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DESIGN AND FABRICATION OF QUADRUPOLE ION MASS SPECTROMETER FOR --ETC(U)

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F19628-78-C-0017

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DESIGN AND FABRICATION OF QUADRUPOLE ION MASS  
SPECTROMETER FOR UPPER ATMOSPHERE

M. McDonald

Wentworth Institute of Technology  
550 Huntington Avenue  
Boston, Massachusetts 02115

Scientific Report No.2

December 1979

Approved for public release; distribution unlimited

AIR FORCE GEOPHYSICS LABORATORY  
AIR FORCE SYSTEMS COMMAND  
UNITED STATES AIR FORCE  
HANSCOM AFB, MASSACHUSETTS 01731

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

| REPORT DOCUMENTATION PAGE                                                                                                                                                                                                                                                                                                                                         |                                                                                                | READ INSTRUCTIONS<br>BEFORE COMPLETING FORM      |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|--------------------------------------------------|--|
| 1. REPORT NUMBER<br>(18) AFGI-TR-80-0025                                                                                                                                                                                                                                                                                                                          | 2. GOVT ACCESSION NO.                                                                          | 3. RECIPIENT'S CATALOG NUMBER<br>(9) Rept. avail |  |
| 4. TITLE (and Subtitle)<br>(6) DESIGN AND FABRICATION OF QUADRUPOLE ION MASS SPECTROMETER FOR UPPER ATMOSPHERE<br>AUG 30 1979                                                                                                                                                                                                                                     | 5. TYPE OF REPORT & PERIOD COVERED<br>Scientific Report No. 2-4<br>October 1978 - August 1979  |                                                  |  |
| 7. AUTHOR(s)<br>(10) M. McDonald                                                                                                                                                                                                                                                                                                                                  | 8. CONTRACT OR GRANT NUMBER(s)<br>(15) F19628-78-C-0017                                        |                                                  |  |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS<br>Wentworth Institute of Technology,<br>550 Huntington Avenue,<br>Boston, Massachusetts, 02115                                                                                                                                                                                                                       | 10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS<br>(16) 62101F<br>668703AH (17) Q3 |                                                  |  |
| 11. CONTROLLING OFFICE NAME AND ADDRESS<br>Air Force Geophysics Laboratory,<br>Hanscom AFB, Massachusetts 01731<br>Monitor/C.A. Forsberg, LKD                                                                                                                                                                                                                     | 12. REPORT DATE<br>(11) December 1979                                                          |                                                  |  |
| 14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)<br>(14) SCIENTIFIC-2                                                                                                                                                                                                                                                                  | 15. SECURITY CLASS. (of this report)<br>Unclassified (12) 11                                   |                                                  |  |
| 16. DISTRIBUTION STATEMENT (of this Report)<br><br>Approved for public release; distribution unlimited.                                                                                                                                                                                                                                                           |                                                                                                |                                                  |  |
| 17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)                                                                                                                                                                                                                                                                        |                                                                                                |                                                  |  |
| 18. SUPPLEMENTARY NOTES                                                                                                                                                                                                                                                                                                                                           |                                                                                                |                                                  |  |
| 19. KEY WORDS (Continue on reverse side if necessary and identify by block number)<br>Quadrupole<br>Ion Mass Spectrometer<br>Gondola (Air Grab)<br>Liquid Helium Cryo Pump                                                                                                                                                                                        |                                                                                                |                                                  |  |
| 20. ABSTRACT (Continue on reverse side if necessary and identify by block number)<br>The material contained in this report describes in a quasi-historical format the design and fabrication of component parts and assemblies used in an Upper Atmosphere Composition Research Program conducted by the Composition Branch of the Aeronomy Laboratory, for AFGL. |                                                                                                |                                                  |  |

WENTWORTH INSTITUTE OF TECHNOLOGY

YEAR END REPORT NO. 2

CONTRACT NO. F19628-78-C-0017

1 OCTOBER 1978 - 30 AUGUST 1979

INTRODUCTION

Contract No. F19628-78-C-0017 was initiated with the Composition Branch, LKD, of the Aeronomy Division of the Air Force Geophysics Laboratory, Hanscom Air Force Base, Bedford, Massachusetts on 1 October 1977. The contract requires that Wentworth Institute of Technology provide the personnel, facilities and materials necessary to design, detail, fabricate, field service, analyze, evaluate and deliver mechanical components and assemblies for aerospace instruments and support equipment.

In order to fulfill this contract the following activities are carried on. Engineering liaisons are conducted with Air Force Geophysics Laboratory personnel in order to establish design requirements for instruments and support equipment. Mechanical design, layout and detail of mechanical components leads to the preparation of assembly drawings. Items are fabricated. Occasionally items are refurbished after a flight. A contract member when needed participates in field operations to work on the assembly and preparation of research instruments. Contract members also analyze and evaluate mechanical components to recommend improvements.

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#### DESCRIPTION OF WORK

In the Drafting Section a drawing of a new electronics cover can for the Cluster Ion Mass Spectrometer (C.I.M.S.) was generated. The material was changed from stainless steel to aluminum. The wall and plate bottoms were made thicker and a highdielectric enamel coating was added to the interior surfaces of the can. This last was made necessary by the presence of an arcing potential between the interior can wall and the C.I.M.S. unit. Drawings 78-50C, 78-51B and 78-52B are aluminum oxide rod spacers and will be used on any later units superseding the old spacer drawings. These new drawings incorporate a new quadrupole bolt circle spacing.

Three gas transport handling spheres were fabricated in the Machine Shop. Initially six heavy duty stainless steel bowls were purchased. A reinforcing plate, a 1" diameter tube extension and a 2 3/4" diameter con-flat flange were T.I.G. welded to the end of each of three bowls. All bowls were then electropolished, cleaned and sent out to have the interior surfaces gold-plated. A nickel strike is made in the process to form a sound base surface for the deposit of the gold surface. The gold plated surface was specified to be .0001" to .0002" thickness.

After gold plating the hemispheres were mated and T.I.G. welded to form a sphere with a con-flat flange on one end. To this flange was mounted a Grandville Phillips 1" diameter gold seal valve. The three spheres were delivered to the AFGL Composition Branch Whole Air Sampling Lab.

A discussion was held at the composition branch on modifications to an existing cryo pump. These modifications would incorporate a Quadr pole Mass Spectrometer and an associated electronics package mounted integrally with the cryo pump and flown on a ballon-launched gondola. A preliminary layout was made showing a method of raising and lowering the Cryo Pump Mass Spectrometer. Due to the high "g" level forces expected on landing, alternate methods and designs are being investigated to insure that the instruments will survive.

Vacuum leak checks were performed on the existing cryo pump.

It was found that several leaks had developed. The unit was dismantled and the leaks were repaired.

Two Tri Samplers used in upper atmospheric composition studies were modified. The Swage-Lock fittings, which attached the blower exhaust assembly to the ultra-high vacuum valves on the samplers, were removed and replaced by "Cajon VRC" vacuum connections. The change was necessitated by the fact that the Swage-Lock connections had proved unreliable in vacuum tests in the field. Nine valves and three blower exhaust assemblies were modified to accommodate the "VRC" connections.

On the Cluster Ion Mass Spectrometer new drawings were made including sketches and a layout of the forward orifice sampling area. The layout was required to determine design parameters for a new grid cone assembly which will be mounted on the quadrupole rods. It will be electrically insulated from the rods and will be mounted as close to the sampling orifice as possible. From the layout drawings were generated the various parts of the grid cone assembly which were then fabricated in the machine shop.

A balloon launched mass spectrometer was designed to interface with an existing cryogenically cooling pump. For this purpose the cryopump and mass spectrometer were modified. Larger diameter tubular quadrupole rods were substituted for the solid rods used in the past.

An assembly drawing of an electronics housing was completed. This housing is intended to replace a cast version. The new housing as designed can be varied in size as required to fit in all component parts for a particular application.

The design of the C.I.M.S. front end was modified to increase the sensitivity of the unit. To this end a conical S.S.T. sheet metal truncated cone piece brazed to a cylindrical ring was designed and fabricated. This unit was mounted to the front end quadrupole section by means of machine screws. The cone section was isolated from the R.F. of the quadrupoles by means of KFL-F spacers.

A new gondola was designed and detailed to be used for the balloon launched whole air samplers. This gondola was designed to accommodate the air grab gondola currently being used for air recovery. The new

design will thus allow recovery to be made either in the air or on the ground.

On the C.I.M.S. the front plates of four existing LASSII housings were removed. Machining of the housings was done to modify them to accommodate new front plates.

Four front plates were fabricated for LASSII housings LKD 78-27C. The width of the cutout of 19 connector retainer plates was increased while the depth of the recess was reduced to fit the connector.

A listing of items fabricated by the Machine Shop during the year on the C.I.M.S. project follows:

| <u>QUANTITY</u> | <u>DESCRIPTION</u>                                                                                                                                                                                                                                                                                                                     |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6               | Quadrupole Rods, LKD78-44B-1                                                                                                                                                                                                                                                                                                           |
| 6               | Quadrupole Rods, LKD78-44B-2                                                                                                                                                                                                                                                                                                           |
| 3               | Multiplier Housings Modified, Verbal<br>Rebored inside diameter to .875                                                                                                                                                                                                                                                                |
| 2               | Thermistor Holders for Cryo Dewar, Sketch                                                                                                                                                                                                                                                                                              |
| 2               | Quadrupole Housings Reworked, LKD77-43D<br>Elongated and widened 10 slots to reduce weight                                                                                                                                                                                                                                             |
| 2               | Rod Housings reworked, LKD77-22D<br>Major removal of stock on sides and flanges to reduce weight. A milling fixture was made to accomplish this.<br><br>Outside diameter reduced on two existing adaptor rings, for electronics cover<br><br>Rebored inside diameter of rib section of two quadrupole housings to allow more clearance |
| 2               | Electronic Cover Cans (aluminum), LKD78-47D                                                                                                                                                                                                                                                                                            |
| 4               | Base Plates (LASS I) modified to fit feed-thrus, Sketch                                                                                                                                                                                                                                                                                |
| 4               | Cover Plates, Modified, LKD77-100D<br>Removed broken feed-thrus and cut air release grooves on three plates. Machined recess on back side of one plate.<br><br>Reworked two electronic cover cans, LKD78-47D.<br>Rebored inside diameter on open end to remove                                                                         |

excessive hi dielectric material. Removed welded bead on outside diameter.

|    |                                                                                                                       |
|----|-----------------------------------------------------------------------------------------------------------------------|
| 1  | Housing, for Rocket Unit, LKD76-132B                                                                                  |
| 2  | Pull-off Caps For M.S. Sensor, LKD76-132B                                                                             |
| 2  | Aperture Covers for M.S. Sensor, LKD76-131B<br>Grinding of special tool was required for dovetail of "O" Ring groove. |
| 8  | Retainers for Marmon Clamps, LKD78-39A                                                                                |
| 2  | Teflon bushings for inlet of cryo pump,<br>Sketch                                                                     |
| 1  | Ion Lab Test Fixture, LKD79-1D                                                                                        |
| 8  | Aperture discs for Air Sampler (Ion source),<br>LKD79-2B. A turning fixture was made for these.                       |
| 1  | Clamp Plate for Lab Fixture, LKD79-1D                                                                                 |
|    | Modified Top Plate of Lab Test Fixture, LKD79-1D                                                                      |
| 2  | Nipples modified (Eclipse), Sketch                                                                                    |
| 2  | Quick disconnect fittings modified (Eclipse),<br>Sketch                                                               |
| 2  | Tube Extensions (Eclipse), Sketch                                                                                     |
| 1  | Valve Body Modified (Eclipse), Sketch                                                                                 |
| 1  | Tee Modified to fit Valve Body (Eclipse), Sketch                                                                      |
| 1  | Pump Out Adaptor Plate for Electronics Can                                                                            |
| 20 | Supports, Radial, LKD77-65B                                                                                           |
|    | Modifications on Lab Test Unit, LKD79-1D                                                                              |
| 1  | Rod Housing, Rocket Instrumentation LASS II,<br>LKD78-49D                                                             |
| 9  | Quadrupole Rods, LKD78-23B1                                                                                           |
| 9  | Quadrupole Rods, LKD78-23B1                                                                                           |
| 4  | Modified Quadrupole Rods, LKD77-47B                                                                                   |
| 12 | Quadrupole Grid Apertures (Lass II), Sketch                                                                           |
| 1  | Quadrupole Grid Aperture Turning Fixture                                                                              |

|    |                                                                                               |
|----|-----------------------------------------------------------------------------------------------|
| 17 | Cone Layouts, .002", .002" and .003" Thick                                                    |
| 2  | Cone Shaped Fixtures for Cone Layout, Sketch                                                  |
| 3  | R.F. Oscillating Box Housings                                                                 |
| 3  | R.F. Oscillating Box Back Plates, LKD77-87C                                                   |
| 1  | R.F. Oscillating Box Milling Fixture                                                          |
| 3  | R.F. Oscillating Box Lower Deck, LKD77-84B                                                    |
| 3  | R.F. Oscillating Box Top Plate, LKD77-81B                                                     |
| 3  | R.F. Oscillating Box Bottom Plate, LKD77-82B                                                  |
| 3  | R.F. Oscillating Box Deck #1, LKD77-85B                                                       |
| 3  | R.F. Oscillating Box Deck #2, LKD77-86B                                                       |
| 3  | R.F. Oscillating Box Side Plate, LKD77-89B                                                    |
| 3  | R.F. Oscillating Box Covers, LKD77-88C                                                        |
| 3  | Assembled R.F. Oscillating Boxes, LKD77-90B                                                   |
| 8  | Grid Plates, LKD77-60B                                                                        |
| 1  | Grid Plate Fixture                                                                            |
| 1  | Lower Split Cone Spot Welding Fixture for Front End of<br>Quadrupole Section, Sketch          |
| 8  | Front End Cone Layout Pieces, Sketch                                                          |
| 15 | KEL-F Insulator Spacers, Sketch                                                               |
| 1  | Special fixture to hold all lengths of Quadrupole Rods<br>for Milling and drilling operations |
| 6  | Quadrupole Rods, LKD78-47B-1                                                                  |
| 6  | Quadrupole Rods, LKD78-47B-2                                                                  |
| 6  | Quadrupole Rods, LKD78-44B-1                                                                  |
| 6  | Quadrupole Rods, LKD78-44B-2                                                                  |
| 1  | Split ring clamp flange for the vacuum table                                                  |
| 4  | Grid Plates for LASSII housing, LKD76-122-B                                                   |
| 3  | Orifice Plates, LKD76-123-C                                                                   |
| 5  | Contact Plates, LKD78-11-C                                                                    |

- |   |                                                                           |
|---|---------------------------------------------------------------------------|
| 4 | Marmon Clamp Straps LASS II, LKD78-37C, machined, bent and spot welded    |
| 4 | Assembled Marmon Clamps                                                   |
| 1 | Feed through unit consisting of flange, Macor disc and Kovar feed through |

The work completed in the Machine Shop for the Whole Air Sampling Lab is as follows:

| <u>QUANTITY</u> | <u>DESCRIPTION</u>                                                                                 |
|-----------------|----------------------------------------------------------------------------------------------------|
| 3               | Con-flat center sections modified to mate with Cryo Lab valve body, for lab vacuum system, Sketch. |
| 3               | Braze adaptors for tri-sampler, Sketch                                                             |
| 4               | Con-flats to mate with flex bellows, Sketch                                                        |
| 11              | Discs for shafts on valve drivers for lab vacuum system, verbal                                    |
|                 | Removed existing handles for valves and cleaned threaded shafts                                    |
| 3               | Top Plates for Transport Spheres, LKD77-46D                                                        |
| 3               | Tubes to fit Top Plates and Con-flats, LKD77-46D                                                   |
| 3               | Con-flats modified to fit tubes, LKD77-46D                                                         |
| 6               | 8-quart Stainless Steel Hemi-spheres, modified, LKD77-46D                                          |
| 2               | Con-flats for valve body operator                                                                  |
| 6               | Modified Con-flats, Sketch                                                                         |
| 6               | Adaptors for Modified Con-flats, Sketch                                                            |
| 6               | 1/2" Diameter Extensions for Adaptors, Sketch                                                      |
| 7               | Modified Granville Phillips Gold Seal Valves, Verbal                                               |
| 6               | Swage Loc Elbows modified, Verbal                                                                  |
| 8               | Cajon Male Weld Glands, modified, Verbal                                                           |
| 1               | 1/2" Diameter Nipple for Gold Seal Valve, Verbal                                                   |
| 2               | Con-flats, modified to mate Varian Gold Cathode Vacuum                                             |

Gauges, Verbal

- 6           Adaptors machined for CVD fittings, Verbal
- 6           Double-sided flanges to fit Swage Loc Fittings,  
Modified

During the year purchases of equipment and supplies were requisitioned as needed. The only travel involved was that associated with trips to the Composition Branch, LKD in Bedford, Massachusetts for the purpose of establishing design requirements as mentioned in this report.