FISHER

CONTROL VALVE SIZING RULE

Operating Instructions

FISHER GOVERNOR COMPANY
MARSHALLTOWN, IOWA, U. S. A.

Preface

The Fisher Control Valve Sizing Rule was designed by the Fisher Governor Company engineering staff to give the users of FISHER valves a ready means of determining valve sizes for air or gas, steam, and liquid flow. When values of inlet pressure, outlet pressure, flow rate, specific gravity, and flowing temperatures are known, FISHER valve sizes may be read directly from the rule. The coefficient scales enable one to determine the required size of any valve at any lift for which the proper coefficient is known.

The liquid coefficient, C_V, used on the FISHER rule is equal to the number of gallons of water per minute that a valve will pass with a one psi pressure drop. The gas coefficient, C_G, is defined by the equation $Q = C_G P_1$, where Q is flow in scfh, P, is inlet pressure in psia and the pressure drop is greater than critical. When sizing a valve for pressure drops less than critical, the inlet pressure is converted to an equivalent critical inlet pressure. This conversion is performed by the first two steps in Gas Sizing Procedure. The steam coefficient, C_S, is determined in a manner similar to the gas coefficient determination.

The rule also includes standard slide rule C and D scales to provide an expedient means of solving related and other problems.

Procedure For Air or Gas Sizing

To determine the valve size when the known values are inlet pressure, outlet pressure, gas flow rate, specific gravity, and flowing temperature, proceed as follows:

1. Move the hair line to the given inlet pressure on the INLET PRESSURE SCALE (P_1).
2. Move the slide so the PRESSURE DROP ($\triangle P$) (inlet pressure minus outlet pressure) is under the hair line. At the PRESSURE DROP INDEX ($\triangle P = .1$), read the pressure on the CORRECTED INLET PRESSURE scale (P_C).
   a. If the pressure on the CORRECTED INLET PRESSURE scale is lower than the INLET PRESSURE (P_1), the inlet pressure to be used in the following steps is that indicated at the PRESSURE DROP INDEX ($\triangle P = .1$) on the CORRECTED INLET PRESSURE (P_C) scale. The hair line should be positioned at this pressure.
   b. If the CORRECTED INLET PRESSURE (P_C) is higher than the INLET PRESSURE (P_1) the conditions have established critical flow, and the hair line must be

positioned over the actual inlet pressure on the CORRECTED INLET PRESSURE (P_C) scale.

Frequently, it will be recognized that critical flow conditions exist ($\triangle P > P_1/2$ where P_1 is inlet in psia) and steps 1, 2, and 2a may be omitted and the hair line located over the actual inlet pressure on the CORRECTED INLET PRESSURE (P_C) scale.

3. Locate the slide so the proper value of SPECIFIC GRAVITY is under the hair line.
4. Move the hair line to the index (S.G.=1).
5. Locate the slide so the proper value on the GAS TEMPERATURE scale is under the hair line.
6. Move the hair line to the flow rate on the FLOW (Q) scale.
7. Under the hair line on the GAS COEFFICIENT (C_G) scale, read the C_G.
8. On the GAS VALVE SIZES scale, read the next larger valve size.

Valve sizes shown on the rule are for flows occurring at maximum valve lifts. If other than maximum flows are desired, consult the table of gas coefficients, FISHER BULLETIN AL-4, for coefficients versus percent of valve travel.

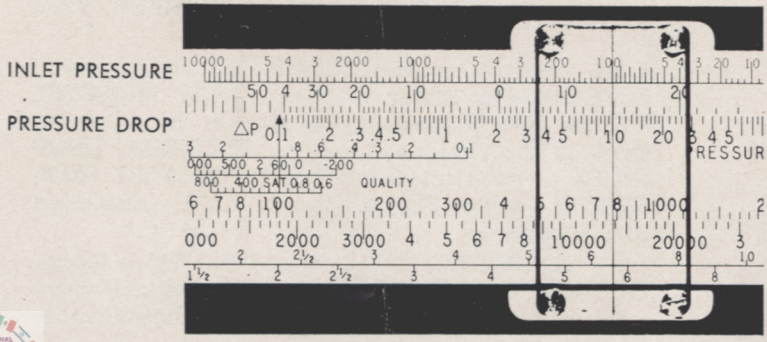
Gas Sizing Example 1

Given:

INLET PRESSURE	100 psig
OUTLET PRESSURE	90 psig
SPECIFIC GRAVITY	1.2
GAS TEMPERATURE	200° F.
FLOW	10,000 scfh

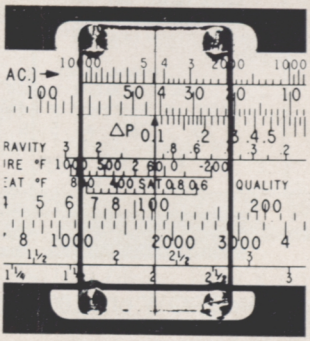
To find valve size required:

1. Locate hair line on 100 psig INLET PRESSURE (P_1).
2. Move SLIDE so 10 psi (100-90) PRESSURE DROP ($\triangle P$) is under hair line.

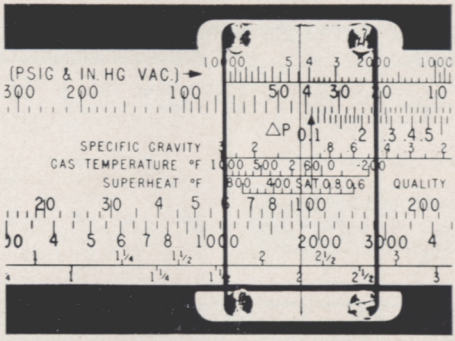


3. Move hair line to PRESSURE DROP INDEX ($\triangle P$=.1). Note that the CORRECTED INLET PRESSURE (P_C) reading at the pressure drop index ($\triangle P$=.1) is 42 psig which is smaller than the inlet pressure, hence, the hair line remains in this position.

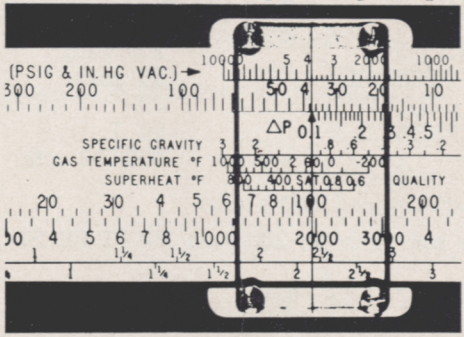
CORRECTED INLET PRESSURE



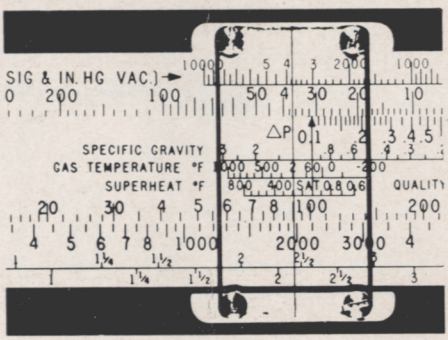
4. Move slide so SPECIFIC GRAVITY 1.2 is under the hair line.



5. Move hair line to INDEX (specific gravity=1.0)

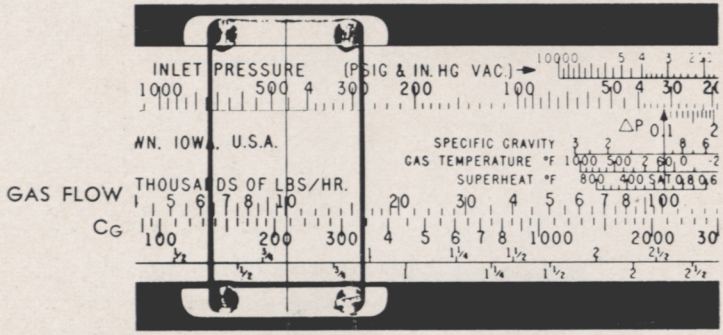


6. Move slide so GAS TEMPERATURE 200° F. is under hair line.



7. Opposite FLOW of 10,000 scfh read GAS COEFFICIENT (C_G) of 217.

8. On GAS VALVE SIZES scale read that 1" single-ported valve or a ¾" double-ported valve is required.



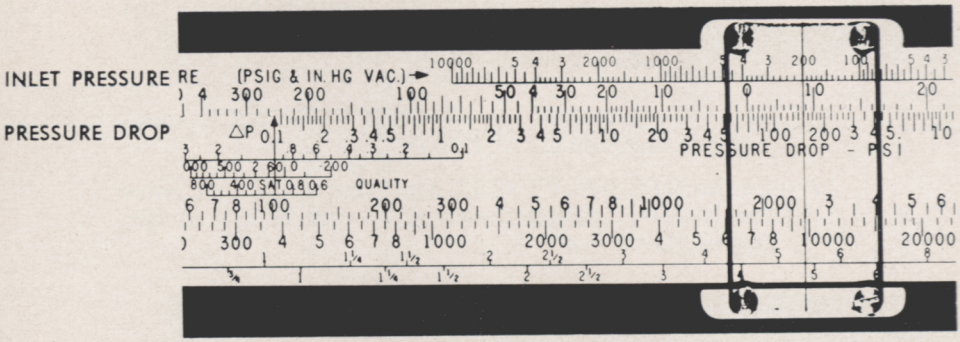
Example 2

INLET PRESSURE	200 psig
OUTLET PRESSURE	50 psig
SPECIFIC GRAVITY	1.0
GAS TEMPERATURE	60° F.
FLOW	500,000 scfh

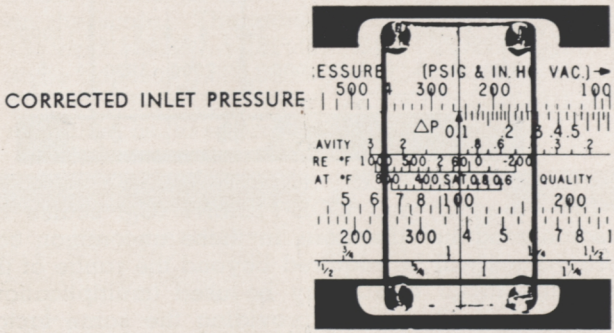
To find required valve size:

1. Locate hair line on 200 psig INLET PRESSURE (P_1).

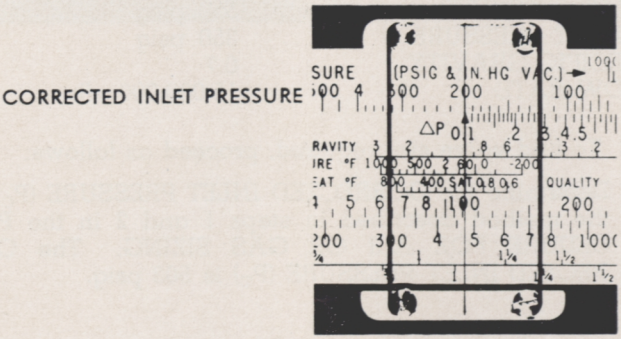
2. Move slide so 150 psi (200-50) PRESSURE DROP ($\triangle P$) is under the hair line.



Move hair line to PRESSURE DROP INDEX ($\triangle P$=.1). Note that the CORRECTED INLET PRESSURE (P_C) is 251 psig.



This is a higher pressure than the actual inlet pressure so critical flow conditions exist and the hair line must be positioned over 200 psig on the CORRECTED INLET PRESSURE (P_C) scale.

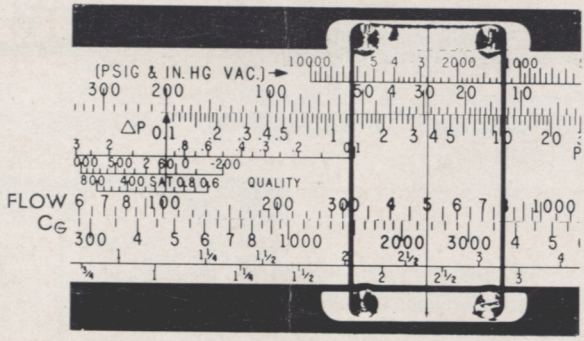


3. Move the slide so specific gravity of 1.0 is under the hair line. The specific gravity of 1.0 and temperature of 60° F. require no correction, therefore steps 4 and 5 may be omitted.

6. Move hair line to 500,000 scfh on FLOW (Q) scale.

7. Under the hair line, on the COEFFICIENT (C_G) scale, read the required C_G of 2320.

8. On the GAS VALVE SIZES scale the next larger valve size is a 2½" double-ported valve and/or a 3" single-ported valve.



The Flow (Q) and COEFFICIENT (C_G) scales have the same modulus, therefore, in those uncommon cases, where values will be required beyond the range of these scales any factor of 10 may be used (multiplication or division) with either scale, providing the same factor is used in the same way with the other scale.

Example 3

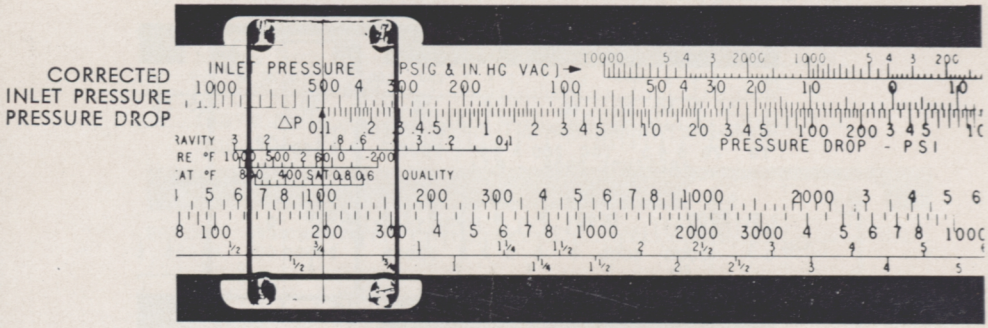
Given:

INLET PRESSURE	550 psig
OUTLET PRESSURE	350 psig
SPECIFIC GRAVITY	0.7
FLOW RATE	15,000,000 cfh

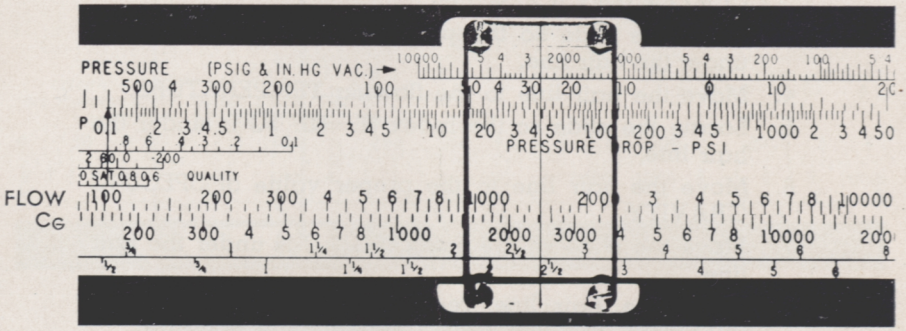
To find valve size required, proceed as follows:

1. Determine the CORRECTED INLET PRESSURE (P_C) by the method described in steps 1 and 2 in the PROCEDURE FOR AIR OR GAS SIZING. The CORRECTED INLET PRESSURE (P_C) is 503 psig.

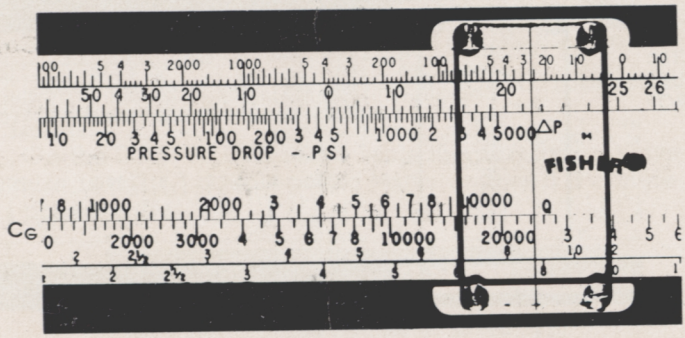
2. Move the slide to correct for specific gravity, as shown in the PROCEDURE FOR AIR OR GAS SIZING.



3. Move the hair line to the value on the FLOW (Q) scale. It will be discovered that 15,000,000 scfh is not on the scale. Therefore, read 15,000,000 divided by 10, or 1,500,000. On the GAS COEFFICIENT (C_G) scale opposite 1,500,000 scfh a C_G of 2440 is read; but this must be multiplied by 10, as the flow of 1,500,000 scfh must be, to return to the correct answer.



Therefore, move the hair line up to a coefficient of 2440 multiplied by 10 or 24,400, and read that an 8" double-ported valve will be required.



Example 4

To determine the pressure drop when the known values are flow rate, valve size and travel, inlet pressure, specific gravity, and temperature, proceed as follows:

1. Determine the appropriate sizing coefficient (C_G) for the valve and travel from the table of coefficients.
2. Place the hair line over the proper coefficient on the COEFFICIENT (C_G) scale.
3. Move the slide so the proper value of FLOW (Q) is under the hair line.
4. Move the hair line to the flowing TEMPERATURE.
5. Locate the slide so the index (T=60° F.) is under the hair line.
6. Move the hair line to the proper value of SPECIFIC GRAVITY.
7. Move the slide so the index (SG=1) is under the hair line.
8. Under the hair line, read the CORRECTED INLET PRESSURE (P_C) (equivalent critical inlet pressure).
9. Move the hair line to the inlet pressure on the INLET PRESSURE (P_1) scale. Under the hair line, read the pressure drop on the PRESSURE DROP ($\triangle P$) scale.

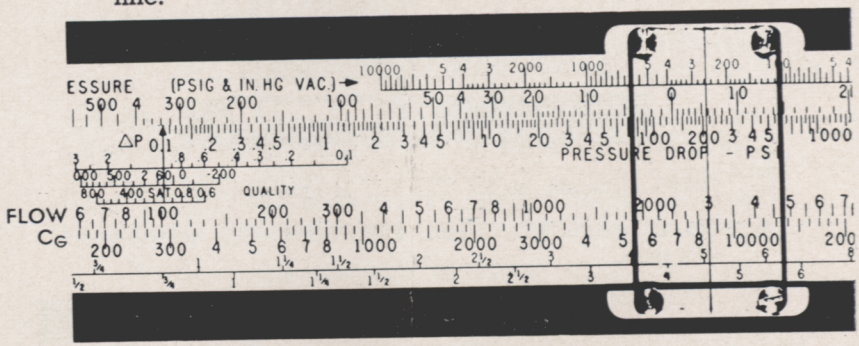
Pressure Drop Example

Given:

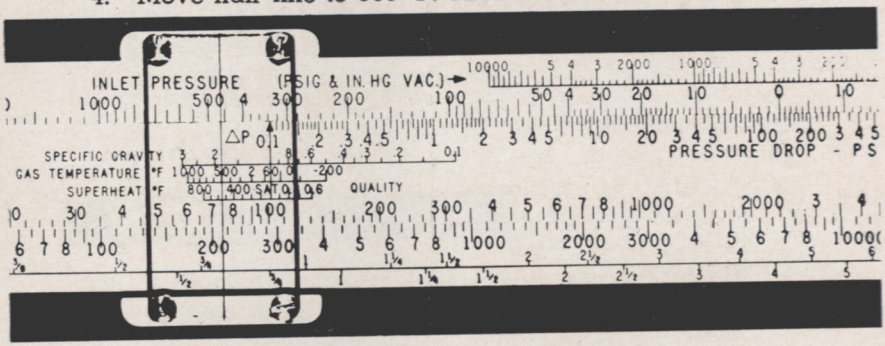
FLOW	3,000,000 scfh
VALVE SIZE, TYPE	4" double-ported quick opening
SPECIFIC GRAVITY	.8
TEMPERATURE	500° F.
INLET	750 psig

To find the required outlet pressure, proceed as follows:

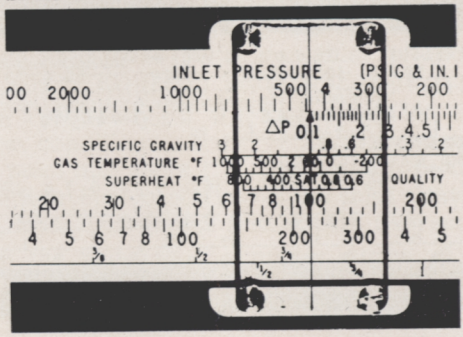
1. In FISHER Bulletin AL-4, the C_G for a 4" double-ported quick opening valve is 8520.
2. Move hair line to 8520 on the GAS COEFFICIENT (C_G) scale.
3. Move slide so 3,000,000 scfh FLOW (Q) is under hair line.



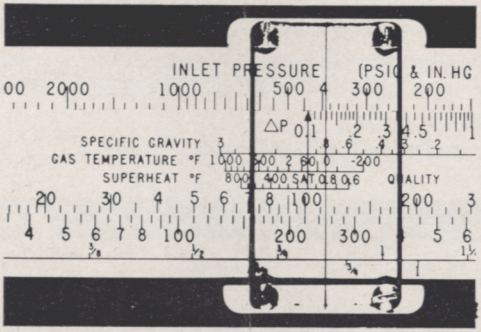
4. Move hair line to 500° F. TEMPERATURE.



5. Move slide so index (T=60° F.) is under hair line.

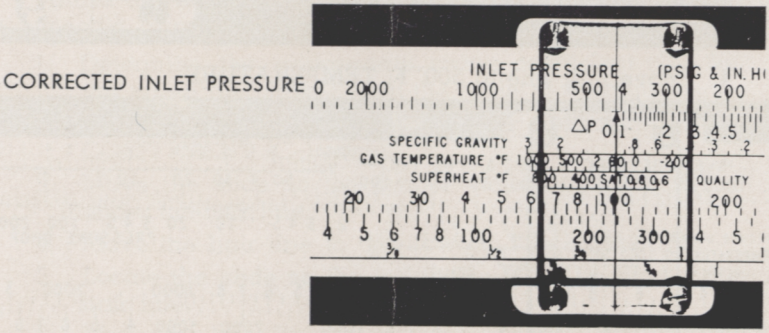


6. Move hair line to .8 SPECIFIC GRAVITY.

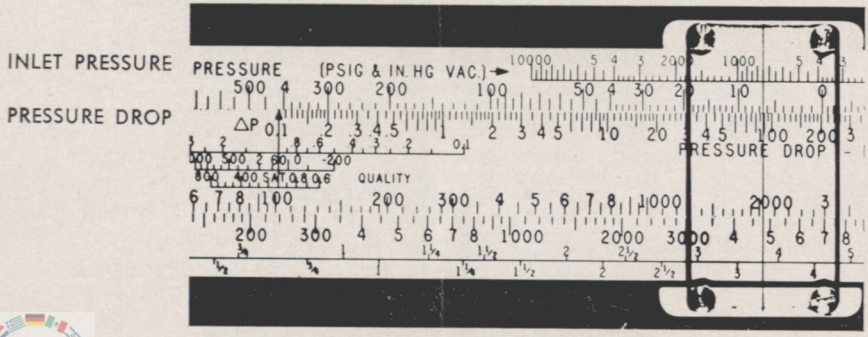


7. Move slide so index (SG=1) is under hair line.

8. On CORRECTED INLET PRESSURE (P_C) scale, read 413 psig.



9. Move hair line to 750 psig on INLET PRESSURE (P_1) scale. On PRESSURE DROP ($\triangle P$) scale, read 89 psi. Outlet pressure equals 750-89=661 psig.



Additional Gas Sizing Examples

Inlet Pressure psig	Outlet Pressure psig	Flow scfh	Specific Gravity	Temperature °F.	Gas Coefficient C_G
520	360	50,000	1.1	60	115
700	300	4,000,000	.6	0	4070
50	40	300,000	1.0	60	729
10″ H_G Vac	15″ H_G Vac	3,500	1.0	60	449

Procedure For Steam Sizing

The steam scales are based on saturated steam, and correction scales are included for superheat and quality. These scales except for superheat or quality corrections and actual valve sizes are identical with the air or gas calculation scales and are used in an identical manner.

To determine the size of valve when the known values are inlet pressure, outlet pressure, flow rate, and steam state, proceed as follows:

1. Move the hair line to the given inlet pressure on the INLET PRESSURE (P_1) scale.
2. Move the slide so the PRESSURE DROP ($\triangle P$) (inlet pressure minus outlet pressure) is under the hair line. At the PRESSURE DROP INDEX ($\triangle P$=.1), read the pressure on the CORRECTED INLET PRESSURE (P_C) scale.
   a. If the pressure on the CORRECTED INLET PRESSURE (P_C) scale is lower than the INLET PRESSURE (P_1). The inlet pressure to be used in the following steps is that indicated at the PRESSURE DROP INDEX ($\triangle P$=.1) on the CORRECTED INLET PRESSURE (P_C) scale. The hair line should be positioned at this pressure.
   b. If the CORRECTED INLET PRESSURE (Pc) is higher than the INLET PRESSURE (P_1), the conditions have established critical flow, and the hair line must be positioned over the given inlet pressure on the CORRECTED INLET PRESSURE (P_C) scale.

      Frequently, it will be recognized that critical flow conditions exist ($\triangle P > P_1/2$ where P_1 is inlet in psia) and steps 1, 2, and 2a may be omitted and the hair line located over the inlet pressure on the CORRECTED INLET PRESSURE (P_C) scale.
3. Locate the slide so the proper value of the steam state, amount of SUPERHEAT in °F., QUALITY or SATURATED, is under the hair line.

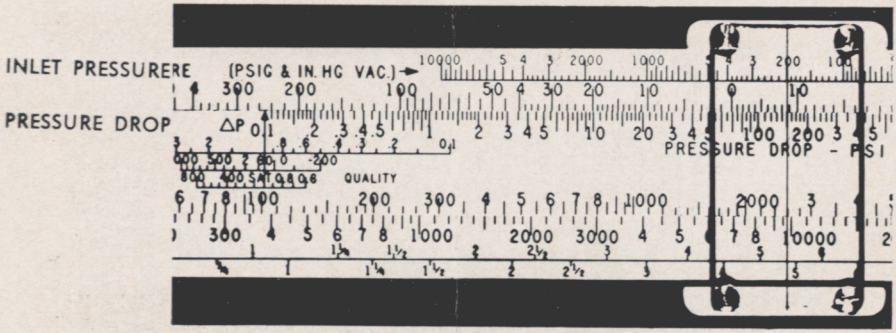
4. Move the hair line to the flow rate in thousand lbs. per hour on the FLOW (Q) scale.
5. Under the hair line, on the COEFFICIENT (C_S) scale, read the required C_S.
6. Turn the rule to the reverse side, not moving the hair line. STEAM VALVE SIZES are now located at the top of the rule. On this scale, read the next larger valve size.

Steam Sizing Example

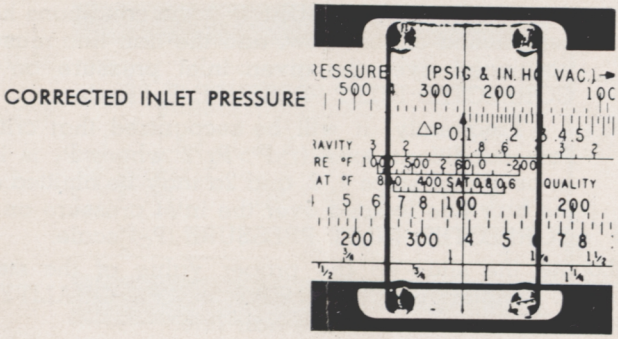
Given:

INLET PRESSURE	200 psig
OUTLET PRESSURE	50 psig
QUALITY	.97
FLOW	4000 lbs./hr.

1. Move hair line to 200 psig on INLET PRESSURE (P_1) scale.
2. Move slide so pressure drop of 150 psi (200-50) on PRESSURE DROP ($\triangle P$) scale is under hair line.

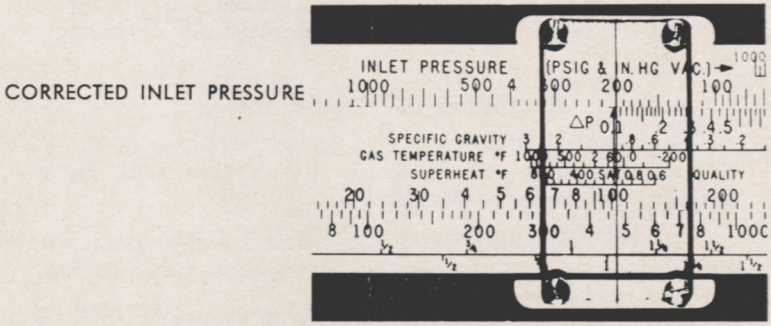


Note that on the CORRECTED INLET PRESSURE (P_C) scale at the PRESSURE DROP INDEX, the CORRECTED INLET PRESSURE is 251 psig.

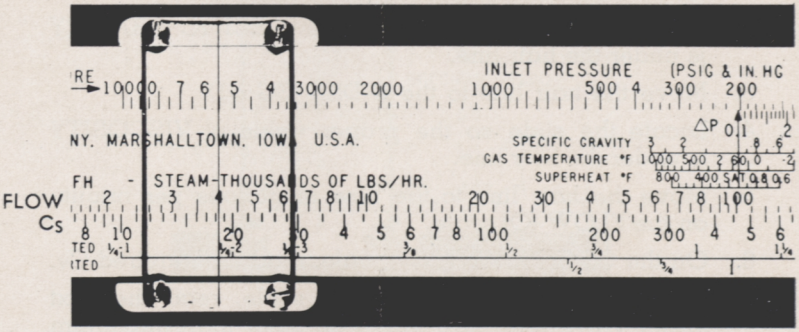


This is larger than 200 so the hair line must be positioned on 200 on the CORRECTED INLET PRESSURE (P_C) scale.

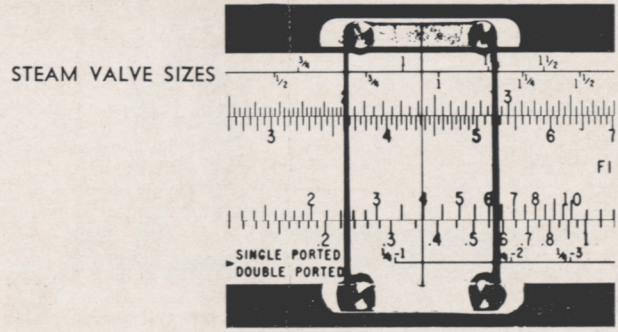
3. Move the slide so a QUALITY of .97 is under the hair line.



4. Move the hair line to a FLOW (Q) rate of 4000 lbs./hr.
5. On the COEFFICIENT (C_S) scale, read a C_S of 18.3.



6. On the reverse side of the rule on the STEAM VALVE SIZES scale, the next larger valve size is a 1¼" single-ported valve or a 1" double-ported valve.



Additional Steam Sizing Examples

Inlet Pressure psig	Outlet Pressure psig	Flow Lbs./Hr.	Steam State	Steam Coefficient C_S
950	200	2800	400° Superheat	3.66
100	65	8500	.80 Quality	77.1
250	150	150,000	Saturated	600

Procedure For Liquid Sizing

Scales for liquid sizing are based on water at 60° F. Correction scales are included for liquids with other specific gravities and viscosities.

To determine the valve size when the inlet pressure, outlet pressure, specific gravity, and viscosity are known, proceed as follows:

1. Locate the hair line on the pressure drop (inlet pressure minus outlet pressure) on the PRESSURE DROP ($\triangle$P) scale.
2. Move the slide so the value of SPECIFIC GRAVITY is under the hair line.
3. Move the hair line to the INDEX (SG=1).
4. Locate the slide so the proper value of VISCOSITY is under the hair line.
5. Move the hair line to the flow in gallons per minute on the FLOW (Q) scale.
6. On the COEFFICIENT (C_V) scale, read the required C_V.
7. On the LIQUID VALVE SIZES scale, read the next larger valve size. If a valve lift other than maximum is to be used, consult the TABLE OF COEFFICIENTS in Fisher Bulletin AL-4.

Liquid Sizing Example

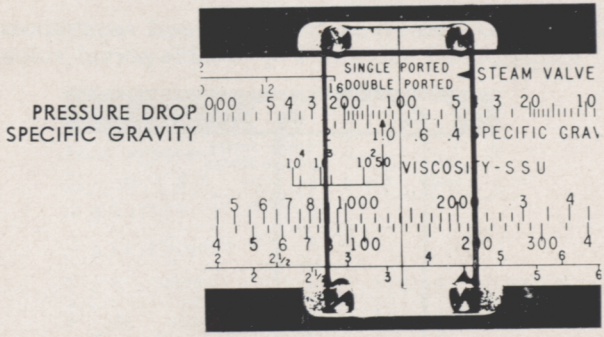
Given:

INLET PRESSURE	1000 psig
OUTLET PRESSURE	900 psig
SPECIFIC GRAVITY	.8
VISCOSITY	100 ssu
FLOW	700 gpm

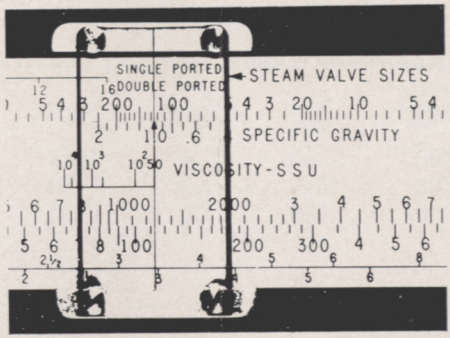
To find required valve size:

1. Locate the hair line on 100 (1000-900) on the PRESSURE DROP ($\triangle$P) scale.

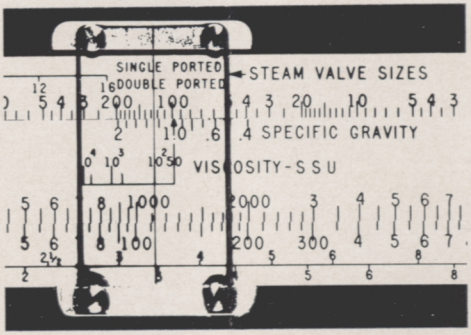
2. Move the slide so a SPECIFIC GRAVITY of .8 is under the hair line.



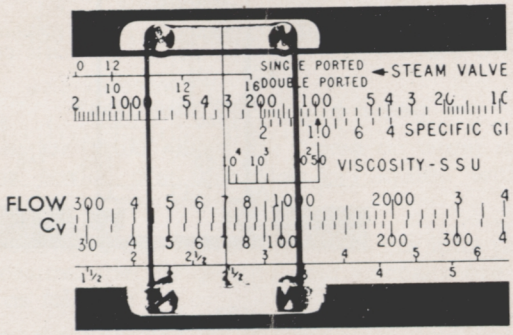
3. Move hair line to INDEX. (SG=1.0)



4. Move slide so 100 ssu VISCOSITY is under hair line.



5. Move hair line to 700 gpm on FLOW (Q) scale.
6. On COEFFICIENT (C_v) scale, read C_v=70.6.
7. On LIQUID VALVE SIZES scale, read requirement of 3" single-ported valve or 2½" double-ported valve.



Additional Liquid Sizing Examples

Inlet Pressure psig	Outlet Pressure psig	Flow gpm	Specific Gravity	Viscosity SSU	Liquid Coefficient C_v
2200	500	60	.8	1000	1.92
500	185	1050	1.2	50	65
15	0	800	1.0	50	207


INTERNATIONAL
SLIDE RULE
MUSEUM