

## Technical Data

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### Series Oval Flowmeter

#### Model 9400



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#### General

The Brodie 9400 Series Oval Flowmeters, Models 9402 through 9459 (sizes 1/2" - 3"), are mechanical, positive displacement meters designed for use in the Chemical Processing, Industrial, Food and Beverage, and Hydrocarbon processing industries. Utilizing precision matched oval gears for exact liquid measurement, these highly accurate meters are virtually unaffected by changes in viscosity and maintain precision accuracy even when handling low viscosity products at low flow rates.

9400 Series Oval meters are supplied in a 3 piece design which uses both a top and bottom flange in place of the closed-end body configuration found on previous models. This 3 piece design meets or exceeds all of the design and performance specifications of the traditional oval while offering several distinct advantages.

The 3 piece Design:

- Allows service access from either side of the measuring chamber
- Provides access without interrupting electrical or mechanical connections to auxiliary equipment
- Allows easy access for visual inspection

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#### Design Features

- High accuracy
- Simple, durable construction
- Low maintenance requirements
- Easy access 3 piece design
- Choice of materials of construction
- Virtually pocketless design
- Virtually immune to viscosity changes

Improves the service life of the meter body In addition to service features, the 3 piece design offers:

- A clean compact design
- Contoured flow paths for smooth liquid transitions
- Complete interchangeability with existing units
- Gear sets that are completely interchangeable

Reference bulletin X-9400 for complete installation and operating instructions.

Mechanical power transmission is established using a proven "Type 7" magnetic coupling to drive a variety of accessories in a number of applications. For applications requiring power generated operation reference DS-9800 Power Pulse Oval™ (sizes 1/2 to 3").

## Principle of Operation

The Oval Flowmeter accurately measures liquid flow by using a slight pressure differential to rotate a pair of oval gears. The meshed gears seal the inlet from the outlet flow developing the pressure differential. When in the orientation as shown in Position 1, Figure 1, Gear A receives torque from the pressure difference, Gear B torsional forces cancel, and Gear A drives Gear B as depicted in Position 2. When Gear A rotates to the position as shown in number 3, it loses torque, but Gear B obtains torque and drives Gear A. This alternate driving action provides smooth rotation of almost constant torque without dead spots. Positions 4, 5, 6, 7, 8 and 9 illustrate this principle through a complete cycle bringing Gear A back to its original orientation as shown in Position 1.

As the gears rotate they trap precise quantities of liquid in the crescent shaped gaps or measuring chambers. The total quantity of flow for one rotation of the pair of oval gears is four times that of the rotational speed of the gears.

Because the amount of slippage between the oval gears and the measuring chamber wall is minimal, the meter is essentially unaffected by changes in viscosity and lubricity of the liquids.

An output shaft is rotated in direct proportion to the oval gears by means of a powerful magnetic coupling. The output shaft drives a gear train that provides meter registration in engineering units of gallons, liters, pounds, etc.

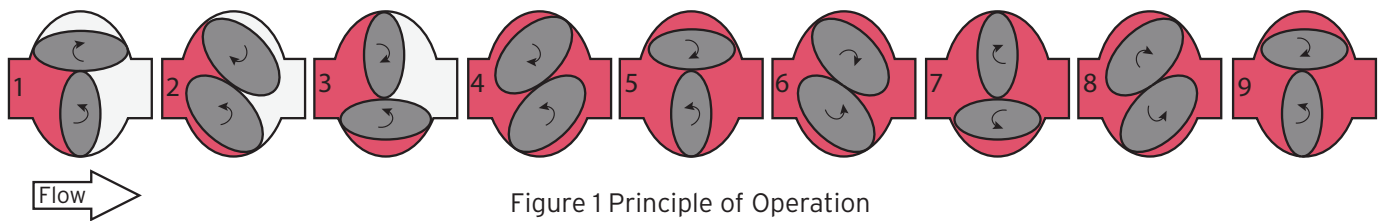


Figure 1 Principle of Operation

## Specification

### Ratings:

#### Maximum Working Pressure

Flange Materials of Construction	ANSI Flange (lbs.)	Pressure Rating at 100° (38°C)	
		psi	kPa
Steel	150 RF	285	1965
Steel	300 RF	740	5102
316 Stn. Stl.	150 RF	275	1896
316 Stn. Stl.	300 RF	720	4964

#### Maximum Working Temperature

0°F to 230°F (-17°C to +110°C) Standard, Class "A"  
 230°F to 392°F (110°C to 200°C) Class "C" Option

#### Accuracy

+/- 0.25% for viscosities of 5 centipoise and above on Class "A" meters only (Temperatures to 230°F or 110°C).

+/- 0.5% on viscosities from 0.2 to 5 centipoise on Class "A" and Class "C" meters (Temperatures to 392°F or 200°C).

**Repeatability:** 0.05% or better

#### Strainer Specifications

Model Number	Connection Size	Mesh	Microns
9402	1/2"	80	150
9453	1"	80	150
9455	1"	60	250
9456	1-1/2"	60	250
9457	2"	40	350
9459	3"	40	350

#### Pressure Drop

To assure maximum service life it is recommended that all Oval meters be sized for maximum flow with a pressure drop of less than 15 psi (103 kPa). As there is no significant shift in accuracy with a viscosity change of 100 centipoise it can be seen that the only limiting factor for higher viscosity change is Flow Range vs. Pressure Drop.

### Materials of Construction

Housing	Rotors	Shafts**	Bearings**	O-ring**
316 Stn. Stl.	316 Stn. Stl.	316 Stn. Stl.	hard carbon	Viton
Cast Steel	316 Stn. Stl.	316 Stn. Stl.	hard carbon	Viton
Alloy 20*	Alloy 20*	Alloy 20*	hard carbon	Viton

\*Available in Models 9402, 9453, 9455 and 9456 only.

\*\*Standard components listed. See Model Code for options. Type 316 stn. stl. is Alloy CF-8M stn. stl. (Alloy 20 is Alloy CN-7M stn. stl.)

### “TYPE 7” MAGNETIC COUPLING

Mechanical power transmission is accomplished by magnetically connecting the output driving shaft of the meter to the driven shaft of the accessory block using a radial gap magnetic coupling (Type 7). Here the driving side of the coupling is exposed to the liquid product by way of the rotor shaft, but the driven side is isolated through the use of a sealed hollow shaft, allowing a dry, magnetic contact coupling. Thus the designation as a “pocketless,” or “chemical” meter, ideal for liquid properties that are coagulative, viscous, dry or requiring periodic flushing or cleaning. Refer to Figure 3.

### Capacities

#### Flowrange Capacities

Connection Size	Model Number	Flow Rates	Cold Water	Hot Water 140°-230°F	LPG 0.2 cP	Gasoline 0.3-0.7 cP	Kerosene 0.8-1.8 cP	Light Oil 2-4 cP	Heavy Oil 5-300 cP
1/2"	9402	gpm	1.3 - 6.6	1.8 - 4.4	3.1 - 8	1.8 - 8	1.3 - 8	0.7 - 9	0.4 - 9
		lpm	5 - 25	6.7 - 17	12 - 30	6.7 - 30	5 - 30	2.5 - 33	1.3 - 33
1"	9453	gpm	2.4 - 13	3.1 - 8.8	4.8 - 16	3.1 - 16	2.4 - 16	1.2 - 17	0.7 - 17
		lpm	9 - 50	12 - 33	18 - 60	12 - 60	9.2 - 60	5 - 67	2.5 - 67
1"	9455	gpm	4.4 - 31	5.3 - 22	7.9 - 37	5.3 - 37	4.4 - 37	1.8 - 44	1 - 44
		lpm	17 - 117	20 - 83	30 - 142	20 - 142	17 - 141	6.7 - 167	4.3 - 167
1-1/2"	9456	gpm	8.8 - 62	11 - 44	15 - 75	11 - 75	8.8 - 75	4 - 88	2.6 - 88
		lpm	33 - 233	42 - 167	58 - 283	42 - 283	33 - 283	15 - 333	10 - 333
2"	9457	gpm	18 - 132	22 - 88	35 - 154	35 - 154	18 - 154	8.8 - 176	5 - 176
		lpm	67 - 500	83 - 333	133 - 583	133 - 583	67 - 583	33 - 667	20 - 667
3"	9459	gpm	35 - 264	44 - 176	66 - 308	44 - 308	35 - 308	26 - 396	18 - 396
		lpm	133 - 1000	167 - 667	250 - 1167	167 - 1167	133 - 1167	100 - 1500	67 - 1500

### Performance

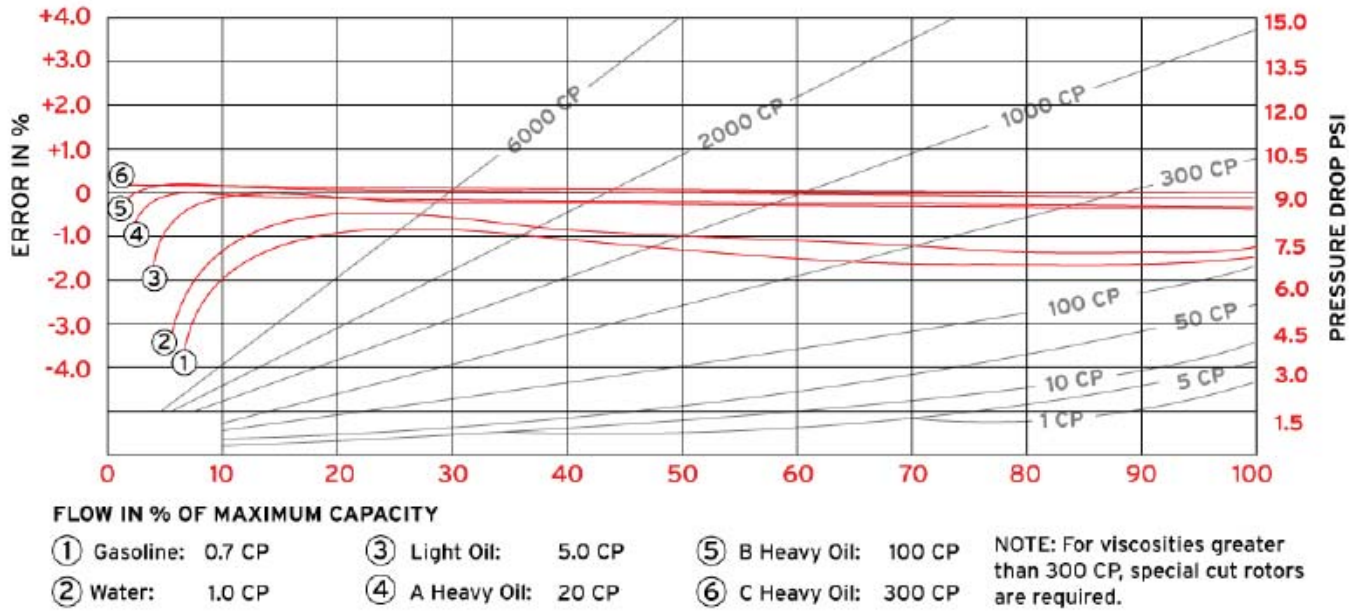
The Typical Performance Curves are representative of all meter sizes as determined through engineering testing. The Accuracy vs. Percent of Flow depicts variations in performance in relation to the lightest viscosity shown through the heaviest. Pressure Drop vs. Percent of Maximum Flow indicates the pressure drop of a typical meter when measuring various viscosities.

### Viscosity

There are two basic classifications of viscosity; Standard (0.2 to 300 centipoise) and High (above 300 centipoise), each of which can be applied to the 9400 Series Oval Flowmeter.

Viscosity vs. Accuracy, One unique advantage of the Oval principle is the ability to measure varying viscosities, within a given range, with only a slight shift in accuracy. Example: A meter calibrated for a product having a rating of 1.0 centipoise, then applied to a product having a rating of 100 centipoise will not shift in accuracy more than 1.2% above initial calibration.

Characteristic Accuracy and Pressure Drop Curves



Dimensions (For Certified Dimensional Prints -Consult Factory)

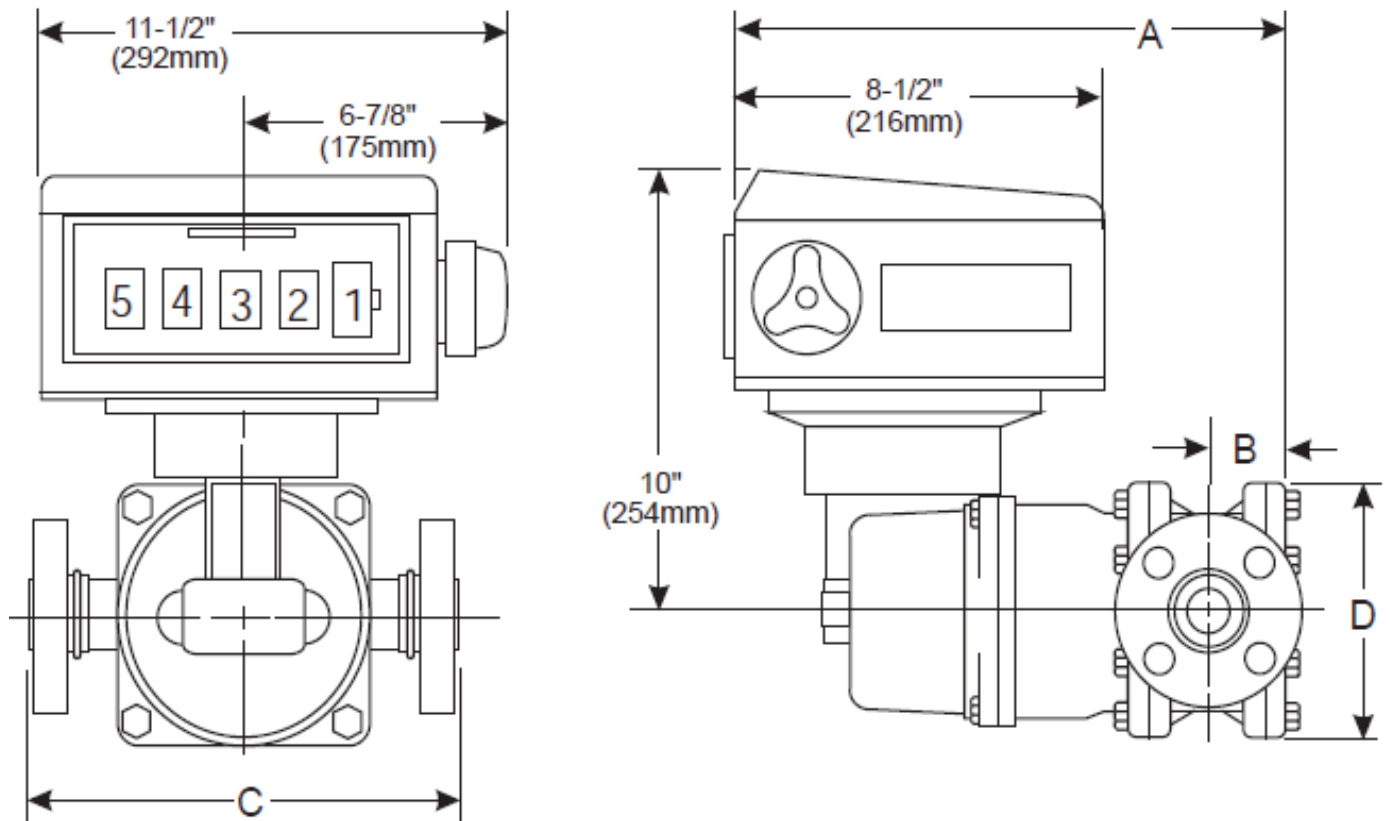


Figure 2 Dimensions - 9400 Series Oval Flowmeter

Model	Size	ANSI Flange Rating	Dimensions			
			A	B	C	D
9402	1/2"	150 lb.	10-5/16"	1-1/16"	8-3/4"	5-1/8"
		(1034 kPa)	(270mm)	(27mm)	(222mm)	(130mm)
9453	1"	150 lb.	11-1/2"	1-1/2"	8-3/4"	5-1/8"
		(1034 kPa)	(292mm)	(39mm)	(222mm)	(130mm)
9455	1"	150 lb.	14-3/8"	1-15/16"	8-3/4"	5-15/16"
		(1034 kPa)	(364mm)	(48mm)	(222mm)	(150mm)
	1"	300 lb.	14-3/8"	1-15/16"	8-3/4"	5-15/16"
		(2068 kPa)	(364mm)	(48mm)	(222mm)	(150mm)
9456	1-1/2"	150 lb.	15-1/2"	2-1/2"	10"	6-3/4"
		(1034 kPa)	(394mm)	(64mm)	(254mm)	(171mm)
	1-1/2"	300 lb.	15-1/2"	2-1/2"	10"	6-3/4"
		(2068 kPa)	(394mm)	(64mm)	(254mm)	(171mm)
9457	2"	150 lb.	15-3/4"	3"	13-3/4"	9-15/16"
		(1034 kPa)	(400mm)	(66mm)	(349mm)	(252mm)
	2"	300 lb.	15-3/4"	3"	13-3/4"	9-15/16"
		(2068 kPa)	(400mm)	(66mm)	(349mm)	(252mm)
9459	3"	150 lb.	19-1/8"	4-9/16"	17-3/8"	13-3/4"
		(1034 kPa)	(486mm)	(116mm)	(441mm)	(349mm)
	3"	300 lb.	19-1/8"	4-9/16"	17-3/8"	13-3/4"
		(2068 kPa)	(486mm)	(116mm)	(441mm)	(349mm)

## General Applications

### Food and Beverage Application

The Brodie 9400 Series Oval is available in a "Clean-In-Place" (C.I.P.) design, Figure 4, for use in the Food and Beverage Industry where various types of syrups and raw liquid products are to be measured. Tri-Clover connections and a quick disconnect rear cover allows ease of maintenance where steam cleaning is a requirement to guarantee sanitary service.

Special design features include:

- All 316 stainless steel construction
- Voidless Rotors
- Silicone O-rings
- Pocketless Design

Totalizing Flow: Volumetric measurement and inventory control may be obtained using the 9400 Series Oval Flowmeter in conjunction with a mechanical Large Dial Register (for local totalization), or may be electronically generated using a pulser. Refer to Figure 5.

Flow Rate Indication: Flow rate expressed in units per minute/hour can be achieved for local and/or remote indication using a combination of accessories. Refer to Figure 5.

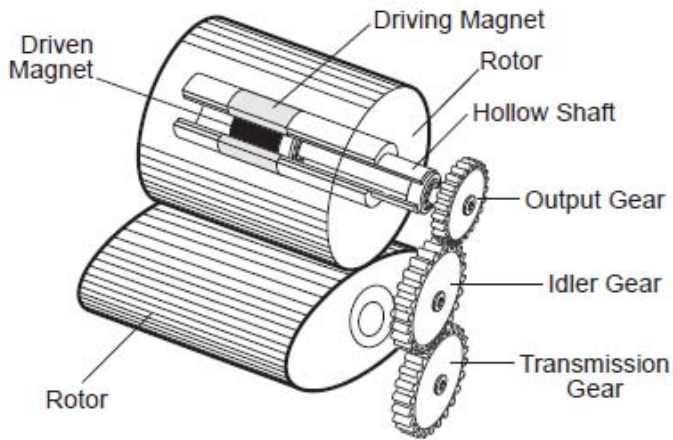


Figure 3 "Type 7" Magnetic Coupling

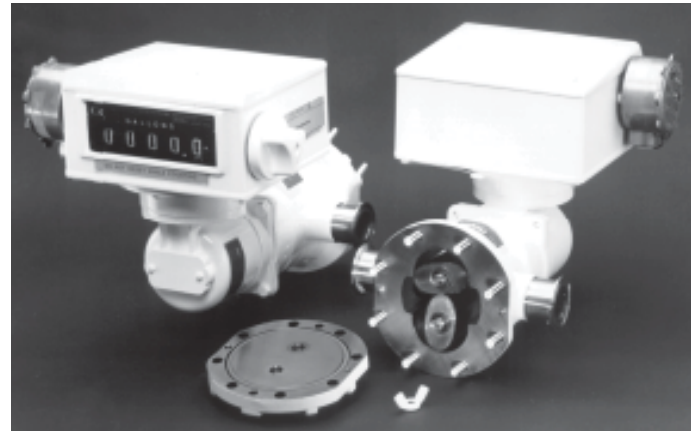
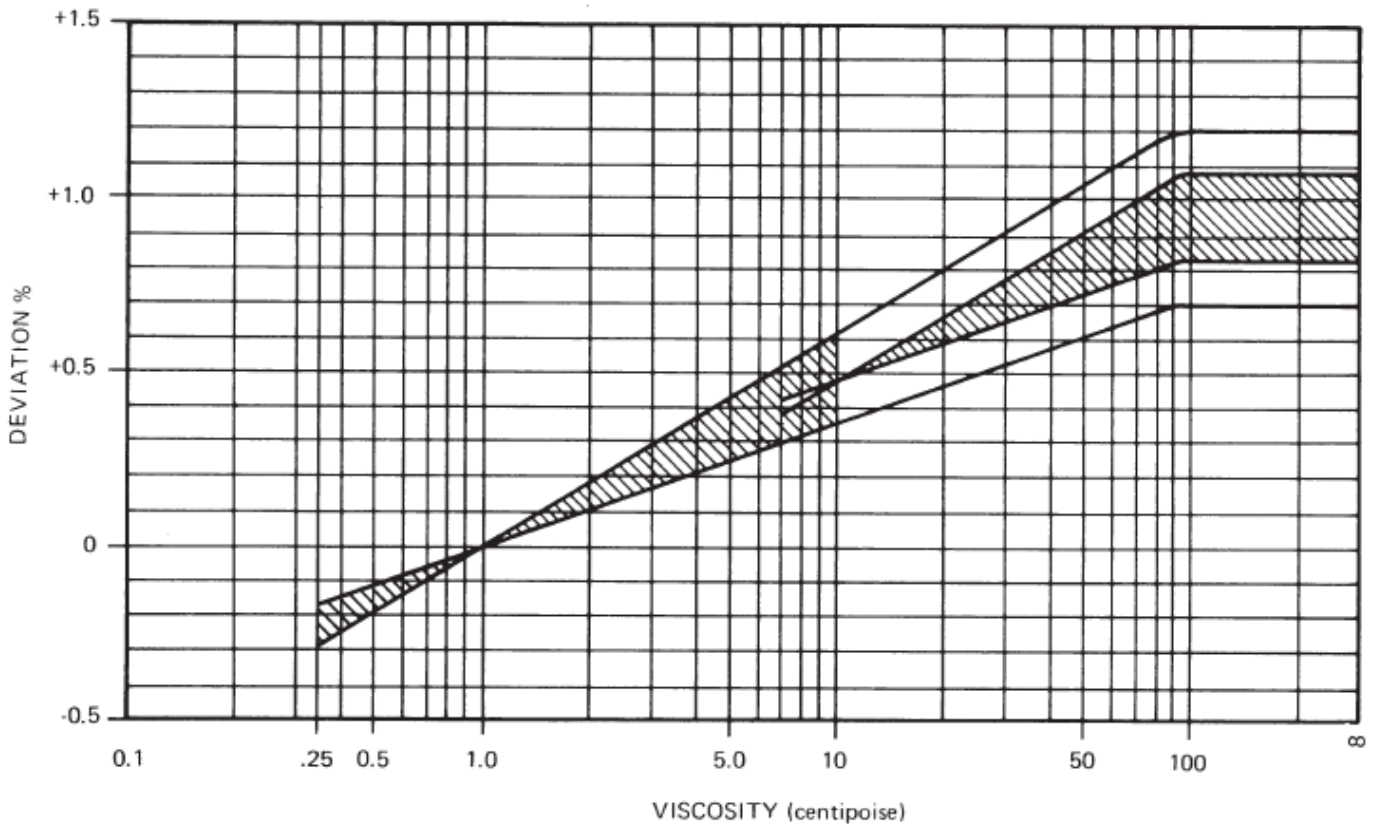


Figure 4 Clean-In-Place Oval Meter

Accuracy vs. Viscosity - Oval Flowmeters with Class "A" Clearances



1. Large Dial Register with mercury wetted pulse transmitter and Low Frequency to Analog Converter with Indicator.
2. Large Dial Register with Electromechanical Flow Rate Indicator.

Batch Control: Automatic batch control is a feature of all Brodie products used in conjunction with specific pneumatic, mechanical and /or electrical accessories. In this operation a predetermined amount of liquid product is measured in preset quantities to fill a vessel, or to be blended with other products in specific combinations. Refer to Figure 5. Flow Control and Recording: Some applications require that minimum and maximum flow rates be controlled to achieve set tolerances within a given system. Brodie 9400 Series Oval Flowmeters, used in combination with specific accessories, are designed to work within those given limits and to record rates as required. Refer to Figure 5.

### ORDERING INFORMATION

In order to process an order, the following information must be supplied in addition to complete model number:

1. Product to be metered
2. Product viscosity
3. Product temperature range
4. Rate of flow
5. Operating pressure
6. Units of Registration
7. Accessories and optional features

### Approximate Shipping Weight and Volume

Model	Shipping Weight	Shipping Volume
9402	33 lbs. (15 kg.)	1.58 ft <sup>3</sup> (.045 m <sup>3</sup> )
9453	48 lbs. (22 kg.)	1.81 ft <sup>3</sup> (.051 m <sup>3</sup> )
9455	64 lbs. (29 kg.)	1.93 ft <sup>3</sup> (.054 m <sup>3</sup> )
9456	79 lbs. (36 kg.)	2.19 ft <sup>3</sup> (.062 m <sup>3</sup> )
9457	159 lbs. (72 kg.)	2.99 ft <sup>3</sup> (.085 m <sup>3</sup> )
9459	259 lbs. (118 kg.)	4.84 ft <sup>3</sup> (.137 m <sup>3</sup> )

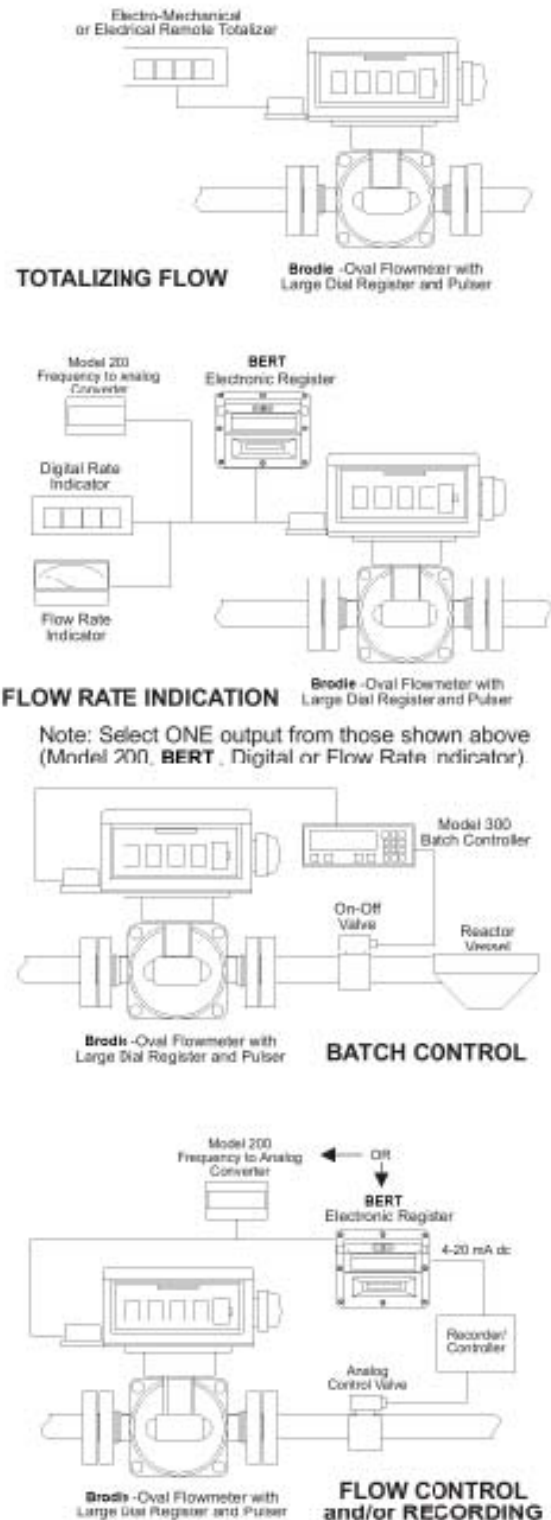


Figure 5 General Applications

**NOTE:**

Do not operate this instrument in excess of the specifications listed. Failure to heed this warning could result in serious injury and/or damage to the equipment.

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