PROPOSAL TO DESIGN AND FABRICATE CURSOR GENERATING CIRCUITRY (U)

Addendum 4 to
Proposal No. C126-CP65

Dated 9 May 1966

Electronic and Optical
Systems Department

Amendment No. 2

TEXAS INSTRUMENTS
INCORPORATED

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SECTION I

INTRODUCTION

Texas Instruments proposes to design and fabricate certain cursor generating circuitry for the FLIR system now under contract in order to provide proper interface with prospective airframe contractors and in order for the FLIR to be integrated properly into the total avionics system.

SECTION II

TECHNICAL DESCRIPTION

Four cursors are required for integrating the Forward Looking Infrared (FLIR) subsystem into the avionics system. They are as follows:

1. Fixed Elevation Boresight.
2. Vertical cursor displaced from centerline by a computed amount.
3. Two indexing marks at top and bottom displaced from centerline by a computed amount.

4. Horizontal cursor displaced from center downward by a computed amount.

The cursors described above will be generated electronically and displayed on the face of the crt as bright lines. Figure 1 shows the proposed format on the display.

The fixed elevation boresight cursor is generated by adding a 15-VDC level to the vertical sweep waveform. This new form fires a Schmitt trigger circuit. The output of the Schmitt trigger is shaped by a monostable multivibrator to give a controlled-short pulse. This pulse, when added to video, yields the fixed horizontal line. Figure 2A shows the block diagram of this proposed circuit. The vertical sweep waveform has a peak voltage of 30-VDC which represents the extreme lower limit of the display format. The addition of the dc-level would intersect the sawtooth at 15-volts which would center the horizontal boresight line on the display. The monostable-multivibrator output is a square wave. The width of this square wave is adjusted to illuminate one horizontal-scan line.

The vertical cursor is generated by adding a variable dc-level to the horizontal-sweep trigger waveforms. Again, the resultant waveform fires a Schmitt trigger. Since the vertical line is a series of dots, the output added to video must be very short pulses. The pulses, or spikes, are obtained by differentiating the output of the Schmitt trigger.

Position of the vertical cursor is determined by the variable-dc-voltage level which operates on the horizontal sweep saw-tooth wave. Peak voltage of the horizontal sweep is 15-VDC. Figure 2B shows the block diagram of the circuitry required.

Two indexing marks are generated by adding two fixed dc-levels to the vertical-sweep waveform. The two separate outputs each fire a Schmitt trigger. This output is then shaped by a multi-vibrator. The two, short square-waves obtained from the multi-vibrator trigger a gate circuit which allows a series of pulses to pass to the video. These pulses generate a short, vertical line at the top and bottom of the display. The gated pulses are obtained similarly to pulses which generate the vertical cursor. They require a variable dc-level which determines the horizontal location of the indexing marks.

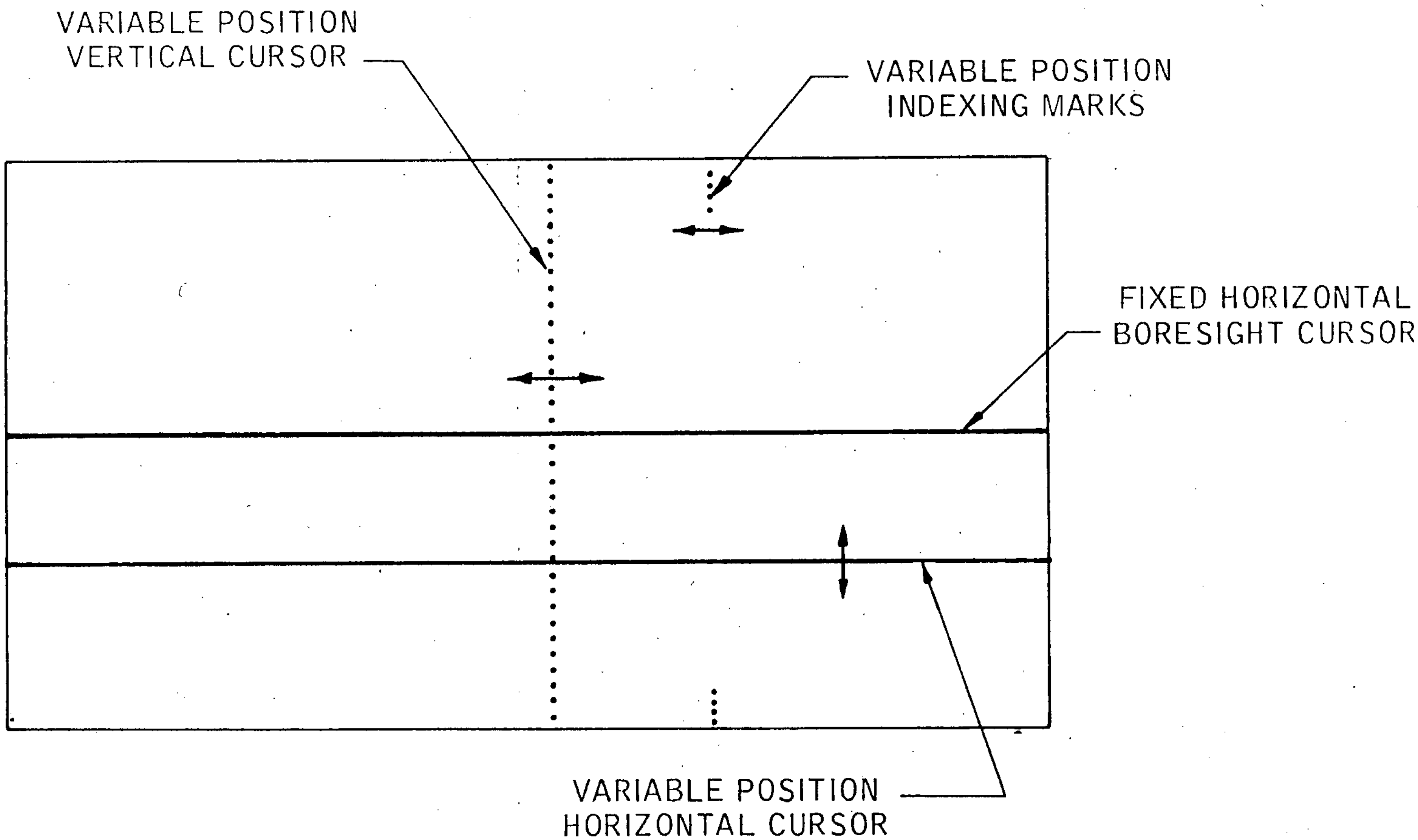
VARIABLE POSITION
VERTICAL CURSOR
VARIABLE POSITION
INDEXING MARKS
FIXED HORIZONTAL
BORESIGHT CURSOR
VARIABLE POSITION
HORIZONTAL CURSOR

FIGURE 1.

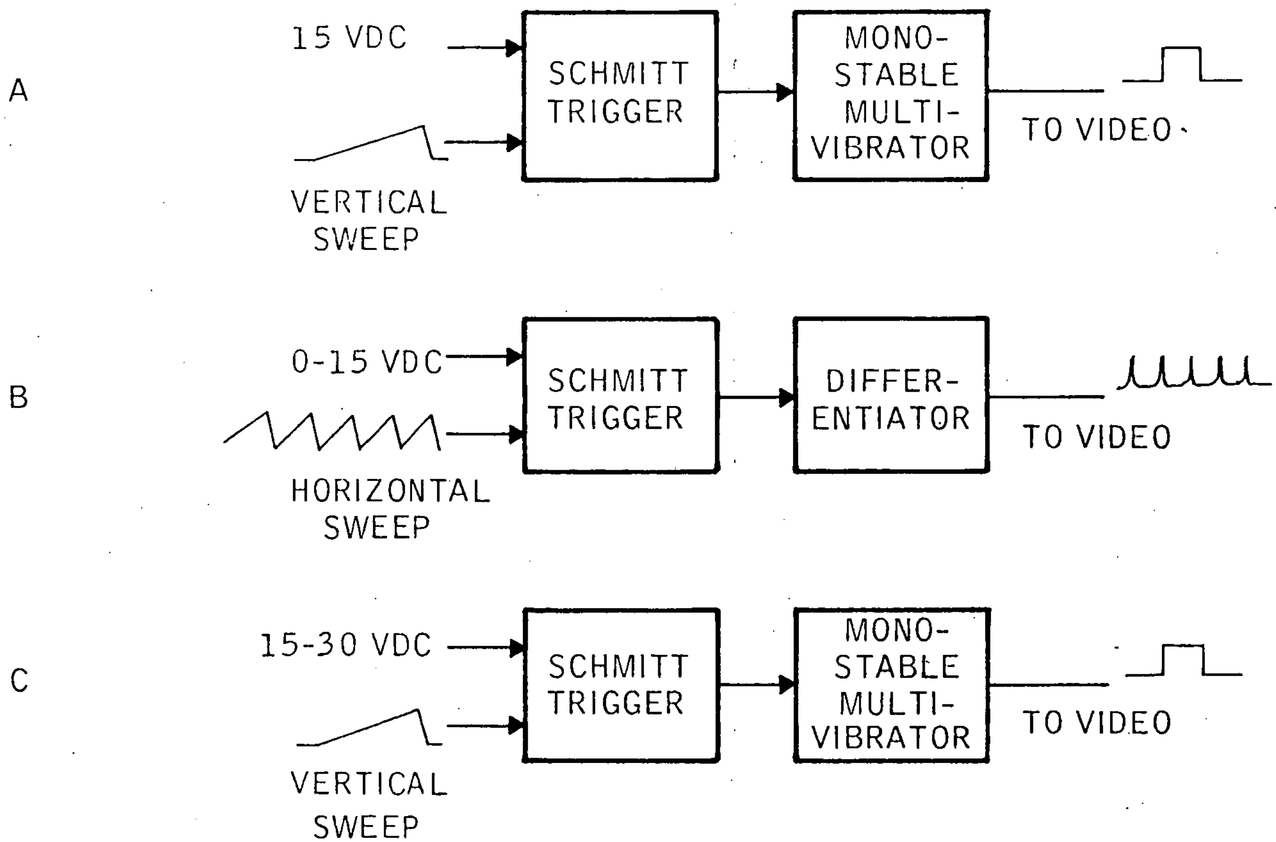
A
15 VDC
SCHMITT TRIGGER
MONO-STABLE MULTI-VIBRATOR
TO VIDEO
VERTICAL SWEEP
B
0-15 VDC
SCHMITT TRIGGER
DIFFER-ENTIATOR
TO VIDEO
HORIZONTAL SWEEP
C
15-30 VDC
SCHMITT TRIGGER
MONO-STABLE MULTI-VIBRATOR
TO VIDEO
VERTICAL SWEEP

FIGURE 2.

The two, fixed dc-voltages are chosen to locate the indexing marks vertically. An input of 2-VDC will fix the top index while the 28-VDC input will locate the bottom index. Width of the square-waves out of the multivibrators is adjustable and determines how many pulses pass to video and therefore control the vertical length of the indices. Figure 3 shows the block diagram.

The variable location horizontal cursor is obtained in the same manner as the boresight cursor. Vertical location is determined by the variable dc-level added to the sawtooth waveform. Figure 2C shows the block diagram.

This method of generating cursors represents the least amount of modification to the present system and would not require elaborate mechanisms. Although some work would be required to make this circuitry compatible with the existing electronics, packaging can be done within the present electronics unit.

Figure 4 shows the proposed location of the printed circuit boards in the electronics unit. Figure 5 is the bottom view of the electronics unit which shows the cable harness and terminal block. The terminal block will be moved to accommodate installation and wiring of the circuit-board connectors. Cable harness modification will also be necessary.

Because existing sweep waveforms are sampled and operated on to obtain proper video inputs, some modification to existing circuits may be necessary to match impedances and prevent overloading. For this reason, Texas Instruments must retain the entire system during the integration and systems test.

SECTION III

PROGRAM SCHEDULE

The effort proposed in Section II consists of:

3.5 man-months of engineering
3.0 man-months of drafting
3.0 man-months of processing and assembly
4.0 man-months of technician effort.

The items and services include design and processing of the necessary circuitry and interfacing of the FLIR system in order to accomplish the design described in Section II.

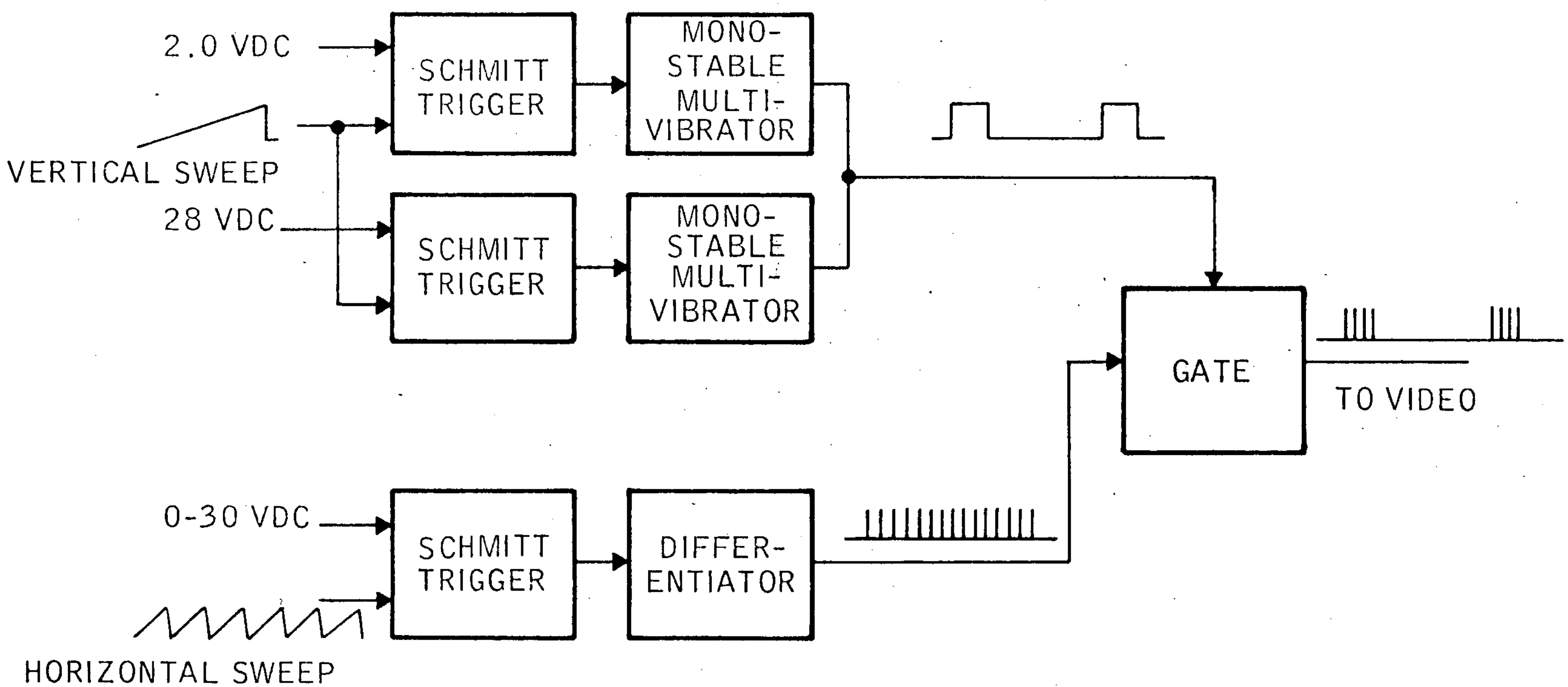
2.0 VDC
VERTICAL SWEEP
28 VDC
SCHMITT TRIGGER
MONO-STABLE MULTI-VIBRATOR
SCHMITT TRIGGER
MONO-STABLE MULTI-VIBRATOR
GATE
TO VIDEO
0-30 VDC
HORIZONTAL SWEEP
SCHMITT TRIGGER
DIFFER-ENTIATOR

FIGURE 3

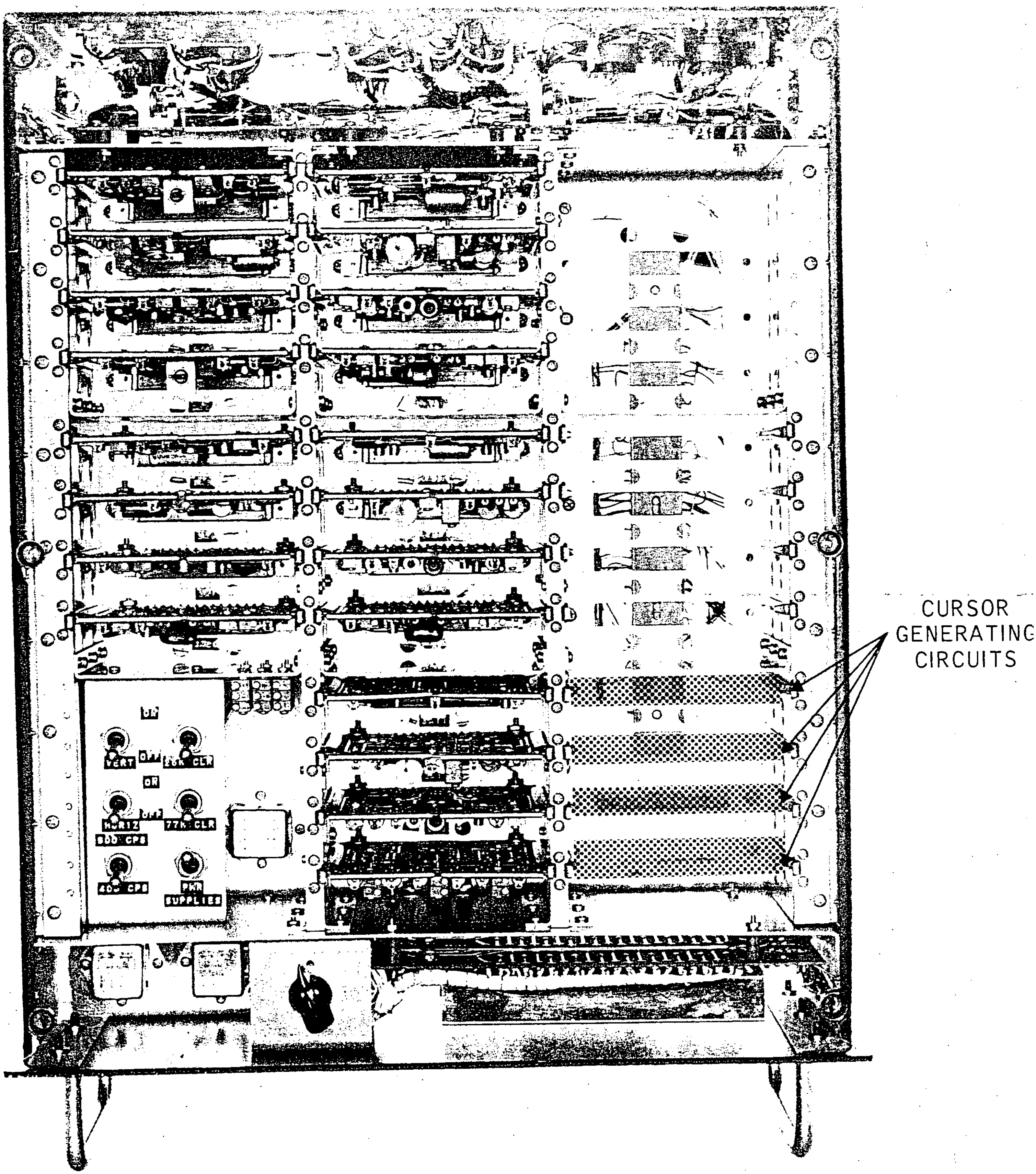
CURSOR GENERATING CIRCUITS
ON
VERT
OFF
26K CLR
OR
HORIZ
77K CLR
800 CPS
400 CPS
PWR SUPPLIES

Figure 4

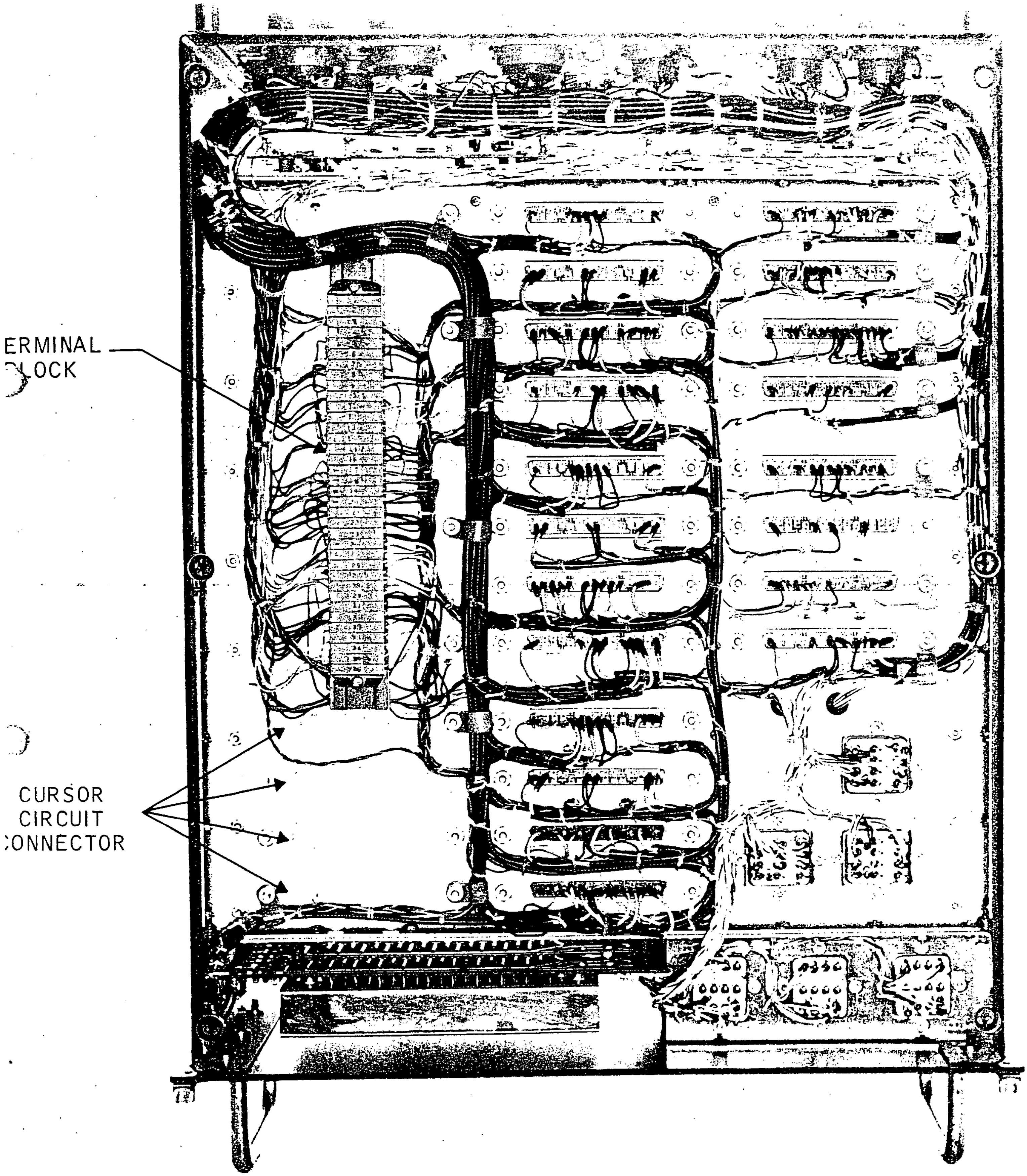

Figure 5

Enclosure (1)

TEXAS INSTRUMENTS INCORPORATED
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PROPOSAL TO MODIFY FLIR-3 SYSTEM FOR IMPROVED PERFORMANCE

Proposal No. C126-CP65
Part 6
7 December 1966

TABLE OF CONTENTS

I. INTRODUCTION

This proposal describes the modifications necessary for increasing sensitivity and ease of operation of the FLIR 3 system.

Increased sensitivity will increase range of target detection and allow more flexibility of tactics.

Ease of operation is obtained by allowing two operators to exercise alternate control and increase crew comfort.

II. SYSTEM MODIFICATION

A. Scanner.

The primary modification of the scanner unit involves installation of a revised detector array. The configuration of the new array is shown in Figure 1. This configuration allows operation of both detectors at 26°K in a single cooler. This modification allows removal of the dichroic mirror which accounts for 50% transmission loss at 14 microns.

The detector is oriented in the configuration shown to obtain the smallest possible image plane. The InSb array is a wafer substrate with the sensitive areas etched by photographic process. The .010 inch spacing will insure negligible cross talk and can be controlled within a few thousands of an inch.

Item 2

The Ge:Hg bars will be indium soldered to individual copper substrates. The bars are lapped to the .040 thickness. Thickness of the copper substrates is extremely uniform and usually made .002 to .005 inch thicker than the detector bar width. Bar location on the substrate is held within .001 inch of the desired location. By stacking the substrate-bar subassembly, very accurate spacing can be achieved. This assembly technique allows individual bars to be replaced in case of failure.

The cooler-detector assembly will be relocated and new mounts fabricated. The optic path changes since the detector is now at the system focal point. This necessitates use of a new pyramidal elevation mirror.

B. Display.

A matrix-grid cathode ray tube will be installed in each display replacing the three-gun CRT. Of the 30 available apertures in the matrix, three will be used. The leading six Ge:Hg detectors will be electrically delayed and added to the trailing set of three InSb detectors.

Measured spot size of the matrix CRT is .015 inch. A .017 maximum spot size is required for 2 mr spatial resolution.

Since horizontal convergence is not required with the matrix CRT, two convergence printed circuit boards and one convergence coil assembly will be removed. Redesign of the Bias Regulator Circuit will be necessary since the matrix CRT requires different grid bias than the existing CRT.

Because extensive rewiring is necessary, the display package will be redesigned to allow relocation of sweep driver heatsink assembly. Relocation will allow use of internal blower so that excessive heat rise will not occur.

Item 2

C. Electronics Unit.

Figure 2 shows the video block diagram with changes noted in red. The new detector configuration with appropriate delay lines will superimpose video from all detectors. Detectors 7, 8 and 9 will be electronically delayed and added to 4, 5 and 6. This summed video is then delayed and added to video from detectors 1, 2 and 3. A seventh delay line then delays the summed video from detectors 2, 5 and 8 to correspond with the No. 2 MATRICON grid displacement.

Since all video is now superimposed, the second set of adder circuits (adjusted externally by control unit knob) can be modified to allow 100% of each spectrum to be simultaneously displayed. Previously, as video from one spectrum was increased, the other spectrum was proportionally attenuated.

Item 1

D. Auxiliary Control Unit.

Operational requirements for the FLIR 3 System have necessitated integration of a second control unit into the system. This auxiliary control will allow a second operator to control all system functions except turn on-off capability.

The functions to be remotely controlled will be Scanner Elevation Positioning, Detector Selection, and Hotspot Threshold Level. Provision will be made to switch control from the main location to the remote location at either station. A light will indicate which station is active; simultaneous control will not be possible. System OFF-COOLDOWN-OPERATE Control will not be duplicated at the remote location, but indication lights will be provided to show system status.

Incorporation of the change requires design of an Auxiliary Control Unit (ACU), modification of the existing Control Unit (CU), and addition of one cable between the two units. No other changes to the system or cabling will be required. This change will not affect the present provisions for control by an external computer.

Item 1

The ACU will consist of a control transmitter and gear box for scanner elevation positioning, a 25 K OHM potentiometer for hotspot marker threshold level, a ganged 50 K OHM potentiometer for video selection, and a 500 OHM rheostat for light intensity adjustment of an edge-lighted panel. Push-to-test, dimmable, pilot lights will be provided to show when the ACU is active and when the system is in cool-down and operate. A switch is included to relinquish or take control. Communication with the main control unit will be by a single cable utilizing a 26 pin connector. All power and excitation voltages will come from the main control unit.

Modification to the main control unit will include removal of one relay, addition of four 4PDT relays, and two SPDT relays. A new edge-lighted panel will be provided as well as a switch to transfer control between the stations. A new pilot lamp will indicate when the panel is active. An additional 26 pin connector will be installed for communication with the ACU. System OFF-COOLDOWN-OPERATE control will remain here and not be duplicated. The

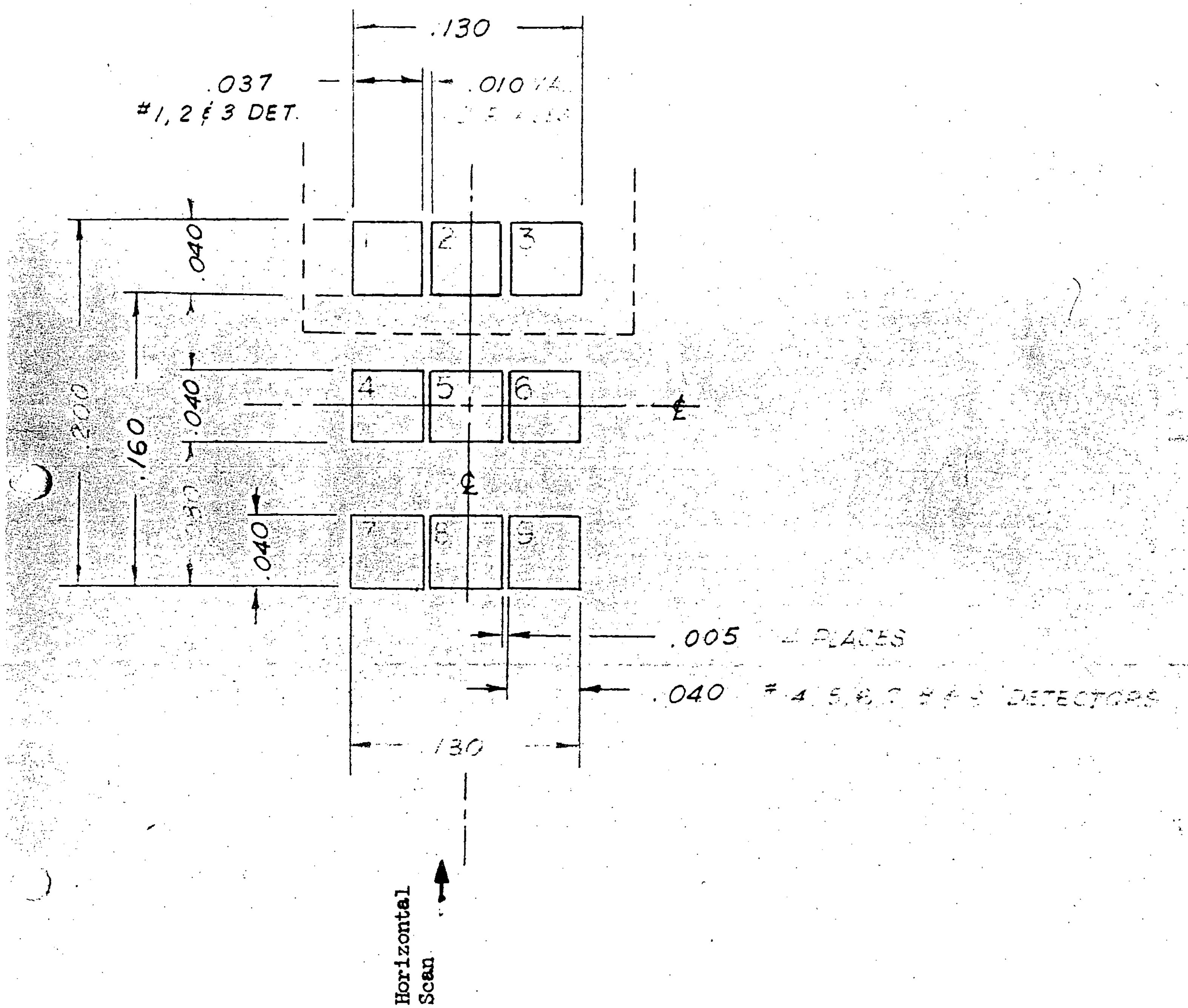
Scanner automatic stowing synchro and logic will remain here and not be duplicated.

Because of long lead time vendor items delivery could not be made before 6 January 1967. If the system is already delivered, the contractor would require the return of the existing Control Unit for one week for modification. If this is unacceptable, a modification kit will be provided and Field Service Personnel can perform necessary modifications to the Control Unit.

III. PROGRAM SCHEDULE

Figure 4 shows the delivery date for the modified system. The modification program started with a detector configured as shown in Figure 3. This detector orientation was dictated because InSb arrays were fabricated and design time for the base was minimum. However, this detector does not superimpose video from both spectrums. The InSb video is displaced down and to the left. Intense targets (hot or cold) would have "ghosts" of varying intensity depending upon the Video Selector knob setting. Since the cursors are triggered from the middle channel of the Ge:Hg sweep, a target appearing on the InSb sweep would be displaced 10 mr from true location as defined by the horizontal cursor. Stores drop could be accomplished with Ge:Hg video only.

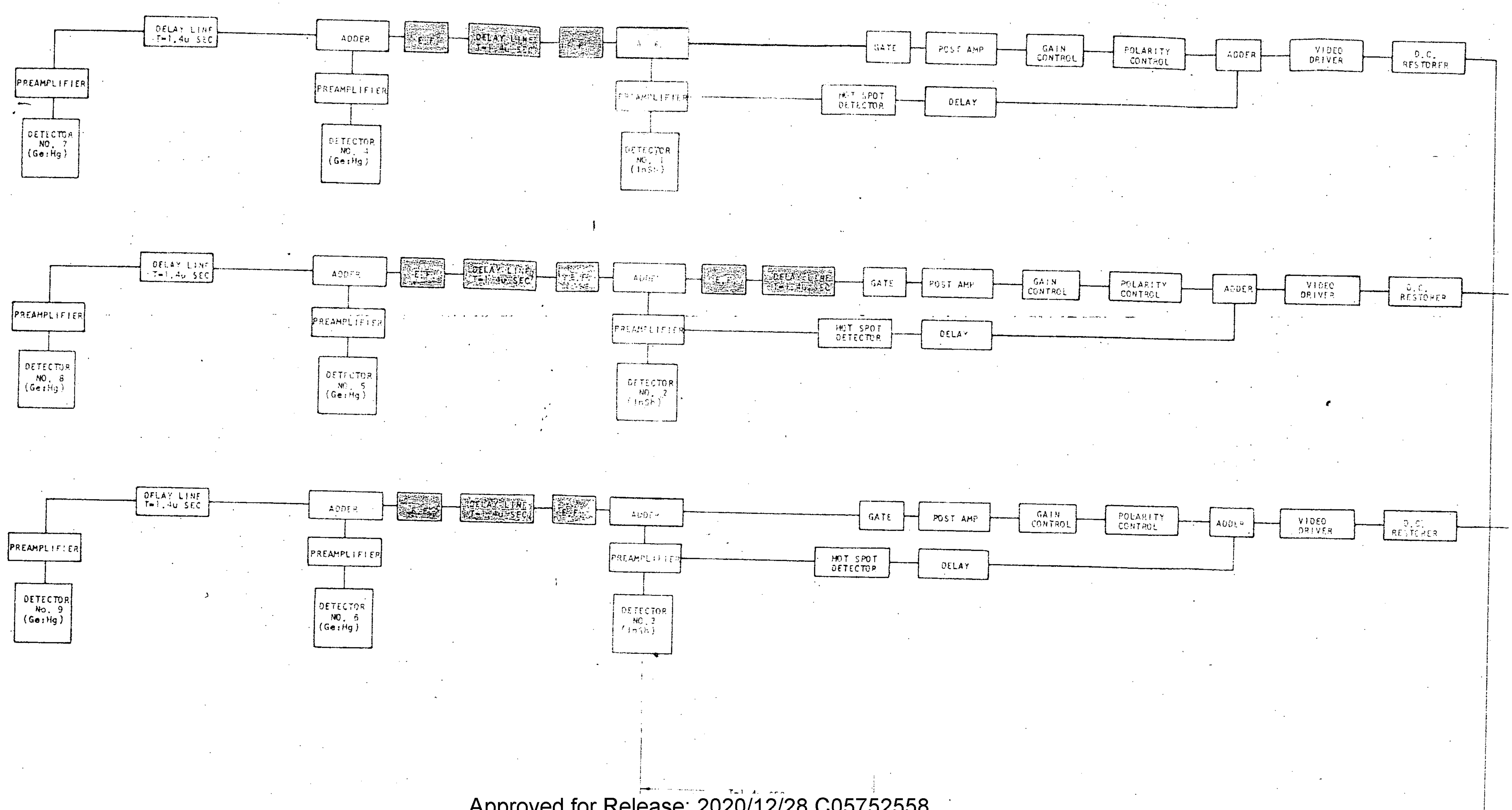
The new detector (Figure 1) would eliminate this undesirable feature. Since it is a new design, the detector will not be received before 30 December. As is the case with the auxiliary control unit, a modification kit may be supplied to Field Service Personnel if the program schedule will not allow in-plant modifications.

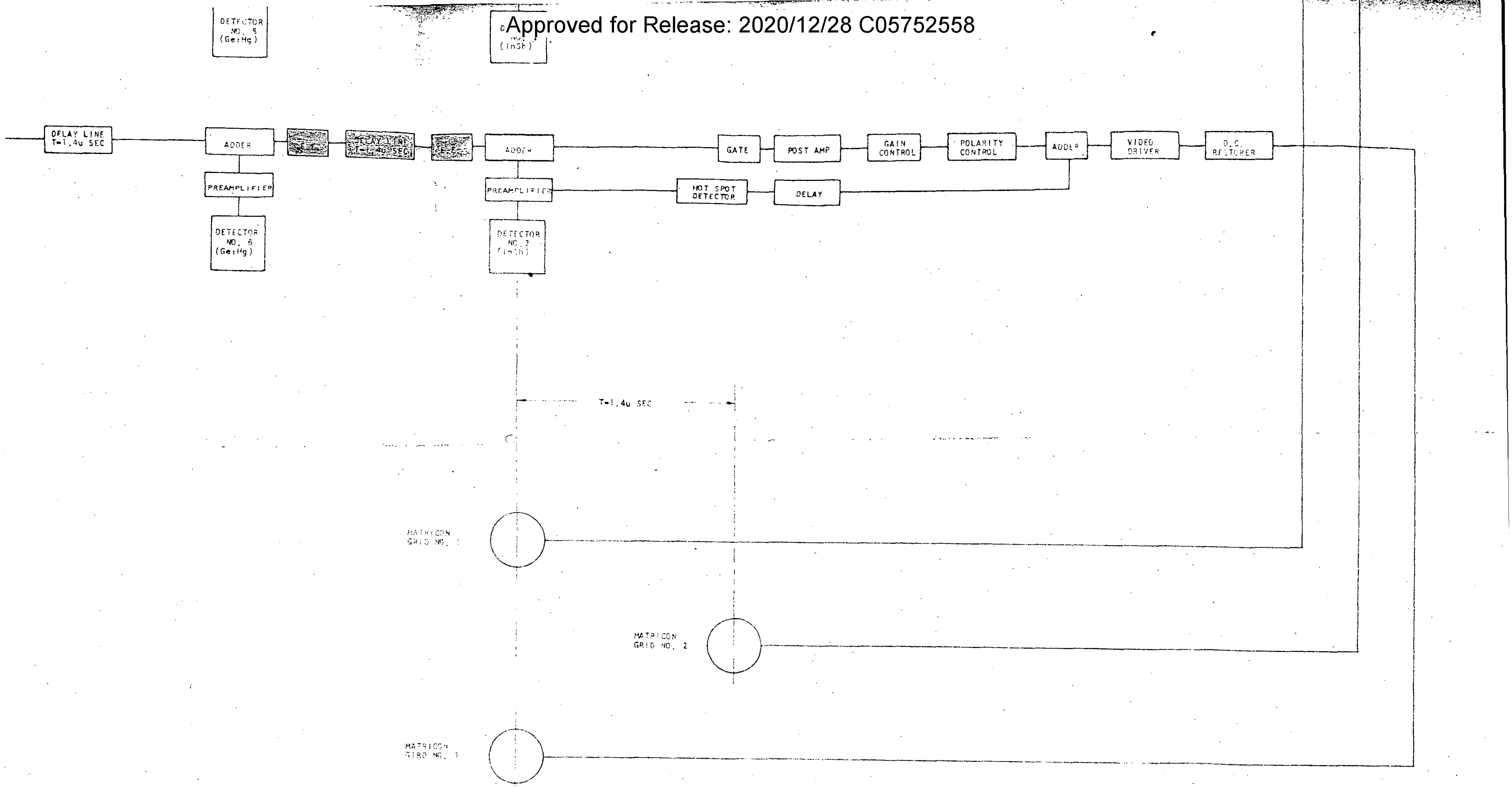


Material: Detector 1, 2, and 3 InSb
Detector 4 through 9 Ge:Hg

New DETECTOR CONFIGURATION

FIGURE 1


DELAY LINE T=1.4u SEC
ADDER
PREAMPLIFIER
DETECTOR NO. 7 (Ge:Hg)
DETECTOR NO. 4 (Ge:Hg)
DETECTOR NO. 1 (InSb)
E.F.
GATE
POST AMP
GAIN CONTROL
POLARITY CONTROL
VIDEO DRIVER
D.C. RESTORER
HOT SPOT DETECTOR
DELAY
DETECTOR NO. 8 (Ge:Hg)
DETECTOR NO. 5 (Ge:Hg)
DETECTOR NO. 2 (InSb)
DETECTOR No. 9 (Ge:Hg)
DETECTOR NO. 6 (Ge:Hg)
DETECTOR NO. 3 (InSb)



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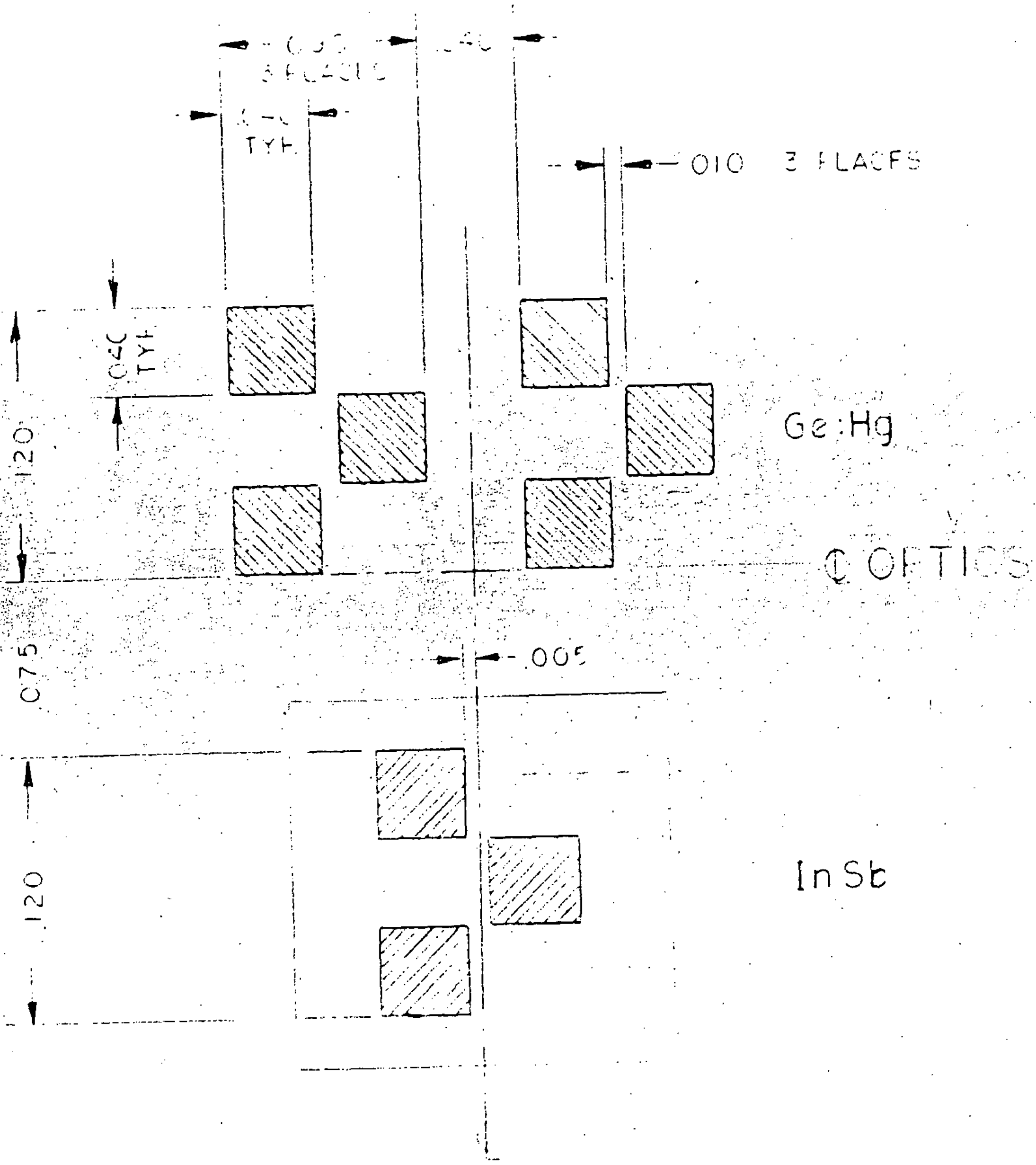
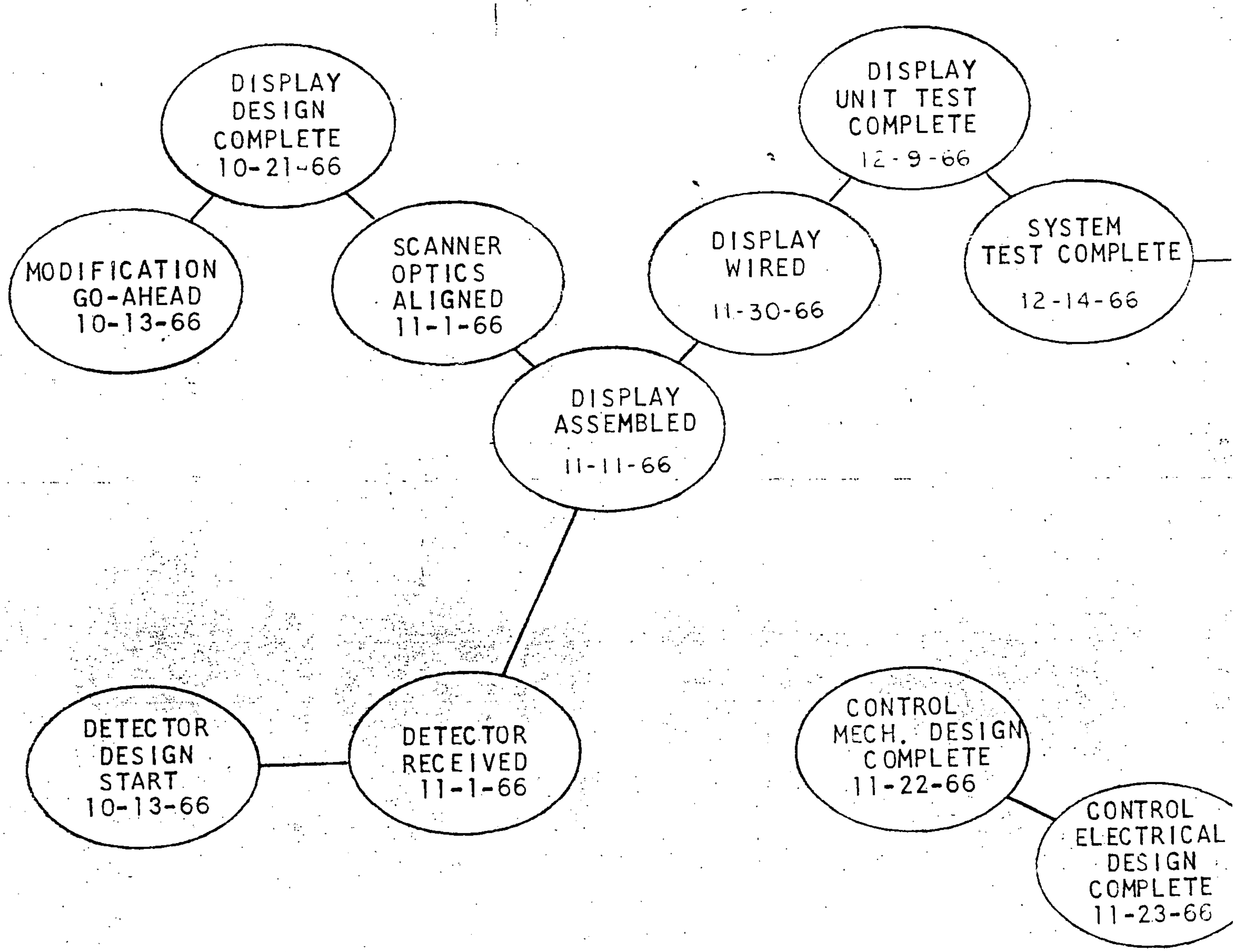


OLD DETECTOR CONFIGURATION

FIGURE 3

PERT

FL

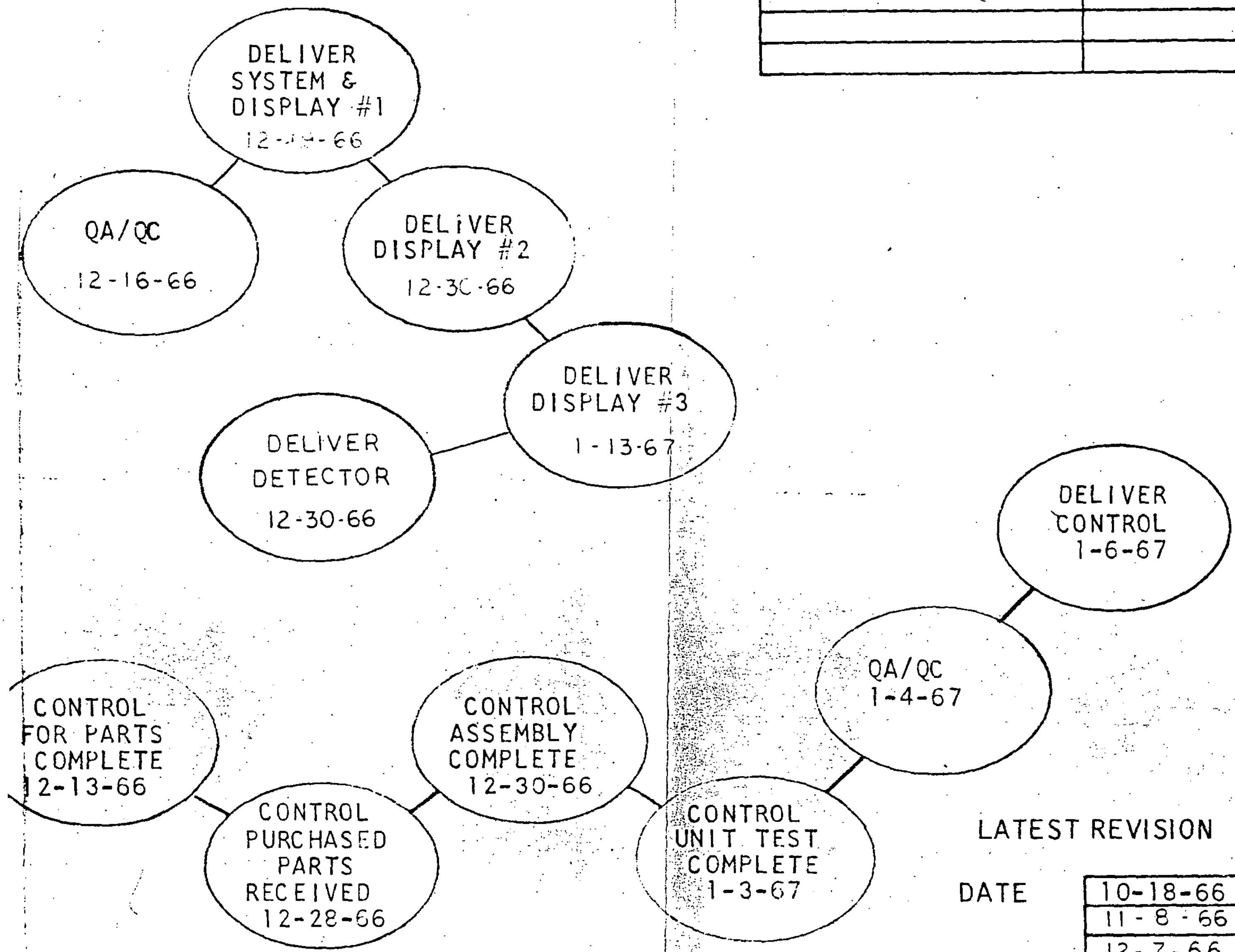

DISPLAY DESIGN COMPLETE 10-21-66
MODIFICATION GO-AHEAD 10-13-66
SCANNER OPTICS ALIGNED 11-1-66
DISPLAY ASSEMBLED 11-11-66
DISPLAY WIRED 11-30-66
DISPLAY UNIT TEST COMPLETE 12-9-66
SYSTEM TEST COMPLETE 12-14-66
DETECTOR DESIGN START 10-13-66
DETECTOR RECEIVED 11-1-66
CONTROL MECH. DESIGN COMPLETE 11-22-66
CONTROL ELECTRICAL DESIGN COMPLETE 11-23-66

FI(

CHART
3

CONTRACT REQUIREMENTS

ITEMS	DATES



LATEST REVISION

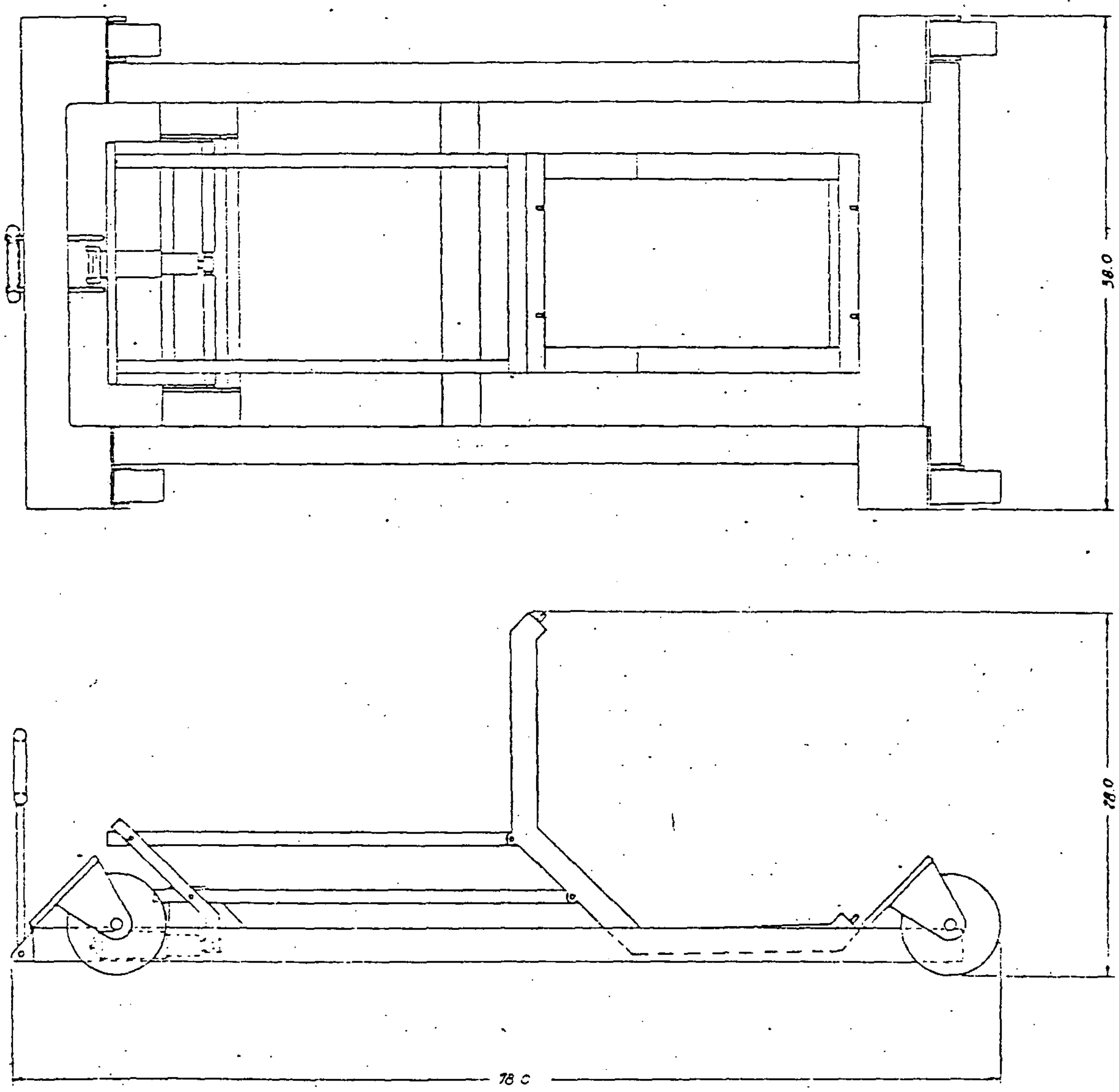
DATE	
	10-18-66
	11-8-66
	12-7-66

RE 4

BY Raymond E. Vache [signature]

 Enclosure (6)

The scanner handling cart is used for installation and removal of the scanner from the aircraft and transportation and storage when the scanner is out of the aircraft. The cart will allow the scanner to be operated when outside the aircraft and facilitate routine maintenance. Operation of the cart will utilize a hydraulic jack working through a parallelogram-type linkage to continually maintain the scanner platform in its normal attitude with respect to the aircraft. This will simplify installation and removal of the scanner as well as allow the elevation servo to be realistically exercised when the scanner is out of the aircraft.



SCANNER HANDLING CART

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