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CDC 36350

COMMUNICATIONS AND RELAY CENTER EQUIPMENT REPAIRMAN, ELECTROMECHANICAL

(AFSC 36350)

Volume 1

Principles of Operation of the AN/FGC–20 and AN/FGC–25 Teletypewriter Sets

Extension Course Institute

Air University

PREPARED BY
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THIS PUBLICATION HAS BEEN REVIEWED AND APPROVED BY COMPETENT PERSONNEL OF THE PREPARING COMMAND IN ACCORDANCE WITH CURRENT DIRECTIVES ON DOCTRINE, POLICY, ESSENTIALITY, PROPRIETY, AND QUALITY.

Preface

EVERYBODY in the Air Force should know by now that OJT stands for on-the-job training. The program has been a mainstay of airman career development for years. In order to meet the ever-increasing training needs of the Air Force, Air Training Command has developed a method for accelerating the program. Part of the new plan is the career development course (CDC). They are off-duty study packages, and the whole new concept is called dual-channel OJT.

The dual-channel concept is an interesting approach to on-the-job training. During duty hours, supervised instruction is directed toward increasing your skill in maintaining the actual communications equipment located at your duty station. In addition to this, you are required to devote a portion of your off-duty time to self-study to improve your performance as a communications and relay center equipment repairman. We are all well aware that one station cannot contain all the equipment specified in your job description. Therefore, this CDC is designed to keep you in touch with various types of equipment for which you are or will be responsible. Keep in mind that this responsibility exists even though you have had little or no opportunity to gain experience on specific units of equipment before you have been assigned to maintain them.

Until the adoption of the dual-channel OJT, an airman had to pass a specialty knowledge test that covered his entire career area and often included questions only remotely related to his specialty.

Undr the new program, the SKT you will take for promotion points is based on the material provided in the volumes of this CDC. Some portions of this CDC provide only a review to refresh your memory, while other parts introduce new equipment just coming into the field.

All in all, every effort has been made to furnish you with the information that fulfills the career field knowledge requirements for AFSC 36350.

We have divided the course into four basic portions. Volume 1 introduces you to the AUTODIN concept and where your place may be in the system, and then continues with an explanation of the underlying theory, the sequences of operation, and the electrical circuits of the Kleinschmidt equipment. Volume 2 explains the Teletype Corporation Model–28 equipment, while Volume 3 covers some of the more exotic types of communications equipment, such as the M–37, "Mighty Mite" and telautograph units. Volume 4 outlines principles and procedures essential for preventive and corrective maintenance of communications equipment and includes such subjects as maintenance management, supply, security, and safety as they apply to your specialty, as well as the operating principles of the multimeter and various other types of test equipment.

In addition to the six chapters of text material, this volume contains an appendix showing the component designations used with the various modes of an AN/FGC–25. Foldouts 1, 2, 3, and 4 are schematics that appear in this volume immediately after the appendix.

If you have questions concerning the accuracy or currency of the subject matter of this text, or recommendations for its improvement, send them to Tech Tng Cen (TTOC), Sheppard AFB TX 76311.

If you have questions on course enrollment or administration, or any of ECI's instructional aids (Your Key to Career Development, Study Reference Guides, Chapter Review Exercises, Volume Review Exercise, and Course Examination), consult your education officer, training officer, or NCO, as appropriate. If he can't answer your questions, send them to ECI, Gunter AFB, AL 36118, preferably on ECI Form 17, Student Request for Assistance.

This volume is valued at 45 hours (15 points).

Material in this volume is technically accurate, adequate, and current as of January 1973.

Contents

CHAPTER 1

Principles of Operation of the AN/FGC-20 Keyboard

OUR SPACE AGE has placed new and exacting demands upon the field of communications. Never before has such a burden of responsibility rested upon the shoulders of the communications technician (YOU).

2. The rapid changes that are taking place in all branches of the communications area make it increasingly difficult to place any limits on any communications career field. However, for the purpose of this course and to support our efforts to pinpoint your position, let us limit our discussion to the present scope of the Wire Maintenance Career Field.

1. The Wire Maintenance Career Field

1-1. The development of communications has received its greatest stimulus from modern warfare. The reason for this is clear. A commander's control over his military force depends directly upon reliable communications. The better the communications, the better the control. From this, you can see the importance of the Wire Maintenance Career Field, for without the specialties which it contains it would be difficult, if not impossible, for any reliable worldwide network of communications to exist. Of course, the military service uses the vast commercial systems in existence as well as the highly trained civilian specialists in the field, but many of the most important links are installed and most of the communications equipment is maintained by service technicians.

1-2. At present, the Wire Maintenance Career Field is divided into two major areas: Outside Wire Maintenance and Inside Plant Maintenance (see fig. 1). The Outside Wire area includes three specialties and the Inside Plant area includes five specialties. This gives us a total of eight specialties in the Wire Maintenance Career Field. You will recall from your study of the "general subjects" that each specialty has five skill levels coded 1, 3, 5, 7 and 9. The code 1 identifies the helper level; code 3 identifies the apprentice; code 5 identifies the skilled level (journeyman); code 7 identifies the supervisor; and code 9 identifies the superintendent. As an airman acquires more knowledge and advances to the next higher skill level, he is said to be climbing his career ladder.

1-3. By organizing the career field and its specialties in this way, the Air Force gives you an opportunity to move up and to produce at your highest capability. It is possible for you to progress from basic airman to chief master sergeant (superintendent) without leaving your specialty. This, of course, demands interest, initiative, and reliability, in addition to a high degree of proficiency in your specialty. The avenue is open, the means are at hand—but the DOING is up to YOU. The first requirement is to "know your job and your equipment." So let's begin with a discussion of your duties and responsibilities.

1-4. **Your Duties and Responsibilities.** Your specialty description lists your duties and responsibilities. Since your specialty is your job in the Air Force, the specialty description is often called a job description. As the name implies, the specialty description lists all the tasks which make up your complete job. For your convenience and study, we will list the various tasks included in your specialty description later in this section. There are, however, several comments that we should make before we get to your specialty description. First, every specialty in the Air Force is covered by a specialty description. (These descriptions are found in Air Force Manual 39–1.) Next, the tasks or operations listed in your specialty description are the very tasks you will perform on the job. Because of the difference in your various assignments, you will not perform some of these tasks as often as you will some of the others, and there are some tasks (such as assembling new equipment) that you may not perform at all during your entire stay in a particular assignment. But you are responsible for all of these tasks when you reach the 5 proficiency level.

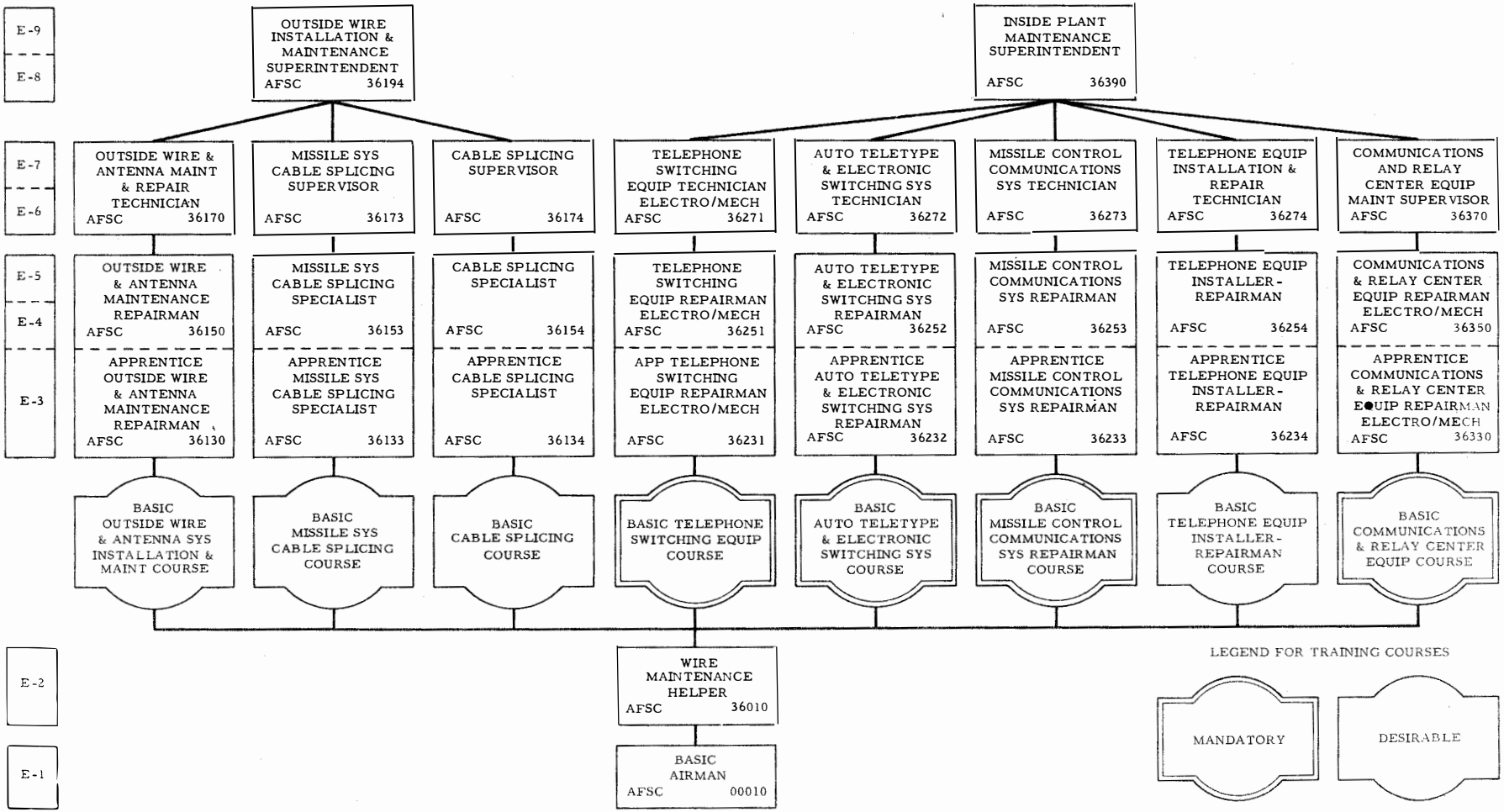

Figure 1. Wire Maintenance Career Field.

1-5. Furthermore, none of the switching centers to which you may be assigned has all the equipment you studied while you attended the resident course. In most cases, when you are transferred to a new location, the equipment is not the same as you had at the old location. Thus, if you expect to meet your responsibilities, it means burning a little midnight oil. For example, one of the tasks in your specialty description states that you will "perform operational tests on (communications) machines." Now everyone knows that to make an operational test of any piece of teletypewriter equipment requires a good working knowledge of that machine. As the man says, "You must know every part by its first name." In short, moving to a new station means study. This is one place where this course will help you. It provides the information for a good "brushup" whenever you are suddenly placed into an unfamiliar area.

1-6. Space does not permit a discussion of each task that has been extracted from your specialty description, but we do make two suggestions. First, study the list from time to time so that you have a good overall picture of your job. Second, while studying the tasks, check your progress. Count the tasks with which you are fully familiar; then study the items in which you need improvement.

1-7. The duties and responsibilities of a repairman with this specialty are listed in four areas:

(1) He must install and test teletypewriter, telautograph communications, and cryptographic machines. Prepare for installation of equipment. Draw positioning marks for placing and mounting of equipment on floors and walls in accordance with plans, diagrams, and specifications. Unload and unpack equipment. Assemble knocked-down components in accordance with specifications. Position and secure complete assemblies. Test power source and connect machine to system. Perform operational tests on machines. Observe functioning of equipment and make required adjustments by securing mechanisms, adjusting spring tensions, and setting clearances. Use finely calibrated scales, gages, calipers, micrometers, and various electrical testing devices to make adjustments and measurements.

(2) He must maintain communications and cryptographic machines and their components. Perform detailed inspections at periodic intervals or when a malfunction is reported by operating personnel. Remove or expose components for inspection and cleaning. Examine equipment for loose, broken, worn, or damaged parts. Conduct electrical and mechanical operational tests of individual components and assemblies and observe functioning of visible parts. Examine for serviceability those parts subject to wear. Trace wire circuits by referring to wiring diagrams. Examine electrical parts for shorts, grounds, and open circuits. Service and lubricate parts. Maintain maintenance records.

(3) He must repair and rebuild cryptographic, telautograph, and teletype machines and their components. Perform major repair when adjustment is not sufficient. Obtain replacement parts or improvise by manufacture or substitution where parts are not readily obtainable. Remove and replace damaged or worn parts, reassemble components, and test reassembled unit for proper functioning. Prepare and maintain preventive maintenance schedules and records.

(4) He must supervise all cryptographic, teletypewriter, and telautograph maintenance personnel. Oversee work in progress, checking for adherence to sound work practices. Examine completed work for completeness of repair and proper functioning. Assign personnel to shifts or teams when perfoming as shift chief. Evaluate individual performance of duty and recommend or conduct on-the-job training.

1-8. Now, turn your attention to communications systems and some of the equipment that you may have to maintain.

1-19. **System Operation.** In the past, it has been customary to approach a subject such as this with a look at the history of communication and how teletypewriter equipment evolved to its present state. Because you are well-acquainted with the background of your equipment, turn and look ahead to what the future has in store for this area of fixed wire communications. Right now, a communications network is being phased in which is certain to have its effect on terminal stations such as the one to which you are presently assigned. This system is the AUTOmatic DIgital Network (AUTODIN). AUTODIN is a computer-controlled, high-speed, secure, flexible network which, when fully operational, will switch millions of messages daily to worldwide destinations. It can do this with minimum delay and maximum security because of its specific composition and mode of operation.

1-10. The AUTODIN system derives its versatility from the use of such equipment and techniques as solid-state switching, store and forward message processing principles, automatic error detection, and programed traffic control. Automatic digital message switching centers are replacing the automatic and electromechanical teletypewriter switches and now handle most of the general-purpose traffic. The system can switch

normal teletype messages to and from subscribers at a 75-baud (100 word per minute) rate, using the familiar start-stop 5-unit code. On the other hand, its present top speed is 2400 baud (3000 word per minute) to a special page printer or 200 cards per minute for high-speed data switching. The equipment at the switching centers is capable of increasing the transmission rate to 4800 baud, if at some future time the facilities are available and there is a need for this speed. This, then, is a brief introduction to the capabilities of the switching system as a whole. You, of course, are more interested in the terminal stations because that is where you fit into the picture.

1-11 **Digital Subscriber Terminal Equipment Operation (DSTE).** When the DSTE installations are equipped and in operation, they contain a variety of components, according to message volume and site requirements.

1-12. *Common control unit (CCU).* The CCU is the unit that provides the automatic control for message processing and the interface between the input/output units and the circuits to the switching center. It is designed for duplex operation and can be connected to two input and two output devices, accepting traffic on an alternate basis.

1-13. *Paper tape reader (PTR) and punch (PTP).* The PTR can read from either an 8-bit or a 5-bit tape (with minor changes) and transmit the information into the AUTODIN system (via the CCU). The PTR can operate at 150, 300, 600, and 1200 baud.

1-14. The high-speed paper tape punch is intended as a receiver or monitor and can also operate at the speeds shown for the PTR. A low-speed punch (receive only) operates at a 150-baud rate. It can also be used to cut tape.

1-15. *Card reader (CR) and punch (CP).* Only one type of card reader is to be used in subscriber terminals and manual card relay centers. This unit can operate at the speeds of the PTR. The high-speed card punch is intended for use as a receiving or monitoring device at speeds of up to 1200 baud. The low-speed unit, operating at 150 or 300 baud, can receive, monitor, or prepare cards for transmission.

1-16. *Universal keyboard (UK).* The UK is designed to be used as an off-line unit for preparing paper tapes and punched cards. It can do this in both the 8-bit and 5-bit codes through the use of an off-line tape or card puncher.

1-17. *Page printer (PP).* The PP is a monitor device but can be used as an output device to produce hard copy. As a monitor, it can be connected to the CCU to allow monitoring either send or receive traffic. The PP prints in 80-character lines at rates produced by continuous standard modulation rates of 150, 300, 600, 1200, and 2400 baud when it is connected to the CCU.

1-18. This gives you an idea of the DSTE equipment that is found in some, not all, terminal stations in the system. Some stations do not handle enough traffic to warrant this type of equipment. They may be equipped with regular teletypewriter equipment and a teletypewriter control unit (TCU), which acts as the interface between the network and the teletypewriter equipment. Other stations, with even less traffic, feed into teletype concentrator stations, which, in turn, transmit the traffic into the AUTODIN network. If you've had visions of putting the key in the lock and closing up your station and going home—forget it! As you can see, your terminal may be in business for a long, long time to come.

1-19. Let us review the operating principles of the teletypewriter equipment you may be maintaining now as well as some equipment that is totally unfamiliar to you but is part of your job responsibility. We will begin with the AN/FGC–20.

2. Introduction to the AN/FGC–20 Teletypewriter

2-1. Having discussed the operation of AUTODIN, we should remind you that this is the general-purpose digital network of the Defense Communications System (DCS) designed to meet Department of Defense (DOD) long haul requirements. In addition to this network, the individual commands have their own teletypewriter systems, which are designed and engineered to meet their specific requirements. Here, the teletypewriter in one form or another is the mainstay of the system and therefore cannot be disregarded.

2-2. The teletypewriter is an integral and extremely important link in the Air Force communications system. Although this machine cannot replace other mediums of communications, neither can it be completely replaced by other systems. It can be used in conjunction with fixed-wire lines for transmission of messages from one station to another. It can be used in conjunction with radio to transmit messages across large bodies of land and water. Finally, it can be used for transmission of information between ground stations and airborne vehicles, between ship and shore stations, and between ships or between planes.

2-3. The natural question is, "Why should we use the teletypewriter when we have radio, telephone, television, or facsimile?" A quick analysis will show you that the teletypewriter has cer-

TABLE 1
MODIFICATIONS

Item	AN/FGC-20X		AN/FGC-20	AN/FGC-21	AN/FGC-20X	AN/FGC-20	AN/FGC-20X, AN/UGC-4	AN/FGC-20	AN/FFC-20 Receive only
	TT-98/FG	TT-98A/FG	TT-100/FG	TT-99/FG	TT-98B/FG	TT-100B/FG	TT-98B/FG	TT-100B/FG	TT-259/FG
Type of Printed Symbol	Standard	Standard	Standard	Weather	Standard	Standard	Standard	Standard	Standard
Motor	Series-governed	Series-governed	Synchro	Synchro	Series-governed	Synchro	Series-governed	Synchro	Synchro
Terminal and switch box	Contains circuitry and components (J11, S8, R8, and R11) for use with a polar relay	Does not contain circuitry and components (J11, S8, R8, and R11) for use with a polar relay	Same as TT-98A/FG	Same as TT-98A/FG	Same as TT-98A/FG	Same as TT-98A/FG	Same as TT-98A/FG	Same as TT-98A/FG	Same as TT-98A/FG
Carriage lock	A locking arm engages a locking stud	Same as TT-98/FG	Same as TT-98/FG	Same as TT-98/FG	A blocking plate engages carraige return driving gear	Same as TT-98B/FG	Same as TT-98B/FG	Same as TT-98B/FG	Same as TT-98B/FG
Repeat blocking lever	Not Adjustable	Not Adjustable	Not Adjustable	Not Adjustable	Not Adjustable	Not Adjustable	Adjustable	Adjustable	None
Friction clutch adjusting collars	Threaded (ID) split-ring adjusting collar	Same as TT-98/FG	Same as TT-98/FG	Same as TT-98/FG	Threaded (ID) split-block adjusting collar	Same as TT-98B/FG	Same as TT-98B/FG	Same as TT-98B/FG	Same as TT-98B/FG

tain advantages over the other types of communications. For example, it produces for the record a typewritten copy in which human error is reduced to a minimum. Again, it produces a copy of material in code form that can be retransmitted without any retyping or rewriting of the message. Furthermore, the use of the teletypewriter in cryptography alone justifies the millions of dollars that have been spent on the development of this machine. (We can be proud of the fact that, as far as we know, the cryptographic messages of the United States have yet to be successfully decoded by foreign agents.)

2-4. Since it is used worldwide, it is only logical that teletypewriter equipment be designed to perform many different jobs. Which teletypewriter should be used at a particular station or on a particular circuit depends upon the kind of copy desired at that station or on that circuit. It is quite obvious, then, that you must be thoroughly familiar with the various units and their capabilities before you can provide the proper hookups, or are able to select the proper equipment for a station.

2-5. One version of the teletypewriter now used by the Air Force is the AN/FGC–20 with its modifications. We have selected this unit of standard teletypewriter equipment as a typical model to introduce other types because of its relative simplicity. This machine illustrates many of the basic mechanical and electrical principles used in teletypewriter equipment.

2-6. This set is specifically designed for high-speed operation, having a normal operating speed of 100 words per minute (w.p.m.). It may, however, be modified to operate at 60, 66, and 75 w.p.m.

2-7. **Modifications.** Modifications in the basic machine have been made in order to allow for the different types of operation that it may be called upon to perform throughout the world. These changes in the basic AN/FGC–20 have been made at the factory and satisfactorily meet a majority of different requirements, such as operating on different power sources and operating in conjunction with foreign equipment.

2-8. The modifications currently in use are shown in table 1. Note the minor differences between models listed in the first column. Thus, an AN/FGC–20X may be any one of four different models, with only minor changes—in circuitry and the carriage lock, the repeat-blocking lever, or friction clutch adjusting collars—distinguishing them from one another. In addition,

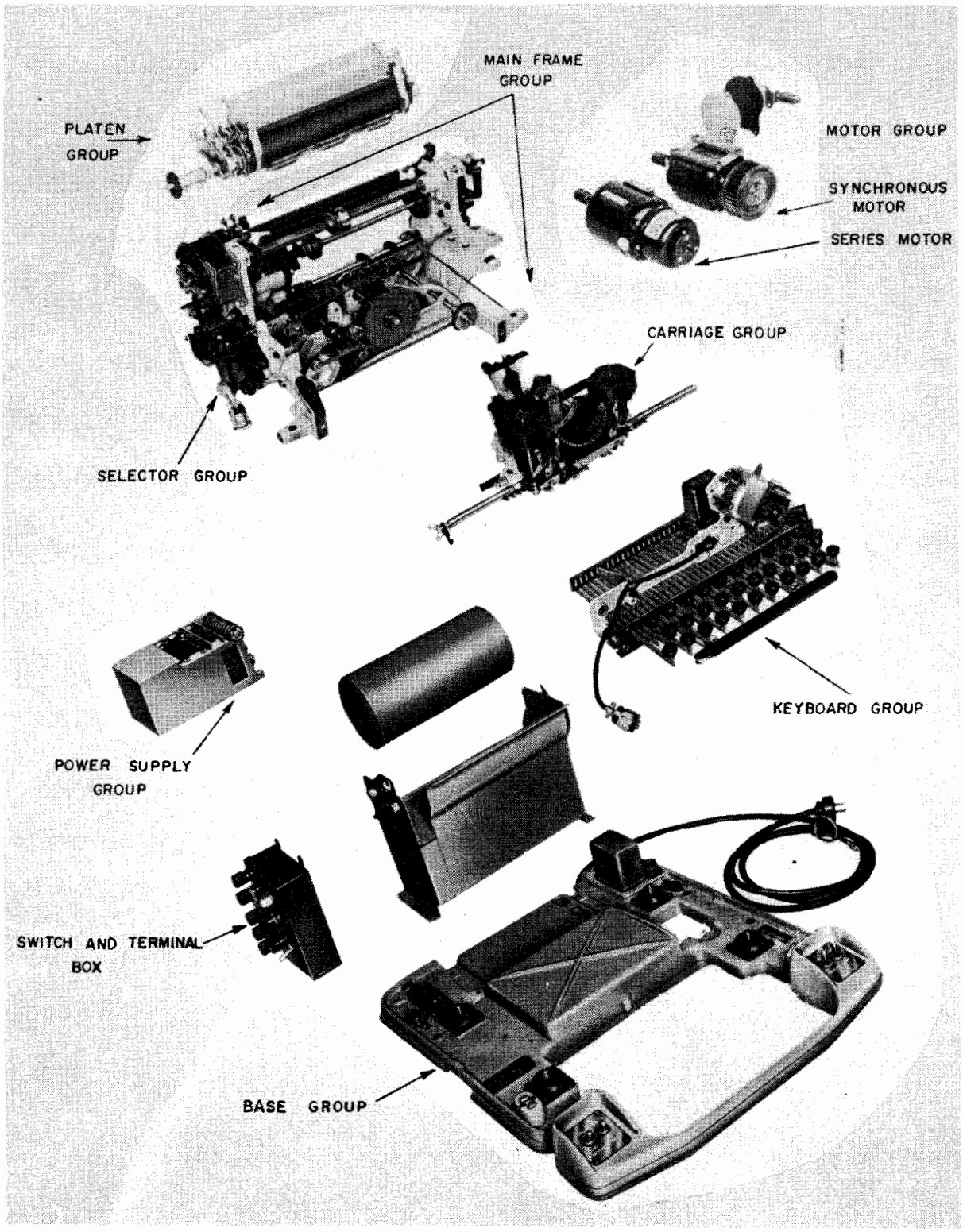

Figure 2. Exploded view of the functional groups of the AN/FGC–20.

the TT–98/FG and the TT–99/FG require circuit modifications when used with certain crypto gear.

2-9. The teletypewriter must be adaptable in order to operate under many conditions and sources of power. For example, most of the world uses alternating current, but there are some countries where direct current is still the primary source of power. Again, even where alternating current is used, the frequency may vary from 20 to 60 cycles per second (c.p.s.). It is a good thing that the teletypewriter has been made so versatile.

2-10. Basically, the Air Force uses teletypewriters for two major tasks: (1) the transmission of orders and messages and (2) the transmission of weather data. To facilitate these two tasks, the AN/FGC–20 has standard communications symbols on the key tops and on the type pallets, and the AN/FGC–21 has weather data symbols on the key tops and type pallets. However, all other parts of these two machines are identical. Thus, in emergencies, their components can be interchanged.

2-11. Both the AN/FGC–20 and the AN/FGC–21 are supplied with a.c. synchronous motors at the factory. These synchronous motors are designed to operate correctly on only 60-cycle, 110–115-volt alternating current. To permit the use of the teletypewriter at locations where this type of a.c. is not available, we must use instead the AN/FGC–20X. The X at the end of the model number indicates that this machine is equipped with a 115-volt, universal, series-governed motor. This motor can operate on any cycle 115-volt alternating current or on 115-volt direct current.

2-12. The AN/FGC–21 is the teletypewriter set that is used in weather stations. The printer for this set is the TT–99/FG. A glance at table 1 shows you that it is equipped with a synchronous motor. Note also that this is the only Air

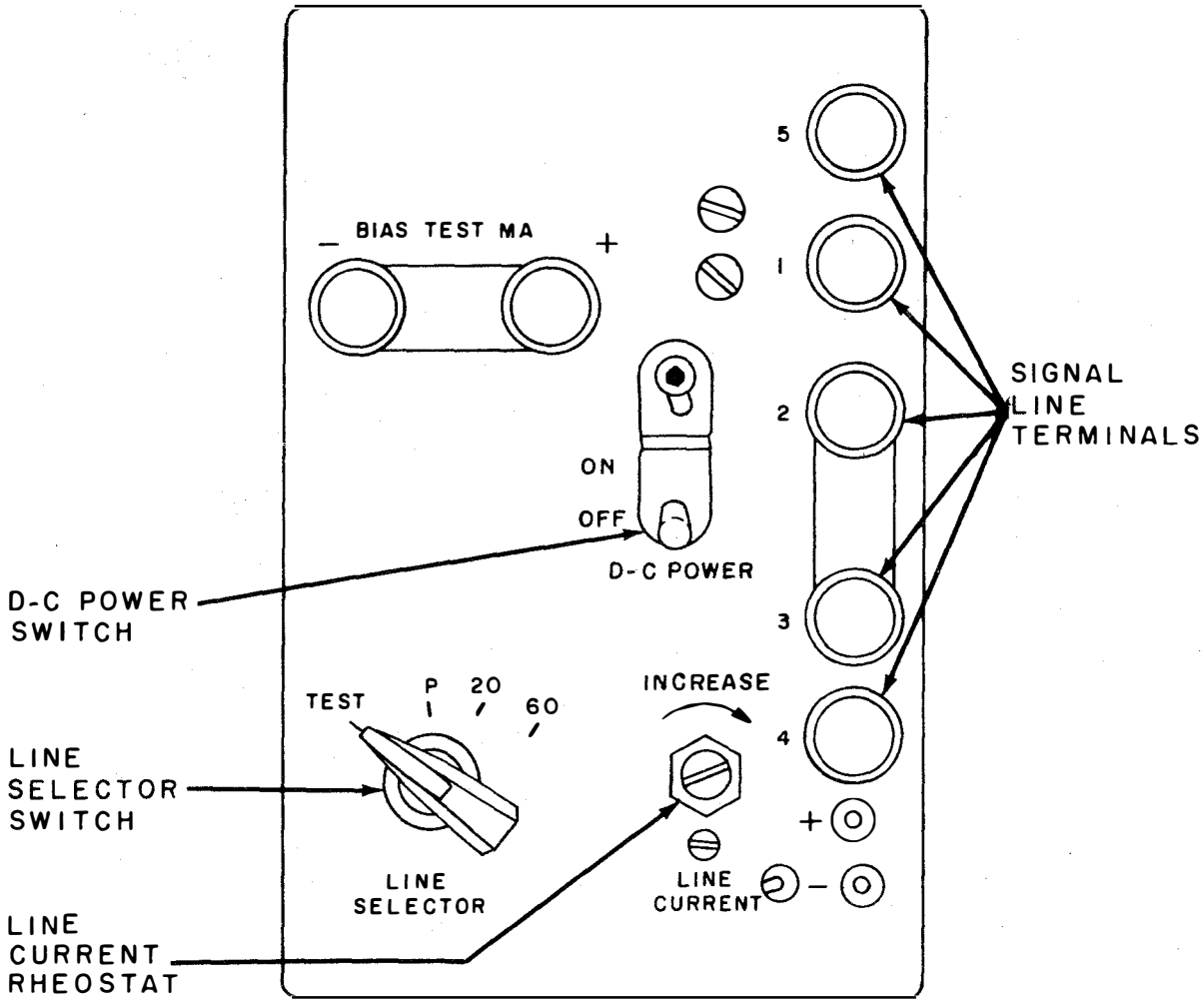

Figure 3. Switch and terminal box AN/FGC–20.

Force weather set of this series currently available.

2-13. In the last column in table 1, you find an AN/FFC–20 model. Note that this is a "receive only" set equipped with a TT–259/FG printer. Obviously, since this set cannot transmit (it has no keyboard), there is no need for it to have a power supply unit. Line signals from the distant transmitter operate the selector magnets. A rectifier connected directly to the a.c. input supplies d.c. for the bias and motor stop relay circuits when these are used.

2-14. **Functional Groups.** The AN/FGC–20 contains nine functional groups—nine portions, each of which can be removed as a unit from the machine.

2-15. These functional groups are shown in an exploded view in figure 2. You can see the relationship between the groups and the complete set. The nine functional groups include: the base group, the switch and terminal box, the keyboard group, the carriage group, the platen group, the main frame group, the motor group, the selector group, and the the power supply PP–978/FG. These groups, though each is a separate unit, are operationally interdependent upon each other; and, in most cases, the machine cannot operate correctly without all of them being present. In the following subsections, we give you a general review of each of these groups. This review is intended to give you a better understanding of the purpose of each group and the relationship of the groups to each other. As you progress in your job, you will find that a good knowledge of these groups is very helpful in troubleshooting.

2-16. *Base group.* The base group of the teletypewriter, shown in figure 2, contains most of the wiring and electrical components of the machine. The base itself is a metal casting used to mount the remainder of the components of the machine, except the table on which the base is located.

2-17. The power input cord is connected directly to the power on-off switch. This power switch, which is designated as S4 on the wiring diagrams, controls all power to the machine. Located adjacent to and directly in front of the power switch is the 2-amp cartridge type power fuse, F1. Power is applied through this fuse to the power supply. The spring type terminal connections for the power supply are located beneath the base, just at the left of the power switch. The motor stop relay unit is located at the right rear of the machine. The switch and terminal box, shown in figure 3, is connected to the various circuits of the machine by the 16-terminal jack J7. The $\frac{1}{16}$-amp fuse F4, located in front and to the left of the jack J7, protects the local d.c. circuits. It is connected in series with the various circuits of the machine which receive local power from rectifier CF1.

2-18. Jack J8, located nearest the left edge of the base, is used to connect the selector magnets to the wiring beneath the base. Jack J5 is used to connect the wiring of the keyboard to the wiring beneath the base. Also, adjusted a.c. or d.c. power is connected to the motor through jack J3 and plug P3.

2-19. *Switch and terminal box.* The switch and terminal box, shown in figure 2, has as its primary purpose the control of the signal line. This box contains the switches, terminals, and protective devices necessary for correct signal line operation. It is connected to the various circuits of the machine through plug P7 and jack J7. The jack of this combination is located on the base, whereas the plug is permanently mounted on the bottom of this box. The switch and terminal box plugs into jack J7 and is fastened at the top to the paper roll mounting bracket.

2-20. The five binding posts (signal line terminals), located on the right side of the switch and terminal box as shown in figure 3, are used to make signal line connections to the machine. Termination of the external signal lines on these posts are discussed in detail in another volume of this course. Internally, posts 1 and 2 are connected across the send circuit. Post 5 is similar to post 1; however, when it is used, it removes 1000 ohms of resistance from the send circuit. The internal receive circuit is across posts 3 and 4. In our drawing, posts 2 and 3 are shown strapped together, placing the internal transmitting and receiving circuits in series for half-duplex operation.

2-21. Rheostat R10, located on the lower right side of the switch and terminal box (see fig. 3), is used to control the amount of current in the transmitting circuit. This rheostat is a 0–5000-ohm variable resistor used to adjust the signal current to the specified amount. Rheostat R10 is located in the circuit between the line binding post 2 and switch S7. The line selector switch S7 is used to control the type of operation of the machine. This switch is a four-position, rotary type switch with four levels of contacts. It is used to condition the machine for neutral, polar, or test operation. When the line selector is in the TEST position, the machine is connected internally so that the machine sends to itself without interfering with the signal line. When it is in the P position, the machine is connected to receive polar impulses from the signal line. Connections for the transmitting circuit are approximately the same for both polar and neutral transmission of

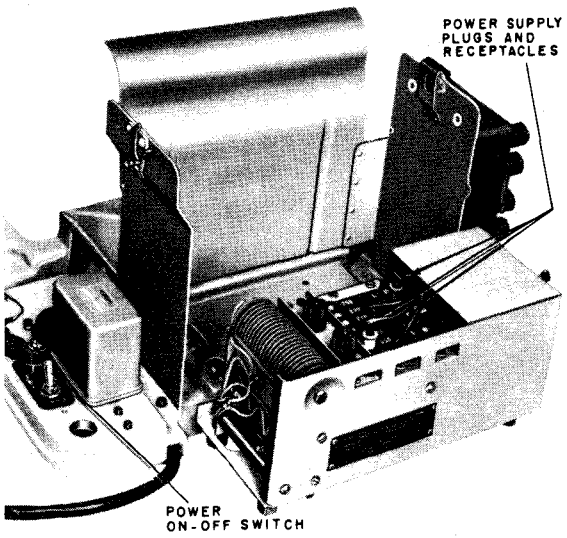

Figure 4. Power supply for AN/FGC–20.

messages. Thus, when the line selector is positioned to 20, the machine is condition to send or to receive neutral signals from the signal line. Maximum line current for this position of the line selector is 20 ma. Again, with the line selector in the 60 position, the machine is conditioned to send or to receive neutral signals from the signal line with a maximum signal current of 60 ma. The d.c. power switch (S11) is shown in the center of the box. When it is in the ON position, the machine can furnish line current for transmission. When it is in the OFF position, the rectifier is disconnected from the signal line.

2-22. *Keyboard group.* The keyboard group, shown in figure 2, contains all of the mechanisms required to change the mechanical action of depressing a key into the electrical impulses of the teletypewriter five-unit code.

2-23. *Carriage group.* The carriage group, shown in figure 2, is the mechanism which does the actual printing of a character. This group is mounted on the carriage casting and includes the type bars, connecting bars, type-selecting arm, and the mechanisms that control the ribbon feeding, ribbon reversing, and ribbon lifting. As the machine is operated, the carriage group is automatically spaced to the right across the machine. At the end of a type line, this group is returned to the left margin by the operation of the carriage return.

2-24. *Platen group.* The platen group, shown in figure 2, holds the paper for printing. The platen itself is a hard rubber roll, which acts as a cushion and stop for the type bars and pallets as they are "thrown" against the paper for printing. The line feed link, a portion of the line feed mechanism, is located on the left-hand side of the platen. A shaft and knob extend from the left-hand end of the platen group to allow the operator to turn the platen manually in either direction. (NOTE: In some models, the knob has been changed to a crank.) An adjustable pinwheel sprocket assembly (not shown in figure 2) is mounted on each end of the platen and permits use of two- or three-copy roll or fanfold perforated paper. The platen group is moved vertically by the figures or letters shift function to provide printing in the FIGURES and LETTERS positions.

2-25. *Main frame group.* The main frame group consists of the castings and parts that remain after all the previously mentioned groups have been removed from the machine. This group, which may be seen in figure 2, includes the left and right frame castings, the gears and shafts that transfer power from the motor to the various assemblies, and miscellaneous mechanisms that perform a variety of functions, including the signal bell, carriage spacing, carriage return, motor stop, and margin bell mechanisms.

2-26. *Motor group.* The motor group, which is the primary source of mechanical power, is mounted on the right frame casting. The synchronous motor, shown on the right in figure 2, is supplied with the AN/FGC–20. The series-governed motor, shown on the left side in figure 2, is supplied with the AN/FGC–20X. Of these two motors, the synchronous motor needs no adjustment and maintains an exact speed of 3600 r.p.m., with a power input of 60-cycle a.c. On the other hand, the series-governed motors are provided with an adjustable governor, which permits adjustment to the proper speed of 3600 revolutions per minute (r.p.m.). Such series-governed motors permit operation in areas where a 60-cycle a.c. power source is not available.

2-27. *Selector group.* The selector group receives the incoming electrical impulses and changes them to mechanical actions. You should remember that a teletypewriter has no mechanical linkage to transfer mechanical action from the keyboard to the carriage. Thus, all characters to be printed, whether they originate locally or at a distant station, must be transmitted electrically to the selector group of a receiving machine. The heart of the selector group is the polar selector magnet assembly.

2-28. *Power supply PP–978/FG.* Power supply PP–978/FG for an AN/FGC–20 (shown in fig. 4 and FO 1) is a dry-disc rectifier and power transformer used to convert a.c. of different voltages to 115 volts d.c. for use in the signal and local test circuits of the machine. This power supply also transforms different a.c. voltages to

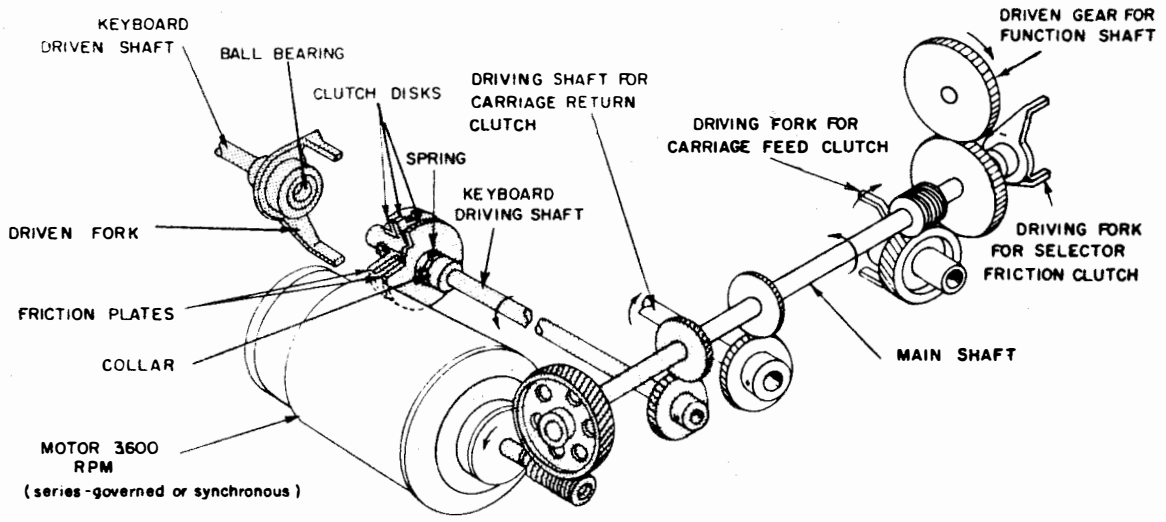

Figure 5. Power distribution for the AN/FGC–20 (transmitting chain shaded).

the 115 volts required for the operation of the motor and other a.c. circuits of the machine.

2-29. The power supply is mounted on the rear of the base and is connected to the wiring of the machine through spring type terminals located on the base.

2-30. The primary source of power, outside of the machine, is connected to the machine through the input power cord and the power on-off switch. Connections are made through switch S4, fuse F1, and the spring terminals to the primary side of the transformer. One side of the power input is connected directly to the primary winding of the transformer; the other side of the power input is connected to a movable plug, shown in figure 4, which is connected according to the voltage of the primary source of power. The primary winding of the transformer has eight "taps," which are numbered 95, 105, 115, 125, 190, 210, 230, and 250. If the input voltage is 125 volts, the movable plug is inserted in the tap marked "125." When this is done, the output on the secondary side of the transformer is stepped down to 115 volts a.c. A.c. power for the motor is taken from the adjusted primary winding of the rectifier at the input taps.

2-31. Power is obtained from the secondary winding, through a movable plug and taps, to the output side of the unit. These taps maintain a d.c. power supply as close as possible to 115 volts. The 8 taps on the output side of the power supply are lettered L, M, and H, and numbered 1, 2, 3, 4, and 5. Through these taps, we can adjust the output of the rectifiers.

2-32. It should be noted that there is a second rectifier assembly located beneath the base unit. This second rectifier stack (CR1) receives its a.c. input from the adjusted voltage of the primary of transformer and provides the machine with the d.c. power required for the operation of the local circuits within the machine. In fact, by using this rectifier and making certain wiring changes, it is possible to operate the machine without power supply PP–978/FG.

3. Code Impulse Generation

3-1. The generation of code impulses begins with the keyboard, when manual transmission is used. To understand the mechanical operation of the keyboard, you must first know a little about the power distribution in the machine. Figure 5 shows the complete power distribution arrangement for the machine. The shaded portion of this figure shows the power chain for the transmitting unit. Power from the motor is transferred to the main shaft by the motor and main

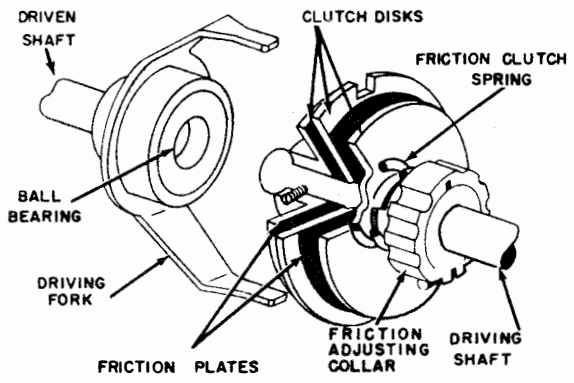

Figure 6. Friction clutch used on the AN/FGC–20.

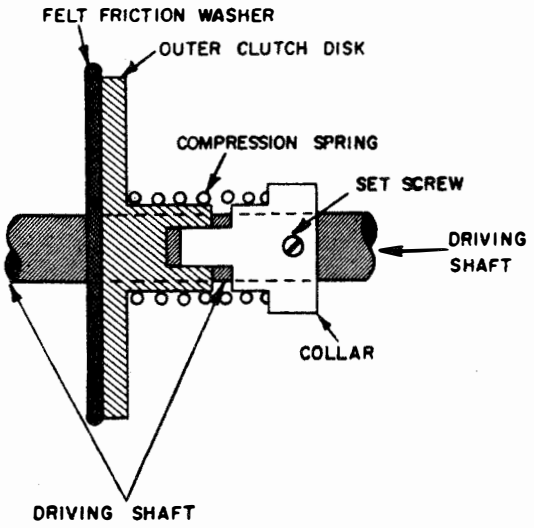

Figure 7. Construction of outer clutch disk.

shaft power gears. At the end of the keyboard driving shaft is the transmitter friction clutch, shown near the top and at the left on figure 5. This clutch is one of three friction clutches found in the AN/FGC–20 and used to make rapid start and stop actions possible. The transmitter friction clutch, shown in figure 6 as well as figure 5, is similar in construction and principles of operation to the other friction clutches on the machine, such as the selector friction clutch.

3-2. The fork on the driven shaft engages the notches on the center disk of the clutch. The two felt friction washers on the driving shaft are held against the center disk by spring pressure on one of the two outer clutch disks. The other of these outer clutch disks is mounted on the driving shaft by means of a setscrew. But the felt friction washers and center clutch disk, while mounted on the driving shaft, are free to move independently of the driving shaft motion. The second outer clutch disk (the nearest disk in fig. 6) is keyed to its associated collar. This collar is mounted on the driving shaft by a setscrew; and the outer clutch disk is attached to the collar by the key. Figure 7 shows the construction of this outer clutch disk in some detail. A compression spring, located between the collar and the outer clutch disk, forces the disk against its bearing felt friction washer. You can adjust the position of this disk by moving the collar back and forth. This changes the spring tension and the amount of friction built up between the clutch disks and the felt friction washers. The friction between the center disk and the outer disks and felt washers on the driving shaft is sufficient to rotate the driven shaft when it is carrying its normal workload. As the load on the driven shaft is increased by brake pressure on the unit it drives or if the unit is shopped by stop-cam action, the friction between the center clutch disk and the outer disks breaks down. Now the center disk slips in rotation between the outer disks. Then when the brake pressure or the stop-cam action is removed, the driven shaft again resumes rotation. This rapid start-stop action is needed for code impulse generation.

3-3. The code impulses required for manual operation are created by the transmitter contacts on the keyboard. This unit has two pairs of contacts arranged so that it can create either neutral or polar impulses. The signals associated with both are reviewed in this section. Figure 8 shows a portion of this mechanism.

3-4. **Neutral Signals.** For neutral operation, one side of the transmitting circuit is connected to the marking contact terminal, and the other side

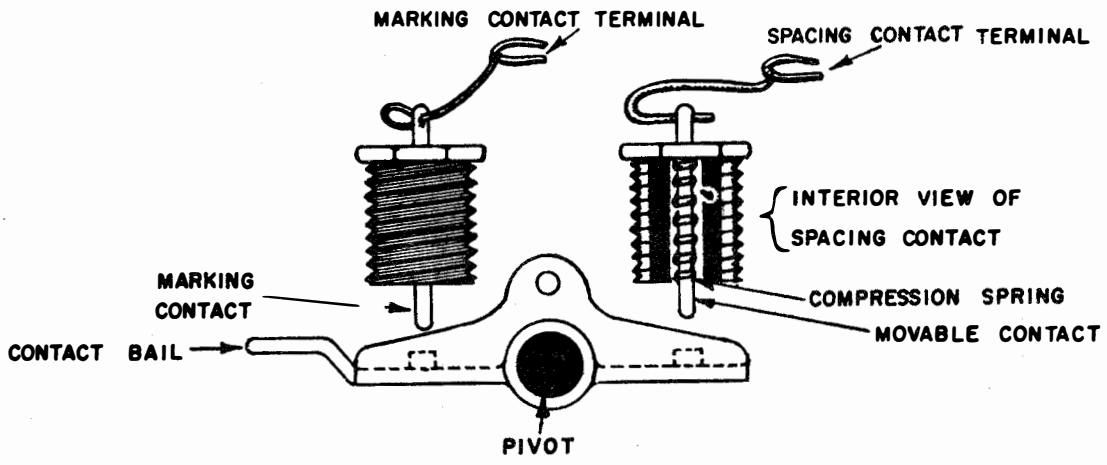

Figure 8. Signal generator unit.

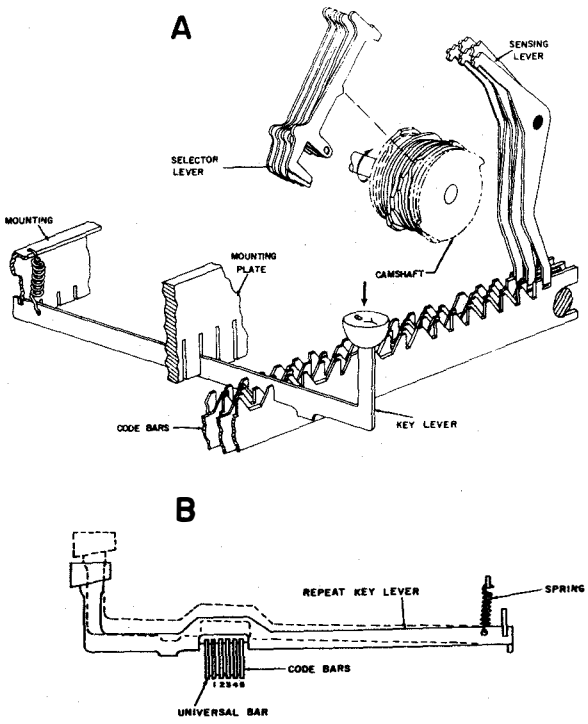

Figure 9. Setting up mechanical form of the five-unit code.

of the circuit is connected to the rear of the contact bail, both of which are shown in figure 8. If a marking (current) impulse is to be transmitted, the left side of the contact bail is raised. The contact bail then completes a circuit from the marking contact terminal through the movable contact to the contact bail and to its connection with the transmitting circuit. For such neutral operation, negative battery is applied to post 1 (or 5). When a spacing (no current) impulse is to be transmitted, the right side of the contact bail is raised. Lifting of the right side of the contact bail moves the left side down, breaking the contact between the marking contact and the contact bail. When this contact is open, the transmitting circuit is not complete, and a spacing impulse is transmitted.

3-5. **Polar Signals.** Polar operation requires that the spacing contact be positioned as shown in figure 8. Then, as the right side contact bail is raised, it makes contact with the spacing contact.

3-6. When a machine is wired for polar transmission, power from the negative side of the rectifier is applied to the marking contact. This means that when the contact bail closes to the marking contact, a negative potential is applied to post 1 (or 5) of the switch and terminal box. At the same time, the positive potential is being applied to post 2. In contrast for a spacing pulse, the contact bail closes to the spacing contact. The situation is now reversed, with the positive potential applied to post 1 and the negative potential to post 2. Thus, current on the line is in one direction for a marking pulse and in the opposite direction for a spacing pulse.

3-7. The threaded contact unit permits adjustment of the contact screws. Figure 8 shows only an interior view of the spacing contact, but in actuality the construction of both the marking and the spacing contacts is identical. The compression spring holds the movable contact in an extended position to insure positive contact with the contact bail.

4. Selecting Sequence of the Keyboard

4-1. To transmit from the keyboard, two different operations must be accomplished. One operation determines the code impulses that are to be transmitted. The second operation releases the driven transmitting shaft so that the code impulses can be transmitted. Although these are separate operations, they are interdependent and must operate together for correct transmission. These mechanical operations are called se-

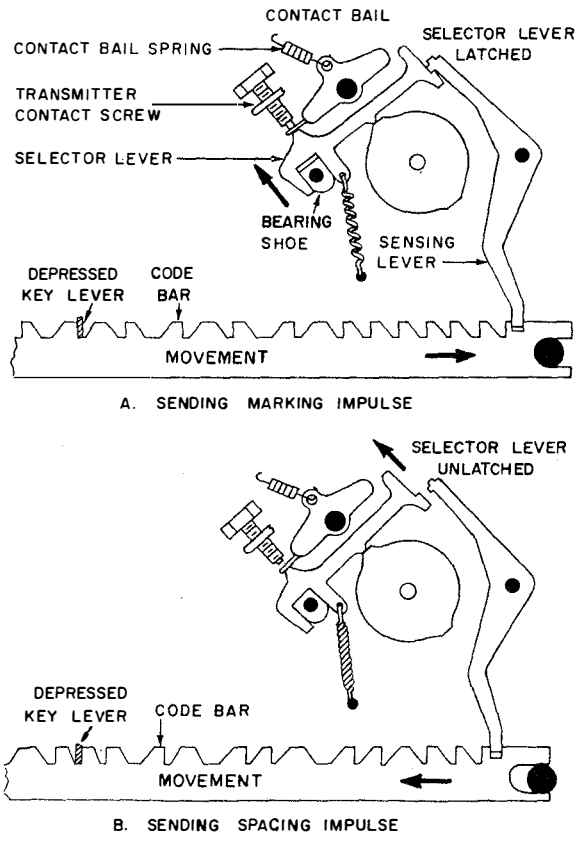

Figure 10. Operation of the transmitter.

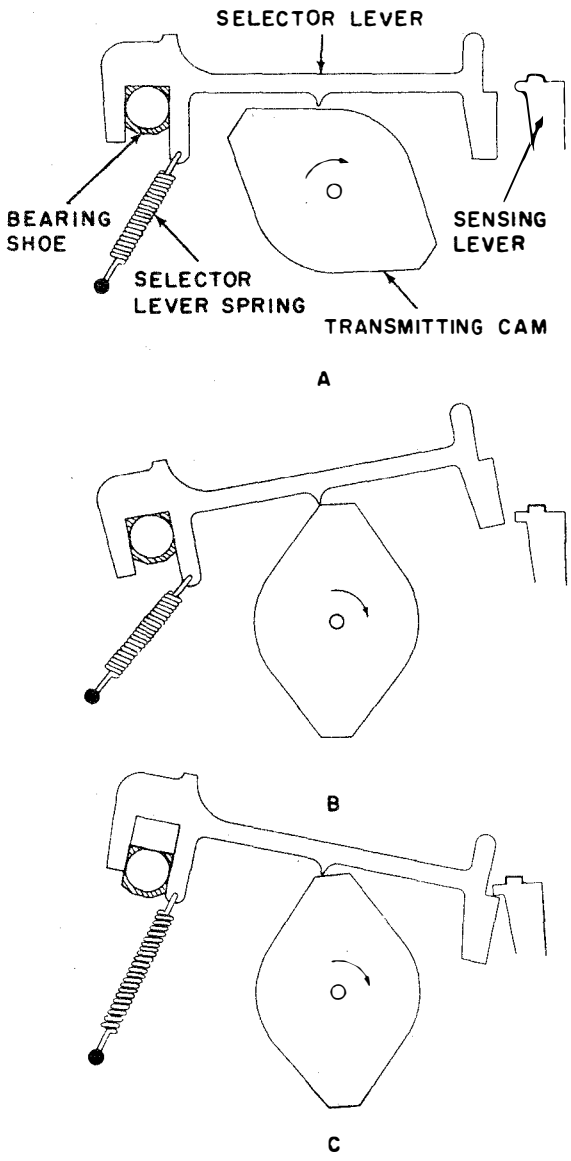

Figure 11. Operation of the selector levers.

quences. A sequence involves a chain of components, each acting upon the following one to cause one or more end results.

4-2. When a machine is operating at a speed of 100 w.p.m., it takes approximately 0.1 second for one character to be transmitted. You will remember that the remaining portion of the preceding stop pulse, a start pulse, the five code pulses, and a part of another stop pulse are transmitted in sequential order within that time of 0.1 second. Although the transmission of the code pulses is sequential, the selection of all five code pulses is accomplished at the same time by your depressing a key top. In this section, then, we discuss those mechanical units which enter into this selecting sequence of the keyboard. Proper operation of the keyboard entails correct movement of the code and universal bars and of the sensing and selection levers, which we will discuss in that order in this section.

4-3. **Keyboard.** The keyboard is our starting point. On any teletypewriter, there are 31 such key tops and 1 space bar. Each lever is pivoted in the back of the keyboard. When you depress the key top, the key lever is forced down against the code bars and universal bar. Figure 9,A, illustrates the keyboard operation.

4-4. *Code and universal bars.* There are five code bars and one universal bar. The code and universal bars are located across the width of the keyboard parallel to the front. These six bars are provided with a series of notches across their width. If, at the instant you depress a key lever, a code bar is in a spacing position and is to be changed to marking for a particular character, or if it is in a marking position and is to be changed to spacing, the key lever strikes a sloping side of the notch. The key lever continues to move down and moves the code bar to the right or the left, depending upon whether the impulse to be transmitted is a marking or a spacing impulse. Then, as the key lever strikes the universal bar, an action shown in figure 9,B, the bar moves to the right. We will discuss the operation of the universal bar in the next section. This movement of the code bars is shown in figure 10.

4-5. *Sensing and selector levers.* The sensing and selector levers must also function properly for a correct selecting sequence of the keyboard to occur. To begin with, the lower end of an associated sensing lever is located in a notch on the right end of every code bar. Consequently, as a code bar is moved to the right for a marking impulse, its corresponding sensing lever is moved counterclockwise. Conversely, if a code bar is moved to the left for a spacing impulse, its corresponding sensing lever is moved clockwise.

4-6. When marking impulses are to be transmitted, the upper ends of the sensing levers move to the left. When a sensing lever is in its fullest counterclockwise position, it engages a notch on its corresponding selector lever. The selector lever may be seen in figures 9 and 10. When spacing impulses are transmitted, the sensing levers are disengaged from their corresponding selector levers.

4-7. The selector levers operate on the principle of a sliding pivot. This type of action permits both ends of the selector lever to move. For example, figure 11,A, shows the selector lever in its unoperated position. At the instant pictured, the transmitting camshaft is rotating, and the camming surface of the selector lever is above

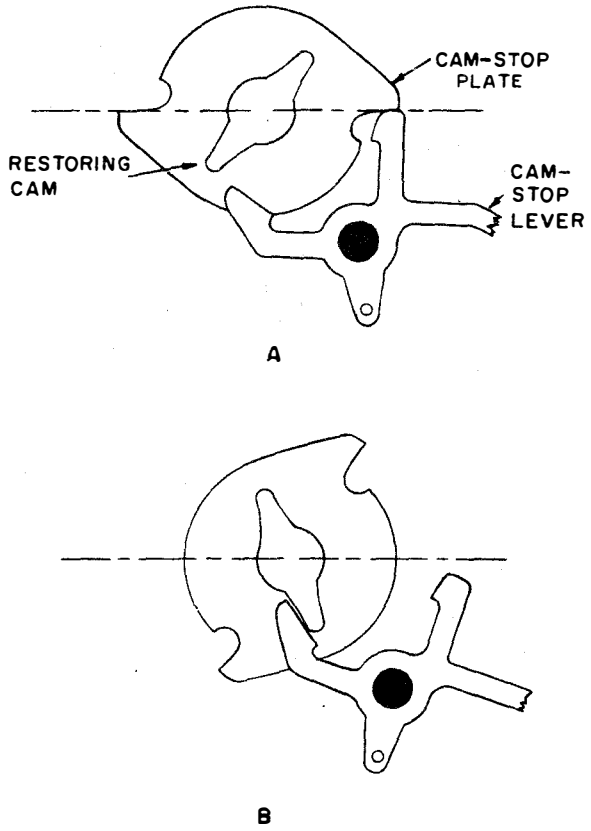

Figure 12. Stopping the transmitter camshaft.

the low part of its cam. Hence, there is no movement of the selector lever. For contrast, look at figure 11,B. In this figure, the camshaft has been rotated to a position where the selector lever is on the high part of the cam. At the same time, the sensing lever has been rotated clockwise for a spacing pulse. As a consequence, the right end of the selector lever is unhindered. The spring located on the left end of the selector lever is strong enough to hold the left end against the pivot; therefore, the right end of the same lever is raised by the high part of the transmitting cam.

4-8. When the sensing lever is moved counterclockwise to engage the notch on the right side of the selector lever, the machine is arranged to transmit a marking impulse. Figure 11,C, shows the sensing lever engaged with the selector lever and the selector lever on the high part of its transmitting cam. As the cam is rotated, the camming surface on the selector lever is forced to rise. Since the right end of the selector lever is held by the sensing lever, the left end must move. But as the left end of the selector lever moves, it slides on its pivot bearing, causing the selector lever spring to be extended.

4-9. In the preceding section, we discussed the generation of code impulses. You will remember that for neutral operation, the contact bail generated these impulses by making with or breaking from the marking contact. You will also remember that the contact bail is located directly above the selector levers, as shown in figure 10. You can see, then, that as a selector lever's right or left side is raised by the transmitting cam, the corresponding right or left side of the contact bail must move. If you study figure 10 more closely, you see that the selector levers can move the contact bail only to the MARKING position. In comparison, the contact bail is moved to the SPACING position by the contact bail spring.

4-10. Taken as a unit, the 5 code bars, through their associated sensing and selector levers, provide for the 5 marking or spacing pulses that make up the 32 code combinations. Of course, for each character or function transmitted, a start and stop pulse is needed to time the receiving mechanism. This action necessitates an additional selector lever, the sixth selector lever, which produces the required start and stop pulse. The right end of this lever is permanently "latched" or held in the MARKING position for neutral transmission so that only the left end of the lever is permitted to move upward whenever this selector lever is on the high part of its cam.

4-11. **Signal Generation.** Signal generation is the end product of a complicated process. Before you have depressed a key top, the sixth selector lever is resting on the high part of its cam. At this same time, the contact bail is closed to the marking contact and the stop impulse is on the signal line. But when you have depressed a key top, the code bars position either to the left or right, depending upon the key which you have depressed. This action, in turn, determines which of the five selector levers are latched (mark) or unlatched (space) by the sensing levers. Then, after the pattern has been arranged, the continuing downward movement of the key lever releases the transmitting shaft and allows the camshaft to rotate.

4-12. At this time, the sixth selector lever rides down to the low part of its cam and the contact bail moves away from the marking contact. This opens the line circuit and transmits the start (space) pulse. At the end of the start pulse, the first code selector lever rides up the high part of its associated cam. If this selector lever is latched, the sliding left end moves the contact bail to close the marking contact. On the other hand, if it is unlatched, the contact bail does not move, and a spacing pulse is transmitted.

4-13. Just as the instant that the first selector lever is ready to drop off the high part of its

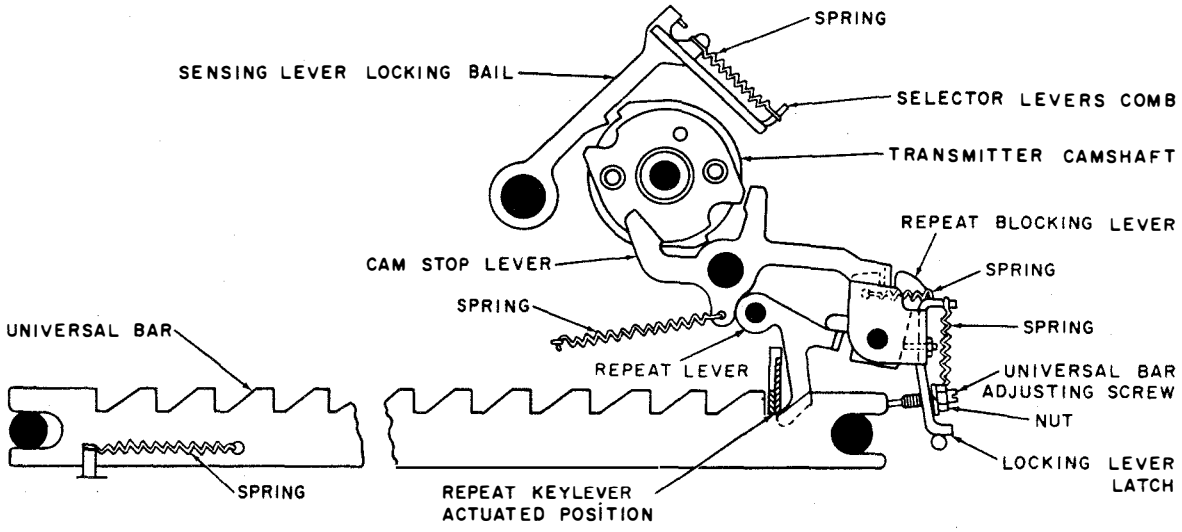

Figure 13. Transmitter camshaft control mechanism.

cam, the second selector lever rides upward on the high part of the second cam. Meanwhile, the staggered cams are so positioned that there is no break between the code pulses if a marking pulse is followed by another marking pulse. Thus, after all five code pulses are transmitted, the sixth selector lever rides up the high part of the sixth cam to once more place the stop pulse on the line.

4-14. Before we leave this particular operation, glance back at figures 9 and 11. Note as you do so that there are two high parts on every cam. The shafts on AN/FGC–20 equipment turn at a speed that allows the mechanism to transmit a character in one-half of a revolution.

5. Transmitter Camshaft Control Mechanism

5-1. You have probably noted in the preceding section that the transmission of code impulses causes the transmitting camshaft to revolve. You should also remember that when a key lever has been moved down and has positioned the code bars, it has also moved the universal bar to the right. The movement of this universal bar controls the rotation of the transmitter camshaft.

5-2. When the transmitter camshaft is held so that it cannot rotate, the keyboard is said to be in an "unoperated position." At such a time, the cam-stop lever is engaged with a tooth on the cam-stop plate, as shown in figure 12,A. In this section, we will discuss the units that control the process of starting and stopping the transmitter camshaft.

5-3. **Camshaft Rotation.** Camshaft rotation depends, as we have said, upon the movement of the universal bar. For instance, as the universal bar is moved to the right by your depressing a key, it automatically moves the universal bar adjusting screw, which is mounted in the locking-lever latch, shown in the lower right on figure 13. Now with the keyboard in the unoperated position, the right extension of the cam-stop lever rests on the top of the locking-lever latch. Therefore, when the universal bar adjusting screw is moved, it tips this locking-lever latch in a counterclockwise direction. When it moves in a counterclockwise direction, the locking-lever latch moves out from under the extension on the cam-stop lever. As this happens, the cam-stop lever spring rotates the cam-stop lever clockwise, moving the upper extension of the cam-stop lever from under the tooth on the transmitter camshaft stop plate. This allows the transmitter friction clutch to rotate the transmitter camshaft.

5-4. The resulting rotation of the transmitter camshaft then causes the raising and lowering of the selector levers by their associated cams. This causes the selected code group to be transmitted to the receiving machine.

5-5. **Reset.** Reset is accomplished by the restoring cam. When the transmitter camshaft has completed approximately 75 percent of the rotation necessary to transmit a complete character (180°), the restoring cam strikes the cam-stop lever, as shown in figure 12,B. Next, as the camshaft continues to rotate, the restoring cam moves the cam-stop lever counterclockwise, and its upper extension is moved to a position in line with a tooth on the stop plate. Accordingly, during the transmission of the stop impulse, the stop plate strikes the cam-stop lever, stopping the rotation of the camshaft.

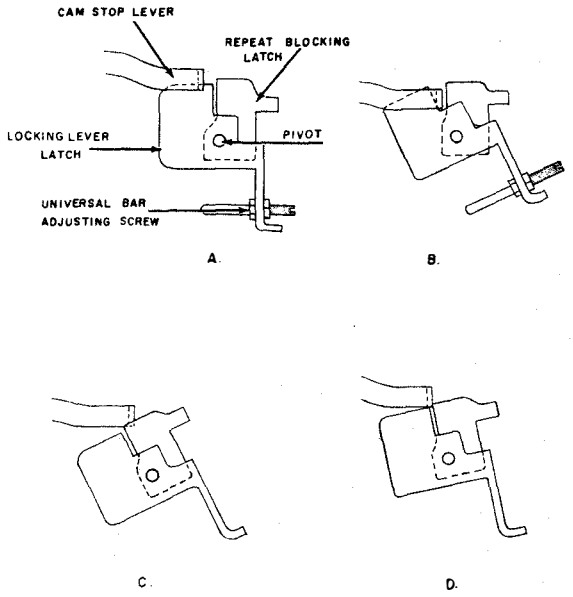

Figure 14. Operation of the locking-lever latch and the repeat-blocking latch.

5-6. As we have seen in our discussion of the operation of the transmitter camshaft thus far, it is not necessary for you to depress a key every time a character is to be transmitted. If you hold a key depressed, the cam-stop lever rotates clockwise, allowing the camshaft to revolve. Then the restoring cam rotates the cam-stop lever counterclockwise, moving its extension in line with the stop cam. Since you are holding the key down, the cam-stop lever again rotates clockwise as the restoring cam passes the cam-stop lever. The reason for this is that the locking-lever latch has been rotated clockwise and is not in position to hold the cam-stop lever counterclockwise. Thus, to prevent repeating characters, it is necessary for us to have additional parts in the mechanism which blocks such action.

5-7. The repeat-blocking lever and its spring are the parts that have been added to prevent the repeating of characters. The repeat-blocking lever is pivoted on the locking-lever latch in such a way that the top of the repeat-blocking lever is approximately one-sixteenth inch above the top of the locking-lever latch. (See fig. 14,A.) However, with the repeat-blocking lever in its normal position, the cam-stop lever rides on top of the locking-lever latch.

5-8. As a result, when the locking-lever latch is rotated counterclockwise by the universal bar, the cam-stop lever strikes the repeat-blocking lever and opens the notch between the repeat-blocking lever and the locking-lever latch far enough for the cam-stop lever to drop, or rotate clockwise, under spring tension, as shown in figure 14,B.

5-9. If the universal bar holds the locking-lever latch in a counterclockwise position and the restoring cam raises the cam-stop lever, the repeat-blocking lever is moved back to its normal position by the repeat-blocking lever spring. Then, as the restoring cam is moved past the cam-stop lever and the cam-stop lever is moved clockwise by its spring, the cam-stop lever comes to rest on the top of the repeat-blocking lever. (See fig. 14,C.) This action keeps the upper extension of the cam-stop lever in line with the tooth on the stop plate. Thus, after the transmission of the selected character, the transmitter camshaft comes to rest, even though the key lever is held depressed and the locking-lever latch is in a counterclockwise position. When the depressed key lever is released, allowing the universal bar to move to the left, the locking-lever latch and the repeat-blocking lever move in a clockwise direction. At the same moment, the cam-stop lever rides off the repeat-blocking lever and drop to the top of the locking-lever latch, where it comes to rest in a position ready to allow the transmitter camshaft to rotae on the selection of the next character.

5-10. When the cam-stop lever drops off the repeat-blocking lever, it drops at the position where it would normally allow the camshaft to rotate. Because of the closing of the gap by the repeat-blocking lever, the notch is not wide enough to allow the cam-stop lever to drop beyond the top of the locking-lever latch. (See fig. 14,D.)

5-11. **Repeat Transmission.** Repeat transmission is a practical necessity, since under some circumstances it is both convenient and necessary to transmit the same character continuously. For this reason, a repeat key has been added to the keyboard to perform this function. In operation, when you have selected a character by depressing a key lever and have also depressed the repeat key, the machine transmits the selected character to the receiving machine as long as both the selected key and the repeat key are held depressed.

5-12. The selected key lever sets up the correct combination on the code bars, sensing levers, and selector levers. When you have depressed the repeat key lever, it then strikes the universal bar, which in turn moves to the right, causing the locking-lever latch to move out from under the cam-stop lever. Again, when you have depressed the repeat key, the repeat key lever also turns the repeat lever, shown in the lower right corner of figure 13. This action rotates the repeat-

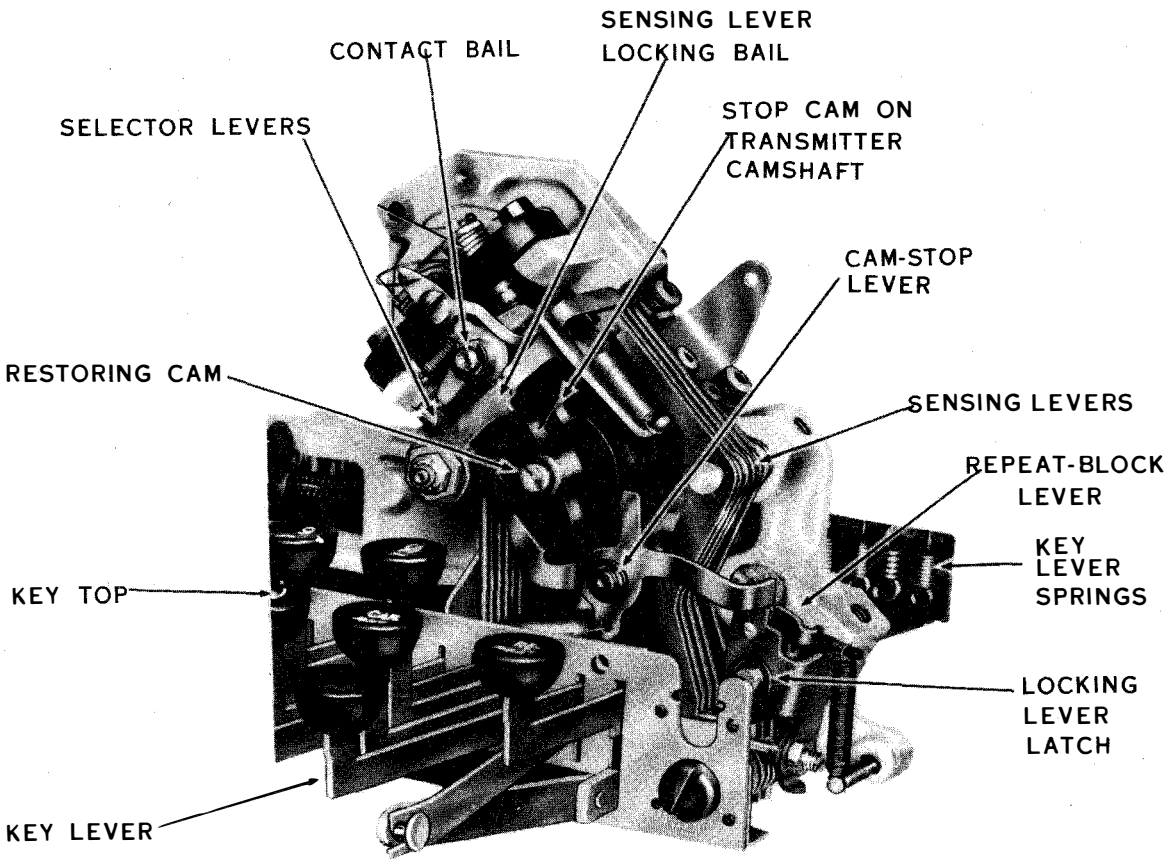

Figure 15. Components of the signal generator mechanism.

blocking lever, opening the notch between the repeat-blocking lever and the locking-lever latch. Therefore, the cam-stop lever, even though it is raised by its restoring cam, drops again and does not stop the camshaft, so that the selected code groups are repeated with each one-half revolution as long as you choose to depress the repeat key lever.

5-13. A photograph of the transmitter camshaft and its associated mechanisms is shown in figure 15. By using this photograph, together with each of the line drawings mentioned in the text, you should be able to gain a comprehensive understanding of the operation of the transmitter mechanism of the AN/FGC–20.

5-14. **Sensing-Lever Locking.** Sensing-lever locking in the selected position is the last operation that is performed by the transmitter camshaft. This action is accomplished by the sensing-lever locking bail and its associated cam, shown in figure 13. The sensing-lever locking bail cam is located on the selector camshaft directly behind the stop plate. In the normal stop position of the transmitter camshaft, the sensing-lever locking bail is resting on the high part of the cam. This positioning allows the sensing levers to be moved by the movement of their associated code bars.

5-15. However, just as soon as the transmitter camshaft starts to rotate, the sensing-lever locking bail drops to the low part of its cam, where it remains until just before the camshaft stops rotating. If you consult figures 9, 10, and 11, you will notice that the tops of the sensing levers have a small bump near their center. After the sensing levers have been positioned and the sensing-lever locking bail has been dropped to the low part of its cam, the right end of the sensing-lever locking bail drops to the top of the sensing levers. Thus, if the sensing levers have been positioned for a marking impulse, the locking bail is on the right side of the bumps; if they have been positioned for a spacing impulse, the locking bail is on the left side of the bumps. In this way, if a second key lever is selected during the transmission of a character, this second key lever cannot be completely depressed, as the sensing-lever locking bail is on top of the sensing levers and the sensing levers are locked in their selected position. They remain locked in their

selected position until the sensing-lever locking bail rides to the high part of its cam.

5-16. **Cams.** The eight cams, along with a stop plate, are located on the transmitter camshaft. As shown in figures 9 and 13, these cams are the stop cam, the fifth code cam, the fourth code cam, the third code cam, the second code cam, the first code cam, the sensing-lever locking bail cam, the cam-stop lever restoring cam, and the stop plate. These cams are named from the rear to the front of the camshaft respectively. As we have stated previously, each cam has two high parts, 180° apart. This arrangement permits the transmission of two characters for each complete revolution of the transmitting shaft.

5-17. This concludes our discussion of the AN/FGC–20 keyboard. It is to your advantage to do the review exercises in the workbook before proceeding to Chapter 2, where we review the operating principles of the page printer.

Operating Principles of the AN/FGC-20 Page Printer Unit

HAVING COMPLETED our discussion of the keyboard, let us now direct our attention to the mechanical operations of the printer. We will discuss the selection, transfer, and printing operations of the page printer and those mechanical operations that are not directly involved in the printing of a character. Finally, in the last section of the chapter, we will investigate the electrical operation of the AN/FGC–20.

2. Perhaps at this time you are mumbling to yourself that this is a heck of a lot of material to pack into a chapter, and you are right! However, we will try to make our review as compact as possible, keeping in mind that it may have been some time since you worked with this type of equipment and making sure we discuss all the important phases of the operation.

3. Let us begin our review with the selecting mechanism of the receiving unit. The code pulses are received from the line by the selector magnet, which starts the mechanical sequence of operations that converts these electrical pulses into mechanical actions. After the selection has been completed, the transfer operation occurs so that the stored intelligence can be transferred to the printing mechanism.

6. Selection and Transfer Mechanism

6-1. The selecting mechanism of the receiving unit receives the incoming signals, translates them into mechanical actions, and selects the type bar and pallet that does the actual printing of the correct character. The action starts at the selector magnet and armature, which is the heart of the machine, since this portion of the receiving unit changes the received electrical impulses into mechanical actions. However, the mechanical train that converts the sequential signals into a simultaneous mechanical transfer is of equal importance. So, we will discuss this sequence after we have reviewed the action of the particular type of selector magnet used with Kleinschmidt equipment.

6-2. **Polar Type Selector Magnet.** The polar type selector magnet can operate correctly on either polar or neutral teletypewriter signals when you position S7 for the type of operation desired. By positioning the switch to TEST, P, 20, or 60, you rearrange the windings of this magnet for the specific type of operation.

6-3. *Windings.* There are four windings around the core of the selector magnet: two bias windings and two line windings. The bias windings, when connected, are in series. The line windings are connected in either series or parallel by means of the selector switch. For example, when the selector switch is shifted to position P, the circuit to the bias winding is opened, and the line windings are connected in parallel to each other. Again, when the selector switch is positioned to either the 20, 60, or TEST position (neutral operation), the bias windings are connected to the local power source, CR1. This power source supplies approximately 8 ma of current in the bias winding circuit for 20-ma line current operation and 12 ma of current in the bias winding for either 60-ma line operation or when the local equipment is tested. When there is 8 ma of current in the bias windings, there is 20 ma of current in each line winding, as both line windings are in series with each other. When S7 is in the 60 position and 12 ma of current flows through the bias winding, there is 30 ma of current in each of the two line windings, which are now connected in parallel. In the P position, when the bias winding is disconnected, the line windings are also in parallel so that one-half of the 30-ma line current flows through each line winding. Current in the windings affects the operation of the polar select magnet.

6-4. *Polar select magnet.* In addition to the four windings we have just discussed, the polar select magnet contains a permanent bar magnet,

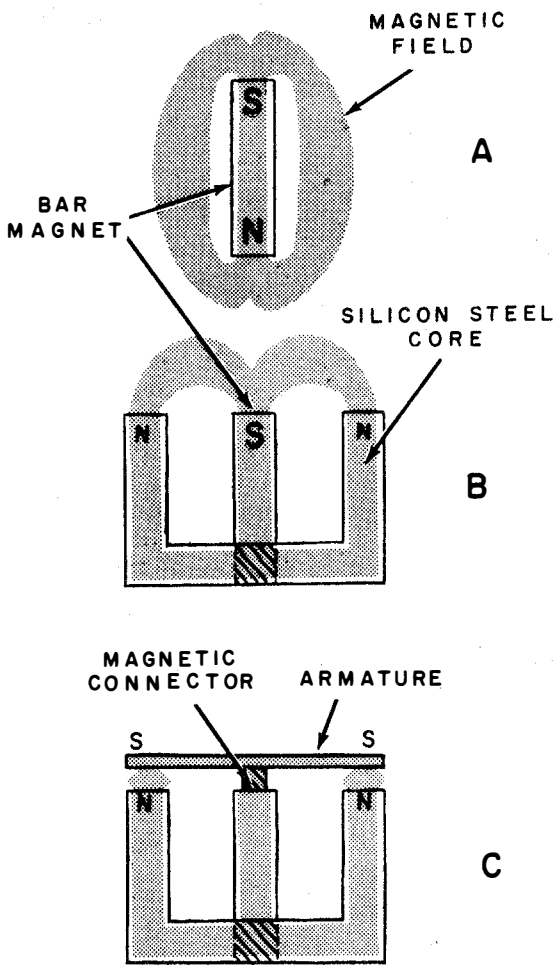

Figure 16. Magnetic field within the polar selector magnet.

an armature, and a U-shaped silicon steel core. These three components are combined as shown in figure 16. When the bar magnet, shown in A of the illustration, is placed in contact with the center of the U-shaped core, the path of the magnetic field is altered and both ends of the core display the same polarity, as illustrated in part B of figure 16. Similarly, when the center of the pivoting armature is magnetically linked to the other end of the bar magnet, each end of the armature acquires the same polarity as the bar magnet. This means, as shown in part C of figure 16, that each end of the armature is equally attracted by each end of the U-shaped core. It is the function of the magnetic field created by the current flow in the windings of the magnet to upset this magnetic balance and to operate the armature to one end of the core or the other.

6-5. *Operation.* Operation of the selector magnet unit is partially pictured in figure 17, illustrating how the windings affect the magnetic charac-

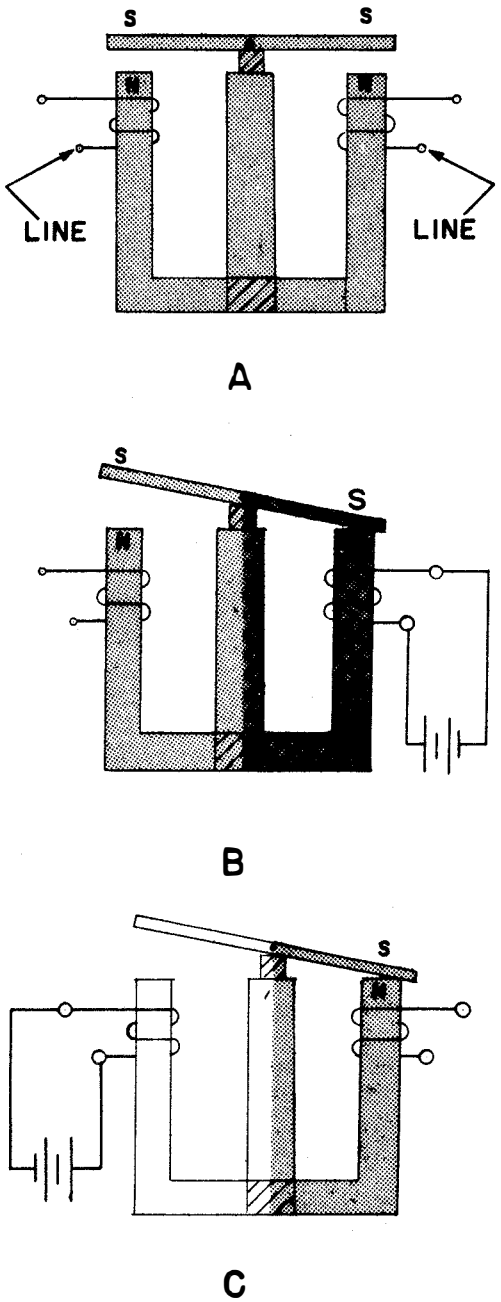

Figure 17. Effects of energized windings of the polar select magnet.

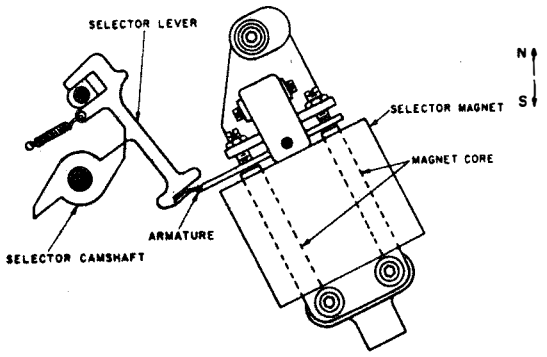

Figure 18. Polar selector magnet.

teristics of this basic selector unit. In part A of figure 17, we have added two line windings to the magnetically balanced selector magnet core and armature. Note that these coils are wound in opposite directions. If we connect them in parallel and apply the same potential to the top ends of both coils, the magnetic field created by one coil will be opposite to that created by the other coil.

6-6. With this in mind, let us connect the battery to one coil, as shown in part B of figure 17. With the coil wound as shown, the current from the battery creates an aiding magnetic field, which increases the attraction between the right half of the core and the armature. At the same time, as shown in part C of the illustration, the same battery is creating an opposing magnetic field in the left half of the U-shaped core and the armature. This effectively cancels out the magnetic field created by the permanent magnet. The combination of the two—increased attraction in the right half and no attraction in the left half—causes the armature to pivot sharply in a clockwise direction. If current flow through the coils is reversed, with polar signals, the attraction is increased in the right half. At this time, the armature pivots counterclockwise.

6-7. When neutral signals are used, the bias winding must be used to affect the magnet when a spacing, or no-current pulse, is on the line. The bias windings are so connected in series that, when no current flows in the line winding, the current in the bias winding creates a magnetic field. This field aids the left-hand half of the core and armature, rotating the armature counterclockwise. When a marking pulse is applied to the line windings, current flows in both the line and the bias windings. On each end of the core, the magnetic fields of both windings oppose each other. However, there is twice as much current through the line windings as that which flows through the bias winding. This means that the field created by half the current in the line windings cancels out the field created by the bias winding. The other half of the line winding current creates a field, which aids the permanent magnetic field on the right side and cancels out the permanent magnetic field in the left side of the core and armature. Thus, the armature rotates clockwise for a marking pulse. In figure 18, which is a line drawing of the selector magnet, you can see that a clockwise movement of the armature for a marking pulse blocks the lower end of the selector lever. A counterclockwise movement of the armature, in response to a spacing pulse, allows the selector lever room to move to the right. This clockwise and counterclockwise movement of the armature, in response to the incoming marking and spacing pulses, allows the machine to make the proper mechanical selection.

6-8. **Selection.** Selection depends primarily on the selector camshaft, which is connected to the main shaft of the machine by a friction clutch. This camshaft is normally held stopped when the machine is in an idle condition. The camshaft is prevented from rotating in a clockwise direction by the interoperation of the selector magnet armature, the stop lever, and the stop plate,

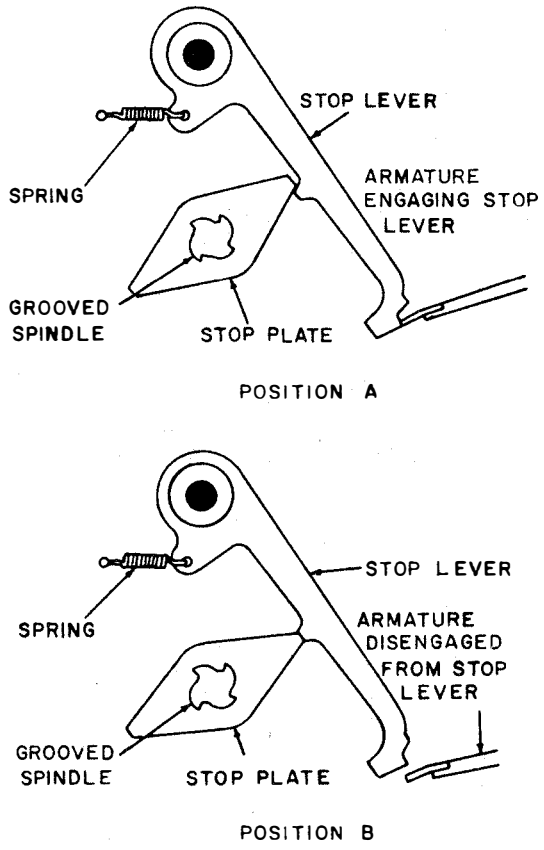

Figure 19. Starting and stopping the selector camshaft.

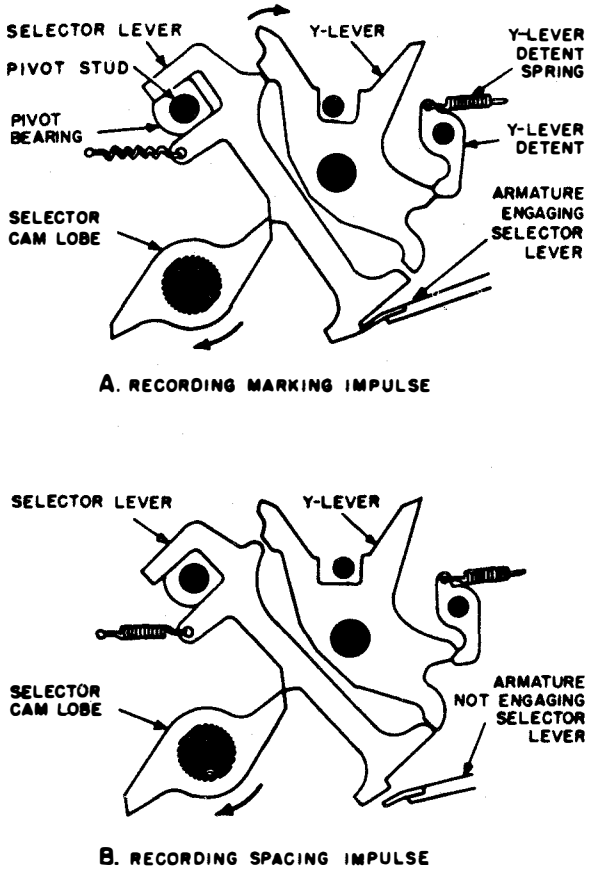

Figure 20. Positioning of the Y-levers.

which is mounted on the end of the camshaft. This action is illustrated by position A in figure 19. The knife edge of the selector armature holds the stop lever, and the stop plate cannot rotate.

6-9. When the start pulse is received, the selector armature rotates counterclockwise, disengaging the stop lever. The stop plate can now cam the stop lever outward, and the stop plate and the associated camshaft are free to revolve. This action is illustrated in position B of figure 19, which shows the disengaged stop lever being moved to the right over the top of the selector armature by the rotating stop plate.

6-10. As soon as the high part of the stop plate passes the camming hump of the stop lever, the lever is returned to its original position by its spring and the stop pulse activated armature at the end of the code sequence. This occurs just before the stop plate completes the half revolution. Of course, many things must occur between the start and the stop pulses just discussed. In that period of time, the machine receives the five code pulses, and interprets, stores, and transfers this intelligence to the portion of the equipment that prints the character selected.

6-11. *Selector cams.* In addition to the stop plate and friction clutch we mentioned in the previous paragraphs, the selector camshaft consists of five selector cams and the transfer lever latch tripping cam. As with the stop plate, each one of the six cams has two high points, located 180° from each other, thus permitting the reception of two characters for each complete revolution of the selector camshaft. Of course, the cams are mounted in order and staggered so that the proper selector lever operates to provide the selecting period for each of the five code pulses in rotation. The exact time when the cams strike the selector levers is determined by the range-finder mechanism, which we will discuss later in this section.

6-12. *Selector levers.* The selector levers used in the receiver unit are similar in design to those in the transmitter. One of the five selector levers is shown in figure 20. When a marking impulse is received in the selector magnet, the armature rotates clockwise. This action blocks the lower end of the selector lever, as shown in A of figure 20. Thus, as the selector camshaft revolves, the high part of the associated cam causes the selector lever to slide on the pivot stud and rotate in a clockwise direction.

6-13. When a spacing pulse is received, as in B of figure 20, the selector lever pivots on the pivot stud and rotates in a counterclockwise direction. This movement—clockwise for mark and counterclockwise for space—controls the operation of the associate Y-lever, shown in the same illustration.

6-14. *Y-levers.* The Y-levers are mounted against the upper side of the associated selector levers, as illustrated in figure 20, and rotate with

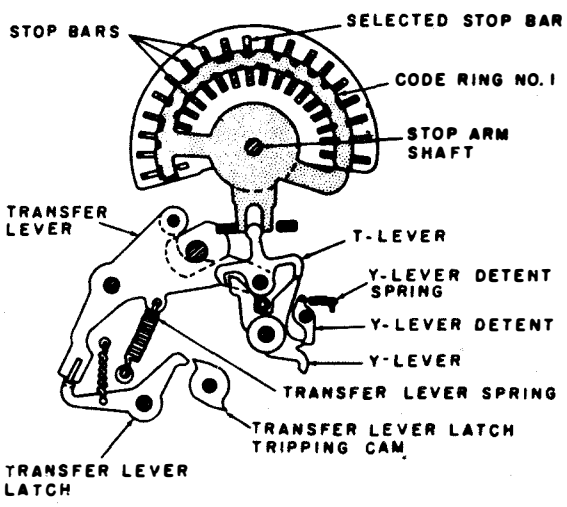

Figure 21. Transfer mechanism.

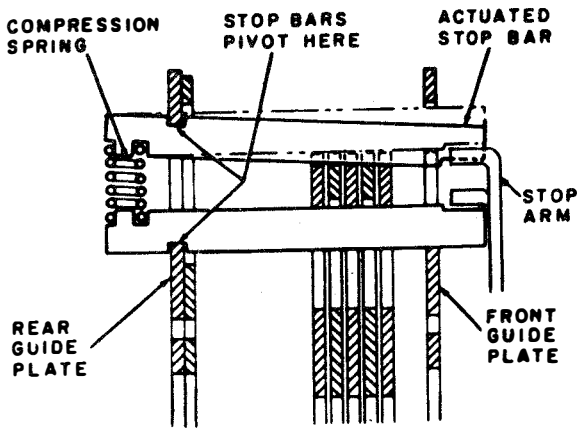

Figure 22. Characters and functions operated by stopbars.

the selector levers. As the high part of the selector cam passes the camming surface of a lever, the selector lever is returned to the unoperated position by the associated spring. The intelligence remains stored in the Y-levers, which are kept in the selected position by the holding action of the Y-lever detents. With the five code pulses stored in the Y-levers, the transfer operation can now take place.

6-15. **Transfer.** The transfer operation begins as the fifth pulse is being stored in the last Y-lever. At this time, the transfer lever latch tripping cam on the selector camshaft is pivoting the transfer lever latch, shown at the lower left on figure 21. When the transfer lever is released, the spring pulls it downward in a clockwise direction. The movement of the transfer lever causes:

- The T-levers to position against the Y-levers.
- The function shaft clutch latch (not shown) to disengage from the stop arm on the sliding clutch drum.

6-16. *T-levers.* The five T-levers pivot on the right end of the transfer lever, as shown in figure 21; and as the transfer lever is rotated downward, the T-levers are brought down on the top of their associated Y-levers. However, the bottoms of the T-levers are wider than the tops of the Y-levers. As a result, if the Y-levers are positioned clockwise, as in figure 21, the right side of the T-lever strikes the right side of the Y-lever and the left side of the T-lever just misses the left side of the Y-lever. This causes the T-lever to rotate counterclockwise. The reverse is true when the Y-lever is positioned counterclockwise or to the left. As you can see, the upper end of the T-lever fits into a fork in the associated code ring.

6-17. *Code rings.* The five code rings pivot on the stop arm shaft and rotate in a clockwise direction for a mark and a counterclockwise direction for a space. They control the movement of the stop bars, which are located around the outside and inside of the rim of the code rings.

6-18. *Stop bars.* The stop bars act against the code rings, which have a series of depressions on the inner and outer edges of the rims. These depressions, when properly aligned by the movement of the code rings, allow the selected code bar to move. Positioned around the rings are 35 stop bars: one for each character of the alphabet and the functions of BLANK, LETTERS, and SPACE. There are two stop bars for each of the functions of LINE FEED, CARRIAGE RETURN, and FIGURES.

6-19. The exact positions for the various stop bars are shown in figure 22. Note that almost half of the stop bars act against the inside of the rim. The notches in the first code ring, in figure 21, are so arranged that when the code ring is set in the marking position, there is a low point opposite the stop bars for the code groups that have a marking impulse (such as A, B, and D) as the first code signal. At the same time, there is a high point blocking the movement of the stop bars for the code groups that have a spacing impulse (such as C, G, and H) as the first code signal. The reverse is true when the code ring is set for a spacing impulse. Similarly, the second code ring is notched in accordance with the second code pulse for each code group. The third code ring is for a third pulse, and so on. Therefore, when the code rings have been set as a result of the transfer operation, there is only one position—except for LF, CR, and FIGS—along the inner or outer radius of the code rings, where there is a notch in each of the five rings in line with a stop bar. This action is shown in figure 23, where the top stop bar has moved

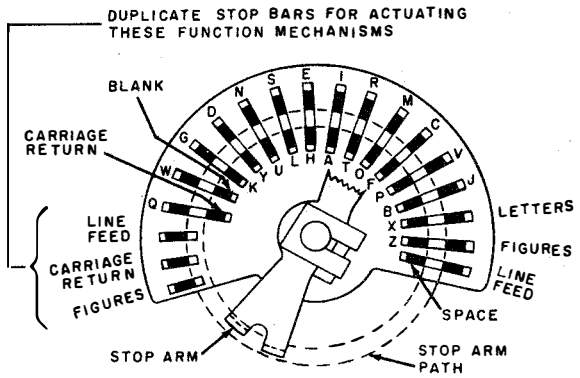

Figure 23. Code ring cage stopbar pushed into aligned notches in code rings.

down into the five notches. The inner bar is shown blocked. The actuated stop bar is positioned by the compression spring; and the other end of the stop bar is now in position to block the movement of the stop arm when it rotates. At the same time, the previously selected stop bar is being pushed back to the unoperated position by the sloping surface at the side of a notch in at least one code ring as the code rings are reset by the transfer operation. This is true unless the same stop bar is selected by repeating a code group.

6-20. This movement of the previously selected stop bar releases the square shaft stop arm and makes it free to turn until it strikes the newly positioned stop bar. The square shaft stop arm is mounted on the end of the square shaft, as shown in figure 24. The code ring cage with its protruding stop bars is not shown. However, you can picture it in position, as shown in figures 22 and 23, as this action continues. At this point, imagine one stop bar either lowered, as shown in figure 23, or raised by the alignment of the notches on the inner circumference.

6-21. As soon as the five code pulses are stored in the Y-levers, the transfer lever, shown at the far right on figure 24, is released. At the same time, the transfer lever spring causes the transfer lever, transfer lever shaft, and the clutch latch, in figure 24, to rotate in a counterclockwise direction. The downward movement of the clutch latch affects the function shaft.

6-22. **Function Shaft.** Once the sliding clutch drum is released, power from the main shaft driving gear is applied to the function shaft. The sliding clutch drum is the driven member of the function shaft clutch, figure 25, and is keyed to the function shaft. When the clutch halves mesh, the function shaft turns in a clockwise direction, as shown in figure 24.

6-23. Subsequently, after the function shaft has made a quarter turn, the transfer-lever restoring cam, on the right end of the function shaft in figure 24, causes the relatching of the transfer

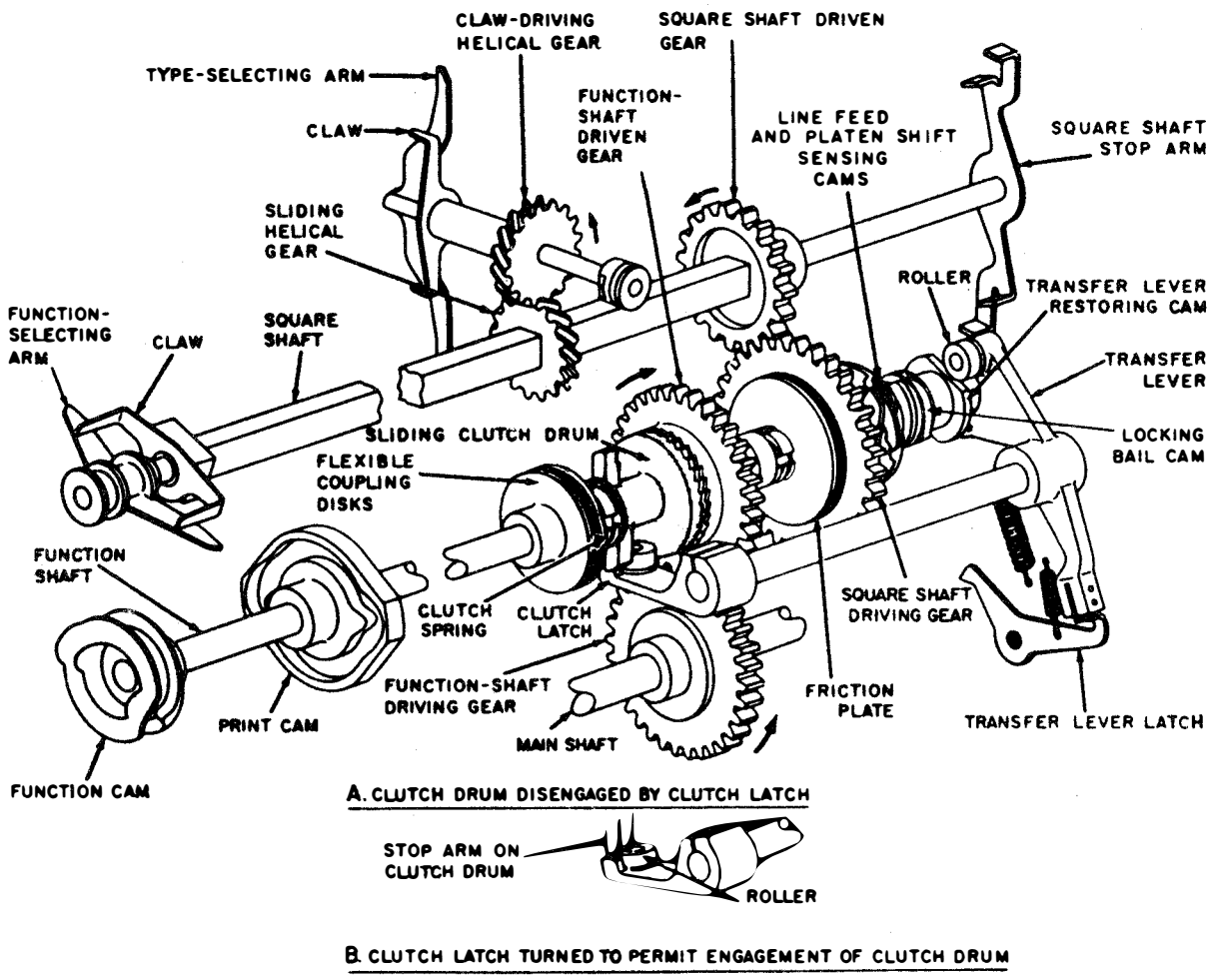

Figure 24. Function shaft operation.

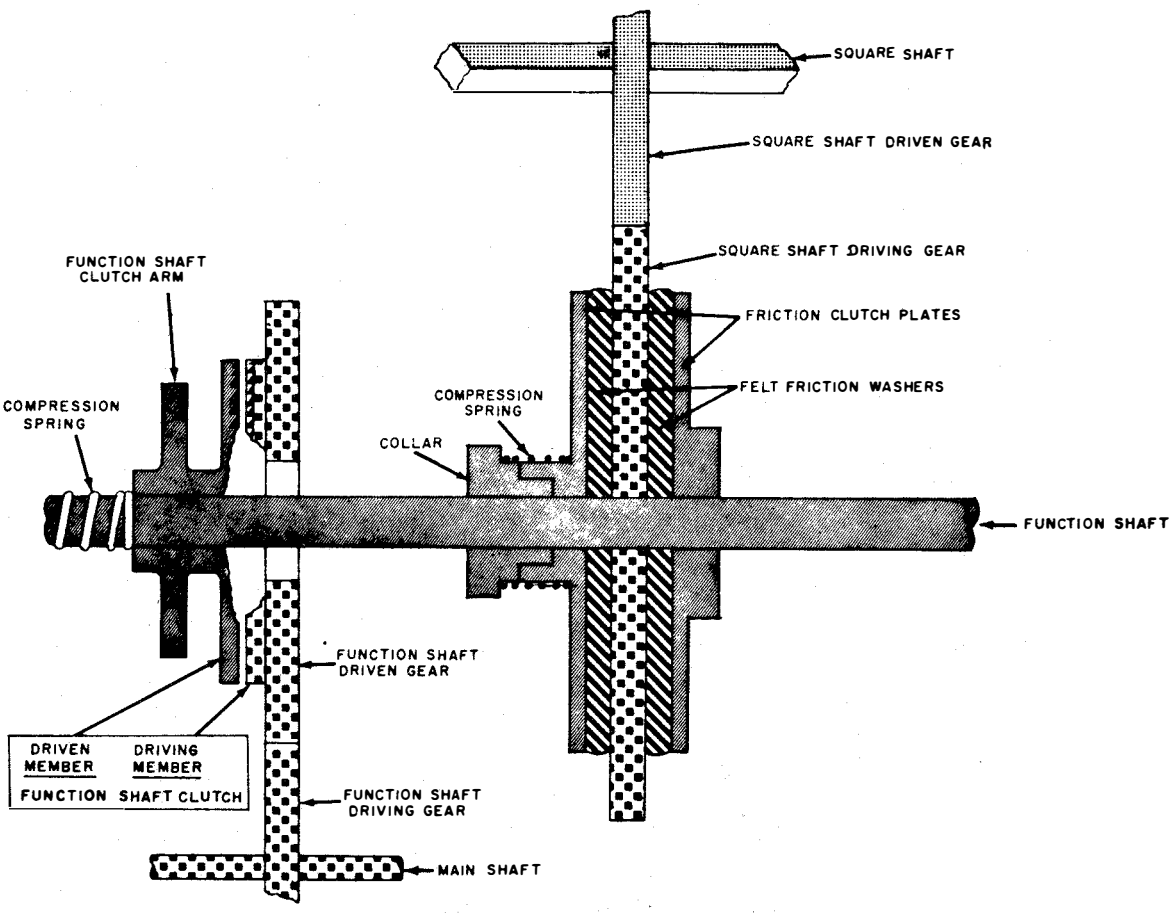

Figure 25. Function shaft clutch.

lever. At the other end of the short transfer lever shaft, the clutch latch is repositioned so that the roller engages the stop arm on the sliding clutch drum. The rotation of the function shaft ceases after one-half of a revolution with the uncoupling of the function shaft clutch.

6-24. While the function shaft is making the half revolution, power is transmitted from the main shaft through the function shaft to the square shaft. The square shaft rotates until the stop arm, shown on the right end of the square shaft in figure 21, strikes the selected stop bar. The square shaft driving gear is mounted between two friction clutch plates. This driving gear slips between the two halves of the friction clutch when the stop arm is blocked by the selected stop bar.

6-25. Note that the sliding helical gear and the function-selecting arm are also positioned by the square shaft. The sliding helical gear insures the proper type bar selection as the type bar carriage moves across the face of the paper.

6-26. **Type Bar Selection.** Type bar selection takes place when the stop arm is blocked by the selected stop bar. At this time, the type-selecting arm is positioned behind the selected connecting bar, which in turn activates the associated type bar. The type-selecting arm is positioned by the helical gears and the square shaft, shown in figure 24. Figure 26 illustrates the sequence of events leading to the printing of the proper character, beginning with the incoming code impulses; the selector mechanism, which selects the correct stop bar; the stop arm and square shaft, which rotates the helical gears and type-selecting

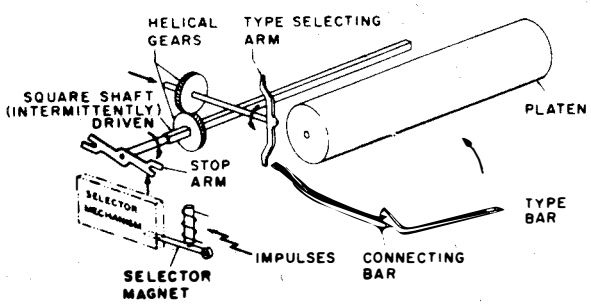

Figure 26. Typing unit basic components.

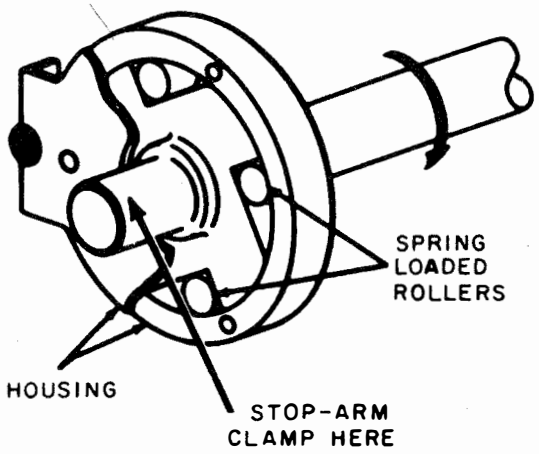

Figure 27. Antibounce clutch.

arm; and finally the connecting bar and type bar, which prints the selected character on the paper.

6-27. **Antibounce Clutch.** The antibounce clutch is located on the square shaft to the right of the square shaft driven gear, shown in figure 24. As the square shaft revolves with considerable force, some mechanism must be provided to prevent a bounceback of the square shaft when the stop arm strikes the selected stop bar. This is necessary in order to keep the type-selecting arm in proper alignment with the selected connecting bar.

6-28. A closeup view of the antibounce clutch is shown in figure 27. The center X-shaped portion is part of the shaft and revolves with the square shaft. The outer housing is held steady by a bracket and does not revolve. There are four spring-loaded rollers, in wedge-shaped openings in the central section, which move with the shaft when it rotates in the proper direction. However, when the shaft tries to rotate in the opposite direction, the rollers immediately jam between the housing and the moving portion of the clutch, thus minimizing any tendency toward bounceback.

7. Printing

7-1. Printing takes place for every character code combination received on the selector magnet except when the platen is in the FIGURES position and when the letters "S" and "H" are received. When the platen is in the FIGURES position and the character "S" is received from the signal line, the signal bell rings and no symbol is printed on the page for this operation. Again, when the letter "H" is received with the machine in the FIGURES position, the motor stop function takes place and no symbol is printed. However, the weather communications equipment (TT–99FG), equipped with the motor stop mechanism, must receive FIGURES, BLANK, and the letter "H" in order to stop the motor. Besides being blank in the FIGURES position, the type bar pallets for the letters "S" and "H" have a hump on them to prevent striking the ribbon so that the paper is not smudged.

7-2. **Function Shaft.** The actual printing of a character is controlled by the rotation of the function shaft. As we explained in Section 6, release of the function shaft causes the square shaft to

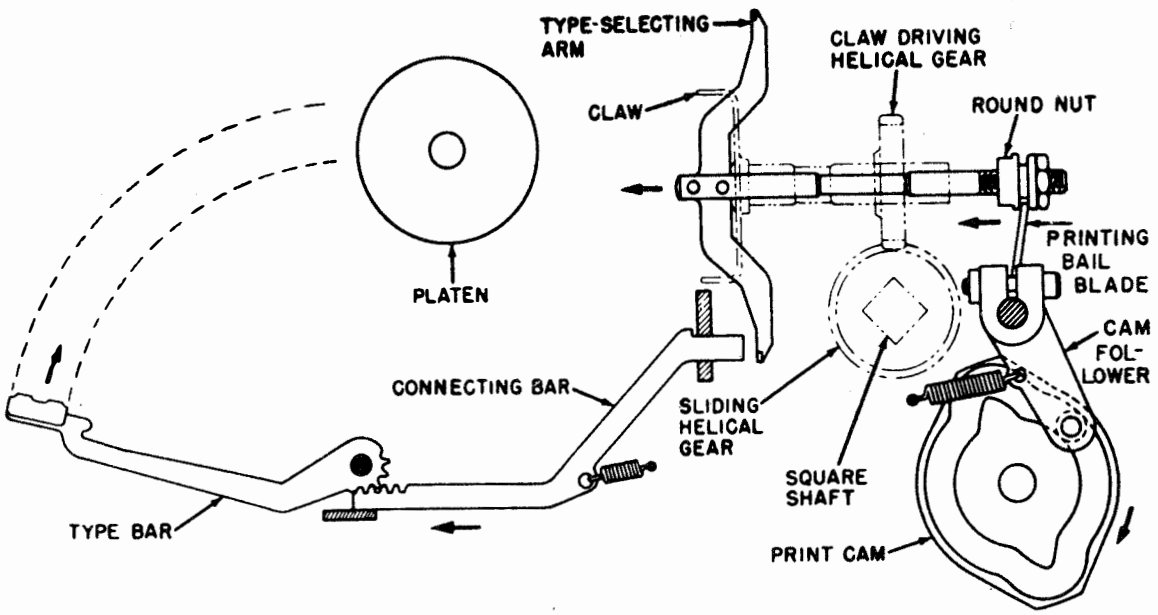

Figure 28. Printing operation—basic components.

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WORKBOOK

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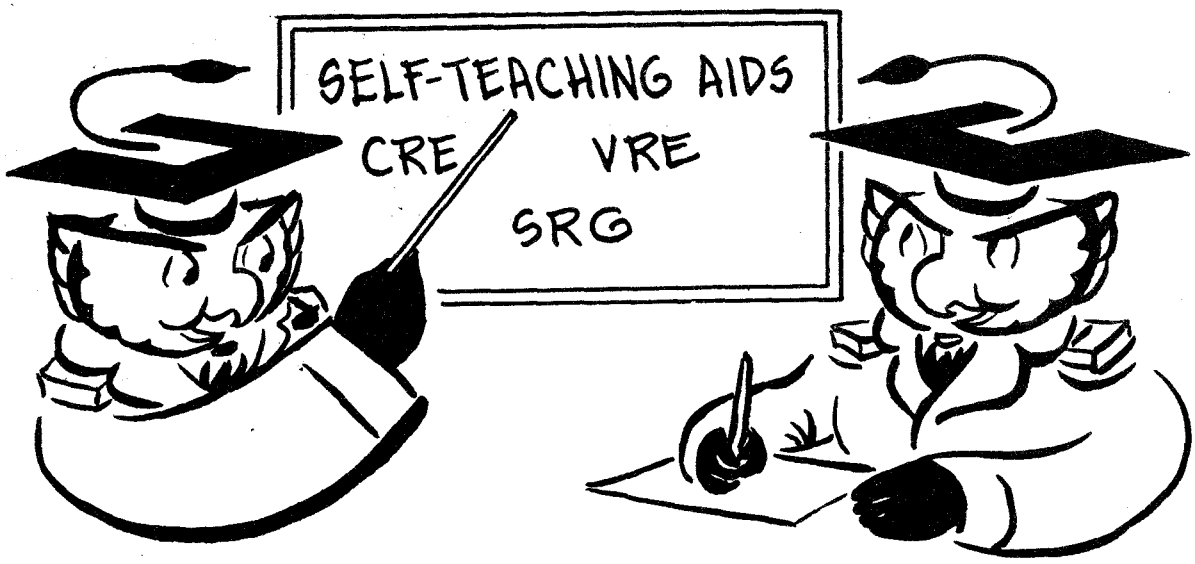

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2. *Use the Guide for Follow-up after you complete the Course Examination.* The CE results will be sent to you on a postcard, which will indicate "Satisfactory" or "Unsatisfactory" completion. The card will list *Guide Numbers* relating to the items missed. Locate these numbers in the Guide and draw a line under the Guide Number, topic, and reference. Review these areas to insure your mastery of the course.

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CHAPTER REVIEW EXERCISES

The following exercises are study aids. Write your answers in pencil in the space provided after each exercise. Immediately after completing each set of exercises, check your responses against the answers for that set. Do not submit your answers to ECI for grading.

CHAPTER 1

Objectives: To demonstrate an understanding of the general purpose and operation of AUTODIN and the principles of operation of the AN/FGC-20 keyboard.

1. Why is the communications machine repairman's job so important to the military communications system? (1-1)

2. What is your understanding of the statement in the text which says "You must know every part by its first name"? (1-5)

3. What types of equipment are within the jurisdiction of the communications machine repairman? (1-7)

4. What is AUTODIN? What is its purpose? (1-9, 10)

5. What is the speed of operation of the HSPTP? The LSCR? The UK? The PP? (1-13-17)

6. Can an ordinary teletypewriter be connected directly to the AUTODIN system? Why? (1-18)

7. What advantage does the teletypewriter have over the telephone for transmitting information? (2-3)

8. Under what conditions would you select a teletypewriter equipped with a series motor rather than a synchronous motor? (2-11)

9. What are the basic differences among the AN/FGC-20, AN/FGC-20X, and AN/FGC-21? (2-10, 11)

10. When you compare the AN/FGC-20 with the AN/FFC-20, what difference do you find? (2-11, 13)

11. If you ordered a "receive only" set and it arrived without a power supply, what action would you take? Why? (2-13)

12. Would it be possible for the AN/FGC-20 to receive a message without all of its nine functional groups being present? Explain your answer. (2-13, 15)

13. What mechanical arrangement provides the electrical connections from the switch and terminal box to circuits of the set? (2-19)

14. In connecting an AN/FGC-20 set to the signal line, you find that the rheostat R10 does not reduce the line current to the proper value. What provision is made to include additional resistance in the line circuit? (2-20)

15. What condition exists within the machine when the line selector switch is placed in the **TEST** position? (2-21; FO 1)

16. An AN/FGC-20 has just been removed from a line using polar signals and you have connected it to a neutral signal line that operates on 60 ma of current. Is moving the line selector switch to 60 all the adjustment that is required? (2-21)

17. What arrangement provides the means of adapting the AN/FGC-20 to operate on various a.c. voltages? (2-30)

18. With the center clutch plate of the transmitter friction mounted so that it is free to move independently of the driving shaft motion, how is the power transferred to the transmitter unit? (3-2)

19. You have found that the keyboard driving shaft clutch is slipping. What mechanical feature is built into the clutch assembly that allows you to correct the condition? (3-2)

20. How would you connect the signal generator for neutral operation? (3-4)

21. You have been instructed to wire the signal generator unit of an AN/FGC-20 for polar operation. How would you do it? (3-6)

22. What is the purpose of the compression spring placed on each of the movable contacts of the signal generator on the AN/FGC-20? (3-7)

23. Why does a code bar move to the right or left when a key lever is depressed? (4-4)

24. What operation does the sensing lever perform? (4-6)

25. What is the purpose of the selector lever? (4-7)

26. The selector levers are said to operate on the principle of a sliding pivot. What is meant by that statement? (4-8)

27. What operation does the sixth selector lever perform? (4-10)

28. What is your understanding of the statement "The keyboard is in the unoperated position"? (5-2, 3)

29. What are the mechanical operations that control the starting and stopping of the transmitter camshaft? (5-3)

30. What mechanical arrangement turns the cam-stop lever when the locking-lever latch is moved away from the right extension of the cam-stop lever? (5-3)

31. How is the cam-stop lever restored to its locking position after being released? (5-5)

32. What components prevent the undesired repeating of characters? How do these components accomplish this operation? (5-6-9)

33. How is repeat transmission accomplished? (5-11)

CHAPTER 2

Objective: To display an understanding of the principles of mechanical operation of the printer, as well as the use of schematics in analyzing the electrical circuits of the AN/FGC-20.

1. What effect will the positioning of the line selector switch to the 60 position have on the windings of the polar select magnet? (6-3)

2. Is there any change in the amount of current required for the bias winding when the line selector switch is moved from the 60 to the 20 position? (6-3)

3. With the line selector switch of the machine in the P position, the selector armature rotates counterclockwise when a particular impulse is received. What pulse will cause this movement? Why? (6-6)

4. What is the condition of the selector camshaft when the machine is not receiving a message but there is current on the line? Why? (6-8)

5. List the purpose of each cam on the selector camshaft. (6-11)

6. Under what condition does the selector lever slide on its pivot bearing? (6-12)

7. What is the purpose of retaining incoming impulses in the Y-levers until all of the impulses for a character have been received? (6-14)

8. What are the operations performed by the transfer lever? (6-16-21)

9. How is an actuated stop bar returned to its unselected position? (6-19)

10. How does the antibounce clutch operate? (6-27, 28)

11. What mechanism prevents printing when the platen is in the FIGURES position and the code combination for S is received? How does it do this? (7-1)

12. What is the reason for having the square shaft rotate faster than the function shaft? (7-3)

13. The type bar is about to strike the platen. At this instant, what is the relative position of the square shaft and the function shaft? (7-4-7)

14. Why isn't the type-selecting arm attached directly to the claw? (7-6, 7)

15. What force disengages the function shaft clutch? (7-10)

16. The transfer lever is returning to its unoperated position. What operations are occurring at this time? (7-14, 15)

17. How does the rangefinder operate to move the selecting period closer to the trailing edges of the code pulses? (7-23-29)

18. What furnishes the power to turn the ribbon spools? (8-3)

19. What mechanism prevents the winding of ribbon as the carriage is moved from right to left across the machine? How does it do this? (8-5; Fig. 32)

20. List the sequence of action that occurs when a ribbon sensing lever protrudes through the window of the ribbon spool. (8-6, 7)

21. What three functions have duplicate stop bars? (9-2)

22. Define the terms "stop bar" and "punch bar." (9-2, 18)

23. Each time a character is transmitted, the carriage return sensing lever restoring cam rotates with the function shaft. What prevents the carriage return function from operating when the sensing lever drops off the high part of the cam? (9-4)

24. In what respect are the figures shift and the line feed functions similar? How do they obtain the power to operate? (9-8)

25. Each time a character is transmitted, the platen shift operating cam rotates with the function shaft. What prevents the cam from operating the figures shift mechanism? (9-11)

26. How is the platen kept from turning when printing is in process? (9-12)

27. What component gives the motor stop punch bar its axial movement? (9-18)

28. What supplies the power to shift the platen to the LETTERS position? (9-20)

29. What is the function of the aperture gate? How does it operate? (9-20-22)

30. Explain why spacing on functions is not desired and how is it suppressed. (9-28)

31. How are the carriage feed and the carriage return interrelated? (9-29)

32. Explain the purpose and the operation of the decelerating cam and arm. (9-35)

33. When and how is manual carriage return obtained? (9-42)

34. Explain the operation of automatic carriage return and line feed. (9-45)

35. There is an open in the wire connected to C of J4. Which circuit in particular is affected? What is the effect on the machine as a whole? (10-6)

36. The power supply unit is arranged as shown on foldout 1. What output is registered at J9-J10 when P1 is connected to a 115-volt a.c. source? Why? (10-8)

37. A voltage reading across J9 and J10 indicates a correct reading while the output of CR1 is zero. Where is the most likely location of the trouble? Why? (10-8, 9)

38. I1 fails to light when S6 is placed in the ON position. Where is the source of trouble located? (10-10)

39. Synchronous motor B2 will not operate even though there is the proper amount of current in the circuit. What could cause this condition? (10-12)

40. An ohmmeter reading across terminal posts 1 and 2 shows a reading of zero ohms. What does this indicate? Where is it located? (10-20)

41. A 20-ma line circuit is connected to terminals 3 and 4 with S7 in the 60-ma position. What effect will this have on the local machine? Why? (10-22, 23)

42. There is a broken connection at 11 of S7, section 1, front. What effect will this have on the operation of the machine? Why? (10-24)

43. A reading at BIAS TEST MA shows 10 ma with S7 in the 20 position. What does this indicate? What procedure should you follow to correct this malfunction? (10-26)

44. Both relays A and B of E1 are operated. What is the condition of the line and machine at this time? (10-30)

45. When do contacts S10 close? Why? (10-33)

CHAPTER 3

Objective: To demonstrate an understanding of the general data concerning the AN/FGC-25, as well as specific information of the principals of sequential and simultaneous operation of the keyboard.

1. Under what conditions would you use an AN/FGC-25X teletypewriter set rather than an AN/FGC-25 set? (11-5; Fig. 63)

2. What is the purpose of the transmitter-distributor control box that is used with the AN/FGC-52 set? (11-7, *c*)

3. What is the highest voltage that is allowed to exist in any part of the AN/FGC-25 teletypewriter without being shielded from accidental contact? (Fig. 63)

4. What are the four basic components that make up the AN/FGC-25 teletypewriter set? (11-11)

5. What is the difference between the page printer used on the AN/FGC-25 and the page printer used on the AN/FGC-20? (11-13, 14)

6. What is the difference between the simultaneous impulses and sequential impulses used with the AN/FGC-25? (11-16, 17)

7. What are the four operational differences between the keyboard of the AN/FGC-20 and the keyboard of the AN/FGC-25? (11-18)

8. How does the typing reperforator used on the AN/FGC-25 differ from other typing reperforators? (11-20)

9. What purpose does the restoring solenoid (L1) serve in the AN/FGC-25? (12-5)

10. How is the L1 solenoid controlled and where are the controls located? (12-6)

11. Where is the simultaneous transmitting unit located in relation to the sequential transmitting unit? (12-9)

12. Is an extra set of code bars required to set up the simultaneous sending unit? (12-9)

13. What operation does the switch arm in the simultaneous sending unit perform? (12-10)

14. What is the advantage of using simultaneous impulses instead of sequential impulses? (12-15)

15. What purpose does the character counting mechanism on the keyboard serve? (12-17)

16. Under what conditions, does the end-of-line switch (S14) operate? Why? (12-22)

CHAPTER 4

Objective: To be able to identify the components and demonstrate the operation of the reperforator, including the switches on the front switch plate.

1. A TT-107/FG is factory equipped to operate at what speed? How can this be changed? (13-2)

2. Where does the selector camshaft receive the power needed for revolving the selector cams? How is this power transmitted? (13-3, 4)

3. What portions of the typing perforator take the place of the square shaft, the printing bail, the type bar carriage, and the spacing mechanism on the AN/FGC-20? (13-5, 6)

4. The stop arm shaft is rotating. What other units are also on the shaft and rotating with the stop arm? (13-9)

5. The stop arm on the stop arm shaft has been positioned by the selected stop bar. The interaction of which units insures proper character selection? (13-9, 10)

6. In what way is the code ring cage of the page printer different from the code ring cage of the typing reperforator? (13-11)

7. List the functions used on the typing reperforator, and name the remaining functions and explain why they are not used on this machine. (13-12-14)

8. If you could observe the code rings in slow motion just prior to printing, you would notice that the rings realign slightly. What causes this movement? (13-15)

9. How does the letters and figures shift operation on an AN/FGC-52 differ from that of an AN/FGC-20? Why? (14-5, 6)

10. Why doesn't the signal bell ring when the code group for the letter "S" is received when the unit is in the LETTERS SHIFT position? (14-12)

11. The bell sensing lever is moving past the bell function stop bar and the signal bell is about to ring. How many times will the bell ring? Why? (14-13)

12. The print hammer is moving upward, yet it does not strike the ribbon. When does this occur? Why? (15-7)

13. Which three functions are recorded on the tape in both punched and printed form? (15-7)

14. How is printing prevented when the figures shift code group is received? (15-7)

15. How is the code for the selected character transferred from the code rings to the punch mechanism? (16-2)

16. The fifth punch interference lever is aligned above its code hole punch lever. What effect does this have on the paper tape as the print and register cam make one-half revolution? Why? (16-2, 3)

17. When does tape feed occur? (16-7)

18. When does ribbon feed occur? Why? (16-12)

19. What replaces the code rings on the typing reperforator? What is their purpose? (17-3)

20. The contacts of S18 are closing. What does this indicate? (17-5)

21. The plungers in the receiving multisolenoid are being positioned so that the ones to the left of the pivot post of the Y-levers are moving down while those to the right of the post are moving upward. What code combination is being received? Why? (17-9, 10)

22. The code plates of the typing reperforator are motionless, yet the unit is preparing tape. How is this possible? Why? (17-17, 18)

23. What is the purpose of the ALR switch? (17-24)

CHAPTER 5

Objective: To be able to explain the mechanical operation of the components of the tape transmitter.

1. What arrangement is added to the tape transmitter so that it can handle either $^{11}/_{16}$ -inch or $^{7}/_{8}$ -inch tape? (18-2)

2. How do you account for the fact that the clutch magnet is energized when the start-stop switch is open? (19-1)

3. What happens when the start-stop lever is placed in the FEED RETRACT position? (19-2)

4. What are the specific functions of each of the three transmitter-distributor control levels? (19-2-4)

5. List the 10 cams located on the tape transmitter camshaft perform? (20-2-12)

6. What condition exists in the tape sensing mechanism when the transmitter camshaft is in the stop position? (20-15)

7. How does the sensing of a character code combination differ from the transmission of that same code combination by the transmitter-distributor? (20-15, 19, 20)

8. When the tape transmitter is in the stop condition, what is the position of the start-stop cam in relation to the start-stop selector lever? (20-16)

9. When you are arranging the tape transmitter to send neutral signals, are there any adjustments to be made to the signal generator contacts? (20-17)

10. What type of impulse does the tape transmitter always send after each stop impulse? (20-17)

11. What are the four distinct movements in the operation of the tape feed claw? (20-21)

12. Which component provides the power to move tape through the tape transmitter? (20-21, 22)

13. What function does the tape feed claw retracting cam perform? (20-21, 22)

14. What mechanical arrangement prevents the tape from slipping and causing a garbled message? (20-24)

CHAPTER 6

Objective: To be able to explain the circuit operation of the AN/FGC-25 and to demonstrate the ability to trace these circuits on the proper schematics.

1. What are the purposes of the following switches? Where are they located?
   a. S6.
   b. S8.
   c. S30.
   (21-3-5)

2. Where are the line binding posts located and what is their purpose? (21-5)

3. A meter in the line 1 circuits indicates low line current. How can you increase the current in the circuit? (21-5)

4. You have been directed to arrange an AN/FGC-25 so that it sends only via the transmitter-distributor on line 2 while the rest of the equipment is connected to line 1. What connections are necessary at the patch panel? (21-10; Fig. 106)

5. An AN/FGC-25 is connected to signal lines in such a manner that it is transmitting to and receiving from two distant stations at the same time. How is this possible? (21-19, 20)

6. F1 is open. What effect does this have on the AN/FGC-25? Why? (22-5)

7. When connecting a TT-179/FG for line operation, you accidentally insert the lead from F6 into TB8-18 instead of TB8-14. What effect, if any does this have on the d.c. circuits? Why? (22-5)

8. An AN/FGC-25 is operating perfectly with one exception. The copy lamps do not light. Could this be caused by an open at F1, TB1, J6, or I1? Why could this not be caused by an opening at some of these locations, and which ones? (22-6; FO 2)

9. The contacts of a series-governed motor are closed. What effect does this have on the motor circuit and the speed of the motor? Why? (22-6)

10. Lamp I3 is glowing. What does this indicate? When is it important? (22-6, 7)

11. A buzzer is activated in the TT-178A/FG. What does this indicate? Why? (22-7)

12. Switch S7 is accidentally changed from 20 to 60. What effect does this have on the machine? The distant station? Why? (22-13)

13. The keyboard transmitter camshaft rotates continuously when S23 is in the KEYBOARD position—after having been set into motion by depressing a key top. What trouble could cause this condition? Where is the most likely location? (22-14-16)

14. The transmitter camshaft rotates each time a key top is depressed with S23 in the TAPE position. Is this normal? Explain. (22-18)

15. A comparison between foldouts 2 and 3 shows a change in the page printer circuit between terminals 7 and 8 of TB4. What is the reasons for this change? (22-18)

16. The position of control switches S23 and S31 determines which set of contacts closes to energize L3. Match the switch position in column 1 with the proper set of contacts in column 2.

Column 1	Column 2
S23 KEYBOARD & TAPE S31 KEYBOARD	S20
S23 TAPE S31 KEYBOARD	S18
S23 ANY S31 REPERFORATOR	S12
(22-21-23)	S11

17. A voltage reading across R204 in the transmitter-distributor circuit indicates current flow at all times whenever the machine is connected to a power source. Is this a normal condition? Explain. (22-25, 26; FO 3)

18. Contacts 2 and 3 of relay A in E1 are closed. What does this indicate? What effect does this have on the signal line? (22-34)

19. How does the positioning of switch S8 affect the operation of E2 in the page printer? Why is this necessary? (22-35)

20. Switch S32 is positioned and switch S18 closes. What occurs as a result of this? (22-41)

21. What is the purpose of the ALR circuit? When is it used? (22-46-48)

ANSWERS FOR CHAPTER REVIEW EXERCISES

CHAPTER 1

1. The success or failure of a military mission depends directly upon the support provided by its communications system. The complexity of modern warfare demands that reliable communications equipment and channels be available at all times. Since the teletypewriter is now an integral part of the Air Force communications system, it is quite obvious that the individual who is responsible for maintaining this equipment holds a very important position.

2. To be a successful troubleshooter and repairman, you must be thoroughly familiar with your equipment. As the statement indicates, you must know the function of every part, its operation and position under all the conditions that can exist in a machine during normal operation.

3. Electromechanical communications, cryptographic, and telautograph equipment are all within the jurisdiction of the communications machine maintenance specialist.

4. AUTODIN is a computer-controlled, high-speed, solid-state data and message switching system, which is extremely secure and flexible. When fully operational, it will handle most of the DOD general-purpose traffic.

5. The high-speed paper tape punch can operate at 150, 300, 600 and 1200 baud; the low-speed card reader at 150 or 300 baud; the universal keyboard operates at the speed of the operator using it; the page printer can receive at a rate of 150, 300, 600, 1200 or 2400 baud.

6. No it cannot. It requires a CCU or a TCU to act as the interface between the network and the teletypewriter set.

7. The teletypewriter provides a typed copy of the message, which prevents the error that is possible when the telephone is used.

8. Equipment using the series motor is selected whenever regulated 60-cycle a.c. power is not available. For example, field equipment and sets sent to foreign countries are normally equipped with series motors.

9. Both the AN/FGC-20 and the AN/FGC-20X contain standard communication symbols, but the AN/FGC-20 is equipped with a synchronous motor, while the AN/FGC-20X is provided with a series-governed motor. In contrast to both, the AN/FGC-21 contains the symbols necessary for transmission of weather data.

10. Unlike the AN/FGC-20, the AN/FFC-20 is a "receive only" machine. It has no keyboard or power supply.

11. No action would be required under the stated conditions. The receive set is not required to furnish line current; therefore, a power supply is not required.

12. It is possible for the AN/FGC-20 to receive a message correctly without two of its nine functional groups. the keyboard group and the power supply. When the machine is receiving a message, the keyboard is idle and the sending station is supplying the line circuit.

13. The switch and terminal box has a plug arrangement mounted in its base. This plug is placed in a jack, which is mounted in the base unit of the machine.

14. Connecting one side of the signal line to binding post 1 places a 1000-ohm fixed resistor in series with the signal circuit, in addition to 5000-ohm variable resistor R10.

15. When the line selector switch is placed in TEST position, the machine signal circuits are disconnected from the line and arranged so that the machine sends to itself.

16. Polar operation requires only 30 ma of line current; therefore, it is necessary to adjust the line resistor so that 60 ma of current is supplied for the neutral signal circuit.

17. The transformer of the power supply is equipped with a series of "taps" for various voltages. By connecting the movable plug to the tap that corresponds to the voltage of the local a.c. power, the output of the transformer is adjusted to the 115 volts a.c. required by the machine.

18. Although the center plate of the transmitter friction clutch is not connected directly to the driving shaft, the tension of the friction clutch spring creates enough friction between friction washers and the center plate to cause the center plate to turn.

19. The driving collar or clutch spring collar, which holds the clutch spring against the outer clutch disk, is held in position by a setscrew. The pressure between the clutch disks can be changed by loosening the setscrew and moving the driving collar to increase or decrease the tension on the spring.

20. For neutral operation, the signal generator uses only the marking contact. Since there is no connection made to the spacing contacts, it is usually moved back so that the bail does not touch it. For neutral operation, one side of the transmitting circuit is connected to the marking contact terminal, and the other side of the circuit is connected to the rear of the contact bail.

21. Polar signals are generated through both the marking and spacing contacts. When you are wiring the signal generator for polar operation, negative battery is connected to the marking contact and positive battery is connected to the spacing contact. Thus, when a marking pulse is transmitted, negative battery is applied to the line through the marking contact. When a spacing impulse is transmitted, positive battery is applied to the line through the closed spacing contact and the bail.

22. The compression spring is placed on each of the movable contacts of the signal generator to insure that a positive contact is made between the contact bail and the selected contact.

23. Each code bar has a series of notches cut across its width, and each notch has one sloping side. When a key lever is depressed, it strikes the sloping side, causing the code bar to move. The direction depends upon whether the impulse is to be marking or spacing.

24. The function of the sensing levers is to lock their associated selector levers in position when a marking impulse is to be transmitted.

25. The selector lever selects the direction in which the contact bail turns and then operates it accordingly.

26. This type of action allows both ends of the selector lever to move. When the upper end is latched, the lower end moves up (slides on its pivot) when the high part of the cam moves against the selector lever.

27. The sixth selector lever moves the contact bail to transmit the start and stop pulses.

28. When the transmitter camshaft is held so that it cannot rotate, the keyboard is said to be in an "unoperated position." The term, also, indicates that the various components involved in selecting and transmitting a character are also in the stop or rest position. For example, a key lever is not depressed, the universal bar is positioned to the left, the right extension of the cam-stop lever rests on the top of the locking-lever latch, etc.

29. As a key lever is moved down, it pushes the universal bar to the right. This movement rotates the locking-lever latch counterclockwise and, as a result, allow the cam-stop lever to be rotated clockwise by its spring. The clockwise movement of the cam-stop lever then releases the transmitter camshaft. Next, as the camshaft revolves, the restoring cam strikes the cam-stop lever, moving it counterclockwise. If the key lever has been released, the universal bar is to the left, and the locking-lever latch is moved under the cam-stop lever by its spring. After the lug on the stop plate has struck the cam-stop lever, the cam-stop lever is prevented from moving by the locking-lever latch. Thus, the transmitter camshaft is stopped until a key lever has been depressed.

30. The cam-stop lever spring is connected so that it maintains a tension on the cam-stop lever in a clockwise direction. Whenever, the locking-lever latch moves away from the right extension of the cam-stop lever, the spring tension causes the cam-stop lever to rotate clockwise.

31. The cam-stop lever is returned to its locking position by the restoring cam. This action begins when the transmitting cam has completed approximately 75 percent of the rotation necessary to transmit a complete character. The stop plate strikes the cam-stop lever during the transmission of the stop pulse.

32. The undesired repeating of characters that can be caused by holding a key lever depressed is prevented by the use of the repeat-blocking lever. This is done as follows: After the cam-stop lever has been allowed to drop and release the transmitter camshaft, it is raised by the restoring cam. At this time, a spring moves the repeat-blocking lever under the cam-stop lever. This action, in turn, prevents the cam-stop lever from releasing the cam-shaft until the key lever has first been released and it or another key lever has been depressed.

33. Repeat transmission continues as long as both the selected key and the repeat key are held depressed. Depressing the repeat key initiates the repeat action. The repeat key rotates the repeat lever, which in turn, rotates the repeat-blocking lever out of the path of the cam-stop lever. This allows the cam-stop lever to move its upper extension out of the path of the tooth on the stop plate, thereby, allowing the cam assembly to route.

CHAPTER 2

1. The line windings are connected to the line in parallel, and the bias winding is connected to an internal power source, rectifier CR1.

2. When the line selector switch is moved from the 60 to the 20 position during neutral operation, the amount of current for the bias winding is reduced from approximately 12 ma to 8 ma.

3. A spacing impulse causes this movement. With the machine in the P position, polar signals are being received, so a reverse current pulse must be on the line. This reverse current increases the magnetic strength of the left-hand core while decreasing that of the right-hand core, thus causing the armature to rotate counterclockwise.

4. When the machine is not receiving a message but there is still current in the line, the selector camshaft is held in the stop position by the stop lever.

5. There are six cams located on the selector camshaft. The purpose of the first five of these cams is to position the selector levers according to the position of the selector magnet armature. The purpose of the sixth cam is to trip the transfer lever latch, which in turn allows the start of the transfer operation.

6. When a marking code pulse is received and the lower end of the selector lever is blocked by the knife edge of the selector armature.

7. Incoming impulses are received in a sequential order because of the limitations of the circuits available for the transmission of electrical impulses. Because it is necessary to have all of the impulses required for a character before printing can take place, these incoming impulses must be stored in some way until all impulses are available. This is accomplished by positioning the Y-levers sequentially, then having the Y-levers position the T-levers simultaneously.

8. The transfer lever, when rotated clockwise by its spring, positions the T-levers against the Y-levers and disengage the function shaft clutch latch from the clutch stop arm. The positioning of the T-levers against the Y-levers then positions the code rings and stop bars for the selection of the correct character by the type-selecting arm. At the same time, the disengagement of the function shaft clutch latch from the stop arm allows the function shaft clutch to engage. Finally, the engagement of this clutch causes the rotation of the square shaft, the print cam, and the function cam.

9. An actuated stop bar is pushed back to its unselected position by the sloping surface at the sides of the notches in the code rings when they are reset for the next character.

10. When the stop arm trys to bounce back from the blocking stop bar, the rollers are wedged in tightly between the movable center portion and the stationary outer ring by the springs.

11. A bump on the letter "S" type bar and a flat surface on the type bar pallet together prevents the printing of a character. It does this as follows: First, the flat portion of the pallet is aligned so that no character is in line to be typed. Then the bump on the type bar is positioned so that as the type bar is thrown upward, it strikes the ribbon guide, stopping the movement of the type bar to the platen.

12. The square shaft rotates faster than the function shaft so that the type-selecting arm is in the proper position before printing takes place.

13. At this instant, both the square shaft and the function shaft have completed their rotation and are in their unoperated position.

14. The type-selecting arm must move horizontally as well as rotate. This would be impossible if it were attached directly to the claw.

15. Actual disengagement is caused by the print cam follower spring through the print cam follower and the print cam.

16. If the transfer lever is returning to its unoperated position, printing is about to take place and the code for the following character is being received in the selector unit.

17. The angle between the stop plate and the selector cams must be increased. The spindle must be allowed to move outward so that the stop plate can rotate slightly in a counterclockwise direction.

18. The movement of the type bar carriage furnishes this power.

19. You have to study figure 32 to find the answer to this question, as the jaw clutch on the bevel gear drive shaft is the mechanism that prevents the winding of the ribbon as the carriage is moved from right to left across the machine. It does this by the slipping of the jaw-clutch teeth when the helical gear turns in the opposite direction.

20. At this time, the following happens:

a. The ribbon reversing cam follower pivots under the ribbon reversing cam.
b. Rotation of the cam forces the cam follower and the connected end of the ribbon reversing beam down.
c. One set of bevel ears meshes, while the other set disengages.
d. The detent holds the beam in the selected position.

21. Each of the functions of line feed, carriage return, and figures has 2 stop bars. One of the stop bars for each such function is used to stop the stop arm and square shaft; the other is used to start the operation of the function mechanism.

22. The term "stop bar" refers to that compartment of the machine which is used to arrest the movement of the stop arm and controls the movement of the carriage return, the line feed, and the figures sensing levers. The term "punch bar" refers to the component which is activated by the function-selecting lever and transfers movement from the lever to the mechanisms of the functions letters, the signal bell, and the motor stop.

23. The carriage return sensing lever is blocked by the carriage return stop bar.

24. They are similar in that both are stop-bar operated. When selecting, the sensing lever positions the cam follower so that the beveled roller and operating cam lock on to each other in such a manner that full power, without fear of slippage, can be delivered.

25. The spring located between the line feed cam follower and the platen shaft cam follower holds the platen shift cam follower in its unoperated position so that the platen shift cam does not engage the cam follower roller.

26. The detent wheel, attached to the platen, is held in place by the line-spacing detent.

27. The motor stop punch bar receives its axial motion from the function-selecting arm.

28. The weight of the platen itself supplies this power. The sequence of operation releases the latched aperture gate, which allows the platen to drop into the LETTERS position.

29. The aperture gate blocks the movement of the signal bell and motor stop punch bars when the platen is in the LETTERS position. When the plate is raised into the FIGURES position, the aperture gate—which is linked to the platen—rotates so that a cutout in the gate lines up with the punch bars and they are free to move upon the reception of the proper code signal.

30. Although spacing is a necessary operation of the machine, it is not desired during the operation of functions. The reason is that, since functions are nontyping operations under normal circumstances, it is undesirable to have a blank or space appear in the typing every time a function is repeated. In order, therefore, to prevent spacing on functions, an opening has been cut in the punch bar guide block for every function. Thus, when the function cam follower rides to the high part of the function cam, the selecting arm is allowed to move forward into the cutaway portion of the punch bar guide block. Since spacing takes place only when the axial movement of the function-selecting arm is blocked, there is no movement of the carriage during the operation of a function.

31. They are interrelated in that the carriage return operation can occur only when the carriage feed clutch drum is uncoupled and the carriage return clutch drum is coupled. Also, both operations occur simultaneously.

32. The purpose of the decelerating cam and arm is to slow down the carriage as it approaches the left-hand margin. This is done as follows: The carriage is returned to the left side by the carriage return shaft, the carriage return driving gear, and the carriage return driven gear. When the carriage is within seven-eighths inch of the left margin, the decelerating arm engages the decelerating cam. Then, as the arm and cam are engaged, a blank area on the carriage return driving gear allows power to return to the carriage to be transferred to the decelerating arm and cam. Finally, as the arm moves into the cam, the turn ratio is reduced until the carriage is slowed sufficiently so that it does not damage the machine as it comes up against the right stop.

33. Manual carriage return is obtained when the operator or repairman pushes the manual carrage return button on the front of the dust cover. When the button is depressed, the movement is transferred to the double blocking lever, which disengages the carriage feed clutch and engages the carriage return clutch.

34. When the carriage starts to move into the 73d space on a line, the automatic carriage return and line feed mechanism is operated. In the 72d space, the right-hand margin trip plate just touches the stop bar shift lever. Next, when the 73d character is received and the carriage is moved, the trip plate makes the shift lever rotate and move the stop bar shift link and blade. The shift blade is then engaged with the carriage return and line feed stop bars, and when the blade is moved, the stop bars are also moved, under their sensing levers. Thus, the sensing levers are allowed to move and operate the carriage return and line feed functions.

35. The a.c. input circuit is the specific circuit that is affected. An open at this point makes the machine inoperative, as there is no current to any portion of the equipment.

36. The reading at J9-J10 will be about 60-65 volts d.c., with C of J4 patched to tap 7 of TB3. T1 is a step-down transformer which cuts the voltage to approximately one-half of the input voltage.

37. The trouble must lie in the part of the circuit that is not common to the basic input circuit. To get a correct reading at J9 and J10, there must be current between C and A of J4. The trouble must be somewhere between the tap at 4 of TB3, through CR1 to the junction with A of J4.

38. It's hard to say from the information given. If I2 does light, the trouble is probably in the lamp I1 itself. If neither lamp lights, the trouble is probably in the wiring or the switch.

39. In all likelihood, the trouble is in the start winding circuit, which is not supplying the needed starting torque. It could be anything in the circuit from the contacts of E3 to the junction with the run winding of the motor.

40. It indicates a short in the circuit, which must be at the terminal posts, for the first units beyond the posts are R3 and R10.

41. The machine will probably run open, as there is more current in the bias windings than in the line windings.

42. The machine will run open in the TEST position only, as this is the only time it is part of the circuit. In the TEST position, there will be no current in the selector magnet.

43. It indicates that there is too much current in the bias circuit. R4 shoud be adjusted until the meter reads 8 ma.

44. The stop pulse is on the line. All machines in the circuit equipped with motor stop units have their motors in the stopped condition.

45. Contacts S10 close each time the function shaft nears the end of one-half revolution and remain closed until the function shaft begins the next half revolution. The circuit through S10 keeps relay C operated until the next code combination is received.

CHAPTER 3

1. The AN/FGC-25X would be used when the local power source could not furnish regulated 60-cycle a.c.

2. The transmitter-distributor control box provides the means for controlling the operation of the transmitter-distributor from an external pulsing source. This control arrangement insures correct operating speeds of the transmitter-distributor.

3. Points having a potential of less than 30 volts usually do not require shielding.

4. The four basic components of the AN/FGC-25 are: the page printer, the preforator, the transmitter-distributor, and the table.

5. The page printer used on the AN/FGC-25 differs from the page printer of the AN/FGC-20 primarily in the form of its keyboard. The keyboard of the AN/FGC-25 depends upon both electrical and mechanical operations to transmit signals, while the keyboard of the AN/FGC-20 requires only mechanical operations to transmit signals. In addition, the keyboard of the AN/FGC-25 can transmit both simultaneous and sequential signals, whereas the AN/FGC-20 can transmit only sequential signals.

6. The sequential impulses used in conjunction with the operation of the AN/FGC-25 are simply the same signals we have previously called the 5-unit teletypewriter code. These signals consist of 7 spacing and marking signals, which are transmitted one following the other. The first impulse transmitted for any character is a spacing (start) impulse, and the last impulse transmitted is a marking (stop) impulse. The intermediate impulses transmitted are the code impulses, and whether they are spacing or marking is determined by the character transmitted. The simultaneous impulses transmitted are basically the same as the sequential impulses, except that there is no start or stop impulse used, and the code impulses are all transmitted at the same time rather than one following the other.

7. The four operational differences between the keyboard of the AN/FGC-20 and keyboard of the AN/FGC-25 are: the use of simultaneous impulses, addition of a tabular mechanism to the AN/FGC-25, addition of the character counting mechanism to the AN/FGC-25, and the electrical operation of the keyboard.

8. The typing reperforator on the AN/FGC-25 differs from other typing reperforators because it contains two receiving units. One of these units receives incoming pulses from the signal line, converts them to simultaneous impulses, and transmits them to the second unit. The second receiving unit receives simultaneous impulses either from the first receiving mechanism or from the keyboard of the page printer and converts them to the mechanical actions necessary for the printing and perforating of tape.

9. The function of L1 (restoring solenoid) is to return the cam-stop lever to its stop position after a code group is transmitted.

10. The L1 solenoid is energized by the keyboard counter switch (S12), which is mounted at the rear of the keyboard transmitter casting.

11. The simultaneous unit is located on the left side of the keyboard assembly, while the sequential unit is located on the right side.

12. The same code bars set up both units.

13. The switch arm transfers the motion of the code bar to its corresponding shunting switch arm.

14. The advantage of using simultaneous impulses rather than sequential impulses is that the transmission and reception speed can be increased over that possible when sequential impulses are used.

15. At times, local tape will be prepared by the operator, without the use of the page printer to produce a copy of the message being prepared on tape for transmission. In this case, the operator has no way of knowing when a receiving page printer is approaching the end of a line of characters if the preparing machine had no character counting mechanism to inform the operator of this fact so that a carriage return and line feed signal can be inserted into the message at the proper time.

16. The end-of-line switch (S14), which is part of the end-of-line indicating mechanism, operates after the 66th character is transmitted. It closes a circuit to light the end-of-line lamp to provide a visual warning to the operator that it is time to operate the carriage return and line feed keys.

CHAPTER 4

1. A receive-only type reperforator is factory equipped to operate at a speed of 368.1 operations per minute. It is also equipped with an alternate set of gears which, when interchanged, can increase the receiving speed to 600 operations per minute. Additional sets of gears can be ordered to cause the machine to operate at 404 or 460 operations per minute.

2. The main shaft supplies the power to revolve the selector camshaft. Such power is transmitted through a friction clutch.

3. When comparing the typing reperforator with the page printer, you find (1) the type wheel shaft takes the place of the square shaft, (2) the print hammer takes the place of the printing bail, (3) the type wheel takes the place of the type bar carriage, and (4) the tape feed mechanism takes the place of the spacing mechanism.

4. The type wheel hub driven gear is positioned at the end of the shaft and rotates with it. In addition, don't forget the antibounce clutch.

5. The interaction of the type wheel driven gear, which is fastened to the stop arm shaft and the type wheel hub assembly, insures proper character selection.

6. The code ring cage of the page printer is almost identical to the code ring cage of the typing reperforator, with one exception: the code ring cage of the page printer is equipped with 35 stop bars, while the code ring cage of the typing reperforator has only 32 stop bars.

7. There are only three functions included in the typing reperforator. They are signal bell, letters shift, and figures shift. The functions not used are carriage return, line feed, and motor stop. The carriage return and line feed functions are not necessary because the typing and perforating of the message take place on a continuous tape. The motor stop function is not included because of design restrictions.

8. This movement is caused by the code ring locking bail engaging the notches in the code rings. This engagement and movement insures proper alignment of the character to be printed.

9. The letters and figures shift operation on an AN/FGC-52 consists of changing the length of forward travel of the reciprocating type wheel. The forward stroke is longer for a figures shift than a letters shift. Therefore, the rearmost characters are aligned above the print hammer after a figures shift. Of course, on an AN/FGC-20, the platen shifts upward for a figures shift and then drops back down for a letters shift.

10. When the unit is in the LETTERS SHIFT position, the upper extension of the bell sensing lever is blocked by the upper arm of the letters-figures shift latch lever, therby preventing the signal bell from ringing.

11. Since the type wheel and function lever cam must make a half revolution to strike the bell a second time, the bell will ring only once for each signal bell code combination received.

12. This occurs whenever the letters shift, figures shift, or space code group is received. The stop bars for these three code combinations are positioned to cause the register wheel to rotate; this means that a solid portion of the wheel is above the blade of the type wheel register lever. This prevents the release of the print hammer eccentric stop, which stops the hammer before it can strike the ribbon and tape.

13. The three functions which are recorded on the tape in both printed and punched form are: carriage return, line feed, and blank.

14. When the figures shift code group is received, printing will not occur because the print hammer lever is blocked by the print hammer lever eccentric stop.

15. The codes for the selected characters are transferred from the code rings to the punch mechanism by the punch interference levers.

16. A hole is punched in the tape by the fifth code punch bar with the punch interference lever in the blocking position. The movement of the punch arm assembly drives the code punch bar upward through the tape.

17. The upward movement of the lower extension of the punch arm assembly moves the feed pawl upward into the tape feed ratchet wheel. The ratchet wheel turns one notch before the upward moving code punch bars reach the tape in the code die assembly.

18. Ribbon feed occurs after every other character. This is because (1) the ribbon feed cam has only one high part and (2) one complete revolution of the shaft is required to cause a ribbon feed sequence to occur.

19. The code plates replace the code rings on the typing reperforator. They position the code actuated switch S32.

20. It is an indication that the intelligence is transferred to switch S32 and that the circuits to the receiving multisolenoid are being pulsed.

21. The blank combination. All Y-levers are being positioned counterclockwise.

22. This condition is possible when S23 is in the TAPE position and S31 is in KEYBD. When so conditioned, the sequential portion of the typing reperforator is bypassed and transmission from the local keyboard is directly to the receiving multisolenoid.

23. The ALR switch operates in conjunction with the LINE switch. When the LINE switch is in the TEST position, by placing the ALR switch to line 1 or line 2 as the case may be, line signals disconnect the page printer from the local test circuit and place it in series with the line so that the incoming message will be received.

CHAPTER 5

1. A sliding bar is installed on the tape retaining lid. This bar is raised out of the way when $\frac{7}{8}$-inch tape is used and dropped against the tap chute when $\frac{11}{16}$ - inch tape is used.

2. The start-stop switch is not located in the clutch magnet circuit, but controls a circut panel parallel to the clutch magnet circuit. When the start-stop switch is closed, a path parallel to the clutch magnet is complete; and, as a result, current applied to the circuit bypasses the magnet, causing it to be deenergized. When the start-stop switch is open, the current flows through the clutch magnet, causing it to energize.

3. When the stop-start lever is placed in the FEED RETRACT position, the start-stop switch is closed and the feed pins of the tape feed calw are lowered so that they do not engage the feed holes in the message tape.

4. The stop-start lever is the manual control to stop and start the unit. It has a third position in which the feed claw is retracted for easy insertion of tape. The tape-out lever automatically stops the transmitter-distributor when the end of the tape passes through the machine. The tight-tape lever stops transmission when it senses a tight-tape condition. This prevents tearing the tape.

5. The 10 cams mounted on the tape transmitter camshaft are: the stop lever cam, the start-stop cam, the tape feed lever cam, the sensing lever restoring cam, the tape feed retracting cam, and the five code impulse cams. All of the mechanical actions in the tape transmitter are generated by the cam assembly.

6. When the transmitter camshaft is in the stop position, the sensing lever restoring bail is resting on the high part of the sensing lever restoring cam. In this position, the bail holds all five code sensing levers so that the sensing pins cannot touch the tape.

7. All five code inpulses are sensed simultaneously by the sensing lever pins. Transmission, however, is in sequential order.

8. The lobe on the start-stop cam is opposite the midpoint of the start-stop selector lever.

9. Generally, when the transmitter is operating to send a neutral signal, the spacing contact is moved back so that the contact bail does not touch it.

10. The tape transmitter always sends a spacing (start) impulse after each stop inpulse.

11. The four distinct movements of the claw are: down (caused by retracting cam), forward (caused by the feed lever cam and the feed claw spring), up (caused by the retracting lever cam and spring, and back (caused by the feed lever spring).

12. Power to move tape through the transmitter is provided by the feed lever spring. After the claw has engaged the tape, the feed lever drops to the low part of the feed lever cam. It is this movement, caused by the feed lever spring, which actually moves the tape through the unit.

13. The purpose of the tape feed claw retracting cam on the tape transmitter is to position the tape feed claw vertically. The down movement of the feed claw withdraws the claw from engagement with the tape. After the claw has been moved forward, the claw is again engaged with the tape in preparation for stepping the tape through the transmitter.

14. Either the tape feed claw or the tape sensing pins are in contact with the message tape at all times.

CHAPTER 6

1. *a.* S6 is the printer copy lamp switch used to turn the copy lamps on and off. It is located to the left of the keyboard in the keyboard guard.
   b. S8 is the signal switch used to connect the printer selector magnet to the signal line. Positioning this switch changes the arrangement of the selector magnet so that the unit may operate properly on 20- and 60-ma neutral signals or 30-ma polar signals. It is located on the printer terminal box.
   c. S30 is the perforator bias switch. It adjusts the bias current of the perforator selector magnet. It is located on the rear control panel of the perforator.

2. The line binding posts are found on the perforator rear control panel and are used to make the line connections. As many as four signal circuits can be terminated at a machine. When the local machine is called upon to supply line current, line 1 or line 2 must be used. Lines 3 and 4 are used when the distant machine supplies the current for the circuit.

3. The current can be increased by adjusting the LINE 1 LINE INCREASE MA. If this does not bring the line current up to the desired reading and the line is connected to A and B, changing the circuit to posts A and C reduces the resistance 1000 ohms by removing R18 from the line circuit.

4. This arrangement requires patch panel condition B. The plugs and jacks are connected as follows: P35 to J38, P36 to J44, P37 to J45, P38 to J36, P39 to J39, P40 to J40, P41 to J41, P42 to J42, P43 to J43, P44 to J35, P45 to J37, P46 to J46, P47 to J47, and P48 to J48.

5. By using patch panel condition K or L, the AN/FGC-25 can be connected to two full-duples circuits.

6. The page printer of the AN/FGC-25 is inoperative, as fuse F1 is in the a.c. input circuit. What effects this has on the remaining equipment depends on the patch panel condition being used.

7. This reduces the d.c. voltage to approximately half of what the output would be when TB8-14 is used. All the taps above 115 (TB8-13) will make T2 a stepdown transformer. All the taps below 115 convert T2 to a stepup transformer.

8. A study of the circuit on foldout 2 shows us that the only possible location is J6. It could not be caused by an open at either F1 or TB1, since these will affect other circuits. Also, as the copy lamps are in parallel, an open at I1, has no effect on I2.

9. There is more current through the motor circuit; consequently, the speed of the motor increases. The closed governor contacts provide a patch to bypass the fixed resistor in the circuit. Reducing the resistance increases the current.

10. It is an indication that at least 66 characters have been transmitted from the keyboard since the last carriage return signal. It is an important indicator when the operator is cutting local tape without using the page printer to monitor the number of characters per line. It informs the operator that it is time to insert a carriage return and a line feed signal into the message to prevent a pileup of characters at the end of a line when the taped message is transmitted to page printers.

11. This indicates that the tape supply in the reperforator is low, switch S216 is closed, and the circuit to DS202 is completed.

12. The machine will in all likelihood garble, as the current in the bias windings has been increased while the line current remains unchanged. There will be no effect on the distant station, as the bias circuit is a local circuit, which cannot affect the distant machine.

13. The condition is caused by the failure of L1 to energize to restore the cam-stop lever to the stopping position. The most likely source of the trouble is at the contacts of S11 or S12.

14. No. The transmitter camshaft should not revolve when S23 is in the TAPE position. This indicates that the lock solenoid L2 is not energizing. Check the circuit for an open caused by dirty contacts, burnt-out coil, or a loose connection at one of the TB blocks.

15. The later models of this set use a manual keyboard control lever instead of lock solenoid L2.

16.

S23 KEYBOARD & TAPE S31 KEYBOARD	S12
S23 TAPE S31 KEYBOARD	S11
S23 (ANY) S31 REPERFORATOR	S18

17. Yes, this is a normal condition. A glance at the circuit (bottom center of FO 3) shows that current flows through the resistor when S205 is either opened or closed.

18. This indicates that the motor stop relay is in effect and no traffic is being transmitted. Of course, these contacts could be closed because of a trouble condition, in which case the transmitting contacts of the local unit are shunted, preventing transmission from the local machine.

19. The positioning of S8 places the windings of E2 (selector magnet) either in series or in parallel with the signal line, depending upon the strength of the neutral signal on the line. When a 60-ma signal is used, the magnets are placed in parallel, with 30 ma of current in each winding. When a 20-ma line signal is used, the windings are placed in series so that the 20-ma pass through both windings.

20. Five circuits to the receiving multisolenoid energize simultaneously to position the Y-levers in the reperforator.

21. The ALR circuit is used when all the equipment is connected to a single line circuit and you are testing the local equipment. With switches S28 and S24 positioned properly, the local equipment is removed from the line and relay A of K1 is placed into the line circuit. When relay A responds to a spacing impulse—indicating that the distant station is transmitting—relay A releases and sets up the sequence of action which removes the page printer from the local test circuit and places it in series with the line so that the incoming message is not lost.

STOP–

1. MATCH ANSWER SHEET TO THIS EXERCISE NUMBER.

2. USE NUMBER 1 PENCIL.

36350 01 21

VOLUME REVIEW EXERCISE

Carefully read the following:

DO'S:

1. Check the "course," "volume," and "form" numbers from the answer sheet address tab against the "VRE answer sheet identification number" in the righthand column of the shipping list. If numbers do not match, take action to return the answer sheet and the shipping list to ECI immediately with a note of explanation.
2. Note that numerical sequence on answer sheet alternates across from column to column.
3. Use only medium sharp #1 black lead pencil for marking answer sheet.
4. Circle the correct answer in this test booklet. After you are sure of your answers, transfer them to the answer sheet. If you *have* to change an answer on the answer sheet, be sure that the erasure is complete. Use a clean eraser. But try to avoid any erasure on the answer sheet if at all possible.
5. Take action to return entire answer sheet to ECI.
6. Keep Volume Review Exercise booklet for review and reference.
7. If *mandatorily* enrolled student, process questions or comments through your unit trainer or OJT supervisor.
   If *voluntarily* enrolled student, send questions or comments to ECI on ECI Form 17.

DON'TS:

1. Don't use answer sheets other than one furnished specifically for each review exercise.
2. Don't mark on the answer sheet except to fill in marking blocks. Double marks or excessive markings which overflow marking blocks will register as errors.
3. Don't fold, spindle, staple, tape, or mutilate the answer sheet.
4. Don't use ink or any marking other than with a #1 black lead pencil.

NOTE: TEXT PAGE REFERENCES ARE USED ON THE VOLUME REVIEW EXERCISE. In parenthesis after each item number on the VRE is the *Text Page Number* where the answer to that item can be located. When answering the items on the VRE, refer to the *Text Pages* indicated by these *Numbers*. The VRE results will be sent to you on a postcard which will list the *actual VRE items you missed*. Go to the VRE booklet and locate the *Text Page Numbers* for the items missed. Go to the text and carefully review the areas covered by these references. Review the entire VRE again before you take the closed-book Course Examination.

Multiple Choice

Note: The first three items in this exercise are based on instructions that were included with your course materials. The correctness or incorrectness of your answers to these items will be reflected in your total score. There are no Test Page Numbers for these first three items.

1. The form number of this VRE must match

   a. my course number.
   b. the number of the Shipping List.
   c. the form number on the answer sheet.
   d. my course volume number.

2. So that the electronic scanner can properly score my answer sheet, I must mark my answers with a

   a. pen with blue ink.
   b. number 1 black lead pencil.
   c. ball point or liquid-lead pen.
   d. pen with black ink.

3. If I tape, staple or mutilate my answer sheet; or if I do not cleanly erase when I make changes on the sheet; or if I write over the numbers and symbols along the top margin of the sheet,

   a. I will receive a new answer sheet.
   b. my answer sheet will be hand-graded.
   c. I will be required to retake the VRE.
   d. my answer sheet will be unscored or scored incorrectly.

Chapter 1

4. (003) In your job as a communications machine maintenance repairman, you are *not* responsible for

   a. testing power sources.
   b. preparations for installation.
   c. unloading and unpacking equipment.
   d. installation plans and specifications.

5. (004) In a DSTE station, the low-speed paper tape punch is receiving traffic. This reception is at a baud rate of

   a. 100.
   b. 150.
   c. 300.
   d. 600.

6. (004) The DSTE page printer is designed to receive traffic from the AUTODIN switching center at all of the following baud rates *except*

   a. 2400.
   b. 1200.
   c. 600.
   d. 100.

7. (005) An AN/FGC-20 is receiving a message from an automatic transmitter. In 20 seconds of operation, it can print 25 average words. This machine is geared to operate at a speed of

   a. 60 w.p.m.
   b. 66 w.p.m.
   c. 75 w.p.m.
   d. 100 w.p.m.

8. (008) A machine designed *only* for the reception of messages is equipped with a

a. TT-5/FG printer.
b. TT-47/UG printer.
c. TT-76/GGC printer.
d. TT-259/FG printer.

9. (009) Connecting bars of the AN/FGC-20 are found in the

a. keyboard group.
b. carriage group.
c. platen group.
d. selector group.

10. (010) An AN/FGC-20 which had been operating with a source voltage of 230 volts a.c. is connected to a 120-volt a.c. source without changing the input tap. The motor is now operating on an a.c. of approximately

a. 60 volts.
b. 90 volts.
c. 105 volts.
d. 120 volts.

11. (010) With a power supply input of 210 volts a.c. as depicted in foldout 1, how is a.c. supplied to CR1?

a. Through J4A (B and C).
b. Directly from the power plug.
c. Through autotransformer action (A and B of J4A).
d. From the isolated secondary of the power supply transformer.

12. (011) When the power transmission chain of the AN/FGC-20 is opposed by stop-cam action, the

a. friction clutches slip.
b. clutch disengages.
c. direction of rotation reverses.
d. keyboard driving shaft stops.

13. (011) The friction clutches used on the AN/FGC-20 require the use of

a. two friction disks.
b. three friction disks.
c. one felt washer.
d. three felt washers.

14. (012) When an AN/FGC-20 is used in full-duplex polar operation, a spacing impulse will apply a

a. negative potential to line terminal 5.
b. negative potential to line terminal 3.
c. positive potential to line terminal 2.
d. positive potential to line terminal 1.

15. (012) Correct connection is insured between the contact bail and the spacing contact of an AN/FGC-20 by the

a. adjustable contact screw.
b. contact compression spring.
c. mobable contact.
d. contact bail spring.

16. (013-014) To transmit a marking impulse from the keyboard of an AN/FGC-20, the

a. selector lever rotates counterclockwise.
b. contact bail rotates clockwise.
c. transmitting cam rotates counterclockwise.
d. sensing lever rotates clockwise.

17. (015) The keyboard of the AN/FGC-20 is held in the unoperated position by the

a. cam-stop lever.
b. universal bar.
c. locking-lever latch.
d. repeat-blocking lever.

18. (016) Depressing a key top of an AN/FGC-20 causes the transmitter camshaft to revolve more than one-half of a revolution. This is caused by a

a. maladjusted key lever.
b. missing locking-lever latch spring.
c. missing repeat-blocking lever spring.
d. maladjusted universal bar adjusting screw.

19. (016) The repeated transmission of a code combination from an AN/FGC-20 is due to the constant positioning of the

a. repeat lever in a clockwise direction.
b. locking lever latch in a clockwise direction.
c. cam-stop lever in a counterclockwise direction.
d. repeat-blocking lever in a clockwise direction.

20. (018) All of the following are located on the transmitter camshaft of an AN/FGC-20 *except* the

a. stop cam.
b. restoring cam.
c. selector lever cam.
d. sensing-lever locking bail cam.

Chapter 2

21. (019) A test instrument indicates that an AN&FGC-20 is operating on polar signals. At this time, a start pulse is on the line, and a meter reading of *one* line winding will show a current of

a. 60 ma.
b. 30 ma.
c. 15 ma.
d. 0 ma.

22. (021-022) The selector camshaft of an AN/FGC-20 has just begun to rotate. This is an indication that

a. the stop pulse is being received.
b. the selector armature is released.
c. one of the five code pulses is on the signal line.
d. the knife edge of the selector armature is below the stop lever.

23. (022) The selector magnet armature of the AN/FGC-20 directly controls the positioning of the

a. selector levers.
b. selector cams.
c. Y-levers.
d. T-levers.

24. (023) The transfer operation is started when the transfer lever latch of the AN/FGC-20 is actuated by the

a. sixth cam.
b. selector lever.
c. transfer lever.
d. selector camshaft.

25. (023) The code rings of an AN/FGC-20 fail to position after a code combination is received. This could be due to a spring missing from

a. a selector lever.
b. the transfer lever.
c. a Y-lever detent.
d. the selector magnet armature.

26. (024-025) The transfer shaft of the AN/FGC-20 begins to reset when the function shaft has rotated

a. 0°.
b. 90°.
c. 180°.
d. 360°.

27. (025-026) The square shaft of the AN/FGC-20 positions the

a. stop arm.
b. code rings.
c. print cam.
d. type-selecting arm.

28. (027) If the time required for the print cam of an AN/FGC-20 to rotate 180° is taken as one unit, in which quarter of the unit will printing take place?

a. First.
b. Second.
c. Third.
d. Fourth.

29. (028) The function shaft clutch teeth on an AN/FGC-20 have very little clearance when disengaged. This could be caused by a

a. missing transfer lever spring.
b. weak print cam follower spring.
c. maladjusted sliding clutch dram.
d. worn square-shaft driving gear friction washers.

30. (028-029) Optimum operation of a well adjusted AN/FGC-20 is obtained by changing the relationship between the

a. selector magnets and armature.
b. stop plate and selector cams.
c. Y-levers and T-levers.
d. square shaft and stop arm.

31. (029) The rangefinder spindle on the AN/FGC-20 is moved outward by the

a. stop plate.
b. rangefinder cam.
c. orientation lever.
d. selector camshaft.

32. (031) Power to operate the ribbon feed mechanism of the AN/FGC-20 originates in the

a. spool drive shaft.
b. driving bevel gear.
c. helical gear.
d. movement of the carriage.

33. (031) The ribbon reverse operation of the AN/FGC-20 is started by the

a. type selecting arm.
b. ribbon eyelet.
c. sensing lever.
d. reversing cam follower.

34. (032) What are the stop bar controlled functions of the AN/FGC-20?

a. CARRIAGE RETURN, LINE FEED, and FIGURES.
b. LINE FEED, CARRIAGE RETURN, and LETTERS.
c. SPACE, CARRIAGE RETURN, and LETTERS.
d. LINE FEED, SPACE, and FIGURES.

35. (032) Two stop bars on an AN/FGC-20 are being positioned following a code combination. This code combination must be for the

a. letter "H."
b. signal bell.
c. motor stop.
d. figures.

36. (032) A character has been received on the AN/FGC-20 and the function shaft is turning prior to the printing of that character. At this time the line feed function sensing lever is resting on the associated

a. stop bar.
b. stop arm.
c. function lever.
d. restoring cam.

37. (034) The AN/FGC-20 is held in the figures position by the

a. platen latching arm.
b. figures sensing lever.
c. aperture gate.
d. platen latch.

38. (035) What are the three punch bar controlled functions of the AN/FGC-20?

a. Motor stop, signal bell, and letters shift.
b. Signal bell, carriage return, and motor stop.
c. Letters shift, motor stop, and carriage return.
d. Tab set, signal bell, and motor stop.

39. (037) Inward movement of the letters punch bar on the AN/FGC-20 releases the

a. platen.
b. aperature gate.
c. guide block.
d. unshift lever.

40. (039) The spacing mechanism of the TT-100/FG is powered through

a. an anti-bounce clutch.
b. a friction clutch.
c. a dog-type clutch.
d. a positive clutch.

41. (041) The carriage of an AN/FGC-20 is moving to the left. At this instant there is no power being applied to the carriage

a. feed driving gear.
b. rack driving gear.
c. return clutch.
d. feed clutch lever.

42. (042-043) Which of the following is *not* a manual push-button operated function in the AN/FGC-20?

a. Letters shift.
b. Figures shift.
c. Carriage return.
d. Spacing.

43. (043-044) When an AN/FGC-20 is adjusted to print a 76-character line, the carriage-return stop bar is released for automatic carriage-return on the

a. 75th character.
b. 76th character.
c. 77th character.
d. 78th character.

44. (045) An AN/FGC-20 is wired as shown in foldout 1. The output to the motor is perfect, with a reading of 115 volts a.c. across 2-4 of TB1. However, due to aging, the output of CR2 is 18 volts low. To increase the a.c. input to CR2 by 18 volts, you would move

a. C of J4 to 230.
b. secondary taps L to H and 4 to 3.
c. secondary taps L to M and 4 to 5.
d. secondary taps L to H and 4 to 1.

45. (050-051) Refer to figure 59 of the text. Which choice, if any, presents a correct positioning of contacts for transmission?

a. B2-B3 closed.
b. B4-B5 open.
c. A2-A3 closed.
d. None of the above.

46. (052) Relay C in a motor stop unit of the TT-99/FG will not operate unless

a. S10 is closed.
b. a blank combination is received.
c. a full motor stop sequence is received.
d. a *figures* and *blank* combination is received.

Chapter 3

47. (053) Which listed teletypewriter transmits at an 8.00-unit interval only?

a. TT-270/FG.
b. TT-271/FG.
c. TT-272/FG.
d. TT-273/FG.

48. (054) An AN/FGC-52 teletypewriter set equipped with a TT-270/FG using a 404 gearset can operate at a maximum of

a. 65.0 wpm.
b. 71.3 wpm.
c. 75.0 wpm.
d. 100.0 wpm.

49. (056) The major difference between the keyboards of the AN/FGC-20 and the AN/FGC-25 is in the

a. type of impulses transmitted.
b. arrangement of key tops.
c. transmitting camshaft.
d. use of the repeat key.

50. (056-057) To receive simultaneous impulses, a machine must be equipped with

a. 11 marking circuits.
b. 7 marking circuits.
c. 5 spacing circuits.
d. 2 spacing circuits.

51. (059) The operation of restoring solenoid L1 on the AN/FGC-25 teletypewriter is controlled by the action of the

a. lockup cam.
b. stop lever cam.
c. start-stop cam.
d. keyboard counter cam.

52. (060) Control of simultaneous transmission from the AN/FGC-25 is accomplished by keyboard reader switch

a. S11.
b. S15.
c. S23.
d. S32.

53. (061) When the keyboard of the AN/FGC-25 is not being used to transmit to the signal line, the XMTR camshaft is locked by solenoid

a. L1.
b. L2.
c. L3.
d. L4.

54. (061) The end-of-line indicator on the AN/FGC-25 is operated by

a. solenoid L1.
b. solenoid L2.
c. the XMTR camshaft.
d. the universal bar.

55. (062-063) The end-of-line lamp on the AN/FGC-25 is lit. This is due to the closing of switch

a. S14.
b. S15.
c. S16.
d. S17.

Chapter 4

56. (065) How many stop bars are found in the code ring cage on the typing reperforator of the AN/FGC-25?

a. 26.
b. 30.
c. 32.
d. 35.

57. (066) On a message type of the AN/FGC-25, no printed indication will be recorded for

a. space.
b. line feed.
c. signal bell.
d. carriage return.

58. (066) The code rings of the typing reperforator on the AN/FGC-25 are released so that they can be positioned as the function shaft

a. is released.
b. clutch teeth engage.
c. completes a half-revolution.
d. moves the cam stud away from the code ring locking bail cam follower.

59. (066-067) Of the following functions, which one is *not* included on the typing reperforator of the AN/FGC-25?

a. Motor stop.
b. Letters shift.
c. Figures shift.
d. Signal bell.

60. (068) To prevent function operation on the typing reperforator of the AN/FGC-25, the sensing lever strikes the

a. type wheel and function lever cam.
b. code rings.
c. cam lever.
d. stop bar.

61. (069) The signal bell on the typing reperforator of the AN/FGC-25 is prevented from operating in the LETTERS position by the

a. "S" stop bar.
b. signal bell sensing lever.
c. type wheel reciprocating cam.
d. letters-figures shift latch lever.

62. (070-071) The "space" combination has been received on the typing reperforator of an AN/FGC-25, and the print hammer is prevented from moving fully upward. This is caused by the

a. rotation of the receiving multisolenoid function shaft.
b. blocking action of the print hammer eccentric stop.
c. notched portion of the register wheel.
d. high part of the print cam.

63. (071) Actual selection of the code combination to be perforated on the message tape of an AN/FGC-25 is done by the

a. code hole punch levers.
b. punch interference levers.
c. print and register cam.
d. type wheel hub assembly.

64. (071) A code punch bar is perforating the tape on an AN/FGC-25. This is caused by the

a. clockwise movement of the code ring.
b. blocking action of the code punch bar.
c. low part of the print and register cam.
d. upward movement of the punch arm assembly.

65. (072-073) Positive positioning of the typing reperforator message tape of the AN/FGC-25 is done by the

a. punch interference levers.
b. code hole punch levers.
c. detent lever.
d. feed pawl.

66. (076) Current is being applied to a coil in the multisolenoid receiving unit through S32 on the AN/FGC-25. The final control of this circuit is through switch

a. S12.
b. S13.
c. S18.
d. S19.

67. (076-077) The code plates on the typing reperforator of the AN/FGC-25 are in the marking condition. At this time, the

a. lower portions of the T-levers are in contact with the Y-levers.
b. upper portions of the contact wipers are touching the individual contacts.
c. lower portions of the contact wipers are touching the common contact strip.
d. upper portions of the contact wipers are touching the common contact strip.

68. (077) Locking of the code plates of the AN/FGC-25 is accomplished by the

a. sixth cam.
b. register cam.
c. code-actuated switch cam.
d. multisolenoid function cam.

69. (078) An AN/FGC-25 can receive copy from the line on both the page printer and the tape receiver. To do so, position switch S23 to the

a. right and S31 to the left.
b. center and S31 to the center.
c. left and S31 to the left.
d. left and S31 to the right.

70. (078-079) An operator is transmitting a message to a distant station from the keyboard of an AN/FGC-25. He is also preparing a tape copy of the message. To do so, he must have positioned switch

a. S23 to the right and S31 to the left.
b. S31 to the right and S23 to the left.
c. S23 to center and S31 to the left.
d. S31 to the right and S23 to center.

Chapter 5

71. (080) The Kleinschmidt tape transmitter can be modified to use tape which is

a. 11/16 inch wide.
b. 12/16 inch wide.
c. 13/16 inch wide.
d. 15/16 inch wide.

72. (081) Which of the following does *not* control the start-stop switch of the transmitter-distributor?

a. The tight tape lever.
b. The start-stop lever.
c. The tape-out lever.
d. The positioning lever.

73. (081) Refer to foldout 3. If the transmitter-distributor of an AN/FGC-25 (later model) is in the STOP position,

a. the clutch magnet is shorted.
b. the clutch magnet circuit is open.
c. the start-stop switch is open.
d. current through the clutch magnet windings is halved.

74. (082) The end of a message tape has passed through the sensing mechanism of the transmitter-distributor of an AN/FGC-25. At this time the

a. tape-out pivots clockwise.
b. lower switch bail lever pivots clockwise.
c. switch operating lever pivots counterclockwise.
d. upper switch bail lever pivots counterclockwise.

75. (083) When the start-stop selector lever of the transmitter-distributor is on the high part of its cam,

a. the stop impulse is being transmitted.
b. code impulses are being transmitted.
c. the transmitting shaft is stopped.
d. tape is being fed through the TT.

76. (084) The power to move the transmitter-distributor sensing levers against the message tape comes from a

a. lever.
b. spring.
c. cam.
d. clutch.

77. (084-085) When the start-stop selector lever of the transmitter-distributor is on the low part of its cam,

a. the stop impulse is transmitted.
b. the transmitting shaft is stopped.
c. code impulses are being transmitted.
d. tape is being fed through the transmitter-distributor.

78. (085) If an impulse to be transmitted from the transmitter-distributor is marking, the selector lever will

a. move up.
b. move down.
c. rotate clockwise.
d. rotate counterclockwise.

79. (086) The tape feed claw mechanism of the AN/FGC-25 is operated by

a. two cams, two levers, and two springs.
b. two cams, two levers, and three springs.
c. one cam, one lever, and two springs.
d. one cam, two levers, and two springs.

Chapter 6

80. (089) The rear switch plate controls include switch

a. S21.
b. S23.
c. S25.
d. S27.

81. (089-090) The AN/FGC-25 is operating with all units in series. The patch panel must be connected for condition

a. A.
b. B.
c. C.
d. D.

82. (090) You are ordered to connect an AN/FGC-25 in such a manner that the transmitter-distributor is on a send only circuit on line 2 while the remaining units are on a half-duplex circuit to line 1. Using figure 106 of the text, you will find that along with other patches, it will be necessary to patch

a. P35 to J42, P36 to J37, and P37 to J40.
b. P40 to J40, P39 to J39, and P38 to J35.
c. P43 to J38, P42 to J42, and P44 to J35.
d. P46 to J46, P41 to J41, and P38 to J36.

83. (091) An AN/FGC-25 is operating with the keyboard connected to one line and the transmitter-distributor connected to another circuit while the tape receiver and the page prints are connected to a third circuit. This machine is arranged for patch panel condition

a. A.
b. B.
c. C.
d. D.

84. (091) An AN/FGC-25 is connected to several signal lines so that it is possible to receive only (both tape and page) from line 3. Automatic transmission is available on line 1, while 2 can only be used for manual transmission. It is possible to make page copies of all messages transmitted from this machine. This AN/FGC-25 must be patched for condition

a. C.
b. E.
c. H.
d. K.

85. (089-092) An AN/FGC-25 has been operating with the transmitter-distributor, keyboard, and tape receiver connected to lines 1 and 2 while page copy is being received from line 3. You are ordered to change the arrangement so that the tape receiver may receive from line 4. To do so, you must change what three patches at the patch panel as shown in figure 106 of the text?

a. P35 to J42, P36 to J41, and P41 to J43.
b. P38 to J47, P41 to J36, and P47 to J38.
c. P37 to J45, P44 to J36, and P47 to J47.
d. P36 to J40, P38 to J46, and P41 to J41.

86. (094) The input to P227 shown on foldout 3 is 210 volts a.c.; however, the voltage reading across J228A is 105 volts. This is an indication that the adjustable tap on the input side of the rectifier is plugged into the jack labeled

a. J230.
b. J210.
c. J115.
d. J105.

87. (096-097) A reading across the test bias terminals of the printer selector magnet bias circuit as shown on foldout 2 should indicate

a. 60 ma.
b. 30 ma.
c. 12 ma.
d. 8.2 ma.

88. (097) Restoring solenoid L1, shown on foldout 2, is energized by closing

a. S23, S20, S11, and S12.
b. S31, S20, S11, and S12.
c. S31, S23, S20, and S11.
d. S31, S23, S11, and S12.

89. (097-098) Restoring solenoid L1, shown on foldout 3, is energized. This is through the closed contacts of

a. S201, S211, S218, and S10.
b. S210, S218, S10, and S11.
c. S211, S218, S10, and S11.
d. S201, S211, S10, and S11.

90. (098) The keyboard control switch S23 shown on foldout 2 is in the TAPE position; however, the transmitting shaft makes a half-revolution each time a key top is depressed. This could be due to

a. proper operation of the machine.
b. improper operation of S20.
c. an open at S23.
d. a short at S12.

91. (099) When the typing reperforator of the AN/FGC-25 is receiving from the signal line, the receiving multisolenoid function shaft is released by

a. S12.
b. S18.
c. S20.
d. S23.

92. (099) A message is being sent to a distant station from the keyboard of an AN/FGC-25. This message is being monitored by the reperforator. At this time the receiving multisolenoid function shaft is controlled by switch

a. S20.
b. S18.
c. S12.
d. S11.

93. (100-101) A message is being transmitted automatically from an AN/FGC-25. Current to control this transmission as shown on foldout 3 is supplied by

a. CR1.
b. CR3.
c. CR201.
d. CR202.

94. (101) On foldout 2, current can be provided for any signal circuit of the AN/FGC-25 through the use of

a. line switching key.
b. line current switch.
c. test jacks.
d. P41 and J41.

95. (102-103) The amount of current in the perforator bias circuit of the AN/FGC-25 shown on foldout 2 is controlled by switch

a. S36.
b. S34.
c. S32.
d. S30.

96. (103-104) Operating S2 on the AN/FGC-25 to the LOCK position shown on foldout 2 places a short across

a. certain contacts of the motor stop relay.
b. the lock solenoid.
c. A and C of J5 and P5.
d. P22.

97. (106) The perforator receive circuit of the AN/FGC-25 shown on foldout 3 terminates at

a. P215 and J215.
b. P214 and J214.
c. P213 and J213.
d. P212 and J212.

98. (107) Automatic line return operation is controlled by a

a. switch.
b. relay.
c. cam.
d. spring.

99. (107) The first step in setting up the automatic line return operation is to position switch

a. S24 to OFF.
b. S24 to LINE 1.
c. S28 to OFF.
d. S28 to TEST.

100. (109-110) A voltage reading across posts A and B of line 2 circuit of an AN/FGC-25 indicates zero voltage. This could be caused by

a. S24 to OFF.
b. S27 to OFF.
c. S28 to line 1.
d. a short at P45-J45.

STUDENT REQUEST FOR ASSISTANCE

SECTION I: ENROLLMENT DATA: MAIL TO: ECI, GUNTER AFB, ALA 36114

1. THIS REQUEST CONCERNS COURSE

2. TEST OFFICE ZIP/SHRED

3. ENROLLMENT DATE (Yr Mo Day)

4. TODAY'S DATE (Yr Mo Day)

5. SOC. SEC. NUMBER ___ — ___ — ____

6. LAST NAME

INITIALS

7. GRADE/RANK

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SECTION IV: REQUEST FOR MATERIALS, RECORDS, OR SERVICE

(Place an "X" through number in box to left of service requested)

1	EXTEND COURSE COMPLETION DATE. (Justify in Remarks)
2	SEND VRE ANSWER SHEETS FOR VOL(s) (circle): 1 2 3 4 5 6 7 8 9 ORIGINALS WERE (Circle one): NOT RECEIVED, LOST, MISUSED
3	SEND COURSE MATERIALS (Specify in remarks) ORIGINALS WERE (Circle one): NOT RECEIVED, LOST, APPL. MAILED DATE:
4	COURSE EXAM NOT YET RECEIVED. FINAL VRE SUBMITTED FOR GRADING ON (Date):
5	RESULTS FOR VRE VOL(s) (circle): 1 2 3 4 5 6 7 8 9 NOT YET RECEIVED. ANSWER SHEET SUBMITTED ON (Date):
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9	OTHER (Explain fully in remarks)

REMARKS:

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I CERTIFY THAT THE INFORMATION ON THIS FORM IS ACCURATE AND THAT THIS REQUEST CANNOT BE ANSWERED AT THIS STATION. (Signature)

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REMARKS (CONTINUED):

SECTION V: REQUEST FOR INSTRUCTOR ASSISTANCE

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Answer You Chose (Letter) _____

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(Textual support for the answer I chose can be found as shown below)

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MY QUESTION IS:

Attach a separate form for each item in question