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**AN IMPROVED CARTRIDGE TYPE LINEAR VARIABLE
DIFFERENTIAL TRANSFORMER**

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AN IMPROVED CARTRIDGE TYPE LINEAR VARIABLE
DIFFERENTIAL TRANSFORMER

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ABSTRACT

This report describes the development, testing and design of a cartridge type linear variable differential transformer with features that provide free linear movement without measurable lateral deflection, high resistance to clamping forces, low hysteresis, longer maintenance free operation, and easier maintenance.

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INTRODUCTION

A linear variable differential transformer was needed that would operate reliably in the semicorrosive atmosphere sometimes encountered in gloved boxes. Sufficient strength was required to resist clamping force deformation to permit increased stability in making set-ups. It was also necessary to have a free moving bearing providing linear movement of the core in relation to the transformer coil with no lateral movement.

This report describes the design, development, fabrication and test results of a transformer cartridge that meets these requirements.

It is believed that transformer cartridges built, using the basic bearing design described, (with modifications to case and stroke dimensions to suit various applications) would meet the needs for measuring linear displacement to close tolerance.

DISCUSSION

Linear variable differential transformers have been used to measure linear displacements in a variety of applications in gloved boxes for many years. In some applications the sensing tip is subject to lateral forces that affect the precision and sensitivity of the LVDT. Gloved box applications and atmospheres have resulted in the need for frequent maintenance, complicated by the necessity for performing such maintenance in the gloved box.

Based on an employee's^{*} suggestion idea, an improved linear variable differential transformer (cartridge type) was designed, fabricated, tested, and placed in service. The suggested idea and main feature of this transformer cartridge is a preloaded ball, core shaft bearing, Figure 1. A working model of this bearing arrangement was fabricated and tested for freedom of movement and rigidity.

* Suggestion HWIR-1667 submitted by C. F. Setbacken, Instrument Technician



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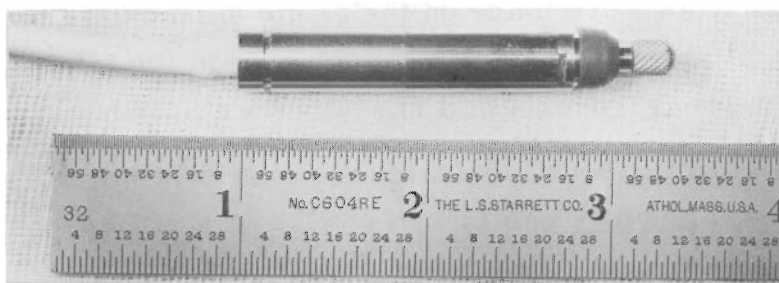
FIGURE 1

Test Model of Preloaded Bearing
Used in Linear Variable Differential Transformer

Working Model Statistics

- Bearing race surface finish - 4 to 8 μ in.
- Bearing preload - 0.0000 to 0.0002 in.
- Force to obtain movement - 4 grams
- Tip deflection - not detectable

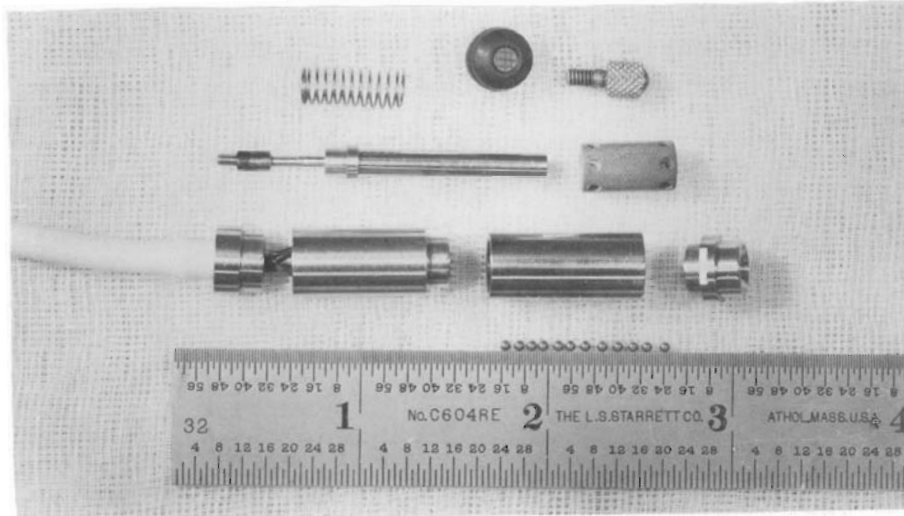
The success of this test model prompted the building of a prototype, incorporating this bearing design, Figures 2 and 3. This model was tested and put into service in a glove box to monitor stylus movement on a tracer lathe.



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FIGURE 2

Prototype Model Built for Test and Actual Use in a Glove Box



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FIGURE 3

Exploded View of Prototype Model Shown in Figure 2

Prototype Model Statistics

- Bearing race surface finish - 2 to 6 μ in.
- Bearing preload - 0.0000 to 0.0001 in.
- Minimum tip force - 3 oz
- Tip deflection with 20 oz.
force at 90 degrees - < 0.000008

This LVDT was easier to clamp into position without restricting core movement due to clamping pressure. Free movement was maintained much longer than had been experienced with other LVDT's.

Refinements were made on the prototype model after superiority was demonstrated. Final designs were based on the information gathered during these tests (Figures 4 and 7).

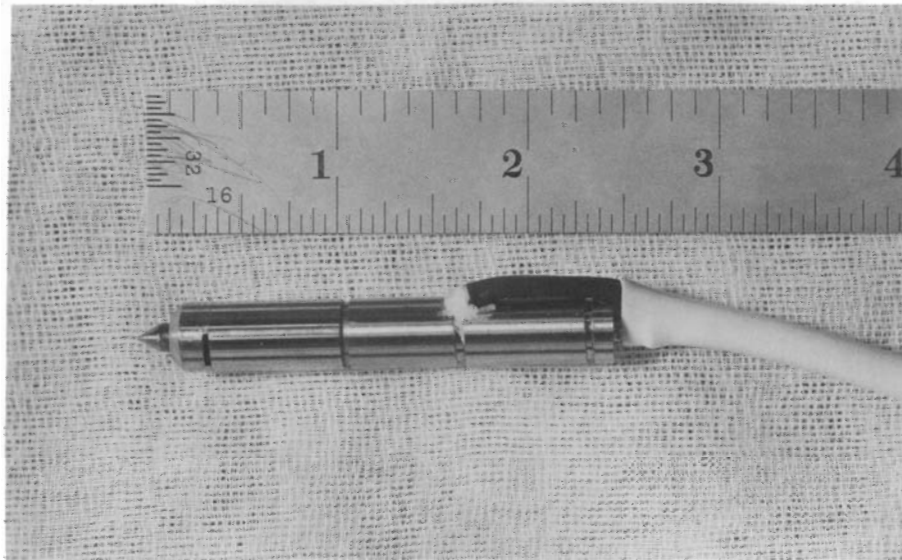
The LVDT that was fabricated from Drawing H-29376 (Figure 7) was tested with the following results:

- Tip force 2 oz.

Tip force friction (1 oz. side force)	2 oz.
*Hysteresis at 45° (Figure 5)	0.000008 in.
Hysteresis at 30° (Figure 5)	0.000005 in.
Dynamic response (1/10 working range) (Figure 6)	50 cycles/sec.

An attachment has been designed that would permit using the LVDT for both recording and controlling (Figure 8). This would be done by adding a section to the case that contains a coil and extending the core shaft to permit the addition of a core. The additional core and coil would add recording capabilities to a controlling LVDT without alteration to the original LVDT.

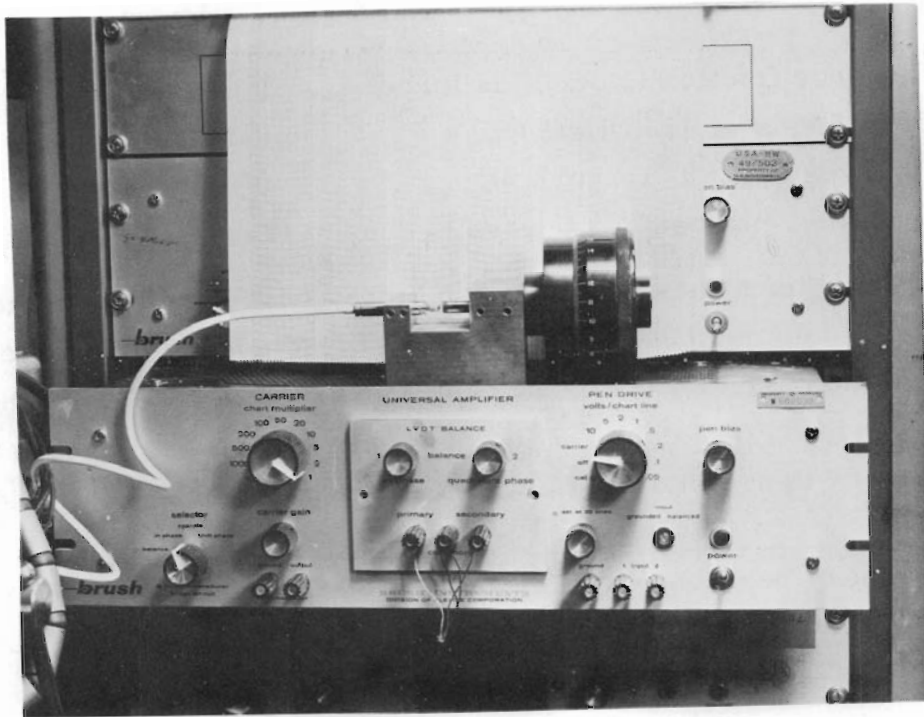
* The amount of read-out error resulting from reversing the direction of core shaft motion while the shaft tip contacts a surface at 90° or an angle other than 90°.



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FIGURE 4

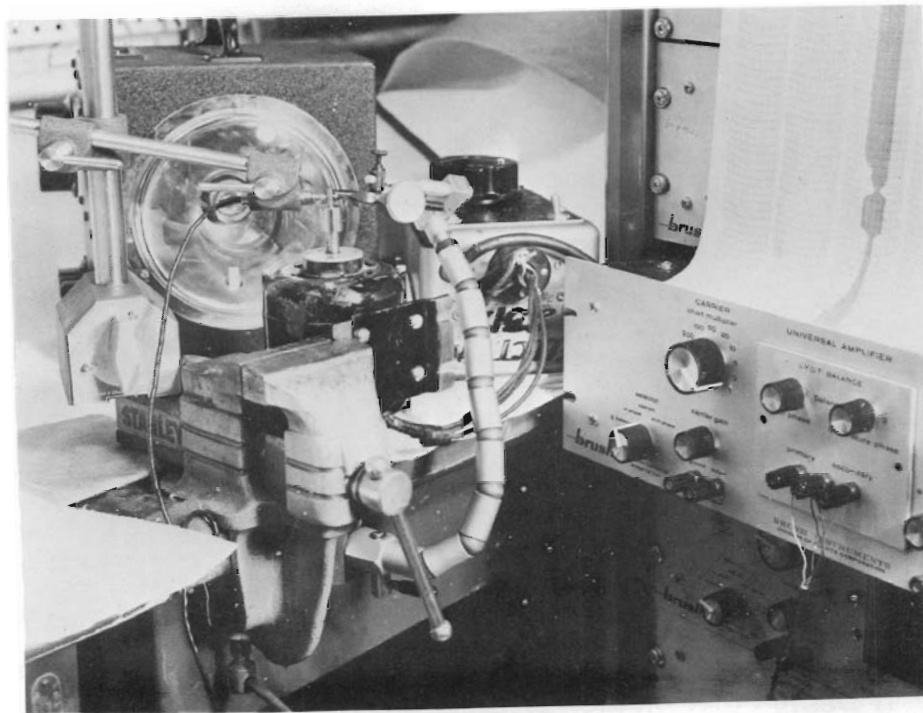
Final Design of Linear Variable Differential Transformer with Recording Attachment



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FIGURE 5

Set-Up Used for Calibrating and Checking the Hysteresis and Linearity of the Linear Variable Differential Transformer



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FIGURE 6

Set-Up for Measuring Dynamic Response

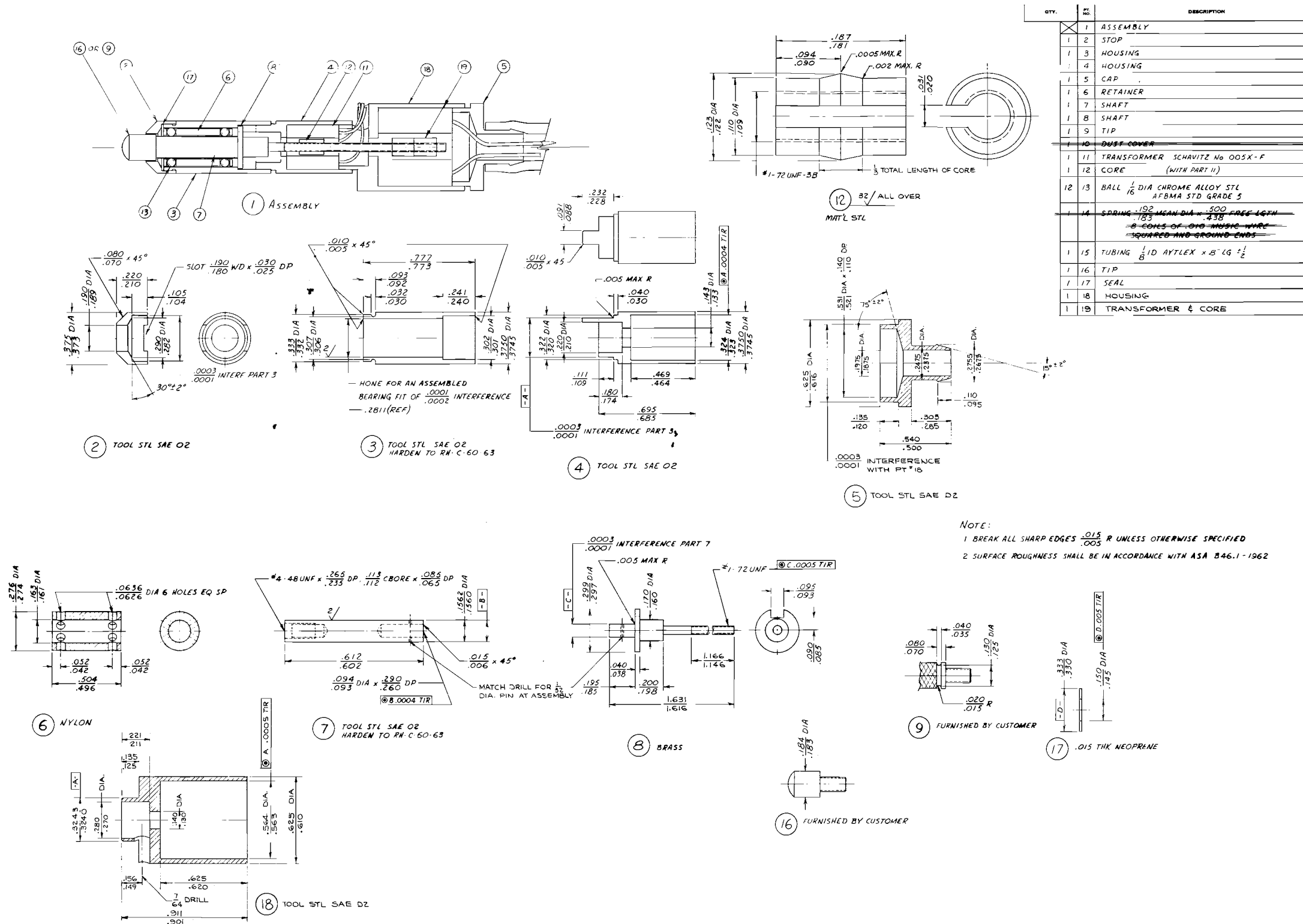
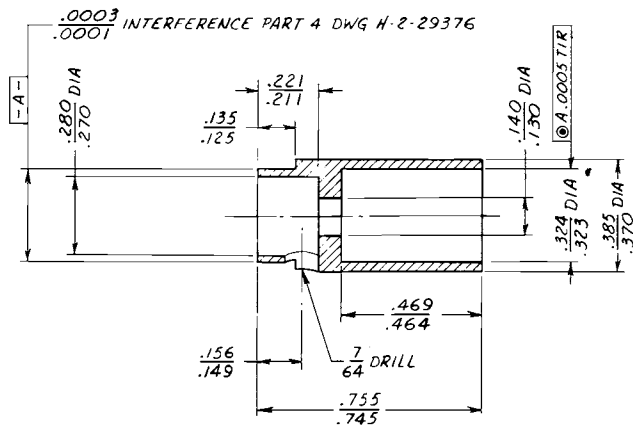
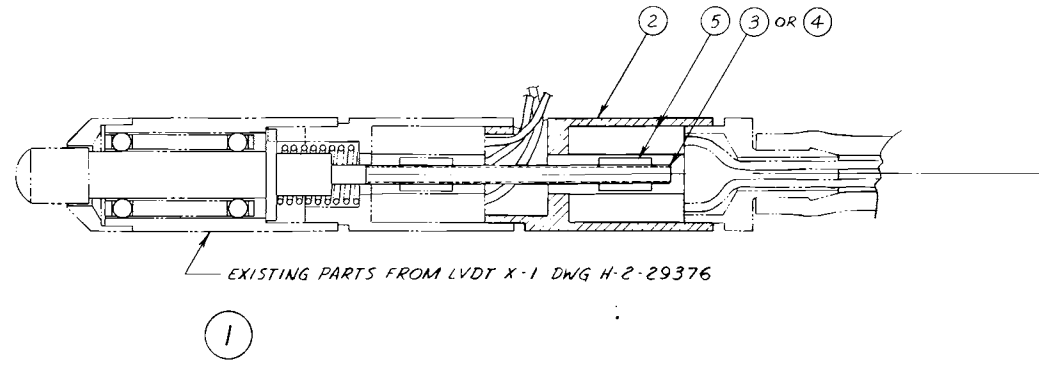


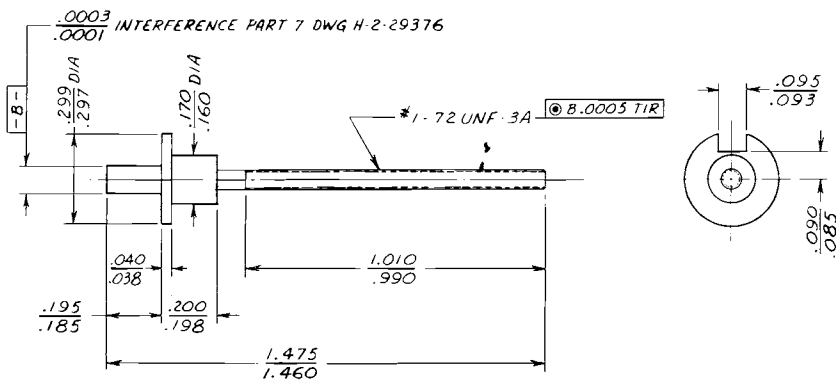
FIGURE 7

Linear Variable Differential Transformer Mechanical Arrangement

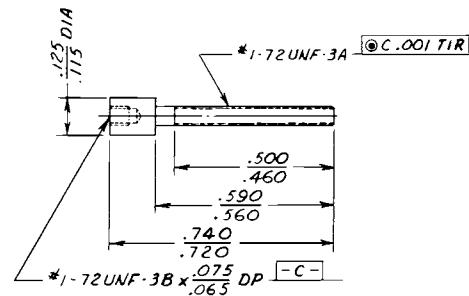
QTY.	PT. NO.	DESCRIPTION
1	1	ASSEMBLY
1	2	HOUSING
1	3	SHAFT
1	4	SHAFT EXTENSION USED ONLY WITH EXISTING SHAFT FROM LVDT X-1
1	5	TRANSFORMER AND CORE SCHAVITZ No 005X-F



2 TOOL STL SAE O2



3 BRASS



4 BRASS

FIGURE 8

An Attachment to Add Recording Capacities to a Control Linear Variable Differential Transformer

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