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WAR DEPARTMENT

COAST ARTILLERY FIELD MANUAL

SERVICE OF GUN DATA COMPUTER M1

15 December 1943

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WAR DEPARTMENT,

WASHINGTON 25, D.C., 15 December 1943.

FM 4-30, Coast Artillery Field Manual, Service of Gun Data Computer M1, is published for the information and guidance of all concerned.

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BY ORDER OF THE SECRETARY OF WAR:

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Chief of Staff.

OFFICIAL:

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(For explanation of symbols see FM 21-6.)

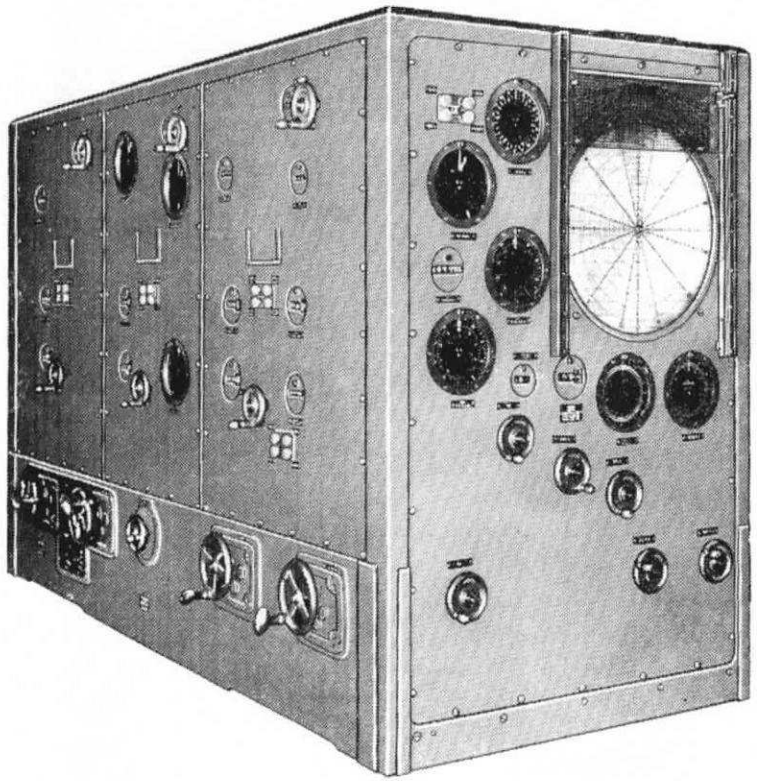
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TABLE OF CONTENTS

	Paragraphs	Page
CHAPTER 1. General	1–4	1
CHAPTER 2. Organization of range section.		
SECTION I. General	5–6	3
II. Organization	7–11	3
CHAPTER 3. Location of controls.		
SECTION I. General	12	7
II. Controls and their purposes	13–20	10
CHAPTER 4. Operating precautions	21–24	21
CHAPTER 5. Description and operation of panel units	25–35	24
CHAPTER 6. Base-end data transmission system.		
SECTION I. Equipment	36–39	33
II. Transmitter and receiver controls	40–42	34
III. Operation	43–46	39
IV. Emergency methods of operation	47–52	43
CHAPTER 7. Output data transmission system.		
SECTION I. Description	53–56	46
II. Orientation	57–60	49
III. Synchronization	61–63	51
IV. Operation	64–65	53
V. Emergency methods of operation	66–69	54
CHAPTER 8. Employment of the computer.		
SECTION I. General	70	56
II. Selection of B station	71–73	57
III. Horizontal base system	74–79	57
IV. Target relocation	80–81	59
V. Vertical base system	82–85	60
VI. Radar system	86–88	63
VII. Airplane spotting	89–91	64
VIII. Airplane control	92–96	65
IX. Generated control	97	66
X. Situation charts	98–103	67
CHAPTER 9. Duties of range section	104–110	78
CHAPTER 10. Drill of range section, general	111–124	83
CHAPTER 11. Routine maintenance	125–130	87
CHAPTER 12. Destruction of materiel in event of imminent capture	131–134	91
APPENDIX I. Glossary		94
APPENDIX II. Drill tables		95
INDEX		113

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COAST ARTILLERY FIELD MANUAL

SERVICE OF GUN DATA COMPUTER M1

CHAPTER 1

GENERAL

■ 1. SCOPE.—This manual furnishes information relative to the operation of the gun data computer M1 and the method of its employment by the using personnel.

■ 2. PURPOSE.—The primary purpose of this manual is to describe the operations of the plotting room detail in the service of the computer. However, the advantages gained by the use of the computer depend greatly upon the training and efficiency of the observing details in their operation of the base-end data transmission system and the proper use of the output data transmission system by the gun crews. For this reason the operation of the data transmission systems is included. Certain terms and symbols are used in the explanations. These are explained in appendix I and FM 4-15.

■ 3. DEMOLITION.—The methods of destruction of the computer and associated equipment in the event of imminent capture by the enemy in a combat zone are also included in this manual.

■ 4. REFERENCES.—*a*. A knowledge of the fundamentals of coast artillery gunnery, fire control, and position finding, as covered in FM's 4-10 and 4-15, will be helpful in understanding the problems involved in locating and tracking naval targets. The application of the gun data computer M1 to position finding is outlined in FM 4-15. Reference may be made to FM 4-15 for instruction in the use of the plotting board and the other fire control equipment which constitute a stand-by system to be employed in the event of a failure of the computer.

b. Details of the functioning of the instrument and its internal mechanisms, and information relative to the care and maintenance of the equipment not covered in this manual will be found in the following Technical Manuals:

TM 9-2646, Ordnance Instruction Guide.
TM 9-1646, Ordnance Maintenance Manual.

CHAPTER 2

ORGANIZATION OF RANGE SECTION

Paragraphs

SECTION I. General 5–6
II. Organization 7–11

SECTION I

GENERAL

■ 5. GENERAL.—The range section of a battery employing the gun data computer M1 is organized essentially the same as those of other major caliber batteries. It is under the immediate command of the range officer and consists of the observing details, the spotting details, and the plotting room detail.

■ 6. RADAR SECTION.—In addition to operating with data furnished by the regular observation stations employing optical instruments, the computer is designed to operate on data furnished from a radar unit.

SECTION II

ORGANIZATION

■ 7. OBSERVING DETAILS.—Each observing detail is assigned to a particular observation station (B^1, B^2, etc.) and is composed of the observer and the reader.

■ 8. SPOTTING DETAILS.—A spotting observer is assigned to each spotting station (S^1, S^2, etc.).

■ 9. PLOTTING ROOM DETAIL.—The plotting room detail required for the proper operation of the computer and supplementary equipment consists of 22 men. Following are assignments of personnel (the numbers refer to the numbered designation of each member of the detail):

Chief of section

No. 1 ..... *A Az* operator at the "A" triangle solver panel.

No. 2 ..... A_0 operator at the "B" triangle solver panel.

No. 3 ..... *C Az* operator at the "C" triangle solver panel.

No. 4 ..... *B Az* operator at the "C" triangle solver panel.

No. 5 ..... R_0 operator at the target position generator panel.

No. 6 ..... Course and speed operator at the target position generator panel.

No. 7 ..... Ballistic charts operator at the ballistic charts panel.

No. 8 ..... Assistant ballistic charts operator at the ballistic charts panel.

No. 9 ..... Range-elevation converter operator at the range-elevation converter panel.

No. 10 ..... Parallax operator at the parallax panel.

No. 11 ..... Wind component indicator operator at the wind component indicator panel.

No. 12 ..... Spotting board operator.

Nos. 13, 14, and 15.... Assistant spotting board operators.

No. 16 ..... Range fire adjustment board operator.

No. 17 ..... Lateral fire adjustment board operator.

No. 18 ..... Switchboard operator.

Nos. 19, 20, and 21... Relief operators.

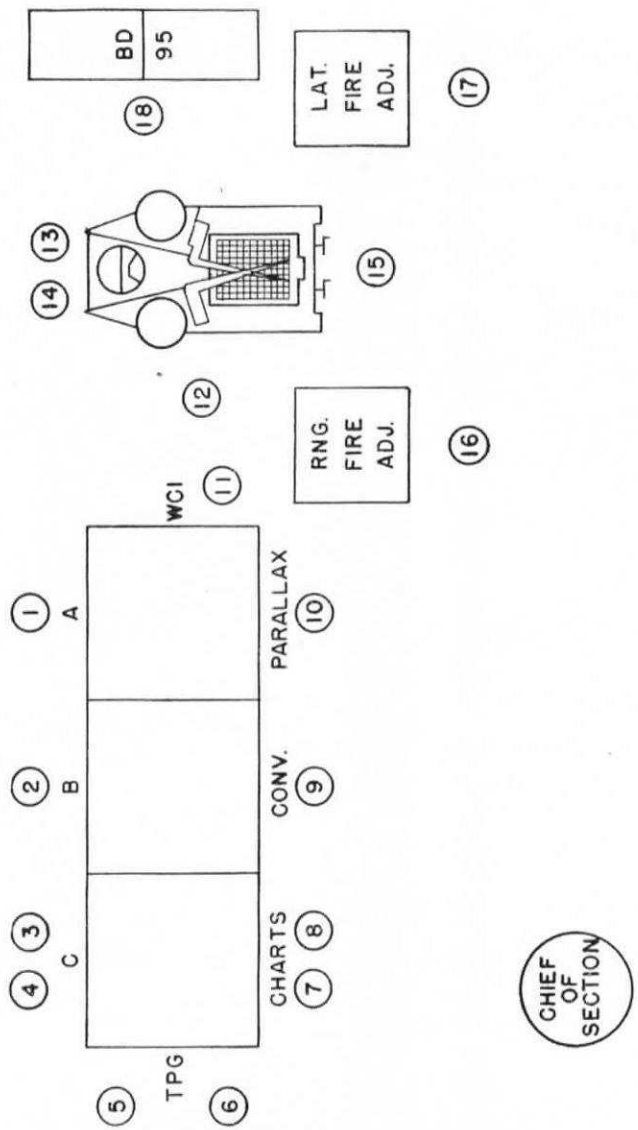


FIGURE 1.—Plotting room detail at DETAILS, POSTS.

■ 10. RECORDERS.—Recorders in such numbers as are necessary to insure complete and accurate records of drills and target practices must be provided. Nos. 19, 20, and 21 are regularly assigned members of the plotting room detail. When they are not required for other duties they may be used as recorders.

■ 11. OPERATORS OF STAND-BY EQUIPMENT.—In addition to the operation of the computer, the personnel must be prepared to operate the plotting board and associated equipment in the event of a change-over to the stand-by method of operation. For this reason each member in the plotting room detail should be trained in both the computer and stand-by methods of operation.

CHAPTER 3

LOCATION OF CONTROLS

		Paragraphs
SECTION I.	General	12
II.	Controls and their purposes	13–20

SECTION I

GENERAL

■ 12. GENERAL.—This section explains the location on the panels of the charts, counters, dials, and handwheels which comprise the operating controls of the gun data computer M1. Many symbols, representing elements of data used in the mechanical solution of mathematical formulas by the computer, appear on the name plates of the various charts, counters, dials, and handwheels. Figures 2 and 3 show the basic triangles solved by the computer and a simplified prediction diagram. Reference to these diagrams is suggested when studying the definitions of the various elements of data as represented by the name plates. Figures 4 and 5 are diagrams showing the positions of the various charts, counters, dials, and handwheels on the computer panels, with a tabulated list of all the controls for reference.

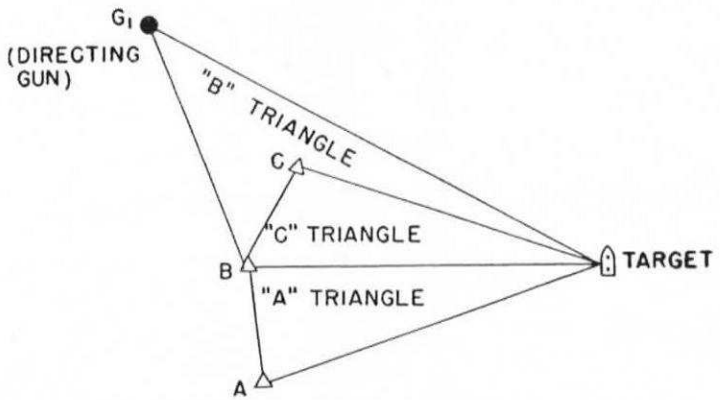


FIGURE 2.—Basic triangles solved by gun data computer M1.

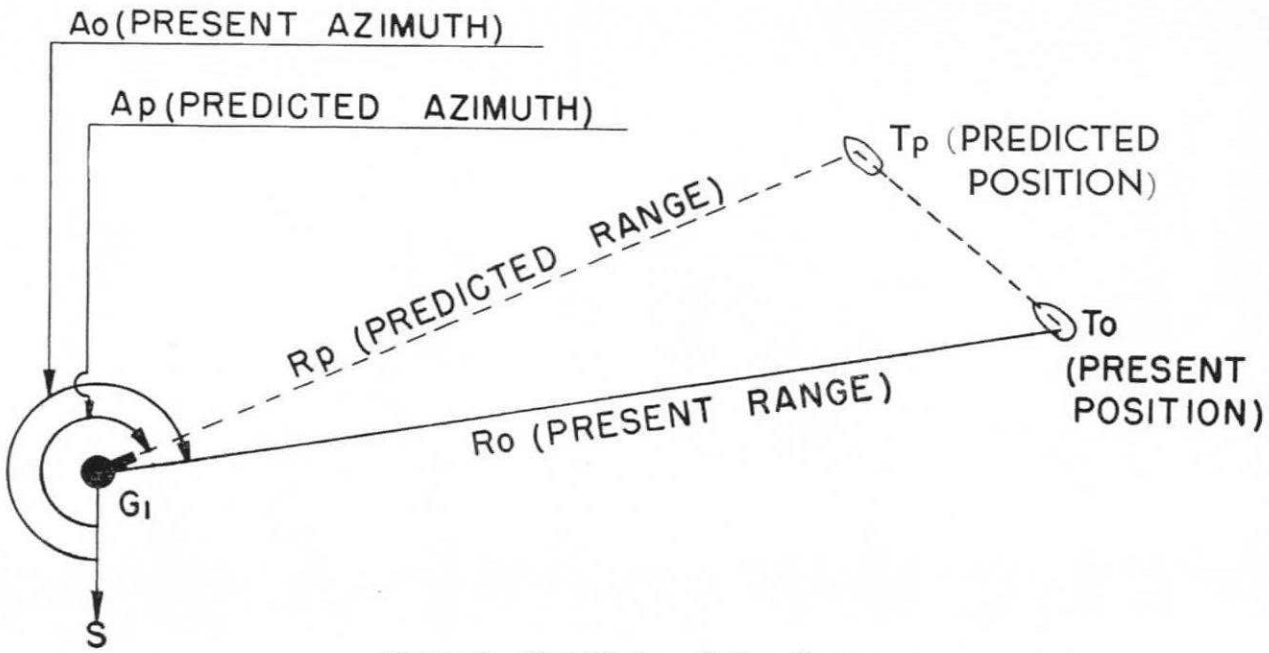


FIGURE 3.—Simplified prediction diagram.

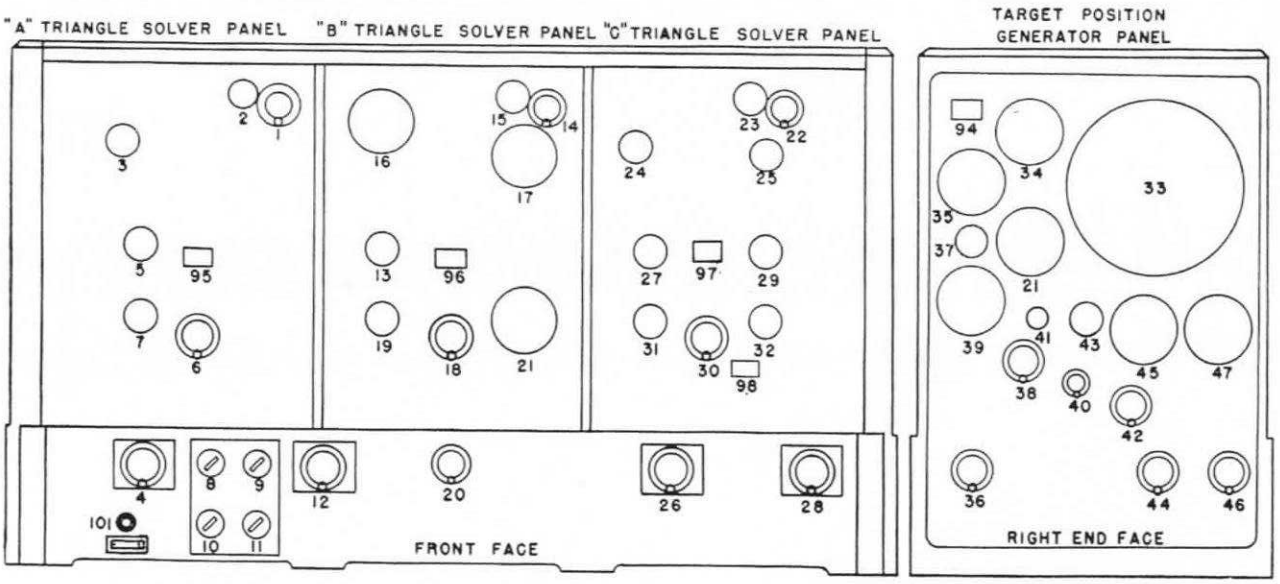


FIGURE 4.—Arrangement of controls on front and right end faces.

SECTION II

CONTROLS AND THEIR PURPOSES

■ 13. "A" TRIANGLE SOLVER PANEL.

Control No.	*Control*	*Purpose of Control*
1	BASE AB handwheel.	To set in length in yards of base line between the A and B stations.
2	BASE AB counter ...	Do.
3	BT counter	To indicate length in yards of the line *BT* as solved by the "A" triangle solver.
4	A AZ handwheel and azimuth receiver.	To set in azimuth in degrees of the line of sight from the A station to the target (T).
5	A AZ counter	Do.
6	AZ AB handwheel ...	To set in azimuth in degrees of the base line between the A and B stations.
7	AZ AB counter	Do.
8	Power SUPPLY switch.	To control electric power to the computer.
9	MOTORS switch	To control electric power to the torque converter motors.
10	ILLUMINATION switch.	To control all panel illuminating lamps.
11	TIME motor switch..	To control electric power to the constant speed motor.
95	A AZ WARNING LIGHTS.	To warn of an incorrect solution of *A Az*.
101	HEATER indicator lamp.	To indicate operation of the heater units.

■ 14. "B" TRIANGLE SOLVER PANEL.

Control No.	*Control*	*Purpose of Control*
12	A_0 handwheel	To set in azimuth in degrees of the line G_1T (present azimuth of the target).
13	A_0 counter	Do.
14	BASE G_1B handwheel.	To set in length in yards of the line between G_1 (gun No. 1), and the B station.
15	BASE G_1B counter ..	Do.
16	BT I MATCH dial ...	To match value of *BT* as solved by the "A" triangle solver.
17	BT II MATCH dial ..	To match value of *BT* as solved by the "C" triangle solver.
18	AZ G_1B handwheel..	To set in azimuth in degrees of line between G_1 (gun No. 1) and the B station.
19	AZ G_1B counter	Do.
20	$R_0\dot{A}_0$ handwheel	To determine the linear rate of change of azimuth of the target, expressed in yards per second (at right angles to line G_1T).
21	$R_0\dot{A}_0$ dial	Do.
96	A_0 WARNING LIGHTS.	To warn of an incorrect solution by the "B" triangle solver and a resultant incorrect A_0.

■ 15. "C" TRIANGLE SOLVER PANEL.

Control No.	Control	Purpose of Control
22	BASE CB handwheel.	To set in the length in yards of the base line between the C and B stations.
23	BASE CB counter	Do.
24	BT counter	To indicate the length in yards of the line *BT* as solved by the "C" triangle solver.
25	CT counter	To indicate the length in yards of the line *CT* as solved by the "C" triangle solver.
26	C AZ handwheel and azimuth receiver.	To set in the azimuth, in degrees, of the line of sight from the C station to the target (T).
27	C AZ counter	Do.
28	B AZ handwheel and azimuth receiver.	To set in the azimuth, in degrees, of the line of sight from the B station to the target (T).
29	B AZ counter	Do.
30	AZ CB handwheel ...	To set in the azimuth, in degrees, of the base line between C and B stations.
31	AZ CB counter	Do.
32	AT counter	To indicate the length in yards of the line *AT* as solved by the "A" triangle solver.

Control No.	Control	Purpose of Control
97	B & C AZ WARNING LIGHTS.	To warn of incorrect solutions of both *B Az* and *C Az*.
98	B AZ WARNING LIGHTS.	To warn of incorrect solution of *B Az*.

■ 16. TARGET POSITION GENERATOR PANEL.

Control No.	Control	Purpose of Control
21	$R_0\dot{A}_0$ dial	To indicate same value as dial No. 21 on "B" triangle solver panel.
33	Airplane spotting board.	To use for plotting deviation of splashes when airplane observation of fire is being employed.
34	CLOCK dial	To indicate the time being generated by constant speed motor.
35	R_0 MATCH dial	To match value of the line G_1T in solving for R_0 (present range).
36	R_0 handwheel	Do.
37	R_0 counter	To indicate value of R_0 in yards.
38	$\dot{R}_0$ handwheel	To determine the linear rate of change of R_0 (present range) in yards per second.
39	$\dot{R}_0$ dial	Do.

Control No.	*Control*	*Purpose of Control*
40	Target SPEED handwheel.	To set in target speed in knots.
41	Target SPEED counter.	Do.
42	Target COURSE handwheel.	To set in target course in degrees.
43	Target COURSE counter.	Do.
44	A_0 SPOT handwheel.	To set in lateral fire adjustment corrections determined by the airplane spotting board.
45	A_0 SPOT reset dial ..	Do.
46	R_0 SPOT handwheel.	To set in range fire adjustment corrections determined by the airplane spotting board.
47	R_0 SPOT reset dial ..	Do.
94	B AZ WARNING LIGHTS.	To warn of an incorrect solution of *B Az.*

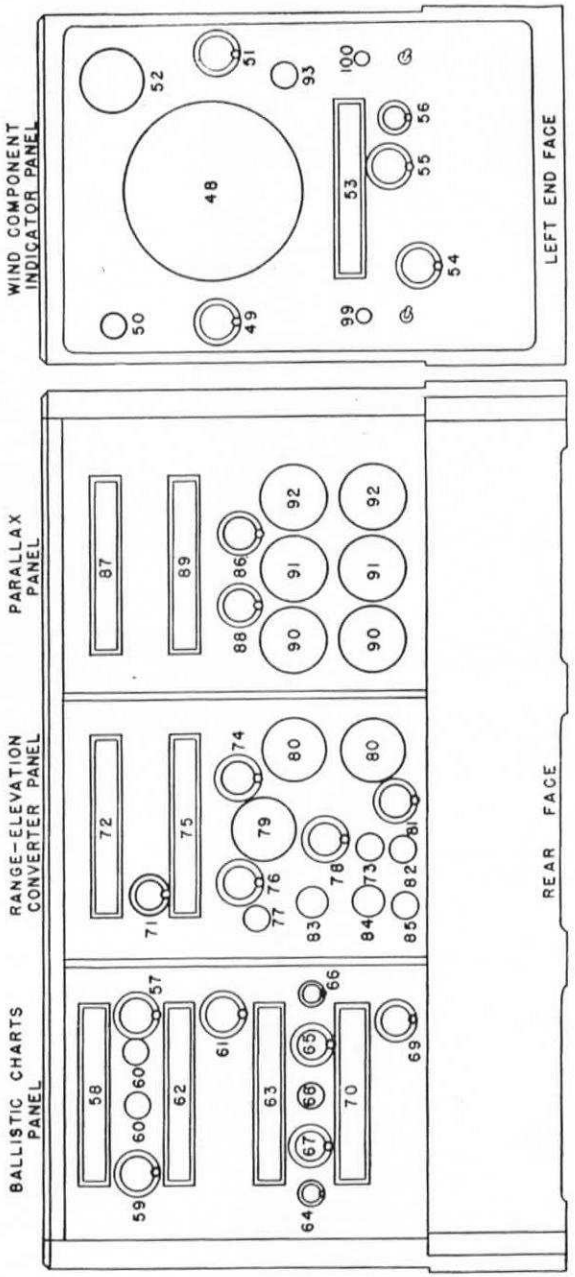


FIGURE 5.—Arrangement of controls on rear and left end faces.

■ 17. WIND COMPONENT INDICATOR PANEL.

Control No.	*Control*	*Purpose of Control*
48	Wind component indicator.	To resolve the ballistic wind into range and deflection components.
49	% RANGE SPOT handwheel.	To set in percent range corrections from range fire adjustment board.
50	% RANGE SPOT counter.	Do.
51	A_p SPOT handwheel.	To set in lateral corrections from the lateral fire adjustment board.
52	A_p SPOT reset dial . .	Do.
53	Weight of PROJECTILE, ROTATION R_N (range), and TIDE correction charts.	To apply range corrections for nonstandard ballistic conditions.
54	Weight of PROJECTILE correction handwheel.	To apply range corrections for nonstandard ballistic conditions.
55	ROTATION R_N (range) correction handwheel.	Do.
56	TIDE correction handwheel.	Do.
93	Voltmeter	To indicate voltage of electric current being received by computer.
99	AZ SIGNAL light and control switch.	To indicate to guns that the firing data are correct.
100	EL SIGNAL light and control switch.	Do.

■ 18. BALLISTIC CHARTS PANEL.

Control No.	*Control*	*Purpose of Control*
57	Muzzle VELOCITY correction handwheel.	To apply range corrections for nonstandard ballistic conditions.
58	Muzzle VELOCITY correction chart.	Do.
59	Muzzle VELOCITY compensation handwheel.	To apply range corrections for nonstandard ballistic conditions.
60	Muzzle VELOCITY compensation counters.	Do.
61	WIND + DRIFT corrections handwheel.	To apply azimuth corrections for nonstandard ballistic conditions.
62	WIND + DRIFT corrections chart.	Do.
63	ROTATION AZimuth and RANGE WIND and ELASTICITY charts.	To apply azimuth and range corrections for nonstandard ballistic conditions.
64	ROTATION AZimuth correction handwheel.	To apply azimuth corrections for nonstandard ballistic conditions.
65	RANGE WIND correction handwheel.	To apply range corrections for nonstandard ballistic conditions.
66	ELASTICITY correction handwheel.	Do.

Control No.	Control	Purpose of Control
67	ATMOSPHERE density compensation handwheel.	To apply range corrections for nonstandard ballistic conditions.
68	ATMOSPHERE density compensation counter.	Do.
69	ATMOSPHERE density correction handwheel.	To apply range corrections for nonstandard ballistic conditions.
70	ATMOSPHERE density correction chart.	Do.

■ 19. RANGE-ELEVATION CONVERTER PANEL.

Control No.	Control	Purpose of Control
71	TIME OF FLIGHT handwheel.	To determine time of flight.
72	TIME OF FLIGHT chart.	Do.
73	TIME OF FLIGHT counter.	To indicate the time of flight in seconds.
74	EL G_1 handwheel ...	To determine quadrant elevation in mils for G_1 (gun No. 1).
75	ELEVATION chart ...	Do.

Control No.	Control	Purpose of Control
76	K handwheel	To set in the K value, which represents a range-elevation conversion constant. It is read from the chart selector dial and set on the K counter.
77	K counter	Do.
78	CHART SELECTOR handwheel.	To position the proper charts in the ballistic charts units for the combination of powder and projectile which is to be fired.
79	CHART SELECTOR dial.	Do.
80	EL G_1 dials and transmitters.	To indicate the quadrant elevation in mils being transmitted to G_1.
81	DEAD TIME handwheel.	To set in dead time in seconds.
82	DEAD TIME counter.	Do.
83	R_p' counter	To indicate the corrected predicted range less the height of site correction.
84	BALLISTIC CORRection counter.	To indicate the total in yards of all ballistic corrections, except height of site, which have been applied to predicted range.
85	DEFLECTION counter.	To indicate the total deflection in degrees.

■ 20. PARALLAX PANEL.

Control No.	*Control*	*Purpose of Control*
86	Rn CORR G_2 handwheel.	To correct elevation of gun No. 2 for range difference due to displacement.
87	Rn CORR G_2 chart ..	Do.
88	Az CORR G_2 handwheel.	To correct azimuth of gun No. 2 for azimuth difference due to displacement.
89	Az CORR G_2 chart ..	Do.
90	AZ G_1 dials and transmitters.	To indicate the corrected predicted azimuth being transmitted to gun No. 1.
91	AZ G_2 dials and transmitters.	To indicate the corrected predicted azimuth being transmitted to gun No. 2.
92	EL G_2 dials and transmitters.	To indicate the quadrant elevation in mils being transmitted to gun No. 2.

CHAPTER 4

OPERATING PRECAUTIONS

■ 21. GENERAL.—In order to assure maximum efficiency during operation, prevent actual damage to the computer mechanisms due to thoughtless or haphazard operation of the various input controls, reduce the amount of needless wear upon the operating parts and thus prolong the service life of the equipment, operating personnel must be thoroughly indoctrinated with the information contained in this chapter.

■ 22. LIMITS OF OPERATION.—The tabulation following shows the absolute limits of operation of some of the counters and dials on the computer. The figures indicate the limits beyond which the counters will not function, as the limit stops have been previously set to halt the action at these points. When counter readings closely approach the limits indicated (as will seldom be the case in normal operation) care should be taken not to attempt operation beyond these points nor should they be approached at a rapid rate. The sudden shock caused by running into a positive stop is transmitted throughout the instrument. Repeated occurrences of this kind will have detrimental effects on the operating efficiency and life of the computer. It is therefore a matter of extreme importance that the operating personnel be aware of these limits of operation and observe the appropriate operating precautions.

Limits of operation

a. On the triangle solver panels:

BASE AB, CB, and G_1B counters — 100 to 50,000 yards.

$R_0\dot{A}_0$ dial ..... 0 to 50 yards/sec. (normal of 25).

b. On the target position generator panel:

R_0 counter	100 to 50,000 yards.
$\dot{R}_0$ and $R_0\dot{A}_0$ dials	0 to 50 yards/sec. (normal of 25).
Target SPEED counter	0 to 44.4 knots.

c. On the ballistic charts panel:

Muzzle VELOCITY compensation counters.	—150 f/s to +150 f/s.
ATMOSPHERE density compensation counter.	84 to 116 percent.

d. On the range-elevation converter panel:

EL G_1 dials	0 to + 847.5 mils.
DEAD TIME counter	0 to 15 seconds.
TIME OF FLIGHT counter	0 to 110 seconds.
K counter	0 to 22.
R_p' counter	100 to 50,000 yards.

e. On the parallax panel:

Rn CORR G_2 handwheel (operational limit).	—44 to +44 mils.
Az CORR G_2 handwheel (operational limit).	—7.5° to +7.5°.
EL G_2 dials	—44 to +891.4 mils.

f. On the wind component indicator panel:

% RANGE SPOT counter	20.0 to 40.0 (normal of 30.0).
A_p SPOT reset dial	3° to 17° (normal of 10°).

■ 23. SAFETY DEVICES.—In order to prevent damage to the internal mechanisms of the computer, various safety devices have been incorporated into its design. Since most of these devices are in the interior of the computer, their care and adjustment need concern only the ordnance machinist assigned to this duty. There is, however, one type of safety

device which should be brought to the attention of the operating personnel. All the handwheels on the computer are equipped with a torque overload device which will allow the handwheel to slip about the shaft to which it is attached if the torque load on the shaft should exceed a safe limit. When the handwheel slips about the shaft, it is an indication that there is an excessive load on the shaft and *not* an indication that the torque overload device is too weak and should be adjusted. Adjustments to torque overload devices should be attempted only by machinists who have been trained on equipment of this type.

■ 24. LIST OF PRECAUTIONS.—Following is a list of operating precautions with which every member of the manning detail should be familiar and which must be observed at all times:

a. Turn on the motor switch before turning handwheels. *Do not* turn handwheels with the motors OFF, as this will cause needless strain and wear on the computer mechanisms.

b. Do not run into the R_0 limit stops. This will occur when a range rate has been set in by the $\dot{R}_0$ handwheel, and the time motor has been allowed to run for a period of time. An increasing or decreasing range rate will run the R_0 counter up or down until it is driven into the limit stops with detrimental effects to the mechanism.

c. Do not continue operation of an input handwheel if jerky or uneven action has been noted. This should be reported to the chief of section at once.

d. Under certain climatic conditions, the heaters should be placed in operation for several hours daily. In tropical, humid climates they will dry out moisture, and in cold climates they will prevent thickening of the lubricants.

e. When operating the time of flight and elevation charts to establish the time of flight and elevation for gun No. 1, always match the pointer of the time of flight chart to the curve before attempting to match the pointer on the elevation chart. Observance of this procedure is important for the rapid and accurate determination of time of flight and elevation.

CHAPTER 5

DESCRIPTION AND OPERATION OF PANEL UNITS

■ 25. WIND COMPONENT INDICATOR.—*a.* The wind component indicator is a device for mechanically resolving the ballistic wind into its resultant range and deflection components (see fig. 6). These components are expressed in reference numbers that indicate which curves of the ballistic charts are to be followed in setting wind corrections. The device consists of a circular scale graduated in mils; a transparent wind arm pointer graduated in miles per hour, with a sliding index; and a grilled central disk with wind reference numbers on horizontal and vertical axes.

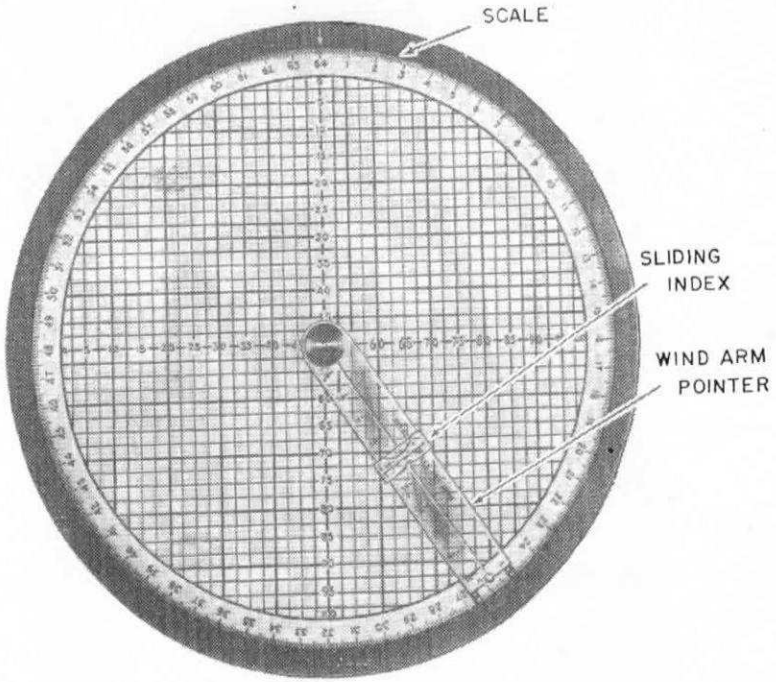


FIGURE 6.—Wind component indicator.

b. In operation, the wind arm pointer is set to the azimuth of the ballistic wind on the mil scale, using data from the meteorological message. The sliding index is moved to the speed of the ballistic wind. Thereafter, $Az\ G_1$ will automatically position both the mil scale and the wind arm pointer which is carried with it. The range and deflection components in reference numbers are read from the grid background at the point of intersection of the index lines on the wind arm pointer and sliding index. The operator calls out these reference numbers for the use of other operators who set the data on the ballistic charts. The range and deflection components are called out as, for example, "Range wind 64" or "Deflection wind 72."

■ 26. RESET DIALS.—There are three reset dials in the computer. They are used solely for the setting in of fire adjustment corrections. The A_0 and R_0 SPOT reset dials, located in the target position generator panel, are used to set in corrections during airplane fire control. The A_p SPOT dial is used for the application of lateral fire adjustment corrections in all other methods of operation. These dials consist of two concentric rings, both graduated alike in reference numbers, with a normal of 10. They are designed to allow the setting in of a series of corrections and algebraically add all values that have been placed. By turning the handwheel, both dials will rotate together to the value of the correction, which may be read from the index at the top of the dial. The handwheel is then pulled OUT, at which time the outer ring will return to the normal setting, leaving the value of the correction recorded on the inner ring. Thus, a series of corrections can be set, using the normal of the outer ring as a guide each time. The algebraic sum of the total corrections will be registered on the inner ring.

■ 27. AIRPLANE CONTROL SPOTTING BOARD.—*a.* The airplane control spotting board consists of a clock dial superimposed over a grid background (see fig. 7). The dial of the clock is properly positioned by target course and present azimuth. The graduations of the grid background, as measured along the vertical axis of the spotting board face, represent the

range deviations in reference numbers. For the determination of azimuth deviations, a transparent scale which can be slid down over the spotting board is provided. The horizontal lines of the sliding scale represent R_0. The lines which radiate diagonally down from the top center of the scale represent the reference numbers of the azimuth deviations.

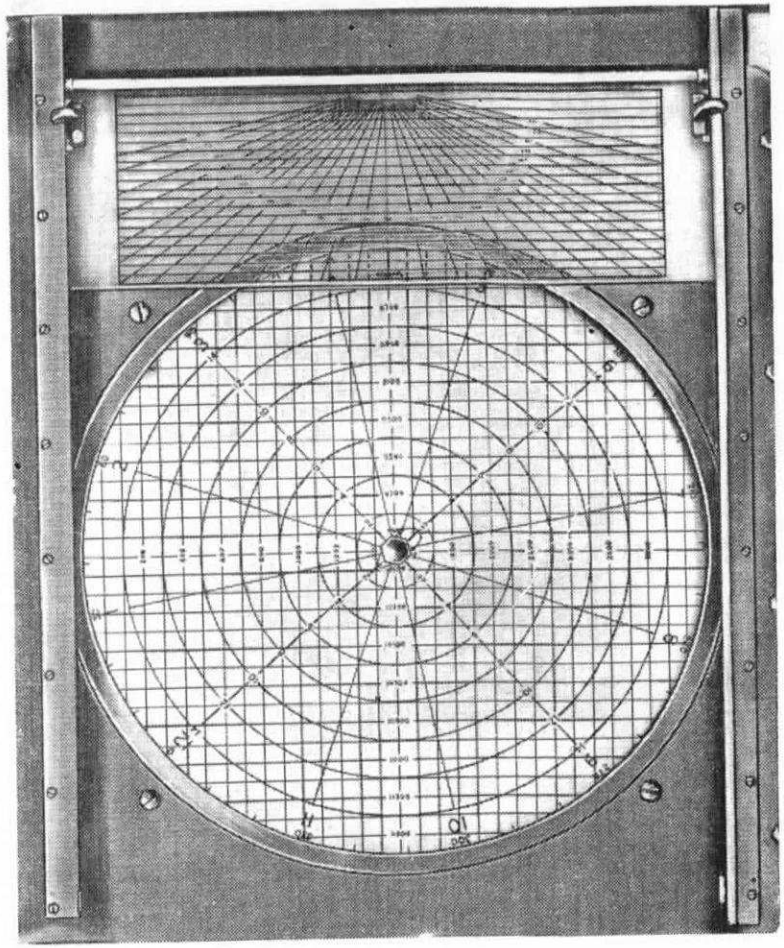


FIGURE 7.—Airplane control spotting board.

b. In operation with airplane control, the airplane observer reports the deviation of the splash from the target as a direction in clock numbers and an estimated number of yards. For example, a splash would be reported thus, "3 o'clock, 400." Using the clock numbers on the spotting board and the circles representing the linear deviation as a guide, the operator plots the deviation of the splash in pencil on the face of the spotting board. The range deviation of the splash from the target may be read by means of the horizontal grid lines. The correction is placed by setting the R_0 SPOT reset dial to the reference number of the range deviation.

c. To determine the azimuth correction, the transparent scale is slid down over the face of the spotting board until the horizontal line representing R_0 rests over the plotted splash. The azimuth deviation in reference numbers may then be read from the nearest diagonal line. The correction is placed by setting the reference number of the azimuth deviation as read from the sliding scale on the A_0 SPOT reset dial.

28. MATCHING DIALS.—*a.* There are two types of matching dials used in the computer. One type is of very simple construction and is used for the $\dot{R}_0$ and $R_0\dot{A}_0$ range and azimuth rate dials. There are only two indexes: one carried on an inner ring, the other on an outer ring. When these indexes are in line the dial is matched.

b. The other type of matching dial is of more intricate construction and allows a very accurate match of two values. This type is used for the BT I, BT II, and R_0 MATCH dials. It consists of three concentric rings which rotate about a fixed central dial. Each ring carries an index line. When the individual index lines are matched, a continuous line is formed. For the dial to be properly matched, the three line segments should all form one line directly beneath a fixed wire index which rests above the rings. The outer ring is geared to the second ring at a ratio of 10 to 1 and the second ring is geared to the inside ring at a ratio of 32 to 1. This facilitates accurate adjustment. These dials will be matched in the procedure of solving for A_0 and R_0. When a match

is obtained, a rate must be set in with the rate handwheel to maintain a match of the indexes. By observing in which direction the indexes become displaced from the wire index, the operator can determine the direction in which he must change the input handwheel to obtain a match and also, in applying the range or azimuth rate, whether the rate should be increased or decreased to maintain the match.

■ 29. BALLISTIC CHARTS.—There are two methods by which the ballistic charts in the computer are employed to apply corrections for nonstandard ballistic conditions. In one method, to apply a correction, it is necessary only to position the pointer to the proper reference line indicated on the ballistic chart. In the other method, a compensating counter is first set to the value of the nonstandard condition. This applies part of the correction and allows greater accuracy to be obtained. The pointer of the ballistic chart is then matched to the reference line representing the value set on the counter. This latter method, employing the compensating counters, is used for atmosphere and muzzle velocity ballistic corrections. All ballistic charts are automatically positioned to the correct range setting by shafts carrying predicted range (R_p). It should be noted that the elevation and time of flight charts, not strictly ballistic charts, are positioned by shafts carrying corrected predicted range (R_p').

■ 30. PARALLAX CHARTS.—In the operation of the parallax charts, the pointers are automatically positioned by predicted range. The reference lines on the charts are graduated in azimuth. In order to apply a parallax correction to the data for G_2 and compensate for its displacement from G_1, the operator turns the handwheel rotating the *chart* until the line corresponding to the azimuth of G_1 appears beneath the pointer. This procedure is followed in applying corrections to both range and azimuth.

■ 31. CHART SELECTOR AND DIAL.—The chart units of the computer carry charts to be used with the various combinations of powder and projectile, including charts for subcaliber ammunition. The proper charts for the charge to

be fired must always be brought into place in the computer before data can be reported as correct. The range-elevation converter panel contains a chart selector handwheel and dial, by means of which the correct charts may be brought into place. By rotating the chart selector handwheel, the charts are rolled backward or forward until the desired chart is brought into position. To indicate the setting of the chart at its correct position, the chart selector dial rotates as the charts are changed, the dial is marked with index lines at points around its circumference, and each index line is labeled to indicate a different chart setting. To position the charts in the computer for a definite combination, the chart selector handwheel is rotated until the index line representing the desired combination of powder and projectile matches the index line on the face of the panel. When a match has been made, the index line must be moved slightly back and forth until a detent mechanism functions and indicates the exact setting. The action of the detent mechanism will be indicated by a slight sticking of the handwheel and, if it passes over the detent rapidly, as would be the case with rapid rotation of the handwheel, a slight click is heard. When the charts have been properly positioned, one additional operation must be made to adjust properly the computer for the combination to be used. A value called "K" must be set into the K counter. This value is indicated on the chart selector dial. There is a different K value for every combination marked on the dial. The K value for the combination in use which is read from the dial and set into the K counter represents a mathematical constant used in the range-elevation conversion.

■ 32. DATA SETTING HANDWHEELS.—This type of handwheel is used in setting in basic, semipermanent data into the computer. All base line length and base line azimuth, chart selector K, and dead time handwheels are of this type. The operating feature of each is that the knob in the handwheel must be pulled OUT about one-quarter inch to allow the handwheel to engage the input shaft. When the setting has been made on the counter or dial, the knob is released and will spring back to the disengaged position. In the

disengaged position, an accidental blow or movement of the handwheel will not affect the data already set in.

■ 33. TWO-SPEED HANDWHEEL.—The A_0 handwheel is of this type. The purpose of this handwheel is to give a high rate of rotation, if desired, so that the operator can rapidly set the A_0 counter to the approximate reading and, when this has been accomplished, change to a slower rate of rotation in order to obtain a more accurate reading with smoother tracking. In operation, the handwheel is pulled OUT about one-half inch to obtain the higher rate of rotation. To change to the lower gear ratio, the handwheel is pushed IN. The normal position of the handwheel is in the IN position. It will be found that when matching the BT dials with the A_0 handwheel, more accurate and smoother adjustments can be obtained by keeping the handwheel in the IN position.

■ 34. WARNING LIGHTS.—*a*. In order to forestall the use of erroneous azimuths, warning lights are used to inform the operator that an azimuth, indicated on a counter which displays the input data that he controls, is false. In addition to warning the operator of a false solution, the lights will indicate whether the particular azimuth concerned should be increased or decreased in order to obtain a correct solution. Four operators need be concerned with the warning light indications, those operators being at the four azimuth inputs, *A Az*, A_0, *B Az*, and *C Az*. The labeling of the individual lamps is self-explanatory. A correct solution is being obtained only when the warning lights are OUT.

b. The most frequent use of the warning lights will be made by the A_0 operator in the process of solving for A_0 by matching either of the BT MATCH dials. The operator matches the BT MATCH dials by setting in A_0. It is possible to create four matches of the BT MATCH dial with four different A_0 values indicated on the counter, only one of which is correct. The A_0 operator should follow the instructions indicated by the illuminated warning lights in making a match of the BT MATCH dials; only when all warning lights are OUT is a correct solution for A_0 being obtained.

c. Another use of warning lights is during target relocation operations. Assume a situation in which the "B" and "C" triangle solvers are being employed to track a target. The *A Az* operator wishes to solve for *A Az* to place the A station observer "on target." To do this he must attain a match of the BT I MATCH dial with no warning lights on. Should the *A Az* lamp labeled INCREASE be illuminated, he would increase the *A Az* to effect a match. If the DECREASE lamp were illuminated he would decrease the *A Az* to obtain a matched condition of the indexes. When both the INCREASE and DECREASE lamps are illuminated at the same time, he may either increase or decrease *A Az* until the lights are extinguished and the dial is matched.

■ 35. COUNTERS AND DIALS, NORMAL SETTINGS.—The computer contains a number of counters and dials of various types. Some indicate the values of data that have been computed by the mechanism, and others register the values of data which are manually controlled by the operators. It is with this latter type that this paragraph is concerned. The limits of operation of many of the manually controlled counters and dials cover a wide range, and it is apparent that much valuable time could be lost in setting up the computer for action should the operators be forced to turn their counters or dials through this wide range. In order to save time during the initial operations preliminary to tracking, the following settings are recommended as those at which the dials and counters will be set by the operators concerned when the order, "Close stations," is given. Changes may be made as necessary to meet local conditions.

BASE AB, CB, and G_1B counters.	The average of the lengths of the base lines used by the battery.
AZ AB, AZ CB, AZ G_1B counters.	Directrix of battery.
A AZ, B AZ, C AZ counters.	Directrix of battery.
A_0 counter	Directrix of battery.
R_0 counter	30,000 yards.

$R_0\dot{A}_0$ dials	25 yards/sec. (outer ring only).
$\dot{R}_0$ dial	25 yards/sec. (outer ring only).
Target SPEED counter	20 knots.
Target COURSE counter	Back azimuth of directrix of battery.
A_0, R_0, and A_p SPOT reset dials.	Normal of 10 (inner and outer dials).
Muzzle VELOCITY compensation counters.	Set last computed muzzle velocity for full charge on proper counter: red or white.
ATMOSPHERE compensation counter.	To meteorological message value corresponding to 30,000 yards range.
DEAD TIME counter	Zero.
CHART SELECTOR dial	Full charge combination.
K counter	K value of full charge combination.
% RANGE SPOT counter	Normal of 30.0.

CHAPTER 6

BASE-END DATA TRANSMISSION SYSTEM

	Paragraphs
SECTION I. Equipment	36–39
II. Transmitter and receiver controls	40–42
III. Operation	43–46
IV. Emergency methods of operation	47–52

SECTION I

EQUIPMENT

■ 36. GENERAL.—The base-end data transmission system consists of a transmitting unit, which is part of the observation instrument or radar set, and a receiver unit attached to the computer in the plotting room. It also includes the transmission cable pairs and switchboards used for the routing of data from the various observation and radar stations to the computer.

■ 37. EQUIPMENT AT OBSERVATION AND RADAR STATIONS.—The observation instrument in use at the observation stations is either the azimuth instrument M2 or the depression position finder M2. Ranges found by the DPF M2 must be transmitted by telephone, as no provision for the electrical transmission of DPF ranges has been made. Range and azimuth data from the radar station are transmitted electrically by transmitters similar to those on the observation instruments.

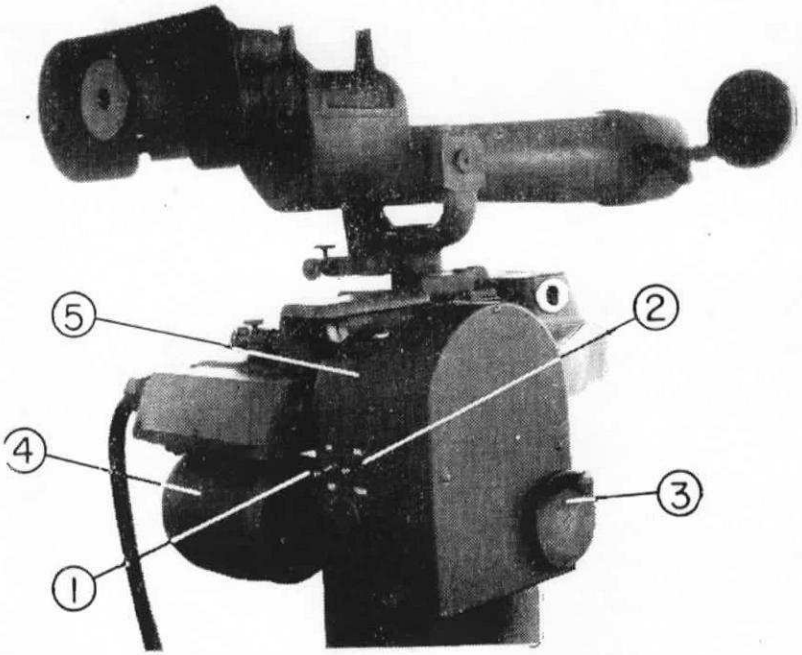
■ 38. EQUIPMENT AT COMPUTER.—The computer has as accessories two types of data receivers which are attached to the input azimuth shafts of the triangle solvers. For the reception of azimuths from the radar and observation stations, the M13 azimuth receiver is attached to the *A Az* and *C Az* input shafts. The M12 azimuth-range receiver, adapted to either reception of azimuths or the reception of radar ranges, is attached at the *B Az* input shaft.

■ 39. WIRE SYSTEM.—The transmission circuits carrying data for the system are the regular telephone cable pairs used by the harbor defense communications system. Two fire control switchboards BD-95, installed in the plotting room, are used for the switching of data transmission and telephone circuits used by the battery.

SECTION II

TRANSMITTER AND RECEIVER CONTROLS

■ 40. AZIMUTH TRANSMITTER.—*a.* The azimuth instrument M2 or DPF M2 has a motor circuit switch which controls the power for the aided-tracking motor and a TRACK-BAL switch which allows the circuit to be balanced prior to transmitting data. The normal position of the



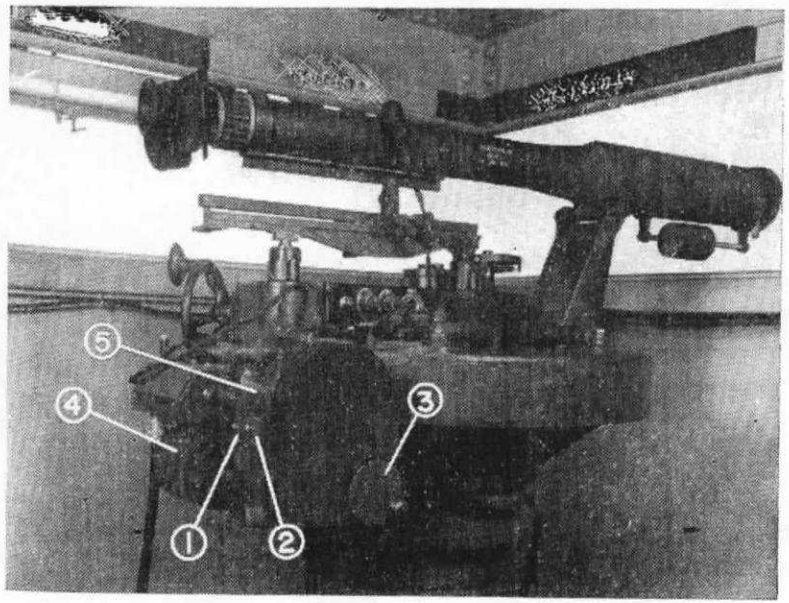
1. Motor circuit switch.
2. Track-bal switch.
3. Tracking handwheel.
4. Aided-tracking motor.
5. Aided-tracking device housing.

FIGURE 8.—Azimuth instrument M2.

TRACK-BAL switch is at the BAL position, and it is thrown to the TRACK position only at the order of the azimuth receiver operator when a target is being tracked.

b. To get on target preliminary to tracking, the throw-out lever is used in the normal manner. This does not in any way affect the azimuth transmitter. It is important that the aided-tracking motor be turned OFF when the throw-out lever is used.

c. The tracking handwheel traverses the observation instrument and, in addition, adjusts the speed of the aided-tracking motor. It has a neutral position, at which there is no rate of traverse supplied by the motor. Movement of the handwheel in a clockwise direction from the neutral position will not only traverse the azimuth instrument to the right, but will set up a rate at which the instrument will continue



1. Motor circuit switch.
2. Track-bal switch.
3. Tracking handwheel.
4. Aided-tracking motor.
5. Aided-tracking device housing.

FIGURE 9.—Depression position finder M2.

traversing. Movement of the handwheel in a counterclockwise direction will traverse the instrument to the left and set a rate at which the instrument will continue to track in that direction.

■ 41. AZIMUTH RECEIVER M13.—*a.* In the base of this unit are the MOTOR CIRCUIT switch which controls the aided-matching motor, and the BRIDGE CIRCUIT switch which is thrown to the ON position to supply direct current to the data transmission lines.

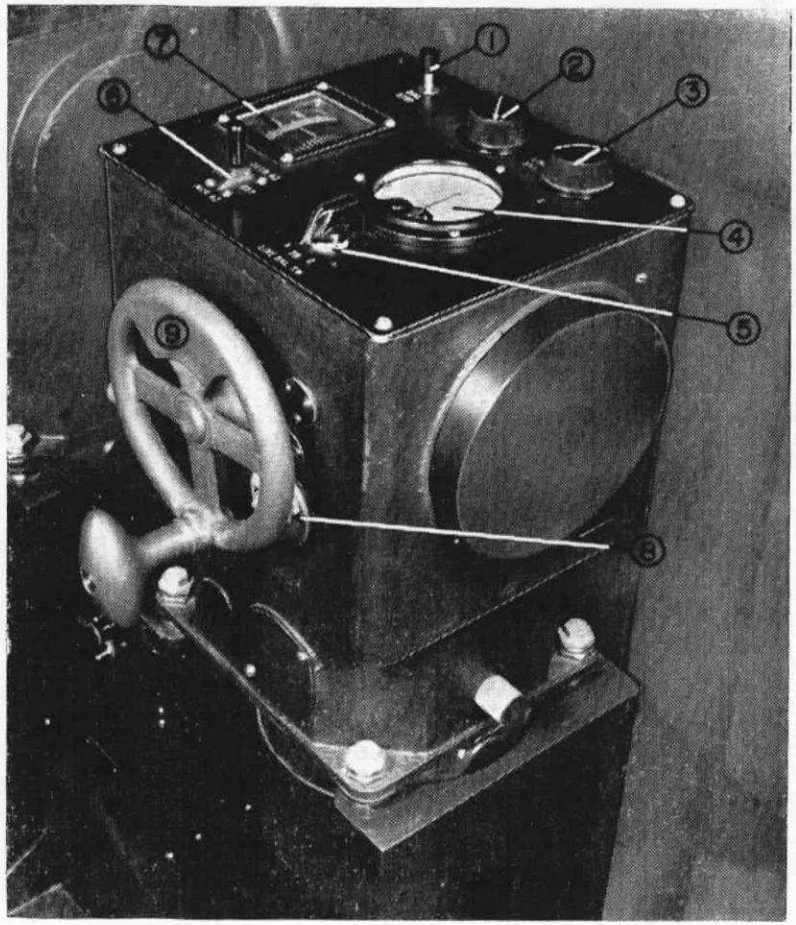
b. On the face of the top panel is the LINE BALance switch which can be thrown to positions 1 and 2 during the line balancing operation but is otherwise kept at the TRack position.

c. Directly above the LINE BALance switch is the meter. A central or zero position of the meter needle during tracking will indicate a matched condition of the hundredths azimuth scale on the receiver with that of the azimuth instrument. A zero position of the needle during the line balancing operation indicates a balanced condition of the transmission circuit.

d. The LINE BAL knobs, Nos. 1 and 2, are used when electrically balancing the data transmission circuit.

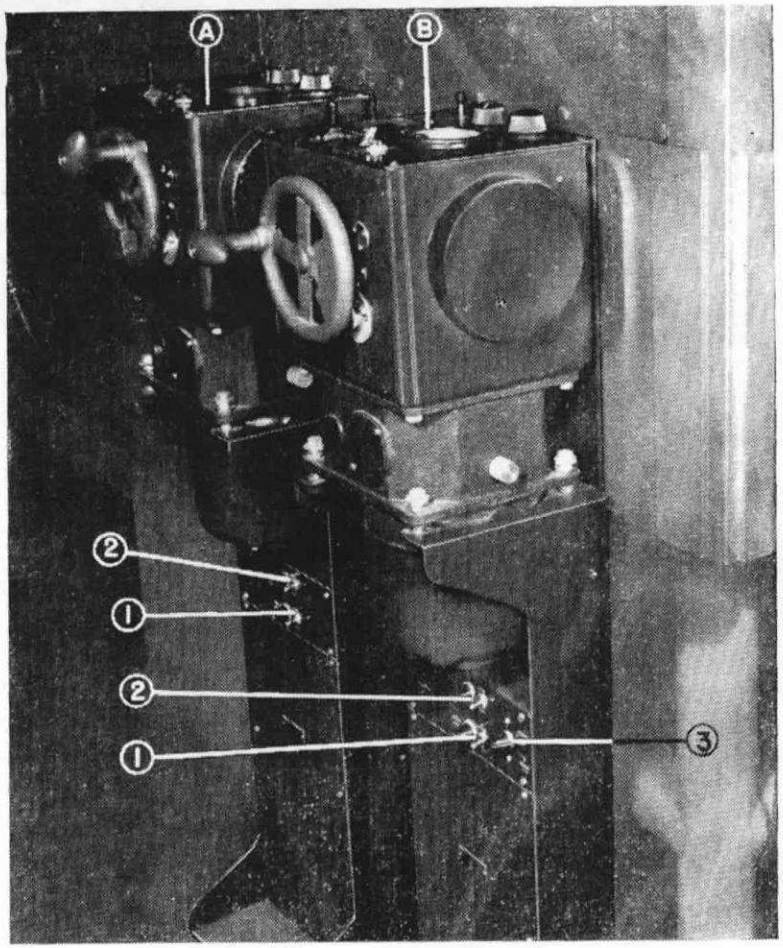
e. The SLEW KEY is used to make large and rapid changes in the reading of the whole degree scale. When thrown to either the INCREASE or DECREASE position it will cause the azimuth scales to rotate at high speed in the desired direction.

f. The aided-matching device built into the azimuth receiver is a similar mechanism to that of the azimuth instrument. The operating handwheel sets in data and regulates the speed at which the motor will change the azimuth scales of the receiver.



1. Dial stop push button.
2. Line balancing knob No. 1.
3. Line balancing knob No. 2.
4. Meter.
5. Line balancing switch.
6. Slewing key.
7. Azimuth scales.
8. Hexagonal meshing nut.
9. Operating handwheel.

FIGURE 10.—Top view, azimuth receiver M13 and azimuth-range receiver M12.



A. Azimuth receiver M13.
1. Motor circuit switch.
2. Bridge circuit switch.

B. Azimuth-range receiver M12.
1. Motor circuit switch.
2. Bridge circuit switch.
3. Azimuth-range change-over switch.

FIGURE 11.—Front view, azimuth receiver M13 and azimuth-range receiver M12.

■ 42. AZIMUTH-RANGE RECEIVER M12.—This receiver differs from the azimuth receiver M13 only in that it contains an azimuth-range change-over switch, located on the pedestal base. When the change-over switch is at the azimuth position, the receiver will function as an azimuth receiver for the *B Az* input of the computer. When the radar system is to be employed, the change-over switch is thrown to the range position; this adapts the receiver to receive range data transmitted electrically from the radar station. The potentiometer in the unit is disconnected by throwing the switch, and a potentiometer attached to the CT shaft of the computer is placed in operation. Range data transmitted by the radar station will therefore be fed to the CT counter of the computer and be controlled by the azimuth-range receiver M12. It should be noted that a change of *B Az*, made by use of the receiver, results in a change of CT as registered on the counter.

SECTION III

OPERATION

■ 43. LINE BALANCING.—*a.* When an observation station has been assigned to track a target and provide data for an azimuth input of the computer, and after the connection of data transmission and telephone circuits between the observation station and the computer has been made, the first operation to be performed is that of "line balancing." The receiver operator is in telephone communication with the reader at the observation station.

b. After throwing the BRIDGE CIRCUIT switch on the base of the receiver to the ON position, the receiver operator calls, "Set switch on balance," to the reader at the base-end station.

c. The observer, at the order relayed by the reader, checks the position of the TRACK-BAL switch to make sure that it is at the normal position of BAL.

d. The receiver operator then turns the LINE BALance switch to position 1 and performs a balance by rotating the LINE BALance knob marked "1," until the meter needle rests at the central or *zero* position.

e. He then turns the LINE BALance switch to position 2 and performs a balance by rotating the LINE BALance knob marked "2," until the meter needle rests at the *zero* position.

f. These operations are repeated until no movement of the meter needle away from the zero position is caused when the LINE BALance switch is thrown to position 1 or position 2. The LINE BALance switch is then set to the TRack position.

g. After the balancing operation has been completed, the receiver operator orders, "Set switch on track."

h. The reader relays this order to the observer who sets the TRACK-BAL switch of the azimuth instrument at the TRACK position.

i. The observer, during these foregoing operations, has continued to track the target, employing the aided-tracking device of the azimuth instrument to maintain the vertical cross wire on the tracking point on the target. The line balancing operations are in no way affected by this procedure.

■ 44. SYNCHRONIZATION.—*a.* Immediately after the line balancing operations have been completed, and the battery commander's "Track" order has been received, the receiver operator throws the MOTOR CIRCUIT switch to the ON position and proceeds with the synchronization operation.

b. The tracking rate of the azimuth instrument continuously moves the meter needle of the azimuth receiver away from its zero position. The receiver operator, by means of the operating handwheel, sets a rate to maintain the needle at its zero position. This establishes a match of the azimuth transmitter and receiver rates and synchronizes only the hundredths scales. However, the receiver may be out of synchronization by any number of whole degrees.

c. To synchronize the whole degree readings with those being continually read to him by the reader at the observation station, the receiver operator operates the SLEW KEY until the whole degree scale checks with the azimuth being read to him. It may be necessary to rematch the meter needle at this time by means of the operating handwheel.

d. The receiver operator continues to listen and synchronize his readings on the whole degree scale and maintain the needle at a zero position. When the data continues to check for a short period, the receiver operator reports, "*A Az* (or *B Az*, etc.) on target," and continues to keep the meter needle at zero, making any necessary adjustments to the matching rate to accomplish this.

e. As changes take place in the tracking rate at the observation station, a like change must be made at the azimuth receiver. Changes in the tracking rate will cause the meter needle to move away from the zero index. The reader should inform the receiver operator of any changes in the target course so that the receiver operator will be prepared to adjust the matching rate.

f. The whole degree synchronization should be checked by the reader and receiver operator at intervals of about 2°. To check the synchronization of the whole degree scales, the reader will read the whole degree when the zero mark of the micrometer passes the index on the azimuth instrument.

■ 45. STATIC CHECK.—*a.* A static check of the data transmission circuits and equipment is made to check the operation of the system prior to drill or at times when the computer is not being employed to track a target. This procedure should be followed when the switchboard operator is making periodic checks of the data transmission lines.

b. The switchboard operator makes the connection of data transmission and telephone circuits between the observation or radar station and the azimuth receiver at the computer. The azimuth instrument or radar equipment is set to any convenient azimuth, and the line balancing and synchronization operations are performed by the azimuth receiver operator in the usual manner. The range transmitter at the radar station is checked in a similar manner. Synchronization should be checked at several readings. If line balancing and synchronization can be performed properly with a fixed reading on the data transmitter, the system is in order and will function equally as well with a moving target.

c. In a battery employing a large number of observation stations, each of the three azimuth receivers should be connected to its respective observation station, so that the static check may be conducted simultaneously. Data transmission circuits and equipment of all observation stations can thus be tested in groups of three to save time.

■ 46. RECEPTION OF RANGE WITH AZIMUTH-RANGE RECEIVER M12.—*a.* The operation of the receiver M12 for the reception of range data from the radar station is identical with its operation for the reception of azimuths, except that the synchronization operations are applied to the CT counter to synchronize it with the ranges being read from the radar station.

b. To place the receiver in operation for the reception of ranges, the AZIMUTH-RANGE switch on the base is thrown to the RANGE position.

c. The BRIDGE CIRCUIT switch is thrown to the ON position, and the line balancing operations are performed in exactly the same manner as for azimuth reception.

d. When the line balancing operations have been completed, the MOTOR CIRCUIT switch is thrown ON, and a rate is set by the operating handwheel to maintain the meter needle at the zero position.

e. The slewing key is then used to rotate rapidly the CT counter and set on it a value in yards to match the ranges being telephoned by the radar reader. All warning lights must be OUT when the match of the CT values is made.

f. When the CT counter is synchronized, it may be necessary to rezero the meter needle by use of the operating handwheel. When a synchronization of ranges on the CT counter and a match of the needle with the zero index have been maintained for a short period, the receiver operator reports, "C range on target," and continues to keep the meter needle at the zero mark, making any necessary adjustments to the matching rate to accomplish this.

g. The synchronization of the CT counter and range, as indicated on the radar unit, should be checked at regular intervals by the receiver operator and the reader.

SECTION IV

EMERGENCY METHODS OF OPERATION

■ 47. FAILURE OF AIDED-TRACKING MOTOR IN TRANSMITTER.—The azimuth instrument M2 or the DPF M2 may be used with manual operation in case of a failure of power or of the aided-tracking motor. Rotation of the tracking handwheel will traverse the instrument in the normal manner without injury to the aided-tracking mechanism. Electrical transmission of data may be maintained during manual operation of the azimuth instruments.

■ 48. FAILURE OF AIDED-MATCHING MOTOR IN RECEIVER.—In case of a failure of the aided-matching motor or the power source, the receivers M12 and M13 may be manually operated to maintain the electrical transmission of data. The operating handwheel is rotated to maintain a match of the meter needle with the zero index. No injury will result to the aided-matching mechanism from manual operation.

■ 49. FAILURE OF COMPUTER.—*a.* In case of failure of the computer, operation with the base-end data transmission system may be continued to supply data to the plotting room for the stand-by method of operation. If necessary, the receiver unit may be unmeshed from the computer by turning the hexagonal nut located on the receiver housing directly behind the operating handwheel. The receiver may then be operated without transmitting rotation to the computer input shaft.

b. On the TI bell the operator will push the dial stop button, which stops the azimuth scales, and telephone or call the azimuth reading to the proper arm setter at the plotting board. Upon release of the dial stop button, the azimuth scales will return rapidly to the correct position.

■ 50. FAILURE OF BASE-END DATA TRANSMISSION SYSTEM.—In case of a failure of the base-end data transmission system, data will be transmitted from the observation or radar stations to the computer by telephone. The operations of

the base-end readers and receiver operators at the computer, in this emergency method of data transmission, must be coordinated to result in a continuous input of data to the computer, approaching as closely as possible the actual continuous data input under normal electrical data transmission. A 5-second TI bell should be employed for greater accuracy in the reading and setting of data into the computer, but satisfactory results can also be obtained without the use of a TI bell. The operating procedures, with and without a TI bell, are as described in the following paragraphs.

■ 51. DATA TELEPHONED ON 5-SECOND TI BELL.—*a.* Upon receipt of the order, "Track," and when telephone communication with the receiver operator has been established, the reader will read at the TI bell the azimuth appearing on the azimuth scales of the azimuth instrument, as, for example, "185.68." The reader will continue to read the azimuths on every successive TI bell. The observer will not stop tracking on the TI bell.

b. The receiver operator will rotate the azimuth dials to set them at the data being telephoned by the reader. When the azimuth dials match the data being telephoned by the reader, the receiver operator will continue rotation of the operating handwheel to set a "matching rate" so that the azimuth reading on the receiver dials will continually match that being telephoned by the reader on the TI bell.

c. When the receiver dials continue to indicate the same azimuth as that shown at the observation instrument, the receiver operator will call, "On target." Thereafter, the reader will cease reading the whole degree reading at every bell and read only the decimal fraction of the degree at each TI bell, thus, ".56, .68, .80," etc. The reader will then call the whole degree reading only on the first bell after the whole degree reading has changed.

d. The procedure in reading range by the radar reader is exactly the same as outlined for the reading of azimuths by the azimuth reader. He will initially read the whole value of the range in yards, for example, 18,790. When a continuous match of the ranges on the CT counter has been attained by the *B Az* receiver operator, the reader will cease reading the whole value of the range at every TI bell and read only the last three digits of the range, as, "790, 810, 830," etc. He will read the whole value of the range on the first TI bell after the value in thousands of yards has changed, as, for example, "19,020."

■ 52. DATA TELEPHONED WITHOUT TI BELL.—*a.* The procedure in telephoning azimuth and range data to the computer without the use of a TI bell is exactly the same as outlined above for the reading of data on the TI bell, except that the reader will read data intermittently at approximately the same interval of time between readings as with the TI bell.

b. The reader, in reading the data, will read that azimuth or range which appeared on the dials at the instant he started the reading. If, for example, the dial reads 174.45° at this instant, and the reader starts to read the azimuth, he should read 174.45°, as that azimuth was indicated at the first sound of his voice, even though a different azimuth was indicated at the completion of the reading.

c. The receiver operator should note the reading of the dials at the first sound of the reader's voice. If the value does not agree, the receiver operator adjusts the rate of data input to obtain synchronization.

d. In summary, it can be stated that when a regularity of the readings is attained by the reader, the first sound of his voice in making the readings is as effective as a TI bell. By training the reader and receiver operator in this emergency method of operation, a high degree of accuracy can be obtained in the telephone transmission of intermittent data to the computer.

CHAPTER 7

OUTPUT DATA TRANSMISSION SYSTEM

	Paragraphs
SECTION I. Description	53–56
II. Orientation	57–60
III. Synchronization	61–63
IV. Operation	64–65
V. Emergency methods of operation	66–69

SECTION I

DESCRIPTION

■ 53. GENERAL.—The output data transmission system consists of the selsyn transmitters which are built into the gun data computer M1, the selsyn receivers which are attached to the gun carriages, and the connecting transmission cables. The computer has selsyn transmitters supplying data to the following selsyn receivers at the guns:

Azimuth indicator, gun No. 1 . . { 1 azimuth receiver, fine. / 1 azimuth receiver, coarse.

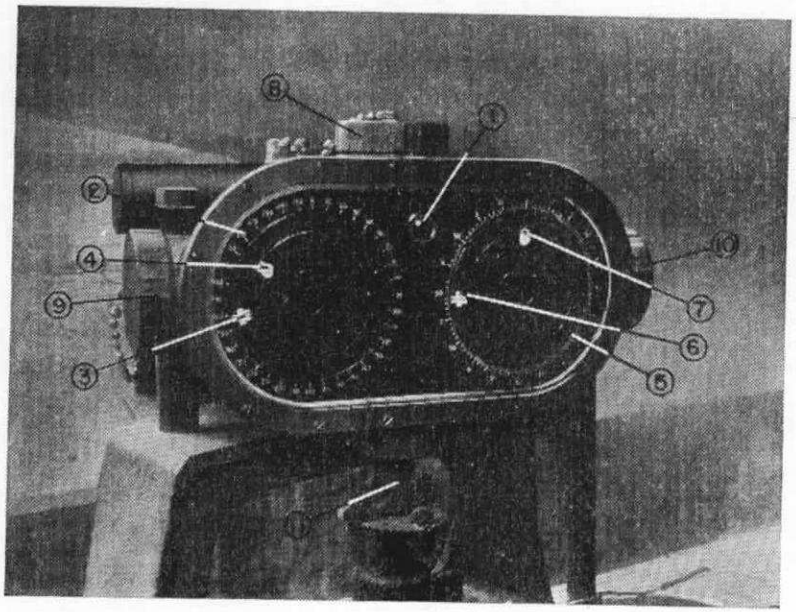
Elevation indicator, gun No. 1 . . { 1 elevation receiver, fine. / 1 elevation receiver, coarse.

Azimuth indicator, gun No. 2 . . { 1 azimuth receiver, fine. / 1 azimuth receiver, coarse.

Elevation indicator, gun No. 2 . . { 1 elevation receiver, fine. / 1 elevation receiver, coarse.

■ 54. ELECTRICAL CIRCUITS.—All electrical circuits for the transmission of firing data and signals from the computer to the guns pass through the main junction box located in the plotting room. Flexible rubber-covered cables carry the circuits from the computer to the junction box, where they connect to the special armored cables which go to the guns. This junction box contains three switches, one of which controls the main power supply to the computer. The other two switches provide a means by which power for the transmission of data to each gun may be turned on or off. The junction box is normally attached under the "B" triangle solver to the framework which supports the computer. However, for easy access, it may be placed anywhere in the plotting room.

■ 55. SIGNAL LAMPS.—A red signal lamp is mounted between the coarse and fine dials of each indicator at the guns. These signal lamps are controlled by switches on the wind component indicator panel of the computer. When ON, they

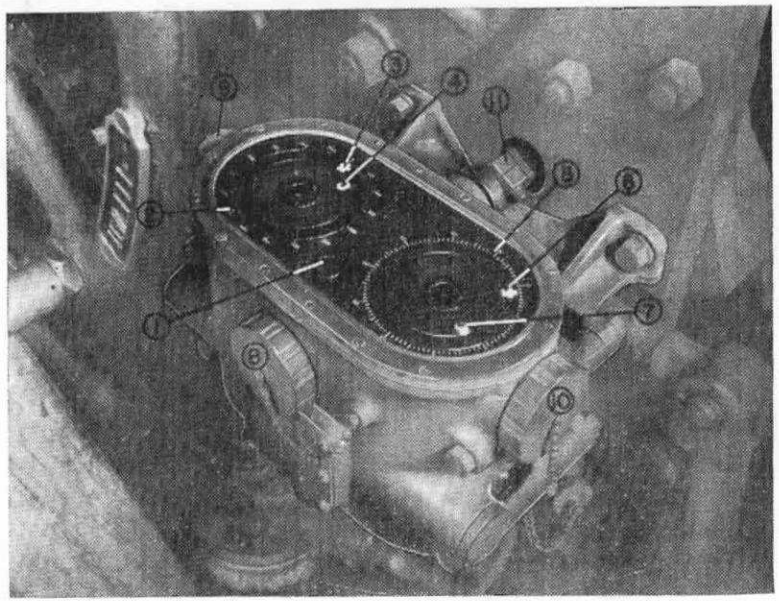


1. Signal lamp.
2. Coarse azimuth scale.
3. Coarse mechanical pointer.
4. Coarse electrical pointer.
5. Fine azimuth scale.
6. Fine mechanical pointer.
7. Fine electrical pointer.
8. Adjusting screws cover plate.
9. Light-well cover plate, coarse dial.
10. Light-well cover plate, fine dial.
11. Mechanical pointer drive shaft leading to adjustable coupling.

FIGURE 12.—Azimuth indicator.

indicate that the data being transmitted from the computer to the indicators at the guns are satisfactory, and that the data may be used to fire.

■ 56. APPLYING DATA TO GUNS.—A follow-the-pointer system of applying data to the guns is employed with the output data transmission system. Data, which are transmitted automatically and electrically by the transmitters in the computer, position the (inner) electrical pointers on the indicators. The indicators likewise contain (outer) mechanical pointers which are connected by gearing to the elevating



1. Signal lamp.
2. Coarse elevation scale.
3. Coarse mechanical pointer.
4. Coarse electrical pointer.
5. Fine elevation scale.
6. Fine mechanical pointer.
7. Fine electrical pointer.
8. Adjusting screws cover plate.
9. Light-well cover plate, coarse dial.
10. Light-well cover plate, fine dial.
11. Adjustable coupling.

FIGURE 13.—Elevation indicator.

or traversing mechanisms of the guns. To set the guns to the data being transmitted from the computer, it is necessary to match the mechanical pointers to the electrical pointers by traversing or elevating the guns, as the case may be. The guns are thus set at the proper data determined by the computer. When setting the gun in azimuth or elevation, the operator first roughly matches the coarse receiver dials and then brings the fine mechanical pointer into coincidence with the fine electrical pointer.

SECTION II

ORIENTATION

■ 57. GENERAL.—*a.* Orientation of the gun battery is divided into two parts: one, orientation in azimuth; two, orientation in elevation.

b. Before orienting the guns, it is essential that calibration fire will have been completed and calibration corrections determined which, when applied to the individual guns, will cause both guns of the battery to shoot alike in range and parallel in azimuth.

■ 58. SELECTION OF REFERENCE PIECE.—In general, gun No. 1 is selected as the reference piece for the application of a calibration correction for muzzle velocity difference.

■ 59. ORIENTATION IN AZIMUTH.—*a.* A gun is oriented in azimuth when the mechanical pointers on the indicator indicate the azimuth at which the bore of the gun is pointing, plus or minus the calibration correction.

b. The azimuth of the bore may be obtained either by boresighting the gun on an orienting point the azimuth of which is known or by using a transit set up over a known point.

c. A calibration correction for azimuth may be applied at the time the gun is being oriented by the application of an angular correction to the mechanical pointers of the azimuth indicator.

d. Assuming that a gun is to be oriented by boresighting on an orienting point the azimuth of which is 159.60°, and that a calibration correction is to be applied to make the gun shoot 0.15° to the RIGHT, the procedure should be as follows:

(1) Insert the boresight in the breech of the gun (the primer vent is used if the gun has no boresight) and affix the cross wires to the muzzle.

(2) Traverse the gun until the cross wires are centered on the orienting point.

(3) Subtract 0.15° from the orienting point azimuth of 159.60° to give the reading of 159.45° which must be indicated by the mechanical pointers when the bore is sighted on the orienting point.

(4) Loosen the clamping screw of the adjustable coupling on the shaft which drives the mechanical pointers.

(5) Rotate the adjusting screw of the adjustable coupling until the mechanical pointers indicate an azimuth of 159.45°.

(6) Tighten the clamping screw.

(7) With the bore sighted on the orienting point, check the reading of the mechanical pointers which should indicate 159.45°.

e. If the calibration correction had been applied to make the gun shoot to the LEFT, the correction would have been added to the azimuth of the orienting point, and the mechanical pointers would have been set to indicate an azimuth of 159.75° when the piece was boresighted on the orienting point.

■ 60. ORIENTATION IN ELEVATION.—*a.* A gun is oriented in elevation when the mechanical pointers on the indicator indicate the quadrant elevation of the axis of the bore, plus or minus the calibration correction.

b. The quadrant elevation of the axis of the bore is obtained by the use of a clinometer.

c. The simplest method by which calibration corrections for muzzle velocity difference may be applied to a gun is by means of a flat angular correction applied to the mechanical pointer of the elevation indicator at the time the gun is being oriented.

d. Assuming that a calibration correction for muzzle velocity difference of plus 5 mils in elevation is to be applied to a piece, the procedure should be as follows:

(1) Elevate the gun to a convenient elevation such as 300 mils and check the elevation with a clinometer.

(2) Subtract the 5-mil plus correction from 300 mils to give a value of 295 mils which must be indicated by the mechanical pointers when the gun is set at 300 mils of elevation.

(3) Loosen the clamping screw of the adjustable coupling on the shaft which drives the mechanical pointers.

(4) Rotate the adjusting screw of the adjustable coupling until the mechanical pointers indicate an elevation of 295 mils.

(5) Tighten the clamping screw.

(6) Check the reading of the mechanical pointers at 295 mils with the gun elevated to a clinometer reading of 300 mils.

e. If the calibration correction had been minus 5 mils in elevation, the correction would have been added to the mechanical pointer reading; thus the pointers would have indicated a reading of 305 mils when the gun was elevated to 300 mils.

SECTION III

SYNCHRONIZATION

■ 61. GENERAL.—The data transmission system is in synchronization when the receiver dials on the guns indicate the same data as those on the transmitter dials in the computer. Synchronization is an entirely separate process from orientation and will be performed after orientation. It should seldom be necessary to synchronize after the initial adjustment has been made, but, primarily as a precaution against faults, the synchronization should be checked periodically and prior to drill.

■ 62. AZIMUTH INDICATORS.—The electrical pointers at the guns are said to be synchronized with the azimuth transmitter dials at the computer when the dials indicate identical

readings at all azimuths. If there is a difference between the data sent and the data received, synchronization may be accomplished by the following procedure:

a. Energize the data transmission system.

b. Set the azimuth transmitter dials so that they read any convenient azimuth.

c. Traverse the gun so that the mechanical pointers on the indicators are set to the same azimuth reading as the transmitter dials at the computer.

d. Unscrew the cover plate on the indicator housing to gain access to the two slotted head adjusting screws. One screw will adjust the coarse dial electrical pointer and the other the fine dial electrical pointer.

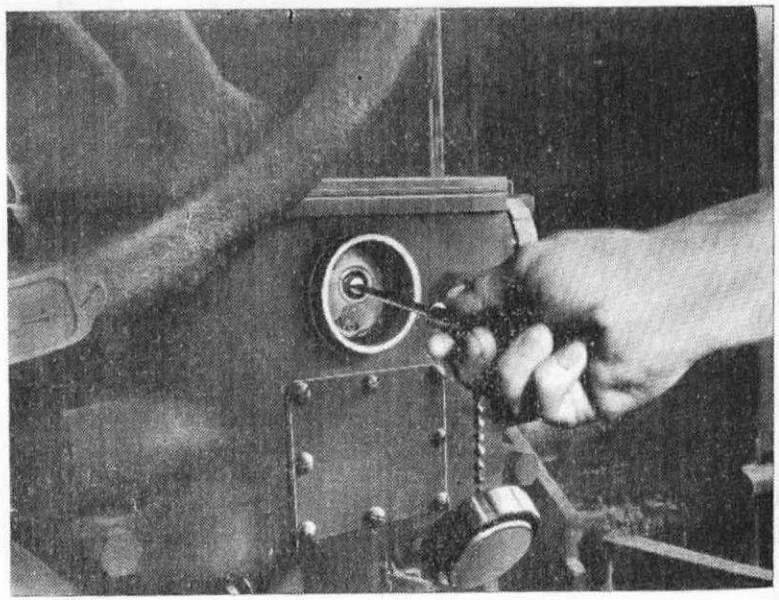


FIGURE 14.—Adjusting electrical pointer.

e. Using a screw driver, turn the adjusting screws until both the coarse and fine dial electrical pointers match the mechanical pointers.

f. Replace the cover plate.

g. After the operations described have been performed, change the transmitter dial readings to check the synchronization at two other widely separated azimuths. If the dials indicate the same readings at the latter two checking azimuths, the system is in synchronization. If the dials do not indicate the same readings at all checking azimuths, a failure in the data transmission system is indicated.

■ 63. ELEVATION INDICATORS.—*a.* The electrical elevation pointers at the guns are said to be synchronized with the elevation transmitter dials at the computer when the dials indicate indentical readings at all elevations.

b. If there is a difference between the data sent and the data received, synchronization may be accomplished by exactly the same procedure outlined for synchronization of the azimuth dials, except that the check is made between the elevation indicators on the guns and the elevation transmitter dials on the computer.

SECTION IV

OPERATION

■ 64. DUTIES OF GUN POINTER.—When the computer is transmitting data for a moving target, the electrical azimuth pointers will have a definite rate of movement. The gun pointer, who will set the gun in azimuth, must achieve a "matching rate" of movement of the gun so that the match of the mechanical and electrical pointers will be maintained constantly. The movement of the gun in matching the pointers should be as smooth as possible. The electrical pointers must not be allowed to move away from the mechanical pointers so that the gun must be moved in "jumps" to create a match. The matching of the pointers must be maintained continuously throughout the tracking of the target and should not be interrupted after the gun is fired.

■ 65. DUTIES OF THE ELEVATION SETTER.—Because the guns are depressed for loading, the elevation setter will be required to rematch the pointers when elevating the gun after each loading. As the guns are continuously laid in azimuth,

they may be fired immediately upon matching of the elevation pointers, without waiting for a TI bell. The elevation data will assume a definite rate of change, resulting in a continuous movement of the electrical pointers. This movement will be fairly constant and will continue while the gun is depressed for loading. The elevation brakes on the gun must be set before the piece can be fired. Setting the elevation brakes of the gun will result in a stoppage of movement of the mechanical pointers. In order that the gun may be fired at the instant the electrical and mechanical pointers of the elevation indicators are in coincidence, and with the elevation brakes of the piece set, the procedure in setting the gun in elevation will be as follows:

a. The elevation setter will note the direction and rate of movement of the electrical pointers.

b. At the order, "Elevate," by the gun commander, the elevation setter will elevate the gun to match the coarse pointers approximately and set the fine mechanical pointer ahead of the electrical pointer so that sufficient time for setting of the elevation brakes is allowed before the fine electrical pointer will move into coincidence with the fine mechanical pointer.

c. The elevation brakes will then be set.

d. At the instant the fine electrical pointer matches the fine mechanical pointer, the elevation setter will, at the discretion of the battery commander, either fire the gun by the electric firing magneto or indicate by arm or voice signal that the piece should be fired.

SECTION V

EMERGENCY METHODS OF OPERATION

■ 66. GENERAL.—In case of a failure of the output data transmission system, the computer may be continued in operation. The data will be telephoned to the guns on a 10-second TI bell and set on the guns by traversing or elevating the pieces until the mechanical pointers indicate the

proper readings on the azimuth or elevation scales of the indicators. A dead time of 10 seconds is set into the computer for this method of operation.

■ 67. PROCEDURE IN PLOTTING ROOM.—Additional operators will be stationed at the transmitter dials of the computer and connected by telephone to the gun pointer or elevation setter of each gun. At the TI bell, the operators at the transmitter dials will read the data indicated on the dials. In case II firing, only elevation data will be read from the transmitter dials. The deflection will be read from the deflection degrees counter and telephoned to the gun pointers at both G_1 and G_2 on every TI bell.

■ 68. DUTIES OF GUN POINTER.—*a.* In case III firing, the gun pointer receives the data telephoned from the plotting room on the TI bell and traverses the gun until the mechanical pointers indicate the data on the azimuth scales of the indicator. The gun will thus be laid in azimuth and may be fired on the next bell.

b. In case II firing, the gun pointer tracks the target with the telescope. When he receives the deflection telephoned from the plotting room on the TI bell, he sets it on the deflection scale of the sight. He brings the cross wires of the telescope on the target and tracks it until the next TI bell. The gun is then fired on the succeeding TI bell. This procedure is necessary due to the fact that angular travel of the target during dead time is included in the computation of the deflection angle.

■ 69. DUTIES OF ELEVATION SETTER.—*a.* The duties of the elevation setter are identical in case III or case II firing.

b. When the gun is loaded and the order to elevate has been received, the elevation setter will set the gun to the data received on the last TI bell by elevating the gun so that the mechanical pointers indicate the data on the mil scales of the elevation indicator.

c. The piece may now be fired on the next TI bell.

CHAPTER 8

EMPLOYMENT OF COMPUTER

		Paragraphs
SECTION I.	General	70
II.	Selection of B station	71–73
III.	Horizontal base system	74–79
IV.	Target relocation	80–81
V.	Vertical base system	82–85
VI.	Radar system	86–88
VII.	Airplane spotting	89–91
VIII.	Airplane control	92–96
IX.	Generated control	97
X.	Situation charts	98–103

SECTION I

GENERAL

■ 70. GENERAL.—*a*. This chapter concerns the various methods of operation by which the gun data computer M1 can be employed. In addition, it covers the preparation of situation charts and tabulated situation data, the purpose of which is to coordinate the operations of all personnel in setting up the computer to bring fire on a target. A study of this chapter before entering upon an examination of the drill tables will be an aid in understanding the purpose of the various individual operations listed for each method of operation.

b. It should be noted that regardless of the method of operation, the procedure by which the computer determines firing data, with ballistic and gun parallax corrections, is the same in all methods of operation. Fire adjustment corrections are placed in the same manner in all methods of operation except airplane fire control. The special means by which fire adjustment corrections are applied in airplane fire control are covered in section VII.

SECTION II

SELECTION OF B STATION

■ 71. SIZE OF ANGLES.—The accuracy of target position data, obtained from the solution of any of the basic triangles by the computer, is directly affected by the size of the angles formed at any point of the triangles. For the accurate mechanical solution of the position finding problem, it is required that none of the triangles which are being solved contain an angle less than 10°.

■ 72. "B" TRIANGLE ANGLES.—Under normal conditions of operation, with base lines of adequate length between those observation stations assigned to do the tracking, it is not probable that an angle smaller than 10° will be developed in either the "A" or "C" triangles. However, if the B station selected for a position finding problem should be too close to G_1, it is possible that the "B" triangle may develop angles under the minimum for accuracy.

■ 73. "B" TRIANGLE BASE.—Care should be taken in the designation of an observation station or known point as the B station that the resultant base of the "B" triangle, which lies between G_1 and the B station, be of sufficient length to obtain angles above the minimum for accuracy at all points of the "B" triangle.

SECTION III

HORIZONTAL BASE SYSTEM

■ 74. STATION DESIGNATIONS.—In the horizontal base method of position finding, either the "A" or "C" triangle solver can be used in conjunction with the "B" triangle solver, and the base-end data can be had from any two adjacent observation stations. Any one of the observation stations in the system can be designated A, B, or C, depending upon which input is to take data from that station.

■ 75. BASE-END DATA FOR COMPUTER.—If the "A" triangle solver is to be used, the length and azimuth of the base line between the stations designated A and B are set on the

BASE AB and AZ AB counters which are located on the "A" triangle solver panel. The length and azimuth of the base line between G_1 and the B station are set on the BASE G_1B and AZ G_1B counters located on the "B" triangle solver panel. At this point the computer is ready to use base-end data. The azimuth from the A station to the target is set in by the *A Az* receiver, and the azimuth from the B station to the target is set in by the *B Az* receiver. With this input data, the "A" triangle solver will solve for the side BT, which will be indicated on the BT counter and will also displace the indexes of the BT I MATCH dial.

■ 76. SOLUTION OF PRESENT AZIMUTH.—For the solution of the present azimuth (A_0), the operator will set in A_0 with the A_0 handwheel until a match of the BT I MATCH dial indexes occurs with no warning lights on. He then sets in an $R_0\dot{A}_0$ azimuth rate to maintain a match of the BT I MATCH dial indexes without further movement of the A_0 handwheel and continues this procedure until the BT I MATCH dial remains matched. A_0 is now continuously registered on the A_0 counter.

■ 77. SOLUTION OF PRESENT RANGE.—For the solution of the present range (R_0), the operator sets in R_0 with the R_0 handwheel until a match of the R_0 MATCH dial indexes occurs. He then sets in an $\dot{R}_0$ range rate to maintain a match of the indexes in the same manner as for the BT I MATCH dial. R_0 is now continuously indicated on the R_0 counter.

■ 78. TO OBTAIN TARGET COURSE.—To obtain the target's course and speed, the operator creates a match of the $\dot{R}_0$ and $R_0\dot{A}_0$ rate dials on the target position generator panel, matching the indexes on the inner rings against the indexes on the outer rings. When both dials have been matched simultaneously by manipulation of the COURSE and SPEED handwheels, the solved course and speed will be indicated on the COURSE and SPEED counters.

■ 79. TRIANGLE SOLVER CHANGE-OVERS.—During tracking with the "A" triangle solver, the length and azimuth of the base line between the stations designated as C and B are set into the "C" triangle solver by the BASE CB and AZ CB counters. The "C" triangle solver is thus made ready to take over the tracking of the target when the A station loses visibility and the "A" triangle solver becomes ineffective. As the B station target azimuths are already an input to the computer, only the C station azimuths are required for a solution of the "C" triangle. When the C station target azimuths are fed to the "C" triangle solver, the side BT is computed and goes to the BT II MATCH dial where it offsets the indexes. To change over from the "A" triangle solver to the "C" triangle solver requires only that the A_0 operator match the BT II MATCH dial instead of the BT I MATCH dial. When the A station loses visibility and flow of data ceases, the change-over may be effected instantly.

SECTION IV

TARGET RELOCATION

■ 80. DEFINITION.—In a situation where the A and B stations are tracking a target and the C station observer is unable to see the target, azimuth of the target from the C station may be solved by the computer with the view of placing the C station observer "on target." This operation is called "target relocation."

■ 81. TARGET RELOCATION.—To accomplish target relocation, the *C Az* operator creates a match of the BT II MATCH dial by setting in *C Az*. When a match of the dial has been attained with warning lights OUT, the *C Az* indicated on the C AZ counter is the solved azimuth from the C station to the target. The *C Az* operator then sets a rate on the *C Az* receiver to maintain a match of the BT II MATCH dial indexes, and the solved *C Az* will be continuously indicated on the C AZ counter. This is telephoned at intervals to the C station observer, who by setting his instrument at the solved azimuth can locate the target. It is possible for an

observer to be put "on target" in this manner when he would have been unable to find it otherwise. Should the C and B stations be tracking a target, relocation for the A station target azimuth may be accomplished in the same manner by the *A Az* operator, who will match the BT I MATCH dial.

Section V

VERTICAL BASE SYSTEM

■ 82. General.—The base-end data consist of azimuth and range from a single observation station equipped with a depression position finder. From the viewpoint of the capabilities of the computer, the azimuth may be fed to any one of the A, B, or C inputs, and either the "A" or "C" triangle solver may be employed to obtain firing data in conjunction with the "B" triangle solver. However, as the "C" triangle solver is designed for the reception of electrically transmitted ranges from the radar station, it should be left free for possible employment of radar, and the "A" triangle solver should be used for vertical base tracking. It must be remembered that vertical base operation is an auxiliary system, used when visibility is so poor that the target can be seen from one observation station only. Under such conditions, there are two possible situations which may develop in regard to target visibility. The visibility may improve so that horizontal base operation may be entered upon, or it may become so poor that the target will become totally obscured and radar operation is the only method possible. Both possibilities must be kept in mind in setting up the computer for the vertical base system.

■ 83. Use of Triangle Solvers.—The triangle solvers are prepared for tracking by setting in base line orientation data, as in the horizontal base system. Figure 15 shows one method of employing the triangle solvers for vertical base operation. The depression position finder has been assigned as the B station. There is a base line on either side of the B station, and, for this reason, both the "A" and "C" triangle solvers will be set up with the orientation data for these

base lines. Orientation data for base line AB are set into the "A" triangle solver and orientation data for the base line CB are set into the "C" triangle solver. The *B Az* operator will receive target azimuths, and the *A Az* operator will receive target ranges from the B station. The "A" triangle solver will be used to locate the target's position. The "C" triangle solver will be held as an auxiliary and can be used in a change-over to the horizontal base system should the target become visible to the C station observer. Should the target become visible to the A station observer, a change-over to horizontal base operation with the "A" triangle solver can be made. Target relocation is performed by the *C Az* operator who attempts to place the C station observer on target. The *A Az* operator is unable to telephone the solved *A Az* directly to the A station observer, as he is in telephonic communication with the B station in order to receive ranges. However, the chief of section, or a member of the detail designated by him, should

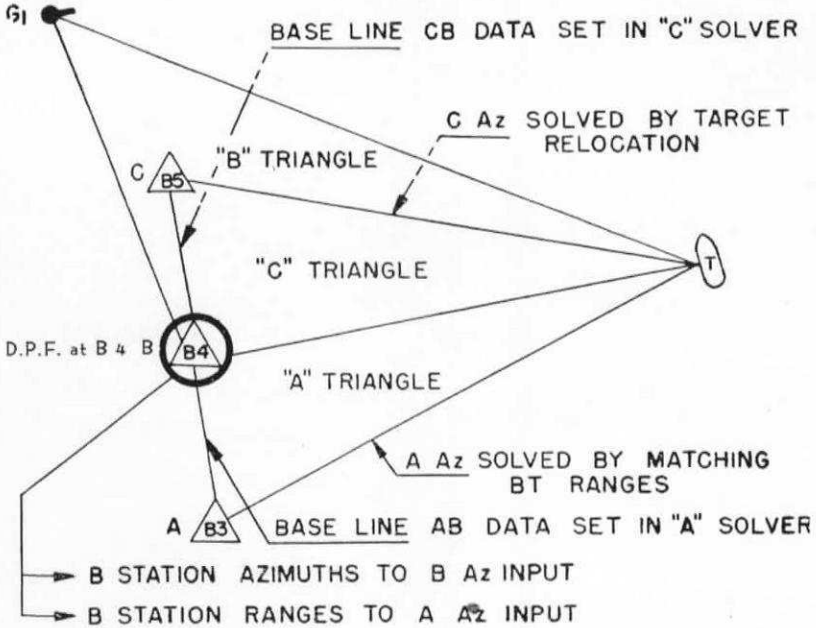


Figure 15.—Employment of triangle solvers in vertical base operation.

at intervals read the *A Az* from the A AZ counter and telephone the data to the A station observer from another telephone connected through the switchboard. The computer is not necessarily limited in the assignment of the DPF station as the B input of the computer. The DPF may be assigned as the A or C station as well. A brief summary of the operations performed by the input operators after base line orientation data have been set into the computer is shown in the following table:

DPF at	No. 1 operator	No. 3 operator	No. 4 operator
A station ..	Sets in *A Az*	Matches BT II MATCH dial.	Sets in value of AT.
B station ..	Sets in value of BT.	Matches BT II MATCH dial.	Sets in *B Az*.
C station ..	Matches BT I MATCH dial.	Sets in *C Az*	Sets in value of CT.
B station (alternate method).	Matches BT I MATCH dial.	Sets in value of BT.	Sets in *B Az*.

■ 84. TOTAL OBSCUREMENT.—If total obscurement of the target appears imminent, the *C Az* operator may cease target relocation operations and set up the "C" triangle solver with orientation data for the radar base line and start tracking while tracking is still in progress with the "A" triangle solver. When the change-over to radar operation is made, it can thus be effected with a minimum loss of time.

■ 85. SOLUTION OF TARGET POSITION.—Assuming a situation such as the one shown in figure 15, the target azimuth from the B station is the *B Az* input. The ranges from the B station are telephoned by the reader to the *A Az* operator. The *A Az* operator sets in *A Az* until the ranges as read by the reader appear on the BT counter with the warning lights OUT. He then sets in a rate on the *A Az* receiver so that the range on the BT counter is continuously correct.

By these operations, the "A" triangle solver has solved for the side BT which offsets the indexes of the BT I MATCH dial. Another solution obtained is the *A Az* which will be continually indicated on the A AZ counter. This *A Az* is telephoned to the A station observer in the manner previously explained. The operations of the A_0 and R_0 operators, and the course and speed operator follow exactly the same procedure as that outlined for horizontal base operation.

SECTION VI

RADAR SYSTEM

■ 86. OPERATION WITH RADAR DATA.—Operation of the computer with radar data is similar to operation with the vertical base system. The data consist of azimuth and range from a single station. Provision is made for the electrical transmission of radar ranges to the CT counter, which is controlled by the *B Az* receiver. For this reason, when electrical transmission of data is used, the radar station must always be designated as the C station, and the "C" triangle solver must be employed.

■ 87. SELECTION OF BASE LINE.—A base line between the C (radar) station and a B station must be selected and its orientation data set into the "C" triangle solver. The orientation data for the base line between G_1 and the B station are set into the "B" triangle solver. The B station selected should be one in the system near the target so that, while radar operation is being conducted, the "A" triangle solver can be set up for the base line between the B station and an adjacent station. This adjacent station is then designated as the A station with the view of a change-over to horizontal base operation should the target become visible to the shore observation stations.

■ 88. SOLUTION OF TARGET POSITION.—The radar azimuths are transmitted to the *C Az* receiver. The *B Az* operator, to adjust the *B Az* receiver for the reception of ranges, sets a switch located in the pedestal of the receiver to the RANGE

position. He synchronizes the CT counter to the ranges telephoned from the radar station and sets a rate on the *B Az* receiver to keep the meter needle zeroed. (The warning lights must be OUT when the CT counter is synchronized.) The CT counter will then indicate continuously the correct ranges transmitted from the radar station. By these operations the "C" triangle solver computes the side BT, which is fed to the "B" triangle solver where it offsets the indexes of the BT II MATCH dial. From this point on the operations are identical with horizontal and vertical base operation.

SECTION VII

AIRPLANE SPOTTING

■ 89. GENERAL.—Under conditions of poor visibility, as the case would be when operation is by the radar system, it is obvious that due to the inability of shore observation stations to observe the fire, fire adjustment by the ordinary methods is not possible. However, if an airplane is available to spot the fire, the airplane spotting board provides a means for fire adjustment by the magnitude method. This method employs the airplane spotting board and the range and lateral fire adjustment boards and is limited in accuracy only by the precision with which the airplane observer can report the deviations of the splashes from the target. The spotting boards M7 or M3 will not be used in this method of fire adjustment.

■ 90. LATERAL CORRECTIONS.—The deviation of the center of impact of a salvo is reported by the airplane observer and is plotted on the face of the airplane spotting board in the normal manner. The lateral correction is obtained from the sliding scale in reference numbers with a normal of 10.0 and can be plotted directly on the lateral fire adjustment board. The rules of lateral fire adjustment by the magnitude method will then be applied and corrections will be placed in the computer by means of the A_p SPOT handwheel and reset dial.

■ 91. RANGE CORRECTIONS.—The range deviation is determined as a linear deviation in yards, with an over or short sensing. The normal for the range corrections on the airplane spotting board is 10,000, and the sense and magnitude of the deviation in yards can be computed mentally by the operator. The percentage of the deviation in range and its conversion to reference numbers can be computed quickly by the range fire adjustment board operator on the slide rule which is part of the M1 fire adjustment board. The deviation in reference numbers is then plotted on the board so that it is converted to a correction. The adjustment of fire according to the rules for the magnitude method is then followed. Percent range corrections are applied to the computer by means of the % RANGE SPOT handwheel and counter.

SECTION VIII

AIRPLANE CONTROL

■ 92. GENERAL.—The airplane control method of position finding is the *least* satisfactory of the various methods of operation. However, its inclusion in this manual is believed essential to complete coverage of the service of the computer. The airplane observer must transmit by radio data from which the approximate range and azimuth from the battery to the target are obtained. No use is made of the triangle solvers in locating the target's position, as the A_0 and R_0 for which they solve are received directly from the airplane observer.

■ 93. SETTING ESTIMATED RANGE AND AZIMUTH.—The estimated range is set in by the R_0 handwheel and registers on the R_0 counter. The estimated azimuth is set in by the A_0 handwheel and will be indicated on the A_0 counter. Once the initial setting of these values has been made, they are *not* changed by the handwheels.

■ 94. SETTING ESTIMATED COURSE AND SPEED.—The estimated course and speed of the target are set in on the target course and speed counters. These values position the inner rings

of the $\dot{R}_0$ and $R_0\dot{A}_0$ rate dials. The A_0 and R_0 operators continually match the indexes on the outer rings of the rate dials against the indexes on the inner rings throughout operation. The TIME switch *must not* be turned ON until after the correct settings of A_0, R_0, target speed, and target course have been made, and the match of the $\dot{R}_0$ and $R_0\dot{A}_0$ dials has been accomplished.

■ 95. SPOT CORRECTIONS.—Target course and A_0 position the airplane spotting board which is used for the adjustment of fire. A detailed description of the operation of the airplane spotting board will be found in chapter 5. The A_0 and R_0 spot corrections are all the fire adjustment corrections necessary to operate under this method. The spotting board M7 or M3 and the fire adjustment boards will not be used. The A_0 and R_0 SPOTS, being continually set in, will correct the errors in the original estimates of A_0 and R_0 and will bring the center of impact on the target if the airplane observer's estimation of the target's course and speed have been correct.

■ 96. USE OF TRIANGLE SOLVERS.—The triangle solvers should be set up with orientation data for those base lines nearest the target and used for a series of target relocation operations. The solved target azimuths for the observation stations are telephoned to the observers to keep them "on target," with the view of commencing normal tracking should visibility improve so that the target can be seen. The individual operations for target relocation under airplane control are explained in the drill tables in the appendix.

SECTION IX

GENERATED CONTROL

■ 97. USE TO SUPPLY DATA.—*a*. While generated control is not a method of position finding, it must be considered in conjunction with the various methods outlined in this section. It is essentially an emergency measure, the purpose of

which is to maintain a flow of data to the guns if, for any one of a number of reasons, the triangle solvers become ineffective. It may be used when data from the observation stations cease, due to temporary obscurement of the target, or it can be used during the time that orientation data for new base lines are being set into the computer. It must be borne in mind that generated control may be entered upon only when an A_0 and R_0 and the course and speed of the target have been determined by previous tracking. It should be remembered also, that data transmitted to the guns when under generated control will be correct only so long as the target does not change course or speed.

b. Having solved for A_0 and R_0 and having determined the target's course and speed, to enter generated control, the course and speed operator leaves the course and speed counters at their last solved positions and makes no further adjustments to the settings. The R_0 operator makes no changes to the last solved R_0, as indicated on the R_0 counter, but continuously matches the outer ring index of the R_0 rate dial to the index on the inner ring. The A_0 operator makes no changes to the last solved A_0, as indicated on the A_0 counter, but continuously maintains a match of the index on the outer ring of the $R_0\dot{A}_0$ rate dial against the index on the inner ring. In this manner the last solved R_0 and A_0 will continuously change according to the range and azimuth rates established by the last solved course and speed of the target. If generated control is entered upon because of target obscurement, target relocation operations may be made to keep the observers "on target."

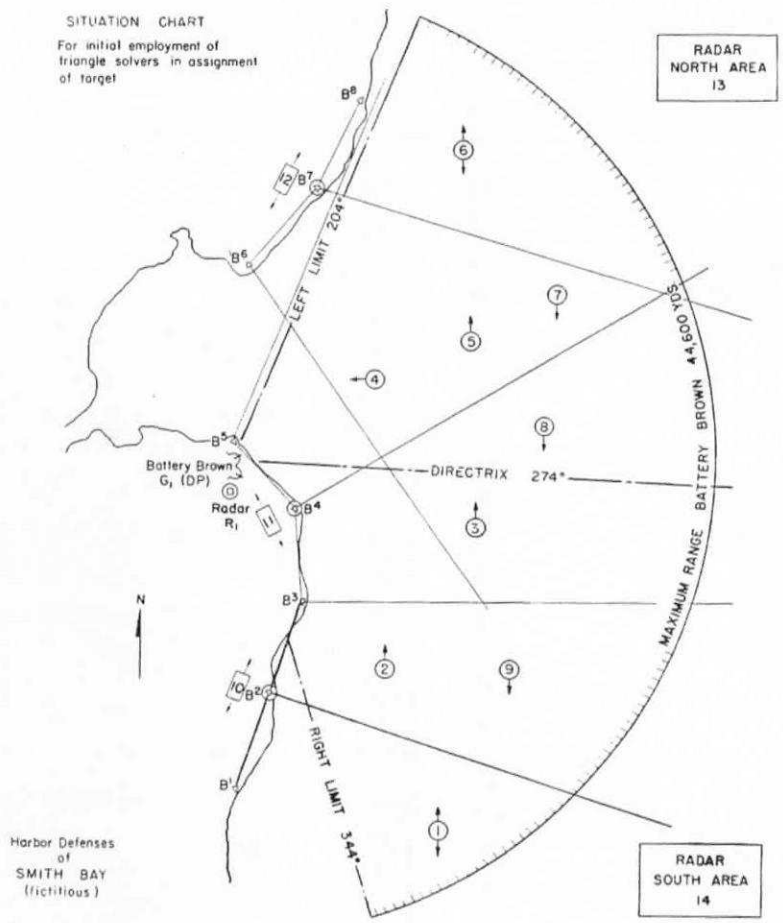
SECTION X

SITUATION CHARTS

■ 98. GENERAL.—Regardless of how well trained and efficient the operating personnel may be in the actual operations of tracking a target with the gun data computer M1, unless the instrument can be rapidly and correctly set up for operation when a target is initially assigned, many of the advantages gained by its use are lost. When a target is assigned to the

battery, it must be realized that, until reports on target identification and visibility are received by the battery commander from the observation stations, there may be no means by which the battery commander can determine which base lines and method of operation should be used. However, once these reports are received, and the battery commander makes the decision regarding employment of base lines and method of operation, a great many operations must be made simultaneously to set the computer up for tracking. Telephone and data transmission lines must be connected, orientation data for the selected base lines must be set into the triangle solvers, the spotting board must be oriented for the spotting base line, and communications between it and the spotting stations established. It is obvious that to issue verbal instructions to each individual operator at the time the target is assigned to the elements of the battery would result in great confusion and loss of time, especially under the stress of an engagement with the enemy. Therefore, some means must be provided by which the computer and associated equipment can be set up rapidly and correctly to track a target in any part of the field of fire, by any of the methods of operation. A solution to this problem is the preparation of situation charts and tabulated instructional data for the operating personnel.

99. EXAMPLE OF SITUATION CHART.—Figure 16 shows a situation chart designed for a fictitious but typical battery installation. It will be noted that there are eight observation stations, of which three, B^2, B^4, and B^7, are equipped with depression position finders. The numbers enclosed in circles represent the numbers of situations for horizontal base operation. Regardless of where the target may be in the field of fire, and whatever its direction of travel, it may be tracked utilizing one of the nine situations provided for operation with the horizontal base system. The numbers 10, 11, and 12, enclosed in the rectangles, indicate vertical base operation with the depression position finders at the adjacent observation stations. Two situations, 13 and 14, are provided for radar operation with data from R^1, the radar station. While the radar station can track a target



Symbols used:

- Situation number and symbol designating direction of travel of target, horizontal base operation.
- Situation number and symbol designating direction of travel of target, vertical base system.
- Observation station.
- Radar station.
- Observation station with depression position finder

FIGURE 16.—Situation chart for harbor defenses of Smith Bay (fictitious)

anywhere in the field of fire, two situations are necessary so that a B station may be selected which is near the target, regardless of whether it is in the north or south area of the field of fire.

■ 100. USE OF SITUATION DATA CARDS.—The battery commander will receive reports from the observation stations relative to visibility, and locate the target on his situation chart. He will decide which method of operation to use and, from the location and direction of travel of the target, decide which situation number to order. Tables II to VII illustrate the tables of tabulated instructional data, called situation data cards, prepared for the use of the switchboard, computer panel, and spotting board operators. When a situation order is received from the battery commander, all operators concerned with the setting up of orientation data and communications refer to their situation data cards and carry out the instructions listed for that situation.

■ 101. METHOD OF CHANGING BASE LINES.—The situations listed on the chart are for the initial employment of the triangle solvers in any given target situation. As the target moves through the field of fire and the limits of visibility of the tracking observation stations are reached, it will be necessary to change base lines by setting up a new situation. The target is again located on the situation chart, and a situation number is ordered as though the target were being assigned for the first time. Generated control should be ordered before situations are changed to maintain the transmission of firing data to the guns during the change-over period.

■ 102. EMPLOYMENT OF "A" AND "C" TRIANGLE SOLVERS.—In almost every situation there are two phases. Either the "A" or "C" triangle solver is employed in the initial phase for tracking the target, with the other triangle solver held as an auxiliary, ready to take over tracking in the second phase when visibility is lost by one of the observation stations used for the initial tracking. Instructions are listed for each operator for the first and second phases of every situation, informing him whether he is to track or relocate. The switchboard operator is informed by his situation data card of the changes which must be made in the spotting board communications when the spotting base line is changed for the second phase of a situation.

■ 103. EXAMPLE OF USE OF SITUATION DATA CARDS.—*a.* To understand the use of the situation data cards, assume that a target has been assigned to the battery, and that the target has been assigned to the observation stations by the battery commander as being in the south area, traveling right to left. All observation stations covering that area search for the target. Reports from the observation stations indicate that the target is visible to the observers at B^2 and B^3. Since the battery commander, in locating the target on the situation chart, knows that the direction of travel is toward B^4, he orders, "Situation two."

b. At the receipt of the situation order, the operators refer to their situation data cards and carry out the following simultaneous operations for the situation which assigns B^2 as the A station, B^3 as the B station, and B^4 as the *C* station.

(1) No. 18, switchboard operator, connects data transmission and telephone lines from B^2 to *A Az*, B^3 to *B Az*, and B^4 to *C Az*. He connects telephone lines from S^3 to No. 13 spotting board operator and S^2 to No. 14 spotting board operator.

(2) No. 1, *A Az* operator, sets orientation data for the base line AB into the "A" triangle solver panel. His instructions indicate that he will track in the initial phase of the situation.

(3) No. 2, A_0 operator, sets orientation data for the base line G_1B into the "B" triangle solver panel. His instructions are to match the BT I MATCH dial in the first phase of the situation.

(4) No. 3, *C Az* operator, sets orientation data for the base line CB into the "C" triangle solver panel. His instructions indicate that the "C" triangle solver will be held as an auxiliary and that he is to relocate for *C Az* should the C station (B^4) observer be unable to see the target.

(5) No. 4, *B Az* operator, has instructions which indicate that he is to track during both phases of the situation.

(6) No. 12, spotting board operator, supervises the setting of orientation data for the spotting base lines between G_1 and the spotting stations S^2 and S^3 into the spotting board M7 or M3.

c. When tracking has progressed and the target has reached a point where it is becoming obscured to the A station (B^2) observer, but is visible to both the B station (B^3) and C station (B^4) observers, the range officer will order, "Change to 'A' (or 'C') triangle solver." At this order, the operators will follow the instructions listed for the second phase of situation two.

(1) No. 18, switchboard operator, disconnects the spotting telephone lines and connects S^4 to No. 13 and S^3 to No. 14.

(2) No. 1, *A Az* operator, relocates to keep A station (B^2) observer on target in case target should turn and retrace course.

(3) No. 2, A_0 operator, ceases match of BT I MATCH dial and matches BT II MATCH dial.

(4) No. 3, *C Az* operator, tracks.

(5) No. 4, *B Az* operator, tracks.

(6) No. 12, spotting board operator, supervises the setting in of orientation data for spotting base lines between G_1 and spotting stations S^3 and S^4 as called for by second phase of situation two.

d. The foregoing operations of the operating personnel should be followed by the checking of all operations with the tabulated situation data cards for each individual.

e. It can be seen that as a means of coordinating the operations of setting up the computer and associated equipment to track a target, the situation chart and tabulated situation data cards for the operating personnel are of primary importance. The situation chart presents a graphical method of enabling the battery commander to select the method of operation and employment of base lines, and the situation data cards allow each operator to perform rapidly and accurately the operations required of him at the assignment of target in setting up the computer to track it. Conditions governing the preparation of a situation chart may vary with the battery installation, but the general form outlined in this section should be followed.

TABLE I—*Base line orientation data*

FOR "A" AND "C" TRIANGLE SOLVERS

Stations		Length (yards)	Azimuth (degrees)	Back azimuth (degrees)
B^1	B^2	9,465	197.53	17.53
B^2	B^3	9,087	196.87	16.87
B^3	B^4	8,796	173.46	353.46
B^4	B^5	8,659	133.84	313.84
B^5	B^6	16,732*	184.38	4.38
B^6	B^7	9,858	220.82	40.82
B^7	B^8	8,953	205.67	25.67

FOR "B" TRIANGLE SOLVER, G_1B

Stations		Length (yards)	Azimuth (degrees)
G_1	B^1	30,564	358.24
G_1	B^2	22,051	349.62
G_1	B^3	14,671	332.69
G_1	B^4	7,124	307.74
G_1	B^5	1,758	163.19
G_1	B^6	18,229	182.73
G_1	B^7	26,643	195.42
G_1	B^8	35,387	198.67

RADAR BASE LINES FOR "C" TRIANGLE SOLVER

Stations		Length (yards)	Azimuth (degrees)
R^1	B^7	29,165	194.36
R^1	B^2	19,235	350.39

*The base line between B^5 and B^6 is not used due to its excessive length. The use of base lines between observation stations longer than 10,000 yards is not recommended.

TABLE II.—*Situation data, switchboard, operator No. 18*

SITUATION — HORIZONTAL BASE

No.	*A Az*	*B Az*	*C Az*	Spotting first phase		Spotting second phase	
				Operator 13	Operator 14	Operator 13	Operator 14
1	B^1	B^2	B^3	S^2	S^1	S^3	S^2
2	B^2	B^3	B^4	S^3	S^2	S^4	S^3
3	B^3	B^4	B^5	S^4	S^3	S^5	S^4
4	.....	B^4	B^5	S^5	S^4	.....	.....
5	B^6	B^7	B^8	S^7	S^6	S^8	S^7
6	B^6	B^7	B^8	S^8	S^7	S^7	S^6
7	B^3	B^4	B^5	S^5	S^4	S^4	S^3
8	B^2	B^3	B^4	S^4	S^3	S^3	S^2
9	B^1	B^2	B^3	S^3	S^2	S^2	S^1

VERTICAL BASE AND RADAR

No.	*A Az*	*B Az*	*C Az*
10	B^2 Tel.	B^2 DTS & Tel.	B^3
11	B^4 Tel.	B^4 DTS & Tel.	B^5
12	B^7 Tel.	B^7 DTS & Tel.	B^8
13	B^6	R^1 Range DTS & Tel.	R^1 *Az* DTS & Tel.
14	B^1	R^1 Range DTS & Tel.	R^1 *Az* DTS & Tel.

Glossary of abbreviations above:

Tel.—Telephone lines.

DTS & Tel.—Data transmission system and telephone lines.

R^1—Radar station.

Range DTS & Tel.—Data transmission system and telephone lines for range data from station.

Az DTS & Tel.—Data transmission system and telephone lines for azimuth data from station.

TABLE III.—*Situation data, A Az input, operator No. 1*

HORIZONTAL BASE

No.	A station	B station	Base AB	Az AB	C station	Instructions	
						First phase	Second phase
1	B^1	B^2	9,465	197.53	B^3	Track	Relocate
2	B^2	B^3	9,087	196.87	B^4	Track	Relocate
3	B^3	B^4	8,796	173.46	B^5	Track	Relocate
4	.....	B^4	.....	.....	B^5	Not used	.....
5	B^6	B^7	9,858	220.82	B^8	Track	Relocate
6	B^6	B^7	9,858	220.82	B^8	Relocate	Track
7	B^3	B^4	8,796	173.46	B^5	Relocate	Track
8	B^2	B^3	9,087	196.87	B^4	Relocate	Track
9	B^1	B^2	9,465	197.53	B^3	Relocate	Track

VERTICAL BASE AND RADAR

No.	A station	B station	Base AB	Az AB	C station	Instructions
10	B^1	B^2	9,465	197.53	B^3	Match BT counter.
11	B^3	B^4	8,796	173.46	B^5	Match BT counter.
12	B^6	B^7	9,858	220.82	B^8	Match BT counter.
13	B^6	B^7	9,858	220.82	R^1	Radar—relocate *A Az.*
14	B^1	B^2	9,465	197.53	R^1	Radar—relocate *A Az.*

TABLE IV.—*Situation data, A_0 input, operator No. 2*

HORIZONTAL BASE

No.	B station	Base G_1B	Az G_1B	A station	C station	Instructions	
						First phase	Second phase
1	B^2	22,051	349.62	B^1	B^3	Match BT I	Match BT II
2	B^3	14,671	332.69	B^2	B^4	Match BT I	Match BT II
3	B^4	7,124	307.74	B^3	B^5	Match BT I	Match BT II
4	B^4	7,124	307.74	.....	B^5	Match BT II	Match BT I
5	B^7	26,643	195.42	B^6	B^8	Match BT I	Match BT II
6	B^7	26,643	195.42	B^6	B^8	Match BT II	Match BT I
7	B^4	7,124	307.74	B^3	B^5	Match BT II	Match BT I
8	B^3	14,671	332.69	B^2	B^4	Match BT II	Match BT I
9	B^2	22,051	349.62	B^1	B^3	Match BT II	Match BT I

VERTICAL BASE AND RADAR

No.	B station	Base G_1B	Az G_1B	A station	C station	Instructions
10	B^2	22,051	349.62	B^1	B^3	Match BT I.
11	B^4	7,124	307.74	B^3	B^5	Match BT I.
12	B^7	26,643	195.42	B^6	B^8	Match BT I.
13	B^7	26,643	195.42	B^6	R^1	Match BT II—radar.
14	B^2	22,051	349.62	B^1	R^1	Match BT II—radar.

TABLE V.—*Situation data, C Az input, operator No. 3*

HORIZONTAL BASE

No.	C station	B station	Base CB	Az CB	A station	Instructions	
						First phase	Second phase
1	B^3	B^2	9,087	16.87	B^1	Relocate	Track
2	B^4	B^3	8,796	353.46	B^2	Relocate	Track
3	B^5	B^4	8,659	313.84	B^3	Relocate	Track
4	B^5	B^4	8,659	313.84	.....	Track	Relocate
5	B^8	B^7	8,953	25.67	B^6	Relocate	Track
6	B^8	B^7	8,953	25.67	B^6	Track	Relocate
7	B^5	B^4	8,659	313.84	B^3	Track	Relocate
8	B^4	B^3	8,796	353.46	B^2	Track	Relocate
9	B^3	B^2	9,087	16.87	B^1	Track	Relocate

VERTICAL BASE AND RADAR

No.	C station	B station	Base CB	Az CB	A station	Instructions
10	B^3	B^2	9,087	16.87	B^1	Relocate for *C Az.*
11	B^5	B^4	8,659	313.84	B^3	Relocate for *C Az.*
12	B^8	B^7	8,953	25.67	B^6	Relocate for *C Az.*
13	R^1	B^7	29,165	194.36	B^6	Track—radar.
14	R^1	B^2	19,235	350.39	B^1	Track—radar.

TABLE VI.—*Situation instructions, B Az input, operator No. 4*

No.	Method	Instructions	B station
1	Horizontal base	Track	B^2
2	.....do	.....do	B^3
3	.....do	.....do	B^4
4	.....do	.....do	B^4
5	.....do	.....do	B^7
6	.....do	.....do	B^7
7	.....do	.....do	B^4
8	.....do	.....do	B^3
9	.....do	.....do	B^2
10	Vertical base	Track *B Az* for vertical base	B^2
11	.....do	.....do	B^4
12	.....do	.....do	B^7
13	Radar	Synchronize CT range for radar	.....
14	.....do	.....do	.....

TABLE VII.—*Situation data*

SPOTTING BOARD M7 OR M3 SPOTTING BOARD OPERATOR NO. 12

Situation No.	First phase			Second phase		
	Base lines	Azimuth	Range	Base lines	Azimuth	Range
1	G_1–S^1	358.24	30,564	G_1–S^2	349.62	22,051
	G_1–S^2	349.62	22,051	G_1–S^3	332.69	14,671
2	G_1–S^2	349.62	22,051	G_1–S^3	332.69	14,671
	G_1–S^3	332.69	14,671	G_1–S^4	307.74	7,124
3	G_1–S^3	332.69	14,671	G_1–S^4	307.74	7,124
	G_1–S^4	307.74	7,124	G_1–S^5	163.19	1,758
4	G_1–S^4	307.74	7,124	.....	.....	.....
	G_1–S^5	163.19	1,758			
5	G_1–S^6	182.73	18,229	G_1–S^7	195.42	26,643
	G_1–S^7	195.42	26,643	G_1–S^8	198.67	35,387
6	G_1–S^7	195.42	26,643	G_1–S^6	182.73	18,229
	G_1–S^8	198.67	35,387	G_1–S^7	195.42	26,643
7	G_1–S^4	307.74	7,124	G_1–S^3	332.69	14,671
	G_1–S^5	163.19	1,758	G_1–S^4	307.74	7,124
8	G_1–S^3	332.69	14,671	G_1–S^2	349.62	22,051
	G_1–S^4	307.74	7,124	G_1–S^3	332.69	14,671
9	G_1–S^2	349.62	22,051	G_1–S^1	358.24	30,564
	G_1–S^3	332.69	14,671	G_1–S^2	349.62	22,051

CHAPTER 9

DUTIES OF RANGE SECTION

■ 104. OBSERVING DETAILS.—*a. Observer.*—The observer is responsible to the range officer for the care, adjustment, and proper use of his instrument and azimuth transmission equipment; for the police of his station; and for the functioning of his detail. At intervals, as specified by the battery commander, it is his duty to make careful inspections of the instrument and azimuth transmitter, check the orientation of the instrument, and test data transmission and telephone lines. He will then report to the switchboard operator, "B^1 (or B^2, etc.) in order," or report such defects as he is unable to remedy. When a target has been indicated by the battery commander and identified by the observer, the latter reports, "B^1 (or B^2, etc.) on target," and immediately adjusts the tracking rate of the azimuth transmitter to follow the target with his instrument. When the battery commander gives the command TRACK, the observer continues to follow the target with his instrument, making any necessary readjustment of the tracking rate to keep the cross wires of the instrument accurately on the observation point of the target. When the connection of data transmission lines to the azimuth receiver at the computer has been made, and the line balancing operations have been completed (see par. 43) he will, at the order of the azimuth receiver operator, relayed by the reader, throw the TRACK-BALance switch to the TRACK position.

NOTE.—In stations equipped with a depression position finder, the observer should keep that instrument in adjustment for the reading of ranges and transmission of azimuths at all times. Whether tracking is to be by horizontal base or vertical base, the observer should be prepared for a change of system on command.

b. Reader.—(1) *General.*—The reader functions under the direction of the observer. He assists in the care and adjustment of the instrument and azimuth transmission equipment and in the police of the station. He performs such duties as are directed by the observer and, when ordered

to test the functioning of any of the equipment, he reports the results of such tests to the observer. Under wartime conditions, with the rotation of personnel on duty resulting from a 24-hour a day schedule for manning observation stations, the reader should be able to carry out any of the observer's duties. The reader's duties when the target has been assigned will vary, depending on whether tracking is to be by horizontal base or vertical base system.

(2) *Duties of reader in horizontal base system.*—When the situation order has been received and the connections of data transmission and telephone lines to the azimuth input at the computer have been made, the reader will repeat to the observer any orders relative to line balancing received from the azimuth receiver operator. When the azimuth receiver operator has balanced the lines, the reader will read the target azimuth to the whole degree at approximately 5-second intervals. He will continue these readings until the azimuth receiver operator has attained synchronization and reported, "On target." Thereafter, during tracking, he will check the synchronization with the azimuth receiver operator at intervals of about 2°.

(3) *Duties of reader in vertical base system.*—When the situation order has been received, the switchboard operator connects the reader's telephone line to both azimuth inputs of the triangle solver being used. At approximately 5-second intervals, the reader will read alternately the target azimuth and target range. He will repeat to the observer any orders relative to line balancing received from the azimuth receiver operator. When the azimuth receiver operator has attained synchronization and reported, "On target," the reader will continue to read ranges only, at approximately 5-second intervals. During tracking, he will check the synchronization of the azimuth transmitter and receiver with the azimuth receiver operator at intervals of 2°.

■ 105. SPOTTING DETAILS.—Inasmuch as the duties of the spotting details in a range section employing the gun data computer M1 differ in no way from those outlined in FM 4-15, repetition here is needless.

■ 106. RANGE OFFICER.—*a.* The duties and responsibilities of the range officer in a battery employing the gun data computer M1 differ from his normal duties and responsibilities as outlined in FM 4-15 only as they are affected by the conditions resulting from computer operation.

b. He is responsible to the battery commander for the condition of the materiel under his charge and for the observance of all operating precautions pertaining to the service of the equipment. It is his duty to make frequent inspections of the computer and data transmission system to insure proper operation and readiness for service at all times. He personally verifies the results of the static and dynamic tests which are run at specified intervals to check the operating accuracy of the computer. He checks the keeping of lubrication and maintenance records to assure the proper periodic lubrication and testing of the computer.

c. It is the duty of the range officer to study the water area to be covered by his battery and to prepare situation charts in advance of practice or action. Certain base lines will be brought into use for certain positions and directions of travel of the target. The orientation data for all base lines concerned with a given target situation, with designation of the proper base-end stations as A, B, or C station, should be tabulated for all possible target positions, directions of travel, and methods of operation. He should prepare a water area chart with tabulated situation data for the guidance of the battery commander in ordering situations. He should also prepare a list of all situations for the use of all operating personnel concerned with setting in orientation data and the necessary instructions for each to follow in every situation.

d. When the situation order is issued by the battery commander, he will command the range section: SET UP FOR SITUATION . . . . When tracking has started and he receives the report of the chief of section that the flow of data being transmitted is smooth, he reports to the battery commander, "Sir, data smooth." He will inform the battery commander immediately of any changes in the target's course or any other occurrence that would cause the firing data to become

inaccurate. As tracking progresses he will study the changing situation and report to the battery commander necessary changes in the employment of base lines.

■ 107. CHIEF OF SECTION.—*a.* The chief of section is in charge of the plotting room detail. He functions under the range officer in supervising the operation of the computer and supplementary fire control equipment. He is responsible to the range officer for the condition of the equipment under his charge, for the training and efficiency of the operating personnel, and for the observance of all operating precautions. He personally supervises all static and dynamic tests of the equipment and is responsible to the range officer for the keeping of records pertaining to the lubrication, maintenance, and testing of the equipment. It is his responsibility to bring to the attention of the range officer all irregularities or defects in the equipment and to function under the direction of the range officer in the performance of all first echelon maintenance duties.

b. Prior to drill, practice, or action, after the details have been posted and the equipment has been examined, he receives the reports from the observation stations, from the spotting stations, and from the various members of the plotting room detail, and reports to the range officer, "Sir, range section in order." When the situation order is issued by the range officer, he will order, "Switches on," and supervise the setting of orientation data into the computer and the connecting of data transmission and telephone lines. When the "on target" reports have been received from the azimuth input operators and tracking is started, he inspects the alinement of matching dials and examines the data transmitter dials for abnormal fluctuations. When the firing data being transmitted to the guns have smoothed out, he throws the AZimuth and ELevation SIGNAL switches to the ON position and reports to the range officer, "Sir, data smooth." He then takes post near the wind component indicator panel and sets in range and lateral fire adjustment corrections as they are called by the fire adjustment board operators. As the opportunity arises he checks the operation of the various inputs and dials during tracking,

and, should there be any indication that the firing data being transmitted are incorrect, he will throw the AZimuth and ELevation SIGNAL switches to the OFF position and report to the range officer, "Sir, data incorrect." When he is certain that the firing data are again smooth, he repeats the procedure of throwing the signal switches to the ON position and reporting the smoothness of the data to the range officer.

c. At the range officer's command CEASE TRACKING, he throws the AZimuth and ELevation SIGNAL switches to the OFF position and commands: SWITCHES OFF. At the range officer's command CLOSE STATIONS, he inspects all dials and counters to check their setting at the zero or normal by the operators. He also verifies that all switches are in the OFF position.

■ 108. SWITCHBOARD OPERATOR.—The switchboard operator is responsible for the proper operation of the two plotting room switchboards and for making operational tests of the data transmission and telephone lines as ordered. When a situation has been ordered by the battery commander, he refers to the instructions tabulated for that situation and makes the connections of data transmission and telephone lines between the observation stations and the computer inputs and the spotting stations and the spotting board operators. He makes other telephone line connections as ordered.

NOTE.—Under wartime conditions, maintenance of communications with observation stations must be on a 24-hour basis. For this reason, several members of the plotting room detail should be trained in the duties of the switchboard operator to allow the necessary reliefs of trained operators.

■ 109. COMPUTER OPERATORS.—The duties of the computer operating personnel, Nos. 1 to 11, inclusive, under the various operating methods, are covered in the drill tables in appendix II.

■ 110. SPOTTING AND FIRE ADJUSTMENT BOARD OPERATORS.—As the duties of the personnel operating the spotting, range, and lateral fire adjustment boards differ in no way from those outlined in FM 4-15, repetition is not made herein.

CHAPTER 10

DRILL OF RANGE SECTION, GENERAL

■ 111. GENERAL.—The employment of the gun data computer M1 in the fire control and position finding system of a battery makes necessary certain changes in the series of commands by which a target is assigned to the range section and tracked by it. This chapter outlines a drill procedure, the purpose of which is to coordinate the particular duties created by computer operation with the range section drill procedure outlined in FM 4-15. While this computer drill furnishes a method of procedure, changes may be made as necessary to meet local conditions.

■ 112. DETAILS, POSTS.—Upon arrival of the plotting room detail at the plotting room, the chief of section commands: DETAILS, POSTS. He then takes post where he can supervise the duties of the plotting room detail. The members of the detail take their posts.

■ 113. EXAMINE EQUIPMENT.—As soon as all personnel are at their posts, the chief of section commands: EXAMINE EQUIPMENT. The members of the detail check the functioning of the various controls and switches at their posts. The communication system is checked by the switchboard operator who, at this time, takes the reports of the base-end stations.

NOTE.—Under wartime conditions, or with the battery on an alert basis, the equipment and the communications systems both will be inspected at least twice daily by the operating personnel. Under such conditions the commands EXAMINE EQUIPMENT and REPORT may be dispensed with prior to drill or action.

■ 114. REPORT.—When it is apparent that all the operators have completed their duties of examining the equipment, the chief of section commands: REPORT. The members of the detail, in numerical order, then will report each on his particular part of the equipment. Any defects which

are discovered will be reported. The switchboard operator will render the reports of the base-end stations with his own.

■ 115. STAND-BY.—After all the reports have been received, the chief of section reports to the range officer, "Sir, range section in order," or reports such defects as he is unable to remedy without delay. The range officer then reports to the battery commander, "Sir, range section in order," or reports such defects as cannot be remedied immediately. If drill, practice, or action is to be entered upon and the battery commander calls the battery to attention, the range officer will command: STAND BY, at which command all members of the range section will assume positions of readiness at their posts.

■ 116. TARGET.—When a target has been assigned to the battery, the battery commander commands: TARGET, and adds as part of the command information relative to water area, type, class, direction of travel, and any other description necessary for prompt and positive identification.

■ 117. SITUATION.—After reports from the observation stations relative to target identification have been received by the battery commander, he refers to the situation chart and selects a situation best suited for the tracking of the target. He then issues a command for use in the situation, as, for example, SITUATION FIVE, at which all personnel will follow the instructions listed on the cards for the situation.

■ 118. TRACK.—The battery commander then commands: TRACK. When the operators have set the orientation data into the computer, connected the base-end data transmission and telephone lines, and have balanced and synchronized the base-end data transmission lines, the range section will track the target. When the firing data going to the guns are smooth, the chief of section will throw the AZimuth and ELevation SIGNAL switches to the ON position, which indicates to the guns that firing may be started when the command is received from the battery commander. At the throwing of the switches, the range officer reports to the battery commander that the firing data are smooth.

■ 119. CHANGE TRIANGLE SOLVER.—When either the "A" or "C" triangle solver is being used for the first tracking phase of a situation, and it is desired to change to the auxiliary solver which has been held in readiness to take over the tracking, the chief of section or the range officer commands: CHANGE TO "A" (or "C") TRIANGLE SOLVER. At this command, the personnel will follow the procedure outlined in the drill tables.

■ 120. GENERATED CONTROL.—During tracking, if the target should become obscured and the base-end data cease, or if, for other reasons, the triangle solvers should become ineffective, the range officer may command: GENERATED CONTROL, at which command the operators will function as outlined in the drill tables. The object of generated control is to continue the transmission of firing data to the guns, computed on the basis of the target's course and speed, which have already been determined by previous tracking.

■ 121. CHANGE SITUATION.—During tracking, it may be necessary, in the battery commander's or range officer's estimation, to change the situation. If this is to be done, the range officer first orders generated control and then commands: CHANGE SITUATION TO NUMBER . . . . At this the operators will continue the operation of the computer under generated control while setting up the new situation.

■ 122. RESUME TRACKING.—While operating under generated control, it may be possible to revert to normal tracking operations. To indicate the synchronization of base-end data receivers and readiness to track, the input operators will report, "On target," at which the range officer will command: RESUME TRACKING.

■ 123. CEASE TRACKING.—At the completion of tracking, or at the battery commander's order, the range officer will command: CEASE TRACKING, at which the operators will cease operations and, after performing the duties outlined in the drill tables, remain at STAND-BY.

■ 124. CLOSE STATIONS.—When drill, practice, or action has been completed and the battery commander has dismissed the battery, the range officer commands: CLOSE STATIONS, at which the personnel makes such adjustments to the equipment as are called for in the drill tables.

CHAPTER 11

ROUTINE MAINTENANCE

■ 125. GENERAL.—*a.* This chapter outlines the installation, routine care, and maintenance of the gun data computer M1 by the operating personnel. Continued observation, inspection, and the experience gained by operation will add to the information contained herein. Ordnance personnel may be consulted for further information.

b. The computer should be checked frequently by means of test problems to insure that it is performing satisfactorily. A check test selected from TM 9-2646, such as the "over-all static check," may be used for this purpose. Since the situation for each computer varies, a copy of the Ordnance Department inspection report of the particular computer is included in the tool box for checking purposes.

■ 126. INSTALLATION.—*a.* Although the M1 computer is designed to withstand all normal service conditions, care should be exercised to prevent undue rough handling in installation. The computer should never be moved without the steel skid-frame attached.

b. When unloading, bring the transporting truck as near as possible to the plotting room. Use a heavy-duty crane to lift the case from the truck, then move the truck and lower the computer case gradually to previously arranged timbers and rollers.

c. Roll the unit into the plotting room entrance and carefully remove the packing case. Then roll the computer on its steel skid-frame to the desired location in the plotting room. A typical arrangement is shown in figure 17.

d. Raise the computer by means of four jacks at corners of the skid-frame.

e. Keep wooden blocking under the computer at all times, so that failure of the jacks will not cause the computer to drop more than 1 or 2 inches.

f. Attach the legs and lower the unit to the floor.

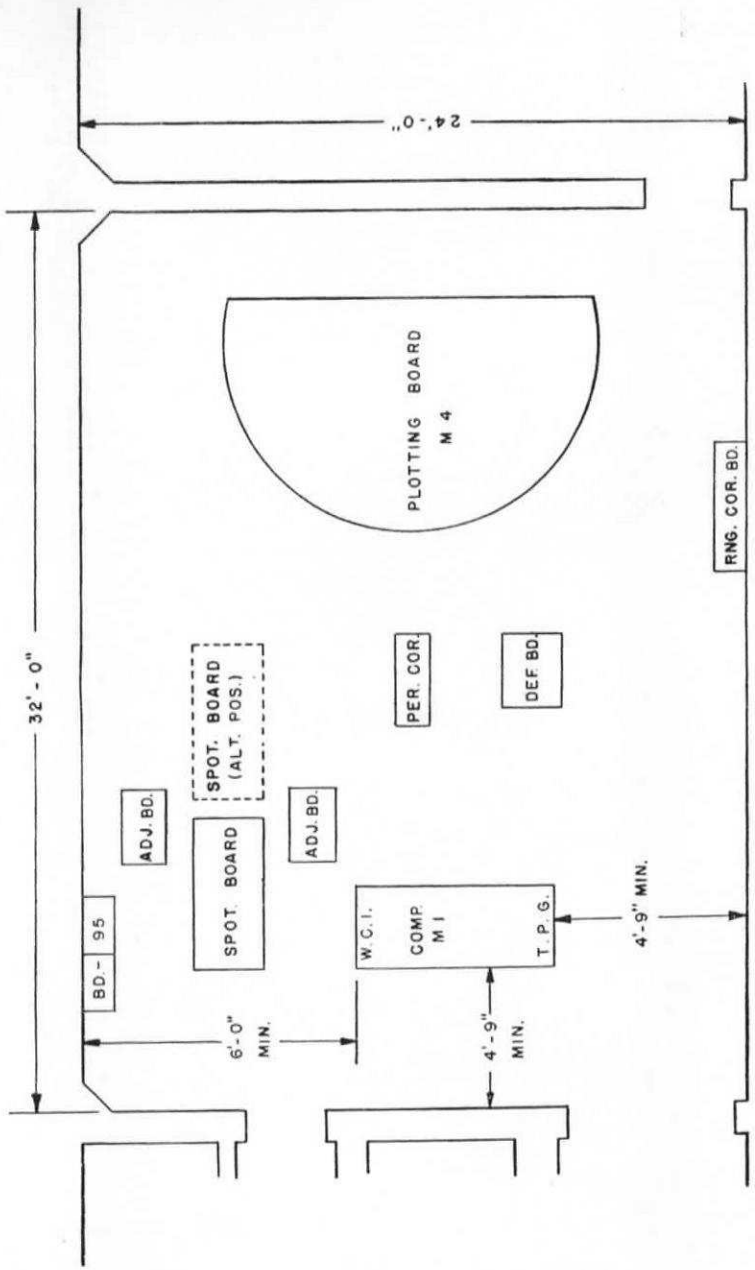


FIGURE 17.—Location of computer in plotting room.

g. If the floor surface is not even, place shims under the legs as required.

h. Remove the steel skid-frame by removing eight top bolts and eight side bolts.

i. The steel skid-frame should be retained and stored in the event that it becomes necessary to move the computer at a future time.

■ 127. CHECKING OF CONSTANT SPEED MOTOR.—A check of the constant speed motor (replacement for power clock) should be made at frequent intervals by means of an accurate stop watch. This is important, as a variation in the constant speed of the varigears will cause an error in the predicted position of the target.

■ 128. REPLACING LAMP BULBS.—There are two hatches on the roof of the computer for removal of the 25-watt lamp bulbs from the spotting board and wind component indicator. After the hatch covers are removed, the bulbs can be reached and unscrewed. It is not necessary to remove the cover plates to replace any lamps. The following bulbs are used in the specified locations in the computer:

a. Illumination of dials, counters, and charts: type 71A, 3-volt lamp, furnished by Killsman Company, Elmhurst, New York.

b. Warning lamps and heater signal lamps: 3.2-volt miniature screw-base incandescent, such as Mazda type 42.

c. Spotting board and wind-component indicator illumination: 25-watt, 115-volt, medium screw-base lamps, such as ordinary Mazda lamps.

d. Ready-to-fire signal lamps: T-4 candelabra, screw-base lamps (signal service long-life), furnished by H. R. Kirkland Company, Morristown, New Jersey.

■ 129. WINDOWS.—Clean the windows with a soft piece of clean cloth slightly moistened with benzine or turpentine. Wipe the surface dry with a soft cloth, frequently using a fresh portion of the material in order to avoid scratching the glass with any grit that may have collected. Keep cleaning cloths for glass separated from other cloths and do not

use them for any other purpose. Wash them frequently with soap and water, making sure that the soap is thoroughly rinsed out of the cloth.

■ 130. STORAGE.—When not in use, the computer should be covered with its protective canvas cover. If there is dampness present, or if the climate is tropical or extremely cold, plug the heater cord into its receptacle under the base of the computer and place the heaters in operation for a few hours daily.

CHAPTER 12

DESTRUCTION OF MATERIEL IN EVENT OF IMMINENT CAPTURE

■ 131. GENERAL.—Tactical situations may arise when, owing to limitations of time or transportation, it will become impossible to evacuate all equipment. In such situations it is imperative that all materiel which cannot be evacuated be destroyed to prevent its capture and use by the enemy. Destruction must be as complete as the available time, equipment, and personnel will permit. If thorough destruction of all parts cannot be completed, the most important features of the materiel should be destroyed, and parts essential to the operation or use of the materiel which cannot be easily duplicated, be ruined or removed. The same essential parts must be destroyed on all like units to prevent the enemy's constructing one complete unit from several damaged ones. The destruction of materiel subject to capture or abandonment in the combat zone will be undertaken only when in the judgment of the military commander concerned such action is necessary.

■ 132. METHODS.—*a.* The destruction procedures outlined are arranged in order of effectiveness. Destruction should be accomplished by method No. 1, if possible. If method No. 1 cannot be used, destruction should be accomplished by one of the other methods outlined, in the priority shown. Whichever method is used, the sequence outlined should be adhered to. Uniformity of destruction will then be obtained, whether or not the method is carried to completion.

b. Certain of the methods outlined require special tools and materials, such as TNT and tetryl caps, which normally may not be items of issue. The issue of such special tools and material, and the conditions under which destruction will be effected are command decisions in each case, according to the tactical situation.

■ 133. DESTRUCTION OF COMPUTER.—The following destruction procedures apply to the gun data computer M1:

a. Method No. 1.—Demolition with TNT is the most satisfactory. Remove the target position generator and wind component indicator panels at either end and the range-elevation converter and "B" triangle solver panels at front and rear. Place 3-pound TNT charges in each opening, connected together with primacord. Insert a tetryl nonelectric cap with at least 5 feet of safety fuze in one charge. Replace the covers as tightly as possible without damaging the fuze. Ignite the fuze and take cover.

b. Method No. 2.—Remove all panels. Completely smash the computer mechanisms, using an ax or sledge hammer. Pour gasoline into the computer and ignite.

c. Method No. 3.—Smash all cable receptacles and plugs. Remove all cables leading from computer to conduits and cut into short lengths if time permits. Smash all glass windows and the counters and dials they cover. Tear the charts from the chart units, heap in a pile with the cables, douse with gasoline and burn. Smash and bend all handwheels with an ax or sledge hammer.

■ 134. DESTRUCTION OF FIRE CONTROL AND PLOTTING ROOM EQUIPMENT.—All fire control equipment, including azimuth instruments, depression position finders, and binoculars, is difficult to replace. It should be the last equipment to be destroyed, if there is any chance of personnel being able to evacuate. If evacuation of personnel is made, all possible items of equipment should be carried. If evacuation of personnel is not possible, or if fire control equipment cannot be removed, it must be thoroughly destroyed as indicated.

a. Observation instruments.—All optical parts of observation instruments such as azimuth instruments and depression position finders, must be removed from the instruments and thoroughly smashed. Bases of instruments, including data transmission and aided-tracking devices, should be smashed.

b. Plotting room equipment.—Most plotting room equipment can be satisfactorily destroyed by burning. Firing tables, charts, slide rules, Field and Technical Manuals,

blueprints, and wooden instruments should be heaped together, doused with gasoline, and thoroughly burned. All metal and electrical parts of such equipment, including spare parts and special tools for the computer, should be thoroughly smashed by an ax or sledge.

c. Communication equipment. — Telephones, telephone switchboards, radio transmitters and receivers, and data transmission equipment should be thoroughly smashed and burned.

APPENDIX I

GLOSSARY

The following symbols are used to indicate the elements of data:

A, B, C	Points locating the positions of observation stations.
G_1	Point locating the position of the directing point or gun No. 1.
G_2	Point locating the position of gun No. 2.
A Az	Azimuth of line A T_0.
B Az	Azimuth of line B T_0.
C Az	Azimuth of line C T_0.
Az G_1	Firing azimuth, gun No. 1.
Az G_2	Firing azimuth, gun No. 2.
A_0	Azimuth of the line from G_1 *to* T_0 (the present azimuth).
$\dot{A}_0$	Angular rate of change of present azimuth (radians per second).
A_p	Azimuth of the line from G_1 to T_p (the predicted azimuth).
ΔA	$(A_p - A_0)$ (uncorrected deflection).
AT	Distance A to T_0.
BT	Distance B to T_0.
CT	Distance C to T_0.
R_0	Distance to G_1 to T_0 (present range).
$\dot{R}_0$	Rate of change of R_0 (yards per second).
R_p	Distance G_1 to T_p (predicted range).
R_p'	Corrected predicted range.
$R_0\dot{A}_0$	Linear rate of lateral displacement (yards per second).
t	Time of flight to T_p.
T_p	Predicted position of target.
T_0	Present position of target.

DRILL TABLE NO. I
DRILL FOR OPERATING PERSONNEL, GUN DATA COMPUTER M1
OPERATION WITH HORIZONTAL BASE SYSTEM
("A" triangle solver employed in first phase of situation)
("C" triangle solver held as an auxiliary)

Details	DETAILS, POSTS	EXAMINE EQUIPMENT	REPORT	TARGET	SITUATION ORDER NO..... and TRACK	CHANGE TO "C" TRIANGLE SOLVER	GENERATED CONTROL	CHANGE TO SITUATION ORDER NO..... and TRACK	CEASE TRACKING	CLOSE STATIONS
Chief of section.	(1) Gives command. (2) Takes post.	(1) Gives command.	(1) Gives command. (3) Reports, "Sir, range section in order," or reports any defects he is unable to remedy.	(1) Orders, "Switches on."	(1) Supervises work of operators in setting orientation data. (9) Inspects BT I and R_0 MATCH dials and selsyn transmitter dials for abnormal fluctuations. (10) Having found no abnormal fluctuations, or corrected the cause of same, throws the azimuth and elevation signal switches to the ON position. Reports to the range officer, "Sir, data smooth." (11) Takes post near the wind component indicator panel and sets in the fire adjustment corrections as they are called by the fire adjustment board operators.	(1) Gives command when *A Az* receiver operator, No. 1, reports that the A station observer is losing visibility, only after the *C Az* operator, No. 3, has reported, "On target." (3) Observes the selsyn transmitter dials for signs of abnormal fluctuations. If present, throws azimuth and elevation signal switches to the OFF position and reports to range officer, "Sir, data incorrect." If no fluctuations occur, takes no action. (4) When fluctuations, if encountered, cease, throws switches to the ON position and reports to range officer, "Sir, data smooth."	Supervises work of operators.	Supervises work of operators and then follows procedure as under SITUATION ORDER NO..... and TRACK.	(1) Throws elevation and azimuth signal switches to the OFF position. (2) Orders, "Switches off." (3) Orders, "Stand by."	(1) Orders, "Switches on." (4) Orders, "Switches off." (5) Inspects settings of dials, counters, and switches.
No. 18, switchboard operator.	(2) Takes post at switchboard.	(2) Makes connections of data transmission and telephone lines for static checks. (4) Receives reports from observation stations.	(2) Reports, "Switchboard and observation stations in order," or reports such defects that may exist in the communications system or at the observation stations.	Remains at stand-by.	(1) Refers to the situation data card and makes the following connections of data transmission and telephone lines: a. From observation station designated as A station to A AZ input. b. From observation station designated as B station to B AZ input. c. From observation station designated as C station to C AZ input. (2) Connects telephone lines from the spotting observers at the A and B stations to spotting board operators, as directed by the situation data card.	(2) Changes spotting telephone lines to connect the spotting observers at the C and B stations to spotting board operators, as directed by instructions for the second phase of the situation data card.	.....	Follows procedure for the new situation order number, as under SITUATION ORDER NO..... and TRACK.	Makes no changes in connections of data transmission and telephone lines, but leaves them as they were for the situation completed.	(1) Relays the "Close station" order to all observation stations, throws all switchboard keys to normal.
All observation stations.	All observing details take post at observation instruments.	(2) All observers check orientation of their instruments. Make static checks. Check position of the line-balance switch at BAL. (3) All observers report to the switchboard operator, "B^0 (or B^p, etc.) in order," or report such defects that they are unable to remedy immediately	.....	All observers search for target in area designated by battery commander. Those observers who sight the target set cross wires of instrument on same and report, "On target." Thereafter, adjust tracking rate of instrument to maintain cross wires on target. If target is obscured, report, "Target obscured," and maintain search.	A station If the observation station is designated as the A station by the situation order, the duties of the observer will be as follows: (1) Continues tracking target. (3) Throws track-balance switch to the TRACK position. Continues tracking. The reader calls, "Switch on track," to *A Az* operator.	(2) If target is temporarily obscured, receives the relocated azimuth from the *A Az* operator and points the instrument to locate target. If target is moving out of visibility and tracking has been taken over by the "C" triangle solver, continues to track in case target should turn and retrace course.	(2) Receives solved target azimuths from the *A Az* operator, relayed by the reader, points instrument at relocated azimuths and searches for target.	Follows procedure for new situation as under SITUATION ORDER NO..... and TRACK.	(1) Ceases tracking and remains at stand-by.	Closes station.
					B station If the observation station is designated as the B station by the situation order. the duties of the observer will be as follows: (1) Continues tracking target. (3) Throws track-balance switch to the TRACK position. Continues tracking. The reader calls,	Continues tracking	(2) Receives solved target azimuths from the *B Az* operator, relayed by the reader, points instrument at relocated azimuths and searches for target.	Follows procedure for new situation as under SITUATION ORDER NO..... and TRACK.	(1) Ceases tracking and remains at stand-by.	Closes station.

		board operator, B^2 (or B^3, etc.) in order," or report such defects that they are unable to remedy immediately		tracking rate of instrument to maintain cross wires on target. If target is obscured, report, "Target obscured," and maintain search.	operator.					
					B station If the observation station is designated as the B station by the situation order, the duties of the observer will be as follows: (1) Continues tracking target. (3) Throws track-balance switch to the TRACK position. Continues tracking. The reader calls, "Switch on track," to *B Az* operator.	Continues tracking.	(2) Receives solved target azimuths from the *B Az* operator, relayed by the reader, points instrument at relocated azimuths and searches for target.	Follows procedure for new situation as under SITUATION ORDER NO. . . . . and TRACK.	(1) Ceases tracking and remains at stand-by.	Closes station.
					C station If the observation station is designated as the C station by the situation order, the duties of the observer will be as follows: (1) If target is obscured, maintains search for target. (3) Throws track-balance switch to the TRACK position. Continues search for target, and stands by for relocation of target. The reader calls, "Switch on track," to the *C Az* operator. (8) Receives solved azimuth of target by telephone from the *C Az* operator, which is relayed by the reader. When the target is located, reports, "On target," to the *C Az* operator, places cross wire of instrument on tracking point, and sets tracking rate to maintain cross wire on target.	Continues tracking.	(2) Receives solved target azimuths from *C Az* operator, relayed by the reader. Points instrument at relocated azimuths and searches for target.	Follows procedure for new situation as under SITUATION ORDER NO. . . . . and TRACK.	(1) Ceases tracking and remains at stand-by.	Closes station.
No. 1, *A Az* operator.	(2) Takes post at "A" triangle solver panel.	(2) Throws on main supply, time, illumination, and motors switches. Checks handwheels, counters, and azimuth receiver for proper operation. (3) When it is apparent that all operators have finished their examination of the equipment, turns all electric switches OFF, unless drill is to be entered upon immediately.	(2) Reports, "'A' solver and switches in order," or reports any defects discovered.	(2) Throws on main supply, time, illumination, and motors switches.	(1) Refers to situation data card and sets in orientation data for the base line AB. (2) Throws bridge circuit switch to the ON position and balances the data transmission circuits. Orders, "Set switch on TRACK," to A station observer. (4) Throws motor switch on azimuth receiver to the ON position and synchronizes the A AZ input. Reports to chief of section, "*A Az* on target." Continually adjusts rate to maintain zero of meter.	(2) When entering second phase of situation, maintains synchronization of A AZ input as long as data comes from the A station, so that the "A" triangle solver can pick up target and track it again should the target turn and retrace course. If data from the A station has ceased due to obscurement of the target, relocates to solve for *A Az* and to keep the A station observer on target.	(1) Performs relocation for *A Az* by matching BT I MATCH dial with A AZ receiver handwheel. Telephones solved *A Az* to A station observer. Sets rate on receiver to maintain match of BT I MATCH dial indexes.	(1) Ceases relocation operations performed under generated control. (2) Follows procedure for new situation as under SITUATION ORDER NO. . . . and TRACK.	(1) Ceases operations and stands by. (3) Throws main supply, time, illumination, and motors switches to the OFF position. Throws bridge circuit and motor switches on azimuth receiver to the OFF position.	(2) Throws main supply, time, illumination, and motors switches to the ON position. (3) Places all counters at normal settings. (5) Throws main supply, time, illumination, and motors switches to the OFF position.
No. 2, *As* operator.	(2) Takes post at "B" triangle solver panel.	(2) Checks handwheels and counters for proper operation.	(2) Reports, "'B' solver in order," or any defects discovered.	Remains at stand-by.	(1) Refers to situation data card and sets in orientation data for the line G_1B. (5) Matches BT I MATCH dial indexes. Sets in $R_8\dot{A}_8$ rate to maintain match of the indexes. Reports to chief of section, "A_8 on target."	(2) Ceases match of BT I MATCH dial indexes, and matches BT II MATCH dial indexes. Avoids sudden changes of A_8 by making gradual movement of BT II MATCH dial indexes.	(1) Makes no further adjustments of A_8, but maintains a continuous match of the $R_8\dot{A}_8$ rate dial indexes by matching the outer ring index to the index on the inner ring with the $R_8\dot{A}_8$ handwheel.	(1) Maintains match of $R_8\dot{A}_8$ rate dial indexes. (2) Sets in orientation data for the line G_1B as directed by the situation data card. (3) When the *A Az* and *B Az*, or *C Az* and *B Az* operators report, "On target," follows procedure as under (5) SITUATION ORDER NO. . . . . and TRACK.	(1) Ceases operations and stands by.	(3) Places counters and dials at normal settings.
No. 3, *C Az* operator.	(2) Takes post at "C" triangle solver panel.	(2) Checks handwheels, counters, and azimuth receiver for proper operation.	(2) Reports, "'C' solver in order," or any defects discovered.	Remains at stand-by.	(1) Refers to situation data card and sets in orientation data for the base line CB. (2) Throws bridge circuit switch to the ON position and balances the data transmission circuits. Orders, "Set switch on TRACK," to C station observer. (7) Throws the receiver motor switch to the ON position and matches the BT II MATCH dial indexes with the C AZ receiver. Sets a rate in the receiver to maintain a match of the BT II indexes. Telephones solved *C Az* to the the observer at the C station. (8) When observer locates the target, synchronizes the C AZ input and reports to the chief of section, "*C Az* on target."	Continues tracking.	(1) Performs relocation for *C Az* by matching BT II MATCH dial indexes with C AZ receiver handwheel. Telephones solved *C Az* to C station observer. Sets rate on receiver to maintain match of BT II MATCH dial indexes.	(1) Ceases relocation operations performed under generated control. (2) Follows procedure for new situation as under SITUATION ORDER NO. . . . and TRACK.	(1) Ceases operations and stands by. (3) Throws bridge circuit and motor switches on azimuth receiver to the OFF position.	(3) Places counters and dials at normal settings.
No. 4, *B Az* operator.	(2) Takes post at "C" triangle solver panel.	(2) Checks handwheels, counters, and azimuth receiver for proper operation.	(2) Reports, "*B Az* in order," or any defects discovered.	Remains at stand-by.	(1) Assists No. 3 in setting in orientation data for the base line CB. (2) Throws bridge circuit switch to	Continues tracking.	(1) Steps around to face *Rs* MATCH dial on target position generator panel. Retains hold on B AZ	(1) Ceases relocation operations performed under generated control. (2) Follows procedure for	(1) Ceases operations and stands by. (2) Throws bridge circuit and motor switches on	(3) Places counters and dials at normal settings.

					target, synchronizes the C AZ input and reports to the chief of section, "*C Az* on target."					
No. 4, *B Az* operator.	(2) Takes post at "C" triangle solver panel.	(2) Checks handwheels, counters, and azimuth receiver for proper operation.	(2) Reports, "*B Az* in order," or any defects discovered.	Remains at stand-by.	(1) Assists No. 3 in setting in orientation data for the base line CB. (2) Throws bridge circuit switch to the ON position and balances the data transmission circuits. Orders, "Set switch on TRACK," to the B station observer. (4) Throws motor switch to the ON position and synchronizes the B AZ input. Reports to chief of section, "*B Az* on target." Continually adjusts rate to maintain zero of meter.	Continues tracking.	(1) Steps around to face R_0 MATCH dial on target position generator panel. Retains hold on B AZ receiver handwheel with left hand and maintains match of R_0 MATCH dial indexes by setting a rate on the B AZ receiver.	(1) Ceases relocation operations performed under generated control. (2) Follows procedure for new situation as under SITUATION ORDER NO.... and TRACK.	(1) Ceases operations and stands by. (2) Throws bridge circuit and motor switches on azimuth receiver to the OFF position.	(3) Places counters and dials at normal settings.
No. 5, R_0 operator.	(2) Takes post at target position generator panel.	(2) Checks handwheels, counters, and clock for proper operation.	(2) Reports, "R_0 in order," or any defects discovered.	Remains at stand-by.	(1) Remains at stand-by. (5) Matches R_0 MATCH dial indexes with R_0 handwheel. Sets in $\dot{R}_0$ rate on $\dot{R}_0$ dial to maintain match of the R_0 MATCH dial indexes. Reports to chief of section, "R_0 on target," after No. 2 has reported, "On target." (6) Calls out the initial R_0 to wind component indicator operator, No. 11, for use in selecting meteorological message zone.	Continues operation.	(1) Makes no further adjustments to R_0. Maintains match of $\dot{R}_0$ rate dial by matching index on outer ring with $\dot{R}_0$ handwheel.	(1) Maintains match of $\dot{R}_0$ rate dial indexes. (3) When the *A Az* and *B Az*, or *C Az* and *B Az* operators report, "On target," follows procedure as under SITUATION ORDER NO..... and TRACK.	(1) Ceases operations and stands by.	(3) Places counters and dials at normal settings.
No. 6, course and speed operator.	(2) Takes post at target position generator panel.	(2) Checks handwheels, counters, and airplane spotting board for proper operation.	(2) Reports, "Course and speed in order," or any defects discovered.	Remains at stand-by.	(1) Remains at stand-by. (6) Matches $\dot{R}_0$ and R_0A_0 rate dial indexes with course and speed handwheels. Matches the inner ring indexes to those on the outer rings.	Continues operation.	(1) Makes no further adjustments to course and speed handwheels. Moves to "C" triangle solver panel and at intervals reads *B Az* from counter to No. 4, who repeats the data to the B station observer.	(1) Makes no adjustments to course and speed handwheels until R_0 operator, No. 5, reports, "R_0 on target." (4) Follows procedure as under SITUATION ORDER NO..... and TRACK.	(1) Ceases operations and stands by.	(3) Places counters and dials at normal settings.
No. 7, ballistic charts operator.	(2) Takes post at ballistic charts panel.	(2) Checks handwheels, counters, and chart pointers for proper operation.	(3) Reports, "Ballistic charts in order," or any defects discovered.	Remains at stand-by.	(1) Remains at stand-by. (8) Sets atmosphere compensation counter to value of meteorological message density reference number called out by No. 11. Sets pointer to proper curve on density chart and maintains continuous match of same. Sets pointer on rotation azimuth chart to curve representing *Az* G_1 called out by No. 10 and maintains continuous match of same.	Continues operation.	Continues operation.	Continues operation.	Ceases operation and stands by.	(3) Places counters at normal settings.
No. 8, assistant ballistic charts operator.	(2) Takes post at ballistic charts panel.	(2) Checks handwheels, counters, and chart pointers for proper operation. Reports to No. 7.	.....	(1) Sets variation from standard muzzle velocity on muzzle velocity compensation counter.	(1) Remains at stand-by. (7) Sets pointers to curves on elasticity and muzzle velocity charts. Maintains continuous match. (8) Sets wind + drift and range-wind chart pointers to curves representing the wind reference numbers called out by No. 11.	Continues operation.	Continues operation.	Continues operation.	Ceases operation and stands by.	(3) Places counters and dials at normal settings.
No. 9, range-elevation converter operator.	(2) Takes post at range-elevation converter panel.	(2) Checks handwheels, counters, chart pointers, and chart selector dial for proper operation.	(2) Reports, "Range-elevation in order," or any defects discovered.	Remains at stand-by.	(1) Sets in dead time if ordered by range officer. (2) Checks chart selector dial and K counter for proper setting. (7) Matches pointers to the curves on the time of flight and range-elevation charts. Maintains continuous match of pointers to curves.	Continues operation.	Continues operation.	Continues operation.	Ceases operation and stands by.	(3) Places counters and dials at normal settings.
No. 10, parallax operator.	(2) Takes post at parallax panel.	(2) Checks handwheels and rotation of chart drums for proper operation.	(2) Reports, "Parallax in order," or any defects discovered.	Remains at stand-by.	(1) Remains at stand-by. (7) Calls out *Az* G_1 at frequent intervals, as read from *Az* G_1 dials. Keeps range correction G_2 and azimuth correction G_2 chart curves, representing *Az* G_1, matched to pointers.	Continues operation.	Continues operation.	Continues operation.	Ceases operation and stands by.	No duties.
No. 11, wind component indicator operator.	(2) Takes post at wind component indicator panel.	(2) Checks handwheels, counters, dials, chart pointers, and wind component indicator for proper operation.	(2) Reports, "Wind component indicator in order," or any defects discovered.	Remains at stand-by.	(6) Sets tide and weight of projectile chart pointers to curves on ballistic charts representing proper values. Furnishes elasticity value to No. 8. (7) Receives initial R_0 from No. 5 and selects proper zone of meteorological message. Calls out the density reference number to No. 7. Sets the ballistic wind data on the wind component indicator and calls out the wind reference number to No. 8. Calls out wind data as it changes. (8) Sets rotation range chart pointer to the curve representing *Az* G_1 called out by No. 10. Maintains continuous match of pointer to proper curve.	Continues operation.	Continues operation.	Continues operation.	Ceases operation and stands by.	(3) Places counters and dials at normal settings.

APPENDIX II

DRILL TABLES

This appendix contains drill tables which outline the individual duties of the computer operating personnel under the various methods of operation. In each case the drill table covers the individual operations for a typical problem in a particular method of operation. It will be noted that the operators at the output side of the computer, Nos. 7, 8, 9, 10, and 11, function in the same manner under all methods of operation. Therefore, to avoid repetition, their duties have been listed under "Horizontal base system," drill table No. 1, and have been placed in no other table.

In outlining the duties of the individual operators in the drill tables, it will be noted that certain operations are performed simultaneously. That is, in general, all operations labeled (1) are performed simultaneously and are completed before any operation labeled (2) is started.

The drills prescribed herein for the computer are conducted with personnel at ease and cannot be carried out with the snap and precision of a formal drill. Many delicate adjustments must be made in the synchronization of azimuth receivers and the matching of dials, and it is obvious that careless attempts to speed up the operations will result in a loss of accuracy. Speed and accuracy should be attained by a high state of training of the operating personnel, with emphasis laid on the saving of time during the initial stages of setting up the computer for a situation and tracking a target.

DRILL TABLE NO. II

DRILL FOR OPERATING PERSONNEL, GUN DATA COMPUTER M1
OPERATION WITH VERTICAL BASE SYSTEM

(Depression position finder at B station, employing "A" triangle solver for solution of target position, with relocation operations to solve for *A Az* and *C Az*)

Details	TARGET	SITUATION ORDER NO..... and TRACK	CHANGE TO HORIZONTAL BASE SYSTEM "A" TRIANGLE SOLVER*	CHANGE TO HORIZONTAL BASE SYSTEM "C" TRIANGLE SOLVER**
Chief of section.	(1) Orders switches ON.	(1) Supervises work of operators. (3) Checks setting of orientation data into triangle solvers. (4) Orders the switchboard operator to inform the A station observer to set the track-balance switch at the TRACK position. Thereafter receives the solved *A Az* from No. 1 and relays this data to the switchboard operator for transmission to the A station observer or designates an operator for this duty. (8) Inspects BT I, R_0 MATCH dials, and selsyn transmitter dials for abnormal fluctuations. (9) Having found no abnormal fluctuations, or corrected cause of same, throws the azimuth and elevation signal switches to the ON position. Reports to the range officer, "Sir, data smooth." (10) Takes post near the wind component indicator panel and sets in any fire adjustment corrections ordered.	(2) Gives command. (5) Checks BT I, R_0 MATCH, and selsyn transmitter dials for signs of abnormal fluctuations.	(2) Gives command. (5) Checks BT I, R_0 MATCH, and selsyn transmitter dials for signs of abnormal fluctuations.
No. 18, switchboard operator.	Remains at stand-by.	(1) Refers to situation data card and performs the following operations: *a.* Connects telephone line from observation station, designated as the B station, to both B AZ and A AZ inputs. *b.* Connects data transmission lines from observation station designated as the B station to B AZ input. *c.* Connects data transmission and telephone lines from observation station designated as the C station to C AZ input. *d.* Connects data transmission lines from observation station designated as the A station to A AZ input. (5) Relays "Set switch on track" order from chief of section to A station observer. Thereafter repeats solved *A Az* data to A station observer.	(3) Disconnects B station telephone lines from A AZ input. Connects telephone lines from the A station to the A AZ input. (4) Connects spotting telephone lines from the A and B stations to the spotting board operators.	(3) Disconnects B station telephone lines from A AZ input and connects the telephone lines from the A station to the A AZ input. (4) Connects spotting telephone lines from the C and B stations to the spotting board operators.

* During tracking by vertical base system, if the A station observer locates the target, the chief of section will command.
** During tracking by the vertical base system, if the C station observer locates the target, the chief of section will command.

DRILL TABLE NO. II—*Continued*

DRILL FOR OPERATING PERSONNEL, GUN DATA COMPUTER M1
OPERATION WITH VERTICAL BASE SYSTEM

(Depression position finder at B station, employing "A" triangle solver for solution of target position, with relocation operations to solve for *A Az* and *C Az*)

Details	TARGET	SITUATION ORDER NO.....and TRACK	CHANGE TO HORIZONTAL BASE SYSTEM "A" TRIANGLE SOLVER*	CHANGE TO HORIZONTAL BASE SYSTEM "C" TRIANGLE SOLVER**
All observation stations.	(1) All observation stations search for target. (2) Only one station, employing a depression position finder, is used. It locates target, at which the observer sets vertical cross wire of instrument on target, waterlines the target with the horizontal cross wire, and reports to battery commander, "B^1 (or B^2, etc.) on target."	A station If the observation station is designated as the A station by the situation order, the duties of the observer will be as follows: (1) Continues search for target. (6) Throws track-balance switch to the TRACK position on receipt of the order from the switchboard operator. (7) Continually points instrument at the solved *A Az* telephoned by the switchboard operator and searches for target.	(1) Locates target and reports, "On target." Sets tracking rate to maintain cross wire of instrument on tracking point on target.	Continues search for target.
		B station The observation station which is tracking the target with a depression position finder will be designated as the B station. The duties of the observing detail are as follows: (1) *Observer:* Continues tracking the target and adjusts tracking handwheel to set tracking rate. Maintains the horizontal cross wire at the waterline of the target.	Continues operations in tracking target. Reader ceases reading ranges.	Continues operations in tracking target. Reader ceases reading ranges.
		Reader: On the 5-second TI bell, alternately reads the range and the azimuth of the target to the whole degree. (3) Observer sets the track-balance switch to the TRACK position at the order of the receiver operator, relayed by the reader. (5) The reader ceases reading azimuths when the *B Az* receiver operator reports, "On target." Thereafter reads only target ranges on the 5-second TI bell. At intervals of 2 to 3 degrees, checks the azimuth synchronization with the *B Az* receiver operator.		
		C station If the observation station is designated as the C station by the situation order, the duties of the observer will be as follows: (1) Continues search for target. (3) Throws track-balance switch to the TRACK position at the order of the receiver operator, relayed by the reader. (7) Continually points instrument at the solved *C Az* received by telephone from the *C Az* receiver operator and searches for target.	Continues search for target.	(1) Locates target and reports, "On target." Sets tracking rate to maintain cross wire of instrument on tracking point of target.

* During tracking by vertical base system, if the A station observer locates the target, the chief of section will command.
**During tracking by the vertical base system, if the C station observer locates the target, the chief of section will command.

DRILL TABLE NO. II—*Continued*

DRILL FOR OPERATING PERSONNEL, GUN DATA COMPUTER M1
OPERATION WITH VERTICAL BASE SYSTEM

(Depression position finder at B station, employing "A" triangle solver for solution of target position, with relocation operations to solve for *A Az* and *C Az*)

Details	TARGET	SITUATION ORDER NO..... and TRACK	CHANGE TO HORIZONTAL BASE SYSTEM "A" TRIANGLE SOLVER*	CHANGE TO HORIZONTAL BASE SYSTEM "C" TRIANGLE SOLVER**
No. 1, *A Az* operator.	(2) Throws on main supply, time, illumination, and motors switches.	(1) Refers to situation data card and sets in orientation data for base line AB. (2) Throws the bridge circuit switch to the ON position. Balances the data transmission circuits and informs chief of section to order the A station observer to "Set switch on TRACK." (3) Throws motor switch on A AZ receiver to the ON position. Sets in *A Az* until range on BT counter matches the range being read from the depression position finder by the B station reader. Sets a rate to maintain a continuous match of the BT counter values. (4) Thereafter, at intervals, reads the solved *A Az* from the A AZ counter to the chief of section or person designated by him to relay this data to the A station observer.	(4) Synchronizes the A AZ input to the target azimuths transmitted from the A station. Adjusts the rate to maintain a continuous zero on meter and reports, "*A Az* on target."	(3) Ceases operation in matching BT ranges on BT counter. (4) Relocates for *A Az* by matching indexes of BT I MATCH dial with the A AZ receiver operating handwheel. Telephones the solved *A Az* to A station.
No. 2, A_0 operator.	Remains at stand-by.	(1) Refers to situation data card and sets in orientation data for the line G_1B. (5) Matches the BT I MATCH dial indexes by use of the A_0 handwheel. Sets in an $\dot{R}_0\dot{A}_0$ rate by use of the $\dot{R}_0\dot{A}_0$ handwheel to maintain a match of the BT I MATCH dial indexes. Reports to chief of section, "A_0 on target."	Maintains match of BT I MATCH dial indexes.	(3) Ceases matching BT I MATCH dial indexes, and matches indexes of the BT II MATCH dial. Reports to chief of section, "A_0 on target."
No. 3, *C Az* operator.	Remains at stand-by.	(1) Refers to situation data card and sets in orientation data for the base line CB. (2) Throws bridge circuit switch to the ON position. Balances data transmission circuits and orders observer to set the track-balance switch to the TRACK position. (6) Throws the C AZ receiver motor switch to the ON position. Relocates for *C Az* by matching the BT II MATCH dial indexes with the C AZ receiver handwheel or slewing key. Sets a rate on receiver to maintain a continuous match of the BT II MATCH dial indexes. At intervals thereafter, reads the solved *C Az* from the C AZ counter to the C station.	Continues relocation operation for *C Az*.	(3) Synchronizes the C AZ input to target azimuths transmitted from the C station. Adjusts the rate to maintain a continuous zero on meter and reports, "*C Az* on target."
No. 4, *B Az* operator.	Remains at stand-by.	(1) Assists No. 3 in setting in orientation data for the base line CB. (2) Throws bridge circuit switch to the ON position. Balances data transmission circuits and orders observer to set the track-balance switch to the TRACK position. (4) Throws B AZ receiver motor switch to the ON position. Synchronizes the B AZ input to target azimuths transmitted from the B station, sets a rate on the receiver to maintain the meter needle at zero, and reports to the chief of section, "*B Az* on target."	Continues operation.	Continues operation.

* During tracking by vertical base system, if the A station observer locates the target, the chief of section will command.
** During tracking by the vertical base system, if the C station observer locates the target, the chief of section will command.

DRILL TABLE NO. II—*Continued*

DRILL FOR OPERATING PERSONNEL, GUN DATA COMPUTER M1
OPERATION WITH VERTICAL BASE SYSTEM

(Depression position finder at B station, employing "A" triangle solver for solution of target position, with relocation operations to solve for *A Az* and *C Az*)

Details	TARGET	SITUATION ORDER NO..... and TRACK	CHANGE TO HORIZONTAL BASE SYSTEM "A" TRIANGLE SOLVER*	CHANGE TO HORIZONTAL BASE SYSTEM "C" TRIANGLE SOLVER**
No. 5, R_0 operator.	Remains at stand-by.	(5) Matches the R_0 MATCH dial indexes by use of the R_0 handwheel. Sets in an $\dot{R}_0$ rate by means of the $\dot{R}_0$ handwheel to maintain a match of the R_0 MATCH dial indexes. Reports to the chief of section, "R_0 on target."	Continues operation.	Continues operation.
No. 6, course and speed operator.	Remains at stand-by.	(7) Matches the inner indexes to the outer indexes of the $\dot{R}_0$ and $R_0\dot{A}_0$ rate dials by use of the course and speed handwheels. Maintains match of both rate dial indexes throughout operation.	Continues operation.	Continues operation.

* During tracking by vertical base system, if the A station observer locates the target, the chief of section will command.
** During tracking by the vertical base system, if the C station observer locates the target, the chief of section will command.

DRILL TABLE NO. III

DRILL FOR OPERATING PERSONNEL, GUN DATA COMPUTER M1
OPERATION WITH RADAR SYSTEM

(Employing "C" triangle solver for solution of target position)
(Relocation operations performed to solve for *A Az* and *B Az* for shore observation stations*)

Details	TARGET	SITUATION ORDER NO..... and TRACK
Chief of section.	(1) Orders switches on.	(1) Supervises work of operators in setting orientation data. (2) Designates an operator to read the solved *B Az* from the B AZ counter and telephone continuously this data to the B station observer. (5) Inspects the BTI and R_0 MATCH dials and selsyn transmitter dials for abnormal fluctuations. (6) Having found no abnormal fluctuations or corrected cause of same, throws the azimuth and elevation signal switches to the ON position. Reports to range officer, "Sir, data smooth."
No. 18, switchboard operator.	Remains at stand-by.	(1) Refers to situation data card and makes the following connections of data transmission and telephone lines: *a.* Connects radar station azimuth data transmission and telephone lines to C AZ input. *b.* Connects radar station range data transmission and telephone lines to B AZ input. *c.* Connects data transmission and telephone lines from the A station to the A AZ input. *d.* Connects the B station telephone line to an extra telephone in plotting room for the reading of the solved *B Az* to the B station.

*Inasmuch as their duties under all other commands are identical with horizontal and vertical base systems of operation, the duties of the individual operators are outlined only for the commands of TARGET, SITUATION ORDER NO., and TRACK.

DRILL TABLE NO. III—*Continued*

DRILL FOR OPERATING PERSONNEL, GUN DATA COMPUTER M1
OPERATION WITH RADAR SYSTEM

(Employing "C" triangle solver for solution of target position)
(Relocation operations performed to solve for *A Az* and *B Az* for shore observation stations*)

Details	TARGET	SITUATION ORDER NO..... and TRACK
All observation stations and the radar station.	The radar station locates the target, at which the operating personnel performs the following operations: (1) Identifies target and tracks same. (2) Reports to battery commander, "On target." Prepares to transmit azimuth and range by data transmission circuits.	Radar station Continues to track target and acts under instructions from the *C Az* and *B Az* operators for the line balancing and synchronization operations. A station If an observation station has been designated as the A station by the situation order, the duties of the observer will be as follows: (1) Continues search for target. (3) Throws the track-balance switch to the TRACK position at the order of the *A Az* receiver operator, relayed by the reader. (7) Receives the solved azimuth of the target by telephone from the *A Az* operator. Continually points the instrument at the solved *A Az* and maintains search for target. B station If an observation station has been designated as the B station by the situation order, the duties of the observer will be as follows: (1) Continues search for target. (5) Receives the solved azimuth of the target by telephone from an operator who will read this data from the B AZ counter. Continually points the instrument at the solved *B Az* and maintains search for target.
No. 1, *A Az* operator.	(2) Throws ON main supply, time, illumination, and motor switches.	(1) Refers to situation data card and sets in orientation data for the base line AB. (2) Throws the bridge circuit switch to the ON position, and balances the data transmission circuits. Orders the A station observer, "Set switch on TRACK." (6) Throws the azimuth receiver motor switch to the ON position and relocates for *A Az* by matching the BT I MATCH dial indexes with the A AZ receiver operating handwheel. Sets rate on receiver to maintain match of indexes. Telephones the solved *A Az* to the A station observer.

*Inasmuch as their duties under all other commands are identical with horizontal and vertical base systems of operation, the duties of the individual operators are outlined only for the commands of TARGET, SITUATION ORDER NO., and TRACK.

DRILL TABLE NO. III—*Continued*

DRILL FOR OPERATING PERSONNEL, GUN DATA COMPUTER M1
OPERATION WITH RADAR SYSTEM

(Employing "C" triangle solver for solution of target position)
(Relocation operations performed to solve for *A Az* and *B Az* for shore observation stations*)

Details	TARGET	SITUATION ORDER NO..... and TRACK
No. 2, A_0 operator.	Remains at stand-by.	(1) Refers to situation data card and sets in orientation data for the base line G_1B. (4) Matches the BT II MATCH dial indexes by use of the A_0 handwheel. Sets in an $R_0\dot{A}_0$ rate by means of the $R_0\dot{A}_0$ handwheel to maintain match of the BT II MATCH dial indexes. Reports to chief of section, "A_0 on target."
No. 3, *C Az* operator.	Remains at stand-by.	(1) Refers to situation data card and sets in orientation data for the base line CB. (2) Throws the bridge circuit switch to the ON position, balances the data transmission circuits, and orders the radar operator, "Set switch on TRACK." (3) Throws the azimuth receiver motor switch to the ON position and synchronizes the azimuth receiver to the data from the radar station. Sets rate on the receiver to maintain the meter needle at the zero position. Reports to chief of section, "*C Az* on target."
No. 4, *B Az* operator.	Remains at stand-by.	(1) Throws the azimuth-range change-over switch on the receiver to the RANGE position. Assists No. 3 in setting in orientation data for the base line CB. (2) Throws the bridge circuit to the ON position, balances the range data transmission circuits, and orders the radar operator, "Set switch on TRACK." (3) Throws the receiver motor switch to the ON position. Synchronizes the range reading on the CT counter by setting in *B Az* until the CT counter readings match the range readings being telephoned from the radar station. Sets rate on receiver to maintain zero on meter. Reports to chief of section, "*B Az* on target."
No. 5, R_0 operator.	Remains at stand-by.	(4) Matches the R_0 MATCH dial indexes by use of the R_0 handwheel. Sets an $\dot{R}_0$ rate with the $\dot{R}_0$ handwheel to maintain the match of the R_0 MATCH dial indexes. Reports to chief of section, "R_0 on target."
No. 6, course and speed operator.	Remains at stand-by.	(6) Matches the inner indexes to the outer indexes on the $R_0\dot{A}_0$ and $\dot{R}_0$ rate dials by use of the course and speed handwheels. Maintains the match of both rate dial indexes throughout operation.

*Inasmuch as their duties under all other commands are identical with horizontal and vertical base systems of operation, the duties of the individual operators are outlined only for the commands of TARGET, SITUATION ORDER NO., and TRACK.

DRILL TABLE NO. IV
DRILL FOR OPERATING PERSONNEL, GUN DATA COMPUTER M1
OPERATION WITH AIRPLANE CONTROL
(Present azimuth, present range, course, and speed of the target estimated by airplane observer)
(Relocation operations performed to place nearest observation stations on target)

Details	AIRPLANE CONTROL and TRACK (All observation stations having reported the target obscured and an observation airplane available, the battery commander will command: AIRPLANE CONTROL and TRACK.)	SITUATION ORDER NO..... and RELOCATE (When under airplane control, the triangle solvers should be set up with orientation data for a situation employing those base lines nearest the target and relocation operations performed to place the observer on target, so that a change-over from airplane control can be made should the target become visible. To accomplish this, the range officer will command: SITUATION ORDER NO..... and RELOCATE.)
Chief of section.	(1) Orders, "Main supply, illumination and motors switches ON." (3) Supervises work of operators. (5) Orders, "Time switch ON." Note: When setting the computer up for airplane control, the time switch must not be turned on until all data reported by the airplane observer have been set into the computer, and matches of the $\dot{R}_0$ and $R_0\dot{A}_0$ rate dial indexes have been obtained. (6) Inspects selsyn transmitter dials for signs of abnormal fluctuations and, having found none or corrected cause of same, throws azimuth and elevation signal switches to the ON position. Reports to range officer, "Sir, data smooth."	(1) Supervises work of operators.

DRILL TABLE NO. IV—*Continued*
DRILL FOR OPERATING PERSONNEL, GUN DATA COMPUTER M1
OPERATION WITH AIRPLANE CONTROL
(Present azimuth, present range, course, and speed of the target estimated by airplane observer)
(Relocation operations performed to place nearest observation stations on target)

Details	AIRPLANE CONTROL and TRACK (All observation stations having reported the target obscured and an observation airplane available, the battery commander will command: AIRPLANE CONTROL and TRACK.)	SITUATION ORDER NO..... and RELOCATE (When under airplane control, the triangle solvers should be set up with orientation data for a situation employing those base lines nearest the target and relocation operations performed to place the observer on target, so that a change-over from airplane control can be made should the target become visible. To accomplish this, the range officer will command: SITUATION ORDER NO..... and RELOCATE.)
No. 18, switchboard operator.	Remains at stand-by.	(1) Refers to situation data card and makes the following connections of data transmission and telephone lines: *a.* Connects data transmission and telephone lines from the observation station designated as the A station to the A AZ input. *b.* Connects data transmission and telephone lines from the observation station designated as the B station to the B AZ input. *c.* Connects data transmission and telephone lines from the observation station designated as the C station to the C AZ input. Stands by to connect spotting telephone lines from observation stations to the spotting board operators should the target become visible.
Airplane observer.	(1) Determines the present azimuth, range, course, and speed of the target. (2) Transmits data by radio. (7) When fire has been opened by the battery, reports the deviations of the splashes from the target by the clock-face method. (8) Continually observes target and reports any changes in course or speed as they occur or reports corrections to original estimations.	Continues transmission of radio reports on deviations of splashes and course and speed of target.

DRILL TABLE NO. IV—*Continued*
DRILL FOR OPERATING PERSONNEL, GUN DATA COMPUTER M1
OPERATION WITH AIRPLANE CONTROL
(Present azimuth, present range, course, and speed of the target estimated by airplane observer)
(Relocation operations performed to place nearest observation stations on target)

Details	AIRPLANE CONTROL and TRACK (All observation stations having reported the target obscured and an observation airplane available, the battery commander will command: AIRPLANE CONTROL and TRACK.)	SITUATION ORDER NO..... and RELOCATE (When under airplane control, the triangle solvers should be set up with orientation data for a situation employing those base lines nearest the target and relocation operations performed to place the observer on target, so that a change-over from airplane control can be made should the target become visible. To accomplish this, the range officer will command: SITUATION ORDER NO..... and RELOCATE.)
All observation stations.	Maintain search for target.	A station If the observation station is designated as the A station by the situation order, the duties of the observer will be as follows: (1) Maintains search for target. (3) Throws the track-balance switch to the TRACK position at the order of the receiver operator, relayed by the reader. (5) Receives the solved target azimuths from the *A Az* receiver operator. Continually points the instrument at the solved azimuths and maintains search for target. B station If the observation station is designated as the B station by the situation order, the duties of the observer will be as follows: (1) Maintains search for target. (3) Throws the track-balance switch to the TRACK position at the order of the receiver operator, relayed by the reader. (5) Receives the solved target azimuths from the *B Az* receiver operator. Continually points the instrument at the solved azimuths and maintains search for target. C station If the observation station is designated as the C station by the situation order, the duties of the observer will be as follows: (1) Maintains search for target. (3) Throws the track-balance switch to the TRACK position at the order of the receiver operator, relayed by the reader. (5) Receives the solved target azimuths from the *C Az* receiver operator. Continually points the instrument at the solved azimuths and maintains search for target.

DRILL TABLE NO. IV—*Continued*
DRILL FOR OPERATING PERSONNEL, GUN DATA COMPUTER M1
OPERATION WITH AIRPLANE CONTROL
(Present azimuth, present range, course, and speed of the target estimated by airplane observer
(Relocation operations performed to place nearest observation stations on target)

Details	AIRPLANE CONTROL and TRACK (All observation stations having reported the target obscured and an observation airplane available, the battery commander will command: AIRPLANE CONTROL and TRACK.)	SITUATION ORDER NO..... and RELOCATE (When under airplane control, the triangle solvers should be set up with orientation data for a situation employing those base lines nearest the target and relocation operations performed to place the observer on target, so that a change-over from airplane control can be made should the target become visible. To accomplish this, the range officer will command: SITUATION ORDER NO..... and RELOCATE.)
No. 1, *A Az* operator.	(2) Throws on main supply, illumination, and motors switches. (5) Throws on time switch.	(1) Refers to situation data card and sets in orientation data for the base line AB. (2) Throws the bridge circuit switch to the ON position, balances the data transmission circuits, and orders the observer, "Set switch on TRACK." (4) Throws the receiver motor switch to the ON position and relocates for *A Az* by matching the BT I MATCH dial indexes by setting in *A Az* with the receiver operating handwheel. Sets a rate on receiver to maintain the match of the BT I MATCH dial indexes. Continually reads the solved *A Az* to A station observer.
No. 2, A_0 operator.	(3) Receives A_0 (present azimuth), relayed from airplane observer and rotates A_0 handwheel until value of A_0 is set on A_0 counter. (4) Makes no further adjustment to A_0 setting. Matches the outer index of the $R\dot{A}_0$ rate dial to the inner index by use of the $R_0\dot{A}_0$ handwheel. Reports to chief of section, "$R_0\dot{A}_0$ matched." Thereafter, continually maintains match of the $R_0\dot{A}_0$ rate dial indexes.	(1) Refers to situation data card and sets in orientation data for the line G_1B, simultaneously maintaining match of the $R_0\dot{A}_0$ rate dial indexes.

DRILL TABLE NO. IV—*Continued*
DRILL FOR OPERATING PERSONNEL, GUN DATA COMPUTER M1
OPERATION WITH AIRPLANE CONTROL
(Present azimuth, present range, course, and speed of the target estimated by airplane observer)
(Relocation operations performed to place nearest observation stations on target)

Details	AIRPLANE CONTROL and TRACK (All observation stations having reported the target obscured and an observation airplane available, the battery commander will command: AIRPLANE CONTROL and TRACK.)	SITUATION ORDER NO..... and RELOCATE (When under airplane control, the triangle solvers should be set up with orientation data for a situation employing those base lines nearest the target and relocation operations performed to place the observer on target, so that a change-over from airplane control can be made should the target become visible. To accomplish this, the range officer will command: SITUATION ORDER NO..... and RELOCATE.)
No. 3, *C Az* operator.	Remains at stand-by.	(1) Refers to situation data card and sets in orientation data for the base line CB. (2) Throws the bridge circuit switch to the ON position, balances the data transmission circuits, and orders the observer, "Set switch on TRACK." (4) Throws the receiver motor switch to the ON position and relocates for *C Az* by matching the BT II MATCH dial indexes by setting in *C Az* with the receiver operation handwheel. Sets a rate on receiver to maintain the match of the BT II MATCH dial indexes. Continually reads the solved *C Az* to the C station observer.
No. 4, *B Az* operator.	Remains at stand-by.	(2) Throws bridge circuit switch to the ON position, balances the data transmission circuits, and orders the observer, "Set switch on TRACK." (4) Throws the receiver motor switch to the ON position. Relocates for *B Az* by stepping around to face the target position generator panel and, at the same time, retaining hold of the B AZ receiver operating handwheel with the left hand, creates a match of the R_0 MATCH dial indexes with the operating handwheel. Sets a rate on the receiver to maintain the match of the R_0 MATCH dial indexes. Thereafter, at intervals, leans around to the B AZ counter and reads the solved *B Az* to the B station observer.

DRILL TABLE NO. IV—*Continued*
DRILL FOR OPERATING PERSONNEL, GUN DATA COMPUTER M1
OPERATION WITH AIRPLANE CONTROL
(Present azimuth, present range, course, and speed of the target estimated by airplane observer)
(Relocation operations performed to place nearest observation stations on target)

Details	AIRPLANE CONTROL and TRACK (All observation stations having reported the target obscured and an observation airplane available, the battery commander will command: AIRPLANE CONTROL and TRACK.)	SITUATION ORDER NO..... and RELOCATE (When under airplane control, the triangle solvers should be set up with orientation data for a situation employing those base lines nearest the target and relocation operations performed to place the observer on target, so that a change-over from airplane control can be made should the target become visible. To accomplish this, the range officer will command: SITUATION ORDER NO..... and RELOCATE.)
No. 5, R_0 operator.	(3) Receives R_0 (present range), relayed from the airplane observer, and rotates R_0 handwheel until value of R_0 is set on the R_0 counter. (4) Makes no further adjustment to R_0 setting. Matches the outer index of the $\dot{R}_0$ rate dial to the inner index by use of the $\dot{R}_0$ handwheel. Reports to the chief of section, "R_0 matched." Thereafter, continually maintains match of the $\dot{R}_0$ rate dial indexes.	Continues operation.
No. 6, course and speed operator.	(3) Receives course and speed of target, relayed from the airplane observer, and rotates course and speed handwheels to set the values on the course and speed counters. (These operations position the airplane spotting board and the inner indexes of the $\dot{R}_0$ and $R_0\dot{A}_0$ rate dials.) (8) Receives reported deviations of splashes from the target, relayed from the airplane observer, plots them on the airplane spotting board, and operates the airplane spotting board to determine the spot corrections. (9) Applies the spot corrections by means of the A_0 spot and R_0 handwheels. Makes changes in target course and speed reported by airplane observer.	Continues operation.

	Paragraph	Page
"A" and "C" triangle solvers, employment of situation charts	102	70
"A" triangle solver panel	13	10
Aided-matching motor in receiver, base-end data transmission system, emergency operation	48	43
Aided-tracking motor in transmitter, base-end data transmission system, emergency operation	47	43
Airplane control	92–96	65–66
Airplane control spotting board	27	25
Airplane spotting	89–91	64–65
Angles, size in selection of B station	71	57
Applying data to guns, output data transmission system	56	48
Azimuth indicators, synchronization of; output data transmission system	62	51
Azimuth, orientation in; output data transmission system	59	49
Azimuth-range receiver M12; base-end data transmission system	42	39
Azimuth receiver M13; base-end data transmission system	41	36
Azimuth, solution of present; horizontal base system	76	58
Azimuth transmitter, base-end data transmission system	40	34
B station, selection of	71–73	57
"B" triangle angles, in selection of B station	72	57
"B" triangle base, in selection of B station	73	57
"B" triangle solver panel	14	11
Ballistic charts	29	28
Ballistic charts panel	18	17
Base-end data for computer, horizontal base system	75	57
Base-end data transmission system:		
Azimuth-range receiver M12	42	39
Azimuth receiver M13	41	36
Azimuth transmitter	40	34
Emergency methods, base-end data transmission system:		
Data telephoned:		
5-second TI bell	51	44
Without TI bell	52	45
Failure of —		
Aided-matching motor in receiver	48	43
Aided-tracking motor in transmitter	47	43
Base-end data transmission system	50	43
Computer	49	43

	Paragraph	Page
Base-end data transmission system—Continued.		
Equipment at computer	38	33
Equipment at observation and radar stations	37	33
Line balancing	43	39
Reception of range with azimuth-range receiver M12	46	42
Static check	45	41
Synchronization	44	40
Wire system	39	34
Base-end data transmission system, emergency operation	50	43
Base line, selection; radar system	87	63
Base lines, method of changing; situation charts	101	70
"C" triangle solver panel	15	12
Cease tracking, drill of range section	123	85
Change situation, drill of range section	121	85
Change triangle solver, drill of range section	119	85
Chart selector and dial	31	28
Chief of section, duties	107	81
Circuits, electrical; output data transmission system	54	46
Close stations, drill of range section	124	86
Computer, base-end data transmission system; emergency operation	49	43
Computer, destruction of	133	92
Computer operators, duties	109	82
Constant speed motor, checking	127	89
Controls and their purposes	13–20	10–20
Controls, location of:		
"A" triangle solver panel	13	10
"B" triangle solver panel	14	11
Ballistic charts panel	18	17
"C" triangle solver panel	15	12
Parallax panel	20	20
Range-elevation converter panel	19	18
Target position generator panel	16	13
Wind component indicator panel	17	16
Corrections, spot; airplane control	95	66
Counters and dials, normal settings	35	31
Course and speed, setting estimated; airplane control	94	65
Data setting handwheels	32	29
Destruction of materiel in event of imminent capture:		
Computer	133	92
Fire control and plotting room equipment	134	92
Methods	132	91
Details, posts; drill of range section	112	83
Drill of range section:		
Cease tracking	123	85
Change situation	121	85
Change triangle solver	119	85

	Paragraph	Page
Drill of range section—Continued.		
Close stations	124	86
Details, posts	112	83
Examine equipment	113	83
Generated control	120	85
Report	114	83
Resume tracking	122	85
Situation	117	84
Stand-by	115	84
Target	116	84
Track	118	84
Duties of range section:		
Chief of section	107	81
Computer operators	109	82
Observing details	104	78
Range officer	106	80
Spotting and fire adustment board operators	110	82
Spotting details	105	79
Switchboard operator	108	82
Electrical circuits, output data transmission system	54	46
Elevation, orientation in; output data transmission system	60	50
Elevation setter, duties; output data transmission system, emergency methods of operation	69	55
Elevation setter, duties; output data transmission system, operation	65	53
Emergency methods of operation, base-end data transmission system	47–52	43–45
Emergency methods of operation, output data transmission system	66–69	54–55
Elevation setter, duties	69	55
Gun pointer, duties	68	55
Plotting room, procedure in	67	55
Employment of computer:		
Airplane control	92–96	65–66
Corrections, spot	95	66
Course and speed, setting estimated	94	65
Range and azimuth, setting estimated	93	65
Triangle solvers, use of	96	66
Airplane spotting	89–91	64–65
Lateral corrections	90	64
Range corrections	91	65
B station, selection of	71–73	57
Angles, size of	71	57
"B" triangle angles	72	57
"B" triangle base	73	57
Generated control, supply data	97	66
Horizontal base system	74–79	57–59
Azimuth, present; solution of	76	58
Base-end data for computer	75	57
Range, present; solution of	77	58
Station designations	74	57

	Paragraph	Page
Employment of computer—Continued.		
Horizontal base system—Continued.		
To obtain target course	78	58
Triangle solver change-overs	79	59
Radar system	86–88	63
Base line, selection of	87	63
Radar data, operation with	86	63
Target position, solution of	88	63
Situation charts	98–103	67–71
"A" and "C" triangle solvers, employment of	102	70
Base lines, method of changing	101	70
Situation data cards, example of use of	103	71
Situation data charts, use of	100	70
Situation chart, example of	99	68
Target relocation	80–81	59
Vertical base system	82–85	60–62
Obscurement, total	84	62
Target position, solution of	85	62
Triangle solvers, use of	83	60
Equipment, base-end data transmission system	36–39	33–34
Equipment at computer, base-end data transmission system	38	33
Equipment at observation and radar stations, base-end data transmission system	37	33
Examine equipment, drill of range section	113	83
Fire control and plotting room equipment, destruction of	134	92
5-second TI bell, data telephoned on	51	44
Generated control, in drill of range section	120	85
Generated control, in employment of the computer	97	66
Gun pointer, duties; output data transmission system, emergency methods of operation	68	55
Gun pointer, duties; output data transmission system, operation	64	53
Horizontal base system	74–79	57–59
Lamp bulbs, replacing	128	89
Lateral corrections, airplane spotting	90	64
Line balancing, base-end data transmission system	43	39
Maintenance, routine:		
Constant speed motor, checking of	127	89
Installation	126	87
Lamp bulbs, replacing	128	89
Storage	130	90
Windows	129	89
Matching dials	28	27
Materiel, destruction of	131–134	91–92
Obscurement, vertical base system	84	62
Observing details:		
Duties of	104	78
Organization	7	3

UNCLASSIFIED

	Paragraph	Page
Operating precautions:		
Operation, limits of	22	21
Safety devices	23	22
Operation, base-end data transmission system	43–46	39–42
Operation, limits of	22	21
Operation, output data transmission system	64–65	53
Elevation setter, duties of	65	53
Gun pointer, duties of	64	53
Orientation, output data transmission system	57–60	49–50
Azimuth, orientation in	59	49
Elevation, orientation in	60	50
Operation, general; emergency methods of	66	54
Orientation, general	57	49
Plotting room, procedure in	67	55
Reference piece, selection of	58	49
Synchronization, general	61	51
Output data transmission system, description	53–56	46–48
Output data transmission system:		
Applying data to guns	56	48
Circuits, electrical	54	46
Signal lamps	55	47
Output data transmission system, elevation indicators; synchronization of	63	53
Output data transmission system; operation, emergency methods	66–69	54–55
Output data transmission system, plotting room	67	55
Panel units, description and operation of:		
Airplane control spotting board	27	25
Ballistic charts	29	28
Chart selector and dial	31	28
Counters and dials, normal settings	35	31
Data setting handwheels	32	29
Matching dials	28	27
Parallax charts	30	28
Reset dials	26	25
Two-speed handwheel	33	30
Warning lights	34	30
Wind component indicator	25	24
Parallax charts	30	28
Parallax panel	20	20
Plotting room details, organization	9	3
Plotting room, procedure in; output data transmission system	67	55
Radar data, operation with	86	63
Radar section, organization	6	3
Radar system	86–88	63
Range and azimuth, setting estimated; airplane control	93	65
Range corrections, airplane spotting	91	65
Range-elevation converter panel	19	18
Range officer, duties	106	80
Range section, drill of; general	111–124	83–86

UNCLASSIFIED

	Paragraph	Page
Range section, duties	104–110	78–82
Chief of section	107	81
Computer operators	109	82
Observing details	104	78
Range officer	106	80
Spotting and fire adjustment board operators	110	82
Spotting details	105	79
Switchboard operators	108	82
Range section, organization:		
Observing details	7	3
Plotting room detail	9	3
Radar section	6	3
Recorders	10	6
Spotting details	8	3
Stand-by equipment, operators	11	6
Range, solution of present; horizontal base system	77	58
Reception of range with azimuth-range receiver M12; base-end data transmission system	46	42
Recorders, organization	10	6
Reference piece, selection of; output data transmission system	58	49
Report, drill of range section	114	83
Reset dials	26	25
Safety devices	23	22
Signal lamps, output data transmission system	55	47
Situation data cards, example of use	103	71
Situation data cards, use	100	70
Situation chart, example	99	68
Situation charts	98–103	67–71
Situation, drill of range section	117	84
Spotting and fire adjustment board operators, duties	110	82
Spotting details:		
Duties	105	79
Organization	8	3
Stand-by, drill of range section	115	84
Stand-by equipment operators, organization	11	6
Static check, base-end data transmission system	45	41
Station designations, horizontal base system	74	57
Storage	130	90
Switchboard operator, duties	108	82
Synchronization:		
Base-end data transmission system	44	40
Output data transmission system	61–63	51–53
Azimuth indicators	62	51
Elevation indicators	63	53
Target course, horizontal base system	78	58
Target, drill of range section	116	84
Target position generator panel	16	13
Target position, solution of; radar system	88	63
Target position, solution of; vertical base system	85	62
Target relocation	80, 81	59

UNCLASSIFIED

	Paragraph	Page
Track, drill of range section	118	84
Transmitter and receiver controls, base-end data transmission system	40–42	34–39
Triangle solver change-overs, horizontal base system	79	59
Triangle solvers, use of; airplane control	96	66
Triangle solvers, use of; vertical base system	83	60
Two-speed handwheel	33	30
Vertical base system	82–85	60–62
Warning lights	34	30
Wind component indicator	25	24
Wind component indicator panel	17	16
Wire system, base-end data transmission system	39	34
Without TI bell, data telephoned	52	45

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