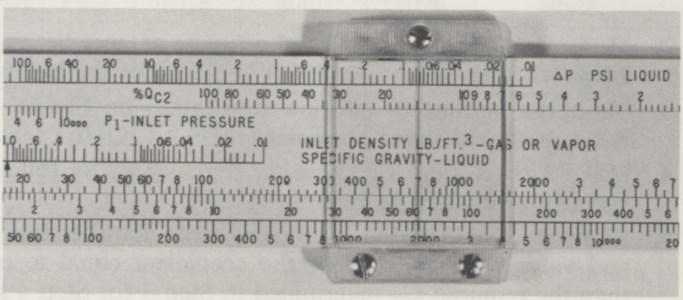
Inlet Pressure	1000 psig
Outlet Pressure	900 psig
Specific Gravity	0.8
Flow Rate	700 gpm
Required:	Valve Size

1. The pressure drop is 100 psi (1000 — 900). Move hairline to 100 psi on △P scale. Use side of rule on which "Copyright 1967" appears.
2. Move slide so that a value of 0.8 on LIQUID SPECIFIC GRAVITY scale is under the hairline.



3. Move hairline to 700 gpm on FLOW-Q scale.
4. Read the required liquid sizing coefficient of 63 on C_V-LIQUID scale.

FLOW
C_V



5. Go to proper coefficient table and pick out the valve size required to pass the given flow. A 2½″ double port Design "A" body with a Throttle Plug valve plug would be adequate (see Bulletin AL-10) and the flow would be passed at approximately 90% travel.

Additional Liquid Sizing Problems

Inlet Pressure, Psig	Outlet Pressure, Psig	Flow Rate, Gpm	Specific Gravity	Sizing Coefficient, C_v
2200	1700	60	0.8	2.4
500	185	1050	1.2	65
15	0	800	1.0	207

FISHER GOVERNOR COMPANY

Main Plants and Corporate Offices: Marshalltown, Iowa 50158

OTHER PLANTS: Woodstock, Ont., Coraopolis, Pa., McKinney, Texas, Toluca, Edo de Mexico
OVERSEAS PLANTS: Fisher Governor Co., Ltd., Rochester, Kent, England
Cowdenbeath, Scotland / Elliott-Automation, Cernay, France;
Revesby, N.S.W. Australia / Tokico, Ltd., Kawasaki City, Japan

Printed in U.S.A. 7.5M-5-67-MP