CHAPTER 10

COMMON OPERATING ADJUSTMENTS—TELETYPE AND FACSIMILE

Teletype and facsimile principles were discussed in chapter 5. This chapter will discuss representative equipments installed aboard ships. Principles of operation, and common operating adjustments will be presented.

TELETYPE EQUIPMENT

A radio teletype system consists of series connected transmitting and receiving loops depending upon the setting of the SEND-REC. switch in the control unit (fig. 10-1). With the SEND-REC. switch in the receive position, the receiving loop includes the page printer (teletypewriter), power supply, teletype panel, converter-comparator, and the control unit. During frequency-shift keying, the transmitting loop includes the page printer, power supply, teletype panel, frequency-shift keyer, and the control unit with the switch in the position shown. When the switch is set to the S/R tone position, the transmitting loop is completed through the tone converter.

A single power supply PP-765/U provides current for the selected series loop. Six teletypewriter systems may be operated from the

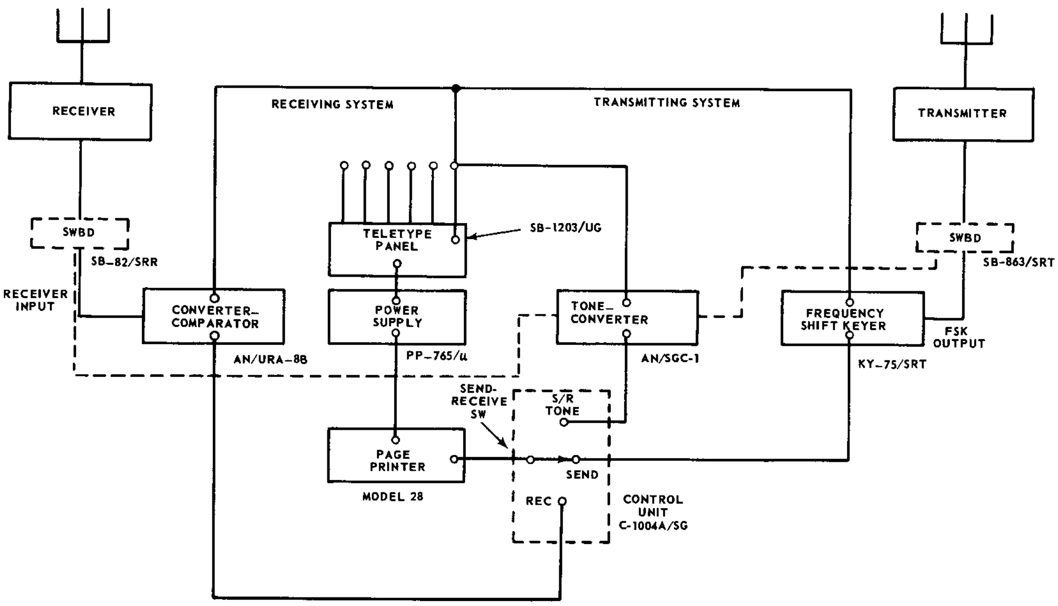

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Figure 10-1.—Block diagram of a representative radio teletype system.

power supply through connections to the teletype panel.

FREQUENCY-SHIFT KEYER KY-75/SRT

The primary purpose of Frequency-Shift Keyer KY-75/SRT (fig. 10-2) is to replace the conventional exciter of a c-w transmitter with a source of r-f excitation that can be shifted a small amount upward or downward to produce r-f teletypewriter or facsimile signals corresponding to the d-c teletypewriter or facsimile signals connected to the input of the keyer.

The output of the keyer can be applied to any existing c-w transmitter capable of operating from a 2- to 20-volt excitation source, for passage through class C amplifier or multiplier stages. The keyer is used principally for comparatively long-distance communications in the high-frequency range. The frequency range of the keyer output signal is from 1 to 6.7 megacycles. Rated power output is 6 watts into a 75-ohm resistive load.

The frequency range is selected by a three-position band switch with calibrated frequency ranges of 1 to 1.8 megacycles, 1.8 to 3.5 megacycles, and 3.5 to 6.7 megacycles. A four-position switch is provided for selection of one of three crystals; the fourth position is provided to permit the use of an external oscillator with the KY-75/SRT. The frequency shift capabilities of the keyer for photo transmission provide a total range of zero to 2000 cycles so that the transmitter frequency may be adjusted to any value from zero to 1000 cycles higher than or 1000 cycles lower than the assigned frequency.

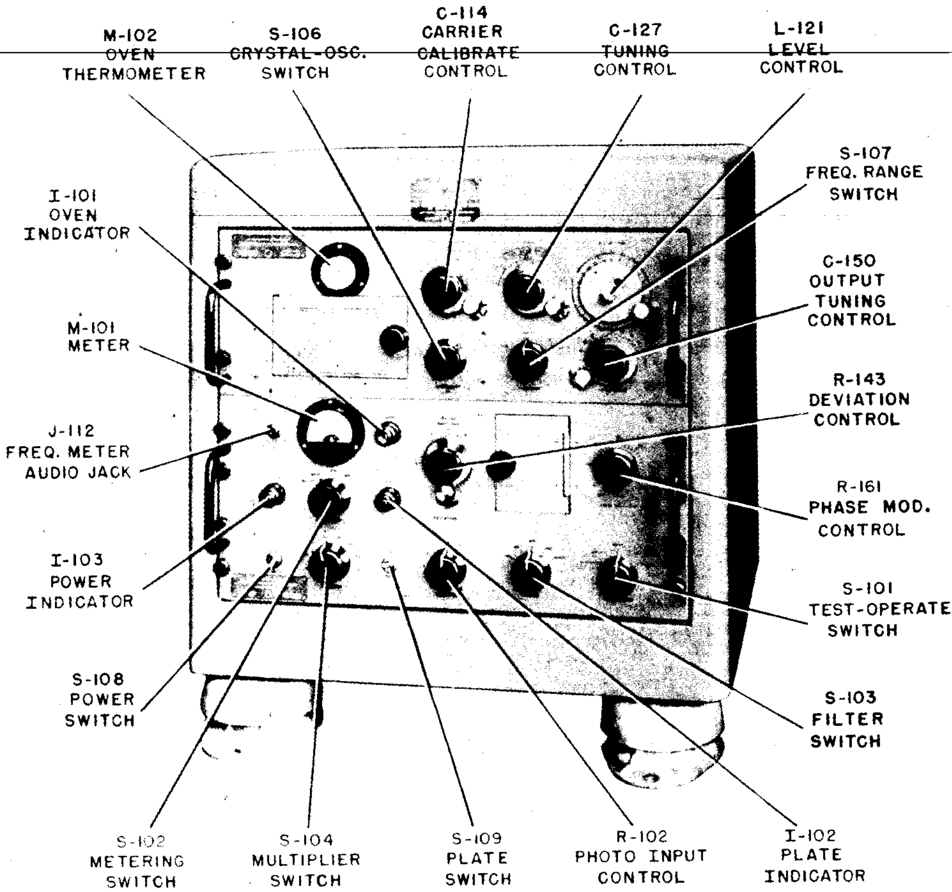

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Figure 10-2.—Frequency-shift keyer KY-75/SRT, front panel compartment identification.

A block diagram of the frequency-shift keyer is illustrated in figure 10-3. There are three functional subdivisions. These include (1) the r-f circuits, (2) the modulator circuits, and (3) the power supply. The r-f circuits comprise the crystal oscillator, V-110; the low frequency oscillator, V-107; the balanced reactance modulator, V-106, the buffer amplifier, V-111; the final power amplifier, V-112; the balanced mixers V108 and V109; and the output circuits. The modulation circuits comprise the test-operate and calibration circuit; the photo-input control, R-102; pulse limiters, V-101 and V-102; phase-modulation oscillator V-105; phase modulation control R-161; cathode followers V-104 and V-103; pulse shaper; deviation dividers; and deviation control R-143.

The test-operate calibrate switch is a five-position switch used to select the circuit arrangement required for frequency-shift or photo operation and the arrangement required to perform the alignment adjustments for carrier, mark, and space signals.

The power supply includes a full-wave rectifier stage, V-116; three voltage regulator stages V-113, V-114, and V-115; and an a-c filament current regulator stage, V-117.

Operating adjustments for the KY-75/SRT will be discussed along with facsimile equipment later in this chapter. Late models of Navy transmitters have built-in keying circuits for frequency-shift operation, and do not require an external keyer for either teletype or facsimile transmission.

CONVERTER-COMPARATOR GROUP AN/URA-8B

The Frequency-Shift Converter-Comparator Group AN/URA-8B comprises two Frequency-Shift Converters CV-89A/URA-8A and one Comparator, CM-22A/URA-8A, as illustrated in figure 10-4. In diversity reception the audio outputs of two standard Navy receivers (like the AN/SRR-12) are fed to their associated frequency-shift converters, as shown in the block diagram of fig. 10-5. The d-c signals from the discriminator circuits of the two frequency-shift converters are compared in the mark space selector circuit of the comparator which automatically selects the better mark and the better space pulse for each character. The second frequency-shift converter is identical to the first and is represented by a single block for simplicity. The receivers may be operating on space diversity (if shore based) or frequency diversity (if aboard ship) on any radio frequency within their ranges. The frequency-shift converter is described first. The comparator is then described briefly, and common operating adjustments are emphasized last.

Frequency-Shift Converter

Each frequency-shift converter includes (1) a discriminator subunit, (2) oscillator-keyer subunit, (3) monitor subunit, (4) power-supply subunit, (5) cable-filter assembly, (6) blower subunit, and (7) chassis-panel assembly (Fig. 10-5).

The discriminator subunit contains wide-shift (200 to 1000 cycles) and narrow-shift (10 to 200 cycles) filters, a discriminator circuit, slow-speed (60 words per minute or less) and fast-speed (more than 60 words per minute) filters, and an axis d-c restorer circuit. The discriminator converts frequency variations into corresponding voltage variations as illustrated in figure 10-6.

Low pass filters attenuate spurious signals above the frequency of the desired pulse-rate to prevent faulty operation due to noise, harmonics and so forth.

The axis restorer maintains the optimum axis, or bias, for keying nonsymmetrical signals and reinserts the d-c component of the signal required for relay tube operation. It produces an optimum output signal when the received signal is heavily biased, either mark or space. It will lock up (close) the teletype loop circuit when a prolonged mark or space signal condition develops to prevent the teletypewriter from running open. The setting of the threshold control affects the time required to lock up the teletype loop circuit.

The oscillator-keyer subunit contains the circuits for keying the teletype d-c loop and operating the teletype printers. It also provides a keyed-tone output by keying a Tone Modulator, which may be selected as any one of eight audio frequencies. Provision is made for the injection of an external tone, if desired.

The oscillator-keyer subunit circuits are used in single receiver operation; but in diversity reception the signal from the converter is taken directly from the low-pass filter (after the discriminator) and fed to the comparator without using the tone and output circuits of the oscillator-keyer subunit. These are available, however, if it is desired to use the

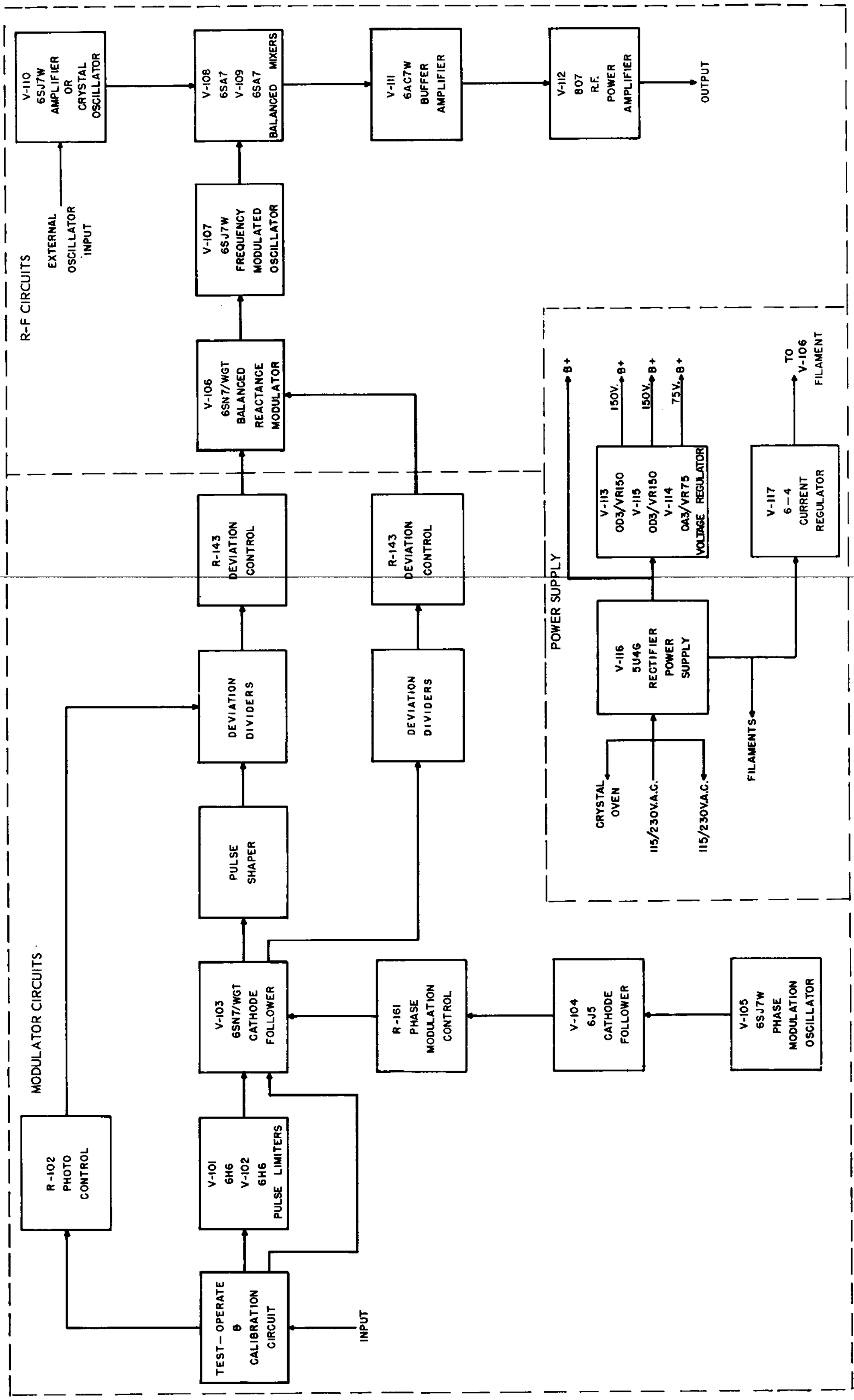

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Figure 10-3.—Block diagram of frequency-shift keyer KY-75/SRT.

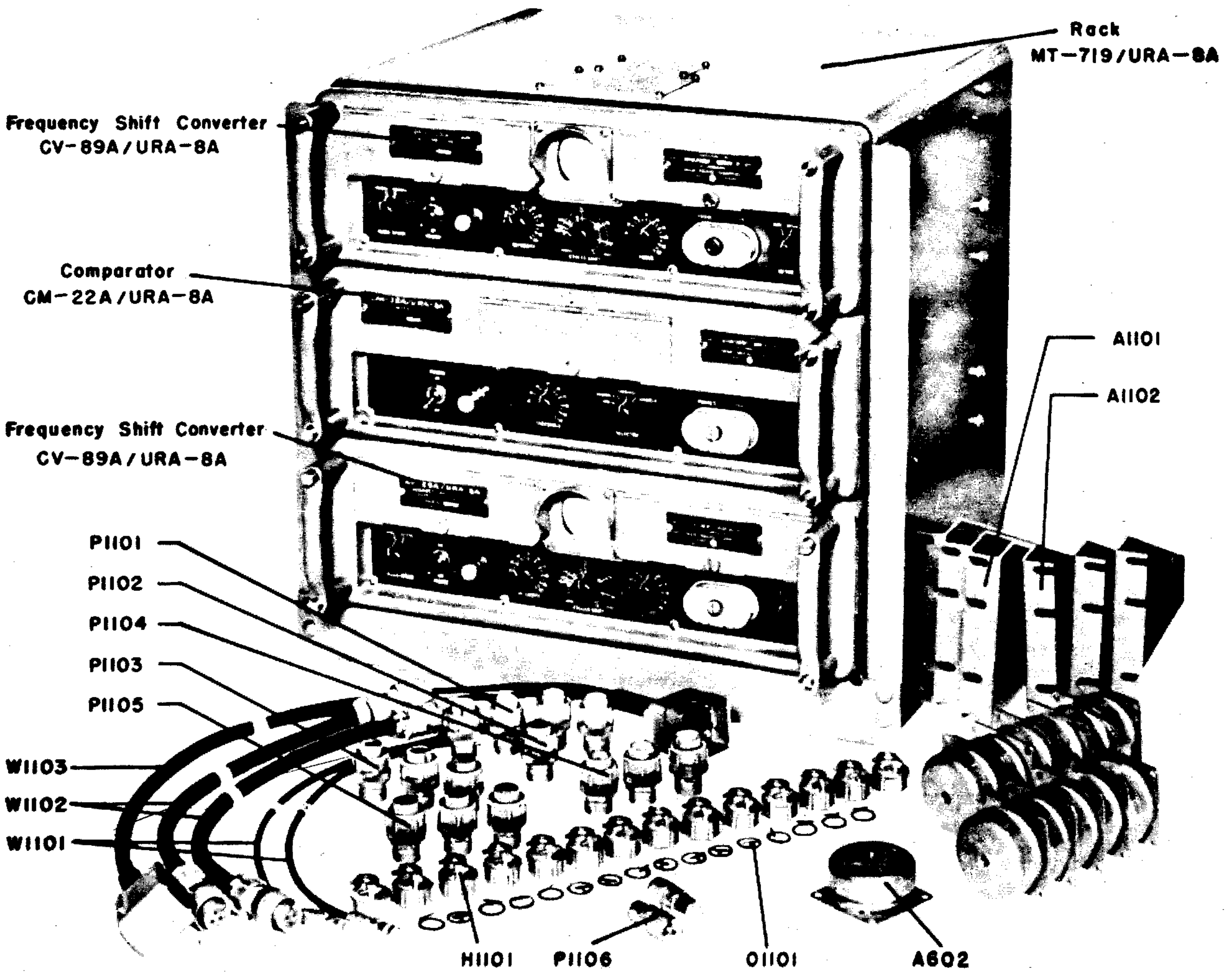

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Figure 10-4.—Frequency-shift converter-comparator group AN/URA-8B.

signal from one channel of the system while operating in diversity reception.

The monitor subunit includes a 2-inch cathode-ray oscilloscope used as a monitor for indicating proper tuning of the receiver, for checking the approximate width of the frequency shift of the signal, and for observing the polarity of the mark-space characters and other details of the signal. It employs a 60-cycle, sine-wave sweep. The vertical amplifier gain control is calibrated in cycles of shift, which are represented by a full pattern between horizontal lines marked on the screen window. The customary oscilloscope controls are provided. An external connection is provided for using a remote monitor or test oscilloscope.

The power supply subunit furnishes all the power required by the other subunits of the frequency-shift converter and is designed to operate from a power source of 105/115/125 volts, 50 to 60 cycles, single phase. A link connector is provided for selecting the correct transformer tap for the particular voltage being used.

The cable filter assembly carries all the connections to the circuits of the chassis-panel assembly and its subunits. On the rear of the cable-filter assembly are ten connectors: one for blower power, and nine extending (in a row) out through the back of the case for accommodating all input and output connections to the frequency-shift converter.

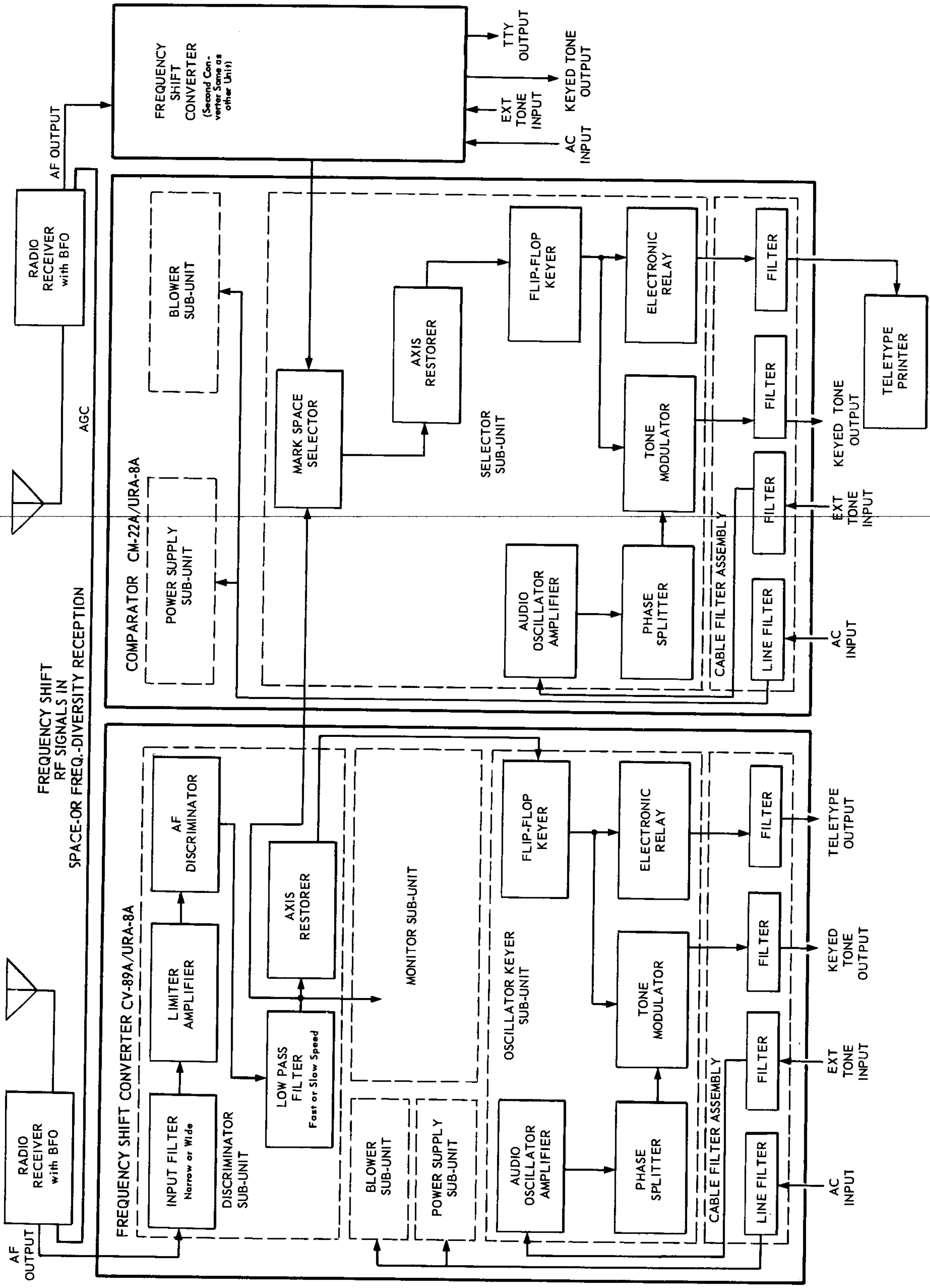

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Figure 10-5. —Block diagram of frequency-shift converter-comparator group AN/URA-8B.

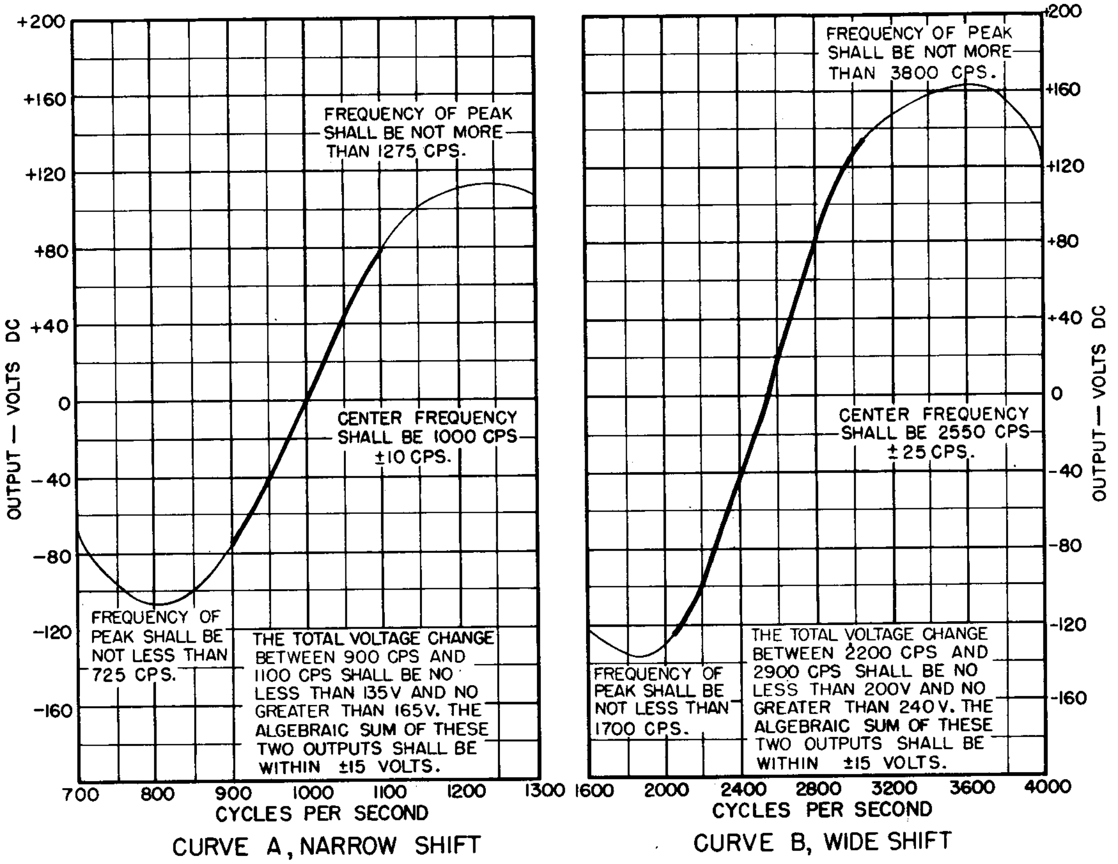

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Figure 10-6.—Discriminator frequency response curves.

The cable filter assembly removes extraneous noise and other signals, which might cause errors in keying. It includes r-f filters for the a-c input, the teletype output, the tone output, and the external tone input circuits.

The blower subunit is mounted on the rear of the case. It forces air through the unit for ventilation when the equipment is being used in high-temperature spaces. The motor operates on 110 volts, 60 cycles, and receives its power by way of a connector on the cable filter assembly. The air intake opening of the cast aluminum housing is covered by an air cleaner, which has an aluminum cloth filter pad. Just inside this opening is a thermostatic switch, which automatically closes to start the motor when the temperature exceeds approximately 49° C.

The chassis-panel assembly consists principally of the front panel and a skeleton chassis into which the four previously described subunits are plugged and mounted. It has cabled wiring carrying the circuits between the receptacles for the subunits and cable filter assembly and to the electrical components on the front cable. The front panel components include the a-c power switch, the pilot light, and two monitor jacks. Other controls and indicators are described under "operation."

Comparator

The Comparator CM-22A/URA-8A (Fig. 10-5) includes (1) a selector subunit, (2) a power-supply subunit, (3) a cable-filter assembly, (4) a blower subunit, (5) a chassis-panel assembly, and (6) a case.

The selector subunit contains the circuit that compares the simultaneous signals from the two frequency-shift converter units and selects the best mark pulse and best space pulse for each character in the signals. The portion of the selector subunit in which this action occurs is illustrated in figure 10-7.

For example, assume that the first converter delivers a 3-volt positive pulse with respect to ground at the same time that the second converter delivers a 2-volt positive pulse. The 3-volt positive pulse will pass through V1A with negligible drop and develop 3 volts across R1. (Assume that the lower end of R1 is at or near ground potential.) This action makes the cathode of V2A 3 volts positive to ground; but the signal from the second converter is only 2 volts positive to ground. Hence V2A is cut off (its plate is negative with respect to its cathode), and only the diode with its plate positive with respect to its cathode will pass the signal. Thus in this example the signal from the first converter is selected by the comparator. The same selection occurs for the negative pulses at V1B and V2B; these pulses have R2 as their common load resistor.

When the signals from the two converters have equal magnitudes, there is some combining in the selector subunit due to phase difference, but otherwise the circuits pass only the stronger mark (positive) or the stronger space (negative) pulse. The selection is instantaneous even to the selection of parts of poorly shaped pulses.

Following the mark-space selector is an axis restorer similar to that in each frequency-shift converter, after which the keying, tone, and output circuits are identical to those in the frequency-shift converter. The selected mark-space pulses are used by these circuits to key the teletype d-c loop and produce the keyed tone output.

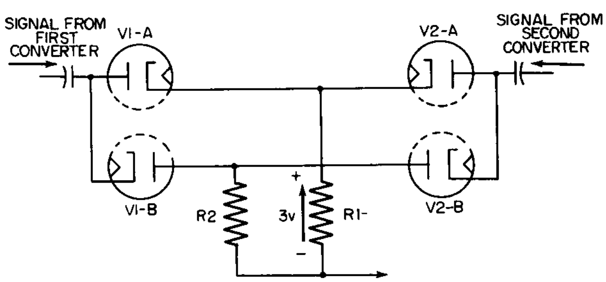

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Figure 10-7.—Portion of selector subunit in comparator CM-22A/URA-8A.

The power supply unit supplies the power required to operate the selector subunit and, like the power supply in the frequency-shift converter, is designed with a link for adjusting the transformer to operate from 105/115/125 volts, 50 to 60 cycles, single phase.

The cable filter assembly of the comparator is nearly identical to the corresponding assembly of the frequency-shift converter. The individual filters in the comparator cable filter assembly are duplicates of those in the frequency-shift converter, filtering the a-c input, the teletype and tone outputs, and the external tone input circuits.

The blower subunit on the rear of the comparator is identical to the one on the frequency-shift converter.

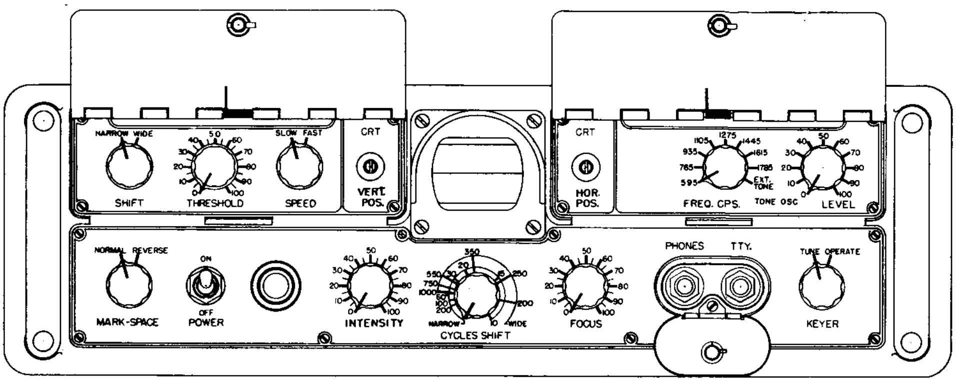
The chassis-panel assembly of the comparator consists principally of the front panel and a skeleton chassis into which the two subunits are plugged and mounted. Its general construction is similar to that of the frequency-shift converter chassis-panel assembly. Cabled wires carry the comparator circuits in the chassis panel assembly between the subunit and cable-filter receptacles and to the electrical components on the front panel. The front panel components include the a-c power switch, the pilot light, and two monitor jacks. Other controls are described under "operation."

Operation

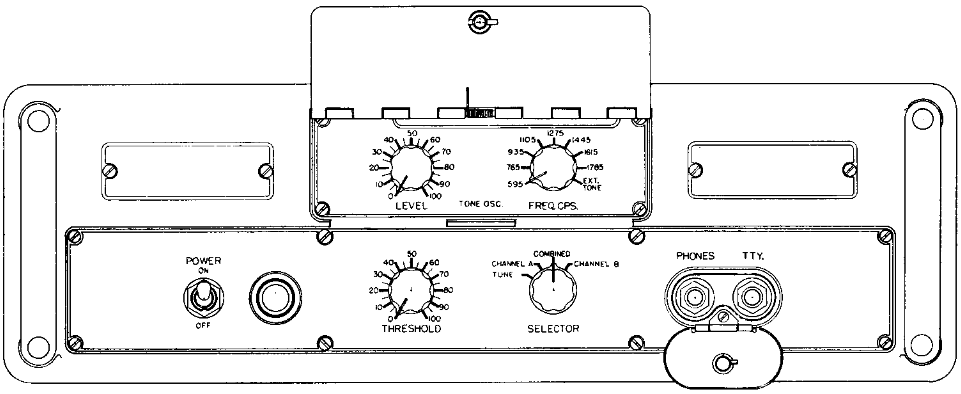
The operating controls of Frequency-Shift Converter CV-89A/URA-8A are illustrated in figure 10-8A, and those for Comparator CM-22A/URA-8A are illustrated in figure 10-8B. The associated monitor oscilloscope patterns are illustrated in figure 10-8C.

In order to obtain optimum performance of the converter-comparator group, it is necessary for the ET 3 to have a basic understanding of the receivers that are used with this equipment. The specific technical manual for the radio receivers being used should be available to the ET 3 to provide complete instructions.

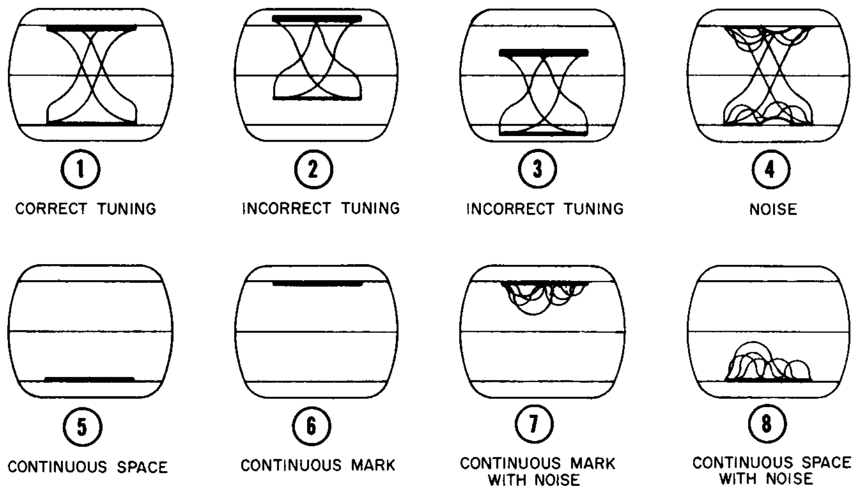
When frequency-shift signals using narrow-shift operation are to be received, the BFO at the receiver should be adjusted to produce a beat note having an average center frequency of 1000 cycles (curve A, fig. 10-6). For wide-shift signals the BFO should be adjusted to produce a beat note having a center frequency of 2550 cycles (curve B, fig. 10-6). Where the BFO is not capable of producing this



A FREQUENCY SHIFT CONVERTER CV-89A/URA-8A



B COMPARATOR CM-22A/URA-8A



C MONITOR OSCILLOSCOPE PATTERNS

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Figure 10-8.—Operating controls and monitor oscilloscope patterns for converter-comparator group AN/URA-8B.

frequency, it may be obtained by slight detuning of the receiver, provided the selectivity is not too sharp.

When employing the higher frequency receivers (AN/SRR-12 and 13) on wide-shift signals, optimum operation is usually obtained with medium selectivity. However, under adverse noise and very weak signal conditions, improved operation can be obtained by using sharp selectivity, provided the BFO can be adjusted to be 2550 cycles higher or lower than the receiver intermediate frequency.

The operating controls for the frequency-shift converter include:

1. Threshold (adjusts bias (axis) to keyer grid).
2. Level (adjusts level of tone output).
3. Cycles shift (adjusts height of oscilloscope pattern and indicates cycles shift).
4. Vertical position (adjusts vertical position of oscilloscope pattern).
5. Horizontal position (adjusts horizontal position of oscilloscope pattern).
6. Intensity (adjusts brightness of oscilloscope pattern).
7. Focus (adjusts sharpness of oscilloscope trace lines).
8. Shift (adjusts discriminator circuits for narrow or wide-shift input).
9. Mark space (reverses polarity of discriminator output voltage).
10. Speed (selects fast- or slow-keying speed filters).
11. Frequency cps (selects frequency-determining elements for tone oscillator).
12. Keyer (for locking up, or closing of teletypewriter circuit during tuning of the receiver).
13. Power (switches a-c power input on and off).

The operating controls for the comparator include:

1. Threshold (adjusts bias (axis) to keyer grid).
2. Level (adjusts level of tone output).
3. Selector (selects input to comparator).
4. Frequency cps (selects frequency determining elements for tone oscillator).
5. Power (switches power on and off).

For diversity operation (fig. 10-8A&B):

1. Set the comparator selector control to TUNE.
2. Turn the comparator threshold control to ZERO.
3. Throw all power switches to ON and allow sufficient time for the receivers to stabilize.
4. Set the shift control on each converter to the WIDE position; or if the shift width of the signal is known, set the shift control to the corresponding position.
5. Turn the cycles shift on each converter to approximately 800 on the wide range. If the cycles shift of the signal to be received is known, set the cycles shift to the corresponding position on the narrow or wide range.
6. Adjust the other oscilloscope controls as required. These adjustments are summarized at the end of this discussion.
7. Set the speed control on each converter to the SLOW position for keying speeds of less than 60 words per minute or to the FAST position for keying speeds in excess of 60 words per minute. However, under unusual conditions, operation is sometimes improved by switching to the FAST position when receiving less than 60 words per minute.
8. Set the comparator frequency cps to the desired tone output frequency and turn the level control to the required output level when tone output is used.
9. Tune the receivers to their respective r-f carriers and adjust the tuning so as to center the signal pattern on the oscilloscope, as shown in figure 10-8 C (1). The tuning of the receivers affects the vertical position of the pattern. The cycles shift control on the converter adjusts the vertical size of the pattern. Aural reproduction of the audio output of the receiver is recommended to aid the operator to identify the signals. If the AN/SRR-12 or 13 receivers are being used, the add decibels switch should be set on +10 and the level control adjusted until the output meter reads 0 db. For this condition, the signal power is equal to 0 + 10 or 10 db. (Because zero db is equivalent to 6 mw into 600 ohms, 10 db is equivalent to a 60 mw output signal from the receiver.)

For dual diversity reception using two AN/SRR-12 or two AN/SRR-13 receivers, links are provided in the diode detector and AGC circuits that make these circuits common to the two receivers by means of receptacles, jacks, and suitable cabling. The gain of both receivers must be balanced. This action is accomplished by regulating the amount of amplification in the first two stages of the second i-f amplifier assembly of each receiver through adjustment of the diversity gain balance control. This control is a recessed screwdriver adjustment on the front panel.

With a common AGC circuit for both receivers, r-f input signals to both receivers (local and remote) will affect both AGC circuits simultaneously. For example, if the r-f input signal to the local receiver becomes stronger than the r-f input signal to the companion receiver, the AGC bias in both receivers will increase. This action decreases the gain of the r-f and i-f stages of both receivers, thereby decreasing the relative magnitude of the output signal of the companion receiver with its relatively weaker input signal. This action facilitates the selector action in the comparator by emphasizing the difference in voltage between the two receiver output signals.

The oscilloscope on each frequency-shift converter functions as a monitor for tuning its associated receiver to the r-f carriers, as previously described. When the receiver is tuned correctly and the cycles shift is properly adjusted, the pattern on the oscilloscope of each converter should coincide with the upper horizontal line for a mark pulse and the lower horizontal line for a space pulse, as illustrated in figure 10-8 C (1). If the receiver is not correctly tuned, the oscilloscope patterns will resemble patterns (2) and (3) in the figure. Under bad noise conditions the patterns will resemble (4), (7), and (8). A correctly tuned steady space and steady mark signal is shown at (5) and (6) respectively.

10. The width of shift being received is indicated on the cycles shift wide or narrow scale when the oscilloscope mark space pattern is adjusted between the upper and lower calibrating lines, as shown at (1). The scale to read is the one that corresponds to the setting of the shift control located on the frequency shift converter (fig. 10-8A).

11. Set the comparator selector (fig. 10-8 B) to channel A (upper converter unit, fig. 10-4).

12. Turn the comparator threshold control clockwise until the teletype printer starts to print.

13. Try the channel A converter mark-space selector in both normal and reverse positions (fig. 10-8 A) and leave it in the position that gives correct copy on the teletype printer. In the correct position the characters are of the right polarity to control the teletype printer, but in the other position the characters are reversed and will not synchronize the control mechanism of the teletype printer. The latter condition results in no intelligence in the printed copy.

14. The teletype printer should now print correct copy (except in the low parts of a fading signal), indicating that A is ready for diversity operation.

15. Set the comparator selector to channel B (lower converter (fig. 10-4).

16. Turn the comparator threshold control clockwise until the teletype printer starts to print.

17. Try the channel B converter mark-space selector in both normal and reverse positions, as described for the channel A converter under item 13 (fig. 10-8A). Leave the selector in the correct position, as described in item 13.

18. The teletype printer should now print correct copy (except in the low parts of a fading signal), indicating that channel B is ready for diversity operation.

19. Set the comparator selector to COMBINED (fig. 10-8B).

20. Adjust the comparator threshold control to the highest scale reading that does not allow noise pulses to cause errors in the copy. A practical way to find this setting is to detune both receivers slightly off their respective r-f carriers to a position where noise alone is received. Then turn the threshold control clockwise to allow the noise to key the teletype printer. Finally turn the threshold control counterclockwise (back it off) to the position where the threshold bias is just enough to prevent the noise from keying the teletype printer.

21. Retune each receiver to its respective r-f carrier (as it was before detuning).

The frequency-shift converter-comparator group is now adjusted for diversity operation, either continuous or intermittent. Except for occasional retuning of the receivers and readjusting for changing conditions, the equipment should require little attention by the ET 3.

With experience in the use of this equipment the art of tuning and adjusting can be developed to the point where the proper settings can be readily recognized from the teletype printer copy and the monitor oscilloscope pattern. Under conditions of bad noise, it is frequently possible to obtain satisfactory teletype copy in diversity operation from signals that audibly are hardly distinguishable from the noise.

When placing the frequency-shift converter-comparator group into operation for the first time, it is necessary to make four initial adjustments on the oscilloscopes associated with each of the converters. Two of these adjustments are semipermanent and need only be checked periodically after they are once set. The other two are panel controls that may have to be readjusted according to light conditions in the room in which the equipment is located.

To make these adjustments on the oscilloscope, (1) turn the receiver off and adjust the intensity and the focus on the converter (fig. 10-8A) to give a clear, fine trace on the screen with the desired brightness; (2) adjust the converter screwdriver adjustment marked VERT POS, to make the horizontal trace coincide with the horizontal centerline on the face of the oscilloscope; and (3) adjust the converter screwdriver adjustment marked, HOR POS, to center the horizontal trace on the screen.

After making these adjustments, turn the receiver on and proceed with the operation of the equipment. During operation the intensity and focus controls should be readjusted whenever necessary to give the clearest possible presentation.

CONVERTER-COMPARATOR GROUP AN/URA-17

Converter-Comparator Group AN/URA-17 (fig. 10-9) is a completely transistorized equipment designed to perform the same functions in the frequency-shift teletype receiving system as the AN/URA-8B, just described.

Although present procurement of frequency-shift converters is confined to the AN/URA-17, there are relatively few installations compared with the large number of AN/URA-8B converters. The greater quantity of AN/URA-8B converters will continue in service for several more years before eventual replacement by the newer model described briefly in the following paragraphs.

General Description

The AN/URA-17 consists of two identical converter units, one of which is shown in figure 10-10. Each converter has its own comparator circuitry. This achieves a considerable reduction in size from model AN/URA-8B, wherein the comparator occupied a separate chassis.

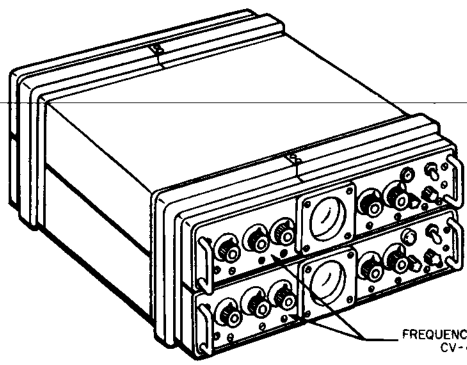

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Figure 10-9.—Converter-comparator group AN/URA-17.

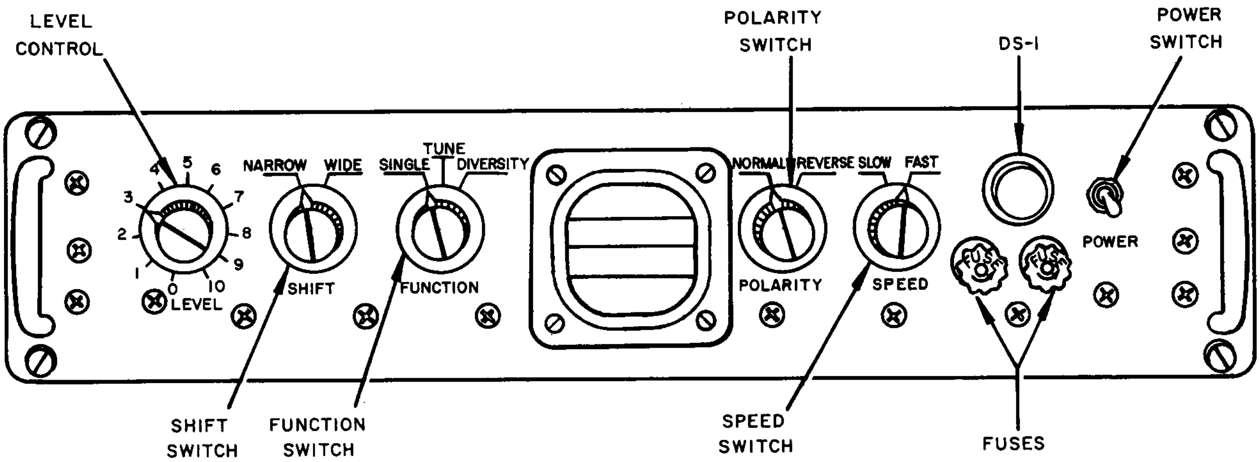

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Figure 10-10.—Frequency-shift converter CV-483/URA-17, front panel controls.

The physical size of the AN/URA-17 is further reduced through use of semiconductors and printed circuit boards. The complete equipment is less than half the size of the AN/URA-8B.

The converter-comparator can be operated with two radio receivers in either space-diversity or frequency-diversity receiving systems. When conditions do not require diversity operation, each converter can be used separately with a single receiver for reception of frequency shift teletype signals. In this latter usage, the two converters can be operated in two independent communication circuits.

For diversity operation, the function switch (fig. 10-10) on both converters must be placed in the diversity position. The teletypewriter may be connected to either converter.

The principal functions of the circuits of the complete equipment are represented in figure 10-11. Two receivers and a teletypewriter are also shown, connected for diversity operation. The two converters are identical, and one is shown as a single block for simplicity.

Tone Converter AN/SGC-1A

Another method of teletype communications employs tone modulation for short range (UHF and VHF) transmission, as mentioned in chapter 5 of this training course. Tone modulation employs a tone converter, one type of which is included in Radio Teletype Terminal Set AN/SGC-1A, as illustrated at the center of figure 10-12. Other associated equipment includes a

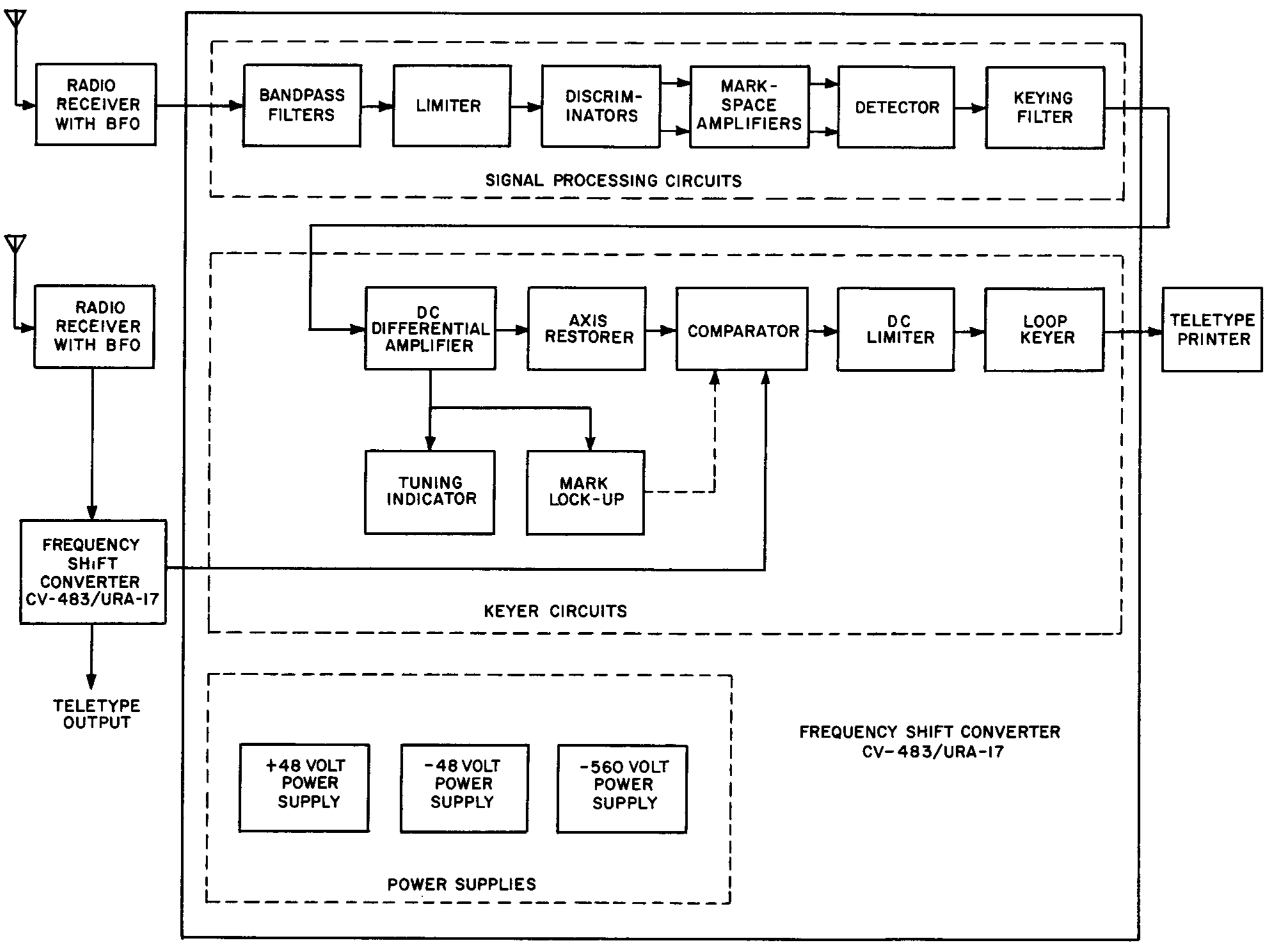

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Figure 10-11.—Converter-comparator group AN/URA-17, functional block diagram.

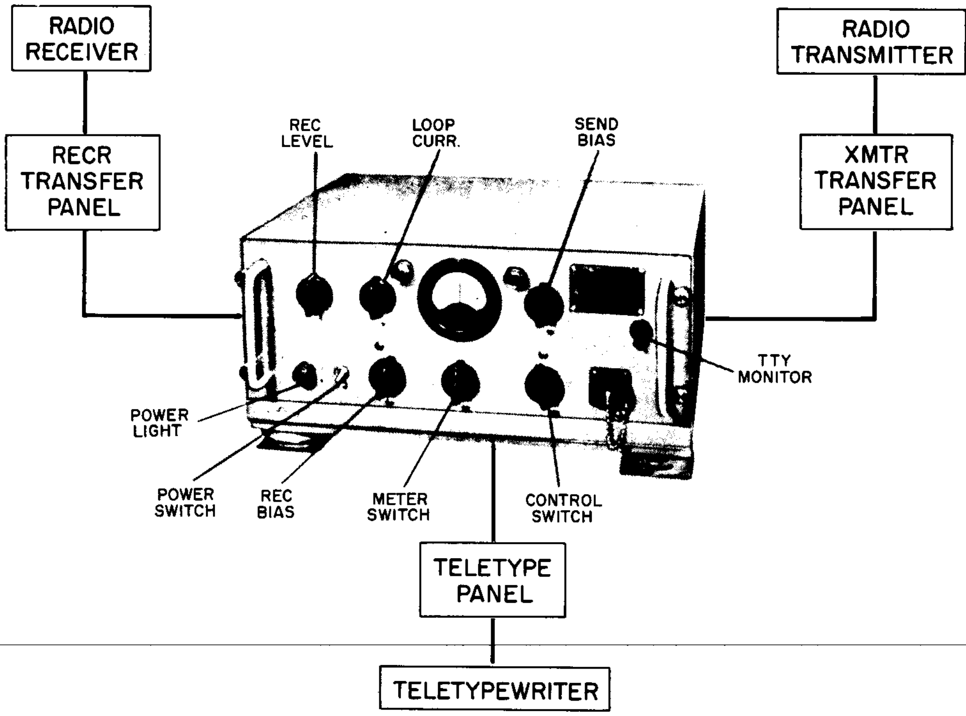

Figure 10-12.—Teletype terminal equipment AN/SGC-1A.

radio receiver and transfer panel, a radiophone transmitter and transfer panel, and a teletypewriter and panel. The blocks indicate that any suitable standard Navy components may be used.

In tone modulation transmission, the teletypewriter pulses are converted into corresponding audio tones, which amplitude modulate the voice-frequency transmitter. Conversion of the audio tones is accomplished by an audio oscillator in the tone converter, which operates at 700 cycles when the teletype loop is in a closed-circuit (mark) condition and at 500 cycles when the loop is in an open-circuit (space) condition.

An internal relay in the tone converter closes a control line to the radio transmitter, which places the unit on the air when the operator begins typing a message. The control line remains closed until after the message has been transmitted.

When receiving messages, the tone converter accepts the mark and space tones coming in from an associated radio receiver and converts the intelligence of the tones into signals suitable to operate the make and break contacts of a relay connected in the local teletypewrter d-c loop circuit. This action causes the local teletypewriter to print in unison with the mark and space signals from the distant teletypewriter.

The receive level calibrated attenuator is located at the upper left side of the front panel on the tone converter. This control permits adjustment of the level of the incoming tone signals from the receiver. The loop current rheostat is next to the receive level control, and is adjusted to 60 ma when the teletype loop is in the mark, or closed circuit condition. A zero-center meter indicator is located at the upper middle portion of the front panel. An associated switch is located directly below the meter. It has several positions to permit measurements to be taken in all the necessary portions of the circuit.

Two indicator lights flank the upper part of the meter. One light indicates the receive condition and the other indicates the transmit condition. Both lights are off when the tone converter is in the standby condition.

The send bias rheostat is located at the right of the meter. This control permits correction of any teletype distortion (for example, unequal length of mark and space signals) in the local teletypewriter loop when sending a teletype message.

At the far right is a jack marked, TTY monitor. A test or monitoring teletypewriter may be patched into this jack, thereby placing it in series with all other equipments in the loop. NOTE: headphones must not be plugged into this jack.

The power indicator light is located at the lower left side of the front panel of the tone converter. The power ON-OFF switch is located next to it.

The receive bias potentiometer is located at the right of the power switch. This control enables correction of distortion (unequal length of mark and space tones) in the receiving tone circuit.

The control switch is located at the right of the meter switch. The position of the control switch determines the function of the tone converter to either receive or to transmit teletype signals.

A 115-volt, 60-cycle convenience outlet is provided at the lower right of the front panel. It bypasses the power switch.

A block diagram of the tone converter is illustrated in figure 10-13. Typical oscilloscope patterns are included. The attenuator is located at the input of the receive circuit to permit adjustment of the level of the incoming 2-tone signal. The band-pass filter passes all frequencies in the band from 400 to 800 cycles and rejects all other frequencies. The amplifier limiter stages have a constant-output level. The frequency discriminator filter selects the fundamental frequencies of 500 cycles and 700 cycles and routes them via separate germanium rectifiers to corresponding d-c amplifiers (in the d-c amplifier block) and associated relay coils in the receiver relay block. A 700-cycle signal causes the receive relay to close the teletype d-c loop; a 500-cycle signal causes the relay to open the loop. Thus, corresponding mark and space signals are developed in the teletype loop circuit.

In sending, the mark and space signals in the d-c loop cause the send relay to apply either a d-c voltage or no d-c voltage respectively to the two-tone oscillator. A mark

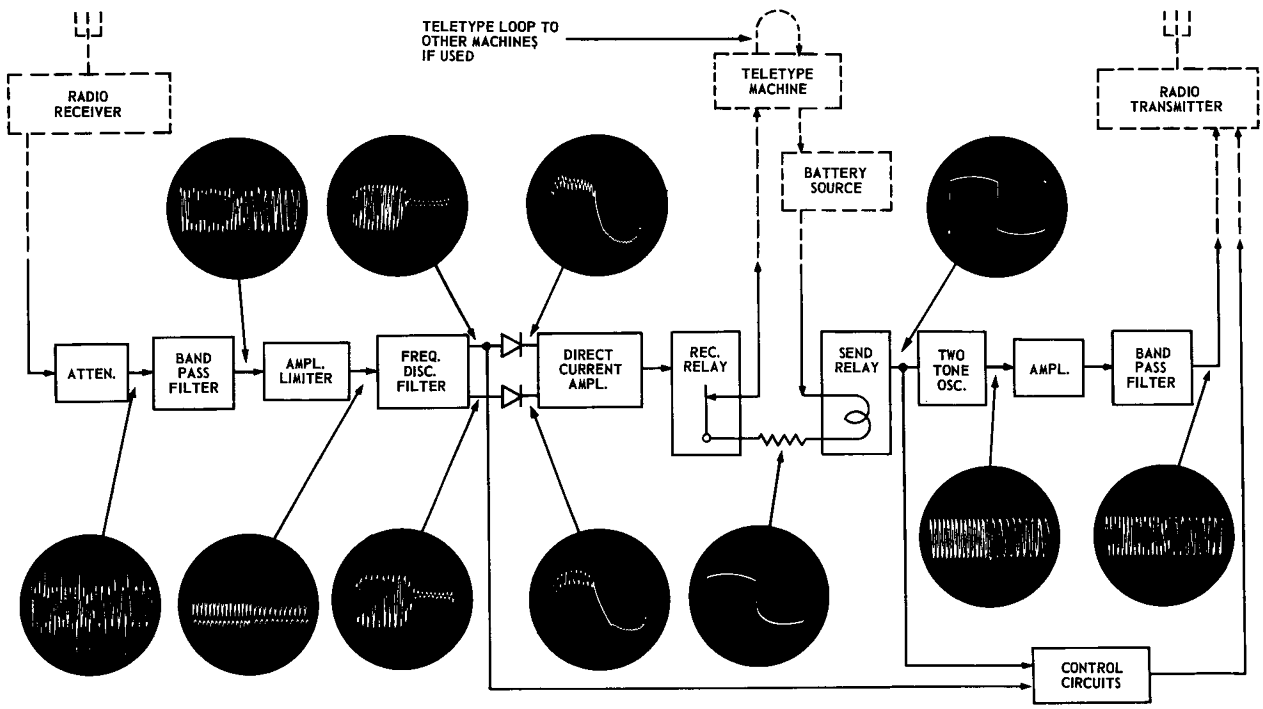

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Figure 10-13.—Block diagram of tone converter.

signal causes the oscillator to operate at 700 cycles; a space signal causes it to operate at 500 cycles.

The output of the oscillator passes through a level-controlling potentiometer (not shown in the diagram) to the amplifier stage. The output of the amplifier passes through a band-pass filter to the ship's radio transmitter.

The control switch is used to change from one operating condition to another or to permit the accomplishment of specific operating or maintenance functions. If it is desired to prevent the sending of a message by the teletypewriter, the control switch may be turned to REC/STDY. Thus, the equipment cannot change to the transmit condition even though the teletypewriter is operated, but it can receive messages or remain in the standby condition.

In carrying on communications, the equipment should not be operated with the control switch turned to TRS because the equipment is then locked in the transmit condition and cannot receive any message until released by turning the control switch to one of the other two operating positions.

Usually, for half-duplex communication, this switch is set at the AUTO position. In auto condition, operators at two or more stations having this equipment can engage in full communication. After a station has completed sending its message, it is ready for reception of any return message after an automatic three-second time delay. When the switch is in the AUTO position, the tone converter may be in one of three conditions: receiving, transmitting, or standby. When in the standby condition, the reception of an incoming mark tone causes the control circuit to change to the receiving condition. Following the end of the incoming message, the internal circuits of the equipment shift back to the standby condition. When in this condition the operation of the local teletypewriter causes the circuits to change from standby to the transmit condition. After the last letter of the message is sent, there is a time delay of about three seconds and then the internal equipment circuits shift back to the standby condition. The interlocking functions prevent the equipment from shifting directly from transmit to receive, or vice versa. Thus, an incoming signal will not interrupt an output signal, nor will keying the local teletypewriter, when receiving, cause the circuit to shift to the transmit condition. The control circuits also, when shifted to transmit condition, cause the control contacts of the transmit control relay to the radio transmitter to close, thereby placing the transmitter carrier on the air.

After a station has sent its message, it is ready for reception of any return message following an automatic three-second time delay. Because of the small time delay inherent in the operation of the control circuits of the local and distant terminals the first character transmitted is usually lost. Therefore, the first character typed should be the "letters" key.

When placing the tone converter in operation, proceed as follows:

1. Turn the power switch (fig. 10-12) to ON.

2. Turn the control switch to TRS (transmit position). If the transmitter power has been turned on, the transmitter will send out a continuous tone; however, this does not matter for a few moments. If desired, the transmitter power may be left off until certain other adjustments have been performed.

3. Turn the meter switch to LOOP CURRENT. Adjust the control marked, LOOP CURR, until the meter reads 60 on the upper scale. If the meter reads zero, the source of loop current may not be energized.

4. Turn the control switch to AUTO. Then hold down the space bar on the teletypewriter and turn the meter switch to SEND BIAS. The meter should read zero on the upper scale. If it does not read zero, correct the reading to zero by means of the send bias control. Turn the meter switch to OFF <u>before</u> releasing the space bar.

5. The radio transmitter may be turned on if it was left off. When a teletypewriter message is received from a distant station, turn the meter switch to RECEIVE LEVEL and adjust the receive level control until the meter indicates 0 dbm (lower scale).

6. The last adjustment is the receive bias control adjustment for which an incoming teletypewriter signal is required from a distant station. The ET should request that a distant operator hold down his teletypewriter space bar for a minute. While he is holding down the space bar, turn the meter switch to RECEIVE BIAS and adjust the receive bias control until the meter reads zero on the upper scale. Then return the meter switch to the OFF position.

The equipment is now adjusted for operation with its associated teletypewriter, receiver, and transmitter for communication with other stations similarly equipped.

COMMUNICATION PATCHING PANEL SB-1203/UG

Teletype panels and communication patching panels are used to interconnect the page printers and terminal equipments. Communication patching panel SB-1203/UG (fig. 10-14) contains 6 channels. The permanent and patching connections provide many circuit arrangements. Each channel comprises a circuit of 3 looping jacks (LPG), 1 SET jack, 1 MISC. jack, and a rheostat for adjusting line current. The LPG and MISC. jacks are identical, and are standard type phone jacks. The SET jacks incorporate the features of a double-pole double-throw switch, as will be seen later. The 6 line current rheostats provide individual channel current adjustment.

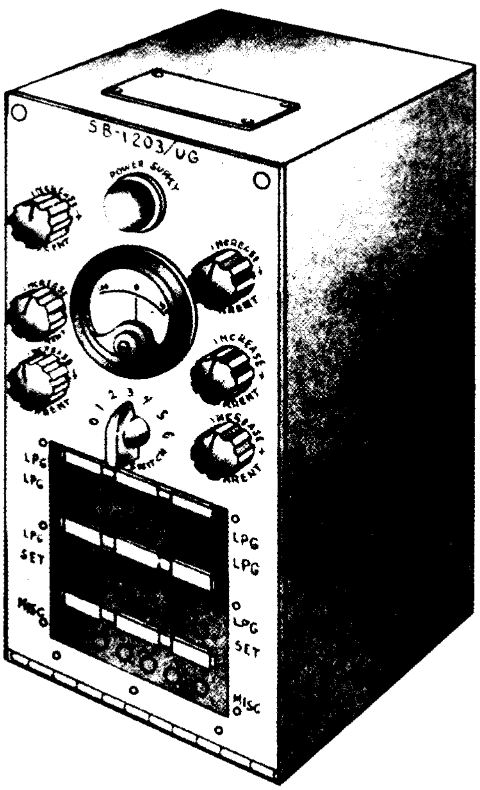

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Figure 10-14.—Communication patching panel SB-1203/UG.

The CURRENT METER is a d-c milliammeter. The METER SWITCH is a two-pole, seven-position, rotary selector switch. When the METER SWITCH is turned to any one of the 6 channels, line current in the selected channel will be indicated on the CURRENT METER.

Figure 10-15 shows a simplified schematic of a single channel. The other five channels are identical. Terminal equipment is connected to terminals 1 and 2 of terminal board TB-101, and the teletypewriter is connected to terminals 1 and 2 of TB-102. When line current is not supplied by the remote station loop, provisions are made to connect a local source of 115 volts d-c across terminals 1 and 2 of TB-104. These connections are paralleled across the corresponding terminals of each loop, and local current can be connected in or out of each loop by removable straps.

Resistor R119 limits the current in each loop to a maximum of 100 ma. Line current is adjusted by the 2500-ohm rheostat R108. One terminal of the rheostat is connected to the first looping jack J101. The SET jack J119 is connected to terminals 1 and 2 of TB-102 completing the circuit between the terminal equipment and the teletypewriter.

The teletypewriter may be transferred to any other channel by patching it from the SET jack J119 to one of the looping jacks in the channel desired. If it is desirable for the teletypewriter in this channel to be inoperative, a dummy plug is inserted in SET jack J119. An additional teletypewriter may be connected to the MISC. jack and patched into any channel.

Operating Adjustments

1. Turn all line current rheostats counterclockwise to allow minimum current.
2. Turn on local or remote power.
3. If the teletypewriter to be used is wired in the same looping channel as the terminal equipment to be used, no patching is required. If the teletypewriter is not wired in the same channel as the terminal equipment, insert one end of a patchcord in the proper SET jack and the other end in either of the looping jacks in the desired channel.
4. Turn the METER SWITCH to the desired channel and adjust the line current to 60 ma.

TRANSMITTER TELETYPE CONTROL UNIT C-1004A/SG

Another equipment used with teletype installations aboard ship is a control unit, for

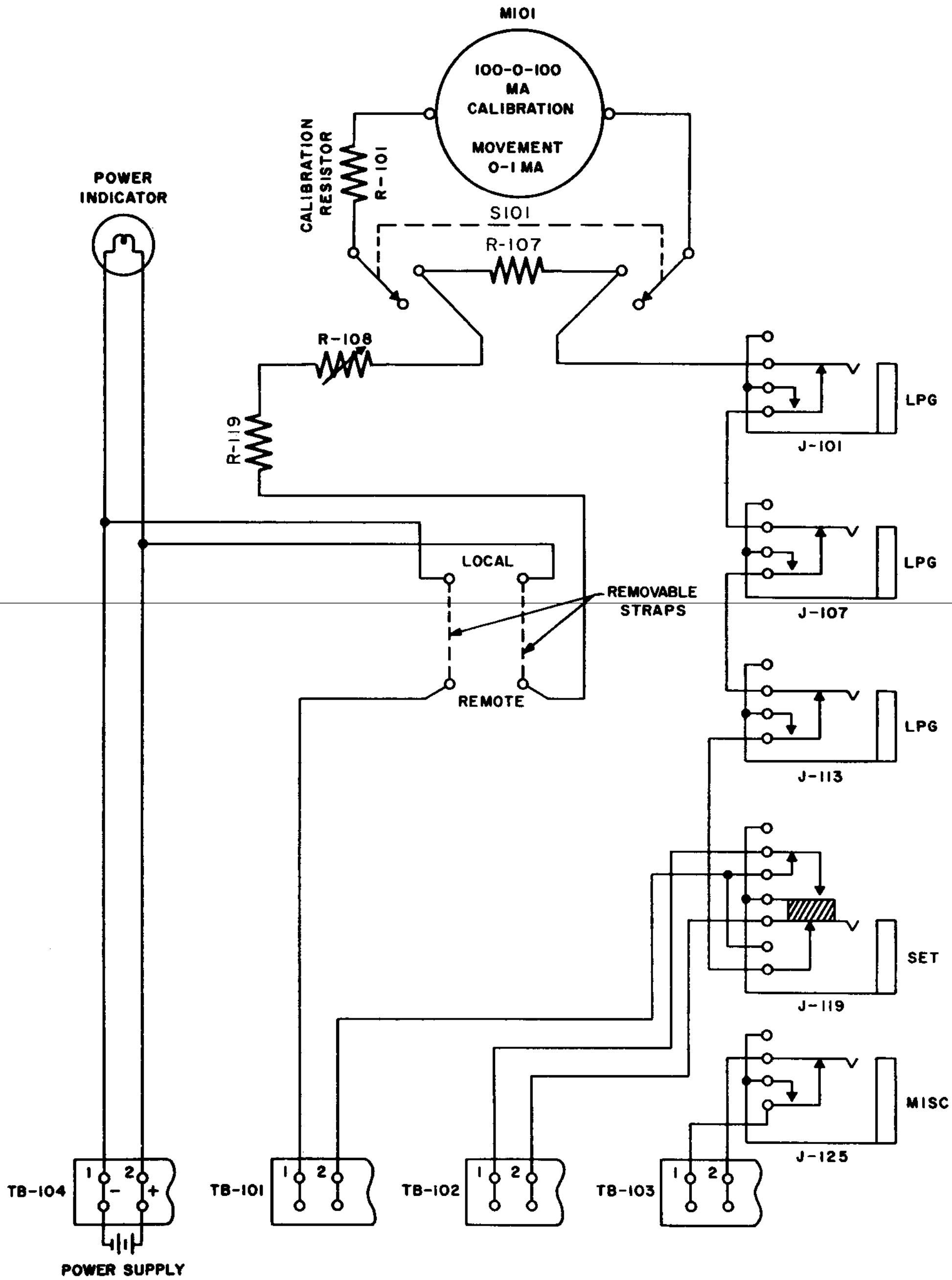

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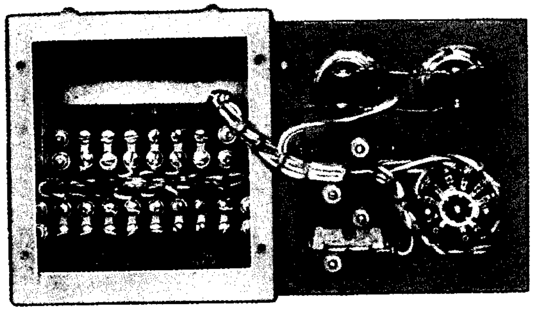
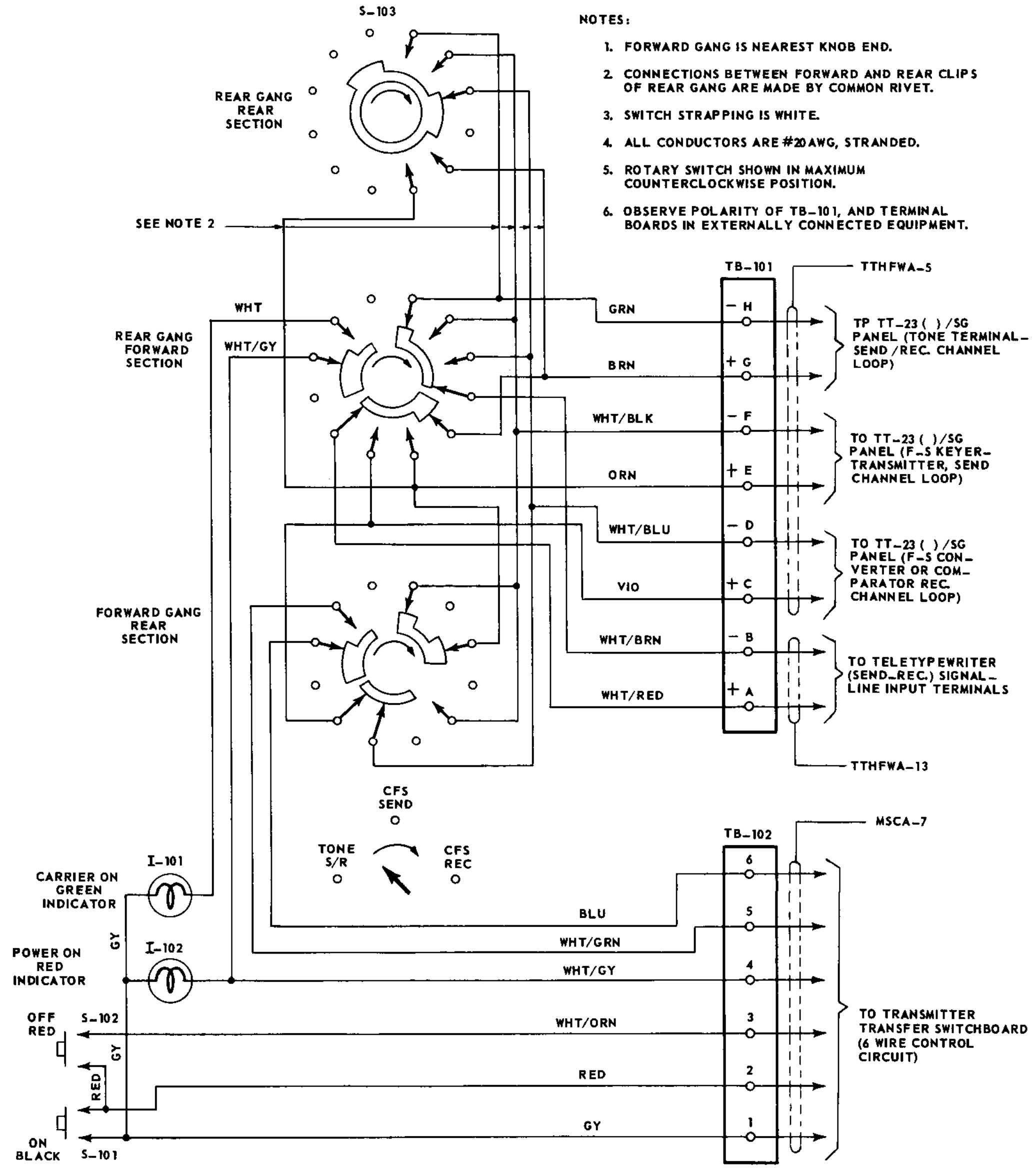
Figure 10-15.—Communication patching panel SB-1203/UG, single channel simplified schematic diagram

example, Navy Model C-1004A/SG (fig. 10-16). This unit permits control of a teletypewriter radio circuit from a remote position. It provides a transmitter power ON-OFF switch, a power-on indicator lamp, a carrier-on indicator lamp, and a three-position rotary selector

A EXTERNAL VIEW



B INTERNAL VIEW



C CIRCUIT DIAGRAM

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Figure 10-16.—Transmitter teletype control unit C1004A/SG.

switch. The rotary selector switch, S103, provides the following functions:

1. Connects a send-receive teletypewriter to (A) a frequency-shift keyer circuit (CFS send), (B) a frequency-shift converter or comparator circuit (CFS receive) or, (C) a tone terminal on a send receive basis (tone S/R).

2. Shorts the other two unused sets of terminals when the send-receive teletypewriter is connected to the set of terminals associated with a particular switch position; that is, when the switch is in the TONE S/R position, the frequency-shift keyer terminals, E and F (CFS send) and the frequency-shift converter terminals, C and D (CFS receive) are shorted (close circuited).

3. Turns on the transmitter carrier by closing a circuit in the radio transmitter (terminals 5 and 6 are shorted in the CFS send position only).

4. Energizes the carrier-on indicator lamp in the CFS SEND position only.

When S103 (fig. 10-16C) is in the TONE S/R position, the carrier-on indicator lamp and the transmitter carrier are off; the teletypewriter is connected to the tone terminal loop (terminals G and H) while the unused terminals, frequency-shift keyer terminals E and F and frequency-shift converter terminals C and D, are shorted.

When S103 is in the CFS RECEIVE position, the carrier-on indicator light and the transmitter carrier are off; the teletypewriter is connected to the frequency-shift converter circuit while the unused terminals, tone terminals G and H and frequency-shift keyer terminals E and F, are shorted.

FACSIMILE EQUIPMENT

Facsimile provides a means of reproducing still pictures over a communications system. The principle of operation is described briefly in chapter 5. Common operating adjustments on various components of facsimile transmitting and receiving terminal equipments are described below.

FACSIMILE TRANSCEIVER TT-41B/TXC-1B

Facsimile Transceiver TT-41B/TXC-1B is an electro-mechanical optical facsimile set of the revolving-drum type for the transmission and reception of page copy. It is used for transmission of maps, photographs, sketches, and printed or handwritten text over regular voice communications channels, either wire or radio, between two or more stations. Colored copy may be transmitted, but all reproduction is in black, white and intermediate shades of gray. Received copy is recorded either directly on chemically treated paper, or photgraphically in either negative or positive form. The equipment will transmit or receive a page of copy 12 by 18 inches in 20 minutes at regular speed or in 40 minutes with half-speed operation. A block diagram of the overall equipment is illustrated in figure 10-17.

The complete electrical circuit of the transceiver and power unit may be subdivided into the following eight principal components: (1) fork oscillator unit, (2) photo cell bridge modulator, (3) signal amplifier circuit, (4) phasing circuit, (5) motor circuit, (6) B+ regulator circuit, (7) rectifier power supply, and (8) exciter lamp supply.

The fork oscillator unit (V1, V2, and V3) generates a highly stable 1800-cycle audio signal for distribution to the bridge modulator circuit, the motor amplifier circuit, and the exciter lamp circuit.

The bridge modulator circuit, built around a 5652 photo tube, V24, is used only on transmission. It amplitude modulates the 1800-cycle signal in accordance with the variations in light intensity of the small portion of the transmitted copy being scanned at any instant.

The signal amplifier circuit (V10, V11, V12, V13, and V14) amplifies the 1800-cycle a-m signal. On transmission the circuit is fed by the photo tube bridge modulator; the output goes to the line terminal and thence via auxiliary equipment to the radio transmitter. On reception the circuit is fed by the signal on the line from a radio receiver; the output drives either the stylus for direct recording or the recorder lamp for photo recording. The signal amplifiers are also used in the talk-back circuit.

The phasing circuit, V15 and V16, is used for phasing of the facsimile receiver before each transmission. A series of phasing pulses from the transmitter actuates a clutch mechanism, which positions the receiver drum so that the clamp bars of both drums (receiver and transmitter) pass the scanning mechanisms at the same time. The clamp bars hold the copy to the drum (fig. 10-18).

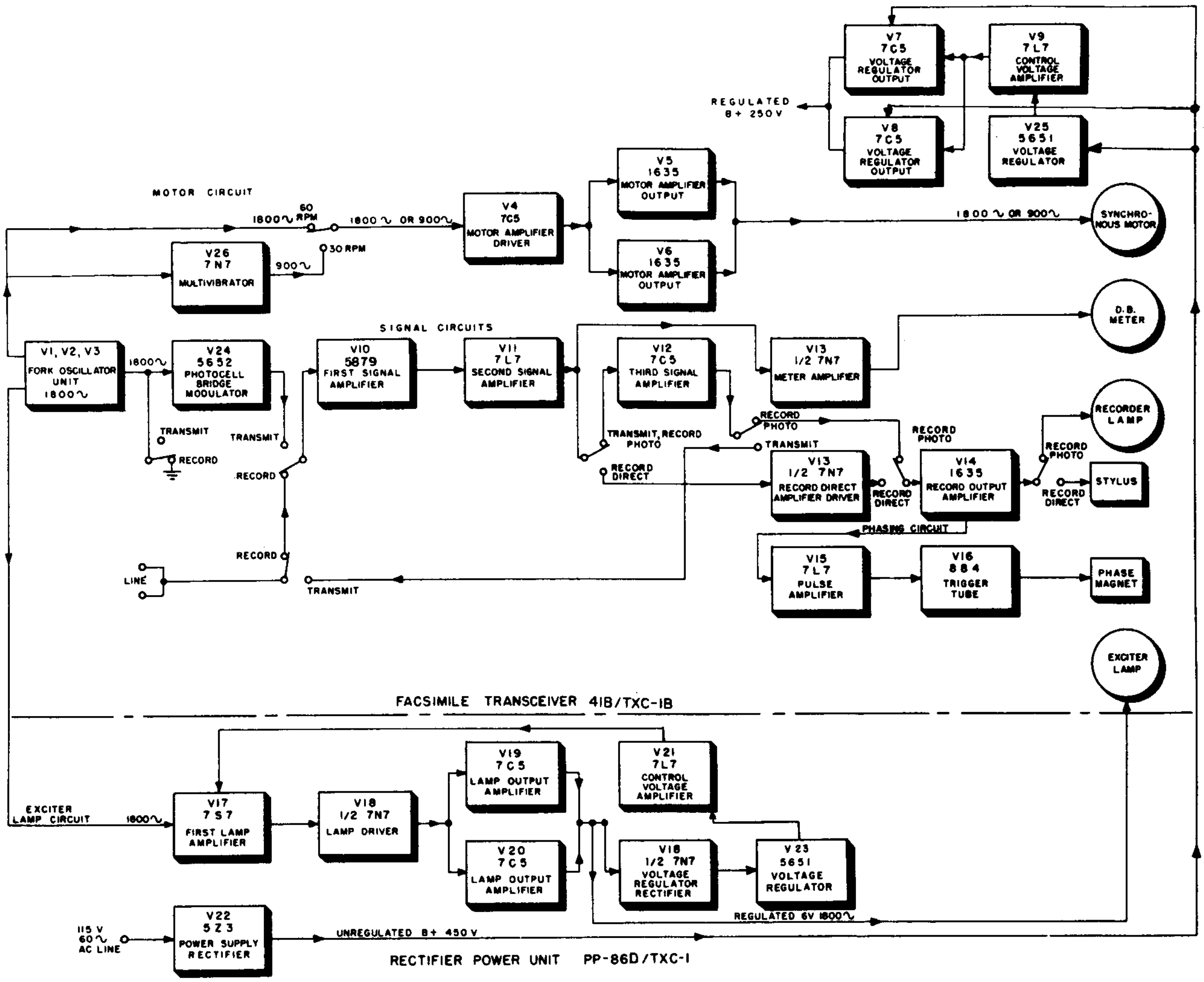

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Figure 10-17.—Block diagram of facsimile transceiver TT-41B/TXC-1B and rectifier power unit PP-86D/TXC.

The motor circuit (V4, V5, and V6, fig. 10-17) amplifies the 1800-cycle signal from the fork oscillator unit and drives the synchronous motor at constant speed. A multivibrator, V26, is used to provide half-speed operation of the synchronous motor.

The B+ regulator circuit (V7, V8, V9, and V25) provides a closely regulated voltage of 250 volts from the rectifier power supply of 450 volts. Regulated B+ voltage is used on critical transceiver circuits.

The rectifier power supply (V22 in the power unit) provides an unregulated 450-volt B+ output. The power unit also provides 6.3 volts a-c for filament operation and 115 volts a-c for starting the synchronous motor (not shown in the figure).

The exciter lamp supply (V17, V18, V19, V20, V21 and V23 in the power unit) amplifies and regulates the 1800-cycle signal from the fork oscillator unit to provide a constant amplitude, constant frequency signal for the transceiver exciter lamp, which illuminates the transmitted copy with a constant brilliancy.

All electrical operating controls of the facsimile transceiver, except the motor speed-control switch are located on the sloping front

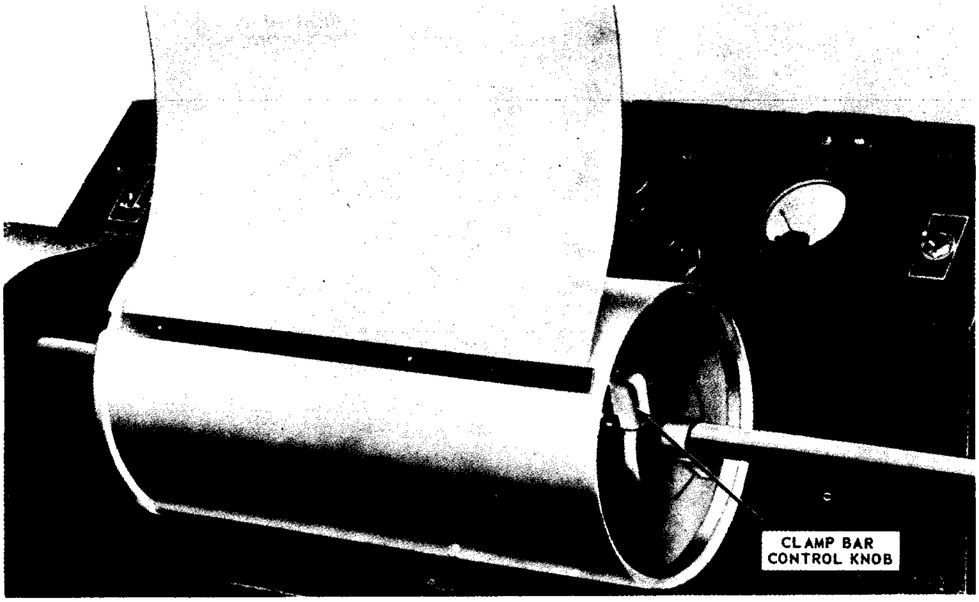

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Figure 10-18.—Placing copy on drum.

panel of the transceiver (fig. 10-19). The motor speed-control switch is located on the left end of the base of the transceiver. Two mechanical controls, the drum engaging lever and the clamp bar, are located on the drum. Input and output connections are located on the right-hand end of the transceiver. The power unit has no operating controls.

The power ON-OFF switch is located on the right-hand side of the control panel. It makes and breaks one side of the 115-volt, 60-cycle a-c line circuit feeding the primary of the main power transformer located in the rectifier power unit. In the OFF position power is removed from all parts of the facsimile set. In the ON position plate and filament voltages are applied to all tubes, and power is available for starting and operating the synchronous motor.

The selector switch located to the left of center on the front panel is the principal control for determining the function of the transceiver. It has five positions, which are labeled (from top to bottom) TRANSMIT, SET RANGE, STANDBY, RECORD PHOTO, and RECORD DIRECT.

In the TRANSMIT position the facsimile transmitting circuit is established, and impulses representing elements of the facsimile copy are sent out over the facsimile circuit. This is the normal operating position when the transceiver is transmitting copy. In this position the switch also closes the radio transmitter relay circuit associated with the carbon mike jack.

In the SET RANGE position the transmitting circuit is established as in the TRANSMIT position, except that impulses are not sent out over the line. This position is used when the operator is engaged in setting the contact range for transmitting a specific piece of copy.

In the STANDBY position the electron tubes are kept ready for operation of the transceiver. This is the normal setting during periods when copy is not being transmitted or received.

In the RECORD PHOTO position the receiving circuit is established to permit use of the recorder lamp for recording the received copy on photographic paper. This switch position is used to set the gain and to phase the receiving transceiver before recording either

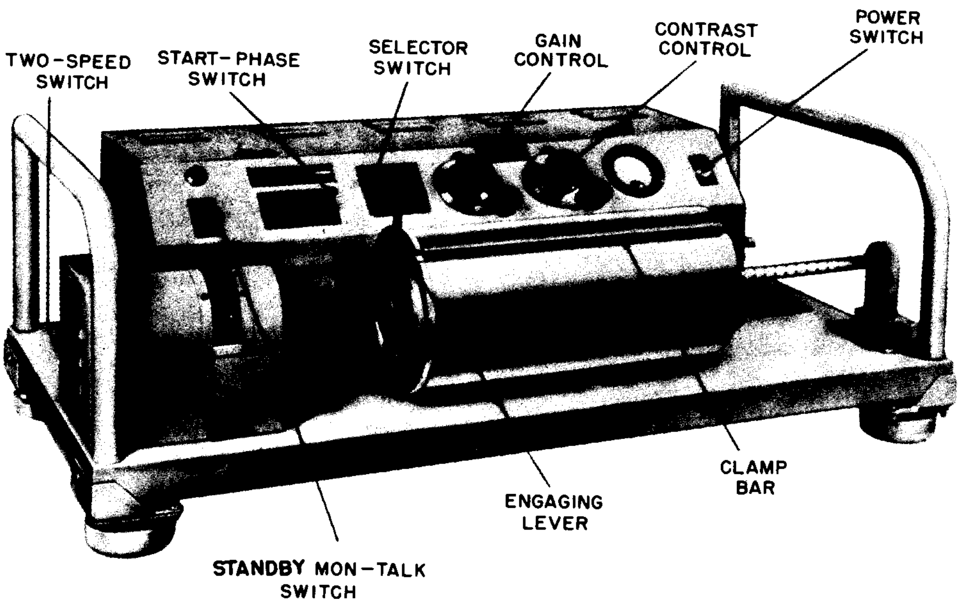

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Figure 10-19.—Facsimile transceiver controls.

"photo" or "direct." A raised stud on the selector switch nameplate enables the operator to set the switch at record PHOTO by "feel" in the dark room.

In the RECORD DIRECT position the receiving circuit is established to permit use of the stylus instead of the recording lamp. The stylus causes recording of received copy on electrosensitive recording paper. Moving the selector switch to the RECORD DIRECT position mechanically moves the stylus into contact with the paper.

The start-phase switch is a three-position, nonlocking lever type switch, which is spring loaded to return to neutral when released from either the START or PHASE positions. The switch is located on the front panel between the selector switch and spare fuse for the motor. The transmitting and receiving operators throw the start-phase switch to the START position momentarily to apply power to the start motor and to bring the synchronous motor above the normal operating speed. When the switch is released, the synchronous motor slows down to its normal operating speed and continues to operate at that speed. The receiving operator throws the start-phase switch to the PHASE position to energize the phasing circuit of the receiving transceiver while the transmitting operator is sending phasing pulses. When the relatively short-phasing operation is completed, the machines remain synchronized.

The motor speed control switch is a three-pole, double-throw toggle switch located on the left end of the base of the transceiver to the rear of the motor cover (fig. 10-19). It is used in the 60-rpm position for normal operation or in the 30-rpm position to provide half-speed operation. When transmitting over long radio circuits under adverse conditions, the 30 rpm half speed position can be used.

The standby-mon-talk switch is a three-position (two locking, one nonlocking) key switch located at the left on the front panel. The three positions, from the top to the bottom, are labeled STANDBY, MON, TALK. The talk-back circuit is operated only when the selector switch is on STANDBY.

In the STANDBY position, with a speaker plugged into the speaker jack, the speaker will be connected in the circuit and the operator can monitor the communication channel. If the standby mon-talk switch is in the STANDBY position, and the selector switch is also in the

STANDBY position, the synchronous motor will not operate. This position is used to receive voice communications when it is not necessary to have the motor running.

In the MON position, with a speaker plugged into the speaker jack, the speaker is also connected and the operator can monitor the communication channel. In this position, however, the motor receives power and can be started and run at synchronous speed. This is the normal position for receiving voice communications, when phasing transmitting and receiving equipments, preparatory to sending and receiving facsimile copy. Some 1800-cycle interference will be noticed in the talk-back circuit.

In the TALK position, with a speaker plugged into the speaker jack, the speaker becomes the microphone of a voice intercom system. The switch must be held in the TALK position; if pressure is released, it will snap back to the MON position. The TALK position is used when talking to the facsimile operator on the other end of the circuit.

It should be noted that the talk-back circuit only operates when the selector switch is at STANDBY. Voice communications cannot be carried on over this circuit when the selector switch is at TRANSMIT, SET RANGE, RECORD PHOTO, or RECORD DIRECT.

It should also be noted that the talk-back circuit will not function over a radio circuit that uses auxiliary radio equipment unless the auxiliary equipment is bypassed for voice communications.

The contrast control is a calibrated potentiometer located to the left of the db meter on the front panel of the transceiver; it adjusts the contrast range (difference between minimum and maximum signal strength) of the transmitted signal by adjusting the magnitudes of the currents in the photo-tube bridge circuit. This control is operated only by the transmitting operator. The dial on this control is numbered from 1 to 100, with the applicable ranges for use when transmitting either positive or negative indicated on the dial.

The contrast control may be used to balance the bridge in the photo-cell bridge modulator (V24, fig. 10-17) either on maximum light (white) or on minimum light (black). In either case when the bridge is balanced, the output signal has a minimum amplitude. Thus, if the contrast control is adjusted so that the bridge is balanced when the light is a maximum, the output signal will have minimum amplitude on white and maximum amplitude on black. This type of transmission is called positive transmission. When the bridge is balanced on minimum light, the output signal will have minimum amplitude on black and maximum amplitude on white. This type of transmission is called negative transmission.

The gain control, located between the contrast control and the selector switch, is a dual potentiometer, which serves to control the level of the signal handled by the transceiver both in transmitting and receiving. It does not change the contrast range.

The front panel db meter, which serves as a guide in setting gain and contrast controls, is calibrated in db with reference to a zero-power level of 6 milliwatts in 600 ohms.

To turn the transceiver on, throw the power on-off switch to ON and turn the selector switch to SET RANGE. Normally a 5-minute warmup period should be allowed before making adjustments or actually transmitting.

To place copy on the drum, raise rear edge of clamp bar (fig. 10-15) by turning the clamp-bar control knob to its clockwise position. Place the lower edge of the copy (face up) under the rear edge of the clamp bar. Turn the knob to its counterclockwise position, thus closing the clamp on the leading edge of the copy and opening the other clamp. Revolve the drum forward, wrapping the copy around the drum. Insert the loose edge of the copy under the clamp; pull the copy tight around the drum with a wiping motion of the hand, and close the clamp by turning the clamp-bar control knob back to its center position. Examine the copy after it is placed on the drum to make sure there are no bulges.

The following adjustments should be made for transmitting positive for direct recording:

1. Turn selector switch to SET RANGE.
2. As a starting point, set the gain control at 65 and the contrast control near zero.
3. Turn the drum so that the whitest portion of the copy is illuminated by the spot of light. Carefully turn the contrast control to a higher setting until the meter reads the required minimum. Check the meter reading and move the drum slightly backward and forward while examining a different white portion of the copy to be sure that the whitest spot is used. For radio operation the required minimum will depend on the type of auxiliary equipment being used with the radio transmitter. Modulator, Radio MD-168/UX will accept any contrast signals from 10 db to 20 db, but the wire line minimum

(1/16 inch below the -10 calibration mark on the db meter) is recommended.

4. Move the drum so that the blackest portion of the copy is illuminated by the spot of light. Be sure that the blackest portion actually is used by again rotating the drum slightly backward and forward while checking the meter.

5. Adjust the gain control so that the meter reads +2 db.

6. Shift back to the whitest portion of the copy and readjust the contrast control for a minimum reading of -10 db on the meter.

7. Repeat steps 4, 5, and 6 until the final adjustments of the gain and contrast controls give meter readings, differing by at least 12 db between the blackest and whitest portions of the copy.

Adjustments for transmitting negative are not given here in the interest of brevity but may be obtained by referring to the appropriate technical manual.

The transmission of facsimile signals by amplitude modulation on the radio channel ordinarily results in a change in the loudness or levelness of the received signals with fading. If fading occurs, streaks or level changes will appear in the record picture. Therefore it is desirable to transmit a type of signal over radio circuits whose amplitude when demodulated at the receiving station will be independent of changes in the volume or level of the radio signal. This action may be accomplished by a frequency shift of the signal in which different picture values are represented by different frequencies. Because the facsimile transceiver generates an amplitude-modulated signal in transmitting and the recorder is designed to operate on an amplitude-modulated signal, picture signal conversion equipment is necessary between the facsimile transmitter and the radio transmitter, and between the radio receiver and the facsimile recorder.

The components of two radio facsimile transmission systems (introduced in chapter 5) will be described in the following portion of this training course. The first system employs carrier frequency-shift (CFS) keying and includes two auxiliary units between the facsimile transmitter and the radio transmitter. These units include Keyer Adapter KY-44A/FX and Frequency-Shift Keyer KY-75/SRT.

KEYER ADAPTER KY-44A/FX

Keyer Adapter KY-44A/FX (fig. 10-20) is used to provide d-c keying signals for frequency-shift exciter units in radio transmitters. The input is an amplitude-modulated, audio-frequency, facsimile signal that may be similar to the output from Facsimile Transceiver TT-41B/TXC-1B in the transmitting position. The input signal level should be maintained within a range of -20 to+ 6 dbm. The output signal is a d-c voltage of varying amplitude between 0 and 20 volts d-c. The input carrier frequency range is from 1500 cycles to 7000 cycles, while the modulation sidebands can range from 100 to 7000 cps. There are four essential circuits: the input, the signal amplifier, the demodulator circuits, and the output circuits.

The power ON-OFF switch turns the set completely on or off. A preliminary warmup period of a few minutes should be allowed before using the set.

The test osc. level control is used for alignment of the unit. This control should be in the OFF position for normal operation.

The input-filter IN-OUT switch should be in the IN position only when receiving frequencies in the range of 900 to 2500 cycles and when signals are noisy. The switch should be in the OUT position for all other input frequencies.

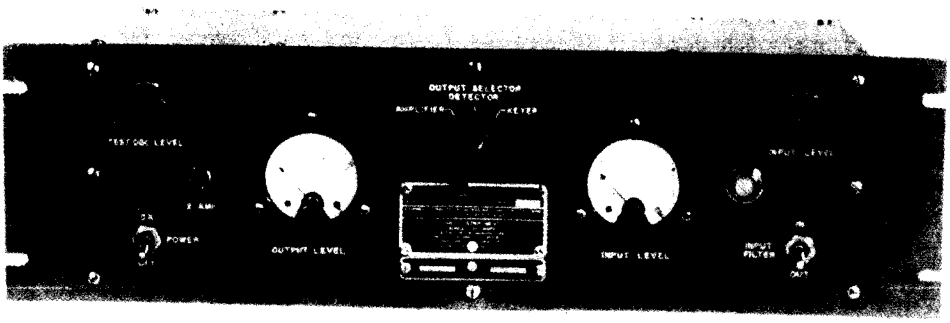
The output selector switch determines the type of output from the unit. In the AMPLIFIER position the unit becomes a linear amplifier. In the DETECTOR position the unit becomes a detector with the carrier still unfiltered from the detected envelope. The output level meter reads average d-c values. The KEYER position converts the unit into a detector with the carrier removed to provide only the d-c keying signals.

FREQUENCY-SHIFT KEYER KY-75/SRT

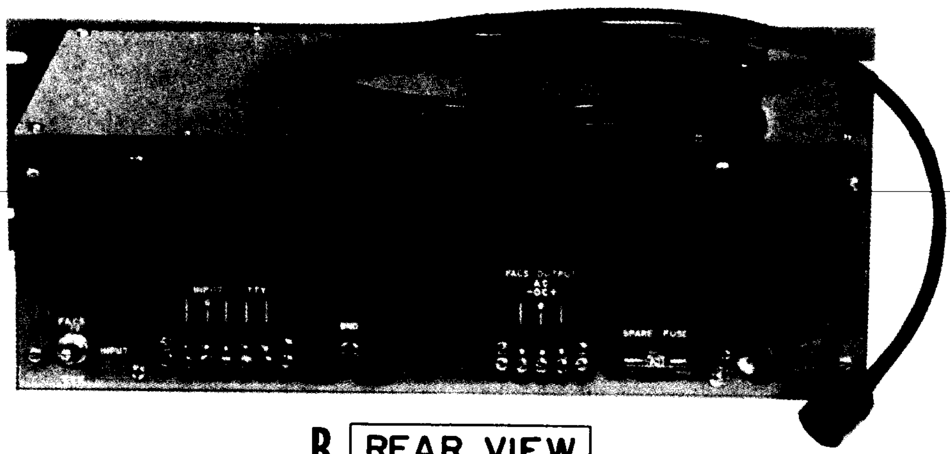
Frequency-shift keyer KY-75/SRT was discussed previously with teletype equipment. The common operating adjustments for photo transmission are listed below.

Operating Adjustments

1. Turn the power switch (fig. 10-2) to ON. The white-jewel power lamp will light. The amber-jewel oven lamp will also light, thereby indicating that the crystal oven heater is on. This lamp will go on and off with changes in the crystal oven temperature. When the lamp is illuminated, heat is being applied and the lamp will remain on until the oven temperature rises to 70°C, at which time it will go off. When the



A FRONT VIEW



B REAR VIEW

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Figure 10-20.—Keyer adapter KY-44A/FX.

lamp is off, no heat is being applied to the oven. The lamp will remain off until the oven temperature falls slightly below 70° C, at which time it will come on again.

2. After the oven lamp has turned off (the oven is at the correct operating temperature), set the plate switch at ON. The red-jewel plate lamp will light. The illumination given off by the foregoing three lamps may be adjusted by rotation of the serrated rim of the lamp assembly.

Note that when the keyer is not in use, the a-c power supply should remain connected and the power switch turned on to maintain the correct operating temperature of the oven. The plate switch should be set at OFF.

3. Set the test operate switch at PHOTO. In this position the limiting (V-101 and V-102, fig. 10-3) and waveshaping circuits are not used.

4. Set the crystal-oscillator switch at the position corresponding to the socket position of the crystal providing the desired channel frequency.

5. Set the frequency range switch to the desired output frequency of the keyer. This frequency is the sum of the crystal frequency and the 200-kc frequency from V-107.

6. Set the input filter switch at PHOTO.

7. Set the multipler switch at the position corresponding to the frequency multiplication factor employed in the transmitter. For example, if the multiplication factor is 8, the switch should be set at "X8."

8. Set the phase-modulation control at OFF (extreme counterclockwise position).

9. Set the metering switch at GRID.

10. Unlock the tuning control. Set the tuning control at a setting corresponding to the keyer output frequency and carefully adjust it about this setting for a maximum meter reading. A normal reading is about 1.5 ma (actual meter reading 0.5 ma). Lock the tuning control.

It will be noticed that three current peaks are observed on the panel meter. These peaks correspond to the resonant peaks for the lower sideband, the r-f carrier, and the upper sideband, respectively. The tuning control is normally set at the position that corresponds to the upper sideband resonant peak.

11. Set the metering switch at PLATE.

12. Release the lock on the output tuning control. Adjust the output tuning control for minimum plate current, as indicated on the meter.

13. Release the lock on the output level control. Set the output level control for the maximum grid drive required to drive the first amplifier or multiplier stage of the transmitter, as indicated by a maximum reading on the grid meter of the associated transmitter.

Care should be taken in this adjustment because if the tuning range is located near the lower markings on the tuning dial it is possible that a dip may also be obtained in the plate current near the higher markings of the dial due to the second harmonic of the keyer frequency.

14. Repeat steps 12 and 13, adjusting the output tuning control and the output level control simultaneously. As the output coupling is increased and the plate tuning maintained at resonance, the output power should increase, as indicated by a rising-plate current reading and an increase in grid drive, as noted on the grid meter of the associated transmitter. Rated power output is obtained when a reading of 85 ma (actual reading of the meter 0.425 ma) is indicated on the panel meter. Lock the output tuning and output level controls in position.

15. Set the deviation control at the desired deviation. This control functions to vary the amount of frequency deviation. The control dial has a multiplication factor of 100 for FSK operation and 200 for photo operation.

During high-frequency transmission when the r-f carrier frequency is multiplied by some factor in the transmitter, the amount of deviation of frequency shift is multiplied simultaneously by the same factor. Therefore it becomes necessary to reduce the amount of deviation in the frequency-shift keyer by a factor equal to the frequency multiplication factor of the transmitter. This action is accomplished by a multiplier switch that provides a means of dividing the frequency deviation by a factor of 1, 2, 3, 4, 6, 8, 9, or 12, thereby reducing the frequency deviation of the keyer signals by the same amount that these signals are multiplied in the transmitter. For example, if the frequency of the transmitter output is to be deviated 425 cycles when the transmitter frequency multiplication is 1; when the multiplication factor is 2, the frequency shift at the keyer output should be $\frac{425}{2} = 212.5$ cycles; when the transmitter multiplication factor is 4 the frequency shift of the factor keyer output should be $\frac{425}{4} = 106.25$ cycles.

In normal operation the deviation control is adjusted to obtain the desired deviation, as read directly on the calibrated dial of the control. After the multiplication factor employed in the transmitter is determined the multiplier switch is set at a position corresponding to this factor. In this manner the amount of deviation is determined and held constant despite any ensuing multiplication in the transmitter.

16. Set the metering switch at photo.

17. Adjust the photo input control, R102, for 5 volts, as indicated on the panel meter. The 5 volts can be obtained by locking the photo scanner in a maximum signal position. If the photo scanner is not available, any battery source providing 5 volts or more can be used.

18. To shut the keyer off, set the plate switch at OFF and the power switch at OFF.

The common operating adjustments of the auxiliary components of the FS method of radio facsimile transmission have been described in the preceding section.

A second method of radio facsimile transmission (introduced in chapter 5) is called the audio frequency-shift (AFS) method. This method may be used with UHF radiophone transmitters with only one additional piece of equipment between the facsimile transmitter and the radio transmitter. A typical equipment for this application is Modulator, Radio MD-168/UX.

MODULATOR, RADIO MD-168/UX

Modulator, Radio MD-168/UX (fig. 10-21) is designed to convert amplitude modulated facsimile signals from a facsimile transmitter

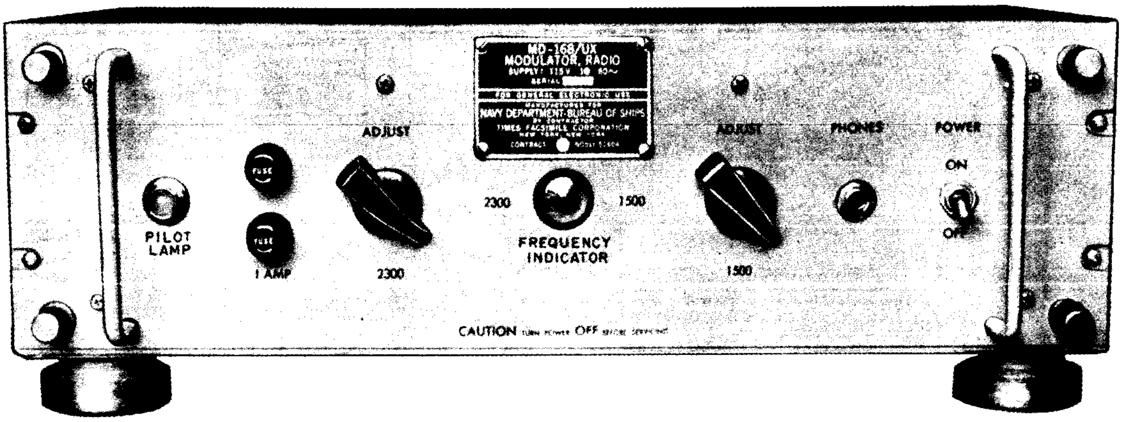

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Figure 10-21.—Modulator radio MD-168/UX.

(for example, Facsimile Transceiver TT-41B/TXC-1B acting as a transmitter) to audio frequency-shift facsimile signals of 1500 to 2300 cycles suitable for modulating a radiophone transmitter.

A block diagram of the modulator is illustrated in figure 10-22. Basically, the unit consists of a preamplifier; a keyer (detector); a variable-frequency, phase-shift oscillator; a frequency indicator; and a power supply (not shown). The amplifier increases the received facsimile signal to the proper level for operating the phase-shift oscillator and a pair of earphones. The input signal to the modulator may be monitored by using the phone jack. The frequency limits of the output signal may be monitored by means of a dual-type, tuning-eye indicator.

The input signal to the modulator has a frequency of 1800 cycles and an amplitude that varies in accordance with the light and dark segments of the picture being scanned at the facsimile transmitter.

The output signal from the modulator is an audio signal in which 1500 cycles represent the maximum signal input (in amplitude) and 2300 cycles represent the minimum signal input (in amplitude) to the modulator from the facsimile transmitter. Amplitudes between maximum and minimum signals are changed to corresponding frequencies between 1500 and 2300 cycles. The output from the modulator is connected to the audio modulator section of a radio a-m transmitter. Because the audio frequency-shift signal from the modulator is of constant amplitude the emitted radio frequency from the radio a-m transmitter is modulated at a constant percentage of modulation. The audio frequency-shift signal is sometimes referred to as sub-carrier-frequency modulation (SCFM).

The variable-frequency, phase-shift oscillator is caused to change its frequency in accordance with the variations in the magnitude of the d-c output voltage from the detector by means of a reactance modulator stage. The phase shift network is so connected that changes in the plate resistance of the reactance modulator (caused by the varying magnitude of the d-c voltage applied to its grid) cause a change in the time constant of one branch of the oscillator phase shift network. This action introduces a change in phase shift through the network, which in turn changes the frequency of the oscillator.

The operating controls and indicators are located on the front panel (fig. 10-21). The pilot lamp operates when the set is turned on. Both sides of the powerline are fused.

The adjust 2300 control is a potentiometer used to adjust the output frequency of the unit to 2300 cycles when the amplitude of the input facsimile signal is a minimum.

The adjust 1500 control is a potentiometer used to adjust the output frequency of the unit to 1500 cycles when the amplitude of the input facsimile signal is a maximum.

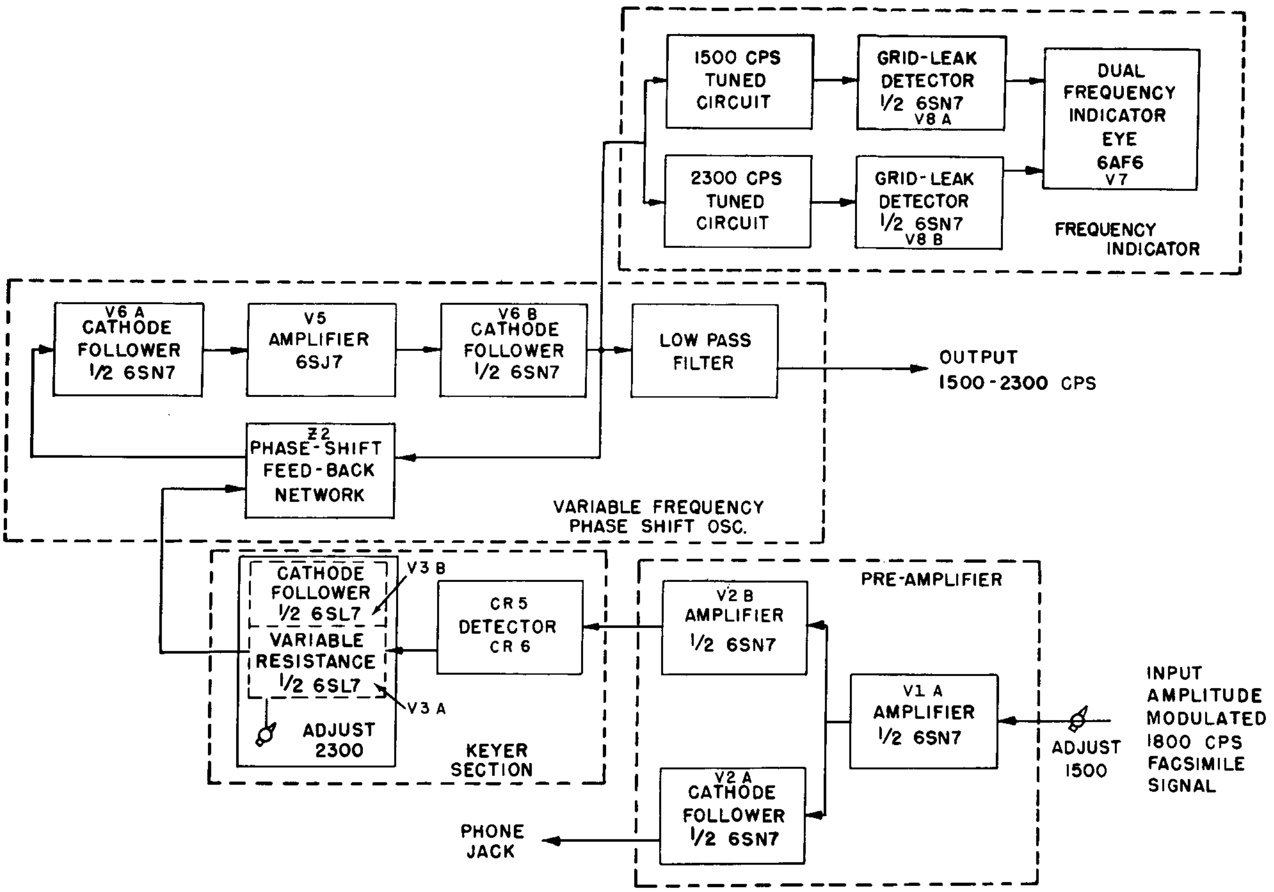

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Figure 10-22.—Block diagram of modulator radio MD-168/UX.

The 2300-1500 frequency indicator is used to indicate the proper frequency limits of the output audio frequency-shift signal. The left half of the indicator closes when the output signal has a frequency of 2300 cycles and the right half closes when the output signal has a frequency of 1500 cycles.

The gain of the amplifier is such that when the adjust 1500 control is set at the proper position, the audible level at the earphones will be a comfortable level.

When the power ON-OFF switch is in the OFF position, power is removed from the entire unit.

When operating the unit, throw the power switch on and allow a 5-minute warmup period.

Turn the adjust 1500 control to the extreme clockwise position. When an incoming signal is being received, the 2300-1500 tuning eye indicator will flicker; monitoring with the headphones will indicate when maximum and minimum levels are being received.

When the input signal to the modulator is maximum adjust the "adjust 1500" control until the 1500 side of the frequency indicator closes.

When the input signal to the modulator is minimum, adjust the "adjust 2300" control until the 2300 side of the frequency indicator closes.

Because the adjust 2300 and adjust 1500 controls are interdependent, repeat the preceding two adjustments.

FACSIMILE RECEIVING EQUIPMENT

To receive radio facsimile signals of either radio carrier frequency-shift transmission or audio frequency-shift transmission, conventional superheterodyne receivers may be used. With either system, the signal output of the radio receiver is an audio frequency-shift signal in which 1500 cycles represent the maximum signal and 2300 cycles represent the minimum signal output from the facsimile transmitter at the sending terminal.

In order to convert the audio frequency-shifted signal output of the radio receiver into an amplitude-modulated signal suitable for operation of a facsimile recorder, an additional unit must be interposed between the receiver and the recorder. This unit may be Frequency Shift Converter CV-172A/U. The facsimile recorder may be similar to Facsimile Recorder RD-92A/UX. The frequency-shift converter is described first, and the subject of radio facsimile receiving equipment is concluded with a discussion of the common operating adjustments of Facsimile Recorder RD-92A/UX.

FREQUENCY SHIFT RECEPTION.—Frequency-shift reception (fig. 10-23 A) requires that a local oscillator frequency be introduced ahead of the second detector of the radio receiver in order to produce an audio beat note with the incoming frequency-shift radio signal. In general, the use of the receiver BFO does not give satisfactory results because for most receivers the converter and beat frequency oscillators do not have adequate stability. Usually one or the other will drift enough during transmission to cause the received copy to be useless toward the end of the transmission.

Frequency-shift reception with radio receivers that have crystal controlled converters and beat frequency oscillators is satisfactory because of the increased stability of the oscillators. The proper crystal frequency must be selected so that the converter oscillator places the FS signals in the center of the i-f pass band. The BFO crystal frequency is selected so that the audio output from the radio receiver is 1500 cycles for one r-f signal limit and 2300 cycles for the other r-f signal limit. A different crystal must be used in the converter oscillator for each operating frequency, but the BFO crystal is not changed. Usually a trimmer capacitor is provided in the converter oscillator circuit to permit a small frequency adjustment to be made.

For receivers that do not have crystal controlled oscillators, the use of a stable oscillator such as Navy Frequency Meter LM is recommended. The signal from the frequency meter auxiliary oscillator is fed to the radio receiver by placing a wire from the oscillator antenna binding post near the antenna terminal of the radio receiver. Positive or negative copy may be received, depending upon which side of the carrier frequency-shift signal the oscillator is set.

If the transmitting station uses the lower radio frequency limit for transmitting the maximum signal from the facsimile transmitter (fig. 10-23 B), the auxiliary oscillator should be set 1500 cycles below this frequency to reproduce the maximum signal at the output of the frequency-shift converter.

If the transmitting station uses the higher radio frequency limit for transmitting the maximum signal from the facsimile transmitter (fig. 10-23 C), the auxiliary oscillator should be set 1500 cycles above this frequency to reproduce the maximum signal at the output of the frequency-shift converter.

If the radio receiver is equipped with an "S" meter, tune for maximum indication on the meter when the auxiliary oscillator is off and frequency-shift signals are being received.

The received copy defect may be blamed on poor radio transmission conditions; whereas, the defect may frequently be corrected by simply tuning the receiver properly. For optimum results care should be taken to tune the receiver so that the FS signals are centered in the pass band of the i-f amplifier in the radio receiver.

The same tuning procedures should be used for tuning a high stability radio receiver, as with a receiver employing an auxiliary oscillator. Turn off the BFO before making the tuning adjustments. After the proper tuning adjustments are made, as previously described, turn on the BFO and vary its control for the proper audio frequency output from the radio receiver. Do not change the receiver tuning to vary the audio frequency.

FREQUENCY-SHIFT CONVERTER CV-172A/U

Frequency-Shift Converter CV-172A/U (fig. 10-24) is used to convert 1500- to 2300-cycle facsimile signals received from a radio circuit to a-m signals suitable for operating a facsimile recorder (for example, Facsimile Recorder RD-92A/UX). The unit contains provision for

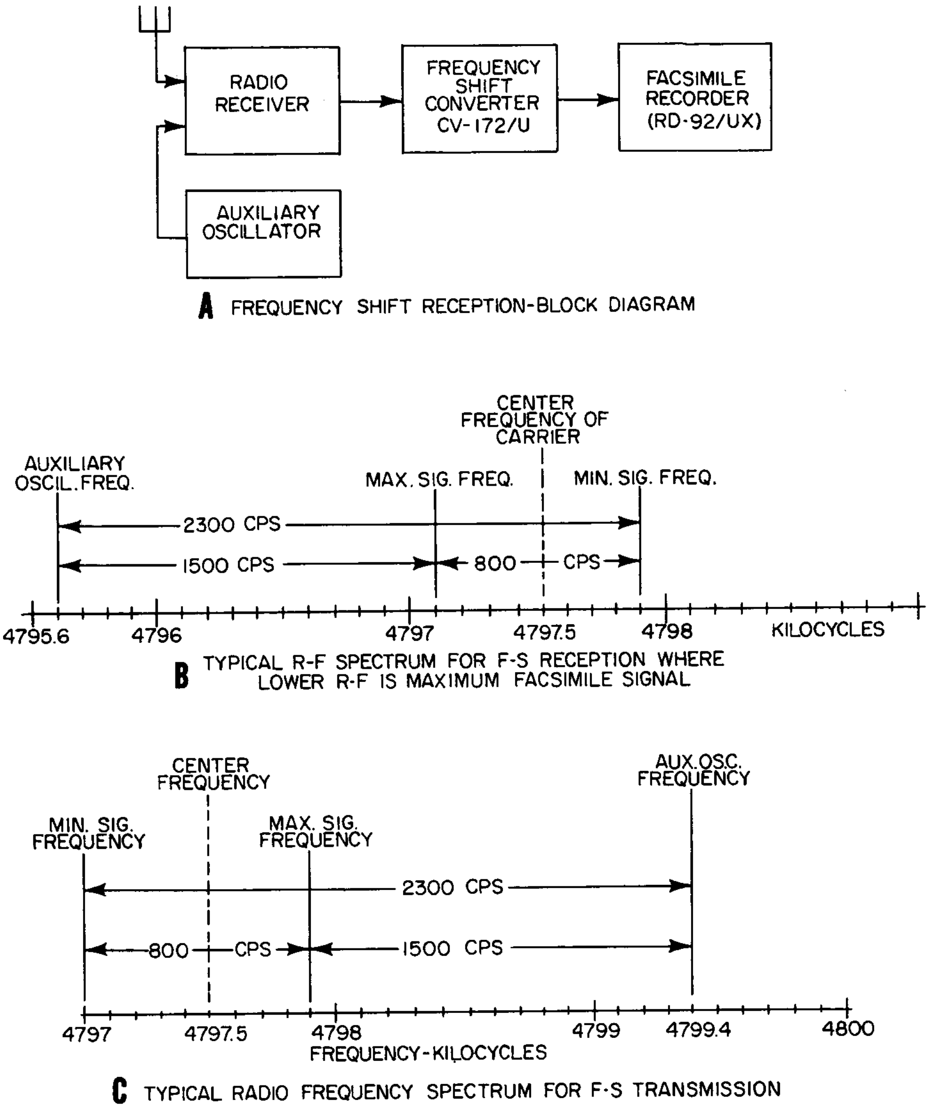

Figure 10-23.—Radio facsimile FS reception.

audible monitoring of the incoming signal and for visual checking of the frequency limits.

Another method that may provide for even more reliable tuning is to turn off the auxiliary oscillator and tune slowly through the frequency-shift signals. As the signals are approached from one side a thumping sound will be heard. Continuing to rotate the tuning dial slowly in the same direction will cause this sound to disappear almost completely and then to reappear again before it disappears on the other side of the signal. The proper tuning position corresponds to the quiet zone between the two thumping sounds.

Satisfactory frequency-shift reception may be obtained with high stability radio receivers without the need for an auxiliary oscillator provided the receivers are properly tuned. If the converter and BFO have been sufficiently stabilized, the BFO can be used as the heterodyne oscillator to provide the audio frequency output.

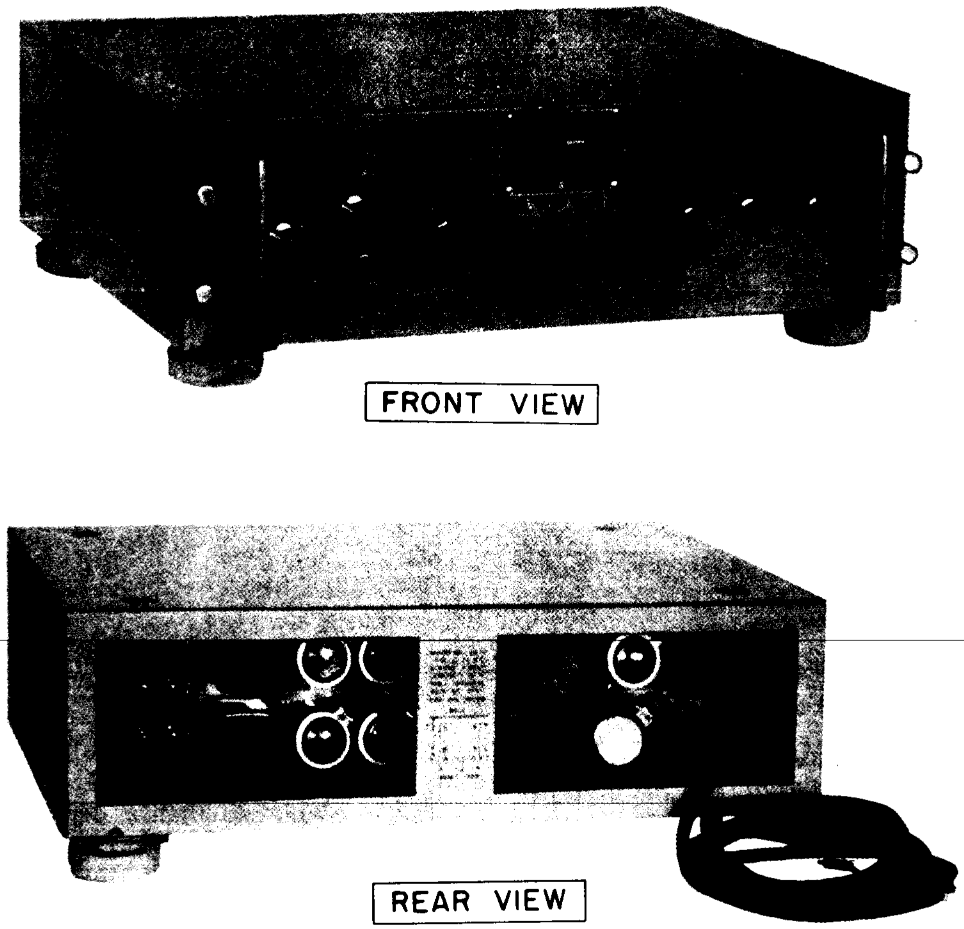

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Figure 10-24.—Frequency-shift converter CV-172A/U.

The ET 3 who is familiar with tuning c-w radio signals has observed that a-f or tone output from the radio receiver changes as either the main tuning dial or the BFO control is moved. Thus it is possible to have the right sense of signals (no inversion) and still not be tuned properly for optimum results. Improper tuning results in an inferior signal-to-noise ratio and may cause broadening of lines or multiple images somewhat similar to those caused by multipath transmission of the radio signals.

The facsimile signal obtained from the radio receiver is fed through an amplifier and filter to a limiter and then through a frequency discriminator (fig. 10-25). The output of the amplifier is controlled by an input level control potentiometer to adjust the signal level to the limiter. A loudspeaker with a separate volume control connects to the output of the line amplifier. This output also feeds two tuned circuits resonated at 1500 and 2300 cycles respectively to operate a tuning eye frequency indicator.

The input signal from the radio receiver is an audio frequency-shift signal in which 1500 cycles represent black and 2300 cycles represent white for the RD-92A/UX recorder. The discriminator is a low-pass filter having a cutoff frequency of 1500 cycles. The output from the filter at 2300 cycles can be adjusted to be from 10 to 20 db lower than the output at 1500 cycles. Thus, the input signal to the converter is changed from an a-f-s signal of substantially

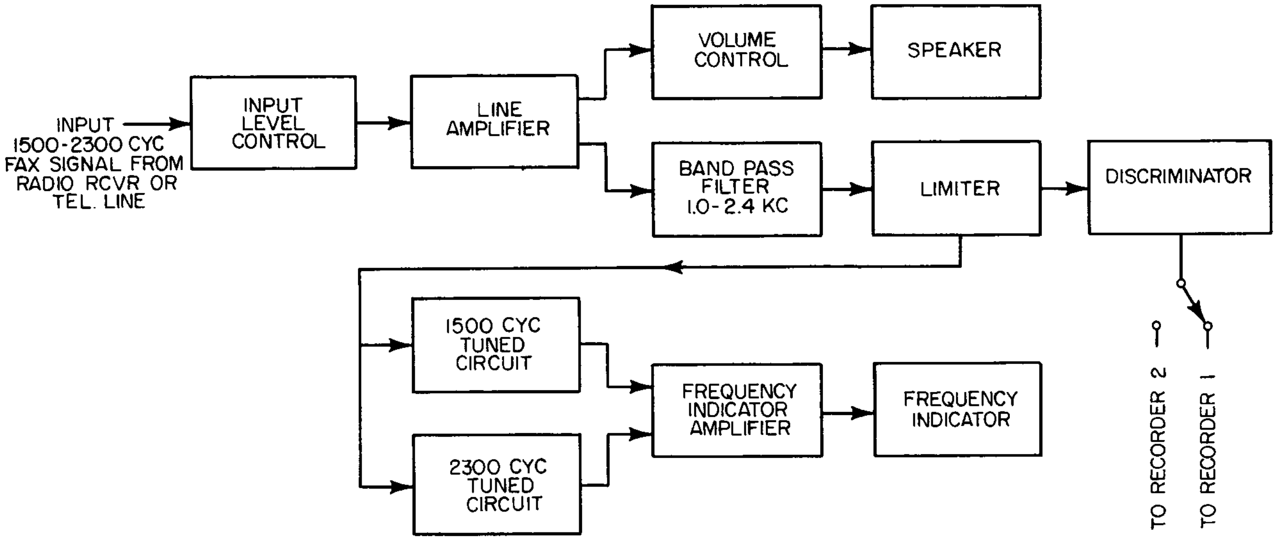

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Figure 10-25.—Block diagram of frequency-shift converter CV-172A/U.

constant amplitude to an output signal of varying amplitude in which the maximum amplitude (corresponding to 1500 cycles) is 10 to 100 times the minimum amplitude (corresponding to 2300 cycles).

To operate the frequency-shift converter, turn the input level control clockwise (fig. 10-24). This action applies power to the unit. Allow a few minutes warmup time.

Adjust the input level and volume controls fully clockwise until a signal is received.

When a signal is received, adjust the input level control until the speaker does not distort. (Distortion exists when there are overtones.) This adjustment provides sufficient level to operate the limiter.

Adjust the volume control for a convenient speaker level.

When a 1500-cycle signal is being received, the "1500" tuning eye will close and the output will be the maximum signal level for, the facsimile recorder. Also, when a 2300-cycle signal is being received, the "2300" tuning eye will close. The difference in output levels will depend upon the trimmer control (not shown), which provides a variable-resistance bypass around the discriminator circuit.

When the radio receiving equipment is properly adjusted, the tuning eye indicators will show that 1500- and 2300-cycle signals are being fed to the input of the frequency-shift converter. When a copy that has mostly background is being received, the high stability radio receiver output may be adjusted by changing the BFO frequency to close the tuning eye corresponding most closely to the background signal frequencies.

FACSIMILE RECORDER RD-92A/UX

The output of Frequency-Shift Converter CV-172A/U may be fed to Facsimile Recorder RD-92A/UX (fig. 10-26) to make recordings of copy transmitted by Facsimile Transceiver TT-41B/TXC-1B (previously described) or equipment having the same transmission characteristics. The facsimile recorder is a self-contained unit comprising an amplifier-power supply chassis and four plug-in assemblies. The assemblies (fig. 10-27) are: (1) the audio frequency oscillator, (2) the amplifier detector, (3) the amplifier modulator, and (4) the recorder subassembly. A circuit test switch mounted on the front panel provides means for quickly testing all important circuits. Neon light indicators across individual fuses and tube heaters

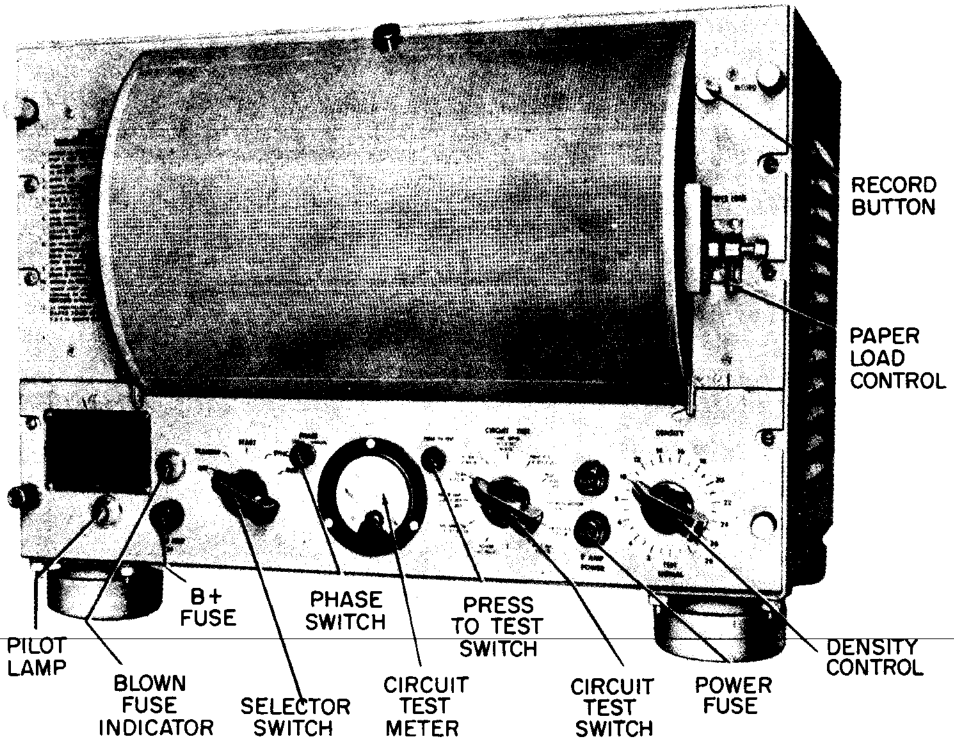

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Figure 10-26.—Facsimile recorder RD-92A/UX.

instantly indicate a blown fuse or burned out tube heater filament.

Facsimile Recorder RD-92A/UX performs its functions of recording pictures, drawings, or messages by rotating a drum at a constant speed, while feeding a stylus needle along the drum, one scanning line for each revolution until the complete drum has been covered. This function is performed by means of three motors and suitable gears and mechanical linkages contained within the recorder subassembly. The power, signal, and phasing currents for proper operation of the recording mechanism are obtained from the outputs of the electronic subassemblies.

The amplifier-detector unit (fig. 10-27) receives the input facsimile signal. This signal, consisting of phasing pulses and facsimile intelligence between the frequency limits of 900 and 2700 cycles, is amplified by a class A amplifier and demodulated through the action of a full-wave rectifier and low-pass filter to form a varying d-c facsimile signal.

The varying d-c facsimile signal output of the amplifier-detector unit is coupled to the amplifier modulator subassembly where it combines with a signal from a 15-kc oscillator in a modulator stage. The 15-kc output of the modulator varies with the amplitude of the d-c facsimile signal. The resulting modulated signal connects through the normally closed contact of relay K1 to the print driver and amplifier in the amplifier-power supply assembly.

The signal from the amplifier modulator unit is amplified by the print driver and amplifier to sufficient intensity, so that, when connected to the stylus needle in the recording mechanism assembly, it will record on the recording paper points representing varying shades of dark elements of the transmitted copy.

For phasing pulses, relay K1 is operated to transfer the signal from the amplifier modulator to the phasing detector and amplifier, located in the amplifier-modulator subassembly. The phasing pulses, which are transmitted at the beginning of each copy, are amplified to

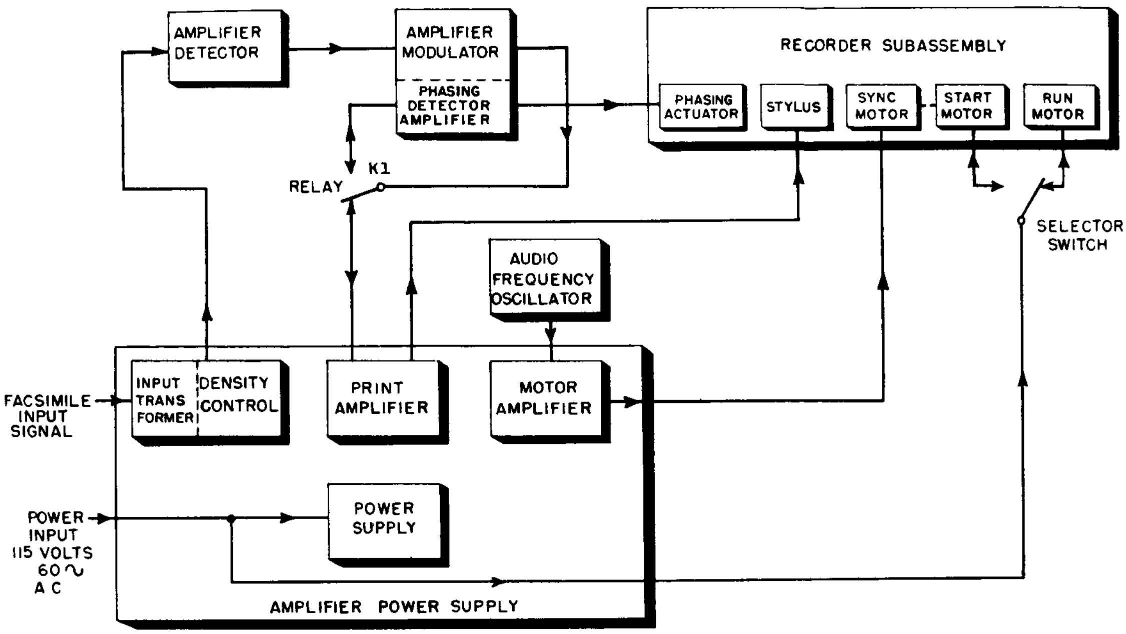

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Figure 10-27.—Simplified block diagram of facsimile recorder RD-92A/UX.

operate the phasing actuator in the recorder subassembly.

The phasing actuator, on receiving the phasing pulses, releases the stop bar on the synchronous-drive mechanism in the proper position to frame the recorder drum with the drum of the facsimile transmitter.

The a-f oscillator generates an 1800-cycle signal, which is amplified by the buffer amplifier (not shown) and motor amplifier in the amplifier-power supply assembly and then coupled to the recording mechanism assembly to operate the synchronous motor. The 1800-cycle signal also connects to the test signal position on the density control (fig. 10-27), where it is available for connection to the input of the signal amplifier for testing the various circuits with the circuit test switch.

The synchronous motor, rotating at a speed of 1800 rpm, is geared down to the required recorder drum speed of 60 rpm. A start motor, mechanically coupled to the synchronous motor, serves to bring the synchronous motor up to a speed higher than synchronous speed after which it coasts down to the synchronous speed when the synchronous motor runs on 1800-cycle power. The synchronous motor regulates the speed of the recorder drum. The run motor drives the drum through reduction gears.

When the record buton (fig. 10-26) is depressed and the selector switch is in the RUN position, the stylus needle records on recording paper fastened to the drum. The stylus is held in a carriage assembly that is moved across the drum to the right when engaged with a lead-screw shaft geared to the drum. When the carriage assembly reaches the right end of the recorder paper, it operates an automatic release mechanism, which disengages the carriage mechanism from the lead screw and lifts the stylus from the paper. A return spring, located in the left side gear box, then pulls the carriage back to the left side of the drum so that it will be ready for the next copy.

Operating Adjustments

To operate Facsimile Recorder RD-92A/UX (fig. 10-26) proceed as follows:

1. Turn the selector switch to the STANDBY position. Note that the pilot light lights up, indicating that power is being applied to the

recorder. Wait about 1 minute for the tubes to warm up. The recorder may be left at STANDBY while waiting for a transmission so that the set is ready for immediate operation.

2. Turn the selector switch to the START position. Wait about 5 seconds for the start motor to bring the synchronous motor above synchronous speed.

3. Turn the selector switch to the SYNC position. Wait until the synchronous motor coasts down, then locks in synchronous speed. This is distinguished by a distinctive high-pitch tone.

4. If the motor does not lock in but falls below the synchronous speed, switch back to the START position and repeat steps 2 and 3. If the motor does not come down to synchronous speed, turn to STANDBY and allow the motor to stop. Omit step 2 and switch directly to the SYNC position.

5. Turn the selector switch to the RUN position. It is necessary for the drum to rotate into the proper position for loading the paper.

To load paper on the drum, proceed as follows:

1. With the selector switch in the RUN position, push the paper load control to the left and hold there until the drum stops rotating. Then lift the projecting lever.

2. Open the hinged cover over the drum.

3. When the paper load lever is lifted, the paper clamp fingers on the drum will open. The paper load lever remains in the UP position. Drop a fresh sheet of recording paper into the space between the paper guide and the drum so that it rests up against the clamp fingers.

4. Flip down the paper load lever. This action causes the fingers to close quickly and grab the paper. This action also releases the drum, which quickly picks up speed to the synchronous speed of 60 rpm.

5. Close the hinged cover.

The adjust density control affects the gain of the signal amplifier so that the proper d-c voltage is obtained to key the print oscillator circuit. Incorrect setting of the density control may result in faulty recording. Proceed as follows:

1. Set the density control when facsimile signals are being received. When steady signals of maximum signal level are received, preferably on phasing signal, start near zero and advance the control to the lowest point that gives maximum reading on the meter on the front panel. This reading is normally about 100.

2. In some types of copy it is desirable to advance the dial setting of the density control slightly beyond the point that gives a maximum meter reading. Try this procedure if the copy is too light.

3. Leave the density control at the setting that gives the best recording.

The phasing operation is performed with the recorder drum stationary. Phasing pulses may be identified by a downward dip of the meter pointer occurring once a second. To phase the recorder proceed as follows:

1. Switch to the SYNC position and wait for the drum to stop.

2. Turn the phase button to LOCAL.

3. When phasing pulses are received, depress the phase button and hold depressed for five pulses. While phasing, two clicks per second are usually heard; one when the phasing actuator trips, and another when the stop bar passes the drum drive coupler. Press and hold for 5 meter pulses.

4. Turn the selector switch to the RUN position. The drum will rotate in the properly phased position.

5. Press record button when the copy starts. This is indicated by a change in meter pulses. Usually the meter reading drops down to about zero and flicks upward instead of downward. The stylus now feeds across the drum to print the copy, and releases automatically at the end of travel.

If it is desired to take less than a complete copy, release the stylus by (1) turning the selector switch from the RUN to SYNC position, or (2) operating the paper load lever. The stylus returns automatically to the lefthand end of the drum when it is released.

FACSIMILE RECORDER SET AN/UXH-2

Facsimile Recorder Set AN/UXH-2 (fig. 10-28) is a continuous page recorder designed to make direct recordings transmitted over land wires or radio. The set is designed to operate at 60, 90, or 120 scans per minute. When receiving from a transmitter with the proper signals, the unit will automatically phase, start recording at the beginning of a transmission, stop when the transmission is complete, and compensate for changes in signal level during the recording. When this automatic operation is utilized the set may be left unattended.

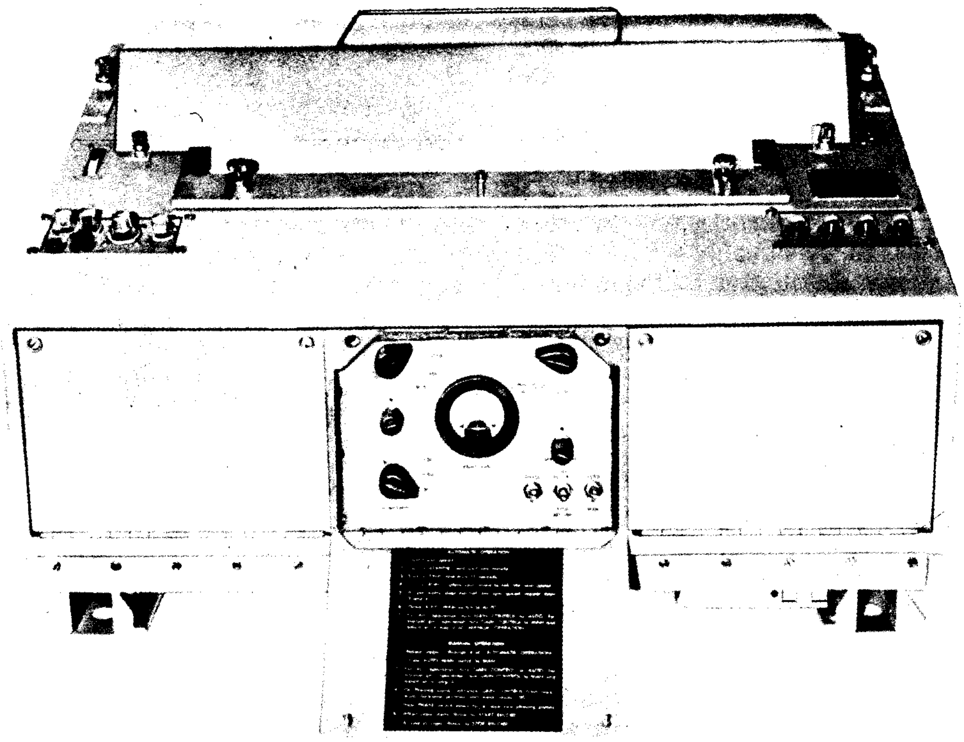

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Figure 10-28.—Facsimile recorder set AN/UXH-2.

Manual operation may be utilized when the transmitting station is not equipped to transmit the necessary control signals for automatic operation.

The AN/UXH-2 consists of three major assemblies: (1) Recorder RO-76/UXH-2, (2) Power Supply PP-1901/UXH-2, and (3) Electrical Control Amplifier AM-1845/UXH-2.

Recorder RO-76/UXH-2

The recording mechanism consists of the SYNC system, run system, stylus and base assembly, and paper feed system. The synchronous (SYNC) motor (fig. 10-29) is brought up to speed by a split-phase induction start motor (not shown). The SYNC motor is then supplied with power by a fork-controlled oscillator circuit, and operates at a synchronous speed of 600, 900, or 1200 rpm, depending upon the scans per minute to be recorded.

The SYNC shaft is driven by the SYNC motor through a reduction gear train, a flywheel and ratchet assembly, and SYNC clutch assembly (fig. 10-29). When the recorder is in standby condition, the SYNC motor is running and the run motor, stylus band, and SYNC arm shaft are stationary.

The phase magnet armature is normally held back so as not to engage the clutch stop arm. During the phasing period the holding current to the phasing magnet is off. The released armature blocks the clutch stop arm, but the sync clutch ratchet continues to rotate at synchronous speed while the sync clutch pawl slips over the ratchet teeth. When a phase pulse is received, the phase magnet armature is pulled back momentarily to permit the clutch to resume rotating in phase at synchronous speed. Subsequent phase pulses will pull the phase magnet armature back each time the stop arm passes it.

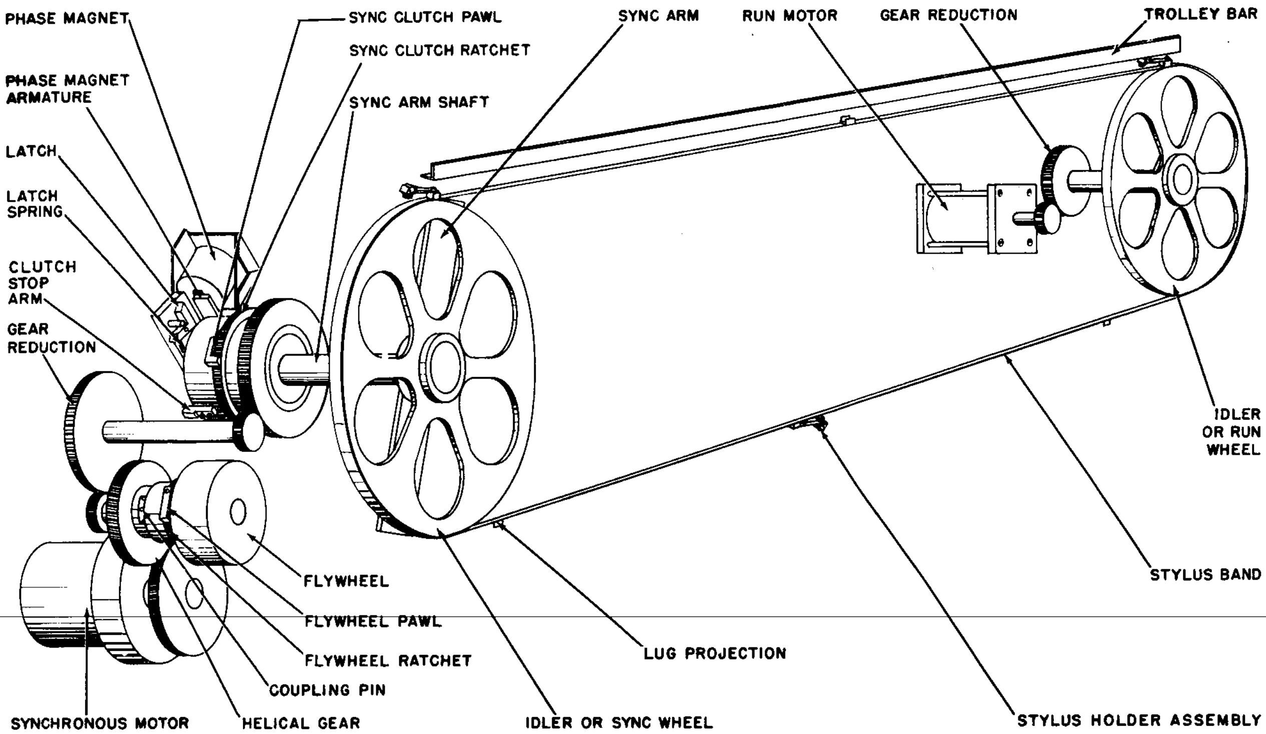

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Figure 10-29.—Recorder facsimile RO-76/UXH-2, simplified view of synchronous drive and run system.

When the start-record signal is received, the run motor starts and drives the stylus band through a reduction gear train and the run wheel.

Power Supply PP-1901/UXH-2

The Power Supply PP-1901/UXH-2, and associated voltage regulator circuits (fig. 10-30), furnishes 6.3 volts a-c, 400 volts d-c (HI B+), 225 volts d-c regulated B+ (RB+), and bias supplies for the set.

Normally the input voltage is 115 volts single phase a-c, however, connections are provided for operation on 220 volts a-c. A utility outlet J601 is provided on the input line to operate auxiliary equipment when desired. Power line filter FL 601 isolates the recorder set from other equipments connected to the power line.

Electrical Control Amplifier AM-1845/UXH-2

Electrical Control Amplifier AM-1845/UXH-2 consists of signal amplifier circuits, automatic level control and print amplifier circuits, automatic control circuits, fork oscillator and SYNC motor drive circuits, and speaker amplifier and test signal circuits.

SIGNAL AMPLIFIER, ALC, AND PRINT CIRCUITS.—The input facsimile signal from the secondary of T301 (fig. 10-30), is fed through gain control R301 to ALC amplifiers V1A and V1B. ALC lockout switch S306 is a single-pole double-throw switch and is part of gain control R301. If the gain control is set at the automatic position, the ALC feedback network controls the bias on V1A and B, automatically compensating for variations in the level of the facsimile signal. Setting the control

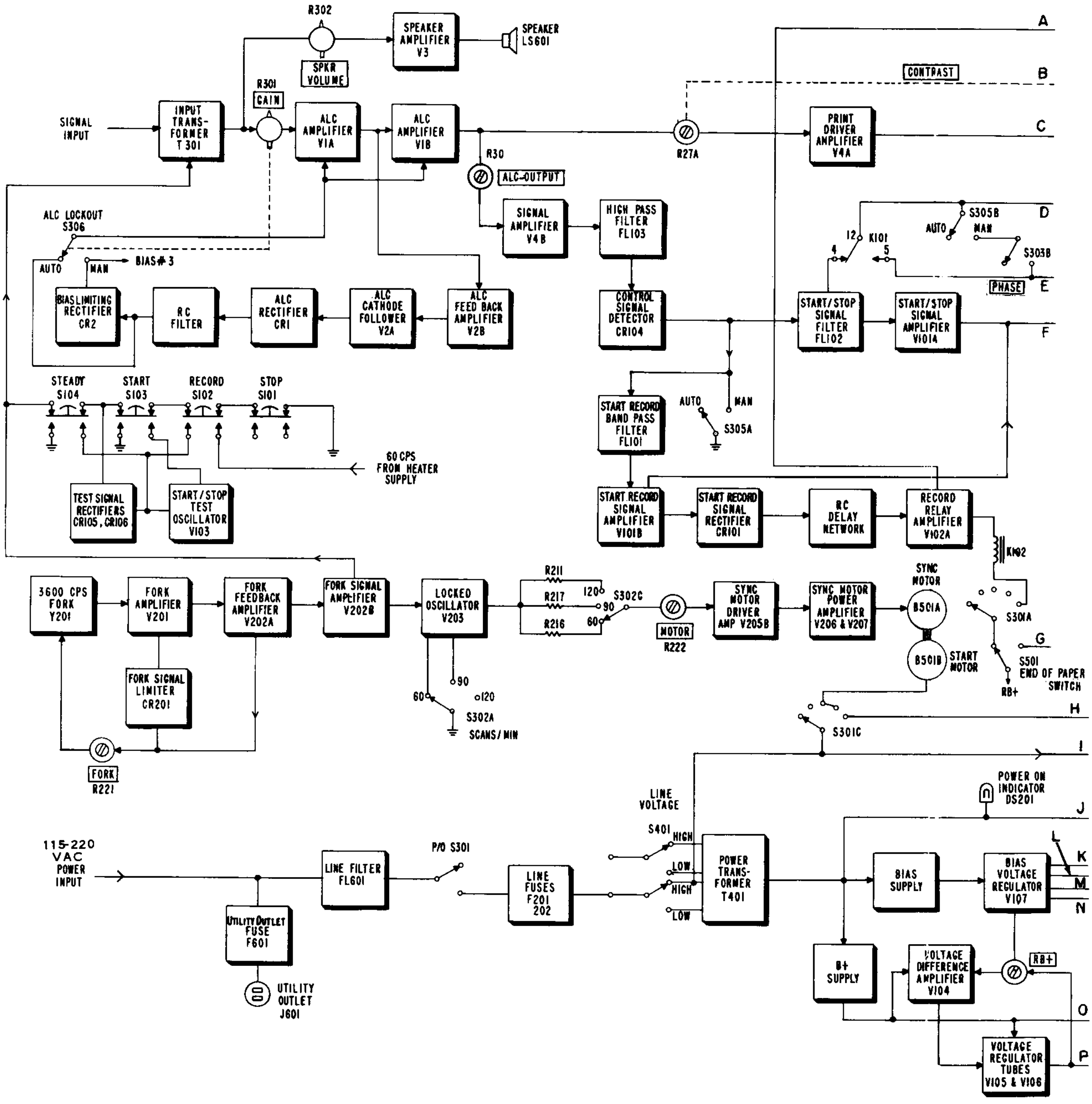

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Figure 10-30.—Facsimile recorder set AN/UXH-2, overall block diagram.

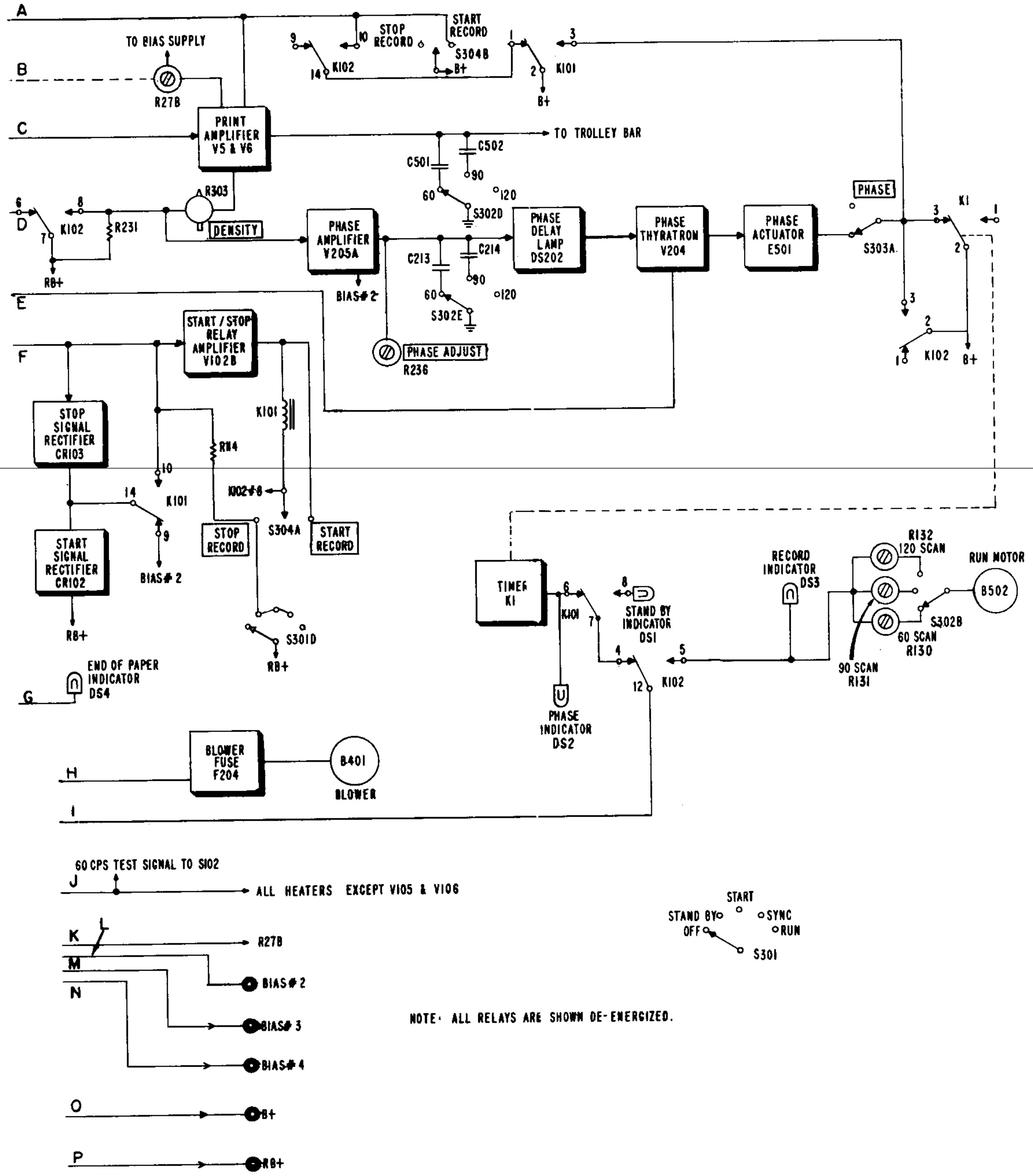

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Figure 10-30.—Facsimile recorder set AN/UXH-2, overall block diagram—Continued.

at the manual position locks out the feedback network, and bias voltage 3 derived from the regulated power supply is applied to the ALC amplifiers. Resistor R301 is then used to adjust the magnitude of the signal input to V1A.

The output signal voltage from V1B is fed to print driver amplifier V4A, then to print amplifiers V5 and V6. Contrast potentiometer R27B is used to control the amount of bias on the grids of V5 and V6. Potentiometer R27A is ganged to R27B so as to vary the signal input to V4A to correspond to the contrast setting, thus maintaining the same recording density. There is no plate voltage on V5 or V6, and consequently no voltage on the trolley bar and stylus needles, until relay K102 is energized.

AUTOMATIC CONTROL CIRCUITS.—When selector switch S301 is turned from OFF to SYNC, start/stop relay K101 is energized by a positive potential applied to the grid of start/stop relay tube V102B to keep the tube conducting and relay K101 energized. This prevents the recording mechanism from starting before S301 is turned to RUN. When S301 is turned to RUN and awaiting a transmission, the positive potential is removed from V102B so that it will respond to the transmitted control signals.

The amplified signal output from V4B is fed through high-pass filter FL103 to control signal detector CR104, and out to the automatic start/stop and start-record circuits. When the amplitude-modulated 300-cycle start signal is received, it is detected by CR104, and filtered by FL102 which is tuned to 300 cycles. The 300-cycle output from FL102 is fed to start/stop signal amplifier V101A. The output of V101A is rectified by CR102 to cut off start/stop relay amplifier V102B, and deenergize relay K101. Deenergizing K101 operates contacts to release the armature of phase actuator E501, energize phasing timer K1, and tune FL102 to the 450-cycle stop signal frequency.

After the start signal, phasing pulses are transmitted for 15 seconds. The phase pulse is filtered and fed to the grid of phase amplifier V205A. The amplified pulse output of V205A is fed to phase delay lamp DS202 which fires thyratron V204. Holding current is supplied to phase actuator E501 pulling back the armature. Contacts of timer K1 remain open during phasing, then close maintaining holding current to actuator E501.

When the start record signal is received, it is filtered by FL101 and applied to the start-record signal amplifier V101B. The output of V101B is rectified by CR101 and fed to record relay amplifier V102A. The output of V102A operates record relay K102. Relay K102 operates contacts to apply power to the run motor B502 to start the stylus band rotating. Timer K1 is released, and holding current for the phase actuator is maintained through relay K102 contacts. Plate voltage is applied to print amplifiers V5 and V6, and print power is fed to the trolley bar and stylus needles.

At the end of the transmission the 450-cycle stop signal is detected by CR104 and fed to FL102 (now tuned to 450 cycles). The output from FL102 is amplified by V101A, rectified by CR102, and fed to start/stop relay amplifier V102B energizing start/stop relay K101. The contacts of K101 are restored to the original positions setting up the recorder for the next transmission.

If the set is operated manually, auto/man switch S305A shorts the inputs to the start/stop and start-record signal filters. A positive potential is applied to start/stop relay amplifier V102B by S301D to operate start/stop relay K101. Holding current is applied to the phase actuator E501 through relay K101 and phase switch S303A. When the phasing signal is received, the operator activates phase switch S303, and S303A removes holding current from the phase actuator. Section S303B applies plate voltage to thyratron V204, and phasing pulses fire V204 as described previously. After three phasing pulses the operator releases S303 to reapply holding current to E501.

When copy signals start, the operator throws the start/record switch (S304B) momentarily to start-record. This places a positive potential on the grid of record relay amplifier V102A causing it to conduct energizing relay K102. Relay K102 applies power to the run motor and sets up the set to record.

When the transmission ends, the operator throws the start-record switch momentarily to stop-record. This causes V102B to conduct energizing relay K101. Relay K101 applies holding current to the phase actuator, removes print power from the stylus needles, and stops the run motor.

When the supply of paper is exhausted, the end-of-paper stop switch (S501) operates to remove the RB+ voltage from relay K102 and stop the recording mechanism.

FORK OSCILLATOR AND SYNC MOTOR DRIVE CIRCUITS.—The fork oscillator circuit provides a stable frequency source for the SYNC motor to keep the recorder synchronized with the remote transmitter. The 3600-cycle signal from the fork, Y201, is amplified by V201 and V202, and fed to locked oscillator V203. Oscillator V203 is locked at either 1200, 900, or 600 cycles depending upon the scans per minute to be recorded. The oscillator output is fed through SYNC motor amplifiers V205B, V206, and V207 to the SYNC motor B501A.

SPEAKER AMPLIFIER AND TEST SIGNAL CIRCUITS.—The speaker amplifier circuit is provided for monitoring the facsimile signal. The output from the secondary of T301 is fed through a volume control (not shown) to speaker amplifier V3, and out to speaker LS601.

The test signal circuit is provided for testing and troubleshooting the set. It consists of four switches, and associated circuits which are used to simulate the signals from a remote transmitter.

Operating Adjustments

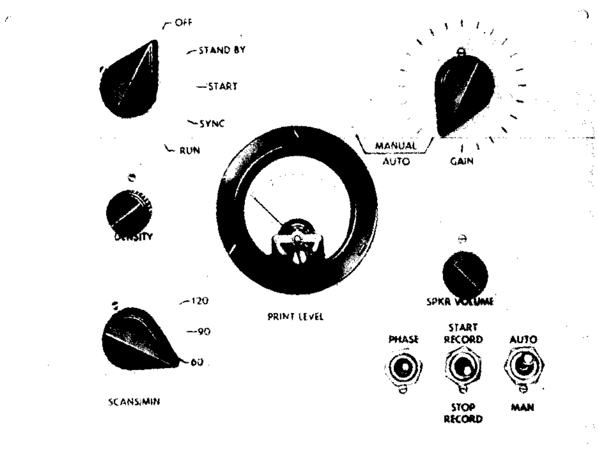
Operating controls for the AN/UXH-2 are located on the control panel (fig. 10-31). The following steps for automatic and manual operation are listed on the inside of the control panel door.

Automatic operation

1. Select scan speed.
2. Turn to standby and wait one minute.
3. Turn to SYNC and wait 15 seconds.
4. Turn to run—allow SYNC motor to fall into synchronous speed.
5. If SYNC motor does not fall into synchronous speed, repeat steps 3 and 4.
6. Throw auto/man switch to auto.
7. For ALC operation, turn gain control to auto. For manual gain operation, turn gain control to man. and adjust as in step 4 of manual operation.

Manual operation

1. Repeat steps 1 through 4 of automatic operation.
2. Throw auto/man switch to man.
3. For ALC operation, turn gain control to auto. For manual gain operation, turn gain control to man. and adjust as in step 4.
4. On phasing signal, advance gain control from maximum clockwise position until meter reads 100.
5. Hold phase switch down for at least two phasing pulses.
6. When copy starts, throw to start-record.
7. At end of copy, throw to stop-record.



70.91

Figure 10-31.—Facsimile recorder set AN/UXH-2, control panel.