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MODIFICATION OF A SOLAR EUV SPECTROMETER.(U)
JUL 77 J F MCGRATH, J P PADUR F19628-76-C-0041
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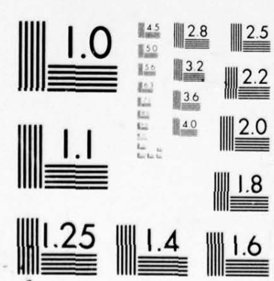

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MODIFICATION OF A SOLAR EUV SPECTROMETER

John F. McGrath
Joseph P. Padur

Comstock & Wescott, Inc.
765 Concord Avenue
Cambridge, Massachusetts 02138

31 July 1977

Final Report for Period 1 November 1975 - 30 June 1977

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AIR FORCE GEOPHYSICS LABORATORY
AIR FORCE SYSTEMS COMMAND
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes the modification of a solar extreme ultraviolet double spectrometer (RM-60) for sounding rockets. This instrument is of the grazing-incidence grating spectrometer design. This report also covers the modification of the existing ground support equipment (GSE) as well as the auxiliary experiment.

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1. GENERAL

This report covers the design, development, and engineering activities of Comstock & Wescott, Inc. in support of a research program of the Air Force Geophysics Laboratory (AFGL). The work discussed in this report covers the modification of spectrometer RM-60 to convert it from a rocket-borne instrument concentrating on plage areas of the sun to one measuring full disc solar fluxes.

The principal engineers on this contract were

Mr. John F. McGrath,
Director of Mechanical Engineering, and

Mr. Joseph P. Padur,
Project Physicist.

Work in the field of electronics, including the flight electronics and ground support equipment (GSE) modification, was subcontracted to TRI-CON Associates, Inc. and was conducted under the direction of Mr. Chester G. Kuczun and Mr. Robert S. Hills. Other technical contributors to the contract were Messrs. Charles W. Peterson, William F. Burke, and George W. Guay of Comstock & Wescott, Inc., and Messrs. Norbert F. Robertie and Timothy A. Doyle of TRI-CON Associates, Inc.

2. RELATED CONTRACTS

The following contracts have preceded the contract covered by this report:

AF19(604)-1097, 1954 to 1956.
Contract concerned with development of a soft X-ray radiation source and an associated high vacuum system.

AF19(604)-1889, 1956 to 1959.
Measurements of EUV and soft X-rays.

AF19(604)-5693, 1959 to 1961.
Investigation of extreme ultraviolet solar radiation and clarification of role of photo-electron emission.

AF19(604)-7496, 1960 to 1963.
Development of a number of rocket and satellite monochromators and retarding potential detectors. Specific reference is made to the Final Report AFCRL-64-773 of this contract.

An associated contract which ran concurrently with AF19(604)-7496 was AF19(628)-2975. This was concerned with research into the photo-emission properties of materials and with the investigation and development of various spectro-scopic instruments.

AF19(628)-4317 was an extension of AF19(604)-7496.

Contract AF19(628)-5188 covered a further extension of this work.

Contract F19628-68-C-0239 covered an extension of the work performed under the former contract and preceded the work covered by this report.

Contract F19628-72-C-0048 covered a modification of a Double-Deck EUV Spectrophotometer.

Contract F19628-72-C-0254 covered design, development, and fabrication of a double spectrophotometer consisting of one grazing incidence and one normal incidence grating spectrophotometer.

Contract F19628-73-C-0253 covered design and fabrication of two double-deck solar extreme ultraviolet spectrometers.

Contract F19628-74-C-0002 covered design and fabrication of a normal-incidence extreme ultraviolet grating spectrometer.

Other contracts carried out by Comstock & Wescott in the field of space instrumentation, but not directly related to this contract, are:

AF19(628)-253 - Research directed toward Design of Instrumentation for Investigation of Aerospace by Rocket and Satellite Probe Techniques.

AF19(628)-4988 - Rocket and Satellite Probe Techniques.

F19628-68-C-0307 - Continuation of AF19(628)-4988.

F19628-72-C-0027 - Continuation of F19628-68-C-0307.

3. ROCKET SPECTROMETER NO. 60-B

3.1 General

The objective of this modification was to convert rocket spectrometer RM-60 (described in detail in AFGL-TR-76-0160) from a rocket-borne instrument concentrating on plage areas of the sun to one, RM-60-B, measuring full disc solar fluxes. The original instrument contained two scanning carriages covering the wavelength range of 55Å to 310Å in one deck and 220Å to 1220Å in the other deck. The modified instrument retained the coverage of 55Å to 310Å in the top deck but the bottom deck was changed to concentrate on four discrete spectral regions centered at a specific wavelength. The four center wavelengths were: 284Å, 630Å, 915Å, and 1206Å.

Some modifications also were carried out on the electronics of the auxiliary experiments of RM-60, namely, the electron spectrometer and the side-viewing photometer.

3.2 Redesign and Fabrication

In order to carry out the above requirements, some effort was afforded to redesign and fabrication of necessary components. It was necessary during the time period of this contract to investigate production problems with the CEM detector manufacturer, necessitating the purchase of new detectors for both decks of this instrument. These problems were enumerated in AFGL-TR-76-0160.

Some of the mechanical and electronics modifications listed below are dimensional changes of components thereby requiring replacement of some subassembly parts used in RM-60 whereas others are entirely new components. Where no reference is made to a specific component or assembly, it is then the same as used in RM-60. Reference therefore should be made to AFGL-TR-76-0160.

3.3 Modifications

3.3.1 Top Deck

(a) Four new CEM detectors (purchase, test, wire, and assemble).

(b) MgF_2 coating on the two shortest wavelength detector cones (those covering 50Å - 101Å and 96Å - 159Å).

(c) Four .005" (.127mm) exit slits for calibration.

(d) One .005" (.127mm) entrance slit for calibration.

(e) One .002" (.0508mm) entrance slit for flight.

(f) One entrance slit assembly mount.

(g) One 5mm slit height limiter.

(h) Rewiring of CEM units to amplifiers and harness.

3.3.2 Bottom Deck

(a) Four new CEM detectors (purchase, test, wire, and assemble).

(b) New carriage for four selected wavelengths.

(c) New belt for carriage drive.

(d) New limit switch assembly.

(e) Four .005" (.127mm) exit slits.

(f) One .002" (.0508mm) entrance slit.

(g) One entrance slit assembly mount.

(h) One 5mm slit height limiter.

(i) Change step rate from 100 frames per second to 10 frames per second.

(j) Add double step capability to circuit board.

(k) Rewiring of CEM units to amplifiers and harness.

3.3.3 Electron Spectrometer

(a) Construct two new electronics boards.

(b) Rewiring of electronics to experiment.

3.3.4 Side Viewing Photometer

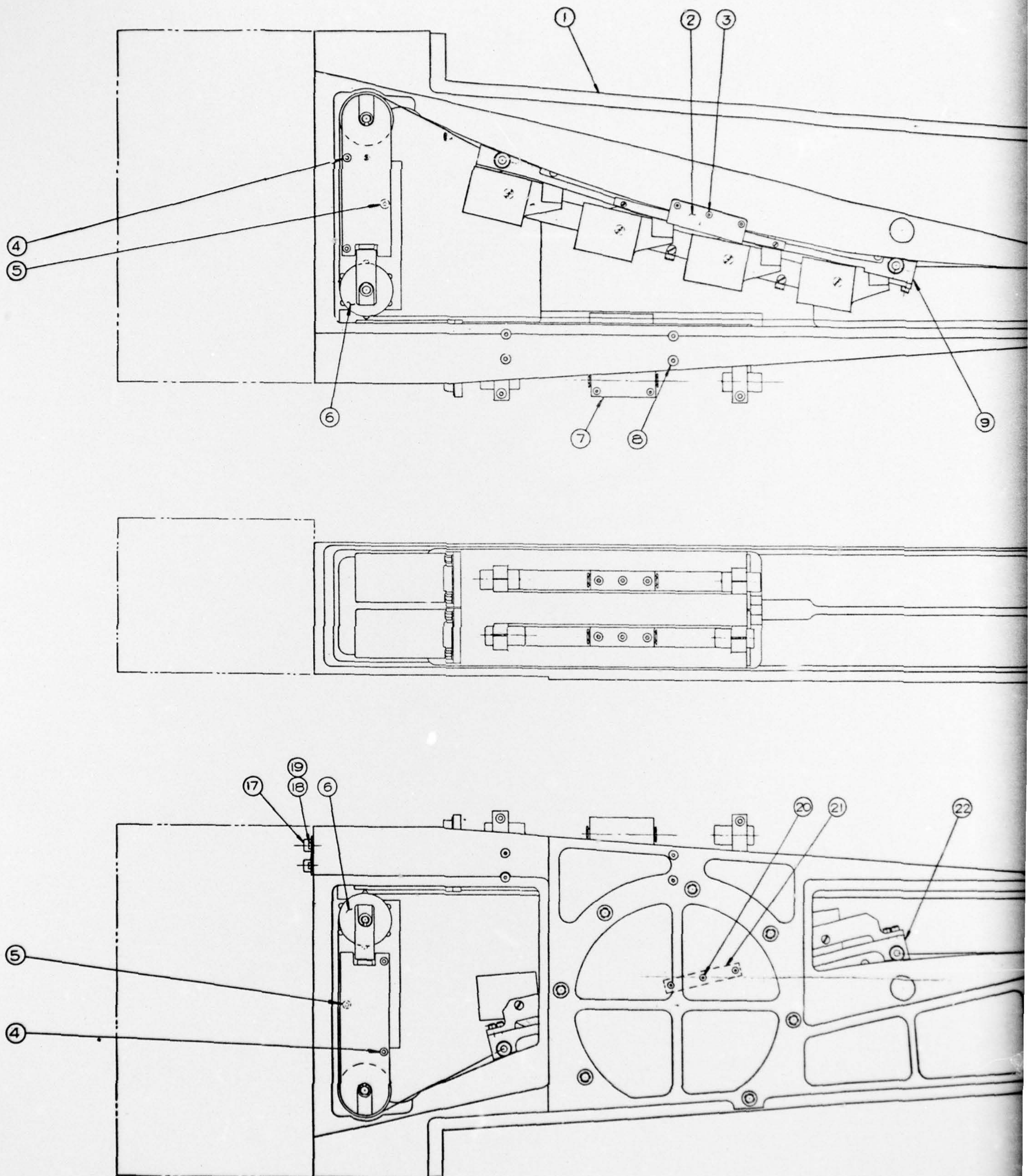
The electronics boards and detector assembly as an auxiliary experiment of RM-60 were removed from the original housing and relocated in another section of the rocket payload in RM-60-B without any electronics board changes.

3.4 Assembly

3.4.1 RM-60-B (Mechanical)

Eight new CEM detectors (two having MgF_2 coated cones) were positioned into the stripped Kel-F holders from which the original eight detectors were removed. They were potted into place, assembled with and wired to their respective amplifiers and plateaued prior to assembly and wiring on their respective carriages. An optical alignment test was carried out on each deck, wherein the exit slits were adjusted parallel to their respective entrance slit prior to calibration. An internal assembly drawing, Figure 1, illustrates the design of the original instrument. Item 22 (Channeltron carrier assembly of bottom deck) has been replaced during this modification by the assembly illustrated in Figure 2.

Table I lists the technical characteristics of the modified instrument.



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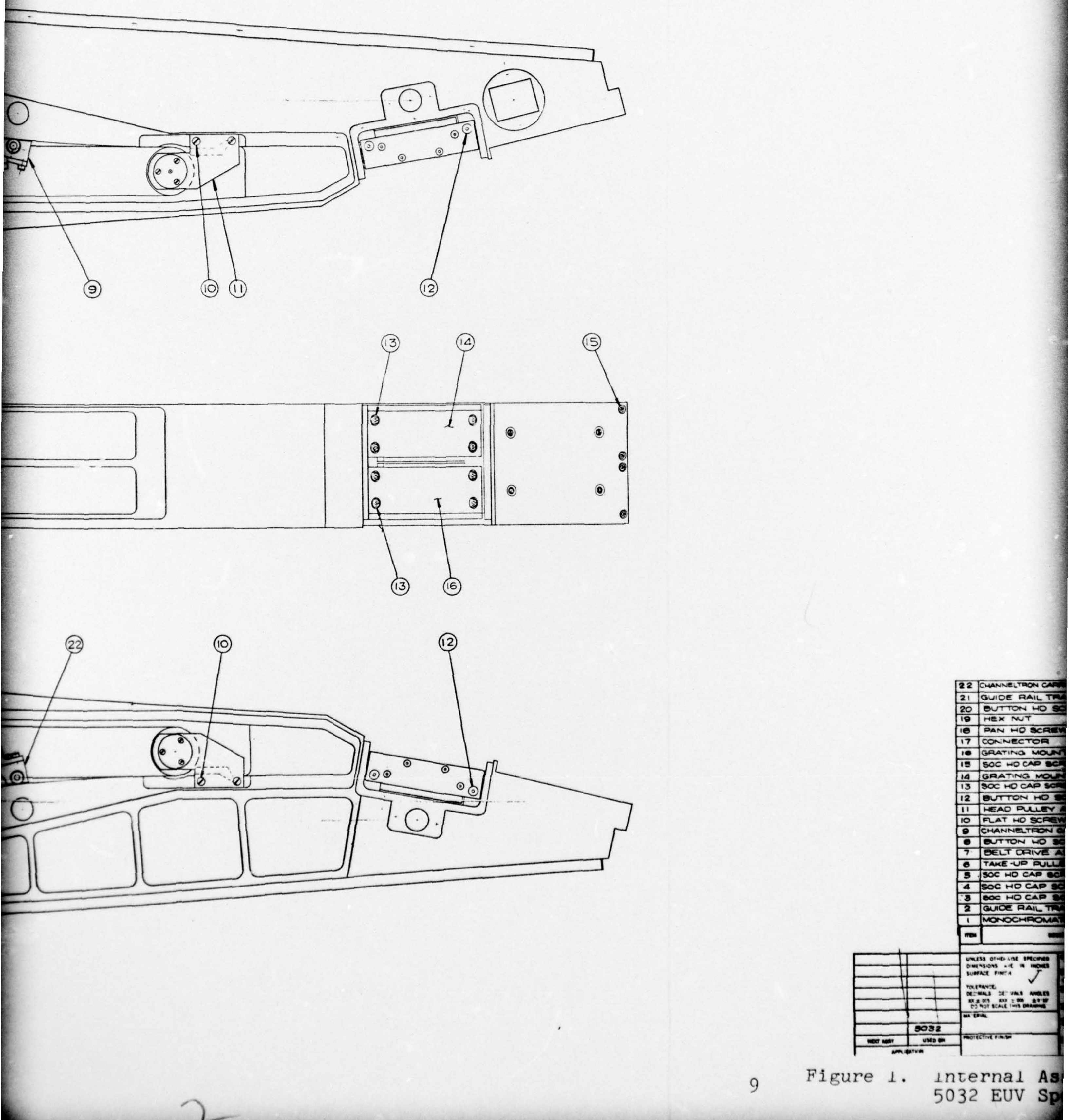
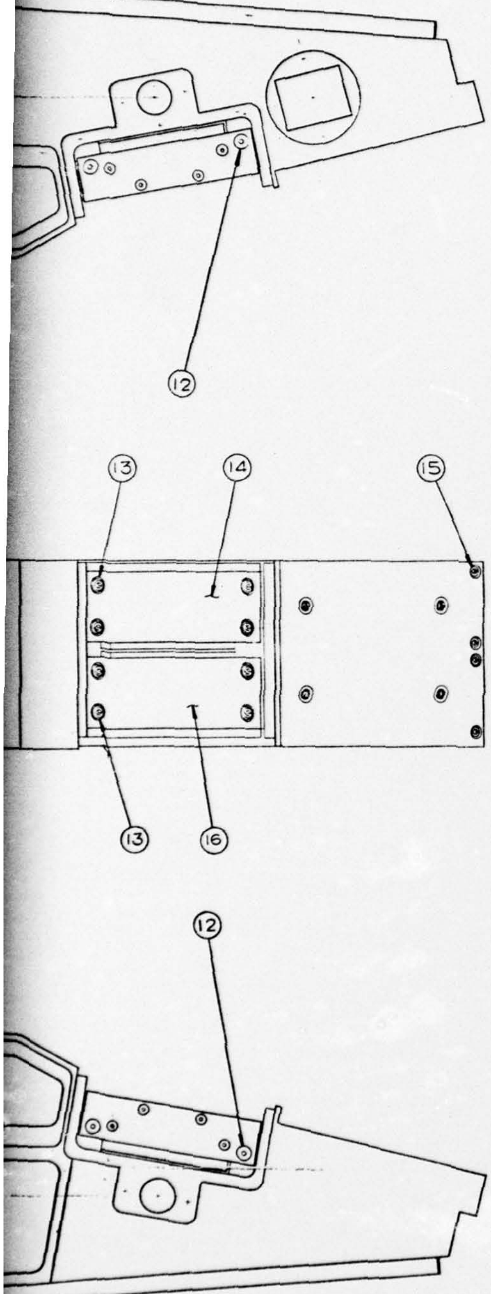


Figure 1. Internal As
5032 EUV Sp



ITEM	DESCRIPTION	PART IDENTIFY NO.	SPECIFICATION	CODE IDENT NO.	QTY REQD
22	CHANNELTRON CARRIER ASSY (BTM DECK)	D 799			1
21	GUIDE RAIL TRAP	A 2655-1			1
20	BUTTON HD SCREW	#2-56UNC x [illegible] LG	ST. STL		3
19	HEX NUT	#4-40UNC	ST. STL		4
18	PAN HD SCREW	#4-40UNC x 1/2 LG	ST. STL		4
17	CONNECTOR	DAM 155	ITT CANNON		2
16	GRATING MOUNT ASSY	C 1225-2			1
15	SOC HD CAP SCREW	#4-40UNC x 3/4 LG	ST. STL		4
14	GRATING MOUNT ASSY	C 1225-1			1
13	SOC HD CAP SCREW	#6-32UNC x [illegible] LG	ST. STL		8
12	BUTTON HD SCREW	#6-32UNC x 3/8 LG	ST. STL		4
11	HEAD PULLEY ASSY	C 1227			1
10	FLAT HD SCREW	#4-40UNC x 3/8 LG	ST. STL		4
9	CHANNELTRON CARRIER (TOP DECK)	D 798			1
8	BUTTON HD SCREW	#6-32UNC x [illegible] LG	ST. STL		8
7	BELT DRIVE ASSY	D 800			1
6	TAKE-UP PULLEY ASSY	C 800			2
5	SOC HD CAP SCREW	#6-32UNC x 1/4 LG	ST. STL		2
4	SOC HD CAP SCREW	#4-40UNC x [illegible] LG	ST. STL		4
3	SOC HD CAP SCREW	#2-56UNC x [illegible] LG	ST. STL		3
2	GUIDE RAIL TRAP	A 2307			1
1	MONOCHROMATOR HOUSING	E 389			1

LIST OF PARTS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
SURFACE FINISH ✓
TOLERANCE: DECIMALS XX ± .015 XXX ± .005 ANGLES ± 0°15'
DO NOT SCALE THIS DRAWING
MATERIAL
PROTECTIVE FINISH

NEXT ASSY | USED ON 5032 | APPLICATION

CONTRACT NO. 73-0253
DRAWN G.W. GUAY | DATE 10 Oct. 1973
CHECKED
APPROVED [signature] 10/10/73
APPROVED
APPROVED

COMSTOCK & WESCOTT, INC.
CAMBRIDGE, MASSACHUSETTS

INTERNAL ASSEMBLY
MODEL 5032 EUV SPECTROMETER

CODE IDENT NO. 31561 | DRAWING NO. E 391
SCALE 1/1 | PROJECT NO. 5032-0 | SHEET 1 OF 2

Figure 1. Internal Assembly Model 5032 EUV Spectrometer

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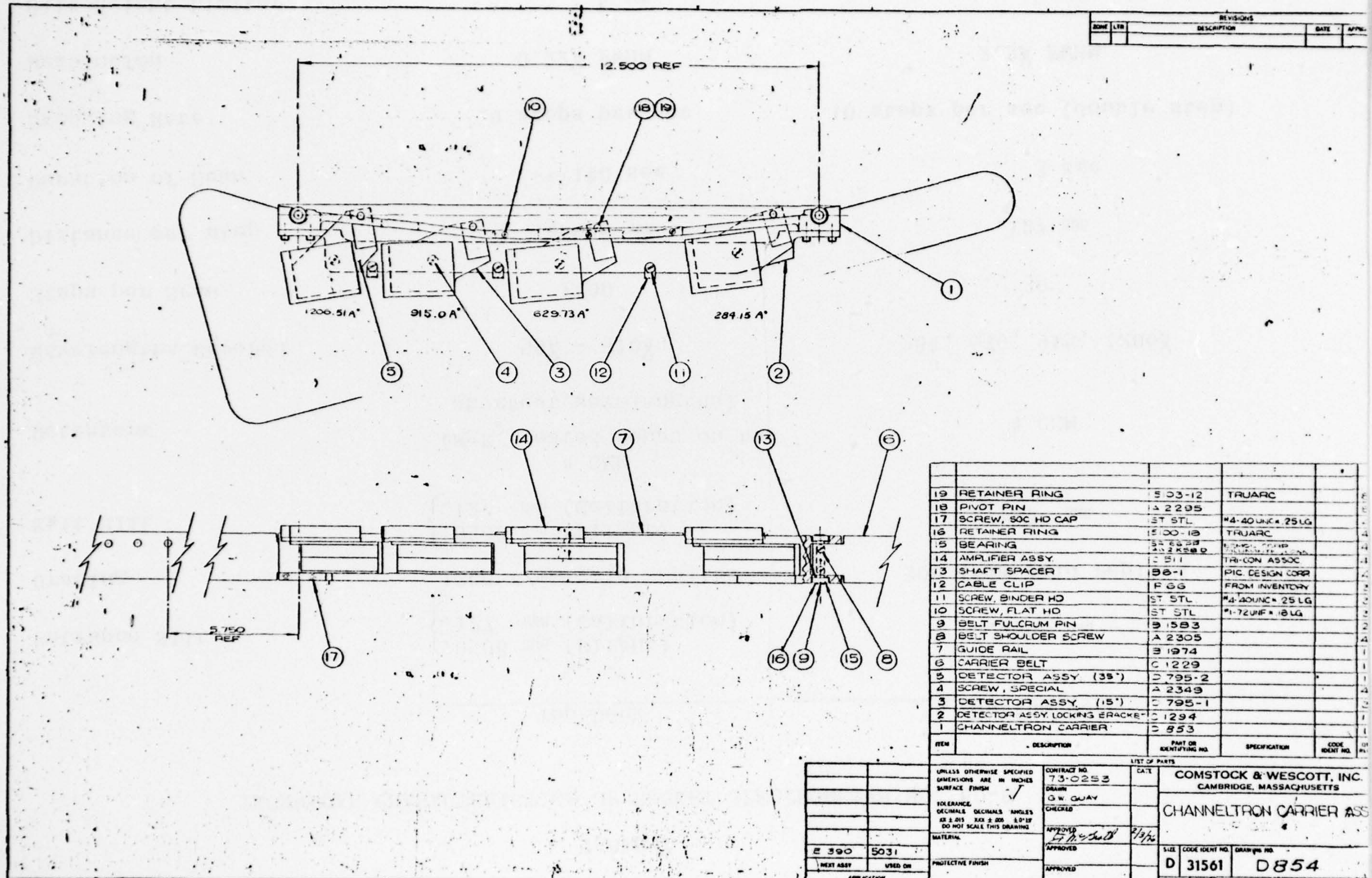


Figure 2. Channeltron Carrier Assembly

TABLE I

TECHNICAL CHARACTERISTICS OF ROCKET SPECTROMETER NO. 60-B

	Top Deck	Bottom Deck
Entrance Slit	.0508 mm (Flight) .127 mm (Calibration)	.0508 mm
Grating	1200 ℓ/mm gold replica	300 ℓ/mm gold replica
Exit Slit	.0508 mm (Flight) .127 mm (Calibration)	.127 mm
Detectors	4 CEM (MgF_2 coated cones on two shortest wavelengths)	4 CEM
Wavelengths Covered	55Å - 310Å	284, 630, 915, 1206Å
Steps per Scan	1400	30
Distance per step	.06096 mm	.127 mm
Duration of Scan	~140 sec	3 sec
Stepping Rate	10 steps per sec	10 steps per sec (double step)
Resolution	0.22Å FWHM	2.2Å FWHM
Slit Height Limiter	5 mm	5 mm

3.4.2 RM-60-B (Electronics)

The frame rate (or scan step rate) of the bottom deck was changed from 100 frames per second to 10 frames per second by adding a 10:1 frequency divider to the timer circuit of the motor drive/timer printed circuit card. The motor drive section of the same board was also modified to step the motor twice during each frame. A schematic of the updated motor drive/timer board is given in Figure 3. A timing diagram for the modified instrument is given in Figure 4.

3.4.3 Auxiliary Experiments

The auxiliary experiments originally built for RM-60 were used on RM-60-B. However, the analyzer voltage steps of the electron spectrometer were changed from the original ones and a new circuit board was required. The new step generator/drive schematic is illustrated in Figure 5. Since the electronics cards were mounted on top of the instrument in RM-60-B rather than in the detector assembly at the rear of the electronics package (RM-60), the five electronics boards were redesigned and incorporated into two newly constructed cards.

As mentioned previously, the photometer cards built for RM-60 were used for RM-60-B but were mounted with the photometer detector in a new rocket extension below the main instrument.

3.5 Test and Delivery

Prior to delivery to AFGL, a preliminary acceptance test was carried out at Comstock & Wescott. This test included the operation of the instrument with the GSE through all of the necessary bench functions. An addendum to the previous "Test and Acceptance Plan for RM-60" was submitted to AFGL to encompass the modification introduced into the operation of the instrument. The instrument was delivered to AFGL for further acceptance testing and calibration. No launch support services were supplied under this contract.

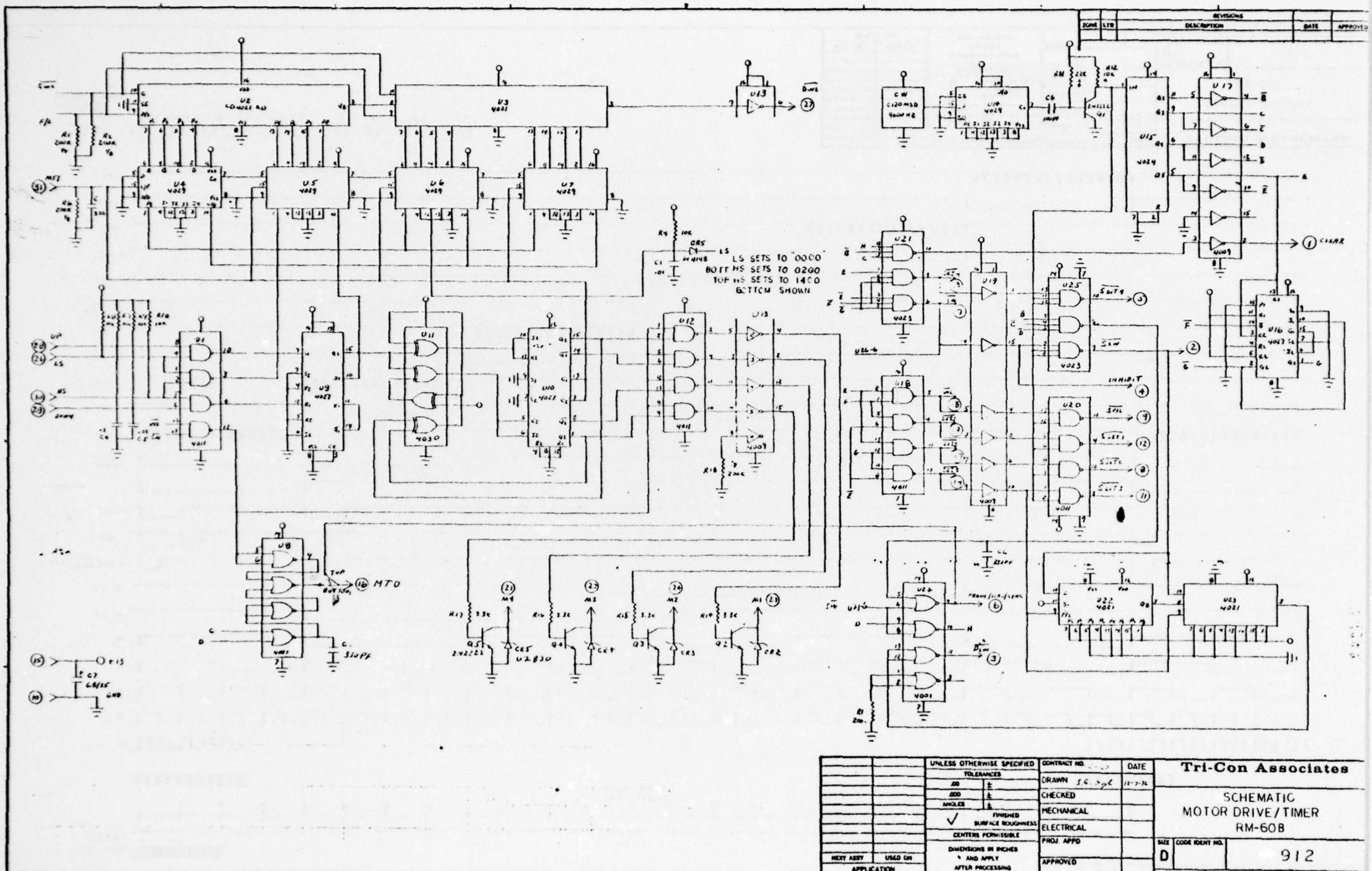


Figure 3. Schematic Motor Drive/Timer RM-60B

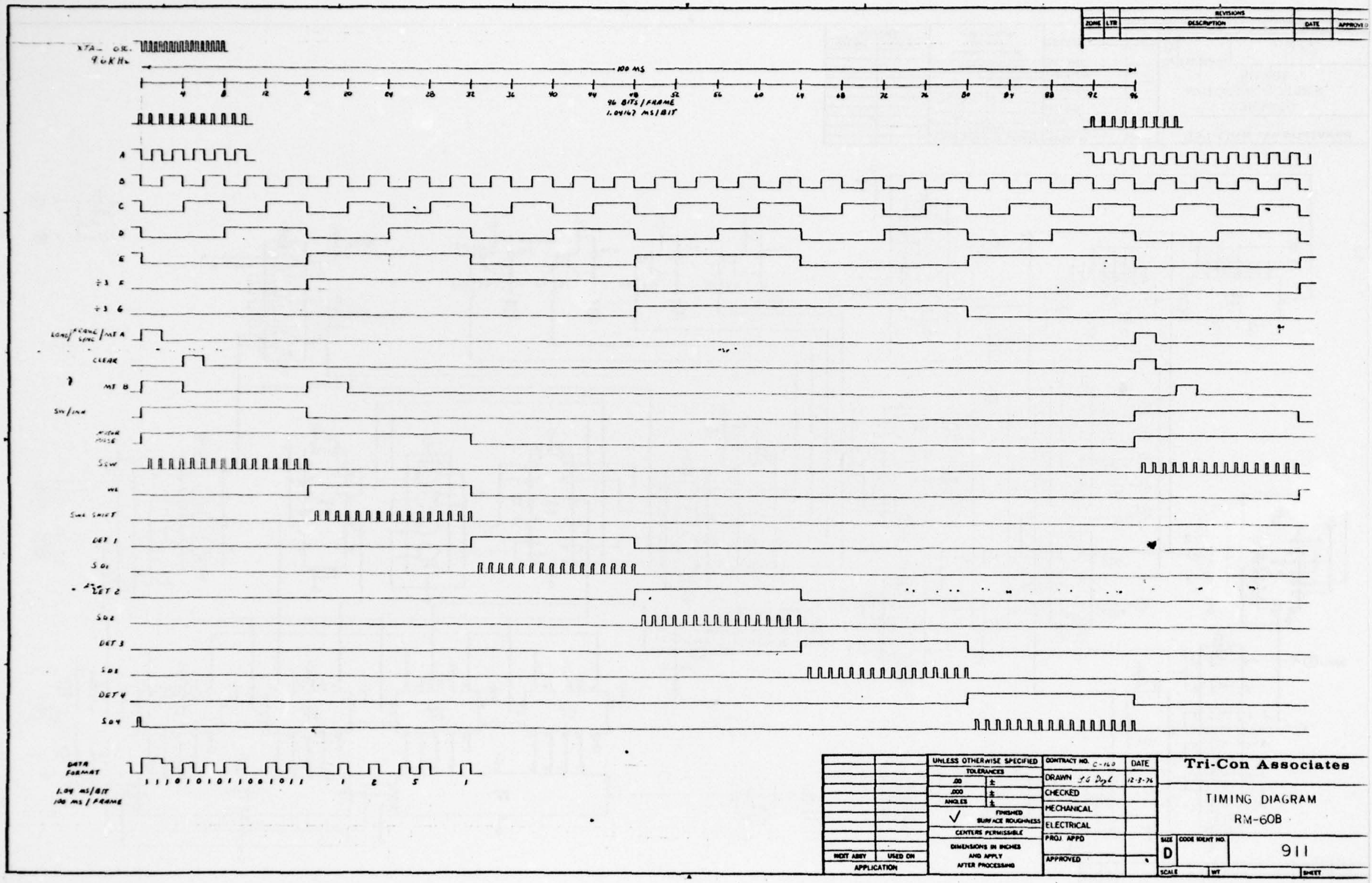


Figure 4. Timing Diagram RM-60B

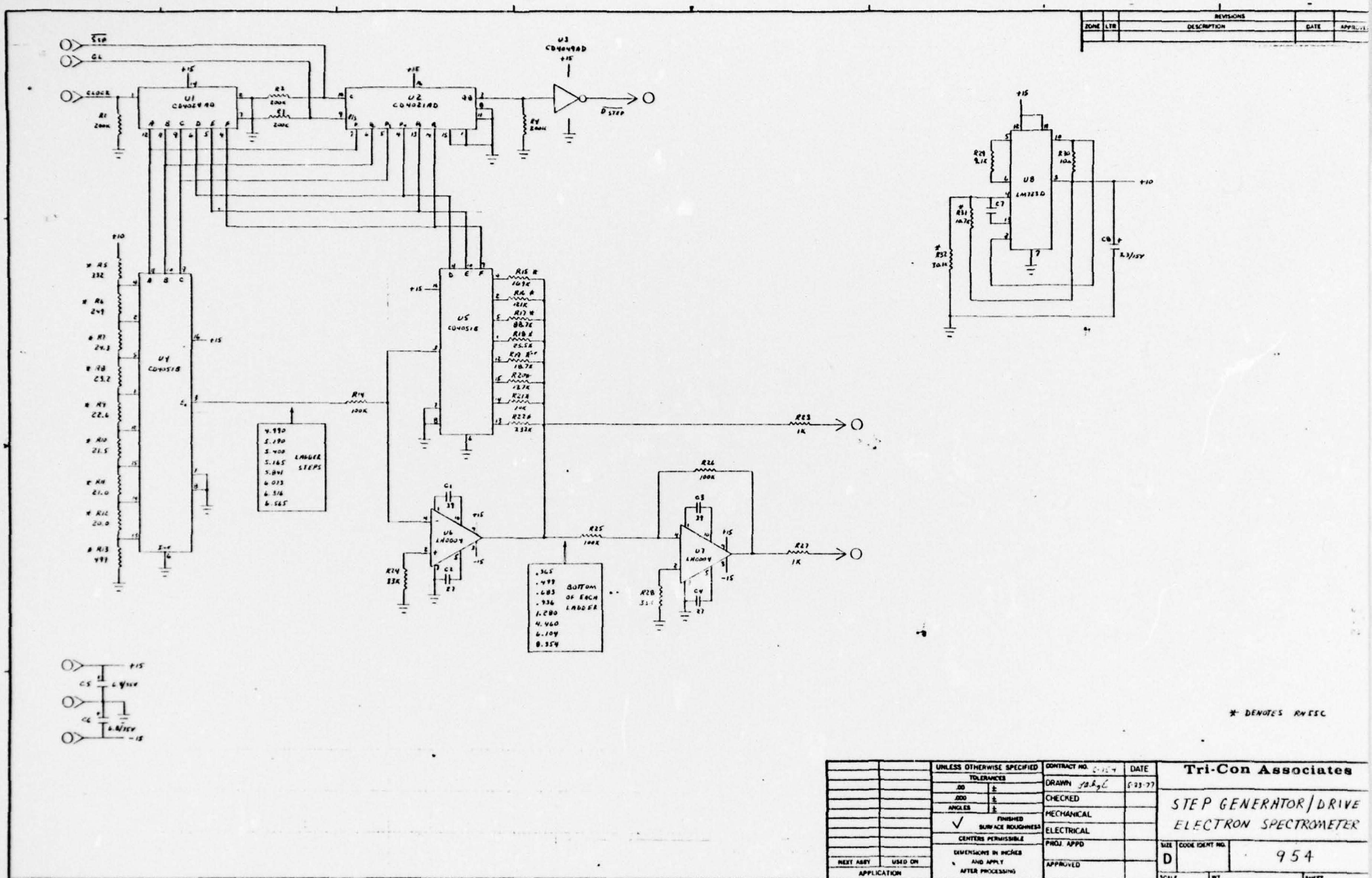
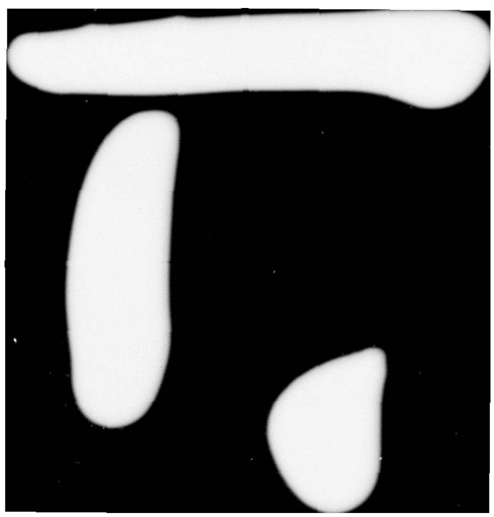


Figure 5. Step Generator/Drive Electron Spectrometer



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Final Report
F19628-76-C-0041

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John F. McGrath
Joseph P. Padur

Errata

Delete the name of John F. McGrath from the cover and Block 7 of the DD Form 1473.

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