circuit's designation and channel letter (if applicable) are recorded, as well as the type of circuit (RATT, CW, etc.). In addition to the entry of total traffic sent and received, total outages, operating hours of channels and circuits, and model numbers of equipment employed are included on the report. The telecommunications engineering report also includes the average group count, computed once a year in October. It is obtained by measuring a representative number of tapes transmitted and received on each channel during the month.

Permanent Message File

Tape relay stations are not required to keep a permanent file of messages. Each station is required, however, to keep monitor tape or page copy for 24 hours on all INCOMING messages. It is mandatory for relay stations to keep monitor tape or page copy on OUTGOING messages for 60 days.

EQUIPMENT

Most relay stations employ, as major equipment, Navy-owned tape relay equipment formerly used by the Postal Telegraph Company, package units (four-in-one: send, receive, automatic number, and monitor), and A. T. & T. leased equipment. The ex-postal telegraph equipment comprises receiving, sending, automatic numbering, and monitoring units, and is used on both radio and landline circuits. It operates at speeds of 60 wpm on radio circuits and either 65 or 75 wpm on landline circuits. Tape relay equipment is leased from A. T. & T. to terminate heavy traffic load trunk circuits. It also consists of receiving, sending, and automatic numbering and monitoring units, and operates at 75 wpm. Navy-owned package units are normally employed on light traffic load circuits, both radio and landline. Each unit operates at 60 wpm on radio and 65 wpm on landline.

In addition, model 15 teletypewriters are used in relay centers for page copy monitoring. Model 19 and 28 sets are employed by service clerks and supervisory personnel to prepare procedure and service messages.

Following is a description of major tape relay equipment.

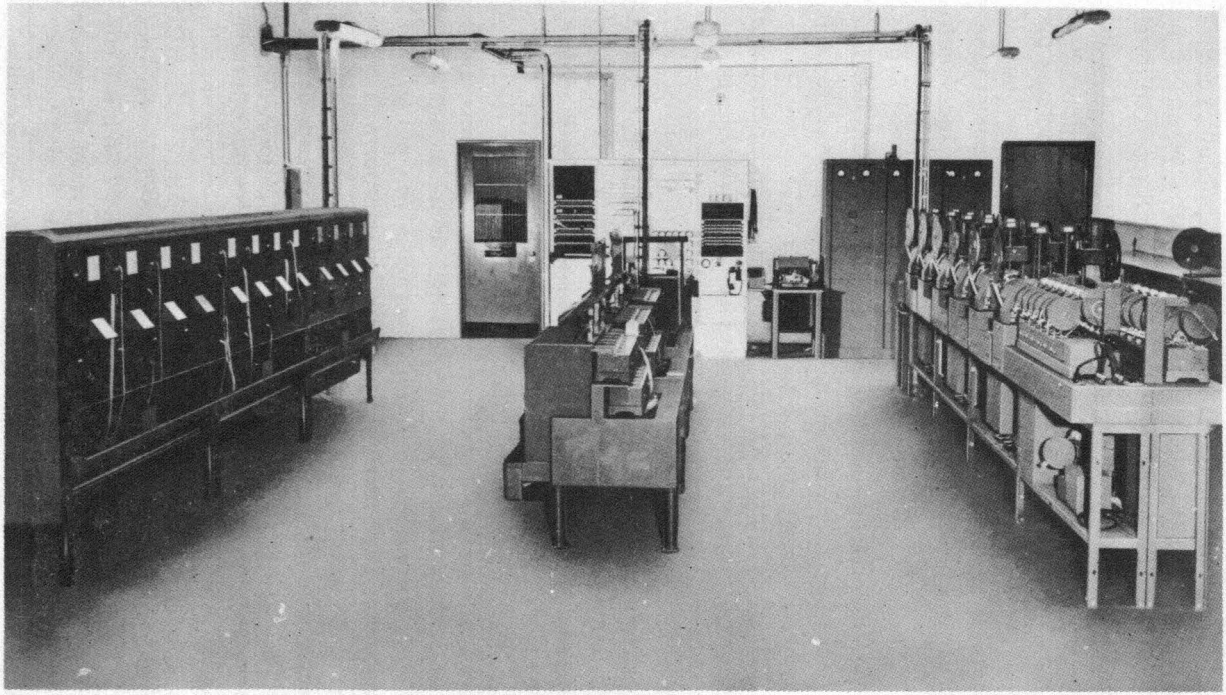

Figure 5–3.—Semiautomatic tape relay installation.

Ex-Postal

Figure 5–3 shows a typical arrangement of semiautomatic equipment. The row of receiving consoles, or cabinets, shown at the left, contains typing reperfs which automatically record incoming messages in the form of perforated tapes on which messages are also printed. These tapes are torn off in message lengths and routed to sending tables, shown near the center of the room. Here the tapes are fed into transmitter-distributors (TD's) associated with the circuits over which the messages are to be sent. At the right of the photograph are automatic numbering equipment and monitor sets associated with the sending circuits. These various equipment units are wired to the group of switchboards and relay frames shown at the far end of the room. The switchboards and relay frames connect the separate units into a complete working terminal.

Duplex and Single Circuits

DUPLEX, as used here, refers to any circuit using separate sending and receiving loops for simultaneously sending and receiving messages. These loops may connect directly to receiving and sending teletypewriter sets at a tributary office, or extend to long line polar duplex or carrier telegraph terminal equipment not part of the semiautomatic equipment. Intrastation sending and receiving circuits are usually operated duplex over separate local line conductors.

SINGLE refers to any circuit arranged for alternate, but not simultaneous, sending and receiving of messages. Such circuits usually extend to tributaries where they are connected to one teletypewriter set used for both sending and receiving. Relays are provided at the relay station to lock receiving equipment during sending and to lock sending equipment during receiving. The tributary can break or interrupt transmission from relay if necessary.

Major Components

RECEIVING CONSOLE.—Typing reperfs used for receiving are mounted in receiving consoles, each of which can contain eight

machines (fig. 5–4). The eight typing reperfs are mounted on individual slides (similar to those used with filing cabinet drawers) to provide easy access for maintenance. Eight openings (one for each reperf) are cut in the front of each cabinet for message tapes. A signal lamp and pushbutton release key are mounted above each opening. Holders for received message records and for circuit designation cards are mounted on the front of each cabinet. A built-in panel box in the lower rear section of the table contains motor-control relays, resistors,

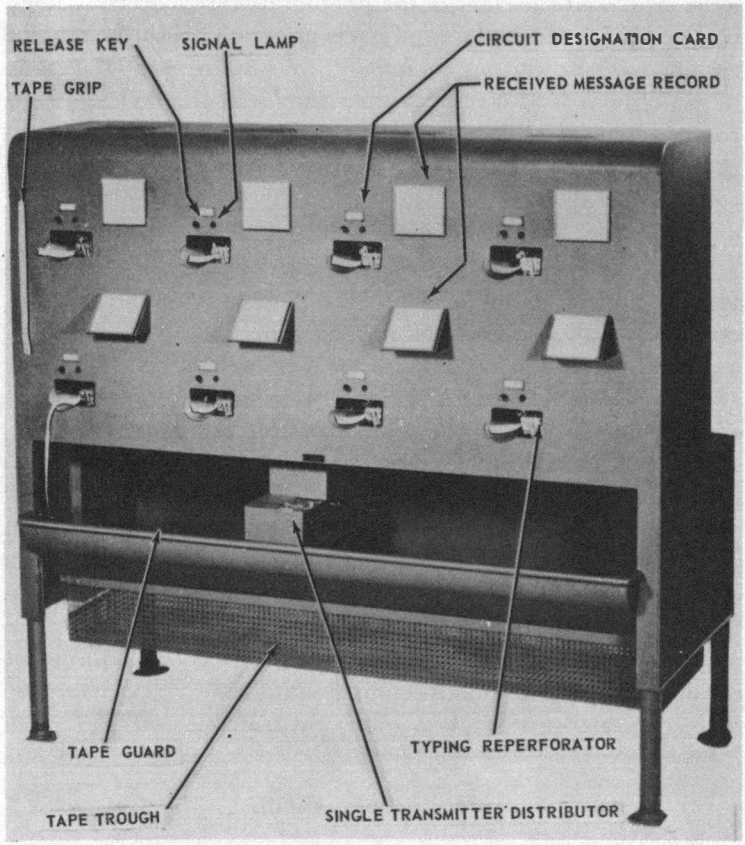

Figure 5–4.—Receiving console.

fuses, and terminal strips for wiring connections. Another compartment in this section of the console may be used for storing rolls of tape.

A single TD is mounted on each receiving console. Each TD is connected to switchboard jacks and can be plugged to the sending side of any duplex or single line circuit. The machine is mounted below the reperfs so that transmission of long message tapes can be started without waiting for the end of the tape to be received.

A TD consists of basic cam-operated units capable of translating perforations in a tape into electrical signal impulses for transmission over one circuit.

Six basic units (called bank transmitters when used as shown in figure 5–5) mounted on a single base with a common motor drive form a multiple TD. Because each unit is connected to a different line circuit, a multiple TD can send messages to six circuits at the same time. This equipment is also used for numbering messages automatically.

A letters-sensing mechanism is added to each unit. This stops the transmitter automatically upon sensing the letters signal perforations located in the number tape immediately after each message number.

Some TD's are mounted on separate bases with individual motors. These are used to handle unusually long tapes and are also used on tape patching and switchboard monitor sets. Single TD's equipped with letters-sensing mechanisms are used as spare number transmitters. In this case they are equipped with reel stands.

SENDING TABLE.—A sending table is used to mount two multiple transmitter distributors of six TD's each, thus providing a bank of transmitters for sending to a maximum of 12 circuits or channels. A tape basket, attached to the back of each table, has six perforated metal compartments for holding tapes that have passed through the transmitters. Six tape holders are mounted on a tape holder bracket on the top of the tape basket. A designation card holder strip is fastened to the front of each multiple TD to designate circuits to which each basic transmitter unit is connected.

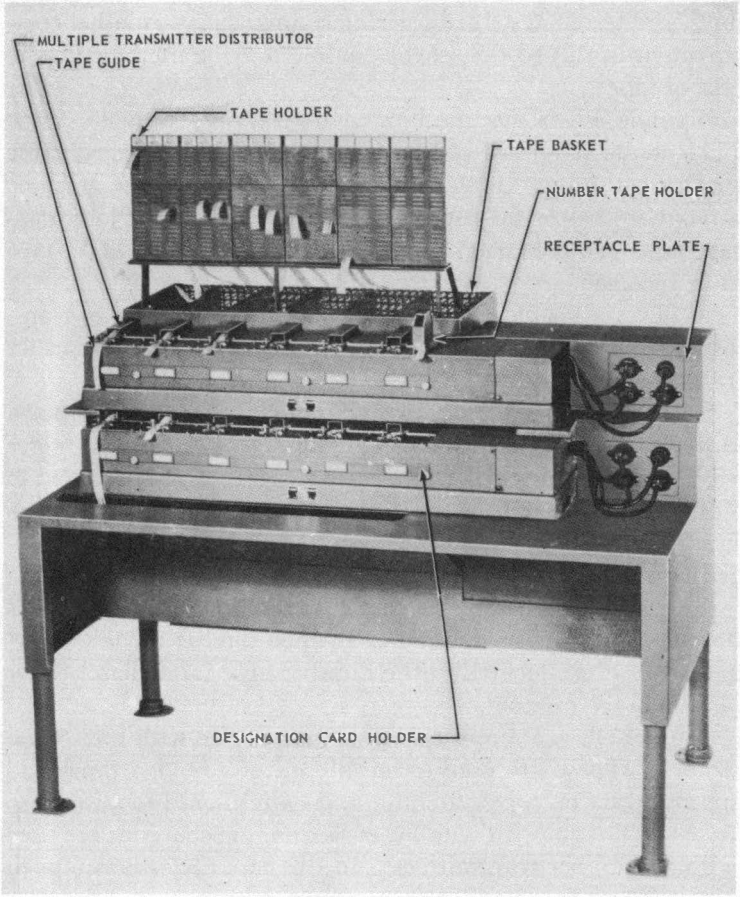

Figure 5–5.—Sending table.

The sending table has a rear compartment with a hinged door which contains a terminal shelf. This is a metal framework to which is attached all wiring required for the table. The shelf has fuse compartments, terminal strips for outside wiring connections, and two receptacle plates. The power and operating circuit cords of the TD's are plugged into these receptacles. Each shelf is arranged to mount two detachable relay boxes when required. Spring connectors, known as frame

jacks, make connection with relay circuits. Switches are provided as part of the shelf for disabling the transmitter and relay circuits whenever a multiple transmitter or relay box needs to be removed for maintenance.

In some cases an upper transmitter unit and corresponding lower transmitter unit are arranged to send alternately to the same circuit. This is known as tandem operation and requires relays to lock each transmitter unit while the other one is operating. Relay boxes must then be added to the terminal shelf to provide lockout relays. By making suitable connections, some of the transmitters can be operated singly, and others tandem. If all transmitters are operated singly, no relay boxes are required.

Automatic Numbering Equipment.—The multiple TD, consisting of six individual TD units, is mounted on a chassis that includes a mounting assembly for six reel arms which hold the number tapes. The assembly includes a small induction motor geared to a long shaft.

Monitor Sets.—Typing reperfs mounted on special chassis give a continuous monitor record of all messages transmitted over each sending circuit equipped for automatic numbering. A monitor set for wire circuits consists of a trunk chassis, tape winder, typing reperf, and relay box. A stand supports two complete sets.

Line Finder.—A line finder is a floor-mounted frame with groups of relays and step-by-step automatic rotary switches. A complete line finder has a capacity of 50 lines and 16 receiving reperfs but usually is arranged for only 24 lines and 8 reperfs. The line finder is used on short lines where incoming traffic per line is light and one reperforator can serve several lines. When an incoming call is received from any of the 24 lines, the line finder will automatically connect it to an idle reperf.

Switchboards and Relay Frames.—Figure 5–6 shows a group of switchboards and relay mounting frames. The group consists of a main switchboard, receiving frame, sending frame, and a testing and monitoring switchboard. The relays on the receiving and sending frames are required for proper function-

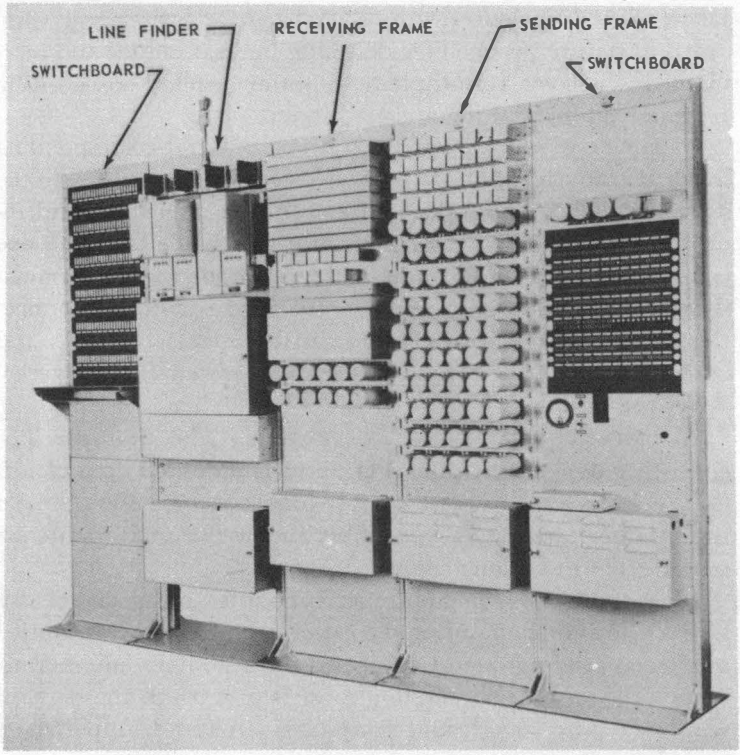

Figure 5–6.—Switchboards and frames.

ing of the circuits, and the switchboards are used for testing, monitoring, and making temporary rearrangements of circuits. A line finder is provided when required.

The switchboards and sending frame may be supplied either fully equipped or half-equipped. A fully equipped switchboard and frames can accommodate a total of 72 line circuits; a half-equipped switchboard, 48. A fully equipped switchboard also has double the number of jacks contained in the half-equipped switchboard.

Switchboards and relay frames each have two long terminal strips mounted on the back. These terminal strips are used to terminate cables to outside line circuits and to various op-

erating tables, monitor sets, etc. The operating units are interconnected by cross-connections or jumper wires run through jumper rings and over brackets. This provides an intermediate distributing frame and permits flexibility in assigning circuits to various operating units.

MAIN SWITCHBOARD.—Outside line or loop conductors are connected to the switchboard usually through a separate cable box which serves as a main distributing frame. For each loop circuit, this switchboard has two series or looping jacks and a set jack. A fully equipped switchboard has jacks for 120-loop circuits, and 48 jacks for miscellaneous use. In small relay centers a half-equipped switchboard is used. It has jacks for 72-loop circuits and 24 jacks for miscellaneous use. The switchboard is completely wired so that jacks can be added readily to expand it to the capacity of the fully equipped switchboard. Below the jack field is a writing shelf with a logbook compartment.

RECEIVING FRAME.—The receiving frame mounts relays associated with the receiving circuits. At the top are 40 pairs of tape feedout relays operated by the pushbutton release keys on the receiving tables. Below these are single circuit control relays for locking the reperf during transmission, and locking the transmitter during reception. These relays also allow the outside station to break or interrupt transmissions from the bank transmitter. Relays (including polar receiving relays) are provided for 12 single circuits. The lower part of the frame includes a power panel for power fuses and current-limiting resistors. A similar panel is located on the line finder and each of the other frames, except on the main switchboard.

SENDING FRAME.—A sending frame mounts 60 polar relays with associated spark suppressors and bias resistors. The first 48 of these relays are used as sending relays. The last 12 are available for miscellaneous purposes. On half-equipped frames the first 24 sending relays and last 6 miscellaneous relays are omitted, together with their associated spark suppressors and resistors.

TESTING AND MONITORING SWITCHBOARD.—This type of switchboard is for testing, monitoring, and making temporary

rearrangements of the semiautomatic operating equipment. A fully equipped switchboard has a lock key, line jack, and transmitter jack for 48 bank transmitter circuits, and series reperf jacks for 48 receiving reperfs. On half-equipped switchboards, the first 24 of the 48 sets of lock keys and jacks are omitted. In small relay centers, certain other jacks are omitted. The lock keys lock the bank transmitters on circuits not in use or temporarily closed down. Jacks are used for monitoring and for plugging in spare transmitters and reperfs. A broadcast repeater on the switchboard may be plugged into any 6-line jacks so that the same message can be sent simultaneously over 6 circuits. Break signal lamps for the 12 single circuits are mounted on the switchboard, as are jacks for spare reperfs, transmitters, and for the single TD's under the receiving tables. Jacks are provided for the lines and reperfs associated with the line finder (if installed). The switchboard also has a control panel, including a test circuit with a milliammeter, two relays, and a cord and plug, associated with the switchboard monitor set. This set is used to monitor line signals.

AN/FGC-6

Other Navy-owned tape relay equipment in use at some stations includes such teletypewriter sets as the AN/FGC-38, -38X, -39, and AN/FGC-6. Major components of the AN/FGC-6 are described below.

Receiving Cabinet.—This cabinet or console normally contains four receiving units (typing reperfs) mounted on two upper shelves. Space is available on the lower shelf for two additional typing reperfs, which makes the unit adaptable as a tape factory. When used as a receiving unit, three of the typing reperfs are for circuit terminations and the fourth for a spare.

Sending Cabinet.—The sending cabinet is different from leased equipment mainly in design of tape bins. Bins for live tapes are built permanently into the cabinet, both front and rear. A separate used tape bin is provided for each circuit.

Tapes may be removed from the front of the sending cabinet with no danger of mixing them with live tapes.

The TD's are arranged in banks of three, with two banks per sending cabinet for tandem transmission. Automatic numbering transmitters are installed in a rear compartment of the sending cabinet. Transmitters are equipped with number delete buttons and open circuit or busy circuit warning lights.

MONITOR CABINET.—In the monitor cabinet, the monitoring typing reperf and associated tape winder are mounted together on the same shelf. Three such units are mounted in each cabinet, and the bottom shelf is used for tape stowage. A throw switch controls sending by the sending operator so that the monitor operator can seize control of the circuit and make reruns directly from the monitor. A small plug board or control panel at the base of the monitor cabinet provides for plugging in a portable transmitter for making reruns.

AN/TGC–1 and AN/TGC–1A

The AN/TGC–1 and AN/TGC–1A teletypewriter sets (fig. 5–7) include facilities for sending, receiving, and monitoring teletype messages on perforated tape on which the message is also typed. Sending, receiving, and monitoring facilities are furnished by a multiple TD (for sending) and two typing reperfs (for receiving and monitoring). These sets are electrically and mechanically similar, the only differences being methods used to increase speed of operation.

The multiple transmitter distributor and typing reperfs of these package sets function in similar manner to the semiautomatic ex-postal gear previously described. They may be used singly in a small relay center, or a number of sets may be set up side by side to provide facilities for handling traffic in large primary stations.

With appropriate wiring and switching changes, the equipment may be operated neutral over one or two half-duplex (single) circuits, and neutral or polar over one or two full duplex circuits. Operation over one full duplex circuit (two external circuits, each consisting of two wires or single wire

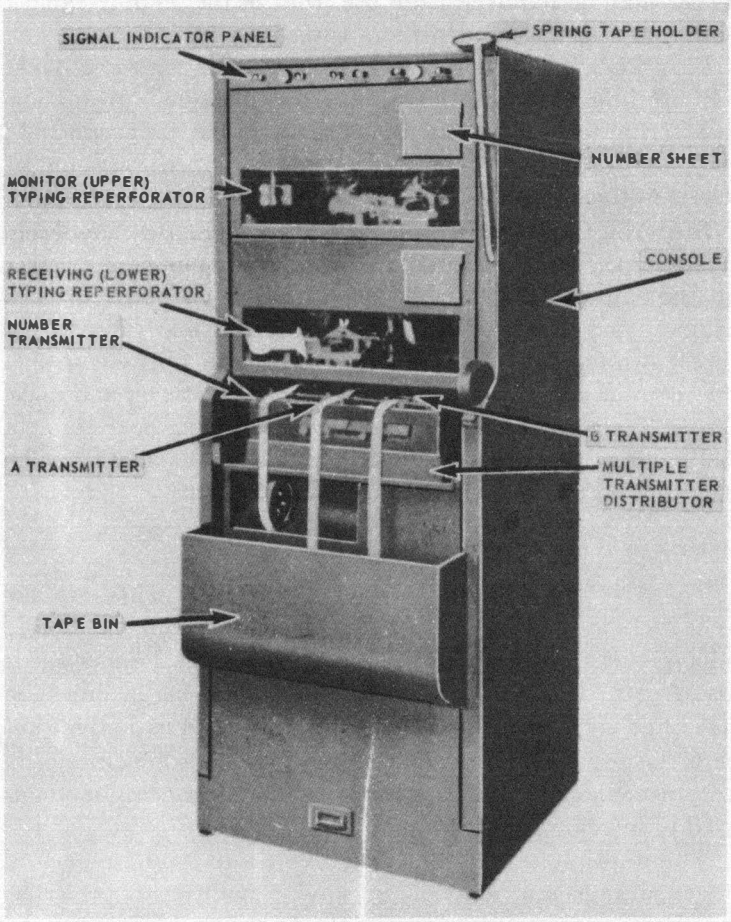

Figure 5–7.—Teletypewriter Set AN/TGC–1 or AN/TGC–1A.

with ground return) or one half-duplex (single) circuit is designated NORMAL. Operation over two full duplex circuits (four external circuits) or two half-duplex (single) circuits is designated SPLIT.

Power for both sets is furnished by series-governed motors adapted for 110-volt a-c or d-c operation. However, power for the typing reperf of the AN/TGC–1 is furnished by a syn-

chronous motor adapted for 60-cycle, 110-volt a-c operation; the AN/TGC–1A typingreperf receives its power from a series-governed motor adapted for 110-volt a-c or d-c operation. This motor is also replacing the synchronous type in the AN/TGC–1.

Each set contains a rectifier to provide a source of d-c (signaling battery) when the external power source is a-c. Tape winder motors are induction-type and operate from a 115-volt, 60-cycle a-c source.

Leased Equipment

Double-Deck Transmitting Consoles.—Each transmitting position consists of one or more double-deck consoles mounting two triple-gate TD's. Since two transmitters may be used alternately on each circuit, transmitter gates in the same relative position on both upper and lower levels of the console are associated with the same working or spare circuit. For example, an upper-level gate for Pearl Harbor send traffic is labeled the BHP (Alfa) channel. The lower-level gate in the same relative position is associated with the same Pearl Harbor circuit. Its channel designation is also BHP (Alfa). One console serves a maximum of three working or spare circuits.

Three sets of control lamps and keys are mounted in each console panel. One set is associated with each pair of alternate transmitter gates. These controls are the no-number key, seize lamp, and tape stop key.

The no-number key is a nonlocking pushbutton which permits sending a message tape from a transmitting position without prefixing the channel identification and next consecutive channel number. When lighted, the seize lamp indicates that the control position has seized a circuit for supervisory functions. Until seize lamp is extinguished by control, the transmitter gates will be inoperative.

When changing number tape reels and servicing torn tape, the number alarm lamp lights, indicating a message transmitted at this time will not have the channel identification and next consecutive channel prefixed.

NOTE.—This lamp will flicker as the numbering transmitter scans the letters character following transmission of channel number. The flicker at this instant indicates that the channel number has been transmitted.

The tape stop key is a locking twist-type key which stops either of the two transmitters with which it is associated, permitting tape removal for servicing with loss of circuit seizure to the alternate transmitter.

AUTOMATIC CHANNEL NUMBERING EQUIPMENT.—One or more reperf cabinets are employed, each mounting one, two, or three triple-gate transmitter assemblies. Each gate of each transmitter assembly is associated with one working or spare circuit. Supply and takeup reels are mounted above and below each gate. Number tapes used on the circuits may be transferred to these reels. Operation of the leased numbering transmitters is identical to operation of Navy-owned (ex-postal) equipment.

MONITORS.—Monitors consist of one or more reperf cabinets each mounting three receiving only typing reperforators. One reperf is associated with the sending side of each full duplex circuit. Three motor-driven tape-winding reels are installed in the base of each cabinet to collect the monitor tape in reel form. A control panel is mounted in the face of each cabinet just below the top edge. Each panel consists of a tape feedout key (nonlocking pushbutton) for each reperf, a tape alarm lamp, and an audible alarm release key (nonlocking pushbutton).

RECEIVING CONSOLES.—Receiving consoles are identical to monitors with two exceptions:

1. One receive only typing reperf is associated with the incoming side of each full duplex circuit.
2. Received copy tape is fed through tape slots to the outside of the cabinets, where it is torn off by the operator. All other features, including the control panel and noninterfering tape feedout are as described under monitors.

EQUIPMENT AT CONTROL POSITION.—An automatic transmitter and a keyboard typing reperf are located at the control

position on a table arranged for a standup operation. In addition, a small patchboard is mounted at the rear of the table with the jack bay facing the operator.

At large primary stations, two control positions, designated control A and control B, are needed. The equipment and the functioning of control B position are identical to control A position previously described, except that no patchboard is mounted on the control B position. All patches for both positions are made at the jack panel mounted on control A table. A second control position jack associated with control B is wired in this jack field. A second patch cord is provided, and at anytime either or both tables may be used as desired for supervisory functions.

SPARE EQUIPMENT.—With the exception of equipment at the control position, leased equipment at each position is backed up with spares of similar type. In addition to spare reperfs, both receiving and monitoring, there are spare banks at both sending and numbering positions. Spare equipment ensures against loss of communications due to failure of any or all component units. In addition, it facilitates replacement of tape and ribbon without disrupting service.

Channel Outage Indicator and Bank Control System

The outage indicator and bank control system is used with overseas (radio) send and receive channels. It furnishes the relay station supervisor and the radio control board supervisor in the COMMCEN a visual reminder when a channel is out due to equipment or circuit difficulties. It also provides the relay station supervisor with a certain amount of remote control over the sending and receiving teletypewriter equipment in the tape relay station.

The system consists of two units approximately the size of ordinary intercom sets. One unit, for indicating purposes only, is located on the radio control board supervisor's desk. It contains 30 switchboard lamps and designation strips. One lamp is assigned to each channel. The controlling unit, located in the tape relay station adjacent to the supervisor's desk, con-

tains 30 switchboard lamps and 30 jack switches. Designation strips assign a lamp and a switch to each channel.

Installation and operation of the system require no modification to existing equipment or wiring. Normal communication cable pairs are used between the radio control board and the tape relay station. The bank control circuits are cabled to spare terminal strips in the relay station distribution frame and cross-connected to appropriate points.

AUTOMATIC RELAY

Plans are underway to convert primary relay centers to fully automatic operation. The automatic relay center is fundamentally a relay point and is not intended to be an originating or terminating station. It is designed to receive messages from many points, to determine where the messages go, and to transmit them expeditiously.

The relay center commences action upon a message almost as soon as it is received. It is capable of routing the message to an outgoing circuit within 15 or 20 seconds. The need for waiting until the entire message is received before beginning outgoing transmission, as in the case of semiautomatic operation, is eliminated.

Equipment breakdowns are brought to the operator's attention immediately by an extensive alarm system. If the center receives a message with a garbled or nonexistent routing indicator, or with an incorrect precedence indicator, the message is routed automatically to an intercept position. Here the operator handles the transmission manually.

Outgoing messages are handled in descending order of precedence. High-precedence traffic gets immediate handling, and signal lamps indicate that such a message is in the center. Messages of the same precedence destined for a particular channel are normally handled on a first-come, first-served basis. Those of the top three degrees of precedence—FLASH, EMERGENCY, and OPERATIONAL IMMEDIATE—automatically interrupt outgoing messages of lower precedence. Audible and visual alarms indicate to the operators that such a cancellation has

taken place. Thus high-precedence traffic in most cases is relayed within a few seconds of receipt.

When a multiple address message is to be transmitted on more than one channel, the equipment sends the message to those channels which are available. Because of the storing operation, special handling is not required for multiple address messages, some of which may be destined for channels which are out of service, shut down for the night, or busy with other traffic.

In many cases a light traffic load between the automatic relay center and various tributaries does not warrant a channel for each tributary. In such cases, a multipoint or party line system proves adequate. Transmission to and from stations on a party line is handled without affecting other stations on the same line.

Equipment for automatic relay is designed for use both on landlines and radio circuits. When used with radio circuits, or when heavily loaded trunks are utilized, more than one channel is often necessary for a particular destination. Traffic is automatically distributed evenly over the channels within the multichannel groups.

During light traffic hours and on weekends, messages normally are held in storage until the channel reopens. With high-priority messages, however, an operator throws a toggle-switch to route such traffic to an intercept position where the message may be examined by an operator.

When a particular channel is shut down for the night, or is out of service, alternative routing is accomplished at an alternative route patch panel with ordinary patch cords.

The relay station watch stander will be replaced to some extent by the automatic equipment. However, many highly trained Radioman supervisors and operators will still be needed to control the system and maintain the equipment.

QUIZ

1. What is the function of a tape relay station?
2. Who are the two principal assistants to the OIC of a tape relay center?
3. Name some important duties of the RCOW.
4. What is a STOP and GO message?
5. What is the principal responsibility of the relay station supervisor?
6. Why do tape relay stations conduct intensive indoctrination courses?
7. What items are indicated in the operational section of the relay status report?
8. Name the four standard message accountability logs.
9. As referred to in the discussion of ex-postal relay equipment, what is a DUPLEX circuit?
10. What is the function of the channel outage indicator and bank control system?