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LINEAR TRANSDUCER TIP
PRESSURE CHECKER

Technological Spinoff Report

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Project Team:
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C. Thompson, Jr.

June 1973

Prepared for the
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**Kansas City
Division**

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LINEAR TRANSDUCER TIP PRESSURE CHECKER

BDX-613-904, UNCLASSIFIED Technological Spinoff Report, June 1973

Prepared by E. B. Cooper, D/445

An instrument has been developed which checks the tip pressure of linear transducers without requiring the removal of the transducers from gage housings. The device has a range of 0 to 50 grams and a repeatability (two sigma confidence) of better than ± 0.75 gram when calibrated before each use.

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THE BENDIX CORPORATION

KANSAS CITY DIVISION

KANSAS CITY, MISSOURI

A prime contractor for the
Atomic Energy Commission

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SUMMARY

The object of this activity was to design and build a device to accurately measure the tip pressures of air-actuated transducers. These transducers are mounted in the housings of gages which are used to detect contour variations in parts with surfaces of revolution.

The basis of the system designed is a micrometer-mounted, strain-gage force transducer. The output from this transducer travels through a dc millivolt amplifier and a voltage divider network, and reads out in grams on a digital panel meter.

The system developed has shown a repeatability of better than ± 0.75 gram when calibrated before each use and ± 1.75 grams when calibrated once a week.

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DISCUSSION

SCOPE AND PURPOSE

The goal of this activity was to design and build a device capable of measuring the tip pressure of air-actuated transducers with an accuracy of ± 1.0 gram over a range of 20 to 30 grams. The transducers are mounted in several locations in a design gage housing to detect contour variations in parts with surfaces of revolution. An additional goal of this effort was to develop a device which could check these transducers without requiring removal from the gage housing.

PRIOR WORK

Bendix Kansas City Division has done extensive developmental work on linear variable differential transformers (LVDT's) with low tip pressures, but has done no prior work on operational tip pressure checkers.

ACTIVITY

The basis of the instrument designed is a strain-gage force transducer (Sensotec). In general, a strain gage can operate in either the ac or dc mode; a BLH Electronics 3-Vdc power supply was chosen to excite the strain gage for this system.

The output from the force transducer produced by a 0- to 50-gram load is 3.0 to 21.6 mV. This output is amplified by a Bell and Howell dc millivolt amplifier. Using span and zero adjustment, the amplifier can shift the input by about 50 percent. The 0- to 9.00-Vdc output of the amplifier is adjusted by a voltage divider so that the readout on a digital panel meter indicates the grams force on the transducer. Figure 1 shows a block diagram of the system, and Figure 2 is a schematic. Figure 3 is a photograph of the completed system. Appendices A through E give specifications for the transducer tip pressure checker and for its individual components.

The linear transducer tip pressure checker has shown a repeatability of better than ± 0.75 grams at a two sigma confidence level throughout the 0- to 50-gram measuring range if calibrated before each use. The average bias of the system in these circumstances is less than 0.008 gram. If the system is calibrated once a week, the repeatability is ± 1.75 grams at a two sigma

Figure 1. Block Diagram of System

Figure 2. Schematic of System

Figure 3. Completed Instrument

confidence level with an average bias of less than 0.1 gram. Table 1 shows data taken when the system was calibrated twice each shift, and Table 2 shows data taken when the system was calibrated once a week. Appendix F gives the calibration procedure for the system.

ACCOMPLISHMENTS

A linear transducer tip pressure checker has been designed and built. The system has a repeatability of better than ± 0.75 gram when calibrated before each use and ± 1.75 grams when calibrated once a week.

FUTURE WORK

Bayonet connectors should be installed on all transducers in gage housings to make the tip pressure checker universal in application. Also, the tip pressure checker should be more extensively evaluated by gage calibration personnel.

Table 1. Data Taken When the System Was Calibrated Twice Each Shift

Applied Force (g)	Linear Transducer Tip Pressure Checker Readings (g)							
	Run One	Run Two	Run Three	Run Four	Run Five	Maximum Reading	Minimum Reading	Average Reading
0	-0.2	-0.1	-0.0	-0.0	-0.1	- - -	- - -	- - -
5	4.7	4.7	4.5	4.5	4.5	4.7	4.5	4.58
10	9.7	9.8	9.6	9.6	9.6	9.8	9.6	9.66
15	14.7	15.0	14.7	14.7	14.8	15.0	14.7	14.78
20	19.9	20.1	19.7	19.8	19.9	20.1	19.7	19.88
25	24.9	25.1	24.8	24.9	25.0	25.1	24.8	24.94
30	29.9	30.5	29.9	20.1	30.2	30.5	29.9	30.12
35	35.0	35.5	35.0	35.2	35.3	35.5	35.0	35.20
40	40.1	40.8	40.0	40.3	40.4	40.8	40.0	40.32
45	45.1	45.7	45.1	45.4	45.5	45.7	45.1	45.36
50	50.1	50.8	50.1	50.5	50.6	50.8	50.1	50.42
45	45.1	45.6	45.1	45.4	45.6	45.6	45.1	45.36
40	40.0	40.6	40.0	40.2	40.4	40.6	40.0	40.24
35	35.0	35.4	35.0	35.1	35.2	35.4	35.4	35.14
30	29.9	30.0	29.9	30.1	30.0	30.0	29.9	29.98
25	24.8	25.2	24.8	24.8	24.9	25.2	24.8	24.90
20	19.7	20.0	19.7	19.7	19.9	20.0	19.7	19.80
15	14.7	14.9	14.6	14.6	14.6	14.9	14.6	14.68
10	9.7	9.8	9.6	9.5	9.5	9.8	9.6	9.62
5	4.7	4.6	4.4	4.4	4.4	4.7	4.4	4.50
0	-0.1	-0.2	-0.0	-0.1	-0.3	- - -	- - -	- - -

Table 2. Data Taken When the System Was Calibrated Once a Week

Applied Force (g)	Linear Transducer Tip Pressure Checker Readings (g)							
	Run One	Run Two	Run Three	Run Four	Run Five	Maximum Reading	Minimum Reading	Average Reading
0	0	-1.0	-.6	-1.1	-1.2	- - -	- - -	- - -
5	4.2	3.7	4.1	3.4	3.7	4.2	3.7	3.82
10	9.4	9.0	9.4	8.7	9.0	9.4	8.7	9.10
15	14.7	14.3	14.7	14.1	14.3	14.7	14.1	14.42
20	19.8	19.7	19.9	19.5	19.7	19.9	19.5	19.72
25	25.0	24.9	25.2	24.6	24.8	25.2	24.6	24.90
30	30.1	30.0	30.5	29.9	30.0	30.5	29.9	29.10
35	35.4	35.4	35.7	35.1	35.3	35.7	35.1	35.38
40	40.4	40.6	41.0	40.5	40.5	41.0	40.4	40.60
45	45.7	45.9	46.3	45.7	45.9	46.3	45.7	45.90
50	50.8	51.2	51.6	50.9	51.1	51.6	50.8	51.12
45	45.6	45.9	46.3	45.6	45.8	46.3	45.6	45.84
40	40.5	40.8	41.1	40.4	40.7	41.1	40.4	40.70
35	35.3	35.2	35.8	35.1	35.2	35.8	35.1	35.32
30	30.1	30.0	30.5	29.9	29.9	30.5	29.9	30.08
25	24.8	24.8	25.3	24.7	24.8	25.3	24.7	24.88
20	19.8	19.4	19.9	19.4	19.4	19.9	19.4	19.58
15	14.7	14.2	14.7	14.1	14.2	14.7	14.1	14.38
10	9.5	8.9	9.4	8.8	8.8	9.5	8.8	9.08
5	4.3	3.6	4.1	3.5	3.5	4.3	3.6	3.80
0	-0.3	-1.0	-0.6	-1.1	-1.3	- - -	- - -	- - -

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Appendix A

LINEAR TRANSDUCER TIP PRESSURE CHECKER GENERAL SPECIFICATIONS

1. Input Voltage: 105 to 125 Vac line, 60 Hz,
single phase
2. Temperature: 50°F to 90°F
3. Accuracy: From 0 to 50 grams ± 0.75 grams,
calibrate before using; from 0 to
50 grams ± 1.75 grams, calibrate
once each week

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Appendix B

STRAIN GAGE GENERAL SPECIFICATIONS

1. Capacity: 0 to 50 g
2. Excitation Volts: 3.0 volts dc or ac rms
3. Compensated Temperature Range: 60°F to 160°F
4. Output for Applied Force:

	<u>Force (g)</u>	<u>Output (mV)</u>
	0	3.0
	10	6.5
ascending	30	14.0
	50	21.6
descending	30	14.0
	10	6.4
	0	2.7

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Appendix C

DC POWER SUPPLY GENERAL SPECIFICATIONS

1. Input Voltage:	105 to 125 Vac line, 60 Hz, single phase
2. Output Voltage:	Continuously variable from 0 to 25 Vdc
3. Output Current:	0 to 200 mA
4. Output Ripple and Noise:	Less than 500 μ V
5. Output Regulation, Line:	Less than 0.005 percent or 500 μ V, whichever is greater
6. Output Regulation, Load:	Less than 0.005 percent or 500 μ V, whichever is greater
7. Output Recovery Time, No Load to Full Load:	Less than 100 μ s
8. Output Current Limiting:	Less than 300 mA
9. Operating Temperature:	35°F to 130°F
10. Resolution:	3mV

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Appendix D

DC AMPLIFIER GENERAL SPECIFICATIONS

1. Input Voltage: 105 to 125 Vac line, 60 Hz
2. Input and Output: Isolated from ground but not from each other
3. Linearity Departure From Straight Line Connecting End Points: ± 0.05 percent
4. Line regulation, 105 to 125 Vac: ± 0.15 percent of span, plus ± 0.05 percent of offset
5. Frequency Response: -30 db at 0.2 Hz
6. Operating Temperature: 20°F to 120°F
7. DC Output: 0 to 10 V
8. DC Input: 4 to 52 mV

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Appendix E

DC DIGITAL PANEL METER GENERAL SPECIFICATIONS

1. Input Voltage: 105 to 125 Vac line, 60 Hz
2. DC Volts Input Range: 0 to 199.9 mV
3. Operating Temperature: 20° to 110°F
4. Accuracy: ± 1 percent of reading from digit

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Appendix F

GENERAL CALIBRATION PROCEDURE FOR LINEAR TRANSDUCER TIP PRESSURE CHECKER

1. Equipment Used in Calibration.

1.1 Digital voltmeter: Cimron, Model 7200A or equivalent.

1.2 Balance scale: Mettler P1200N or equivalent.

2. Calibration Procedures.

2.1 Transducer tip pressure checker must be operated from a source of 105-125 Vac, 60 Hz, capable of supplying 2 amperes.

2.2 Allow checker to warm up for 30 minutes minimum before calibrating.

2.3 Connect digital voltmeter to check points 1 and 2 on front panel of transducer tip pressure checker. Adjust variable power supply for 3 Vdc ± 0.005 Vdc. NOTE: Make sure that power supply is not accidentally turned to higher than 5 Vdc when strain gage with micrometer head assembly is plugged into transducer tip pressure checker instrument.

2.4 Connect digital voltmeter to check points 5 and 6 with no load. The output of the amplifier should be 0.00 ± 0.02 Vdc. This may be adjusted using the zero adjustment on the back of the amplifier. Apply a 50-gram load and adjust span for 9.000 ± 0.1 .

2.5 Connect digital voltmeter to check points 7 and 8. Apply a 25-gram load to the transducer, and adjust the pot located on the front of the instrument for a reading of 25.0 ± 0.1 millivolts (25.0 ± 0.1 grams).