NAVSHIPS 900,754 RESTRICTED

INSTRUCTION BOOK FOR

FREQUENCY SHIFT KEYER NAVY MODEL FSA

WESTERN ELECTRIC COMPANY, INC.

NEW YORK, N. Y.

NAVY DEPARTMENT BUREAU OF SHIPS

Contract NXsr-55610 *Approved 15 OCTOBER 1945*

CONTRACTUAL GUARANTEE

The Contractor guarantees that the articles provided for under this contract will conform to the specifications herein, will be suitable for the purposes intended, and will be free from any defects in material and workmanship. Any such failure or defects except in vacuum tubes, which shall occur within one year after delivery to the Government shall be corrected by the Contractor, upon written notice by the Government, and the Contractor shall repair or replace such defective articles or parts thereof with all possible speed and diligence until such articles conform with the specifications herein, are suitable for the purposes intended and are free from any defects in material and workmanship. The cost of any such repairs or replacements, including transportation expenses within the continental limits of the United States, shall be borne by the Contractor.

INSTALLATION RECORD

Contract Number NXsr 55610 Date of Contract 31 March 1944

Serial Number of equipment.....

Date of acceptance by the Navy.....

Date of delivery to contract destination.....

Date of completion of installation.....

Date placed in service.....

REPORT OF FAILURE

Report of failure of any part of this equipment during its service life, shall be made to the Bureau of Ships in accordance with current instructions. The report shall cover all details of the failure and give the date of installation of the equipment. For procedure in reporting failures, see Chapter 67 of the "Bureau of Ships Manual," or superseding instructions.

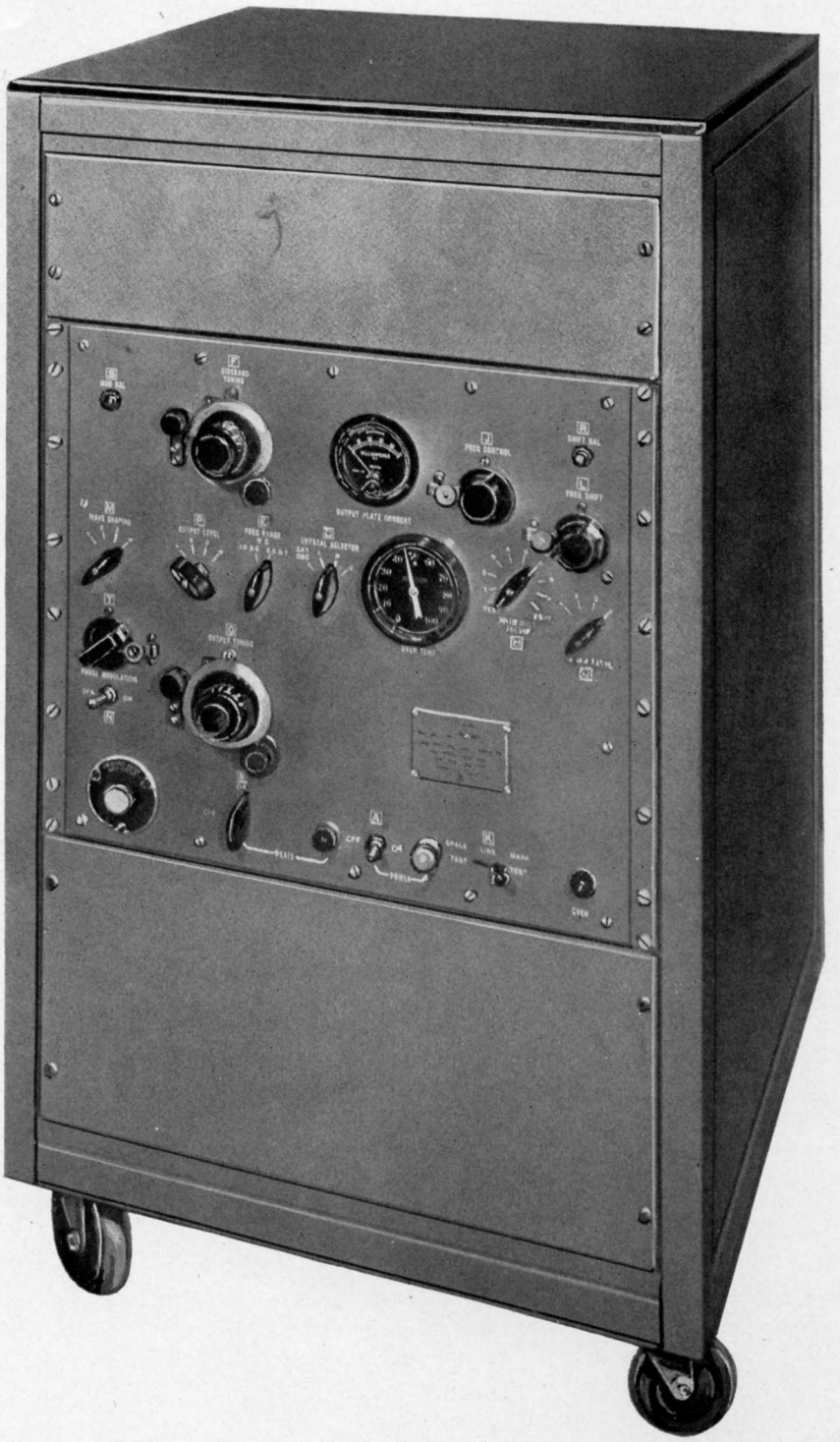

Figure 1—1. Model FSA Keyer in Mobile Cabinet

SECTION 1

GENERAL DESCRIPTION

1. PURPOSE AND USE.

A frequency shift keyer is used in a radio telegraph system to cause a radio transmitter to emit one frequency for a mark signal and a different frequency for a space signal, rather than to interrupt a single-frequency carrier. As compared to the opening and closing of a single-frequency carrier, the two-frequency method of operation is less subject to distortion from radio fading. This results in a considerable improvement in transmission.

The radio-frequency output of the Model FSA Frequency Shift Keyer (fig. 1-1) is one to 6.7 megacycles. This frequency is shifted upward or downward a small amount to produce output r-f telegraph signals corresponding to the d-c polar or neutral signals connected to the keyer. The difference between the upper and lower r-f shifts is commonly about 850 cycles, but the total shift can be set for values ranging from a few cycles to 1,000 cycles. The r-f output of the keyer is connected to the power amplifiers of a radio transmitter (fig. 1-2).

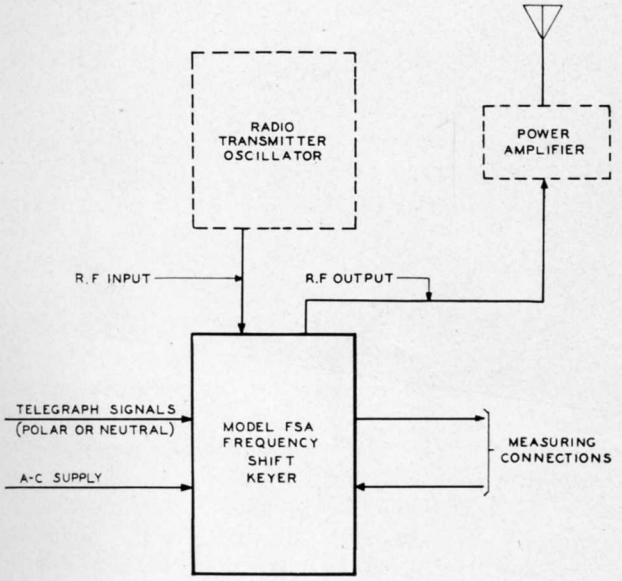

Figure 1—2. Block Diagram

The Model FSA Frequency Shift Keyer is mounted in a mobile cabinet for a land installation, and in a shock-resisting cabinet when used on shipboard. In either case it is connected to a radio transmitter by cable assemblies. The keyer chassis may be installed in the radio transmitter if space is available.

2. PRINCIPLE OF OPERATION.

Radio-frequency shift keying is used principally for comparatively long distance communication in the high-frequency range. The keyer can be connected to different types of Navy transmitters and is arranged so that the closure of the contacts of a telegraph key, or a teletypewriter, produces a marking signal which causes the transmitter to emit a frequency above the mean assigned frequency of the transmitter. The opening of the contacts of a telegraph key, or a teletypewriter, produces a spacing signal which causes the transmitter to emit a frequency below the normal frequency of the transmitter. The upper and lower values of the shifted frequency are adjusted to be located symmetrically about the assigned transmitter frequency (respectively above and below the carrier by about 425 cycles, if the total shift is 850 cycles).

The principle of operation of the keyer is suggested by the functional block diagram (fig. 2-1). The input radio frequency of the keyer may be that of an oscillator associated with a Navy transmitter or that of a crystal oscillator of the keyer. The keyer oscillator is equipped with three crystals, any of which may be selected by a CRYSTAL SELECTOR switch. The input frequency of the keyer is in the range 0.8 to 6.5 mc, which is 200 kc less than the output frequency. As described later, the frequency of a 200-kc oscillator is raised and lowered a small amount in response to mark and space telegraph signals. The radio-frequency output of the transmitter (or keyer) oscillator and the frequency-modulated output of the 200-kc oscillator are combined in a balanced modulator. The transmitter (or keyer) oscillator frequency is balanced out. Only the sum and difference frequencies, resulting from mixing the input radio frequency and the 200-kc oscillator frequency, are present in the output of the balanced modulator. The plate circuit of the modulator is tuned to the higher or sum frequency.

The components of the crystal oscillator and the 200-kc oscillator are located in an oven, the temperature of which is closely regulated at about 60° C (140° F).

The output of the balanced modulator is amplified in two stages consisting of an intermediate amplifier and an output or power amplifier. The intermediate stage permits a low output from the balanced modulator and acts as a filter to increase the power of the wanted sideband. A ganged variable capacitor SIDEBAND TUNING tunes the output circuits of the balanced modulator and the intermediate amplifier. A variable capacitor OUTPUT TUNING tunes the output circuit of the power-amplifier stage. The plate circuit of the output amplifier includes an autotransformer for matching the low impedance of the line to the radio transmitter. The autotransformer is multitapped with connections to the contacts of an OUTPUT LEVEL switch.

The tuned circuits of the balanced modulator and the intermediate and output amplifiers are separated into two bands in the ranges of 1.0 to 2.6 mc and 2.6 to 6.7 mc, either of which is selected by a FREQ RANGE—MC switch.

Figure 1—3. Model FSA Keyer Chassis, Front View

The keying circuit normally operates on polar signals, but a simple strap change permits operation with neutral signals. In ordinary cases the negative side of the external keying circuit is at ground potential. Wiring changes can be made to permit operation with polar or neutral signals when the positive side of the keying circuit is at ground potential.

The keying tube (fig. 2-1) acts as an amplifier and phase inverter to produce an output which is applied in push-pull to the grids of two balanced reactance modulators. The form of the output keying voltage may be modified by series inductance and bridged capacity as controlled by a WAVE SHAPING switch; it may also be "wobbled" at about 200 cycles per second by turning on a PHASE MODULATION switch. The amount of phase modulation is varied by adjusting an associated dial. Phase modulation may tend to improve transmission under some conditions of severe selective fading.

The output voltage from the keying tube reflects mark and space signals with or without wave shaping and phase modulation and is connected to the two balanced reactance modulator tubes. The full output of the balanced reactance modulator tubes or a fraction of it is connected to a reactance amplifier through a point on a voltage divider selected by an XMTR MULT FACTOR switch. The output of the reactance amplifier is connected to the 200-kc oscillator and causes the frequency of the 200-kc oscillator to increase a small amount (for example, 425 cycles for a mark signal) and to decrease a small amount (for example, 425 cycles for a space signal). The amount the frequency of the 200-kc oscillator is changed depends upon the output of the reactance amplifier, which in turn is influenced by the input from the balanced reactance modulators. The input is varied by the setting of the XMTR MULT FACTOR switch and by the position of a FREQ SHIFT dial. This variation allows for multipliers in the associated radio transmitter in order to maintain a constant frequency shift at the output of the transmitter (for example, 850 cycles).

The 200-kc oscillator is a self-excited balanced type, the frequency of which is changed by the output of the reactance amplifier and to a limited extent by a variable capacitor FREQ CONTROL. The output of the 200-kc oscillator is frequency-modulated by telegraph mark and space signals with or without superimposed wave shaping and phase modulation. This frequency-modulated 200-kc oscillator output is combined in the balanced modulator with the frequency of the transmitter (or keyer) oscillator.

The keyer has a rectifier power-supply circuit which produces a low-voltage a-c heater supply, a positive 300-volt plate supply, a regulated positive 150-volt screen grid supply, and a regulated negative 150-volt bias supply.

3. UNITS OF EQUIPMENT.

a. MODEL FSA FREQUENCY SHIFT KEYER.—The Model FSA Frequency Shift Keyer (Navy type CW-35060) is assembled on a chassis which is equipped with a front panel containing operating control dials, switch knobs and handles, a milliammeter, a temperature-controlled oven indicator, pilots, etc. (fig. 1-3). The unit includes 16 electron tubes, five of which are associated with a self-contained power circuit which supplies an a-c heater voltage and rectified d-c voltages.

The radio transmitter at the radio transmitting station is equipped with a Connector Panel Navy Type 62254 which is universal in that connections can be made to different types of frequency shift keyers. The connector panel contains coaxial jacks, power supply, and other receptacles which correspond to those of the Model FSA Frequency Shift Keyer. The keyer can be quickly associated with other components of the system by connecting six patching cable assemblies. These six connections provide a primary power supply to the keyer and complete the input, output, and test connections.

b. MOBILE CABINET. — The mobile cabinet, CW-10389, (fig. 1-4) is a steel cabinet about three feet high and is equipped with roller casters to facilitate moving it about a land-based radio transmitting station. Mounting space is available for Navy equipment other than the keyer.

c. SHOCK-RESISTING CABINET.—The shock-resisting cabinet, CW-10390, (fig. 1-5) is about 20 inches high and is equipped with rubber shock mounts to minimize the effects of shipboard shocks and vibrations on the components of the chassis-mounted FSA keyer.

d. CABLE ASSEMBLIES.—Six cable assemblies connect the Model FSA Frequency Shift Keyer with the radio transmitter, a primary power outlet, and other units.

e. SPARE PARTS.—Equipment spare parts for each installation are furnished as well as stock spare parts for a group of installations. The spare parts are boxed separately.

f. TESTING FACILITIES.—No special testing equipment is required for the Model FSA Frequency Shift Keyer other than an OCT frequency shift monitor and test equipment ordinarily available at a radio transmitting station. Two of the six cable assemblies mentioned in paragraph 3*d* and the associated receptacles of the keyer are used to connect to radio-frequency measuring equipment of the radio transmitter.

g. MOISTUREPROOFING AND FUNGIPROOFING. —The Model FSA Frequency Shift Keyer is given a treatment to aid in rendering the equipment resistant to the effects of moisture and fungus growth under tropical conditions. This involves applying a varnish containing a fungicidal agent to the wiring, wiring terminals, and insulating surfaces of the equipment.

4. REFERENCE DATA.

a. GENERAL AND PHYSICAL CHARACTERISTICS. —Table 1-1 lists general data, weights, and dimensions of the equipment units (packed and unpacked), used with the frequency shift keyer.

b. ELECTRICAL CHARACTERISTICS.—Table 1-2 lists electrical characteristic data which are grouped in eight major subdivisions to facilitate the use of the table for reference purposes.

c. ELECTRON TUBE COMPLEMENT.—Table 1-3 lists the 16 electron tubes used in the frequency shift keyer circuit.