INSTRUCTION BULLETIN

10B9016
PRIMARY ELEMENTS & PIPING FOR KINETIC MANOMETERS
[ORI-FLOWRATOR METERS]

INTRODUCTION

A kinetic manometer is a variable area by-pass type instrument designed to measure fluid flow in conjunction with an orifice plate with flange, other recommended taps or a flow nozzle. The ABB Ori-Flowrator meter is designated as Model 10B4500 Series. Operation and maintenance of these meters is covered by other instructions bulletins. Figure 1 shows that the kinetic manometer is connected in parallel with the primary element. The total pressure drop across the kinetic manometer is therefore approximately equal to the pressure drop across the orifice plate. A range orifice located in the kinetic manometer inlet or outlet determines the differential pressure range of the instrument.The bore of the range orifice is sized so that the flow rate through it at maximum pressure drop is exactly equal to the flow rate required to lift the float to the maximum scale position. Flow rate through the range orifice is measured by the variable area meter section of the kinetic manometer. Since the flow rate through the range orifice is proportional to the instantaneous flow rate through the main line, the variable area meter also measures the main line instantaneous flowrate.

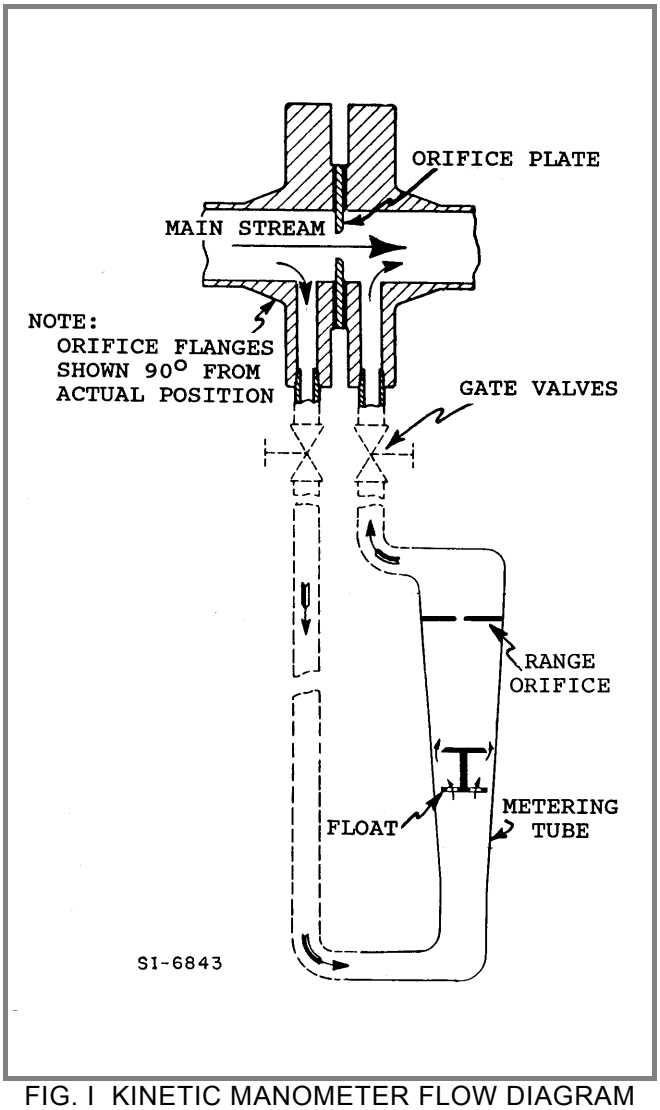

FIG. I KINETIC MANOMETER FLOW DIAGRAM

I General

The primary element is a flow restricting device which when placed in a pipe line produces a pressure drop that varies as the fluid flow rate. In order to obtain maximum accuracy with any primary element, obstructions or bends in the pipe line near the primary element that would disturb the flow pattern must be eliminated. To accomplish this a minimum length of straight pipe must be placed between the orifice and the nearest pipe fittings. When this is impossible, the insertion of a straightening vane on the upstream side of the primary element permits a reduction in the required length of straight pipe. Installation diagrams specifying required lengths of straight pipe with or without straightening vanes are shown in Fig. II.

II Orifice Plate

A) General

The orifice plate must be installed with the sharp edge upstream. Best results will be obtained when the orifice plate (concentric type) is accurately centered with respect to the internal diameter of the pipe line and when the orifice metering edge is sharp and smooth. When an orifice plate is installed in a horizontal line to measure wet stream or wet gas flow, a small hole should be drilled through the orifice plate near the bottom to prevent condensate build up in front of the plate. When metering gassy liquids it is recommended that a vent hole be drilled through the primary element near the top to allow a passage for trapped gasses. See Figures III & IV. If the orifice is installed in a vertical line a drain hole is not necessary.

B) Flanged Taps

The size of all flange taps must be 1/2". Modify the tap size where necessary to conform to this requirement. Remove burrs by slightly rounding the edges of the tap holes with emery cloth. The center of the upstream tap is placed 1" from the upstream face of the orifice plate and the center of the downstream tap is placed 1" from the downstream face. Gasket thickness must be allowed for if the taps are located with reference to the flange bearing faces. The connecting pipe which fits into the flanged taps must not protrude into the fluid stream. Where flanges are slipped or screwed on the main line pipe, the open end of the connecting pipe must not be obstructed by the main line pipe. See Fig. V.

C) Vena Contracta Taps

These tap locations are theoretically determined by the ratio between the pipe ID and orifice bore diameter. In practice however, the center of the upstream tap is placed 1 pipe diameter from the upstream orifice face; the center of the downstream is placed 1 pipe diameter minus 0.8 throat diameter from the downstream orifice face. See Fig. II.

D) Pipe Taps

In most applications pipe taps are less desirable then either vena contracta or flange tape. They are, however, used with pipe smaller than 2 1/2" in diameter. Pipe taps are placed 2 1/2 pipe diameters upstream and 8 pipe diameters downstream from the orifice plate.

III Venturi Tubes & Flow Nozzles

Consult the A.S.M.E. "FlowCode" or the ABB " Differential Head Flow Meter Handbook"

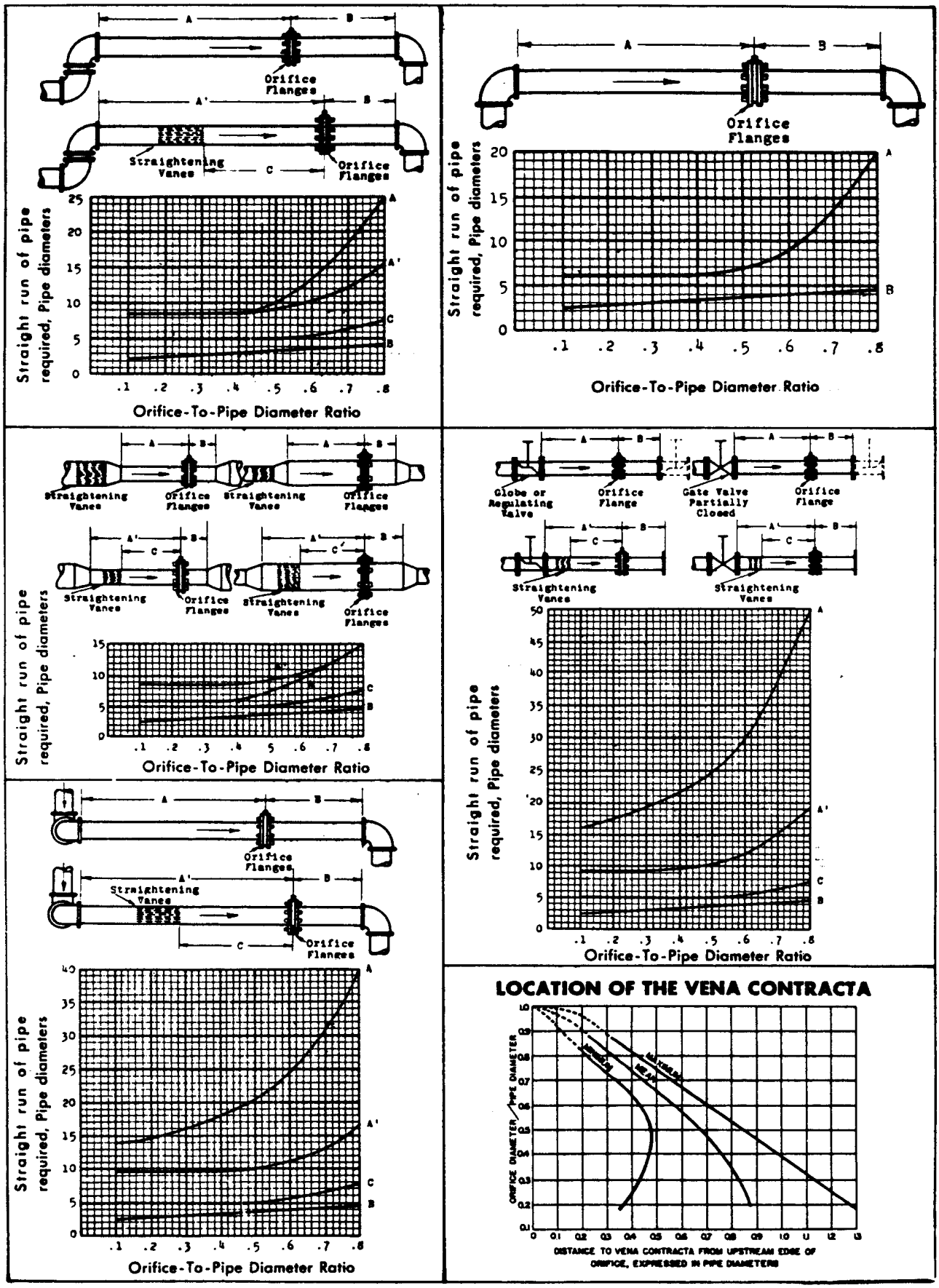
A
B
Orifice Flanges
A'
Straightening Vanes
C
Straight run of pipe required, Pipe diameters
Orifice-To-Pipe Diameter Ratio
Globe or Regulating Valve
Gate Valve Partially Closed
LOCATION OF THE VENA CONTRACTA
ORIFICE DIAMETER / PIPE DIAMETER
DISTANCE TO VENA CONTRACTA FROM UPSTREAM EDGE OF ORIFICE, EXPRESSED IN PIPE DIAMETERS

Figure II

LEAD LINES, FITTINGS & AUXILIARY EQUIPMENT

I Connecting Line Size

Equalizing manifolds, condensate or seal pots are not required with kinetic manometers. A shut-off valve, normally a gate valve, should be placed in each lead line between the main line and the kinetic manometer. Where the kinetic manometer is installed close to the primary element, the lead line and fittings must be 1/2" pipe size; where the kinetic manometer is installed over six feet from the primary element, lead line and fittings sizes should conform to the values in Table I. Use reducing couplings at the kinetic manometer and at the flange taps when the lead line pipe is greater than 1/2" size. All lead line and mainline piping should be adequately supported by straps or braces according to the A.S.M.E. "Pipe Fitters Code".

The main line tap holes are usually drilled after the flanges are aligned and fitted. Deburr all tapped and drilled holes. The connecting pipe which fits into the flange taps must not protrude into the fluid stream. Where flanges are slipped or screwed onthe mainline pipe, the ends of the connecting pipe must not be covered.

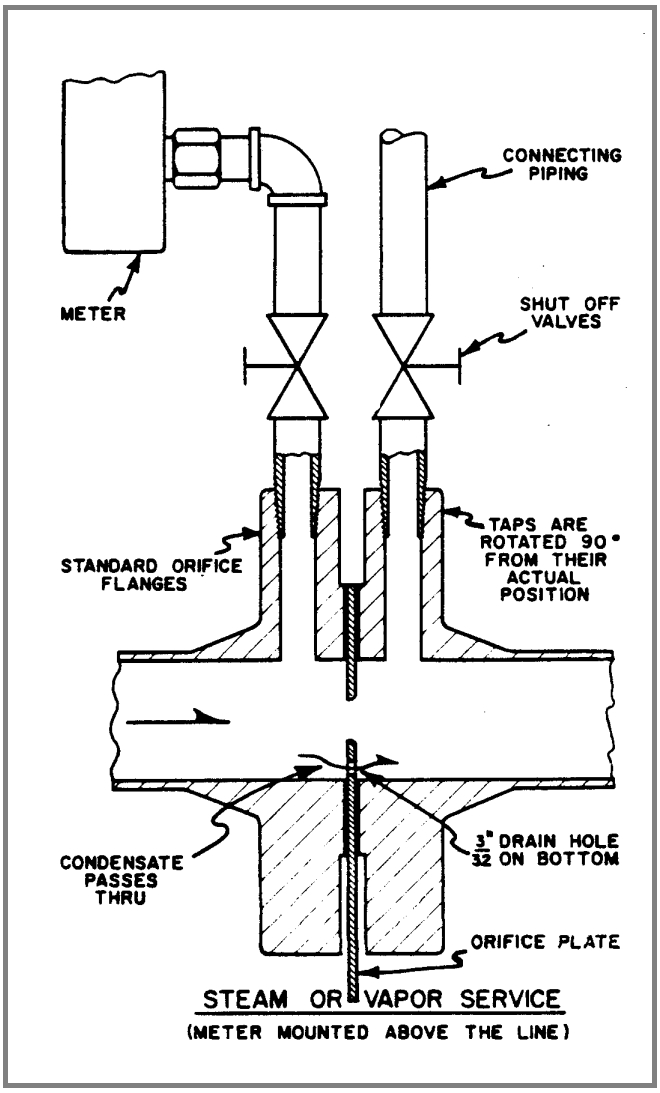

Figure III

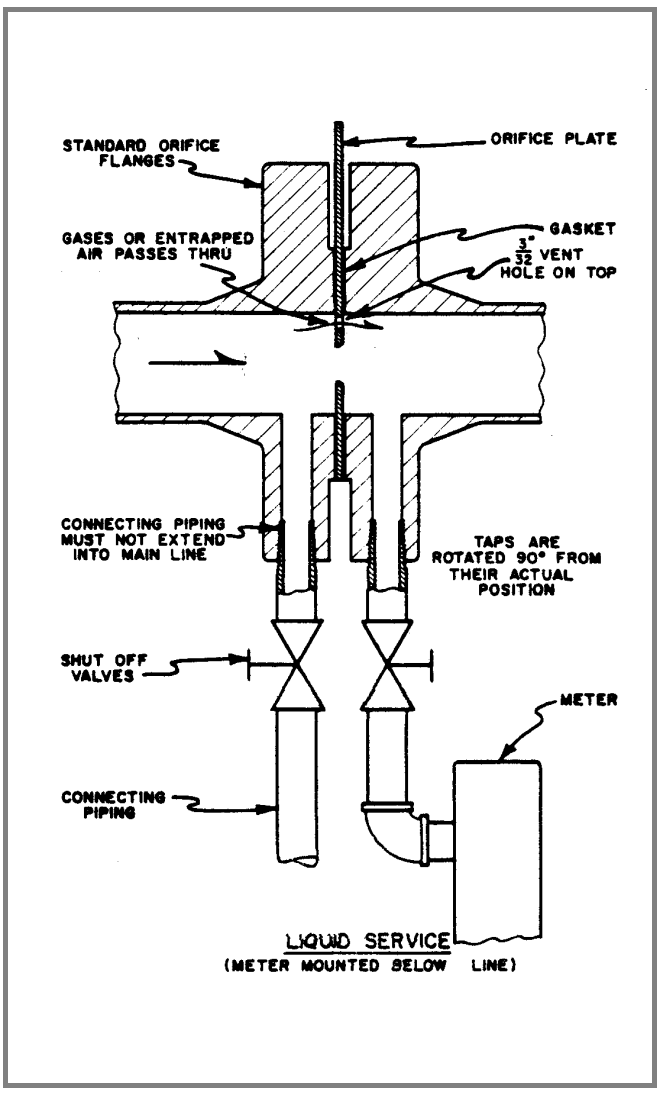

Figure IV

II Location of Manometer & Lead Lines

When metering steam or vapor, it is recommended that the kinetic manometer and connecting piping be installed above the main line. As an added precaution, the piping should be lagged to keep condensation to a minimum. When metering liquids, the kinetic manometer and connecting piping should be mounted below the line. Low points in connecting lines are detrimental since they prevent entrapped gases, vapor, and condensate escaping into the main line.

III Purge Systems

On applications where slurries are handled or where highly caustic fluids are metered-through glass tubes, a purge system is recommended for a kinetic manometer. The principal.' conditions which govern the selection and application of a purge system are as follows:

1) Purge fluid should neither react with, contaminate, nor seriously dilute the main line fluid.

2) Purge flow should enter the system at a point in the connecting piping 6" below the upstream (high pressure) main line tap. See Fig. VI.

3) Purge flow rate should exceed the maximum kinetic manometer reading.

4) The kinetic manometer should be calibrated with the purge flow operative.

5) Experimental data indicates that a pu r g e rate of 2 GPM added to a nonpurged kinetic manometer system introduces errors of 1% of maximum at full scale reading, of 2% of maximum at midscale reading, and of 4% of maximum at 1/10 full scale.

Pipe Sizes For Installation Where Manometer Is Mounted Away From Main Line Orifice. Applicable To Flange Taps Or Vena Contracta Taps		Equiv. Pipe Length Of Fittings - Ft.		
Pipe Size	Allowable Equiv. Length Of Manometer Piping	90° EL	45° EL	Gate Valve
1/2"	Up To 9 Ft.	1.5	.75	.35
*3/4"	Up To 30 Ft.	2.0	1.0	.45
*1"	Up To 60 Ft.	2.5	1.2	.60

Notes
Keep Number Of Fittings To A Minimum
*Use Necessary Reducing Fittings At Orifice & Manometer
Pipe To Be Free Of Burrs
Friction Losses Based On Schedule 40 Pipe

Table 1

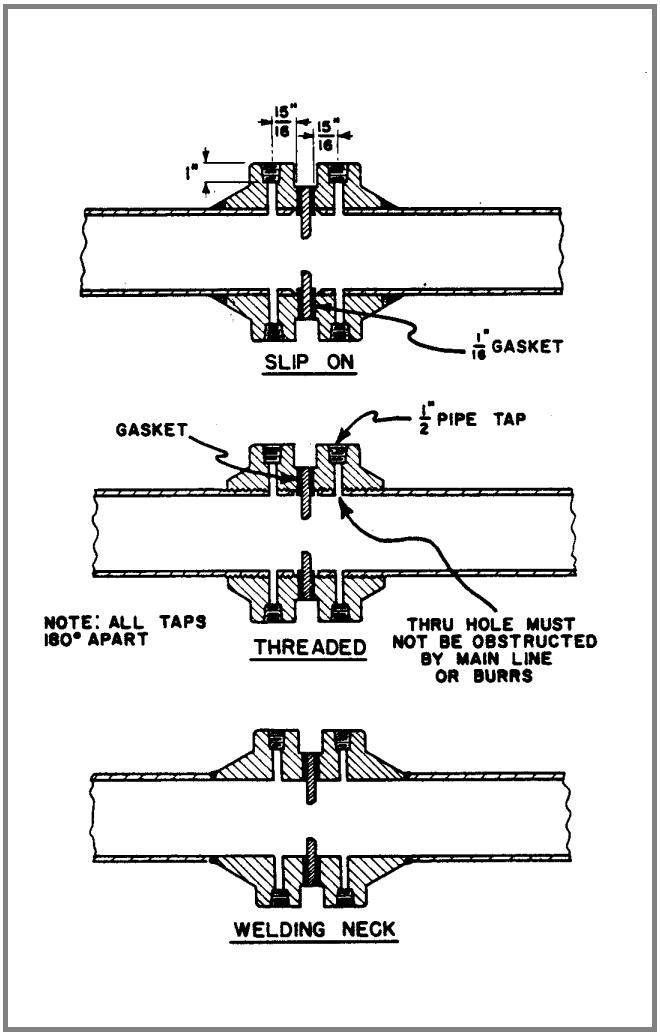

Fig. V Orifice Flange Connections

6) Additional experimental data indicates that a tolerance of ±10% in purge flow rates introduces errors of 0.5% or less of the maximum flow-rate of the measured variable.

7) Table I is still applicable when purge systems are used.

IV Range Orifice

The range orifice determines the differential pressure range of a kinetic manometer. This orifice is placed in the outlet connection of the Series 10B4500 Ori-Flowrator meters. The differential pressure range of a kinetic manometer may be changed, within the limits of the following paragraph, by placing a different size range orifice in the instrument.

Since gas density is a function of absolute pressure, there is a critical ratio of range orifice differential to main line pressure above which errors in gas flow measurement result. The maximum differential range orifice used for gas measurement must not exceed 4 times the downstream absolute pressure (psig). Liquids are considered almost incompressible; there fore, the allowable range orifice size is greater.

V Static Pressure & Temperature Measurement

It is recommended when metering gases that a static pressure tap be placed in the main line near the kinetic manometer tap on the downstream side of the primary element. Measurement of the gas static pressure allows a closer check on its density and consequently a more accurate measurement of the actual flow. In conjunction with the static pressure tap it may also be desirable to measure the temperature of the gas in the main line. Generally the temperature is measured on the side of the orifice where static pressure is measured. Temperature bulbs, if used, should be inserted in the main line at a sufficient distance from the primary element to prevent flow disturbances. Normally this distance is 3 to 5 pipe diameters downstream and 10 to 15 pipe diameters upstream.

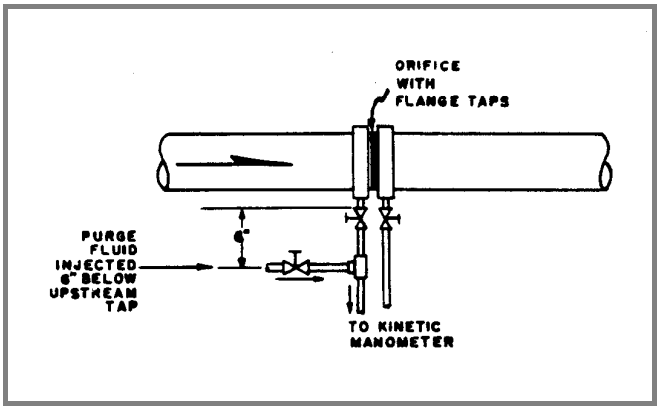

Fig. VI Purge System

MAINTENANCE

The size of the orifice bore which is generally stamped on the plate tab by the manufacturer, should be ch:ecked regularly. When cleaning or checking the dimensions of either the nrain line or range orifice be carefulnot to damage the metering edge. The connecting piping betweenthe manometer and primary element should also be inspected to determine whether scale build-up has decreased the effective I. D. of the piping sufficiently to create excessive pressure loss. Occasionally it will also be necessary to remove did and scum from the pressure taps.

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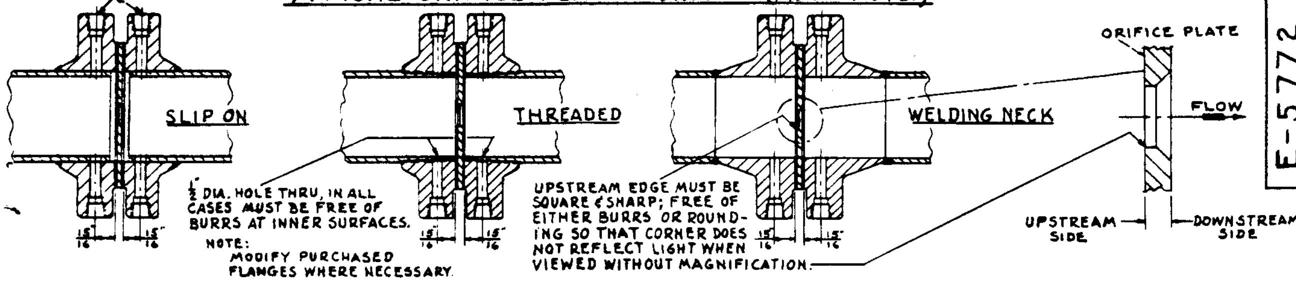
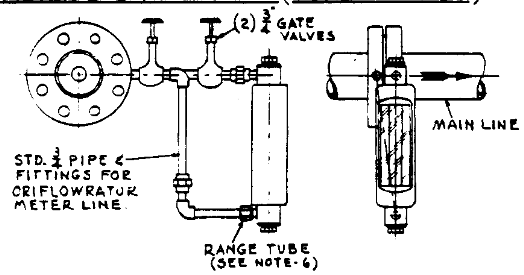
TYPICAL ORIFICE FLANGE UNIONS (A.G.A. STD.)



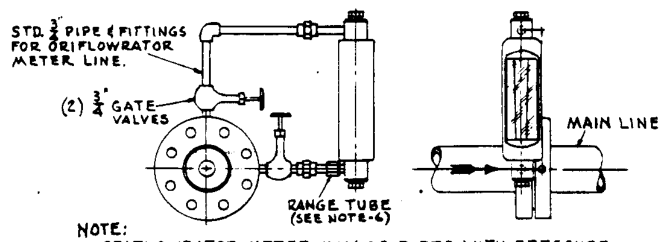
$\frac{1}{2}$" PIPE TAP
SLIP ON
THREADED
WELDING NECK
ORIFICE PLATE
FLOW
UPSTREAM SIDE
DOWNSTREAM SIDE
$\frac{1}{2}$" DIA. HOLE THRU, IN ALL CASES MUST BE FREE OF BURRS AT INNER SURFACES.
NOTE: MODIFY PURCHASED FLANGES WHERE NECESSARY.
UPSTREAM EDGE MUST BE SQUARE & SHARP; FREE OF EITHER BURRS OR ROUNDING SO THAT CORNER DOES NOT REFLECT LIGHT WHEN VIEWED WITHOUT MAGNIFICATION.
$\frac{15}{16}$"

RECOMMENDED INSTALLATION FOR FLANGE TAPS

METER BELOW MAIN LINE (LIQUID OR DRY GAS)



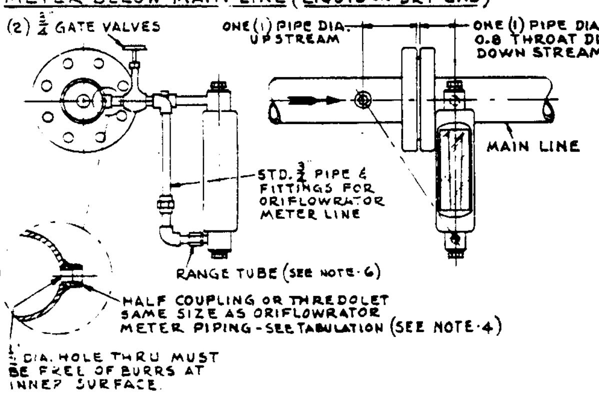
METER ABOVE MAIN LINE (VAPOR OR GAS)



NOTE:
ORIFLOWRATOR METER MAY BE PIPED WITH PRESSURE TAPS ON TOP OF MAIN LINE FLANGES, IF DESIRED.

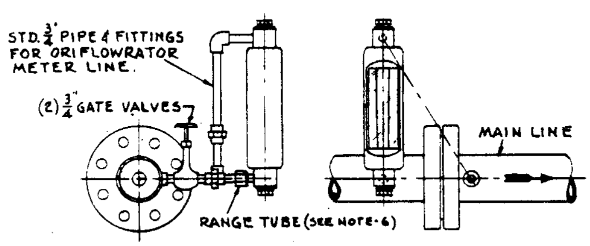
RECOMMENDED INSTALLATION FOR VENA CONTRACTA TAPS (MAIN LINE 4" OR LARGER)

METER BELOW MAIN LINE (LIQUID OR DRY GAS)



(2) $\frac{3}{4}$" GATE VALVES
ONE (1) PIPE DIA. UPSTREAM
ONE (1) PIPE DIA. MINUS 0.8 THROAT DIA. DOWN STREAM.
MAIN LINE
STD. $\frac{3}{4}$" PIPE & FITTINGS FOR ORIFLOWRATOR METER LINE
RANGE TUBE (SEE NOTE-6)
HALF COUPLING OR THREDOLET SAME SIZE AS ORIFLOWRATOR METER PIPING - SEE TABULATION (SEE NOTE-4)
$\frac{1}{2}$" DIA. HOLE THRU MUST BE FREE OF BURRS AT INNER SURFACE.

METER ABOVE MAIN LINE (VAPOR OR GAS)

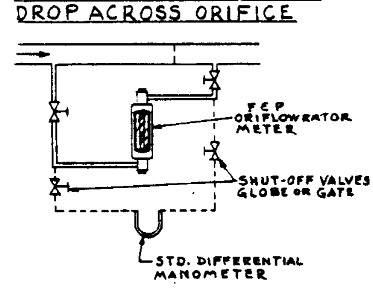


NOTE:
ORIFLOWRATOR METER MAY BE PIPED WITH PRESSURE TAPS ON TOP OF MAIN LINE FLANGES, IF DESIRED

PIPE SIZES FOR INSTALLATIONS WHERE ORIFLOWRATOR METER IS MOUNTED AWAY FROM MAIN LINE ORIFICE. APPLICABLE TO FLANGE TAPS OR VENA CONTRACTA TAPS.		EQUIV. PIPE LENGTH OF FITTINGS FT.		
PIPE SIZE	ALLOWABLE EQUIV. LENGTH OF ORIFLOWRATOR PIPING	90° EL	45° EL	GATE VALVE
$\frac{1}{2}$"	UP TO 6 FT.	1.5	.75	.35
* $\frac{3}{4}$"	UP TO 20 FT.	2.0	1.0	.45
* 1"	UP TO 60 FT.	2.5	1.2	.60

NOTES:
KEEP NUMBER OF FITTINGS TO A MINIMUM.
* USE NECESSARY REDUCING FITTINGS AT ORIFICE & METER. PIPE TO BE FREE OF BURRS. FRICTION LOSSES BASED ON SCHEDULE 40 PIPE.

SCHEMATIC ORIFLOWRATOR METER HOOK-UP FOR CHECKING PRESSURE DROP ACROSS ORIFICE



NOTES:
1- LAG ORIFLOWRATOR METER PIPING WHEN NECESSARY.
2- MEASURE PRESSURE AT DOWNSTREAM TAP.
3- MEASURE TEMPERATURE 3-5 PIPE DIAMETERS DOWNSTREAM OR 10-15 PIPE DIAMETERS UPSTREAM.
4- PIPE TAPS ARE NOT RECOMMENDED.
5- VENT HIGH POINTS WHEN METERING LIQUIDS.
6- RANGE TUBE MAY BE INTERNAL OR EXTERNAL.

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REF DWG No(s) E-4460

TYPICAL INSTALLATIONS FOR ORIFLOWRATOR METERS

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