

**PROCEDURES FOR  
ASSEMBLY, DISASSEMBLY,  
AND INSPECTION (PADI)  
OF THE  
HYBRID III 5<sup>TH</sup> PERCENTILE FEMALE DUMMY'S  
NINE ACCELEROMETER ARRAY HEAD (NAAH)  
WITH REDUNDANT HEAD C.G. ACCELEROMETERS**

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## **1.0 INTRODUCTION**

### **1.1 Foreword**

The nine accelerometer array head is so named because nine accelerometers are installed within the head for studying head angular motion. Three of these accelerometers are located at the center of gravity (c.g.) of the head, and the remaining six are located two each at the top, left side and front of the skull. This nine linear accelerometer scheme allows the linear accelerations at the c.g. and the head angular accelerations in time to be directly determined by three simple formulas. In addition, another three linear accelerometers are used at the head c.g. as backup for determining the resultant head acceleration. In the event one of the primary accelerometers at the c.g. fails during a very costly crash test, these redundant accelerometers will provide the measurements necessary to calculate the resultant head accelerations required for determining HIC values.

The National Highway Traffic Safety Administration has prepared this document under the title “Procedures for Assembly, Disassembly, and Inspection of the Hybrid-III 5<sup>th</sup> Percentile Female Nine Accelerometer Array Head with Redundant Head C.G. Accelerometers,” otherwise known as “PADI for the H-III 5<sup>th</sup> Female NAAH With Redundant C.G. Accelerometers.” The document is based on drawings from Robert A. Denton, Incorporated. The NAAH With Redundant C.G. Accelerometers is depicted in Figure 1.1. Its size, weight distribution, and moment of inertia are that of an average 5<sup>th</sup> Percentile Female. This special head is used for assessing head injuries in motor vehicle crashes.

### **1.2 Purpose**

This document contains procedures for assembly, disassembly, inspection, and adjustments of the H-III 5<sup>th</sup> NAAH With Redundant C.G. Accelerometers to assure the head is properly prepared and adjusted for testing. The head calibration tests are unchanged from those in the final rule for Part 572 Subpart O and ensure the head is capable of repeatable and reproducible performance while its responses remain within the biofidelity corridors. This document is a guide for the user to properly inspect, assemble, and adjust the H-III 5<sup>th</sup> Female NAAH With Redundant C.G. Accelerometers as needed.

### **1.3 Part Numbers**

All parts in this procedure refer to Figures 1.1, 1.2, and to the drawing packages specified in the Part 572 Subpart O and E. The part number for the nine accelerometer array head mount with redundant accelerometers is Denton Drawing No. C-5044-D dated 1/15/01. The accelerometers are Part Number SA572-S4 as specified in Figure 1.2. The weight and c.g. specifications are identical to those specified for the Hybrid III 5<sup>th</sup> Percentile Female Dummy head on NHTSA drawings 880105-100X and 880105-000 Sheet 6 of 6. Copies of drawings for the Subpart O or E dummies can be obtained from Reprographics Technologies, 9000 Virginia Manor Road, Beltsville, MD 20705; Telephone (301) 210-5600.

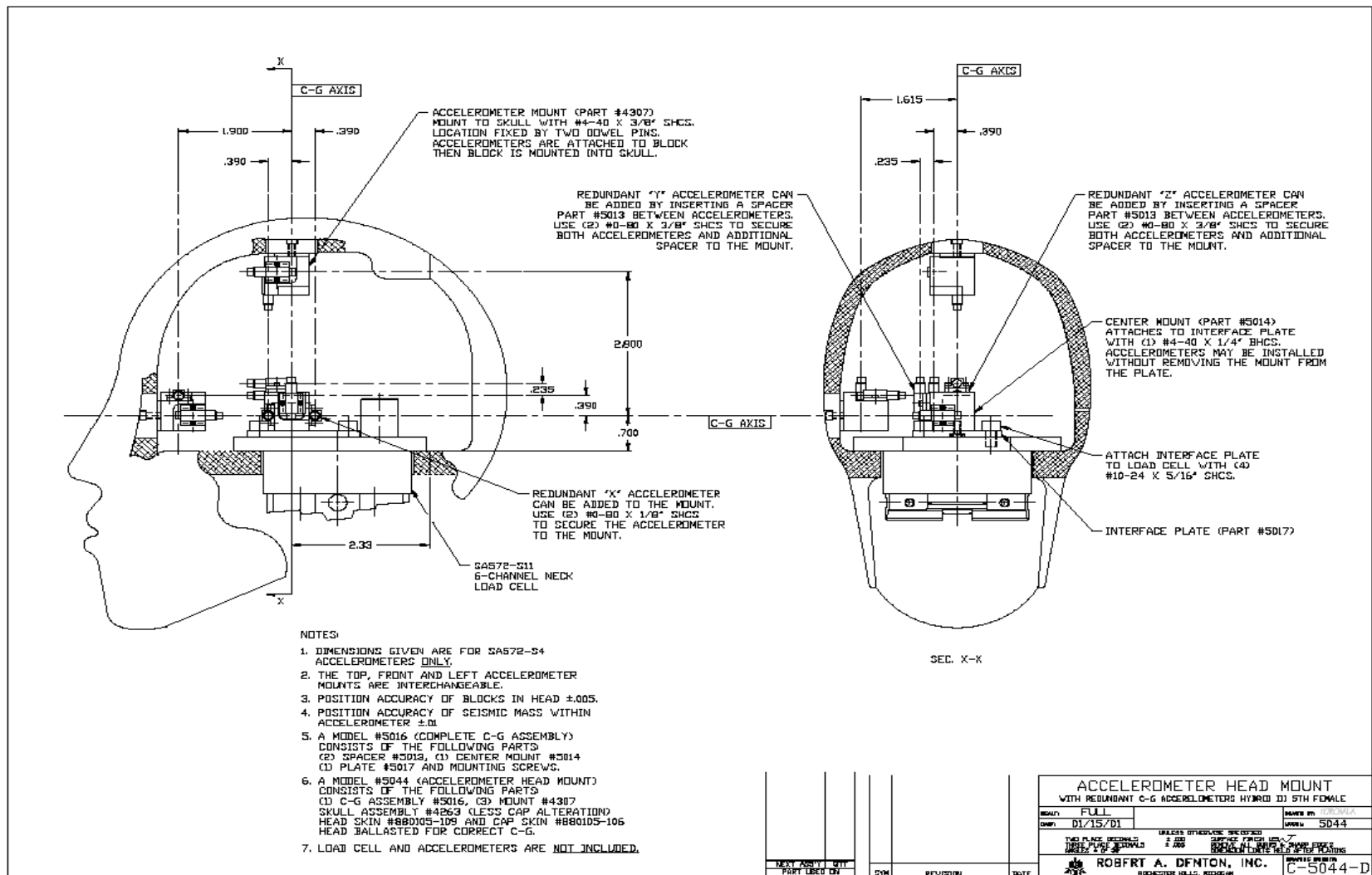


Figure 1.1 – Nine Accelerometer Array Head With Redundant C.G. Accelerometers

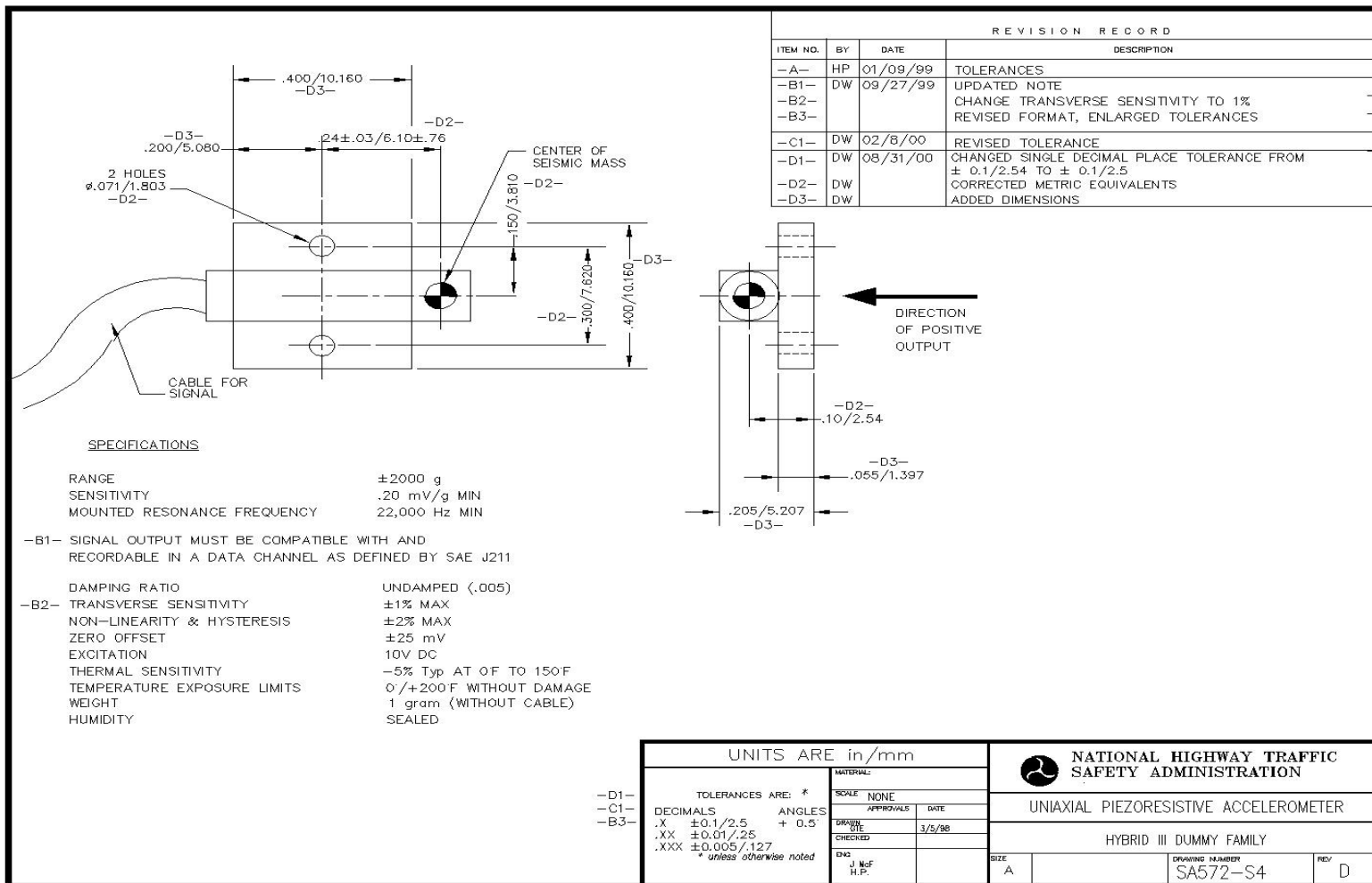


Figure 1.2 -- SA572-S4 Uniaxial Piezoresistive Accelerometer

## **1.4 Abbreviations and References**

The abbreviations for threaded fasteners used throughout the procedure are listed in Table 1.1.

**Table 1.1 -- Threaded Fasteners**

<b>Abbreviation</b>	<b>Description</b>
SHCS	Socket Head Cap Screw
FHCS	Flat Head Cap Screw
BHCS	Button Head Cap Screw

The parts specific to the assembled NAAH are included on the drawing in Figures 1.1 and 1.2. Some references are made to parts from the Hybrid III 50<sup>th</sup> percentile Part 572, Subpart E Dummy Drawings. These drawings are not included.

## **1.5 Torque Specifications**

The torque requirements for the screws used throughout the dummy head are shown in Table 1.2.

**Table 1.2 -- Screw Torques**

<b>Screw Type</b>	<b>Size (English)</b>	<b>Torque (in-lb)</b>	<b>Torque (Nm)</b>
SHCS/FHCS/BHCS	0-80	As Required	
	4-40		
	10-24, 10-32	90	10.2
	1/4 - 20, 1/4 -28	190	21.5

## **2.0 HEAD CONSTRUCTION - NINE ACCELEROMETER ARRAY WITH REDUNDANT C.G. ACCELEROMETERS**

The nine accelerometer array with redundant c.g. accelerometers head construction consists of a modified Hybrid III 5<sup>th</sup> percentile female skull (Figure 1.1) containing three mounting pads permanently inserted into the skull and the following parts which can be disassembled from the skull:

- a. Three outboard triaxial mounts (Part No. 4307, Figure 1.1) for uniaxial accelerometers (only two of the three axes per mount are used) accommodating six accelerometers.



- b. A c.g. assembly (Model No. 5016) consisting of center mount (Part No. 5014, Figure 1.1), two spacers (Part No. 5013, Figure 1.1), and an interface plate (Part No. 5017, Figure 1.1) and mounting screws. This assembly accommodates six uniaxial accelerometers.

The four special accelerometer mounts are specifically located at:

1. The c.g. of the head mounted on top of the upper neck load cell or its structural replacement
2. The top of the head directly above the c.g.
3. The front of the head directly forward of the c.g.
4. The left side of the head directly lateral of the c.g.

The formulas for determining angular accelerations at the c.g. use the following distances between the head c.g. (center of seismic masses) and the outboard mount axis centers:

1. C.G. to left side = 1.615 inches
2. C.G. to front = 1.900 inches
3. C.G. to top = 2.800 inches

**2.1 Instrumentation**

The NAAH With Redundant C.G. Accelerometers has provisions for mounting accelerometers oriented in the direction specified in Table 2.1. It also accommodates an upper neck load cell.

**Table 2.1 -- Nine Accelerometer Array and Redundant Accelerometer Orientations**

<b>NAAH Transducer</b>	<b>Part No.</b>	<b>Location</b>	<b>Axis</b>	<b>Expected Direction of Positive Accelerometer Output wrt NHTSA's Coordinate System*</b>
Head Accelerometer	SA572-S4	Head C.G.	x	+
		Head C.G.	y	-
		Head C.G.	z	-
		Head C.G. Redundant	x	-
		Head C.G. Redundant	y	-
		Head C.G. Redundant	z	-
		Top	x	+
		Top	y	-
		Top	z	-

		Front	y	-
		Front	z	-
		Left Side	x	+
		Left Side	z	-

\* Forward, right and down are positive in accordance with NHTSA's coordinate system.

### **3.0 PROCEDURES FOR ASSEMBLY, DISASSEMBLY AND INSPECTION**

#### **3.1 Head Assembly**

The nine accelerometer array with redundant c.g. accelerometers head for the Hybrid III 5<sup>th</sup> percentile female dummy is shipped from the manufacturer to NHTSA assembled without accelerometers having the correct center of gravity and weight. It is necessary to disassemble the head to install any electronic instrumentation the user requires.

The following procedure is recommended for installation of the twelve accelerometers (SA572-S4) in the NAAH head. It should be noted that the upper neck load cell (SA572-S11) or its structural replacement (Drawing 78051-383X) cannot be put in or taken out if the left outboard accelerometer mount is attached.

The procedure covers:

- a. Removing from the head the upper neck load cell structural replacement (Drawing 78051-383X), outboard mounts (Part No. 4307, Figure 1.1) and c.g. assembly (Model No. 5016, Figure 1.1)
- b. Attaching the accelerometers to mounts
- c. Installing the mounts in the head

Note: The load cell structural replacement may be replaced with an upper neck load cell (SA572-S11).

1. Remove the skull cap/skull cap skin assembly (Drawings 880105-103/ 880105-106) by taking out the four #10-24 x 1/2" SHCSs that hold the skull cap to the skull to expose the accelerometer head mount with redundant c.g. accelerometers as shown in Figure 1.1.
2. Remove the head skin (880105-109).

3. Remove the left outboard accelerometer mount (Part No. 4307, Figure 1.1) from the dummy head by removing the #4-40 x 3/8" SHCS from the left outer side of the skull (Figure 1.1).
  - a. Attach two accelerometers (Part No. SA572-S4, Figure 1.2) in the X and Z directions to the left outboard mount using #0-80 UNF x 1/8" SHCS in accordance with Figure 1.1. Orient the accelerometers per Figure 1.1 and Table 2.1. Label the accelerometer wires "X and Z left."
4. Remove the load cell structural replacement (Drawing 78051- 383X) by removing the four 1/4 - 28 x 7/8" SHCSs and corresponding 1/4" ID x 3/8 x 1/16" OD washers.
  - a. If using an SA572-S11 upper neck load cell remove the c.g. assembly (Model No.5016, Figure 1.1) from the load cell structural replacement (Drawing 78051- 383X) by removing the four #10-24 x 5/16" SHCSs attached to the interface plate (Part No. 5017, Figure 1.1).
5. Remove the front outboard mount (Part No. 4307, Figure 1.1) by removing the #4-40 x 3/8" SHCS from the front outer surface of the head.
  - a. Attach two accelerometers (Part No. SA572-S4, Figure 1.2) in the Y and Z directions to the front outboard mount using #0-80 UNF x 1/8" SHCSs in accordance with Figure 1.1. Orient the accelerometers per Figure 1.1 and Table 2.1. Label the accelerometer wires "Y and Z front."
6. Remove the top outboard mount (Part No. 4307, Figure 1.1) by removing the #4-40 x 3/8" SHCS from the top outer surface of the head.
  - a. Attach two accelerometers (Part No. SA572-S4, Figure 1.2) in the X and Y directions to the top outboard mount using #0-80 UNF x 1/8" SHCSs in accordance with Figure 1.1. Orient the accelerometers per Figure 1.1 and Table 2.1. Label the accelerometer wires "X and Y top."
7. Install the front and top outboard mounts (Part No. 4307, Figure 1.1) with accelerometers to their corresponding permanently fastened pads in the front and top of the skull. Note that the mounts can be installed on the pad dowel pins in only one way for the # 4-40 screw to properly align the mount to the pad. Also, note that these outboard mounts are made of aluminum and are subject to internal thread stripping.
  - a. These permanently fastened pads have two small dowel pins and a thru hole for a #4-40 x 3/8" SHCS for attaching to outboard mounts. A typical permanently fastened mounting pad as viewed from the rear side of the skull is shown in Figure 3.1.
  - b. Make sure the accelerometers are properly oriented as per Figures 1.1, 3.2, 3.3, and Table 2.1.
  - c. Figure 3.4 shows that the #4-40 x 3/8" SHCS is accessed from outside the head.

8. Install the six accelerometers (Part No. SA572-S4, Figure 1.2) in the X, Y, and Z directions on the c.g. assembly (Model No. 5016, note 5 on Figure 1.1) on the upper neck load cell (SA572-S11) or load cell structural replacement (Drawing 78051- 383X) after assembling the mounts as described below.
  - a. If not already in place, attach the center mount (Part No. 5014, Figure 1.1) to the interface plate (Part No. 5017, Figure 1.1) by accessing the #4-40 x 1/4" BHCS on the bottom of the interface plate (Figure 3.5). Note that the center mount can be installed on the interface plate in only one way for the # 4-40 screw to properly align the mount to the interface plate. Also, note that the center mount is made of aluminum and is subject to internal thread stripping.
  - b. Attach the interface plate (Part No. 5017, Figure 1.1) and center mount (Part No. 5014, Figure 1.1) to the upper neck load cell SA572-S11 or structural replacement (Drawing 78051- 383X) with four #10-24 x 5/16" SHCSs. Two locator pins assure proper alignment of the interface plate on the load cell or load cell structural replacement. The through holes in the interface plate are shown in Figure 3.5. The center mount and locator pins are shown in Figure 3.6. A perspective view of the assembly is shown in Figure 3.7.
  - c. Attach two accelerometers (Part No. SA572-S4, Figure 1.2) in the X direction to the center mount (Part No. 5014, Figure 1.1) using #0-80 UNF x 1/8" SHCSs. Attach four accelerometers (Part No. SA572-S4, Figure 1.2), two each in the Y and Z directions using the redundant accelerometer mounts (spacers) (Part No. 5013, Figure 1.1) and four #0-80 UNF x 3/8" SHCSs. Orient the accelerometers per Figures 1.1 and 3.8, and Table 2.1. Label the accelerometer wires "Head X Center, Head Y Center, Head Z Center, Head X Redundant, Head Y Redundant, Head Z Redundant."
  - d. Attach the wires to a wire tie anchor on the load cell SA572-S11 (Figure 3.8).

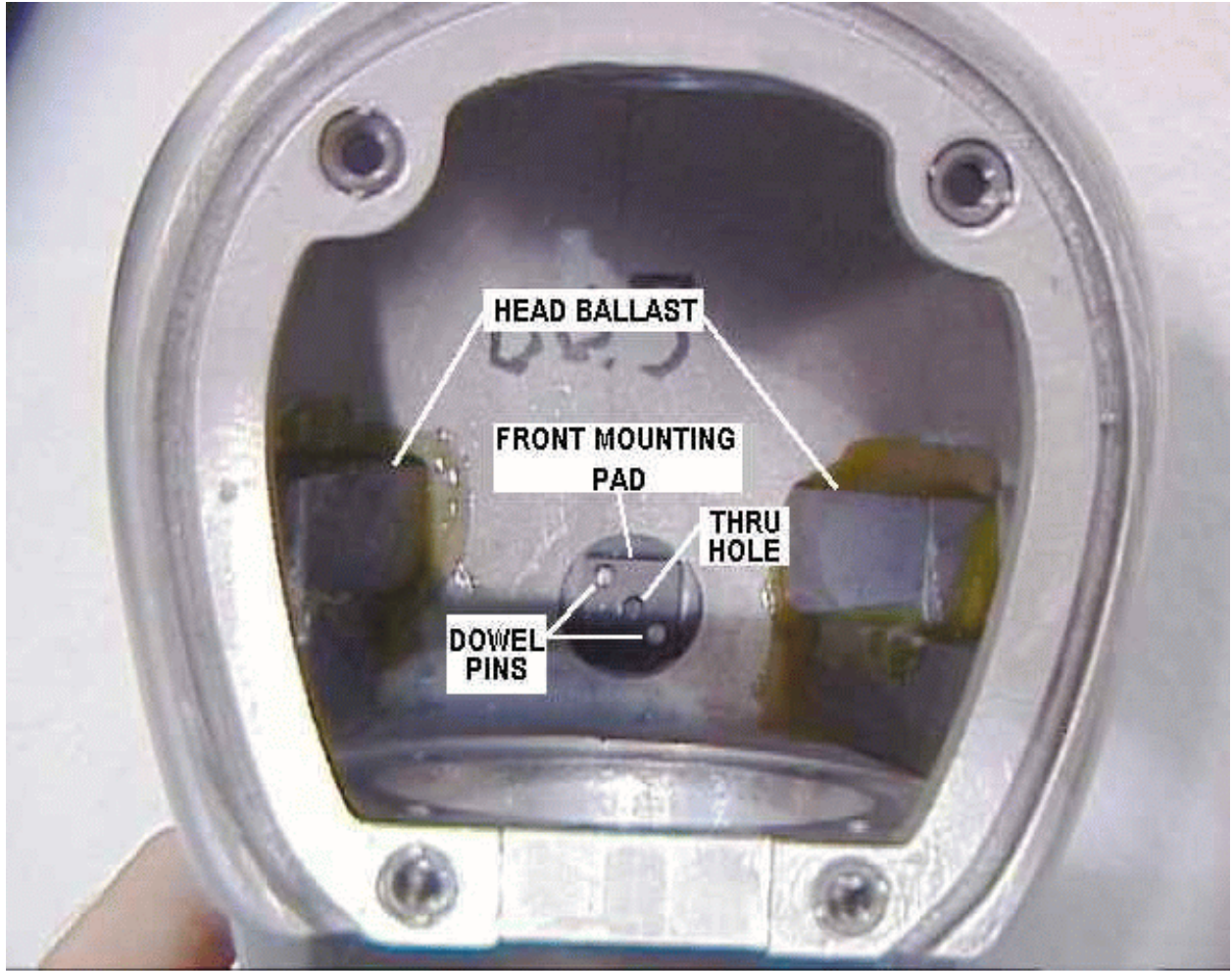


Figure 3.1 -- Front mounting pad (permanently installed) (left and top pads are not shown)



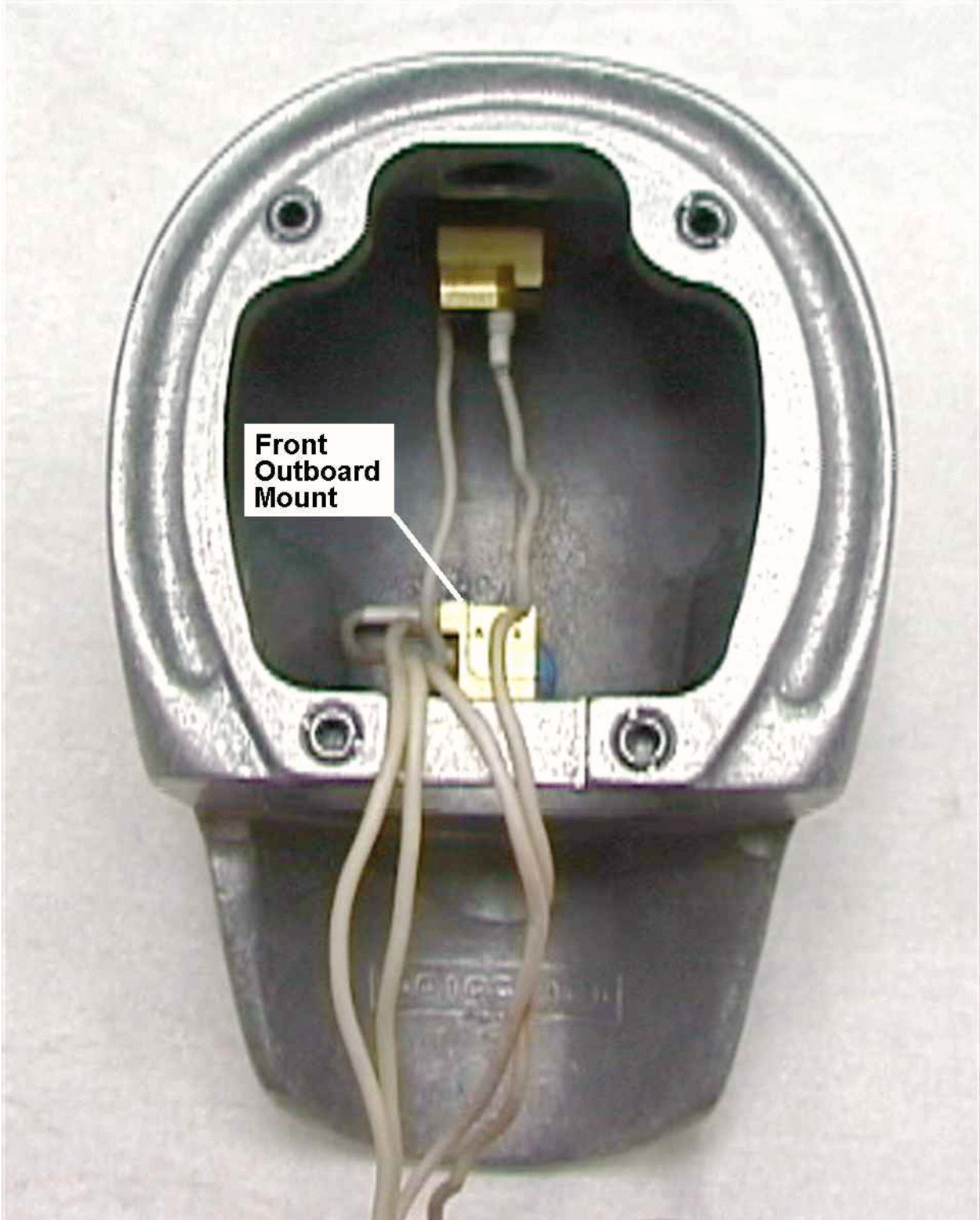


Figure 3.2 -- Rear view of accelerometers on front outboard mount installed in skull





Figure 3.3 -- Bottom view of accelerometers on top outboard mount installed in skull

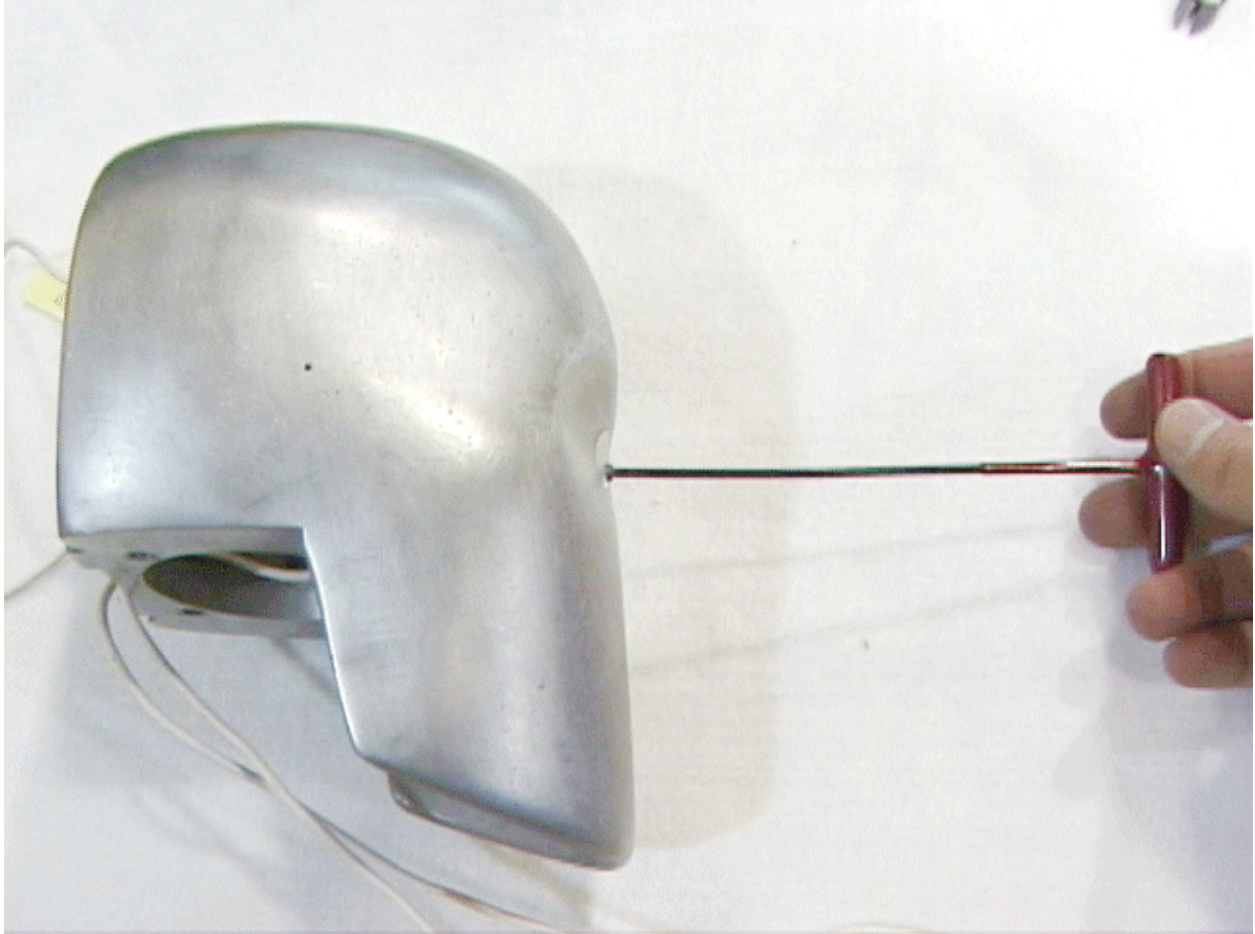


Figure 3.4 -- Attach outboard mounts to permanently fastened mounting pad from the outside



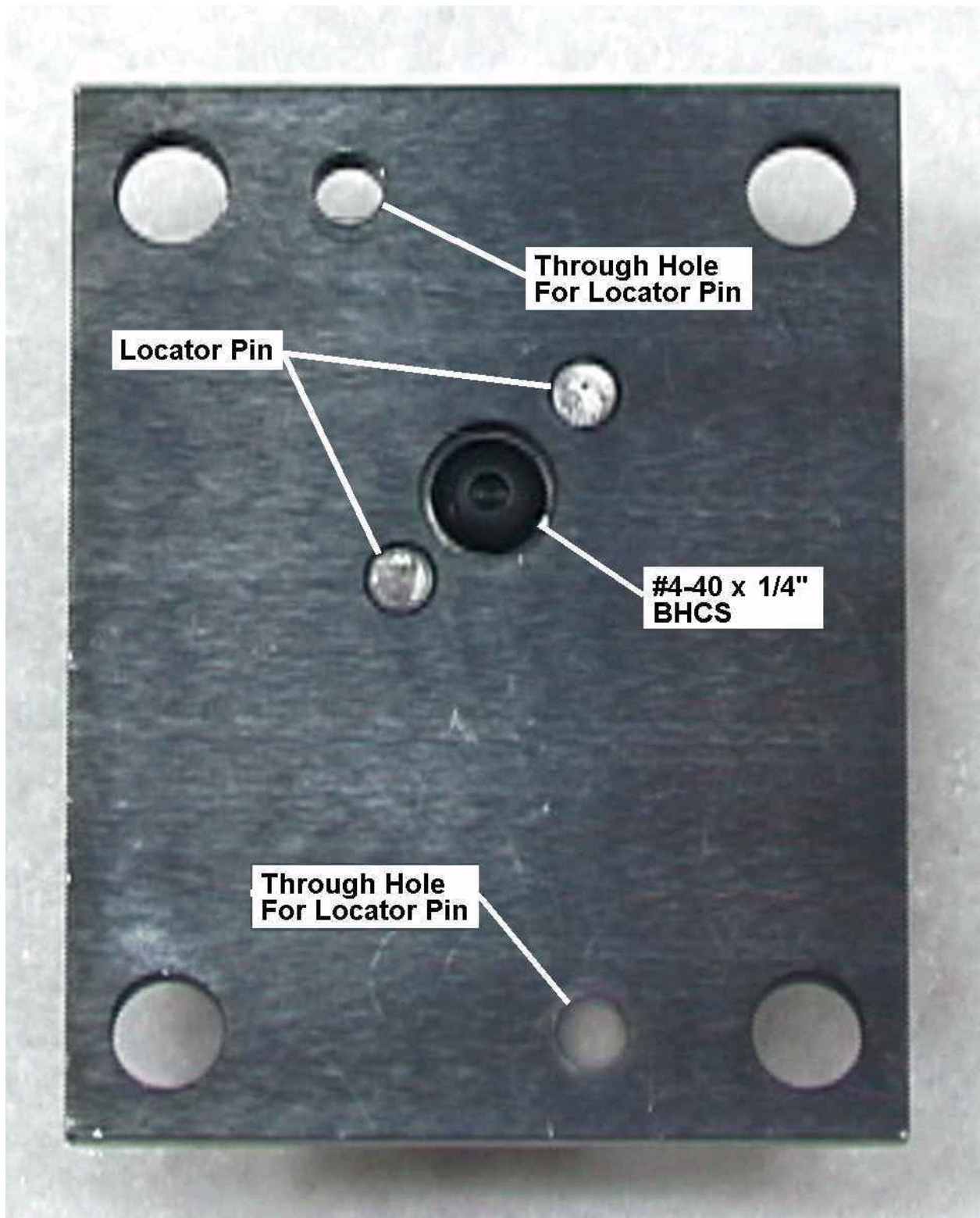


Figure 3.5 -- Bottom view of interface plate with screw for attaching to center mount



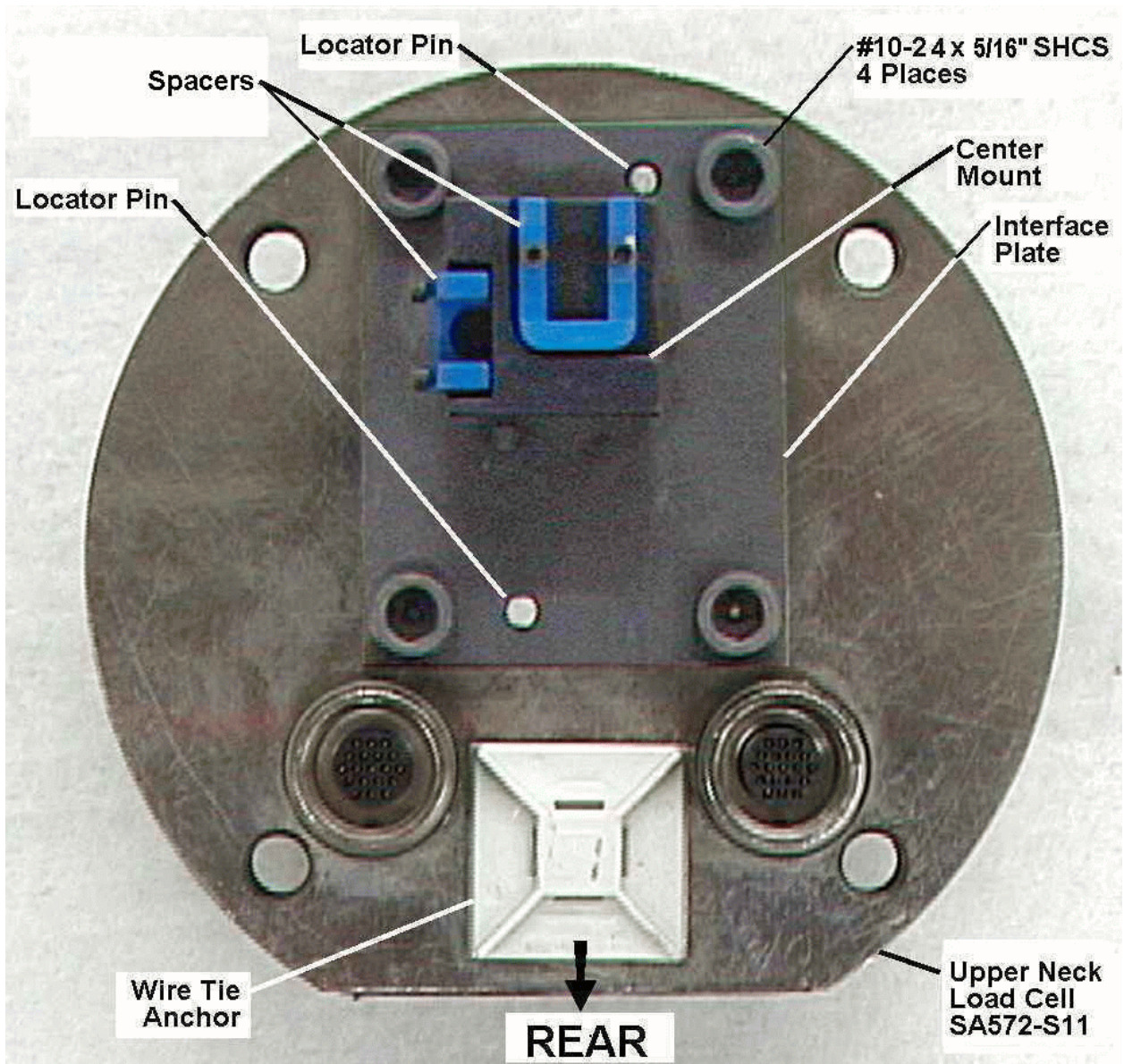


Figure 3.6 -- Interface plate and center mount installed on load cell (top view)

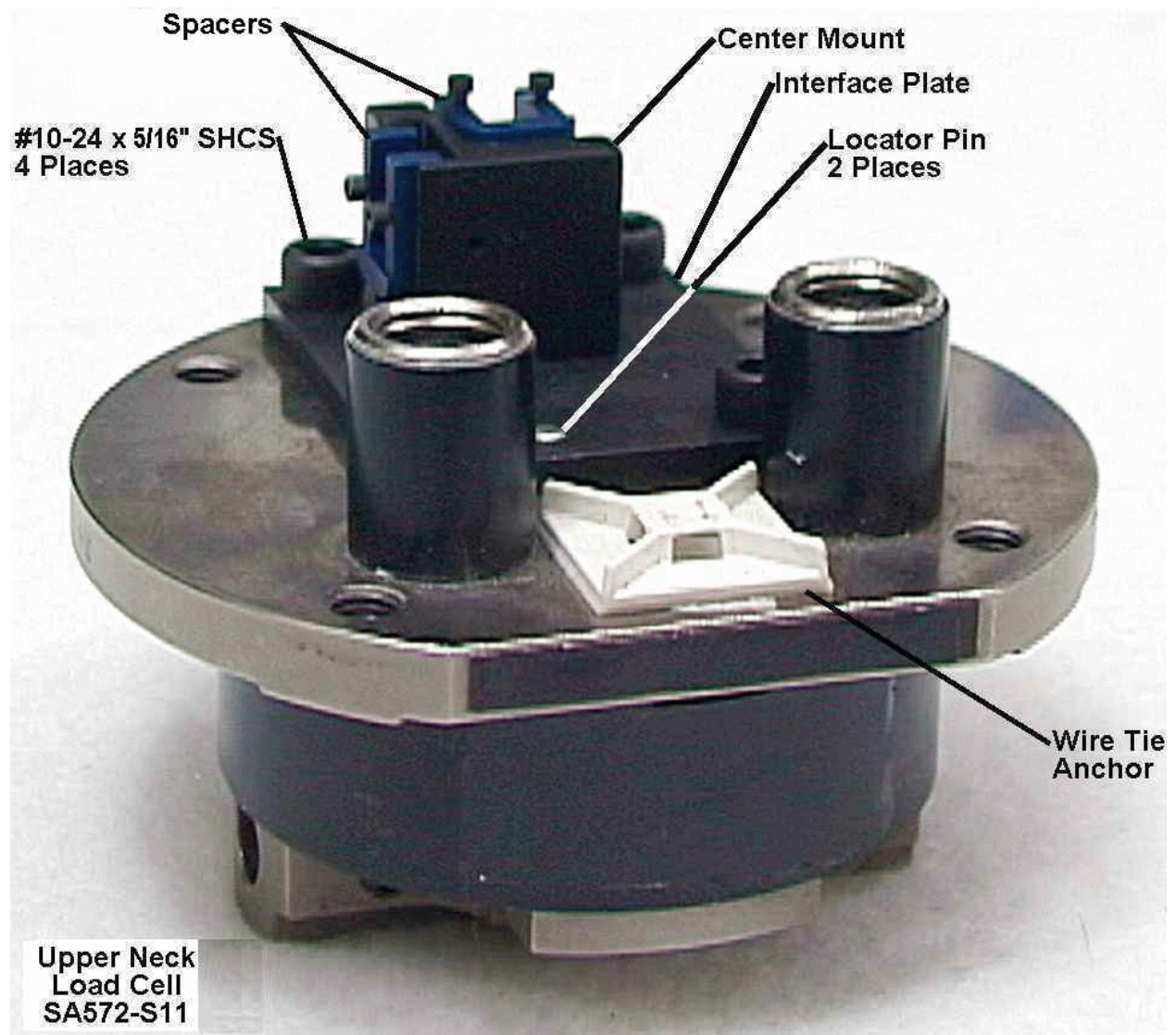


Figure 3.7 -- Interface plate and center mount installed on load cell (perspective view)



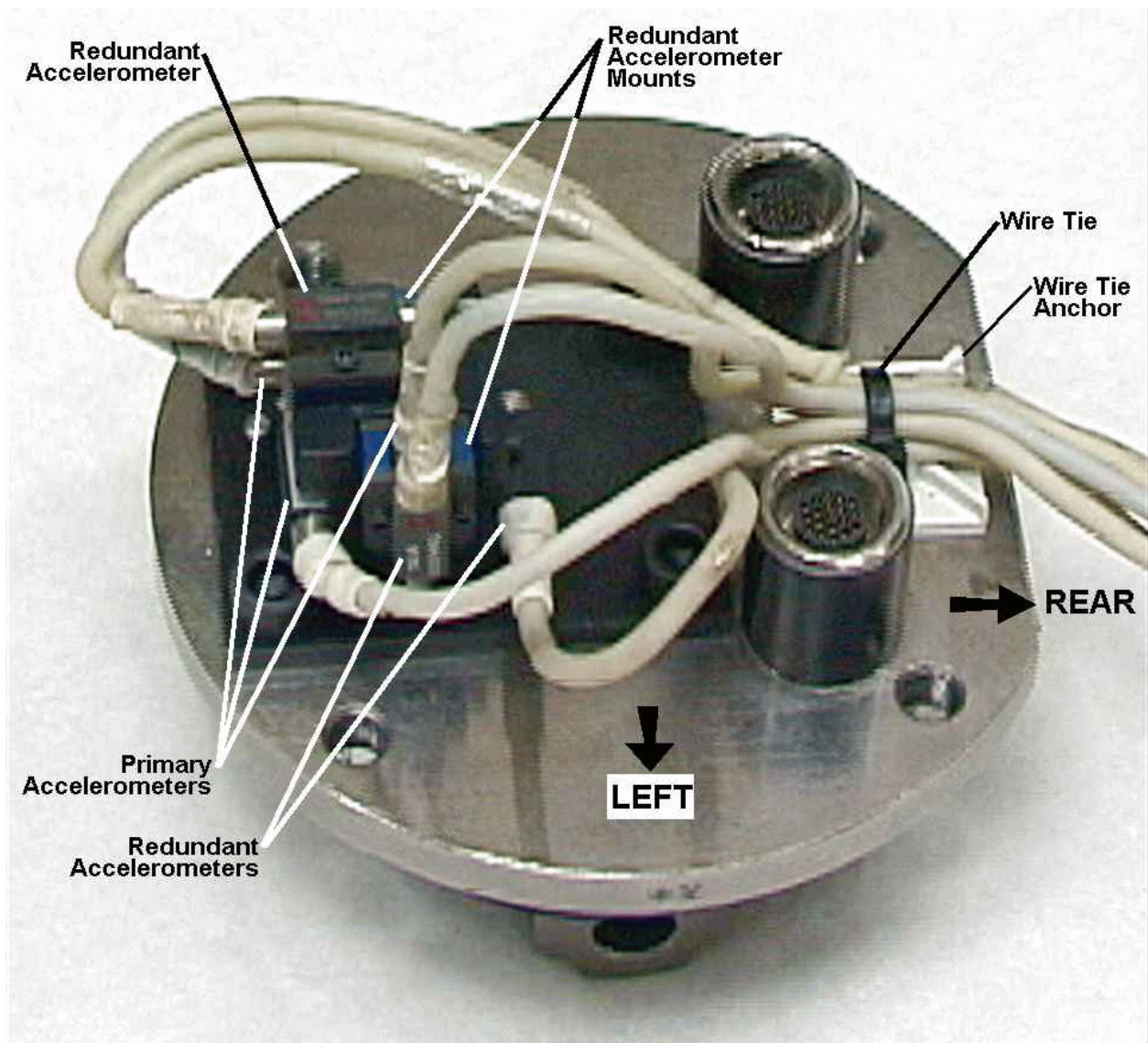


Figure 3.8 -- Perspective view of accelerometers on c.g. assembly and load cell

9. Install the SA572-11 upper neck load cell or load cell structural replacement (Drawing 78051-383X) with its c.g. and redundant mounted accelerometers (Part No. SA572-S4, Figure 1.2) in the dummy head by completing the following task.

Insert the SA572-11 upper neck load cell or its structural replacement (Drawing 78051-383X) with its accelerometers into the head and lower it into the thru hole. Secure with the four 1/4 - 28 x 7/8" SHCSs and 1/4" ID x 3/8" OD x 1/16" TH washers from the underside of the head. The installation of the top, front and center accelerometers and load cell is pictured in Figure 3.9.

10. Install the left outboard mount (Part No. 4307, Figure 1.1) with accelerometers by attaching a #4-40 x 3/8" SHCS from the left outer surface of the head. Note that the mount can be installed on the pad dowel pins in only one way for the # 4-40 screw to properly align the mount to the pad. Also, note that the outboard mount is made of aluminum and is subject to internal thread stripping. Attach the load cell cables to the load cell if they are not already connected. The installation is pictured in Figure 3.10. The orientation of the accelerometers should agree with Figure 1.1 and Table 2.1.
11. Install the head skin (Figure 3.11).
12. Allowing some strain relief in the head, route the cables in a flat bundle in the recess at the rear base of the head so they are not pinched when installing the skull cap. Use the wire tie anchor and wire ties as required (Figure 3.11). Duct tape can be temporarily used to keep the wires off the skull cap mating surface (Figure 3.11).
13. Install the skull cap and its skin assuring the cables are not pinched and remove the duct tape (Figure 3.12).

### **3.1 Head Disassembly and Inspection**

Disassembly of the nine accelerometer array head is in reverse order from its assembly.

The outboard mounts (Part No. 4307, Figure 1.1) and center mount (Part No. 5014, Figure 1.1) used to hold accelerometers are made of aluminum and are subject to internal thread stripping. During disassembly they should be inspected and replaced if needed.



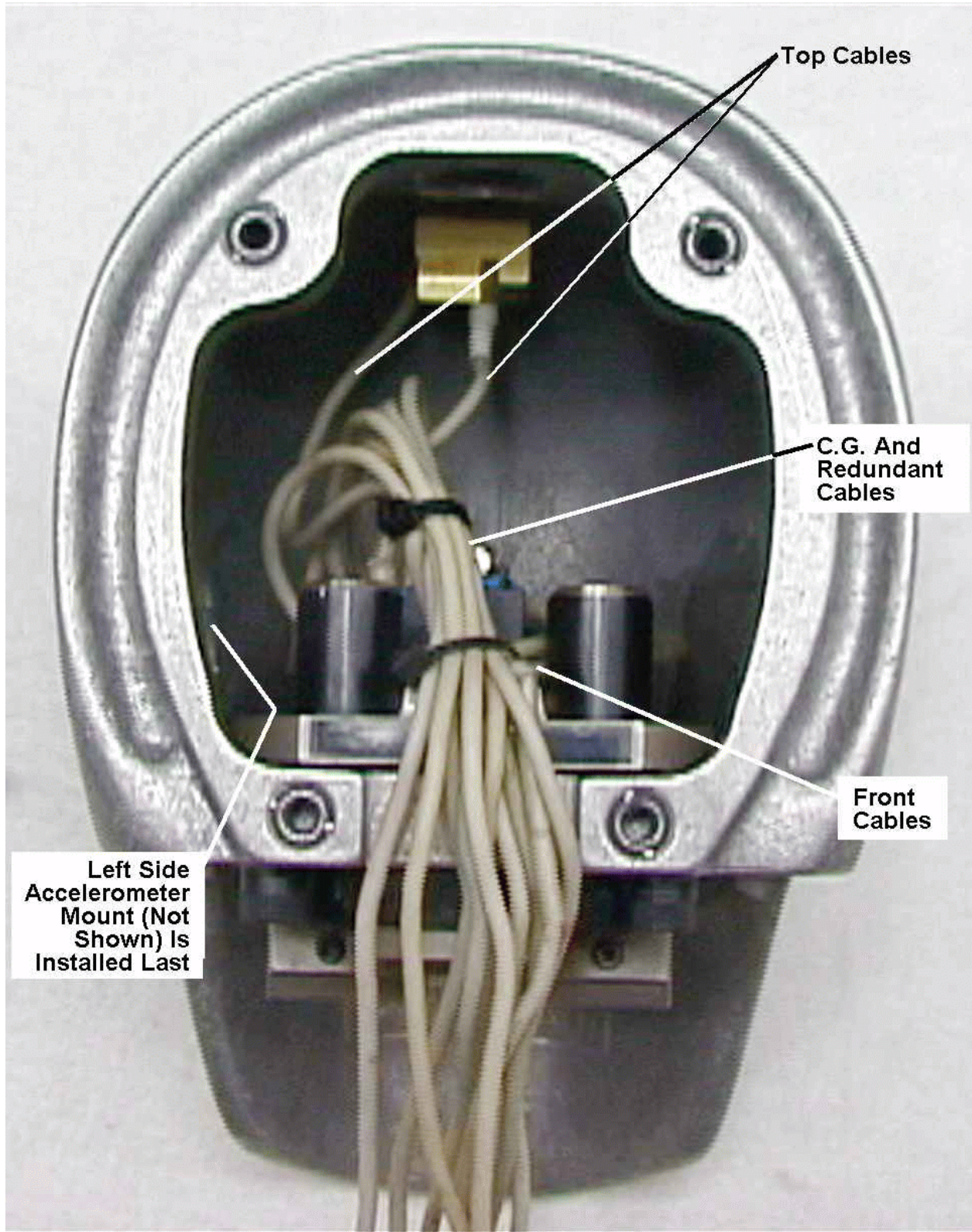


Figure 3.9 -- Rear view of top, front, and center accelerometers installed in skull



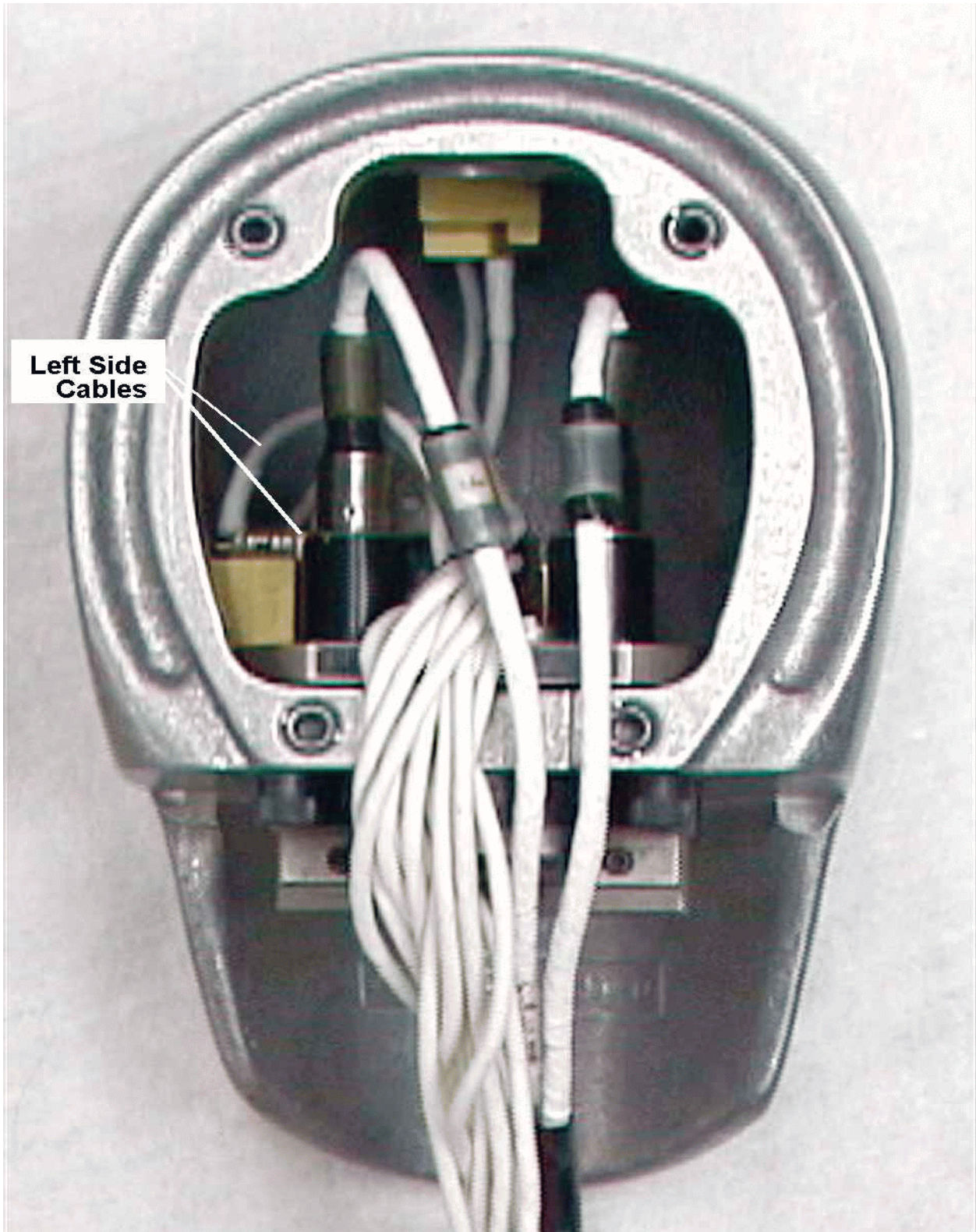


Figure 3.10 -- Nine accelerometers plus three c.g. redundant accelerometers and a load cell installed in skull



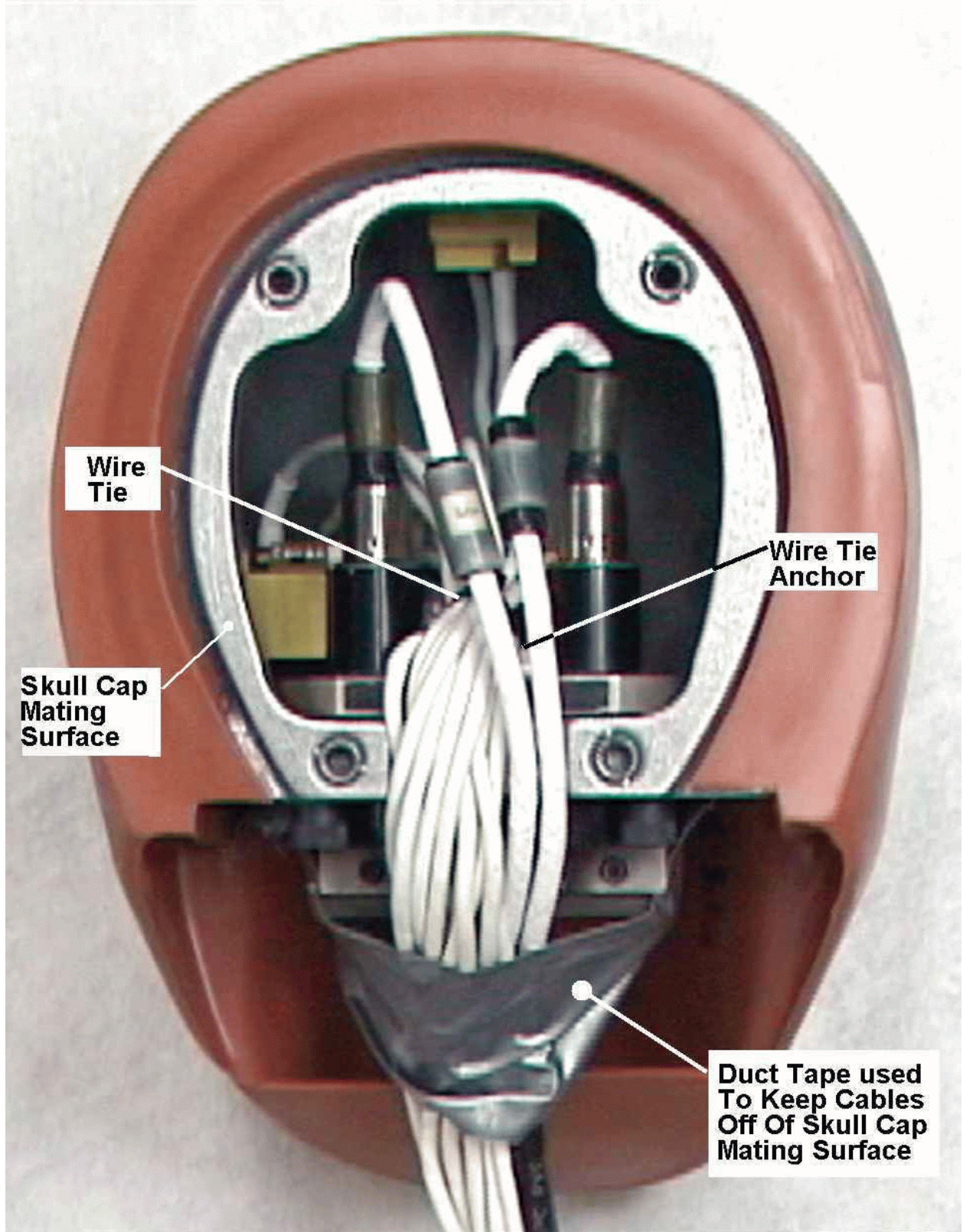


Figure 3.11 -- Cable routing



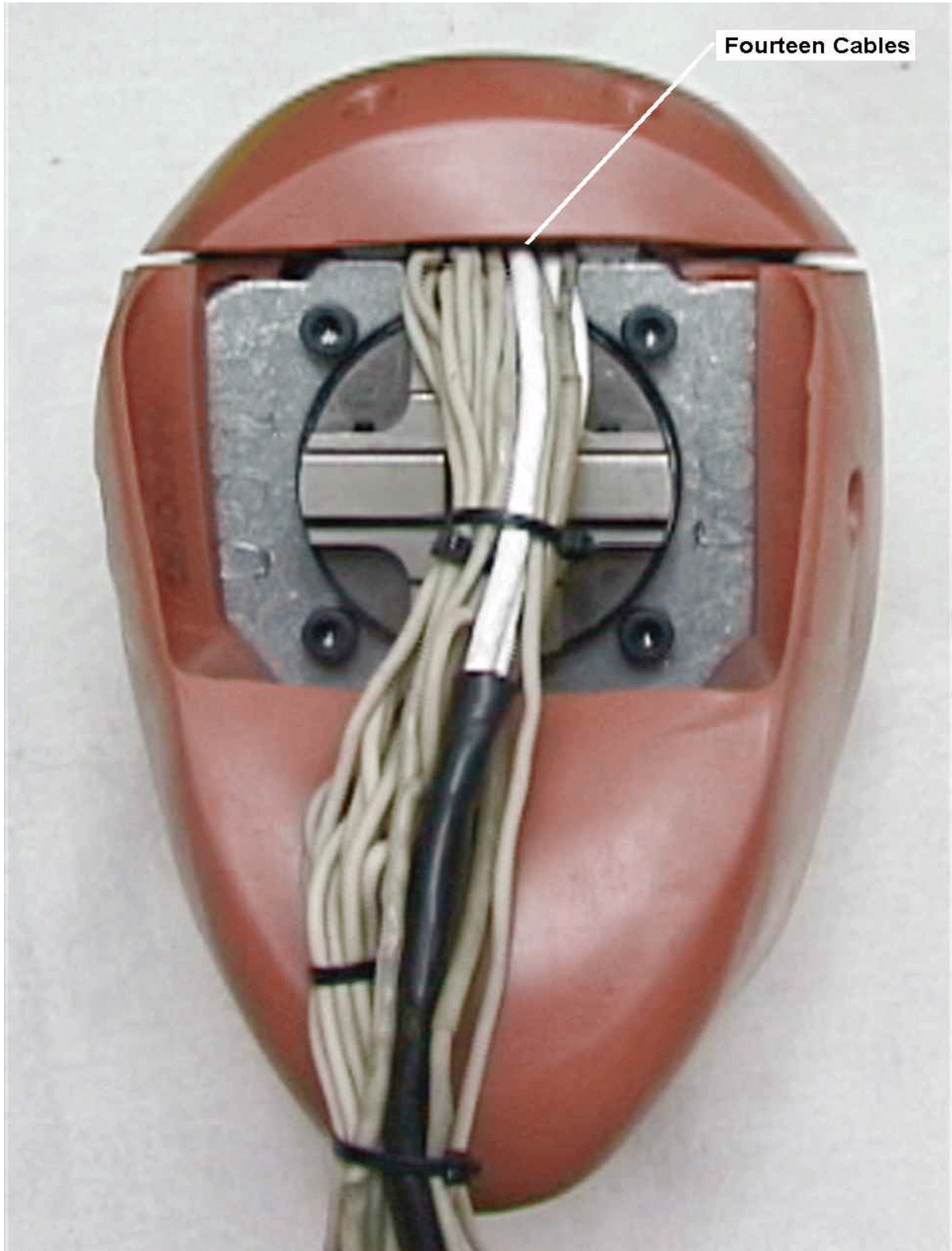


Figure 3.12 -- Cable routing with skull cap installed