



MODEL 226C  
DP INDICATOR  
(For use with Model 224C DPU)

Installation Manual  
Part No. 10105, Rev.01  
July 2007

[This manual is for indicator only - see separate 224/224C DPU manual.]

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Before installing this instrument, become familiar with the installation instructions in Section 2 and in the separate 224/224C DPU manual.

**DANGER** notes indicate the presence of a hazard which will cause severe personal injury, death, or substantial property damage if warning is ignored.

**WARNING** notes indicate the presence of a hazard which can cause severe personal injury, death, or substantial property damage if warning is ignored.

**CAUTION** notes indicate the presence of a hazard which will or can cause moderate personal injury or property damage if warning is ignored.

**DANGER, WARNING, and/or CAUTION** notes that appear on the following pages of this manual should be reviewed before proceeding: None. (Important! Before installing or operating this instrument, review all safety notices contained in the separate 224/224C DPU manual.)

### PRODUCT WARRANTY STATEMENT

The product warranty applicable to this instrument is stated on the back cover of this manual.

### RECORD OF CHANGES

CHANGE NO.	DATE	DESCRIPTION
83A2	11/82	Rev. text; deleted 227 and 247 information
85B2	2/85	Assign. new manual no.; added warranty
86J3	10/86	Added appendix warning reference to warranty page; add ref. to BUA replacement in para. 5-4; pg. 5-1. Revised warning notice; pg. 6-5; Corrected 246 parts list
93H1	8/93	Incorporated Warranty errata sheet
96J7	10/96	Updated M246 Parts Drawing/List; Added 224C Appendix.
98F10	11/98	Rev. Co. Name/Logo; Updated instrument portion to "C" version reference; pg., 6-3, Item 1, Part No. corrected
00A50f	1/01	New Booklet format; Removed 246 information; Incorporated 224C appendix into body
02E50a	5/02	Non-Technical format/content changes
04C19b	3/04	New PRIME Booklet format; removed 224 DPU info, ref. separate 224/224C DPU manual
01	7/07	Revised corporate name/logo/contact information to reflect Cameron ownership.

## SECTION 1 - INTRODUCTION

### 1-1. General

The Model 226C Differential Pressure (DP) Indicator is used to measure liquid flow or liquid level. The indicator has a 3-inch dial with a 270° pointer arc. For flow measurements, the instrument is connected to the low- and high-pressure sides of a primary device located in the process run. The primary device may be any pressure drop device such as an orifice plate, venturi tube, or flow tube. For liquid level measurements, the instrument is connected to monitor changes in hydrostatic pressure caused by variations of liquid height in a vessel. The movement of the D.P. Indicator has micrometer screws for zero and span adjustments. These adjustments may be performed without removing the scale plate or the indicating pointer.

### 1-2. Main Components

The main components of the M226C are the M224C Differential Pressure Unit (DPU) and the Indicator. For detailed information on the actuating DPU, see the separate 224/224C DPU manual.

### 1-3. Indicator (refer to Figures 1-1 and 2-1)

The DPU torque tube shaft is connected to the movement follower arm of the indicating mechanism. The torque tube shaft rotates in response to the differential pressure applied. The movement of the torque tube shaft is transmitted through the movement follower arm and the associated mechanism to set the indicating pointer at the position on the indicator scale relative to the differential pressure sensed by the DPU.

### 1-4. Specifications

Indication Accuracy:

0-30" w.c. to 0-200 psi ..... ±0.5% of full scale

0-201 psi to 0-400 psi ..... ±0.75% of full scale

Temperature Limits ..... -60°F to +200°F (-53°C to +93°C)

Dial Size ..... 3 inches (76 mm)

DP Ranges ..... See separate 224/224C DPU Manual

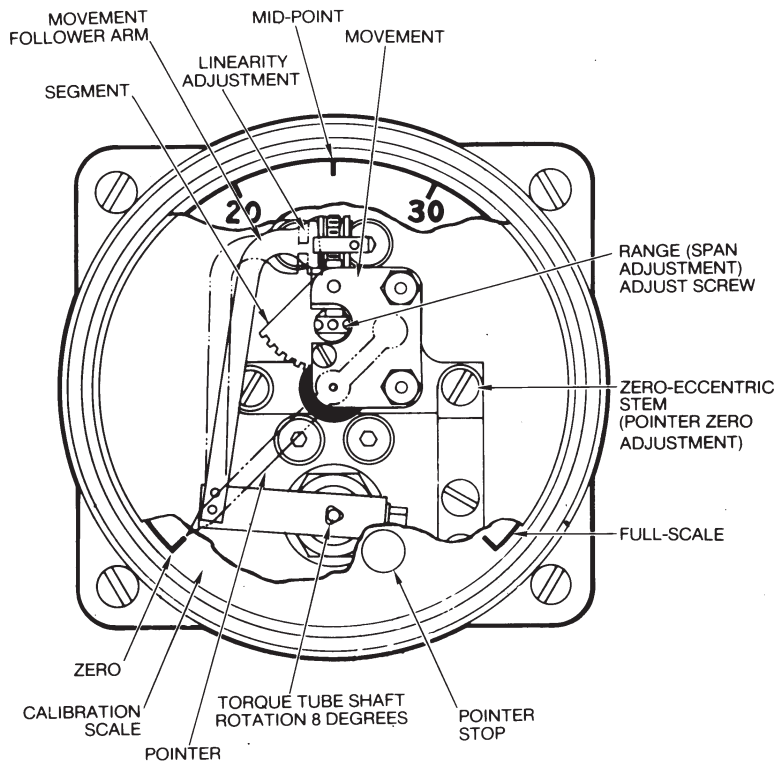


Figure 1-1. Indicator Components

## SECTION 2 - INSTALLATION

### 2-1. General

The instrument should be inspected at time of unpacking to detect any damage that may have occurred during shipment. Note: The unit was checked for accuracy at the factory — do not change any of the settings during examination or accuracy will be affected.

For applications requiring special cleaning/precautions, a polyethylene bag is used to protect the instrument from contamination. This bag should be removed only under conditions of extreme cleanliness.

### 2-2. Mounting/Piping/DPU Installation

Refer to the separate 224/224C DPU Manual.

### 2-3. Startup

For additional startup procedures, Warnings, and information, refer to the separate 224/224C DPU Manual. Observe the following practices when starting up the instrument:

1. Always start with the block valves closed.
2. Perform a zero check on the instrument as follows.
  - a. Open the bypass valve(s), then open one shutoff valve. This procedure equalizes the pressure between both sides of the instrument. The instrument should indicate zero.
  - b. If the instrument does not indicate zero, check for gas or liquid entrapment in the lines or in the DPU (depending on the orientation of the piping layout and service).
  - c. If necessary, adjust the pen or pointer by turning the zero adjust on the instrument.

NOTE: For gas service, it is recommended that zero check be performed with both block valves closed. If the gas flow is pulsating, there may be a standing wave effect in the process line which can displace the indicator and appear as a zero error.

3. Check the manifold and piping for leaks as follows.
  - a. Open the bypass valve(s), then open one shutoff valve to pressurize the instrument.
  - b. Close the shutoff valve and the bypass valve.
  - c. Any leakage will be indicated by pen or pointer movement, up or down scale.

NOTE: Be careful not to subject the DPU to unnecessary shock or over-range pressure during operations.



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## SECTION 3 - MAINTENANCE AND CALIBRATION

### 3-1. DPU Installation/Maintenance/Repair

DPU inspection, cleaning, service, repair, range change, and BUA replacement procedures (along with applicable WARNINGS, CAUTIONS, and NOTICES) are presented in the separate 224/224C DPU manual.

### 3-2. Tools Required For Maintenance

Table 3-1. Tools

Equipment	Purpose
Pointer Puller (0163-0005B)	Pointer Removal
Small Screwdriver	Calibration Adjustment
Medium Screwdriver	Bezel Removal and Replacement
1/4" Open-end Wrench	Zero Adjustment

### 3-3. Bezel/Lens Installation and Removal

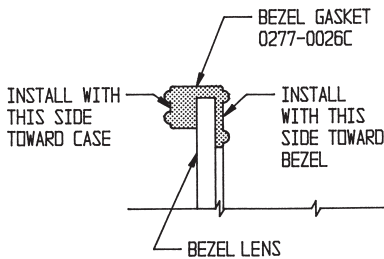


Figure 3-1. Bezel/Lens

The two snubbers (p/n 0266-0028C) on the scaleplate should not be compressed against the lens cover and the pointer should not touch the lens.

To remove the bezel and cover lens:

1. Remove exterior snap ring.
2. Remove lens, lens-gasket, and gasket ring.
3. Remove indicating pointer (see Pointer procedure below).
4. Remove scale retaining snap ring and remove the scale plate.

#### NOTICE

Ensure correct bezel gasket orientation before placing instrument back in service. Incorrect bezel gasket orientation will cause the instrument indicator to jam, resulting in inaccurate readings.

### 3-4. Calibration Check

To ensure the unit calibration is within factory-set calibration tolerances, perform the following procedure. **NOTICE:** Review all procedures, WARNINGS/NOTICES in the separate 224/224C DPU manual BEFORE performing this procedure.

#### A. Preliminary Steps

Mount the unit in a calibration facility, with centerline of the bellows in a horizontal plane (See Test/Calibration Equipment in separate 224/224C DPU manual). Exercise the unit by applying full range pressure to the high pressure port, a minimum of five cycles.

#### B. Calibration Check Procedure

1. Securely mount the indicator in an approximately level position and connect the DPU to a standard pressure source (see separate 224/224C DPU manual).
2. If the zero indication is incorrect, remove the bezel and lens and reset the pointer by slipping pointer on hub by holding pointer and turning hub with wrench, as shown in Fig. 3-2.
3. To test for reverse travel, connect the pressure source to the low pressure (LP) DPU housing and vent the high pressure (HP) DPU housing. Apply pressures approximately 150% of the DP range. The pointer should move approximately 5 to 10 percent below zero.
4. To test for overtravel, connect the pressure source to the high pressure (HP) DPU housing and vent the low pressure (LP) DPU housing. Apply pressures approximately 150% of the DP range. The pointer should move approximately 5 to 10 percent above fullscale.
5. Apply 0%, 50%, and 100% of fullscale pressure. If the indication is within the specified limits, the instrument calibration is satisfactory and no adjustments are necessary. If the indications are incorrect, perform a Complete Calibration.
6. Ensure the instrument's zero indication is correct; otherwise, repeat step 2 above.

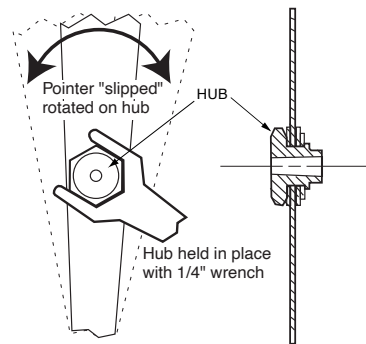


Figure 3-2. "Slipping" Pointer



### 3-5. Pointer Installation and Removal

During adjustment and calibration of the unit, it may be necessary to remove and reinstall the pointer, per the following procedures:

#### A. Pointer Installation

1. Position pointer on movement shaft with pointer set at zero scale. It may be necessary to enlarge the hub hole, using a tapered broach (included in the toolkit (p/n 0288-1032B)).
2. Lightly tap pointer hub with a hand-set or other flat-end tool. Use perpendicular blows to avoid bending shaft.
3. Check indicating switch for calibration over its entire range (refer to Switch Calibration in this section). If indicating switch is correctly calibrated, secure pointer to movement shaft by tapping hub with a hand-set or other flat-end tool.

#### B. Pointer Removal

Pointer is removed with Pointer Puller (included in the calibration toolkit 0288-1032B), see Figure 3-3.

1. Slide pointer puller along pointer until pin protruding from tip of screw in pointer puller is directly over movement shaft and arms of pointer puller are directly under pointer.
2. Gently turn knurled head of screw clockwise, pushing pin against movement shaft and lifting pointer with arms. Finger pressure should be sufficient to pull the pointer free. If more pressure is required, an Allen wrench (inserted into head of the screw) can be used. However, care should be exercised: too much pressure can cause the pin to break.

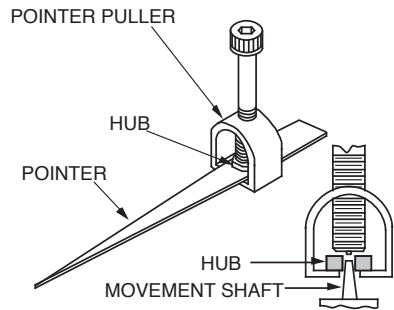


Figure 3-3. Pointer Puller  
If more pressure is required, an Allen wrench (inserted into head of the screw) can be used. However, care should be exercised: too much pressure can cause the pin to break.

### 3-6. Complete Calibration (refer to Fig. 1-1 and 3-4)

Before performing this procedure, perform the calibration check procedure, starting on page 6. Notice: Complete calibration is required whenever DPU is replaced.

1. Connect the instrument to a standard pressure source, as shown on page 5.
2. Vent the low-pressure housing to atmosphere by removing one plug from the housing.
3. Check the indicator: all bearings and pivots should be free of dirt and should not have excessive play. All screws and nuts should be properly tightened.
4. At zero pressure, the indicator range adjust screw should be aligned vertically with the pointer shaft and torque tube shaft. If necessary, loosen the follower arm/torque tube shaft screw and move the follower arm to place the range screw in the correct position. Tighten the follower arm screw, being careful not to bend the torque tube shaft.
5. Install a calibration scale ring in the indicator, and replace the pointer, setting the pointer at zero.

### 3-6. Complete Calibration (refer to Fig. 1-1 and 3-4) (Continued)

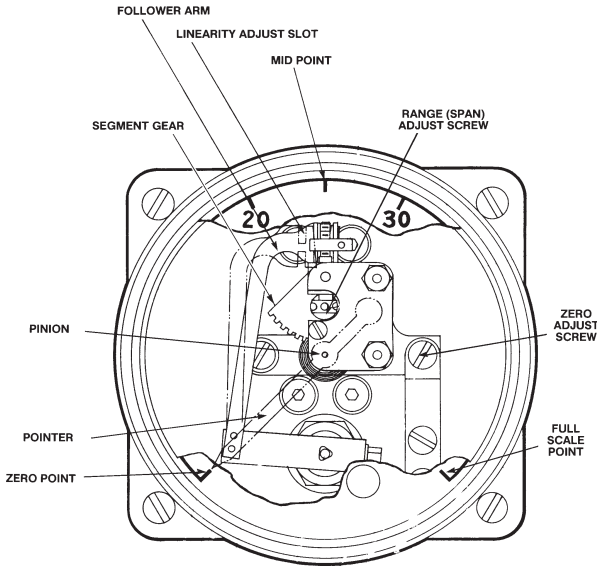


Figure 3-4. Internal Adjustments

6. Note the pointer deflection while rotating the zero adjust screw one full turn in both directions. Set the zero adjust screw to the midpoint of the deflection.
7. Remove and position the pointer at exact zero.
8. Apply 50% differential pressure, alternatively, to the high- and low-pressure housings. Apply 150% overrange pressure at least five times to each pressure housing.
9. Release all pressure to the pressure housings and reposition the pointer at zero.
10. Apply 100% differential pressure and observe the pointer indication.  
If the pointer indicates less than 100% differential pressure, turn the range adjustment screw clockwise.  
If the pointer indicates more than 100% differential pressure, turn the range adjustment screw counterclockwise.
11. Repeat step 10 until the pointer indicates zero and 100%, respectively.
12. Apply 50% pressure, and observe pointer indication.  
If the pointer indication is high, insert a screwdriver into the upper slot off the follower arm and by gently twisting the screwdriver, spread the ends of the slot apart.  
If the pointer indication is low, spread the ends of the lower slot in the follower arm.

### 3-6. Complete Calibration (refer to Fig. 1-1 and 3-4) (Continued)

13. Check the pointer indication at 0% and 100% differential pressure. Repeat steps 10 through 12 until the desired accuracy is obtained.
14. Check the pointer indication at 25% and 75% pressure.
15. Remove the pointer and the calibration scale ring.
16. Reassemble the lens and scale components (see pages 5 and 6).

### 3-7. Drive Arm Attachment

Drive Arm/Shaft Attachment procedure below (refer to the separate 224/224C DPU manual):

- a. Slip drive arm over torque tube shaft; clear end of torque-tube housing by approximately 0.030-inches before securing to prevent interference.
- b. To tighten drive arm assembly onto torque-tube shaft:

- 1) While supporting block/shaft, tighten clamp screw until snug to shaft.
- 2) Still supporting block/shaft, tighten clamp screw an additional:

- Sintered: 1/3 to 1/2 turn (This screw can normally turn one full revolution before breaking.)
- Slotted: 1/4 to 1/3 turn (The slot in the slotted clamp block should still be open.)

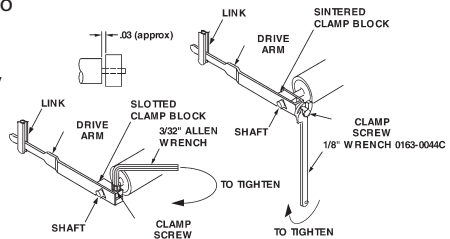


Figure 3-7. Drive Arm/Shaft

**NOTICE:** For Seismic and High Shock Qualified Units, perform Drive Arm Tightness Test, per paragraph 3-8.

### 3-8. Drive Arm Tightness Test

This procedure tests the drive arm to torque tube attachment for tightness, by applying torque developed by the DPU onto a fixed drive arm. Care should be taken to apply pressure slowly, as torque is being applied to the connection through the torque tube drive shaft and not the torque tube itself.

With pointer at normal 0% torque tube rotation position (max. minimum scale position or 0% on a normal 0 to 100% scale unit), adjust drive arm stop bracket (or use alternate means) to prevent pointer from moving (stop bracket interferes with drive arm movement). Note: On reverse acting/split range units, it will be necessary to pressurize DPU to move pointer to max. minimum scale position, and on suppressed units, it will be necessary to apply pressure to establish a reference point to check for "zero" shift.

Pressurize DPU to full calibrated scale DP (100% of full scale range) to achieve 8-degrees of torque tube drive shaft equivalent torque onto the connection.

Observe shift in the unit "zero" following DPU depressurization (as required) and drive arm stop bracket readjusting (to allow free movement of drive arm and pointer). A downscale (counter-clockwise) shift in "zero" of greater than 1/2% is indicative of drive arm slippage necessitating further clamp block tightening.

### 3-9. Preventative Maintenance

- DPU Piping — Periodically inspect the integrity of the DPU piping. Tighten all pipe joints as necessary.
- DPU Inspection and Cleaning — See separate 224/224C DPU manual.
- Switch — Periodically inspect the switch mechanism to verify that all mounting screws are seated properly. Inspect linkage for wear. Inspect integrity of electrical circuits. Tighten as necessary.

### 3-10. Troubleshooting

Refer to Table 3-2 and the separate 224/224C DPU manual.

Table 3-2. Troubleshooting

Problem	Possible Source	Probable Cause	Corrective Action
Low or No Indication	Primary Element or DPU (Refer to DPU Manual)	Orifice installed backwards or oversized	Replace Orifice
		Flow Blocked Upstream from run	Clean out run or open valve
		Loss of liquid in Reference Leg (liquid level)	Refill Reference Leg
		Density changes in process media or Reference Leg	Refill Reference Leg with same density liquid as process media
	Primary Element to DPU Piping (Refer to DPU Manual)	Pressure tap holes plugged and/or piping plugged	Clean out piping
		Bypass Valve Open or Leaking	Close bypass valve(s) and/or repair leaks
		Liquids or Gases trapped in piping	Vent piping
		Block or shutoff valves closed	Open block or shutoff valves
		Piping leaks on HP side	Repair leaks
	Bellows Unit (Refer to DPU Manual)	Housing filled with solids restricting bellows movement	Clean out housing
		Gas (liquid service) or liquid (gas service) trapped in housing	Vent housing
		HP housing gasket leak	Replace gasket
		DPU tampered with	Return BUA for repair
	Indicator, Alarm Switch Mechanism	Loose linkage or movement	Tighten or replace
		Out of Calibration	Calibrate
		Pointer loose	Tighten pointer
		Dirty or corroded mechanism	Clean or replace
		Wiring interfering with movement	Re-route wiring
		Dirty mechanism	Clean mechanism

Table 3-2. Troubleshooting (Continued)

Problem	Possible Source	Probable Cause	Corrective Action
High Indication	Primary Source	Orifice partially restricted or too small	Clean out or replace
	Primary Element to DPU piping	Piping leaks on LP side	Repair leaks
	Bellows Unit (Refer to DPU Manual)	Gas (liquid service) or liquid (gas service) trapped in housing	Vent housing
		LP housing gasket leak	Replace gasket
		Range Spring broken or DPU tampered with	Return BUA for repair
	Indicator, Alarm Switch Mechanism	Loose linkage or movement	Tighten or replace
		Out of Calibration	Calibrate
Erratic Indication	Primary Element	Flow pulsating	Install dampening device upstream of DPU run
	Primary Element to DPU piping	Liquid (gas service) or gas bubble (liquid service) trapped in piping	Remove
		Vapor generator incorrectly installed	Re-pipe
		Reference Leg gassy or Liquid vaporizing	See piping instructions in DPU Manual
	Bellows Unit (Refer to DPU Manual)	Obstructed Bellows Travel	Clean Bellows
		Gas trapped in DPU HP or LP housing	Remove (see Startup procedure)
		Linkage dragging or dirty	Adjust or Clean
		Pointer Dragging on Scaleplate	Adjust Pointer Position
Inaccurate or No Electrical Alarm	Power Supply	Blown Fuse	Replace Fuse
		Broken or loose wire	Repair
	Alarm Switch	Switch not properly Adjusted	Adjust Switch
		Dirty or Burned	Replace switch contacts

### 3-10. Troubleshooting (Continued)

Refer to Table 3-1 and the separate 224/224C DPU manual.

Table 3-2. Troubleshooting (Continued)

Problem	Possible Source	Probable Cause	Corrective Action
Switch Drifts (set-point not repeatable)	Process Changes	Transients or surges cause switches to actuate prematurely	Add time delay gages or add time circuit
		Setpoint and/or Deadband are too wide in pressure valves	Specify DP Range as low as practical; setpoint repeatability and deadband are percentage of full range
		Electrical overloads affect the spring properties of the leaf actuator in the switch	Examine circuits for Voltage, amperes
		DC inductive loads cause arcing and burning of contacts	Consider arc-suppression devices or relays
		Accumulation of fluids in piping generate artificial signal	Vent gas or drain liquids from signal lines
	Calibration Techniques	Failure to check setpoint after locking	Verify setpoint repeatability after locking switch plate
		Rapid pressure change or venting system	During calibration, make pressure changes in slow, discrete steps
		Pressure application in reverse	Test low-alarm with decreasing pressure and high-alarm with increasing pressure
		Reference Gage Inaccuracy	Suitable pressure standard such as manometer, deadweight tester, or Heise-type gage may be required
		Damage to Switch Contacts	Adjust plunger Screws carefully to avoid damage to internal parts of switch

SECTION 4 - PARTS DRAWING/LIST

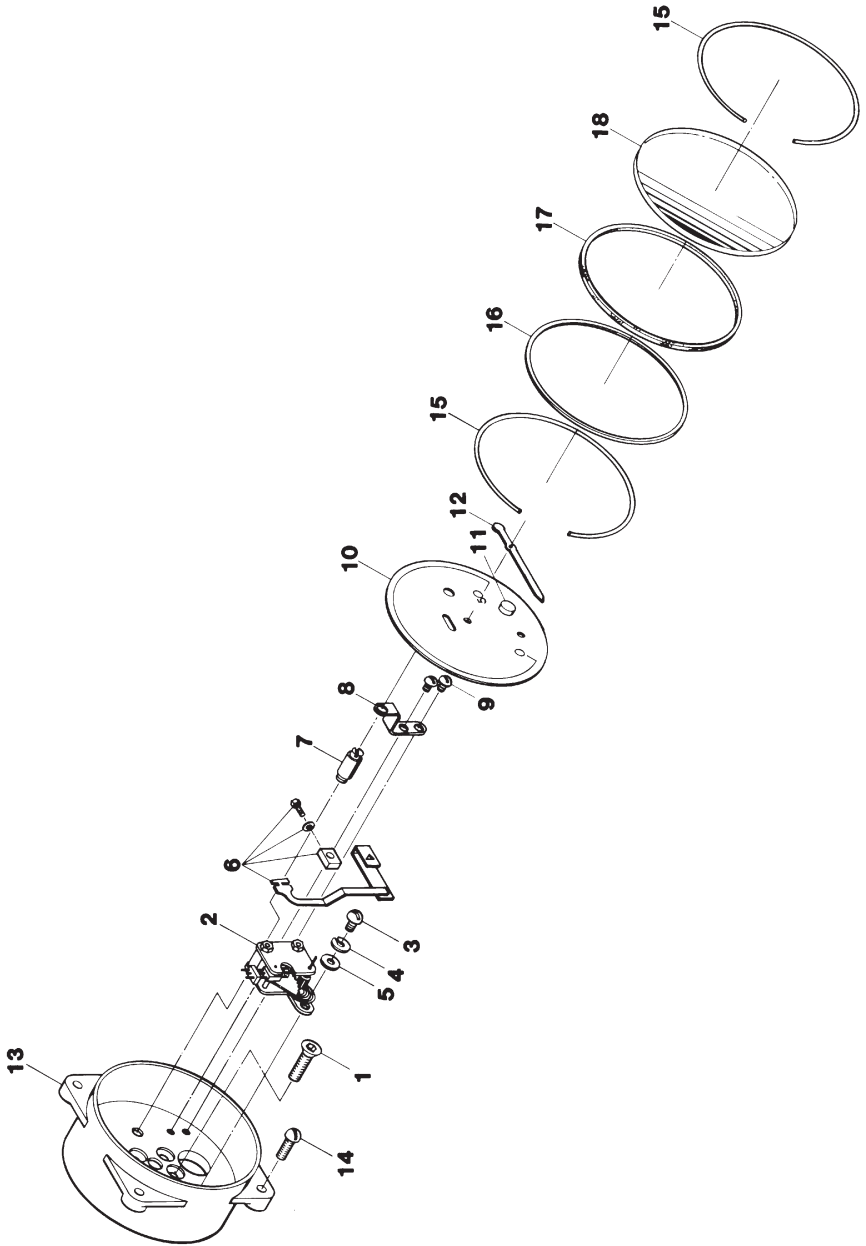


Figure 4-1. 226C Parts Drawing

**SECTION 4 - PARTS DRAWING/LIST**
**(Continued)**
**Table 4-1. 226C Parts List**

ITEM	DESCRIPTION	PART NO.	PER UNIT
1	Screw, 10-32 X 1/2", SST (See Note 2)	0240-0015J	4
2*	Movement	0226-0001B	1
3	Screw, SST, 4-40 X 1/4"	0111-0034J	1
4	Washer, Split Lock	0003-0007K	1
5	Washer	0003-0008K	1
6	Arm, Movement Follower	0226-0002B	1
7	Stem, Zero, Eccentric	0226-0001C	1
8	Support, Zero Eccentric Stem	0226-0002C	1
9	Screw, SST, 4-40 X 3/16"	0111-0047J	2
10	Scaleplate (See Note 3)	0226-0030C	1
11	Snubber, Pointer	0226-0028C	1
12*	Pointer:		1
	White	0149-0001B	
	Black	0149-0003B	
13	Case	0226-0703C	1
14	Screw, 8/32 X 7/16", Steel NP	0111-0020J	4
15	Ring, Snap	0149-0015C	2
16*	Ring, Gasket	0163-0018C	1
17*	Gasket, Lens	0226-0037C	1
18*	Lens	0163-0035C	1
19*	Calibration Kit (Not Shown)	0288-1032B	1
20*	Pointer Puller (Not Shown)	0163-0005B	1
21	224C Differential Pressure Unit (DPU) (Not Shown)	SEE DPU MANUAL	1

**Notes:**

\* Indicates recommended spare part.

- When ordering parts, please specify serial number of instrument.
- For units manufactured prior to 1968, order 6 screws (6-32 X 7/16", Steel Cad. plated, p/n: 0240-0007J)/ Horizontal distance between screws is 25/64".
- Scaleplate Identification:

If the scaleplate shows an "SCR" number, this will identify it. Otherwise, provide the following information:

- Square root or linear graduations
- Scale (e.g., 0-100, 24-0-100, etc.)
- Number of graduations (linear scales only)
- data, (e.g., "PSI," "Inches of Water Column," etc.)
- Standard plates have black background

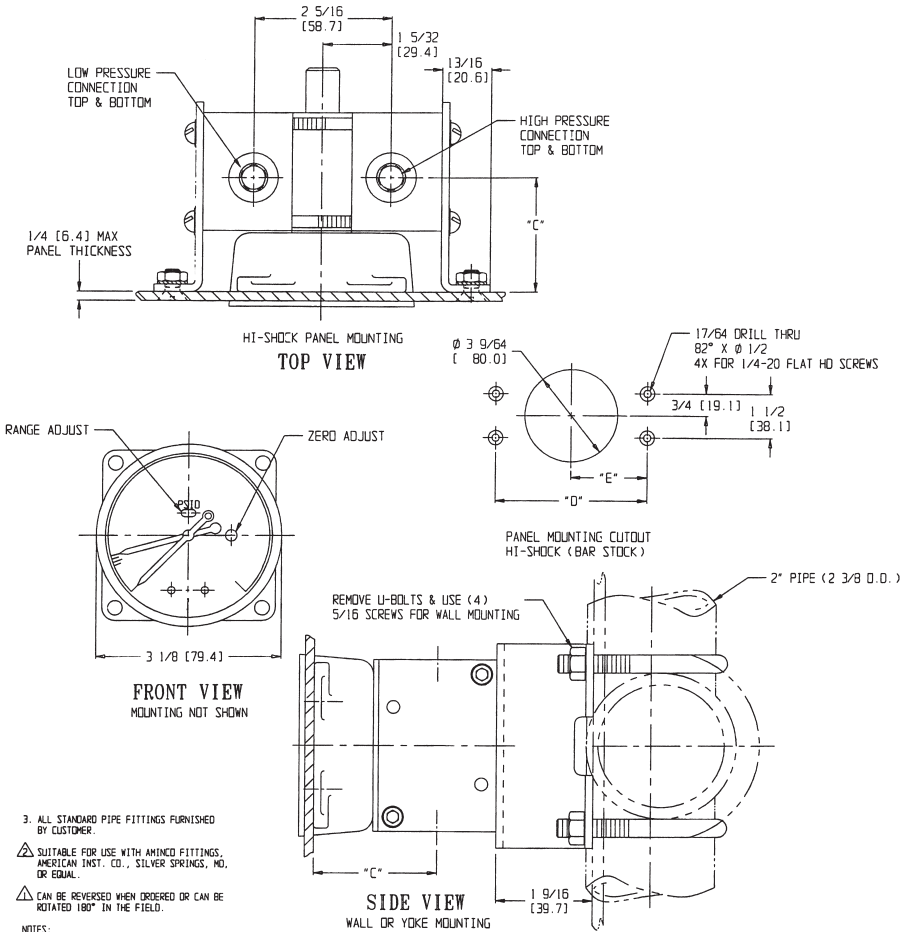




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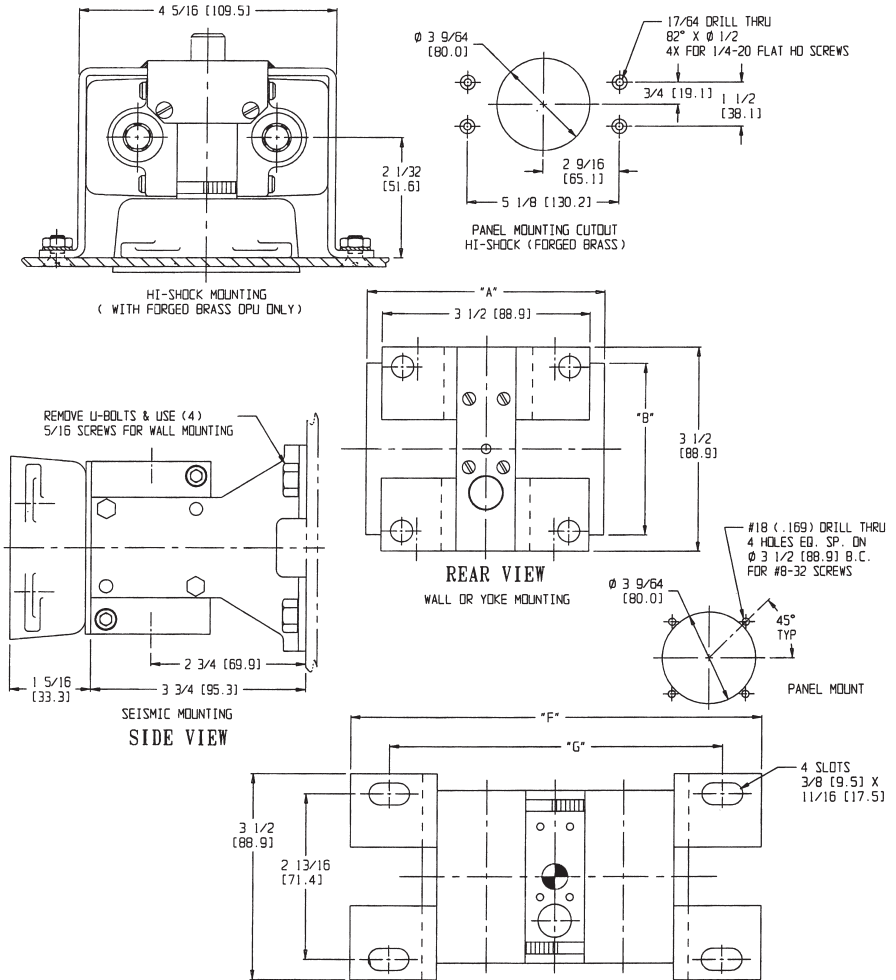
# SECTION 5 - DRAWINGS

(Metric conversions are approximate.)



PRESSURE RATING	MATERIAL	DIM A ±.03	DIM B ±.01	DIM C ±.01	DIM D	DIM E	DIM F	DIM G	PRESS CONNECTION	
									TOP	BOTTOM
500 TO 1500 PSI	ALL	4 [101.6]	2-15/16 [74.6]	2-1/32 [51.6]	5-1/32 [127.8]	1-33/64 [38.5]	6-15/16 [176.2]	5-5/8 [142.9]	1/2 NPT	1/4 NPT
									△ 9/16-18 UNF	△ 9/16-18 UNF
									△ 1/4 NPT	△ 1/4 NPT
3000 TO 10,000 PSI	ALL	4-3/8 [111.1]	3-1/4 [82.6]	2-5/32 [54.8]	5-13/32 [137.3]	2-45/64 [68.6]	7-5/16 [187.9]	8 [152.4]	1/2 NPT	1/2 NPT
									7/16 MS	7/16 MS
									1/8 NPT	1/8 NPT

Figure 5-1. 226C OD Drawing (Part 1 of 2)  
 (Ref. Drawing 226C-10013, Rev. 00)



(Metric conversions are approximate.)

Figure 5-1. 226C OD Drawing (Part 2 of 2)  
(Ref. Drawing 226C-10013, Rev. 00)

## Product Warranty

### A. Warranty

Cameron International Corporation ("Cameron") warrants that at the time of shipment, the products manufactured by Cameron and sold hereunder will be free from defects in material and workmanship, and will conform to the specifications furnished by or approved by Cameron.

### B. Warranty Adjustment

- (1) If any defect within this warranty appears, Buyer shall notify Cameron immediately.
- (2) Cameron agrees to repair or furnish a replacement for, but not install, any product which within one (1) year from the date of shipment by Cameron shall, upon test and examination by Cameron, prove defective within the above warranty.
- (3) No product will be accepted for return or replacement without the written authorization of Cameron. Upon such authorization, and in accordance with instructions by Cameron, the product will be returned shipping charges prepaid by Buyer. Replacements made under this warranty will be shipped prepaid.

### C. Exclusions from Warranty

- (1) THE FOREGOING WARRANTY IS IN LIEU OF AND EXCLUDES ALL OTHER EXPRESSED OR IMPLIED WARRANTIES OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE, OR OTHERWISE.
- (2) Components manufactured by any supplier other than Cameron shall bear only the warranty made by the manufacturer of that product, and Cameron assumes no responsibility for the performance or reliability of the unit as a whole.
- (3) "In no event shall Cameron be liable for indirect, incidental, or consequential damages nor shall the liability of Cameron arising in connection with any products sold hereunder (whether such liability arises from a claim based on contract, warranty, tort, or otherwise) exceed the actual amount paid by Buyer to Cameron for the products delivered hereunder."
- (4) The warranty does not extend to any product manufactured by Cameron which has been subjected to misuse, neglect, accident, improper installation or to use in violation of instructions furnished by Cameron.
- (5) The warranty does not extend to or apply to any unit which has been repaired or altered at any place other than at Cameron's factory or service locations by persons not expressly approved by Cameron.