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TERMINATION REPORT

THE ASTRA - 1

NAVIGATION COMPUTER

Submitted to

AFHQ/AMTS/CAE/DIE-Eng/1E3-3
Royal Canadian Airforce
Ottawa Ontario

National Research Council
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By

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31 March 1959

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SECTION 2

SPECIFIED REQUIREMENTS

2.1 GENERAL DESCRIPTION

The Astra Airborne Navigation Computer shall have the capability of operating in conjunction with a ground environment system and of functioning in all phases of operation of the interceptor including interception, return-to-base and ferry missions. It shall be capable at all times of indicating the present position of the interceptor. Computations shall be in plane geometry and all input angles, distances, and speeds except true airspeed shall be treated as being in the geometrical plane of the computation. The Navigation Computer shall receive ground speed and drift angle information from Doppler radar; heading from the heading reference; horizontal true airspeed from the Air Data Computer. The Navigation Computer shall also receive target velocity and position either automatically via Data-Link or by manual insertion. By processing this data, the Navigation Computer shall be capable of supplying the distance bearing and course to any one of five pre-selected bases; the distance, bearing and collision course to a moving target and a suitable steering signal for the Automatic Flight Control System. The computer shall also indicate time-to-go to the interception point, or base.

The Navigation Computer shall perform the required functions to the accuracy called for in Section 7 and under the environmental conditions set down in Section 6.

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SECTION 3

GENERAL SYSTEM DESCRIPTION

3.1 SYSTEM COMPONENTS (Figure 1)

In its final form the Astra Computer consisted of the ten units listed below.

3.1.1 Displays (Figures 2-14):

Pilot's Destination Indicator (P.D.I.)	- Pilot's Cockpit
Observer's Destination Indicator (O. D. I.)	- Observer's Cockpit
Wind Data Display (W. D. D.)	- Observer's Cockpit
Target Data Display (T. D. D.)	- Observer's Cockpit

3.1.2 Control Units (Figures 15-20)

Pilot's Destination Indicator Control (P.D.I.C.)	- Pilot's Cockpit
Navigation Computer Control (N. C. C.)	- Observer's Cockpit

3.1.3 Dead Reckoner (Figures 21-30)

Ground Speed Computer (G.S.C.)	
Ground Speed Integrator (G.S.I.)	Electronics
Computer and Relay Unit (C.R.U.)	Bay
Mounting tray for these three units	

3.2 FUNCTION

The Astra Computer will perform the following functions:

3.2.1 General (Figure 31):

3.2.1.1 Compute the interceptor position in a rectangular grid system (hereafter referred to as the Computer grid) by dead reckoning techniques.

3.2.1.2 Allow the computed interceptor position to be corrected at any time in accordance with a fix without interfering with an interception in progress.

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3.2.2 Interception Mode (Figure 32)

3.2.2.1 Accept target position and velocity fixes as available from G.C.I. stations or other ground environment and compute the target position in the Computer grid.

3.2.2.2 Display the distance and bearing of the target from the interceptor and the time-to-go to the collision point.

3.2.2.3 Display the interceptor heading for collision with the target, and supply a signal to the Autopilot to acquire and maintain this heading.

3.2.3 Return-to-Base Mode (Figure 33)

3.2.3.1 Display the distance and bearing from the interceptor to any one of several pre-selected bases or G.C.I. stations, (or to any selected ground point whose co-ordinates are known to the observer) and the time-to-go to the selected point.

3.2.3.2 Upon selection of a destination, display the heading for homing to the selected point and supply a signal to the Autopilot to acquire and maintain this heading.

3.2.3.3 Although the function outlined in paragraph 3.2.3.1 will normally be carried out after the interception, it can be carried out at any time.

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SECTION 4

DETAILED SYSTEM DESCRIPTION

The following section describes in detail the operation of the Computer and indicates the specific function of each of the units listed above. See Figures 35 and 36, for the System Block Diagram and the Information Flow Diagram.

4.1 OPERATION

4.1.1 Interceptor Position Computation and Correction (Figure 37)

4.1.1.1 The Computer accepts inputs of grid heading, true airspeed, climb angle, Doppler ground speed and Doppler drift. From these signals it computes the interceptor position in the Computer grid and the wind velocity. The mechanism used to compute wind velocity filters out small random fluctuations in the Doppler output signals.

4.1.1.2 During periods of Doppler inactivity due to interceptor manoeuvers, the latest value of wind velocity is automatically used. Also, in the event of Doppler failure, the latest value of wind velocity is automatically used, unless it is desirable to insert a new value, which may be done at any time.

4.1.1.3 The computed interceptor position may be corrected at any time if a fix can be obtained. Upon receipt of a distance and bearing fix with respect to a base whose designation appears on a Base Selector unit, a simple procedure allows correction of the computed position to the actual value. This procedure does not interfere with the progress of an interception.

4.1.1.4 Fixes with respect to G.C.I. stations appearing on a G.C.I. Selector unit, may also be used. In fact, any ground point can be used as a fix point, so long as its position is known to the observer.

4.1.2 Interception Mode (Figure 38, 39)

4.1.2.1 The Computer accepts target velocity and position fixes with respect to one of the G.C.I. stations designated on a G.C.I. Selector unit. These fixes may be automatically inserted from a Data-Link receiver, or may be inserted manually when received by 'voice radio' from the G.C.I. station. The G.C.I. station need not operate in the same grid system as the

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interceptor. During the time between fixes, the target's position is extrapolated by the Computer.

4.1.2.2 The Computer can also accept target position fixes with respect to the interceptor position. These fixes are manually inserted.

4.1.2.3 The required heading for the interceptor to collide with the target (command heading) is computed, and displayed on the Destination Indicators. This heading may be flown manually by reference to the Destination Indicator, or may be acquired and maintained by the Autopilot.

4.1.2.4 The distance and bearing of the target from the interceptor are computed, and displayed on the Destination Indicators. In addition, the time-to-go to collision is computed, and displayed on the Target Data Display.

4.1.3 Return-to-Base Mode (Figure 40)

4.1.3.1 The bearing, distance and command heading to a selected destination are computed, and displayed on the Destination Indicators. The time-to-go is computed, and displayed on the Target Data Display. The command heading may be flown manually, or by Autopilot.

The destination may be any one of the following:-

4.1.3.1.1 A base designated on one of the Base Selectors carried by the interceptor.

4.1.3.1.2 A G.C.I. station designated on one of the G.C.I. Selectors carried by the interceptor.

4.1.3.1.3 Any point whose co-ordinates are known, in G.C.I. grid reference, with respect to one of the G.C.I. stations designated on a G.C.I. Selector.

4.1.3.1.4 Any point whose co-ordinates are inserted into the Computer, from the ground, by Data-Link.

4.2 UNIT FUNCTIONS

4.2.1 Displays

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4.2.1.1 Destination Indicators (Pilot's and Observer's) (Figures 2, 5, 41)

These units, which are identical, operate as repeater-type instruments and display the following information:-

4.2.1.1.1 Interceptor grid or magnetic heading is displayed on a compass card read against the lubber line. Selection of heading reference for both Indicators is made by the Heading switch on the Pilot's Destination Indicator Control.

4.2.1.1.2 Bearing of target, G.C.I. station or base is applied to a pointer which read against the lubber line gives relative bearing and against the compass card gives bearing.

4.2.1.1.3 Command heading for collision with target or homing on selected point. The command heading is applied to a pointer which read against the lubber line gives heading error and against the compass card gives command heading. The interceptor is normally flown to align this pointer with the lubber line.

4.2.1.1.4 Distance of target, G.C.I. station or base is displayed on a three-digit, 0-999 mile counter.

4.2.1.2 Wind Data Display (Figures 2, 6-8, 42-44)

This unit displays the following information:-

4.2.1.2.1 Wind Direction - displayed on a pointer read against a fixed dial.

4.2.1.2.2 Wind Speed - displayed on a three-digit, 0-250 knot counter.

4.2.1.2.3 Grivation - displayed on a two-digit, 89° E-O-89° W counter.

4.2.1.2.4 Grid Heading - displayed on a three-digit 0-360° counter.

This unit also carries the following controls:-

4.2.1.2.5 Wind direction and wind speed manual setting knobs.

4.2.1.2.6 Grivation manual setting knob.

4.2.1.2.7 An emergency switch, to be operated in the event of flux valve failure.

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4.2.1.2.8 Stable Platform manual alignment push-buttons.

4.2.1.2.9 There is in addition a Doppler mode lamp which is illuminated when Doppler is inactive.

4.2.1.2.10 The circuits contained in this unit operate in conjunction with the Ground Speed Computer and Doppler to compute wind speed and direction. In addition, grid and magnetic headings are combined in such a way as to produce grivation, and also supply a stabilized magnetic heading for the Destination Indicators.

4.2.1.3 Target Data Display (Figure 3, 9-14, 45)

This unit displays the following information:-

4.2.1.3.1 Target distance from G.C.I. station - displayed on a three-digit, 0-999 mile counter.

4.2.1.3.2 Target bearing from G.C.I. station - displayed on a pointer read against a fixed dial.

4.2.1.3.3 Target speed - displayed on a four-digit, 0-1500 knot counter.

4.2.1.3.4 Target track - displayed on a pointer read against a fixed dial.

4.2.1.3.5 Time-to-go to destination - displayed on a three-digit, 0-99.9 minute counter.

This unit also carries the following controls:-

4.2.1.3.6 Manual setting knobs - for target distance, bearing, speed and track.

4.2.1.3.7 Target Data switch - for insertion of different types of target fix information.

4.2.1.3.8 Mark push-button - for establishing the zero time for a manually-inserted target fix.

4.2.1.3.9 Heading-Hold-Off push-button - which releases the Autopilot signal from the heading hold condition.

There are in addition:-

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4.2.1.3.10 Data-Link mode identification lamps - (two).

4.2.1.3.11 Heading-Hold lamp - which is illuminated when the output signal to the Autopilot is held constant to maintain a constant heading.

4.2.1.3.12 This unit contains the circuitry required to convert the cartesian target data information to polar information, to compute the time-to-go, and to perform switching functions associated with the insertion of target information.

4.2.1.3.13 This unit also carries the following Selector units:-

4.2.1.3.13.1 G.C.I. Selector

This removable unit carries five push-buttons, each of which, when operated, inserts into the Computer the grid coordinates of a G.C.I. station, together with the orientation of the G.C.I. station's grid with respect to the Computer grid. This allows target information given with respect to a G.C.I. station to be converted into information relative to the Computer grid. Other units, set for different G.C.I. stations may be interchanged with the unit in use at any time.

4.2.1.3.13.2 Base Selector

This removable unit carries five push-buttons, each of which, when operated, inserts into the Computer the grid coordinates of a base.

Other units, set for different bases, may be interchanged with the unit in use at any time.

4.2.2 Control Units

4.2.2.1 Pilot's Destination Indicator Control (Figures 15-17, 46)

This unit carries two switches, the Heading switch and the Bearing switch.

4.2.2.1.1 Heading Switch

This three-position switch selects the heading references for the observer's and pilot's Destination Indicators. The switch positions are:-

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4.2.2.1.1.1 Normal - Pilot's reference is magnetic. Observer's reference is grid.

4.2.2.1.1.2 Grid - Pilot's reference is grid. Observer's reference is grid.

4.2.2.1.1.3 Flux Valve Only - Pilot's reference is magnetic. Observer's reference is magnetic.

The last two positions are intended for emergency use in case of failure of the Flux Valve or the Stable Platform, respectively, but may be used under normal conditions.

4.2.2.1.2 Bearing Switch

This three-position switch selects the distance, bearing and command heading signals to be displayed on the Pilot's Destination Indicator. The switch positions are:-

4.2.2.1.2.1 Normal - The Indicator displays the distance, bearing and command heading to the target or to some ground point, as selected by the observer.

4.2.2.1.2.2 ADF (LF/MF) / ADF (UHF) - The Indicator displays bearing to an ADF station.

4.2.2.2 Navigation Computer Control (Figures 15, 18-20, 47)

This unit carries a Computer power switch, a Doppler power switch, a Bearing switch and interceptor position reset push-buttons.

4.2.2.2.1 Power Switch

This switch is the power on/off switch for the Navigation Computer.

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4.2.2.2.2 Doppler Power Switch

This switch is the power switch for the Doppler Radar. It has three positions - off, standby and on.

4.2.2.2.3 Bearing Switch

The Bearing Switch selects the bearing, distance and command heading signals to be displayed on the observer's Destination Indicator. The positions are:-

4.2.2.2.3.1 Normal	-	Bearing, distance and command heading of the target, or of some ground point, as selected by the observer on the Target Data Display.
4.2.2.2.3.2 ADF (LF/MF)	-	Bearing of an ADF station.
4.2.2.2.3.3 ADF (UHF)	-	Bearing of an ADF station.
4.2.2.2.3.4 Set Indicator	-	Identical to Normal position, except that circuit connections are made to allow insertion of a position fix.

4.2.2.2.3.4 Reset Switches

The position reset push-buttons allow the observer, when the bearing switch is in the Set Indicator position, to correct the computed interceptor position by slewing his Destination Indicator readings to the fix values.

4.2.3 Dead Reckoner Units (Figures 21-30, 48-50)

The Ground Speed Computer, Ground Speed Integrator, and Computer and Relay Unit perform most of the computations required in the operation of the Computer. These units carry no displays or controls, and require no attention in flight.

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SECTION 5

OPERATIONAL PROCEDURES

This section describes the control settings required in the operational use of the Computer.

5.1 COMPUTER ZEROING

Before take-off, the Computer must be 'zeroed'. This is done in the following manner:-

5.1.1 Correct Aircraft Position

5.1.1.1 Operate push-button corresponding to the base where the interceptor is located. The Heading-Hold lamp on the T.D.D. will come on.

5.1.1.2 Turn the N.C.C. Bearing switch to the Set-Indicator position.

5.1.1.3 Operate the appropriate push-button on the N.C.C. to set the distance on the Destination Indicators to zero.

5.1.1.4 Turn the N.C.C. Bearing switch to the Normal position.

5.1.2 Reset Storage

5.1.2.1 Turn the Target Data switch on the T.D.D. to the Relative-To-Aircraft position.

5.1.2.2 Operate the Mark push-button on the T.D.D.

5.1.2.3 After approximately ten seconds, operate the Heading Hold Off push-button on the T.D.D. The Heading-Hold lamp on the T.D.D. will go out.

The Computer is now prepared for take-off.

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5.2 AIRCRAFT POSITION FIXING

NOTE

In the following description it is to be noted that whenever the Heading-Hold lamp is on, the interceptor heading is held constant. This applies, of course, only if the Computer output is controlling the interceptor heading.

5.2.1 Over a Base

If the interceptor flies over a base designated on the Base Selector unit, the computed interceptor position may be corrected by the following procedure:-

5.2.1.1 At the moment the interceptor is over the base, turn the N.C.C. Bearing Switch to the Set Indicator position. The Heading-Hold lamp on the T.D.D. will come on.

5.2.1.2 Select the appropriate base on the Base Selector unit.

5.2.1.3 Set the distance on the Destination Indicator to zero by operating the appropriate push-button on the N.C.C.

5.2.1.4 Turn the N.C.C. Bearing switch to the Normal position.

5.2.1.5 Operate the Heading-Hold-Off push-button on the T.D.D. The Heading-Hold lamp will go out.

5.2.2 Position Fix From a Base

If the interceptor receives a position fix with respect to a base designated on the Base Selector unit, the computed interceptor position may be corrected by the following procedure:-

5.2.2.1 At the moment the Mark signal is received from the ground, designating the time at which the fix is correct, turn the N.C.C. Bearing switch to the Set Indicator position. The Heading-Hold lamp on the T.D.D. will come on.

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5.2.2.2 Proceed as in Section 5.2.1, but set the distance and bearing on the Destination Indicators to the values transmitted to the interceptor using the N.C.C. push-buttons.

NOTE

The fix must be in Computer grid co-ordinates.

5.2.3 Over a G.C.I. Station

If the interceptor flies over a G.C.I. station designated on the G.C.I. Selector unit, the computed interceptor position may be corrected by the following procedure:-

5.2.3.1 At the moment the interceptor is over the G.C.I. station, turn the N.C.C. Bearing switch to the Set Indicator position. The Heading-Hold lamp on the T.D.D. will come on.

5.2.3.2 Select the appropriate G.C.I. station on the G.C.I. Selector.

5.2.3.3 Set the target distance counter on the T.D.D. to zero, using the appropriate knob.

5.2.3.4 Operate the appropriate push-button on the N.C.C. to set the distance on the Destination Indicators to zero.

5.2.3.5 Turn the N.C.C. Bearing switch to the Normal position.

5.2.3.6 Reset the target distance on the T.D.D. to its original value.

5.2.3.7 Operate the Heading-Hold-Off push-button on the T.D.D. The Heading Hold lamp will go off.

5.2.4 Position Fix from a G.C.I. Station

If the interceptor receives a position fix with respect to a G.C.I. station designated on the G.C.I. Selector unit, the computed interceptor position may be corrected by the following procedure:-

5.2.4.1 At the moment the Mark signal is received from the ground, designating the time at which the fix is correct, turn the N.C.C. Bearing switch to the Set Indicator position.

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5.2.4.2 If the fix is in Computer grid coordinates proceed as in Section 5.2.3, but set the distance and bearing on the Destination Indicators to the values transmitted to the interceptor, using the N.C.C. push-buttons.

5.2.4.3 If the fix is in G.C.I. station coordinates, proceed as in Section 5.2.3, but set the target distance and bearing on the T.D.D. to the values transmitted to the interceptor, using the appropriate T.D.D. knobs.

5.3 TARGET POSITION AND VELOCITY FIXING

Target position and velocity fixing can be carried out in the following three ways:-

5.3.1 Automatic Fix Insertion by Data-Link

To select automatic insertion of target position and velocity information into the Computer from Data-Link, the following procedure is used:-

5.3.1.1 Turn the Target Data switch on the T.D.D. to the Data-Link position. The Heading-Hold lamp on the T.D.D. will come on.

5.3.1.2 Operate the appropriate push-button on the G.C.I. Selector unit to select the G.C.I. station from which the target information is to be received.

5.3.1.3 Wait for a fix to be inserted into the Computer. This will be indicated by a movement of the target position and velocity displays on the T.D.D.

5.3.1.4 Operate the Heading-Hold-Off push-button on the T.D.D. The Heading-Hold lamp will go out.

5.3.2 Manual Fix Insertion

To insert target velocity and position information transmitted by voice from the ground, into the Computer, the following procedure is used:-

5.3.2.1 Turn the Target Data switch on the T.D.D. to the Relative-To-G.C.I. position. The Heading-Hold lamp on the T.D.D. will come on.

5.3.2.2 Operate the appropriate push-button on the G.C.I. Selector Unit to select the G.C.I. station from which the target information is to be received.

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5.3.2.3 Insert the fix transmitted from the ground into the Computer by operating the appropriate knobs on the T.D.D.

5.3.2.4 At the moment the Mark signal is received from the ground, designating the time at which the fix is correct, operate the Mark push-button on the T.D.D.

5.3.2.5 After a period of approximately five seconds, operate the Heading-Hold-Off push-button on the T.D.D. The Heading-Hold lamp on the T.D.D. will go out.

NOTE

Operations 5.3.2.3 and 5.3.2.4 may be interchanged depending on whether the Mark signal is received before or after the fix information.

5.3.3 Relative-To-Aircraft Manual Insertion

If the target position transmitted by voice from the ground is given with respect to the interceptor, rather than a G.C.I. station, a similar procedure to Section 5.3.2 is used. In this case, however, the Target Data switch is operated to the Relative-To-Aircraft position and the Heading-Hold-Off push-button is not to be operated until approximately ten seconds after the Mark push-button is pressed.

5.4 SELECTION OF CLOSE CONTROL (C.C.) OR MODIFIED CLOSE CONTROL (M.C.C.)

5.4.1 With the Target Data switch in the Data-Link position, the interceptor operates in the C.C. or M.C.C. mode as dictated by the Data-Link transmissions. In the C.C. mode, the interceptor is steered by the Data-Link transmissions. Data-Link control of the interceptor may be removed by turning the Target Data Switch off the Data-Link position.

5.4.2 With the Target Data switch on the T.D.D. in the Relative-To-G.C.I. or Relative-To-Aircraft position, the interceptor operates in M.C.C. mode, with the interceptor being steered in accordance with the heading command output from the Computer.

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In this mode, the interceptor may be held to the command heading automatically by the Automatic Flight Control System, or may be manually steered by the pilot. In either case the heading is maintained so as to bring the command heading pointer coincident with the lubber line on the Destination Indicators.

5.5 USE OF A.D.F.

5.5.1 The bearing of an ADF station can be displayed on the Pilot's or Observer's Destination Indicator, by operating the Bearing switch on the PDIC or NCC, respectively, to the appropriate position. This can be done in either C.C. or M.C.C. mode.

5.5.2 To home on the ADF station, the heading must be maintained so as to bring the Relative Bearing pointer into coincidence with the lubber line. This can be done on M.C.C. mode only. (See Section 5.4)

5.6 EMERGENCY PROCEDURES

5.6.1 Flux-Valve Failure

In the event of Flux-Valve failure, the Flux-Valve switch on the W.D.D. must be operated to the Failed Position.

5.6.1.1 If magnetic heading is to be displayed on the Pilot's Destination Indicator, the assumed value of grivation must be manually set on the W.D.D., and the Heading switch on the P.D.I.C. must be in the Normal position.

5.6.1.2 If grid heading is to be displayed on the P.D.I., two alternatives exist:

5.6.1.2.1 The P.D.I.C. Heading switch is operated to the Grid position.

5.6.1.2.2 The P.D.I.C. Heading switch is operated to the Normal position, and the grivation is manually set to zero on the W.D.D.

5.6.2 Stable Platform Failure

In the event of Stable Platform failure, the Heading switch on the P.D.I.C. must be operated to the Flux-Valve Only position. Both Destination Indicators will then display magnetic heading.

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5.6.2.1 If grid heading is to be displayed on the W.D.D., the grivation must be set to the assumed correct value.

5.6.2.2 If magnetic heading is to be displayed on the W.D.D., the grivation must be set to zero.

5.6.3 Power Failure

In the event of power failure, the Computer is inoperative except for the sections concerned in providing for display on the following functions:-

Grid Heading (W.D.D. and O.D.I.)
Magnetic Heading (PDI)
Grivation (WDD)
ADF Bearing (ODI, PDI)

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SECTION 6

ENVIRONMENTAL TESTS

The Computer shall be subjected to the following environmental conditions:-

High Temperature - Sea level
High Altitude
Low Temperature - Sea level
Condensation
Vibration
Shock
Voltage and frequency variation

6.1 HIGH TEMPERATURE - SEA LEVEL

6.1.1 Non-Operating

Subject the equipment to an ambient temperature of +85°C (relative humidity not more than 5%) for two hours after it has stabilized at this temperature. Then inspect the equipment for deterioration, mechanical failure or corrosion of any internal or external components, which could in any way prevent the equipment from meeting operational requirements during service life.

6.1.2 Operating (Ducted or Directed Air-Cooled Equipment) (Dead-Reckoner Units)

6.1.2.1 The equipment shall be stabilised in an ambient temperature of +71°C in an off condition with no cooling air.

6.1.2.2 After stabilisation the equipment shall be turned on at the maximum specified input voltage, (Section 6.7) and cooling air shall be supplied in accordance with Table 1 (R.C.A. Spec. 8954602). The equipment shall then be operated for four hours maintaining the ambient temperature between +71°C and +57°C. During this period the equipment shall be switched through a minimum of three operational cycles.

6.1.2.3 The equipment shall then be inspected for deterioration of performance outside the limits quoted in Section 7.0.

6.1.3 Operating (Ambient Air-Cooled Equipment)
(All units except Dead-Reckoner Units)

6.1.3.1 The equipment shall be stabilised at an ambient temperature of +71 °C in an off condition.

6.1.3.2 After stabilisation the chamber temperature shall be changed to 43°C and the equipment shall be turned on at the maximum specified voltage. (Section 6.7) The equipment shall be operated in this condition for four hours. During this period the equipment shall be switched through a minimum of three operational cycles.

6.1.3.3 The equipment shall then be inspected for deterioration of performance outside the limits quoted in Section 7.0.

6.2 HIGH ALTITUDE

6.2.1 (Ducted or Directed Air Cooled Equipment) - (Dead-Reckoner Units)

6.2.1.1 The equipment shall be placed in a test chamber and shall be maintained in an off condition until the chamber altitude is increased to 70,000 feet.

6.2.1.2 The equipment shall then be operated for thirty minutes after the specified minimum warm-up period. Cooling shall be provided sufficient to maintain safe equipment operating temperatures. During this period, the equipment shall be switched through a minimum of three operational cycles.

6.2.1.3 No arcing, flash over, corona or similar discharge shall occur during this test.

6.2.1.4 The equipment shall then be inspected for deterioration of performance outside the limits quoted in Section 7.0.

6.2.2 (Ambient Air-Cooled Equipment) (All Units except Dead-Reckoner Units)

6.2.2.1 The equipment shall be stabilised in an ambient temperature of +43°C and an altitude of 70,000 feet in an off condition.

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6.2.2.2 The equipment shall then be operated in this condition for four hours. During this period, the equipment shall be switched through a minimum of three operational cycles.

6.2.2.3 No arcing, flashover, corona, or similar discharge shall occur during this test.

6.2.2.4 The equipment shall then be inspected for deterioration of performance outside the limits quoted in Section 7.0.

6.3 LOW TEMPERATURE - SEA LEVEL (ALL UNITS)

6.3.1 The equipment shall be maintained in an ambient of -55°C in an off condition for a period of twenty-four hours, or until temperature stabilisation has occured (whichever is longer).

6.3.2 The equipment and cooling air as applicable in accordance with Table 1 (R.C.A Spec. 8954602) shall then be turned on at the minimum specified voltage (Section 6.7).

6.3.3 The equipment shall then be inspected for deterioration of performance outside the limits quoted in Section 7.0.

6.4 CONDENSATION (ALL UNITS)

6.4.1 The equipment shall be stabilised in an off condition at -10°C at sea level pressure.

6.4.2 The test chamber door shall then be opened and shall remain open until the frost has melted, but shall be closed before the moisture evaporates.

6.4.3 The equipment shall then be switched on.

6.4.4 The equipment shall be inspected for deterioration of performance outside the limits quoted in Section 7.0.

6.5 VIBRATION

6.5.1 Equipment with Isolators

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6.5.1.1 Equipment normally isolated shall be subjected to vibration with isolators in place, in each of the three planes, according to the schedule below. This test shall apply also to vibration and shock racks with dummy loads (or equipment) installed.

CPS	DOUBLE AMPL.	MAX. ACCLN.	SWEEP TIME	TEST TIME	RESONANCE TEST TIME
5-55-5	0.036"	---	1-3 min.	15 min.	15 min.
55-500-55	---	10 g	15-20 min.	75 min.	15 min.

6.5.1.2 The equipment then shall be inspected for deterioration of performance outside the limits quoted in Section 7.0.

6.5.2 Equipment with Isolators (Alternative Procedure)

6.5.2.1 If vibration and shock racks are not available, the individual units shall be vibrated without isolators in each of the three planes according to the following schedule.

CPS	DOUBLE AMPL.	MAX. ACCLN.	SWEEP TIME	TEST TIME	RESONANCE TEST TIME
5-16-5	.150"	---	1-3 min.	10 min.	15 min.
16-500-16	---	2 g	15-20 min.	90 min.	15 min.

6.5.2.2 The equipment shall then be inspected for deterioration of performance outside the limits quoted in Section 7.0.

6.5.3 Equipment without Isolators

6.5.3.1 Equipment mounted to the airframe without isolators shall be subjected to vibration in each of the three planes according to the following schedule.

CPS	DOUBLE AMPL.	MAX. ACCLN.	SWEEP TIME	TEST TIME	RESONANCE TEST TIME
5-55-5	0.036"	---	1-3 min.	15 min.	15 min.
55-500-55	---	5 g	15-20 min.	75 min.	15 min.

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6.5.3.2 The equipment shall then be inspected for deterioration of performance outside the limits quoted in Section 7.0.

6.6 SHOCK

6.6.1 Equipment with Isolators

6.6.1.1 Equipment normally isolated shall be subjected to shock testing with isolators in place. This equipment shall be subjected to 18-impact shocks of 10g consisting of three shocks in opposite directions along each of three axes, each shock impulse having a time duration of 11 ± 1 milliseconds. The 'g' value shall be within ± 10 percent when measured with a 100 cps filter and the maximum 'g' value shall occur at approximately 5 1/2 milliseconds.

6.6.1.2 The equipment shall not suffer damage, come loose from mounting base nor subsequently fail to provide the performance specified in RCA (Camden) Spec. 8951017.

6.6.2 Equipment with Isolators (Alternative Procedure)

6.6.2.1 This test may be performed in lieu of paragraph 6.6.1 for independent testing of units normally mounted on a common isolation rack with other units, if all units in each rack are not available concurrently.

6.6.2.2 The equipment shall be subjected to shock testing without isolators. The equipment shall be subjected to 18-impact shocks of 20g consisting of three shocks in opposite directions along each of three axes, each shock impulse having a time duration of 25 ± 3 milliseconds. The 'g' value shall be within ± 10 percent when measured with a 100 cps filter, and the maximum 'g' shall occur at approximately 12 1/2 milliseconds.

6.6.2.3 The equipment shall not suffer damage nor subsequently fail to provide the performance specified in Section 7.0.

6.6.3 Equipment without Isolators

6.6.3.1 Equipment mounted to the airframe without isolators shall be subjected to shock testing according to the procedure in paragraph 6.6.2.

6.6.3.2 The equipment shall not suffer damage nor subsequently fail to provide the performance specified in Section 7.0.

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6.7 VOLTAGE VARIATION AND FREQUENCY

6.7.1 The equipment shall be subjected to voltage and frequency variation over the following ranges:

A.C. Voltage	115 Volts 400 c/s	:-	108 to 121 volts 396 to 404 c/s
D.C. Voltage	28 Volts	:-	26 to 30 volts

The D.C. voltage shall have ripple contents as follows:-

400 cps	:-	less than 0.2%
1200 cps	:-	less than 1.5%

Total less than 10% peak to peak.

6.7.2 The equipment shall be inspected for deterioration of performance outside the limits quoted in Section 7.0.

6.8 The foregoing environmental tests have been extracted from R.C.A. (Camden) Spec. 8954602.

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SECTION 7

ACCURACY REQUIREMENTS

The Computer shall perform to the limits of accuracy set down in RCA Specification 8951017. These limits are as follows:

7.1 SYSTEM

The Navigation Computer error shall not exceed a value of two miles per hour + 1/2% of distance travelled. This error does not include display errors of the Destination Indicators.

7.2 WIND DATA DISPLAY

7.2.1 Grid Heading

Interceptor grid heading shall be displayed with an accuracy of ± 1/2 degree.

7.3 TARGET DATA DISPLAY

7.3.1 Target Distance Display

7.3.1.1 Automatic Input

Target distance as inserted automatically by the Data-Link Coupler shall have an accuracy of display of ± 1 nautical mile.

7.3.1.2 Manual Input

Target distance as inserted manually shall have an accuracy of display of ± 1 nautical mile.

7.3.2 Target Bearing Dispaly

7.3.2.1 Automatic Input

Target bearing as inserted automatically by the Data-Link Coupler shall have accuracy of display of ± 1 degree.

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7.3.2.2 Manual Input

Target bearing as inserted manually shall have an accuracy of display ± 1 degree.

7.3.3 Target Speed Display

7.3.3.1 Automatic Input

Target speed as inserted automatically by the Data-Link Coupler shall have an accuracy of display of ± 1 knot.

7.3.3.2 Manual Input

Target speed as inserted manually shall have an accuracy of display of ± 1 knot.

7.3.4 Target Track Display

7.3.4.1 Automatic Input

Target track as inserted automatically by the Data-Link Coupler shall have an accuracy of display of ± 1 degree.

7.3.4.2 Manual Input

Target track as inserted manually shall have an accuracy of display of ± 1 degree.

7.3.5 Time-To-Go

'Time-to-go' shall be displayed with an accuracy of ± 1 percent of full scale.

7.4 DESTINATION INDICATOR DISPLAYS

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7.4.1 Aircraft Heading

Interceptor grid or magnetic heading shall be displayed with an accuracy of ± 1/2 degree.

7.4.2 Distance to Target or Destination

Distance to target or destination shall be displayed with an accuracy of ± 1 nautical mile.

7.4.3 Bearing to Target, Destination or A.D.F. Station

Bearing to target, destination or A.D.F. Station shall be displayed with an accuracy of ± 1/2 degree.

7.4.4 Heading Error

Heading error shall be displayed with an accuracy of ± 1 degree.

7.5 OUTPUT SIGNALS

7.5.1 N/S Distance from Grid Zero

N/S distance from grid zero shall be transmitted with an accuracy of ± 8.5 nautical miles.

7.5.2 N/S and E/W Ground Speed

N/S and E/W ground speed shall be transmitted with an accuracy of ± 10 knots.

7.6 The foregoing accuracy figures do not cover every Computer display or output signal. The figures quoted have been extracted from R.C.A. (Camden) Spec. 8951017.

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SECTION 8

ACCURACY

The following paragraphs will deal with the Computer accuracy at room-temperature and will then mention the effects of environmental testing.

Since environmental testing of the Navigation Computer was not very far advanced at termination, none of the units was completely tested under the environmental conditions listed in Section 6.

8.1 ROOM TEMPERATURE

8.1.1 Interceptor grid heading display on W.D.D. - the required accuracy of ± 1/2 degree was obtained.

8.1.2 Target distance display - the required accuracy of ± 1 nautical mile was obtained.

8.1.3 Target bearing display - the required accuracy of ± 1 degree was obtained.

8.1.4 Target speed display - the required accuracy of ± 1 knot was obtained.

8.1.5 Target track display - the required accuracy of ± 1 degree was obtained.

8.1.6 Time-to-go display - the required accuracy of ± 1% of full scale was obtained.

8.1.7 Interceptor heading display (on D.I.) - the required accuracy of ± 1/2 degree was not obtained. (See paragraph 8.2.3).

8.1.8 Target or destination distance display - the required accuracy of ± 1 nautical mile was obtained.

8.1.9 Target destination or A.D.F. bearing display - the required accuracy of ± 1/2 degree was obtained.

8.1.10 Heading error display - the required accuracy of ± 1/2 degree was not obtained. (See paragraph 8.2.3).

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8.1.11 N/S distance from grid zero - the required accuracy of ± 8.5 nautical miles was obtained.

8.1.12 N/S and E/W ground speed - the required accuracy of ± 10 knots was obtained.

8.1.13 The inaccuracies at room temperature mentioned in paragraphs 8.1.7 and 8.1.10 were caused by torsional wind-up in certain gear passes. This fault was apparent in the first two systems only, as subsequent redesign eliminated this difficulty.

8.2 EFFECTS OF ENVIRONMENTAL TESTING

This section will deal with accuracy figures on a unit basis.

8.2.1 Wind Data Display

This unit displays the Interceptor grid heading mentioned in paragraph 8.1.1.

8.2.1.1 Low-Temperature Test -55 °C

This unit has not been subjected to a low-temperature test.

8.2.1.2 High-Temperature Test +71°C

This test was carried out before R.C.A. changed the temperature figure to +43 °C.

This test did not effect the heading accuracy figure of ± 1/2 degree.

8.2.1.3 High-Altitude Test - 70,000 feet

This test did not affect the heading accuracy figure of ± 1/2 degree.

8.2.1.4 Condensation Test

This unit has not been subjected to a condensation test.

8.2.1.5 Vibration Test

This unit was not operational during the vibration test. After the test was completed the unit was switched on and the heading accuracy was found to be to the required standard.

8.2.1.6 Shock Test

This unit has not been subjected to a shock test.

8.2.2 Target Data Display

This unit displays the following data:-

Target distance	(Para. 8.1.2)
Target bearing	(Para. 8.1.3)
Target speed	(Para. 8.1.4)
Target track	(Para. 8.1.5)
Time-to-go	(Para. 8.1.6)

8.2.2.1 Low-Temperature -55°C

This unit has not been subjected to a low-temperature test.

8.2.2.2 High-Temperature Test +43°C

This unit has not been subjected to a high-temperature test.

8.2.2.3 High-Altitude Test - 70,000 feet

This unit has not been subjected to a high-altitude test.

8.2.2.4 Condensation Test

This unit has not been subjected to a condensation test.

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8.2.2.5 Vibration Test

This unit was not operational during the vibration test. After the test was completed the unit was switched on and the accuracies were found to be within the limits required.

8.2.3 Destination Indicators

These units display the following data:-

Interceptor heading (para. 8.1.7)
Target or destination distance (para. 8.1.8)
Target, destination or A.D.F. bearing (para. 8.1.9)
Heading error (para. 8.1.10).

8.2.3.1 Low-Temperature Test -55°C

This unit displays Interceptor heading, bearing and heading error to the required accuracy down to -10°C, and the target or destination distance down to -30°C.

To obtain the required accuracy down to -55°C minor redesign of gear passes, (to preserve mechanical freedom at low temperature) would be required.

8.2.3.2 High-Temperature + 71°C

This test was carried out before R.C.A. changed the temperature figure to +43°C.

This test did not cause the Indicators to lose their required accuracy.

8.2.3.3 High-Altitude Test - 70,000 feet

This test did not cause the Indicators to lose their required accuracy.

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8.2.3.4 Condensation Test

These units have not been subjected to a condensation test.

8.2.3.5 Vibration Test

These units were not operational during the vibration test. After the test was completed the units were switched on and the accuracy of the displays was found to be to the required standard.

8.2.3.6 Shock Test

These units were not subjected to a shock test.

8.2.4 Ground Speed Integrator

This unit provides the following outputs:

N/S distance from grid zero (para. 8.1.11)
N/S and E/W ground speed (para. 8.1.12)

8.2.4.1 Low-Temperature Test -55°C

The integrator held the required accuracy down to -50°C. To obtain the required accuracy at -55°C the amplifier gain will need to be increased.

8.2.4.2 High-Temperature Test +71°C

This test did not cause the Integrator to lose its required accuracy.

8.2.4.3 High-Altidude Test - 70,000 feet

This test did not cause the Integrator to lose its required accuracy.

8.2.4.4 Condensation Test

This unit has not been subjected to a condensation test.

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8.2.4.5 Vibration Tests

This test did not cause the Integrator to lose its required accuracy.

8.2.4.6 Shock Test

This unit has not been subjected to a shock test.

8.2.5 System

The required system accuracy figure of two miles per hour + 1/2% of distance travelled has never been checked under environmental conditions.

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SECTION 9

PROBLEM AREAS

Several problems were encountered during the development of the Astra Computer. These problems involved the following components.

9.1 RELAYS

9.1.1 Intermittent Pin Contact

Intermittent pin contact was a major source of trouble. This fault was attributable to the fact that contact pressure between pin and socket was insufficient to remove the oxide film on the socket when the relay was inserted into the holder. This fault was overcome in two ways:-

(1) Gold-plated socket contacts were obtained. These contacts exhibited a marked improvement in performance since the amount of oxide formed was negligible.

(2) Sockets produced by a different manufacturer, having higher contact pressure, were used.

9.1.2 Current Leakage

Current leakage was detected in relays of a particular manufacturer. This fault manifested itself as a leakage path (less than 500K) across relay contacts which were required to be open-circuited during certain modes of operation. When the relay contacts were placed in the input signal lines to a summing amplifier, the effect of the small current flowing across the relay contacts was to modify the signal input. This caused the servo-loop to drive to an incorrect null position. Errors of up to eight miles in range have been noticed due to this condition.

It was not possible in all cases to remedy this condition by circuit changes. Where possible however, amplifier signal input lines not used during a particular mode of operation were grounded for the duration of the mode.

This condition was eliminated by changing to relays of a different manufacturer.

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In a number of circuits in the Computer, the slider voltage of a potentiometer is compared with that from another potentiometer connected across the output winding of a resolver. Without compensation the changing phase-shift of the resolver, due to changing temperature, results in a decrease in sensitivity of the servo-loop and also an increase in the temperature of the motor. It was found that if a temperature-sensitive network having a suitable negative rate-of-change is connected in series with the resolver input, then partial compensation is achieved, and the phase of the resolver output remains approximately constant over the temperature range stated above. A thermistor network having approximately this characteristic is used in series with each resolver in the Astra system. The in-phase input to each servo-loop includes a phase-lead capacitor adjusted to give a good null at the summing junction of the amplifier, which remains good over a temperature range 0 °C to 60 °C.

In the interests of interchangeability a standard thermistor network has to be applied to each resolver, giving a first-order approximation to perfect compensation. In an individual application where a thermistor network can be tailored to a particular resolver, a reasonably accurate degree of compensation can be achieved over a temperature range -50°C to +50 °C.

A rod type thermistor was used in Astra, and was mounted remote from the resolver concerned. During initial warm-up the thermistor reached a thermal steady-state long before the associated resolver. During this period errors in servo outputs up to 0.3 or 0.4% of full scale were noticed. A change to a wafer type thermistor mounted directly on the resolver was envisaged which would ensure that the thermistor and resolver ambient temperatures remain identical at all times.

This change was implemented on similar circuits in other equipment and was found to be quite satisfactory.

9.2 TEMPERATURE EFFECTS ON AMPLIFIER GAIN

The gain of the amplifiers used in the Astra Computer is constant over a temperature range 0°C to +20°C. As the temperature increases to +80°C the gain increases by 3.5 db. As the temperature decreases to -55°C the gain decreases by 12 db.

In addition, the phase shift of voltage through the amplifiers is approximately 90° in the range 0°C + 80°C, falling to approximately 45° at -55°C. The effect of this change is equivalent to a change in gain of approximately 3 db.

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The effect of these two conditions is to decrease the sensitivity of the amplifier at low temperatures, and to increase the sensitivity at high temperatures. If the gain is increased to offset the decrease in sensitivity at low temperatures, then the associated servo-loop hunts at high temperatures.

It was intended to increase the overall gain by adding a preamplifier and also to incorporate a thermistor network at the input of the amplifier. This network would hold the overall gain approximately constant with temperature. No compensation for phase-shift was considered necessary as its effect on the overall gain was comparatively small.

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SECTION 10

STATE OF DESIGN

10.1 The state of design of the Astra-Navigation Computer was well advanced at termination. This is evident from the following facts:-

10.1.1 R.C.A. (Montreal) had completed acceptance tests on two systems.

10.1.2 A roof-test on one system at Camden, N.J. was well under way.

10.2 System design was virtually complete. It remained only to incorporate the Aircraft Relative Fix facility. This facility would not have been required until the fifth system.

10.3 The remaining design problems were limited to ensuring that individual units passed the environmental tests listed in Section 6.0.

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SECTION 11

CONCLUSIONS

11.1 Although the Astra-Navigation Computer was designed to be compatible with the Arrow and the Astra fire control system, it possesses the following features which make its immediate use with other systems practicable:-

11.1.1 It is a self-contained navigation system requiring only the usual inputs as set down in Section 2.0.

11.1.2 Since the Computer consists of several small units (1.2 cubic feet total volume) its incorporation into other aircraft should present no problem. In addition three of the largest units require no attention in flight and can therefore be located in any convenient position.

11.1.3 The overall weight of the Computer is only 80 pounds.

11.1.4 The maximum power requirements of the Computer are:-

120 watts of 400 cps at 115 volts
110 watts of D.C. at 28 volts.

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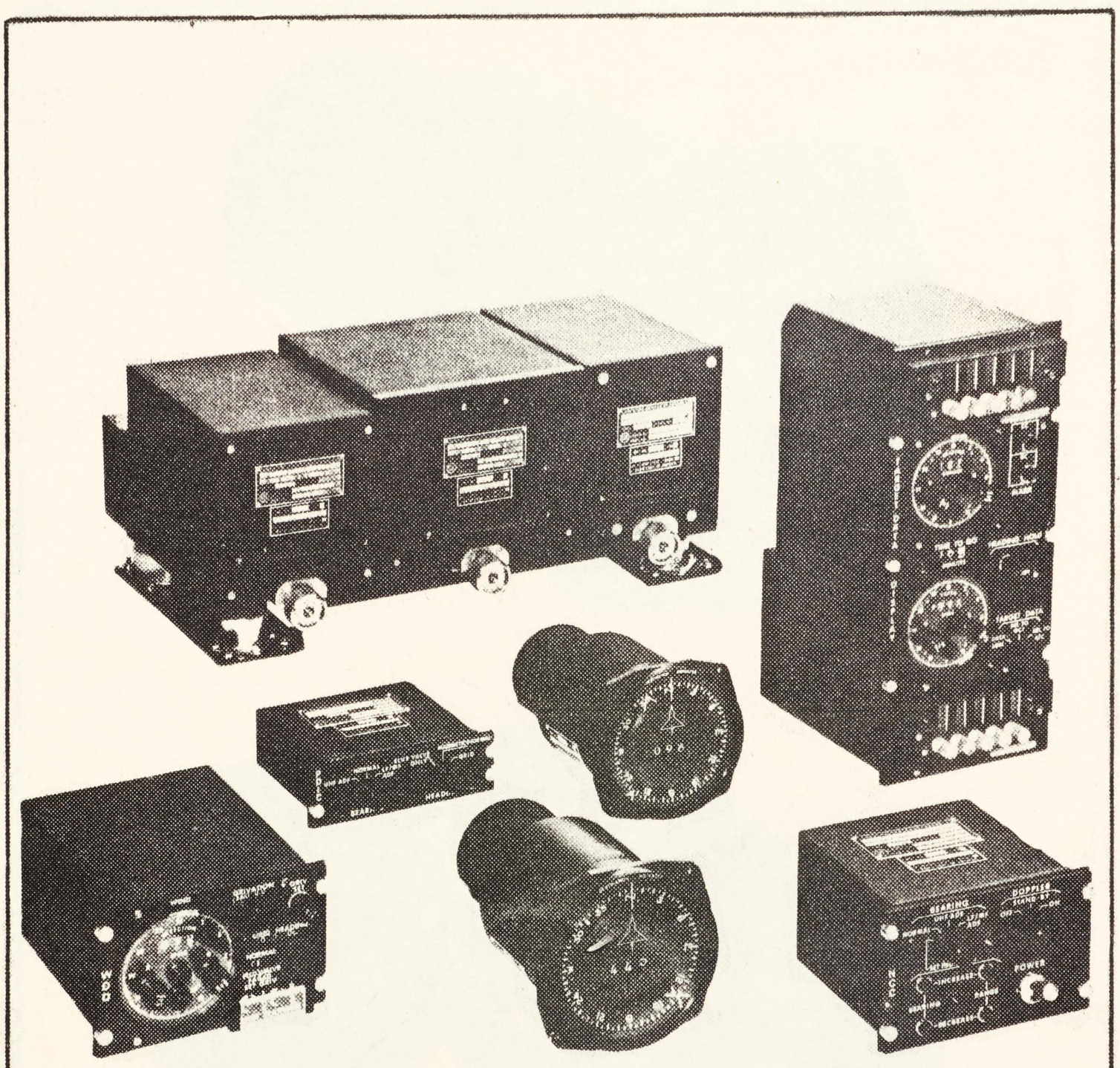

Figure 1. Astra 1 Computer

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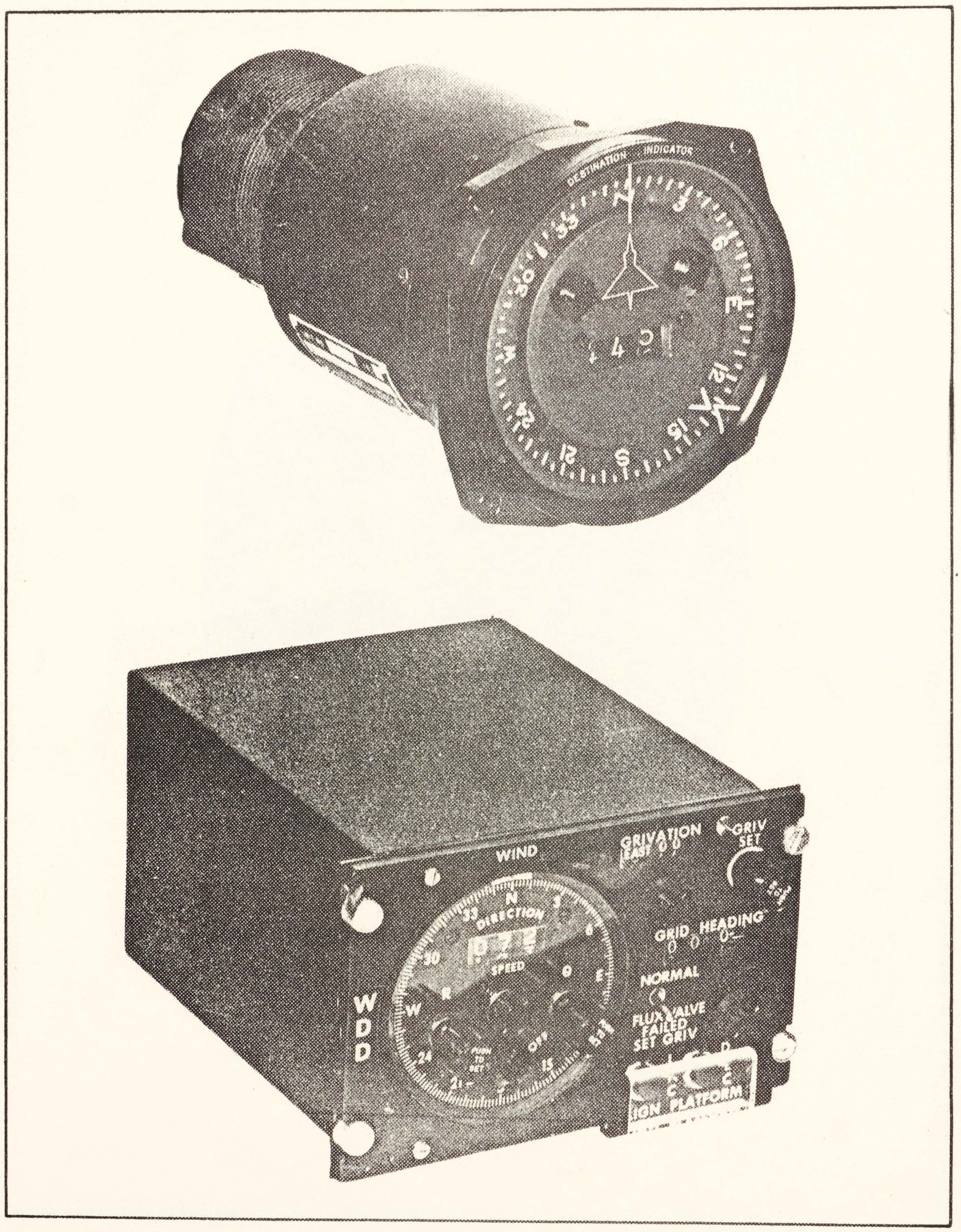

Figure 2. Destination Indicator and Wind Data Display

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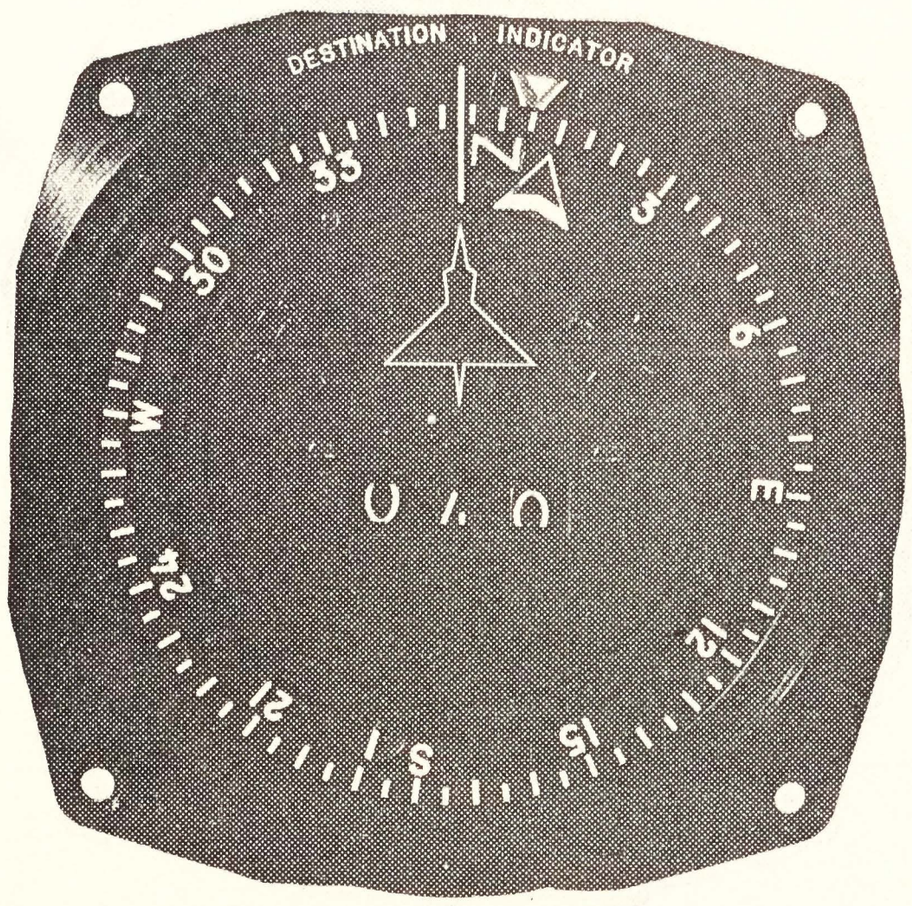

Figure 3. Destination Indicator - Face

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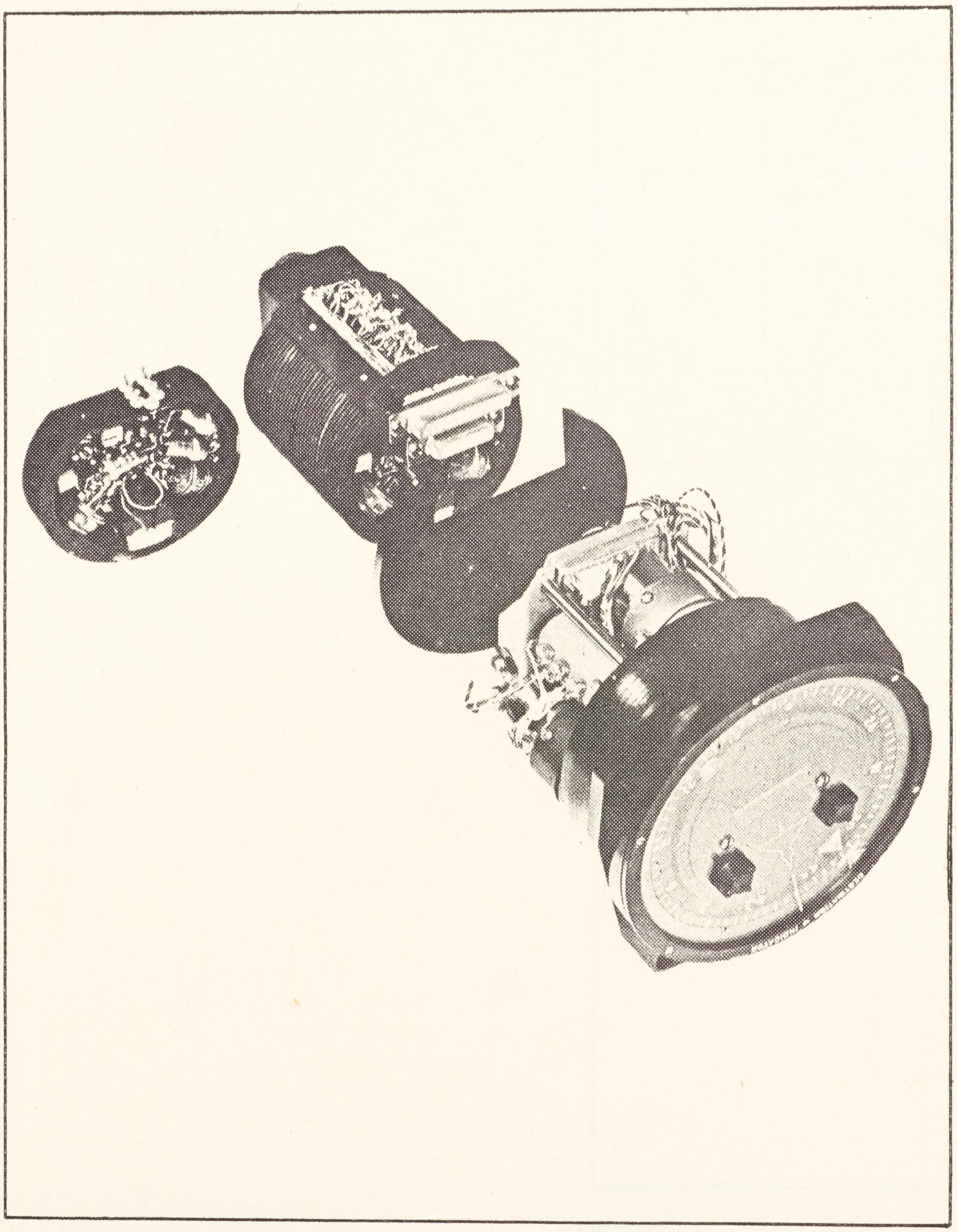

Figure 4. Destination Indicator - Exploded View

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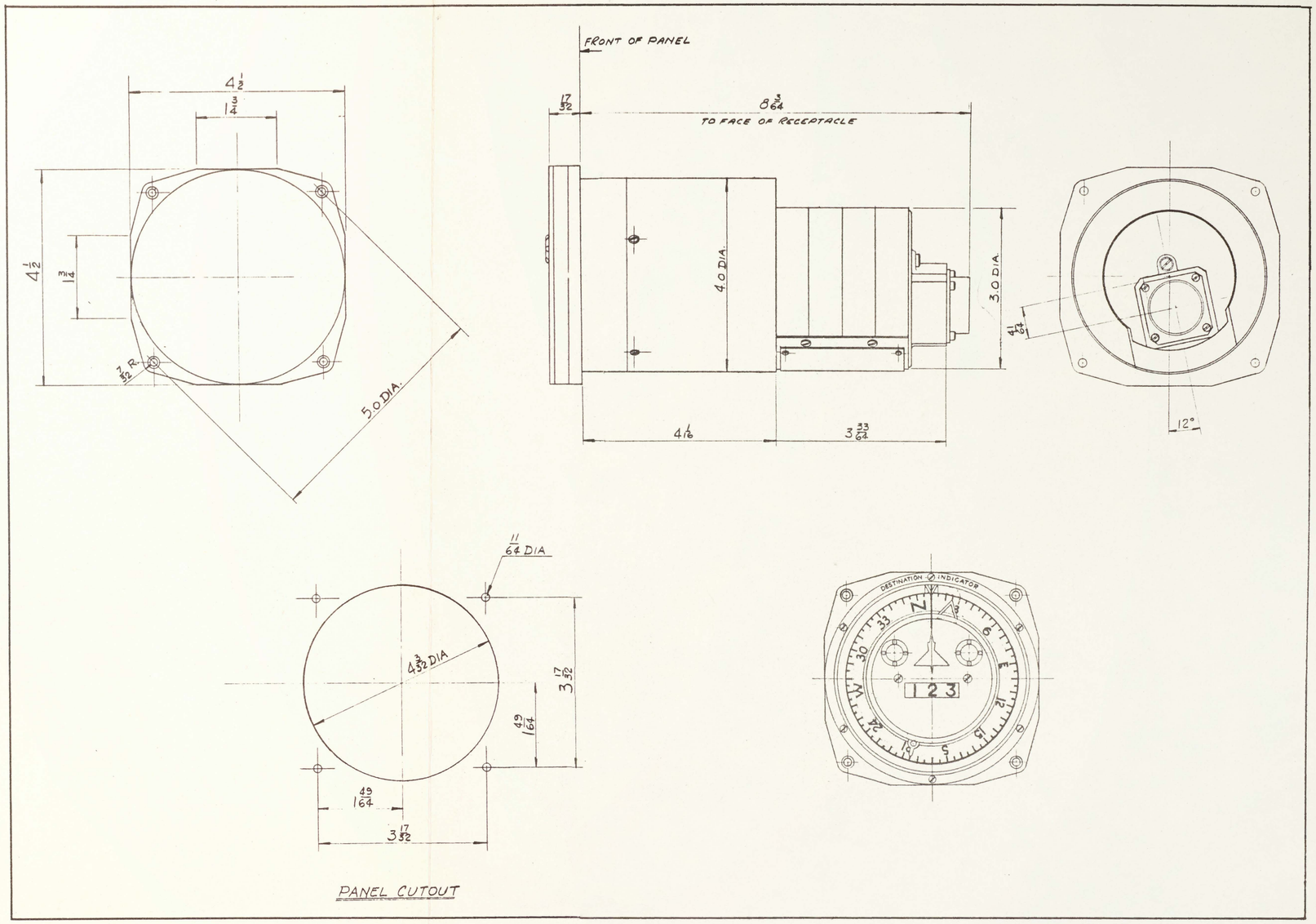

Figure 5

Figure 5 - Destination Indicator - Outline Drawing

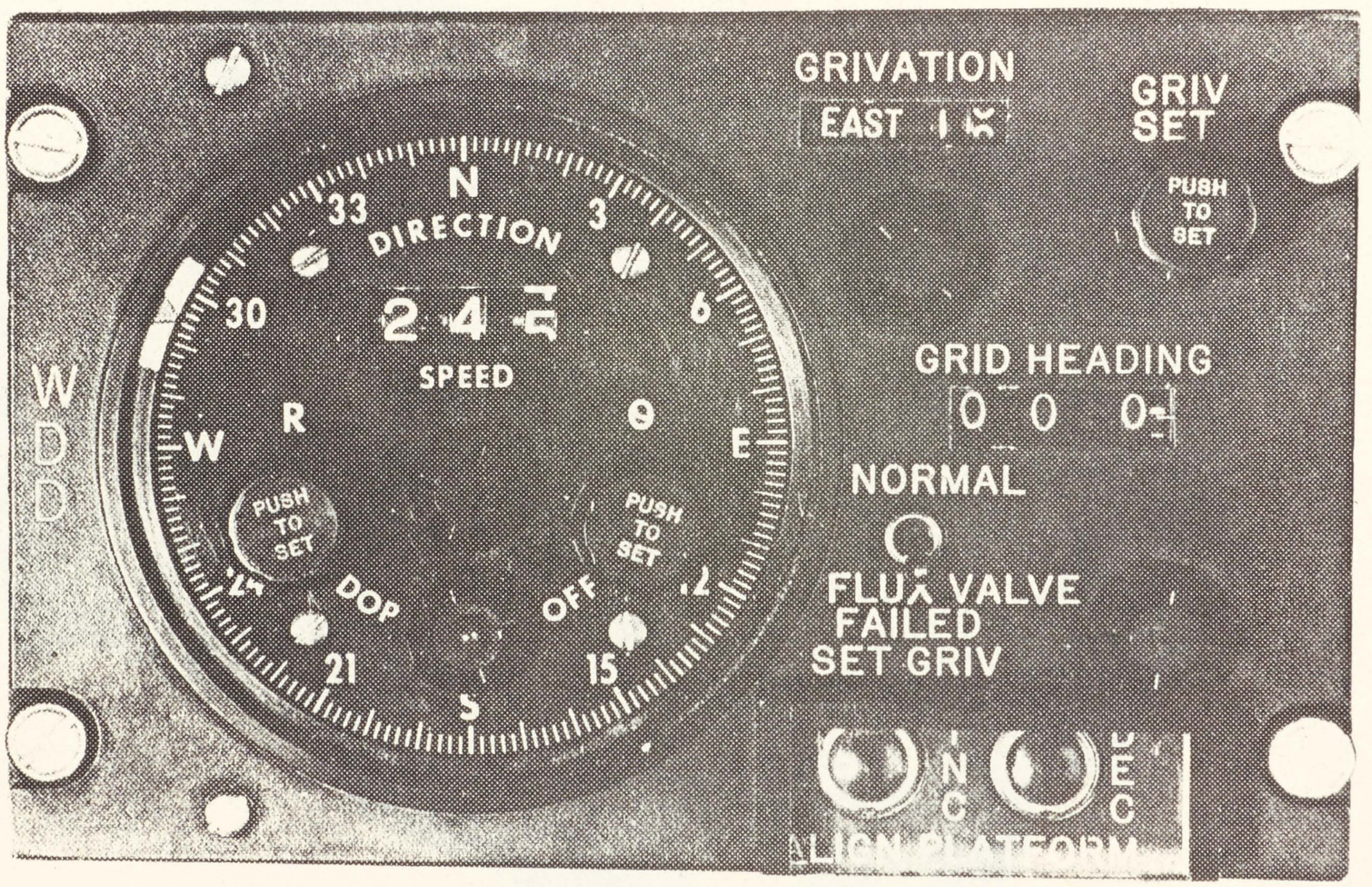

Figure 6. Wind Data Display - Face

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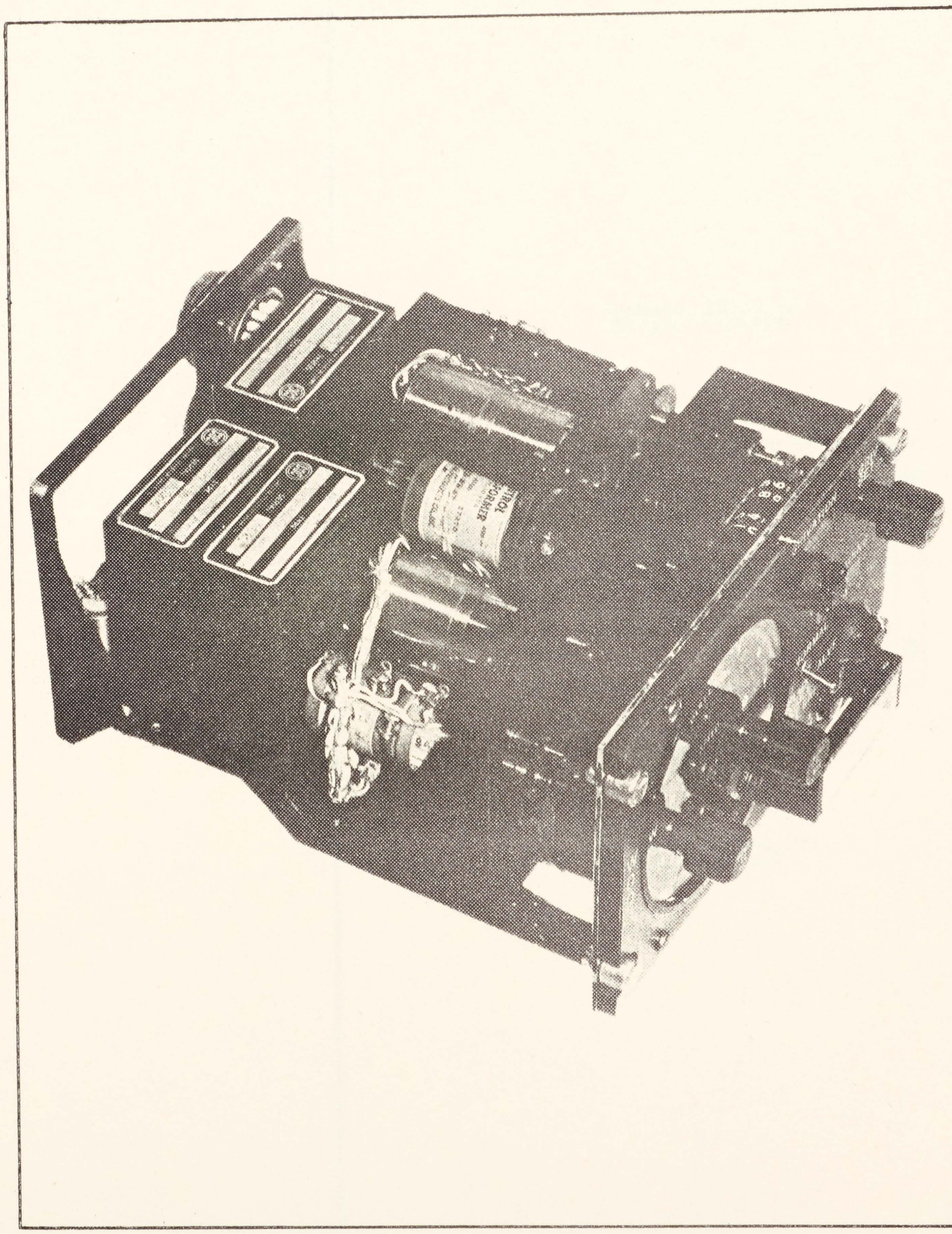

Figure 7. Wind Data Display - Internal View

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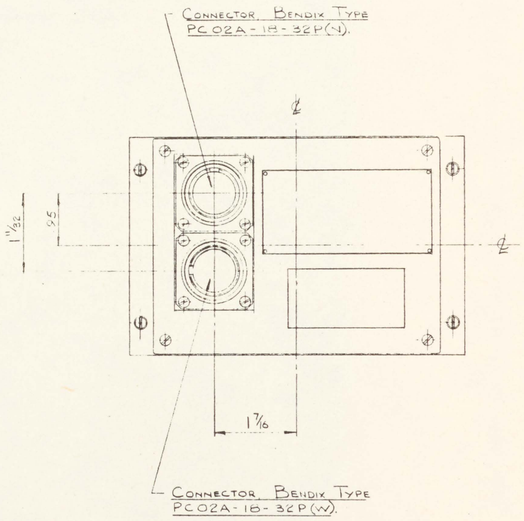
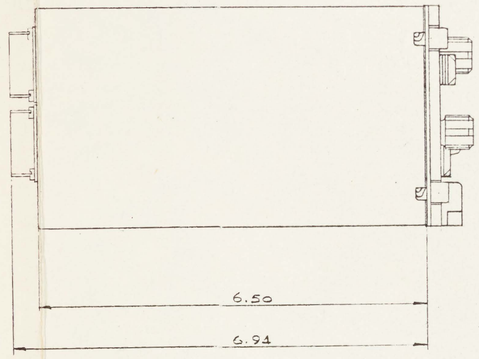
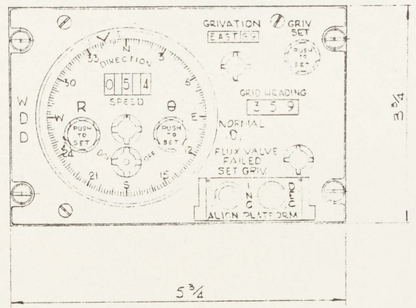






WEIGHT- 6LB., 8OZ.

Figure 8

Figure 8 - Wind Data Display - Outline Drawing

UNCLASSIFIED

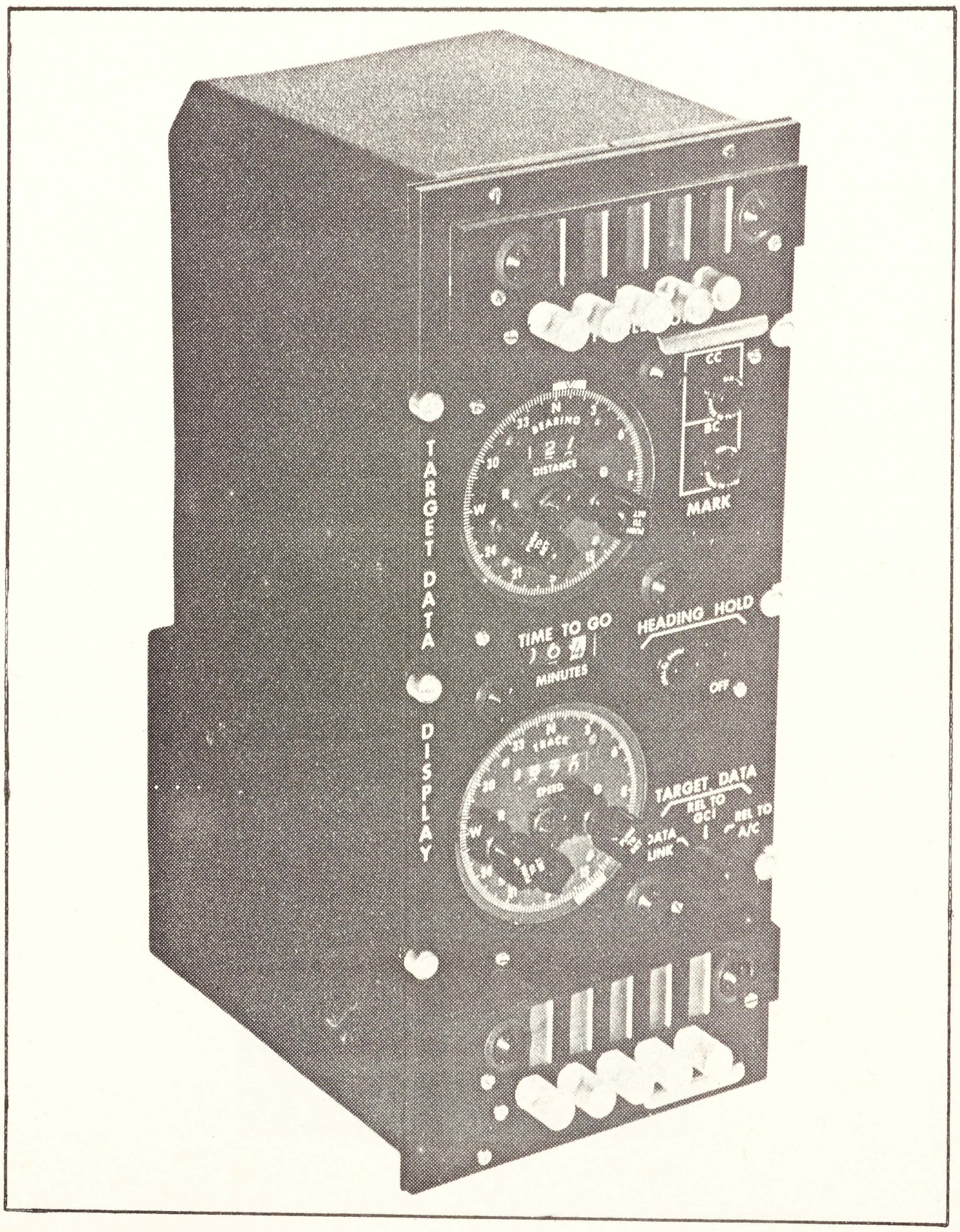


Figure 9. Target Data Display

UNCLASSIFIED

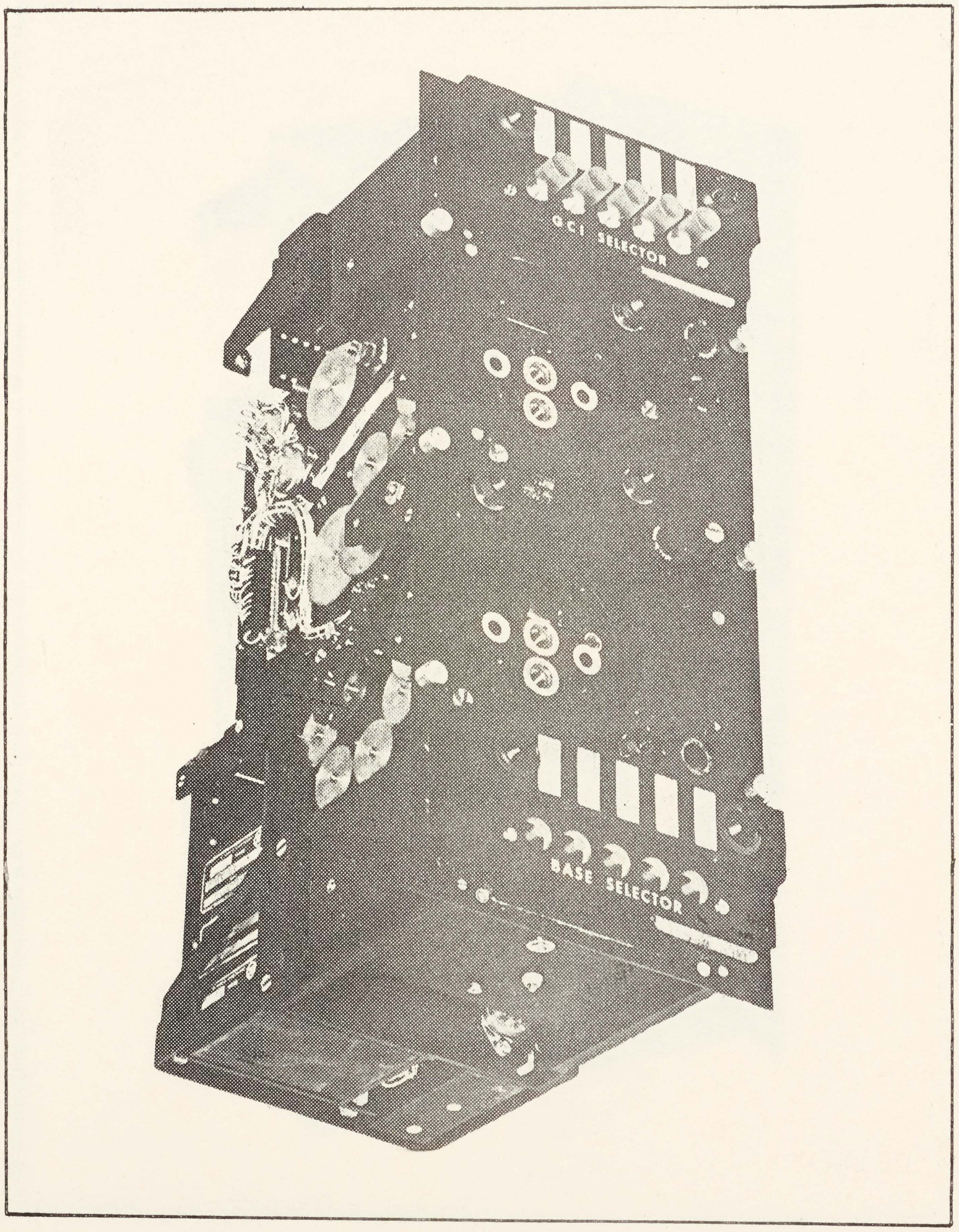


Figure 11. Target Data Display - Internal

UNCLASSIFIED

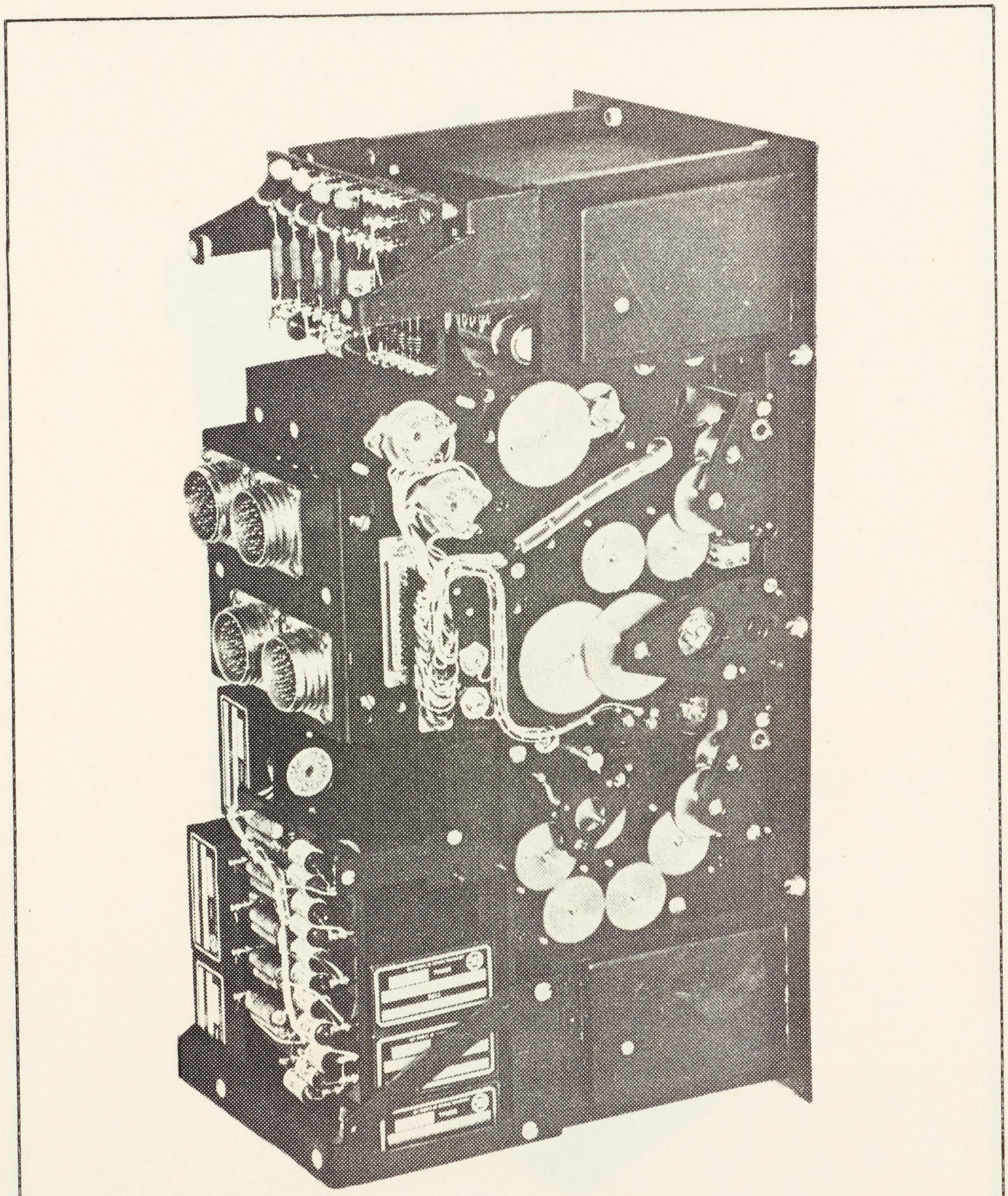


Figure 12. Target Data Display - Internal

UNCLASSIFIED

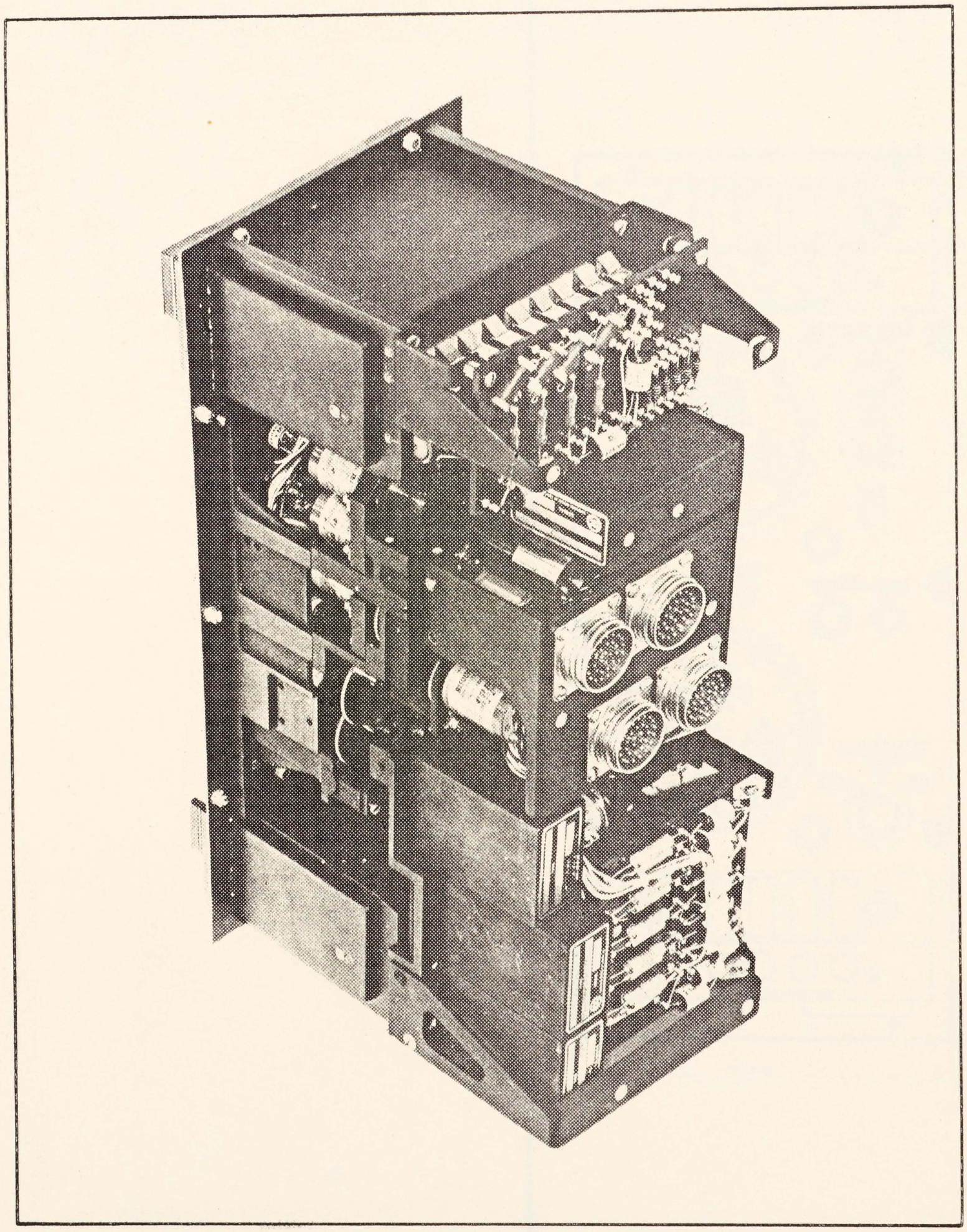


Figure 13. Target Data Display - Internal

UNCLASSIFIED

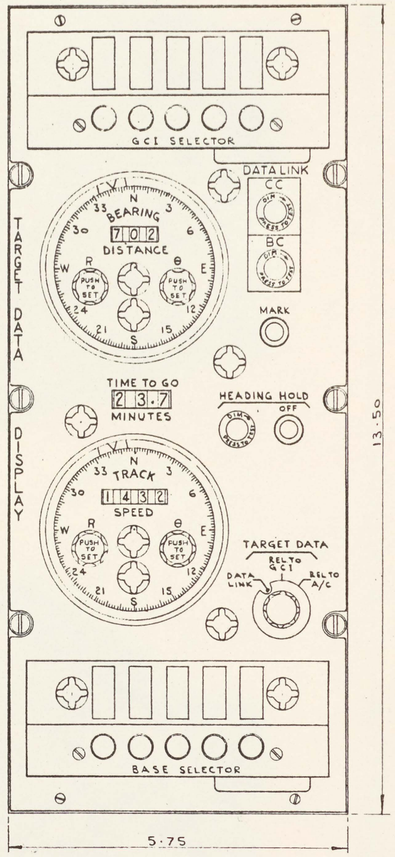


Figure 14

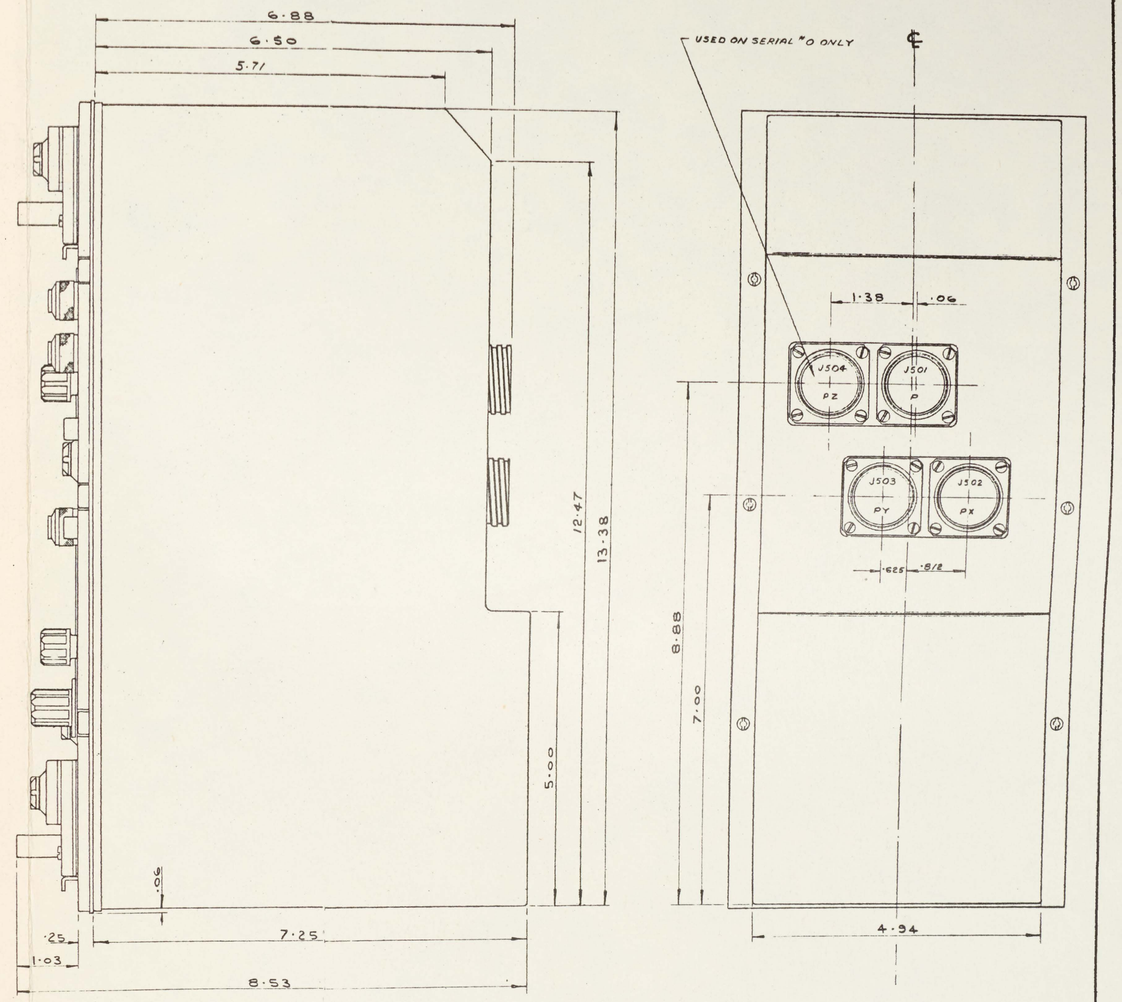


Figure 14 - Target Data Display - Outline Drawing

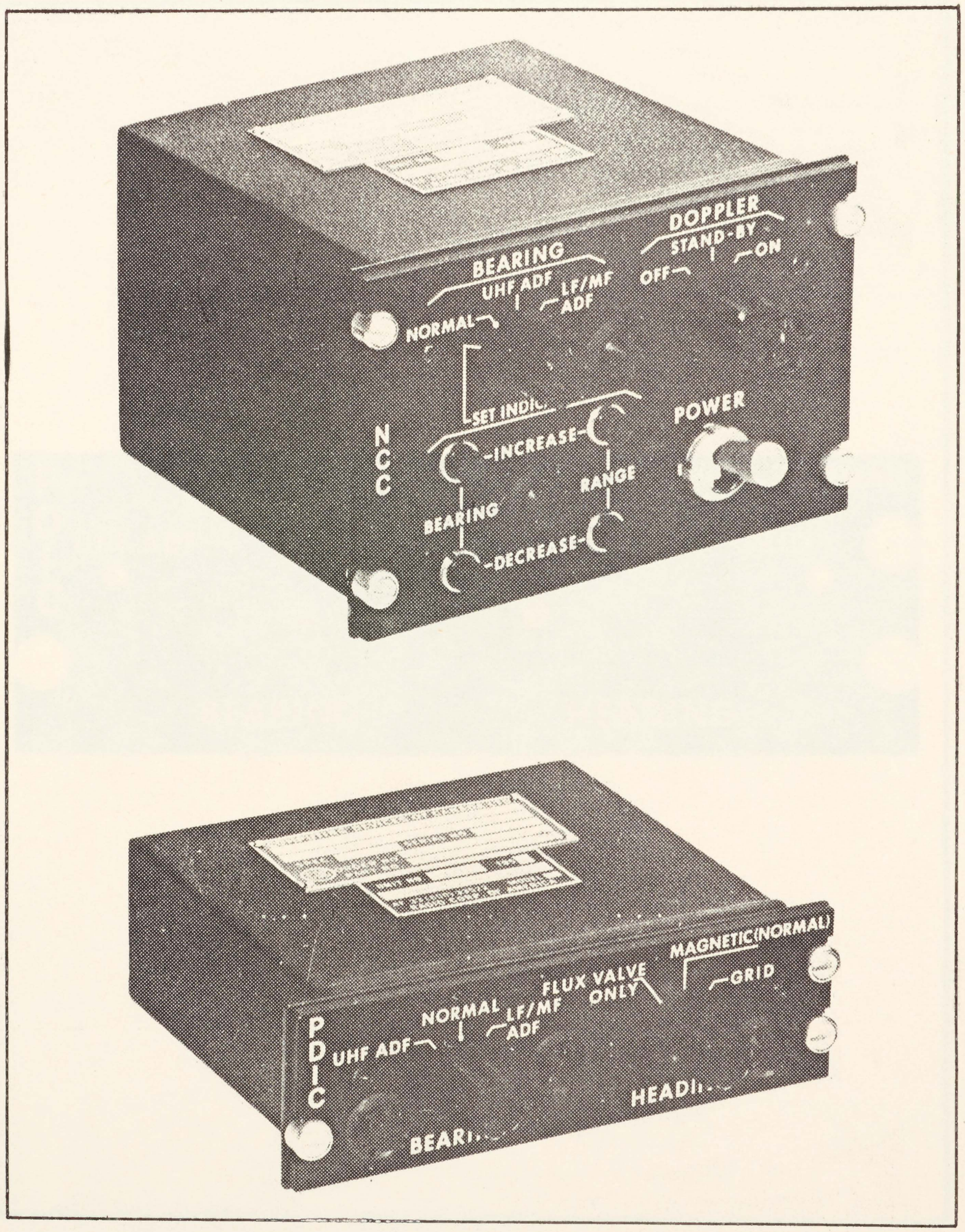


Figure 15. Control Units

UNCLASSIFIED

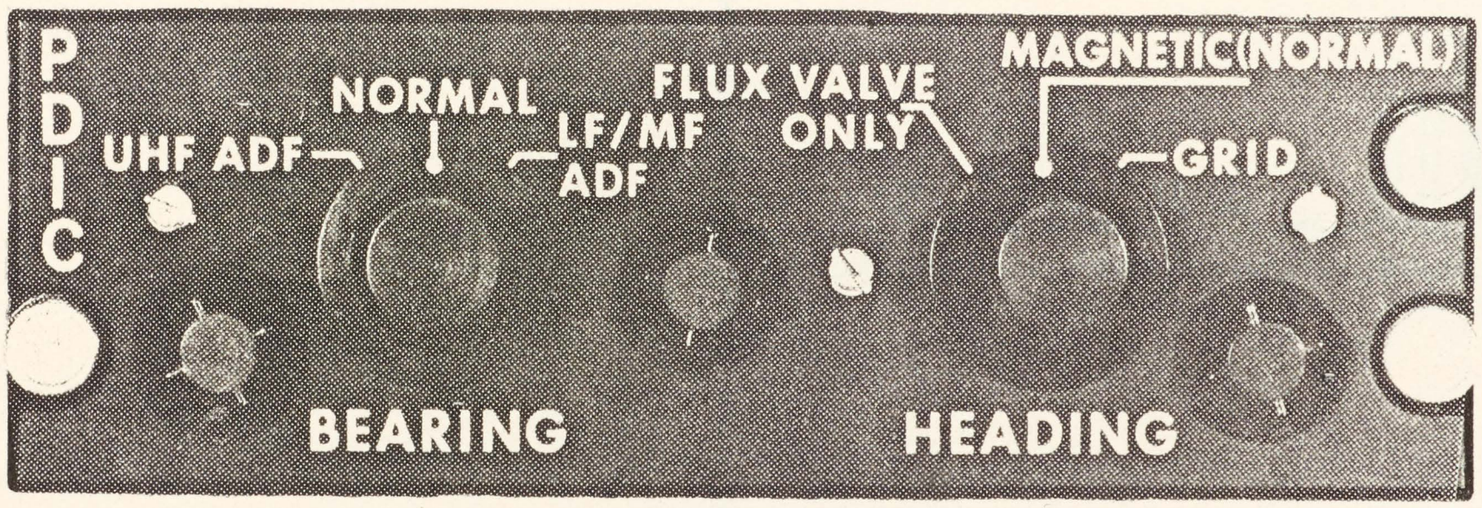


Figure 16. Pilot's Destination Indicator Control - Face

UNCLASSIFIED

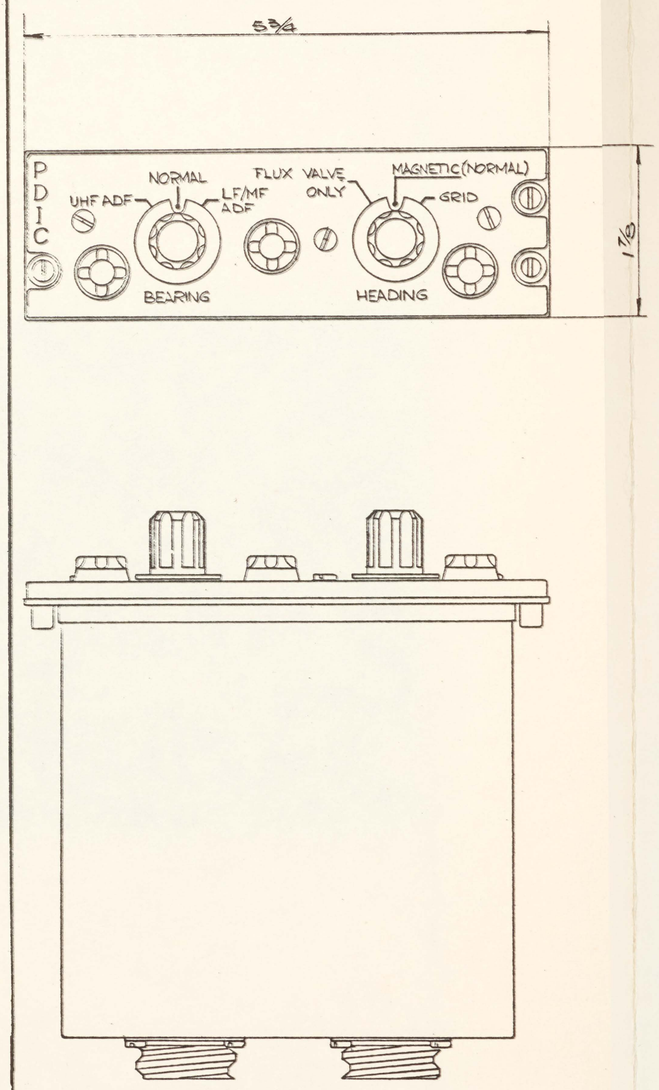
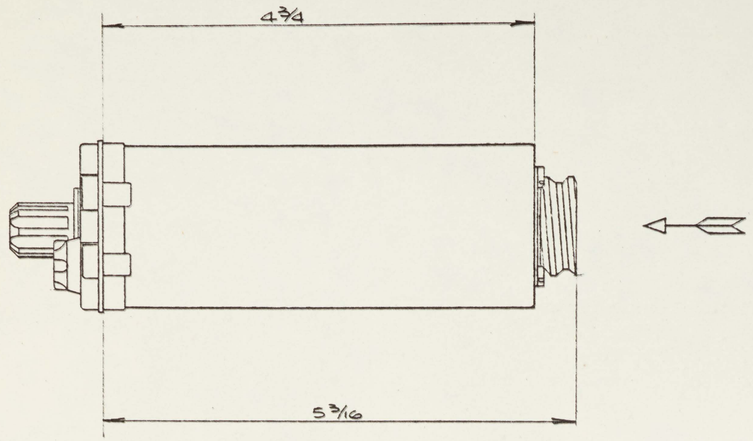


Figure 17



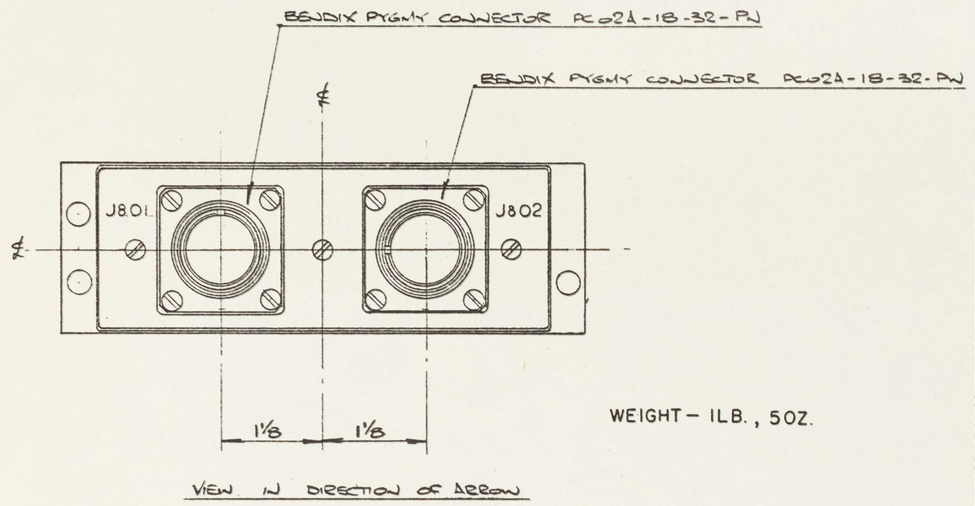


Figure 17 - Pilot's Destination Indicator Control - Outline Drawing

UNCLASSIFIED

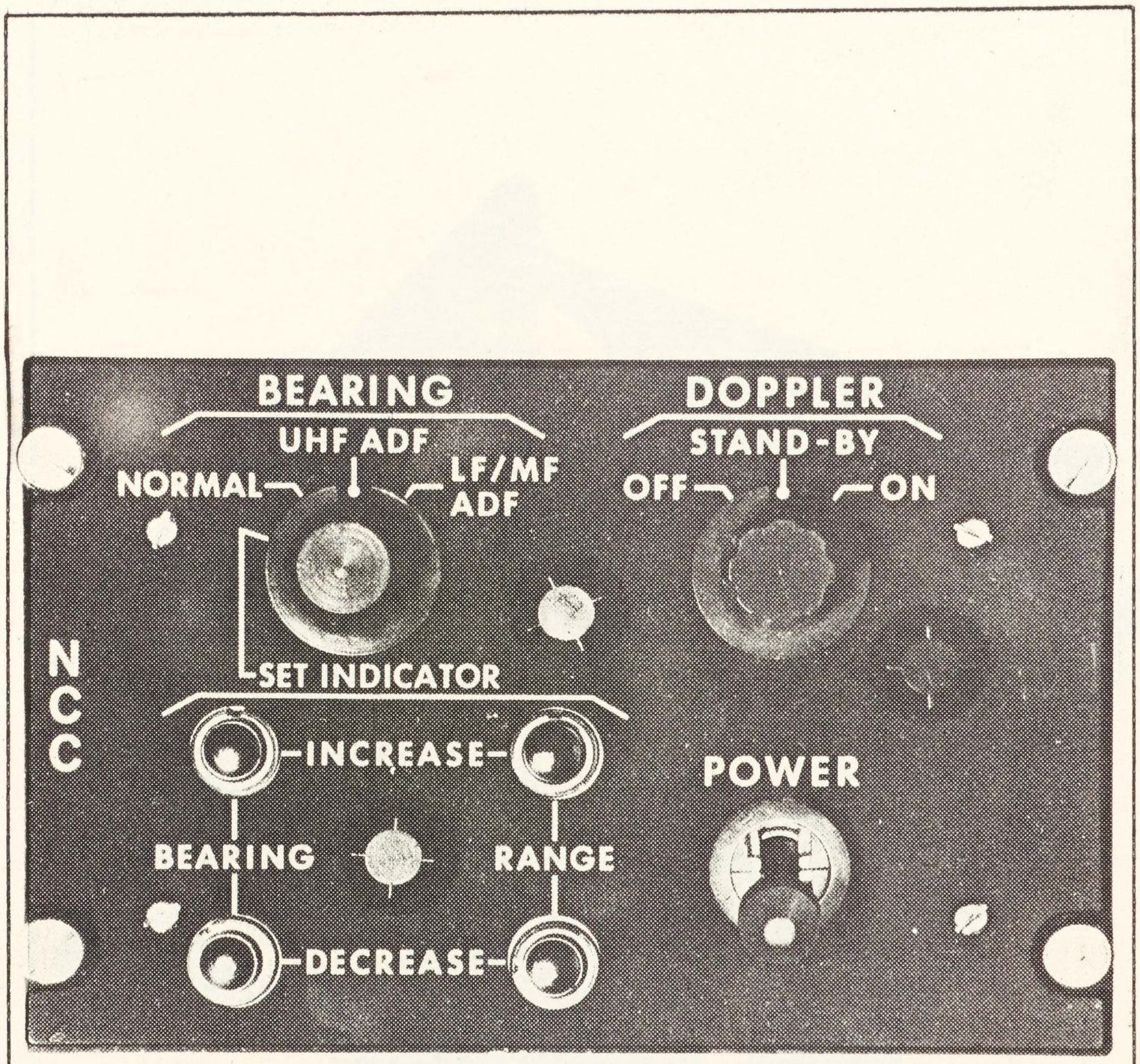


Figure 18. Navigation Computer Control - Face

UNCLASSIFIED

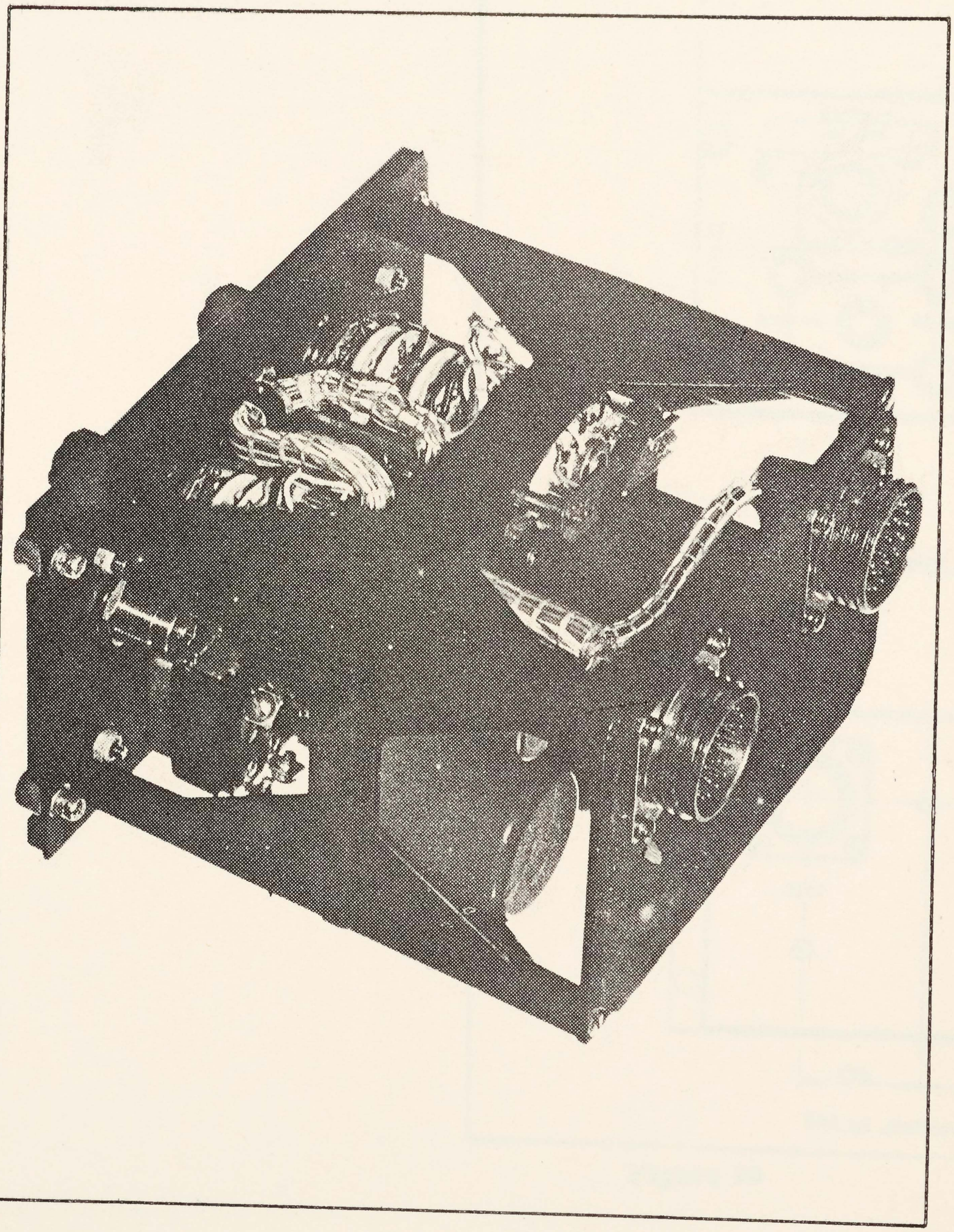


Figure 19. Navigation Computer Control - Internal

UNCLASSIFIED
Confidential

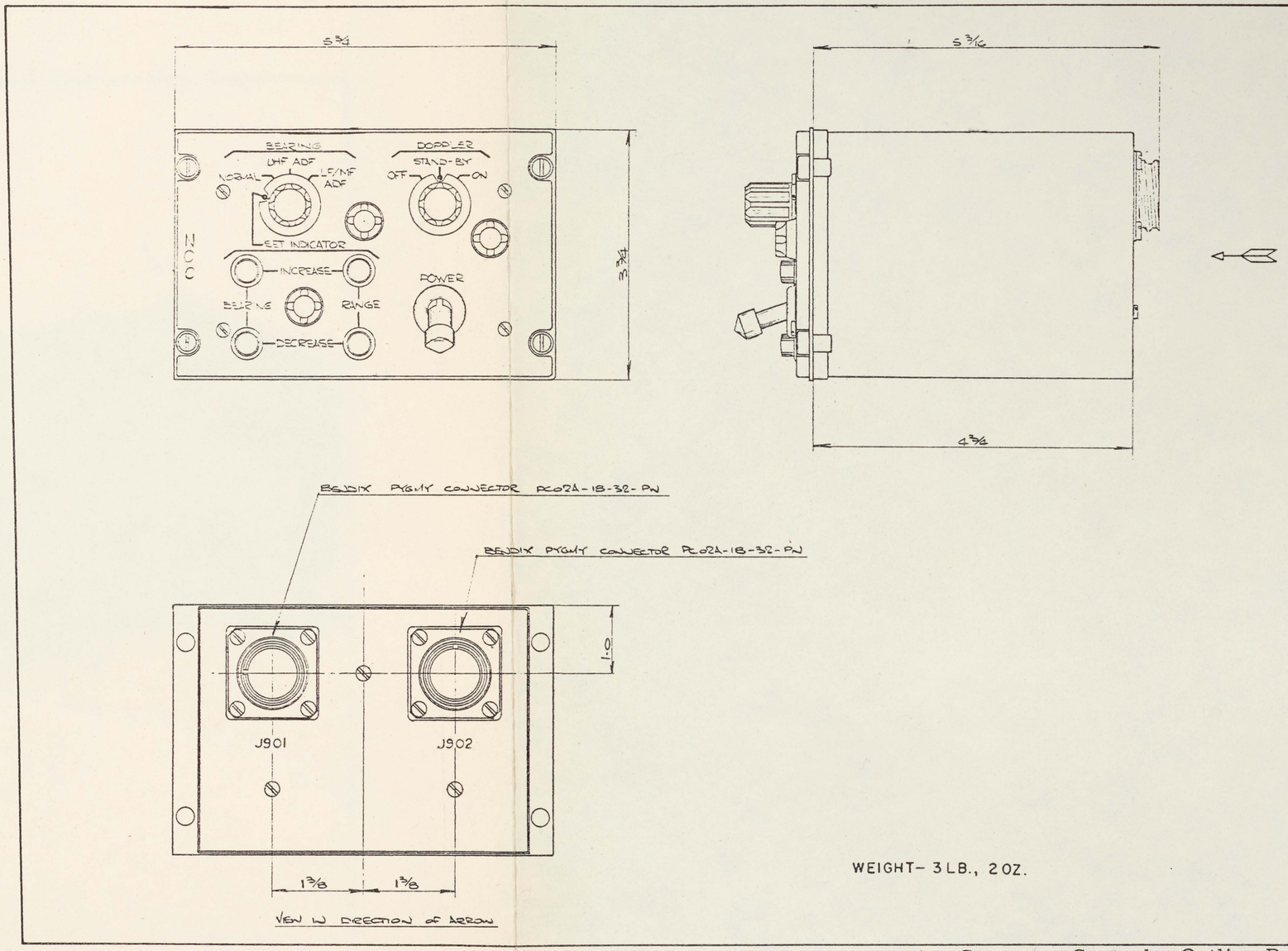


Figure 20

Figure 20 - Navigation Computer Control - Outline Drawing

UNCLASSIFIED

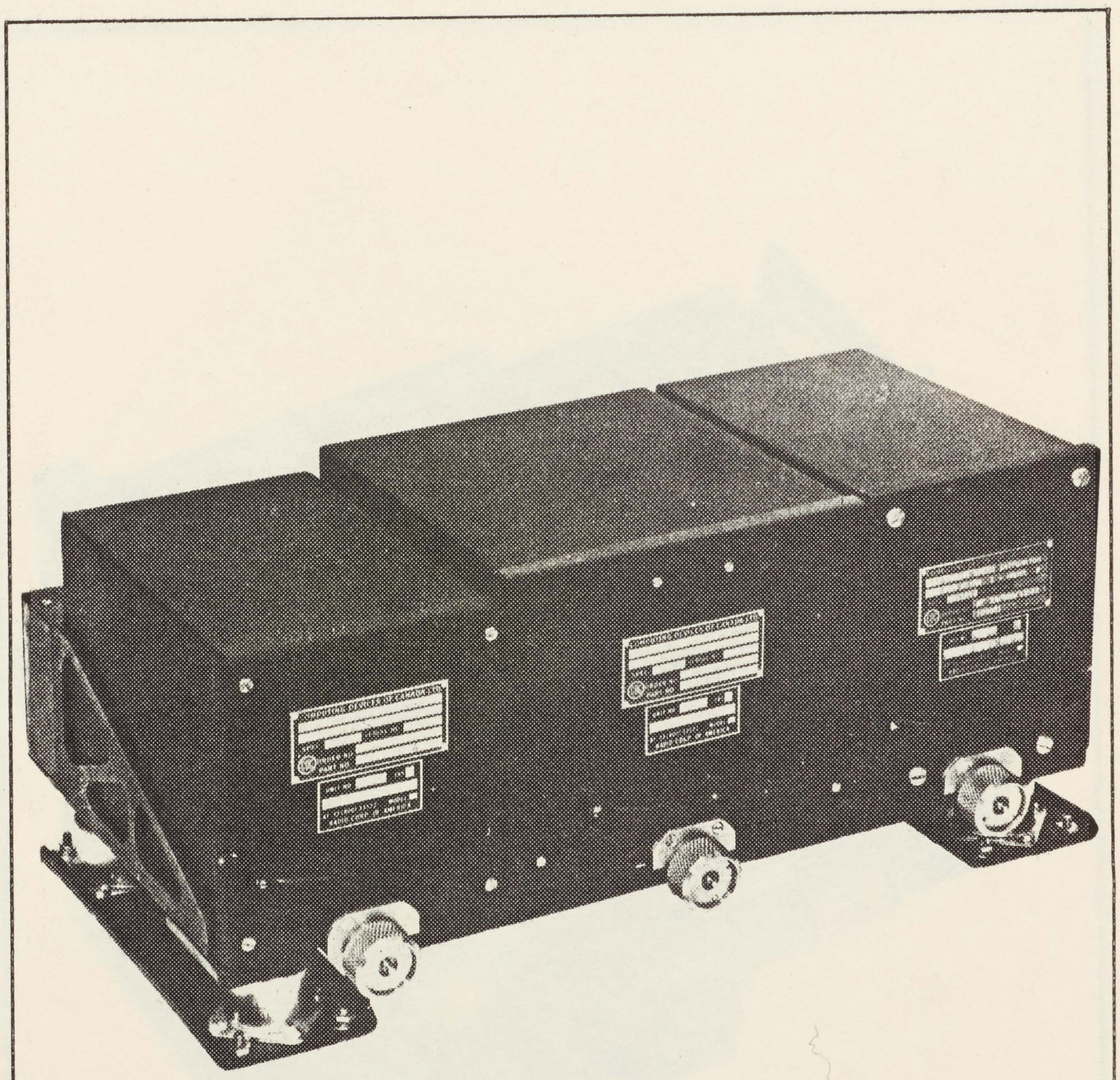


Figure 21. Dead Reckoner Units

UNCLASSIFIED

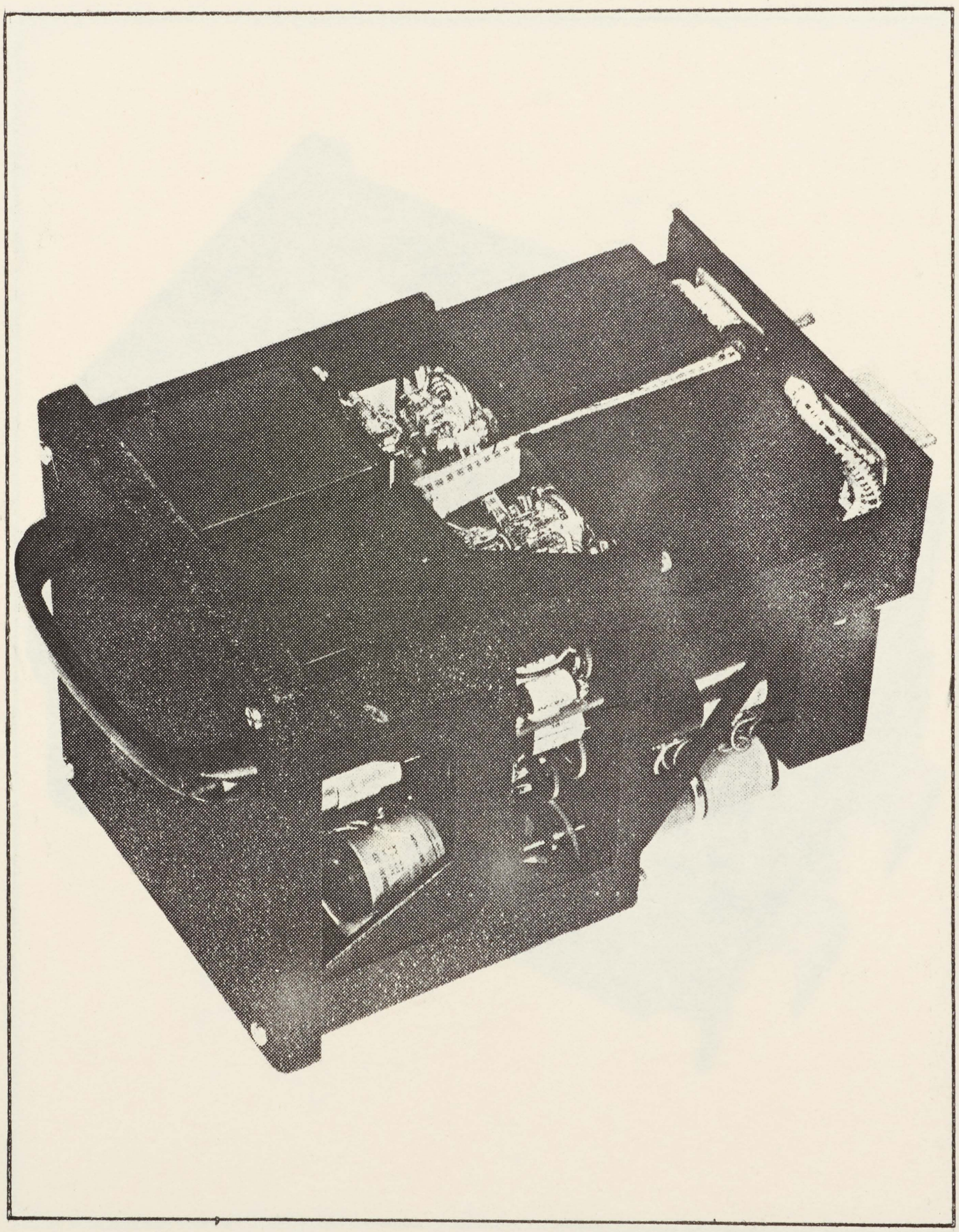


Figure 22. Ground Speed Computer - Internal

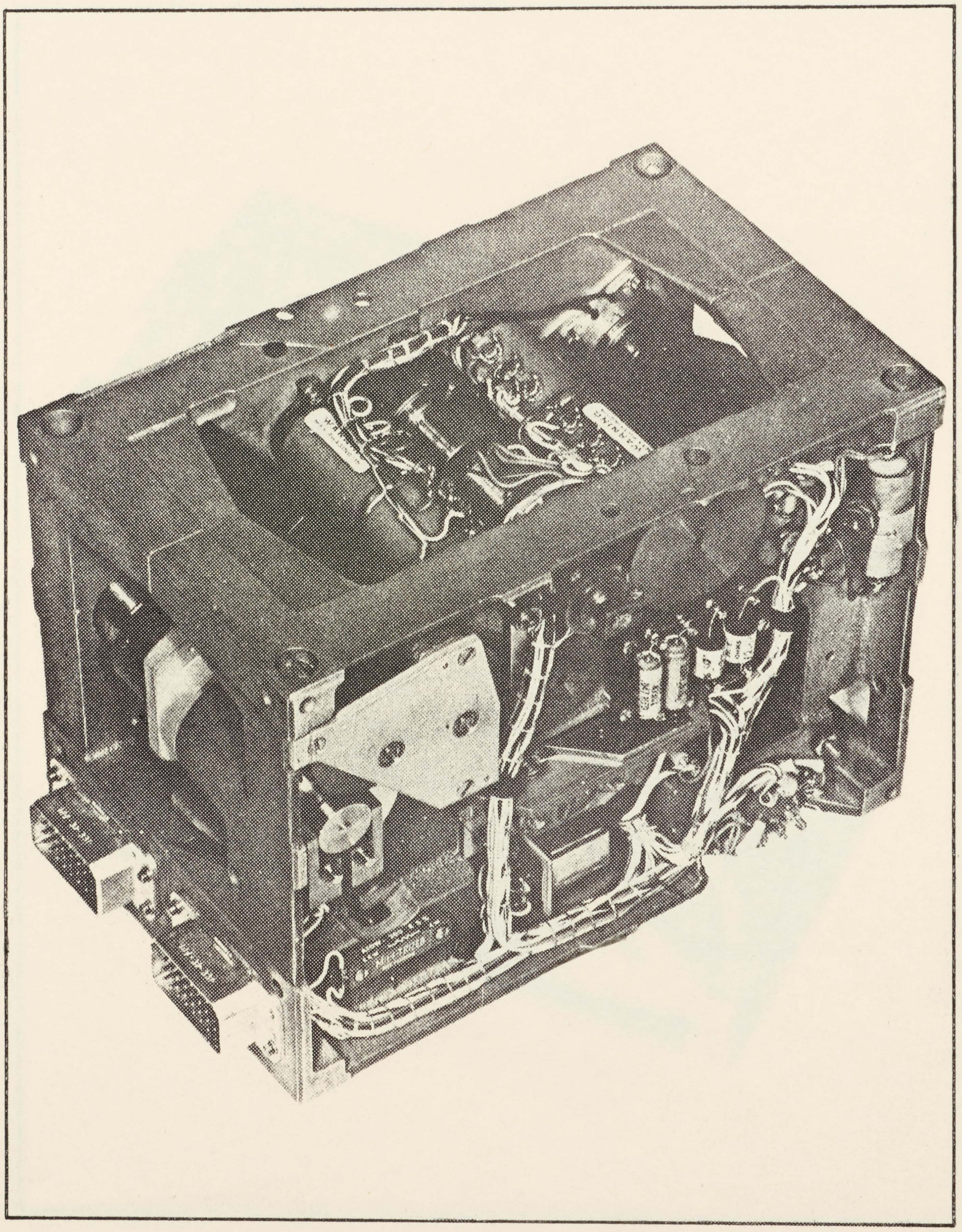


Figure 24. Ground Speed Integrator - Internal

UNCLASSIFIED

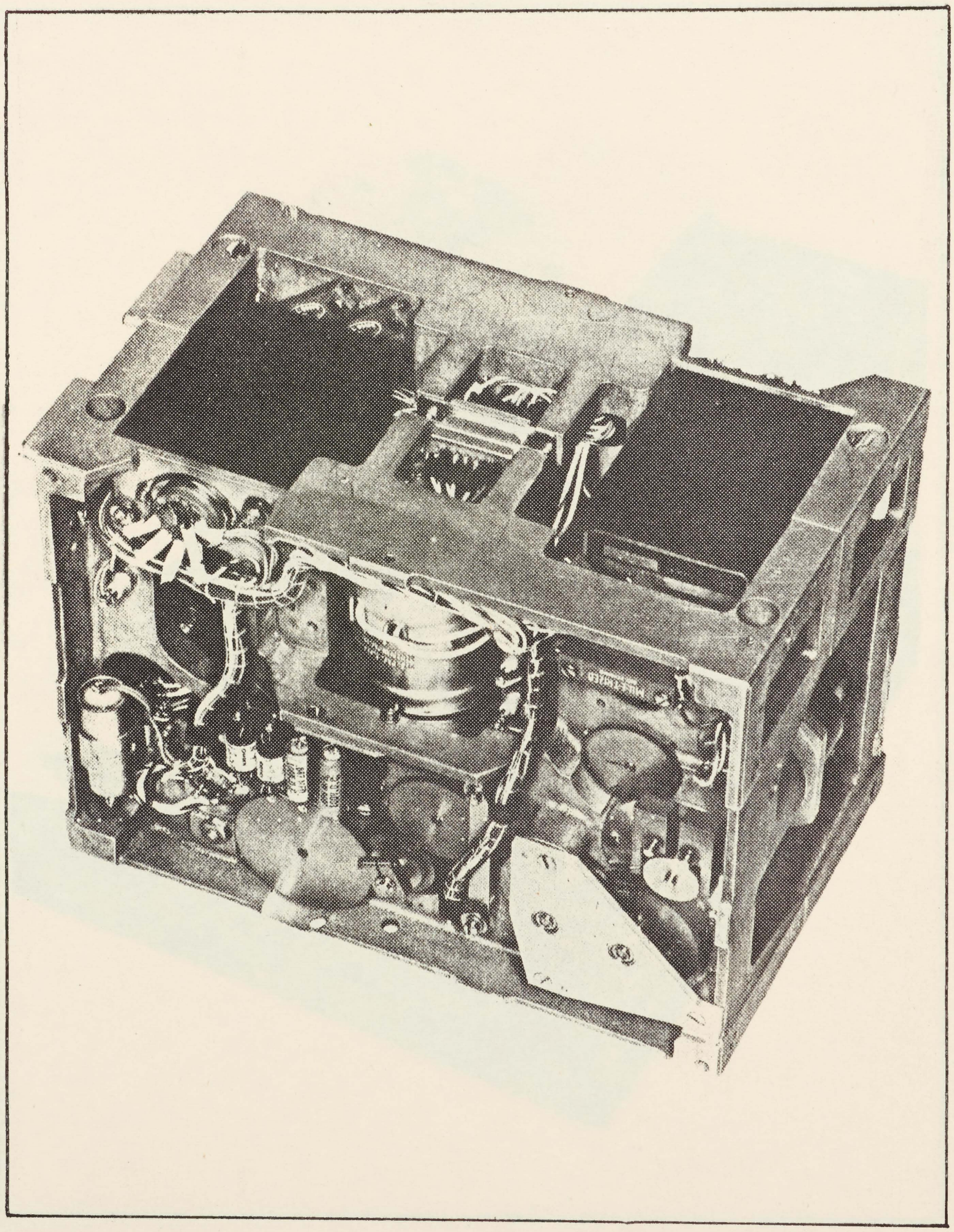


Figure 25. Ground Speed Integrator - Internal

UNCLASSIFIED

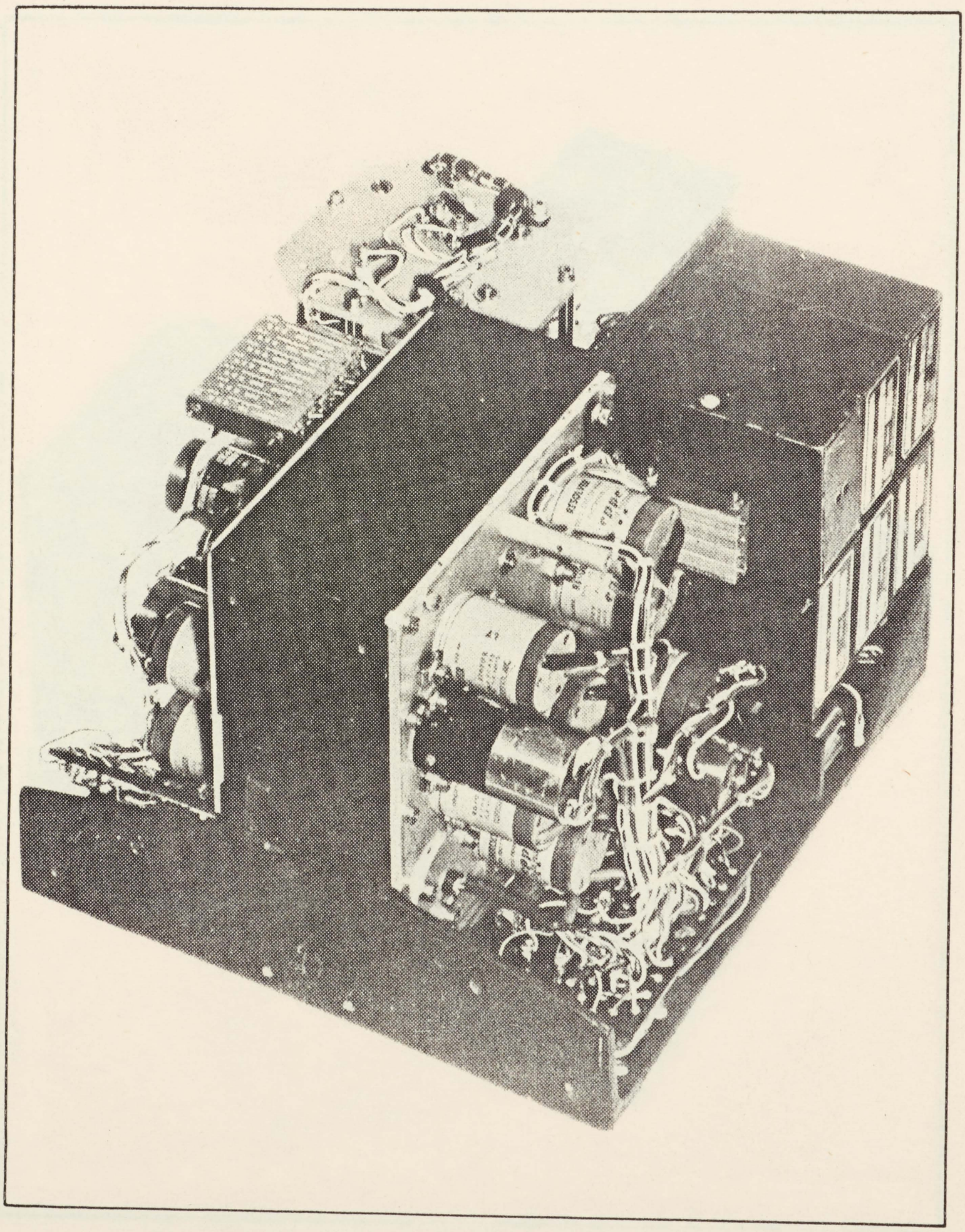


Figure 26. Computer and Relay Unit - Internal

UNCLASSIFIED

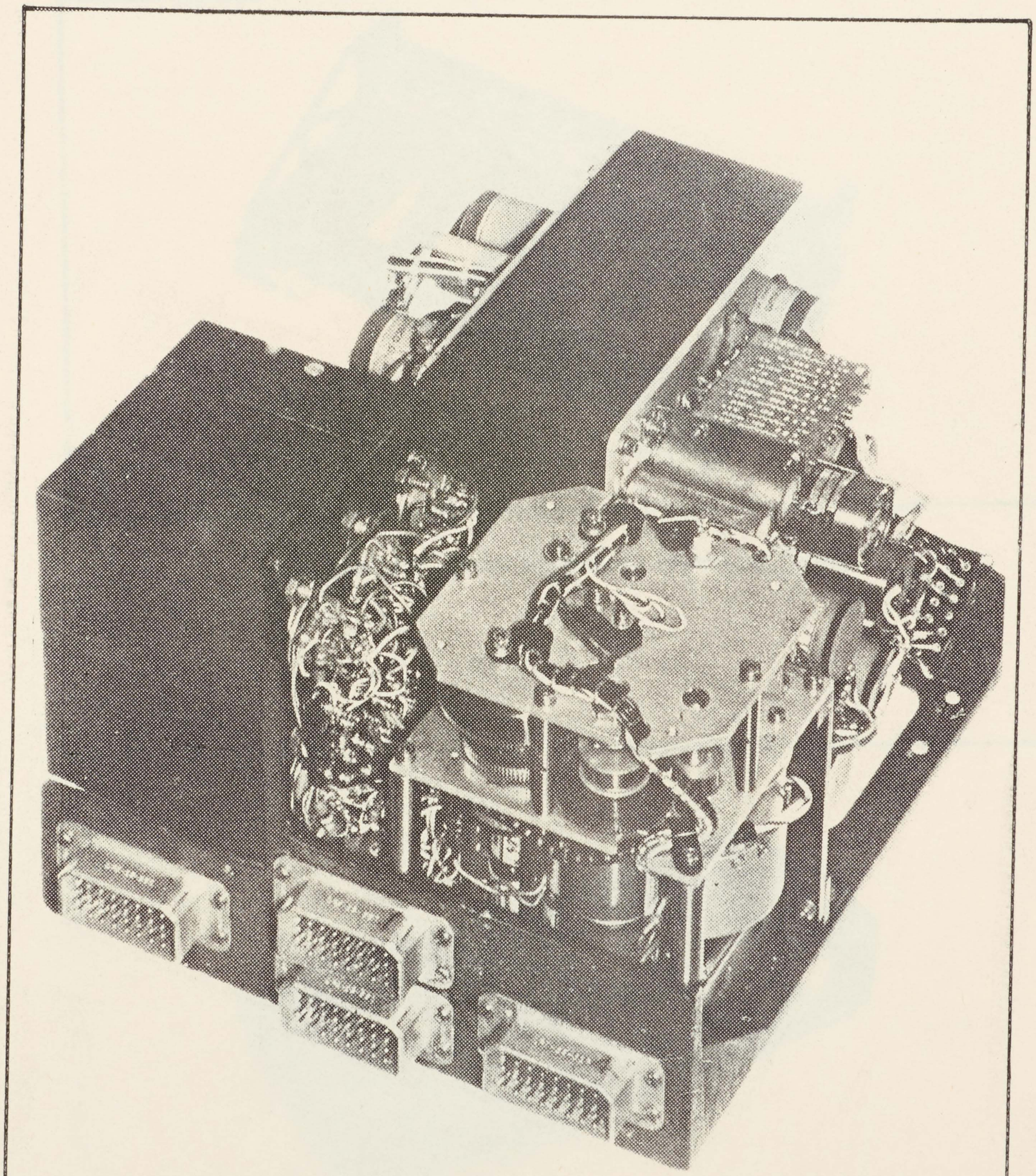


Figure 27. Computer and Relay Unit - Internal

UNCLASSIFIED

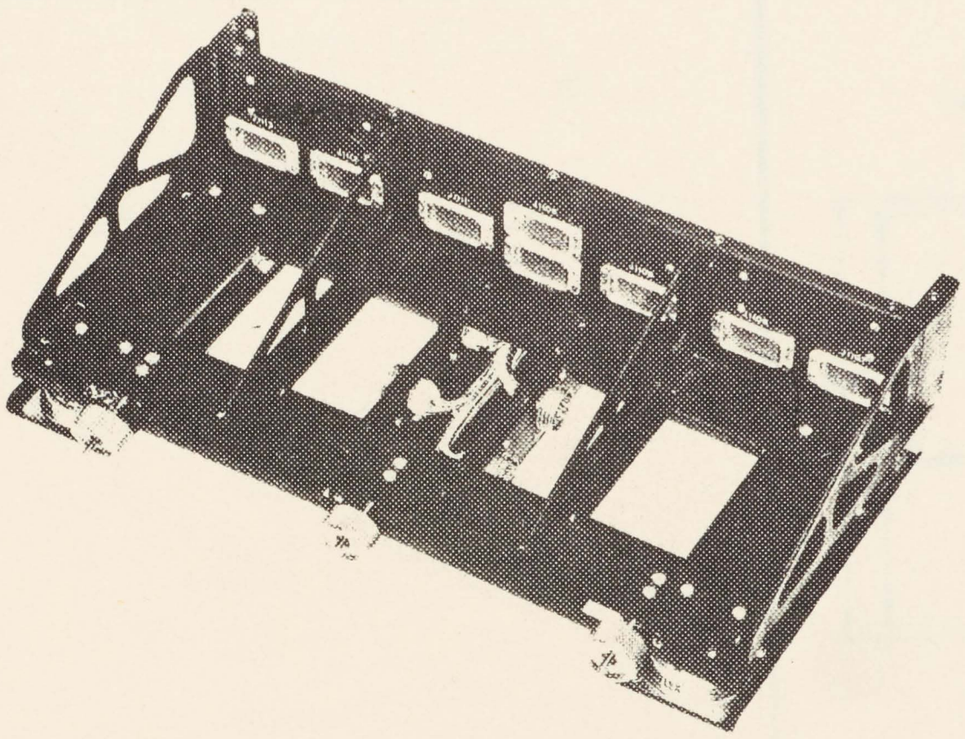


Figure 28. Dead Reckoner Mounting Tray

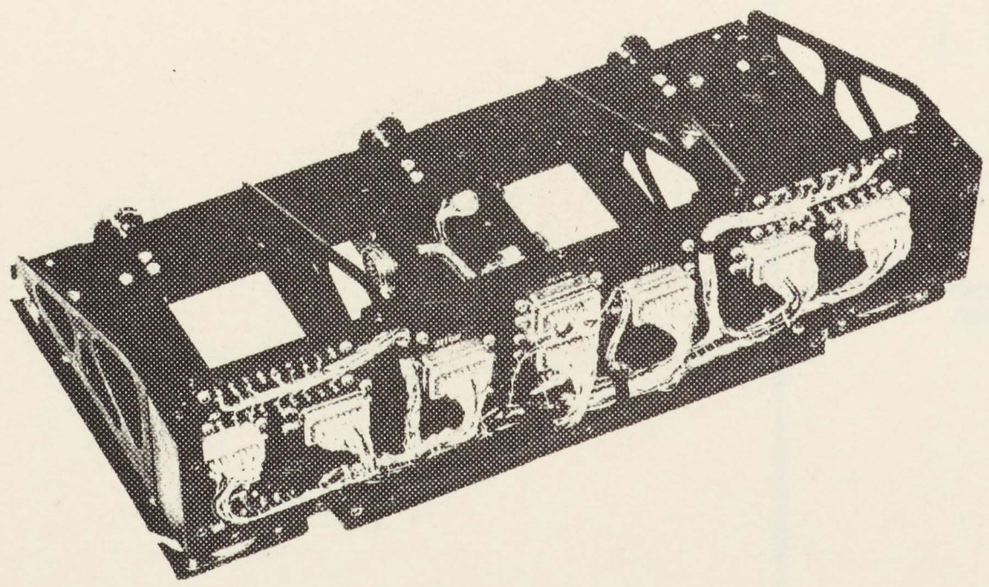


Figure 29. Dead Reckoner Mounting Tray

UNCLASSIFIED

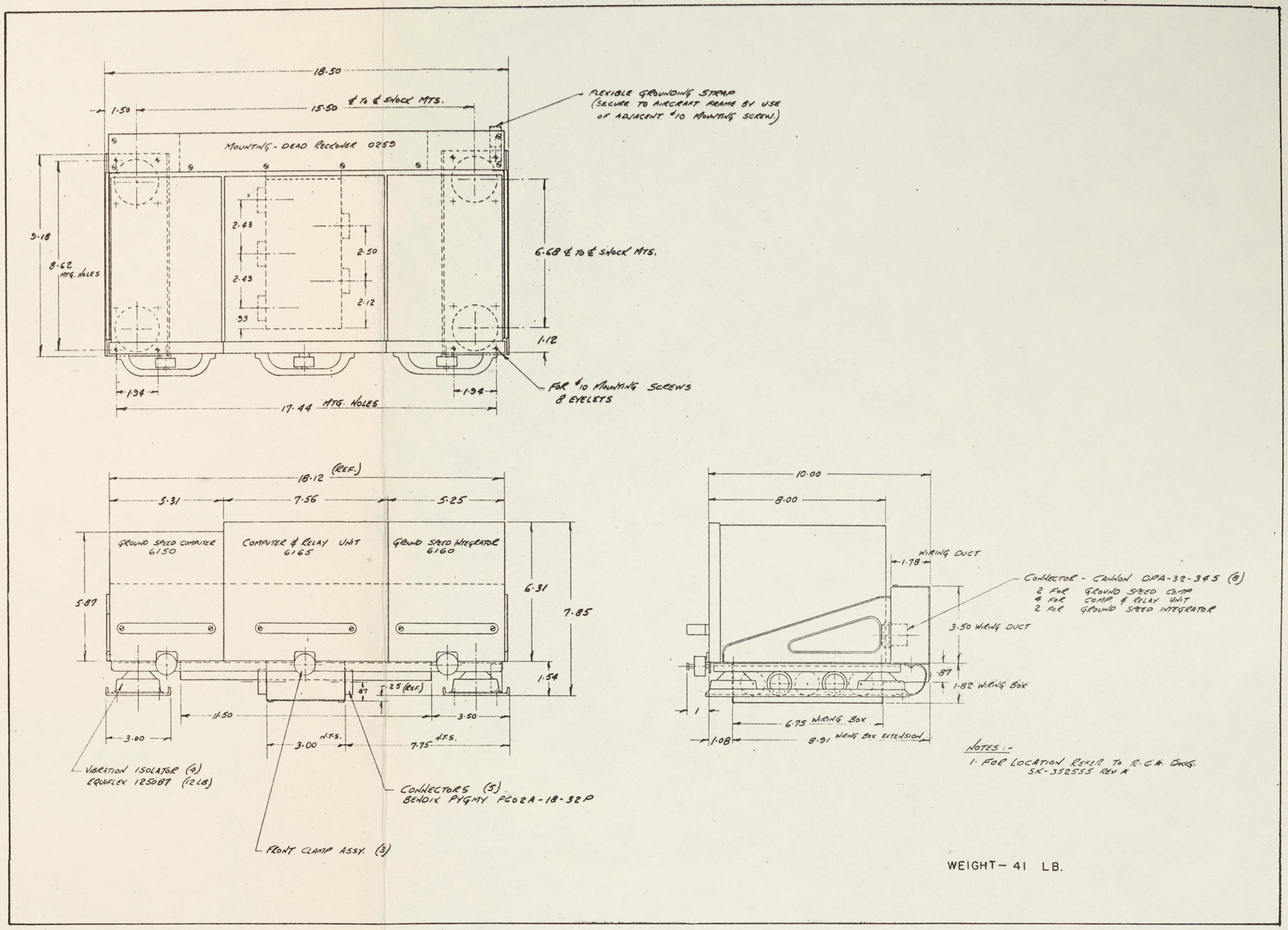
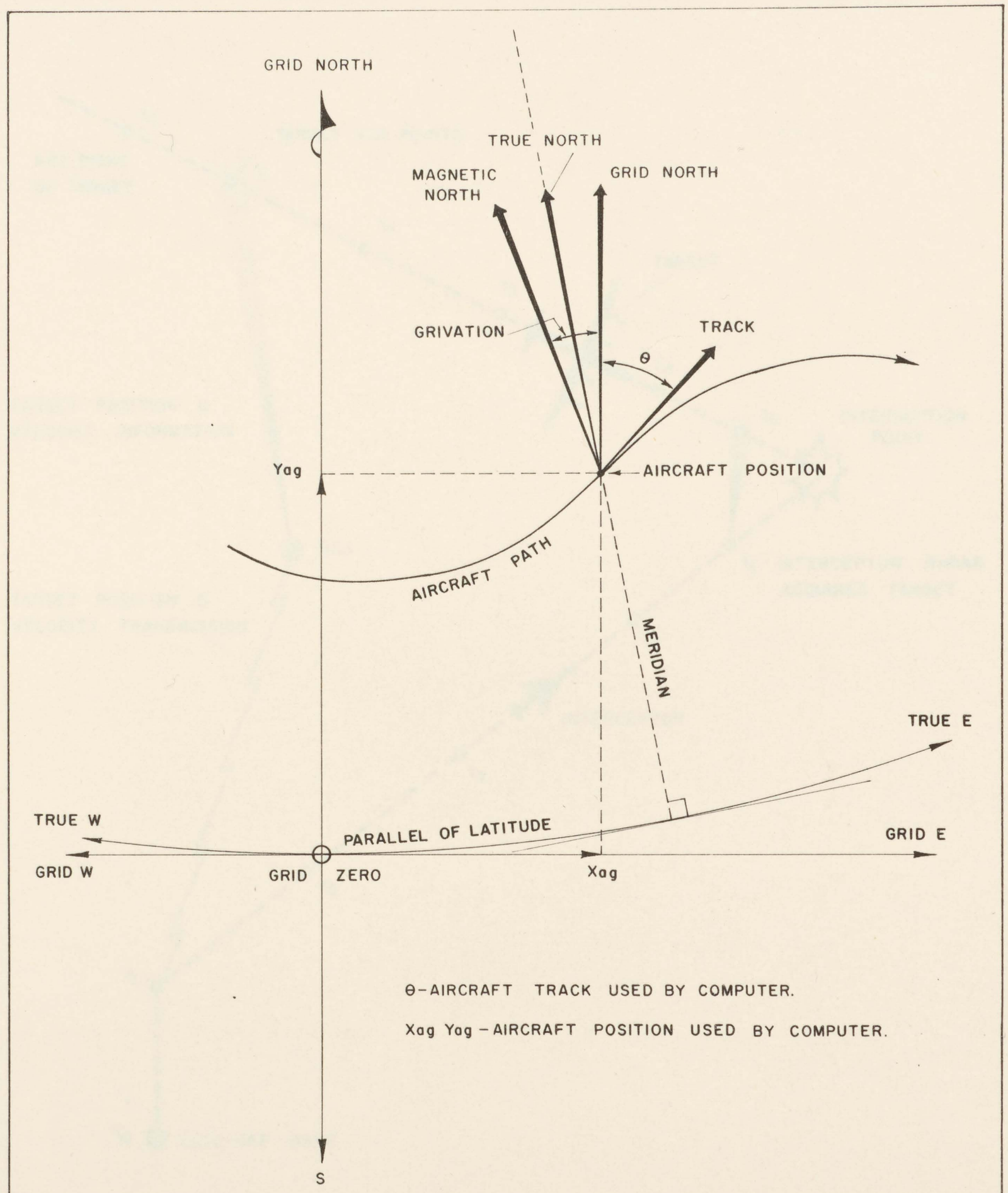


Figure 30

Figure 30 - Dead Reckoner Units in Mounting Tray - Outline Drawing

UNCLASSIFIED



θ-AIRCRAFT TRACK USED BY COMPUTER.

Xag Yag - AIRCRAFT POSITION USED BY COMPUTER.

Figure 31 - Interceptor Grid

UNCLASSIFIED

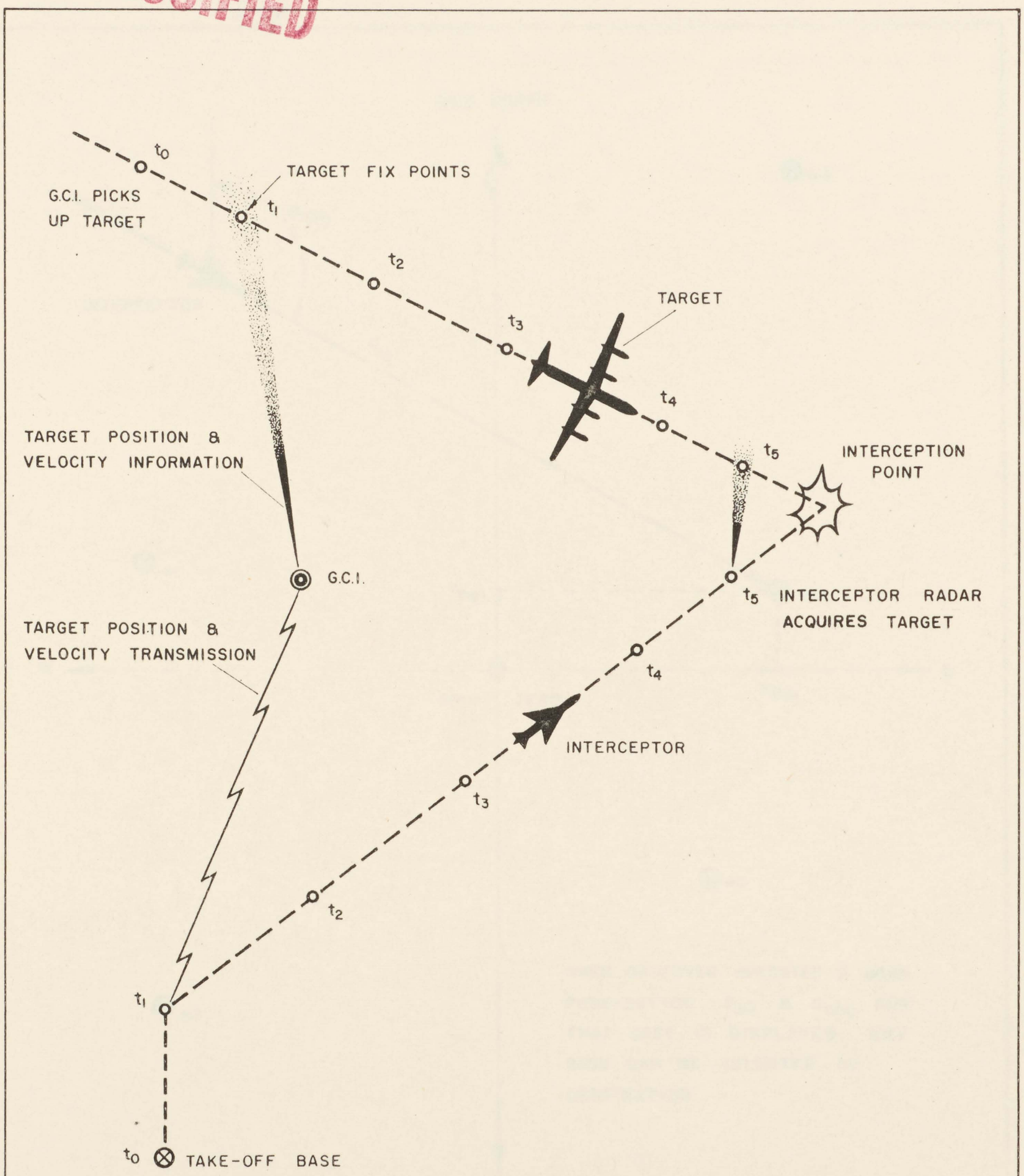


Figure 32 - Target Interceptor

UNCLASSIFIED

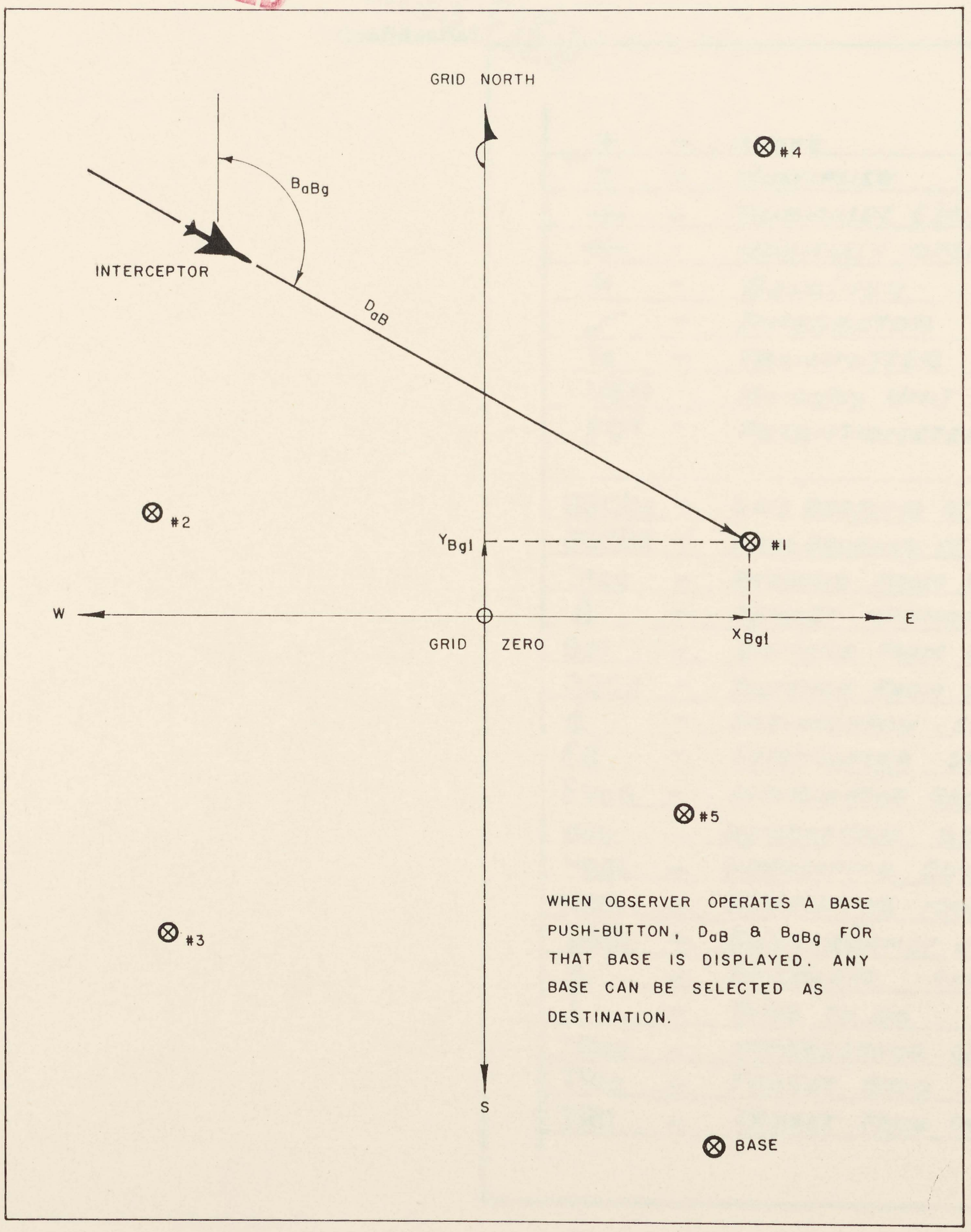


Figure 33 - Return to Base

UNCLASSIFIED

+	–	ADDER
X	–	MULTIPLIER
⊣	–	NORMALLY CLOSED CONTACT
⊣⊢	–	NORMALLY OPEN CONTACT
R	–	RESOLVER
∫	–	INTEGRATOR
Tx	–	TRANSMITTER
MEM	–	MEMORY UNIT
POT	–	POTENTIOMETER
BGCItg	–	GRID BEARING OF TARGET FROM GCI STATION
BGCItt	–	TRUE BEARING OF TARGET FROM GCI STATION
Btag	–	BEARING FROM INTERCEPTOR TO TARGET
β	–	TARGET APPROACH ANGLE
Dat	–	DISTANCE FROM INTERCEPTOR TO TARGET
DGCIt	–	DISTANCE FROM GCI STATION TO TARGET
δ	–	INTERCEPTOR DRIFT
Eδ	–	INTERCEPTOR DRIFT ERROR
EVaG	–	INTERCEPTOR GROUND SPPED ERROR
Hag	–	INTERCEPTOR GRID HEADING
Hagc	–	INTERCEPTOR COMMAND GRID HEADING
Ham	–	INTERCEPTOR MAGNETIC HEADING
φGCI	–	CONVERGENCY OF GCI STATION
φi	–	INTERCEPT ANGLE
t	–	TIME TO GO
TRag	–	INTERCEPTOR GRID TRACK
TRtg	–	TARGET GRID TRACK
TRtt	–	TARGET TRUE TRACK
Vah	–	HORIZONTAL COMPONENT OF INTERCEPTOR AIR SPEED
VaG	–	INTERCEPTOR GROUND SPEED
Vc	–	CLOSING SPEED
VtG	–	TARGET GROUND SPEED
WDg	–	WIND DIRECTION - GRID
WS	–	WIND SPEED
Xag	–	INTERCEPTOR GRID POSITION /N/S/
Xags	–	INTERCEPTOR GRID POSITION /N/S/ STORED
Xtg	–	TARGET GRID POSITION /N/S/
XGCIg	–	N/S POSITION OF GCI STATION
XGCIt	–	N/S POSITION OF TARGET RELATIVE TO GCI STATION /TRUE/
XGCItg	–	N/S POSITION OF TARGET RELATIVE TO GCI STATION /GRID/
Yag	–	INTERCEPTOR GRID POSITION /E/W/
Yags	–	INTERCEPTOR GRID POSITION /E/W/ STORED
Ytg	–	TARGET GRID POSITION /E/W/
YGCIg	–	E/W POSITION OF GCI STATION
YGCIt	–	E/W POSITION OF TARGET RELATIVE TO GCI STATION /TRUE/
YGCItg	–	E/W POSITION OF TARGET RELATIVE TO GCI STATION /GRID/

BLOCK & INFORMATION FLOW DIAGRAMS

LIST OF SYMBOLS

FIGURE: 34

Figure 34

Figure 34 - Block and Flow Diagram Symbols

UNCLASSIFIED

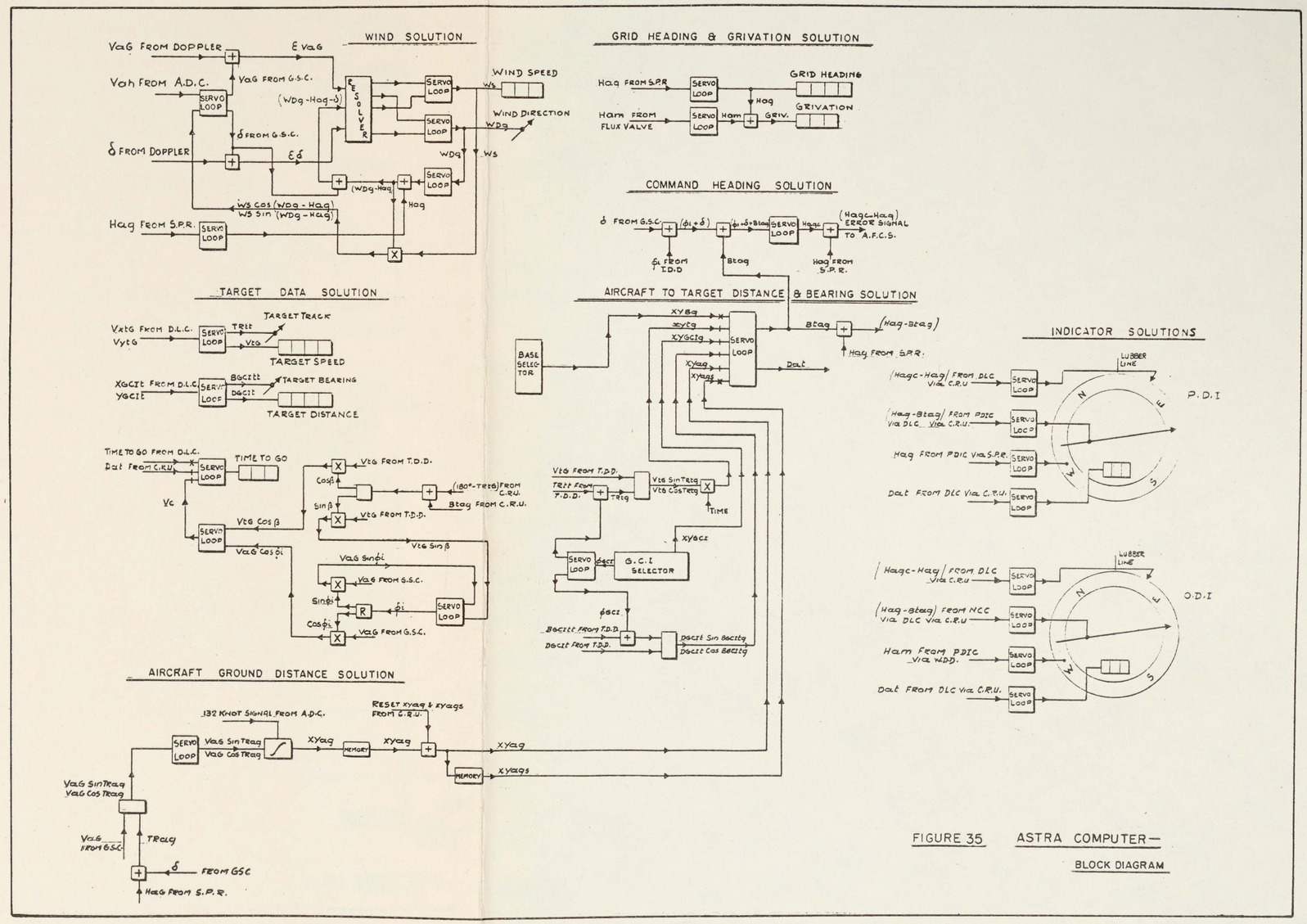


FIGURE 35 ASTRA COMPUTER— BLOCK DIAGRAM

Figure 35

Figure 35 - Block Diagram

UNCLASSIFIED
Confidential

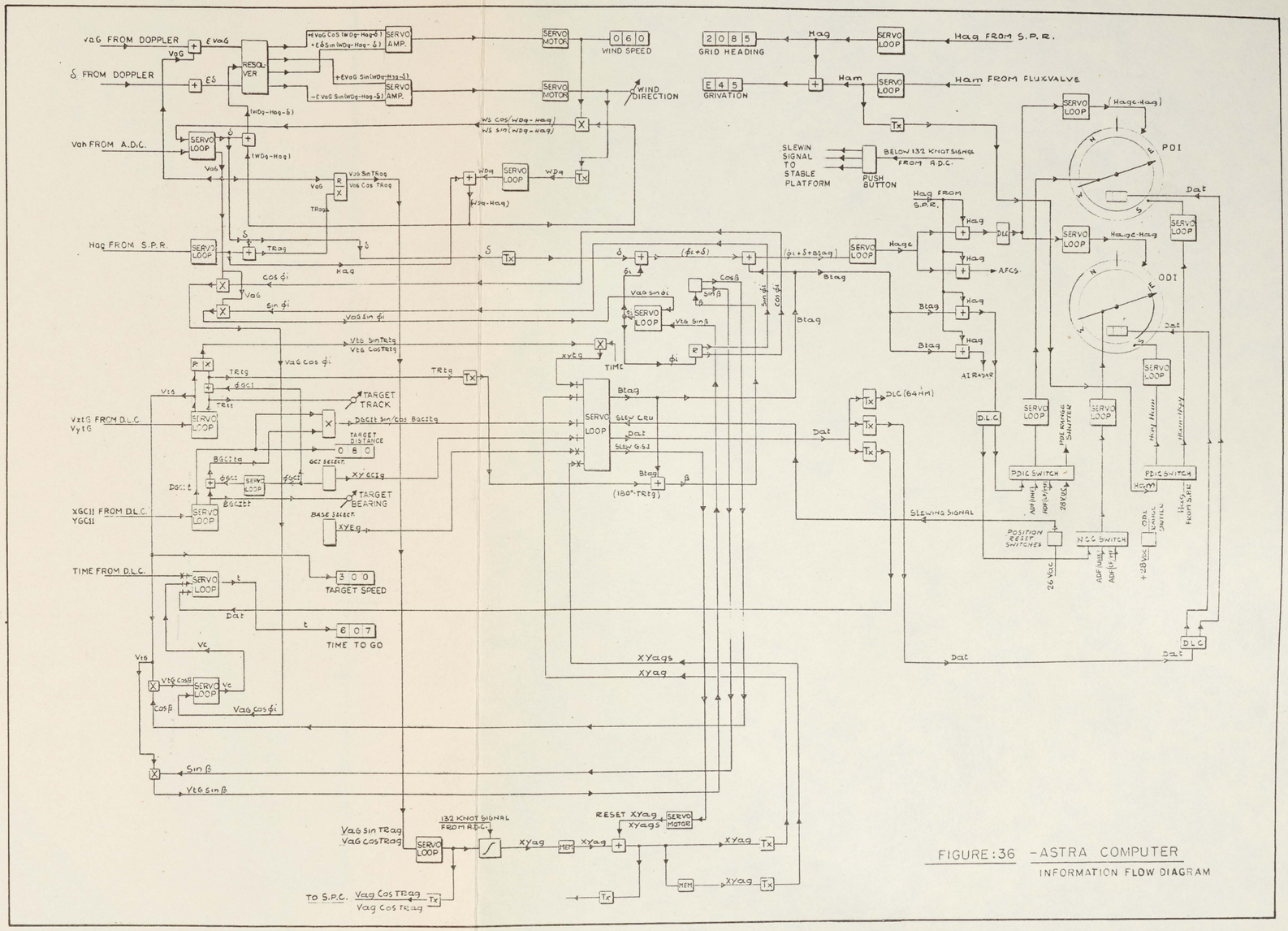


Figure 36

Figure 36 - Information Flow Diagram

115

UNCLASSIFIED

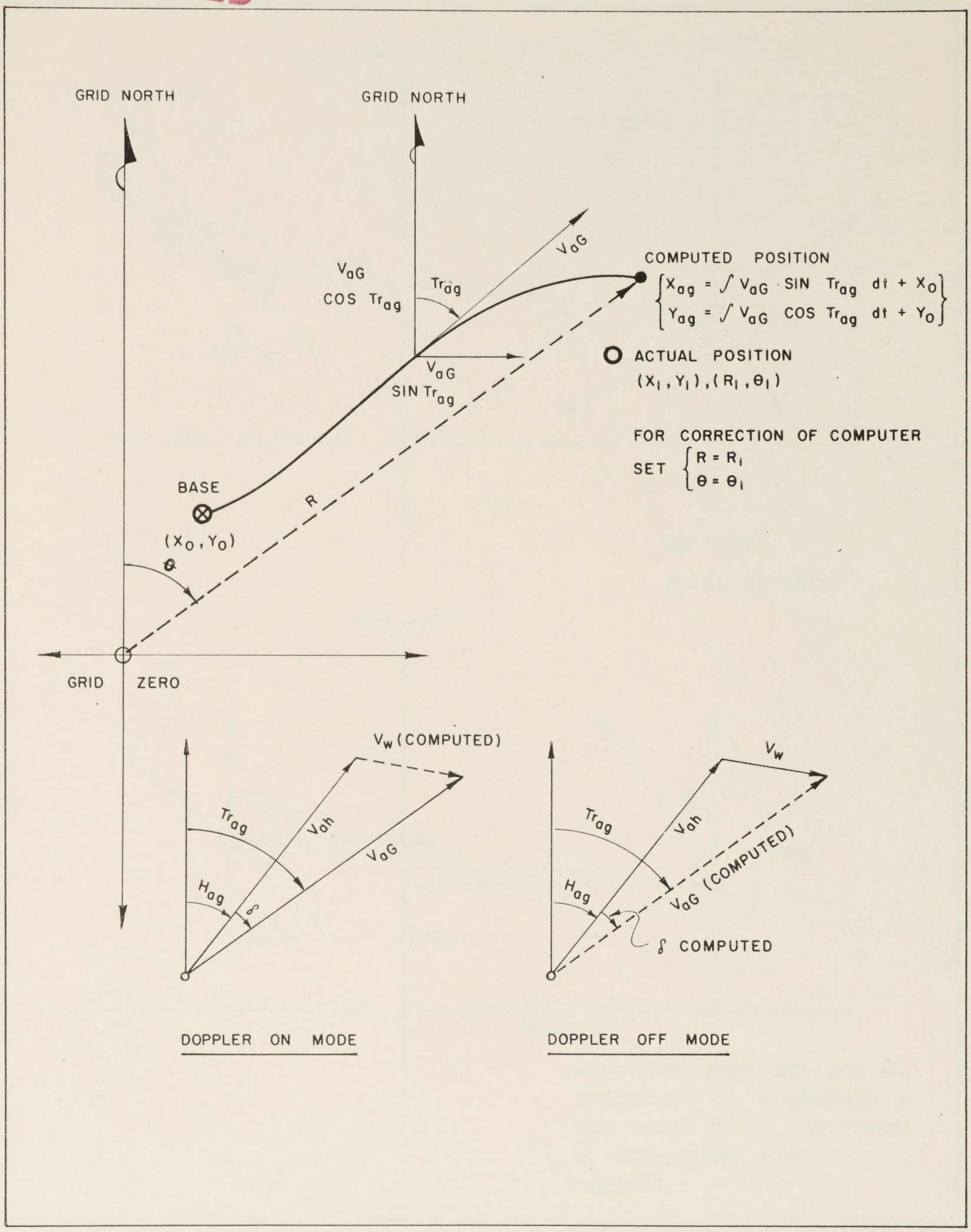


Figure 37 - Interceptor Position Computation and Correction

UNCLASSIFIED

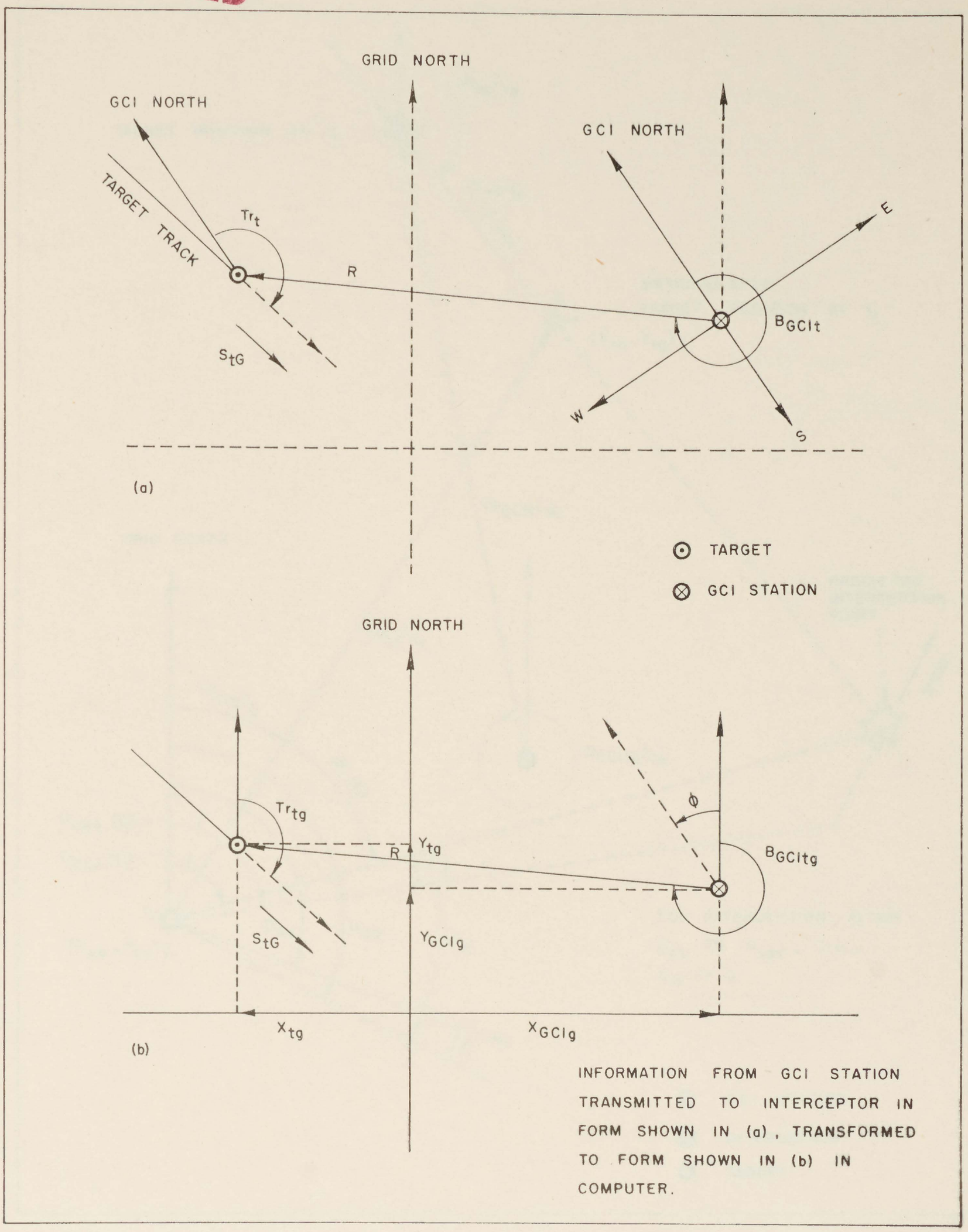


Figure 38 - Target in Relation to G.C.I. and Computing Grids

UNCLASSIFIED

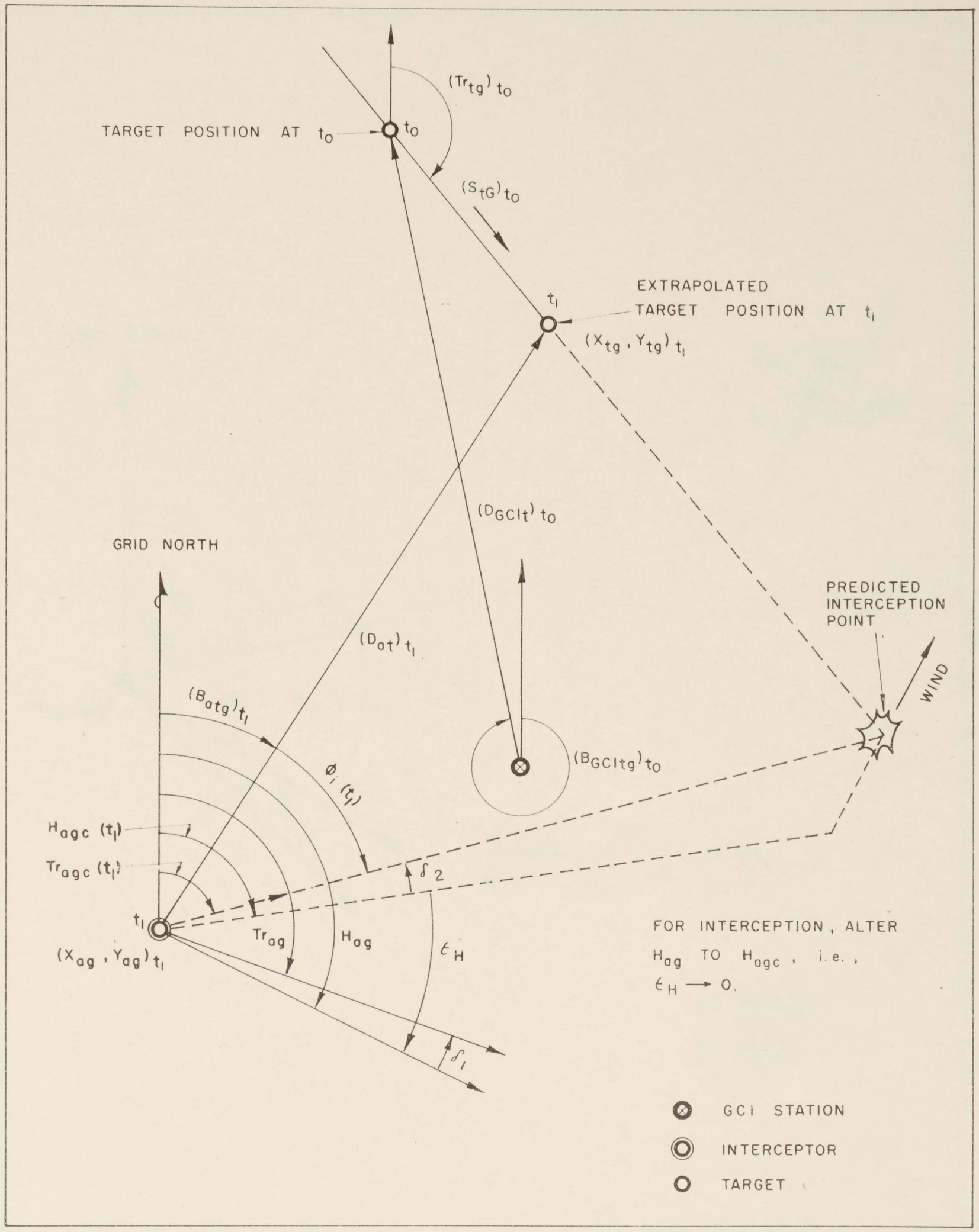


Figure 39 - Target Interception

UNCLASSIFIED

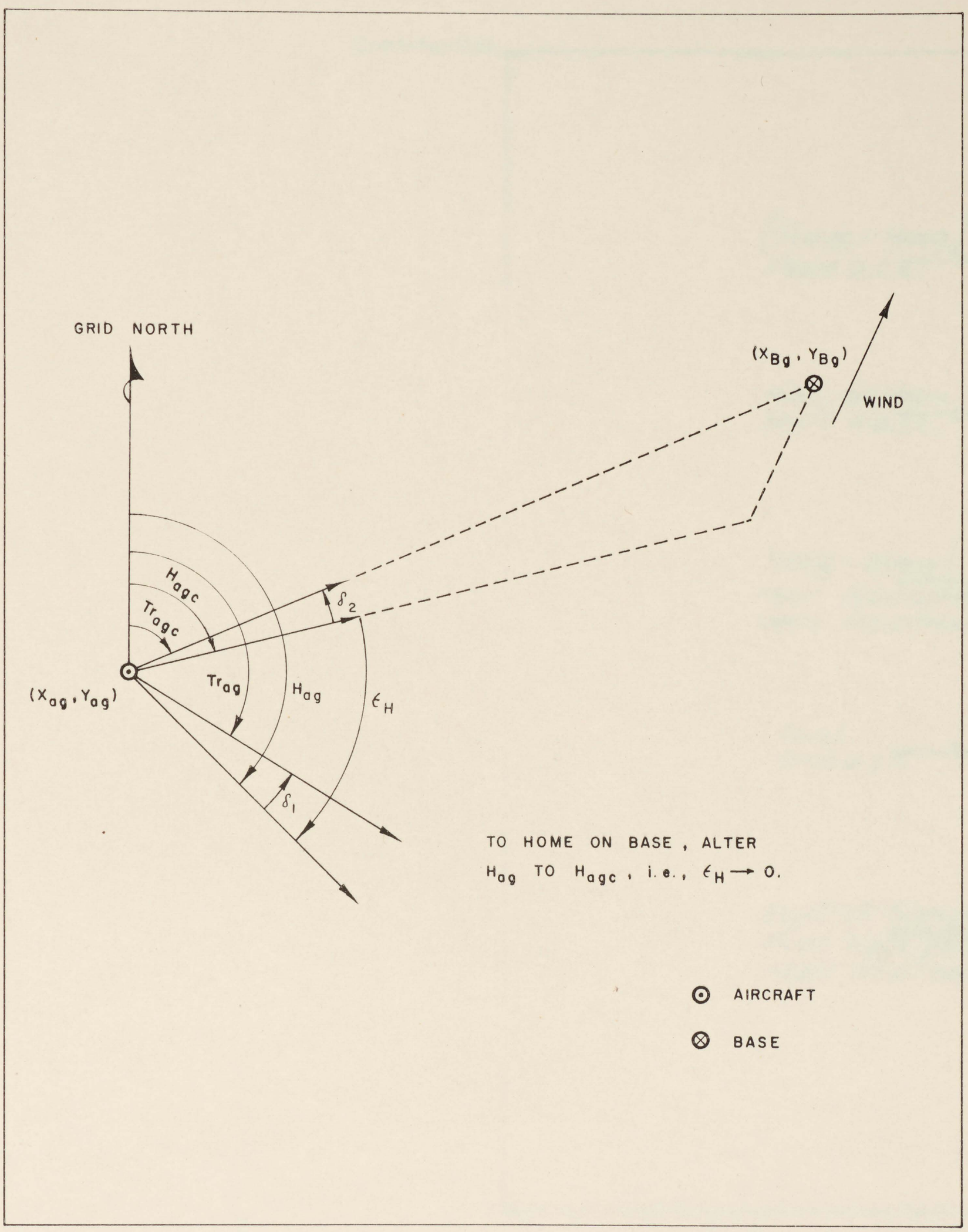


Figure 40 - Return to Base

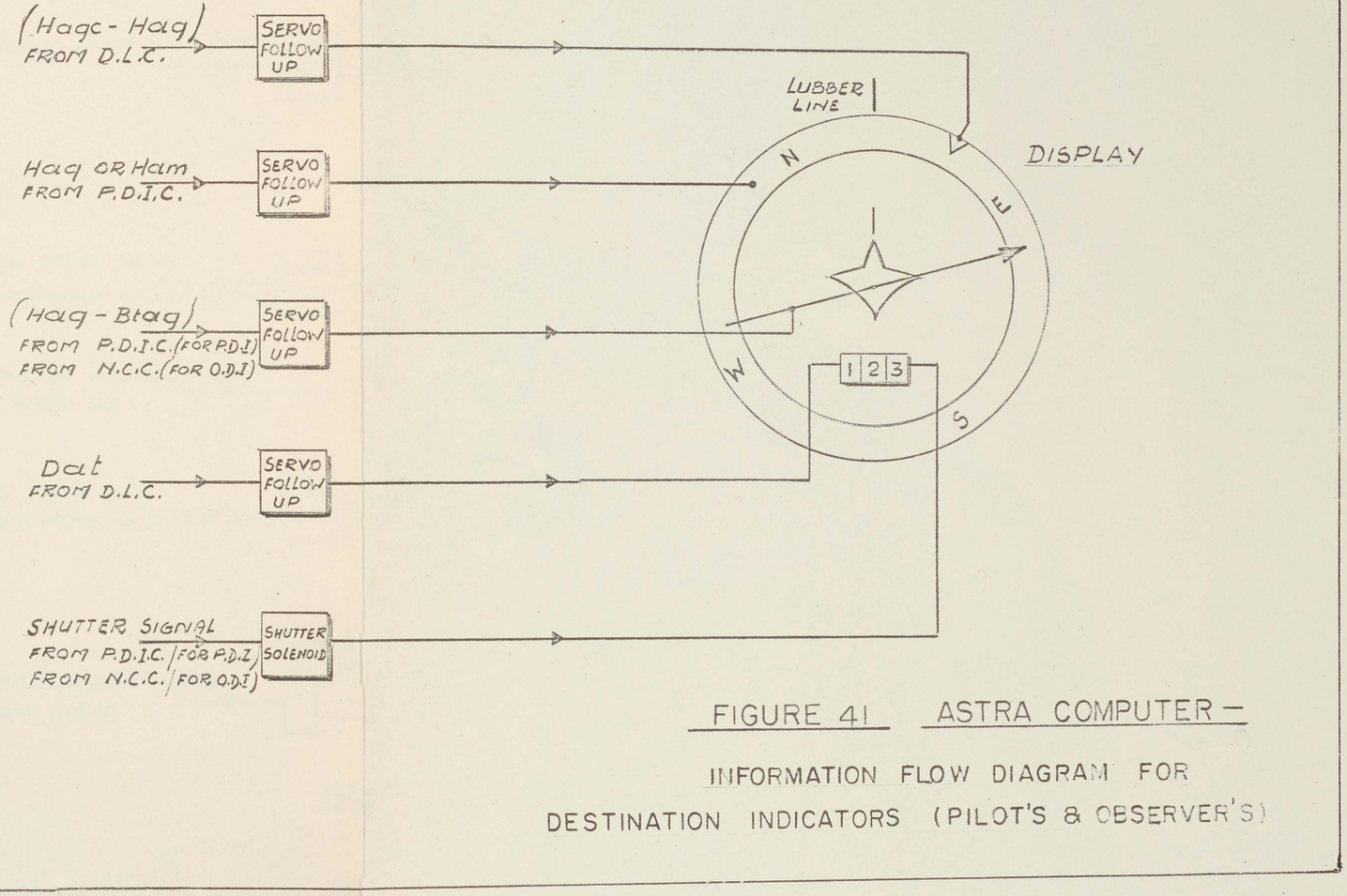


FIGURE 41 ASTRA COMPUTER —

INFORMATION FLOW DIAGRAM FOR

DESTINATION INDICATORS (PILOT'S & OBSERVER'S)

Figure 42

Figure 41 - Destination Indicator Information Flow Diagram

UNCLASSIFIED

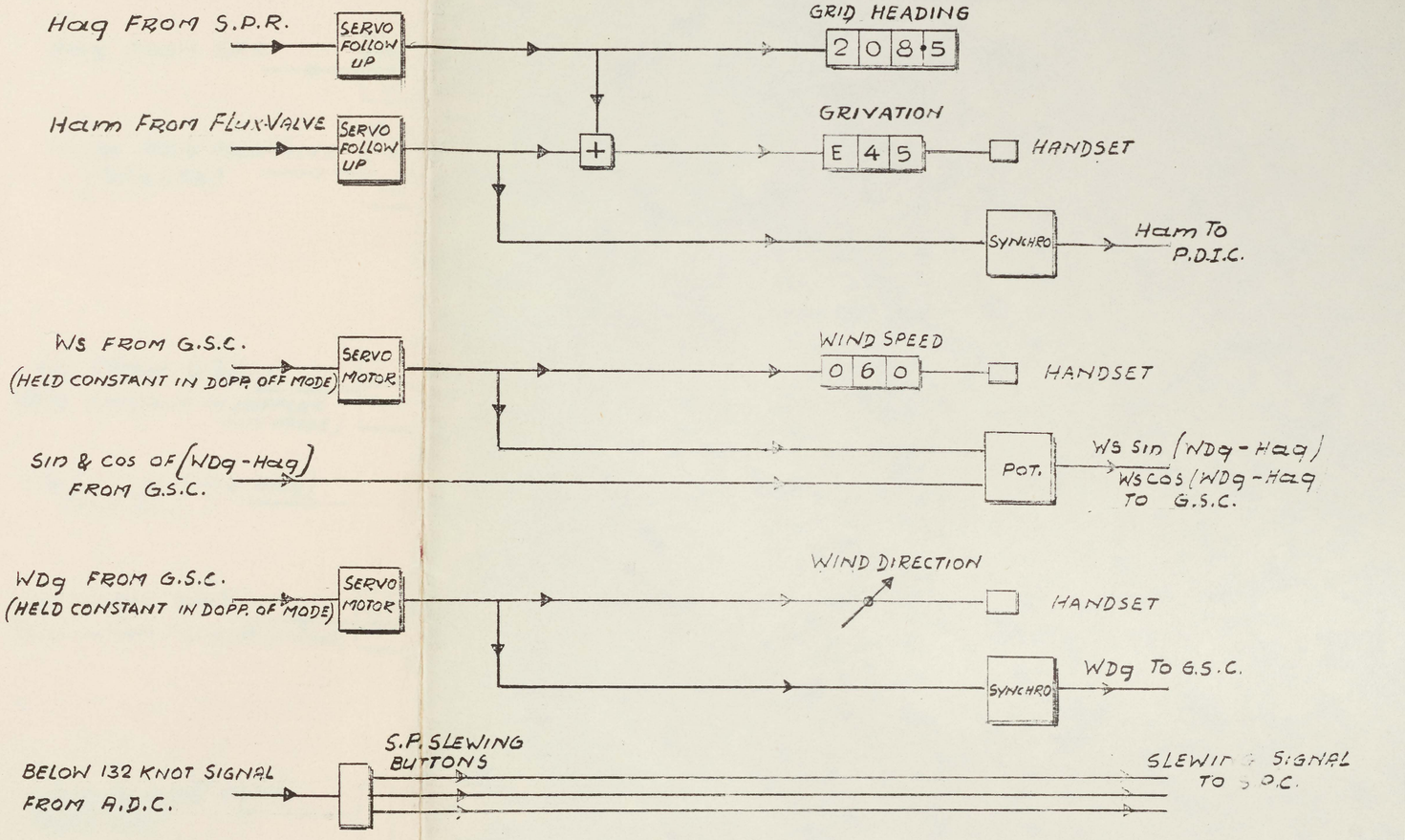


FIGURE: 42 ASTRA COMPUTER INFORMATION FLOW DIAGRAM FOR WIND DATA DISPLAY (NORMAL MODE)

Figure 42

Figure 42 - Wind Data Display Information Flow Diagram (Normal)

UNCLASSIFIED
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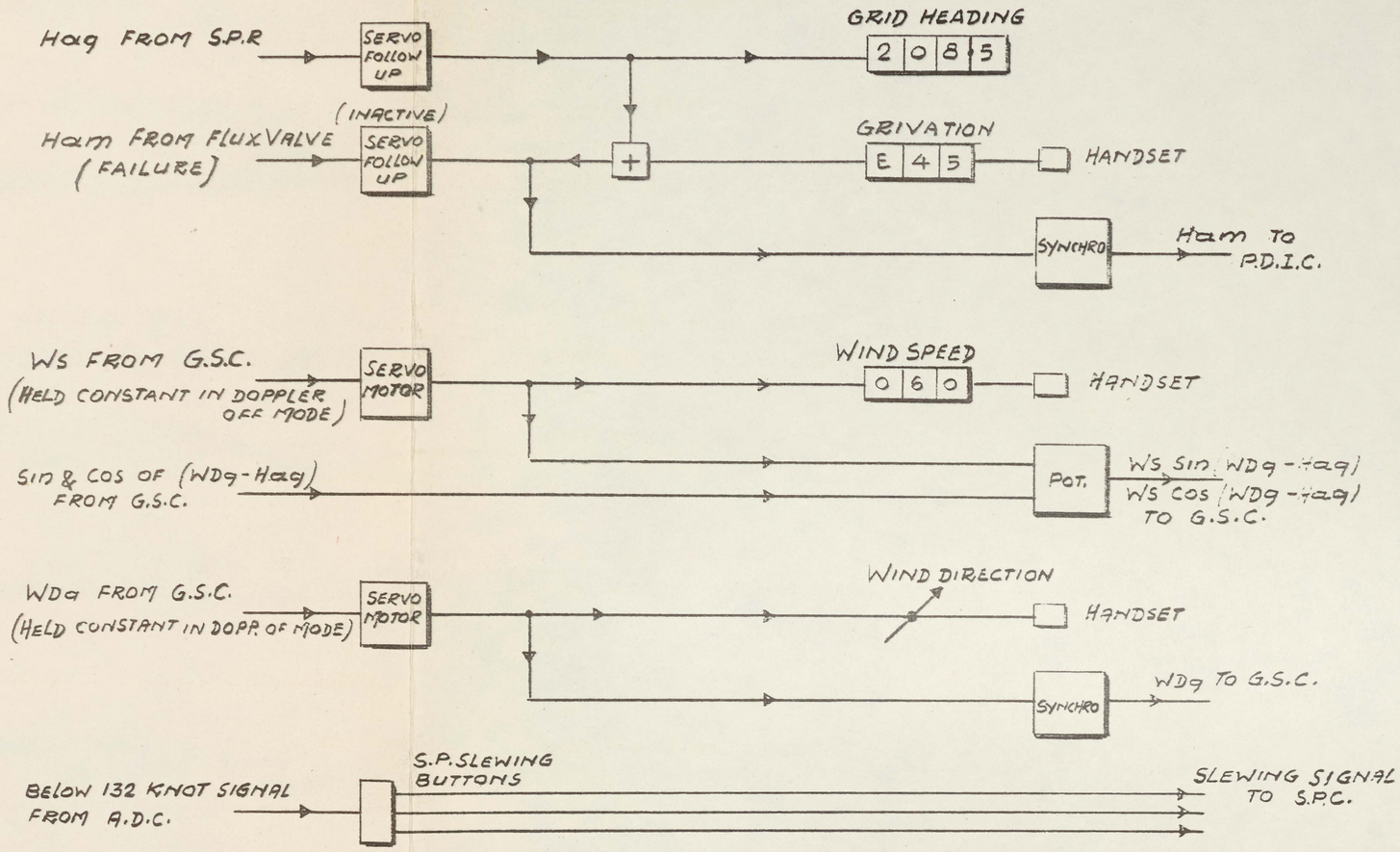


FIGURE 43 ASTRA COMPUTER — INFORMATION FLOW DIAGRAM FOR WIND DATA DISPLAY (FLUX VALVE FAILURE MODE)

Figure 43

Figure 43 - Wind Data Display Information Flow Diagram (Flux Valve Failed)

UNCLASSIFIED

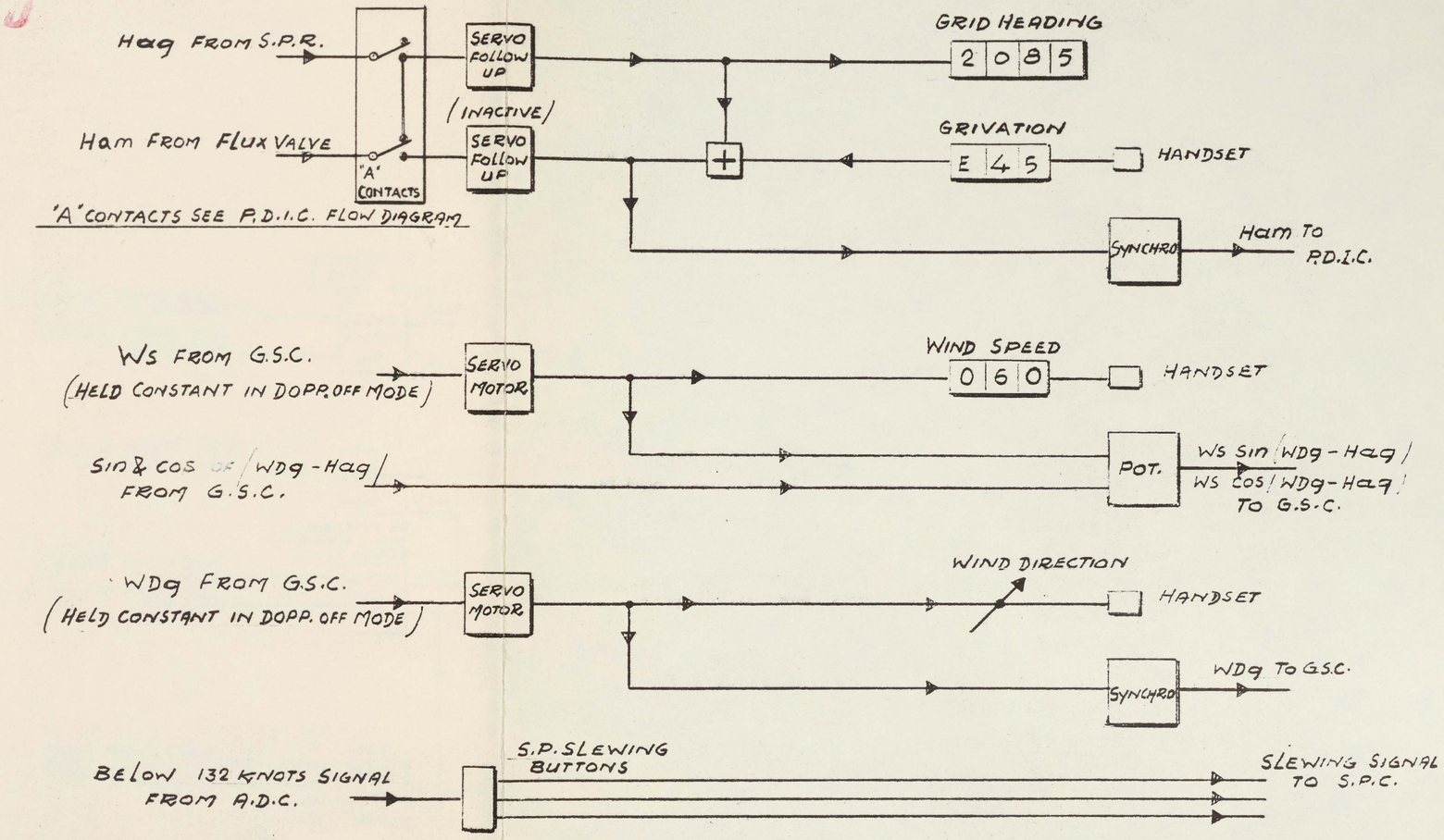


FIGURE 44 ASTRA COMPUTER – INFORMATION DIAGRAM FOR WIND DATA DISPLAY (FLUX VALVE ONLY MODE)

Figure 44

Figure 44 - Wind Data Display Information Flow Diagram (Flux Valve Only

UNCLASSIFIED

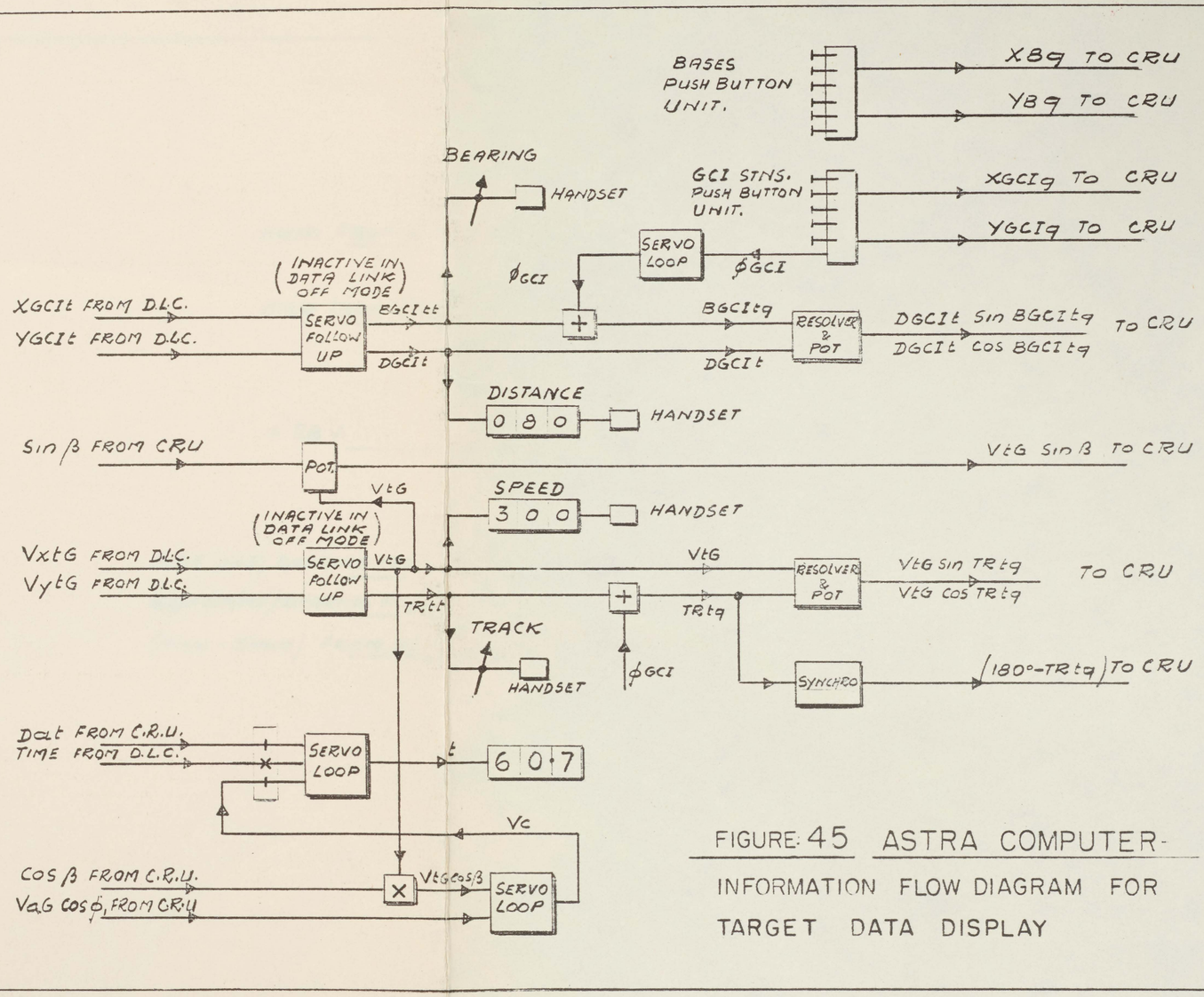


FIGURE 45 ASTRA COMPUTER-
INFORMATION FLOW DIAGRAM FOR
TARGET DATA DISPLAY

Figure 45

Figure 45 - Target Data Display Information Flow Diagram

UNCLASSIFIED

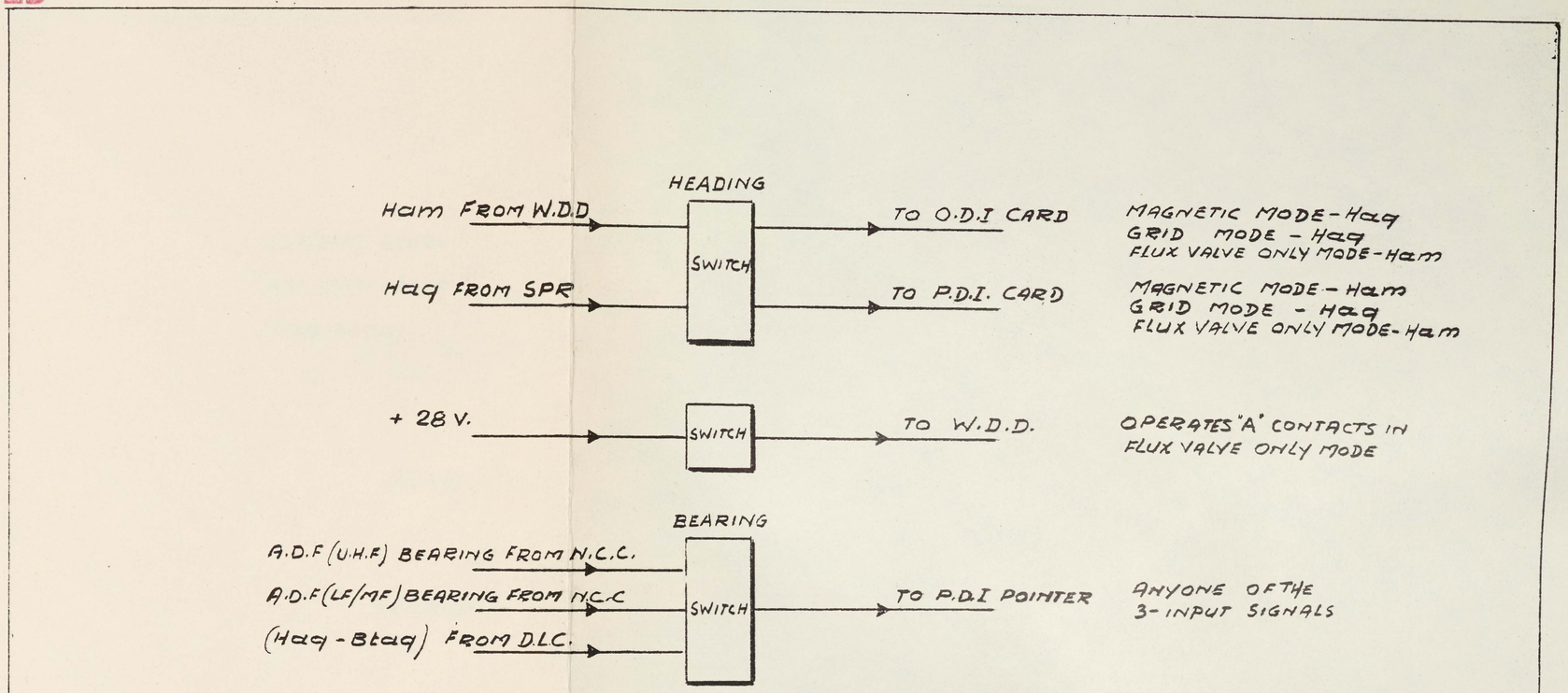


FIGURE 46 ASTRA COMPUTER

INFORMATION FLOW DIAGRAM FOR

PILOTS DESTINATION INDICATOR CONTROL

Figure 46

Figure 46 -Pilot's Destination Indicator Control Flow Diagram

UNCLASSIFIED

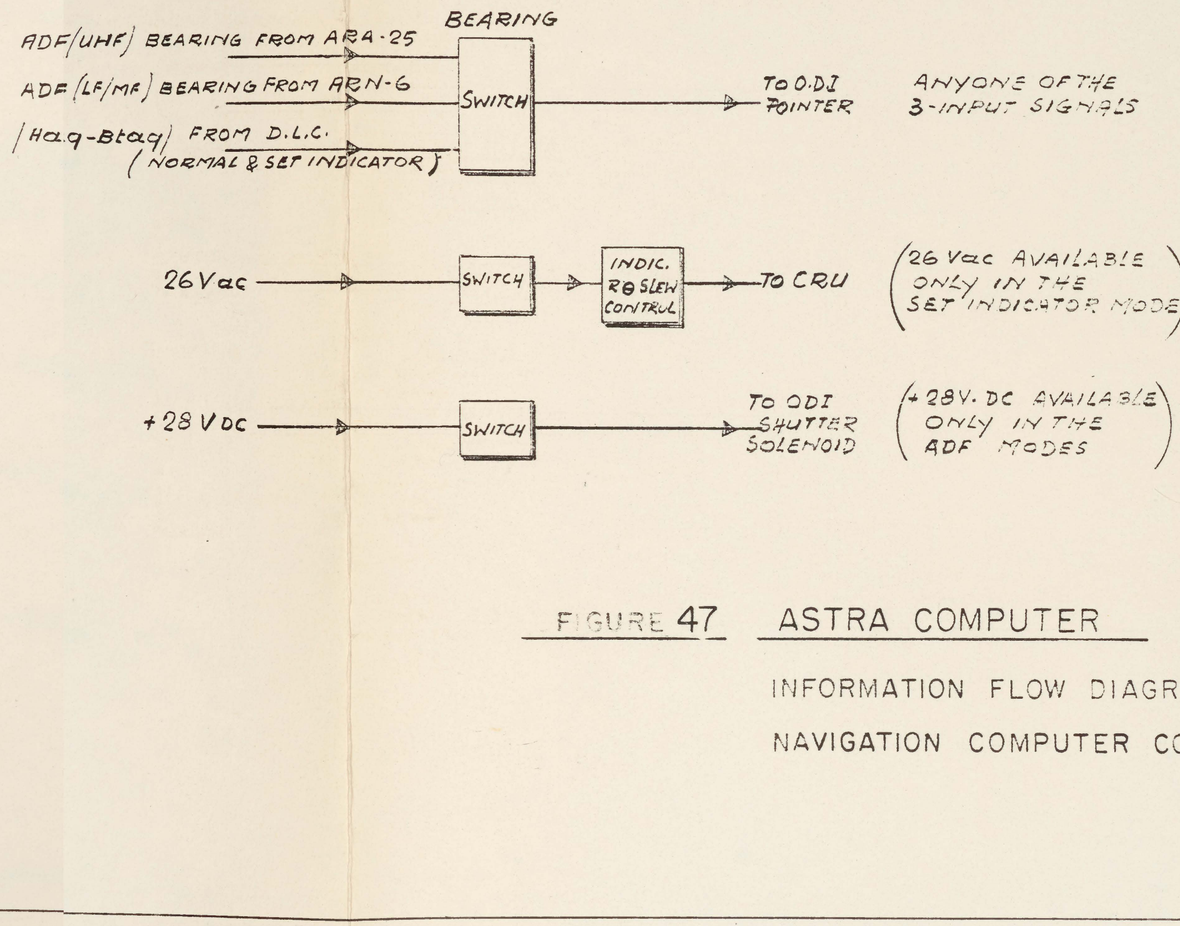


FIGURE 47 ASTRA COMPUTER

INFORMATION FLOW DIAGRAM FOR

NAVIGATION COMPUTER CONTROL

Figure 47

Figure 47 - Navigation Computer Control Information Flow Diagram

UNCLASSIFIED

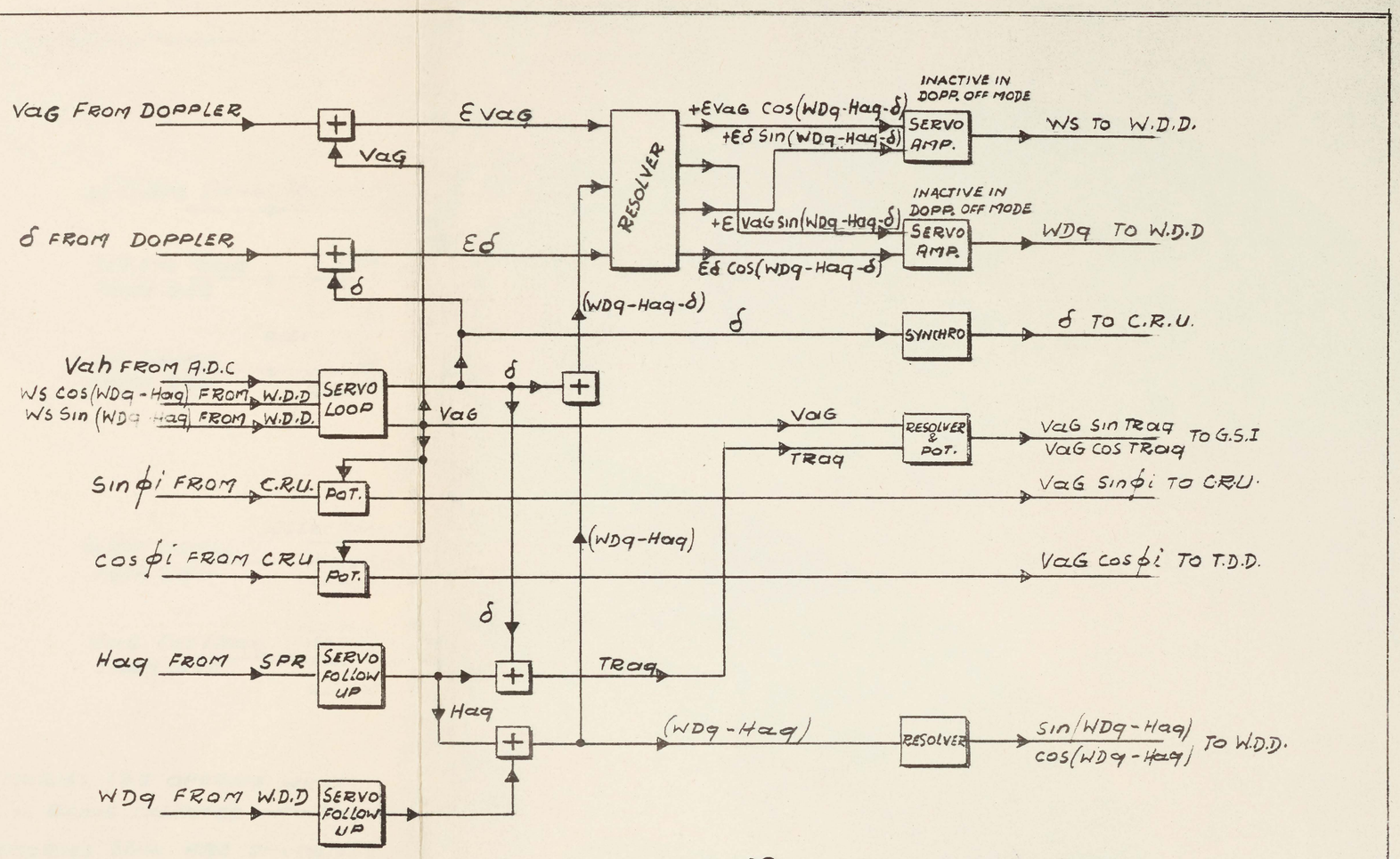


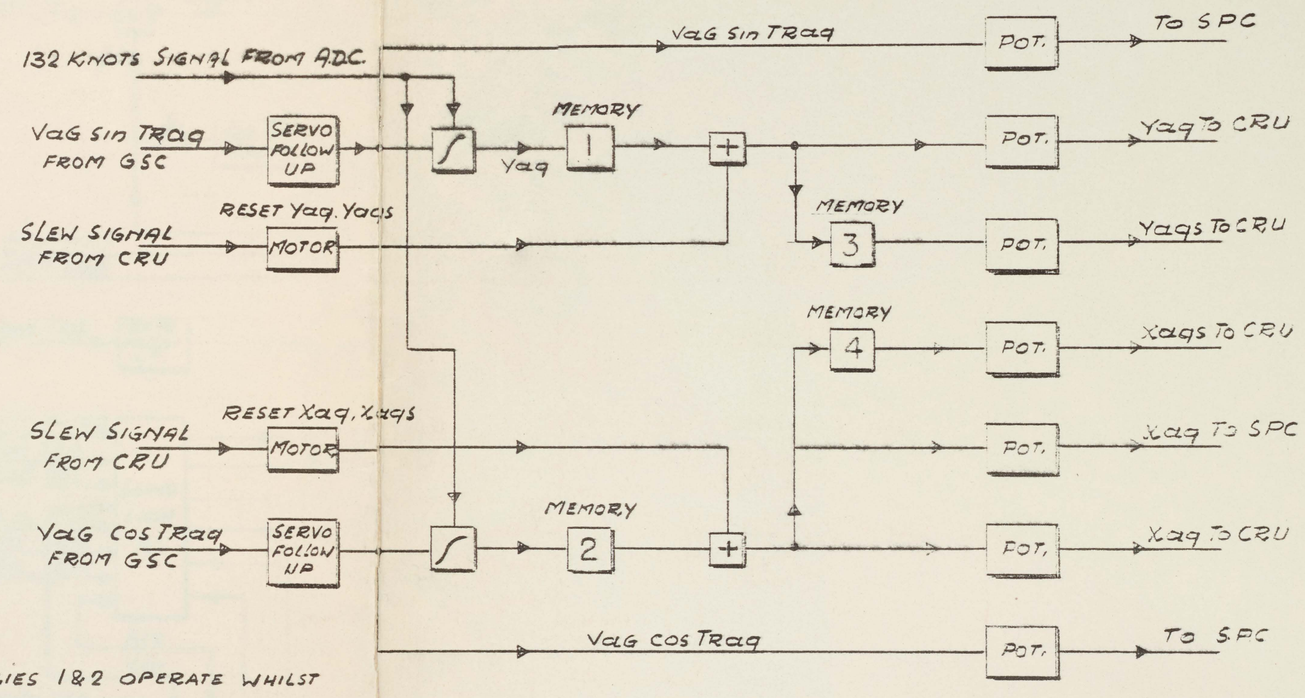
FIGURE 48 ASTRA COMPUTER

INFORMATION FLOW DIAGRAM FOR GROUND SPEED COMPUTER

Figure 48

Figure 48 - Ground Speed Computer Information Flow Diagram

UNCLASSIFIED



MEMORIES 1&2 OPERATE WHILST FIX IS BEING INSERTED INTO COMPUTER

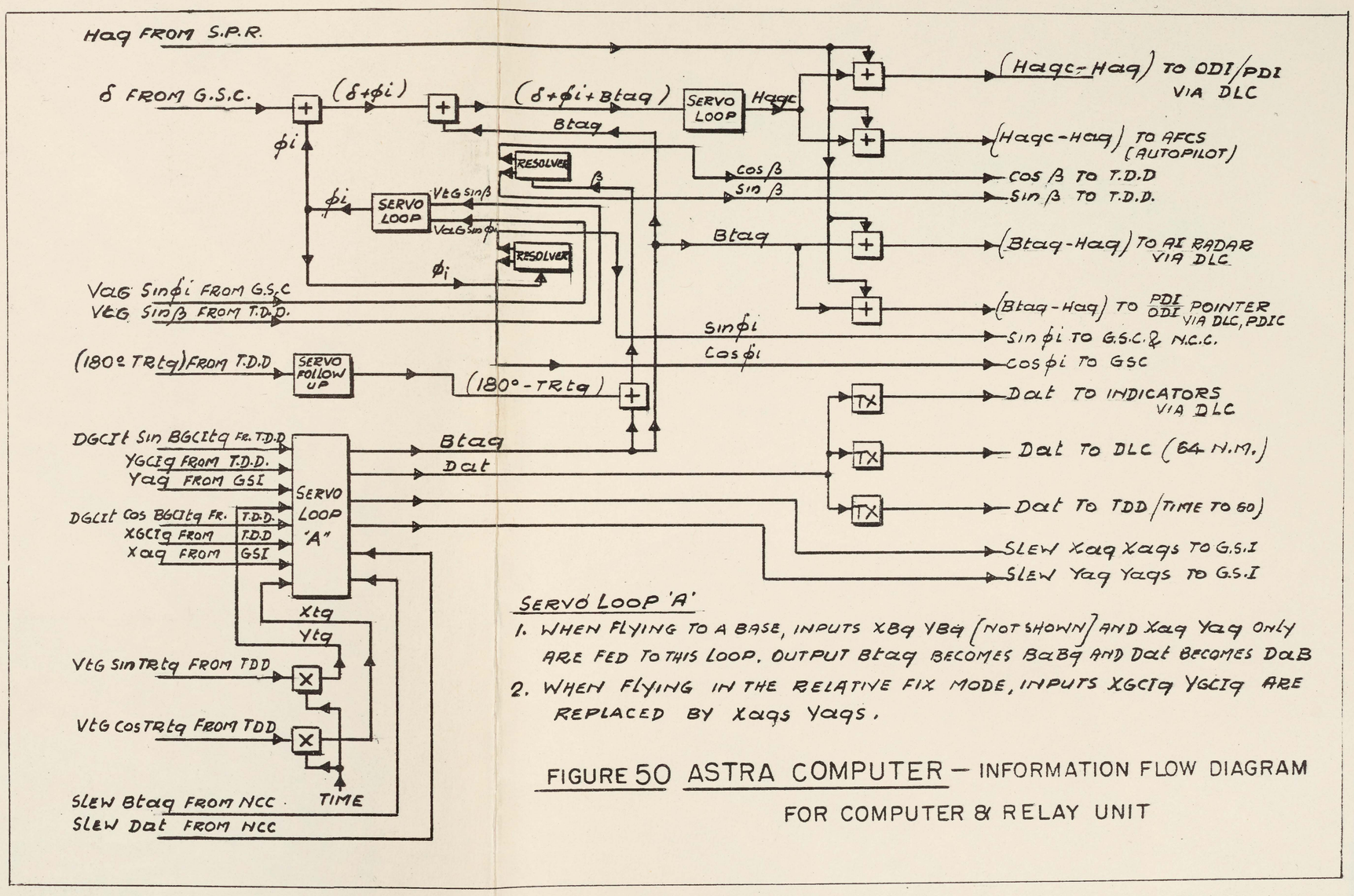
MEMORIES 3&4 ARE ENERGISED WHILST THE COMPUTER IS IN THE RELATIVE FIX MODE. IN THIS MODE FIX INSERTION CAUSES THESE MEMORIES TO BE DE-ENERGISED

FIGURE 49 ASTRA COMPUTER

INFORMATION FLOW DIAGRAM FOR.
GROUND SPEED INTEGRATOR

Figure 49

Figure 49 - Ground Speed Integrator Information Flow Diagram



SERVO LOOP 'A'

1. WHEN FLYING TO A BASE, INPUTS XBq YBq (NOT SHOWN) AND Xaq Yaq ONLY ARE FED TO THIS LOOP. OUTPUT Btaq BECOMES BaBq AND Dat BECOMES DaB
2. WHEN FLYING IN THE RELATIVE FIX MODE, INPUTS XGCIq YGCIq ARE REPLACED BY Xaqs Yaqs.

FIGURE 50 ASTRA COMPUTER — INFORMATION FLOW DIAGRAM FOR COMPUTER & RELAY UNIT

Figure 50

Figure 50 - Computer and Relay Unit Information Flow Diagram

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WDD
BOX 400

GSC
BOX 200

GRU
BOX 300

ZONE	REV.	REVISION DESCRIPTIONS	DATE	APPROVAL

PLATFORM ALIGNMENT

NOTE: N.C. = NO CONNECTION

REV'S	REV'S	REV'S	REV'S	ITEM OR SYMBOL	PART NUMBER	DESCRIPTION
304	303	302	301			LIST OF MATERIAL

CLASSIFICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES			DRAFTSMAN C.J.C.	DATE 12-5
TOLERANCES ON:				
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS	DESIGNER	
UP TO 6	±.02	±.005	CHECKER	
ABOVE 6 TO 24	±.03	±.010	ENGINEER	
ABOVE 24	±.05	±.015		
ANGULAR DIMENSIONS ±1°				
SEE MFRG. SPEC. FOR STOCK TOLERANCES FOR MFG. SPEC. SEE ENG. MEMO				

GROUP OR PART	NEXT ASS'Y.	USED ON	NEXT ASS'Y.	FINAL ASS'Y.
APPLICATION			QTY. REQ'D.	

TITLE: SYSTEM SCHEMATIC (ELECTRO-MECHANICAL) ISTAR I SERIES-3

MAT'L, FIN., & HT. TREAT. AS NOTED

SCALE | WT.

RADIO CORPORATION OF AMERICA CAMDEN, N.J.

DWG. NO. 100549

SHEET 1 OF 3

REV.

J. H. WEIL CO., PHILA. PA. ARE-A-TREK 151-19

RCA RADIO-MAY SHIPPING IN U.S.A.

T.D.D.
BOX 500

BEARING

BASE STATIONS

GCI STATIONS

GCI TWNS & BASE STNS.

TRACK

RANGE

SPEED

OLC TIME

OLC TIME SCALE CHANGE

FROM DATA LINK

TO LP 512

SPC

HAND SET

SWITCHED DLC

DLC RELAY (STEERING) (NCC)

DLC RELAY (NCC)

ZONE	REV.	REVISION DESCRIPTIONS	DATE	APPROVAL

REQ'D.	REQ'D.	REQ'D.	REQ'D.	ITEM OR SYMBOL	PART NUMBER	DESCRIPTION
504	503	502	501			LIST OF MATERIAL

CLASSIFICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES		
TOLERANCES ON:		
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	±.02	±.005
ABOVE 6 TO 24	±.05	±.010
ABOVE 24	±.06	±.015
ANGULAR DIMENSIONS ± ½°		

ALL EXTERNAL THREADS TO BE CLASS 3A BEFORE PLATING AND CLASS 2 AFTER PLATING. ALL INTERNAL THREADS TO BE CLASS 2B, UNLESS OTHERWISE SPECIFIED.

GROUP OR PART	NEXT ASSY.	USED ON	NEXT ASSY.	FINAL ASSY.
APPLICATION			QTY. REQ'D.	

SEE PURCH. SPEC. FOR STOCK TOLERANCE FOR MISC. TYPES, SEE DWG. 96400

DRAFTSMAN	JFS	DATE 4/14/52
DESIGNER		
CHECKER		
ENGINEER		

TITLE: SCHEMATIC (ELECTRO-MECHANICAL) ASTRA I - SERIAL - 3

MATL., FIN., & HT. TREAT, AS NOTED

SCALE | WT. | SHEET 2 of 3

RADIO CORPORATION OF AMERICA (Camden, N.J.)

DWG. NO. 100549

REV.

J. M. WEIL CO., PHILA., PA. ARC-ATEX 551-10

RCA 96400-00-700 PRINTED IN U.S.A.

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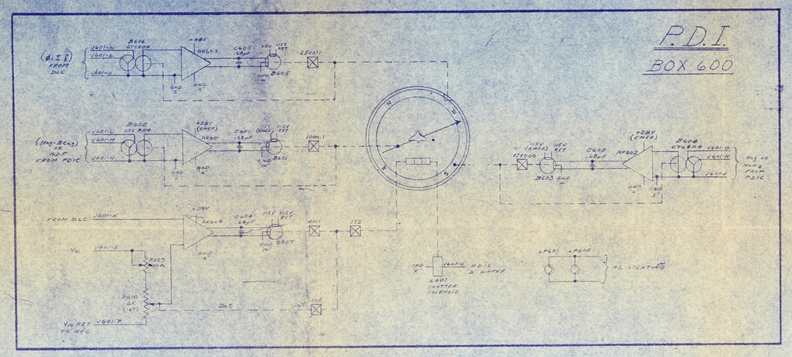
ZONE	REV.	REVISION DESCRIPTIONS	DATE	APPROVAL

P.D.I. BOX 600



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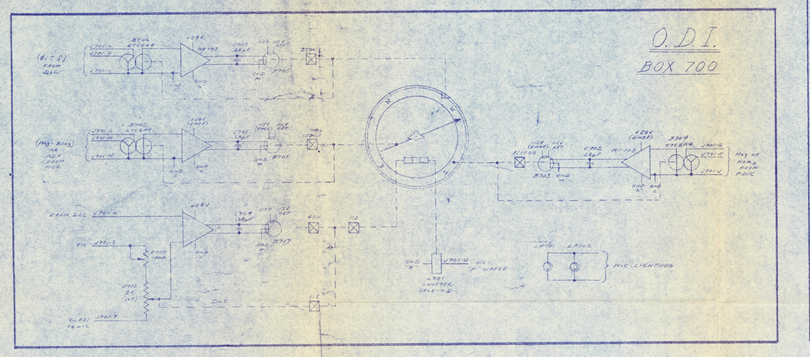

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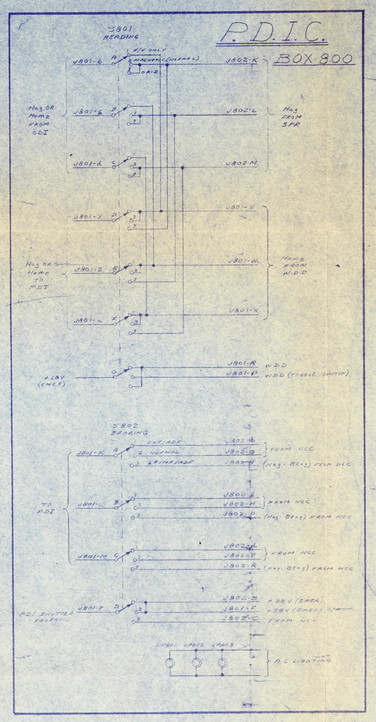
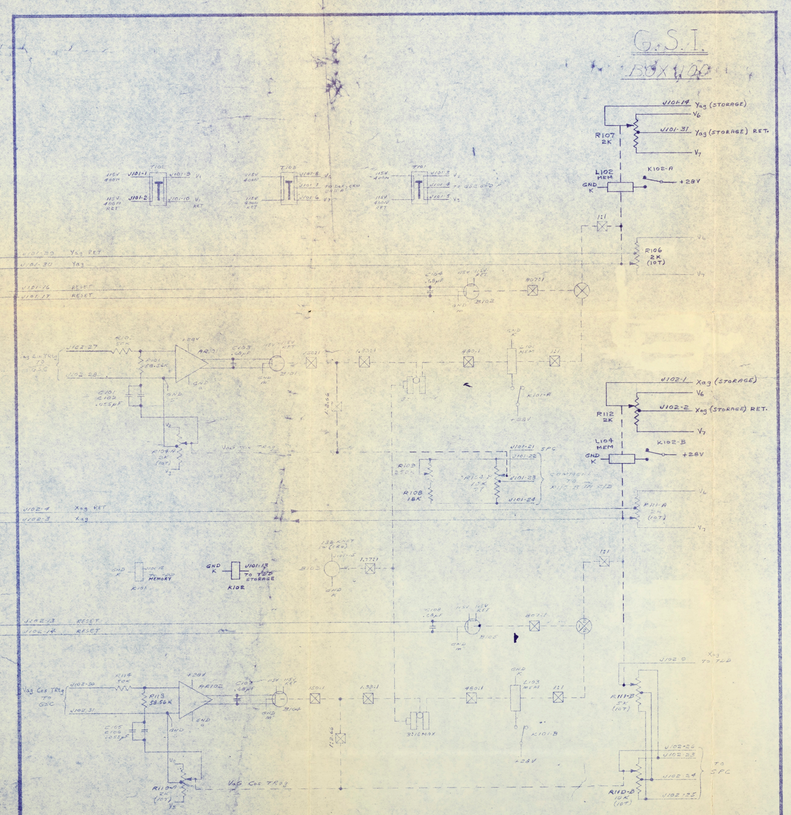
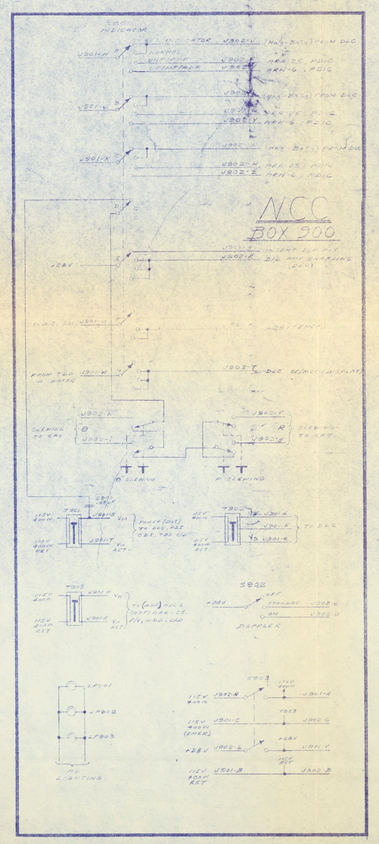


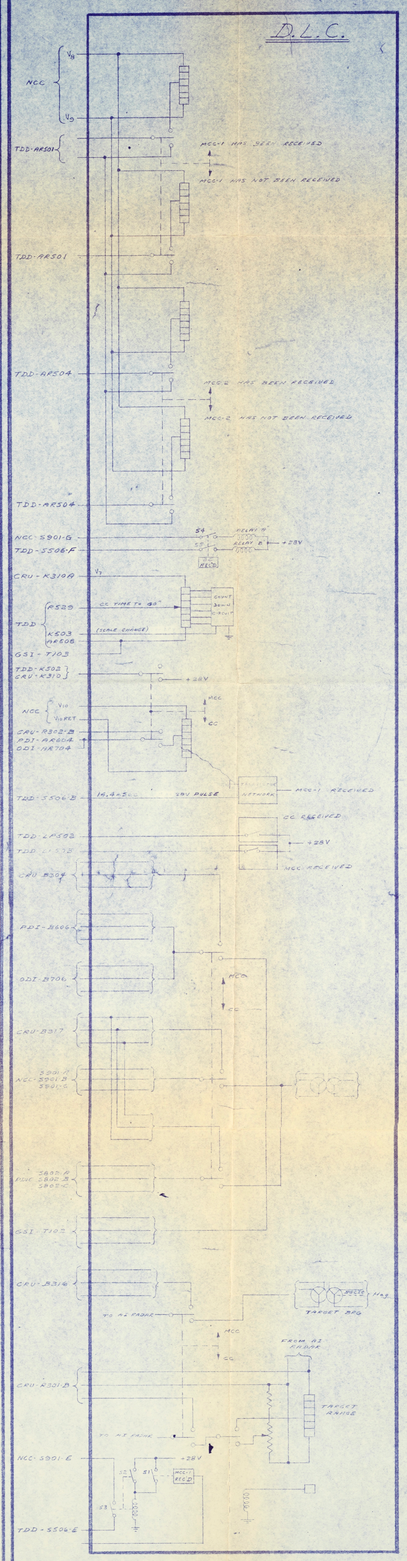
G.S.I. BOX 400



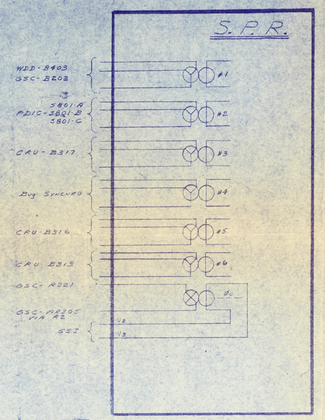
NCC BOX 900



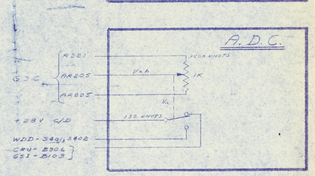
D.L.C.



S.P.R.



A.D.C.



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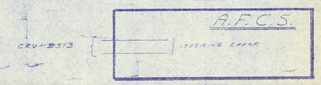

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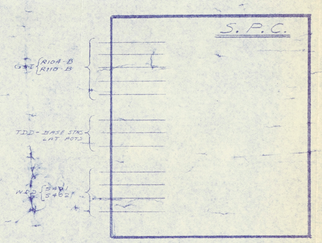
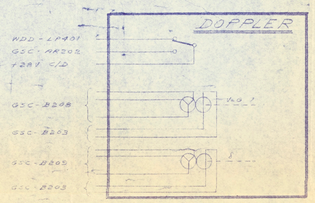
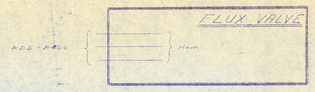


DOPPLER

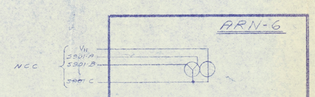


FLUX VALVE



ARA-25

ARN-6



MFG'R.	MFG'R.	MFG'R.	MFG'R.	ITEM OR SYMBOL	PART NUMBER	DESCRIPTION
504	503	502	501		LIST OF MATERIAL	

CLASSIFICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ON:			DRAFTSMAN E.P.C.	DATE MAY 57
BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS	DESIGNER	
UP TO 6	± .01	± .005	CHECKER	
ABOVE 6 TO 24	± .03	± .010	ENGINEER	
ABOVE 24	± .08	± .015		
ANGULAR DIMENSIONS ± ½°				
SEE PUNCH, SPEC. FOR STOCK TOLERANCE FOR MFG. SPEC. SEE SPEC. 56400				

ALL EXTERNAL THREADS TO BE CLASS 2A BEFORE PLATING AND CLASS 2 AFTER PLATING. ALL INTERNAL THREADS TO BE CLASS 2B, UNLESS OTHERWISE SPECIFIED.

GROUP OR PART	NEXT ASSY.	USED ON	NEXT ASSY	FINAL ASSY
	APPLICATION		QTY. REQ'D.	

TITLE: SYSTEM SCHEMATIC (ELECTRO-MECHANICAL) ASTRA-1, SERIAL-3

MATL., FIN., & HT. TREAT, AS NOTED

SCALE: WT: SHEET 3 of 3

RADIO CORPORATION OF AMERICA CAMDEN, N.J.

DWG. NO. 100549

REV. E

J. M. WELL CO., PHILA., PA. ARK-A-REX 101-10

OBSOLETE