CAMERON

Measurement Systems

BARTON® MODEL 289A/291B DIFFERENTIAL PRESSURE INDICATING SWITCHES

Installation Manual

Manual No. 10305, Rev. B
December 2004

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[This manual is for the Indicating Switch only—refer to Model 199 DPU manual, Part No. 10030, for detailed information about the DPU used with the indicating switch.]

SAFETY

Before installing this instrument, review the installation instructions and safety notices in Section 2 of this manual and in the Barton® Model 199 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 ignore.

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

SECTION 1 - INTRODUCTION

1-1. General

The Barton® weatherproof Model 289A and the explosion-proof Model 291B are differential pressure indicating switches (Figure 1-1). The 289A has a NEMA-4 watertight die-cast aluminum case (finished with a weather-resistant black epoxy resin paint). The cover lens is secured in the bezel with an elastomer ring to reduce the possibility of accidental breakage. This ring also acts as a seal between the bezel and the case to ensure a moisture, fume and dust-free atmosphere for the indicator and switch mechanism.

Model 291B has an explosion-proof case that is certified for Class I, Division 1, Groups B, C & D service. The large cover lens allows maximum readability of the indicating pointer.

Switches and all adjustments are readily accessible when the cover is removed (Figure 1-2, page 4). The built-in switches energize either single or dual alarm circuits when the measured differential pressures exceed predetermined limits. These limits may be either maximum, minimum, or both.

Figure 1-1. Model 289A (left) and Model 291B (right) Differential Pressure Indicating Switches

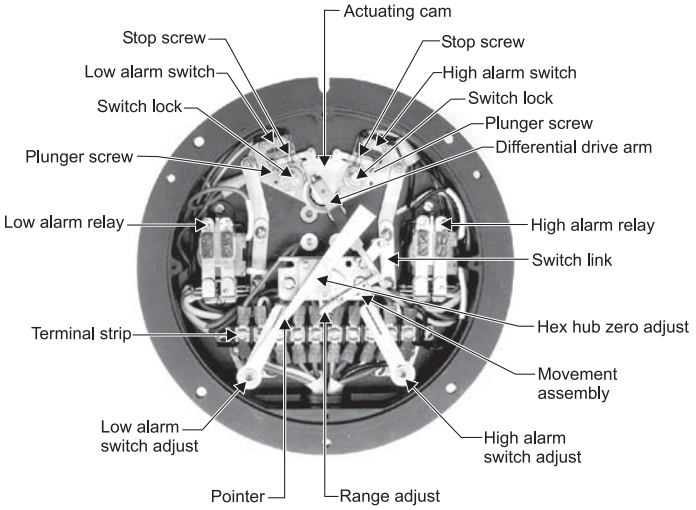


Figure 1-2. Switches and adjustable controls

1-2. Main Components

A. Indicating Switch

B. Differential Pressure Unit (DPU)

- 289A and 291B are actuated by a Barton® Model 199 DPU

For detailed information on the actuating DPU, see the Barton® Model 199 DPU user manual (Part No. 10030).

1-3. Indicating Switch (refer to Figures 1-3 and 2-1)

Rotation of the DPU's torque tube shaft is coupled through connecting linkage within the switch case to move the pointer across the scale plate. An actuating cam, directly connected to the torque tube shaft, rotates with the motion of the shaft. Two cam follower roller/actuator arm assemblies, one for each switch, respond to torque tube rotation by opening and closing the switches as they ride on and off the cam. The levels of differential pressure at which the switches actuate are adjustable with high and low alarm switch adjustments on the scale plate. Standard models have two alarm switches - one or both may be used. Each switch can be connected to operate normally-opened or normally-closed. The direct-set switch contacts are adjustable over a scale range of 5-95% nominal.

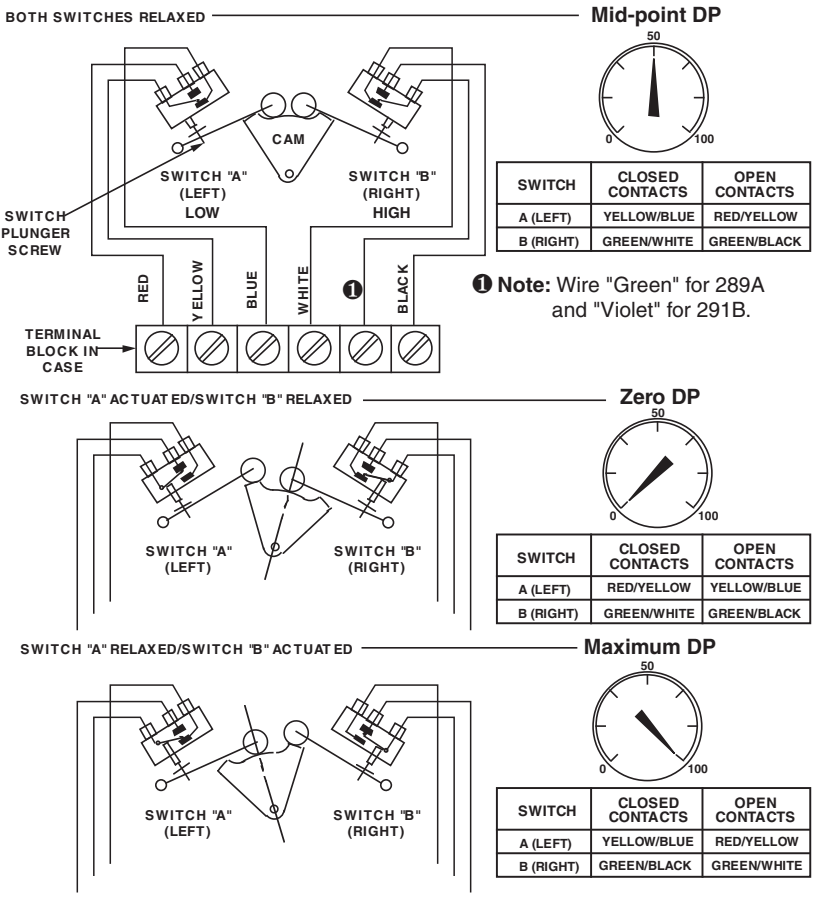


Figure 1-3. Switch Actuation Example

Notes: (1) Cam rotates counterclockwise with increased pressure; (2) Switches shown with low switch set at 25% differential pressure (DP); High switch set at 75% differential pressure (DP); (3) To change setpoint: loosen lock screw, move switch plate, tighten screw and test setpoint; (4) Internal wires use No. 22 AWG and external wires use No. 18 AWG.

1-4. Specifications

General:

Actuating Unit (DPU).....Barton® Model 199 DPU
Dial Size .....6 inches (152 mm)
Temperature Limits (Ambient)...40°F/°C to +180°F (+80°C)
Indication Accuracy (SPDT)..... 0-10" w.c. to 0-349" w.c. ± 1.0% F.S.
(0-25 mbar to 0-867 mbar ± 1.0% F.S.)
0-350" w.c. to 0-100 PSID ± 1.25% F.S.
(0-869 mbar to 0-6.9 bar ± 1.25% F.S.)
Indication Accuracy (DPDT).....Add 1% to SPDT values
Point of Switch Actuation.....Add 1/2% to SPDT values

Switch:

Accuracy of
Switch Repeatability .....±0.25% of full scale
Switch Deadband .....±5% (SPDT); ±6% (DPDT)
Switch Type .....Mechanical, Snap-Acting
Contact Type .....Single Pole, Double Throw (SPDT)
Double Pole, Double Throw (DPDT)

Switch Rating:

125 VAC .....5 Amps[a]
250 VAC .....2.5 Amps[a]
30 VDC Inductive .....1.0 Amps[b]
30 VDC Resistive .....3.0 Amps
125 VDC Inductive .....0.2 Amps[a,b]
125 VDC Resistive .....0.4 Amps[a]

Relay:

Coil Power Requirement:
DC Relay .....1.5 Watts
AC Relay.....2.75 Volt Amps
Contact Types .....Single Pole, Double Throw (SPDT)
Double Pole, Double Throw (DPDT)
Contact Rating .....15 Amps at 115 VAC[a]
CE Rating: Less than 50 VDC or 35 VAC

[a] Non-CE Use Only. Voltage limited to less than 50 VDC or 35 VAC for CE applications.

[b] Arc suppression recommended for inductive loadings.

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 Barton® Model 199 DPU user manual (Part No. 10030).

2-3. Electrical Connection (Switches/Relays)

Units are supplied with either single or dual alarm switches and/or relays (depending on customer order). The direct-set switch contacts are adjustable over the entire scale range.

Wiring diagrams on page 8 show the electrical connections for the switches.The high switch and low switch setpoint adjustment procedures are covered in section 3-7, page 12. For physical location of switches and connections, see page 3.

2-4. Switch Use

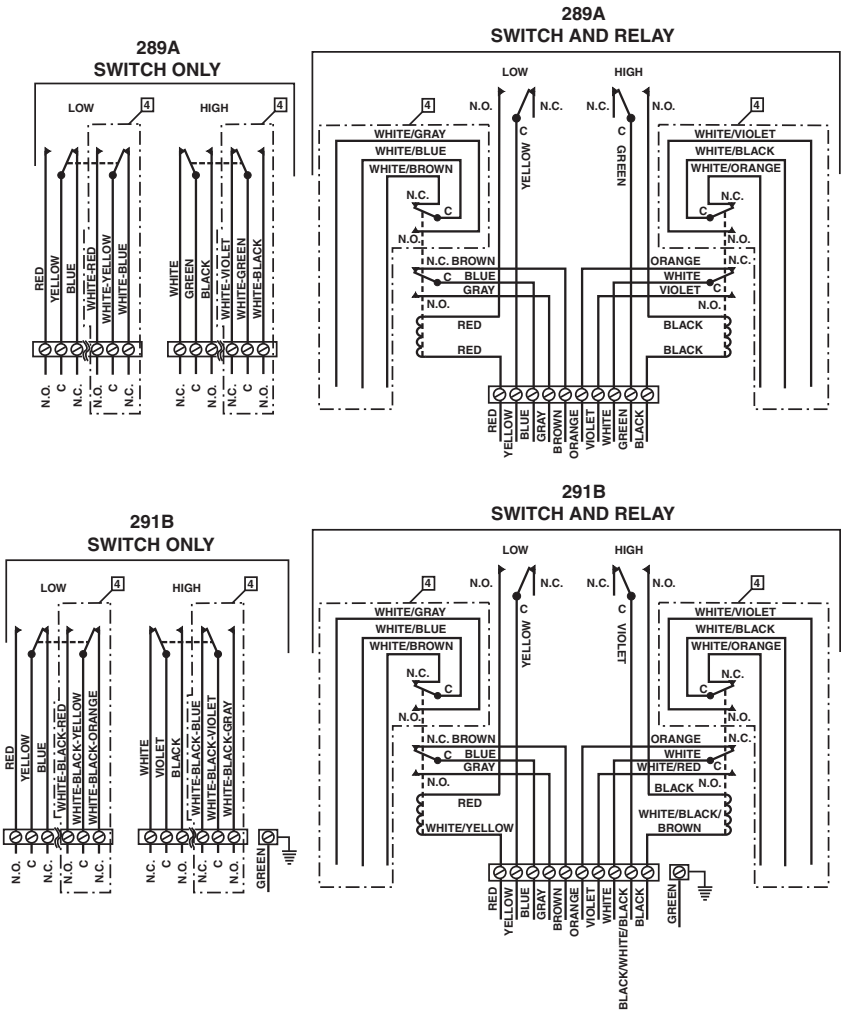
Switch contact life is influenced by various application conditions such as temperature, humidity, airborne contamination, vibration, amount of plunger travel, cycling rate, and rate of plunger travel (and others), as well as by the electrical (circuit) characteristics.

Note: Arc suppression for inductive loads will prolong the life of the switch contacts.

Note: Due to their size, subminiature switches have small mechanical clearances; therefore, no rating above 250 VAC has been established.

2-5. Startup

For startup procedures, warnings, and information, refer to the Barton® Model 199 DPU user manual (Part No. 10030).



Notes (both configurations):

- Internal wires are No. 22 AWG; External wires are No. 18 AWG
- Switch and relay ratings are shown on page 5.
- Relay coils are available in the following voltages: 6, 12, 24, 120*, and 230* VAC or 6, 12, 24, 110* VDC (* = non-CE use only)

Figure 2-1. Switch Wiring Connections

SECTION 3 - MAINTENANCE AND CALIBRATION

3-1. Required Tools (Toolkit Part No. 0288-1032B)

Tool	Purpose
Pointer puller	Pointer removal
Small screwdriver	Calibration adjustments
Medium screwdriver	Bezel removal/DPU bracket screws
1/8” Open-end wrench	Calibration adjustments
1/8 Hex Allen wrench	Switch setpoint adjustment

3-2. DPU Installation/Test/Calibration/Maintenance

Refer to the Barton Model 199 DPU user manual (Part No. 10030).

3-3. Bezel/Lens (or Cover) Installation and Removal

WARNING
(EXPLOSIONPROOF UNITS)

PRIOR TO LOOSENING ANY ATTACHING HARDWARE, HOUSING BOLTS, OR COVER ASSEMBLY, ASSURE SURROUNDING AREA IS, AND REMAINS, WELL VENTILATED.

PRIOR TO LOOSENING OR REMOVAL CASE/COVER ASSEMBLY, ALL ELECTRICAL POWER SUPPLIES MUST BE TURNED OFF.

THE COVER MUST BE REMOVED TO CALIBRATE THE INSTRUMENT.

BEFORE ANY MAINTENANCE/CALIBRATION, REVIEW MODEL 199 DPU MANUAL (Part No. 10030).

For non-explosionproof units, the bezel gasket (Part No. 0277-0026C) must be installed as shown below:

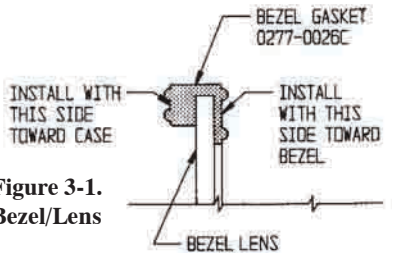


Figure 3-1. Bezel/Lens

To remove the bezel and cover lens on non-explosionproof units:

1. Loosen three screws on the front of bezel.
2. Tilt out bottom of bezel and slide bezel upward.

The two snubbers (Part No. 0266-0028C) on the scaleplate should not be compressed against the lens cover and the pointer should not touch the lens.

Note—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.

For explosionproof units, cover is unscrewed to gain access to the internal components. Note: On some units, a set screw must be loosened with a 1/8-in. allen wrench before the bezel can be removed. When re-installing cover, tighten cover securely and inspect lens for cracks or other defects that may affect the explosionproof rating.

3-4. Calibration Check

Normally all that is required to put switch into service is to verify that it remains at factory-set calibration, per the following instructions. (See Warning on pg. 9):

1. Securely mount unit in an appropriately level position and connect DPU to a standard pressure source, per Model 199 DPU manual.
2. If zero indication is incorrect, remove bezel/lens (cover on explosionproof units) and reset pointer to zero. Note: For an exact zero setting, hold the hexagon hub with a wrench and carefully slip the pointer on its hub until it points to zero graduation. Replace bezel/lens (or cover).
3. To test for reverse travel, connect pressure source to low-pressure (LP) housing and vent high-pressure (HP) housing. Apply pressures approximately 150% of the differential pressure range. The pointer should move approximately 5% to 10% below zero.
4. To test for overtravel, connect pressure source to HP housing and vent LP housing. Apply pressures approximately 150% of differential pressure range. Pointer should move approximately 5% to 10% above fullscale.
5. Apply 0%, 50% and 100% of full scale pressure. If indication is within specified limits, instrument calibration is satisfactory and no adjustments are necessary. If indications are incorrect, perform calibration procedure.
6. Make sure instrument zero indication is correct; otherwise, repeat Step 2.
7. Verify switch setpoints (refer to section 3-7, page 12).

3-5. Pointer Installation and Removal

A. Pointer Installation (See Warning on page 9)
   1. Position pointer on movement shaft with pointer set at zero scale. If necessary, enlarge hub hole using a tapered broach (in toolkit) (Part No. 0288-1032B).
   2. Lightly tap pointer hub with a flat-end tool. Use perpendicular blows to avoid bending shaft.
   3. Check calibration over entire range (see section 3-8.). If unit is correctly calibrated, secure pointer to movement shaft by tapping hub with a hand-set or other flat-end tool.

B. Pointer Removal (See Warning on page 9)

   The pointer is removed with Barton Pointer Puller (Part No. 0163-0005B), which is included in toolkit (Part No. 0288-1032B).

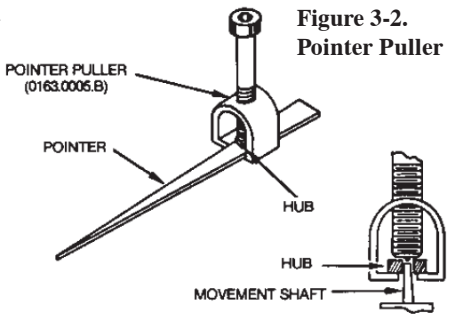


Figure 3-2. Pointer Puller

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, insert an Allen wrench into head of the screw for leverage. Avoid applying excessive pressure, which can cause the pin to break.

3-6. Indicator Calibration

(DP=Differential Pressure) (See Warning on pg. 9)

1. Securely mount instrument in an approximately level position and connect DPU into the test setup, as described in the Model 199 DPU manual.
2. Apply 50% differential pressure and align linkage between drive arm and movement as shown in Figure 3-3. Release pressure from DPU.
3. Check pointer for zero indication. If necessary, set pointer to zero by slipping pointer on hub (hold pointer with fingers and turn hub with a wrench).

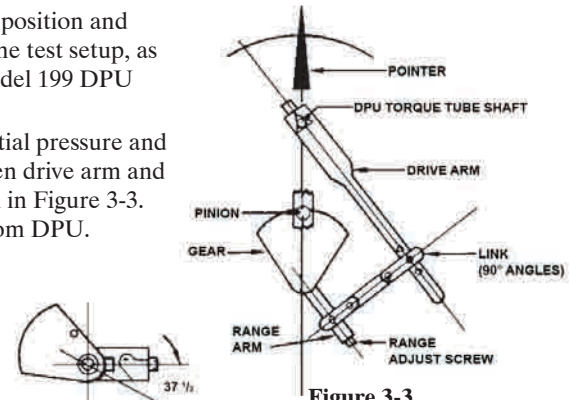
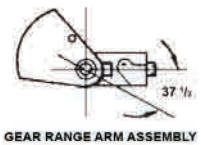


Figure 3-3. Linkage Alignment (50% differential pressure)



GEAR RANGE ARM ASSEMBLY

4. Apply 100% pressure. If pointer exceeds full-scale, lengthen the movement range arm by by turning the range adjust screw counterclockwise. If the pointer does not reach full scale, shorten the range arm by turning the range adjust screw clockwise.
5. Release pressure. Set pointer to zero using pointer hub for zero adjustment.
6. Repeat as necessary to obtain zero and full-scale readings.
7. Apply 50% differential pressure. If pointer does not indicate 50% scale, a linearity adjustment is necessary. Loosen drive arm screw and move arm to shift pointer in direction of error a distance of about 10 times linearity error. (50% DP) Tighten drive arm screw.
8. Release pressure and reset pointer at zero. Check the span. If gear in movement reaches limit of travel as a result of linearity adjustment (step 7), slip range arm along gear approximately 5 degrees from normal 37.5 degree angle to approximately 43 degrees. Range arm is slipped by applying pressure to range arm with thumb, while holding gear firmly in place. Retest pointer response at 50%, 0%, and 100% of full-scale differential pressure, and adjust linkage until readings are acceptable.

9. Apply 0%, 25%, 50%, 75%, 100%, 75%, 50%, 25%, and 0% of full-scale differential pressure consecutively to instrument without overshoot. Lightly tap indicator to overcome friction. Pointer should accurately indicate each applied pressure.
10. Set stops to prevent pointer from striking snubbers on scale. Test setting by moving pointer from zero position to 50% position manually and then letting pointer return freely. If necessary, tap pointer hub to tighten it to shaft.

3-7. Changing Switch Setpoint

(Tools: Screwdriver, 1/8 Hex Allen wrench) (See Warning on pg. 9)

Setpoint — The measured pressure at which the snap-switch actuates and thereby changes the states of the N.O and N.C. contacts. For example, the setpoint of the low switch is 24 psid with decreasing pressure.

Deadband — The difference in the measured pressures between switch-actuation and switch-reset. Deadband is usually expressed as percentage of full scale (% of F.S.). Deadband is not adjustable. For example, the switch above was found to reset at 26.4 psid with increasing pressure. The deadband was 2.4 psi, or 4% of the full scale (0 to 60 psid).

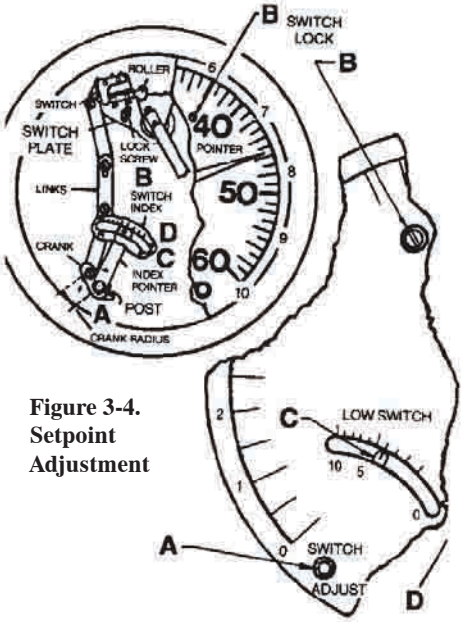


Figure 3-4. Setpoint Adjustment

A. In-Service Instruments (calibration pressures cannot be applied)
   1. Remove bezel. **Do not remove pointer or scale.**
   2. Insert hex wrench in switch adjust post, (item A, Fig. 3-4).
   3. Loosen switch lock-screw, (item B), 1/2 to 1 turn.
   4. With hex wrench, move index pointer (item C) to new set-point as indicated on switch index (item D).
   5. If possible, check setpoint by varying process pressures and observing pointer readings when switch actuates. (Open manifold bypass valve slowly and watch for "pointer-jump" at setpoint or by electrical signal.) Adjust setting if necessary, repeat test several times to verify stability.

Note: Switch index has 10 divisions shown by tick marks in Figure 3-4. Positions 0, 5, and 10 are also labeled along the bottom of the index as well.

Example: Scale has range of 0-60 psid. Setpoint is 24 psid, with decreasing pressure, (24/60 x 10 = 4).

Move index pointer (item C) to division 4. Start from bottom of switch index (0 on low, 10 on high). Tighten switch lock (item B) snug plus 1/4 turn. Do not over-tighten. This will place setpoint within ±2% of full scale.

B. Out-of-Service (Disconnected from process Setpoint Adjustment lines or mounted on bench)
   1. Drain and vent housings.
   2. Attach calibration pressure source (air or N_2) to HP housing.
   3. Apply pressures and observe pointer readings for accuracy. Use a pressure standard (Heise gage or equivalent) for reference. Change pressures slowly in discrete steps. A "bleed-pressure" method may cause errors.
   4. Change switch setpoint as described in Part A, page 12.
   5. Check setpoint by changing measured pressure to actuate switch. For Example: To verify low-switch setpoint to 24 psid, apply approximately 30 psi. Then reduce pressure to approximately 25 psid, hold for a few seconds, then continue in 1/4 psid steps until switch actuates. If setpoint is incorrect, continue instructions in Part A.
   6. To measure switch deadband, reduce pressure to zero, then increase pressure until switch resets.
   7. To verify repeatability of setpoint, repeat step 5 several times. For improved accuracy, use smaller increments of pressure. Allow extra time for slow response gages and for test systems that have long runs of small bore tubing.
   8. High alarm switches right side of the scale) are adjusted in a similar manner. Apply increasing pressure to establish the switch setpoint, decreasing pressure to measure deadband.

C. Notes
   1. Always check setpoint after tightening switch lock screws.
   2. Either switch may be set at any point of the scale, except allowance must be made for deadband to enable switch to reset itself. For example, high switch (right side of scale) may be set at 100% of F.S., but should not be set near zero. Also, low switch may be set at zero, but not near full scale. (Observe deadband values for specific models).
   3. If switch performance is unsatisfactory (such as setpoint does not repeat, deadband is excessive, pointer exhibits hysteresis, contacts are unstable. etc.) remove scale and inspect switch and mechanism. Scale is split for removal without pulling pointer.
      a. SPDT: This is the standard model (low, high, or both).
      b. DPDT: Two switches are stacked and actuated by a single lever (low, high, or both).
      c. Three (or four) SPDT: Switches have independent switch points. Nos. 1 and 3 are usually low switches set for decreasing pressures. Nos. 2 and 4 are usually set for increasing pressures.
      d. Hermetically Sealed Switch (Micro 11HM41): this switch has wide deadband, case is modified for electrical clearances, amperes are reduced for 60 Hz service.

3-8. Complete Calibration

Before performing complete calibration procedure, verify that instrument is out of calibration, by performing calibration check procedure (section 3-4), page 10. If instrument is out of calibration, before performing complete calibration procedure, remove bezel/lens and inspect switch mechanism to verify the following (see Figure 3-5) (See Warning on pg. 9):

- The roller rotates without wobble or binding.
- The cam does not touch the roller side shields.
- The actuator arm moves freely on its pivot.
- All switch mounting screws are tight.
- Linkages are straight and do not bind at the pivots.

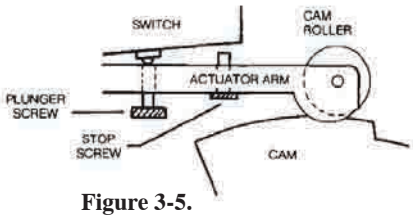


Figure 3-5.
Cam/Follower Position

Correct any problems that are encountered.

A. Calibration Setup

1. Connect lamp or buzzer to switch output leads. Connect a test voltage to switch input terminals on terminal strip. (A low voltage is recommended for safety.) If relay is installed in instrument, coil voltage must be applied to switch.
2. Unlock switch plate, back out stop screw, and move plate until roller is positioned at top of the cam. Observe that switch does not actuate when roller is moved from low point on cam to high point. If it does actuate, back out plunger screw with roller on top of cam until switch de-actuates.
3. Advance plunger screw until switch actuates, then advance plunger screw an additional 60° (one flat).
4. Exercise switch roller across top of cam to verify steady operation. Advance stop screw to touch switch, then back out screw 1.5 turns (9 flats).

B. Calibration Procedure (see Figure 3-6)

To calibrate switch linkage (required when instrument is rebuilt), proceed as follows:

1. Loosen three linkage screws and turn crank to 12 o'clock position.
2. Use a 1/8-in. Allen wrench to hold index shaft and slip index pointer to 0 on switch index.

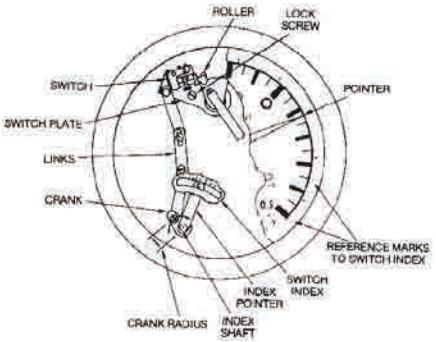


Figure 3-6.
Linkage Arrangement

B. Calibration Procedure (continued)

3. Tighten screw on crank to mid-slot position.
4. Turn switch index pointer to "1" (index numbers refer to numbers on outer edge of scaleplate).
5. Apply 10% differential pressure and adjust switch plate until switch actuates. Lock the two linkage screws.
6. Rotate index pointer to "9." Apply 90% differential pressure and adjust crank radius until switch actuates.
7. Recheck 10% and 90% setpoints. Adjust crank radius and index pointer until both setpoints are 2% accurate (nominal).
8. If switch is to be field-set at low differential pressure values (1% or 2% of pressure range), check crank to prevent a top-dead-center position. Otherwise, minimum setpoint position will be restricted and setpoint may become reversed.
9. Adjust switch to actuate at desired pressure by applying test pressures in a decreasing direction, in discrete steps. Allow unit and pressure system to stabilize. Then change pressure a small amount. The magnitude of the pressure change is determined by desired accuracy of test. Tighten lock screw before testing switch performance.

   The high switch is usually set to actuate at increasing pressure. Therefore, when calibrating high switch, apply test pressure in an increasing direction.

   This amount of loading will prevent cam-runout of a similar condition. Excessive plunger loading (more than 3 flats) may cause roller to drag on cam. Cam friction will be apparent by excessive hysteresis, erratic pointer readings and inconsistent switch operation.
10. Check switch deadband, (actuate to reset) by applying differential pressures in a decreasing then increasing (opposite for high switch direction). Observe pressures. To reduce deadband, advance plunger screw (two flats maximum).
11. Adjust high switch to actuate at desired pressure. The procedure is the same as for the low switch.

3-9. Preventative Maintenance

- Indicating Switch — Periodically inspect alarm switch mechanism to verify that all mounting screws are seated properly. Inspect linkage for wear. Inspect integrity of electrical circuits. Tighten as necessary.
- DPU — **Warning/Caution notices**, inspection/cleaning procedures, and maintenance procedures are presented in the Model 199 DPU manual. **Never perform any maintenance/repair on the instrument or DPU without first reviewing all procedures and Warning/Caution notices in the DPU manual.**

3-10. Locking Drive Arm to Torque Tube

Refer to Model 199 DPU manual. For explosionproof units, refer to Figure 5-3, Model 291 Detail Drawing, pg. 28 (See Warning on pg. 9).

1. Slip drive arm over torque tube shaft; clear end of torque-tube housing by approximately 0.030-in. before securing to prevent interference.
2. To tighten drive arm assembly onto torque-tube shaft:
   a. While supporting block/shaft, tighten clamp screw until snug to shaft.
   b. 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.)

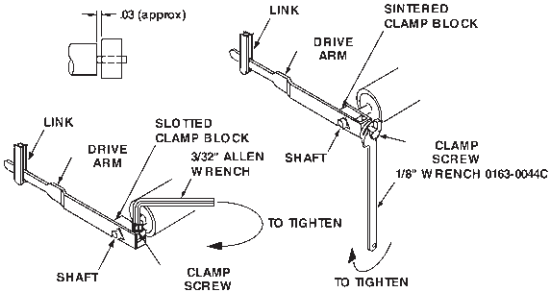


Figure 3-4. Locking Drive Arm to Torque Tube

3-11. Troubleshooting

(See **Warning** on pg. 9. Refer to Table 3-1 and Model 199 DPU manual.

Table 3-1. 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.
Low or no Indication (cont'd)	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 housng 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.
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.

Table 3-1. Troubleshooting (cont'd)

Problem	Possible Source	Probable Cause	Corrective Action
High indication (cont'd)	Indicator, alarm switch mechanism	Loose linkage or movement	Tighten or replace.
		Out of Calibration	Calibrate.
Erratic indication	Primary element	Flow pulsating	M199 DPU – adjust dampening; All o hers – 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 instruc ions 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 posi ion.
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.

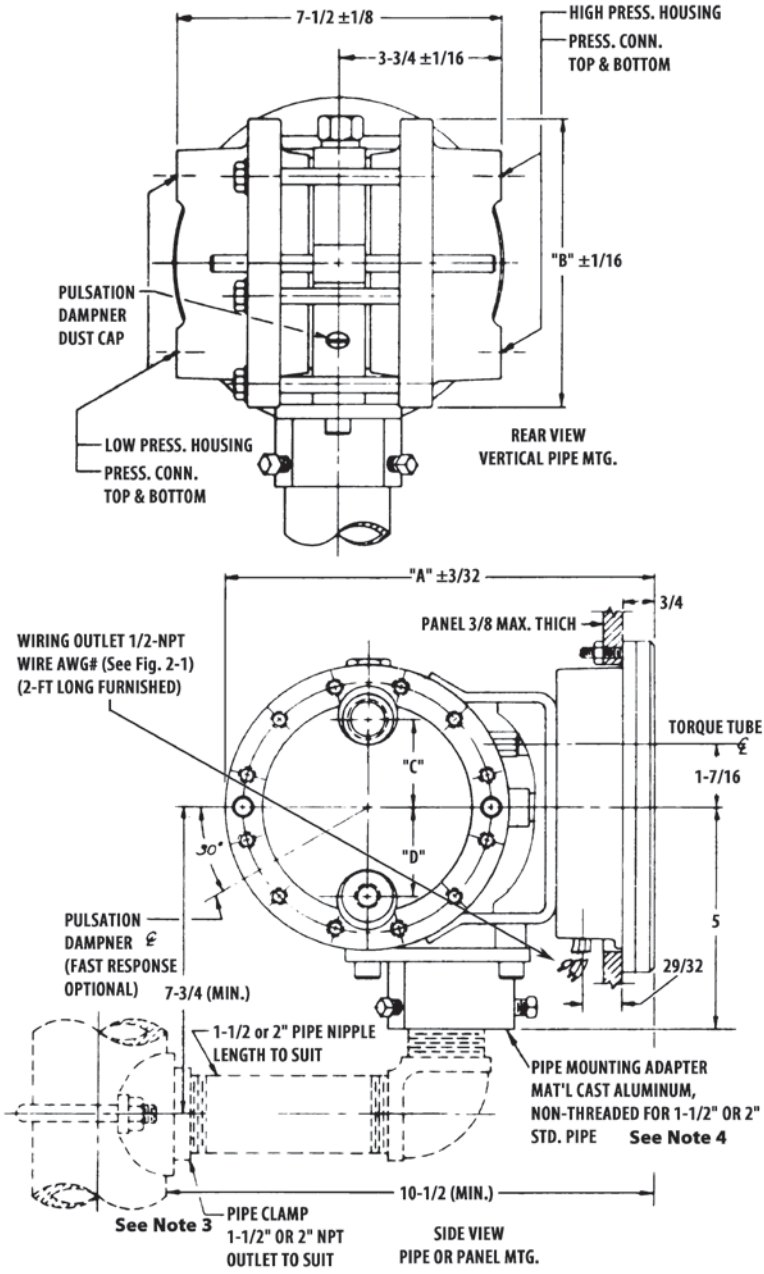


Figure 4-1. Model 289A Outside Dimensions (Part 1 of 2)

Figure 4-2.
Model 289A
Outside Dimensions
(Part 2 of 2)

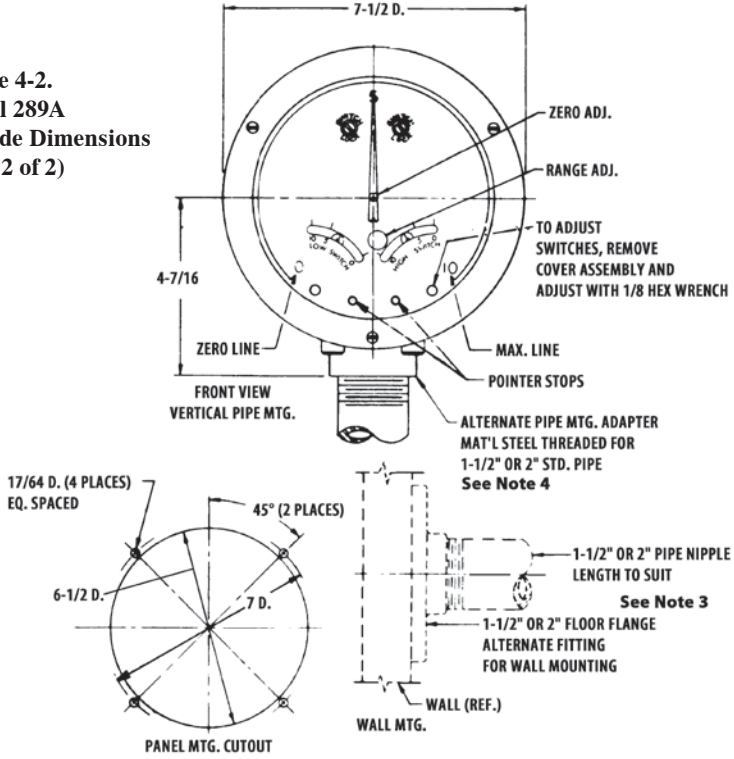


Table 4-1. Model 289A Dimensions (as shown in Figure 4-1, pg. 19)

PRESSURE RATING PSI (MPa)	HOUSING MATERIAL	PRESSURE CONNECTION		DIM. A INCHES (mm)	DIM. B INCHES (mm)	DIM. C INCHES (mm)	DIM. D INCHES (mm)	# BOLTS
		TOP	BOTTOM					
1,000 (6.9)	CAST ALUM. 356-T6	1/2 NPT (Note 1)	1/4 NPT (Note 1)	9-29/32 (251.6)	6-5/8 (168.3)	2 (50.8)	2-9/64 (51.2)	6
	FORGED STNL. ST. 316	1/2 NPT (Note 1)	1/4 NPT (Note 1)	9-29/32 (251.6)	6-5/8 (168.3)	2 (50.8)	2-9/64 (51.2)	12
2,500 (17.2)	FORGED ST. AISI C1018	1/2 NPT (Note 1)	1/4 NPT (Note 1)	10-5/32 (257.9)	7-1/8 (181.0)	2 (50.8)	2-9/64 (51.2)	6
3,000 (20.7)	FORGED STNL. ST. 316	1/2 NPT (Note 1)	1/4 NPT (Note 1)	10-5/32 (257.9)	7-1/8 (181.0)	2 (50.8)	2-9/64 (51.2)	12
	MONEL K500	1/2 NPT (Note 1)	1/4 NPT (Note 1)	10-5/32 (257.9)	7-1/8 (181.0)	2 (50.8)	2-9/64 (51.2)	12
4,500 (31.0)	FORGED ALLOY ST 4142	1/2 NPT (Note 1)	1/4 NPT (Note 1)	10-5/32 (257.9)	7-1/8 (181.0)	2 (50.8)	2-9/64 (51.2)	12
6,000 (41.4)	FORGED ALLOY ST 4142 FORGED STNL ST 17-4 PH	9/16-18 UNF (Note 2)	9/16-18 UNF (Note 2)	10-5/32 (257.9)	7-1/8 (181.0)	2 (50.8)	2 (50.8)	12
	FORGED ALLOY ST 4142 FORGED STNL ST 17-4 PH	1/2 NPT (Note 1)	1/4 NPT (Note 1)	10-5/32 (257.9)	7-1/8 (181.0)	2 (50.8)	2-9/64 (51.2)	12

Note 1: Can be reversed when ordered or can be rotated 180° in the field.

Note 2: Suitable for use with Aminko fittings (American Inst. Co., Silver Springs, MD) or equiv.

Note 3: All standard pipe fittings furnished by customer.

Note 4: Cast alum. pipe mount supplied, unless otherwise specified. Specify pipe size when ordering threaded Stl. adapter.

Metric conversions are approximate.

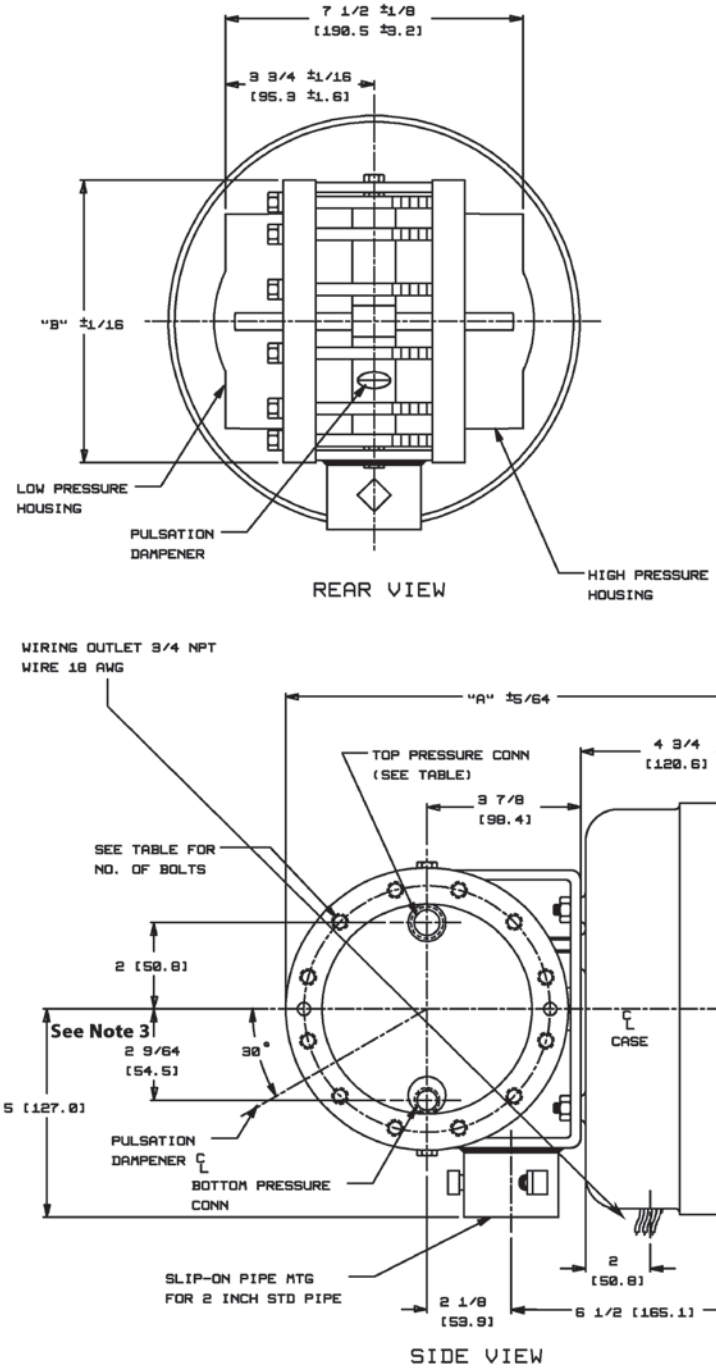


Figure 4-3. Model 291B Outside Dimensions (Part 1 of 2)

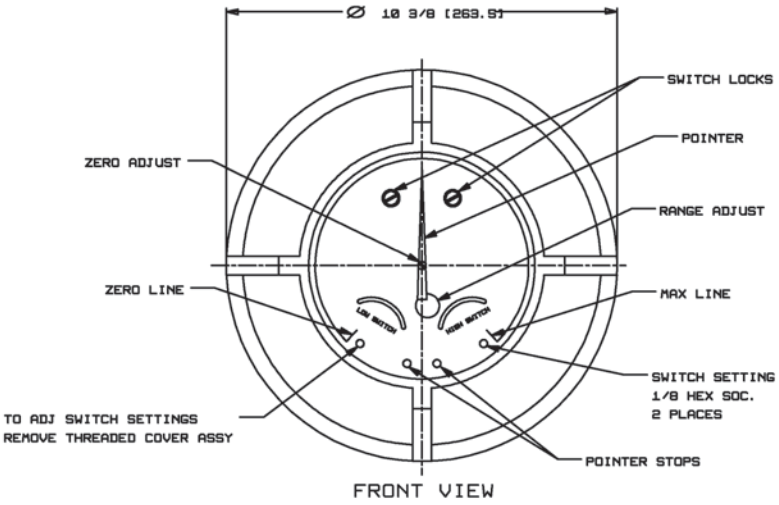


Figure 4-4. Model 291B Outside Dimensions (Part 2 of 2)

Table 4-2. Model 291B Dimensions (as shown in Figure 4-3, pg. 21)

PRESSURE RATING PSI (MPa)	HOUSING MATERIAL	PRESSURE CONNECTION		DIM. A INCHES (mm)	DIM. B INCHES (mm)	# BOLTS
		TOP	BOTTOM			
1,000 (6.9)	CAST ALUM. 356-T6	1/2 NPT (Note 1)	1/4 NPT (Note 1)	12 (304.8)	6-5/8 (168.3)	6
	FORGED STNL. ST. 316	1/2 NPT (Note 1)	1/4 NPT (Note 1)	12 (304.8)	6-5/8 (168.3)	12
2,500 (17.2)	FORGED ST. AISI C1018	1/2 NPT (Note 1)	1/4 NPT (Note 1)	12-1/4 (309.9)	7-1/8 (181.0)	6
3,000 (20.7)	FORGED STNL. ST. 316	1/2 NPT (Note 1)	1/4 NPT (Note 1)	12-1/4 (309.9)	7-1/8 (181.0)	12
4,500 (31.0)	FORGED ALLOY ST 4142	1/2 NPT (Note 1)	1/4 NPT (Note 1)	12-1/4 (309.9)	7-1/8 (181.0)	12
6,000 (41.4)	FORGED ALLOY ST 4142 FORGED STNL ST 17-4 PH	9/16-18 UNF (Note 2)	9/16-18 UNF (Note 2)	12-1/4 (309.9)	7-1/8 (181.0)	12
	FORGED ALLOY ST 4142 FORGED STNL ST 17-4 PH	1/2 NPT (Note 1)	1/4 NPT (Note 1)	12-1/4 (309.9)	7-1/8 (181.0)	12

Note 1: Can be reversed when ordered or can be rotated 180° in the field.

Note 2: Suitable for use with Aminko fittings (American Inst. Co., Silver Springs, MD) or equiv.

Note 3: For Aminco ports, dimension is 2 in. (50 8 mm).

Metric conversions are approximate.

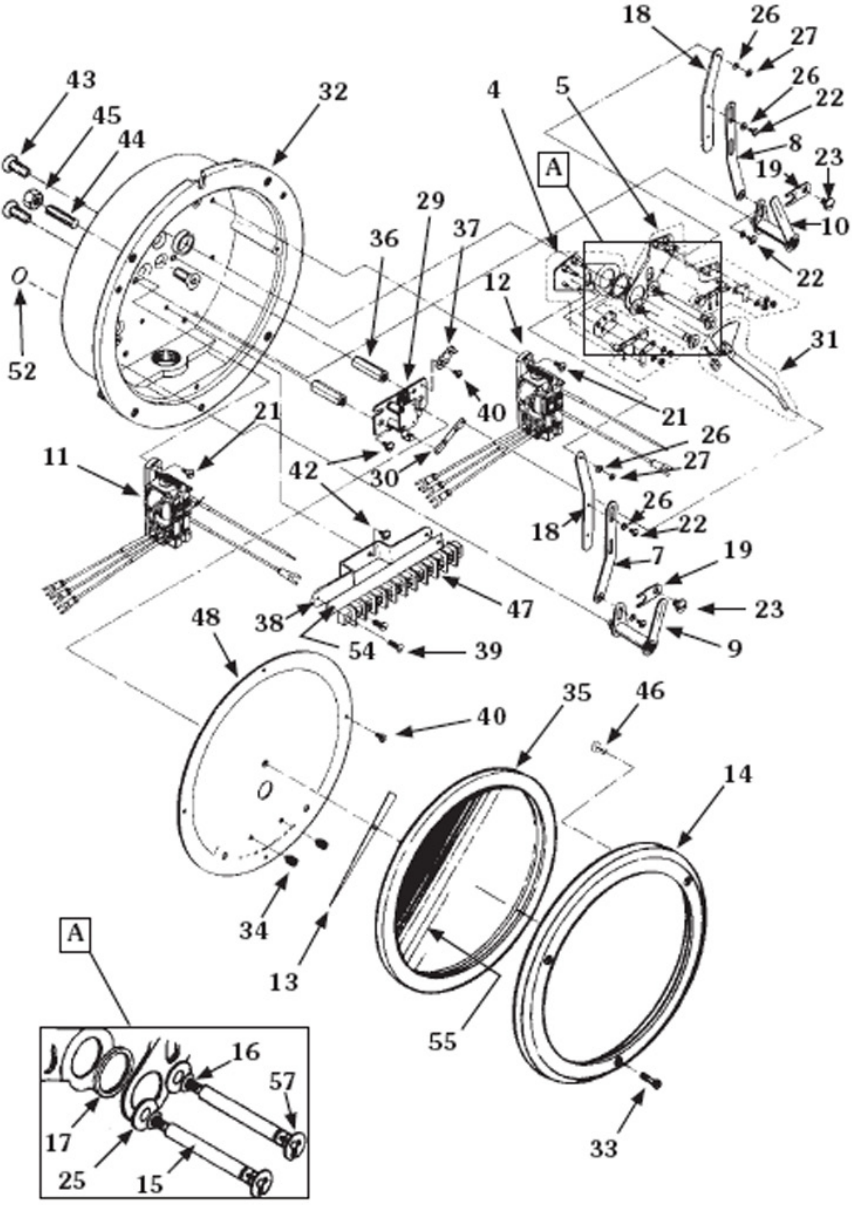


Figure 5-1. Model 289A Assembly Drawing

WARNING

Use only spare parts identified in this manual. Cameron bears no legal responsibility for the performance of a product that has been serviced or repaired with parts that are not authorized by Cameron.

Table 5-1. Model 289A Parts List

ITEM	DESCRIPTION	PART NO.	PER UNIT
1	DIFFERENTIAL PRESSURE UNIT (NOT SHOWN)	SEE DPU 199 MANUAL	1
2	LOW ALARM, EXT. WIRING ASSY., 2.5' LENGTH (NOT SHOWN):		1
	UNITS WITHOUT RELAY, SPDT	0288-0021B	
	UNITS WITHOUT RELAY, DPDT	S401-0018Z	
	UNITS WITH RELAY, SPDT OR DPDT	0288-0008B	
3	HIGH ALARM, EXT. WIRING ASSY., 2.5' LENGTH (NOT SHOWN):		1
	UNITS WITHOUT RELAY. SPDT	S655-0056B	
	UNITS WITHOUT RELAY, DPDT	S401-0093Z	
	UNITS WITH RELAY, SPDT OR DPDT	0288-0007B	
4	LOW ALARM, SWITCH ASSY.:		1
	UNITS WITHOUT RELAY. SPDT	0288-0024B	
	UNITS WITHOUT RELAY, DPDT	S401-0053Z	
	UNITS WITH RELAY, SPDT OR DPDT	0288-0039B	
5	HIGH ALARM, SWITCH ASSY.:		1
	UNITS WITHOUT RELAY, SPDT	0288-0025B	
	UNITS WITHOUT RELAY, DPDT	S401-0056Z	
	UNITS WITH RELAY, SPDT OR DPDT	0288-0040B	
6	NOT USED		
7	LOW ALARM DRIVE PLATE ASSY.	0288-0026B	1
8	HIGH ALARM DRIVE PLATE ASSY.	0288-0027B	1
9	LOW SWITCH ADJUSTMENT INDEX ASSY.	0288-0028B	1
10	HIGH SWITCH ADJUSTMENT INDEX ASSY.	0288-0029B	1
11	LOW RELAY ASSY. (* = Non-CE Use Only):		1
	Coil Voltage / **Wired SPDT** / **Wired DPDT**		
	6 VAC / 0288-0015B / 0288-1045B		
	12 VAC / 0288-0045B / 0288-1035B		
	24 VAC / 0288-0016B / 0288-1044B		
	*125 VAC / 0288-0017B / 0288-1043B		
	*250 VAC / 0288-0046B / 0288-1034B		
	6 VDC / 0288-0018B / 0288-1038B		
	12 VDC / 0288-0019B / 0288-1037B		
	24 VDC / 0288-0020B / 0288-1036B		
	*110 VDC / 0288-0047B / 0288-1033B		
12	HIGH RELAY ASSY. (* = Non-CE Use Only):		1
	Coil Voltage / **Wired SPDT** / **Wired DPDT**		
	6VAC / 0288-0009B / 0288-1054B		
	12 VAC / 0288-0042B / 0288-1048B		
	24 VAC / 0288-0010B / 0288-1053B		
	*125 VAC / 0288-0011B / 0288-1052B		
	*250 VAC / 0288-0043B / 0288-1047B		
	6VDC / 0288-0012B / 0288-1051B		
	12 VDC / 0288-0013B / 0288-1050B		
	24 VDC / 0288-0014B / 0288-1049B		
	*110 VDC / 0288-0044B / 0288-1046B		

Table 5-1. Model 289A Parts List (cont'd)

ITEM	DESCRIPTION	PART NO.	PER UNIT
**13	POINTER ASSY.:		1
	WHITE	0288-0030B	
	BLACK	0288-0031B	
14	BEZEL ASSY. (WITH PLASTIC LENS)	0277-0018B	1
15	PLATE SCREW:		
	LOW OR HIGH ALARM (SINGLE)	0317-0012C	1
	DUAL ALARM	0317-0012C	2
16	SPRING WASHER:		
	LOW OR HIGH ALARM (SINGLE)	0257-0019C	1
	DUAL ALARM	0257-0019C	2
17	SWITCH PLATE SPACER, HIGH ALARM (SINGLE)	0258-0007C	1
18	LINK PLATE:		
	LOW OR HIGH ALARM (SINGLE)	0288-0016C	1
	DUAL ALARM	0288-0016C	2
19	STRAP:		
	LOW OR HIGH ALARM (SINGLE)	0288-0017C	1
	DUAL ALARM	0288-0017C	2
20	PLUG, SCREW, 4-40 X 1/8. SL., RD., HD. (NOT SHOWN):		
	LOW OR HIGH ALARM (SINGLE)	0111-0007J	5
	DUAL ALARM	0111-0007J	4
	LOW OR HIGH ALARM (SINGLE) WITH RELAY	0111-0007J	3
21	SCREW, 4-40 X 1/4 SST SL. ,FL., HD. (WITH RELAY ONLY):		
	LOW OR HIGH ALARM (SINGLE)	0112-1022J	2
	DUAL ALARM	0112-1022J	4
22	SCREW, 3-48 X 3/16, SST SL., BINDING HD.:		
	LOW OR HIGH ALARM (SINGLE)	0117-0007J	3
	DUAL ALARM	0117-0007J	6
23	SCREW, 8-32 X 1/4, SST, SL., BINDING HD.:		
	LOW OR HIGH ALARM (SINGLE)	0117-0016J	1
	DUAL ALARM	0117-0016J	2
24	PLUG SCR., 8-32 X 1/4, SST, PAN HD. (SINGLE) (NOT SHOWN)	0119-0042J	1
25	WASHER, SST:		
	LOW OR HIGH ALARM (SINGLE)	0317-0019J	1
	DUAL ALARM	0317-0019J	2
26	WASHER, NO.3 FLAT, SST:		
	LOW OR HIGH ALARM (SINGLE)	0003-0045K	4
	DUAL ALARM	0003-0045K	8
27	GRIP RING (LOW/HIGH ALM.) (SINGLE/DUAL)	0087-0011 T	1
28	WIRE NUT CONNECTOR (NOT SHOWN):		
	LOW OR HIGH ALARM (SINGLE) WITH RELAY	0109-0017T	1
	DUAL ALARM WITH RELAY	0109-0017T	2
29	MOVEMENT ASSEMBLY	0288-0035B	1
30	LINK ASSEMBLY	0288-0036B	1
31	DRIVE ARM ASSEMBLY: 289A (199 DPU)	0288-0037B	1
32	CASE ASSEMBLY	0288-0038B	1

Table 5-1. Model 289A Parts List (cont'd)

ITEM	DESCRIPTION	PART NO.	PER UNIT
32	CASE ASSEMBLY	0288-0038B	1
33	SCREW, RETAINER	0181-0007C	3
34	STOP, SNUBBER	0226-0028C	2
**35	GASKET, BEZEL	0277-0026C	1
36	RISER, MOVEMENT	0277-0035C	2
37	BRACKET, STOP	0288-0028C	1
38	BRACKET, TERMINAL BLOCK	0288-0029C	1
39	SCREW, 6-32 X 3/8, SL., RD., HD.	0111-0015J	2
40	SCREW, 4-40 X 3/16 SST, SL., FIL., HD.	0114-0023J	4
41	SCREW, 4-40 X 3/16, SST., SL, BINDING HD.	0117-0012J	1
42	SCREW, 6-32 X 3/16 SST, SL. BINDING HD.	0117-0013J	4
43	SCREW, 10-32 X 1/2, FL. HD., SOC.	0240-0015J	10
44	SCREW, 1/2-20 X 1, SL. SET SCREW	0340-0003J	4
45	NUT, 1/4-20 HEX	0500-0010J	4
46	STUD, BEZEL, RETAINING, DRIV-LOK	0004-0005K	1
47	BLOCK, TERMINAL	0038-0033T	1
48	PLATE, SCALE (SEE NOTES BELOW):		1
	BLACK	0288-0031C	
	WHITE	0288-1014C	
49	ID. TAG (NOT SHOWN)	0199-0125C	1
50	SWITCH, WIRED, LOW ALARM (NOT SHOWN):		1
	LOW ALARM, SPDT (WITHOUT RELAY)	0257-0009B	
	LOW ALARM, DPDT (WITHOUT RELAY) #1	0257-0009B	
	LOW ALARM, DPDT (WITHOUT RELAY) #2	S401-0016Z	
	LOW ALARM (WITH RELAY)	0288-0004B	
51	SWITCH, WIRED, HIGH ALARM (NOT SHOWN):		1
	HIGH ALARM, SPDT (WITHOUT RELAY)	0257-0008B	
	HIGH ALARM, DPDT (WITHOUT RELAY) #1	0257-0008B	
	HIGH ALARM, DPDT (WITHOUT RELAY) #2	S401-0017Z	
	HIGH ALARM (WITH RELAY)	0288-0003B	
52	DISC, SEALER, 112" (WITH 3M 468 ADHESIVE)	0192-1035T	1
53	CALIBRATION KIT (NOT SHOWN)	0288-1032B	1
54	INSULATOR STRIP	0038-1345T	1
55	LENS (PLASTIC)	0181-0038C	1
56	PULLER, POINTER (NOT SHOWN)	0163-0005B	1
57	RETAINER RING:		
	SINGLE ALARM	0087-0015T	1
	DUAL ALARM	0087-0015T	2

* INDICATES NON-CE USE ONLY.
** INDICATES RECOMMENDED SPARE PART. WHEN ORDERING PARTS, PLEASE SPECIFY THE SERIAL NUMBER OF THE INSTRUMENT WITH WHICH THEY ARE TO BE USED.

SCALEPLATE IDENTIFICATION:
IF THE PLATE SHOWS AN SCR NUMBER, THIS WITH IDENTIFY IT. OTHERWISE, PROVIDE THE FOLLOWING-INFORMATION:

- SQUARE ROOT OR LINEAR GRADUCATION
- SCALE (E.G., 0-100, 25-0-100, ETC.)
- NUMBER OF GRADUATIONS (LINEAR SCALES ONLY)
- DATA (E.G., PSID, INCHES WATER COLUMN, ETC.)

IF THE PLATE HAS MULTIPLE SCALES OR COLORS (OTHER THAN BLACK AND WHITE), CONSULT FACTORY FOR PRICING/DESCRIPTION.

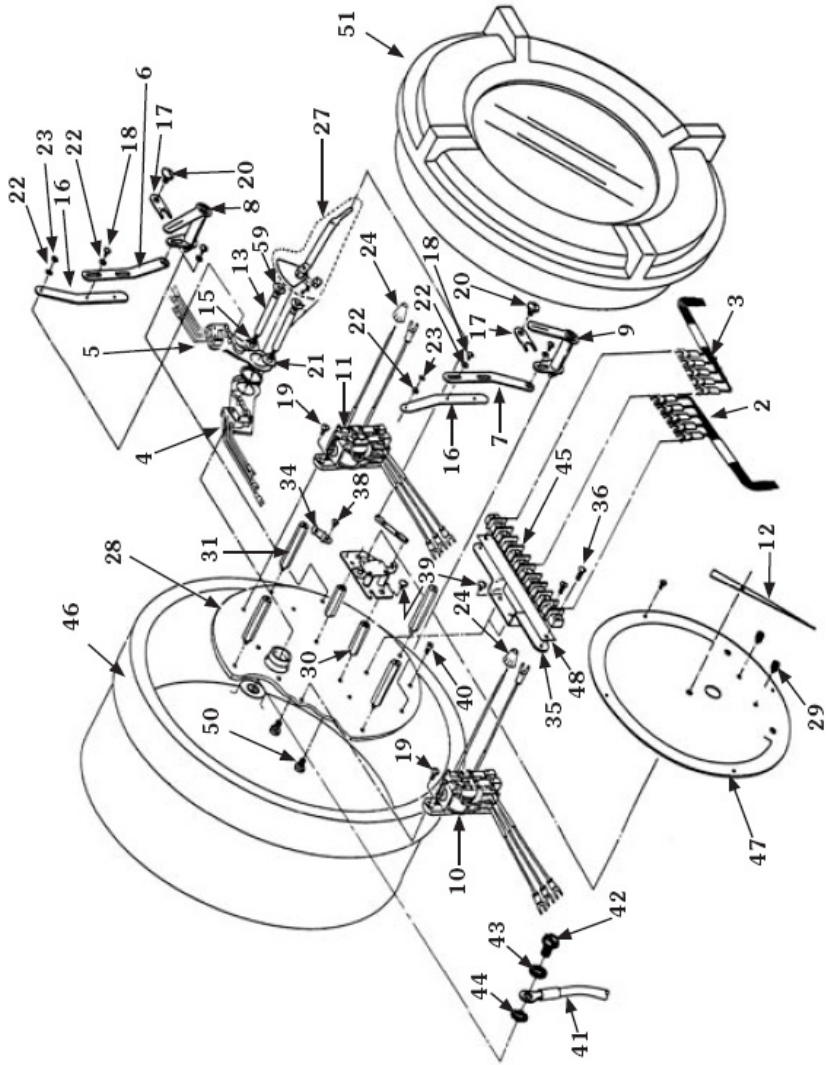


Figure 5-2. Model 291B Assembly Drawing

WARNING

Use only spare parts identified in this manual. Cameron bears no legal responsibility for the performance of a product that has been serviced or repaired with parts that are not authorized by Cameron.

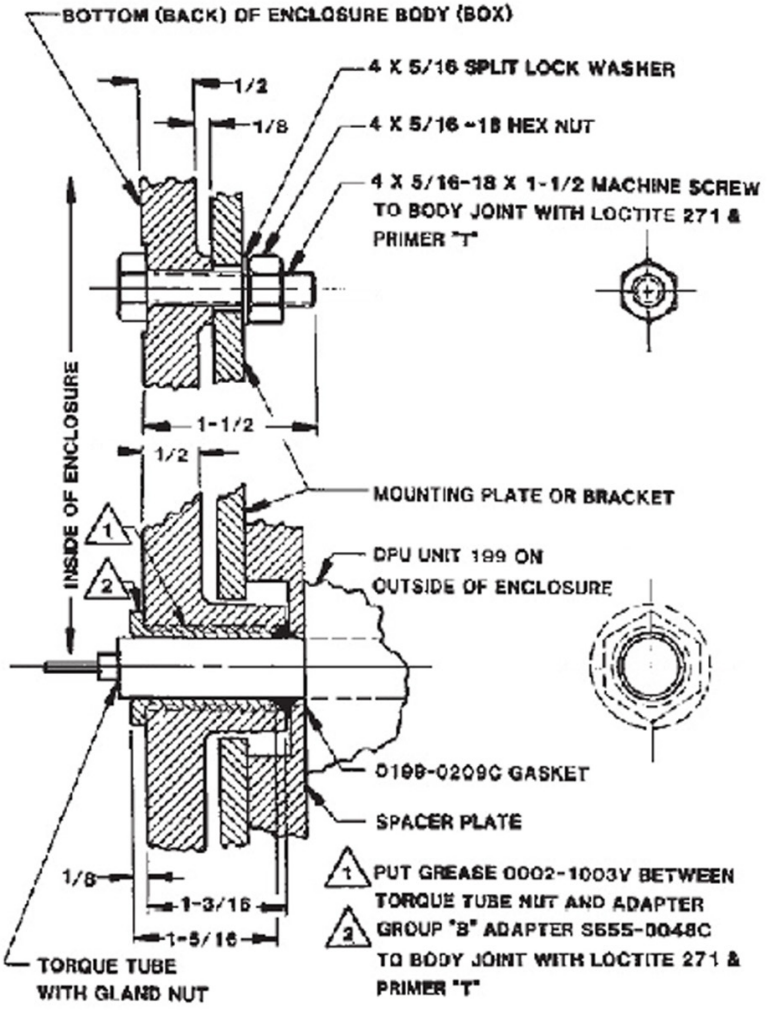


Figure 5-3. Model 291B Detail Drawing

Table 5-2. Model 291B Parts List

ITEM	DESCRIPTION			PART NO.	PER UNIT
1	DIFFERENTIAL PRESSURE UNIT (NOT SHOWN)			SEE DPU 199 MANUAL	1
2	HIGH EXTERNAL WIRING ASSY. (2.5' Long):				1
	HIGH ALARM, SPDT (WITHOUT RELAY)			S655-0056B	
	HIGH ALARM, DPDT (WITHOUT RELAY)			290B-1090B	
	HIGH ALARM (WITH RELAY)			290B-1084B	
3	LOW EXTERNAL WIRING ASSY. (2.5' Long):				1
	LOW ALARM, SPDT (WITHOUT RELAY)			0288-0021B	
	LOW ALARM, DPDT (WITHOUT RELAY)			290B-1089B	
	LOW ALARM (WITH RELAY)			0288-0008B	
4	LOW SWITCH ASSY.:				1
	LOW ALARM, SPDT (WITHOUT RELAY)			0288-0024B	
	LOW ALARM, DPDT (WITHOUT RELAY)			290B-1010B	
	LOW ALARM (WITH RELAY)			0288-0039B	
5	HIGH SWITCH ASSY.:				1
	HIGH ALARM, SPDT (WITHOUT RELAY)			290B-1006B	
	HIGH ALARM, DPDT (WITHOUT RELAY)			290B-1012B	
	HIGH ALARM (WITH RELAY)			290B-1008B	
6	LOW ALARM DRIVE PLATE ASSY.			0288-0026B	1
7	HIGH ALARM DRIVE PLATE ASSY.			0288-0027B	1
8	LOW SWITCH ADJUSTMENT INDEX ASSY.			0288-0028B	1
9	HIGH SWITCH ADJUSTMENT INDEX ASSY.			0288-0029B	1
10	LOW RELAY ASSY. (* = Non-CE Use Only):				1
		Coil Voltage	**Wired SPDT**	**Wired DPDT**	
		6 VAC	0288-0015B	0288-1045B	
		12 VAC	0288-0045B	0288-1035B	
		24 VAC	0288-0016B	0288-1044B	
		*125 VAC	0288-0017B	0288-1043B	
		*250 VAC	0288-0046B	0288-1034B	
		6 VDC	0288-0018B	0288-1038B	
		12 VDC	0288-0019B	0288-1037B	
		24 VDC	0288-0020B	0288-1036B	
		*110 VDC	0288-0047B	0288-1033B	
11	HIGH RELAY ASSY. (* = Non-CE Use Only):				1
		Coil Voltage	**Wired SPDT**	**Wired DPDT**	
		6VAC	0288-0009B	0288-1054B	
		12 VAC	0288-0042B	0288-1048B	
		24 VAC	0288-0010B	0288-1053B	
		*125 VAC	0288-0011B	0288-1052B	
		*250 VAC	0288-0043B	0288-1047B	
		6VDC	0288-0012B	0288-1051B	
		12 VDC	0288-0013B	0288-1050B	
		24 VDC	0288-0014B	0288-1049B	
		*110 VDC	0288-0044B	0288-1046B	

Table 5-2. Model 291B Parts List (cont'd)

ITEM	DESCRIPTION	PART NO.	PER UNIT
**12	POINTER ASSY.:		1
	WHITE	0288-0030B	
	BLACK	0288-0031B	
13	PLATE SCREW:		
	LOW OR HIGH ALARM (SINGLE)	0317-0012C	1
	DUAL ALARM	0317-0012C	2
14	SPRING WASHER:		
	LOW OR HIGH ALARM (SINGLE)	0257-0019C	1
	DUAL ALARM	0257-0019C	2
15	SWITCH PLATE SPACER, HIGH ALARM (SINGLE)	0258-0007C	1
16	LINK PLATE:		
	LOW OR HIGH ALARM (SINGLE)	0288-0016C	1
	DUAL ALARM	0288-0016C	2
17	STRAP:		
	LOW OR HIGH ALARM (SINGLE)	0288-0017C	1
	DUAL ALARM	0288-0017C	2
18	SCREW, 3-48 X 3/16, SST SL., BINDING HD.:		
	LOW OR HIGH ALARM (SINGLE)	0117-0007J	3
	DUAL ALARM	0117-0007J	6
19	SCREW, 4-40 X 1/4 SST SL. ,FL., HD. (WITH RELAY ONLY):		
	LOW OR HIGH ALARM (SINGLE)	0112-0037J	2
	DUAL ALARM	0112-0037J	4
20	SCREW, 8-32 X 1/4, SST, SL., BINDING HD.:		
	LOW OR HIGH ALARM (SINGLE)	0117-0016J	1
	DUAL ALARM	0117-0016J	2
21	WASHER, #8 FLAT, SST:		
	LOW OR HIGH ALARM (SINGLE)	0317-0019J	1
	DUAL ALARM	0317-0019J	2
22	WASHER, NO. 3 FLAT, SST:		
	LOW OR HIGH ALARM (SINGLE)	0003-0045K	4
	DUAL ALARM	0003-0045K	8
23	GRIP RING (LOW/HIGH ALM.) (SINGLE/DUAL)	0087 -0011 T	1
24	WIRE NUT CONNECTOR (NOT SHOWN):		
	LOW OR HIGH ALARM (SINGLE) WITH RELAY	0109-0017T	1
	DUAL ALARM WITH RELAY	0109-0017T	2
25	MOVEMENT ASSEMBLY	0288-0035B	1
26	LINK ASSEMBLY	0288-0036B	1
27	DRIVE ARM ASSEMBLY: 289A (199 DPU)	0288-0037B	1
28	PLATE, MOUNTING ASSEMBLY	0290-0002B	1
29	STOP, SNUBBER	0226-0028C	2
30	RISER, MOVEMENT	0277-0035C	2
31	RISER, SCALEPLATE	0277-0003C	4
34	BRACKET, STOP	0288-0028C	1
35	BRACKET, TERMINAL BLOCK	0288-0029C	1
36	SCREW, 6-32 X 3/8, SL., RD., HD.	0111-0015J	2
37	SCREW, 4-40 X 3/16 SST, SL., FIL., HD.	0114-0023J	4

Table 5-2. Model 291B Parts List (cont'd)

ITEM	DESCRIPTION	PART NO.	PER UNIT
38	SCREW, 4-40 X 3/16, SST., SL, BINDING HD.	0117-0012J	1
39	SCREW, 6-32 X 3/16 SST, SL. BINDING HD.	0117-0013J	4
40	SCREW, 8-32 X 3/16, BIN. HD.	0117-0014J	3
41	GROUND WIRE, GREEN	IT10-1063B	1
42	SCREW, SL, HEX, HD.	0117-1012J	1
43	INT. TOOTH LOCK WASHER	0003-0066K	1
44	EXT. TOOTH LOCK WASHER	0038-0050K	1
45	BLOCK, TERMINAL	0038-0033T	1
46	CASE, EXPLOSIONPROOF	IT10-1091B	1
47	PLATE, SCALE (SEE NOTES BELOW):		1
	BLACK	0288-0031C	
	WHITE	0288-1014C	
48	INSULATOR STRIP	0038-1345T	1
49	ADAPTOR, EXPLOSIONPROOF (NOT SHOWN)	S655-0048C	1
50	SCREW, 10-32 X 1/2, FL. HD., SOC.	0240-0019J	2
51	COVER, EXPLOSIONPROOF	IT10-1090B	1
52	SWITCH, WIRED, LOW ALARM:		1
	LOW ALARM, SPDT (WITHOUT RELAY)	0257-0009B	
	LOW ALARM, DPDT (WITHOUT RELAY) #1	0257-0009B	
	LOW ALARM, DPDT (WITHOUT RELAY) #2	290B-1009B	
	LOW ALARM (WITHOUT RELAY) #1	0288-0004B	
53	SWITCH, WIRED, HIGH ALARM:		1
	HIGH ALARM, SPDT (WITHOUT RELAY)	290B-1004B	
	HIGH ALARM, DPDT (WITHOUT RELAY) #1	290B-1004B	
	HIGH ALARM, DPDT (WITHOUT RELAY) #2	290B-1011B	
	HIGH ALARM (WITH RELAY)	290B-1059B	
56	PULLER, POINTER (NOT SHOWN)	0163-0005B	1
57	CALIBRATION KIT (NOT SHOWN)	0288-1032B	1
58	NAMEPLATE (NOT SHOWN)	0290-1009G	1
59	RETAINER RING:		
	SINGLE ALARM	0087-0015T	1
	DUAL ALARM	0087-0015T	2

NOTES:

* INDICATES NON-CE USE ONLY.
** NDICATES RECOMMENDED SPARE PART. WHEN ORDERING PARTS, PLEASE SPEC FY THE SERIAL NUMBER OF THE INSTRUMENT WITH WHICH THEY ARE TO BE USED.

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.

Product Brand

Barton® is a registered trademark of Cameron International Corporation ("Cameron").

MEASUREMENT SYSTEMS

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CAMERON