RESTRICTED

OP 1064 A
VOLUME 1

COMPUTER MARK 1 AND MODS.

MAINTENANCE

A BUREAU OF ORDNANCE PUBLICATION

Gene Slover's US Navy Pages

Table of Contents

Fwd. M. B. Plot.

COMPUTER MARK I AND MODS

MAINTENANCE

This publication is RESTRICTED and will be handled in accordance with Article 76, United States Navy Regulations, 1920.

Gene Slover's US Navy Pages

Table of Contents

NAVY DEPARTMENT

BUREAU OF ORDNANCE

WASHINGTON 25, D. C.

18 July 1947

RESTRICTED

ORDNANCE PAMPHLET 1064A

COMPUTER MARK 1 AND MODS MAINTENANCE

1. Ordnance Pamphlet 1064A contains information on the tests, trouble shooting analysis, repairs and maintenance procedures for the Computer Mark 1. The contents are presented in two volumes, and the procedures described therein may be performed aboard ship.

2. This pamphlet is intended for use of shipboard maintenance personnel and should be used in conjunction with NavOrd Form 1229 Computer Mark 1 Log Book.

3. This pamphlet supersedes the following publications:

NavOrd OD 3133 (Revision A)
NavOrd OD 3137
NavOrd OD 3139
NavOrd OD 3140 (Revision B)
NavOrd OD 3180
NavOrd OD 3181
NavOrd OD 3183
NavOrd OD 3184 (Revision A)
NavOrd OD 3185 (Preliminary)
NavOrd OD 4174 (Revision C)
NavOrd OD 4186
NavOrd OD 5157

Ordnance Pamphlet 1453 (Preliminary)

Additional information may be found in:

OP 1064	Computer Mark 1 and Mods
OP 1064C	Star Shell Computer Mark 1 Mods 0, 1, 2, and 3.
OP 1064D	Computer Mark 1 Mods 8 and 12
OP 1064E	Computer Mark 1 Mods 14 and 16
OP 1064F	Computer Mark 1 Mod 15

4. This publication is RESTRICTED and should be handled in accordance with Article 76, U.S. Navy Regulations, 1920.

G. F. HUSSEY, JR.
Vice Admiral, U.S. Navy
Chief of the Bureau of Ordnance

Gene Slover's US Navy Pages
Table of Contents

CONTENTS

Enter the page number you want into your reader's page locator.

VOLUME ONE

PART ONE

Page

TESTS

Introduction 8
"A" Tests, including Star Shell . . 12
"B" Tests 22
"C" Tests 38
Rate Control Tests 54
Transmission Tests 60
Time Motor Regulator Tests . . 84
Tables of Operating Limits . . . 86

PART TWO

ANALYSIS OF TEST ERRORS

Introduction 88
"A" Test Analysis, including Star Shell 90
"B" Test Analysis 146
"C" Test Analysis 166
Rate Control Test Analysis . . . 176
Transmission Test Analysis . . . 180

PART THREE

UNIT CHECK TESTS

Table of Contents 187
Unit Check Tests 188
Summary of Unit Check Tests . . 228

PART FOUR

READJUSTMENT PROCEDURE

Introduction 232
Covers 236
Clamps 240

VOLUME TWO

PART FIVE

Page

LOCATING CASUALTIES . . . 545

PART SIX

LUBRICATION 578

PART SEVEN

REMOVAL OF MECHANISMS

Table of Contents 584
Introduction 586
Control Unit 588
Computer Unit 661
Indicator Unit 738
Corrector Unit 754
Star Shell Computer 804

PART EIGHT

FACTORY ADJUSTMENT PROCEDURE 815

PART NINE

SKETCH LISTS 855

Gene Slover's US Navy Pages

INTRODUCTION

Ordnance Pamphlet 1064A contains information necessary for the maintenance of Computer Mark 1. Since the majority of these instruments that are in service are either Mod 7 or 13, this book is written primarily for the Computer Mark 1 Mod 7 or Mark 1 Mod 13, equipped with a Star Shell Computer Mark 1, a Selector Drive Mark 1, and a Target Course Indicator Mark 1. However, sufficient information is given to cover the older instruments also, namely Mods 0, 1, 2, 3, 4, 6, 9, and 10. Maintenance information for other mods is contained in companion publications as follows: OP 1064D, Mods 8 and 12; OP 1064E, Mods 14 and 16; and OP 1064F, Mod 15. Maintenance of the Star Shell Computer Mark 1 Mods 0, 1, 2, and 3 is covered in OP 1064C. Information for the complete overhaul of Computer Mark 1 is contained in OP 1064B.

Since the information covered by this publication, OP 1064A, is extensive, two volumes are required. The division into volumes is of no significance other than for ease in handling.

The following summary of the various sections of the book will serve to indicate the material covered.

PART 1 – TESTS

Detailed instructions are given for setting up, running, and recording the results of all the standard tests required to check computer operation. This section serves as an adjunct to the test procedure given in the Computer Mark 1 Log Book, NAVORD Form 1229.

PART 2 – ANALYSIS OF TEST ERRORS

For each type of test, methods are given for locating the causes of errors, together with the procedure to be followed in correcting them.

PART 3 – UNIT CHECK TESTS

Special tests and detailed instructions for performing them are given in order to identify the seat of trouble in a computer that is not operating properly. These tests serve as a reference to be used while analyzing errors in the A and B tests.

Gene Slover's US Navy Pages Table of Contents

PART 4 – READJUSTMENT PROCEDURE

All of the adjustment points in the computer are listed in numerical order for quick reference. For each adjustment the location, method of checking, and steps necessary for readjustment are given. This information will be of value in the course of correcting test errors or after disassembly and reassembly of part of the instrument.

PART 5 – LOCATING CASUALTIES

The more common sources of mechanical or electrical trouble are listed for reference in trouble analysis. Methods are given for correcting these troubles. Descriptive and maintenance information is given for some of the special units used in the Computer Mark 1 which are not covered elsewhere.

PART 6 – LUBRICATION

Information is given for the selection of suitable lubricants and for the proper methods of using them.

PART 7 – REMOVAL OF MECHANISMS

Instructions are given for use in the removal and replacement of any unit, or subassembly, of the computer. This information will be of value if a casualty occurs and a unit must be removed for bench repair.

PART 8 – FACTORY ADJUSTMENT PROCEDURE

Detailed information is given for complete adjustment of the computer after a major repair job or after the entire instrument has been disassembled and reassembled.

PART 9 – SKETCH LISTS

Drawing numbers of all units in the computer are listed so that the proper drawings may be ordered for reference while repairing a unit.

In order to obtain the fullest benefit from the information covered in this OP, it is essential for the maintenance man to have first-hand knowledge of the general nature and operation of the Computer Mark 1, as covered in OP 1064. Also, he must have, as a background, considerable experience in basic repair operations and basic mechanisms maintenance, as covered in OP 1140A. Although an attempt has been made to keep each part of the presentation as simple and direct as possible, the complexity of the mechanism requires such a background as a preliminary to understanding its maintenance.

Part one

TESTS

Introduction

This section deals with the various, periodically conducted tests of the Computer Mk 1 and the Star Shell Computer Mk 1. The primary purpose of these tests is to check the functional accuracy of the computing mechanism and transmission system. When the experienced operator runs the tests, he will also be able, by the feel of the input handcranks, or by the sound of the instrument, to detect any variation from normal. Such a variation might indicate potential trouble even though the test results at that time were satisfactory.

In order to perform these duties effectively, the test operator should have special kinds of experience. Primarily, he should be familiar with the operation and function of the computer. Although the instructions for running tests are explicit enough to enable even inexperienced personnel to set up the problems and read the results, such personnel would not be able to analyze the results properly or to decide whether the computer was operating satisfactorily in every respect. In order to run the tests intelligently, the operator should be thoroughly familiar with typical operation, as well as with the functions of the internal mechanisms, as described in OP 1064 and OP 1140. Also, he should be familiar with the instrument itself, and the sections in this OP dealing with *Analysis of Test Errors*, and *Locating Casualties*. Familiarity with the instrument involves knowing the location, function, and "feel" of each handcrank, the location and calibration of each dial and counter, and the sound of the instrument. Also, it involves knowing that precision in making settings and readings is necessary for producing consistent test results. Familiarity with the material under *Analysis of Test Errors* and *Locating Casualties* will enable the operator quickly to recognize symptoms of trouble which might damage the mechanism if operation were continued. Also, if the test errors become excessive, the operator will be able to decide whether the test should be continued to gain further information, or whether corrective measures should be taken immediately.

Gene Slover's US Navy Pages
Table of Contents

The test instructions given in this section are merely illustrative or descriptive of the operations necessary to run each type of test. For the time table of tests, and the necessary problem setup and record forms, refer to the Computer Mk 1 Log Book, NAVORD Form 1229. In addition to the periodic tests called for by the time table, a complete set of tests should always be run after any repair or readjustment.

In tests requiring a record to be kept, the results should be recorded and the errors computed before the next problem is set up. After a complete set of test problems has been conducted, the over-all average and maximum errors should then be computed. If excessive errors occur in a single problem, the error calculations and the problem result readings should be checked. Also, the problem should be completely reset to eliminate the possibility of an originally faulty setup. This does not mean bringing the quantities on from the other direction. The errors should be within the allowable limit regardless of which way the quantities are brought on.

Throughout the tests, computation of error follows the universally used procedure based on the definition of an error. By definition, an error equals the observed reading minus the calculated value of the quantity under observation. It should be noted that the operation indicated by the word "minus" is one of *algebraic subtraction.* The following table of examples will serve to make this clear:

Calculated Value	*Observed Reading*	*Error*
49°50′	49°52′	+2
49°50′	49°49′	−1
−0°11′	−0°13′	−2
−0°11′	−0°08′	+3

It is highly important that the method of computing error be thoroughly understood and followed because it forms the basis for the reasoning in the chapters on *Analysis of Test Errors.*

A Test

The A test provides a static check of all the computing mechanisms in the instrument. For each problem, a particular setup is made and the resulting values of the output quantities are read.

Gene Slover's US Navy Pages
Table of Contents

Star Shell A Test

The star shell A test checks the computing mechanisms of the star shell computer and also the mechanisms of the Computer Mk 1 which supply mechanical inputs to the star shell computer.

On the Mod 0 instruments, the gun order dials are behind the front cover. As an alternative to removing this front cover every time a star shell A test is run, an approximate reading may be obtained by transmitting star shell gun orders to a gun mount and reading the problem results there.

B Test

Primarily, the B test checks the integrator group in the computer. The relative motion component solvers, except the ship and target vector gears, also are checked by the B test. Since, in the B test, the ship and target vector gears, when corresponding speeds are above zero, are at the angular position for maximum output, small errors in their angular position will not affect the results significantly.

In order to conduct an accurate test, and to obtain consistent results, the setup must be made with extreme care. This is especially true of the short range settings in the bearing B test. Also, when running repeated tests for purposes of refining the adjustments, it is usually desirable to bring the input values onto their settings from the same direction each time. However, the instrument should be so adjusted and the lost motion in the gear train sufficiently small that the test errors are within the allowable value regardless of the direction of setup.

C Test

The C test is a factory test which normally is not run on shipboard. Problems in the first group are run in LOCAL control and may be run at any time. Those in the second group are run in SEMI-AUTO control and require a special cable connection to make the computer regenerative. A substitute check for this second group may be run by connecting the computer with the director.

The C test checks the tracking section which is made up of the relative motion group and the integrator group. Unlike the A and B tests, in which constant input values are used, the C test uses constantly changing inputs similar to the actual tracking problem. The C test is unlike the actual tracking problem in that these input values are permitted to build up errors instead of being constantly corrected by rate control.

Gene Slover's US Navy Pages
Table of Contents

Rate Control Test

The rate control tests check the mechanisms in the rate control section. The *jE* and *jBr* solenoid clutches and follow-up motors are checked only in the AUTO rate control test. Specified corrections to generated range, generated elevation, and generated bearing are introduced into the rate control mechanisms, and should result in specified changes in *A*, *Sh*, and *dH*.

Transmission Test

The transmission test is one of the most important checks of the fire control system. This test consists of checking each receiver and each transmitter for accuracy throughout the limits of its operation. The test should be made for each possible switchboard combination.

The experienced operator will be able to check transmission in a much shorter time by means of a combination of special tests. Such tests are the receiver synchronization test, the round robin test, and the over-all test. If any error occurs or if there is any doubt of the correct operation of a unit, the complete transmission test of that unit should be performed.

The transmission test for the Star Shell Computer Mk 1 Mod 0 may be run by transmitting star shell A-test results to the gun mounts. If excessive errors occur, the front cover should be removed and the regular transmission test run.

Time Motor Regulator Test

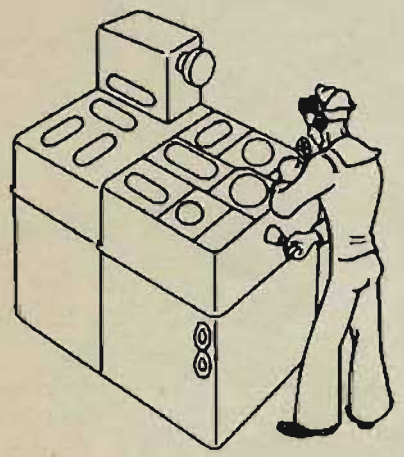
The time motor regulator test is a stop watch check on the speed of the time line.

Table of Operating Limits

The table of operating limits provides a check list of all limit stops and intermittent drives in the instrument. These limits should always be checked after any repair or readjustment.

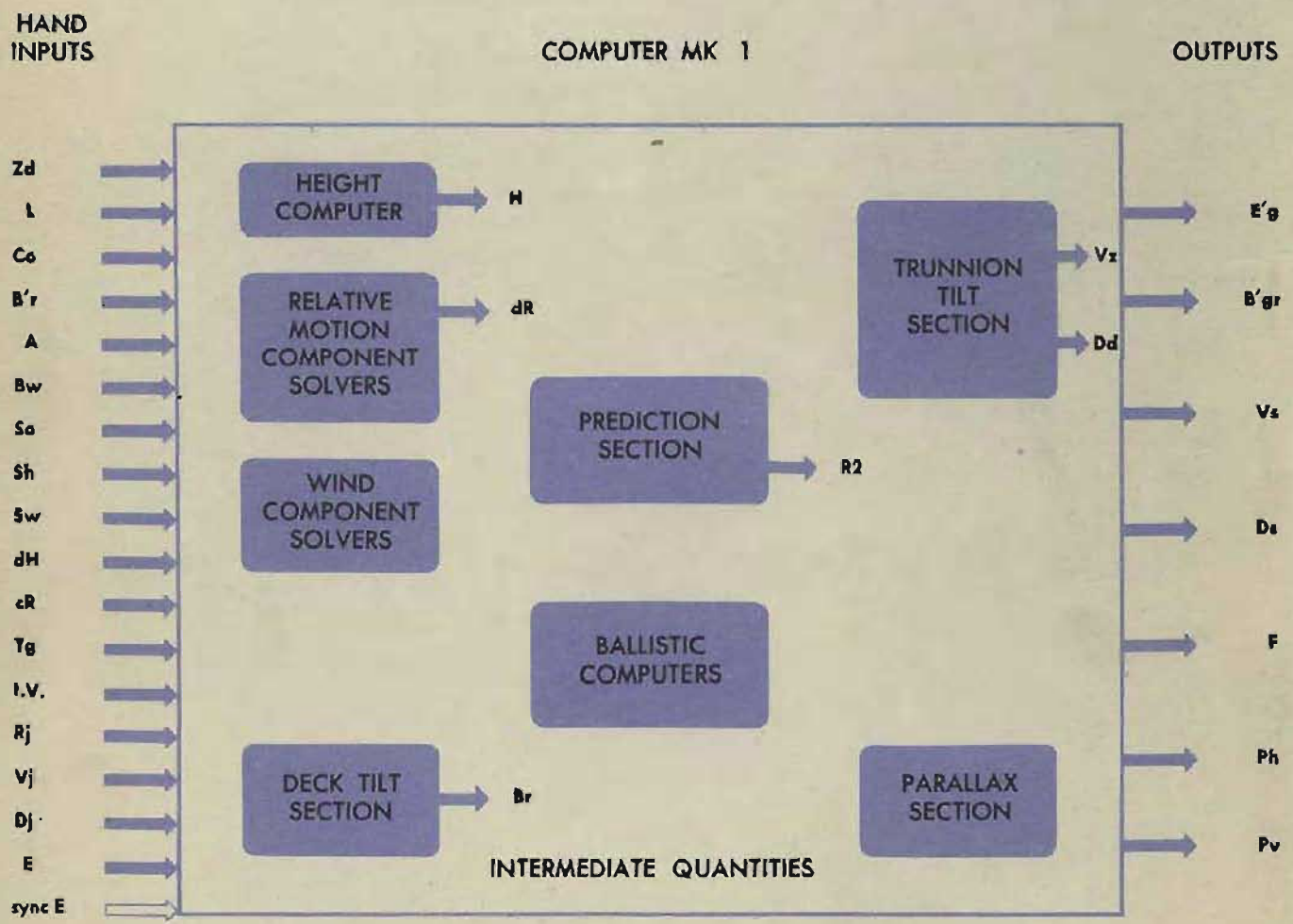
Gene Slover's US Navy Pages
Table of Contents

A TESTS
Including Star Shell A Tests



What is tested

The A tests are run to check all the computing mechanisms except those that require a time input. They are *static* tests. They check the adjustment of the dials and counters to the shaft lines and the adjustment of the shaft lines and the mechanisms to each other, as determined by various clamps. During A tests the power switch is ON, and most of the electrical circuits, servo motors, and follow-ups are operating. The time motor is OFF throughout the A tests.



When A tests are run

A tests are conducted according to the schedule specified in NAVORD FORM 1229. A complete set of A tests should also be run after any readjustment or repair.

How the computer is tested

The fifteen A test problems check the computer outputs. If the errors in the outputs are within the allowable limits of error, the test is complete.

First, the power switch is turned ON. Then specified initial input values are set into the computer. The resulting computer outputs, or transmitted quantities, are observed and compared with specified values calculated for the instrument.

If the differences between the observed and the calculated values are within the specified allowable limits, the sections of the computer checked by the A tests are in correct adjustment. When the differences are NOT within the allowable limits, reference should be made to *A Test Analysis*, page 90.

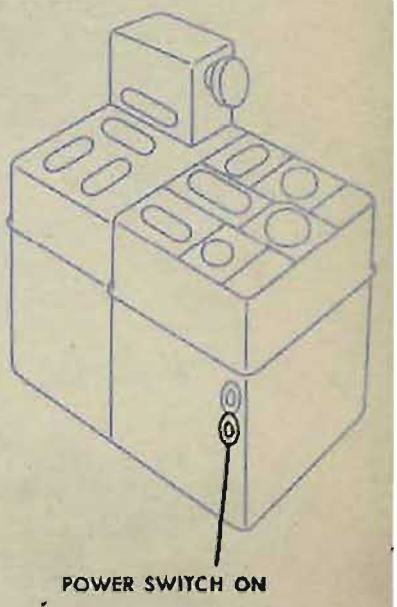
All specified inputs, calculated output values, and allowable error limits, used in running the A tests are given on the A test forms in NAVORD FORM 1229.

There are three test forms:

A table of input quantities for problem setup.

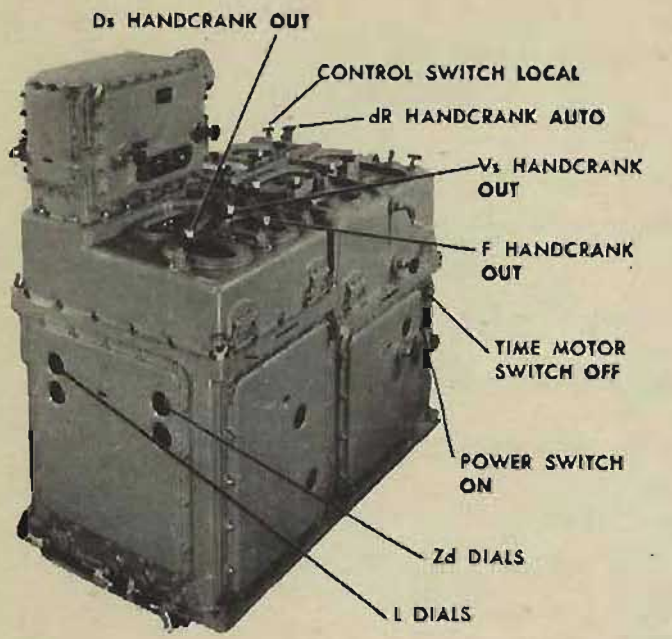
A record form of intermediate quantities.

A record form of A test problem results.



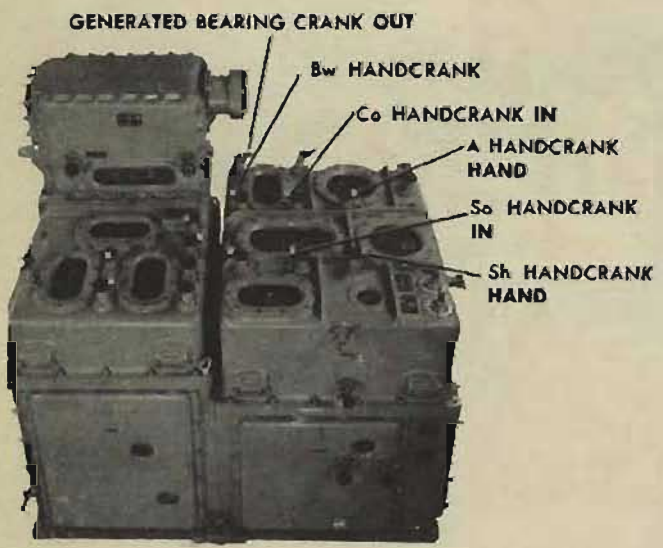
Gene Slover's US Navy Pages
Table of Contents

SETUP without the director



Preliminary steps

1. At the fire control switchboard, energize the power circuit to the computer. All other circuits to the computer should be turned OFF.
2. At the computer, turn the power switch ON.
3. Set the *dR* handcrank in AUTO.
4. Set the *Ds*, *Vs*, and *F* handcranks in the OUT position.
5. Turn the control switch to LOCAL.
6. Keep the time motor switch OFF throughout the A tests.



Setting up problem 1

1. Set cross-level, *Zd*, to read 1100′ on the computer dials.
2. Set level, *L*, to read 2300′ on the computer dials.
3. Set ship course, *Co*, at 180°. Use the ship course handcrank in the IN position.
4. Set director train, *B′r*, to read 0° on the stable element dials. Use the generated bearing crank in the OUT position.
5. Set target angle, *A*, at 0°. Use the target angle handcrank in the HAND position.
6. Set wind direction, *Bw*, at 0°. Use the wind direction handcrank.
7. Set ship speed, *So*, at 38 knots. Use the ship speed handcrank in the IN position.

   NOTE:
   On the ship speed dial, the same dial mark indicates both 0 knots and 45 knots. When 0 knots is being set on the dial, make sure that the actual value being set *is* 0 knots and not 45 knots.
8. Set horizontal target speed, *Sh*, at 300 knots. Use the target speed handcrank in the HAND position.

A TEST - COMPUTER MARK I MOD 13 *PROBLEM SETUP*

PROB. NUMBER	CROSS LEVEL	LEVEL	SHIP COURSE	DIRECTOR TRAIN	TARGET ANGLE	WIND DIRECTION	SHIP SPEED	TARGET SPEED	WIND SPEED	RATE OF CLIMB	GENERATED PRESENT RANGE	DEAD TIME	INITIAL VELOCITY	RANGE SPOT	ELEVATION SPOT	DEFLECTION SPOT	ANGLE OF ELEVATION	DIRECTOR ELEVATION	DIVING SPEED
	Zd	L	Co	B′r	A	Bw	So	Sh	Sw	dH	cR	Tg	I.V.	Rj	Vj	Dj	E	Eb	dR
1	1100	2300	180°	0°00′	0°	0°	38	300	10	+100	10000	4	2550	0	0	0	15°00′	3200	

9 Set wind speed, *Sw*, at 10 knots. Use the wind speed handcrank.

10 Set rate of climb, *dH*, at +100 knots. Use the rate of climb handcrank in the IN position.

11 Set generated present range, *cR*, at 10,000 yards. Use the generated range crank in the OUT position.

12 Set dead time, *Tg*, at 4 seconds.

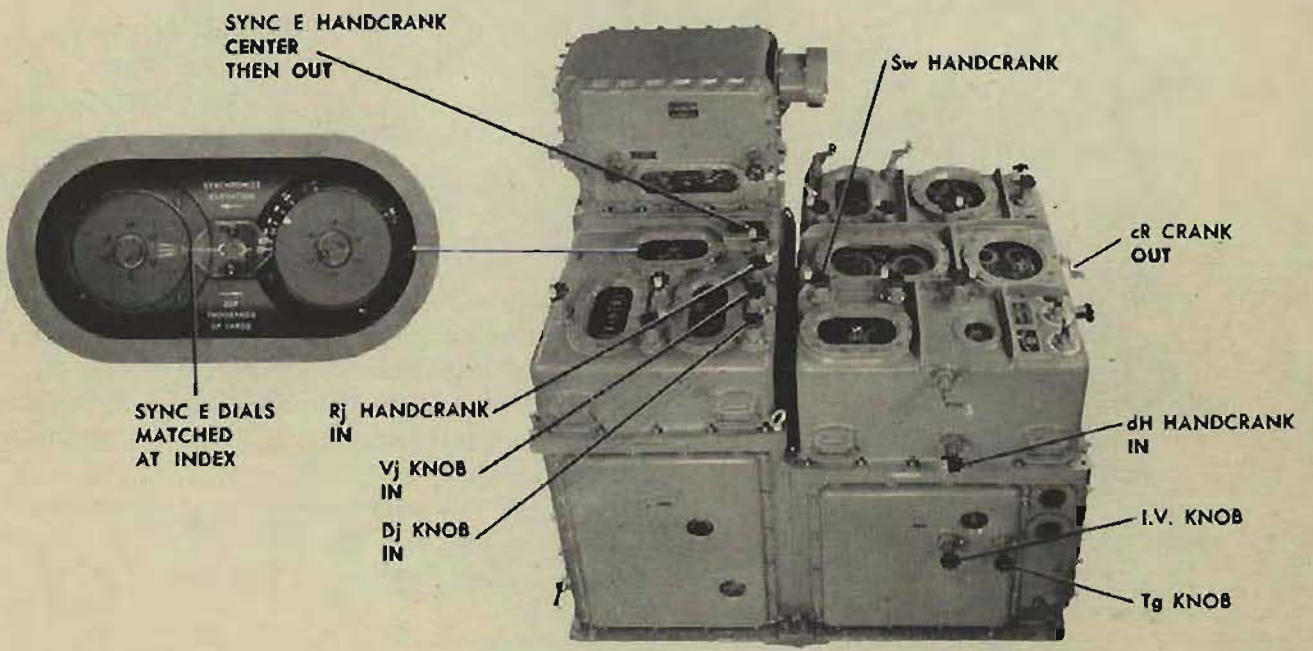
13 Set initial velocity, *I.V.*, at 2550 f.s.

14 Set range spot, *Rj*, on 0. Use the range spot handcrank in the IN position.

15 Set elevation spot, *Vj*, on 0. Use the elevation spot knob in the IN position.

16 Set deflection spot, *Dj*, on 0. Use the deflection spot knob in the IN position.

17 Director sight elevation, *Eb*, is not set directly, since the director is not being used. Instead, set elevation, *E*, at 15°00′, using the sync *E* handcrank in the CENTER position. Then pull the sync *E* handcrank OUT and match the sync *E* dials at the index.

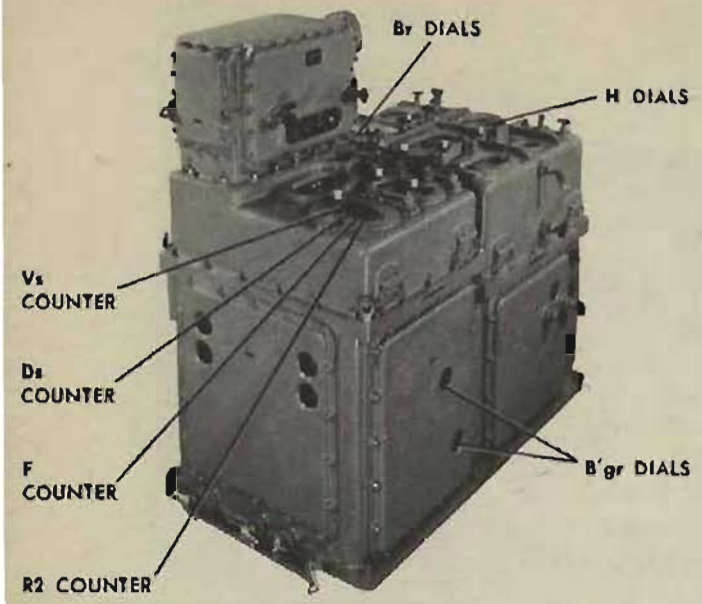


The computer is now set up for A test problem 1. Read and record the problem results. Then set up and record the other test problems.

In problem 7 there is an additional input, diving speed. Set 400 DIVE on the target speed diving dial, using the range rate diving speed handcrank in HAND position.

IF THE DIRECTOR IS USED in running A tests, turn the control switch to SEMI-AUTO and set in director train, *B′r*, and director elevation, *Eb*, from the director. Match the sync *E* dials at the index with the sync *E* handcrank IN.

Gene Slover's US Navy Pages
Table of Contents

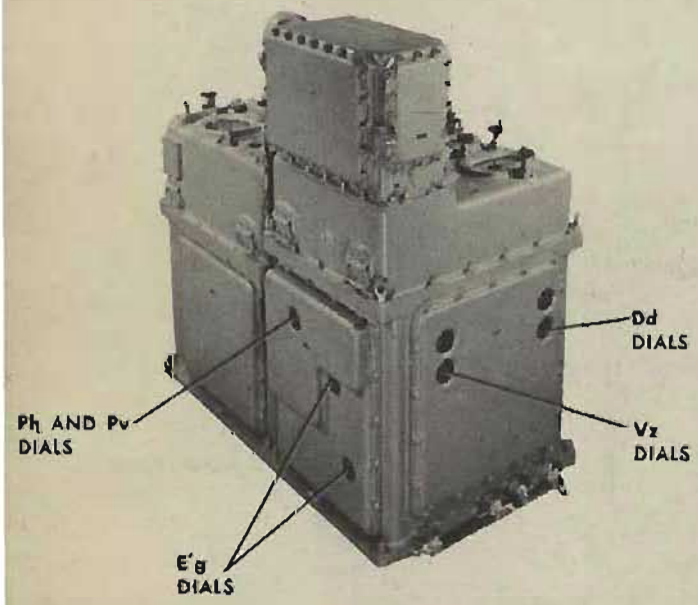


RECORDING THE A TEST PROBLEM RESULTS

Record the values on the computer dials and counters for the quantities listed below. These quantities are the transmitted quantities and those intermediate quantities which can be read without removing any covers.

The quantities to be recorded are:

1. Fuse, *F*
2. Sight angle, *Vs*
3. Sight deflection, *Ds*
4. Advance range, *R2*
5. Gun train order, *B'gr*
6. Deck deflection, *Dd*
7. Trunnion tilt elevation correction, *Vz*
8. Gun elevation order, *E'g*
9. Train parallax, *Ph*
10. Elevation parallax, *Pv*
11. Horizontal relative target bearing, *Br*
12. Height, *H*



Computing errors

As in all other computer tests, the errors in A tests are computed by algebraically subtracting the calculated value from the observed reading. For example, the error in problem 1 for gun train order, *B'gr*, would be computed as follows: The calculated value is given as 348°19′. Suppose that the instrument dial reading recorded is 348°22′. Error = (observed reading) − (calculated value) = (348°22′) − (+348°19′) = +3′.

PROBLEM RESULTS — A TEST

PROBLEM	DATE	F * (A) CALC.	F * (B) CALC.	F * READ	F * ERROR	Vs * CALC.	Vs * READ	Vs * ERROR	Ds * CALC.	Ds * READ	Ds * ERROR	R2 ‡ CALC.	R2 ‡ READ	B'gr * CALC.	B'gr * READ	B'gr * ERROR
1		13.09	13.77			3052			496.6			7724		348° 19′		

In the same problem the calculated value of *Ph* is $-0°11'$. If the instrument reading is $-0°7'$, the error will be $(-0°7') - (-0°11') = +4'$.

If the instrument reading is $-0°15'$, the error will be $(-0°15') - (-0°11') = -4'$. The sign of the error is of special importance in test analysis.

The other errors are calculated and recorded in the same way. When computing errors be careful to:

1 Use the values in column (A) for instruments with Ser. Nos. 780 and lower, and in column (B) for Ser. Nos. 781 and higher.

2 Use the values in column (C) and (E) for instruments in which director train, *B'r*, drives the parallax component solver (BB's, CB's, CA's, and CL's). Use column (D) and (F) when gun train order, *B'gr*, drives the parallax component solver (CV's, DD's, AO's, AV's, etc.).

Allowable limits of error

The allowable limits of error are based on the AVERAGE and MAXIMUM errors.

To find the average error, first add the errors (without regard to plus and minus signs) of all problems for each quantity to get the SUM of error for each quantity. Then divide the SUM by 15 (the number of errors recorded) to get the AVERAGE error for each quantity.

To find the maximum error, select the largest of all errors recorded for the quantity tested. Record it as the MAXIMUM error.

Compare the average and maximum error of each quantity with the allowable average and allowable maximum given. If the errors do not exceed the allowable limits, the A tests are completed. If the errors exceed the allowable limits, refer to the A test analysis, page 90, to locate the source of the errors.

A TEST — PROBLEM RESULTS

Dd ‡		Vz ‡		E'g *			Ph *				Pv *				Br ‡			H ‡	
CALC.	READ	CALC.	READ	CALC.	READ	ERROR	(C) CALC.	(D) CALC.	READ	ERROR	(E) CALC.	(F) CALC.	READ	ERROR	CALC.	READ	ERROR	CALC.	READ
-11° 41'		82		4170			0° 00'	-0° 11'			0° 23'	0° 23'			0° 00'			7765	

*TRANSMITTED QUANTITY ‡INTERMEDIATE QUANTITY

Gene Slover's US Navy Pages
Table of Contents

STAR SHELL A TESTS

The star shell A tests check the star shell computer and those sections of the Computer Mark 1 which compute the values mechanically transmitted to the star shell computer. The star shell A tests are made in the same way as the Computer Mark 1 A tests.

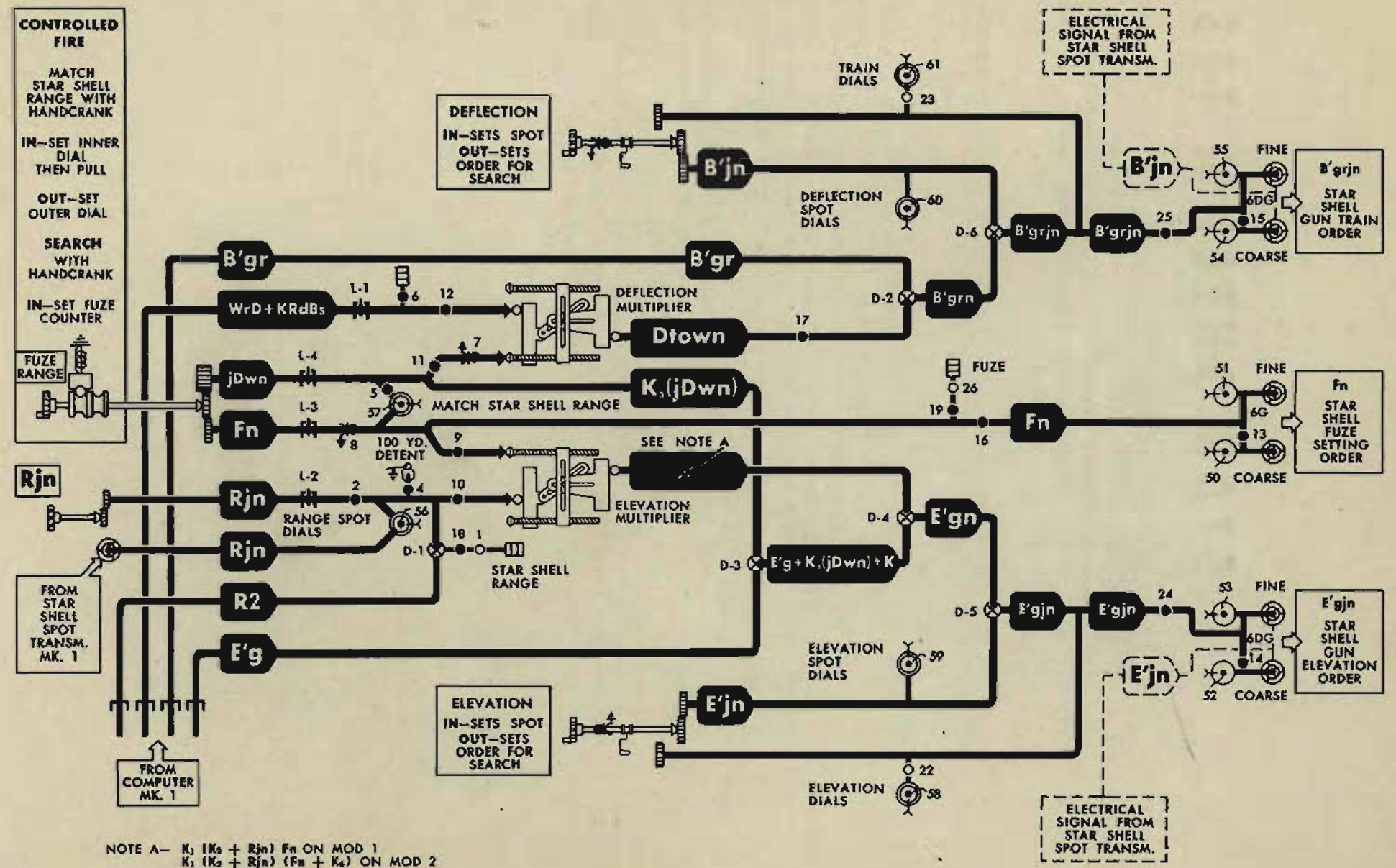
The star shell computed outputs are read on the star shell gun order dials.

On the Star Shell Computer Mark 1, Mod 0, the gun order dials are under the front cover. This cover must be removed before the gun orders can be read. Star shell computer A tests may also be run without removing the front cover by using a method in which star shell gun orders are transmitted to the gun mounts and read at the mounts. This method requires that elevation and deflection spots be set at zero at the star shell spot transmitter. The errors read at the gun mounts are system errors which cannot be charged entirely to the star shell computer.

On the Star Shell Computer Mark 1, Mods 1 and 2, gun orders can be read without removing the front cover.

Gene Slover's US Navy Pages Table of Contents

THE STAR SHELL COMPUTER MARK 1, MODS 1 AND 2



Gene Slover's US Navy Pages | Table of Contents

Star shell A test record forms

The information needed to run and record the five star shell A test problems is contained in the star shell A test record forms in NAVORD FORM 1229. There are two forms: table of problem setups and a record form for problem results.

The star shell A test input quantities are the same as the computer A test input quantities, with the addition of star shell range spot, *Rjn*, deflection spot, *B'jn*, and elevation spot, *E'jn*.

The problem result forms list the calculated values for the computed and intermediate quantities, and provide space for recording the readings and errors.

A TEST – STAR SHELL COMPUTER – MARK 1 PROBLEM SETUP

PROB. NUMBER	CROSS LEVEL	LEVEL	SHIP COURSE	DIRECTOR TRAIN	TARGET ANGLE	WIND DIRECTION	SHIP SPEED	TARGET SPEED	WIND SPEED	GENERATED PRESENT RANGE	DEAD TIME	INITIAL VELOCITY	STAR SHELL RANGE SPOT	STAR SHELL TRAIN SPOT	STAR SHELL ELEV. SPOT	ANGLE OF ELEVATION	DIR. ELEVATION
	Zd	L	Co	B'r	A	Bw	So	Sh	Sw	cR	Tg	I.V.	Rjn	Bjn	Ejn	E	Eb
1	2000	2000	0°	90°	270°	180°	0	0	0	6000	4	2550	0	0	0	-0° 12'	1988
2	2000	2300	225°	45°	45°	0°	20	25	10	7000	4	2500	0	0	0	-0° 10'	2290
3	2000	2000	0°	270°	90°	0°	25	25	30	10000	4	2550	OUT 1000	0	0	-0° 09'	1991
4	1700	2600	90°	0°	30°	270°	26	40	40	15000	5	2550	IN 500	0	0	-0° 08'	2592
5	2120	2600	270°	270°	270°	180°	30	30	0	5000	3	2550	0	0	0	-0° 13'	2587

NOTE: dH, Rj, Vj and Dj = 0 for all problems.

STAR SHELL COMPUTER MARK 1 A TEST PROBLEM RESULTS

PROBLEM	COMPUTED QUANTITIES									INTERMEDIATE QUANTITIES									
	Fn			B'grn			E'gn			WrD + 8/7 RdBs		R2		R2n		B'gr		E'g	
	CALC.	READ	ERROR	CALC.	READ	ERROR	CALC.	READ	ERROR	CALC.	READ	CALC.	READ	CALC.	READ	CALC.	READ	CALC.	READ
1	12.85			89°54'			2612			0		6000		7000		89°54'		2238	
2	15.49			50°33'			2982			32.22		6941		7941		46°37'		2610	
3	29.65			275°26'			3177			54.99		9993		11993		271°00'		2604	
4	38.82			359°35'			4231			83.56		13608		14108		357°58'		3773	
5	10.33			261°23'			3177			96.43		5008		6008		267°36'		2787	
	SUM																		
	AVG.	.05			8			8											
	MAX.	.15			18			18											

DATE:

TESTED BY:

Gene Slover's US Navy Pages Table of Contents

Setting up star shell problem 1

1 Set up the Computer Mark 1 for A tests.

2 On Star Shell Computer Mark 1, Mod 0:
   a) Remove the front cover, or if the system check is preferred, set up star shell gun order transmission to the gun mounts.
   b) Set deflection and elevation spot at 0 at the star shell spot transmitter.

   On Star Shell Computer Mark 1, Mods 1 and 2:
   a) With the deflection and elevation handcranks in SPOT position, set deflection and elevation spots at 0.
   b) Check that each coarse spot dial index is matched at the fixed index.

3 At the computer, set in the hand inputs listed in the problem setup record form for problem 1. Use the handcrank in the positions described for the Computer Mark 1 A tests.

4 At the star shell computer, set the range spot ring dial at 0.

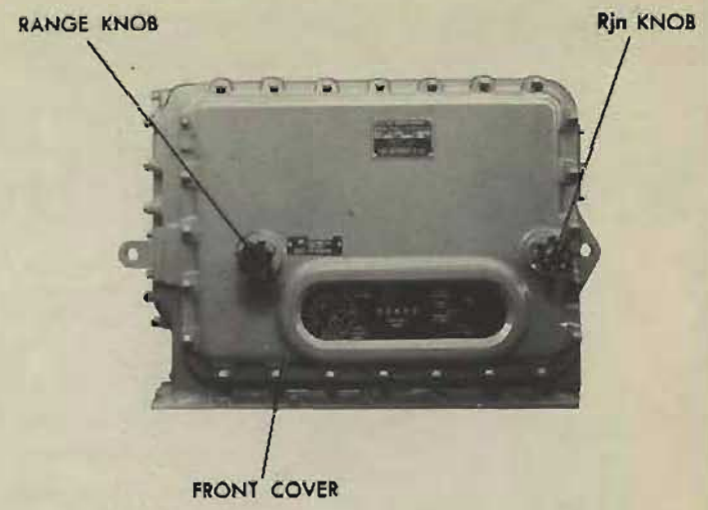
5 Set fuze range by matching the inner star shell range dial to the star shell range counter. Use either the range handcrank in the IN position or the *Fn* gear. To keep fuze errors within the allowable limits, it is important to set fuze range at its exact value.

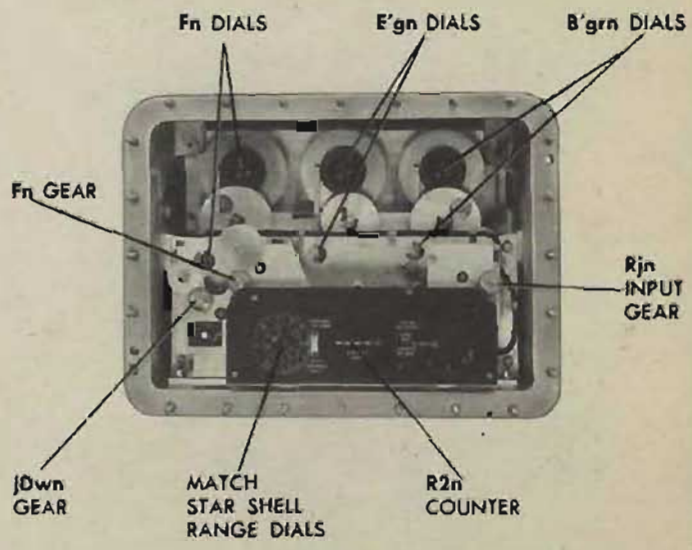
6 Match the star shell range ring dial to the star shell range counter. Use either the range handcrank in the OUT position or the *jDwn* gear.

7 Read and record the star shell gun orders.

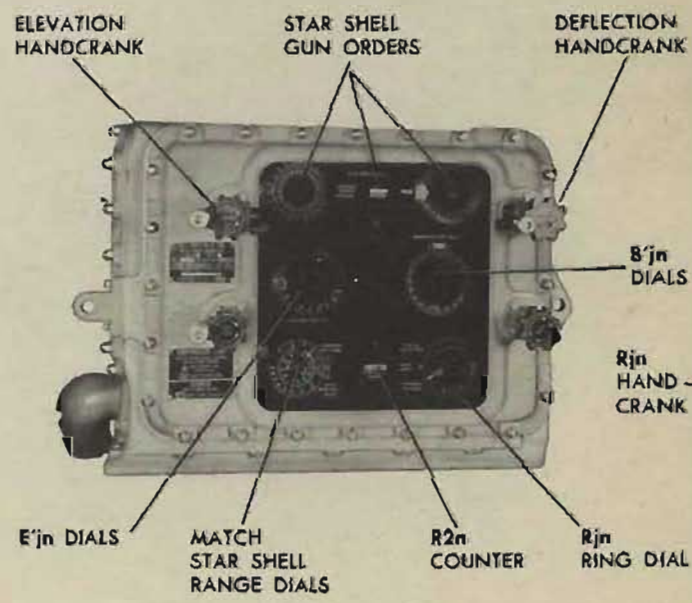
Make all other star shell A tests, following the same procedure. Calculate and record star shell A test errors. These errors are calculated by the method used to calculate Computer Mark 1 A test errors.

If the errors do not exceed the given allowable limits, the star shell A test results are satisfactory. If the errors exceed the allowable limits, refer to star shell A test analysis, page 90, and locate the source of error.





MOD 0



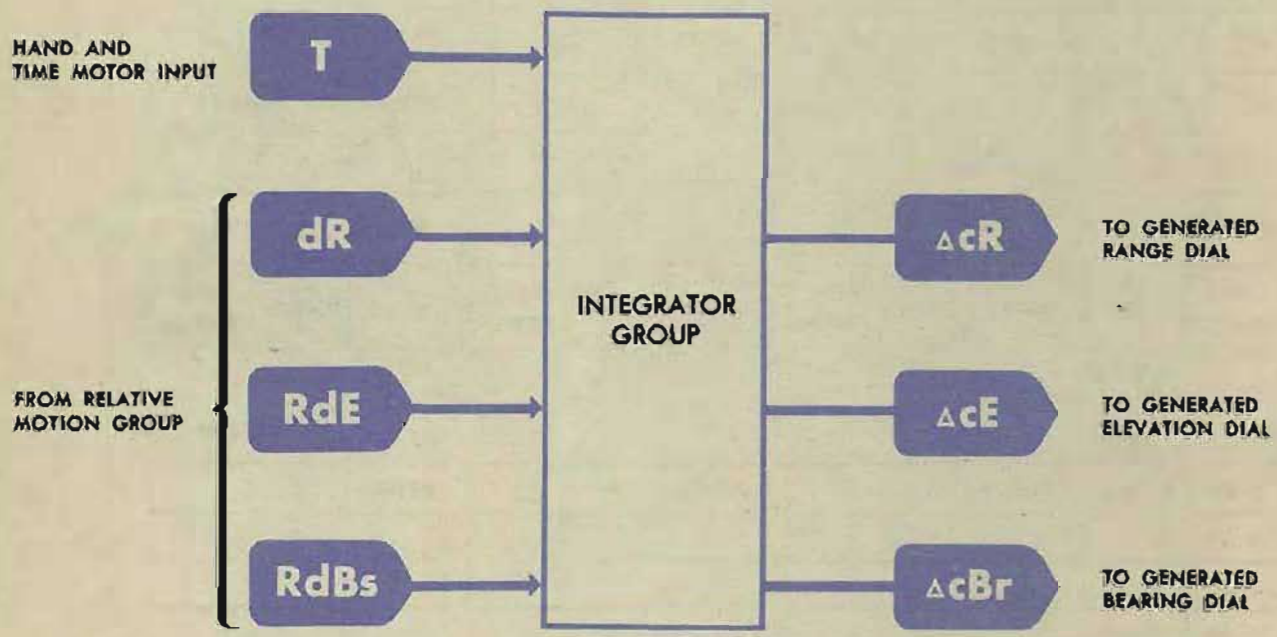
MODS 1 AND 2

Gene Slover's US Navy Pages

Table of Contents

B TESTS

B tests check both the adjustment of the integrator group and the relationship of the relative motion group to the integrators. Specified inputs of time, *T*, and of relative motion rates, *dR*, *RdE*, and *RdBs*, are supplied to the integrator group, and the integrator outputs are then recorded at specified time intervals. The integrator outputs recorded are the generated changes of range, elevation, and bearing, ΔcR, ΔcE, and ΔcBr.



How B tests are run

The B tests consist of three sets of problems: eleven problems for testing range, eleven for elevation, and eleven for bearing.

The generated values of range, elevation, and bearing are read on the computer dials at the end of each specified time interval and entered on the record forms for problem results. They are then compared with a set of calculated correct values. If the B test results are to be satisfactory, the summary average and maximum rate errors must come within the allowable limits specified on the test forms.

The schedule for running B tests is given in NAVORD Form 1229.

Gene Slover's US Navy Pages
Table of Contents

B TEST FORMS

All the forms required for setting up and recording results of B tests are provided in NAVORD Form 1229. Sample sheets are shown here.

B TESTS

BEARING — PROBLEM SETUP

PROB. NO.	So KNOTS	Sh KNOTS	Br DEG.	A DEG.	E DEG.	cR YARDS	dB DEG./MIN.
23	0	0	0°	0°	0°	5000	0°
24	35	360	270°	270°	60°	2150	-711.2°
25	35	360	270°	270°	0°	1700	-449.7°

B TEST — PROBLEM RESULTS

TIME MIN.SEC.	CALC.	READ	ERROR	RATE ERROR	READ	ERROR	RATE ERROR	READ	ERROR	RATE ERROR

RANGE — PROBLEM 5

0:00	22000	22000	0	–	22000	0	–	22000	0	–
0:30	20311									
1:00	18622									
1:30	16933									
2:00	15244									
DATE:			SUM							

B TESTS — SUMMARY SHEET

RANGE — ALLOW OVERALL AVG. 26 MAX. 78

PROB.	DATE	CK. BY	AVG.	MAX.
2				
3				
4				
5				
6				
7				
8				

ELEVATION — ALLOW OVERALL AVG. 34 MAX. 102

PROB.	DATE	CK. BY	AVG.	MAX.
13				
14				
15				
16				
17				
18				
19				

BEARING — ALLOW OVERALL AVG. 34 MAX. 102

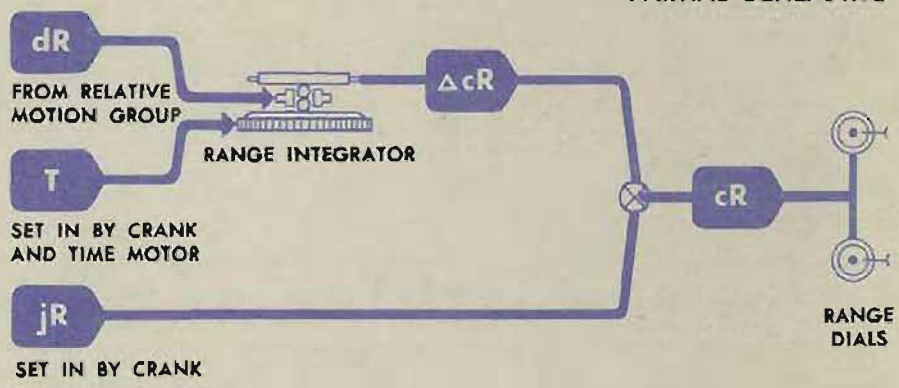
PROB.	DATE	CK. BY	AVG.	MAX.
24				
25				
26				
27				
28				
29				
30				

Range B tests check ΔcR

Generated change of range, ΔcR, is computed by multiplying direct range rate, dR, by time, T. dR, from the relative motion group, positions the range integrator carriage. A specified value of time, T, set in by the time crank and time motor, drives the range integrator disk. The integrator output is ΔcR. ΔcR is added to a value of jR set in by the generated range crank. jR plus ΔcR gives generated range, cR.

The value of cR is read on the generated range dials at the time intervals specified on the record form for problem results. The dial readings are recorded on this form and compared with the calculated values.

GENERATED RANGE
PARTIAL SCHEMATIC

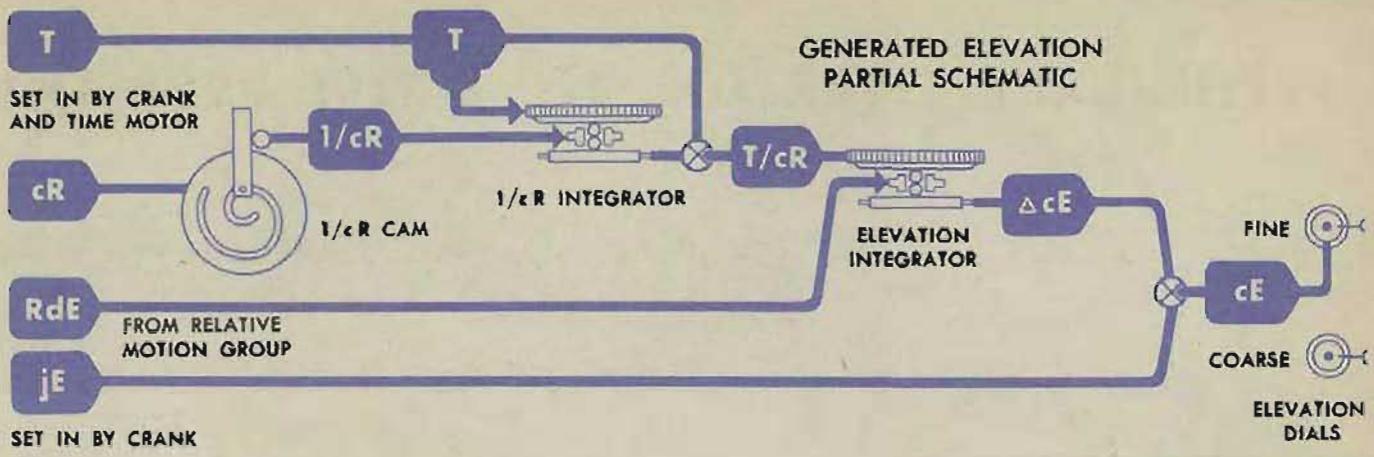


Elevation B tests check ΔcE

Generated change of elevation, ΔcE, is computed by multiplying linear elevation rate, RdE, by T/cR. Generated range, cR, is the input to the $1/cR$ cam. The cam output, $1/cR$, positions the $1/cR$ integrator carriage. The input to the $1/cR$ integrator disk is a specified value of time which is set in by the time crank and time motor. The output of the $1/cR$ integrator is T/cR, which becomes an input to the disk of the elevation integrator. The input to the elevation integrator carriage is RdE, an output of the relative motion group. The output of the elevation integrator is ΔcE. This is added to a value of jE set in by the generated elevation crank. jE plus ΔcE is generated elevation, cE.

The value of cE is read on the fine generated elevation dial at the time intervals specified on the record form for problem results. The dial readings are recorded on this form and compared with the calculated values.

Gene Slover's US Navy Pages
Table of Contents



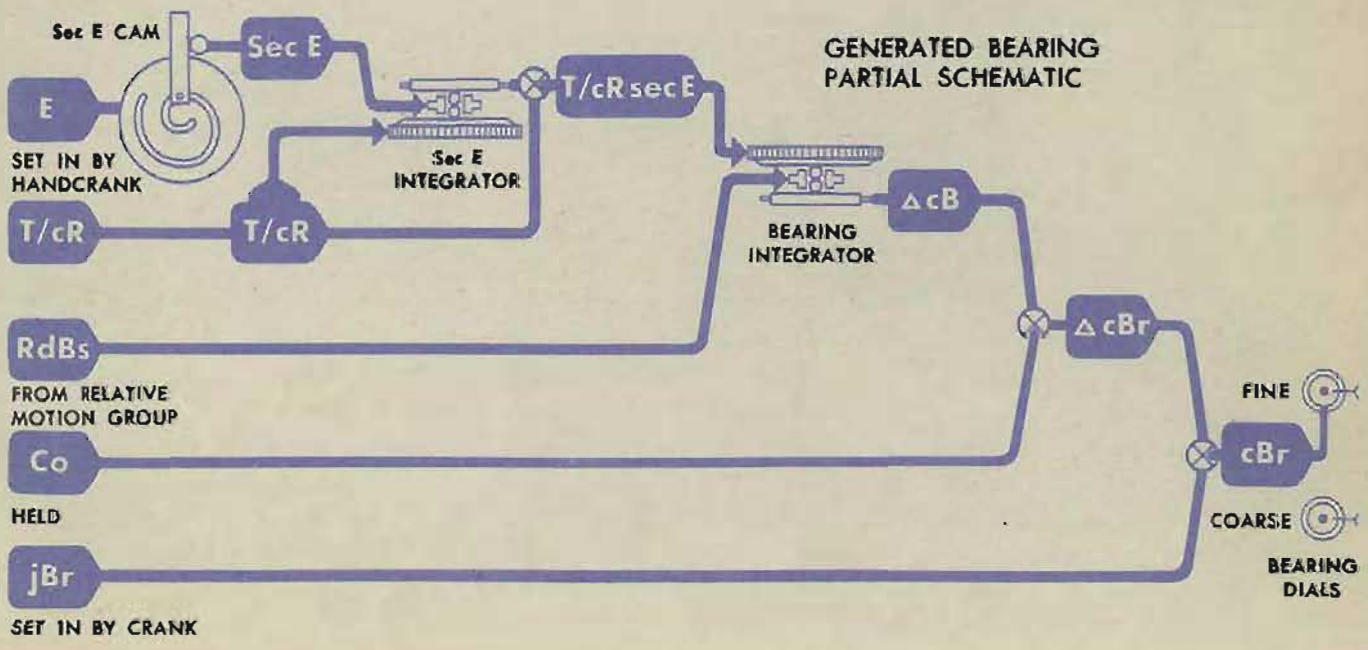
Bearing B tests check △cBr

Generated change of bearing, $\triangle cBr$, is computed by multiplying the linear deflection rate, $RdBs$, by (T/cR) sec E. Target elevation, E, the input to the sec E cam, is set in by the sync E handcrank. The cam output, sec E, is the input to the sec E integrator carriage. The input to the sec E integrator disk is T/cR.

The output of the sec E integrator is (T/cR) sec E. This quantity becomes an input to the bearing integrator. The other input to the bearing integrator is $RdBs$, from the relative motion group. The output of the bearing integrator is $\triangle cB$.

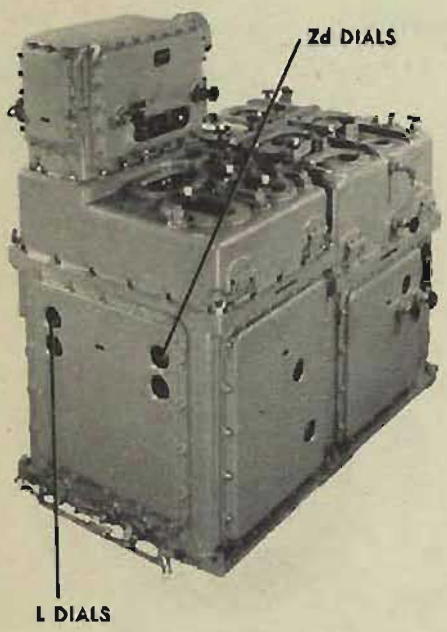
$\triangle cB$ combines with Co, which is held at a constant value to form $\triangle cBr$. $\triangle cBr$ is added to a value of jBr, set in by the generated bearing crank, to form generated relative target bearing, cBr.

The value of cBr is read on the fine generated bearing dial at the time intervals specified on the record form for problem results. The dial readings are recorded on this form and compared with the calculated values.



Gene Slover's US Navy Pages
Table of Contents

PRELIMINARY SETUP FOR ALL B TEST PROBLEMS



1 At the fire control switchboard, make sure that all the switches connecting the computer to the director are OFF

2 At the stable element, set level, *L*, to read 2000′ on the computer level dial.

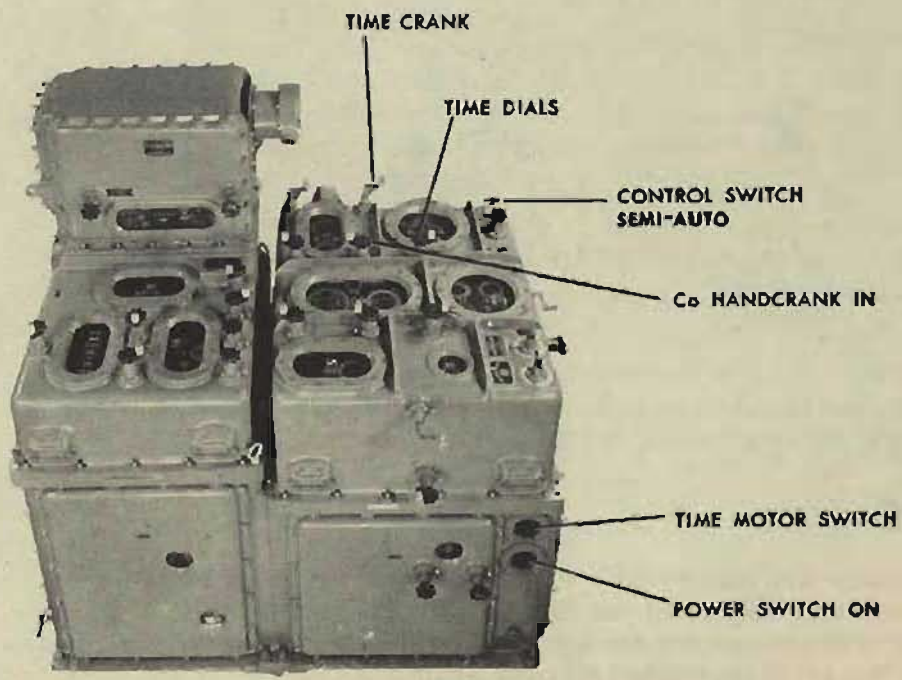
3 At the selector drive, set cross-level, *Zd*, to read 2000′ on the computer cross-level dial.

4 At the computer, turn the power switch ON.

5 Turn the control switch to SEMI-AUTO.

6 Lock the ship course handcrank in its IN position.

7 Pull the time crank OUT, and turn it clockwise to set the graduation mark on the half-second dial at the fixed index. Then, with the time crank IN, zero the minute and second dials. All the time dials should be exactly at zero at the start of each B test problem.



Gene Slover's US Navy Pages Table of Contents

TIME DURING B TESTS

In B tests, actual time is not used. Time is represented by revolutions of the time shaft line as recorded on the time dials. The actual time required for the time shaft to turn the time dials to the value of two minutes, for example, might be more than two minutes during a test, but this would not affect the test.

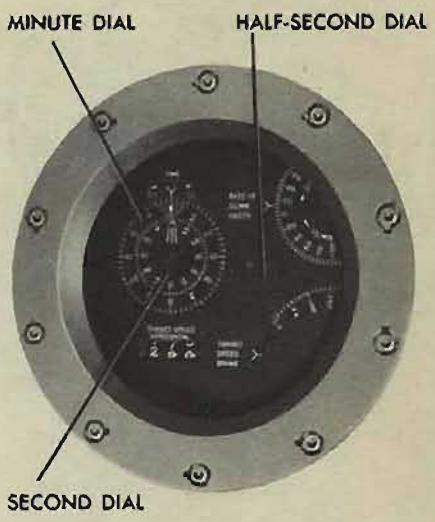
For this reason, the time motor regulator, which controls the speed of the time motor, is not tested by the B tests but is tested separately as described on page 84.

At the beginning of a problem

Each B test problem begins at the moment that the time dials are moved off zero. If, however, the time motor were turned ON at the beginning of the problem, the suddenly applied load might cause slippage in the integrators and introduce an error into their outputs. To avoid this, each problem is started by turning the time crank in its OUT position to work the time shaft line up to speed. Three or four revolutions of the time handcrank are usually sufficient, but practice is needed before it can be done smoothly.

When the shaft line has been brought up to speed, the time motor is turned ON, and the time handcrank is lowered to its CENTER position.

In the bearing problems it is especially important that the time shaft line be brought up to speed gradually; the inertia of the bearing filter may otherwise cause excessive slippage in the bearing integrator.



TIME DIALS

At the end of a problem

To avoid running a problem beyond the specified time, the time motor is always turned OFF several seconds *before* the time dials reach the specified time limit for the test. The time crank in its OUT position is used to turn the time shaft line slowly until the time dials register the exact reading required. The half-second dial should be used to obtain the exact dial reading.

When the time motor is switched OFF, it is desirable to turn the time crank up to the correct speed in the CENTER position and then bring it OUT into mesh with the time line without jarring the line.

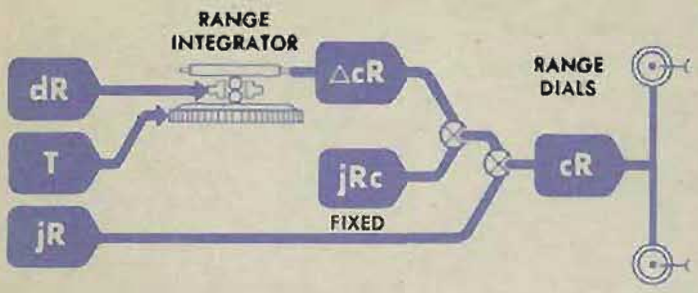
With practice this can be done quite smoothly. The time crank can then be used to aid or retard the line so that the time dials will stop right on the desired value, without overtravel.

WARNING

If the time dials are accidentally turned beyond the specified final time reading, they must *not* be turned back because this may damage the time motor regulator. The time dials must be zeroed and the problem started all over again.

Gene Slover's US Navy Pages
Table of Contents

RANGE B TESTS



For each range B test problem, the inputs specified on the range B test problem setup form are set into the computer to establish a fixed value of direct range rate, *dR*. The range rate diving speed handcrank is switched to AUTO.

For each problem, the time dials are set at zero, and generated range is then set at the initial value specified on the record form for problem results.

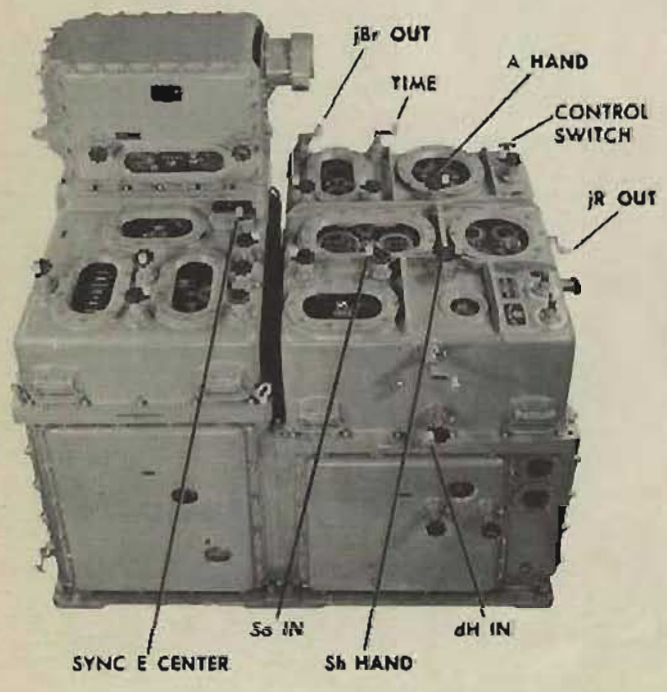
The output of the range integrator, ΔcR, is tested by reading the generated range dials at given time intervals and comparing these readings with the calculated values.

Setting up the computer for range problem 2

B TEST

RANGE PROBLEM SETUP

PROB NO.	So KNOTS	Sh KNOTS	dH KNOTS	Br DEG.	A DEG.	E DEG.	cR YARDS TO START	dR YDS/MIN.
1	0	0	0	90°	90°	0°	5000	0
2	35	395	0	0°	0°	0°	22000	-14525.4
3	0	300	0	90°	0°	0°	22000	-10134.0
			-235		90°	60°		



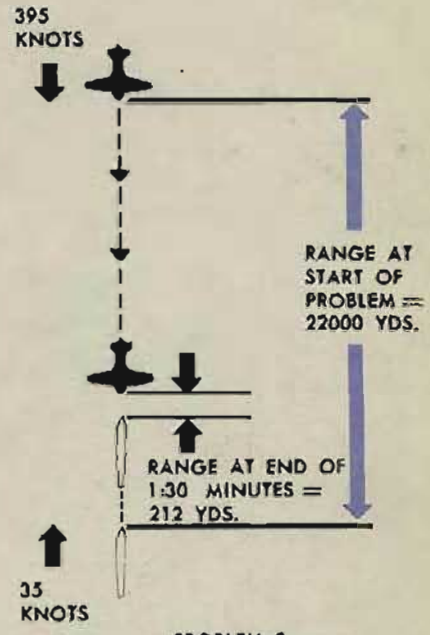
1. Turn the ship speed handcrank in the IN position to set *So* at 35 knots.
2. Shift the target speed handcrank to HAND, and set *Sh* at 395 knots.
3. Push the rate of climb handcrank IN, and set *dH* at 0 knots.
4. Set *Br* at 0 degrees. To do this, turn the control switch to LOCAL and use the generated bearing crank in the OUT position. Return the control switch to SEMI-AUTO.
   Note that *Br* can also be set into the computer by transmitting *B'r* from the director. (Since *L* and *Zd* are both set at 2000', *B'r* = *Br*).
5. Turn the target angle handcrank to HAND and set *A* at 0 degrees.
6. Put the sync *E* handcrank in its CENTER position, and set *E* at 0 degrees.

Gene Slover's US Navy Pages Table of Contents

7 Check that all the time dials are on zero, and that the graduation on the half-second dial is at the fixed index.
8 Pull the generated range crank OUT, and set *cR* at 22,000 yards. This initial value of *cR* for problem 2 is given on the record form for problem results, opposite the 0:00 minutes time dial reading.

Running range problem 2

1 Turn the time crank in the OUT position to work up the speed of the time shaft line.
2 As soon as the time shaft line is turning at approximately operating speed, turn the time motor switch ON and let the crank disengage.
3 Run the problem for about 25 seconds on the time dials, and then turn the time motor switch OFF.
4 Turn the handcrank slowly to bring the second dial almost to 30. Then, very slowly, make the half-second dial index line up with the fixed index. This should bring the second dial to read 30 against the fixed index.
5 Read the *cR* dial and enter the *cR* reading on the record form for problem results.
6 Run the problem in the same manner for the remaining time intervals. If the time crank is turned beyond the specified time dial reading, the time dials must be reset on zero and the problem repeated.



PROBLEM 2
SHOWS cR DECREASING
AT 430 KNOTS

B TEST — PROBLEM RESULTS

TIME MIN. SEC.	CALC.	READ	ERROR	RATE ERROR	READ	ERROR	RATE ERROR	READ	ERROR	RATE ERROR
RANGE								PROBLEM 2		
0:00	22000	22000	0	—	22000	0	—	22000	0	—
0:30	14737	14740	+3	6						
1:00	7475	7480	+5	5						
1:30	212	220	+8	5						
DATE:			SUM	16						
TESTED BY:			AVG	5						
			MAX	6						

Recording the problem results

Record the *cR* dial readings under problem results in the column headed: READ.

The remaining range problems, with the exception of problem 1, are set up, run, and recorded in exactly the same manner as range problem 2. Problem 1 is the zero rate problem and is run for a single time interval of 3 minutes. A separate allowable maximum for this problem is specified on the zero rate summary sheet.

Gene Slover's US Navy Pages
Table of Contents

COMPUTING ERRORS IN RANGE B TESTS

The problems selected for the B tests are extreme cases in which the errors in the mechanisms are magnified and easily noticed. The group of mechanisms used to generate changes of range is operating properly if the B test errors are within the allowable limits specified on the B test summary sheets.

First the linear range errors are found by comparing the recorded readings of cR with the mathematically calculated cR. When the linear errors have been recorded, the problem rate errors, the summary average rate errors, and the summary maximum rate errors are calculated.

The allowable limits are based on the average rate error for all the range problems, called the summary average, and the maximum rate error for all the range problems, called the summary maximum.

B TEST — PROBLEM RESULTS

TIME MIN.SEC.	CALC.	READ	ERROR	RATE ERROR	READ	ERROR	RATE ERROR	READ	ERROR	RATE ERROR
RANGE								PROBLEM 3		
0:00	22000	22000	0	—	22000	0	—	22000	0	—
0:30	16933	16920	-13	26						
1:00	11866	11840	-26	26						
1:30	6799	6755	-44	29						
2:00	1732	1670	-62	31						
DATE:			SUM	112						
			AVG	28						
TESTED BY:			MAX	31						

Linear errors

The linear error is the observed reading minus the calculated value. Linear errors may be either plus or minus.

Suppose that in problem 3 the values of generated range read on the dials during the test were 16,920 yards after 30 seconds, 11,840 yards after one minute, and so on, as recorded in the READ column. At the first reading, the linear error is 16,920—16,933, which is —13. At the second reading, cR is 11,840. The linear error for the second reading is 11,840—11,866, which is —26. In the same way the linear errors for the third and fourth readings are —44 and —62.

Gene Slover's US Navy Pages Table of Contents

Problem rate errors

The rate error is the linear error at each reading divided by the elapsed time in minutes between the start of the problem and the time of reading.

$$\text{Rate error} = \frac{\text{linear error}}{\text{time in minutes}}$$

In problem 3, the linear error at the second reading is −26. (Minus and plus signs can be ignored in calculating rate errors.) The time is 1 minute.

$$\frac{26 \text{ yards}}{1 \text{ minute}} = 26 \text{ yards per minute}$$

The rate error for this reading is therefore 26.

Problem average and problem maximum rate errors

To find the problem average rate error, add all the rate errors and divide their sum by the number of readings. In problem 3, the problem average rate error is 112/4, which is 28.

The problem maximum rate error is the largest rate error. In this problem, the problem maximum rate error is 31.

The linear errors, rate errors, average rate error, maximum rate error for each range problem are recorded on the form for problem results. All the problem averages and maximum rate errors are then recorded in the columns provided on the B test summary sheets.

SUMMARY SHEET

RANGE

ALLOW OVERALL AVG. 26 MAX. 78

PROB.	DATE	CK. BY	AVG.	MAX.
2			5	6
3			28	31
4			67	72
5			20	23
6			8	11
7			19	22
8			6	10
9			24	30
10			23	29
11			15	18
OVERALL AVG. & MAX.			21.5	72

Summary average rate errors

The problem averages are added and their sum is entered in the space provided on the summary sheet. In this set of problems the sum is 215. The summary average is then found by dividing the sum of the problem averages by the number of problem averages recorded. The summary average in this case is 215/10, which is 21.5. This summary average is then compared with the given allowable average. It must not exceed the allowable average, which in this case is 26.

Problem maximum rate errors

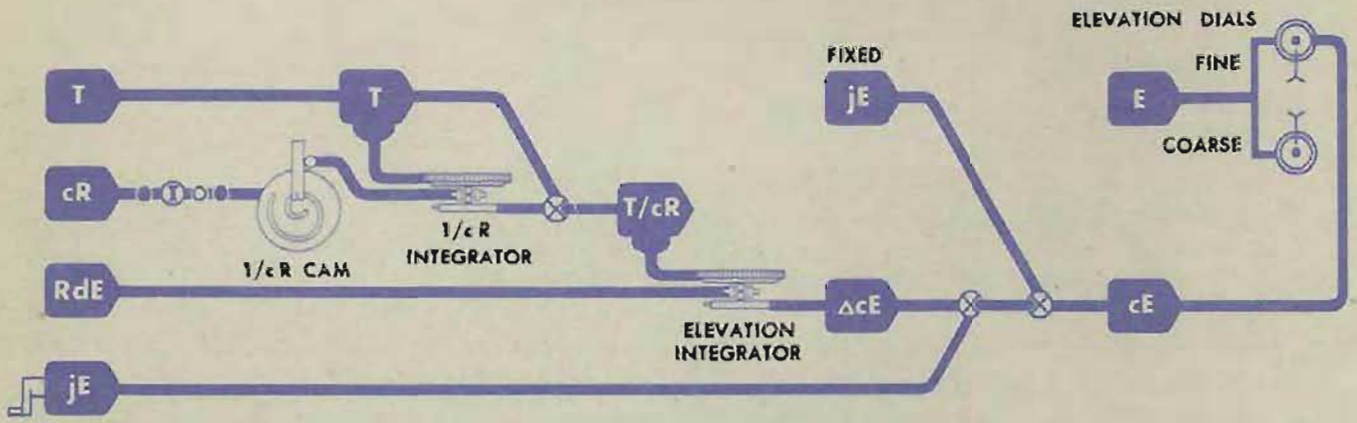
The largest problem maximum rate error is entered as the summary maximum and is compared with the given allowable maximum. In this example, the largest problem maximum is 72. The allowable maximum is 78. Since in this example both the summary average and the summary maximum are within the allowable limits, these results demonstrate that the range integrator output, $\triangle cR$, is sufficiently accurate.

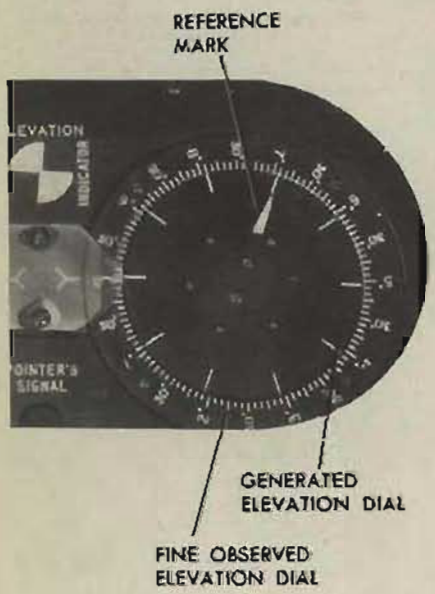
ELEVATION B TESTS

For each elevation B test problem, the initial inputs specified on the elevation B test problem setup form are set into the computer to establish a fixed value of linear elevation rate, *RdE*.

For each problem, the time dials are set at zero, and generated elevation is then set at the initial value specified on the record form for problem results.

The output of the elevation integrator, $\triangle cE$, is tested by reading the generated elevation dial at given time intervals and comparing these readings with the calculated values.





Marking the cE dial

The output of the elevation integrator is read on the generated elevation dial against the fine observed elevation dial. Each dial has a value of 10° per revolution.

For convenience in this discussion, *jE* is the elevation value introduced by turning the generated elevation crank, and *cE* is the elevation value generated by the elevation integrator in the time interval specified by the test problem.

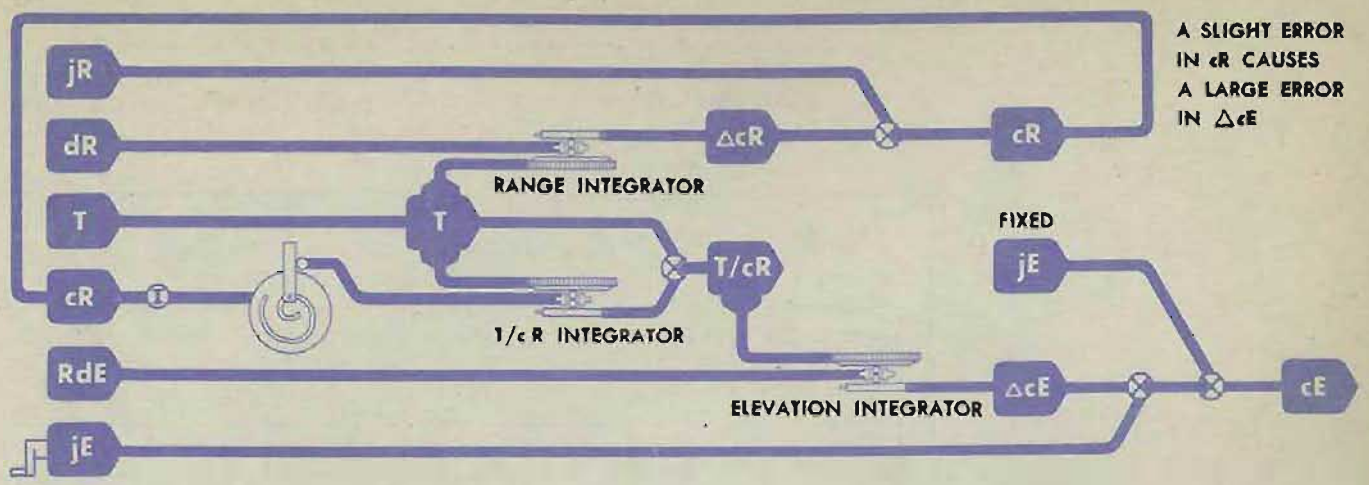
One of the indexes on the generated elevation dial must be selected as a reference. This is done by selecting the index in line with one of the dial hub screws, or by identifying an index mark with a pencil line, a spot of paint, or a small triangle of adhesive tape.

With the dial marked, *jE* can be introduced with the generated elevation crank OUT. The value of *cE* can then be read against the fine observed elevation dial at the end of the specified time interval.

On earlier machines there are fine and coarse generated elevation dials. Each dial has a special-shape index mark for use as a reference.

Preventing changes in range

Generated range, *cR*, is one of the fixed inputs in elevation and bearing B tests. The slightest change in *cR* during elevation and bearing B tests can cause excessive errors in generated elevation, *cE*, and generated bearing, *cBr*. To prevent any change in *cR* during the tests, a zero range rate is established.



To establish a zero range rate, set the *dR* dial at zero, turn the time motor ON, and watch the ΔcR gearing through the access hole to the left of the range rate ratio knob. Adjust the *dR* handcrank until the ΔcR gearing stands still.

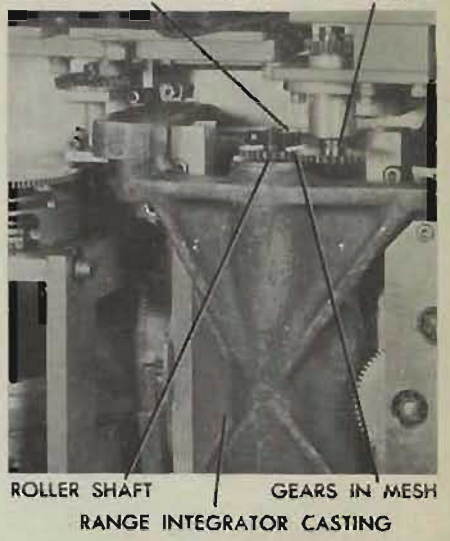
In older machines no access hole was provided. On these machines set *dR* as follows: Set the *dR* dial at zero with the *dR* handcrank at HAND; then set *cR* at some known input value with the generated range crank. Run the time motor for 3 minutes and observe whether there is any change in *cR*. If the *cR* dial reading changes, adjust the *dR* handcrank until the *cR* reading remains constant.

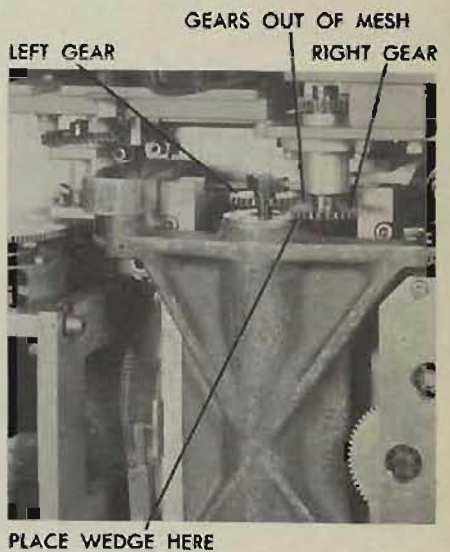
In later computers the range integrator may be disconnected from the ΔcR line to eliminate wear on the integrator disk at the zero position. When the range integrator is disconnected, errors in generated range are eliminated. Initial range, *jR*, can be set at the given value at the beginning of an elevation problem, and the value of range *will not change* during the problem. The *dR* handcrank should be set at AUTO when the range integrator is disconnected.

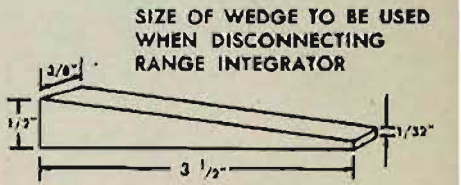
Disconnecting the range integrator

1. Remove the plug from the range integrator access hole in cover 1. This brings two spur gears into view. The left gear is on the roller shaft of the range integrator, and the right gear is on a shaft which is part of the ΔcR line.
2. Turn the time crank *clockwise* in the OUT position until the screw of clamp A-167 on the left gear can be reached easily.
3. Loosen clamp A-167.
4. Carefully raise the left gear just out of mesh with the right gear.

   CAUTION:
   Do not remove the left gear from the integrator shaft.
5. With the left gear raised, slip-tighten clamp A-167. Making the clamp too tight may cause the gear hub to collapse.
6. Lock the right gear. To do this, insert a wedge under the gear *by hand*. Any pressure greater than hand pressure may injure the gear. The wedge should lie between the right gear and the integrator casting and should stick out beyond the plug hole. This wedge should be made of high-grade bakelite or some other material that will not chip or break easily and which will not damage the gear.







Running elevation B tests

1 First establish a zero range rate and then set the computer dials at the specified values given on the elevation B test problem setup form.

ELEVATION — PROBLEM SETUP

PROB. NO.	So KNOTS	Sh KNOTS	dH KNOTS	Br DEG.	A DEG.	E DEG.	cR YARDS	dE DEG./MIN.
12	0	0	0	90°	90°	0°	5000	0
13	35	285	0	180°	180°	80°	2400	-254.1
20	30	280	+180	0°	0°	50°	4000	+152.2

2 Using problem 13, for example, zero the time dials and then match the selected index on the fine generated elevation dial with the 0°00′ graduation on the observed elevation dial, using the generated elevation crank in the OUT position.

B TEST — PROBLEM RESULTS

ELEVATION — PROBLEM 13

TIME MIN. SEC.	CALC.	READ	ERROR	RATE ERROR	READ	ERROR	RATE ERROR	READ	ERROR	RATE ERROR
0:00	0°00′	0°00′	0	—	0°00′	0	—	0°00′	0	—
0:30	127°05′	126°58′	-7	14						
1:00	254°06′	253°50′	-16	16						
DATE:			SUM	30						
TESTED BY:			AVG	15						
			MAX	16						

3 Run the problem for 30 seconds, the first specified time interval, keeping count of the dial revolutions. Begin and finish the run, using the time crank as described for the range problems.

4 Read the generated elevation ring dial against the selected index and record the value on the record form for problem results.

5 Complete the problem in the same manner.

ELEVATION — PROBLEM 20

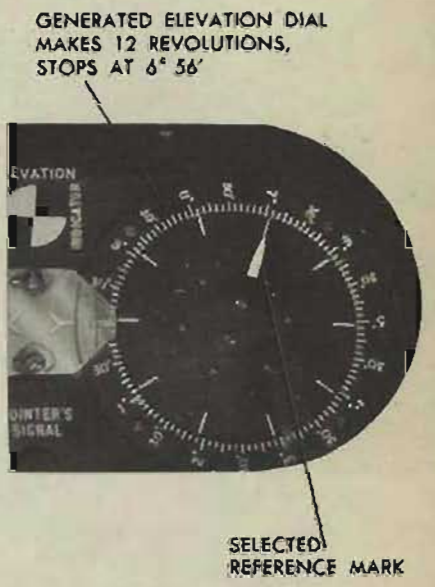
TIME MIN. SEC.	CALC.	READ	ERROR	RATE ERROR	READ	ERROR	RATE ERROR	READ	ERROR	RATE ERROR
0:00	0°00′	0°00′	0	—	0°00′	0	—	0°00′	0	—
0:30	283°53′	283°40′	-13	26						

Gene Slover's US Navy Pages Table of Contents

Reading the generated elevation dial

The calculated values of generated elevation, given as 360°−*cE*, were devised in this form to represent the direct dial readings without regard to the direction of rotation. The full value of *cE* cannot be read on the fine dial, because the value of a full revolution of the dial is only 10°. Instead, the number of revolutions of the fine dial is counted and compared with the value of *dE* in deg./min. given on the problem setup form. (*dE* represents the angular rate of the change of elevation.) If the number of revolutions of the dial checks with the *dE* value given, then *the part of the calculated value not read* on the generated dial is copied into the instrument reading column, followed by the actual fine dial reading.

For example, consider problem 13. In this problem the calculated value is 127°03′ at the end of the first 30-second time interval. The value of *dE* is given as −254.1 deg./min. For 30 seconds the value is −127.05°. Since the fine dial has a value of 10° per revolution, it should make 12 revolutions in the 30-second time period. If after making twelve full revolutions, the selected index mark on the generated elevation dial stops at the reading of 6°56′, as shown, then this reading 6°56′ is put down in the instrument reading column and the rest of the reading is copied from the calculated value, giving 126°56′ as the full entry value.



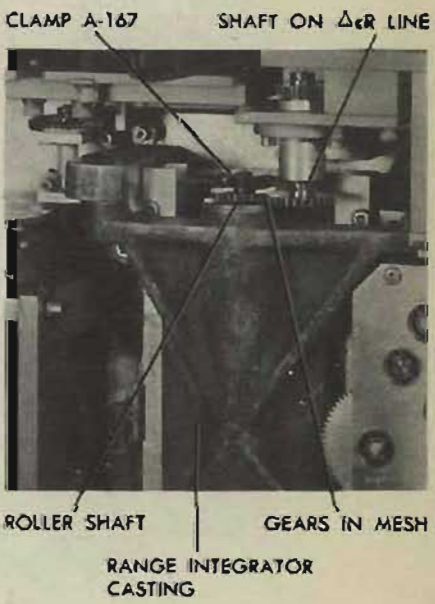
As another example, consider problem 20. Here the calculated value is 283°53′ at the end of 30 seconds. The problem setup form gives *dE* as +152.2 deg./min. For 30 seconds, the value would be +76.1°, representing 7 revolutions of the dial. If the dial makes 7 revolutions and stops at 3°40′, the reading of 28 is copied from the record form for problem results and is followed by the 3°40′ read on the dial. The full entry will then be 283°40′.

The remaining elevation problems are run in the same manner. The errors and the rate errors for each reading and the average and maximum errors for each problem are calculated in the same way as range problem errors and are entered on the B test summary sheet.

The summary average and the summary maximum rate errors are then compared with the given allowable errors.

At the conclusion of the elevation B tests, return the *dR* handcrank to AUTO if it is in HAND.

Reconnect the range integrator if it is disconnected.



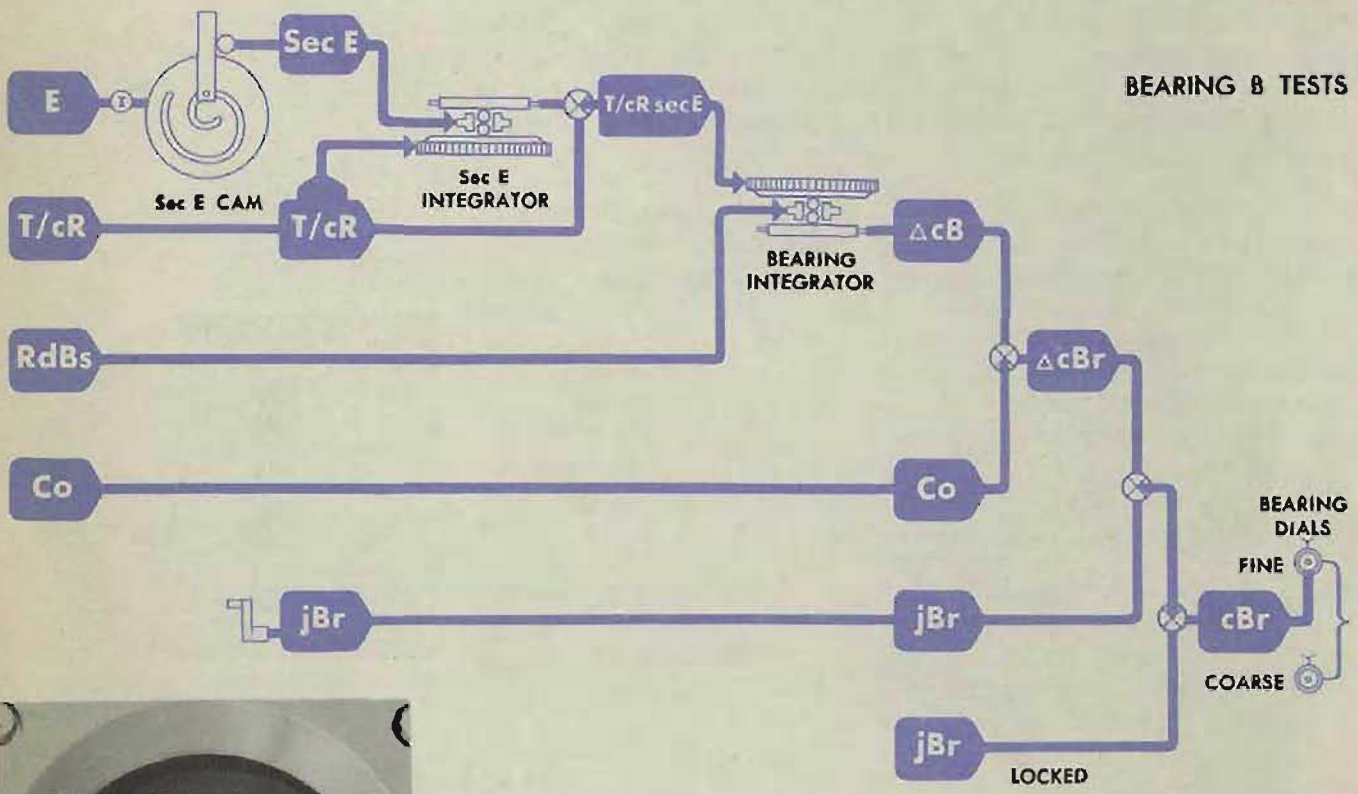
Reconnecting the range integrator

1. Carefully remove the bakelite wedge between the gear and the integrator casting.
2. Loosen clamp A-167. Lower the left gear gently until the gears mesh.
3. Tighten clamp A-167 carefully. Overtightening this clamp may snap the hardened roller output shaft.
4. Replace the plug in cover 1.

Gene Slover's US Navy Pages
Table of Contents

BEARING B TESTS

Disconnect the range integrator or establish a zero range rate. Select a reference index on the fine generated bearing dial and mark it as described in elevation B tests. Set the computer dials at the values specified on the bearing B test problem setup form, being especially careful to set cR and E accurately.



Running the bearing tests

Run the bearing B tests, following the procedure used in elevation B tests.

In bearing B tests it is especially important to start and stop the time line gradually because of the added inertia of the bearing filter.

The bearing dial readings are entered on the record form for problem results, and the problem average and maximum errors are calculated in the same way as the elevation errors. The summary average and summary maximum rate errors are then compared with the given allowable errors.

Reconnect the range integrator if it is disconnected. If it is not disconnected, put the dR handcrank back to AUTO.

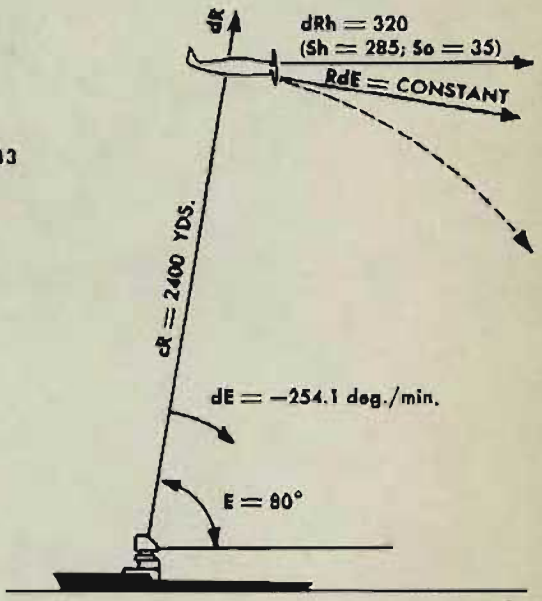
Gene Slover's US Navy Pages Table of Contents

Typical B test problems

The B test problems are designed to test the integrators and do not represent problems encountered in normal operation. Here are diagrams of three typical B test problems: one for range, one for elevation, and one for bearing.

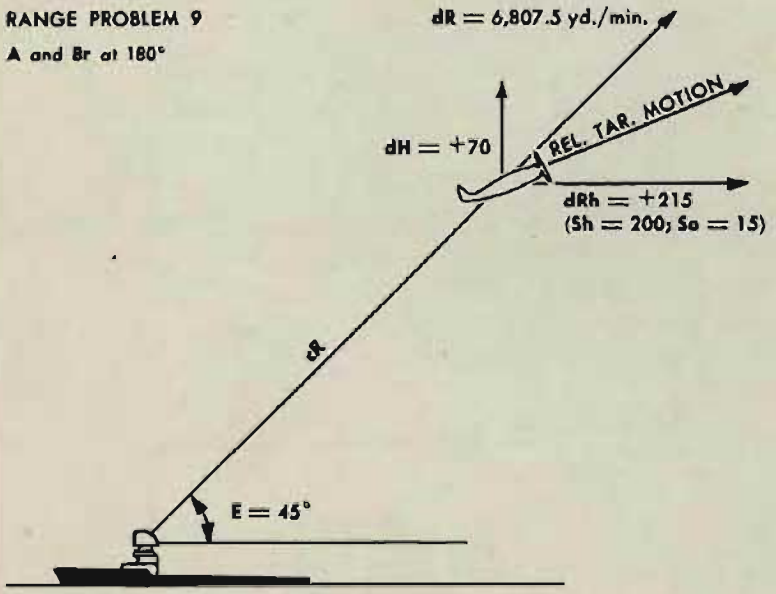
ELEVATION PROBLEM 13

A and Br at 180°
dH = 0



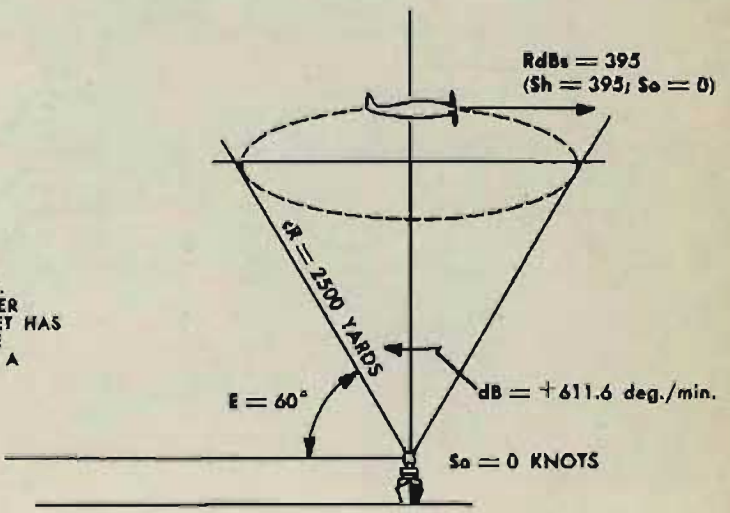
RANGE PROBLEM 9

A and Br at 180°



BEARING PROBLEM 33

TARGET CIRCLES OWN SHIP WHICH IS STATIONARY. TARGET SPEED 395 KNOTS. TARGET BEARING INCREASES 611° 36' PER MINUTE. AT END OF 3 MINUTES TARGET HAS COMPLETED SLIGHTLY MORE THAN FIVE REVOLUTIONS AROUND OWN SHIP AT A CONSTANT ELEVATION.



C TESTS

What C tests check

The C tests are dynamic tests—that is, running tests. They check the accuracy of the integrator group outputs over a period of time during which the integrator group inputs are continuously changing. The time motor is ON during these tests. The time line drives the integrators, which generate changes of range, elevation, and bearing.

C tests check the adjustment and operation of the mechanisms which compute the relative motion rates and generate the changes of range, elevation, and bearing.

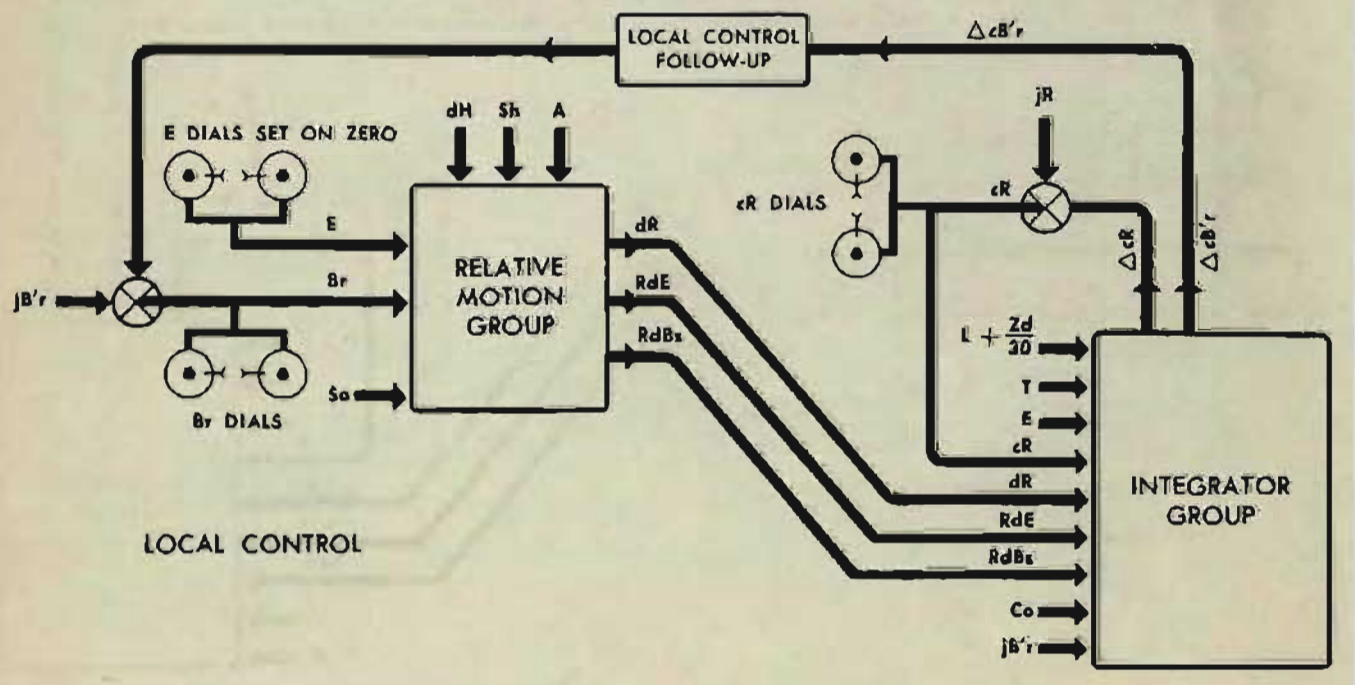
The two types of C test problems

There are two sets of C test problems:

Four problems testing the computer in local control.
Ten problems testing the computer in semi-automatic control.

Problems testing the computer in local control

C test problems 1 through 4 are run in local control. They are surface problems. Elevation is set at 0°00′, and only changes of range and bearing are tèsted.



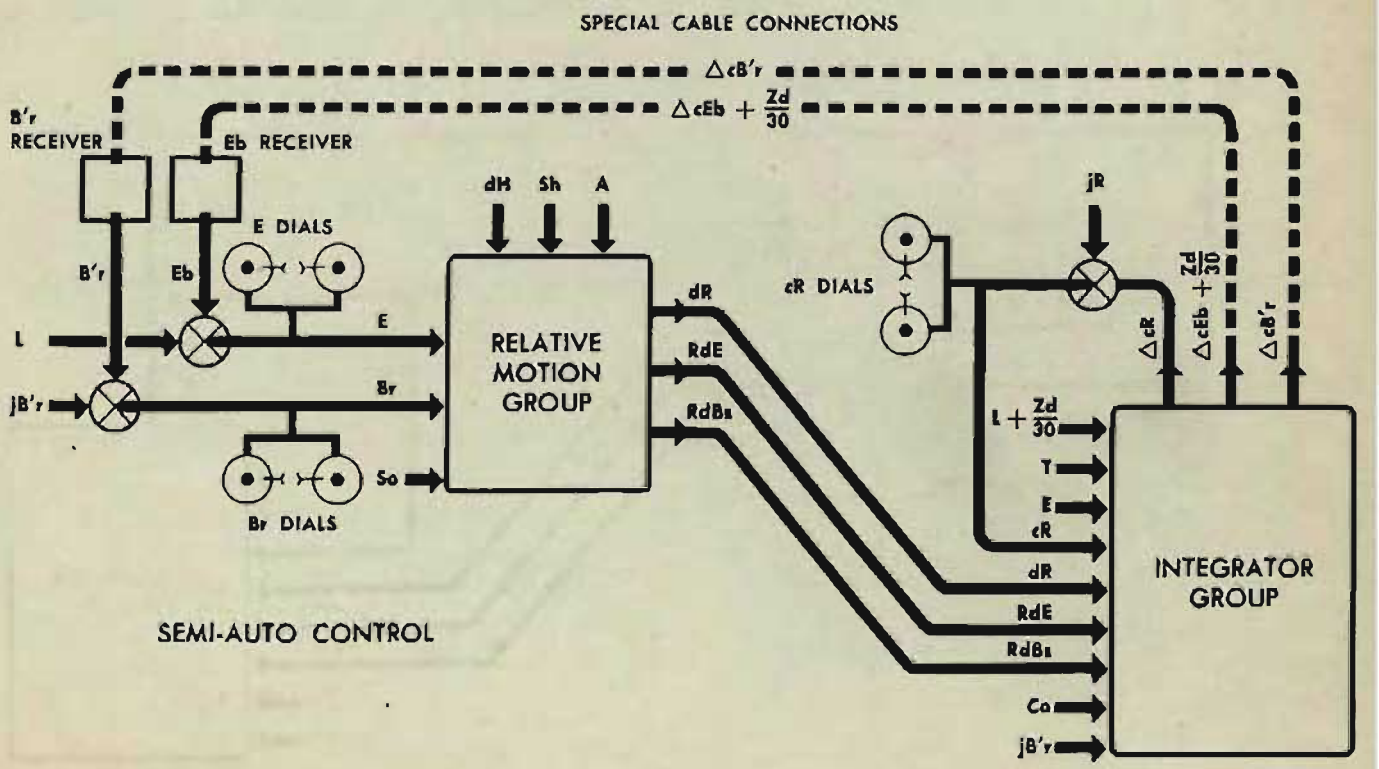
Gene Slover's US Navy Pages
Table of Contents

Problems testing the computer in semi-automatic control

Problems 5 through 14 are run in semi-auto control. Two of these are surface problems, and the remainder are air problems.

Special electrical connections are needed to run the problems in semi-auto control.

At the discretion of the gunnery officer, these problems may be run as a system test, using the director instead of the special connections. When the director is used, the test merely constitutes a check of the system, because the errors are not entirely chargeable to the Computer Mark 1. Such errors may be greater than the limits allowed for the computer alone, even though the computer is in satisfactory condition.



Gene Slover's US Navy Pages

Table of Contents

C TEST RECORD FORMS

All the information necessary for running the C test problems is given on the C test problem record forms ORD SK 104371—43 to 50 inclusive.

There are two C test summary record forms: one for problems 1 through 4, on which only bearing and range errors are recorded; and another for problems 5 through 14, on which bearing, elevation, and range errors are recorded.

All C test record forms should be filled out completely, dated, and filed for future reference.

PROBLEM RECORD FORM

C TEST PROBLEM 2

TIME	BEARING			RATE ERRORS		RANGE			RATE ERRORS	
	CALC.	READ.	ERROR	DIFF. ERROR	ERROR / TIME	CALC.	READ.	ERROR	DIFF. ERROR	ERROR / TIME
MINUTES SECONDS	DEGREES MINUTES	DEGREES MINUTES	MINUTES	MINUTES PER MIN.	MINUTES PER MIN.	YARDS	YARDS	YARDS	YARDS PER MIN.	YARDS PER MIN.
0:00	180°00'	180°00'	0			5000	5000	0		
0:30	180°00'					5338				
1:00	180°00'					5676				
1:30	180°00'					6013				
2:00	180°00'					6351				
2:30	180°00'					6689				
3:00	180°00'					7027				
3:30	180°00'					7364				
4:00	180°00'					7702				
4:30	180°00'					8040				
5:00	180°00'					8378				
SUM						SUM				
AVERAGE						AVERAGE				
MAXIMUM						MAXIMUM				

SET: L at 2000' Zd at 2000' E at 0° A at 180°
dH at 10 KNOTS Sh at 10 KNOTS Go at 90° So at 10 KNOTS
Br and cR at INITIAL VALUES
CONTROL SWITCH at LOCAL
SYNCHRONIZE ELEVATION HANDCRANK at CENTER

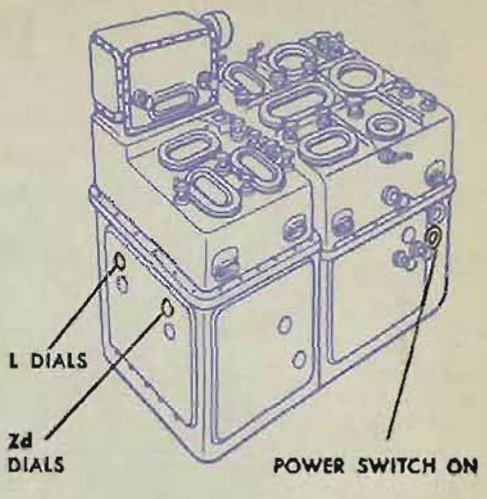
SUMMARY RECORD FORM

SUMMARY OF RESULTS

PROBLEM NO.	BEARING RATE ERRORS Minutes per minute				RANGE RATE ERRORS Yards per minute			
	DIFFERENCE ERROR		ERROR / TIME		DIFFERENCE ERROR		ERROR / TIME	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
1								
2								
3								
4								
SUM		—		—		—		—
AVERAGE		—		—		—		—
MAXIMUM	—		—		—		—	
ALLOWABLE AVG.	25	—	25	—	30	—	30	—
ALLOWABLE MAX.	—	75	—	75	—	90	—	90

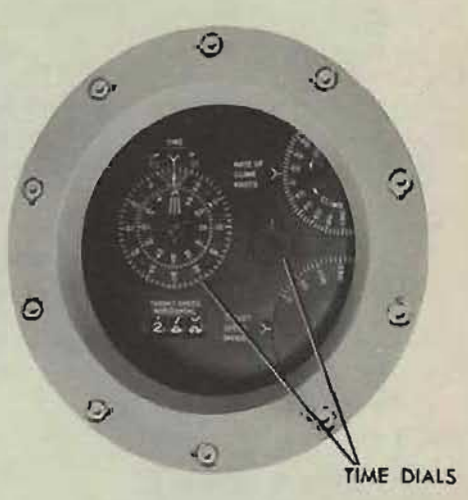
Gene Slover's US Navy Pages Table of Contents

PRELIMINARY SETUP FOR ALL C TEST PROBLEMS



1 Turn the power switch ON.
2 Set level, *L*, at 2000′ on the computer dials.
3 Set cross-level, *Zd*, at 2000′ on the computer dials.
4 Set the time dials on 0.

Time in C tests is the same as time in B tests. It is represented by the revolutions of the time line as registered on the time dials.

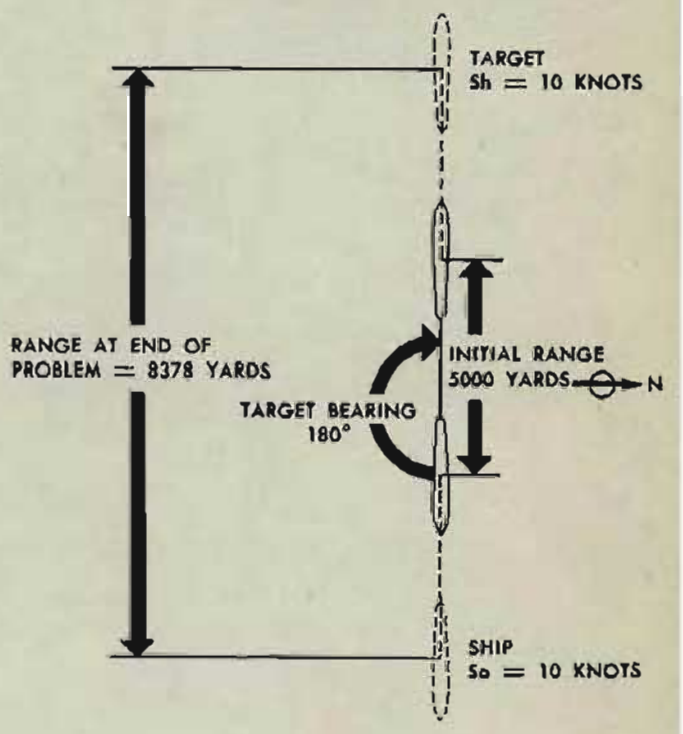


Each problem begins at the moment that the time dials move off 0.

The speed of the time line must be worked up gradually with the time crank OUT, before the time motor switch is turned ON.

If the time line is not turning at approximately normal running speed when the time motor is turned ON, excessive slippage may occur in the integrators before the inertia of the line is overcome.

If the time dials are turned beyond the required reading, do not turn them back. Set the time dials on 0 and repeat the problem. Turning the time line backward may damage the time motor regulator, and will introduce additional errors in the tests.



C TEST PROBLEM 2

Gene Slover's US Navy Pages
Table of Contents

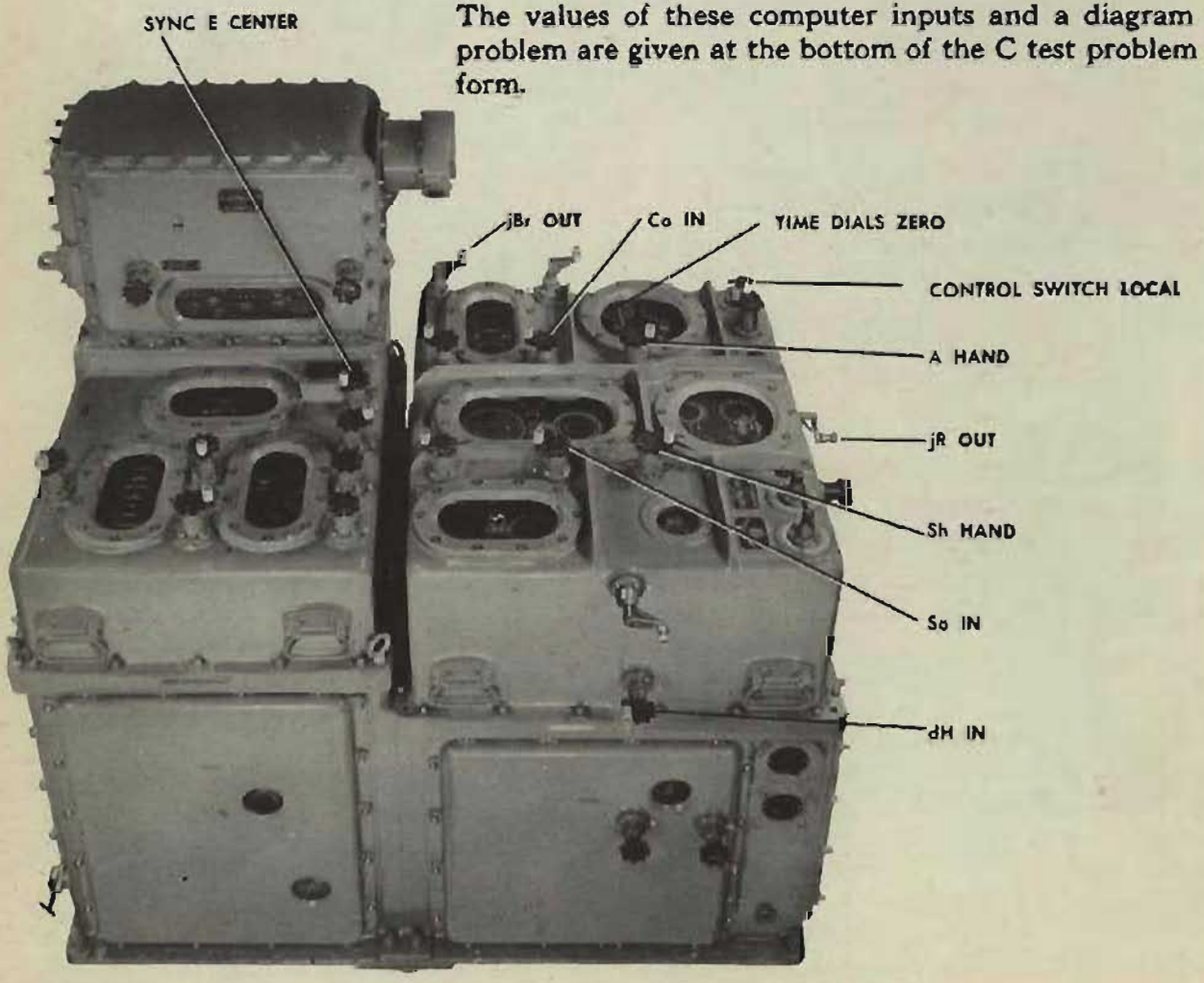
PROBLEMS 1 THROUGH 4

Problems 1 through 4 are surface problems which test the group of mechanisms that generate changes of range and bearing.

Setting up the computer for problem 1

1. Check that the time dials are on 0.
2. Turn the control switch to LOCAL.
3. Set *E* at 0°00′ with the sync *E* handcrank in the CENTER position. The handcrank should remain in the CENTER position throughout the problems.
4. Set *dH* at 0, with the rate of climb handcrank IN.
5. Put the ship course handcrank IN.
6. Set initial *jBr* on 284°00′, with the generated bearing crank OUT.
7. Set *A* at 14°, with the target angle handcrank at HAND.
8. Set *Sh* at 30 knots, with the target speed handcrank at HAND.
9. Set *So* at 30 knots, with the ship speed handcrank IN.
10. Set initial *cR* at 14,000 yards, with the generated range crank OUT.

The values of these computer inputs and a diagram of the problem are given at the bottom of the C test problem record form.



Gene Slover's US Navy Pages Table of Contents

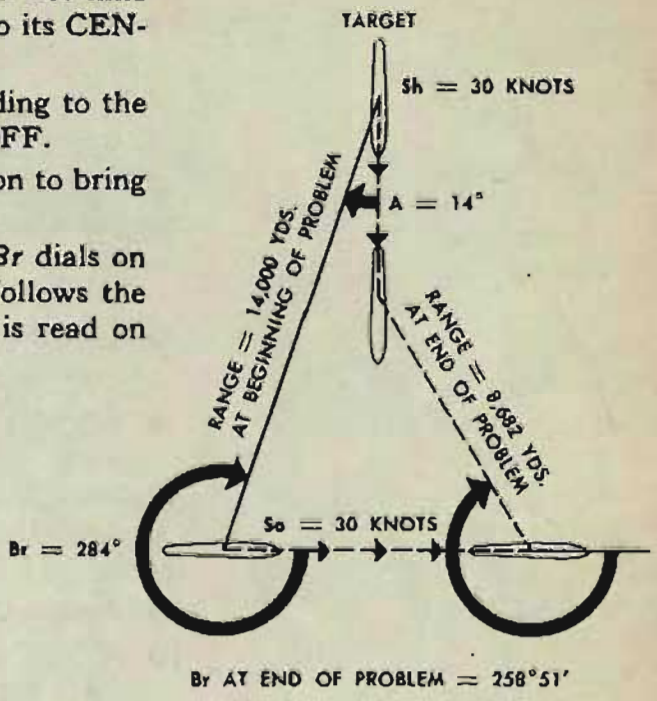
Running problem 1

1 Gradually work up speed in the time motor by turning the time crank in the OUT position. Then turn the time motor switch ON and return the time crank to its CENTER position.

2 Run the problem for about 25 seconds according to the time dials. Then turn the time motor switch OFF.

3 Slowly turn the time crank in the OUT position to bring the time dials to a stop at exactly 30 seconds.

4 Record the readings of the *cR* dials and the *Br* dials on the problem form. In all C tests the *Br* dial follows the movement of the *cBr* dial; therefore bearing is read on the *Br* ring dials against the fixed index.



C TEST PROBLEM 1

Continue the problem until the time dial reading is 1:00 minute, and then record the second set of readings. Complete the problem and record the dial readings at each time interval specified on the problem record form.

Problems 2, 3, and 4 are run and recorded in the same way.

TIME	BEARING Br					RANGE cR				
	CALC.	READ.	ERROR	RATE ERROR MIN./MIN.		CALC.	READ.	ERROR	RATE ERROR YDS./MIN.	
MIN. & SEC.	DEG. & MIN.	DEG. & MIN.	MIN.	DIFF. ERRORS	ERROR / TIME	YDS.	YDS.	YDS.	DIFF. ERRORS	ERROR / TIME
C TEST NO. 1										
0:00	284°0'	284°0'	0			14000	14000	0		
0:30	282°25'					13391				
1:00	280°42'					12793				
1:30	278°48'					12208				
2:00	276°43'					11637				
2:30	274°25					11084				
3:00	271°53'					10550				
3:30	269°5'					10039				
4:00	266°0'					9554				
4:30	262°36'					9100				
5:00	258°51'					8682				
TOTAL						TOTAL				
AVG. RATE ERROR						AVG. RATE ERROR				
MAX. RATE ERROR						MAX. RATE ERROR				

Gene Slover's US Navy Pages
Table of Contents

COMPUTING ERRORS IN C TESTS

The mechanisms that generate changes in range and bearing are in satisfactory adjustment when the errors come within the allowable limits given on the C test summary record form for problems 1 through 4.

The errors are the differences between the recorded readings of *cR* and *Br* and the mathematically calculated values of *cR* and *Br*.

The allowable limits are based on average and maximum rate errors.

Errors

These errors are obtained by algebraic subtraction. The calculated value is subtracted from the observed reading. It is necessary to record the signs of the errors, because they are used in computing the difference errors and also in analyzing excessive errors.

Rate errors

There are two types of rate errors in C tests, difference errors and error/time rate errors.

A difference error is the difference between the errors for readings taken one minute apart. Where readings are taken at 30-second intervals, the first difference error to be recorded is the difference between the error at the start of the problem and the error at the second reading, which is after a one-minute interval. The second difference error is the difference between the error at the first reading and the third reading.

TIME	BEARING Br					RANGE cR				
	CALC.	READ.	ERROR	RATE ERROR MIN./MIN.		CALC.	READ.	ERROR	RATE ERROR YDS./MIN.	
MIN. & SEC.	DEG. & MIN.	DEG. & MIN.	MIN.	DIFF. ERRORS	ERROR / TIME	YDS.	YDS.	YDS.	DIFF. ERRORS	ERROR / TIME
C TEST NO. 1										
0:00	284°0'	284°0'	0			14000	14000	0		
0:30	282°25'					13391				
1:00	280°42'					12793				
1:30	278°48'					12208				
2:00	276°43'					11637				
2:30	274°26'					11084				
3:00	271°53'					10550				
3:30	269°5'					10039				
4:00	266°0'					9554				
4:30	262°36'					9100				
5:00	258°51'					8682				
TOTAL						TOTAL				
AVG. RATE ERROR						AVG. RATE ERROR				
MAX. RATE ERROR						MAX. RATE ERROR				

Gene Slover's US Navy Pages Table of Contents

The error/time rate error is computed by dividing the error by the time *in minutes* that has elapsed since the beginning of the problem.

Average errors

The average error for the problem is computed by adding each column of rate errors and dividing the sum by the number of rate errors recorded.

Maximum errors

The maximum error is the largest error of each group.

Compute the errors for each of the first four problems. Record the problem averages and maximums on the C test summary record form for problems 1 through 4. Compute and record the sums and averages and record the maximum in each column; compare these results with the allowable averages and maximum given.

The four surface problems are satisfactory when:

average bearing rate errors are below 25,
maximum bearing rate errors are below 75,
average range rate errors are below 30,
maximum range rate errors are below 90.

If the errors exceed the allowable limits, refer to the chapter on C test analysis to locate and correct the errors.

SUMMARY OF RESULTS

PROBLEM NO.	BEARING RATE ERRORS Minutes per minute				RANGE RATE ERRORS Yards per minute			
	DIFFERENCE ERROR		ERROR / TIME		DIFFERENCE ERROR		ERROR / TIME	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
1								
2								
3								
4								
SUM		—		—		—		—
AVERAGE		—		—		—		—
MAXIMUM	—		—		—		—	
ALLOWABLE AVG.	25	—	25	—	30	—	30	—
ALLOWABLE MAX.	—	75	—	75	—	90	—	90

Gene Slover's US Navy Pages
Table of Contents

PROBLEMS IN SEMI-AUTO CONTROL

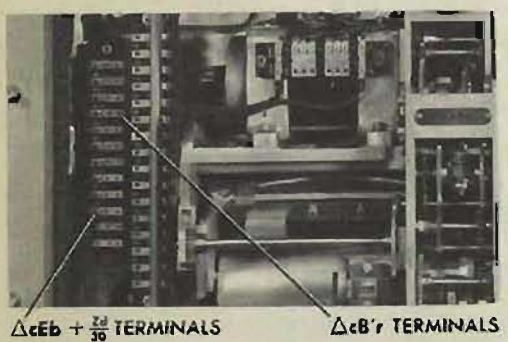
Without using the director

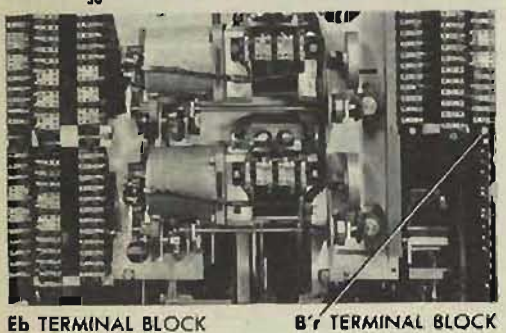
In local control the observed and the generated dials turn together. It is possible to read the initial value plus the generated changes on the observed dials. In semi-auto control the observed and generated dials do not turn together. The generated changes are transmitted to the director where they correct the initial values. The initial value plus the generated changes then registers on the observed dials.

C test problems 5 through 14 are run in semi-automatic control. In normal semi-automatic operation, the computer outputs transmitted to the director change the computer inputs received from the director. In order to eliminate the director, the computer is made regenerative; that is, the computer outputs are fed back directly into the computer inputs. Special test cable connections are used for this purpose.

These cable connections allow generated bearing and elevation to be transmitted directly to the bearing and elevation receivers. No special range connections are needed, since range is regenerative within the computer.

The transmitters and receivers must be disconnected from the director before the special cable connections can be made.





Disconnecting director wiring

1 Disconnect the ship's wiring from the stators of both the bearing correction and the elevation correction indicating transmitters.

2 Disconnect the ship's wiring from the coarse and fine stators of the director train and the director elevation receivers.

Do *not* disconnect the ship's wiring to the rotor supply, because the transmitter and receiver synchros can be energized at the fire control switchboard only if the rotor wiring is connected.

Wiring designation charts inside covers 4 and 7 will indicate which wires should be disconnected from the terminal blocks.

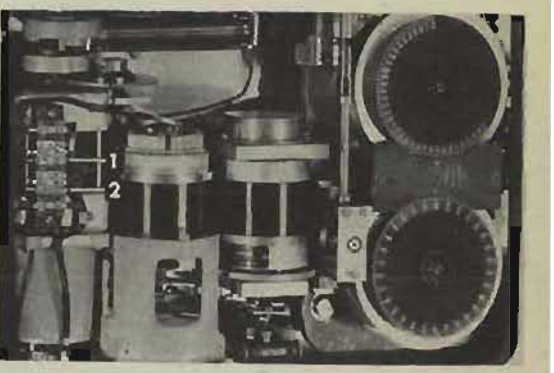
Gene Slover's US Navy Pages
Table of Contents

Only the fine receivers should be connected. The coarse controls must therefore be de-energized.

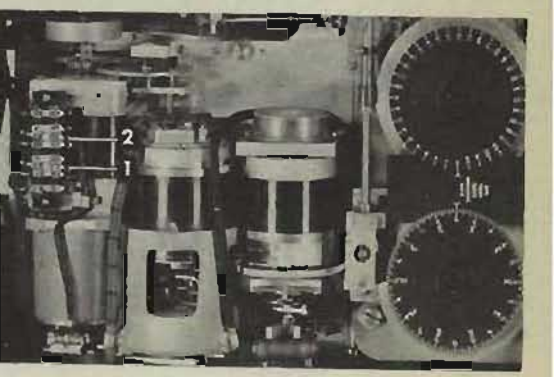
1 Disconnect leads 1 and 2 on the director train and director sight elevation receivers.

2 Place a small rubber band around the outer edge of the scissor arms of each coarse control to keep the interrupter contacts closed throughout the test.

Eb LEADS AND TERMINALS



Er LEADS AND TERMINALS



Making the cable connections

Use jumpers to connect the bearing correction indicating transmitter to the director train receiver:

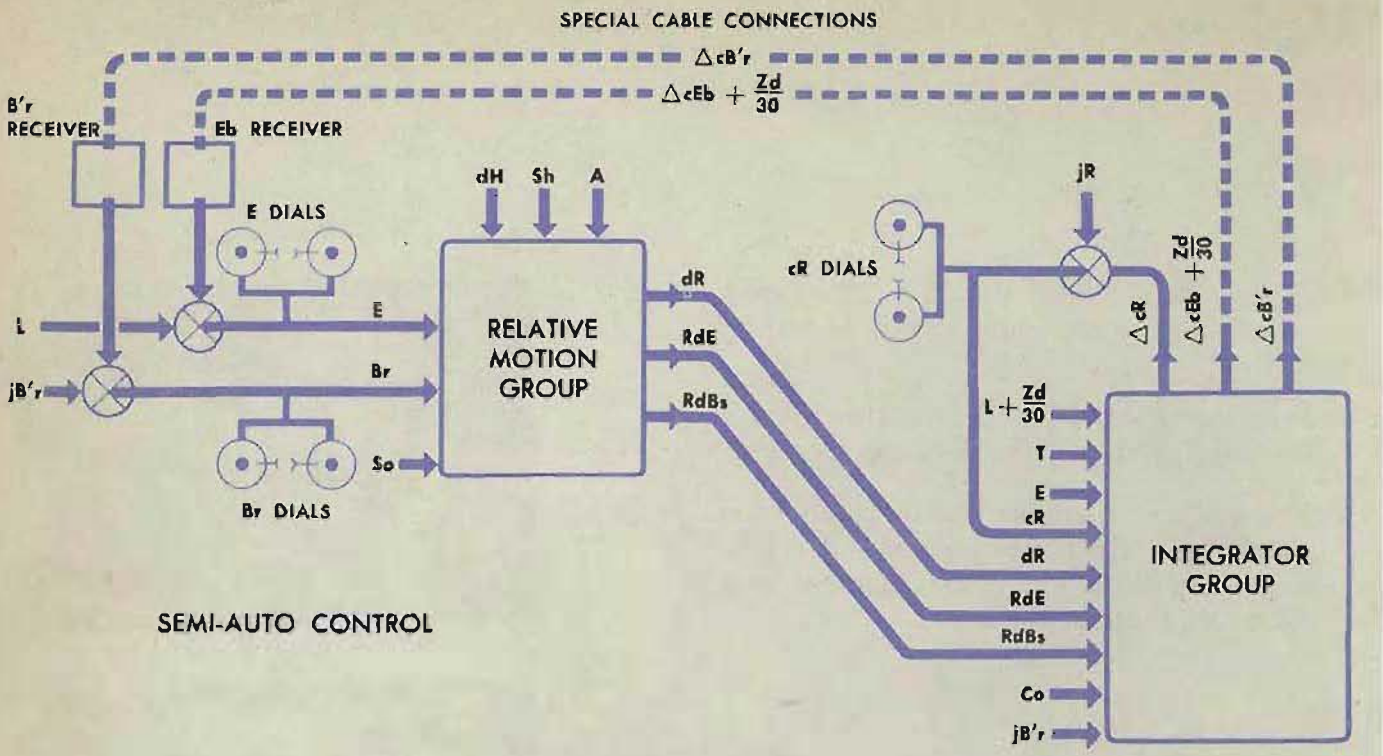
Connect S1 to S3 FINE
Connect S2 to S2 FINE
Connect S3 to S1 FINE

NOTE:
Since the rotors of the two motors which are to be connected turn in opposite directions, the connections are reversed.

Connect the elevation correction indicating transmitter to the director sight elevation receiver:

Connect S1 to S1 FINE
Connect S2 to S2 FINE
Connect S3 to S3 FINE

Gene Slover's US Navy Pages
Table of Contents



PROBLEMS 5 THROUGH 14

The computer is regenerative when the elevation and bearing cable connections are made.

The sum of integrator outputs and initial values can be read directly on the range, elevation, and bearing dials. In this way, the tracking section is tested.

During the tests the time line is turned by the time motor and the time crank, as previously explained. Readings of the range, elevation, and bearing dials are recorded at given time intervals. The readings are then compared to the calculated values on the problem record forms.

TIME	BEARING Br					ELEVATION E					RANGE cR				
	CALC.	READ.	ERR.	RATE ERROR MIN./MIN.		CALC.	READ.	ERR.	RATE ERROR MIN./MIN.		CALC.	READ.	ERR.	RATE ERROR YDS./MIN.	
MIN. & SEC.	DEG. & MIN.	DEG. & MIN.	MIN.	DIFF. ERRORS	ERROR TIME	DEG. & MIN.	DEG. & MIN.	MIN.	DIFF. ERRORS	ERROR TIME	YDS.	YDS.	YDS.	DIFF. ERRORS	ERROR TIME
C TEST NO. 5															
0:00	0°0'	0°0'	0			0°0'	0°0'	0			14000	14000	0		
0:30	0°0'					0°0'					12818				
1:00	0°0'					0°0'					11636				
1:30						0°0'					10453				
						0°0'					271				
3:30	0°0'														
4:00	0°0'										4542				
4:30	0°0'					0°0'					3360				
TOTAL						TOTAL					TOTAL				
AVG. RATE ERROR						AVG. RATE ERROR					AVG. RATE ERROR				
MAX. RATE ERROR						MAX. RATE EPROR					MAX. RATE ERROR				

Gene Slover's US Navy Pages Table of Contents

PRELIMINARY SETUP FOR PROBLEMS 5 THROUGH 14

1 Turn the power ON.

2 Energize the bearing and elevation correction transmitters at the switchboard.

3 Energize the *Eb* and *B'r* receivers at the switchboard.

4 Set *L* and *Zd* at 2000'.

Setting up the computer for problem 5

1 Set *Co* at 270°, with the ship course handcrank in the IN position.

2 Set *Br* on 0°00' as follows:
- **a** Turn the control switch to LOCAL. Turn the generated bearing crank in the OUT position until *Br* reads 0°00'.
- **b** Turn the control switch to SEMI-AUTO. The bearing dials will run off the setting by some amount up to 5°.
- **c** Offset *Co* enough to reposition the bearing dials on the setting.

NOTE: The value of *Co* actually has no effect on C test problems.

3 Set *E* at 0°00' as follows:
- **a** Turn the sync *E* handcrank in the CENTER position until *E* is set at 0°00'.
- **b** Pull the sync *E* handcrank to the OUT position. Match the sync *E* dials at the index.
- **c** Turn the power OFF.
- **d** Push the sync *E* handcrank to the IN position.
- **e** Turn the power ON.
- **f** The elevation dials will run off the setting some amount up to 5°.
- **g** With the sync *E* handcrank still in the IN position, offset the sync *E* dials enough to reposition the elevation dials on the setting.

NOTE: The sync *E* dials should be approximately matched to prevent the *Eb* shaft line from running into its limit stop during the test.

4 Set *A* at 0°, with the target angle handcrank in the HAND position.
NOTE: Target angle must be set at the initial value as accurately as possible to obtain satisfactory C test results.

5 Set *Sh* at 40 knots, with the target speed handcrank in the HAND position.

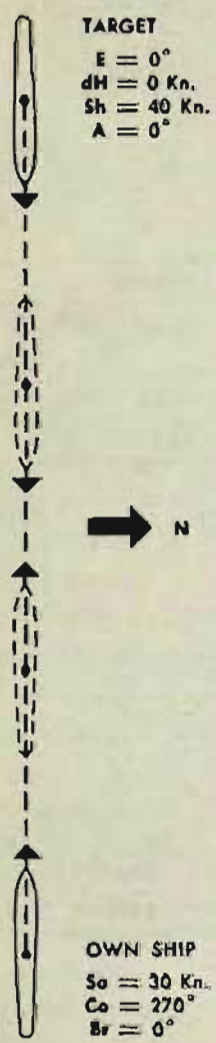
6 Set *dH* at 0 knots, with the rate of climb handcrank in the IN position.

7 Set *So* at 30 knots, with the ship speed handcrank in the IN position.

8 Set *cR* at 14,000 yards, with the generated range crank in the OUT position.

Gene Slover's US Navy Pages
Table of Contents

Running problem 5



1 Gradually work up speed in the time motor by turning the time crank in the OUT position.

2 Turn the time motor switch ON. Return the time crank to the CENTER position.

3 Run the problem for about 25 seconds according to the time dials. Then turn the time motor switch OFF.

4 Slowly turn the time crank in the OUT position, bringing the time dials to a stop at exactly 30 seconds. Record the readings of the *cR*, *Br*, and *E* dials on the problem record form.

Continue the problem until readings have been recorded for each time dial reading given. Compute the errors and rate errors of each quantity tested. Run problems 6 through 14 in the same manner.

Setting up and running problem 14

In this problem, changes occur in all three generated values: bearing, elevation, and range. In problem 5, a surface problem, elevation remains constant.

To set up problem 14, set in the initial values given on the C test record form for problem 14. Use the same switches and handcranks in the positions described for problem 5.

Run problem 14 in the same manner as problem 5 and compute the errors.

COMPUTING THE ERRORS

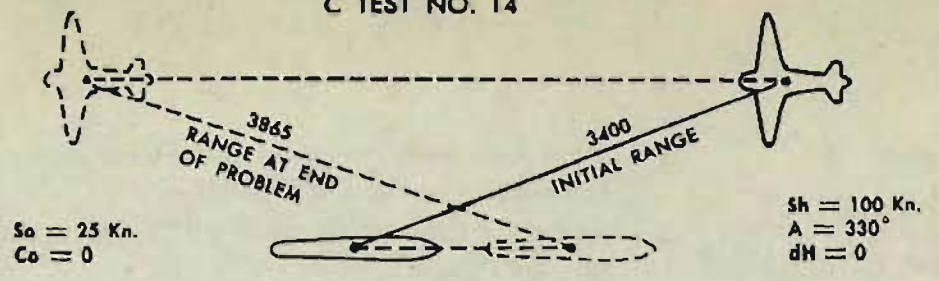
Record the average and maximum errors for each problem on the C test summary record form for problems 5 through 14.

Compute the overall (summary) averages and maximums for all problems in the manner described for problems 1 through 4. Compare these errors with the allowable limits.

If the average and maximum errors exceed the allowable limits given on the summary record form, refer to the chapter on C test analysis.

Gene Slover's US Navy Pages Table of Contents

C TEST NO. 14



	BEARING Br					ELEVATION E					RANGE cR				
TIME MIN. & SEC.	CALC. DEG. & MIN.	READ. DEG. & MIN.	ERR. MIN.	DIFF. ERR. MIN./MIN.	ERR. TIME	CALC. DEG. & MIN.	READ. DEG. & MIN.	ERR. MIN.	DIFF. ERR. MIN./MIN.	ERR. TIME	CALC. YDS.	READ. YDS.	ERR. YDS.	DIFF. ERR. YDS./MIN.	ERR. TIME
0:00	330°00'	330°00'	0			10°00'	10°00'	0			3400	3400	0		
0:10	322°41'					12°04'					2825				
0:20	311°43'					14°45'					2319				
0:30	295°13'					17°42'					1943				
0:40	272°54'					18°24'					1777				
0:50	249°43'					18°18'					1880				
1:00	231°42'					16°28'					2214				
1:10	219°34'					12°40'					2694				
1:20	211°31'					10°27'					3255				
1:30	206°00'					8°47'					3865				
	TOTAL					TOTAL					TOTAL				
	AVG. RATE ERROR					AVG. RATE ERROR					AVG. RATE ERROR				
	MAX. RATE ERROR					MAX. RATE ERROR					MAX. RATE ERROR				

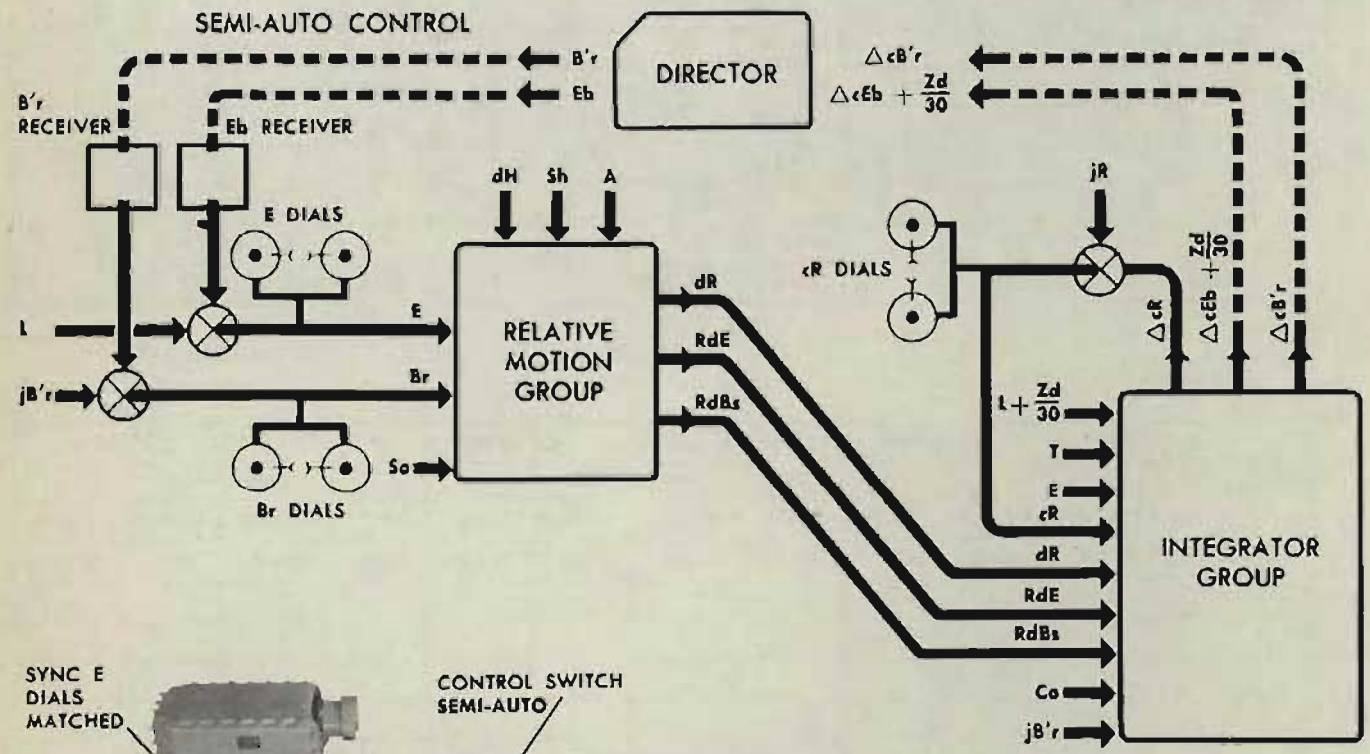
C TEST NO.	BEARING RATE ERRORS MIN./MIN.				ELEVATION RATE ERRORS MIN./MIN.				RANGE RATE ERRORS MIN./MIN.			
	DIFF. ERRORS		ERROR/TIME		DIFF. ERRORS		ERROR/TIME		DIFF. ERRORS		ERROR/TIME	
	AVG.	MAX.	AVG.	MAX.	AVG.	MAX.	AVG.	MAX.	AVG.	MAX.	AVG.	MAX.
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
OVERALL AVG. & MAX. RATE ERRORS, C TESTS 5-14												
ALLOW. OVER-ALL	33	99	33	99	33	99	33	99	30	90	30	90

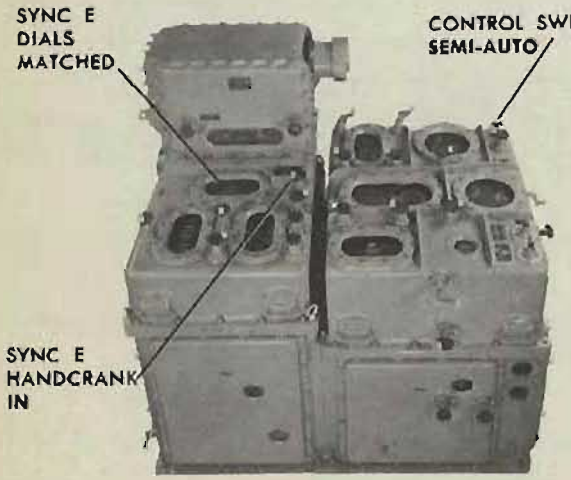
RUNNING THE PROBLEMS AS A SYSTEM TEST

Relative target bearing, *Br*, and target elevation, *E*, are set into the computer by setting director train, *B'r*, and director sight elevation, *Eb*, at the director, with the selector lever in AUTO control. Director train and director sight elevation are transmitted electrically to the computer. All other inputs are set in by hand at the computer.

The system test checks the outputs from the integrator group as well as the transmission of bearing and elevation quantities between the director and the computer.

The time line is turned by the time crank and the time motor, as previously described. Readings on the range, elevation, and bearing dials are recorded at given time intervals. They are compared to the calculated values given on the problem record forms.





Preliminary setups for problems 5 through 14

To set up the computer for problems 5 through 14:

1. Turn the control switch to SEMI-AUTO.
2. Match the indexes on the sync *E* dials with the sync *E* handcrank in the IN position.
3. Set *L* and *Zd* at 2000'.

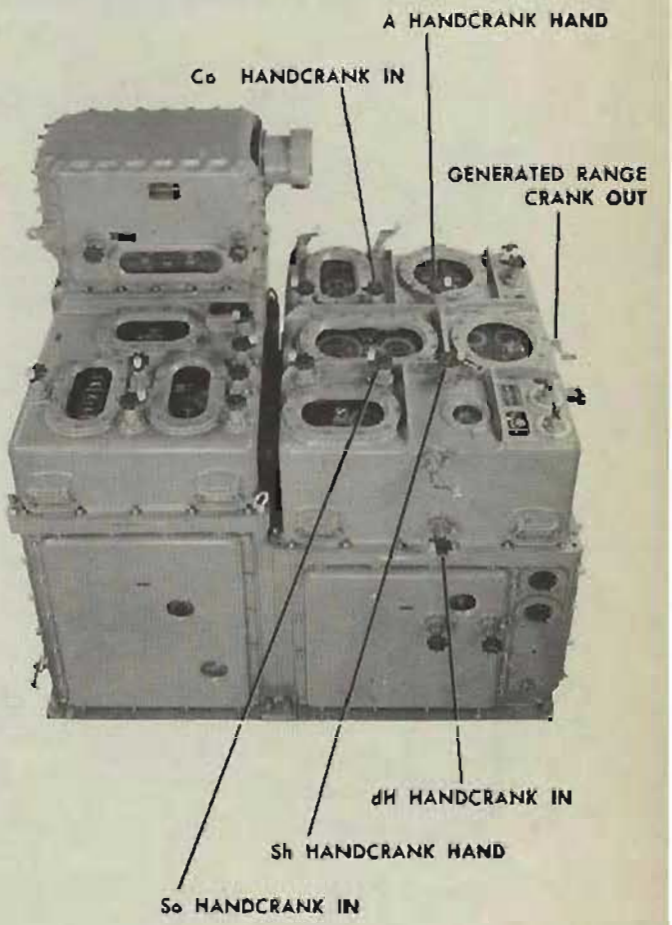
Gene Slover's US Navy Pages Table of Contents

Setting up the computer for problem 5

1 Set *Co* at 270°, with the ship course handcrank in the IN position.
2 Set elevation, *E*, on 0°00′ at the director.
3 Set relative target bearing, *Br*, on 0°00′, by setting director train, *B'r*, on 0°00′ at the director.
4 Set *A* at 0°, with the target angle handcrank in the HAND position.
5 Set *Sh* at 40 knots, with the target speed handcrank in the HAND position.
6 Set *dH* at 0 knots, with the rate of climb handcrank in the IN position.
7 Set *So* at 30 knots, with the ship speed handcrank in the IN position.
8 Set *cR* at 14,000 yards, with the generated range crank in the OUT position.

CAUTION:
The director handwheels must not be turned while these tests are run.

Run the problems and record the results in the manner previously described.



Computing errors

Record the average and maximum error for each problem on the C test summary record form for problems 5 through 14. Compute the summary averages and maximums for all problems in the manner described for the LOCAL CONTROL problems. Compare these summary errors with the allowable limits.

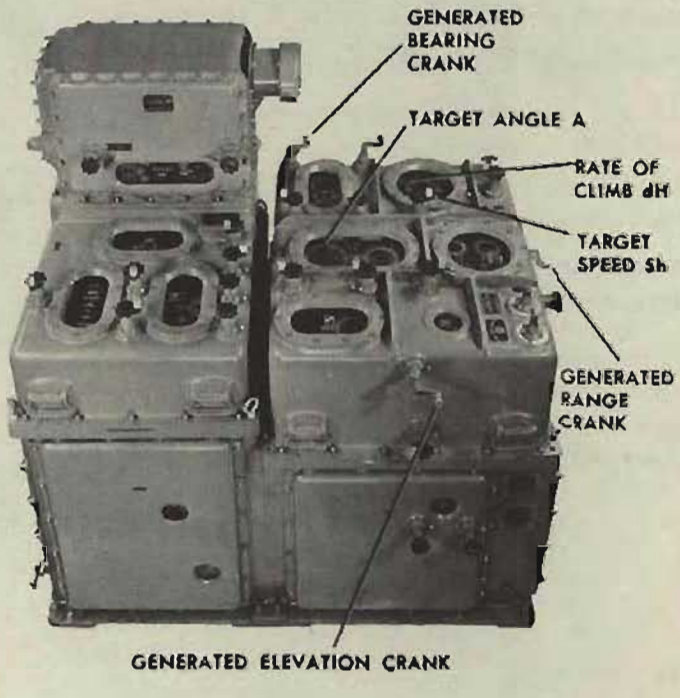
Note that the errors obtained from the system test include possible director and transmission errors in addition to any computer errors. The allowable limits on the summary record form *are based on errors occurring in the computer only*. Therefore, if the errors are *considerably beyond* the allowable limits, refer to the chapter on C test analysis.

Gene Slover's US Navy Pages
Table of Contents

RATE CONTROL TESTS

What is tested

The rate control tests are a means of checking the proper functioning of the rate control system. The mechanisms of this section correct the original estimates of target angle, *A*, target speed, *Sh*, and rate of climb, *dH*.



How the tests are run

Specified changes of generated range, generated elevation, and generated bearing are made in order to introduce computed rate corrections into the rate control mechanisms. The effect of these rate corrections on *A*, *Sh*, and *dH* is observed. The computed changes in these quantities are then compared with mathematically calculated changes.

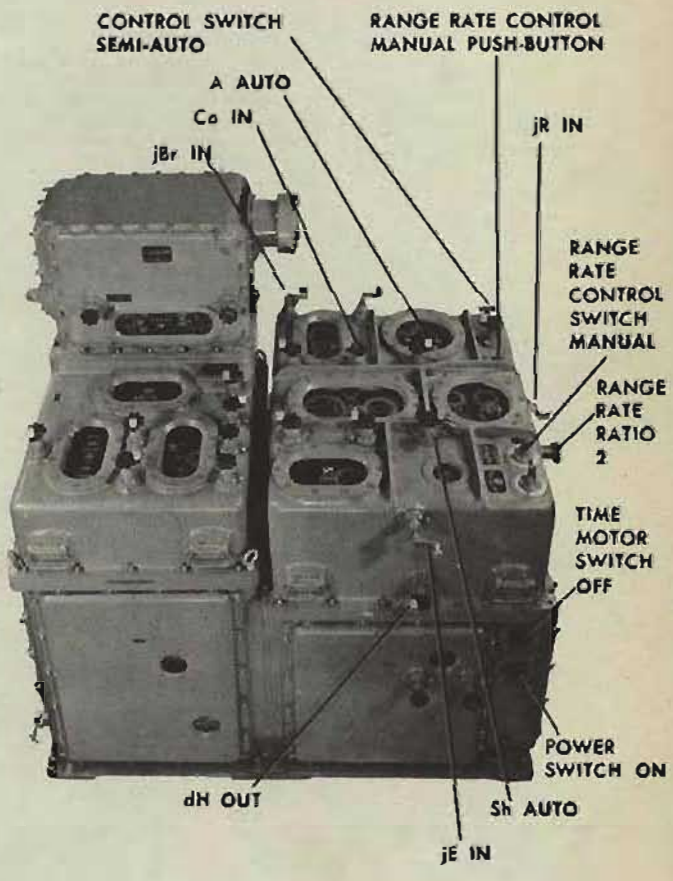
The rate control tests may be run either in semi-automatic or in automatic control. The necessary information and test data are given in the rate control test form, NAVORD Form 1229.

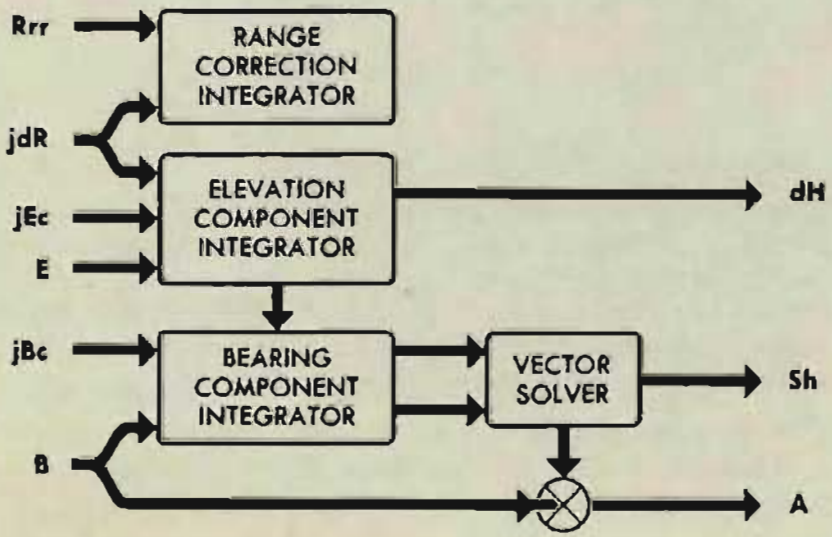
Gene Slover's US Navy Pages Table of Contents

SEMI-AUTO RATE CONTROL TESTS

1. Turn the power switch ON. Leave the time motor OFF.
2. Turn the control switch to SEMI-AUTO.
3. Turn the range rate control switch to MANUAL.
4. Put the target speed and target angle handcranks in AUTO.
5. Pull the rate of climb handcrank OUT.
6. Lock the generated range, generated elevation, and generated bearing cranks in the IN position.
7. Set the range rate ratio knob at 2. Make certain the knob is engaged. To check this, observe that the limit stop acts at 1 or 5.

In any range rate correction problem, the setting of the range rate ratio knob may be changed ±0.2 to reduce the error to the allowable limit.





Gene Slover's US Navy Pages
Table of Contents

Running the tests

Whenever changes of generated range are introduced, the range rate control manual push-button must be depressed.

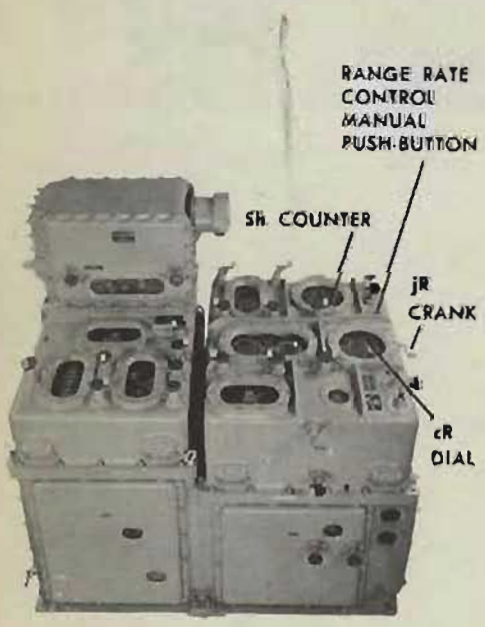
Changes of generated range, generated elevation, and generated bearing feed into the vector solver. These changes must be made *slowly* in order to obtain the full output of the limited *Sh* and *Ct* follow-ups.

OPERATION	E = 0°		E = 80°	
	A = 0°	A = 90°	A = 180°	A = 270°
INCREASE cR 450 YDS.	Sh DEC.	A INC.	dH INC.	dH INC.
DECREASE cR 450 YDS.	Sh INC.	A DEC.	dH DEC.	dH DEC.
INCREASE cE 2°00'	dH INC.	dH INC.	Sh DEC.	A INC.
DECREASE cE 2°00'	dH DEC.	dH DEC.	Sh INC.	A DEC.
INCREASE cBr 2°00'	A INC.	Sh INC.	A DEC.	Sh DEC.
DECREASE cBr 2°00'	A DEC.	Sh DEC.	A INC.	Sh INC.

THE RESULTING CHANGES IN Sh AND dH SHOULD BE 88 ± 5 KNOTS

Set *E* at 0°.
Set *A* at 0° by one of the following methods:

1. Depress the target course indicator INCREASE or DECREASE push-button.
2. Shift the target angle handcrank to HAND. Make the required setting. Then return the handcrank to the AUTO position.
3. Set *A* by rate-controlling.



To make computation easier, set *Sh* at either 200 or 300 knots by one of the following methods:

1. Set the target speed switch to increase or decrease *Sh*.
2. Shift the target speed handcrank to HAND. Make the required setting. Then return the handcrank to the AUTO position.
3. Set *Sh* by rate-controlling.

Making changes of generated range

Turn the generated range crank, *without* depressing the range rate control manual push-button, until *cR* reads some even value at the fixed index.

Read the *Sh* counter.

Depress the range rate control manual push-button and *slowly increase cR* 450 yards. *Sh* should decrease 88 (±5) knots.

Depress the manual push-button and *slowly decrease cR* 450 yards. *Sh* should increase 88 (±5) knots.

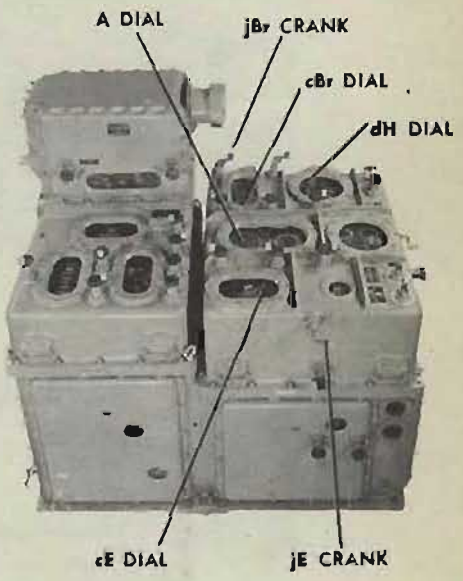
Gene Slover's US Navy Pages Table of Contents

Making changes of generated elevation

Pull the generated elevation crank OUT against spring pressure. Match one of the graduations of the inner fine elevation dial against the fixed index. Release the handcrank to its IN position.
Read the *dH* dial.
Slowly increase *cE* 2°00′, using the generated elevation handcrank in the IN position. *cE* is increasing when the inner fine dial turns clockwise.
dH should increase 88 (±5) knots.
Decrease *cE* 2°00′.
dH should decrease 88 (±5) knots.

Making changes of generated bearing

Pull the generated bearing crank OUT against its spring pressure. Match one of the graduations on the inner fine bearing dial against the fixed index. Release the handcrank to its IN position.
Target angle should be 0°.
Using the generated bearing crank in the IN position, *slowly increase cBr* 2°00′. *cBr* is increasing when the inner fine dial turns counterclockwise.
Target angle should increase.
Decrease *cBr* 2°00′.
Target angle should decrease.



Set *A* at 90°.
At this new value of *A*, again increase and decrease generated range, generated elevation, and generated bearing in the manner described. The resulting changes in *dH*, *A* and *Sh* should correspond to the changes indicated on the test form.

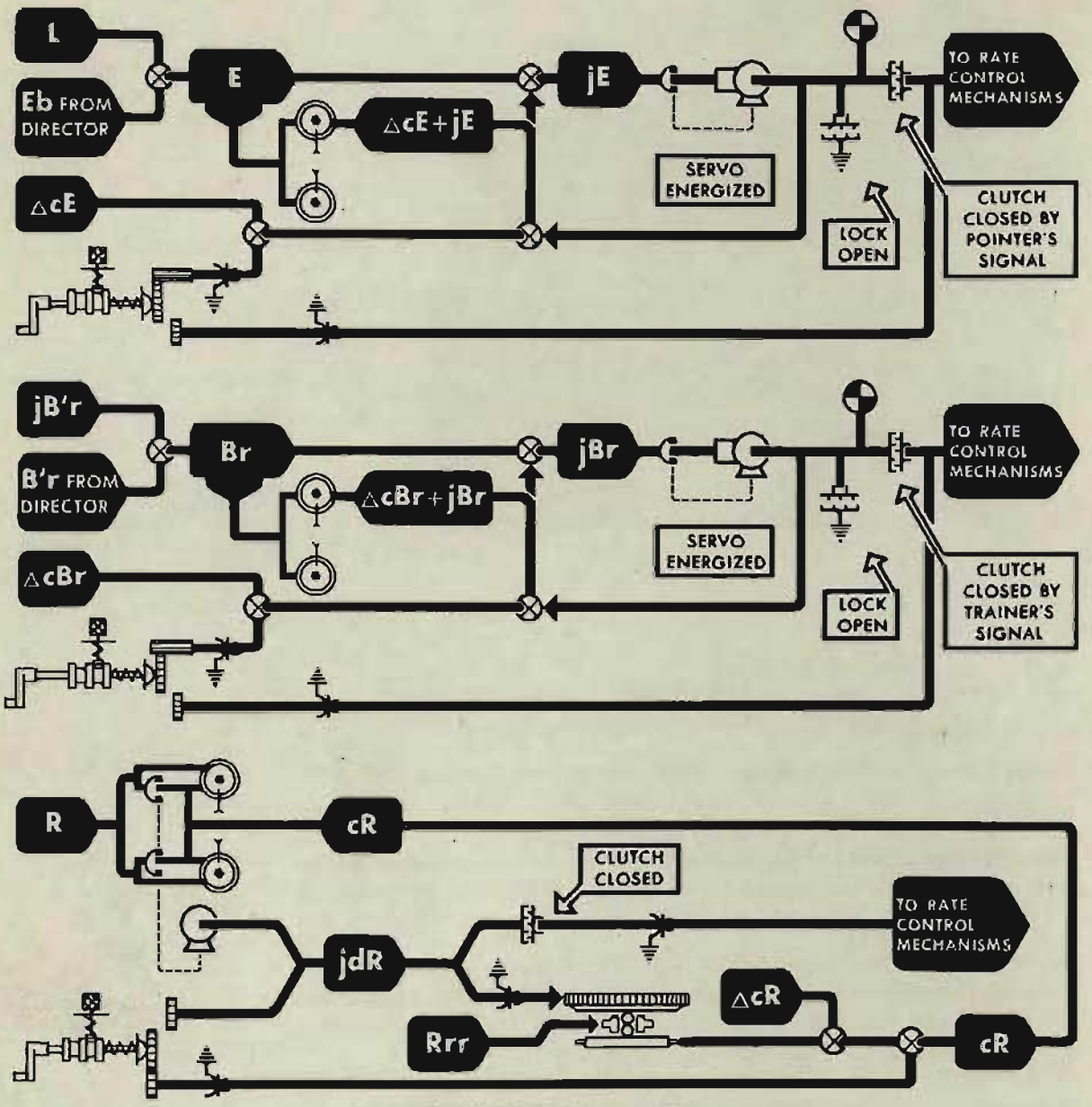
Change elevation to 80°.
Set *A* at 180°, and 270°.
At each of these values of *A*, increase and decrease generated range, generated elevation, and generated bearing in the manner described. The resulting changes will be different from the changes in the tests in which *E* was set at 0°. Also, with *E* at 0°, only one value changes at a time; with *E* at 80°, other values, as well as those listed, may drive off slightly.

No specific change in target angle is given.
To check the changes in *A*, use the following setup:
Set *A* at 90° and *E* at 0°.
Set *Sh* at 200 knots.
Slowly increase *cR* 450 yards, with the manual push-button depressed.
A should increase about 22°.
Slowly decrease *cR* 450 yards.
A should decrease about 22°.

Gene Slover's US Navy Pages
Table of Contents

AUTOMATIC RATE CONTROL

An automatic rate control test should be run to check the *jE* and the *jBr* locks, clutches, and motors, and the electrical connections between the director signal keys and the computer. Introduce the changes in generated range, elevation, and bearing at the director. Observe the changes in *A*, *Sh*, and *dH* at the computer.



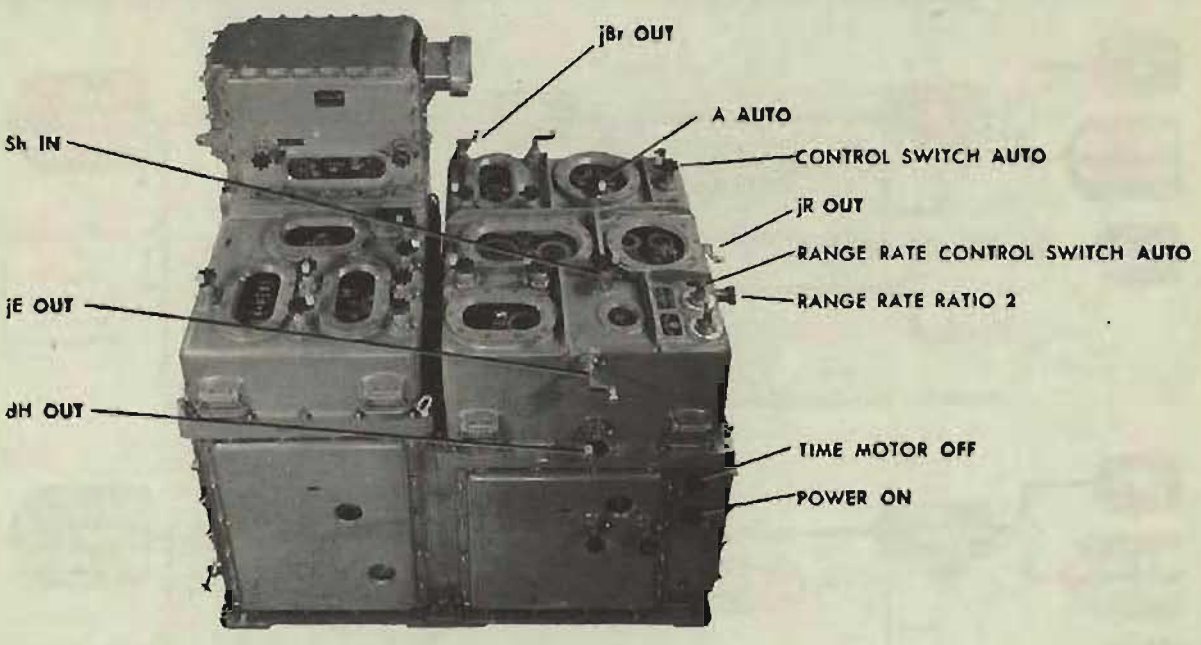
AUTOMATIC RATE CONTROL

Setting up the computer

1. Turn the power ON. Leave the time motor OFF.
2. Turn the control switch to AUTO.
3. Turn the range rate control switch to AUTO.
4. Position the range rate ratio knob at 2.
5. Set *L* and *Zd* at 2000′.
6. Lock the generated range, elevation, and bearing cranks in the OUT position.
7. Lock the *dH* handcrank OUT.
8. Set the *Sh* and *A* handcranks in AUTO.
9. Set the *Co* handcrank IN.

Gene Slover's US Navy Pages
Table of Contents

10 Set the fire control switchboard to receive director sight elevation, *Eb*, director train, *B'r*, and direct range, *R*, from the director.



Running the tests

Set *A* at 0° and set *Sh* at 200 or 300 knots, following the procedures outlined in the semi-automatic rate control tests.

Have the director pointer set director sight elevation, *Eb*, at 0°.

Read the *Sh* counter.

Have the director range finder operator *slowly increase* range 450 yards, with his signal key closed. *Sh* should decrease 88 (±5) knots.

Have the director range finder operator *slowly decrease* range 450 yards, with his signal key closed. *Sh* should increase 88 (±5) knots.

Read the *dH* dial.

Have the director pointer *slowly increase Eb* 2°00′, with his signal key closed. *dH* should increase 88(±5) knots.

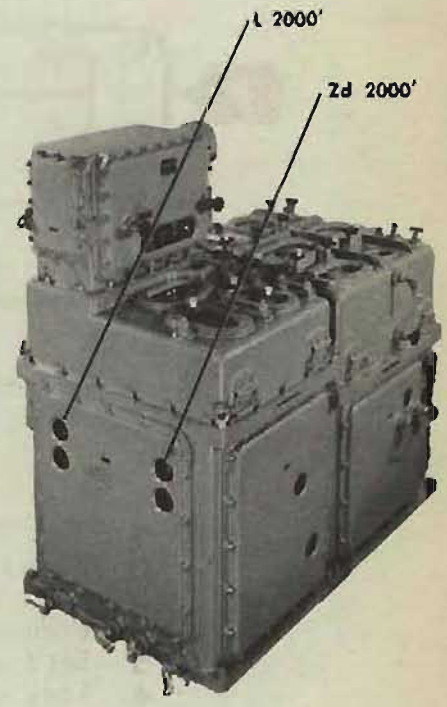
Have the director pointer *slowly decrease Eb* 2°00′, with his signal key closed. *dH* should decrease 88(±5) knots.

Read the *A* dial.

Have the director trainer *slowly increase B'r* 2°00′, with his signal key closed. *A* should increase.

Have the director trainer *slowly decrease B'r* 2°00′, with his signal key closed. *A* should decrease.

If the results of the rate control tests are not satisfactory, consult the chapter on rate control test analysis.



Gene Slover's US Navy Pages
Table of Contents

TRANSMISSION TESTS

Transmission tests are among the most important checks of the fire control system. The miles of shipboard and instrument wiring and the hundreds of interconnecting switches require constant checking in order to locate a damaged wire, a partial ground, or a dirty contact before the circuit fails.

Transmission tests check each transmitter and each receiver for accuracy of transmission. Values which cover the range of travel of both the fine and coarse synchros are set on the transmitter and are read on the receiver. The complete test should be repeated for every possible switching combination throughout the ship.

But such a test would require several days of diligent work by experienced men. Instead of the complete transmission tests, three shorter checks may be used which will give the experienced man a good indication of the operation of most of the transmission circuits and receivers. These checks are the receiver synchronization test, the round robin test, and the overall test. If any of these special tests indicates faulty operation, the full transmission test should be run to check the particular circuit involved.

The RECEIVER SYNCHRONIZATION TEST measures the time a receiver takes to drive to synchronism from a specified offset. The offset is usually 180° of the coarse synchro rotor. With the circuit de-energized, the receiver is offset the specified amount, and then the circuit is energized. The rotors of the receiver synchros should snap to position, and the servo motor should drive the receiver to synchronism in the specified time. This specified time is that for a factory test of a new instrument and does not strictly apply to a shipboard test. After a little experience, however, the operator can judge whether the receiver drives to synchronism within a reasonable time period and with a normal number of overtravels.

Gene Slover's US Navy Pages
Table of Contents

The ROUND ROBIN TEST checks the tracking circuits. Changes of generated director train, generated director elevation, and generated range are transmitted to the director, which in turn transmits these values down to the computer. The observed dials on the computer should remain matched with the generated dials.

The OVERALL TRANSMISSION TEST is made by transmitting train and elevation from the director through the computer to the guns. The computer is set for zero prediction so that the gun orders are equal to the director values. In this way the transmission test of director elevation and director train is combined with that of gun elevation order and gun train order. The overall error is observed at the gun mounts. The experienced operator need check accuracy at one point only and then observe whether the guns follow smoothly from limit to limit in both directions as the director is driven slowly and smoothly from limit to limit.

Those circuits not covered by the above special tests should be checked by the standard transmission tests. Here again, the experienced operator may check for satisfactory operation without taking readings at every point specified in the table of values. Accuracy of alignment of the receiver with the transmitter may be determined at any single transmitted value. Whether the circuit is clear of opens, grounds, or dirty contact surfaces may be checked by observing the smoothness of operation of the receiver as the transmitter is turned slowly and smoothly between limits in both increasing and decreasing directions.

In the STAR SHELL COMPUTER MARK 1, MOD O, the gun order dials cannot be read without removal of the front cover. The Mod 1 and 2 instruments are equipped with a large window through which gun order values may be read so that transmission tests may be conducted in the same manner as for the Computer Mark 1. In order to eliminate the necessity for removing the front cover of the Mod O instrument, the transmission tests may be combined with the star shell A tests. Circuits are closed to transmit star shell gun orders to a gun mount, and the A test problem result values are read at the gun mount. If excessive errors occur, the front cover should be removed and the separate star shell transmission tests run.

Gene Slover's US Navy Pages
Table of Contents

SYNCHRONIZATION

When the Computer Mark 1 leaves the factory, all the receivers are adjusted to synchronize through a given travel in less than the maximum allowable N.I.O. time limit. The allowable time limit for a specified amount of travel varies for each receiver. These limits are arbitrarily established for a new computer undergoing N.I.O. acceptance tests at the factory.

SYNCHRONIZING TEST OF RECEIVERS

RECEIVER	DISPLACEMENT	MAXIMUM IN SECONDS
SHIP COURSE (Co)	180°	25
DIRECTOR TRAIN (B'r)	180°	15
DIRECTOR ELEVATION (Eb)	4800 MIN.	10
RANGE AUTOMATIC (R)	15000 YARDS	25
RANGE SPOT (Rj)	2000 YARDS	10
ELEVATION SPOT (Vj)	180 MILS	15
DEFLECTION SPOT (Dj)	180 MILS	15
SHIP SPEED (So)	16 KNOTS	5

Timing receiver synchronization

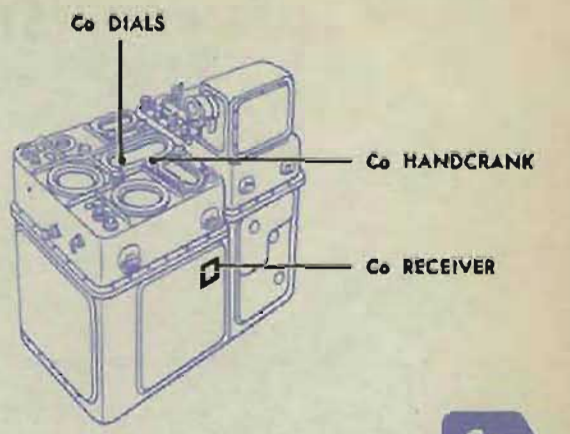
Make certain that the transmitted value is not changed during the checking of the synchronization time of a receiver.

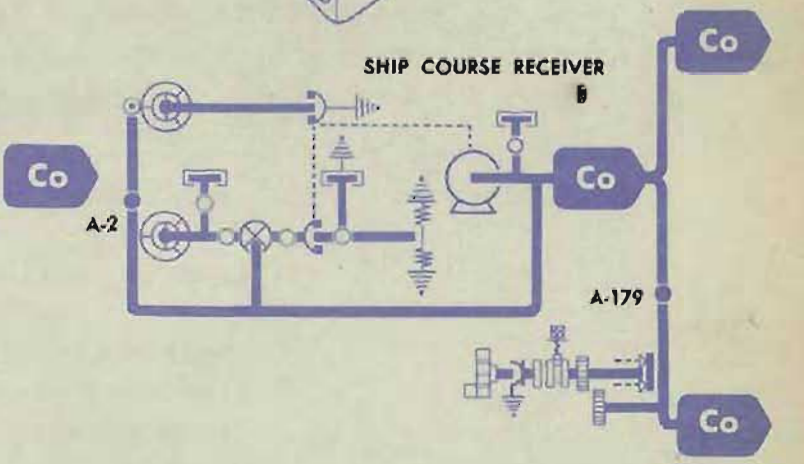
The *B'r*, *Co*, *Vj*, *Dj*, and *Rj* receivers are timed through one half revolution of the rotor. To control the direction of rotation, it is necessary to offset the rotor somewhat less than one half revolution.

Gene Slover's US Navy Pages Table of Contents

Timing the Co receiver

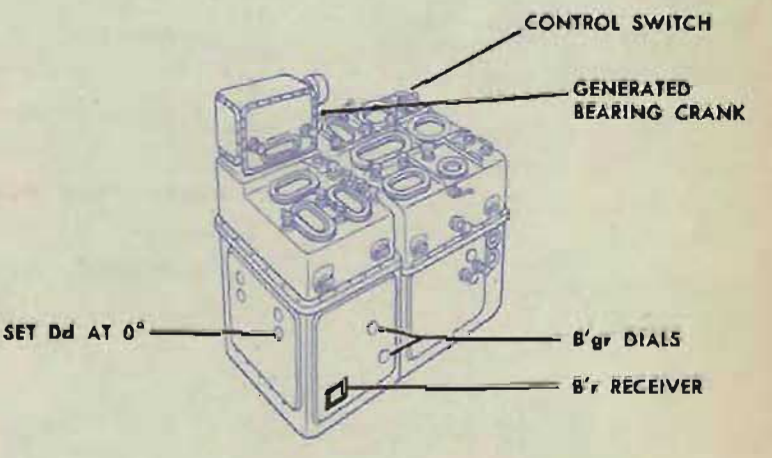
1 Set up the fire control switchboard to receive *Co* from the gyro compass.
2 At the computer, note the value of *Co*.
3 At the switchboard, open the *Co* receiver switch.
4 At the computer, put the *Co* handcrank IN and offset *Co* slightly less than 180°. Return the *Co* handcrank to the OUT position.
5 At the switchboard, close the *Co* receiver switch.
6 With a stop watch, measure the time from the instant the switch is closed to the instant the receiver synchronizes at its original value on the *Co* dial.
7 Repeat this procedure, offsetting *Co* slightly less than 180° in the other direction.

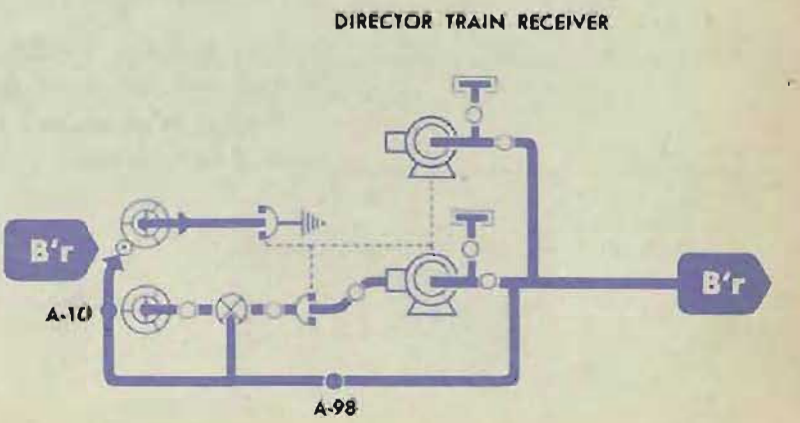


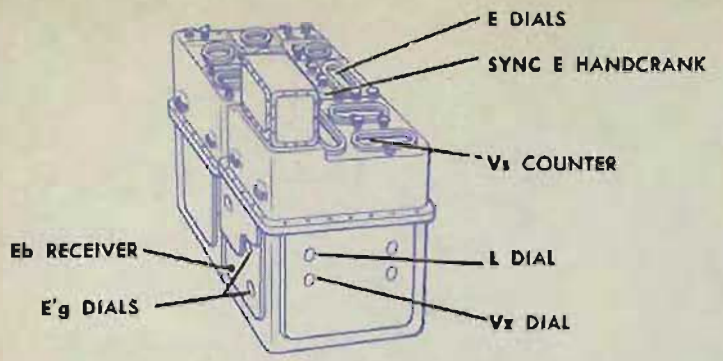


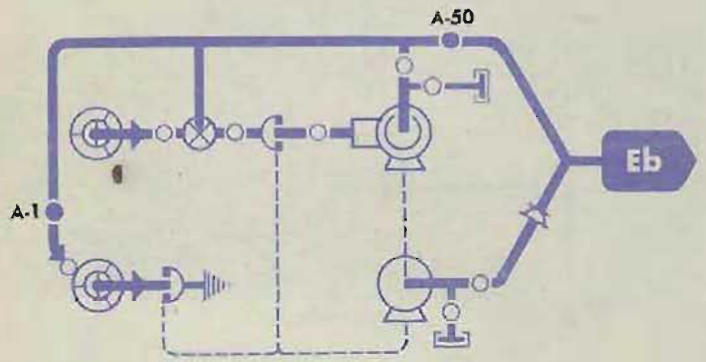
Timing the B′r receiver

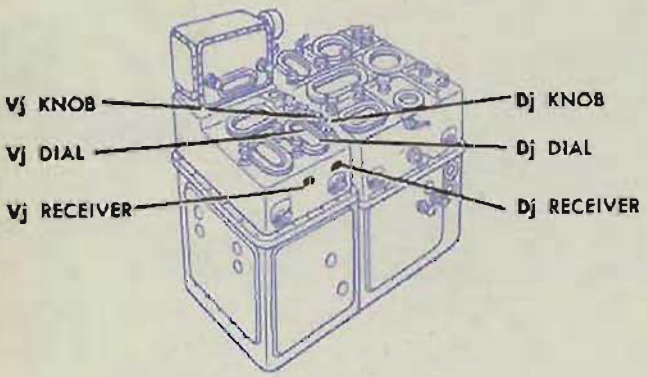
1 Set up the fire control switchboard to receive *B′r* from the director.
2 At the computer, turn the control switch to SEMI-AUTO.
3 Read the received value of *B′r* by setting *Dd* at 0° and reading *B′r* on the *B′gr* dials, or by reading *B′r* on the stable element dials.
4 At the switchboard, open the *B′r* receiver switch.
5 At the computer, turn the control switch to LOCAL. Use the generated bearing crank in the OUT position to offset *B′r* slightly less than 180°. Return the control switch to SEMI-AUTO.
6 At the switchboard, close the *B′r* receiver switch.
7 With a stop watch, measure the time from the instant the switch is closed to the instant the receiver synchronizes at its original value on the *B′gr* or stable element dials.
8 Repeat this procedure, offsetting *B′r* slightly less than 180° in the other direction.

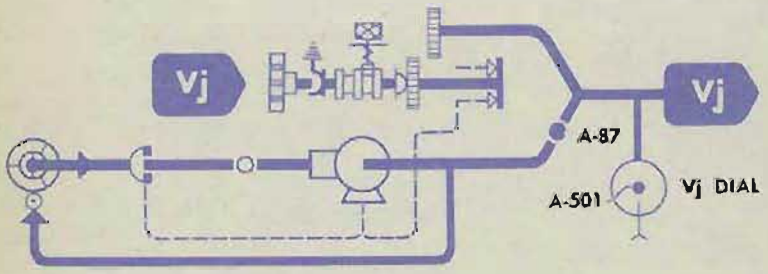


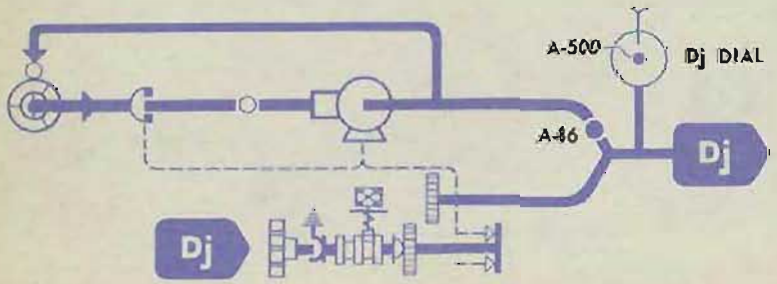












Timing the Eb receiver

1. Set *L* and *Vs* at 2000′ and *Vz* at 0′.
2. Set up the fire control switchboard to receive *Eb* from the director.
3. Transmit a 0° (or 2000′ on earlier machines) value of *Eb* from the director. Read the received value of *Eb* on the *E′g* dials, or match the sync *E* dials and read *Eb* on the *E* dials. Check that the dials read 0° (2000′).
4. At the switchboard, open the *Eb* receiver switch.
5. At the director, increase *Eb* to 80° (6800′).
6. Close the *Eb* switch.
7. With a stop watch, measure the time from the instant the switch is closed to the instant the receiver is synchronized at 6800′ (80°).
8. Open the *Eb* switch.
9. At the director, decrease *Eb* to 0° (2000′).
10. Close the *Eb* switch, and measure the time until the receiver synchronizes at 0° (2000′).

Timing the Vj and Dj receivers

The procedure for checking these two receivers is the same except that different switches and knobs are used.

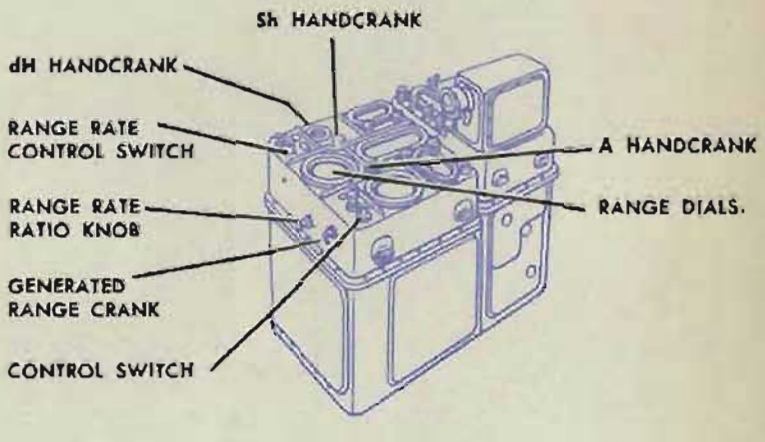
1. Set up the fire control switchboard to receive *Vj* (or *Dj*) from the director.
2. Transmit 0 mils *Vj* (or *Dj*) from the director. At the computer, check that the received value of *Vj* (or *Dj*) is 0 mils.
3. Open the *Vj* (or *Dj*) receiver switch at the switchboard.
4. Set *Vj* (or *Dj*) at slightly less than 180 DOWN (or LEFT), with the *Vj* (or *Dj*) knob in the IN position. Pull the knob OUT.
5. Close the *Vj* (or *Dj*) receiver switch.
6. With a stop watch, measure the time from the instant that the switch is closed to the instant that the receiver is again synchronized at 0 mils.
7. Repeat this procedure, offsetting *Vj* (or *Dj*) slightly less than 180 mils in the other direction.

Gene Slover's US Navy Pages Table of Contents

Timing the range receiver

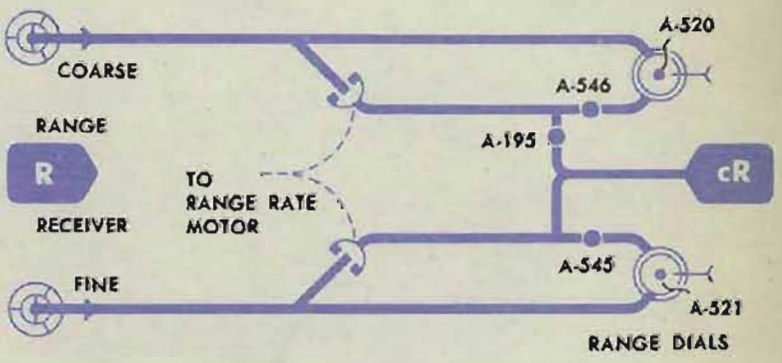
Preliminary setup

1 Set up the fire control switchboard to receive range from the director.
2 At the computer, set *E* at 25°.
3 Set the range rate ratio knob at 5.
4 Set the *A* and *Sh* handcranks at AUTO.
5 Pull the generated range crank and the *dH* handcrank OUT.
6 Turn the range rate control switch to AUTO.



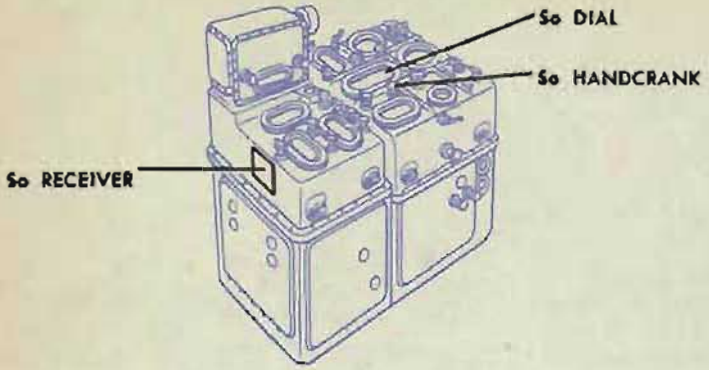
Increasing

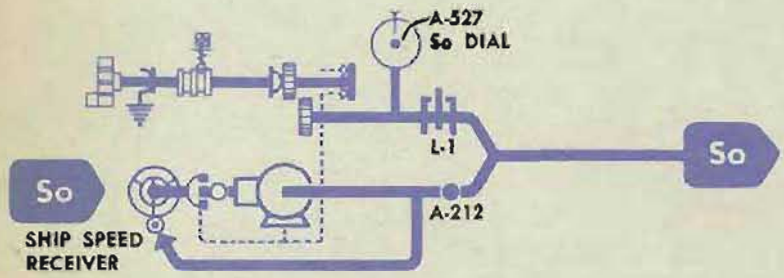
1 At the switchboard, open the range receiver switch.
2 At the computer, set *dH* at DIVE 250 knots and return the handcrank to the OUT position.
3 Set the range ring dials at 5000 yards.
4 Transmit 20,000 yards range from the director, keeping the range finder signal button depressed.
5 At the switchboard, close the range receiver switch.
6 With a stop watch, measure the time from the instant that the switch is closed to the instant that the receiver synchronizes at 20,000 yards on the range ring dials.



Decreasing

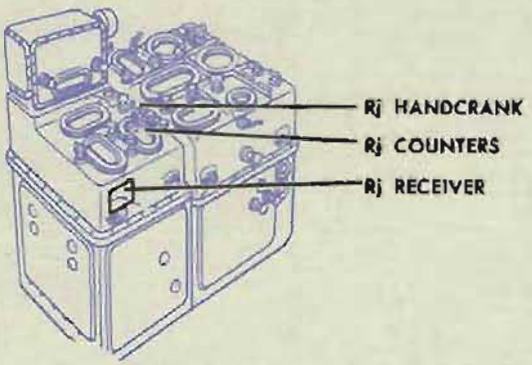
1 Open the range receiver switch.
2 Set *dH* at CLIMB 150 knots and return the handcrank to the OUT position.
3 Transmit 5000 yards range from the director, keeping the range finder signal button depressed.
4 At the switchboard, close the range receiver switch.
5 Measure the time from the instant that the switch is closed to the instant that the receiver synchronizes at 5000 yards.

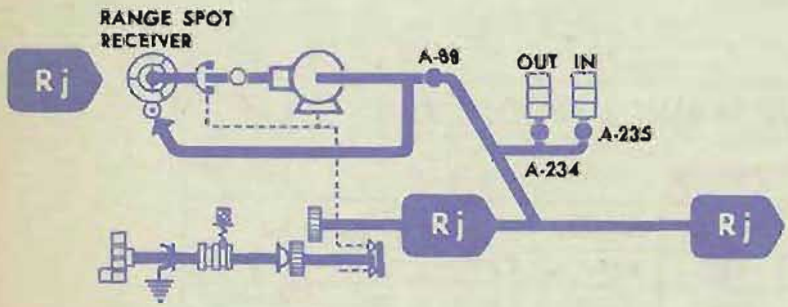




Timing the So receiver

1. Set up the fire control switchboard to receive *So* from the pitometer log.
2. Note the value of *So* on the computer dial.
3. At the switchboard, open the *So* receiver switch.
4. Push the *So* handcrank IN and offset *So* 16 knots. Pull the handcrank OUT.
5. Close the *So* switch.
6. With a stop watch, measure the time between the instant that the switch is closed and the instant that the receiver synchronizes, with the *So* dial at its original value.
7. Repeat this procedure, offsetting *So* 16 knots in the other direction if possible.





Timing the Rj receiver

1. Set up the fire control switchboard to receive *Rj* from the director.
2. At the director, set *Rj* at IN 1000 yards. At the computer, check that the *Rj* counter reads IN 1000 yards.
3. At the switchboard, open the *Rj* receiver switch.
4. Push the *Rj* handcrank IN, offset *Rj* slightly less than 2000 yards, and pull the *Rj* handcrank OUT.
5. Close the *Rj* receiver switch.
6. Measure the time between the instant that the switch is closed and the instant that the receiver synchronizes at 1000 yards IN on the *Rj* counter.
7. Repeat this procedure, offsetting *Rj* slightly less than 2000 yards in the other direction.

Gene Slover's US Navy Pages
Table of Contents

TRANSMISSION TESTS

These transmission tests are made according to the information given in NAVORD Form 1229, Transmission Tests. Each one tests a single transmitter or receiver. For each test the allowable limits of error are given in NAVORD Form 1229.

ALL READINGS ARE TO BE CHECKED FOR INCREASING AND DECREASING SETTINGS

COMPUTER MARK I							MAX. ALLOW. ERROR
QUANTITY	CHECK POINTS						
GUN TRAIN (I)	59°	118°	177°	236°	295°	354°	2 MIN.
GUN TRAIN (A)	59°	118°	177°	236°	295°	354°	2 MIN.
GUN ELEV. (I)	1200'	1850'	3200'	4550'	5900'	7000'	2 MIN.
GUN ELEV. (A)	1200'	1850'	3200'	4550'	5900'	7000'	2 MIN.
TRAIN PARALLAX	R 10° 50'	R 5° 50'	R 0° 50'	L 0° 50'	L 5° 50'	L 10° 50'	2 MIN.
ELEV. PARALLAX	U 3° 30'	U 2° 50'	U 0° 50'	D 0° 50'	D 2° 50'	D 3° 30'	2 MIN.
FUZE SETTING	2.00	9.00	18.00	27.00	36.00	44.00	.01 SEC.
SIGHT ANGLE	2100'	2360'	2720'	3080'	3440'	3700'	3 MIN.
SIGHT DEFLECTION	330	400	470	540	610	670	1.0 MIL.
RANGE (A)	1500	4800	11400	14700	17900	20000	45 YDS.
RANGE CORR.	100	200	400	600	800	1000	30 YDS.
BEARING CORR. (I)	2°	4°	6°	8°	10°		2 MIN.
BEARING CORR. (A)	1°	2°	3°	4°	5°		2 MIN.
ELEV. CORR. (I)	2°	4°	6°	8°	10°		2 MIN.
ELEV. CORR. (A)	1°	2°	3°	4°	5°		2 MIN.
TARGET COURSE	60°	120°	180°	240°	300°	360°	2.0 DEG.
DIRECTOR TRAIN	59°	118°	177°	236°	295°	354°	6 MIN.
DIRECTOR ELEVATION	1200'	1850'	3200'	4550'	5900'	7000'	6 MIN.
RANGE SPOT	IN 1700	IN 1100	IN 60	OUT 60	OUT 1100	OUT 1700	30 YDS.
ELEV. SPOT	U 170	U 115	U 55	D 55	D 115	D 170	3.0 MIL.
DEFL. SPOT	R 170	R 115	R 55	L 55	L 115	L 170	3.0 MIL.
* SHIP SPEED	10	15	20	25	30	40	0.6 KN.
* SHIP COURSE	59°	118°	177°	236°	295°	354°	6 MIN.

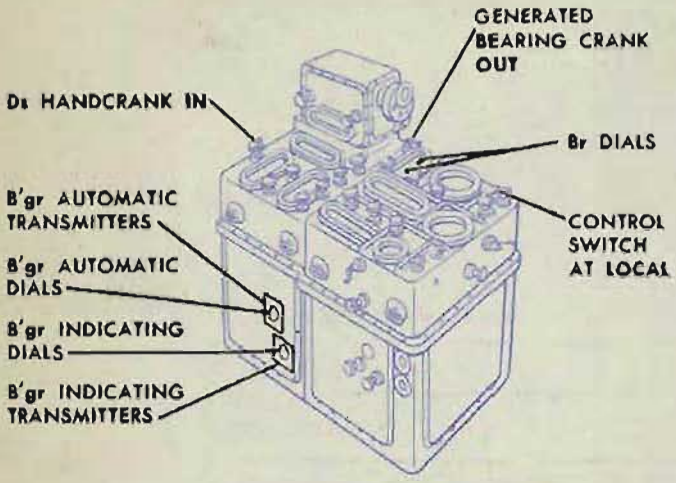
* THESE CHECK POINTS ARE GIVEN FOR SHOP TESTS WITH DUMMY TRANSMITTERS
NOTE: (I) = INDICATING (A) = AUTOMATIC

STAR SHELL COMPUTER MARK I MODS. 0, 1							MAX. ALLOW. ERROR
QUANTITY	CHECK POINTS						
S. S. RANGE SPOT	IN 1500	IN 900	IN 300	OUT 300	OUT 900	OUT 1500	50 YDS.
S. S. GUN TRAIN +	59°	118°	177°	236°	295°	354°	5 MIN.
S. S. GUN ELEVATION +	1200	2000	2900	4000	4500	5200	5 MIN.
S. S. FUZE SETTING	9.00	15.30	21.60	27.90	34.20	40.50	0.01 SEC.

NOTE: + HOLD S. S. DEFLECTION AND ELEVATION SPOTS ON ZERO FOR THESE TESTS

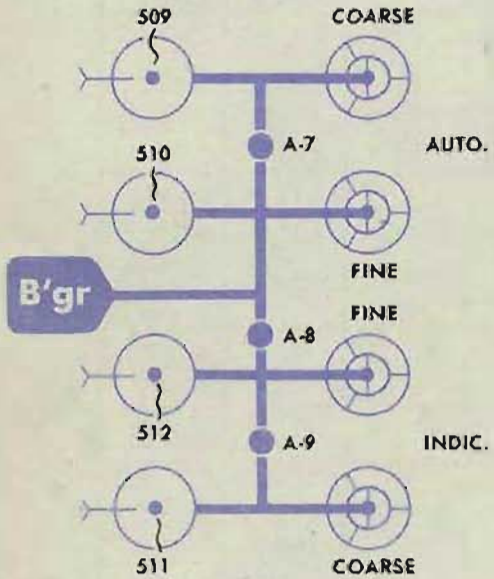
Gene Slover's US Navy Pages
Table of Contents

RUNNING TRANSMISSION TESTS



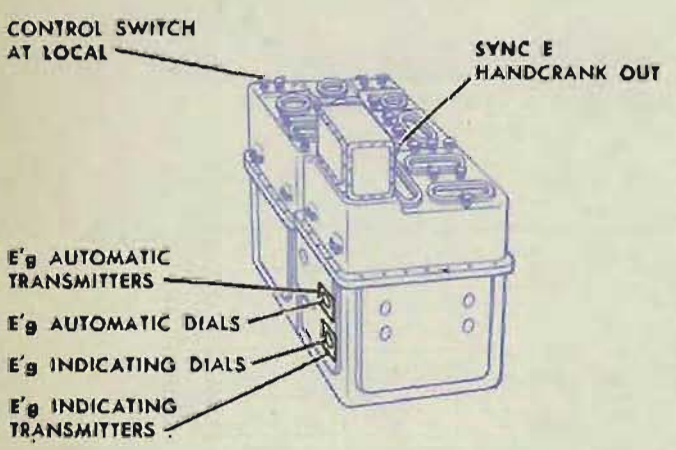
Checking B'gr indicating transmission

1. Set up the fire control switchboard to transmit *B'gr* indicating (No. 1) to each gun mount.
2. At the gun mounts, set each gun on exactly 59°. Shift control to MANUAL.
3. At the computer, turn the control switch to LOCAL.
4. Set the *Br* dials at 59°, with the generated bearing crank in the OUT position. Use the *Ds* handcrank in the IN position to set the *B'gr* indicating dials at 59°, from the increasing and decreasing directions.
5. At the gun mounts, read the error on the follow-the-pointer dials for each direction of transmitter setting.
6. Continue the test in the same manner with *B'gr* at 118°, 177°, 236°, 295°, and 354°.



Checking B'gr auto transmission

1. Set up the fire control switchboard to transmit *B'gr* automatic (No. 2) to each gun mount.
2. At the gun mounts, put the guns in AUTO control.
3. Run the balance of the test in the same manner as the *B'gr* indicating transmission test, but read the error on the train dials at the guns.



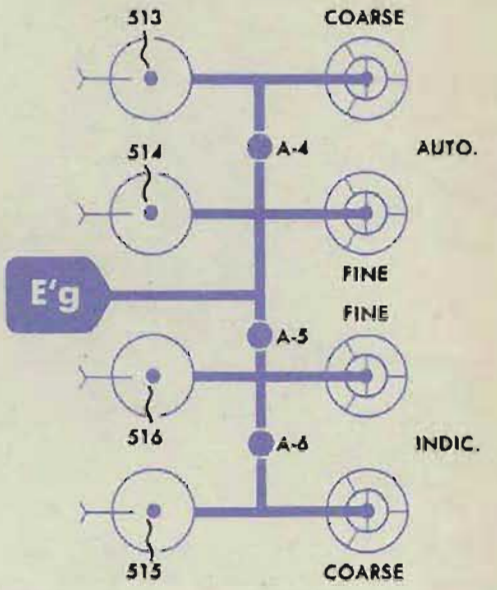
Checking E'g indicating transmission

1. Set up the fire control switchboard to transmit *E'g* indicating (No. 1) to each gun mount.
2. At the gun mounts, set gun elevation at exactly 1200′. Shift control to MANUAL.
3. At the computer, turn the control switch to LOCAL. Use the sync *E* handcrank in the OUT position to set the *E'g* indicating dials at 1200′, from the increasing and decreasing directions.
4. Read the transmission error at each gun mount on the follow-the-pointer dials for each direction of transmitter setting.
5. Continue the test in the same manner with *E'g* at 1850′, 3200′, 4550′, 5900′, and 7000′.

Gene Slover's US Navy Pages
Table of Contents

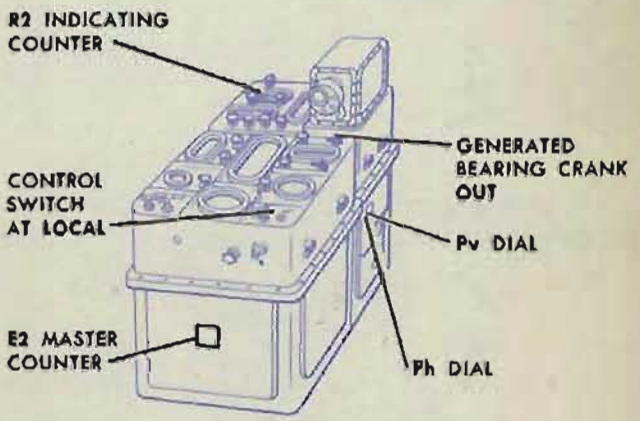
Checking E'g auto transmission

1 Set up the fire control switchboard to transmit *E'g* automatic (No. 2) to each gun mount.
2 At the gun mounts, put each gun in AUTO control.
3 Run the balance of the test in the same manner as the *E'g* indicating transmission test, but read the errors on the elevation dials at the guns.



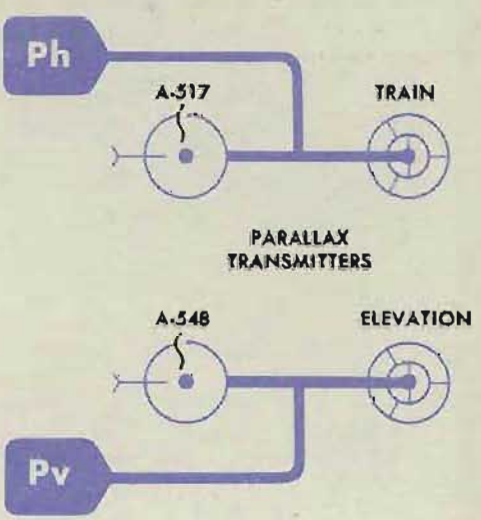
Checking Ph transmission

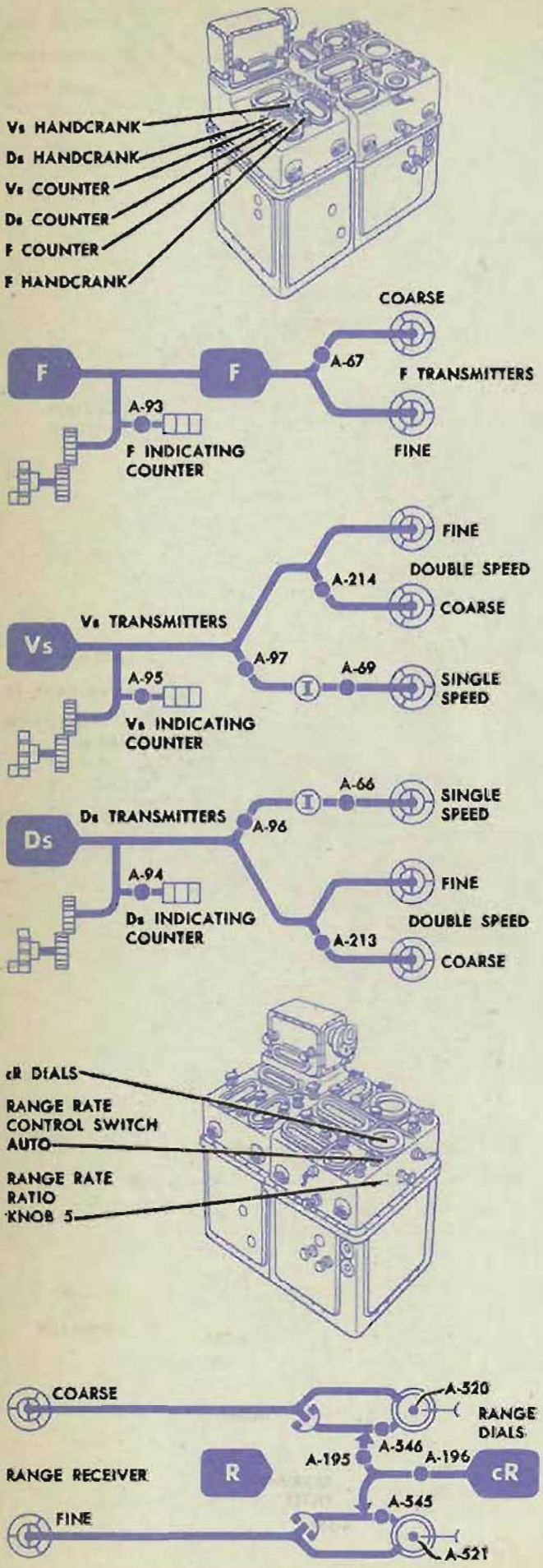
1 Set up the fire control switchboard to transmit *Ph* to each gun mount.
2 At the computer, turn the control switch to LOCAL.
3 Set *R2* at a low value and *E2* at a high value.
4 Use the generated bearing crank in the OUT position to set the *Ph* dial at RIGHT 10°50′, from the increasing and decreasing directions.
5 At the gun mounts, read the received value on the train parallax ring dial for each direction of dial setting.
6 Continue the test in the same manner with *Ph* at RIGHT 5°50′, RIGHT 0°50′, LEFT 0°50′, LEFT 5°50′, and LEFT 10°50′.



Checking Pv transmission

1 Set up the fire control switchboard to transmit *Pv* to each gun mount.
2 At the computer, turn the control switch to LOCAL.
3 Set *R2* at a low value and *E2* at a high value.
4 Use the generated bearing crank in the OUT position to set the *Pv* dial at UP 3°30′, from both the increasing and decreasing directions.
5 At the gun mounts, read the value transmitted to each gun mount on the elevation parallax ring dial, if the mount receives *Pv*.
6 Continue the test in the same manner with *Pv* at UP 2°50′, UP 0°50′, DOWN 0°50′, DOWN 2°50′, DOWN 3°30′.





Checking F transmission

1. Set up the fire control switchboard to transmit *F* to each gun mount.
2. At the computer, set the *F* counter at 2.00 seconds from the increasing and decreasing directions with the fuze handcrank IN.
3. At the gun mounts, read the received value on the fuze setting indicator regulator for each setting.
4. Continue the test in the same manner with *F* at 9.00, 18.00, 27.00, 36.00, and 44.00 seconds.

Checking Vs transmission

1. Set up the fire control switchboard to transmit *Vs* to each gun mount.
2. At the computer, set the *Vs* counter at 2100′ from the increasing and decreasing directions with the *Vs* handcrank IN.
3. At the gun mounts, read the received value on the sight angle dials for each setting.
4. Continue the test in the same manner with *Vs* at 2360′, 2720′, 3080′, 3440′, and 3700′.

Checking Ds transmission

1. Set up the fire control switchboard to transmit *Ds* to each gun mount.
2. At the computer, set the *Ds* counter on 330 mils from the increasing and decreasing directions with the *Ds* handcrank IN.
3. At the gun mounts, read the received value on the sight deflection dials for each setting.
4. Continue the test in the same way with *Ds* at 400, 470, 540, 610, and 670 mils.

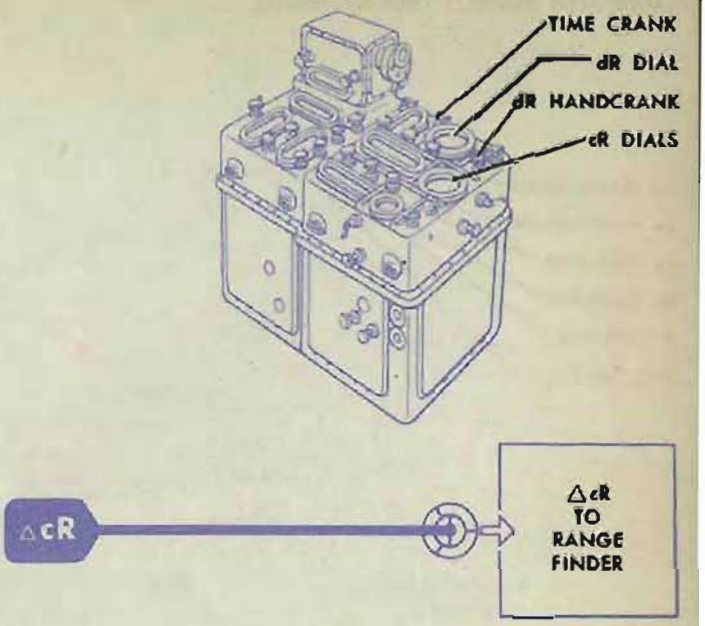
Checking the range receiver

1. Set up the fire control switchboard to receive range from the director.
2. At the computer, turn the range rate control switch to AUTO, and set the range rate ratio knob at 5.
3. At the director, transmit 1500 yards range. The range finder operator should set this value exactly at 1500 yards from both the increasing and decreasing directions. The signal key should be kept closed to keep the range receiver synchronized while the setting is made.
4. At the computer, read the received value on the *cR* dials for each transmitter setting.
5. Continue the test by transmitting range values of 4800, 11,400, 14,700, 17,900, and 20,000 yards from the director.

Gene Slover's US Navy Pages Table of Contents

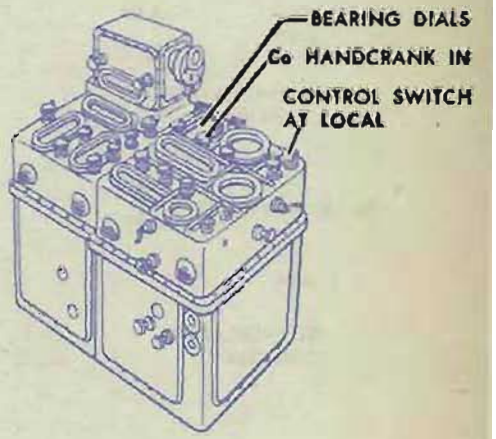
Checking △cR transmission

1 Set up the fire control switchboard to transmit △*cR* to the director.
2 At the director, turn the change of range receiver ON. Set the range dials at some even value within the limits of the 200-yard graduations.
3 At the computer, set *cR* equal to the director setting. Set *dR* at some negative value on the inscribed side of the dial.
4 Turn the time line until *cR* decreases 200 yards.
5 At the director, read the change on the director range dials.
6 Repeat steps 4 and 5 four times (total change, 1000 yards).
7 Set *dR* at some positive value and repeat the test.



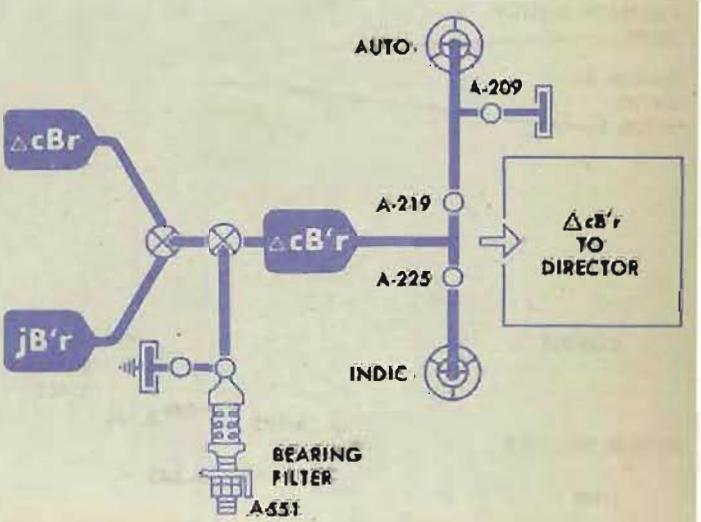
Checking △cB′r indicating transmission

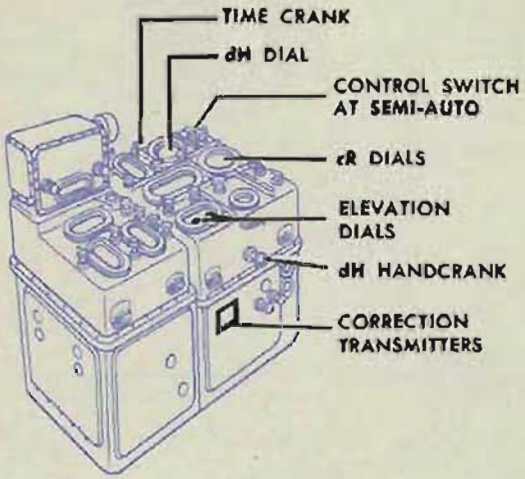
1 Set up the fire control switchboard to transmit △*cB′r* to the director.
2 At the computer, turn the control switch to LOCAL. Use the *Co* handcrank in the IN position to set the bearing dials at some even value.
3 At the director, set the selector lever in AUTO. Match the train indicating dial at the index.
4 At the computer, turn the *Co* handcrank slowly to increase bearing 2°.
5 At the director, check that the train indicating dial remains matched at the index.
6 Repeat steps 4 and 5 four times (total change, 10°).
7 Repeat the test in the decreasing direction.



Checking △cB′r auto transmission

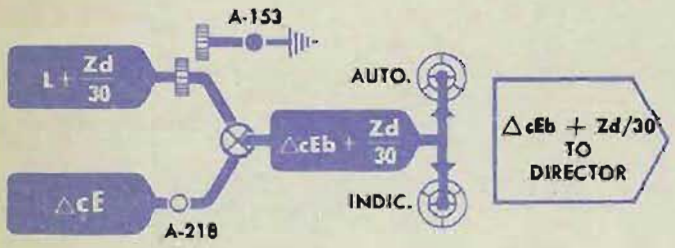
1 Set up the fire control switchboard to transmit △*cB′r* to the director.
2 At the computer, turn the control switch to LOCAL. Use the *Co* handcrank in the IN position to set the bearing dials on an even value.
3 At the director, set the selector lever in AUTO. Set the train dials at some even value.
4 At the computer, turn the *Co* handcrank slowly to increase bearing 1°.
5 Check that the director dials increase 1°.
6 Repeat steps 4 and 5 four times (total change, 5°).
7 Repeat the test in the decreasing direction.





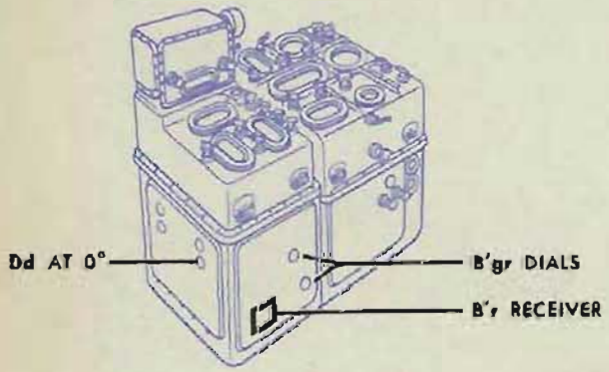
Checking △cEb + Zd/30 indicating transmission

1. Set up the fire control switchboard to transmit *△cEb + Zd/30* to the director.
2. At the director, set the selector lever in AUTO. Match the elevation indicating dial at the index.
3. At the computer, turn the control switch to SEMI-AUTO. Set *cR* at 1500 yards. Set *dH* at CLIMB 150.
4. Turn the time crank until *cE* increases 2°.
5. At the director, check that the elevation indicating dial remains matched.
6. Repeat steps 4 and 5 four times (total change, 10°).
7. Set *dH* at DIVE 150 and repeat the test.



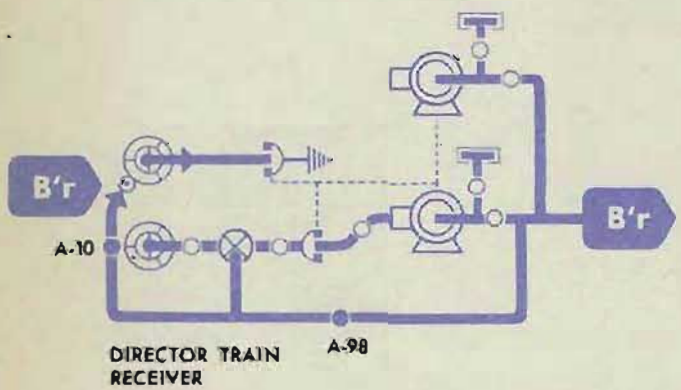
Checking △cEb + Zd/30 auto transmission

1. Set up the fire control switchboard to transmit *△cEb + Zd/30* to the director.
2. At the director, set the selector lever in AUTO. Set the director elevation dials at some even value.
3. At the computer, turn the control switch to SEMI-AUTO. Set *cR* at 1500 yards. Set *dH* at CLIMB 150.
4. Turn the time crank until *cE* increases 1°.
5. At the director, check that the elevation dial increases 1°.
6. Repeat steps 4 and 5 four times (total change 5°).
7. Set *dH* at DIVE 150 and repeat the test.



Checking the B'r receiver

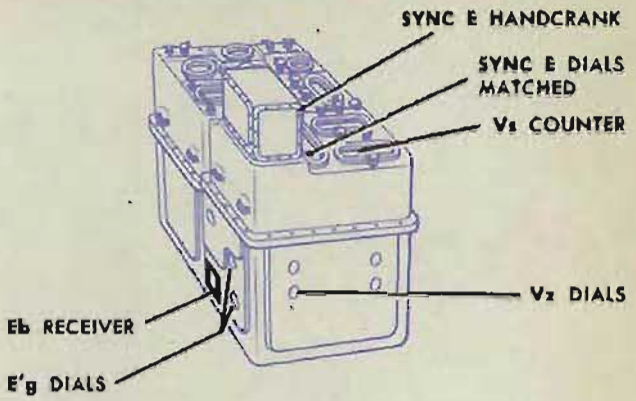
1. Set up the fire control switchboard to receive *B'r* from the director.
2. At the computer, set *Dd* on 0.
3. At the director, transmit a *B'r* value of 59°. The trainer should set this value on exactly 59° from both the increasing and decreasing directions.
4. At the computer, read the received value of *B'r* on the *B'gr* dials, for each transmitter setting.
5. Continue the test by transmitting *B'r* values of 118°, 177°, 236°, 295°, and 354°.

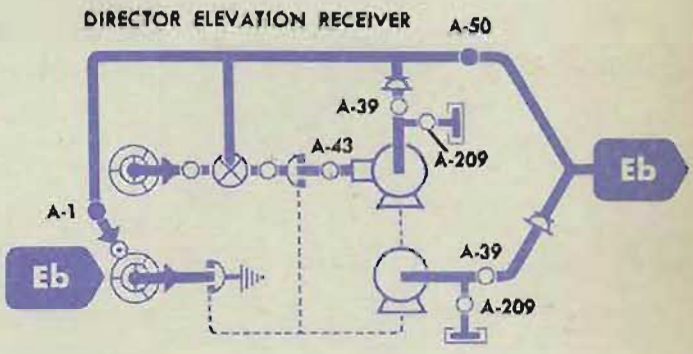


Gene Slover's US Navy Pages
Table of Contents

Checking the Eb receiver

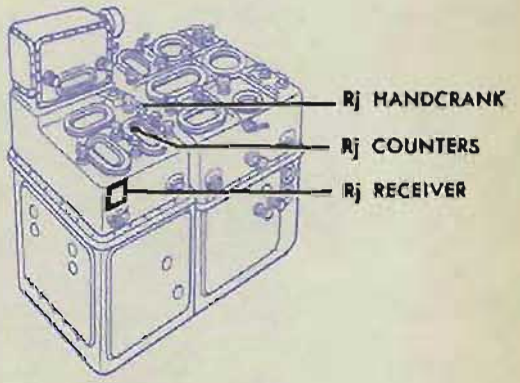
1 Set up the fire control switchboard to receive *Eb* from the director.
2 At the computer, set *Vs* at 2000′, *Vz* at 0, and match the sync *E* dials at the index.
3 At the director, transmit a value of −13°20′ (1200′) of *Eb*. The pointer should set the value on exactly −13°20′ from the increasing and decreasing directions.
4 At the computer, read the value of *Eb* received on the *E′g* dials for each setting.
5 Continue the test by transmitting *Eb* values of 1850′, 3200′, 4550′, 5900′, and 7000′.

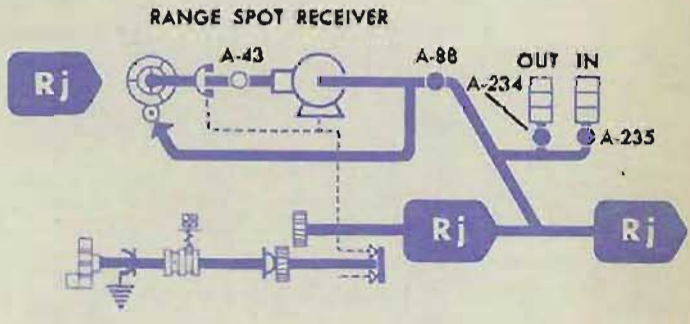


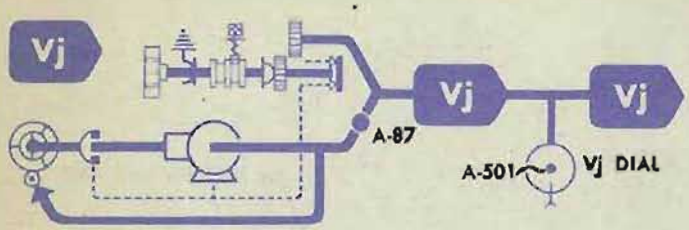


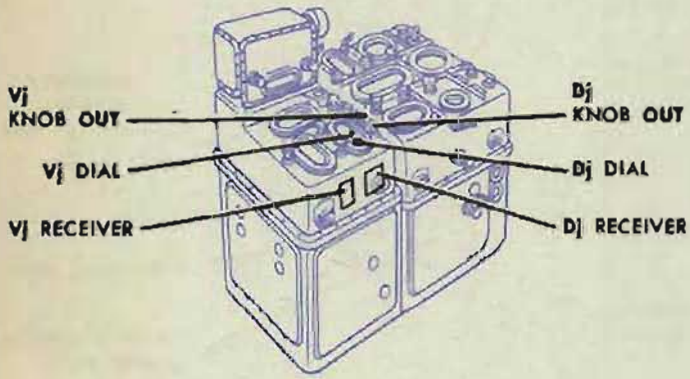
Checking the Rj receiver

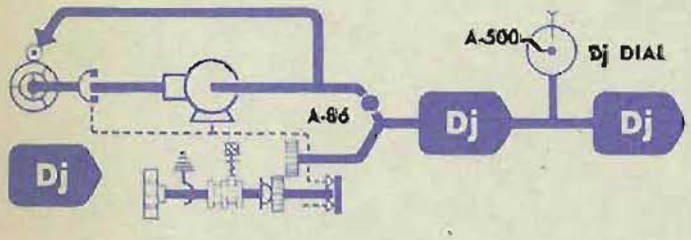
1 Set up the fire control switchboard to receive range spot from the director.
2 At the computer, pull the *Rj* knob out.
3 At the director, transmit an *Rj* value of IN 1700 yards from the increasing and decreasing directions.
4 At the computer, read the value received on the *Rj* counter for each direction of setting.
5 Continue the test by transmitting *Rj* values of IN 1100, IN 60, OUT 60, OUT 1100, and OUT 1700 yards.

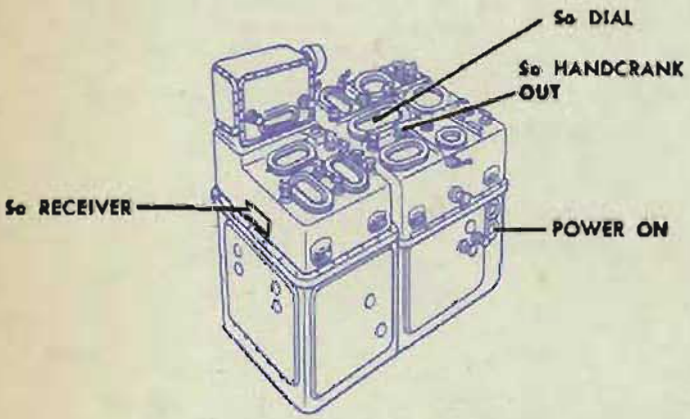


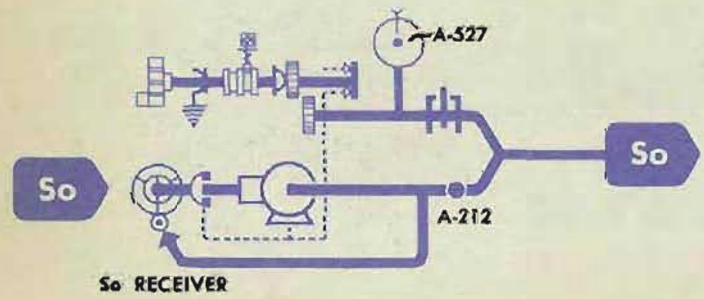












Checking the Vj receiver

1. Set up the fire-control switchboard to receive elevation spot from the director.
2. At the computer, pull the *Vj* knob out.
3. At the director, transmit a *Vj* value of UP 170, from the increasing and decreasing directions.
4. At the computer, read the value on the *Vj* dial for each direction of setting.
5. Continue the test by transmitting *Vj* values of UP 115, UP 55, DOWN 55, DOWN 115, and DOWN 170 mils.

Checking the Dj receiver

1. Set up the fire-control switchboard to receive deflection spot from the director.
2. At the computer, pull the *Dj* knob out.
3. At the director, transmit a *Dj* value of RIGHT 170, from the increasing and decreasing directions.
4. At the computer read the value on the *Dj* dial for each direction of setting.
5. Continue the test by transmitting *Dj* values of RIGHT 115, RIGHT 55, LEFT 55, LEFT 115, and LEFT 170 mils.

Checking the So receiver

It is not practical to run the complete transmission test of the *So* receiver in the normal shipboard setup because of the difficulty in varying the transmitted values of *So*. An approximate check of receiver operation can be made by comparing the value on the computer *So* dial with the pitometer log reading at any given time during normal automatic operation of the *So* receiver. The readings should not differ more than 0.6 knots.

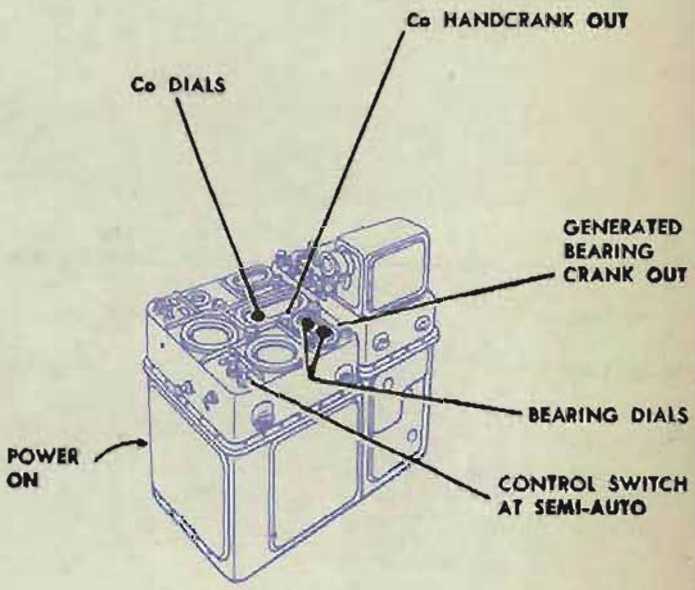
To run the complete transmission test:

1. Connect a dummy transmitter to the *So* circuit in the computer.
2. Pull the *So* handcrank OUT; turn the power switch ON.
3. Transmit a value of 10 knots from the dummy. Set the value from the increasing and decreasing directions.
4. At the computer, read the received value on the *So* dial for each direction of setting.
5. Continue the test by transmitting *So* values of 15, 20, 25, 30, and 40 knots.

Gene Slover's US Navy Pages
Table of Contents

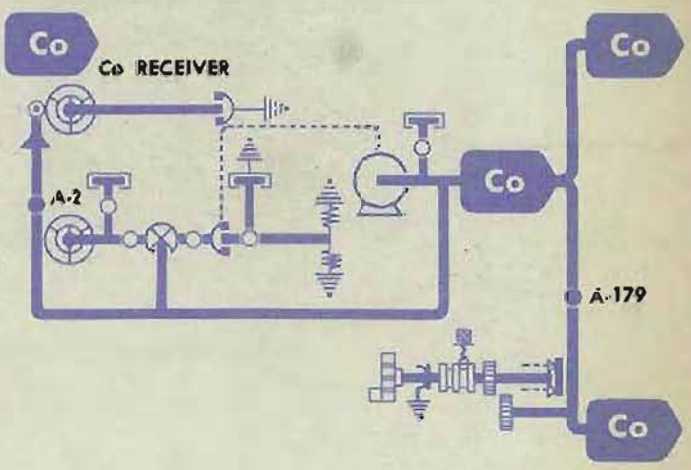
Checking the Co receiver

It is not practical to run the complete transmission test of the *Co* receiver in the normal shipboard setup because of the difficulty in varying the transmitted value of *Co*. An approximate check of receiver operation can be made by comparing the value of *Co* read on the computer dials with the master compass reading at any given time during normal automatic operation of the *Co* receiver.



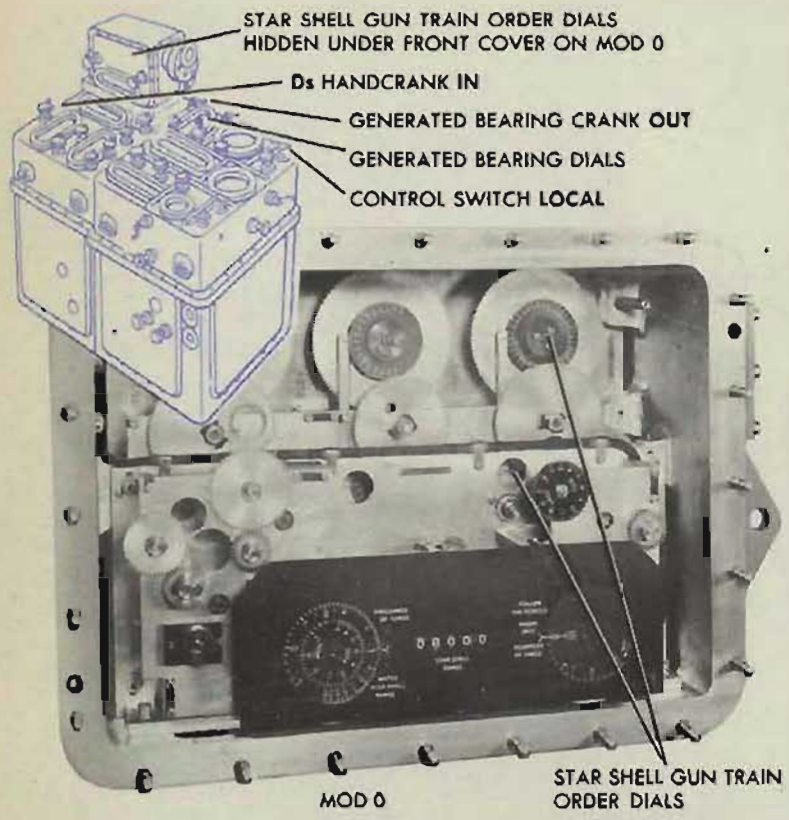
To run the complete transmission test:

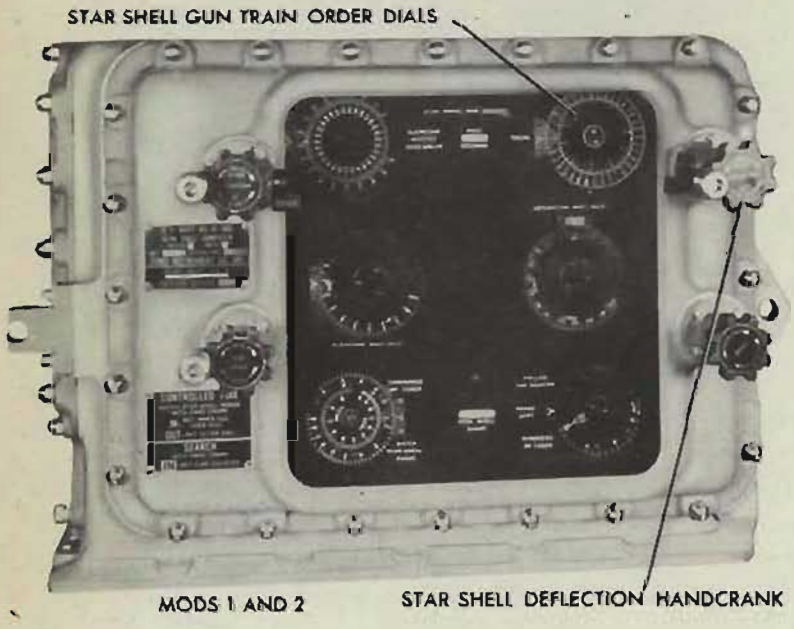
1. Connect dummy transmitters to the *Co* and *B'r* circuits in the computer.
2. Transmit 0° *B'r* to the computer, and energize the *B'r* receiver.
3. Pull the *Co* handcrank OUT, and turn the power switch ON. Turn the control switch to SEMI-AUTO. Set *So* and *Sh* on 0 knots. Set *L* and *Zd* on 2000'.
4. Transmit 0° *Co* to the computer. Check that the computer ship and compass ring dials read a 0° value of *Co*.
5. Match one index of the fine generated bearing dial to the zero index of the fine ring dial with the generated bearing crank in the OUT position.
6. Set the *Co* transmitter on 0° from both the increasing and decreasing directions.
7. Use the generated bearing crank to adjust the fine generated bearing dial index initially so that the lost motion is evenly distributed on each side of the zero index of the fine ring dial, for each direction of transmitter setting.
8. Continue the test, without disturbing the generated bearing setup, for *Co* values of 59°, 118°, 177°, 236°, 295°, and 354°. Read the computer ship dial against the compass ring dial for coarse values. Read the selected index of the fine generated bearing dial against the ring dial for fine values.

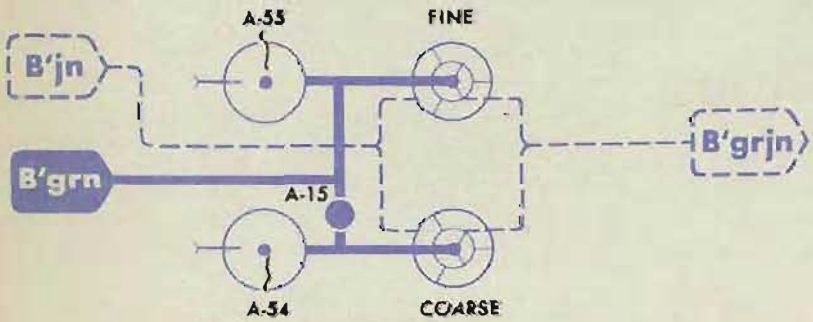


Gene Slover's US Navy Pages
Table of Contents

STAR SHELL TRANSMISSION TESTS







An approximate transmission test for the Star Shell Computer Mod 0 can be made by setting up a star shell A test problem and reading the transmitted orders at the gun mounts. For a more accurate transmission test, the front cover of the star shell computer should be removed and the transmitter dials set at the given values. On mods 1 and 2 these dials can be read without removing the cover.

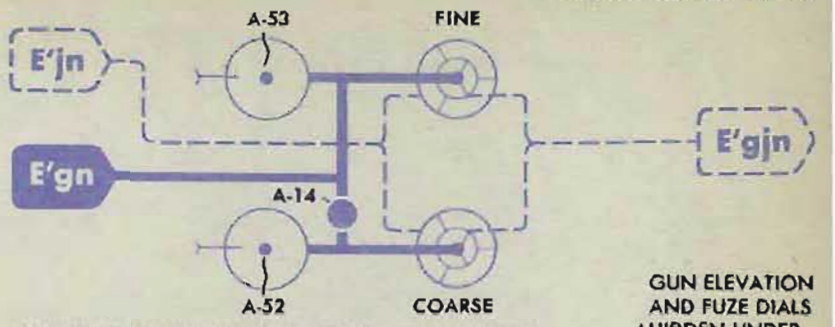
Checking B'grjn transmission

1. Set up the fire control switchboard to transmit star shell gun train order to each gun mount.
2. At the director, set star shell deflection spot on 0.
3. At the gun mounts, put the guns in AUTO control.
4. At the computer,
   for mod 0:
   Turn the control switch to LOCAL.
   Set the bearing dials on 59°, with the generated bearing crank in the OUT position. Use the *Ds* handcrank in the IN position to set the star shell gun train order dials on the exact value of 59° from both the increasing and decreasing directions.
   for mods 1 and 2:
   Put the star shell deflection handcrank in the SEARCH position, and set the star shell gun train order dials on 59°, from both the increasing and decreasing directions.
5. At the gun mounts, read the received value on the train dials for each direction of transmitter setting.
6. Continue the test in the same manner for *B'grjn* values of 118°, 177°, 236°, 295°, and 354°.

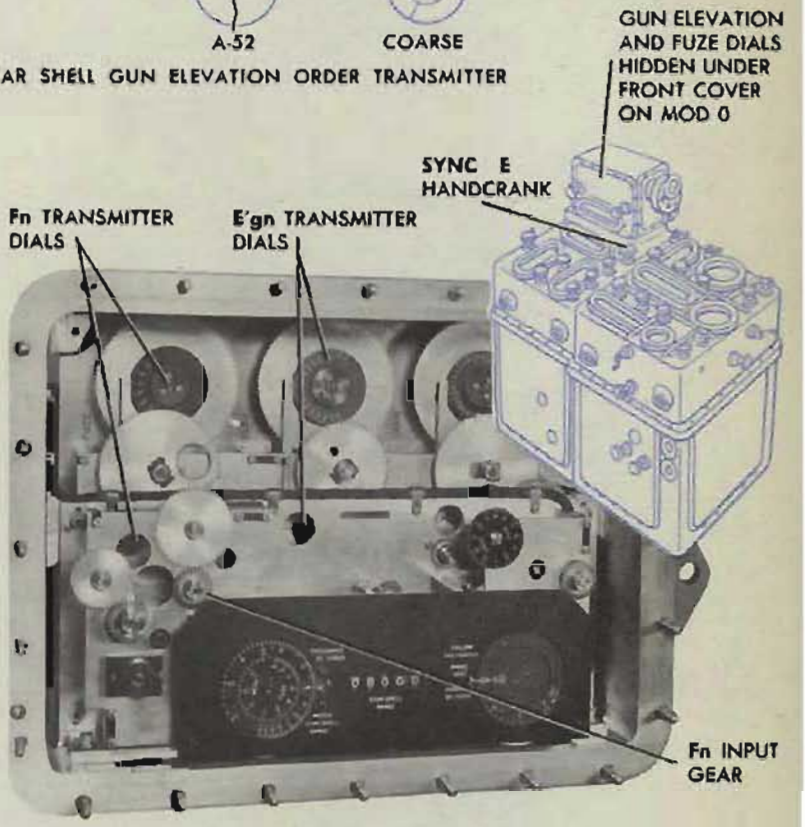
Gene Slover's US Navy Pages
Table of Contents

Checking E'gjn transmission

1 Set up the fire control switchboard to transmit star shell gun elevation order to each gun mount.
2 At the director, set star shell elevation spot on 0.
3 At the gun mounts, put the guns in AUTO control.
4 At the computer,
   for mod 0:
      Use the sync *E* handcrank in the OUT position to set the star shell gun elevation order dials on 1200′, from both increasing and decreasing directions.
   for mods 1 and 2:
      Put the star shell elevation handcrank in the SEARCH position and set the star shell gun elevation order dials on 1200′, from both increasing and decreasing directions.
5 At the gun mounts, read the received value on the elevation dials for each direction of transmitter setting.
6 Continue the test in the same manner for *E'gjn* values of 2000′, 2900′, 4000′, 4500′, and 5200′.



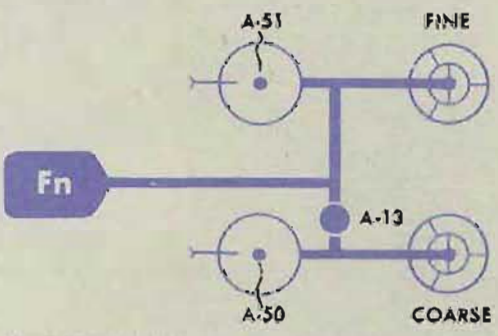
STAR SHELL GUN ELEVATION ORDER TRANSMITTER



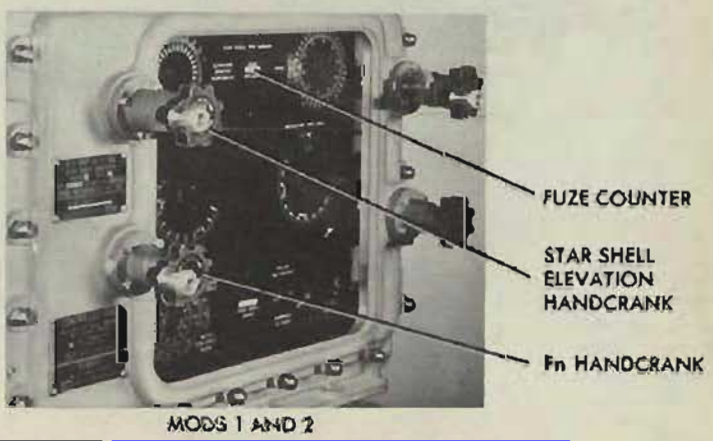
MOD 0

Checking Fn transmission

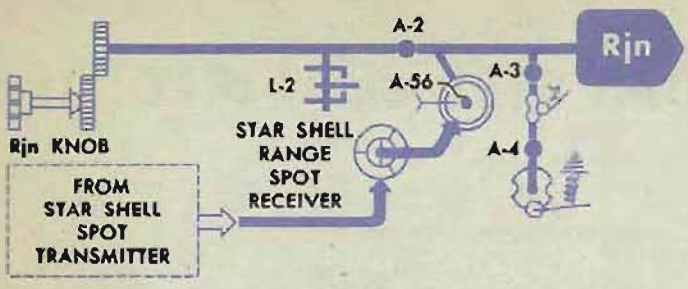
1 Set up the fire control switchboard to transmit star shell fuze setting order to each gun mount.
2 At the computer,
   for mod 0:
      Turn the *Fn* input gear to set the *Fn* dials at 9.00 seconds, from both increasing and decreasing directions.
   for mods 1 and 2:
      Use the *Fn* handcrank in the IN position to set the star shell fuze counter on 9.00 seconds, from both increasing and decreasing directions.
3 At the gun mounts, read the error on the fuze setting indicator regulator for each direction of transmitter setting.
4 Continue the test in the same manner for *Fn* values of 15.30, 21.60, 27.90, 34.20, and 40.50 seconds.



STAR SHELL FUZE ORDER TRANSMITTER

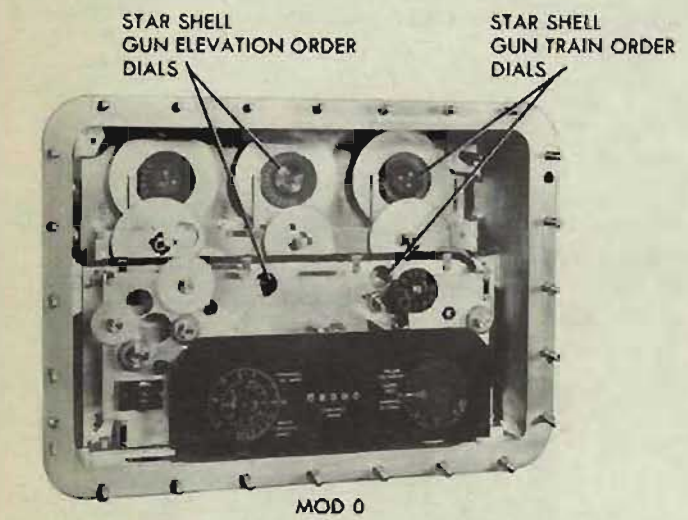


MODS 1 AND 2



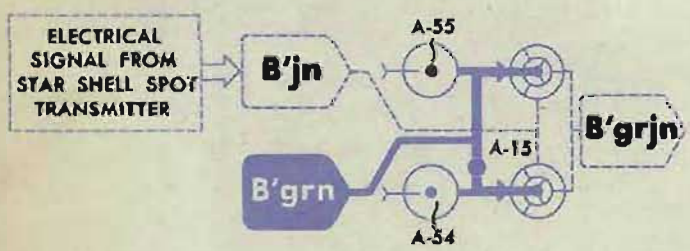
Checking Rjn transmission

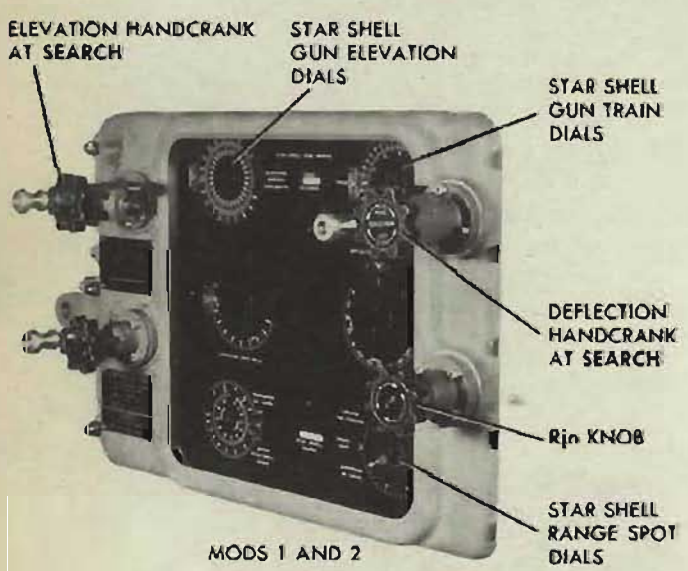
1. Set up the fire control switchboard to transmit star shell range spot to the star shell computer.
2. At the director, set star shell range spot at IN 1500 yards.
3. At the computer, match the star shell range spot dials and check that they read IN 1500 yards.
4. Continue the test in the same manner with range spot values of IN 900, IN 300, 0, OUT 300, OUT 900, and OUT 1500 yards.



Checking B'jn transmission

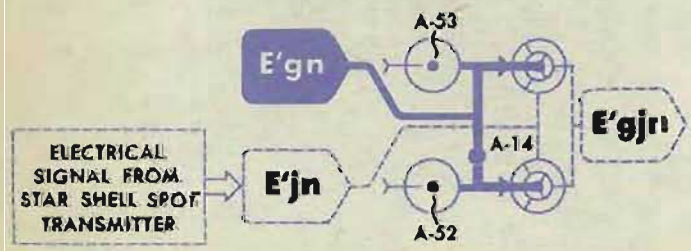
1. Set up the fire control switchboard to transmit star shell deflection spot to the star shell computer, and star shell gun train order to the guns.
2. At the gun mounts, put the guns in AUTOMATIC control.
3. At the star shell computer, set the star shell gun train order transmitter at 270°.
4. At the director, set star shell deflection spot at RIGHT 100 mils.
5. At the guns, read the gun train dials. They should now read 275°44′.
6. At the director; set star shell deflection spot at LEFT 100 mils.
7. At the guns, read the gun train dials. They should now read 264°16′.





Checking E'jn transmission

1. Set up the fire control switchboard to transmit star shell elevation spot to the star shell computer, and star shell gun elevation order to the guns.
2. At the gun mounts, put the guns in AUTOMATIC control.
3. At the star shell computer, set the star shell gun elevation order transmitter at 2000′.
4. At the director, set star shell elevation spot at UP 100 mils.
5. At the guns, read the gun elevation dials. They should now read 2344′.
6. At the director, set star shell elevation spot at DOWN 100 mils.
7. At the guns, read the gun elevation dials. They should now read 1656′.



ROUND ROBIN TEST — COMPUTER and DIRECTOR

A test of bearing, elevation, and range transmission between the computer and the director can be made instead of tests of the individual unit transmission. If excessive errors are found, the individual transmission checks should then be made to locate the errors.

Running the bearing test

At the fire control switchboard:

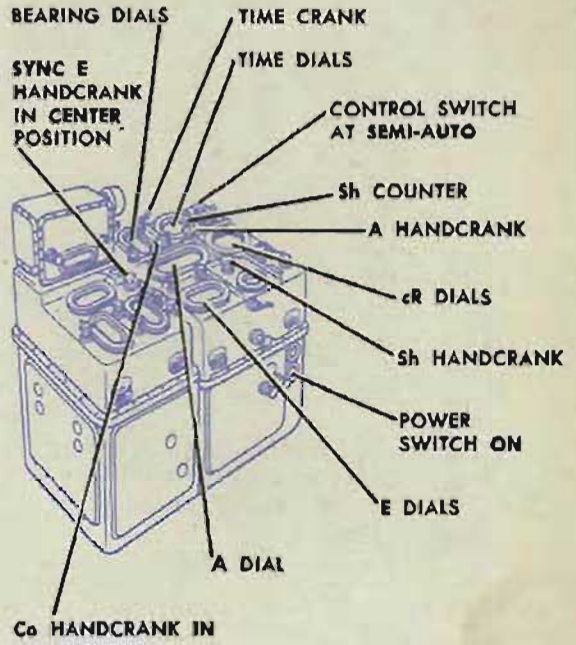
1 Energize director train transmission and bearing correction transmission.

At the director:

1 Energize the train motor.
2 Set the train selector lever in AUTO.
3 Set director train at 0°.
4 Stand by without moving the handwheels.

At the computer:

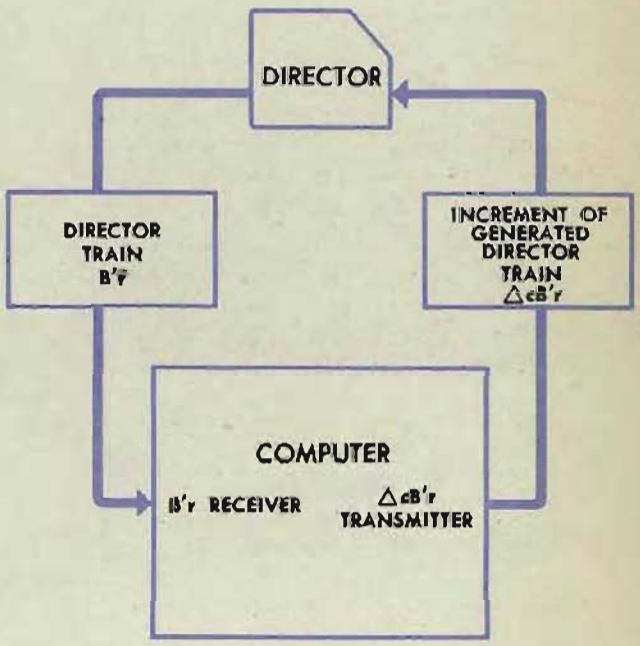
1 Turn the power ON.
Turn the control switch to SEMI-AUTO.
Set *L* and *Zd* at 2000′.
Set *A* at 90°.
Set *E* at 0°.
Set *Sh* at 300 knots.
Set *cR* at 3000 yards.
Put the *Co* handcrank IN.
2 Turn the time crank in the OUT position slowly and smoothly until at least 10° of bearing have been generated. Check that observed bearing turns smoothly and remains matched with generated bearing.
3 Repeat this procedure, starting with *A* at 270°.



Checking the overall transmission error

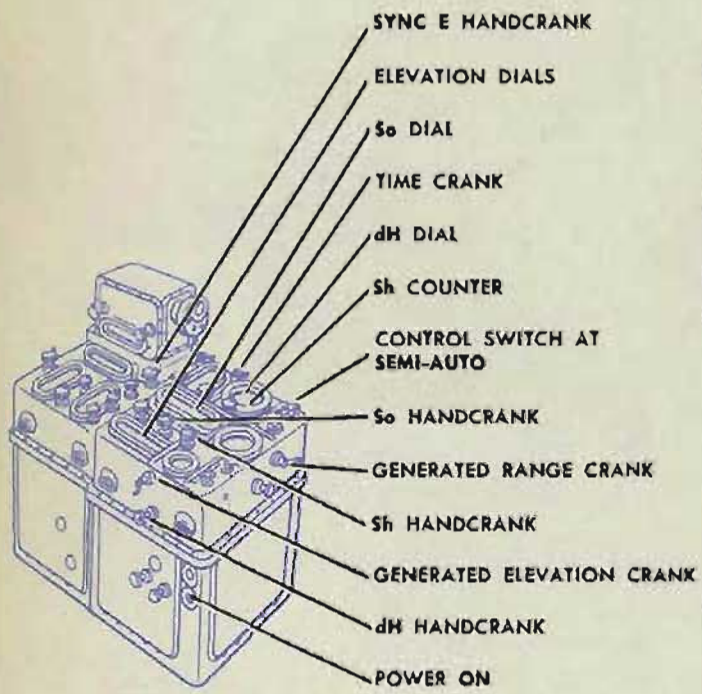
At the computer:

1 Set *A* at 90°.
2 Turn the time crank in the OUT position until observed bearing is on a definite value.
3 Turn the generated bearing crank in the OUT position and match one index of the fine inner dial to the 0 index of the fine ring dial.
4 Turn the time crank again until observed bearing increases about 1°.
5 Set *A* at 270°.
6 Turn the time crank until observed bearing is set at the value chosen in step 2.
7 Read the fine bearing dials. The difference between the previously chosen index of the inner dial and the 0 index of the ring dial represents the system error.



Gene Slover's US Navy Pages
Table of Contents

Running the elevation test



At the fire control switchboard:

1 Energize director elevation transmission and elevation correction transmission.

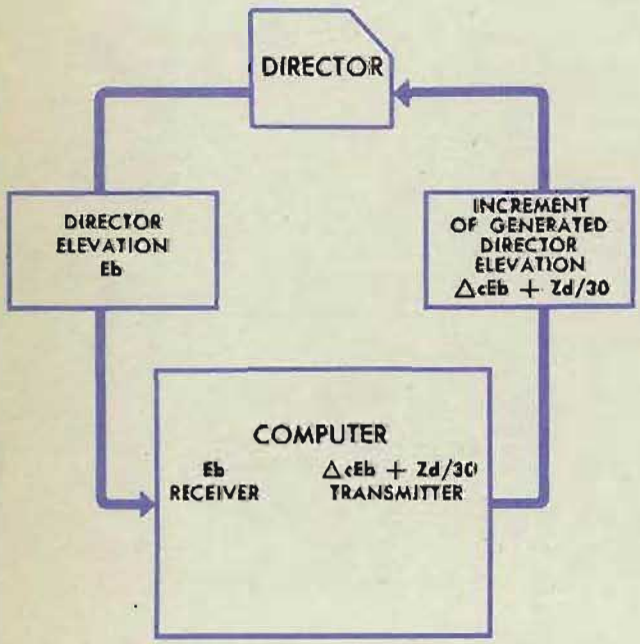
At the director:

1 Energize the elevation motor.
2 Set the elevation selector lever in AUTO.
3 Set director elevation at 0.
4 Stand by without moving the handwheels.

At the computer:

1 Turn the power ON.
Turn the control switch to SEMI-AUTO.
Set *L* and *Zd* at 2000′.
Set *So* and *Sh* at 0 knots.
Set *dH* on CLIMB 150 knots.
Set *cR* on 2000 yards. Match the sync *E* dials at the index with the sync *E* handcrank in the IN position.
2 Turn the time crank in the OUT position slowly and smoothly until at least 10° of elevation have been generated.
3 Check that observed elevation turns smoothly and stays matched with generated elevation.
4 Repeat this procedure with *dH* at DIVE 150 knots.

Checking the overall transmission error



1 Reset *dH* at CLIMB 150 knots.
2 Turn the time crank in the OUT position until observed elevation is set on a definite value.
3 Match one index of the fine inner dial to the 0 index of the fine ring dial with the generated elevation crank in the OUT position.
4 Turn the time crank again until observed elevation increases about 1°.
5 Set *dH* at DIVE 150 knots.
6 Turn the time crank again until observed elevation is on the same definite value chosen in step 2.
7 Read the fine elevation dials. The difference between the previously chosen index of the inner dial and the 0 index of the ring dial represents the system error.

Gene Slover's US Navy Pages Table of Contents

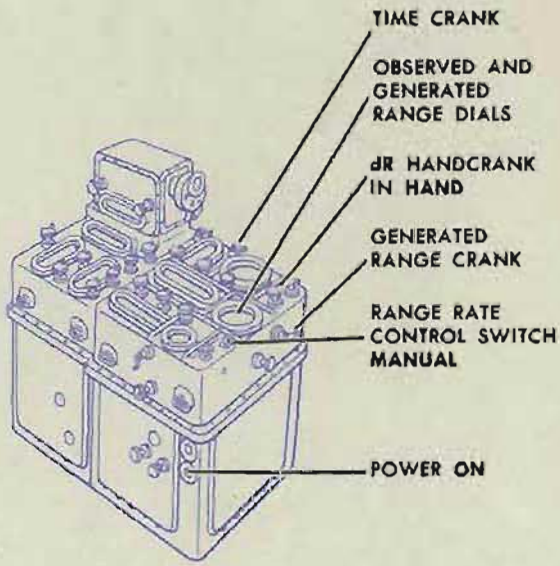
Running the range test

At the fire control switchboard:

1 Energize range transmission and range correction transmission.

At the director:

1 Turn the change of range receiver ON.
2 Turn the range selector switch to RANGE FINDER.
3 Set optical range at 10,000 yards.
4 Stand by without changing range.

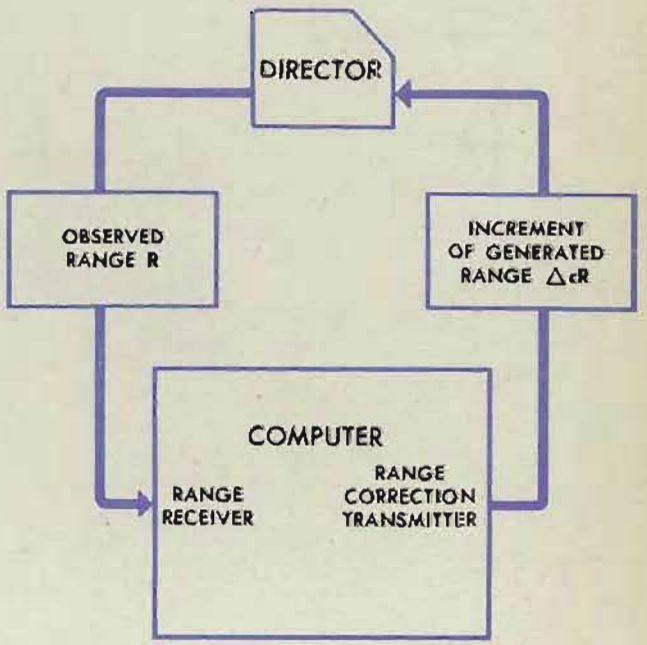


At the computer:

1 Turn the power ON.
Turn the range rate control switch to MANUAL.
Set *cR* at 10,000 yards.
Put the *dR* handcrank in HAND and set in a large positive rate.
2 Turn the time crank in the OUT position slowly and smoothly until at least 1000 yards range have been generated.
3 Check that observed range turns smoothly and stays matched with generated range.
4 Repeat this procedure with *dR* set at a large negative value.

Checking the overall transmission error

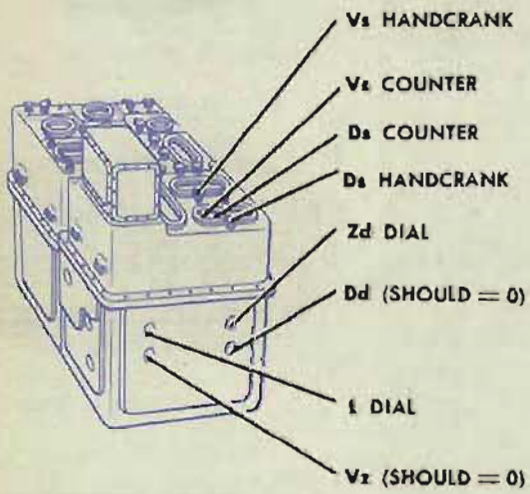
1 Set *dR* at a large positive value.
2 Turn the time crank slowly until the index of the fine observed range dial is at the fixed index.
3 Match the generated range dial index exactly at the fixed index with the generated range crank in the OUT position.
4 Turn the time crank slowly until *cR* has increased about 500 yards.
5 Set *dR* at a large negative rate.
6 Turn the time crank slowly until *cR* is again at the value set in step 3.
7 The difference between the observed and generated dials represents the system error.



Gene Slover's US Navy Pages
Table of Contents

OVERALL TRANSMISSION SYSTEM CHECK

An overall check of train and elevation transmission can be made instead of the individual unit check tests. If excessive errors are found, the individual transmission checks should be made to determine the source of error. The overall check is made by transmitting values from the director through the computer to the gun mounts.



Making the overall check

At the fire control switchboard:

1 Energize train and elevation transmission from the director to the computer, and from the computer to each gun mount.

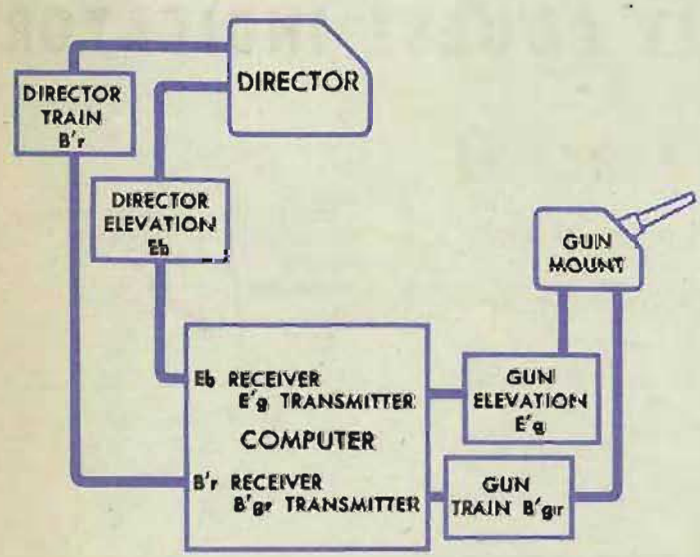
At the computer:

1 Energize and set up the computer to receive *B′r* and *Eb*.

2 Set *L*, *Zd*, and *Vs* at 2000′.
Set *Ds* at 500 mils.
Dd and *Vz* should now be at 0, with *B′gr* equal to *B′r*, and *E′g* equal to *Eb*.

At the director:

1 Set *B′r* and *Eb* at suitable values.
The director train indicator and the director elevation indicator dials should be brought on to these values slowly and carefully. The director may be operated in LOCAL control to approach the value, but to obtain an accurate setting, MANUAL control should be used. Set the director dials first in the increasing direction and then in the decreasing direction from an offset of approximately 2°.



At the gun mounts:

1 Energize the mounts and put them in AUTO.

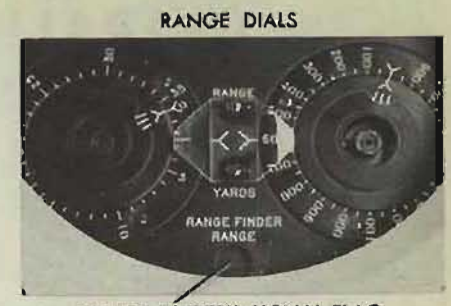
2 Read the transmitted values on the train indicator regulator and the elevation indicator regulator dials.
The difference between the reading at the gun mount and the value set at the director is the total system error.
NOTE:
When the fire control switchboard is set up for indicating transmission only, the mount should be shifted to LOCAL and the reading taken after pointers are matched.

Gene Slover's US Navy Pages
Table of Contents

CHECKING THE SIGNAL FLAGS

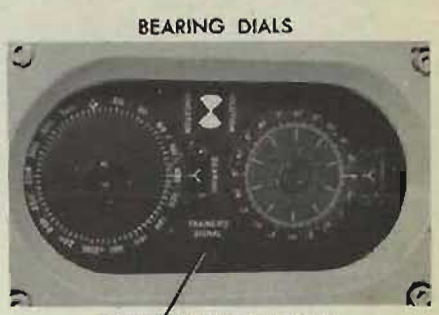
Range finder's signal flag

1 Energize the range transmission circuit and turn the power switch ON.
2 Check that the range finder's signal flag shows white when the range finder's signal key is closed.
3 Check that it releases and shows black when the signal key is open.



Trainer's signal flag

1 Energize the bearing transmission circuit and turn the power switch ON.
2 Check that the trainer's signal flag shows red when the trainer's signal key is closed.
3 Check that it releases and shows black when the signal key is open.



Pointer's signal flag

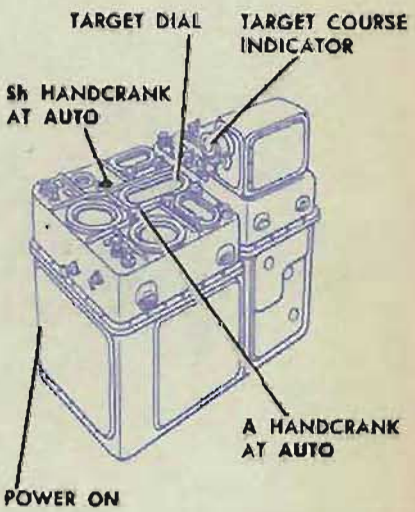
1 Energize the elevation transmission circuit and turn the power ON.
2 Check that the pointer's signal flag shows red when the pointer's signal key is closed.
3 Check that it releases and shows black when the signal key is open.

If a signal flag fails to operate, makes excessive noise, or sticks, see OP 1140A, Solenoid Signal Mechanism.

CHECKING THE TARGET COURSE INDICATOR

Operation

1 Turn the power switch ON.
2 Put the *Sh* and *A* handcranks in AUTO.
3 Depress the INCREASE button on the target course indicator.
Ct on the indicator should increase, and *A* on the computer target dial should decrease.
4 Depress the DECREASE button and check the operation in the opposite direction.



Transmission

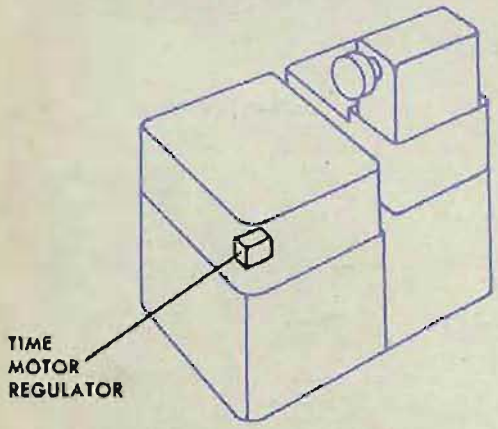
1 Set *B* at 0°.
2 Set *A* at each value listed below, and check that the target course indicator reads the corresponding value of *Ct*.

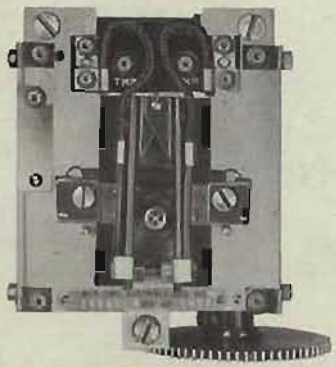
A–	120°	60°	0°	300°	240°	180°
Ct–	60°	120°	180°	240°	300°	360°

If the target course indicator does not operate correctly, see Locating Casualties, Target Course Indicator, page 566.

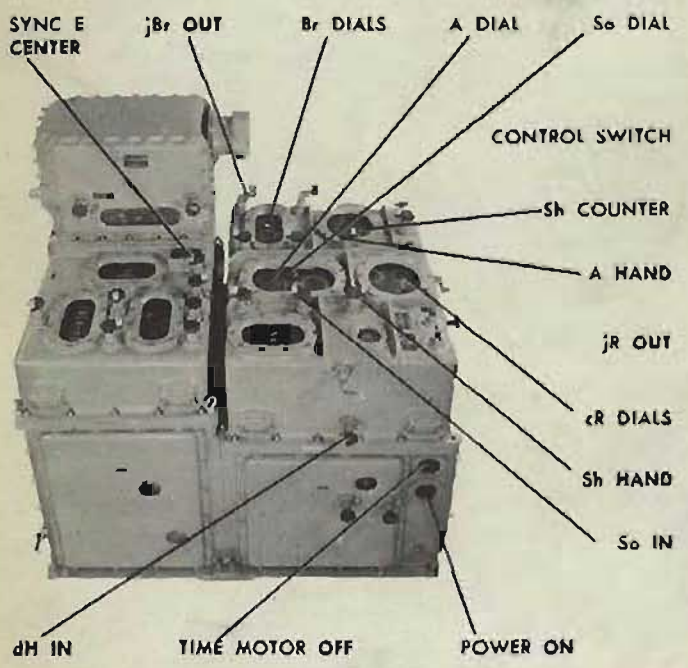
Gene Slover's US Navy Pages
Table of Contents

THE TIME MOTOR REGULATOR TEST





TIME MOTOR REGULATOR



The time motor regulator is tested by checking the speed of the time motor output with a stop watch. This test should be run as prescribed in the Log Book NAVORD FORM 1229, and should always be run when excessive errors occur in the B tests.

Before running the test

First, check that the power supply voltage to the computer is 115 ± 10 volts and that the frequency is 60 cycles ± 10%. Then:

1. Energize the computer power circuit at the fire control switchboard.
2. Turn the computer power switch ON.
3. Turn the time motor switch OFF.
4. Turn the control switch to SEMI-AUTO.

Set the following values into the computer to obtain an average load on the time motor shaft line:

Set *So* at [illegible] knots with the ship speed handcrank IN.

Set *Sh* at [illegible] knots with the target speed handcrank at HAND.

Set *dH* at [illegible] knots with the rate of climb handcrank IN.

Set *Br* at 135° with the generated bearing crank OUT, and the control switch at LOCAL.

Set *A* at 135° with the target angle handcrank at HAND.

Set *E* at 45° with the synchronize elevation handcrank at CENTER.

Set *cR* at [illegible] yards with the generated range crank OUT.

Return the control switch to SEMI-AUTO.

dR KNOB IN HAND & dR ON ZERO

[illegible]

RESTRICTED

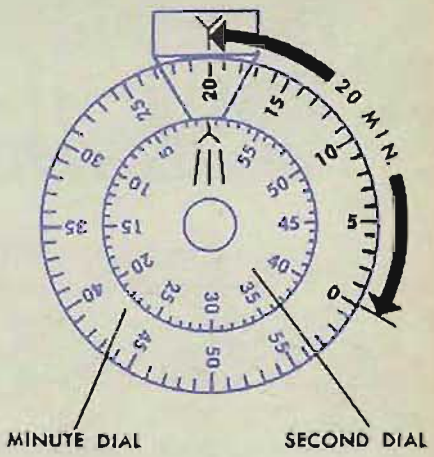
Gene Slover's US Navy Pages Table of Contents

Running the test

Turn the time motor switch ON.

Let the time motor run for at least one minute so that the regulator can take control.

Then, using a stop watch, measure the number of seconds that elapse during any twenty-minute period on the time dial.



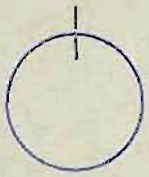
Recording test results

Record the results of the time motor regulator test on a time motor regulator test record form, in the log book.

Under *Time, Stop Watch,* enter the total number of seconds indicated on the stop watch for the twenty-minute dial movement.

Under *Error, Seconds,* enter the number of seconds over or under 20 minutes 0 seconds recorded on the stop watch. If the stop watch reading is over 20 minutes 0 seconds, the error is minus, and the time shaft line is turning too slow. If the reading is under 20 minutes 0 seconds, the error is plus, and the time shaft is turning too fast.

Under *Error, Seconds per Minute,* enter the error divided by twenty.



Adjusting the time motor regulator

If the error is greater than ±0.05 second per minute, the regulator may require adjustment. See *Locating Casualties, Time Motor Regulator,* page 562.

TIME MOTOR REGULATOR TESTS
RECORD OF TESTS

DATE	VOLTS AC SUPPLY	TIME STOP WATCH	ERR. SEC.	ERR. SEC./MIN.	DATE	VOLTS AC SUPPLY	TIME STOP WATCH	ERR. SEC.	ERR. SEC./MIN.
3 May 46	118	20 min. 0.8 sec.	-0.8	0.04					

Gene Slover's US Navy Pages
Table of Contents

TABLES OF OPERATING LIMITS

These tables list all limit stops and intermittent drives and the limits of operation of each. Limits of operation for the computer generally apply to Mod 7. Limits for the star shell computer apply to Mods 0, 1, and 2 as indicated.

These tables of operating limits are used when A or B test results indicate faulty operation. Then the limit stops and intermittent drives in the networks in error should be checked. The adjustment clamp associated with each limit stop is listed in the tables. For clamp locations, modification differences, and readjustments, refer to the *Readjustment Procedure.*

If any limit stop or intermittent drive requires readjustment, all adjustments on the line should be checked. To locate adjustment points on the line, consult a schematic diagram. To check these adjustments, refer to the *Readjustment Procedure.*

OPERATING LIMITS – INTERMITTENT DRIVES

INTERMITTENT DRIVE	LIMITS		ADJUSTMENT CLAMP
	LOWER	UPPER	
cR	750 Yds.	22,500 Yds.	A-233
E	-2°	+85°	A-250
E_2	0°	90°	A-72
dRs	-450 Kn.	+450 Kn.	A-181
Ds	320'	680'	A-96
Eb+Vs	1640'	7160'	A-60
Vs	2000'	3800'	A-97
R_2	1500 Yds.	18,900 Yds.	A-156

OPERATING LIMITS – STAR SHELL COMPUTER MK. 1

LIMIT STOP NUMBER	QUANTITY	LIMITS		ADJUSTMENT CLAMP
		LOWER	UPPER	
L-1	WrD + KRdBs	-60 Kn.	+60 Kn.	A-6, Mods 0,1,2
L-2	Rjn	IN 1500	OUT 1500	A-2, Mod 0
L-2	Rjn	IN 2857	OUT 1500	A-2, Mod 1
L-2	Rjn	IN 2700	OUT 1500	A-2, Mod 2
L-3	Fn	8.20 secs.	41.55 secs.	A-16, Mod 0
L-3	Fn	8.20 secs.	41.55 secs.	A-19, Mod 1
L-3	Fn	9.70 secs.	46.70 secs.	A-19, Mod 2
L-4	jDwn	4000 Yds.	15,000 Yds.	A-5, Mods 0 and 1
L-4	jDwn	8000 Yds.	19,500 Yds.	A-5, Mod 2

Gene Slover's US Navy Pages

Table of Contents

OPERATING LIMITS – LIMIT STOPS, COMPUTER MK. I				
LIMIT STOP NUMBER	QUANTITY	LIMITS		ADJUSTMENT CLAMP
		LOWER	UPPER	
L-1	So	0	45 Kn.	A-527
L-2	Sh	0	400 Kn.	A-193
L-3	Sw	0	60 Kn.	A-528
L-4	dH	-250 Kn.	+150 Kn.	A-525
L-5	dRh	-440 Kn.	+440 Kn.	A-119
L-6	RdBs	-400 Kn.	+400 Kn.	A-121
L-7	RdE	-400 Kn.	+400 Kn.	A-118
L-8	dR	-450 Kn.	+450 Kn.	A-524
L-9	Ywgr	-100 Kn.	+100 Kn.	A-101
L-10	cR	0	35,000 Yds.	A-196
L-11	Eb	500'	8600'	A-90
L-12	E	-25° 00'	+85° 00'	A-116
L-13	Rrr	1	5	A-172
L-14	Tg	0	6 secs.	A-535
L-14	Tg+F-Tf	0	50 secs.	A-262
L-15	I.V.	2350 f.s.	2600 f.s.	A-536
L-16	L	480'	3520'	A-58
L-17	Zd	480'	3520'	A-30
L-18	jB'r	-11° 40'	+11° 40'	A-199
L-19	R_2	500 Yds.	18000 Yds.	A-74
L-20	Tf/R_2	.00122	.00336	A-38
L-21	R_2	300 Yds.	18,200 Yds.	A-41
L-22	Vf+Pe	0	2500'	A-14
L-23	R_2	300 Yds.	18,200 Yds.	A-16
L-24	Tf	0.6 sec.	60.6 secs.	A-19
L-25	R_2	300 Yds.	18,200 Yds.	A-21
L-26	DISCONTINUED			
L-27	DISCONTINUED			
L-28	Dtwj	-518 mils	+518 mils	A-198
L-29	Rj	IN 12,000	OUT 1800	A-234 A-235
L-30	Dj	LEFT 180	RIGHT 180	A-500
L-31	Vj	DOWN 180	UP 180	A-501
L-32	Dd	-120°	+120°	A-31
L-33	UNASSIGNED			
L-34	Vz	-2940'	+1860'	A-29
L-35	F	0.6 sec.	55.0 secs.	A-45
L-36	R_3	-1250 Yds.	+19,750 Yds.	A-47
L-36	R_3	-13,150 Yds.	+31,650 Yds.	A-48
L-37	V	200'	3800'	A-184
L-38	Tg	0	6 secs.	A-535
L-39	I.V.	2350 f.s.	2600 f.s.	A-607

Gene Slover's US Navy Pages

Table of Contents

Part two

ANALYSIS OF TEST ERRORS

Introduction

The following chapters on the *Analysis of Test Errors* provide a means for locating the causes of the errors, as well as methods for correcting them. The procedure described in each chapter consists of classifying the types of errors, determining the conditions under which the errors exist, and, finally, locating the unit or mechanism actually causing the errors. The method of correcting the errors will depend upon the nature of the trouble. It is essential for the test operator to be familiar with OP 1140, which describes the function and operation, and OP 1140A, which describes the maintenance, of the various standard units. Also, in this OP, the section on *Locating Casualties* should be studied frequently so that the operator will be able to recognize typical troubles.

Whenever the results of a test problem show excessive errors, the problem should be completely rechecked. After checking the error calculations, reread all of the problem setup values. Then move all of the input quantities off their settings. Repeat the setup and rerun the test problem. If the excessive errors no longer exist, although no mistake was made originally in the setup or error calculation, the trouble was probably due to sticking in a unit or shaft line, and moving an input quantity released it. The exact cause of the trouble should be located and corrected. If the large errors persist, the next step is to run several other test problems, preferably the complete set, to gain information for analysis of the errors. However, if any apparent symptoms of trouble such as binding of lines, erratic operation, or unusual noises, appear in the course of running a test, the instrument should be secured and the trouble located before proceeding further with the test.

Gene Slover's US Navy Pages
Table of Contents

In correcting an excessive error, the loosening and readjustment of a clamp should not be attempted until all other possible causes of the error have been eliminated. Adjustment clamps do not slip without reason. If it is decided that a clamp has slipped, try to tighten it before starting to loosen it for readjustment. If the clamp can be tightened further, it may reasonably be assumed that the clamp slipped during normal operation. If the clamp is already tight, and seems to hold the adjustment properly, keep checking until the cause of the adjustment error is located.

Gene Slover's US Navy Pages
Table of Contents

A TEST ANALYSIS

This test analysis provides a method of finding and correcting A test errors. To find the cause of these errors, the type of errors should be determined first. Then all the networks in error can be found, and the network causing the errors and the exact cause of the error in that network can be located and corrected. Several additional A test problems should be run before any attempt is made to locate and correct the errors. This eliminates the possibility that the errors were introduced by faulty setup of the problem or by mistakes in computation.

TYPES OF ERRORS

A test errors can be divided into two types: small errors and large errors.

Small errors in a transmitted quantity are errors that are greater than the allowable average, but are within the allowable maximum.

Large errors in a transmitted quantity are errors which exceed the allowable maximum. *Large errors should be located and corrected.*

CAUSES OF ERRORS

Small errors, or errors that have gradually increased over a period of time, are usually due to wear in the computer. Errors due to wear generally require repair to reduce lost motion in the units and shaft lines.

Large errors in the transmitted quantities are usually caused by a dead or faulty follow-up, a mechanical defect in a shaft line or mechanism, a disengaged coupling, or an adjustment error. By comparing the instrument readings with the A test computed intermediate quantities, all the networks in error can be determined. When all the networks in error are known, the network causing the error can be found and the source of the error located.

Determining the networks in error

Each transmitted quantity is computed in several networks. The independent variables are the inputs to the first group of networks. The outputs of these networks are the intermediate quantities which are, in turn, inputs to several other networks. The transmitted quantities are the outputs from the final group of networks. Therefore, the cause of error in a transmitted quantity may be in any one of several networks. Errors in more than one of the transmitted quantities are usually caused by an error in an intermediate network.

Gene Slover's US Navy Pages Table of Contents

To find the intermediate networks in error, the dial or counter reading of each intermediate quantity should be checked against its value on the A test record form for the problem setup in the instrument. When an intermediate quantity is correct, all the quantities used in computing it are correct. When an intermediate quantity is in error, its network or one or more of its network inputs are also in error.

Locating the cause of error in a network

When the network causing the errors is determined, any follow-ups in the network should be checked. Then all shaft lines and computing mechanisms should be carefully inspected for mechanical defects. If no mechanical defects are found, all dials and counters in the network should be checked against their limit stops. After all these checks have been made, the adjustments in the network should be checked, beginning with the last adjustment known to be correct.

Checking follow-ups

The following zero test can be used to check the operation of all the follow-ups before checking the individual networks:

1 Set the computer for A tests, and set in the following independent variables: *Co, So, Sh, Sw, dH, Bw, Tg,* and *E* on 0; match the sync *E* dials.
Set *Rj, Vj,* and *Dj* on 0.
Set *Br* on 270° and *A* on 90°.
Set *L* and *Zd* on 2000′.
Set *I.V.* on 2550 f.s.
Set *cR* to make *Vs* equal 2100′.

2 Read the following transmitted and intermediate quantities, and compare the reading with the value given:
B′gr should read 270°00′ ± 5′.
E′g should read 2100′ ± 5′.
Ds should read 500 mils ± 1.5 mils.
R2 should equal *cR* ± 10 yards.
cR should read 2840 yards ± 20 yards.
Pv should read 0°.
Ph should read 2° LEFT.
F should read 3.88 sec. ± 0.05 sec.
Dd and *Vz* should read 0′.
Check the follow-ups used in computing any quantity in error.

A faulty follow-up may cause error in several ways. It may synchronize slowly or not at all. The output may be erratic or oscillating. Check the synchronization. If the follow-up is dead or faulty, refer to the chapter on follow-ups in this OP and in OP 1140A.

Gene Slover's US Navy Pages
Table of Contents

Checking for mechanical troubles

An error may be caused by mechanical troubles such as faulty gear meshes, jammed or broken mechanisms, foreign material in the instrument, or an adjustment which has slipped.

Turn each shaft line in the network in error to check that there is no jamming, sticking, slipping, or excessive lost motion in the lines.

If all shaft lines are in proper working condition, check the computing units in the network. A series of unit check tests are provided for this purpose on pages 190 to 227. If there are mechanical defects in any unit, refer to OP 1140A.

Checking for disengaged couplings

An Oldham coupling between two shafts may disengage and then engage again after one shaft has made one or more revolutions. This will throw the shaft line out of adjustment. A disengaged coupling may also cause a removable shaft to fall out or may cause jamming and sticking of a shaft line. Look for any shaft that may have fallen out and check that all the couplings in the network are engaged. Refer to *Shaft Line Devices*, OP 1140A.

Checking for adjustment errors

A clamp may have slipped and altered the adjustment between mechanisms, or it may have caused an error in a counter or dial reading. No readjustment should be made before the cause of a faulty adjustment is found. If mechanical trouble in a unit has caused a clamp to slip and the clamp is readjusted before the mechanical defect has been corrected, the clamp will slip again and upset the adjustment.

No readjustment should be made until the preceding adjustments on the line have been checked and the value on the line is known to be correct.

The instructions given for making readjustments should be followed *carefully*. After readjusting any clamp, all other adjustments in the network in error should be checked.

A complete set of A tests should be run after any readjustment.

Warning

Altering an adjustment to compensate for an error in one A test usually will not correct the cause of the error. Altering one quantity without removing the cause of the error merely alters the output quantity for that particular A test. In most cases, the overall results will be made worse.

Gene Slover's US Navy Pages
Table of Contents

THE INTERMEDIATE QUANTITIES

During the analysis of test errors, the intermediate quantities are set at definite values for check tests of individual units. The following section deals with the reading and the setting up of the various intermediate quantities.

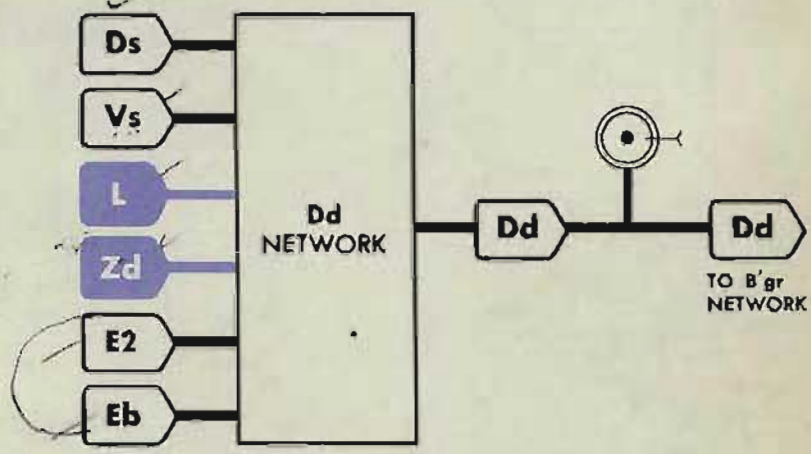
The intermediate quantities given on the A test record form may be divided into three groups:

Quantities that can be read without removing the covers.
Quantities that can be read only after the covers are removed.
Quantities that cannot be read.

The following intermediate quantities can be read without removing any covers.

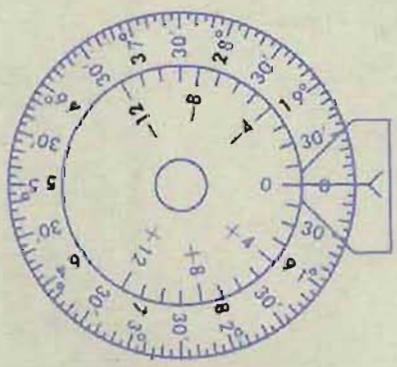
Dd Total deflection in deck plane

Dd will be in error if there is an error in *Ds, Eb, E2, Vs, L,* or *Zd. Dd* is an input to the *B'gr* network. Therefore an error in *Dd* will cause an error in *B'gr.*



Reading Dd

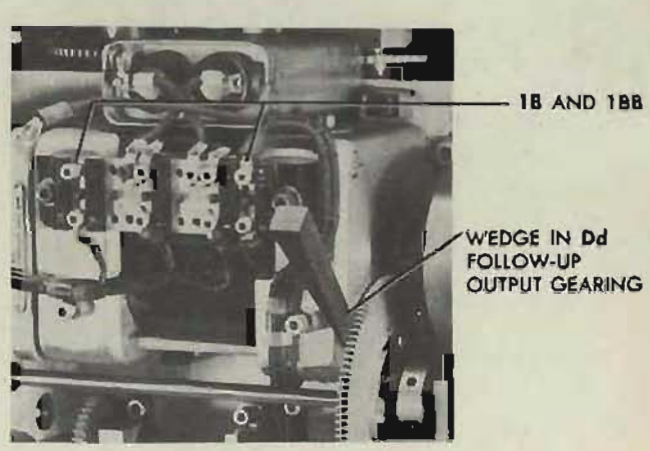
Dd can be estimated to within 1′ on the *Dd* dials at the rear of the computer. The plus values are shown in white, the minus in red.



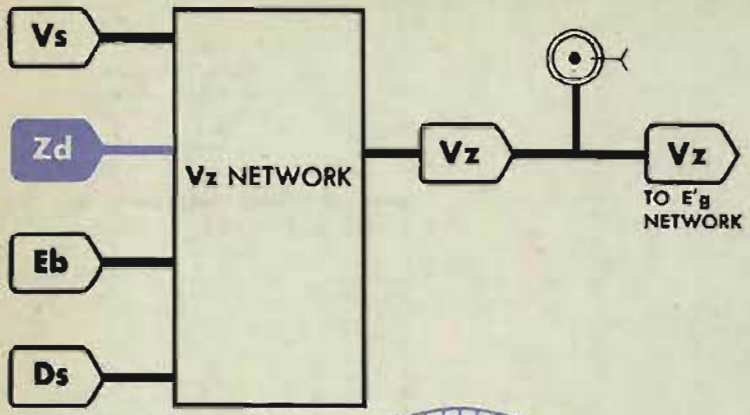
Setting Dd

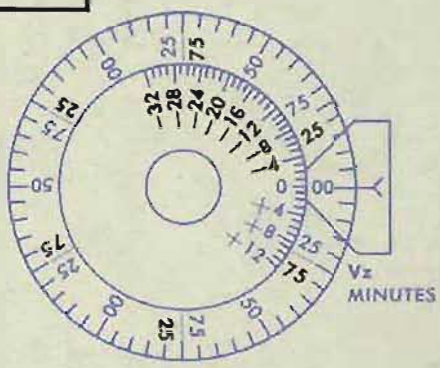
To set *Dd* at a desired value, push the *Ds* handcrank IN and turn it until that value of *Dd* is read on the *Dd* dials. As an alternative, disconnect power leads 1B and 1BB of the *Dd* follow-up and turn the output gearing by hand. When the *Dd* dials read the desired value, wedge the *Dd* follow-up output gearing.

To set *Dd* at computed zero, set *Zd* at 2000′ and *Ds* at 500 mils.



Gene Slover's US Navy Pages
Table of Contents





Vz Trunnion tilt elevation correction

Vz will be in error if there is an error in *Vs*, *Ds*, *Eb*, or *Zd*. *Vz* is an input to the *E'g* network. Therefore, an error in *Vz* will cause an error in *E'g*.

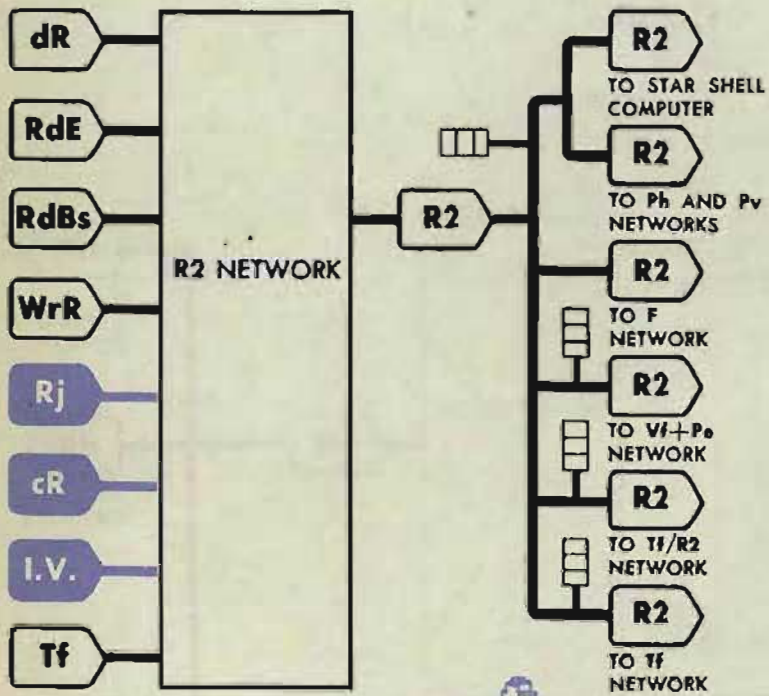
Reading Vz

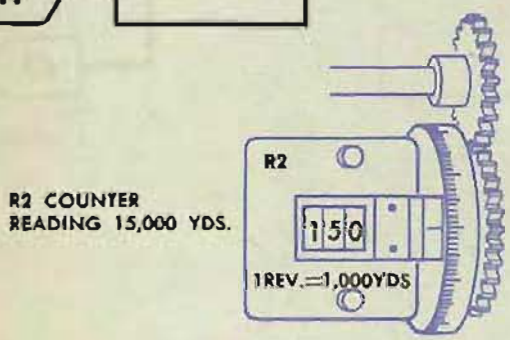
Vz can be estimated to within 1′ on the *Vz* dials, at the rear of the computer. The plus values are shown in white, the minus in red.

Setting Vz

To set *Vz* at a desired value, disconnect power leads 1D and 1DD of the *Vz* follow-up and turn the output gearing by hand. When the *Vz* dials read the desired value, wedge the *Vz* follow-up output gearing.

To set *Vz* at computed zero, set *Ds* at 500 mils and *Zd* at 2000′.





R2 Advance range

R2 will be in error if there is an error in *dR*, *RdE*, *RdBs*, *WrR*, *Tf*, *cR*, or *I.V.* *R2* is an input to the *Tf*, *Tf R2*, *Vf + Pe*, *F*, *Ph* and *Pv* networks and to the star shell computer. Therefore, an error in *R2* will cause errors in all these quantities.

Reading R2

R2 can be read to the nearest 5 yards on the *R2* indicating counter at the rear of the computer, or on one of the three other *R2* counters under cover 4.

Setting R2

To set *R2* at a desired value, turn the generated range crank in the OUT position until the *R2* indicating counter reads that value.

To set *R2* equal to *cR*, set *So*, *Sh*, *Sw*, *dH*, and *Rj* at zero, *Br* and *A* at 90°, and *I.V.* at 2550. *R2* should then equal *cR*.

Gene Slover's US Navy Pages
Table of Contents

Br Relative target bearing

Br will be in error if there is an error in *L*, *Zd*, or *B'r*.

Reading Br

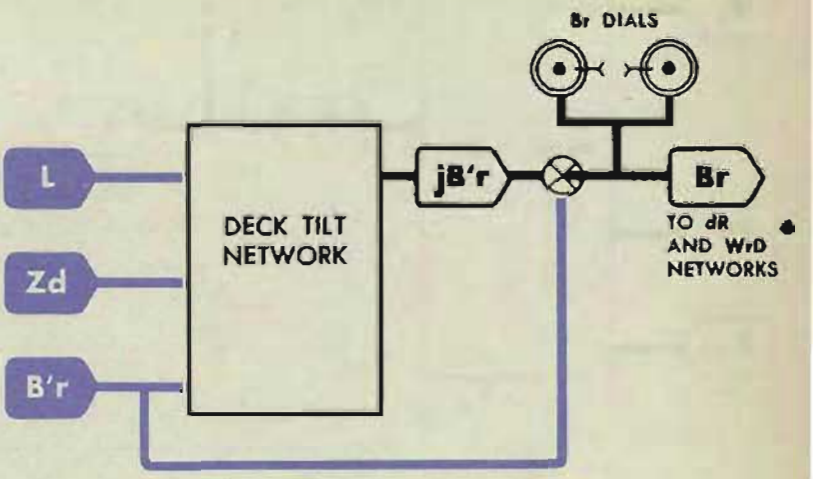
Br can be estimated to within 1′ on the bearing dial.

Setting Br

To set *Br* at a desired value, set the control switch at LOCAL and turn the generated bearing crank in the OUT position until the bearing dials read that value.

To set *Br* equal to *B'r*, set *L* and *Zd* on 2000′. *Br* should then equal the value of *B'r* being transmitted from the director.

To set *Br* equal to *B'gr*, set *L* and *Zd* on 2000′. Set *Dd* on zero. *B'r* should then equal *B'gr*.



dR Range rate – diving speed

dR will be in error if there is an error in *Br*, *E*, *So*, *Sh*, *dH* or *A*. *dR* is an input to the *R2*, *F*, and integrator networks. Therefore, an error in *dR* will cause an error in these quantities.

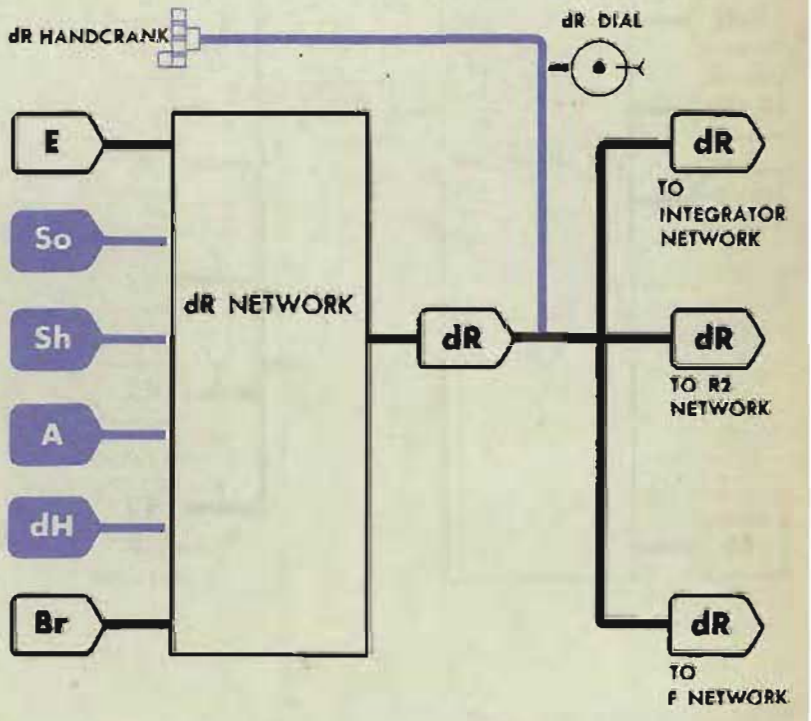
Reading dR

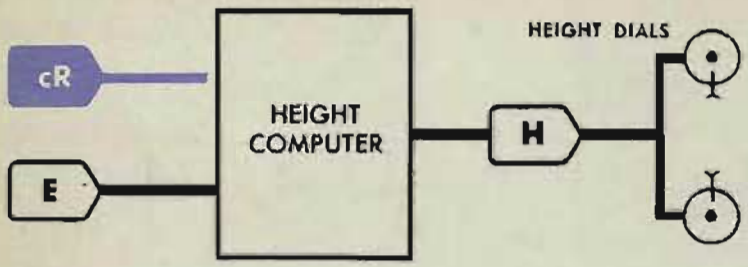
dR can be read on the *dR* dial, at the front of the computer. The *dR* dial is graduated and numbered on the negative, or diving, side only. Therefore, positive values of *dR* cannot be read. Negative values of *dR* can be estimated to within 1 knot. To check for a small error, a test should be used in which *dR* has a negative value in round numbers.

Setting dR

Set *dR* directly by turning the *dR* handcrank in the HAND position.

To set *dR* at computed zero, set *So*, *Sh*, and *dH* at zero; *dR* handcrank at AUTO.





H Height

H will be in error if *cR* or *E* is in error. *H* is an input to the height dials only.

Reading H

H can be estimated to within 5′ on the *H* dials at the front of the computer.

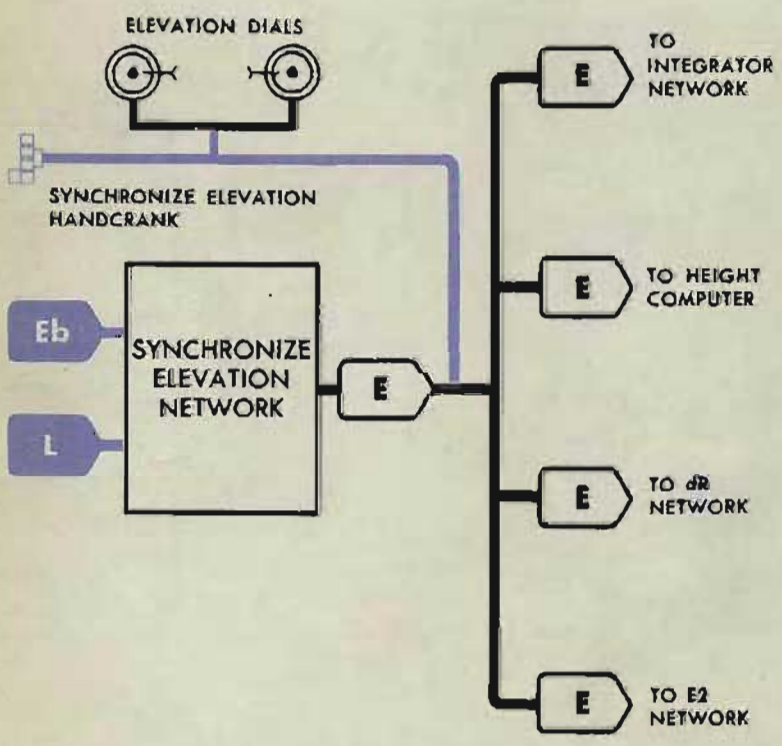
Setting H

To set *H* at a desired value, set *E* at a high value and turn the generated range crank until that value of *H* can be read on the height dials.

To set *H* at 0, set *E* or *cR*, or both, at 0.

NOTE:
Errors in *H* have no effect on any of the transmitted or intermediate quantities.

Check *H* by making the unit check test of the height computer.



E Target elevation

E is an intermediate quantity when *Eb* is received from the director.

$E = Eb - L$

E will be in error if *L* or *Eb* is in error.

E is an input to the *dR*, *E2*, *H* and integrator networks. Therefore, an error in *E* will cause an error in all these quantities.

Reading E

E can be estimated to within 1′ on the *E* dials at the front of the computer, and on either of the two *E* check counters installed in computers with Serial Nos. 435 and higher.

Setting E

To set *E*, turn the synchronize elevation handcrank in the CENTER position, until the *E* dials read the desired value.

Gene Slover's US Navy Pages Table of Contents

The following intermediate quantities can be read on counters after cover is removed.

E2 Predicted angle of elevation

$E2 = E + V$

E2 will be in error if *E* or *V* is in error. *E2* is an input to the *Tf*, *Tf/R2*, *Vf + Pe*, *F*, *V*, *WrR* and *WrE*, *Dd* and *Ph* and *Pv* networks. Therefore, an error in *E2* will cause an error in all these quantities.

Reading E2

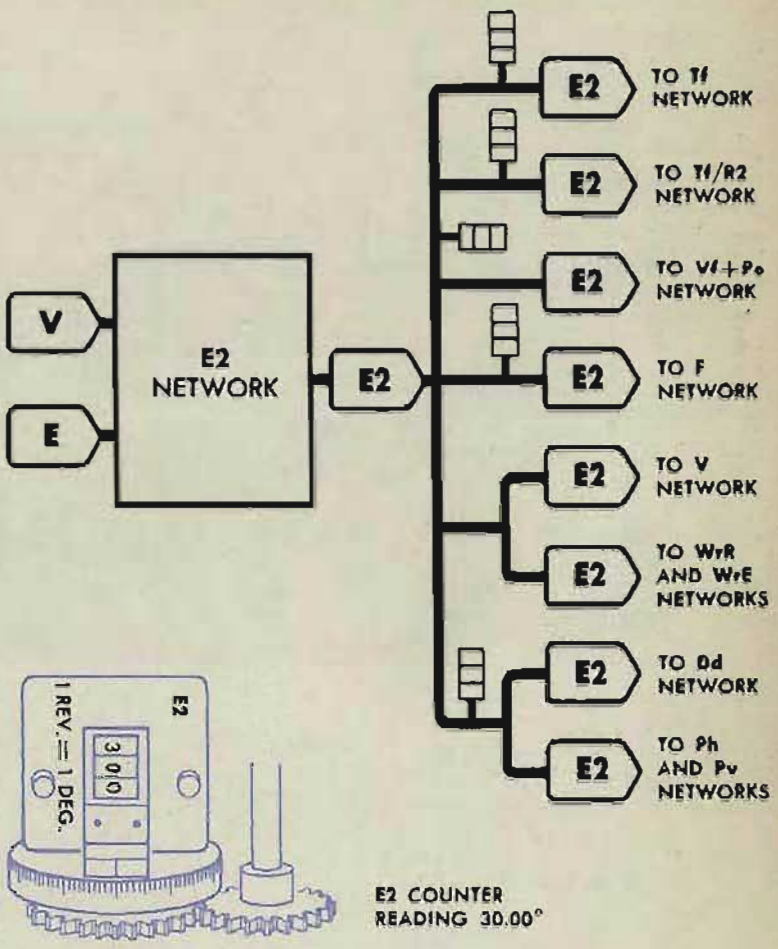
E2 can be read to within 0.01° on any of the five *E2* counters under cover 4, or on the *E2* matching counter under cover 6.

Setting E2

To set *E2*, turn the synchronize elevation handcrank in the CENTER position until the *E2* counter reads the desired value.

To set *E2* equal to *E*, set *Sw*, *So*, *Sh*, and *dH* at zero, *Br* and *A* at 90°, *Ds* at 500 mils, and *Vj* at 0 mils. Pull the sight angle handcrank OUT so that the *V* follow-up will synchronize. *E2* should now equal *E*.

ALTERNATE SETTING: Remove cover 4 and set *Vf + Pe* on zero. Set *Vs* on 2000′, and *I.V.* on 2550. *E2* should now equal *E*.



E2 COUNTER READING 30.00°

Tf Time of flight

Tf will be in error if *E2* or *R2* is in error. *Tf* is an input to the *R2* network. Therefore, an error in *Tf* will cause an error in *R2*.

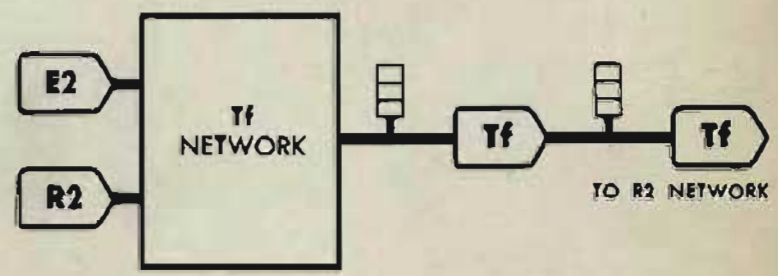
Reading Tf

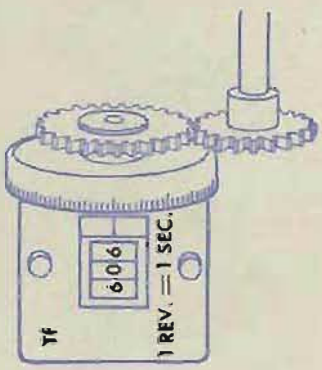
Tf can be read to within 0.01 seconds on either of the *Tf* counters under cover 4.

Setting Tf

To set *Tf*, turn the power ON and turn the generated range crank in the OUT position until the *Tf* counters read the desired value.

ALTERNATE SETTING: Disconnect power leads A and AA from the *Tf* follow-up and turn the output gearing by hand. When the *Tf* counters read the desired value, wedge the *Tf* follow-up output gearing.

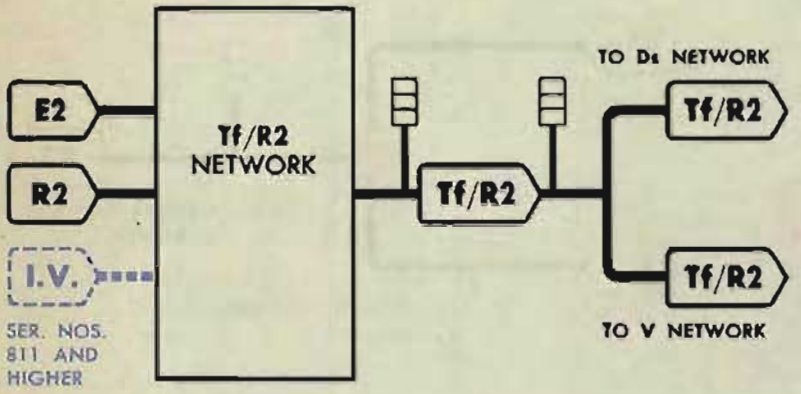


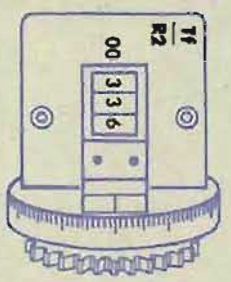


Tf COUNTER READING 60.60 SEC.

Gene Slover's US Navy Pages

Table of Contents





Tf/R2 Time of flight divided by advance range

Tf/R2 will be in error if *E2* or *R2* is in error. *Tf/R2* is an input to the *Ds* and *V* networks. Therefore, an error in *Tf/R2* will cause an error in *Ds* and *V*.

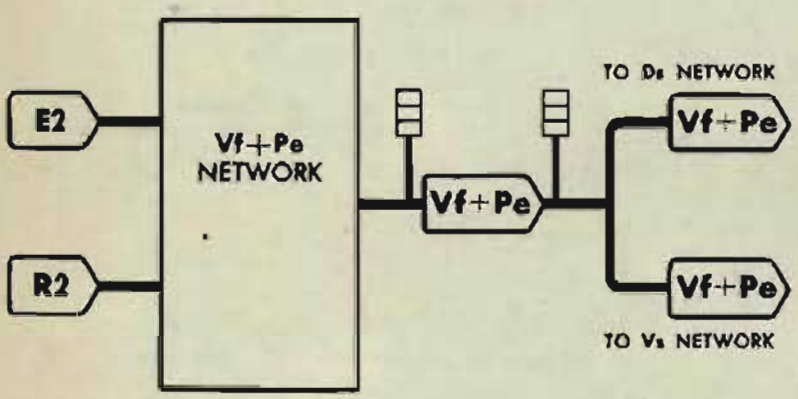
Reading Tf/R2

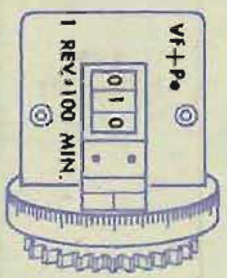
Tf/R2 can be read to within 0.000001 second per yard on either of the *Tf/R2* counters under cover 4.

Setting Tf/R2

To set *Tf/R2* at a desired value, turn the power ON, and turn the generated range crank in the OUT position until the *Tf/R2* counters read that value.

ALTERNATE SETTING: Disconnect power leads B and BB of the *Tf/R2* follow-up and turn the output gearing by hand. When the *Tf/R2* counters read the desired value, wedge the *Tf/R2* follow-up output gearing.





Vf + Pe Superelevation plus elevation parallax

Vf + Pe will be in error if *E2* or *R2* is in error. *Vf + Pe* is an input to the *Vs* and *Ds* networks. An error, therefore, in *Vf + Pe* will cause errors in *Vs* and *Ds*.

NOTE:
Vf + Pe has only a small effect on *Ds*.

Reading Vf+Pe

Vf + Pe can be read to within 1′ on either of the two *Vf + Pe* counters under cover 4.

Setting Vf+Pe

To set *Vf + Pe*, turn the power ON and turn the generated range crank in the OUT position until the *Vf + Pe* counter reads the desired value.

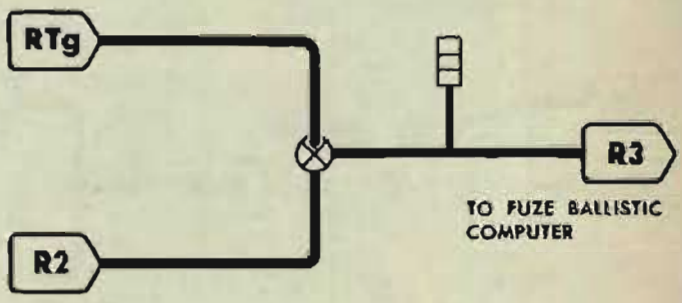
ALTERNATE SETTING: Disconnect power leads C and CC of the *Vf + Pe* follow-up and turn the output gearing by hand. When the *Vf + Pe* counters read the desired value, wedge the *Vf + Pe* follow-up output gearing.

Gene Slover's US Navy Pages Table of Contents

R3 Fuze range

$R3 = R2 + RTg$

R3 will be in error if *R2*, *dR* or *Tg* is in error. On Serial Nos. 781 and higher, errors in *Tf*, *F*, *I.V.*, *RdBs* or *RdE* will also cause errors in *R3*. *R3* is an intermediate quantity in the *F* network, and is used in computing the transmitted quantity of fuze. Therefore, an error in *R3* will cause an error in *F*.



Reading R3

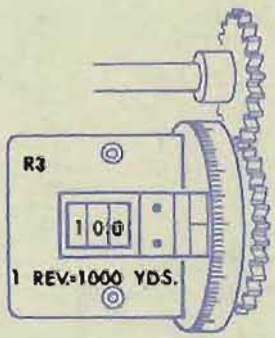
R3 can be estimated to within 1 yard on the *R3* counter under cover 4.

Setting R3

To set *R3*, turn the generated range crank in the OUT position until the *R3* counter reads the desired value.

To set *R3* equal to *R2*, set *dR* and *Tg* at 0; on Serial Nos. 781 and higher, also set *RdBs* and *RdE* at 0, set *I.V.* at 2550 f.s., and set *Tf* equal to *F*.

The following intermediate quantities cannot be read on any computer dial or counter. The complete network for each quantity has to be checked to determine if the quantity is in error.



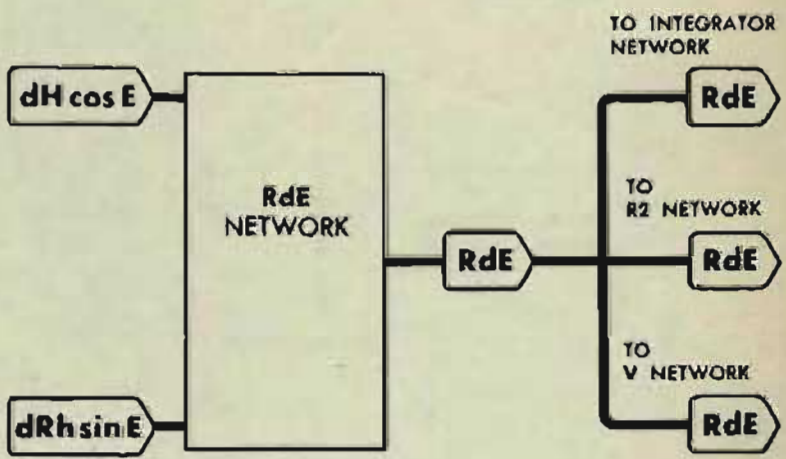
R3 COUNTER READING 10,000 YDS.

RdE Linear elevation rate

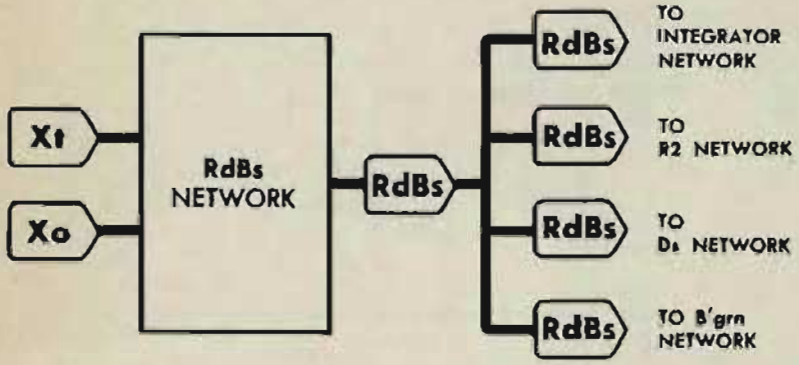
RdE will be in error if the relative motion network is in error.

RdE is an input to the *R2*, *V*, and integrator networks. Therefore an error in *RdE* will cause an error in these networks.

Values of *RdE* cannot be read because no *RdE* dial or counter is provided in the computer. See *Checking the RdE Network*, page 137.



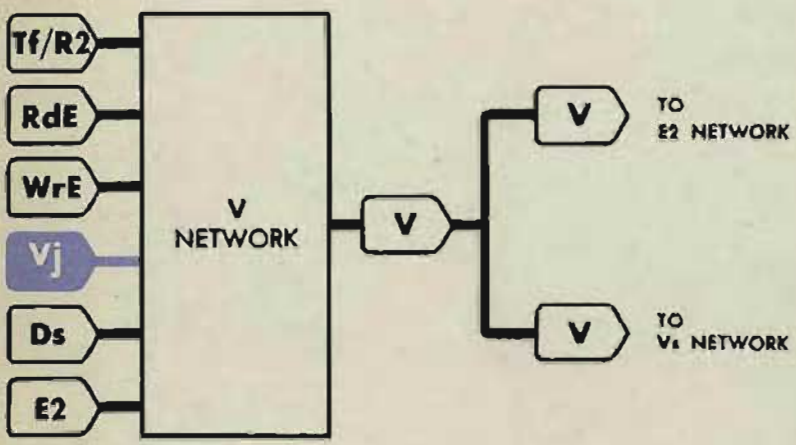
RdBs Linear deflection rate



RdBs is an input to the *R2*, *Ds*, and integrator networks and to the star shell computer. An error, therefore, in *RdBs* will cause an error in these networks.

Values of *RdBs* cannot be read because no *RdBs* dial or counter is provided in the computer. See *Checking the RdBs Network*, page 137.

V Elevation prediction

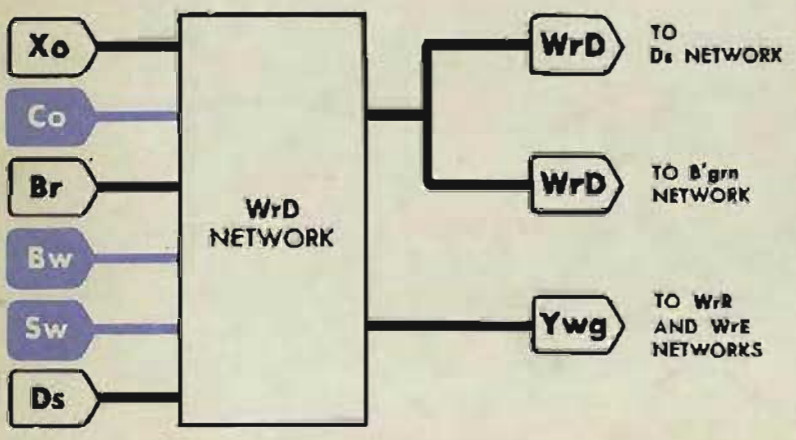


V will be in error if there is an error in *RdE*, *WrE*, *Tf/R2*, *Ds*, *E2* or *Vj*.

V is an input to the *E2* and *Vs* networks. Therefore, an error in *V* causes an error in *E2* and *Vs*.

Values of *V* cannot be read because no *V* dial or counter is provided in the computer. See *Checking the V Network*, page 126.

WrD Apparent wind affecting deflection prediction



WrD will be in error if there is an error in *Ds*, *Sw*, *Br*, *Co*, *Xo*, or *Bw*.

WrD is an input to the *Ds* network. Therefore, an error in *WrD* will cause error in *Ds*.

Values of *WrD* cannot be read because no *WrD* dial or counter is provided in the instrument. See *Checking the WrD Network*, page 138.

Gene Slover's US Navy Pages
Table of Contents

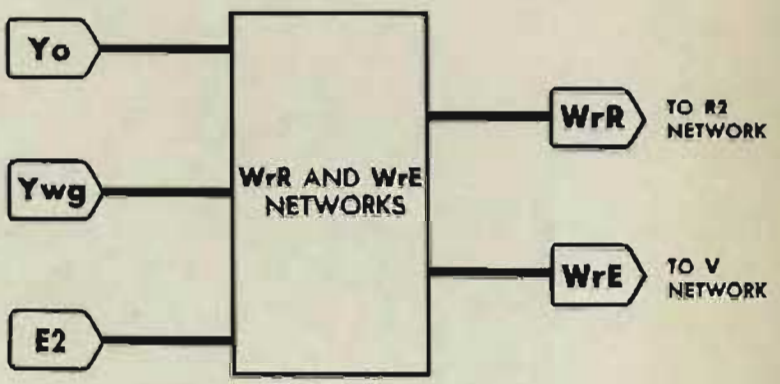
WrE Apparent wind affecting elevation prediction, and WrR Apparent wind affecting range prediction

WrE and *WrR* will be in error if *WrD* (and, therefore, *Ywg* and *Yo*) or *E2* is in error.

WrE is an input to the *V* network. Therefore an error in *WrE* will cause an error in *V* and *Vs*.

WrR is an input to the *R2* network. Therefore an error in *WrR* will cause an error in *R2*.

To check *WrE* and *WrR*, see *Checking the WrE and WrR Network*, page 128.



Eb Director elevation

Eb becomes an intermediate quantity when A tests are run by setting *E* into the computer with the sync *E* handcrank.

$Eb = E + L$

Eb will be in error if *E* or *L* is in error.

Eb is an input to the *Vz*, *Dd*, and *E'g* networks. Therefore, an error in *Eb* will cause errors in these quantities.

Reading Eb

There is no *Eb* dial or counter in the computer. Certain values must be set into the computer to make *Eb* equal *E* or *E'g* which can be read at the computer.

Setting Eb equal to E

Set *L* on 2000'. Set *E* on the desired value of *Eb* with the sync *E* handcrank in the CENTER position. Then put the sync *E* handcrank in the OUT position, and match the sync *E* dials at the index.

Setting Eb equal to E'g

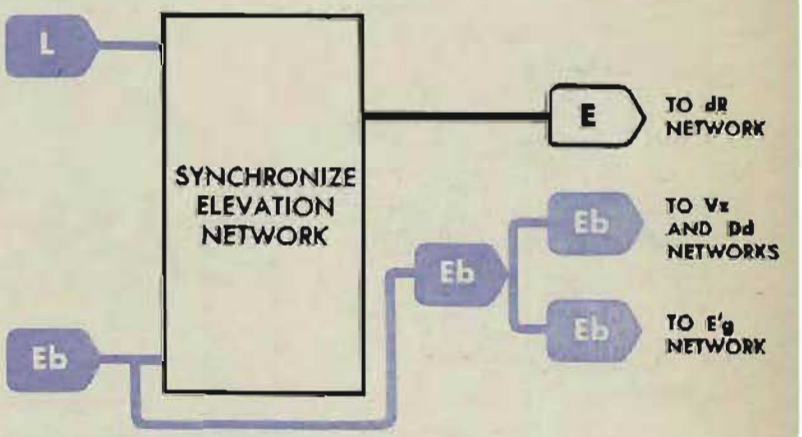
Set *Vs* on 2000'.

Set *Vz* on zero.

Turn the sync *E* handcrank in the OUT position to set the desired value of *Eb* on the *E'g* dials.

Setting Eb with the director

Put the sync *E* handcrank in the *IN* position and match the sync *E* dials at the index. Transmit *Eb* from the director.



Gene Slover's US Navy Pages
Table of Contents

Several transmitted quantities are inputs to other networks, as well as final computer outputs.

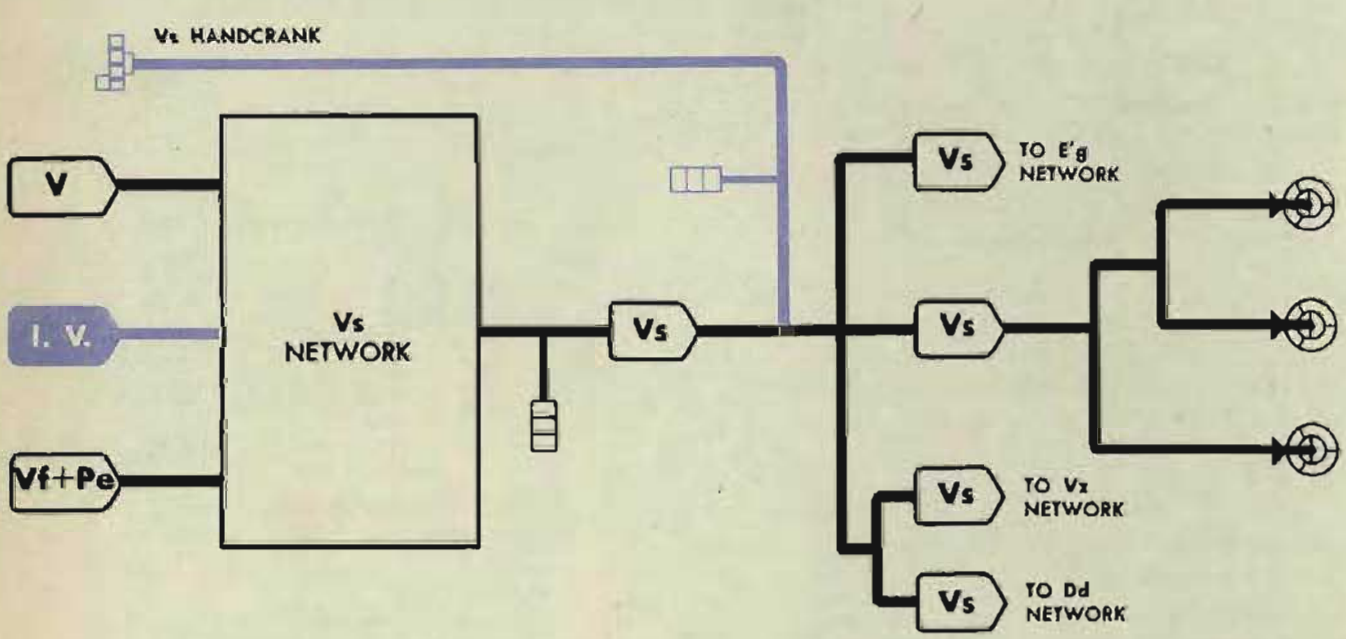
Vs Sight angle

Vs is used as an input to the *E'g*, *Vz* and *Dd* networks. Therefore an error in *Vs* will cause errors in *E'g*, *Vz*, and *Dd*.

Vs can be read to within 1′ on the sight angle indicating counter at the rear of the computer or on the *Vs* master counter under cover 6. A value of 2000′ is the arbitrary zero.

To set *Vs* at a desired value, push the sight angle handcrank IN, and turn it until the *Vs* counter reads that value.

To set *Vs* at computed zero, set *So*, *Sh*, *Sw*, and *dH* at 0 knots, *A*, *Br* and *Bws* at 90°, *E2* at 0°, *Vj* at 0, *Vf* + *Pe* at 0′, and *Ds* at 500 mils. Set *I.V.* at 2550 f.s. and *Tf/R2* at its lower limit. Pull the sight angle handcrank *OUT* and turn the power ON. The *Vs* indicating counter should now read 2000′.



Ds Sight deflection

Ds is used as an input to the *Dd*, *Vz*, *V*, and *WrD* networks. Therefore, an error in *Ds* will cause errors in all these quantities.

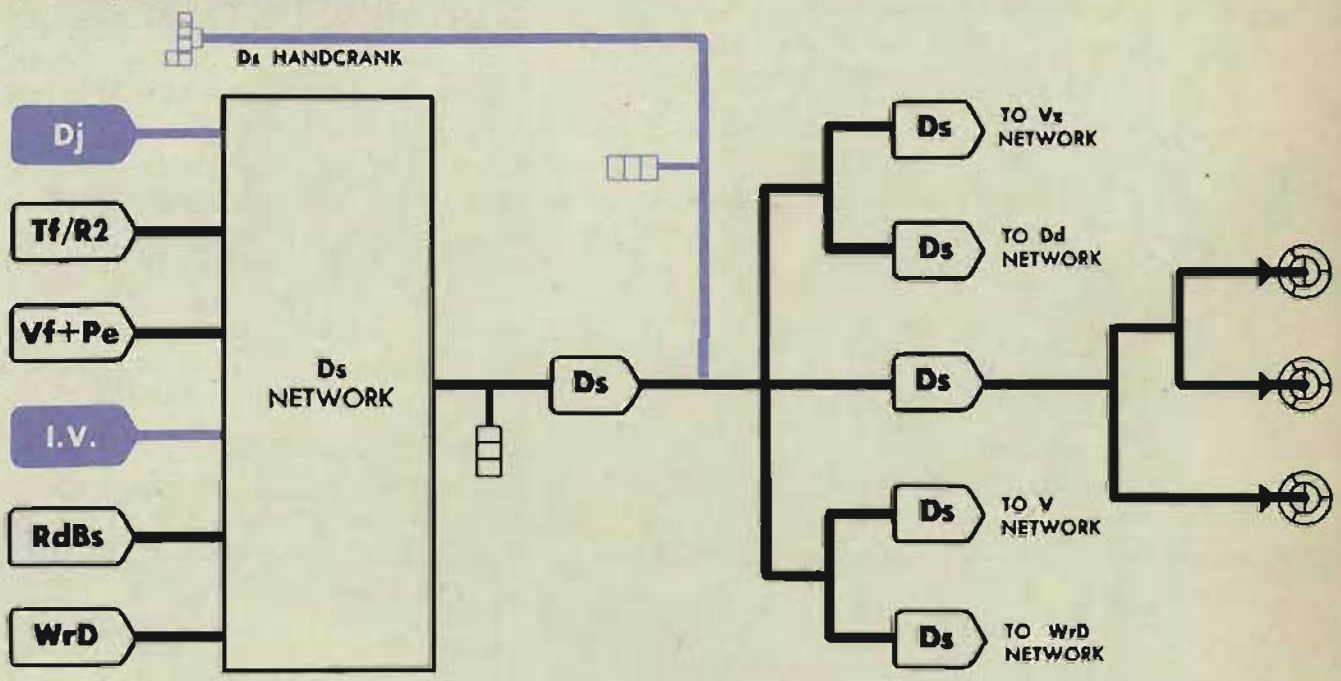
Ds can be estimated to within 0.1 mil on the *Ds* indicating counter at the rear top of the machine or on the *Ds* master counter under cover 8.

A value of 500 mils is the arbitrary zero.

Values below 000 or above 999 cannot be read directly on the *Ds* indicating counter. Such values may be read on the *Ds* master counter.

To set *Ds* at a desired value, turn the sight deflection handcrank in the IN position until the *Ds* indicating counter reads that value.

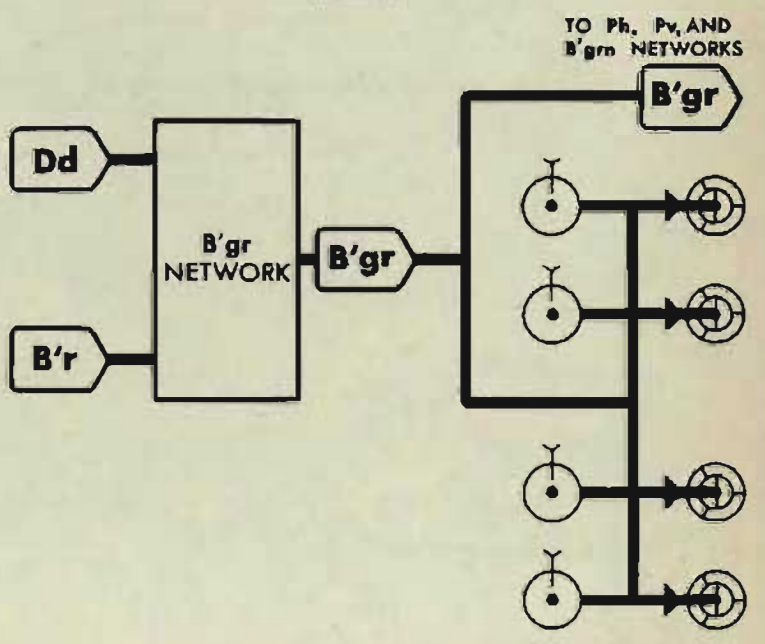
To set *Ds* at computed zero (500 mils), set *So*, *Sh*, *Sw*, *Br*, *A*, and *Dj* at zero, *Tf/R2* at its low limit, *Vf* + *Pe* at 100′, and *I.V.* at 2550 f.s.



B′gr Gun train order

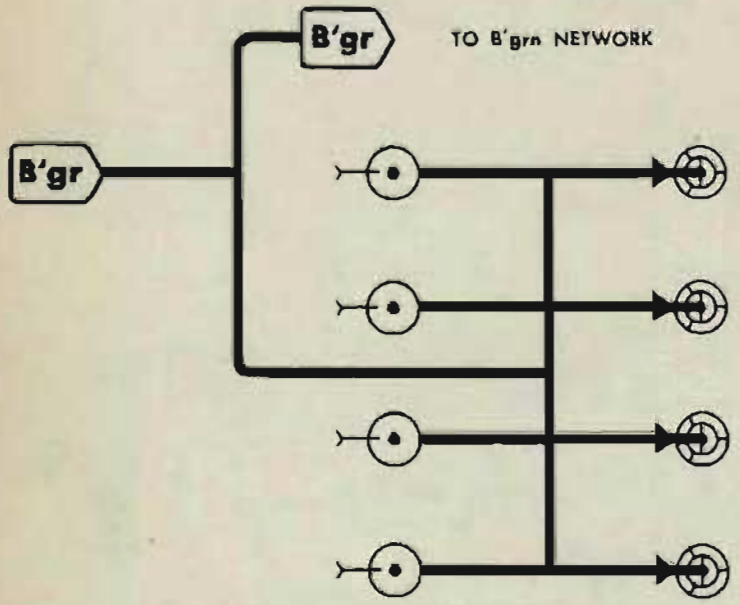
In computers that use *B′gr* as an input to the parallax network, an error in *B′gr* will cause errors in *Ph* and *Pv*. *B′gr* can be estimated to within 1′ on the *B′gr* automatic or indicating dials at the rear of the computer under cover 8.

To set *B′gr*, turn the control switch to LOCAL and turn the generated bearing crank in the OUT position until the *B′gr* dials read the desired value.



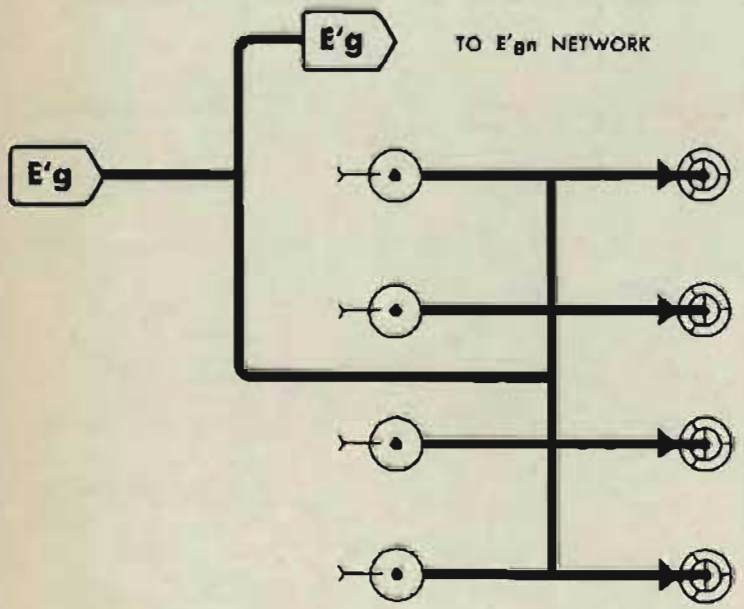
STAR SHELL INTERMEDIATE QUANTITIES

Most of the intermediate quantities used for the Computer Mark 1 A test analysis are also used during Star Shell Computer A test analysis. In addition, four of the computed quantities are inputs to the star shell computer. These additional quantities used as intermediates are:



B'gr Gun train order

B'gr is an input to the *B'grn* network. Therefore an error in *B'gr* will cause an error of equal size in *B'grn*. See page 103 for reading and setting *B'gr*.



E'g Gun elevation order

E'g is an input to the *E'gn* network. Therefore, an error in *E'g* will cause an error of equal size in *E'gn*.

E'g can be estimated to within 1' on the *E'g* dials to the rear of the computer.

To set *E'g* at a desired value, turn the sync *E* handcrank in the OUT position until the *E'g* dials read that value.

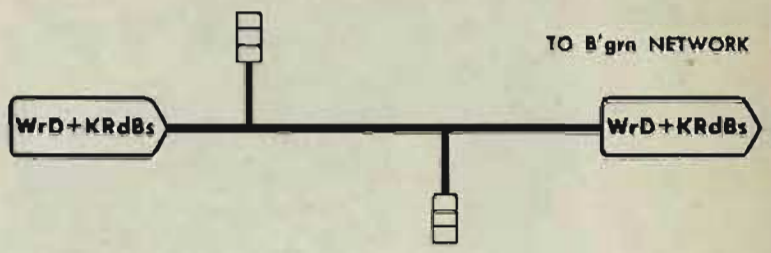
R2 Advance range

R2 is an input to the *R2n* network. Therefore an error in *R2* will cause an error of equal size in *R2n*. See page 94 for reading and setting *R2*.

Gene Slover's US Navy Pages
Table of Contents

WrD + KRdBs Star shell deflection

WrD + KRdBs will be in error if *WrD* or *RdBs* is in error. *WrD + KRdBs* is an input to the *B'grn* network. Therefore an error in *WrD + KRdBs* will cause an error in *B'grn*.



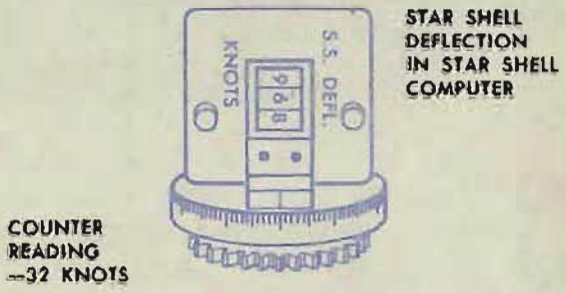
Reading WrD + KRdBs

WrD + KRdBs can be read to within one knot on the star shell deflection counters under computer cover 3 and the rear cover of the star shell computer.

Setting WrD + KRdBs

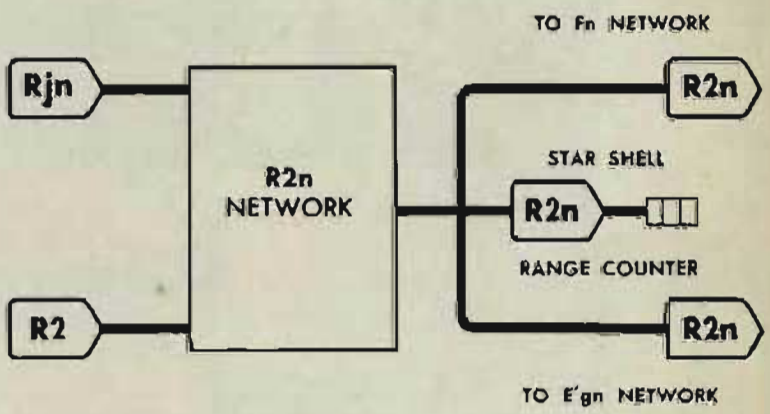
To set *WrD + KRdBs* at a desired value, disconnect power leads 1G and 1GG on the *WrD + KRdBs* follow-up and turn the output gearing by hand until the star shell deflection counter reads that value. Then wedge the follow-up output gearing.

ALTERNATE SETTING: Set *Sh* at 200 knots.
Turn *A* from 0° until the star shell deflection counter reads the desired value.



R2n Star shell range

R2n is an intermediate quantity within the star shell computer.
$R2n = R2 + K + Rjn$
R2n will be in error if *R2* or *Rjn* is in error. *R2n* is an input to the *Fn*, *B'grn*, and *E'gn* networks. Therefore an error in *R2n* will cause errors in these quantities.



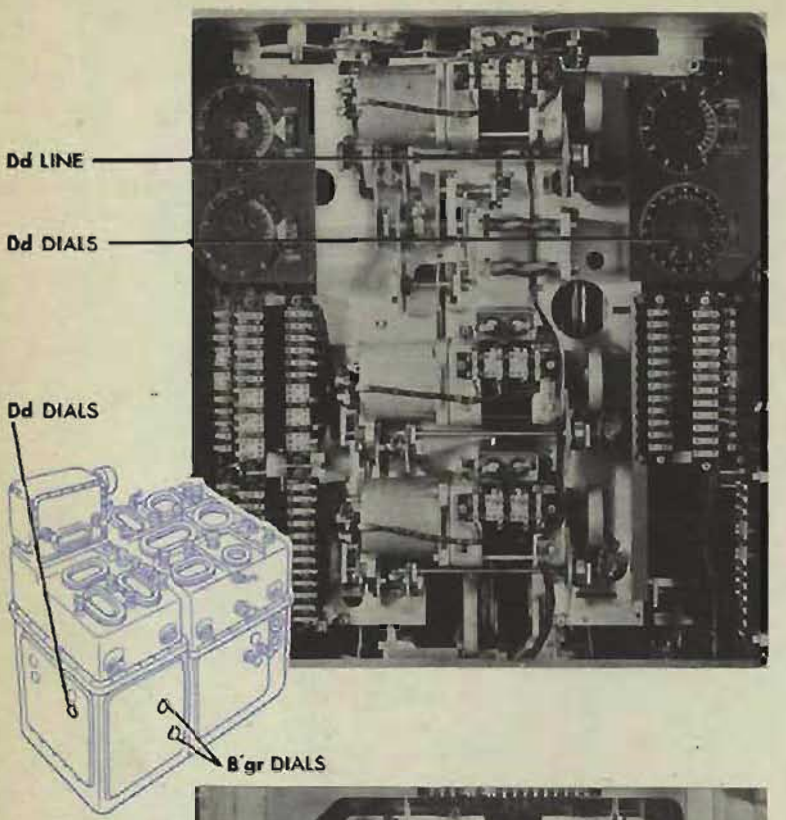
Reading R2n

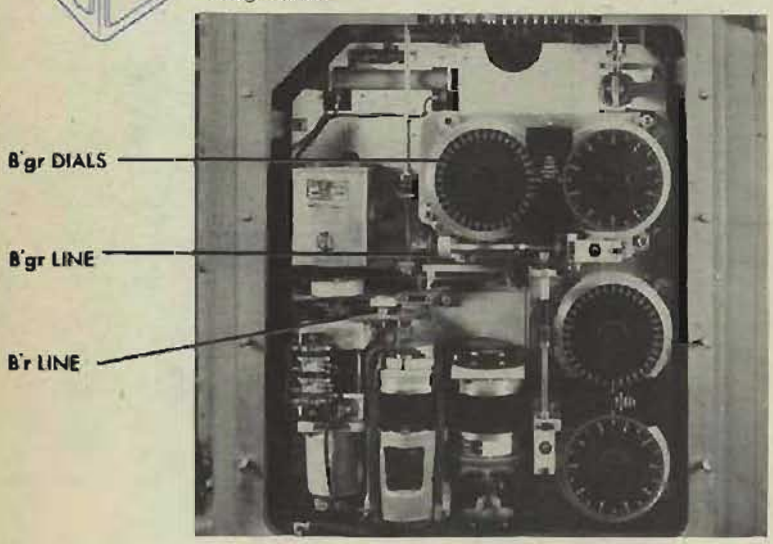
R2n can be read to within 10 yards on the star shell range counter at the front of the star shell computer.

Setting R2n

To set *R2n*, turn *cR* with the power ON, until the star shell range counter reads the desired value.

Gene Slover's US Navy Pages
Table of Contents





ERRORS IN B'gr

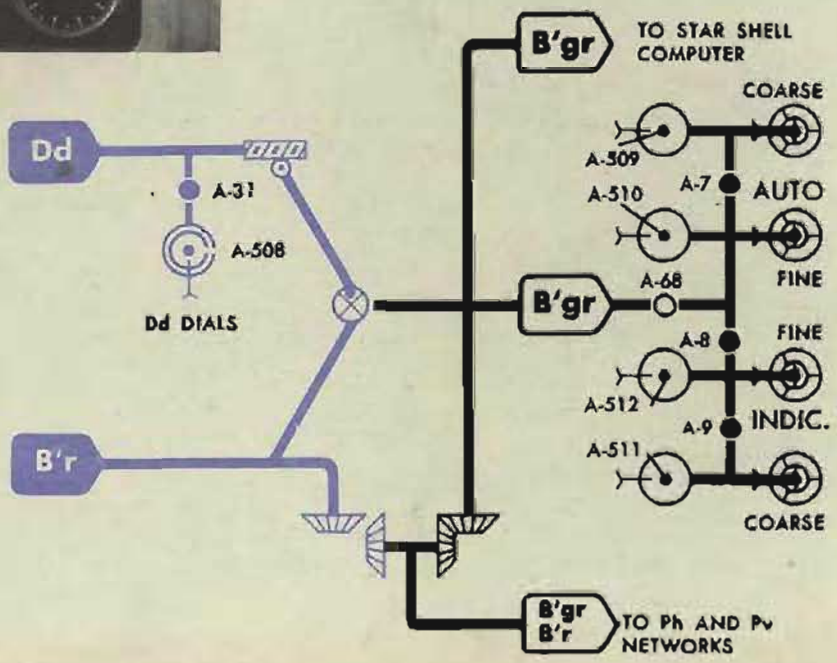
$B'gr = Dd + B'r$

If the *B'gr* transmitters have been removed and reinstalled, check A-68 and A-8.

Check the *Dd* input by comparing the reading on the *Dd* dials with the value given on the problem results form. If the *Dd* dial reading does not agree with the value given, check the *Dd* network; see page 117.

Check the *B'r* input by checking the problem setup values on the stable element dials. If *B'gr* is still incorrect, check A-602.

If both inputs are correct, check A-68, A-8, A-9, and A-7.



Gene Slover's US Navy Pages
Table of Contents

ERRORS IN E'g

$E'g = Vs - Vz + Eb$

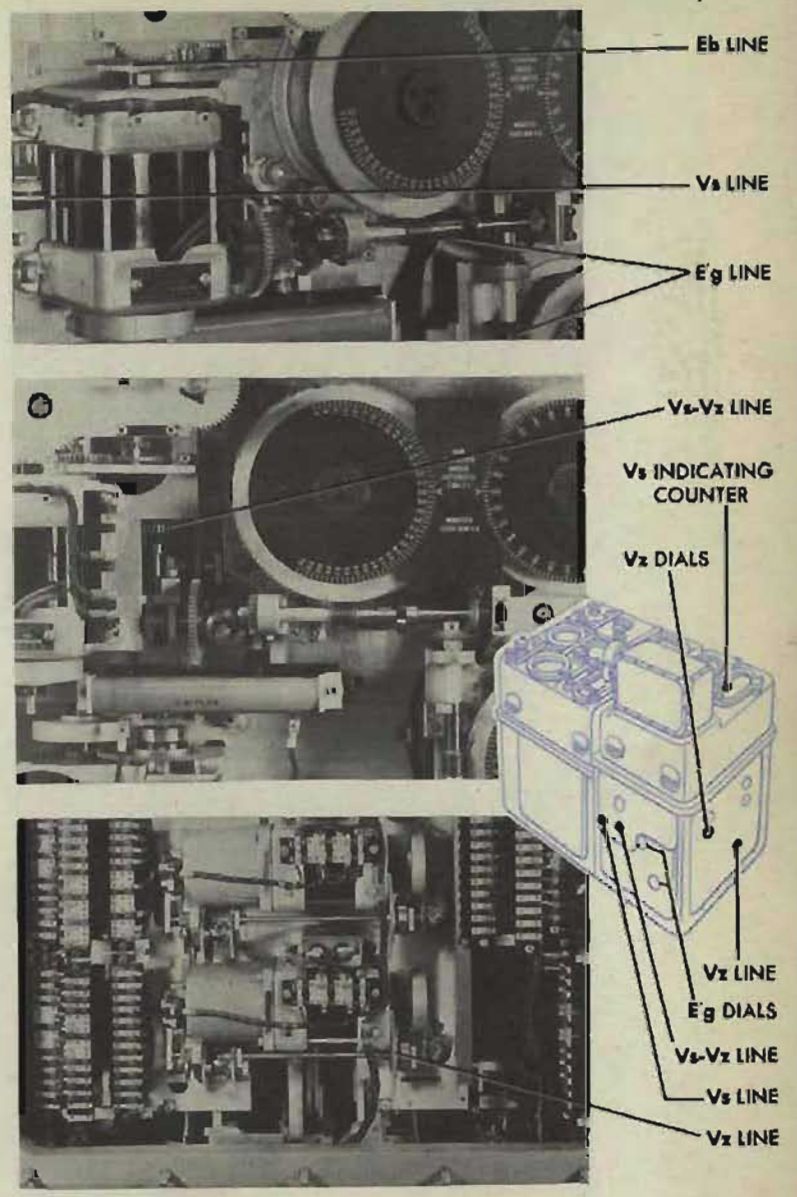
If the *E'g* transmitters have been removed and reinstalled, check A-51 and A-5.

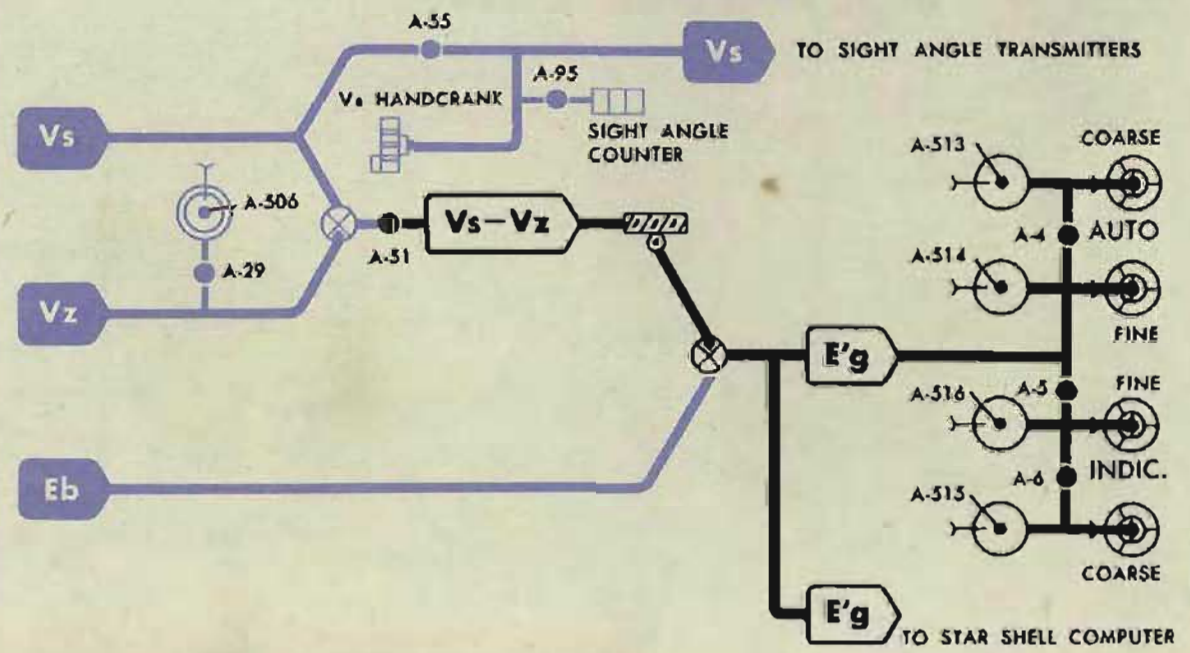
Check the *Vs* input by comparing the reading on the *Vs* indicating counter with the value given on the problem results form. If the *Vs* counter reading does not agree with the value given, check the *Vs* network; see page 108.

Check the *Vz* input by comparing the reading on the *Vz* dial with the value given on the problem results form. If the *Vz* dial reading does not agree with the value given, check the *Vz* network; see page 119.

Check the *Eb* input by checking the synchronize elevation network; see page 132.

If all three network inputs are correct, check A-51, A-5, A-6, and A-4.





Gene Slover's US Navy Pages

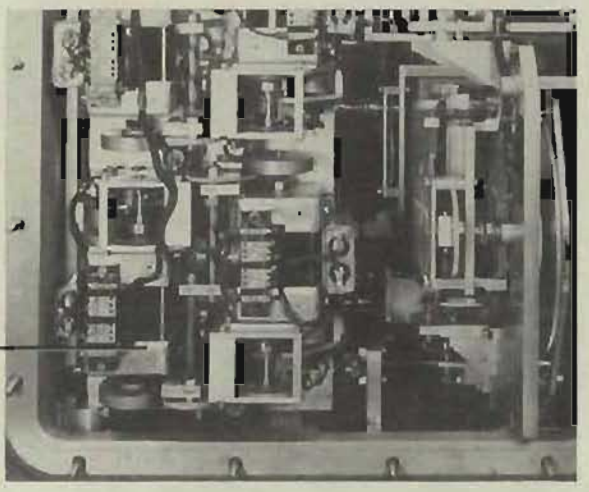
Table of Contents

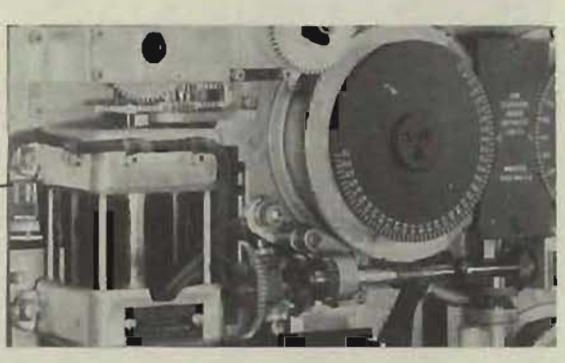
ERRORS IN Vs

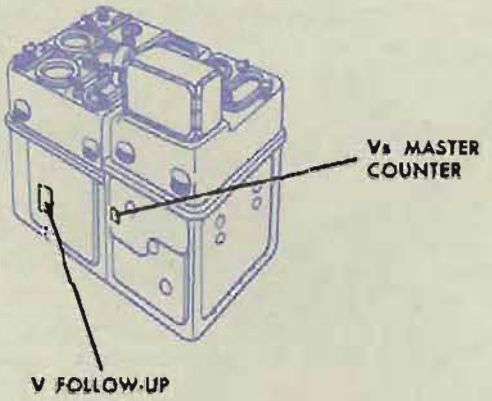
$Vs = V + Vl + Pe + Vlm$

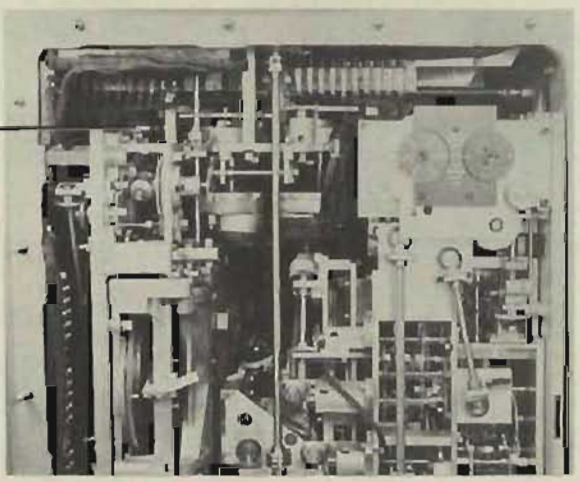
Check the V follow-up.

Check the reading on the Vs indicating counter against the reading on the Vs master counter. If the counter readings do not agree, check A-55 and A-95.







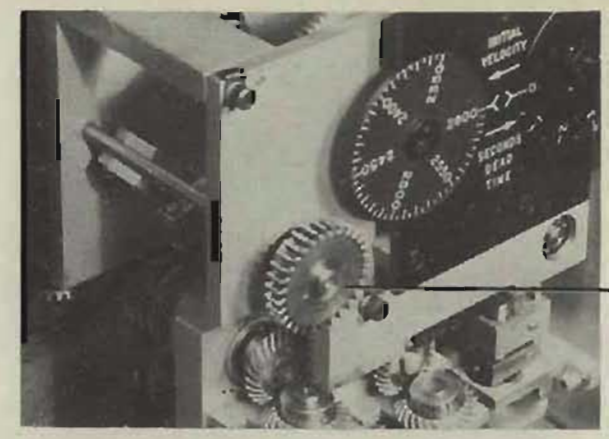


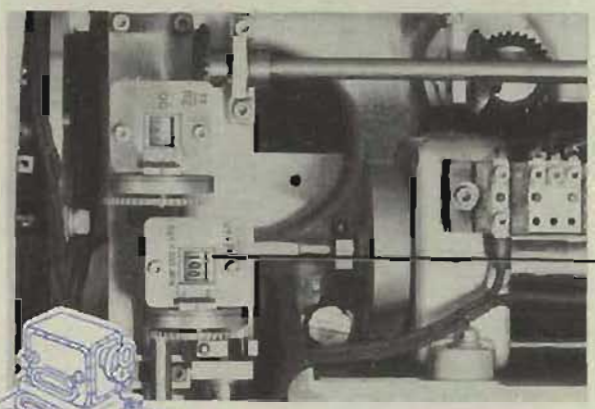
Gene Slover's US Navy Pages
Table of Contents

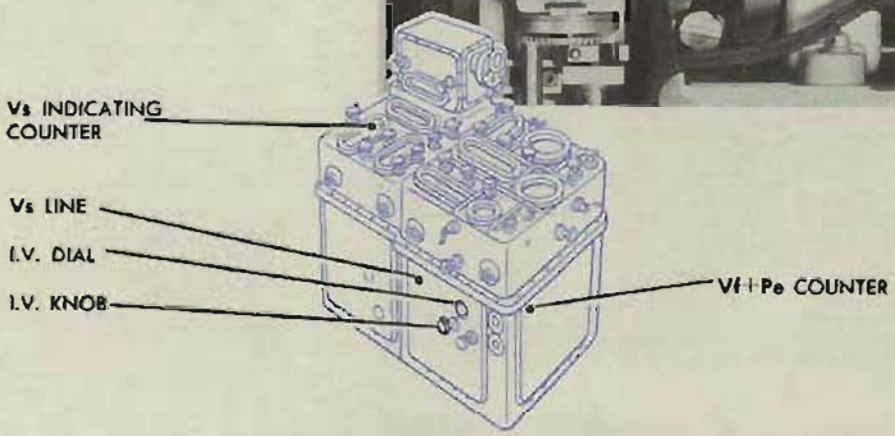
Check the *I.V.* input, by checking A-536.

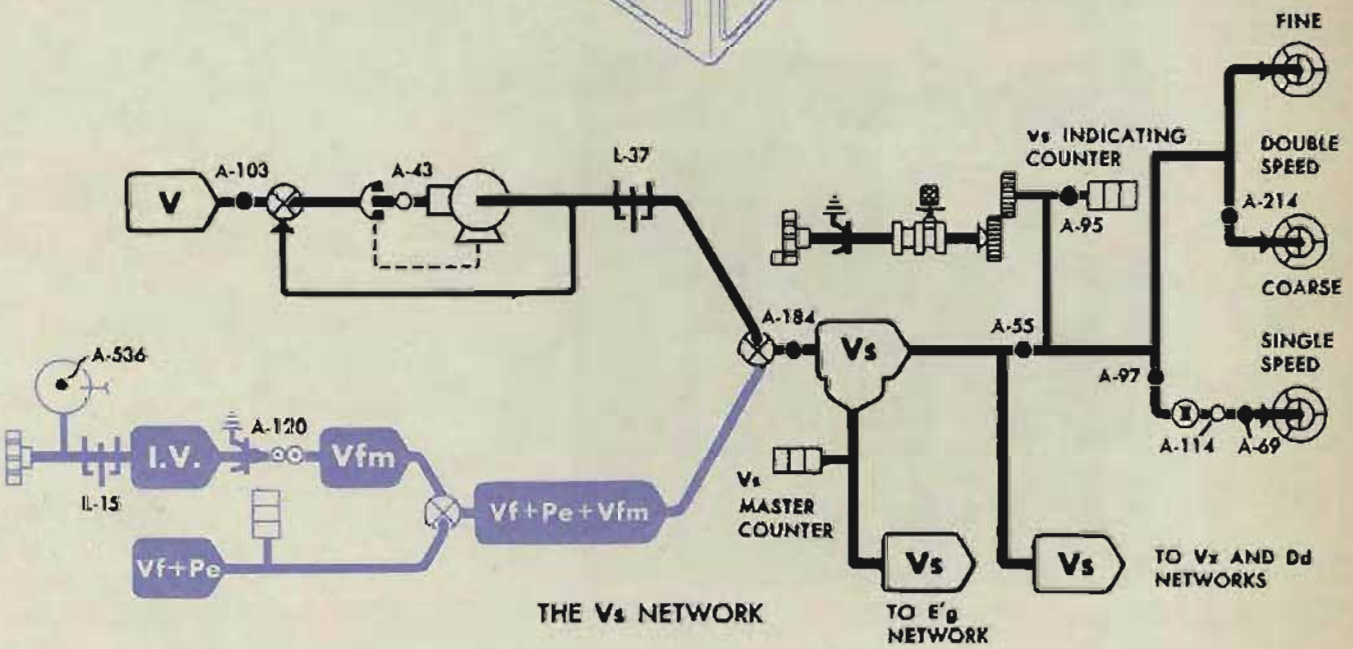
Check the *Vf + Pe* input by comparing the reading on the *Vf + Pe* counter with the value given in the intermediate quantities. If the readings do not agree, check the *Vf + Pe* network; see page 131.

If *Vs* is still in error, check A-184. If A-184 is in adjustment but *Vs* is in error, check the *V* network; see page 126.









THE Vs NETWORK

Gene Slover's US Navy Pages

Table of Contents