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Technical Report - SDC 279-3-10

PRELIMINARY LAYOUT OF CONTROLS AND DISPLAYS ON THE APA-56 PRODUCTION CONSOLE.

New York University — SDC Human Engineering Project 20-F-4
Human Engineering Project — Contract N6onr-279, T.O. III
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FOREWORD

This research was designed to produce a console configuration for the AN/APA 56 which would enable the operator to make optimal use of the equipment. The results of this study are contained in Figure 1 in the body of the report. It is recommended that this console design be incorporated in future models of the AN/APA 56.

James J. Regan
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LIST OF FIGURES

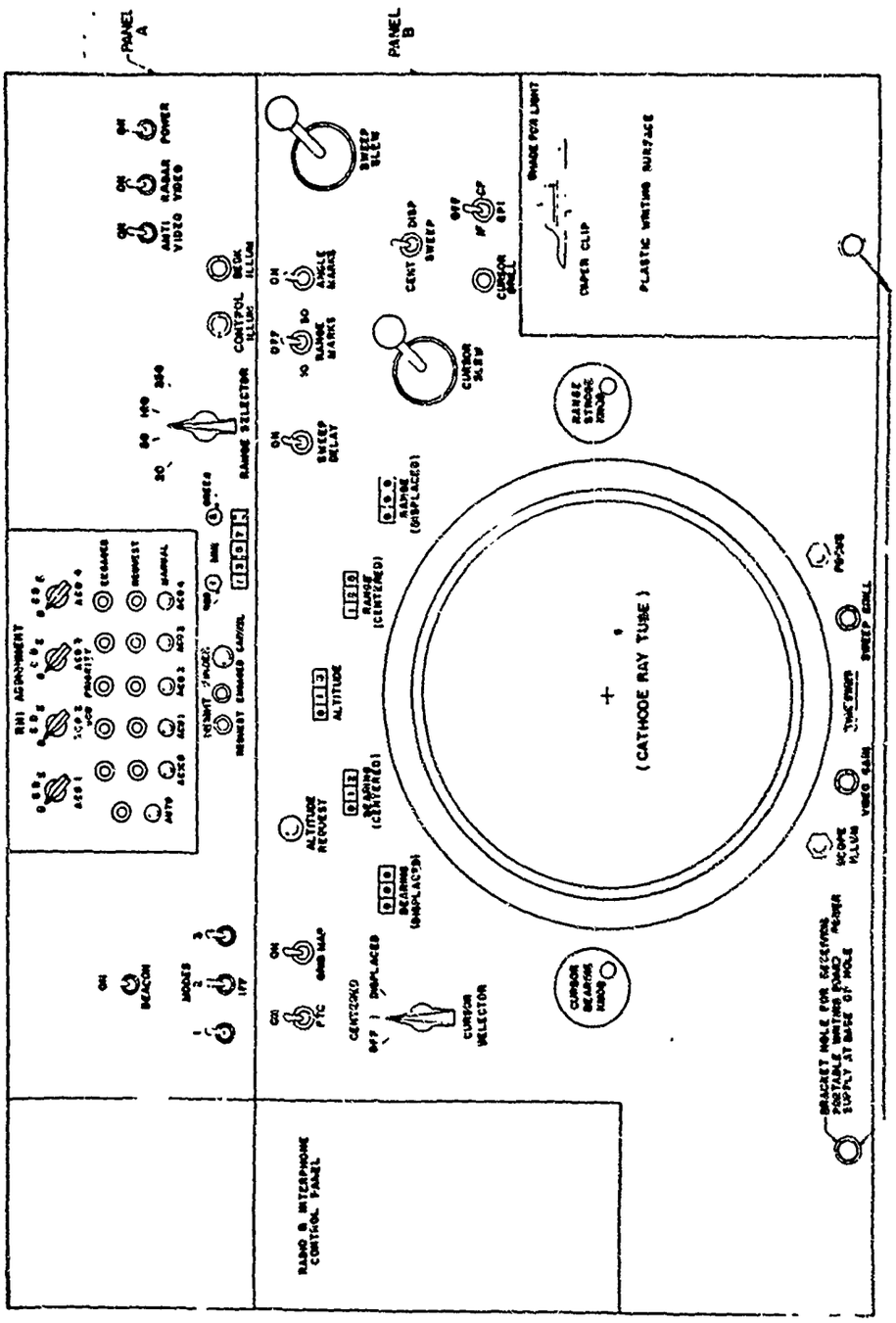


Figure 1

Complete Layout of Controls and Displays on the APA-56 Console.

The purpose of this report is to present the results of a study to determine the optimal layout of the controls and displays of the AN/APA-56 console in accordance with the Bureau of Aeronautics specifications MIL-I-6988A (Aer), 1 July 1951. The console layout (Figure 1) is designed to conform as much as possible with human engineering principles.

The proposed layout is the result of research by the New York University Human Engineering Group following recommendations contained in Memorandum Report SDC-279-3-1, (5), and is based upon extended observation of air control officer performance with the prototype equipment and consultation with Naval personnel.

The APA-56 consoles are the main components of the airborne Combat Information Center in the WV-2. The air control officer (ACO) using the console obtains the radar information which permits him to carry on his various functions, the most important of which is probably to provide airborne early warning. Of nearly equal importance is the air control of intercepts. In addition to these functions, the operator might be called upon to perform the following:

1. Strike coordination
2. Anti-submarine warfare functions
3. Search and rescue work
4. Homing lost aircraft
5. Obtaining weather information

It is important, therefore, that the ACO be able to operate the console with maximal efficiency and minimal effort.

In arriving at a control panel design, various sources of data were used. Data from research in motion study, psychology and physiology were appled (1, 2, 3, 4, 6). In addition, reports of Naval personnel based on their experience with the WV-1 and other airborne radar equipment were utilized.

In general the following factors determine the location of individual controls and displays:

1. Function of controls and displays
2. Frequency of their use
3. Relationship between control and display
4. Necessity for distinguishing one control or display from another
5. Principles of motion economy (1)
6. Design limitations

We can consider that the operator's position is the focal point from which radiates the location of displays and controls (1). His primary stimulus is provided by the cathode ray tube, which has been positioned in front of him for ease of viewing and accessibility for writing thereon.

With the foregoing considerations in mind, let us examine the arrangement of the group composed of the altitude counter and request button, the centered and displaced bearing and range counters with their control knobs, the cursor selector switch and the cursor joy stick (Figure 2). This group may be considered together since the individual control and display is operated and viewed in a sequential manner. The centered cursor presentation is used when requesting altitude information from the height

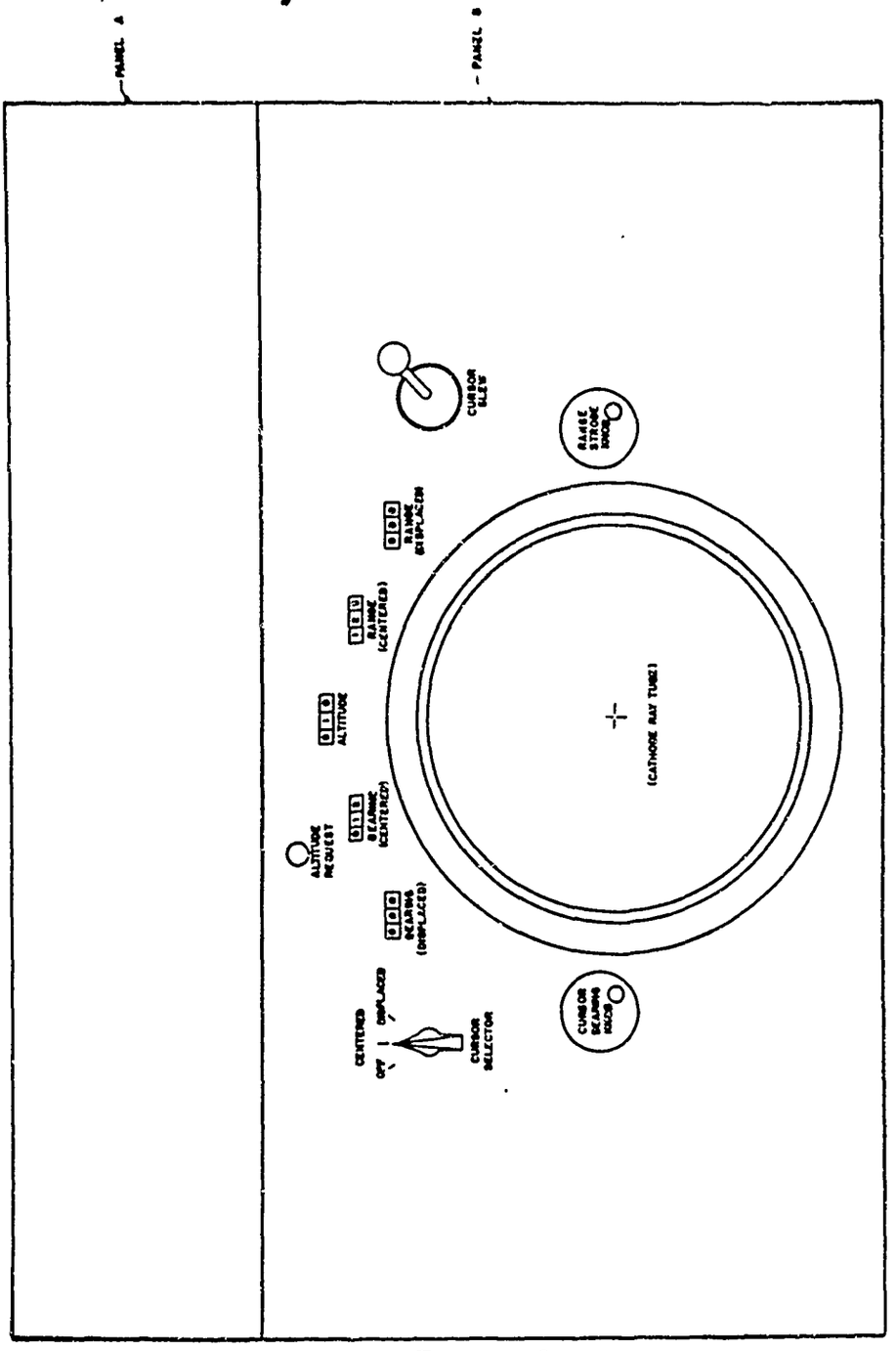


Figure 2

Console Detail

finder as well as in determining range and bearing of targets with relation to the WV-2. With the cursor selector switch in the displaced position, bearing and range may be obtained between one pip and another without relation to the WV-2.

The optimal arrangement of displays is to have them grouped in such a manner that the operator need look at only one area on his console to obtain the desired information. They should also be placed near the cathode ray tube so that the attention of the operator, when looking at them, is diverted as little as possible from the tube. Such an arrangement has been followed to the extent allowed by the limitations of the design. See Figures 1 and 2.

Figure 3 is a drawing of the console giving the overall dimensions. These dimensions were based upon the following requirements:

1. The console operator while sitting must be able to look over the console and see the aft display board which is placed in front of the console operators.

2. The console must be removable from the WV-2 for maintenance without disturbing any other equipment.

3. Aisle space must be maintained in order that the CIC crew can move freely in the aircraft.

The allocation of controls to both the right and left hand is shown in the right- and left-hand process charts, Operation 1, Figure 4 and Operation 2, Figure 5. The counters related to each of the control knobs are placed on the corresponding side of the operator for kinesthetic assocation, and to conform to manufacturing design limitations.

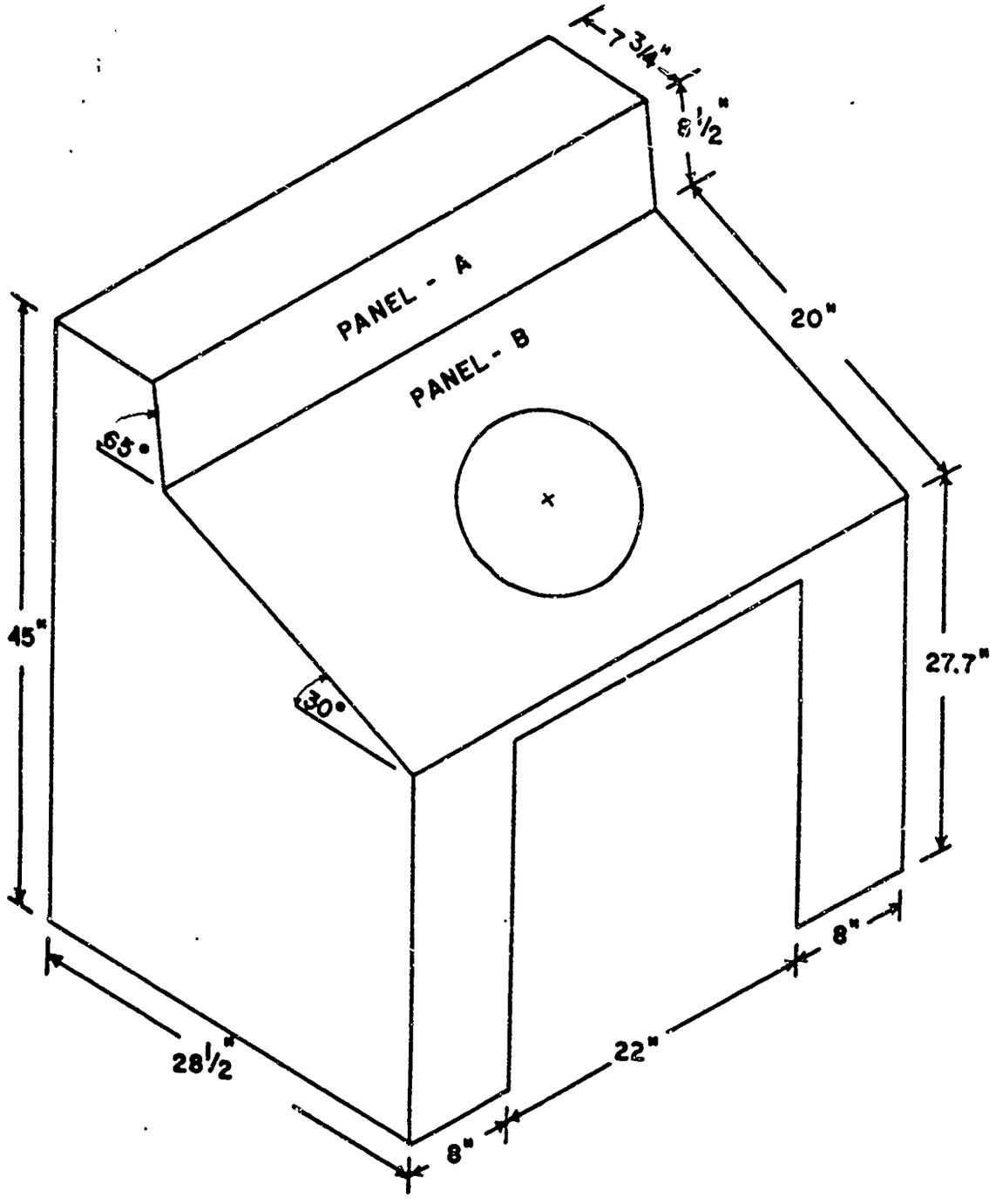


Figure 3

APA-56 Console Configuration

Referring to Figure 2 the reader will note that the centered range and bearing counters have been placed close to one another in a centered location with the displaced counters below and displaced laterally from the centered counters. When the cursor selector switch is in the displaced position, only the displaced bearing and range counters will be illuminated; conversely the centered counters will be illuminated only when the switch is in the centered position.

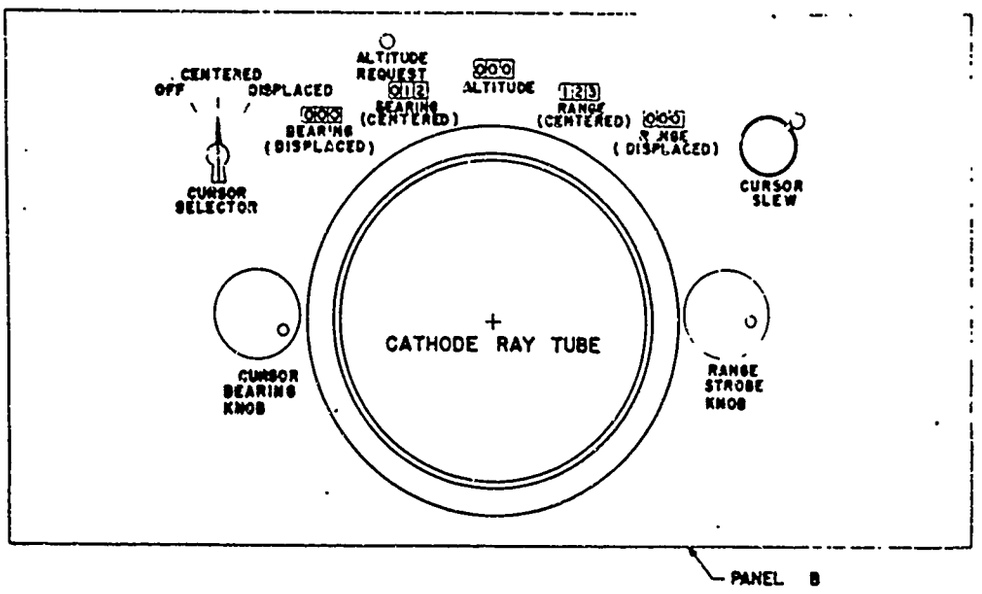
The altitude counter has been placed midway between and slightly above the centered range and bearing counters.

The altitude request button has been placed to the left of the altitude counter for use by the left hand, as shown in Operation 1, Figure 4.

In order that the right-handed operator may make the fine adjustments necessary in the operation of the cursor slew, the cursor slew joy stick has been assigned to the right hand. To balance the load between hands, the cursor selector switch has been assigned to the left hand.

The right- and left-hand process charts of Figure 4 and Figure 5 show adequate utilization of both hands in obtaining bearing, range and altitude of a target with the centered cursor presentation, and range and bearing of one target to another with displaced presentation.

The placing of the controls and displays which are described below is not determined by an analysis of sequence of operations, as was the case with the group already discussed. Their use is



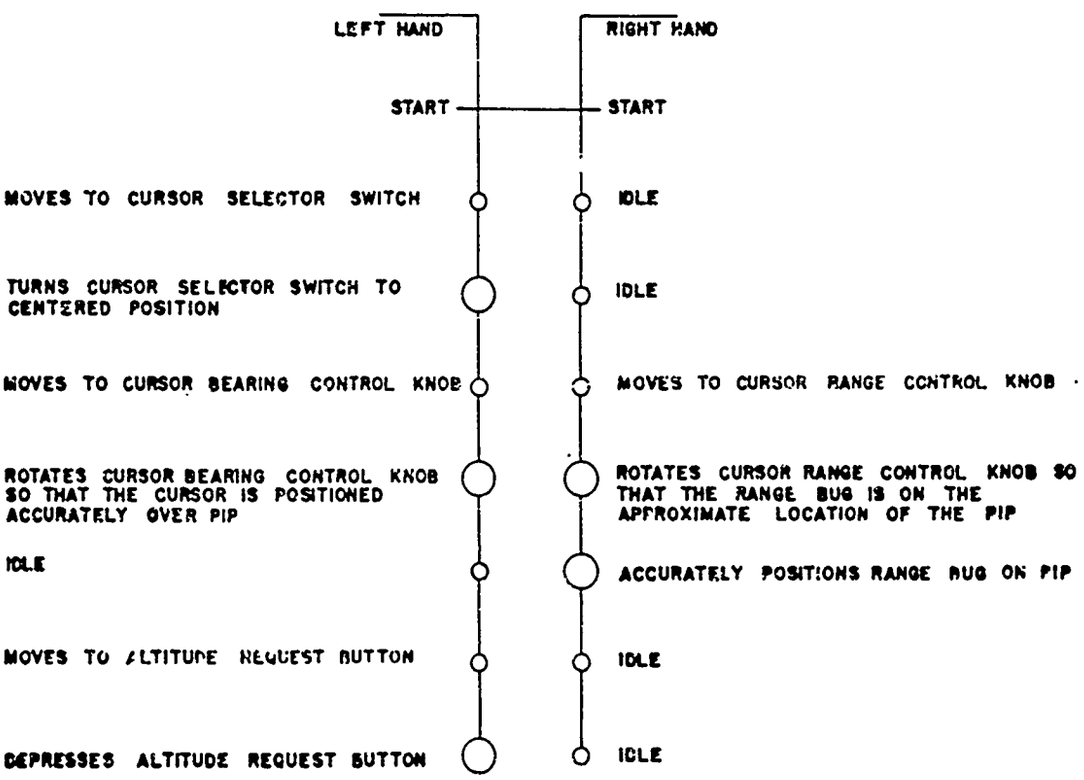


Figure 4

Operation 1. Obtaining Bearing, Range and Altitude of a Pip.

non-sequential. They are placed in available space, where they do not interfere with the operation of controls requiring adjustment in sequence. In the case of controls which are infrequently used, they are positioned where they will not interfere with those requiring frequent operation.

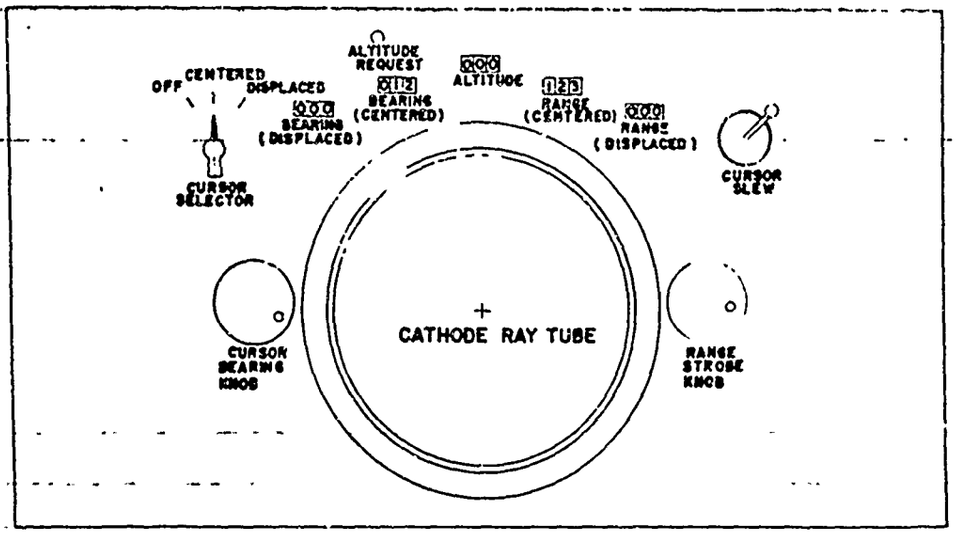
Referring to Figure 1, let us consider the space allocated for communications apparatus and displays. Since complete information about specific controls has not reached us, their final location within the area is not given. The whole unit provides the means whereby the console operator transmits his information. The frequency with which this unit is used demands that it be as conveniently placed as possible. That section composed of the upper left portion of Panel B and the left side of Panel A has been chosen because it does not interfere with the operation of other controls and helps to balance the work load between hands. For convenience, the rest of the controls and displays grouped around the cathode ray tube are discussed in sequence, starting with the lower right-hand section of the console face and proceeding counterclockwise.

Plastic Writing Surface

This has been placed in the lower right of Panel B because the operator normally writes with his right hand. The surface should be edge lighted when a grease pencil is used. A light should be provided in the paper clip so that the operator can read papers attached to it.

Ground Position Indicator (GPI) Control

This control will be operated frequently and is placed above



PANEL B

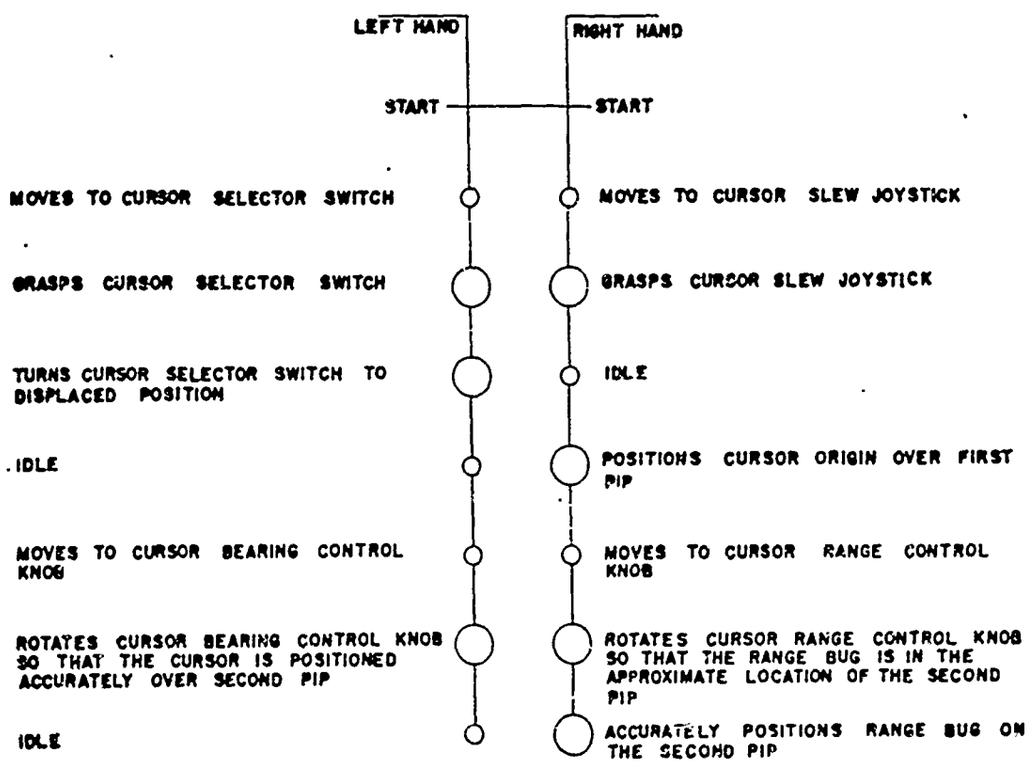


Figure 5

Operation 2. Obtaining Bearing and Range from One Pip to Another.

the plastic writing surface where it is readily accessible for the right hand.

Cursor Brilliance Control

This control has been placed near the cursor slew joy stick. When a very dim pip appears, the operator is able to reduce the intensity of the cursor to insure that it will not obscure the pip.

Sweep Delay, Range Marks, and Angle Marks Controls

These controls will be operated infrequently and are placed in the upper right section of Panel B for minimal interference with other controls.

Sweep Slew and Centered and Displaced Sweep Control

The sweep slew and its control have been located in the upper right of Panel B. Space is provided so that the right-handed operator can easily manipulate the joy stick. Since the joy stick is operated when the sweep control is in the displaced position, the sweep control has been placed so that the right hand can operate it and move readily to the joy stick. The sweep slew joy stick should be provided with a locking system so that it cannot be jarred out of position. This will prevent blurring of the cathode ray tube presentation.

AMTI Video Switch, Radar Video Switch, Power Switch

These controls are "on - off" switches. The power switch is used to turn the console on and off. The video switches control the type of presentation and probably will be operated infrequently. These switches have been placed in the right-hand section of Panel A in such a way that they can be manipulated without interference from the sweep slew joy stick.

Control Illumination and Desk Illumination Controls

These controls require an initial adjustment and are operated infrequently. They have been placed in the right section of Panel A for minimal interference with other controls.

Range Selector Control

This control will be used occasionally during the operation of the console, and it is placed in the right-hand section of Panel A for minimal interference with other controls.

RHI Assignment Unit

Specifications stipulate that the controls and displays of this unit be located on one panel. The controls will be used infrequently and can be operated by either hand. This unit has been placed in the center of Panel A.

Target Timing Indicator and Clock

The target timing indicator will be used frequently. It has been placed in the lower center section of Panel A so that the red and green lights will attract the operator's attention. The clock has been placed below and between the indicator lights.

Height Finder Request and Engaged Lights; Height Finder Cancel Button

The request and engaged lights are positioned in the lower center section of Panel A for ease of viewing. The cancel button is placed to the right of the lights.

FTC, Grid Map Switches, IFF and Beacon Switches

These switches will be operated frequently and are placed in the upper left section of Panel B and the lower left section of Panel A for the following reasons:

1. The controls require no fine adjustments and can be readily operated by the left hand.

2. Their placements helps balance the load between hands.

3. They provide minimal interference with other controls.

Scope Illumination, Video Gain, Sweep Brilliance and Focus Controls

These controls affect the presentation to the operator of the picture on the cathode ray tube. They are placed below the CRT for association and for accessibility to the operator.

Time Start Control

This control has been positioned so that the operator will be able to start the timing cycle easily, without shifting his attention from the cathode ray tube. This has been placed at the bottom of the cathode ray tube.

Recommendations

Figure 1 shows the layout of controls and indicators arrived at by the methods described. The following suggestions are made in an effort to obtain greatest operator efficiency.

A. Counter Lights

It is suggested that:

1. The cursor selector switch control the lights on the bearing and range counters.
2. The centered bearing and range counters be lighted when the cursor selector switch is in the centered position.
3. The displaced bearing and range counters light when the selector switch is in the displaced position.

B. Auxiliary Writing Desk

Figure 6 shows the auxiliary writing surface that can be used by either a right- or left-handed air control officer. It will serve the following functions:

1. Provide a writing surface for the left-handed console operator on the left-hand side of the console.
2. Provide an additional writing surface and storage area for papers for the right-handed operators when placed on the right side of the console. The left-handed operator will be able to store papers on the regular writing surface provided on the console control panel.
3. The specifications state that a status board shall be provided, if practicable. The board was not provided because of

space limitation, but it is felt that with the addition of an auxiliary writing desk, a writing area is provided that can serve the same functions as a status board.

C. Target Timing Indicator

A target timing indicator should be incorporated in the console to help the operator determine the speed of the pip moving on the cathode ray tube. One suggestion is that it consist of two lights, one red and the other green. It is suggested that the lights operate in the following sequence. After that time start control is depressed, the red light will light and flash at the 60th second and will continue for 65 seconds thereafter. The green light will light at the 120th second and remain on for ten seconds.

The cycle should be able to be started or interrupted at any time. The cycle should not restart unless activated by the "push to start" control. This control should only require the pressure of one finger.

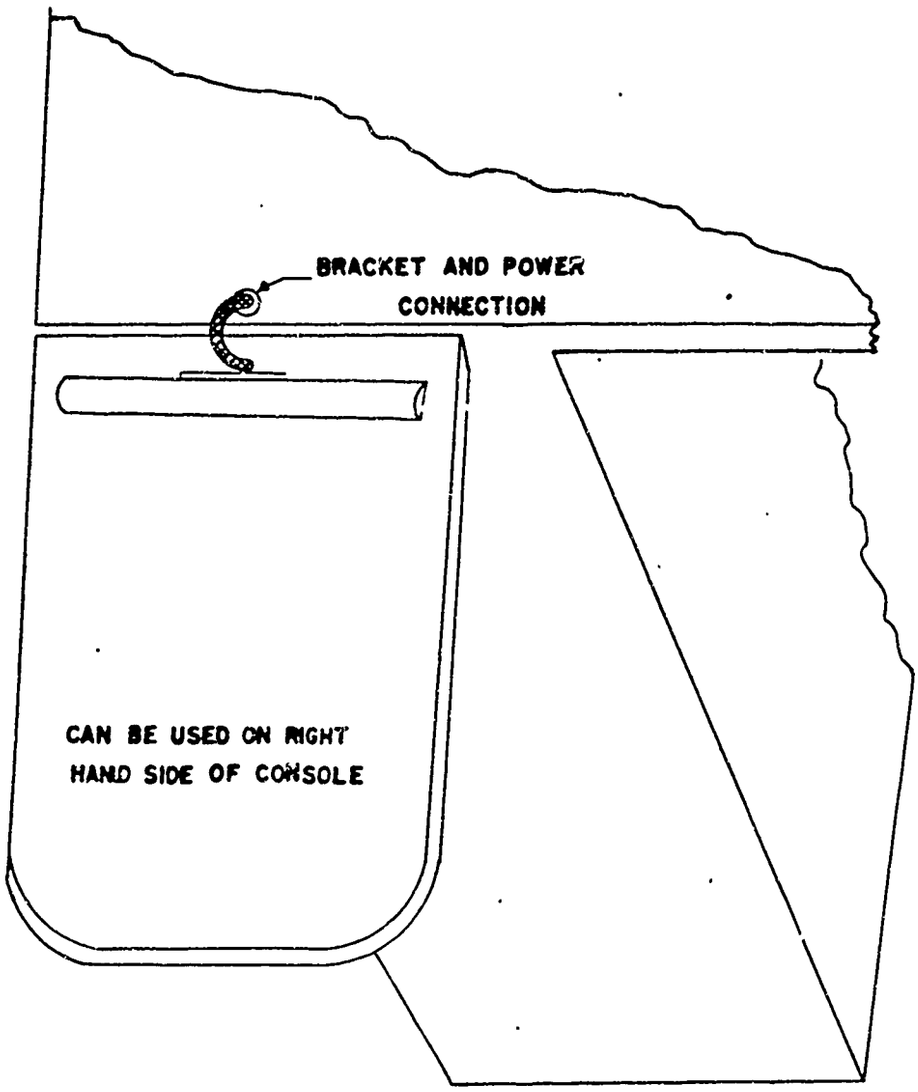


Figure 6

Auxiliary Writing Desk

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