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COPY

NATIONAL SECURITY AGENCY
Washington 25, D.C.

Serial: CSEC 115
1 May 1959.

SECRET

CANADIAN SENIOR LIAISON OFFICER, WASHINGTON

SUBJECT: TSEC/KL-7 Canadian User Report After First Year of Operation (U)

REFERENCES: (a) CANCOMSLO (W) Memorandum for Director of Communications Security, Subject as above, dated 24 Mar 58.

(b) CANCOMSLO (W) Memorandum for Director of Communications Security, Subject as above, dated 11 Mar 59.

1. The inclosure to reference (a), TSEC/KL-7 Canadian User Report After First Year of Operation, has been reviewed by the National Security Agency (NSA). Comments to this report, requested by reference (b), are contained in Inclosure No. 1. Photographs and drawings supporting these comments are included as Inclosure Nos. 2, 3, 4, 5 and 6.

2. The information contained in this report has been very helpful in evaluating the operational performance of the TSEC/KL-7 equipments and in improving the reliability of the equipments. Cooperation of the CANCOMSLO in forwarding this and other similar information is greatly appreciated.

FOR THE DIRECTOR OF COMMUNICATIONS SECURITY:

JOHN M. CRIDER
Captain, USN
Deputy Director of
Communications Security.

6 Incls:
1. Comments
2. Photos, P/L operation for TSEC/KL-7
3. Drawing, Tapered keyboard arrangement
4. Photos, 8 inch tape holders
5. Drawing, Cover, right hand end plate
6. Drawing, Test base assembly

CSEC information declassified and approved for release on 28 April 2011, CSEC ATIP Case #A-2010-00015

NSA information declassified and approved for release on 21 April 2011. FOIA Case # 64246

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Comments on "CANADIAN USERS REPORT AFTER FIRST YEAR OF OPERATION"

1. The following comments are furnished with respect to operators' criticisms of specific features of the TSEC/KL-7, as listed in paragraph 2 of the Canadian report:

a. Criticism: The lack of a P/L tape on encryption (i.e., monitor copy). Reasons given are that a P/L tape would provide a checking medium and aid operators resuming encryption after interruptions.

Comment: It is impracticable to modify the existing TSEC/KL-7 equipment to provide for a P/L tape output from the TSEC/KL-7 itself. However, a P/L decipher tape can be obtained concurrent with an encipher tape through the use of a KLX-1/TSEC Input Output Adapter. The adapter provides tandem (back-to-back) operation of two TSEC/KL-7 equipments, one being a "master" which produces an encipher tape and the other being a "slave" which produces a P/L decipher tape. The adapter also provides a means by which a TSEC/HL-1B can be connected to the TSEC/KL-7 equipments (either single or in tandem) to allow automatic conversion from a teletypewriter code system to the TSEC/KL-7 literal system. Four photographs which show various views of a developmental model of the KLX-1/TSEC are enclosed. The KLX-1/TSEC is now being Service tested. (Inclosure No. 2)

b. Criticism: The keyboard is cramped and the keys are flat. This objection tends to disappear as operators become more experienced in operating the machine.

Comment: No change has been made or is planned to improve the cramped keyboard. However, the handle of the selector lever was shortened and was offset slightly to the left to allow more room for operators' fingers. Also, a snap-on cover was added to the front of the printer unit to elimate the possibility of injury to operators' fingers by the rotating print wheel should they overreach the "Q" or "W" keys. As for the flatness of the keyboard, in 1953 several methods intended to provide the optional use of a tapered keyboard arrangement were examined, but the estimated tooling and manufacturing costs were prohibitive. As an example, one method required replacing the upper two rows with keytops of increased heights, thereby providing a stepped arrangement. However, this would necessitate the purchase of a new keytop molds, and it was estimated that the cost of the keytop molds would approximate $3,500 each. The entire tooling cost would have been approximately $70,000.

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Since the cost was prohibitive, it was decided that no further action should be taken. However, because of recent inquiries by the U.S. Air Force, indicating that a larger quantity of the stepped keys may be required, plans are being made to re-investigate the feasibility shortly after mid-1959. A partial solution to this problem may be realized by stacking extra key caps on the second and third rows of keys, giving each row a slight stair-step configuration. Drawings of this arrangement are contained in Inclosure No. 3.

c. Criticism: Some operators commented that the paper tape roll was too small, and recommended that an adapter for a larger roll of tape be adopted.

Comment: In Jan 1956 an interim device was designed to provide use of an eight inch roll of tape with the TSEC/KL-7. A simple pin was fitted into the rear hole at the top of the left side rail. A nine inch metal disc having the center hole correspond with the pin diameter was placed on the pin in a horizontal position. A roll of tape was placed over the pin in such a manner that the tape would unwind in a clockwise direction. The end of the tape was then passed through the right bracket at the rear support and around the front bar. This afforded a direct alignment with the tape chute at the first stage of the feed-print mechanism. Operation was easily accomplished (i.e., all printing keys, space bar, and indicator lamp were accessible and rotor alignment was easily read through the cipher unit viewing window). The individual rotor set keys were also readily accessible, though not with the same convenience as is found when four inch rolls are used. Although this device was usable, it was never finalized and never promulgated for general use, because of insufficient requirements. If eight inch tape holders are required, recommend they be fabricated locally. Photographs similar to a holder described in this comment are contained in Inclosure No. 4.

d. Criticism: The copy holder for static operation is unsuitable.

Comment: Comments from U.S. users were to the effect that the copy holder, which is mounted in the cover of the carrying case, did not prevent the paper from blowing back into the cover during operations under field conditions. To alleviate this problem a metal strip was pinned to each end of the copy holder in such a way that both strips could be pivoted down to provide a backing support for the paper during operation of the machine and could be pivoted up out of the way when the carrying case was closed. No other action is planned to further improve this holder.

e. Criticism: Assembly of rotors considered slow.

Comment: Changing of wiring inside the rotors is still a relatively slow process. However, improvements have been made on the rotors to eliminate the older need to disassemble the rotors into notch rings, alphabet rings, retaining rings, and bodies in order to change patterns. On the latest rotors, patterns can be changed by simple depression-rotation-release actions on either the alphabet rings or notch rings.

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2. The following comments are furnished with respect to specific instances of deficiencies encountered during the early stages of operation, as listed in paragraph 3 of the Canadian report:

a. Deficiency: Faulty pulse generators. This defect has been under investigation for some time, but instances appear to have been restricted to the early stage of operation.

Comment: Various holders of the TSEC/KL-7 equipments have reported the deficiency of the pulse generators, and, as a result, extensive investigations have been performed. Recently, a method for solving the users' problems of the faulty pulse generators has been formulated. All users who have experienced the fault will be notified in separate correspondence by 1 June 1959, of the courses of action they should take to obtain good pulse generators.

b. Deficiency: Right hand plate and contact assembly. Several instances of breakage of this part have been reported.

Comment: Other users reported the same deficiency on early TSEC/KL-7 equipments. After investigation, it was determined that the basic problem was that the end plate, due primarily to moisture absorption and problems in the molding process, was too large and fitted very tightly in the cipher unit shell. As a result, operators were required to exert too much force in removing the right hand end plate from the cipher unit with resultant breakage. Corrective measures taken were: (1) utilization of improved molding process, (2) reduction of the peripheral dimensions of the end plate, and (3) the cover for the right hand end plate was changed from bakelite to aluminum.

c. Deficiency: Several cases of unserviceability of the cipher unit end plate latch have been reported. Due to its light construction it does not stand up to continued use.

Comment: Other users reported the same deficiency on early TSEC/KL-7 equipments. Corrective action was taken to change the latch from a pivoted, spring-steel catch to a stronger and more positive-locking, sliding-type latch. (A print of a manufacturing drawing of the right hand end plate CE11105 is enclosed to illustrate the design of the latest type of latch). (Inclosure No. 5).

d. Deficiency: End play between KLB-7/TSEC (base of machine) and KLK-7/TSEC (cipher unit). This was also an early fault in the machine which was remedied through fitting a specially designed plastic wedge between the two parts.

Comment: There is still a slight rocking motion of the Cipher Unit during rotor stepping operations; however, the slight motion does not impair the functioning of the TSEC/KL-7. Early in production it was found that accumulative tolerances of parts could cause interference which could possibly result in non-interchangeability of cipher units and stepping units on TSEC/KL-7 equipments. To prevent this, the re-entry circuits terminal blocks in the Stepping Units were shortened.

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Comment: This alone would have allowed increased rocking motion; however, at the same time, the curved depression in the Stepping Unit (into which the Stepping Unit fits) was milled down to allow the Stepping Unit to seat closer to the base panel, and the cipher unit latches were modified to provide a firmer hold-down for the cipher unit. The specially designed plastic wedge mentioned above was evaluated and was approved for local fabrication and optional use.

3. The following comments are furnished with respect to the recommendations for Canadian users, as listed in paragraph 5 of the Canadian report:

a. Recommendation: A modification of the base, which would allow checking of circuits with the power on, would facilitate electrical fault finding.

Comment: A cut out base was not considered structurally sound enough for permanent installation and normal usage. Figure 58 in AMSP 512 (A), Repair and Maintenance Instructions for TSEC/KL-7), (AFSAM-7), shows the location of terminals (top center of the figure) which are accessible from the top side of the contact panel after removal of the KLA-7/TSEC Stepping Unit. Many troubles can be located through the use of those terminals as test points. If extensive voltage checks throughout the machine are required, the use of the special test base CE 87052, which contains cutouts to facilitate troubleshooting of electrical circuits, is recommended. The special test base is included in the list of recommended tools for the TSEC/KL-7 (see page 12-1 of AMSP 512 (A)). A print of the manufacturing drawing for the special test base is inclosed with these comments for further information. (Inclosure No. 6)

b. Recommendation: Paragraph 525 (a) of AMSP 507 (A) states that an eraser is to be used to clean flat head contacts and Quietone spread on with fingers. It has been found that immediate removal of this Quietone with twilljean cloth has been very satisfactory in operation.

Comment: AMSP 507 (B) has recently been put into effect and supersedes AMSP 507 (A). Paragraph 527 (a) of AMSP 507 (B), which corresponds to paragraph 525 (a) of AMSP 507 (A), provides a slightly different procedure for cleaning and lubricating flat head contacts. However, the new procedure does not incorporate the above recommendation that the cleaner-lubricant be removed immediately. Investigations of various types of cleaner-lubricants and methods of application are still continuing.

c. Recommendation: It is considered that the warning lamp indicating upper case should be replaced with a brighter lamp as the present lamp is difficult to observe.

Comment: Early-produced TSEC/KL-7 equipments had clear plastic domes over the figures indicator neon lamps, and the lamps were fairly bright. However, because the TSEC/KL-7 was basically

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designed for field combat conditions and because the light could easily reveal communications and headquarters locations under those conditions, a change was made to the equipment to purposely reduce the brightness of the indicator; the dome was painted black except for a small clear slit. Recognition of upper case condition can be improved on equipments being used in offices by the removal of the plastic domes.

d. Recommendation: Some operators recommend that a larger size paper roll and holder be incorporated. (It is considered that this modification might not be practical).

Comment: Same as comment given in paragraph 1.c. above.

e. Recommendation: It is recommended that the registration plates be placed in more easily observed locations.

Comment: It is recognized that observations of cipher unit and stepping unit nameplates are somewhat difficult when the TSEC/KL-7 is in its carrying case. However, changes during production to effect easier observation of nameplates would have been too costly. Since production has been completed, such a change would be prohibitive; therefore, no change will be made.

f. Recommendation: A stronger metal clip should be designed to hold the removable end plate of the cipher unit in place. It might prove more practicable to scrap the existing type of clip and to incorporate an improved type of fastener to hold this end plate in place.

Comment: Same comment as given in paragraph 2.c. above.

g. Recommendation: Molding for the right hand end plate and contact assembly should be made of more durable material.

Comment: Same comment as given in paragraph 2.b. above.

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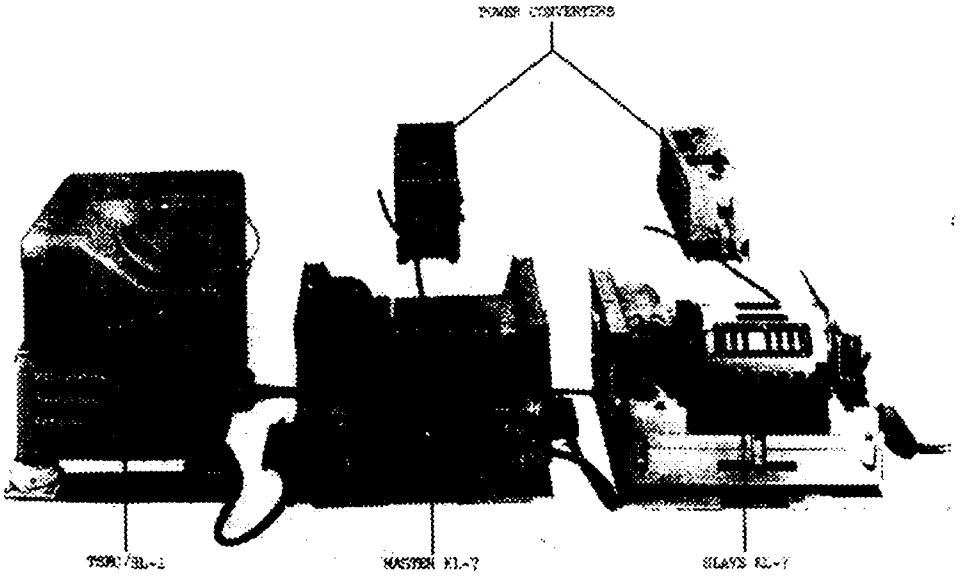

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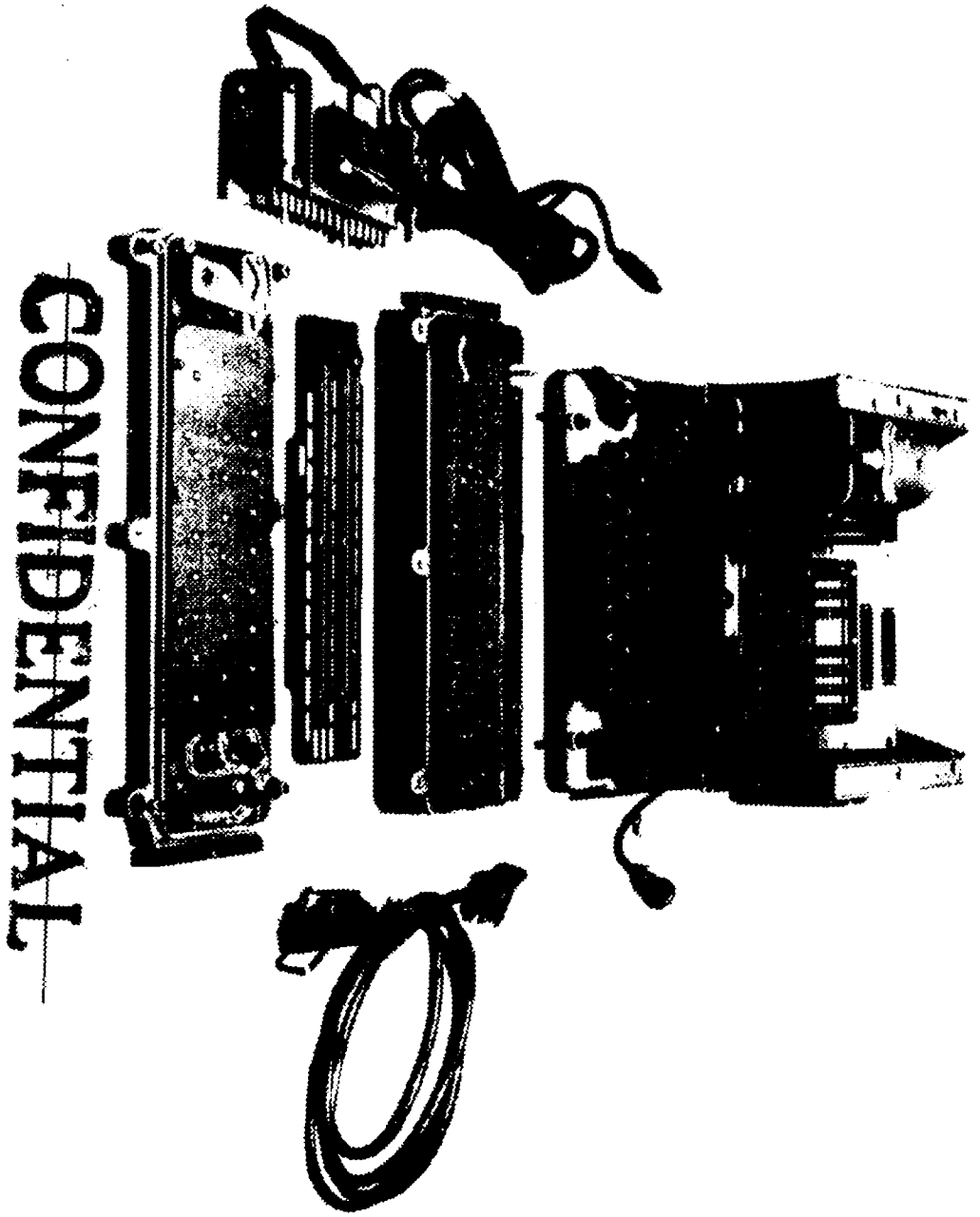

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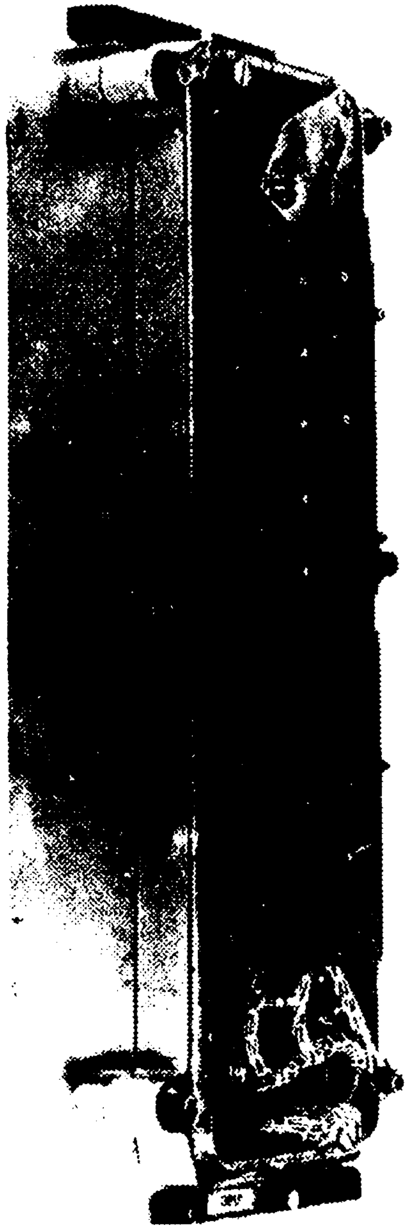

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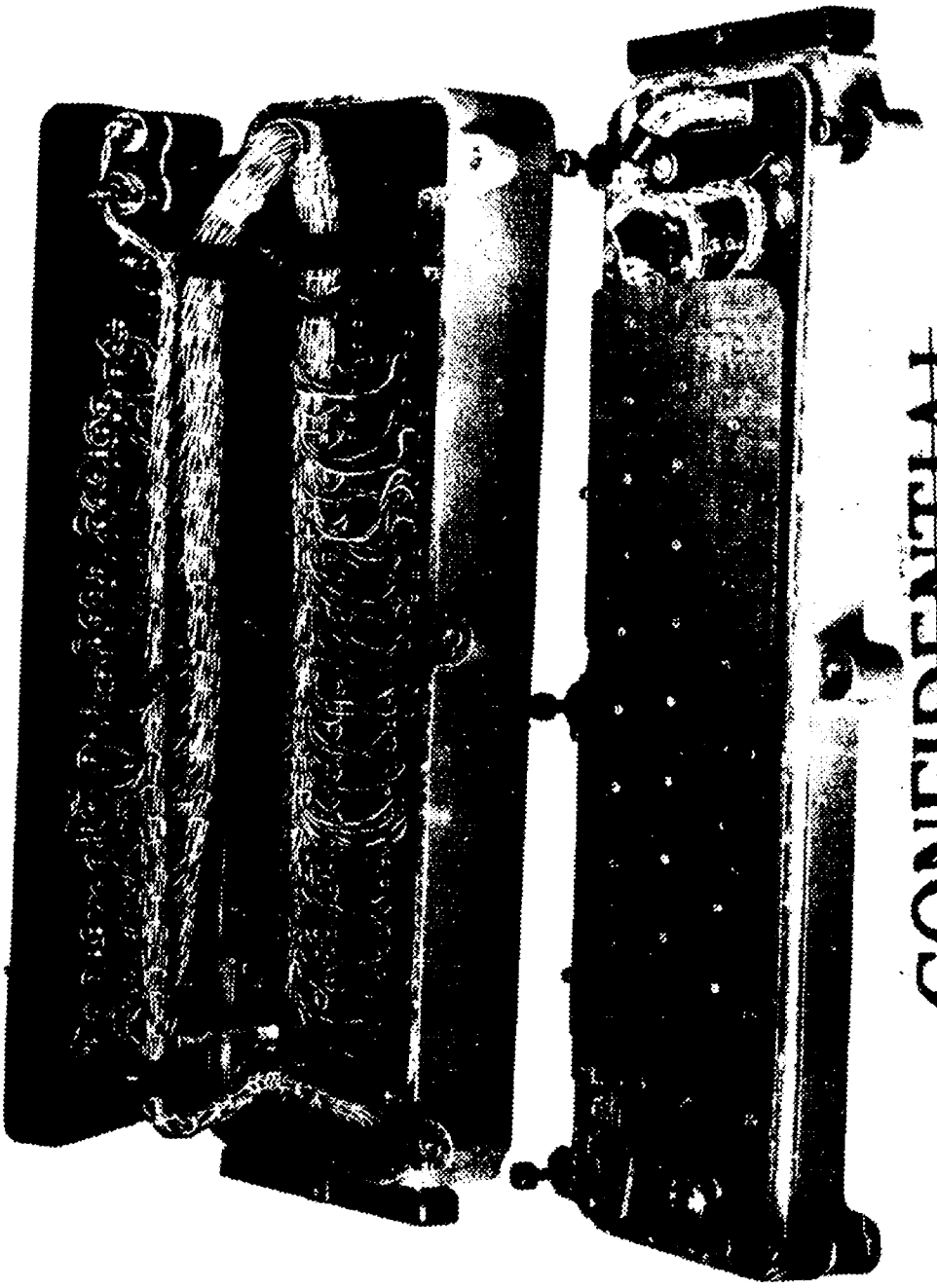

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PROCEDURE TO MODIFY KEYTOPS OF THREE TSEC/KL-7 EQUIPMENTS AND PROVIDE TAPERED KEYBOARD ARRANGEMENT

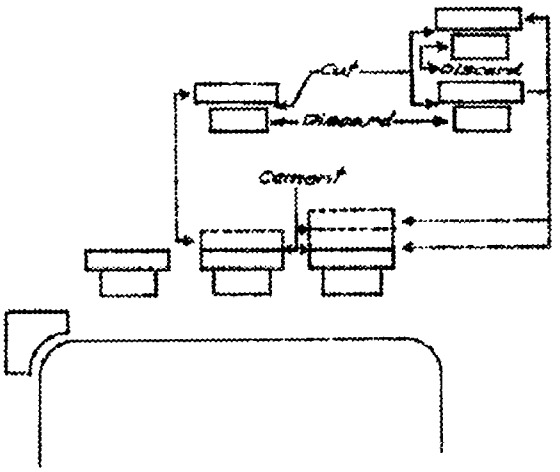
1. Procure the following items in the quantity indicated from replacement spare parts:

Part No.	Keytop Designator	Quantity	Part No.	Keytop Designator	Quantity
CE 11167	"A"	3 each	CE 11507	"Q-1"	6 each
CE 11499	"S"	3 each	CE 11508	"W-2"	6 each
CE 11356	"D"	3 each	CE 11509	"E-3"	6 each
CE 11486	"F"	3 each	CE 11510	"R-4"	6 each
CE 11487	"G"	3 each	CE 11511	"T-5"	6 each
CE 11488	"H"	3 each	CE 11512	"Y-6	6 each
CE 11490	"J"	3 each	CE 11513	"U-7"	6 each
CE 11491	"K"	3 each	CE 11514	"I-8"	6 each
CE 11492	"L"	3 each	CE 11515	"O-9"	6 each
CE 11172	"RPT"	3 each	CE 11516	"P-Ø"	6 each

2. Remove the shank portion of the keytops listed above without cutting into the upper portion (refer to sketch given below). This can be done with a saw or by lathe.

3. Cement one each of the modified keytops to the keytops of the middle row, matching the character designation with its counterpart presently on the equipment.

4. Cement two each of the modified keytops to the keytops of the upper row, matching the character designations with their counterpart presently on the equipment.



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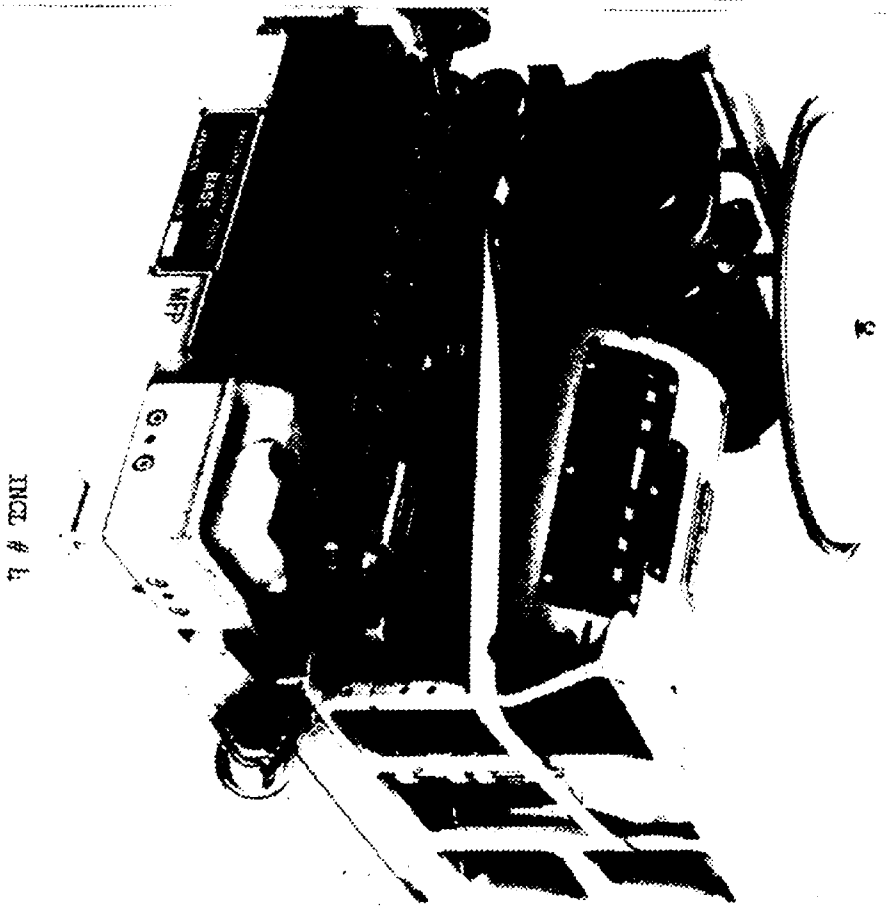
4. Using a conventional TSEC/KL-7, a 9" diameter cardboard disc, or any rigid material capable of supporting the roll of tape, was placed in a horizontal position over the rear hole at the top of the left side bracket. The disc, containing a center hole to correspond with the size of bolt, two nuts, two flat washers, and one lockwasher. The bolt extends approximately ½" above the disc to provide a pivot support for the tape roll. A roll of tape is placed over the bolt in such a manner that the tape will unwind in a clock-wise direction. A wooden spool, or equivalent, can be devised for use with rolls containing 2" cores.



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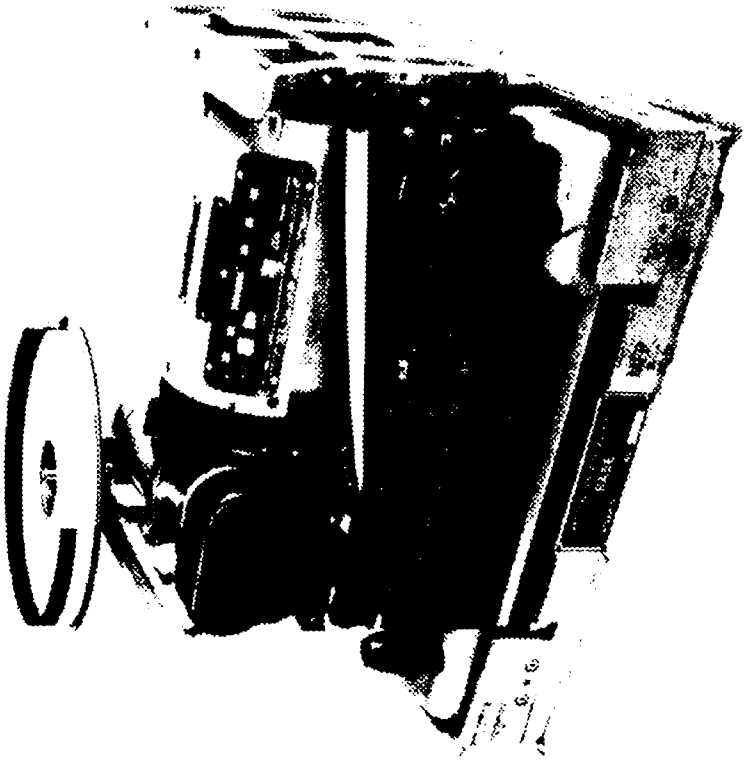

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SECURITY INFORMATION

INTERIM OPERATING INSTRUCTIONS
FOR
POLLUX CRYPTOSYSTEMS—JOINT

This document consists of cover and 45 numbered pages, 1 to 45 inclusive

Verify presence of each page upon receipt

DEPARTMENT OF DEFENSE
ARMED FORCES SECURITY AGENCY
WASHINGTON 25, D. C.

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DEPARTMENT OF DEFENSE
NATIONAL SECURITY AGENCY
WASHINGTON 25, D. C.

26 January 1953

INTERIM OPERATING INSTRUCTIONS FOR POLLUX CRYPTOSYSTEMS—JOINT

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4. This publication is distributed to authorized holders of AFSAM 7 and associated publications.

5. THIS DOCUMENT CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE LAWS, TITLE 18, U. S. C., SECTIONS 793, 794 AND TITLE 50, U. S. C., SECTIONS 46, 46a AND 46b. ITS TRANSMISSION OR THE REVELATION OF ITS CONTENTS IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

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RALPH J. CANINE
Major General, US Army
Director, National Security Agency

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RECORD OF CORRECTIONS

Identification of Correction or Change and Reg. No. (if any)	Date Entered	By whom entered (Signature; rank or rate; Name of Command)
By authority C/SEC	9 Mar 54	1154-41
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CHAPTER 1

DESCRIPTION

1000—GENERAL

1001. POLLUX Operation.—The designator POLLUX applies to the general cryptosystem produced by the cipher machine AFSAM 7.

1002. Category of Cryptosystems.—Cryptosystems employing AFSAM 7 are Category A as explained in Section 2100, AFSAG 1210A.

1003. Authorization for Use.—The AFSAM 7 is authorized for the encipherment of messages of all classifications.

1004. Maintenance. Chapter 5 contains instructions to be followed in the maintenance and repair of the cipher machine by intermediate repair facilities.

1005. Comments or Recommendations.—It is requested that any comments or recommendations concerning the instructions contained herein be submitted to the Director, National Security Agency, Attn: NSA–04, through normal Service channels. Such comments or recommendations should be specific as to page or paragraph number and subject matter. It is particularly important that any instructions which are not clear, are too brief, or are apparently lacking, be reported without delay in order that any necessary corrections may be promulgated by change or superseding editions.

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1100—AFSAM 7

1101. General.—The AFSAM 7 is a keyboard-operated tape-printing cipher machine. Each machine is designed on a unit assembly basis. The rotor stepping unit (AFSAM 107) and the cipher unit (AFSAM 207) are CONFIDENTIAL and registered. The base (AFSAM 7) is RESTRICTED and registered. (See pl. 1, pp. 10.)

1102. Keyboard.—The *keyboard* resembles a typewriter keyboard and can be operated at a maximum speed of 60 words per minute. The keyboard includes 26 alphabet keys (the top row of which also includes the numerals 1 to 0), a "RPT" (Repeat) key, a "FIG" (Figures) key, a "LET" (Letters) key, and a space bar. When the "RPT" key is depressed in conjunction with any operative key, the machine will operate continuously until the "RPT" key is released. The "FIG" key causes a figures shift in the printer so that the keys in the top row will print figures. The "LET" key causes the printer to unshift producing lower case (letters) versions.

1103. Function Controller.—The positions of the function controller and their effect on the operation of the machine are as follows:

a. "O" Position (Off).—The power line is open and no current is supplied to the machine.

b. "P" Position (Plain text).

(1) All keys and the space bar are operative; the machine will print text exactly as typed. The rotors remain motionless during typing.

(2) With the function controller in the "P" position, rotors may be aligned by depressing the individual rotor-set keys which are located beneath the rotor apertures of the cipher unit.

c. "E" Position (Encipher).—All keys and the space bar are operative. The machine enciphers any character struck and prints the result in five-letter groups. The rotor maze advances when the "FIG" or "LET" key is depressed.

d. "D" Position (Decipher).—All keys are operative. The space bar is inoperative. The machine deciphers the letters struck on the keyboard and prints the resulting plain text. The rotor maze does not step when the "FIG" or "LET" key is depressed.

Note: The numbers 1 through 0 appear on the top row of alphabet keys. When the "FIG" key is struck during decipherment, enciphered versions of the letters of the top row will decipher as the numerical equivalents appearing on the corresponding keys. For example, "E" and "3" appear on the same key; if the "FIG" key is struck, enciphered "E" will decipher as "3."

1104. Rotor Stepping Unit.—The rotor stepping unit, AFSAM 107, is mounted on the base of the machine. It may be removed by loosening the two captive thumb screws and pulling the unit toward the operator and up.

1105. Cipher Unit.—The cipher unit, AFSAM 207, is mounted in the AFSAM 107. It has a shaft on which eight rotor assemblies may be mounted. The cipher unit may be removed by depressing the cipher unit latches on either side of the unit.

1106. Power Requirements.—The AFSAM 7 is operated from a 21–31 volt d. c. power supply. A power converter may be obtained for 100–125 or 200–250 volt (50–60 cycle) alternating current.

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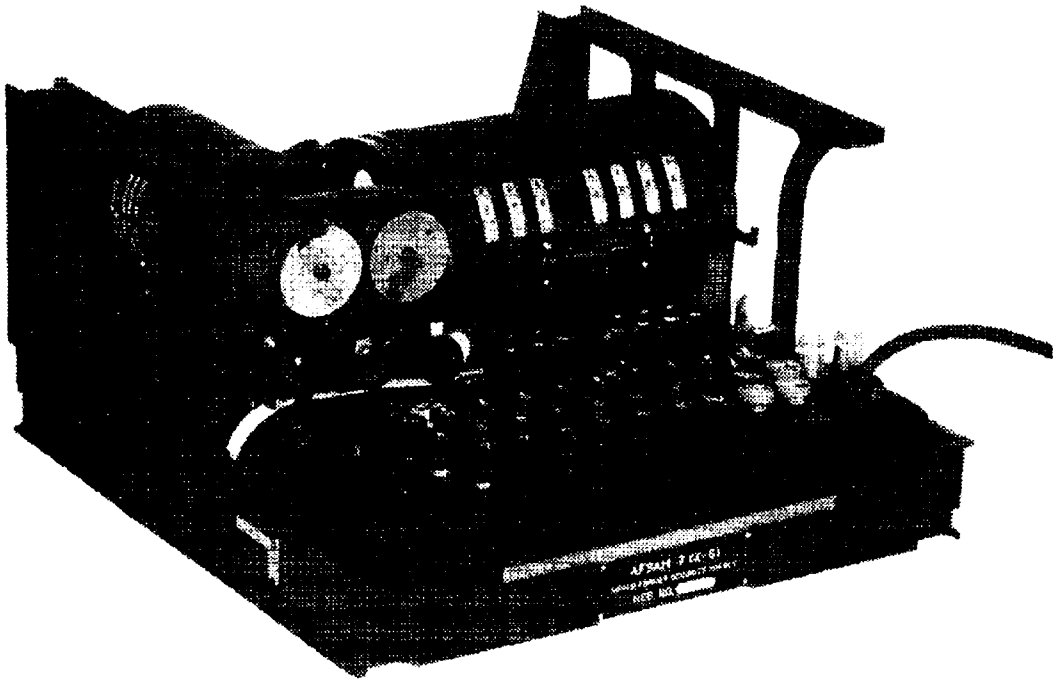

Plate 1

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1200—KEYING MATERIALS

1201. Rotors.

a. Sets of eight rotor assemblies, each set consisting of eight cores, eight retaining rings, seven alphabet rings (plus one extra ring), seven notch rings, and one wide ring, are issued for use with the AFSAM 7. Rotor assemblies are CONFIDENTIAL and registered. Each set of rotor assemblies is identified by a title and a number. Each of seven of the rotor assemblies consists of a core identified by a letter-number pattern, a correspondingly numbered notch ring, an alphabet ring, and a lock ring; the eighth assembly consists of a core, a wide ring, and a lock ring. Each complete assembly is accountable by its core number.

b. The numbers 1 to 36 appear on the sides of the alphabet rings and the wide ring. Each of these rings is set with the number designated by the key list aligned to the bench mark of a core. Each notch ring is set independently to a letter on its associated alphabet ring according to the key list. The rotor assemblies are *not* reversible. The wide ring assembly MUST ALWAYS BE PLACED IN THE FOURTH POSITION IN THE CIPHER UNIT.

1202. Key Lists.

a. Certain key lists used with the AFSAM 7 bear the designator POLLUX. Each key list is SECRET and registered* and contains the following material for each date:

(1) A list of the cores to be placed in each of the eight positions in the cipher unit.

(2) The setting of the alphabet ring to be used with each core.

(3) The setting of the wide ring on the core in the fourth position.

(4) The notch ring to be used with each core (listed in conjunction with the letter of the alphabet ring to which the notch ring bench mark is to be set).

(5) The rotor assemblies are listed from left to right in the order in which they are to be inserted in the cipher unit.

(6) A system indicator.

b. The arrangement of the keying data in a POLLUX key list is illustrated below:

DATE	1 Core / Alph Ring / Notch Ring & Set	2 Core / Alph Ring / Notch Ring & Set	3 Core / Alph Ring / Notch Ring & Set	4 Core / WIDE RING Set	5 Core / Alph Ring / Notch Ring & Set
1	7 13 6-G	8 7 3-M+	5 2 2-F	2 23	1 11 5-J+

6 Core / Alph Ring / Notch Ring & Set	7 Core / Alph Ring / Notch Ring & Set	8 Core / Alph Ring / Notch Ring & Set	36-45 LTR CK GPS	
6 35 7-P	3 5 4-A	4 18 1-R	QXPDI/MXRES	4

Note: Blank spaces on alphabet rings are indicated in key lists by the letters which *precede* them in the alphabet printed in conjunction with a plus (+) sign. Thus, "J+" indicates the space between the letter J and K, "M+" indicates the space between M and N, etc. There are 10 such spaces on each alphabet ring.

*Daily SOI extracts of NSA-produced SECRET and registered master copies are CONFIDENTIAL and non-registered.

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f. Additional Information on Rotor Assembly.

(1) To permit disassembly; remove the retaining ring by grasping and squeezing both of the retaining ring projections and simultaneously lifting upward.

(2) To replace the retaining ring after properly aligning the alphabet and notch rings; hold the assembled core flat side down with one hand, grasp and squeeze the retaining ring projections with the thumb and index finger of the other hand and insert the ring - flat side down - into the groove of the rotor core. When the retaining ring is seated into the groove, release the ring projections.

(3) In order to insert the completed assembly in the cipher unit, hold the rotor in one hand and the cipher unit in the other. Tilt the cipher unit and allow the rotor to slide in over the shaft. Do not hold the cipher unit so that the shaft is vertical and drop the rotor straight down as damage may result.

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CHAPTER 2

OPERATION

2000—KEYING INSTRUCTIONS

2001. Rotor Assembly and Arrangement.—The elements of each rotor are selected and assembled in accordance with the key list and each rotor is placed in the cipher unit as soon as assembly is complete. This is accomplished as follows, using the sample key list:

a. Note that the key list contains eight numbered columns, one for each of the eight rotors. Select the core listed in the first column (7) and place any one of the alphabet rings on the core with the designated alphabet ring number (13) opposite the bench mark on the flat side of the core.

b. Find the notch ring designated in the first column (6) and place it on the rotor so that its paired bench marks bracket the designated letter (G) of the alphabet ring.

c. Place the retaining ring in position, check to see that the correct core, notch ring, and alignments have been set up, then insert the completed rotor assembly into the cipher unit *with the flat side in.*

d. Repeat the process above for each of the rotors in turn. In the case of the wide ring assembly, which has no associated notch ring, align the appropriate number (23) appearing on the side of the wide ring to the bench mark of the designated core (2), and place the retaining ring in position. The wide ring is placed in the cipher unit by engaging the two lobes on the ring in the corresponding keyways in the frame of the cipher unit.

Note: The wide ring assembly is always the fourth listed in the key list and MUST ALWAYS BE PLACED IN THE FOURTH POSITION IN THE CIPHER UNIT.

e. When all rotors have been assembled and inserted, place the side of the cipher unit in position, and close the slide catch. (Note: With all eight rotors in the cipher unit, the last rotor projects slightly from the unit and must be pressed in when positioning the side of the cipher unit.)

2002. 36–45 Check.

a. The 36–45 letter check groups are provided in the key lists as a means of performing a check on the operation of the machine and upon the correctness of the rotor assembly and arrangement. The 36–45 check shall be made after each change of rotor assembly and arrangement. The check is made in the following manner:

(1) After the rotors have been assembled and placed in the machine, turn the controller to "P" and allow time for warm up. The cipher machine is ready for operation when the bulb lights after the "FIG" key is depressed. (Return to lower case by depressing the "LET" key.)

(2) Hold back the tape release lever to conserve tape and align the seven visible rotors to "AAAAAAA" by depressing in order each of the rotor-set keys. (The rotor-set keys are located below each rotor window when cipher unit is in place.)

(3) Turn the controller to "E." (Note that the rotor maze steps once.)

(4) Set the stroke counter to zero, press down the "Repeat" and "A" key simultaneously and hold until 45 letters have been printed.

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(5) Compare the last two groups of the resultant encipherment with the 36-45 check groups in the key list. If the groups are not identical, the above procedure should be repeated with all points carefully checked.

b. If the 36-45 check cannot be made successfully and rechecks have indicated that the rotor assemblies and arrangements are correct, dirty rotor or cipher unit contacts or faulty mechanical operation may be the cause of the trouble and appropriate corrective measures should be taken. The machine should not be used until the 36-45 check is correct in all respects.

2003. System Indicator and Message Classification.

a. System indicators are the five-letter groups indicated in the key lists (or in a separate indicator list) which identify the specific POLLUX cryptosystem used for encipherment. The system indicator is *never* enciphered.

b. The classification shall always be inserted in the beginning of each message within the first 25 letters of the plain text, and shall be enciphered as part of the message.

2004. Message Indicator.—The message indicator consists of five letters selected at random by the operator and is used to determine the *message rotor alignment* as explained in paragraph 2005. *The message indicator shall be different for each message or part.* When it is necessary, as in the case of a service, to reencipher a message, or part, or any portion thereof, a different message indicator shall be selected. Bona fide five-letter words, abbreviations, etc., shall not be used as message indicators under any circumstances.

Note: Do not deviate from this procedure in selection of message indicators. A random group must be selected, then aligned. *Do not step the rotors to a random alignment, and copy the result as the message indicator.*

2005. Message Rotor Alignment.—The alignment of the rotors at the beginning of encipherment or decipherment constitutes the message rotor alignment. The message rotor alignment is derived in the following manner:

a. Select at random a five-letter message indicator and record it.

b. With the controller at "P," align the first five rotors to the message indicator by depressing, in order, the rotor-set keys. Repeat the alignment of the first and second rotors on the sixth and seventh rotors, respectively. The seven-letter result is the message rotor alignment.

For example:

Message Indicator..... Q B D F P (selected at random)
Message Rotor Alignment..... Q B D F P Q B

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2100—ENCIPHERING AND DECIPHERING

2101. Application of General Cryptoprocedures.—Instructions regarding the application of general cryptoprocedures such as arrangement of indicators and text, division of messages into cryptoparts and correction of typing errors are contained in the effective edition of AFSAG 1210 or AFSAG 1211. Messages should be divided into cryptoparts with each part containing not more than 350 groups of cipher text. Bisection and variable spacing are not required.

2102. Sequence of Operations in Encipherment.—After the message has been divided into parts, if necessary, it shall be enciphered in the following manner:

a. Prepare the machine for operation in accordance with paragraphs 2001 and 2002, referring to the appropriate POLLUX key list to determine the rotor assembly, rotor arrangement, and the 36-45 letter check.

[redacted] a message indicator and determine the message rotor alignment in accord-

[redacted] times and type the system

DO NOT ENCRYPT USING THIS SYSTEM ONLY.
THIS SYSTEM GIVES TRUE INDICATOR IN CLEAR.
REFER TO SUPPLEMENTARY INSTRUCTIONS.

~~SECRET~~

s.15(1)

SGT

occurs which will [redacted]
followed by a space, repeat the last correct word [redacted]
from that point. If the last group of cipher text does not contain five [redacted]
"LET" key once and then encipher as many random letters as necessary to complete the group.

g. After the text has been enciphered, switch the controller to "P," type the system indicator, advance the tape until the printing is clear of the tape channel, and tear off the tape.

2103. Sequence of Operations in Decipherment.

a. Prepare the machine for operation in accordance with paragraphs 2001 and 2002, referring to the appropriate POLLUX key list (as indicated by the system indicator) to determine the rotor assembly, rotor arrangement, and the 36-45 check.

b. Determine the message rotor alignment from the message indicator received and align it on the rotors in accordance with paragraph 2005.

c. Turn the controller to "D." (Note that maze steps once as the controller passes from "P" to "E.")

d. Set the stroke counter to zero.

e. Type the cipher text of the message, exclusive of indicators. Disregard the spaces between groups. The plain text will be printed on the tape in word lengths. The letter "X" will always be printed in the place of "Z" and "Y" in place of "J," e. g., "XERO" for "ZERO" and "YUMP" for "JUMP."

f. After completing decipherment, advance the tape until the printing is clear of the tape channel and tear off the tape.

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2200 AIDS FOR DECIPHERING GARBLED MESSAGES

2201. General.—When a message garbles during decipherment, either from the beginning or after some plain text has appeared, the operator should first check his own work to insure that he has not made an error in setting up the machine or in typing. The possibility that the garble is caused by a typing error (such as an omission or repetition of a cipher letter) can be checked by noting the counter reading and resuming typing at the appropriate point in the cipher text. For example, if the counter reading is 38 when the garble is noticed, typing should resume with the 35th cipher letter. When the possibility of an error by the deciphering operator has been ruled out, corrective measures given below should be tried. All errors, except typing errors, shall be brought to the attention of the officer in charge of the cryptocenter who shall determine whether the error requires message or mail report as explained in the effective edition of AFSAG 1210 or AFSAG 1211.

2202. When No Plain Text Appears.

a. Missing or additional groups at the beginning of the message.—Check the group count in the message heading against the actual number of groups.

(1) If one or more groups are missing, strike any letter key as many times as there are missing letters. Ignore the result, then decipher beginning with the first group.

(2) If one or more groups have been added, omit the indicated number of letters and decipher.

b. Error in the date-time group.

(1) Try to decipher using the data given in the key list for the date preceding and then for the date following the date given in the date-time group.

(2) Try to decipher using the data given in the key list for the date of receipt and then for the date preceding and the date following the date of receipt.

c. Incorrect edition of key list.—Try to decipher using the key list for the previous month and for the month following.

d. Incorrect message rotor alignment.—Try to decipher using the alignment reached at the end of the 36-45 letter check.

e. Transposition of letters of the message rotor alignment in the alignment of the rotors.—Transpose pairs of adjacent letters in the message rotor alignment when aligning rotors. The exchange of positions of two letters is most likely to occur when the result forms a pronounceable combination or when two letters are often used in reverse. For example, LULFELU aligned as LULEFLU.

2203. When Some Plain Text Appears.—Procedures in subsequent paragraphs involve the performance of certain operations with rotors aligned to the "point of garble." The point of garble is defined as the alignment reached by the rotors on decipherment of the last plain-text letter known or assumed to be correct.

a. Deletion of one or more groups.

(1) If a check of the group count shows that one or more groups are missing, advance the rotors to the point of garble by striking any key the required number of times. Record the rotor alignment and the counter reading. Strike any key the same number of times as there are missing letters, ignore the result, then try to decipher.

(2) If this does not result in plain text, align the rotors to the point of garble as recorded in (1) above, then decipher the group following the point of garble as many times as necessary (without realigning the rotors) until plain text appears, checking for plain text after each decipherment. For example, if the garbled text starts at a counter reading of 95 (19 groups), decipher the 20th group as many times as necessary (without realigning the rotors) until plain text appears.

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b. Added or repeated groups.

(1) If a check of the group count shows that one or more groups have been added or repeated, advance the rotors to the point of garble by striking any letter key the required number of times. Record the rotor alignment and the counter reading. Omit the indicated number of groups and continue to decipher.

(2) If this does not result in plain text, decipher the 11th group following the garble as many times as necessary (without realigning the rotors) until plain text appears. Check each decipherment of the group for readable text. For example, if the recorded letter count at the point of garble is 205 (41 groups), decipher the 52d group as many times as necessary (without realigning the rotors) until plain text appears. If there are not 11 groups following the point of garble, decipher the next to the last group of the message as many times as necessary (without realigning the rotors) until plain text appears.

(3) The number of extra groups can be determined by subtracting from 11 the number of times the 11th group was deciphered to produce plain text.

c. One letter of a six-letter group (made by defective spacing of the machine) is lost in handling.—Advance the rotors to the point of garble, strike any key once to replace the missing letter, and then decipher normally.

d. Cipher group consisting of only four letters.—Record the rotor alignment and the counter reading immediately before deciphering the four-letter group. Strike any letter key once to replace the missing letter, and then continue to decipher.

Note: In case an important word remains garbled in *c* or *d* above, realign to the point immediately preceding the group yielding garbles and decipher, striking any letter key in a different position until a logical word is obtained. If necessary, consult a Morse error chart for two-letter combinations commonly transmitted as one letter, or a teletypewriter garble table for letters frequently garbled into function control symbols. Substitute such letters in the cipher text and decipher.

e. Cipher group consisting of six letters.—(Occasionally a six-letter group will be printed because of machine fault, in which case all six letters will be required to get plain text.) Record the rotor alignment and the counter reading immediately before deciphering the six-letter group; then decipher all six letters of the group and continue to decipher several groups. If the result is a garble, decipher only the first five letters of the group, dropping the sixth, and continue to decipher several groups. If there is still a garble, drop other letters of the group one at a time until plain text results.

f. Two or more letters garbled in transmission causing an important word to be partially garbled.—Consult a Morse error chart or a teletypewriter garble table for letters commonly garbled in transmission. Substitute such letters in the cipher text and decipher.

g. One hand of the enciphering operator misplaced on the keyboard.—(Note that words when deciphered retain their correct length even though garbled.) Example: AIRCRAFT REOIRTED IOERATUBG IVER SOUTHERB AREA. (In this example the right hand of the enciphering operator was placed one position over from the correct position.) Observe the text as it appears on the tape. Fit in probable plain-text words and try to justify them by a particular misplacement of the operator's hand.

2204. Special AFSAM 7 Garbles.—Because of the number of elements involved, AFSAM 7 rotors are easily set up incorrectly. An error in core setting will produce completely undecipherable text and a service must be sent. If, however, a notch-ring is off-set, it may produce plain text for a short stretch before garbled text appears. The number of possible off-sets precludes trial-and-error attempts at correcting the alignment. A third characteristic error in AFSAM 7 text is caused by the "FIG" circuit becoming incorrectly activated. In this case, numbers will appear in place of the top row keys. When the "FIG" circuit is active, numerals will be produced in place of the letters associated with them (back row of keys).

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3006. [illegible] DESTRUCTION

a. The disassembly of rotors and the destruction of key lists, is essential. Destruction of AFSAM 107 and AFSAM 207 units, unassembled rotors, and operating and maintenance instructions is desirable if time and circumstances permit. The destruction of the AFSAM 7 base is not required but should be accomplished if possible.

b. Emergency destruction may be accomplished by disassembly and manual methods, or, if desired, by use of the M2A1 and AN-M14 incendiaries. When time and circumstances do permit the following procedures to avail for the manual destruction of the AFSAM 7.

(1) Disassemble each rotor by removing the retaining notch and alphabet rings.

(2) Destroy the wires within the core by unplugging them and then either cutting or ripping them loose. Access to the wiring may be gained by either removing the six screws from the face of the core or by smashing the rotor core.

(3) Remove the Stepping Control Unit from the machine and completely destroy it.

(4) The remainder of the AFSAM 7 shall be destroyed by whatever expedient seems possible.

c. When conditions permit, the remnants of the destroyed AFSAM 7 shall be burned by a M2A1 incendiary.

d. When time and circumstances do not permit the manual destruction of the AFSAM 7 as outlined above, a M2A1 incendiary shall be placed on top of the machine and ignited.

3007. DESCRIPTION OF M2A1.--The M2A1 is a thermite incendiary similar to but smaller than the M1A1/M1A2. It is designed specifically for the destruction of the cipher machine SIGABA, and may be used to destroy the AFSAM 7 and other registered cipher equipments not normally provided with M1A1's. The M2A1 measures 10" x 1", weighs approximately 12 pounds, and can be detonated by either manual or electrical means.

3008. IGNITERS FOR M2A1 INCENDIARY (AN-M14).--Since igniters of many M2A1's now available are unreliable, two incendiary hand grenades (AN-M14) should be available for use in the event of ignition failure of the M2A1 during emergency destruction. The grenades should be requisitioned in accordance with Service procedures and utilized when necessary, in accordance with the instructions in Section 6300 of AFSAG 1200A.

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CHAPTER 3

PHYSICAL SECURITY

3000—GENERAL

3001. Custodian.—The custodian of AFSAM 7 and/or documents pertaining thereto shall be a commissioned or warrant officer except in situations where such assignment is impossible.

3002. Accounting.

a. In accounting for rotors, an account for a particular set shall include rotors as assembled, i. e., rotor set AB 1 8 shall include not only the numbered cores 1 through 8 but also the 7 notch rings issued with those cores.

b. Commands to whom bulk issue of material has been made will account to the appropriate issuing office for all material within the command according to current accounting procedures. For other commands, normal accounting will be required.

3003. Use and Transport in Aircraft.—Equipment and associated material for the AFSAM 7 may be used and transported in aircraft except that they may not be carried over communist or communist-controlled territory without specific authorization by the Chief of Staff, U. S. Army, Chief of Naval Operations, or Chief of Staff, U. S. Air Force.

3004. Other Physical Security Considerations.—The AFSAM 7 base cipher unit, rotor stepping unit, rotors, and other associated material will be given the maximum security possible under the circumstances to prevent unauthorized viewing and physical loss.

3005

~~3500~~. **Clearances.**—Cryptoclearance is not required for access to AFSAM 7, its component parts, or any associated POLLUX cryptomaterial. All personnel having access to the AFSAM 7 and its components will require clearance for information of at least a CONFIDENTIAL classification in accordance with Service instructions. CONFIDENTIAL clearance is required for access to SOI extracts. SECRET clearance is required for access to all other key lists.

3006. See opposite page

NOTE: It must be remembered that this additional information does not constitute permanent procedure. Permanent procedures for the destruction of rotors, AFSAM 107 and AFSAM 207 units, and the AFSAM 7 base by manual disassembly methods are being prepared and will be included in appropriate instructional documents.

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CHAPTER 4

4000—REPORTING VIOLATIONS

4001. General.—Violations of physical and cryptosecurity in POLLUX cryptosystems shall normally be reported by following the instructions in the effective edition of AFSAG 1210 or AFSAG 1211. *Only* when the effective edition of AFSAG 1210 or AFSAG 1211 is not held, violations shall be reported in accordance with the procedures below.

4002. Action by Reporting Stations.—When any of the violations listed in Section 4100 occur, the reporting station shall send a message report to the next higher headquarters holding the effective edition of AFSAG 1210 or AFSAG 1211 for action.

a. The message shall be classified CONFIDENTIAL.

b. The message shall be assigned a DEFERRED precedence unless it concerns a physical compromise or a violation involving faulty reencryption in which case the message shall be assigned a PRIORITY precedence.

c. Contents of message reports shall be as follows:

(1) State the nature of the violation.

(2) Include the short title and edition designator of the cryptomaterial involved.

(3) Include the date-time group, the means of transmission, the originator, and the addressee(s).

(4) List all reencryptions, retransmissions, and services involved. If there were none, state "NO LINKAGE."

(5) Give the length of the message(s) involved.

(6) In the case of physical compromise, briefly state the circumstances and indicate the probability of compromise by using one of the following statements: COMPROMISE CERTAIN, COMPROMISE PROBABLE, COMPROMISE IMPROBABLE, or COMPROMISE IMPOSSIBLE (as in known destruction by fire).

d. Send (by mail or courier) a copy of each message involved *exactly* as transmitted. Include copies of all services, reencryptions, and retransmissions involved. These copies shall be classified CONFIDENTIAL and shall be sent to the same headquarters as that to which the message report was sent.

4003. Action by Higher Headquarters on Receipt of Message Reports.

a. Refer to the effective edition of AFSAG 1210 or AFSAG 1211 and determine the specific type of report required. Forward such reports as directed in those documents.

b. If the reporting station did not include sufficient information to make a full report to the Director, National Security Agency, send an interim report and request the necessary amplification from the reporting station (or, if more appropriate, from the violating station).

c. On receipt of copies, forward them to the Director, National Security Agency, if the specific violation so requires.

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4100—SPECIFIC VIOLATIONS

4101. General. Reports of the violations below should contain, in addition to the specific information required in paragraph 4002*c*, all relevant information which can aid in the evaluation of the seriousness of the case. Violations to be reported are as follows:

a. *Any physical compromise.*

b. Failure to comply with any of the instructions pertaining to selection and use of message indicators (par. 2004). State the circumstances. For example, if a message indicator was re-used, state how many times, and for what purpose. If the message indicator was nonrandom, what was used—a bona fide word? Was an alignment used which was reached by the rotors during any phase of operation?

c. Faulty rotor stepping. (Do not use the machine until it has been repaired if more than one faulty step is observed.) If the rotors did not move at all, monoalphabetic substitution may have resulted and all addressees must be informed that the message must be considered compromised and that it shall not be serviced.

d. Transmission in the clear of any alignment reached by the rotors during any phase of operation.

e. Transmission of a message or cryptopart containing more than 350 groups. (State the number of groups the message contained.)

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CHAPTER 5

MAINTENANCE INSTRUCTIONS FOR INTERMEDIATE REPAIR FACILITIES

5000—PREPARATION FOR USE

5001. General.—The instructions in this chapter are presented primarily for the use of personnel who have had no formal training in the maintenance of the AFSAM 7. If followed, the procedures outlined below will enable untrained personnel to perform emergency repairs on the equipment by substituting component assemblies. Instructions on preventive maintenance and cleaning are also included.

5002. Storage.— When not in use, store the AFSAM 7 in its carrying case (fig. 1). This will protect it and keep it clean.

5003. Unpacking the Equipment.—Use the following procedure to unpack the AFSAM 7:

a. Place the carrying case right side up and remove the metal shipping band.

b. Unfasten the six cover holding latches (fig. 1(1)), and remove the cover by raising it vertically.

c. Tip the case downward to the operating position (fig. 1). Place the cover on top of the carrying case, with the copy holder uppermost.

5004. Initial Inspection.—Inspect the AFSAM 7 and its accessories for any signs of damage or omissions as soon as it is unpacked. All cases of damage during shipment, or failure of the cipher machine to operate in accordance with the test given in paragraph 5006 should be reported in detail to the office of issue through normal Service channels.

5005. Installation Procedure.—Following the initial inspection of the equipment, the AFSAM 7 is to be prepared for operation in the following manner:

a. Cleaning Rotors.—Thoroughly clean the surfaces of the flat head contacts of the rotors (fig. 4(2)) with a dry, rough, lint-free cloth. Clean the rotor pressure contacts (fig. 4(6)) by polishing them with the canvas cleaning block assembly (fig. 6(6)).

(1) Put a small amount of Lubriplate #105 (fig. 6(4)) on a piece of Twilljean (fig. 6(2)) or any other lint-free cloth. Fold the cloth, and rub it gently between the fingers so as to work the lubricant into the fabric.

(2) Wrap the cloth around the end of a finger and rub the cloth lightly over the surface of the rotor flat head contacts (fig 4(2)).

(3) No definite time schedule is established for relubrication of the rotors since it is dependent on operating conditions. However, when the rotors become dirty or dry, repeat the cleaning and lubricating procedures.

(4) Do not use chemicals to clean the rotors or any other plastic parts. They might have an injurious effect on the material.

b. Placement of Rotors.—The rotors (fig. 5(2) and (19)) are placed in the cipher unit assembly shell (fig. 4(13)) so that when the cipher unit is completely assembled, the rotor pressure contacts face toward the right-hand end plate assembly (fig. 5(18)).

Note: See paragraph 5203 for instructions regarding the removal and replacement of the cipher unit.

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(1) Place the first three rotors on the shaft in their proper sequence (see par. 2001), and slide them into the shell.

(2) Next, place the stationary rotor (fig. 5(2)) on the shaft, and position it so as to align its tabs with the two machined keyways in the shell. One of these keyways is of greater width, insuring proper alignment.

(3) Place the remaining four rotors on the shaft in their proper sequence, and slide them into the shell. The last rotor will have a tendency to remain outside the shell.

(4) Place the right-hand end plate assembly on the shaft, and compress the rotors into the shell until the right-hand end plate latch (fig. 5(3)) can be engaged in the machined groove on the rotor shaft, thus locking the rotors within the shell.

(5) The end plate assemblies of the cipher unit extend through the stepping unit and make connection with pressure contacts (fig. 5(8)) on the contact panel. *Take care that these contacts and the end plate assemblies are not damaged during removal or installation of the cipher unit.*

(6) Replace the cipher unit.

c. *Installation of Typewriter Ribbon.*—The typewriter ribbon is contained on two metal ribbon spools (fig. 2(10)). It is fed down and around the figured wheel (fig. 1(9)) in the ribbon track. Initial installation of the ribbon may differ in appearance from the normal operating trackage because of the direction in which the ribbon is wound during manufacture. The driving action of the mechanism is such that both spools rotate counterclockwise. The ribbon reversing mechanism is so designed that after the ribbon has once been completely unwound from the new metal spool, the normal route of the ribbon will be assumed automatically. The ribbon is normally unwound from the top right of the left-hand spool, and travels down around the ribbon track and up to the top right of the right-hand spool. The new ribbon is installed in the following manner:

(1) Raise the latches of the two ribbon spools and withdraw the spools from the shafts of the reel drive plates. Disconnect the ribbon from the empty spool.

(2) Unwind approximately 8 inches of ribbon from the new full spool, and attach this spool to the left reel drive plate.

(3) Attach the free end of the ribbon to the empty metal spool. The ribbon should be threaded onto this spool from the top right. Make sure that the free end of the ribbon is passed through the hub of the spool and up onto the serrated teeth which should pierce the ribbon. In this manner, the pull of the ribbon is constantly against the serrated teeth, and will not loosen when the end of the ribbon is reached and the direction of travel reversed. Attach the empty spool to the right reel drive plate.

(4) Rewind any excess slack in the ribbon onto the free-running spool.

d. *Installation of Paper Tape.*—The roll of paper tape is housed in the paper tape container (fig. 1(10)) at the right side of the printer assembly. It is positioned under the figured wheel by means of a guide block and paper tape guide. The roll of paper tape is installed in the following manner:

(1) Release the spring hood assembly by turning the swivel pin assembly 90 degrees (fig. 3(18)). Restrict the upward travel of the spring hood with the right hand.

(2) Flatten the roll of tape by tapping it against the carrying case or any other suitable flat object.

(3) Tear off the first wrap of tape and discard it. Unroll approximately 1 foot of tape.

(4) Place the roll of tape between the sides of the paper tape container. The end of the tape should come off the bottom of the roll with the gummed side up.

(5) Depress the roll of tape into the paper tape container, and secure the spring hood assembly by means of the swivel pin assembly.

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(6) Form the free end of the tape around the guide block of the paper tape container, and pull the tape until it is taut and extends past the paper tape feed roll (fig. 2(8)).

(7) Hold the tape around the guide block and thread the end of the tape through the paper tape guide, with the gummed side of the tape down.

(8) Push inward against the feed roll follower assembly (fig. 2(9)), and slide the tape between the paper tape feed roll (fig. 2(8)) and the feed roll follower. Release the feed roll follower assembly, allowing it to ride on top of the paper tape feed roll, holding the tape in place.

(9) Check the tape to see that it is smooth and unwrinkled. Push inward against the feed roll follower assembly, and take up any slack in the tape. Release the feed roll follower assembly and tear off the excess tape by grasping the loose end and pulling upward and outward with a sharp motion.

e. *Connecting Power Supply.*—The AFSAM 7 is designed to operate from a voltage supply of 21 to 31 volts DC. The source of power must be checked to see that it is capable of supplying power within the specified limits. After checking the power, connect the AFSAM 7 to the power source by means of the power cable. See paragraph 5108. The current consumption of the AFSAM 7 is 2.5 amperes.

5006. Test Procedure.—The following test procedure is to be used in the initial set-up of the equipment, to check the operation of the AFSAM 7 following any prolonged period of time during which the cipher machine has not been operated, and also for the diagnosis of trouble in the equipment. While not infallible, it will, in the majority of cases, localize trouble to major components. The test is designed to check the cipher machine—not particular keying elements. The test sequence listed below must be followed, or the trouble chart in paragraph 5301 will not apply. The procedure is arranged so that once a component has been checked for proper operation it may be eliminated as a possible source of trouble in any subsequent test steps. During the test, as during the normal operation of the cipher machine, typing at speeds in excess of 60 words per minute will result in malfunctioning of the equipment and the dropping of characters in the reproduced text. In the event that improper results are obtained during any of the following test steps, refer to paragraph 5301 for the appropriate trouble-shooting procedures.

a. *Plain Text.*—With the external power supply connected to the AFSAM 7, turn the selector handle (fig. 3(13)) from the O (off) to the P (plain) position. The motor generator will start and run continuously, and the figured wheel will rotate in a clockwise direction as viewed from the front. Wait approximately 15 seconds for the tubes to warm up.

* (1) Depress the FIG key. The neon glow lamp (fig. 5(9)) should light.

(2) Depress the LET key. The glow lamp should go out.

(3) Set the counter (fig. 3(9)) to zero.

(4) Type the following test sentence: THE 236TH QUICK RED FOX JUMPED 780 TIMES OVER 1459 LAZY BROWN DOGS. The reproduction on the paper tape should be the same, and the counter should register 66.

(5) Mark this part of the paper tape "#1."

(6) Depress the X key and then the RPT key. The machine should print a continuous line of X's in a rhythmical manner. There should be no blank character spaces between the X's.

(7) Depress one of the seven set keys (fig. 2(5)).

(a) Hold the set key depressed. Its associated rotor should step continuously, in a rhythmical manner.

(b) Momentarily depress and release the set key. The associated rotor should step one position only.

(c) Repeat steps (a) and (b) above until the rotor has completed three revolutions.

(8) Repeat the steps in subparagraph (7) above for each of the six remaining set keys.

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b. Encipher.

(1) With the selector handle in the P position, set the seven rotors to A by means of their respective set keys.

(2) Turn the selector handle from the P to the E (encipher) position.

(a) The cipher machine should cycle once.

(b) The paper tape mechanism should feed the paper tape one space.

(c) There should be no printing on the paper tape.

(d) At least three of the rotors should step one position.

(3) Set the counter to zero.

(4) Depress the X key and then the RPT key, and hold them depressed until the counter registers 1000. The cipher machine should print 200 groups of 5 letters each.

(5) Mark this part of the paper tape "#2."

(6) Note the reading of the seven rotors with reference to the cipher unit index marks on the shell (fig. 1(4)). Record the reading on the end of tape #2.

(7) Turn the selector handle from the E to the P position. The machine should cycle once.

(8) Repeat steps (1) through (4) above.

(9) Mark this part of the paper tape "#3."

(10) Compare the reading of the seven rotors with that obtained in step (6) above. They should be identical.

(11) Compare paper tapes #2 and #3. They should be identical.

(12) Turn the selector handle from the E to the P position.

(13) Repeat steps (1) through (3) above.

(14) Type the sample sentence given in subparagraph a (4) above. The cipher machine should print fourteen 5-letter groups with a group of 2 letters at the end. The glow lamp should light each of the three times the FIG key is depressed, and go out each time the LET key is depressed. The counter should register 72.

(15) Mark this part of the paper tape "#4."

c. Decipher.

(1) Turn the selector handle from the E to the P position.

(2) Repeat steps (1) through (3) in subparagraph *b* above, except that in step (2) turn the selector handle from the P to the D (decipher) position.

(3) Type the enciphered version of the test sentence as reproduced on the part of paper tape marked "#4." The glow lamp should go on and off three times during the typing. The cipher machine should reproduce the test sentence in subparagraph (4) below.

Note: "-" indicates one space.

(4) THE-236-TH-QUICK-RED-FOX-YUMPED--780--TIMES-OVER--1459--LAXY-BROWN-DOGS.

(5) The counter should register 72.

Note: The space bar will not operate in decipher.

d. Conclusions.—The test procedure above determines that the cipher machine is operating correctly.

5007. Operation of AFSAM 7 in the Office Case.—The operation of the AFSAM 7 in its office case (fig. 2) is essentially the same as operation in the carrying case. Subparagraphs 5201*a*(1) and *b*(2) contain instructions on the removal of the AFSAM 7 from its carrying case and installation of the machine in the office case. After the machine is secured in the office case, perform the test procedure given in paragraph 5006.

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5008. Errors in Reproduction.—The two classes of errors which may cause the cipher machine to function incorrectly are operational and functional.

a. Operational Errors.—Operational errors are due to mistakes made by the operator in either setting up or operating the equipment. They can be largely eliminated by the use of proper care on the part of the operator.

b. Functional Errors. Functional errors consist principally of troubles due to maladjustments, dirty contacts, short or open circuits, or power failures. If the operator cannot correct the functional errors by component assembly replacement, the equipment should be sent through normal Service channels to a higher echelon for the necessary repairs. Rotors should be cleaned and lubricated in accordance with the instructions in subparagraph 5005*a* before being used.

5009. Transporting AFSAM 7 On Packboard.—The AFSAM 7 in its carrying case is easily transported on the standard packboard. To lash the unit to the packboard, follow the instructions outlined below.

a. Be sure that the canvas on the packboard is tight, and adjust the shoulder straps so as to keep the load high and comfortable.

b. Lay the packboard on the ground with the shoulder straps down and remove the lashing rope from the board.
NOTE: The lashing rope is normally used to secure the AFSAM 7 carrying case to the packboard. However, if rope is not available, field wire or any other field expedient may be used.

c. Slide the AFSAM 7 completely into the carrying case, place the cover in position, and fasten the six cover holding catches.

d. Lay the carrying case on its side on the upper portion of the packboard in such position that it will be carried upright with the carrying case handle folded away from the packboard (see fig. 7).
NOTE: It is important that the case be positioned on the packboard as outlined above so as to provide even distribution of the load.

e. Lash the carrying case to the packboard, weaving the rope back and forth and diagonally across the board. No detailed method of lashing is given here since there are numerous methods. Pull the lashing rope as tight as possible to prevent any shifting of the case. Use knots which are easy to untie.
CAUTION: Do not drop the loaded packboard to the ground.

f. Wind the lashing rope around the leg of the board when not in use.

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5100—COMPONENT ASSEMBLIES

5101. Cipher Machine.—The AFSAM 7 is composed essentially of the following assemblies: a base, keyboard with the sliding contact board and guide rail, contact panel, printer, stepping unit, and cipher unit.

5102. Base Assembly.—The magnesium base assembly (fig. 5(12)) forms a supporting frame on which the other components of the cipher machine are mounted. Tracks machined along its four sides, and two attached brackets provide shock mounting within the carrying case. Pads and inserts are positioned throughout the base to provide the means of locating, fastening, and supporting the other components. The tracks at the front corners engage a double set of shock mounts in the carrying case, providing maximum support at these points. Four inserts in the corners provide for mounting the base within an office case. A spring-loaded stop pin projects through the bottom of the case. When the cipher machine is drawn forward in the carrying case, the spring-loaded stop pin engages the slot in the carrying case spring stop. This limits the cipher machine to its operating position, and prevents unintentional withdrawal. Depression of the spring stop allows full removal of the cipher machine.

5103. Keyboard Assembly.—The keyboard assembly (fig. 3(12)) is located at the front of the cipher machine, and is removable as a unit. It functions as a typing keyboard, and, in conjunction with a sliding contact board assembly, establishes the various circuits of the cipher machine. The keyboard assembly is mounted directly on the contact panel assembly (fig. 5(11)), and is therefore insulated from the base of the cipher machine. A power cable and cover plate assembly (fig. 1(7) and 3(11)) and two fuse holder assemblies (fig. 3(10)) located at the right end of the keyboard assembly provide the means of introducing electrical power to run the cipher machine. The sliding contact board and guide rail assembly (fig. 4(3)) lies directly below the keyboard assembly, above the forward area of the contact panel assembly. It functions as a four-position, multicircuit switching device, and, as far as this publication is concerned, will be discussed as part of the keyboard assembly.

5104. Contact Panel Assembly.—The contact panel assembly (fig. 5(11)) is attached directly to the cipher machine base. It provides the interunit wiring of the cipher machine, contains the fixed contacts that establish the interunit connections, carries the various electrical circuit components, and is the mounting base to which the keyboard is secured.

5105. Printer Assembly.—The printer assembly (fig. 3(19) and 4(7)) is mounted on the left side of the base assembly by means of four captive mounting screws, and is removable as a unit. It provides the mechanical power for the cipher machine, the high voltage used in the electronic circuits, and the precisely-timed electrical pulses which initiate the printing of characters on a paper tape. It also provides automatic opening and closing of predetermined circuits at the proper times, and automatically spaces the paper tape and the inked ribbon.

5106. Stepping Unit Assembly. The stepping unit assembly (fig. 3(5) and 4(15)) is mounted at the right center of the cipher machine, and is removable as a unit. It also may be removed with the cipher unit attached. It automatically steps the rotors of the cipher unit in a definite pattern during encipherment and decipherment, and provides a means of stepping rotors individually by means of the rotor set keys. A counter mounted on the front of the rotor stepping unit records each cycle made by the cipher machine.

5107. Cipher Unit Assembly.—The cipher unit assembly (fig. 2(3) and 3(7)) is attached to the stepping unit by means of the right- and left-hand cipher unit latches (fig. 2(4)) which engage the rotor shaft. It provides the means for enciphering characters in a definite but unrecognizable pattern by means of eight (seven movable and one stationary) rotors which are housed within the unit. Since there is a definite pattern to the enciphered version, the cipher unit assembly also provides the means for deciphering characters in the same sequence.

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5108. AC Power Converter Assembly.—The AC power converter assembly (fig. 1(6) and 3(3)) is designed to supply 21 to 31 volts DC for operation of the AFSAM 7. The power converter selector switch, located on top of the power converter (fig. 3(4)) may be set to allow operation of the converter using either a 100–125 or a 200–250-volt, 50–60-cycle, AC input power source. One side of the input to the power converter is fused to prevent injury to the circuits by accidental connection to a 200–250-volt power source when the selector switch is set for 100–125 volts. The other fuse holder on the converter contains a spare fuse (fig. 3(2)). The current consumption of the AFSAM 7 is 2.5 amperes.

5109. Carrying Case Assembly.—The carrying case assembly (fig. 1(11)) is designed so that the cipher machine may be operated while partially within the case. It provides a shock- and water-resistant container for transporting the cipher machine either by hand or on a standard pack board. Fittings within the case provide a copy holder (fig. 1(2)), and storage for the operating light, cable, additional paper tape (fig. 1(3)), and spare typewriter ribbons.

5110. Accessories and Case Assembly.—The accessories and case assembly resembles the carrying case in outward appearance. However, it is equipped with interior fittings for storage of accessory and spare equipment for the AFSAM 7. The contents of the accessories case vary with the installation where it is employed. The fully equipped accessories case normally contains the following equipment: a base assembly on which the various components are mounted and in which is a drawer, an AC power converter assembly, a stepping unit assembly, and two cipher unit assemblies.

5111. Office Case Assembly.—The office case assembly (fig. 2) provides a means of storing and transporting the AFSAM 7 under office conditions where the risk of damage from blows or exposure is less than under field conditions. The case is made of aluminum and does not contain sealing gaskets or shock mounts. The AC power converter assembly (see par. 5108) is mounted inside the case, at the rear, with an attached cable for connecting to a standard AC receptacle. The power cable for the cipher machine attaches to the converter inside the case. The double-hinged cover (fig. 2(2)) folds back to provide a rack for holding copy (fig. 2(1)).