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DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR DIAL INDICATING PRESSURE GAGES (GENERAL)

Headquarters, Department of the Army, Washington, DC
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* This bulletin supersedes TB 9-6685-319-50, 1 July 1973, including all changes.

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SECTION I
IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Dial Indicating Pressure Gages (General). Various manufacturers' manuals were used as the prime data sources in compiling these instructions. The equipment being calibrated will be referred to as the TI (test instrument) throughout this bulletin.

a. Model Variations. Variations among models are indicated in the text.

b. Time and Technique. The time required for this calibration is approximately 2 hours, using the physical technique.

2. Forms, Records, and Reports

a. Forms, records, and reports required for calibration personnel at all levels are prescribed by TB 750-25.

b. Adjustments to be reported are designated (R) at the end of the sentence in which they appear. When adjustments are in tables, the (R) follows the designated adjustment. Report only those adjustments made and designated with (R).

3. Calibration Description TI parameters and performance specifications which pertain to this calibration are listed in table 1.

Table 1. Calibration Description

Test instrument parameters	Performance specifications
Range and accuracy[1]	Performance at cardinal points in accordance with specifications for gage being tested

[1]In those cases where accuracy of TI cannot be determined, TI will be certified to one graduation of TI scale.

SECTION II
EQUIPMENT REQUIREMENTS

4. Equipment Required. Table 2 identifies the specific equipment to be used in this calibration procedure. This equipment is issued with Secondary Transfer Calibration Standards Set AN/GSM-286. Alternate items may be used by the calibrating activity when the equipment listed in table 2 is not available. the items selected must be verified to perform satisfactorily prior to use and must bear evidence of current calibration. The equipment must meet or exceed the minimum use specifications listed in table 2. The accuracies listed in table 2 provide a four-to-one ratio between the standard and TI. Where the four-to-one ratio cannot be met, the actual accuracy of the equipment selected is shown in parenthesis.

5. Accessories Required. The accessories listed in table 3 are issued as indicated in paragraph 4 above and are used in this calibration procedure. When necessary, these items may be substituted by equivalent items, unless specifically prohibited.

Table 2. Minimum Specifications of Equipment Required

Item	Common name	Minimum use specifications	Manufacturer and model (part number)
A1	PNEUMATIC PRESSURE STANDARD	Range: 0 to 200 psi Accuracy: [1] ±0.025% (±0.125% of FS)	Cybersystems, Inc., Model ZA00225A1 (MIS-30859)
A2	PRESSURE GAGE TESTER	Range: 0 to 10,000 psi Accuracy: [2] ±0.025% (±0.15% of reading)	Mansfield and Green, Model 10-10525 (10-10525)

[1]Equipment limitation: ±0.05% of FS
[2]Equipment limitation: ±0.015% of reading.

Table 3. Accessories Required

Item	Common name	Description (part number)
B1	ADAPTER[1]	Male 1/4-in., SP to male 7/16-30 UNF, 37° flare (part of MIS-26326)
B2	ADAPTER	Male 3/8-18 NPT to female 1/4-18 NPT (part of 8598963)
B3	ADAPTER	Male 7/8-14 UNF w/"o" ring to female 3/8-18 NPT (part of 8598963)
B4	ADAPTER	Male 7/16-30 UNF, 37° flare to female 1/8-18 NPT (part of 7913310)
B5	ADAPTER	Male 1/2-30 UNF to female 7/8-14 UNF (part of 8598963)
B6	CONNECTOR	Stainless steel, female 1/4-18 NPT to male 7/16-20 UNF, 37° flare (part of 7913310)
B7	DISTILLED WATER	Additional equipment required
B8	FLUID SEPARATOR	MIS-26326
B9	HOSE	3-ft, 3000 psi operating pressure, female 7/16-20 UNF, 37° flare angle fittings (7913310)
B10	HOSE	5-ft, 5000 psi operating pressure (part of 7913310)
B11	HOSE	Male 1/4-18 NPT ends (part of 8598963)
B12	NITROGEN TANK	Water pumper nitrogen (7910373)
B13	PNEUMATIC PRESSURE CONTROLLER	MIS-10324
B14	REGULATOR	MIS-10325 Type II
B15	SQUEEZE BOTTLE	(Part of MIS-26326)
B16	TEE	Stainless steel, swivel nut (8491696) (part of 7913310)
B17	TUBE ASSEMBLY	1/4-in. AN back-to-back (female 7/16-20 UNF, 37° flare both ends (7913309) (part of 7913310)

[1]Two required

SECTION III
CALIBRATION PROCESS FOR HYDRAULIC GAGES

6. Preliminary Instructions

a. The instructions outlined in paragraphs 6 and 7 are preparatory to the calibration process. Personnel should become familiar with the entire bulletin before beginning the calibration.

b. Items of equipment used in this procedure are referenced within the text by common name and item identification number as listed in tables 2 and 3. For the identification of equipment referenced by item numbers prefixed with A, see table 2, and for prefix B, see table 3.

c. Unless otherwise specified, verify the result of each test and, whenever the test requirement is not met, take corrective action before continuing with the calibration. Adjustments required to calibrate the TI are included in this procedure. additional maintenance; information is contained in the manufacturer's manual for this TI.

d. Unless otherwise specified all controls and controls settings refer to the TI.

7. Equipment Setup

a. Remove pressure gage tester (A2) from carrying case.

b. Remove filler plug and fill pressure gage jester with hydraulic oil (MIL-L7870A).

c. Reinstall filler plug and secure pressure gage test to an adequate workbench. Level pressure gage tester.

d. Visually inspect TI for signs of damage or deterioration.

e. Thoroughly clean bourdon tube or diaphragm of TI. First, rotate TI and allow any liquid which may be in the bourdon tube or diaphragm area to flow out. Using an eye dropper or small glass tube, fill bourdon tube or diaphragm area with toluene, methyl alcohol, or freon TF solution. Allow solution to remain in the gage for 5 minutes. Drain gage and dry for at least 10 minutes.

f. If required, zero-adjust dial indicator of TI by removing retaining ring and coverglass and adjusting the calibration screw.

8. 0 to 10,000 Psi Hydraulic Gages (0.1 to 20 Percent Accuracy)

a. Performance Check

(1) Connect equipment as shown in figure 1.

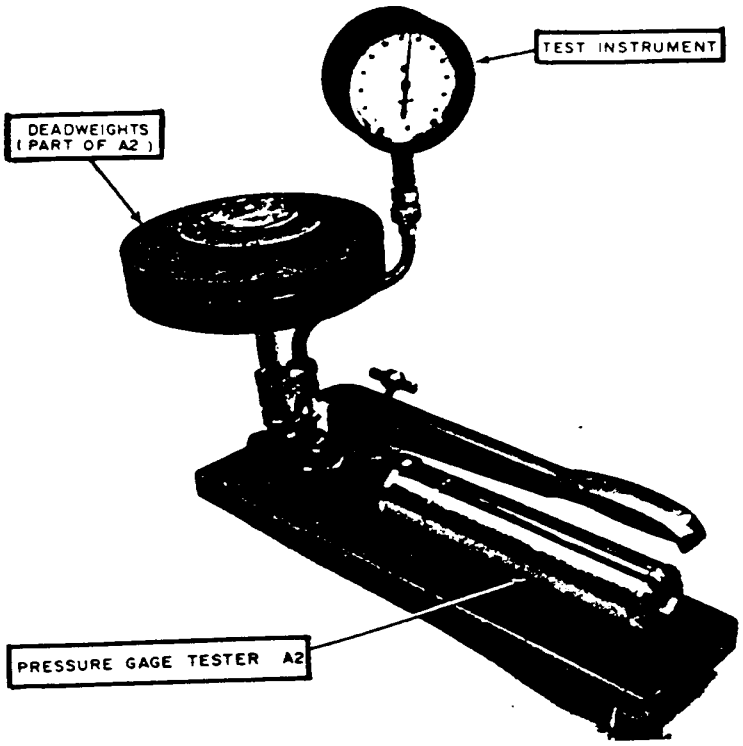

Figure 1. 1.0 to 10,0000 psi hydraulic gages (0.1 to 1.0 percent accuracy) - equipment setup.

(2) Calculate tolerance limits for TI, using accuracy specified for applicable gage

(3) Place enough deadweights (supplied with pressure gage tester (A2)) on applicable low or high pressure piston to obtain a pressure equal to cardinal point nearest 10 percent of TI scale.

CAUTION

To avoid scoring the piston guide and damage to the deadweight cylinder, constantly rotate weights and piston when inserting or removing piston or when applying pressure.

(4) Using hand pump, apply pressure to deadweight cylinder until (low or high pressure) piston is approximately 9/16-inch above deadweight cylinder.

(5) Visually inspect equipment connection for leakage. If leakage appears release pressure and tighten or seal connections as required.

CAUTION

Do not remove weights installed in (3) above from low or high pressure piston during remainder of this procedure.

(6) Place enough deadweights on applicable low or high pressure piston to obtain the 90 percent cardinal point of TI. Refer to table 4 for conversion table.

Table 4. Conversion Table

Number of deadweights supplied with pressure gage tester (ea)	Value of each weight (lbs)	1 weight equal the equivalent pressure (psi)[1]	
		Low Pressure Piston	High Pressure Piston
18	10	100	500
1	9 1/2	95	475
4	2	20	100
4	1/2	5	25

[1]Pressure generated by deadweight testers are affected by acceleration of gravity. Mansfield and Green, Model 10-1025 deadweight tester generates true pressures at locations where the acceleration of gravity is 980.217 cm/s^2. The acceleration of gravity must be considered when using the deadweight tester to calibrate TI's with an accuracy of ±0.35% of FS or better. To correct for the effect of gravity, multiply total pressure of weight combination by local gravity (units -cm/s^2**)** and divide by 980.217 cm/s^2.

(7) Repeat (4) above.

(8) If TI does not indicate within limits calculated in (2) above perform b below.

(9) Repeat (2) and (6) through (8) above, using enough weights to obtain cardinal points nearest to 80, 60, 40, 20, and 10 percent of TI scale.

(10) Thoroughly clean TI in accordance with paragraph 7 above.

b. Adjustments (Typical, fig. 2)

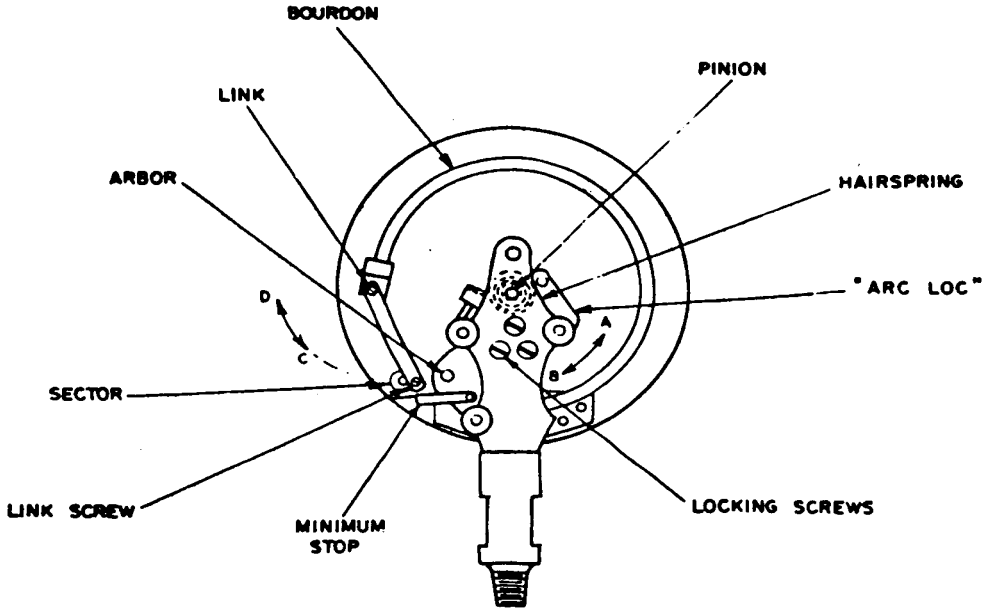

Figure 2. Typical pressure gage.

NOTE

The following adjustment procedure applies specifically to solfront gages, but may be used as a guide for other gages. Manufacturers' instructions should be used if available.

(1) Deviations either plus or minus by a constant value are corrected by repositioning the pointer. Remove bezel ring, loosen locking screw (marked L) 1/4 turn, and adjust screw marked "A". Tighten locking screw and install ,bezel ring.

(2) Deviations varying linearly over range of TI are corrected by repositioning link screw. Remove protective back or case from mechanism, loosen link screw and move in slot of sector as required. Tighten link and install protective back of case.

(3) Deviations varying non-linearly over range of TI are corrected by repositioning arc-loc movement. Remove protective back or case, loosen the three locking screws and rotate arc-loc movement as required. If indications are first increasingly plus and then decreasingly plus, rotate arc-loc movement in direction "A". If indications are first increasingly minus and then decreasingly minus, rotate arc-loc movement in direction "B". Tighten locking screws.

(4) Repeat (1), (2) or (3) as necessary to obtain indications within tolerance.

9. 0 to 5000 Psi Panel Mounted Hydraulic Gages (1.0 to 20 Percent Accuracy)

a. Performance Check

NOTE

Convert accuracies of TI and standard into pressure units (psi). If four-to-one accuracy ratio (in pressure units) cannot be attained, use procedure in paragraph **10** below.

(1) Select a standard pressure gage from pressure gage tester (A2) which will cover the same range as the TI.

(2) Connect appropriate standard pressure gage and TI in the system in a way that will ensure that the same pressure will be applied to both gages**.**

NOTE

The standard pressure gage should be located so that reference plane of each instrument is the same height to eliminate an error caused by hydraulic head pressure.

(3) Calculate tolerance limits for TI, using accuracy specified for applicable gage.

(4) Using system pressure source, apply pressure to obtain an indication on standard pressure gage equal to 10 percent of TI scale.

NOTE

It is preferred that the system pressure source be utilized when calibrating panel mounted pressure gages, since TI and system pressure source are connected. If system pressure source is not available, utilize procedure in paragraph **8** above.

(5) If TI indication does not indicate within limits calculated in (3) above, perform **b** below.

(6) Repeat (1) through (5) above, using cardinal points nearest to 80, 60, 40 and 20 percent of TI scale.

b. Adjustments. Perform **8b** above.

10. 0 to 10,000 Psi Panel Mounted Hydraulic Gages

a. Performance Check

WARNING

To prevent injury to personnel and/or damage to equipment, make certain that all components are within range of unit to be calibrated and all connections are securely sealed prior to applying pressure to TI.

(1) Connect equipment as listed in (a) through (d) below:

(a) Cap one vertical port on deadweight tester (part of A2).

(b) Connect applicable low or high pressure cylinder to other vertical port on deadweight tester and install appropriate piston.

(c) Connect horizontal outlet port of deadweight tester to input port of TI.

(d) Cap all other system outlet ports and close system shut-off valve.

NOTE

The deadweight tester should be located so that reference planes of TI and deadweight tester are same height to eliminate an error caused by hydraulic head pressure.

(2) Calculate tolerance limits for TI, using accuracy specified for applicable gage.

(3) Place enough deadweights (supplied with pressure gage tester) on the applicable low or high pressure piston to obtain an indication on standard pressure gage equal to 10 percent of TI scale.

(4) Using hand pump, apply pressure to system until (low or high pressure) piston is approximately $^{9}/_{16}$-inch above deadweight cylinder.

(5) If TI indication does not indicate within limits calculated in (2) above, perform **b** below.

(6) Repeat (2) through (5) above, using cardinal points nearest to 80, 60, 40, and 20 percent of TI scale.

b. Adjustments. Perform **8b** above.

11. Final Procedure

a. Deenergize and disconnect all equipment.

b. Annotate and affix DA label/form in accordance with TB 750-25.

SECTION IV
CALIBRATION PROCESS FOR PNEUMATIC GAGES

12. Preliminary Instructions

a. The instructions outlined in paragraphs **12** and **13** are preparatory to the calibration process. Personnel should become familiar with the entire bulletin before beginning the calibration.

b. Items of equipment used in this procedure are referenced within the text by common name and item identification number as listed in tables 2 and 3. For the identification of equipment referenced by item numbers prefixed with A, see table 2, and for prefix B, see table 3.

c. Unless otherwise specified, verify the result of each test and, whenever the test requirement is not met, take corrective action before continuing with the calibration. Adjustments required to calibrate the TI are included in this procedure. Additional maintenance information is contained in the manufacturer's manual for this TI.

d. Unless otherwise specified, all controls and control settings refer to the TI.

13. Equipment Setup

a. Visually inspect TI for signs of damage or deterioration.

b. Thoroughly clean bourdon tube or diaphragm of TI. First, rotate TI and allow any liquid which may be in the bourdon tube or diaphragm area to flow out. Using an eye dropper or small glass tube, fill bourdon tube or diaphragm area with toluene, methyl

alcohol, or freon TF solution. Allow solution to remain in the gage for 5 minutes. Drain gage and dry for at least 10 minutes.

c. If required, zero-adjust dial indicator of TI by removing retaining ring and coverglass and adjusting the calibration screw.

14. 0 to 235 Psi Pneumatic Gages (0.1 to 1.0 Percent Accuracy)

a. Performance Check

(1) Connect equipment as shown in figure 3, connection A.

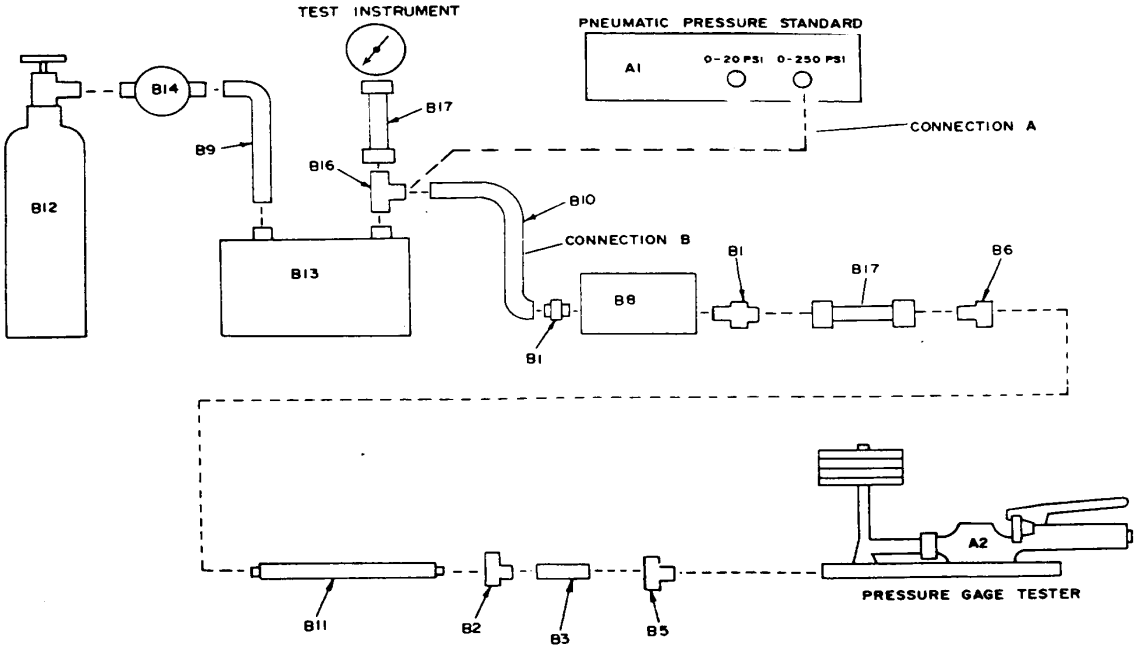

Figure 3. 0 to 1000 psi pneumatic gages (0.1 to 1.0 percent accuracy) - equipment setup.

NOTE

The maximum input to the 0 to 20 psia port should not exceed 6 psi. The maximum input to 0 to 250 psia port should not exceed 235 psi.

WARNING

To prevent injury to personnel and/or damage to equipment, make certain that all components are within range of unit to be calibrated and all connections are securely sealed prior to applying pressure to TI. Never attempt to tighten connection with pressure applied. Ensure that TI is clean and free of oil or grease.

(2) Position controls on pneumatic pressure standard (A1) as listed in (a) through (d) below:

(a) **UNITS DISPLAYED** switch to **PSIA**.

(b) **RANGE** pushbutton to **0-250**.

(e) **SENSITIVITY** pushbutton to **HIGH**.

(d) **SOURCE** pushbutton to **INT**.

(3) Calculate tolerance limits for TI, using accuracy specified for applicable gage

(4) Open exhaust, metering and shutoff valves on pneumatic pressure controller (B13).

(5) Press **RESET** and **ZERO** pushbutton on pneumatic pressure standard.

(6) Close exhaust, metering and shutoff valves on pneumatic pressure standard.

(7) Turn regulator control fully ccw.

(8) Open nitrogen tank (B12) valve and adjust regulator until outlet gage of regulator indicates maximum pressure of TI.

(9) Open inlet valve on pneumatic pressure controller.

(10) Slowly open shut off valve on pneumatic pressure controller.

(11) Increase pneumatic pressure, using metering valve on pneumatic pressure controller until TI reaches full scale.

(12) If TI indication does not indicate within limits calculated in (3) above, perform **b** below.

(13) Close inlet valve and slowly open exhaust valve.

(14) Release pressure by opening metering valve.

NOTE

Pressure changes can be made by proper use of inlet, exhaust, metering, and shut off valves.

(15) Repeat (2) and (6) through (14) above at cardinal points nearest to 80, 60, 40, and 20 percent of TI scale.

b. Adjustments. Perform **8b** above.

15. 235 to 1000 Psi Pneumatic Gages (0.1 to 1.0 Percent Accuracy)

WARNING

To prevent injury to personnel or damage to equipment, make certain that all components used are clean and have not been contaminated with oil or grease.

a. Performance Check

(1) Connect equipment as shown in figure 3, connection B.

(2) Calculate tolerance limits for TI, using accuracy specified for applicable gage.

(3) Open exhaust, metering and shutoff valves on pneumatic pressure controller (B13).

(4) Close reservoir valve on deadweight tester, and inlet valves on pneumatic pressure controller.

(5) Loosen fill and vent plug on pressure gage tester.

(6) Operate hand pump until weight table rises (tare weight).

(7) Open reservoir valve, allowing weight table to fall to bottom stop; then wait about 10 seconds before closing reservoir valve.

(8) Close shutoff, metering, and exhaust valves on pneumatic pressure controller.

WARNING

To avoid scoring the piston guide and damage to the deadweight cylinder, constantly rotate weights and piston when inserting or removing piston or when applying pressure.

(9) Place enough deadweights (supplied with pressure gage tester (A2)) on applicable low or high pressure piston to obtain a pressure equal to cardinal point nearest to 10 percent of TI scale.

(10) Turn regulator (Bl4) fully ccw.

(11) Open nitrogen tank (B12) valve and adjust regulator until outlet gage of regulator indicates maximum pressure of TI.

(12) Ensure that metering and exhaust valves on pneumatic pressure controller are closed.

(13) Open inlet valve on pneumatic pressure controller.

(14) Slowly open shutoff valve on pneumatic pressure controller.

(15) Increase pneumatic pressure, using metering valve on pneumatic pressure controller until weight rises approximately $^{9}/_{16}$-inch above the deadweight cylinder

NOTE

Making all pressure changes (however large or small) with pneumatic pressure controller. Vernier pressure changes can be made using screw-type pump on pneumatic pressure controller. The hydraulic hand pump should not be used after initial diaphragm positioning in (6) and (7) above.

(16) After reading and recording TI indication, a correction must be applied to each indication. The difference between reference plane of fluid separator (B8) and deadweight tester when both are resting on same table is 0.988-inch for high range position and 3.578-inches for low range position. The density of recommended oil (MIL-L-7870A) is 0.8653 gm/cc at 23 gm/cc at 230C; therefore, 1-inch of this oil produces a pressure of 0.03125 psi. Thus, 0.031 psi (0.0312 psi x 0.98 inch) for high range position and 0.112 psi (0.3125 psi x 3.578 inch) for low range position must be subtracted from each TI indication.

(17) If TI indication after correction does not indicate within limits calculated in (2) above, perform **b** below.

(18) Close inlet valve and slowly open exhaust valve.

(19) Release pressure by opening metering valve.

(20) Repeat (2) and (12) through (19) above, using enough weights to obtain cardinal points nearest to 80, 60, 40, and 20 percent of TI scale. Pressure changes can be made by proper use of inlet, exhaust, metering, and shutoff valves.

b. Adjustments. Perform **8b** above.

16. 1000 to 5000 Psi Pneumatic Gages (0.1 to 1 Percent Accuracy)

WARNING

To prevent injury to personnel or damage to equipment, make certain that all components used are clean and have not been contaminated with oil or grease.

a. Performance Check

(1) Connect equipment as shown in figure 4, except do not connect hose (B10) to fluid separator (B8).

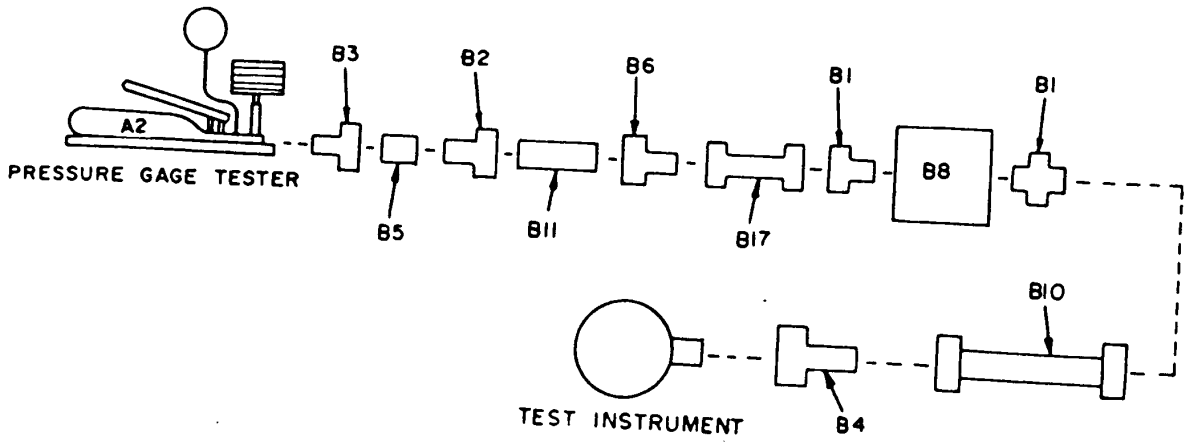

Figure 4. 1000 to 5000 psi pneumatic gages (0.1 to 1 percent accuracy) - equipment setup.

(2) Open vent port on fluid separator.

(3) Operate hand pump until all the air is bled from hydraulic side of fluid separator.

(4) With fluid separator full of oil, install plug-in vent port.

(5) Connect appropriate standard gage to pressure gage tester (A2).

(6) Fill pneumatic side of fluid separator with distilled water (B7), using squeeze bottle (B15).

(7) Fill hose (B10) with distilled water and connect to fluid separator.

NOTE

In filling pneumatic side of fluid separator hose, connection, and TI; it is important that the components be filled completely and kept as full as possible during connection. Position diaphragm to pneumatic side and hydraulic side several times by manipulation of hand pump and reservoir valve on pressure gage tester.

(8) Position fluid separator diaphragm to oil side by opening reservoir valve on pressure gage tester and holding hose (B10) above fluid separator, creating a head pressure. Refill hose as water falls.

(9) Fill TI with distilled water and connect to hose.

(10) Calculate tolerance limits for TI, using accuracy specified for applicable gage.

(11) Place enough deadweights (supplied with pressure gage tester) on applicable low or high pressure piston to obtain a pressure equal to cardinal point nearest to 10 percent of TI scale.

WARNING

To avoid scoring the piston guide and damage to the deadweight cylinder, constantly rotate weights and piston when inserting or removing piston or when applying pressure.

(12) Using hand pump, apply pressure to deadweight cylinder until (low or high pressure) piston is approximately 9/16-inch above deadweight cylinder.

(13) Visually inspect equipment connections for leakage. H leakage appears, release pressure and tighten or seal connections as required.

CAUTION

Do not remove weights installed in (11) above from low or high pressure pistons during remainder of this procedure.

(14) Place enough deadweights on applicable low or high pressure piston to obtain the 90 percent cardinal point of TI. Refer to table 4 for conversion table.

(15) Repeat (12) above.

(16) If TI indication does not indicate within limits calculated in (10 above**,** perform **b** below.

(17) Repeat (10) and (14) through (16) above, using enough weights to obtain cardinal points nearest to 80, 60, 40, 20, and 10 percent of TI scale.

b. Adjustments. Perform **8b** above.

17. Final Procedure

a. Deenergize and disconnect all equipment and reinstall protective cover on TI.

b. Annotate and affix DA Label/Form in accordance with TB 750-25.

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By Order of the Secretary of the Army:

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