Instructions for Differential Pressure Transmitter

IB-2B213
Issue 3
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391T Model A

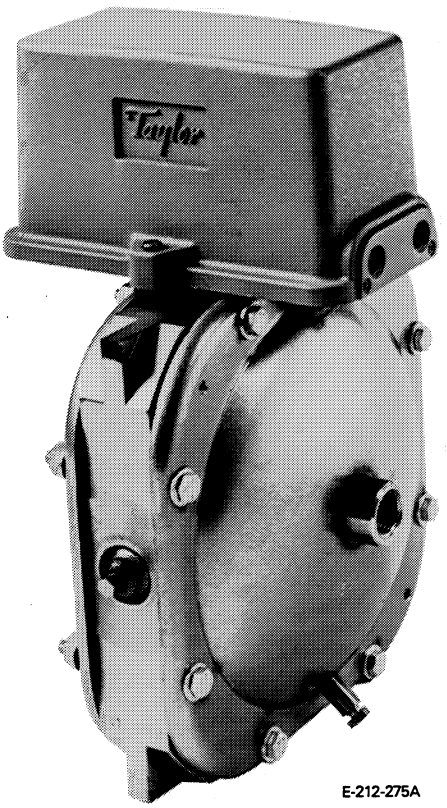

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ABB Instrumentation

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WARNING - Hazards which could result in personal injury.

CAUTION - Hazards which could result in equipment or property damage.

NOTE - Alerts user to pertinent facts and conditions.

Although **DANGER** and **WARNING** hazards are related to personal injury, and **CAUTION** hazards are associated with equipment or property damage, it should be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process system performance leading to personal injury or death. Therefore, comply fully with all **DANGER, WARNING** and **CAUTION** notices.

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INTRODUCTION

1.1 DESCRIPTION

The Taylor Differential Pressure Transmitter, 391T, is a force balance instrument which measures differential pressure and transmits a proportional pneumatic output signal. The transmitter measures differential spans from 1 to 10 inches of water (0.25 to 2.5 kPa) at operating pressures to 50 psig (350 kPa).

The span of the transmitter is continuously adjustable. A Vernier-scaled span adjustment aids reproduction of previously calibrated spans without recalibration.

A die-cast aluminum case houses the pneumatic transmitter section, which includes a direct-acting, non-bleed output relay.

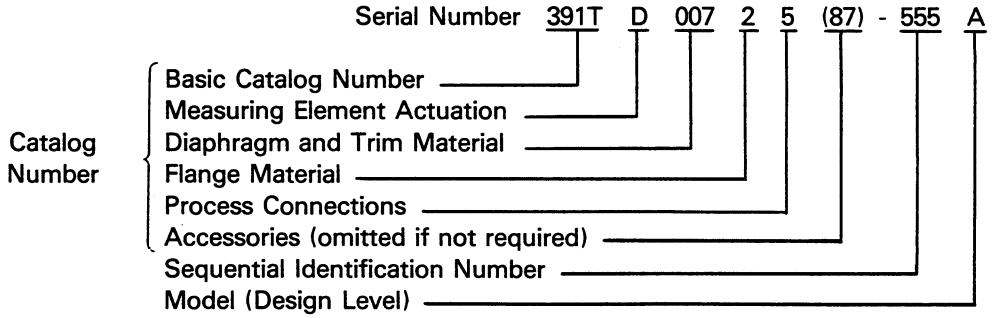
The zero adjustment is accessible through the instrument cover. Adjustment sensitivity is identical at all span settings. An optional suppression/elevation spring is available for biasing zero on liquid level applications.

Adjustable input damping is standard on the transmitter. The damping adjustment changes the transmitter response time to fit specific process requirements.

1.2 SERIAL AND CATALOG NUMBERS

The serial number stamped on the data plate consists of the catalog number and a sequential identification number. The catalog number describes the construction of the transmitter.

An X before the serial number indicates that the instrument has been built to meet a customer's special requirements.



BASIC CATALOG NUMBER

391T — Extra Low Range Transmitter
Span adj from 1 to 10 in. water
(0.25 to 2.5 kPa)
50 psig (350 kPa)
max working pressure

MEASURING ELEMENT ACTUATION

D — Differential Pressure

DIAPHRAGM AND TRIM MATERIAL

000 — Hastelloy-C diaphragm and type 316L SST trim per NACE standard MR-01-75 (1980 Rev)

007 — Hastelloy-C diaphragm and type 316L SST trim

FLANGE AND ADAPTER MATERIAL

2 — Type 316 SST

PROCESS CONNECTIONS
5 — Flange Face Connections, 1/2-inch Int NPT

ACCESSORIES
(87) — Suppression/Elevation Spring
( ) — Air Sets (refer to Table 1)
(146) — Mounting Bracket Kit
(277) — Fiberglas Cover and Epoxy-Coated Subbase
(278) — Fiberglas Cover

EXAMPLE:
Serial Number 391TD00725(87)-555A identifies an extra low range transmitter adjustable from 1 to 10 inches of water (0.25 to 2.5 kPa) and a 50 psig (350 kPa) maximum working pressure (391T), actuated by differential pressure (D). It has Hastelloy-C diaphragms and type 316 SST trim (007), type 316 SST flange material (2), 1/2-inch Int NPT process connections (5), and a suppression/elevation spring (87). The sequential identification number is 555 and the design level is Model A.

Table 1. Accessory Numbers for Air Sets

Accessory Number	Filter Regulator	Air Supply Gage	Output Gage 0-100% ±1	Output Gage 0-100% ±1 (20-100 kPa)	Output Gage 0-10 Sq Rt ±1%	Output Gage 0-10 Sq Rt ±1% (20-100 kPa)
(103)	X					
(104)	X	X				
(105)	X	X	X			
(107)	X	X			X	
(109)			X			
(111)					X	
(297)	X	X		X		
(298)	X	X				X
(299)				X		
(300)						X

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1.3 WETTED MATERIAL IDENTIFICATION

The following abbreviations are used on the instrument data plate to identify materials wetted by the process.

Hastelloy-C — HAST
Type 316 SST — 316

1.4 FILLING MEDIUM IDENTIFICATION

The following abbreviation is stamped on the diaphragm capsule to identify the filling medium:

SI — Silicone

1.5 SPECIFICATIONS

SPAN
Adjustable from 1 to 10 in. water (0.25 to 2.5 kPa)

CALIBRATION ACCURACY (Zero Based)
±1.0% of span (0.5% ultimate capability)

RANGE LIMITS
Refer to Table 2

OUTPUT
3 to 15 psig (20 to 100 kPa)

AIR SUPPLY PRESSURE
20 psig (140 kPa) - recommended
18 psig (125 kPa) - minimum
25 psig (170 kPa) - maximum

AIR CONSUMPTION
0.2 scfm maximum (0.0056 m^3/min)

INPUT DAMPING
Adjustable: Approximately 0.16 to 1.0 second for 63.2% response; continuously adjustable

AMBIENT TEMPERATURE LIMITS
Measuring Element: −40°F (−40°C) min, 300°F (149°C) max
Transmitter Housing: −40°F (−40°C) min, 180°F (83°C) max
Storage: −90°F (−68°C) min, 180°F (83°C) max

WEIGHT
36 lb (16.4 kg)

VOLUMETRIC DISPLACEMENT
(for maximum differential)
0.6 in^3 (10 cc)

Table 2. Range Limits

Calibration	Range Limits			
	Inches of Water		Kilopascals	
	Lower (3 psi output)	Upper (15 psi output)	Lower (20 kPa output)	Upper (100 kPa output)
Zero Based	±5% of Span	+1 to +10	±5% of Span	+0.25 to +2.5
Suppressed Zero	0 to +9	+1 to +10	0 to +2.2	+0.25 to 2.5
Elevated Zero	−10 to 0	−9 to +10	−2.5 to 0	−2.2 to +2.5
Center Zero	−5 to −0.5	+0.5 to +5	−1.2 to −0.1	+0.1 to +1.2

Transmitters with a Suppression/Elevation Spring, Accessory (87), can be calibrated for suppressed, elevated, or center zero.

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INSTALLATION

2.1 MOUNTING

Refer to **Process Installation Section, IB-12B922,** for information on locating the transmitter for specific applications.

Select a mounting location where there is minimum vibration. The ambient temperature must not exceed the limits listed under **1.5 Specifications.**

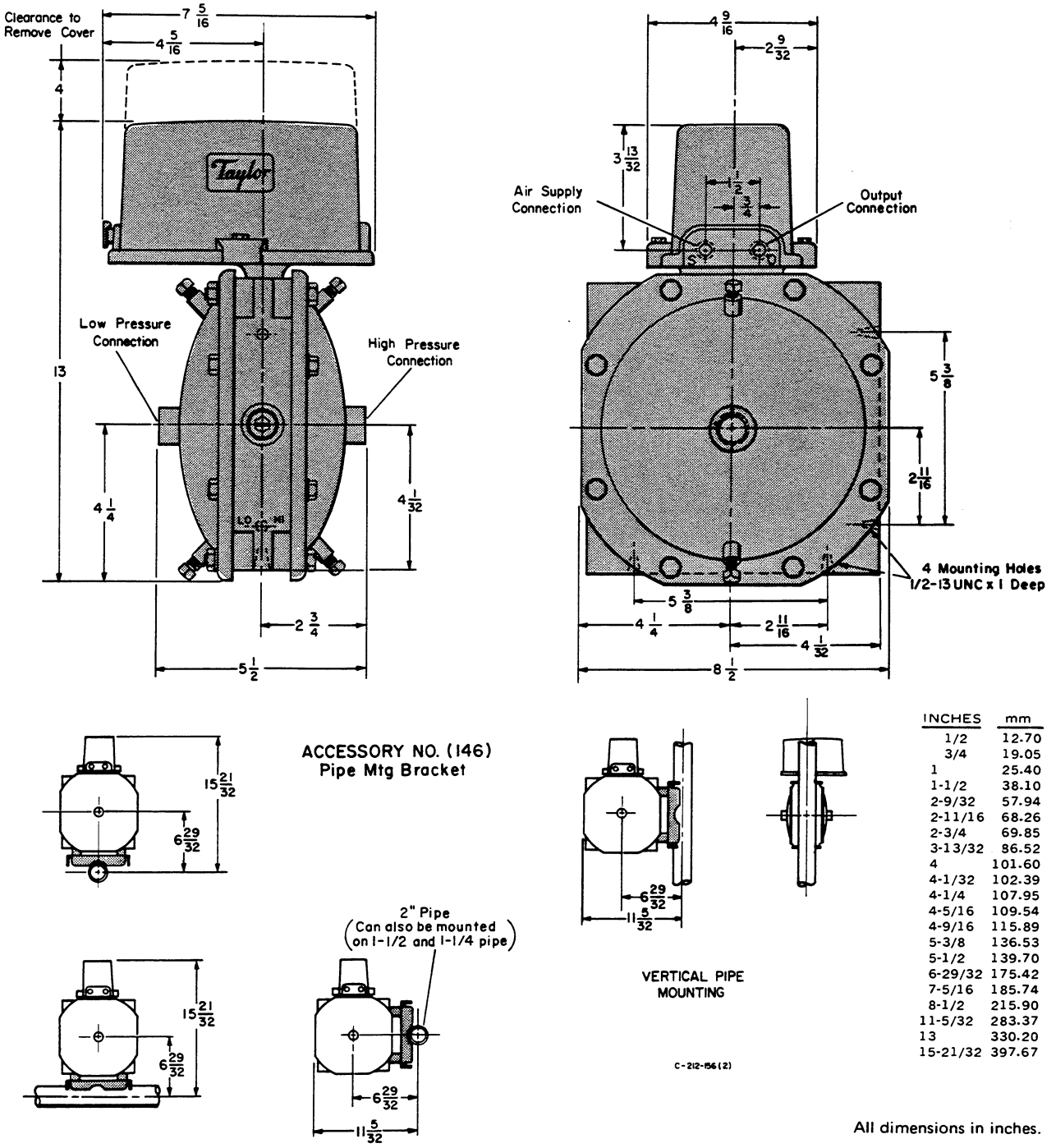
Mount the transmitter so that the measuring element diaphragms are vertical and the measuring element is below the case, Figure 1. Operation is not affected by mounting in other positions, but some rezeroing may be required (refer to **3.2 Field Zero Adjustment**).

NOTE

If the transmitter is not mounted in the recommended position, Figure 1, it must be equipped with a Suppression/Elevation Spring, Accessory (87), to provide for rezeroing. To install a Suppression/Elevation Spring, refer to the **Maintenance Section.**

Select a mounting location where there is minimum vibration. Ambient temperature should not be less than −40°F (−40°C) or more than 180°F (82.2°C). When used on gas service where condensible vapor is present, the transmitter should be located above the elevation of the process taps to avoid collection of condensate in the measuring element.

Mounting bracket, U-bolt, spacers, clamp and fasteners, Figure 2, are packaged with the instrument. The bracket is suitable for either pipe or surface mounting. For pipe mounting, the bracket accepts 1-1/4 inch through 2-inch pipe and can be positioned for use on horizontal or vertical pipe, Figure 1.



INCHES	mm
1/2	12.70
3/4	19.05
1	25.40
1-1/2	38.10
2-9/32	57.94
2-11/16	68.26
2-3/4	69.85
3-13/32	86.52
4	101.60
4-1/32	102.39
4-1/4	107.95
4-5/16	109.54
4-9/16	115.89
5-3/8	136.53
5-1/2	139.70
6-29/32	175.42
7-5/16	185.74
8-1/2	215.90
11-5/32	283.37
13	330.20
15-21/32	397.67

All dimensions in inches.

High and Low Pressure Connection 1/2 Int NPT
Air Supply and Output Connections 1/4 Int NPT

For reference only; not for construction.

Figure 1. Mounting Dimensions

2.2 PNEUMATIC CONNECTIONS

WARNING

Use of a supply gas other than air can create a hazardous environment because a small amount of the gas continuously vents to the atmosphere.

The air supply and output ports are located on the end of the transmitter case, Figure 3. Both ports are 1/4-inch Int NPT. One-quarter inch tubing is recommended for air lines.

Connect a clean, dry, 20 psig (140 kPa) air supply to the port marked **S**. Connect the output from the port marked **O** to the receiver. The output line must be free of leaks.

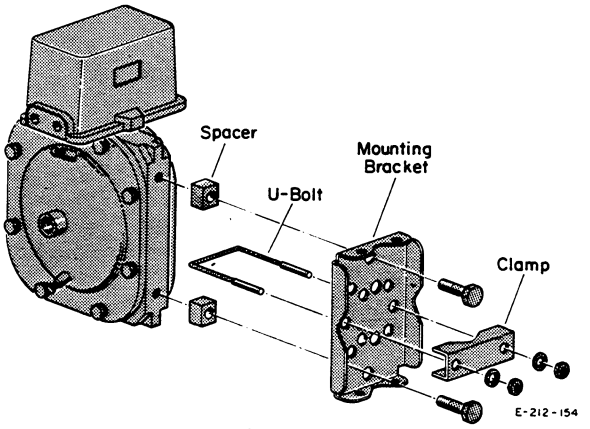


Figure 2. Assembling Optional Mounting Bracket Kit, Accessory (146)

2.3 PROCESS CONNECTIONS

Connect the high and low pressure process lines to the 1/2-inch Int NPT ports in the measuring element, Figure 1. A recommended piping arrangement is shown in Figure 2. The equalizing valve provides a convenient means of obtaining zero differential across the measuring element for zero adjustment after installation.

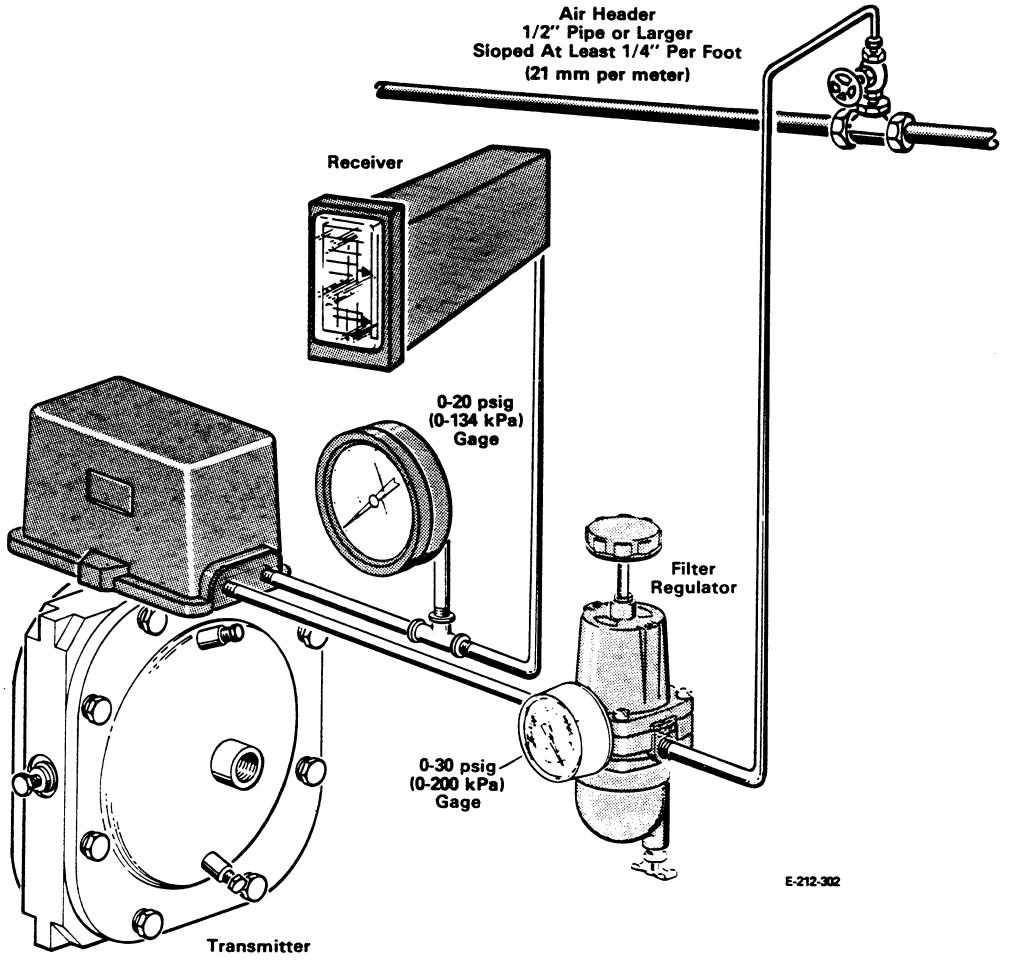


Figure 3. Pneumatic Connections

3

OPERATION

3.1 PUTTING INTO OPERATION

Turn on the air supply and adjust to 20 psig (140 kPa), then proceed as follows:

1. Make sure low pressure and high pressure valves, Figure 4, are closed.

2. Open shut-off valves and equalizing valve.

3. Slowly open high pressure valve to admit process fluid to both sides of measuring element.

4. On liquid service, vent all entrapped air from both sides of measuring element using vent valves. Venting is not required on gas service.

5. After venting, output should be 3 psig (20 kPa).

   If it is not, adjust **zero** screw through access hole in end of cover. (If instrument has a suppression/elevation spring, first turn **bias** screw, Figure 5, to obtain 3 psig (20 kPa). If necessary, trim zero by turning **zero** screw.) Clockwise rotation of either screw increases output.

6. Close equalizing valve, then open low pressure valve.

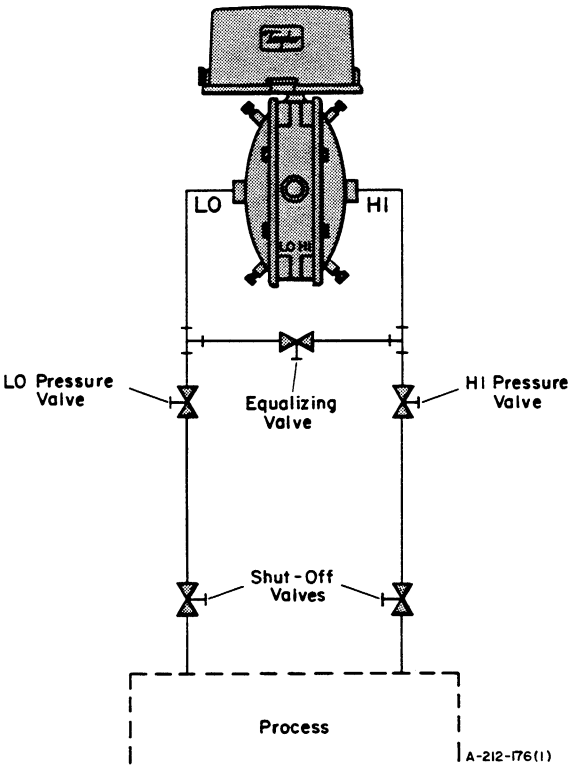


Figure 4. Process Connection Lines

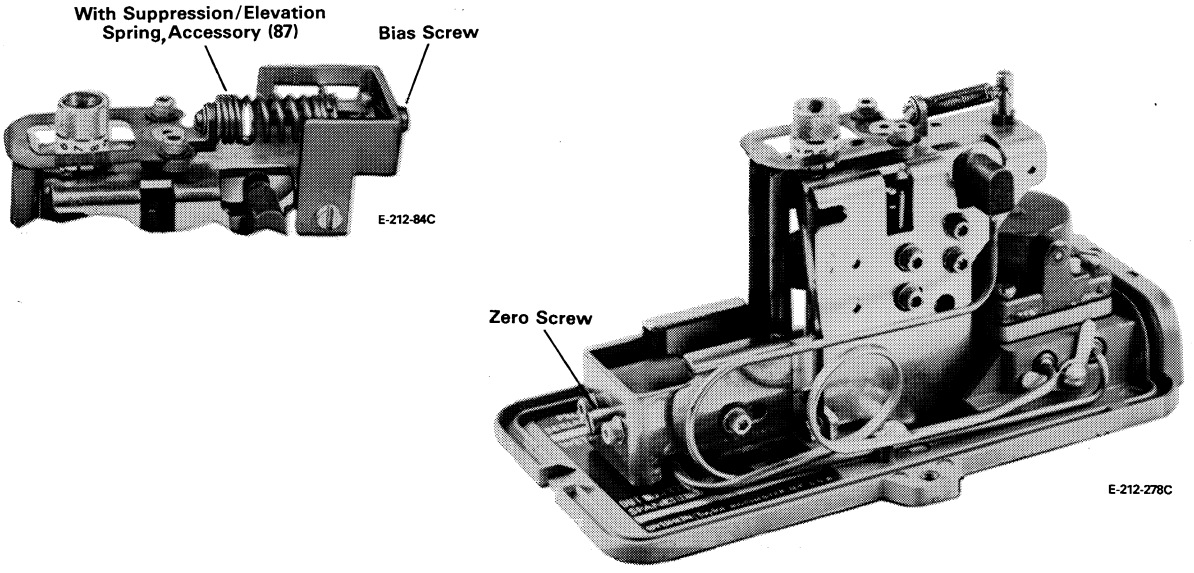


Figure 5. Zero Adjustment

3.2 FIELD ZERO ADJUSTMENT

To adjust zero on an installed transmitter use the following procedure:

1. Close low pressure valve, Figure 4.

2. Open equalizing valve to put zero differential across measuring element. Output should be 3 psig (20 kPa).

   If it is not, adjust **zero** screw through access hole in end of cover. (If instrument has a suppression/elevation spring, first turn **bias** screw, Figure 5, to obtain 3 psig (20 kPa). If necessary, trim zero by turning **zero** screw.) Clockwise rotation of either screw increases output.

3. Close equalizing valve.

4. Open low pressure valve.

3.3 DAMPING ADJUSTMENT

The response time of the transmitter can be changed by adjusting input damping in the measuring element. Maximum damping (slowest response time) is obtained when the damping adjustment, Figure 6, is turned clockwise to its stop. The adjustment cannot make the instrument inoperative.

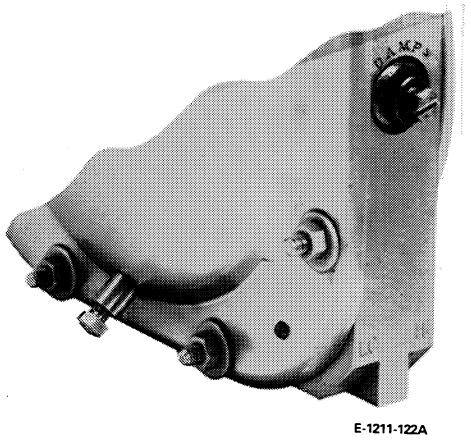


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Figure 6. Damping Adjustment

Before putting the transmitter into operation, adjust for **minimum** damping by turning the damping adjustment counterclockwise to its stop. In operation, increase damping as required by process conditions.

3.4 CALIBRATION INDEX

The calibration index reproduces any previously calibrated span within ±0.5% without recalibration. The index scale, Figure 7, divides the span scale into 60 increments. One full turn of the span screw moves the scale indicator one increment; and the vernier scale on the span screw divides the increment into tenths. Using these scales, span settings can be converted into index numbers.

For example, if a transmitter has been calibrated for 100 inches (25 kPa) of water, the index reading might be 26.53. Digits in front of the decimal are read from the index scale using the top edge of the indicator. Digits after the decimal are read from the Vernier scale. With the index number noted, the span can be changed and then returned to 100 inches by adjusting the scale indicator to the index number. Only rezeroing may be required.

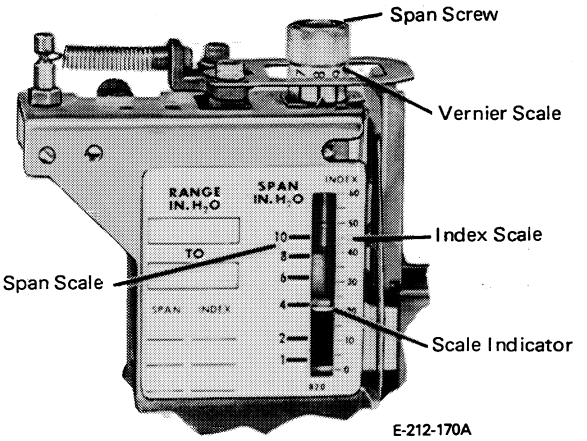

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Figure 7. Calibration Index

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FUNCTIONAL DESCRIPTION

4.1 GENERAL

The transmitter operates on the force balance principle: force developed by the measuring element is balanced by the force produced by output pressure acting on the follow-up bellows, Figure 8.

An increase in differential pressure, acting on the measuring element diaphragms, develops force which moves the lower end of the force beam to the right. The nozzle-baffle gap decreases and nozzle back pressure increases. This pressure is fed to chamber A of the output relay.

As the pressure in chamber A increases, the diaphragm assembly moves the relay stem downward, closing the vent port and opening the air supply port to increase the output. The output increases until it balances the downward force on the diaphragm assembly.

The output pressure is fed to the follow-up bellows which applies force to the span lever. This force is transferred through the flexible strip back to the force beam. The nozzle-baffle gap is restored approximately to its original position as equilibrium is established between measuring element force and follow-up force. Since the follow-up force is produced by output pressure, the output is proportional to differential.

4.2 SUPPRESSION/ELEVATION SPRING, ACCESSORY (87)

The suppression/elevation spring biases output to compensate for the effect of initial head pressures which are often encountered in liquid level applications.

On an open tank liquid level installation where the minimum level is above the elevation of the HI side process tap, output will be above the required zero value at minimum level. The suppression/elevation spring, compressed by adjustment of the bias screw, provides force which balances the measuring element force resulting from the initial head pressure. Thus, the spring **suppresses** the output to the required zero value.

On a closed tank liquid level installation with a wet leg, output will be below the required zero value at minimum level. The suppression/elevation spring, tensioned by adjustment of the bias screw, provides balancing force which **elevates** the output to the required zero value.

Suppression or elevation adjustments are made as part of the transmitter calibration procedure. The head pressures are simulated by calibration pressures applied to the measuring element.

4.3 DAMPING

The liquid-filled measuring element provides damping which determines the speed with which the transmitter output responds to changes in differential pressure. When a change in differential pressure occurs, a very small amount of liquid flows through the connecting path between the high and low side diaphragm cavities. The size of the connecting path determines the amount of damping.

A damping adjustment is built into the measuring element. When the damping adjustment is fully open, as shown in Figure 8, liquid flows unrestricted past the adjustment screw and also through the clearance around the diaphragm rod. This is the minimum damping condition and the transmitter response is fast.

As the damping adjustment is turned to close off the variable restriction, damping increases. With the adjustment fully closed, only the highly restricted path around the diaphragm rod is open. This is the maximum restriction and the slowest response condition.

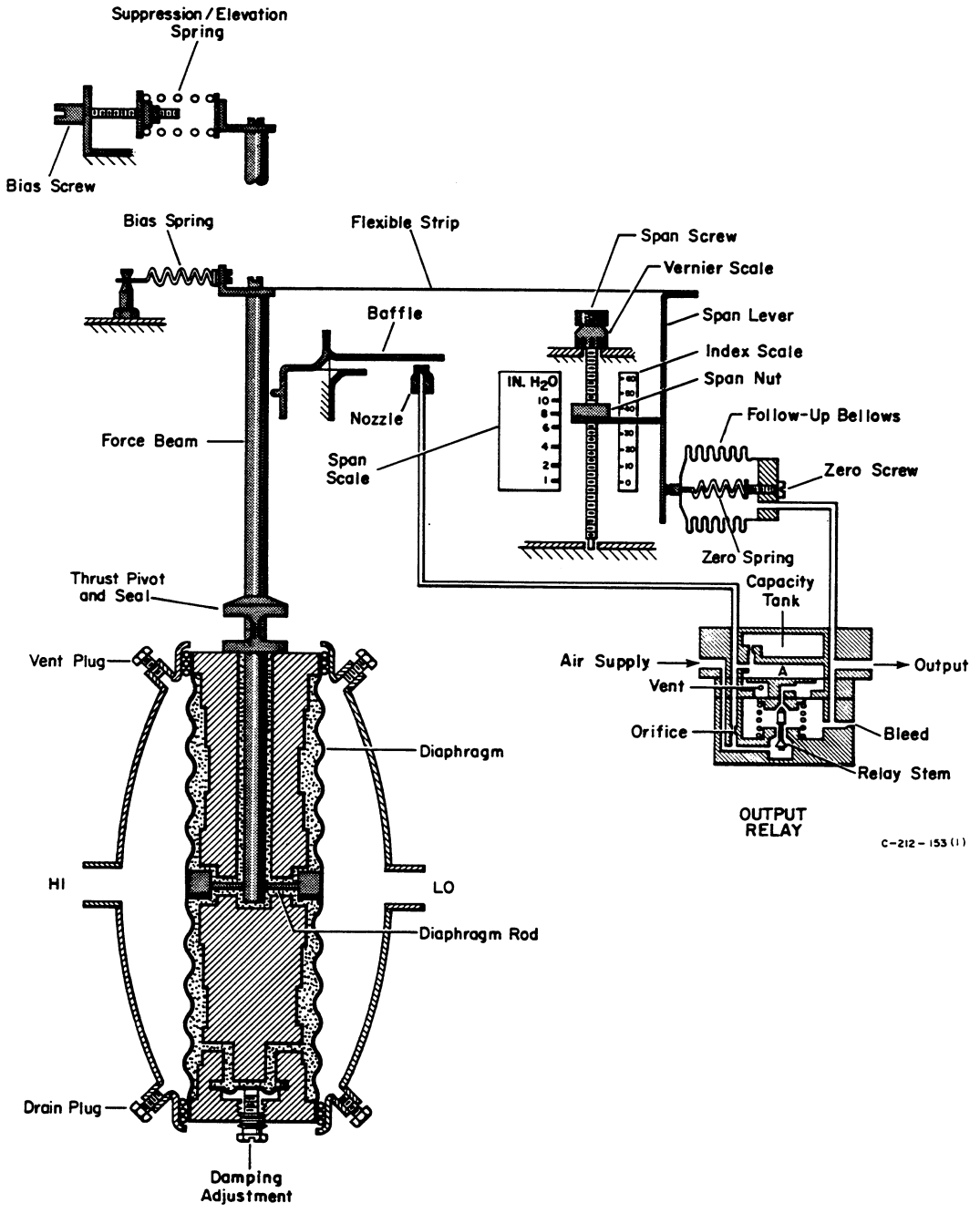

Figure 8. Schematic Diagram of Transmitter