# S P E C I F I C A T I O N S

## SINGLE CHANNEL RADIOTELETYPE STATION

## USING PRESS WIRELESS RECEIVERS

RESTRICTED

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# SPECIFICATION

FOR

# INSTALLATION OF ARMY SINGLE CHANNEL RADIOTELETYPE EQUIPMENT USING AN/FRR3 RECEIVING EQUIPMENT


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# USE OF AN/FRR3 DIVERSITY RADIO RECEIVER WITH AN/FGC1 RADIO TELETYPE TIRMINAL EQUIPMENT

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# INTRODUCTION

Radioteletype is a system of communication developed by the Army to provide an improved semi-automatic transmission service. The system avails itself of many of the modern findings in both radio transmission and the reception of dual frequency signals.

During World War I, an attempt was made to discourage the interception of confidential radio messages by using two transmitters on different wavelengths. One transmitter would key the dots of Morse Code and the other would send the dashes. The scheme was unsatisfactory from a cryptographic view, but it did pave the way for further experiments in the improvement of transmission service through the use of a separate frequency to represent the "space" between code characters instead of the former "blank" or "carrier off".

At the same time, engineers were observing the phenomenon that radio signals which were induced into antennas spaced 10 or more wavelengths apart would fade independently. (Space diversity).

The system to be described, includes the latest developments in keying a single standard transmitter to provide separate marking and spacing frequencies. In addition, dual (space) diversity receivers improve the solidarity of the circuit, and special voice frequency terminal equipment discriminates against static and man-made interference to alleviate that ever present problem.

The efficiency of land wire teletype circuits needs little, if any, further recommendation. For many years, commercial services and the Government have used this means of message handling in connection with various types of ciphering devices. The circuits were capable of handling as high as 75 words per minute with the message being prepared and received "in the clear" although the signal lines would carry scrambled letters.

Very little modification is required to change-over a land wire teletype station into one capable of radio operation; but, since the radio signals are available to our enemies as well as ourselves, certain precautions must be taken to make secure the information contained in the messages. It is for that reason, in the pages to follow, the reader will become acquainted with Subscriber Sets, Sigcum, Typing Reperforators and other special equipment associated with the preparation and reception of Radioteletype traffic.

## Section 1

### 1. General

1.1 A Radioteletype Station comprises four major departments, the Transmitting Station, the Receiving Station, the Signal Center and the Code Room. Each of these divisions will be treated separately in the paragraphs to follow.

### 2. Two types of radioteletype circuits are employed:

a. Simplex or half duplex, when the radio carrier frequency is the same for both transmitting and receiving. This limits transmission to one direction at a time.

b. Full duplex, when different frequencies are assigned to each end of circuit. This permits simultaneous transmission and reception in both directions.

### 3. Transmitting Station

The transmitter is called upon to provide a continuous carrier instead of the interrupted condition which results from CW keying. In addition, the carrier must shift frequency by 850 cycles, alternately between "mark" and "space" signals. In order to accomplish the simulated "FM" operation, the crystal oscillator portion of STANDARD Signal Corps amplitude type transmitters is modified by the addition of an externally located exciter.

In most instances, the crystal itself is removed and the output of the exciter is fed directly into the grid of the oscillator tube via the crystal socket. An adapter is contained in the modification kit which duplicates the pin locations of the crystal holder and eliminates the necessity of modifying the transmitter proper.

#### 3.1 Transmitter Exciter

The transmitter exciter (FS-12A) is a self contained RF Generator arranged for table or rack mounting. For complete circuit analysis and operating instructions, attention is directed to "FS-12A Instruction Book".

3.2 Sketch TTIS provides a block schematic of the exciter. It will be noted that a crystal, high frequency oscillator, and a stable low frequency electron coupled oscillator, additively combine in a balanced modulator, mixer circuit. Further investigation will reveal a variable resistance electronic arrangement which acts upon the tuned circuit of the 200 KC oscillator to vary its frequency. A potentiometer permits control of the plate resistance of the shifter tube, which in turn limits to any desired

value, the amount of frequency shift produced.

3.3 A 255A Relay is inserted in the control circuit and keys the shifter tube by causing it to conduct for "space, and to cut off for "mark". In this way, the excitation frequency is lowered for a "space", and returns to normal for "mark", corresponding to the respective teletype "open" and close" pulses. (Later keyers will substitute and electronic keyer for the mechanical device.)

3.4 The exciter provides ample excitation, in the 2 to 6 mc range, for any Signal Corps high frequency transmitter, and a front panel switch selects any one of three crystals, for as many output frequencies.

3.5 Since the plates of the tubes in the high power stages of the transmitter are not given momentary "key-up" periods of rest and cooling as is obtained in conventional keying circuits, it may be suspected that operation at reduced power will be required. This will not be necessary as all Signal Corps transmitters are designed for full power input under continuous "key down" conditions. The transmitter should be normally loaded, and the grid drive of every stage kept up to normal operating currents.

3.6 Provision is made for remotely controlling the radio transmitter from the Signal Center so that the carrier may be removed during those periods when transmission is not required. The control actually consists of any extension of the CW keying circuit and provides a rapid break-in type control.

4. Receiving Station

The Receiving Station should be located several miles from the Transmitting Station at a site chosen for its freedom from man-made interference and by actual signal strength checks, for its good radio reception qualities. The Receiving Apparatus may be a pair of SuperPros modified for diversity operation, a bank of Wilcox CR 3D fixed tuned receivers or the Press Wireless AN/FRR3. Immediately adjacent to and interconnected with the receiver, is the Terminal Equipment AN/FGC-1 (AN/FGC-1-X for 25 cycle input).

The receiving antenna system should consist of two directional antennas directed on the same azimuth, and spaced several wavelengths apart. The dual diversity arrangement thus provided, increases the reliability of reception.

4.1 Receiving Equipment

Irrespective of the type of receiver which is furnished, whether it is a Hammerlund, Wilcox or Press Wireless, most requirements and the sequence of operations will be identical.

The receiver consists of two superheterodynes in space diversity. The oscillators, both high frequency and beat frequency, are crystal controlled in order to provide the utmost in stability, and each oscillator is common to both receivers. A separate electron coupled, variable frequency beat oscillator is included in the oscillator compartment to permit automatic frequency control, and to provide additional tuning range when operating without AFC.

4.2 Fig. #1 portrays the sequence of operations in the Receiver bay and Fig. #2 follows the circuit thru the AN/FGC1 Terminal Equipment.

It is suggested that the instruction books which cover both of the components be reviewed for comprehensive installation, tuning and operating details.

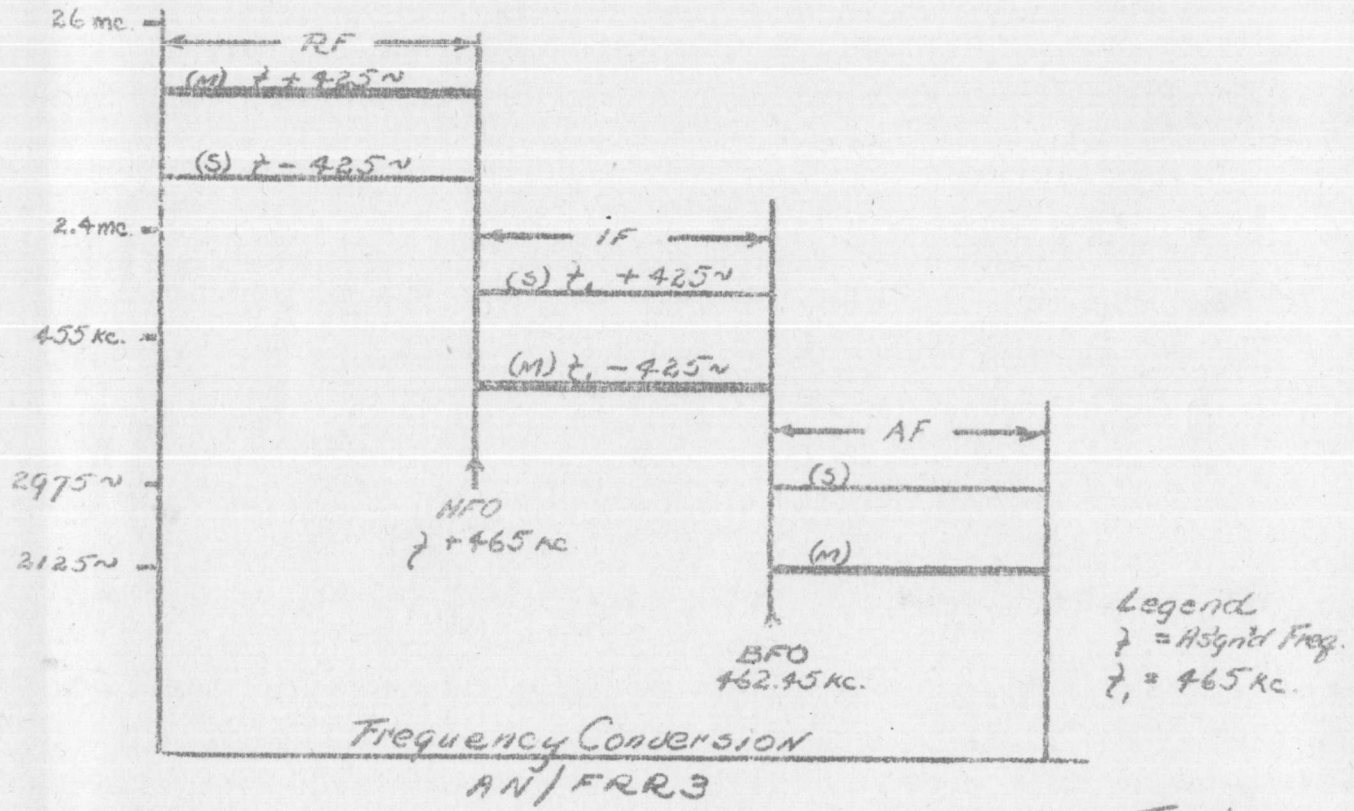



Fig. 1

4.3 The received signal is a constant amplitude carrier which shifts approximately 850 cycles alternately between "marks" and "spaces". Conversion to voice frequencies is accomplished by beating the intermediate frequency with a fixed value, which may be 462.45 KC. The resultant output of each receiver, (2125 cycles for "marks" and 2975 cycles for "spaces") is carried to its respective channel in the AN/FGC1 terminal.

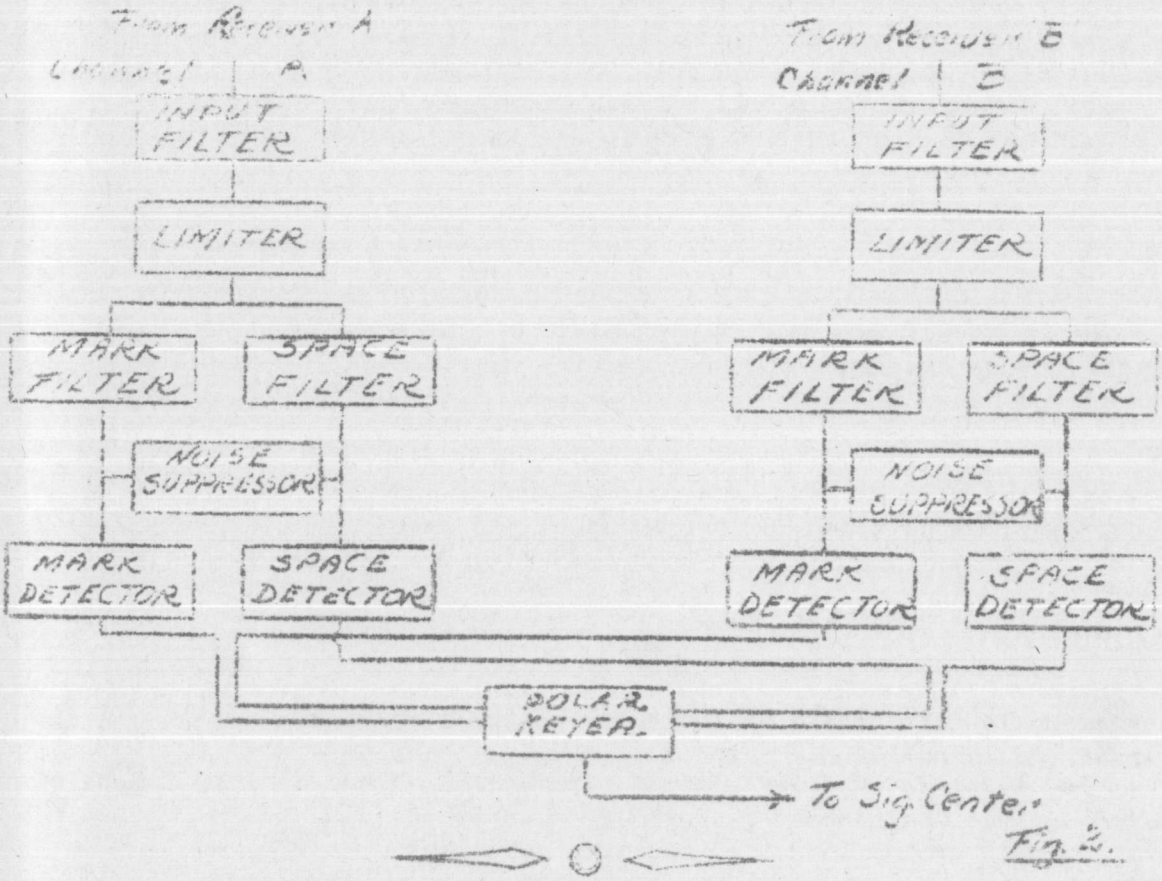



Fig. 2.

4.4 Channels A and B in the terminal are identical and each consists of:

a. A band pass filter which passes all frequencies within the "marking" and "spacing" bands, but excludes noise frequencies outside of those bands.

b. A limiter which substantially levels the amplitude of the signals.

c. Narrow band filters which separate the "marks" and "spaces".

d. An amplifier-noise-suppressor-detector which increases the amplitude of the signals, suppresses noise and converts the tones to direct currents capable of actuating the receiving relay by energizing its respective "mark" and "space".

e. A receiving relay (Western Electric type 255A), the contacts of which are wired through a rectifier in the terminal to produce polar Signal Cirucit actuating currents.

4.5 Reference is invited to Dwg. E-S-C-32505A and Fig. 2 for block diagrams portraying the sequence of operations in the entire receiving station. It will be noted that the diversity circuits are completely isolated from each other until the direct currents from the "mark" detectors are paralleled at the "mark" relay winding and the "space" detectors" outputs join at the "space" winding.

## 5. Signal Center and Code Room

The first step in the transmission of a message by radioteletype takes place in the Code Room. It is here that the operator types the message on a 15 or 19 type Printer, and the resultant operations produce an enciphered tape. Sketches of typical Code Room installations are shown in Dwg. E-S-C-32505A.

It will be noted that in addition to the teletype printers, the Code Room contains at least one 131B2 Subscriber Set with a Sigcum and a 133 Subscriber Set which is used as a room circuit terminal. (see "Parts Description" Sect. 2)

### 5.1 Sending

Signal Security Division requires the preparation of enciphered text in tape form in order to permit observation of the message prior to its transmission. In this way, the operator can be certain that the message is actually encoded and that no failure has occured which might cause confidential information to be transmitted in the clear.

Code Rooms are therefore invariably set up as Room Circuits (See "Definitions" Sect. 2).

When the operator types a message, it appears as "home copy", in the clear on his teletypewriter, but it is simultaneously subjected to the enciphering of the Sigcum. A switch is provided on the front of the 131B2 which when in the "text" position by passes the Sigcum to produce "clear" tape, and when in the "cipher" position cuts the Sigcum into the circuit to produce "scrambled" tape. The DC pulses are passed from the 131B2 into a 132A2 or 133 Set where they actuate the mechanical tape perforator known as a typing re-perforator. This machine not only punches the tape, but also prints the equivalent letter thereon to permit the observations previously referred to.

The prepared tape is hand carried to the Message Center where it is fed into the transmitter-distributor on the 132A2 or 133 Table. (The sequence of message preparation and transmission varies slightly when conditions demand a combined Message Center and Code Room).

The transmitter-distributor, in connection with rectifier in the 132A2 or 133 Set, supplies polar signal currents on the keying line to the transmitter.

5.2 Receiving

The receiving circuit may employ the same 132A2 set used in the transmitting leg. In the case of simplex operation, the same 131B2, Sigcum and printer are used for both receiving and transmitting.

The signals from the receiving station are conducted to the 132A2 Set wherein is contained a synchronizing device. This unit is electrically alert and will add the starting pulse to a teletype signal character if for any reason that pulse is not received. In this way, one letter may be distorted, but synchronism will not be lost.

The Synchronizer is followed by the 132A2's typing reperforator. The resultant enciphered tape is hand carried to the code Room where it is processed through the transmitter distributor on the 133 Table, through the 131B2 and Sigcum, and finally appears as clear text on the receiving teletype printer.

Room circuits will be provided in the quantity justified by the terminal traffic load.

## Section II Signal Center

### 1. General

This section of the specification covers the teletypewriter and associated equipment at the Signal Center.

1.1 Following is a brief description of the various station sets referred to in this section of the specification.

a. 131B2 Teletype Secrecy Equipment

A table which contains a telegraph repeater, mixing relay circuit. The unit when combined with a teletypewriter provides the basic element for one terminal of a secrecy system. Direction of transmission through the unit is possible in either direction but only in one direction at a time. When used in a simplex or half duplex system, the direction of transmission is under control of the local sending contacts. When used in one leg of a duplex system, the unit is locked in the required position. Reference is made to Western Electric Specification X-63684 which furnishes the detailed description and operation of the unit.

b. 132A2 Subscriber Set

The 132A2 Subscriber Sub Set is built into a table which contains a wiring cabinet wherein is housed a synchronizing unit and a rectifier. Mounted on the table top is one transmitter distributor and one typing reperforator. The synchronizing unit is connected into the receiving leg of a radio channel.

Reference is made to Western Electric Company Specification X-66154 which furnishes the detailed description and operation of the 132A2 Set.

c. 133A1 Relaying Unit

A table similar to the 132A2 unit, but less the synchronizer. For use in a code room circuit in the encoding and decoding of tape. It can also be used for relaying tape to a distant location over wire facilities. When used in a code room circuit, DC power is obtained from the 131B2 Set. When used for relaying tape, an REC 10 rectifier from a #15 teletypewriter furnishes the DC power. A KS-5844 List 01 rectifier may also be used to furnish the DC power. Reference is made to W.E. Spec. X-66152 which furnishes detailed description of the unit.

d. Definitions

(1) Signal Circuit

That part of the radioteletype station over which signals, radio frequency or audio frequency are transmitted or received.

(2) Control Circuit

That part of the radioteletype station which controls the transmitter, receiver, and associated equipment. In general, it consists of control lines to the transmitter and the receiver, and permits the operator to disable one while the other is being used for communication.

(3) Room Circuit

That part of the radioteletype station which permits the preparation of tape, either in the clear, in cipher or both, and is not connected, either electrically or mechanically, to any portion of the signal or control circuits. It is used to provide "off line" operation (see below). At least one Room Circuit is provided per station. However, the total number of circuits will depend upon the terminating traffic.

(4) Off Line Operation

A procedure whereby it is impossible to connect the secrecy equipment directly to the signal circuits, and where other equipment is provided to permit visual inspection to determine that enciphering is complete. This procedure is required and will be used at all Radioteletype Stations.

2. Supplementary Information

Teletype Manual #10 Instruction Manual for Teletype Model 19 Set.

Teletype Manual #7 Instruction Manual for Teletype Model 15 Set.

X-63684, 131B2 Printer Station Equipment for Army and Navy Installation (furnished with 131B2 Set).

X-66154, Instruction Book for 132A2 Sets (furnished with 132A2 Set).

X-66152, Instruction Book for 133A1 Set (furnished with 133A1 Set).

SD-70054-011, 12802 Subscribers Set (furnished with 12802 Set).

3. Drawings

3.1 ESC-32505 Block Schematic - Single Channel Radioteletype

ESE-32533A Interconnection Drawing, Duplex Operation - AN/FRR3 Receiver

Sketch TT1A Typical Floor Plan Layout

4. Installation Notes

4.1 Detailed installation notes are furnished with each piece of equipment, however, the following general notes should be followed.

a. Recommended equipment arrangement is shown on the typical floor plan drawing.

b. The station ground should be run in along with the signal and control leads and looped to each equipment.

c. Power wiring should be engineered locally.

d. A local telephone circuit should be provided from the transmitting station to the signal center and from the receiving station to the signal center.

e. 132A2 Set

(1) Two types of neutral to polar repeaters may be used with the 132A2 Set. (a) present unit in 133A1 set which will be relocated to the 132A2 Set or (b) a "Repeater and Control Circuit" designed for use in the 132A2 set when used on a simplex radio teletype circuit. This repeater and control circuit contains additional equipment over and above that required for duplex operation and arrangements are made on the circuit drawing to disable the additional equipment.

(2) Particular reference is made to the testing and adjusting of the snychronizer in this set as outlined in the instruction book.

f. 131B2 Set

(1) Wiring options to be provided shall be made per the wiring drawing and not the schematic drawing.

g. The typing reperforator on the 132A2 Set shall be rotated counter-clockwise 90 degrees on the table top so that the tape from the reperforator will come out over the right hand end of the table top.

h. The tape stop arm on the transmitter distibutors on 132A2 sets shall be removed and a wire placed across the contacts to close the circuit at all times.

i. One 15 teletypewriter is furnished for line up tests on all circuits. This printer can be patched into the circuit at the 63C2 patching panel.

j. The rectifier on the Model 15 teletypewriter is not used when operating with the 131B2 Set.

k. For making polarity tests to the transmitting station, a spare signal can be set up by inserting an open plug in the "misc" jack (63C2 Panel) associated with the neutral to polar repeator in the 132A2 Set.

l. Overall signal center tests can be made by patching "set" jack in transmitting leg to "set" jack in receiving leg.

m. The RE 54A keys shall be installed on the side of the 132A2 Set. The "Trans" key on the TD side and "Mon Restore" on the TR side. The Mon Restore key will lock up the monitor circuit in the terminal equipment in the mark condition when the distant transmitter leaves the air so that the typing reperforator will not run open.

n. When the 133A1 Set is used in an alternate encipher and decipher room circuit, the typing reperforator shall be rotated as per paragraph g above and the tape arm removed and contacts strapped. This change is not recommended for the simultaneous encipher and decipher code room circuit since the enciphered tape will usually be fed directly

into the transmitter distributor of the 133A1 Set for deciphering of the message to check for correct enciphering.

4.2 Testing

a. It is recommended that final tests shall be conducted by using a standard test tape in lieu of other forms of test sentences.

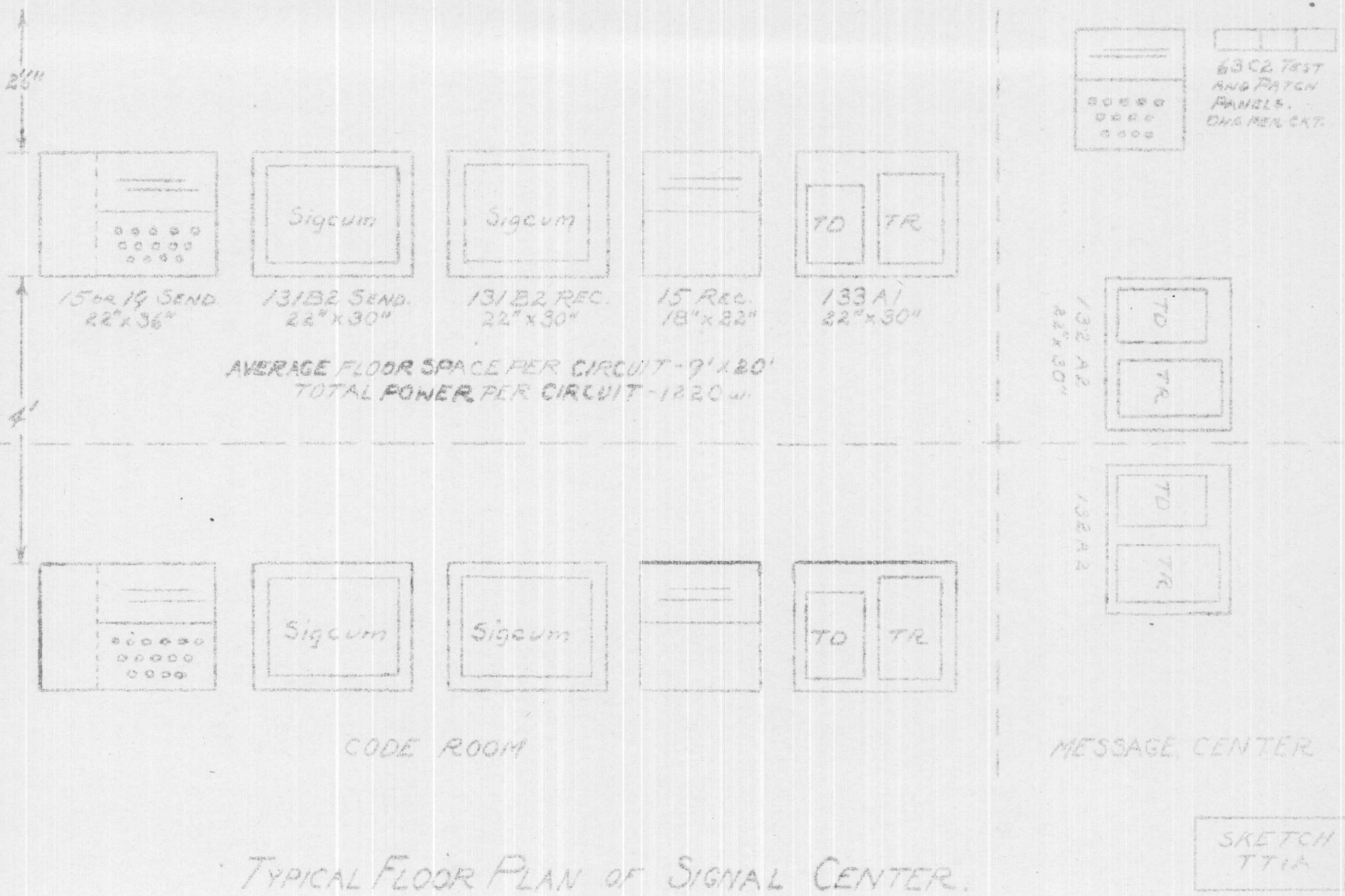
The tape shall consist of the following:

THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK (SPACE) 1234567890 (SPACE) ** SENDING. (Carriage Return) (Line Feed)

Repeat three times and join the ends. Insert the endless tape into the TD set.

** Operator's initials.

b. Chart B may be used for instruction purposes instead of wordy requests for changes.




SKETCH T71A

TYPICAL FLOOR PLAN OF SIGNAL CENTER.


TYPICAL CODE ROOM. PLAN "B".
FLOOR SPACE SAME AS "A".


TYPICAL CODE ROOM
PLAN "C"
FLOOR SPACE 8'x14'

SKETCH
TT-1B

Section III Receiving Station

A. Since this specification has been prepared exclusively for the Radioteletype Station wherein the receiving equipment is AN/FRR3 and AN/FGC1 in combination, no alternate or optional arrangements will be proposed. The section comprises a preliminary instruction book, which when used in conjunction with the Instruction Manuals furnished with the equipment, will provide complete installation, operational and maintenance information.

B. The monitor circuit shall be modified as per the interconnection drawing. This modification provides a lock up circuit, controlled by the signal center, to hold the terminal equipment in a marking condition when the distant transmitter is off the air. The monitor lock up circuit is released upon the receipt of a mark signal from the distant station.

Attention is directed to W.E. Spec. X-63642 for detailed data on AN/FGC1 Terminal Equipment.

C. Drawings Attached

Chart A - Frequency Indicator Curve

Chart B-- Suggested Procedure Code

D. Signal and Control Lines

Provisions shall be made to supply at least 6 wires (3 pairs) between the Receiving Station and the Signal Center as follows:

1. One pair to carry signal currents.
2. One pair to control the receiver.
3. One pair to be used as an order wire. If a main switchboard is located on the post, the order wire should be routed through it. If no main telephone service is available, the order wire shall be run directly between the two buildings and EE-8A Field Telephones may be installed.

E. The following weights and cubes will assist in identifying the various components upon their arrival.

| | | Net Weight | Packed for Domestic Shipment | Packed for Export Shipment | Displacement Packed for Expt. Shipment |
|---|---|---|---|---|---|
| Cabinet with 5 panels removed. Includes one ea. spare tubes kit and one ea. remote control unit. | | 387 lbs. | 781 lbs. | 800 lbs. | 40.2 cu. ft. |
| Receiver A | | 46 lbs. | | | |
| Receiver B and Instr. Books | Packed Together | 46 lbs.<br>2 lbs | 181 lbs. | 200 lbs. | 7.4 cu. ft. |
| Multiplier | | 29½ lbs. | | | |
| Oscillator | Packed | 35 lbs. | | | |
| Antenna Panel | Together | 39 lbs. | 158 lbs. | 175 lbs. | 8.0 cu. ft. |

F. All installation and functional details relative to the AN/FGC1 are contained in Technical Manual TM-11-356 which is supplied with the Voice Frequency Terminal Equipment.

1. General

1.1 This section of the specification pertains exclusively to the Radioteletype Station using the AN/FRR3 (Press Wireless Inc. model 2017K) Diversity Radio Receiver in connection with the companion AN/FGC1 Radioteletype Terminal Equipment.

These two units combine to comprise a complete Radioteletype Receiving Terminal.

The AN/FRR3 Receiving Equipment consists of two superhetrodyne receivers with common high frequency and beat frequency oscillators, separate antenna matching networks for each receiver, a self-contained power supply, and provisions for both local and remote automatic-dial control of any one of five pretuned radio frequency bands, and/or any combination of four antennas.

The receiver is housed in a steel, cabinet-type rack, 84" high, $22\frac{1}{4}$" wide and 17" deep. Doors at front and rear make for accessibility of all components.

Designed for single frequency operation on any one of five pretuned bands, the tuned circuits are arranged as follows:

| | | | | | |
|---|---|---|---|---|---|
| Band | 1 | - | 2.4 | to | 4.2 mc. |
| " | 2 | - | 4.2 | " | 6.9 mc. |
| " | 3 | - | 6.9 | " | 11.2 mc. |
| " | 4 | - | 11.2 | " | 17.5 mc. |
| " | 5 | - | 15.0 | " | 23.0 mc. |

Provisions are included for extending the high frequency range limit to 26 mc. (See Instruction Book for AN/FRR3).

1.2 Power requirements.

110/220 volts - 50/60 cycles
750 watts.

1.3 Antenna:
High gain, directional antennas are recommended for optimum performance of the receiver. These should be spaced several wave-lengths apart and directed upon the desired azimuth. Antenna transmission lines to the Receiver may be of 70,200 or 600 ohms impedance.

1.4 Definitions of terminology.

FREQUENCY INDICATOR - A device associated with the AN/FGC1 equipment which measures the difference between the input audio frequency in the band 1600 to 3600 cycles, and the frequency of 2550 cycles which is generated by a local oscillator. Connected to Channel A at the output of the Limiter, a zero indication on the meter indicates a difference of 425 cycles. Negative readings (left of zero) indicate a difference of less than 425 cycles. An alarm bell which rings when the frequency deviates more than the allowable limit is associated with the Frequency Indicator Circuit. (See Par. 9-M in TM-11-356). The general characteristics of the meter are plotted on the graph, Chart A.

AFC - AUTOMATIC FREQUENCY CONTROL - A device associated with the AN/FGC1 Equipment which electrically and automatically converts the difference between 2125 cycles (Mark) and the input mark frequency to a proportional voltage which is applied to the AFC tube in the receiver. Its action is to maintain the correct frequency irrespective of slight variations in transmitter or receiver frequencies. The control voltage, which is zero when the mark frequency is exactly correct (2125 cycles), appears across an ungrounded pair of terminals. It is important, therefore, that the output of the AFC circuit be correctly poled when it is connected to the AFC tube in the receiver. The AFC equipment is connected to the outputs of both receivers in the AN/FGC1 equipment ahead of the input filters.

1.5 The Oscillator Panel supplies a crystal controlled oscillator, and a variable oscillator for high frequency conversion, as well as a choice of crystal of variable Beat Frequency oscillator (Crystal, AFC or Manual). The HFO and BFO provide common frequencies to both receivers so that the audio tone from either receiver is identical. The frequency of the HFO can be changed by at least $\pm$.015% by means of a front panel adjustment which changes the inductance of a coil in series with the crystal. A suitable harmonic of this crystal frequency is selected, and it will always be 465 kc. higher than the assigned carrier frequency.

Three choices of common BFO are available:

1 - Crystal. 462.45 kc $\pm$.01%
2 - Self excited oscillator.

a. Automatic Frequency Control by means of a variable

resistance tube coupled to the AFC circuit in the AN/FGC1 Equipment.

b. Manual Control (obtained by strapping AFC terminals on receiver).

1.6 If, for example, the assigned carrier frequency were 12,000 KC, the transmitter would be adjusted as closely as possible to provide the following marking and spacing frequencies:

Mark = 12,000 + 0.425 = 12,000.425 KC (resting frequency)

Space = 12,000 - 0.425 = 11,999.575 KC

Average = 12,000 KC

1.7 Since the harmonic of the high frequency oscillator in the receiver is 465 KC greater than the average carrier frequency, the marking and spacing frequencies in the IF stages will be centered with the marking frequency as the lower of the two. The IF and audio output frequencies desired are therefore:

| IF | Audio Out. |
|---|---|
| Mark 465 - 0.425 = 464.575 KC | 464.575 - 462.450 = 2.125 KC |
| Space 465 + 0.425 = 465.425 KC | 465.425 - 462.450 = 2.975 KC |
| Average 465 KC | = 2.550 KC |

NOTE: In problems of this type, considerable arithmetic will be saved if average frequencies are used throughout. Thus, the high frequency oscillator is 465 KC above the assigned frequency. The IF average is 465 KC and the average audio output is 2,550 cycles.

1.8 It will be noted that the correct adjustment of the transmitting oscillator and two receiving oscillators must be precise in order to obtain the correct audio frequency outputs which are required for satisfactory service. To take care of moderate variations, an AFC circuit is provided, which will automatically keep the marking audio frequency near its correct value. However, the AFC circuit changes only the BFO, and it is necessary to operate the HFO so that the desired signal remains in the IF pass band (which is 6 db down at 465 $\pm$ 2.5 KC).

1.9 Occasionally, it may be impossible to use the crystal BFO, and the AFC circuit may be effected by unwanted interference or it may not be available for other reasons. Therefore, by strapping out the AFC terminals, the triode oscillator is available for manual tuning of the BFO. This is the least desirable arrangement, but it may be used to provide service when temporary conditions make the use of crystal and AFC-BFO impracticable. In general, AFC should be used at all times. If not practicable, crystal or manual oscillator should be used in that order.

2. Installation.

2.1 When the cabinets of both AN/FRR3 and AN/FGC1 are properly installed, the AN/FRR3 will stand to the left of the AN/FGC1 as you face the fronts of cabinets. Before bringing the two cabinets together, remove the panels from the top and bottom on the adjoining side surfaces of both cabinets. Place the cabinets so as to allow at least a 2½ foot clearance around the entire equipment (a clearance of 3' to 4' at front and rear is desirable). The flooring under the equipment should be as firm and free from vibration as is possible to obtain.

2.1a Bolt the two cabinets securely together through the four holds in the corners of the large oblong openings at the top and bottom of the cabinets. Then anchor the cabinets to the floor by means of lag or expansion screws through the four holes in the corners of the bottoms.

2.1b Bond the cabinets together at top and bottom with the braid supplied with the AN/FRR3 equipment. Working from the front, fasten the right side of AN/FRR3 and the left side of AN/FGC1 using 10-32 screws in the tapped holes in the racks.

NOTE: In bonding these two units together, make sure that all paint, grease, dirt or foreign matter is thoroughly removed from the bonding surfaces. Scrape or file until bare metal is exposed!

2.1c Remove the pieces of flat sheet steel which cover the door louvres on each cabinet. Store them carefully for they must be reinstalled as a protection against dampness if the equipment is to stand inoperative for any extended length of time.

2.1d Remove the cords which anchor the various plugs prior to installing the chassis in the cabinet. Conductor cables connecting the various chassis are securely stitched to the cable

supports on the sides of the Receiver cabinet. The plug ends of these cables are tied down with cord during shipment. Be careful when releasing these plug ends during installation of the equipment that no damage occurs to the permanent cable anchorage.

2.1e Chassis.
Fasten all chassis in the cabinet with the 10-32 fillister head screws and washers (obtained from the small cloth bags tied to each chassis). The order of chassis from top to bottom in the cabinet in shown in Table A.

TABLE A

| | | |
|---|---|---|
| 1 | Antenna Matching Panel | (marked ANTENNA) |
| 1 | Superheterodyne Receiver | (marked RECEIVER CHANNEL B) |
| 1 | Multiplier Panel | (marked MULTIPLIER) |
| 1 | High & Low Freq. Oscillator | (marked OSCILLATOR) |
| 1 | Superheterodyne Receiver | (marked RECEIVER CHANNEL B) |
| 1 | Relay Control Panel | (marked REMOTE CONTROL) |
| 1 | Power Control Panel | (marked POWER CONTROL) |
| 1 | Power Filter Panel | (marked POWER FILTER) |
| 1 | Power Supply Panel | (marked POWER SUPPLY) |

NOTE: An auxiliary dial control unit is provided for remote control and should be installed at the Signal Center.

2.1f Plug all cable connectors into their proper chassis following the cable diagram. These connectors are keyed so that it is impossible to make a wrong connection. The aid in installation, each plug is numbered corresponding to the number stenciled on the proper chassis beside its associated receptacle.

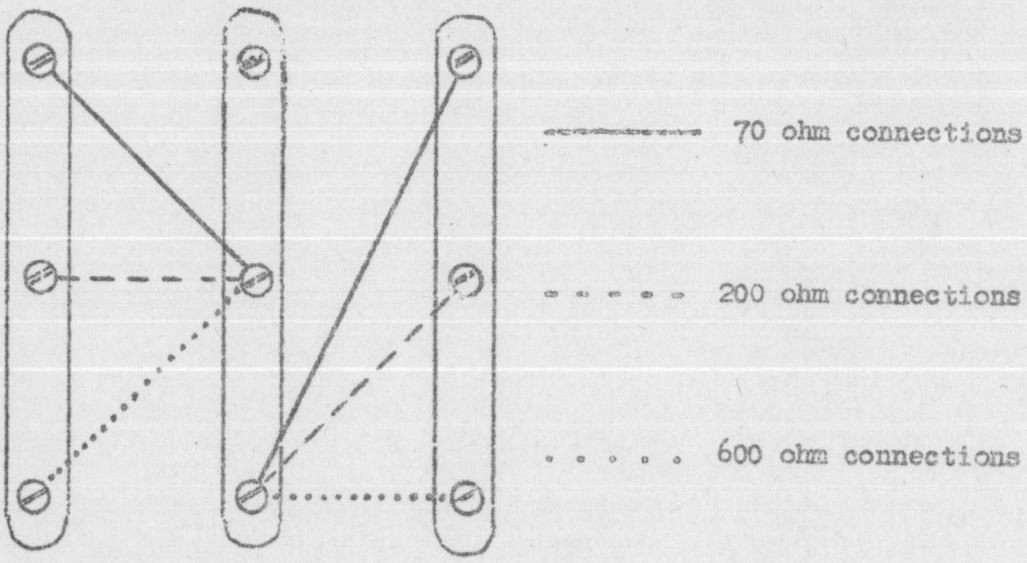
2.1g There are four pairs of twisted leads attached to the bottom of the antenna feed-thru insulators on the top of the Receiver Cabinet. Connect these leads to the four correspondingly numbered pairs of terminals on the Antenna chassis, so that one

pair of diversity antennas is connected to Antenna I and Antenna IV, and the other pair (if used) to Antenna II and Antenna III.

2.1h The following surge impedance values of prescribed antenna transmission lines may be considered average:

| | |
|---|---|
| Twisted pair<br>Coaxial cable<br>Parallel-lay-Polyethylene | 70 ohms |
| Four wire line<br>(Per DWG ES-E-386B) | 200 ohms |
| Two wire line<br>(Per DWG ES-E-250D) | 600 ohms |

An antenna matching network with adjustable taps is provided. (Uppermost panel). Using the above table as a guide, strap the connections on the rear of this chassis, as indicated below, to obtain proper impedance matching.



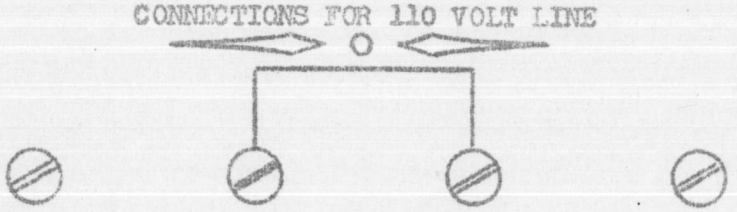

2.2 Power Connection.
AN/FRR3 is shipped with transformer terminal connections arranged for 220 volts operation. If the equipment is to be operated on 110 volts, the connections must be changed on eight of these connection strips located as follows:

TABLE B

| Connection Blocks | Chassis |
|---|---|
| 1 | ANTENNA |
| 1 | RECEIVER (Channel A) |
| 1 | RECEIVER (Channel B) |
| 1 | MULTIPLIER |
| 4 | POWER SUPPLY |

2.2a Make these connections for 110 volt operation as shown in the accompanying sketch.

CONNECTIONS FOR 110 VOLT LINE



CONNECTIONS FOR 220 VOLT LINE

2.2b Place the two 110 volt, 100 watt heater lamps in the sockets at the rear of the POWER CONTROL chassis.

NOTE: Power cable shall consist of two, #12 wires in conduit, or #12 BX.

2.2c To connect the power cable to the AN/FRR3, unscrew the bolts (Large heads) which support the front panel of the POWER CONTROL chassis, and lay it forward on one of the packing cartons. Perform this operation carefully in order to avoid damaging the panel wiring.

Connect the two #12 power wires to the open terminals on the power switch, and then replace the panel.

2.2d Throw the POWER SWITCH to the ON position. The 100 watt heater lamps should light. (Brightly if 220 volt service is used, dimly if 110 volt power is used.) Also, note that the two oven temperature indicators on the front of the MULTIPLIER panel light up.

2.2e INSTALLATION OF OSCILLATOR-MULTIPLIER COUPLING SHAFT.

a. Remove the rear cover of the OSCILLATOR UNIT.

b. Remove the 1" plug button from the rear of the MULTIPLIER chassis. This will give access to the switch shaft.

c. Throw Power Switch "ON" and dial "01" to supply power to the set. Then dial "3" so that the flat surface of the multiplier switch shaft will face the rear.

d. From the cloth bag attached to the MULTIPLIER chassis take the flexible shaft and its mounting screws. Feed this flexible shaft through the opening in the top of the OSCILLATOR unit into the MULTIPLIER chassis and fasten it to the switch shaft. A flashlight aimed through the one inch opening will greatly help in this operation.

e. Manually rotate the OSCILLATOR band switch to the #3 position. (When the black paint dot points toward rear of chassis). Place the free end of the flexible shaft on the switch shaft and tighten it securely.

f. Have an assistant press the red MOTOR SWITCH on the MULTIPLIER chassis until the other pair of set screws become accessible. Tighten these screws on the flexible shaft.

g. Dial positions "1" to "5" inclusive and observe that the oscillator band switch connects properly to coils "1" to "5". Throw POWER SWITCH OFF.

2.2f Install the two VT 244 rectifier tubes in their sockets in the POWER SUPPLY chassis.

2.2g Connect the shielded cable from the Oscillator chassis to the MULTIPLIER chassis terminals. Polarity here is not important.

2.2h CONNECTIONS TO AN/FGC1 EQUIPMENT.

a. Bond the ground connection in the AN/FRR3 Radio Receiver to the ground connection on the cabinet upright in the AN/FGC1 cabinet. (Lower left as you face the back of the cabinet).

b. Bond cabinets as previously discussed.

c. Using shielded pair, with shield connected as designated, make the following connections:

AN/FGC1

| Panel | Terminal Block | Terminal Number | Panel | Terminal Number |
|---|---|---|---|---|
| Limiter A | A | 1 | Rec. A | Audio Output 600 Ω |
| " | A | 2 | " | Audio Output Gnd. |
| " | A | 2 (shield) | | |
| Limiter B | A | 1 | Rec. B | Audio Output 600 Ω |
| " | A | 2 | " | Audio Output Gnd. |
| AFC | B | 5 | | AFC #2 |
| AFC | B | 7 | | AFC #1 |
| AFC | B | 8 (shield) | | |
| Bay Terminals | A | 9 | Dial Control | AN/FGC1 Disabling |
| | A | 10 | " | " |

NOTE: Read Par. 8 in TM 11-356 (AN/FGC1 Technical Manual) and proceed in accordance with that routine prior to making the following operations.

d. Feed the power cable from the AN/FGC1 equipment through the openings between the two cabinets and plug the power connector into the socket on the rear of the POWER CONTROL chassis.

e. Hold the dial control key switch in the DIAL position and dial "01". This will close the power relay, and power will be supplied to all components. The indicating lamps on the ANTENNA, MULTIPLIER, and both RECEIVERS will light, as will the indicator on the POWER SUPPLY panel.

2.2i Operating Temperature

After the power is turned on it will require approximately two hours for the oscillator crystal oven to reach its operating temperature of 55 degrees centigrade. An additional five hours will be necessary for all components to absorb heat and become stable at this temperature. During this period, the frequency of both the beat-frequency and variable-frequency oscillators will change slightly and will require frequent correction. The temperature of the oscillator oven is indicated by the two heat-indicator lamps on the left side of the MULTIPLIER panel. The illumination of both lamps indicates that the oven is below operating temperature. If both lamps are off, the temperature is high. Intermittent lighting of the upper lamp (marked NORMAL) indicates proper operating temperature.

NOTE: The period of time required for the entire equipment to reach operating temperature will depend on the local ambient temperature.

3. Oscillator-Multiplier

The HFO consists of an oscillator operating in the 1 to 4 mc range, followed by a MULTIPLIER which multiplies and amplifies the harmonics. An RF limiter is included in the circuit which substantially levels the output over the entire operating spectrum.

Harmonic operations are performed for each of the five bands as indicated in Table C. Columns 3 and 4 will assist in determining the proper constants to substitute into the formula for determining the correct crystal frequency.

3.1 Oscillator Tuning Procedure.

a. Remove all tuning covers.

b. Select crystals of the proper frequency according to the following crystal formula:

Carrier frequency (in KC), plus 465, divided by the order of the harmonic, plus .045% equals the crystal frequency required.

EXAMPLE: To compute the crystal frequency, let us again assume that the listening frequency is 12,000 KC.

Referring to the Band Frequency Chart (Below) we learn that 12,000 KC lies in Band 4, and that the 5th harmonic of the HFO crystal is used.

The formula becomes:

Crystal frequency $= \frac{\text{Carrier frequency} + \text{IF}}{5}$

" " $= \frac{12{,}000 + 465}{5} = \frac{12465}{5}$

" " $= 2493$ KC

However, a novel system of actually tuning the crystal has been incorporated in the oscillator, and, in order to center the desired frequency in the tuning range, an allowance to the sub-harmonic frequency of .045% must be added.

Therefore, to the 2493 KC figure we add the product of 2493 x .00045 which equals 1.12 KC.

The required crystal frequency then, is 2494.12 KC. Crystals which are supplied for AN/FRR3 use will be marked as follows:

For Carrier Frequency e.g. 12,000 KC.
Actual Xtal Frequency e.g. 2494.12 KC.

TABLE C

Tuning Ranges

| Band | Frequency Range | Crystal Freq. | Harmonic Used |
|---|---|---|---|
| 1 | 2.4 to 4.2 mc | 1.4 to 2.3 mc | 2nd |
| 2 | 4.2 to 6.9 mc | 2.3 to 3.7 mc | 2nd |
| 3 | 6.9 to 11.2 mc | 2.4 to 3.9 mc | 3rd |
| 4 | 11.2 to 17.5 mc | 2.3 to 3.6 mc | 5th |
| 5 | 15.0 to 23.0 mc | 2.2 to 3.4 mc | 7th |
| 5* | 17.5 to 26.0 mc | 2.5 to 3.8 mc | 7th |

c. Insert the proper crystal in the oscillator socket which is numbered in accordance with the band covering the desired listening frequency. Close the oven.

d. Turn the large slotted shaft on the Oscillator Panel corresponding to the band being used, to its XTAL position. This is its clockwise limit and switches from the Variable Oscillator to the Crystal Oscillator.

e. Set the Multiplier and Amplifier tuning adjustments corresponding to the band being used in accordance with the approximate settings indicated on the left chart on the inside of the front door.

NOTE: There are located on the inside of the front door, two charts which graphically provide an approximate indication for the settings of the tuning controls. The chart at the left is a calibration of the Antenna, 1st RF, 2nd RF, Mixer, Multiplier and Amplifier tuning settings for each of the five bands, with reference to the depths of the screw-heads below the front panel. A SIMPLE WAY TO SET UP ALL OF THESE TUNING CONTROLS IS: Determine the proper depth in inches, wrap a layer of tape around the shaft of the screwdriver so that the distance from the blade to the edge of the tape corresponds in inches to the desired frequency. It is then only necessary to rotate the controls until the tape edge is level with the panel. The chart at the right is calibrated in inches to represent the distance from the front panel out to the heads of the VFO tuning screws. Here again, the tape may be adjusted to the specified length.
WARNING. These settings are only approximate, and slight trimming will be required to establish exact peaking. Tune for maximum closure of the "eye" on the MULTIPLIER panel.

It should be noted that if the desired frequency lies in Band three, only those controls marked "3" need be adjusted to tune this frequency. If the frequency lies in Band Four, only those tuning screws marked "4" have an effect on that frequency, etc., for each band.

f. Warm up the SCR-211 (Station Frequency Meter) and set it to the frequency of the station to be received. Connect a wire from the antenna terminal on the Frequency Meter to one terminal of Antenna III on the top of the AN/FRR3 cabinet.

g. Lift the Oper. key on the DIAL PANEL and dial 7. This will connect Antenna III to Receiver A. Dial up the band to be tested in accordance with Table D, Page 26.

h. On Receiver A, turn AVC to "ON", DIV to "OFF". Plug phones into Phone Jack.

i. Turn the BFO Knob on the OSCILLATOR CONTROL PANEL to XTAL.

j. Turn the Vernier control of the high frequency crystal oscillator until a zero beat is obtained with the incoming signal from the SCR 211 Frequency Meter. This corresponds to an IF frequency of 462.45 KC. Turn the vernier crystal control counter-clockwise until the correct marking frequency is obtained as indicated on the frequency indicator of AN/FGC1 equipment.* This insures that the IF frequency is above the BFO Crystal frequency.

*NOTE: There are several ways of determining the correct marking frequency. Some operators will prefer one method and some another. For convenience, some of these are listed below.

1. The phones may be plugged into M CH F OUT, and the vernier adjusted until the marking frequency is heard. Care must be taken, however, not to tune on the 2nd harmonic. This can be determined by alternately listening to NOR TEST LEVEL (2550 ) and RAD REC OUT. If tuning is done on the second harmonic, the tones will be almost an octave apart. When the adjustment of the crystal vernier is correct, the tones from RAD REC OUT and NOR TEST LEVEL will be identical.

2. Patch out Limiter by patching from INP FILT OUT to CH FILTS IN and measure M CH OUT with AC meter. The reading should exceed 10 when the output of RAD REC OUT is at normal level.

3. Patch out Limiter and observe REC REL. 1 current. Tune the crystal vernier for maximum current.

NOTE: It is believed that a satisfactory method, after some experience is obtained, is for the operator to remember the pitch desired which is about the same as that of NCR TEST LEVEL, and to obtain a zero reading on the Frequency Indicator. When tuning is correct, the meter will read zero, and will swing to 100 on the right when the crystal vernier is rotated clockwise, and to 100 on the left when the vernier is turned counter-clockwise.

k. Turn the HFO control on the OSCILLATOR PANEL to OFF. Operate the INDICATOR CONTROL knob until the tuning indicator "eye" on Receiver A is almost closed. Trim MIXER, 2nd RF and 1st RF tuning controls for best sensitivity which is indicated by maximum closure of the "eye" on Receiver "A" panel. Repeat several times. It may be desirable to adjust the sensitivity control for the band being used to get the most sensitive indication on the tuning indicator. Do not readjust the tuning control on the ANTENNA Panel.

l. Repeat for Receiver B by connecting the SCR 211 Frequency Meter to Antenna II and repeat the line-up procedure.

m. Repeat on Receivers A & B for other Carrier Frequencies desired.

TABLE D

DIALING FUNCTIONS

| DIAL | FUNCTION | | |
|---|---|---|---|
| 1 | Band 1 | | |
| 2 | Band 2 | | |
| 3 | Band 3 | | |
| 4 | Band 4 | | |
| 5 | Band 5 | | |
| | ANTENNA | RECEIVER | CONDITION |
| 6 | IV | A | OPERATE |
| | I | B | OPERATE |
| 7 | III | A | OPERATE |
| | II | B | OPERATE |
| 8 | IV | A | MONITOR |
| | II | B | MONITOR |
| 9 | III | A | MONITOR |
| | I | B | MONITOR |
| 01 | POWER ON | | |
| 02 | POWER OFF (Except oscillator oven and | | |

3.2 Operation with VFO

Operation with the VFO is similar to the foregoing, except the slotted shaft on the OSCILLATOR Panel is set to its vertical position, and the oscillator is set initially in accordance with the chart on the right-hand side of the front door. The SCR 211 Frequency Meter is then connected to the set and a zero beat obtained with the BFO XTAL. The frequency is then increased by rotating the VFO control until the correct marking frequency is obtained. This adjustment may be somewhat difficult at the higher frequencies, but it will be found that the Vernier adjustment normally used for crystal tuning can be used for fine adjustments. Care must be taken not to get the VFO below the carrier frequency.

3.2a The correct adjustment may be found in various ways. One method is to turn off the BFO and find two points, where with no input to the set, noise is at maximum. The point where the tuning screw is most counter-clockwise is the correct point. Another method is to set the SCR 211 Frequency Meter to the desired frequency and turn the BFO to XTAL. Two points of zero beat will then be obtained when the VFO is adjusted, and the most counter-clockwise point is the correct one.

4. Alignment of IF at Spacing Frequency.

4.1 In most instances, the vibration occasioned in shipment will cause the adjustments of the IF transformers to change. Unless the IF circuits are restored to peak tuning, extremely poor performance of the overall receiver will result. It is imperative, therefore, that upon completion of RF tuning, the IF transformers shall be tuned.
Ordinarily, the trimming required to retune the transformers will be slight, but even these slight adjustments will materially effect the operation of the set.

4.2 THE FOLLOWING PROCEDURE SHALL BE FOLLOWED IN ALL INSTALLATIONS PRIOR TO ESTABLISHING RADIO CIRCUITS.

a. Receiver A. (Considering completion of all previous steps)

1. Couple the antenna of the SCR 211 set to the Antenna terminals of the AN/FRR3 set, Receiver A.

2. Set the high frequency oscillator and the BFO to XTAL position. Switch AVC to OFF. Reduce the sensitivity control to minimum. Switch Diversity OFF.

3. Adjust the frequency of the SCR 211 set to obtain an audible note, and adjust the frequency of the audible note to the spacing frequency 2975 cycles. (One method of obtaining the correct spacing frequency is to patch from RAD REC OUT to CH FILTS IN, and to patch from S CHF OUT to A-C METER. Slowly adjust the SCR 211 until maximum indication on the meter is obtained). Remove the patch cords and connect D-C METER to FREQ IND OUT and adjust by a small amount the Crystal Vernier Control to obtain zero indication on the meter. Turning the Vernier control clockwise should cause the frequency indicator meter needle to move toward the left. Adjust again for zero indication. This provides a frequency of 465.425 KC in the IF amplifier for line up purposes. This frequency is selected instead of 465 KC to help suppress the "audio image" (459.9 plus or minus 1 KC)

4. Connect a suitable AC meter such as that associated with the I-56 Test Set to the receiver output, (Ground and 600Ω) and obtain a suitable indication on the meter scale. Adjust the trimmer screws on the IF transformers L-106, L-107, L-108 and L-109, but not L-110 (which is part of the AVC amplifier circuit), to obtain maximum voltage indication.

5. Turn AVC switch to ON and adjust L-110 for minimum voltage indication on the meter.

6. Repeat Steps 4 and 5 for final line up. The overall performance of the system is dependent on the care taken in these adjustments. Having once aligned the IF amplifiers in accordance with the above for one band, it is unnecessary to change the adjustment when operating on other carrier frequencies.

b. Receiver B.

1. Connect the Antenna coupling to Receiver "B", and connect the output meter to the GND and 600 ohm taps on the output of Receiver "B". Repeat the same tuning procedure which was used on Receiver "A" to line up Receiver "B".

2. Disconnect AC meter and SCR 211 set.

5. Reception from Distant Station.

In first establishing radioteletype communication, there is usually no easy way to communicate directly with the distant station. It is desirable, therefore, to make as many local tests as possible before attempting overall communication. These tests include careful checks of both the transmitting and receiving facilities. The poling of the transmitting side is checked by sending a steady marking signal from the teletype equipment, observing the condition of the sending relay at the transmitter, and then zero beating the output of the frequency shifter with an SCR 211 frequency meter. Then a steady spacing signal is sent from the teletype equipment. The position of the sending relay is observed, and the SCR 211 is again set to zero beat.

If the marking frequency is higher than the spacing frequency, as it should be, it will be necessary to turn the SCR 211 dial very slightly in a counter-clockwise direction (toward the lower end of the scale) to get back zero beat on the spacing frequency. If the reverse condition occurs, there is a turnover which must be corrected. Care must be taken to correct this turnover at the right point. That is, all teletype equipment must be poled the same way at the Signal Center so that patches may be made at the loop switchboard without causing turnovers.

The steady spacing signal referred to above may be transmitted by stopping the TD motor, operating the armature of the starting magnet by hand, and then slowly turning the flywheel of the motor toward the right, as viewed from the front, until the brushes rest on the "Start" segment.

Similar tests should be made on the receiving equipment to insure proper poling. When the armature of the 255A relay in the AN/FGC1 terminal is held on the right side, the teletype set or reperforator should be "closed". When the armature is held on the left side, the reperforator should run "open".

In the case of a simplex circuit, or a duplex circuit when a monitoring receiver is available, it is usually desirable to send teletype signals out on the air, pick them up at the local receiver, and copy them with the receiving teletype equipment. If this cannot readily be done, local loop tests should be made at the Signal Center by patching the output of the sending teletype equipment to

the input of the receiving equipment.

The general test procedure, herein described, that of sending a signal on the proper frequency from an SCR 211 into the receiver may be further utilized in checking the positions of the various relays.

Finally, it is usually necessary to arrange by radiogram for overall tests. A good plan is to have the distant station send steady carrier (marking) for a specified period long enough to tune the receiver. During the testing period, the station call letters should be sent occasionally, since there may be a steady carrier on a nearby frequency which might be confused with the desired frequency. The radiogram should also specify that slow marks and spaces be sent for a short period following the steady marking signal. This is done so that the filter outputs, receiving relay current, and relay position in the AN/FGC1 Equipment can be checked. Finally, reversals, RY, or a test sentence should be transmitted.

The recommended test tape shall be: (Space) THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 ** SENDING (carriage return) (line feed) (space). Perforate a tape consisting of the above, repeated three times. Join the ends, and insert the endless tape in the TD set for test transmissions.
** Operator's initials.

When transmission is satisfactory in one direction on one frequency, similar action should be taken in the other direction. Finally, two-way communication may be established and the remaining frequencies lined up. It is undesirable, and confusion will result if both directions are simultaneously aligned, or if both directions shift to a different frequency at the same time. Try to maintain communication in one direction of transmission while tests or changes are being made in the other direction. If necessary, instructions may be sent "blind" because it will be known that personnel at the other end of the radio circuit are listening.

## 5.1 ANTENNA CONNECTIONS

Connect the pair of Diversity Antennas to be used to Antenna terminals I & IV. Dial "6" to connect Receiver A to Antenna IV and Receiver B to Antenna I. If reception is to be obtained from an additional point, connect the second pair of Diversity Antennas to terminals I and III.

5.2 RECEIVER A.

a. Dial Band desired.

b. Set BFO oscillator control to crystal (XTAL), AVC to ON, DIV to OFF.

c. Adjust the HFO XTAL Vernier Control until the frequency meter indicates zero, and REC. RELAY 1 current is positive (showing marking current). Turn XTAL Vernier counter-clockwise a small amount and note that frequency meter goes to left. Reset to zero.

NOTE: In general, it is probably undesirable to readjust trimmers on receivers or on front of antenna panel on signals from distant station.

d. However, the air condensers (on the rear of the ANTENNA TUNING Panel) which are accessible from the rear of cabinet should be adjusted. It may be found that the tuning indication on the receiver is more sensitive with the BFO in the "OFF" position. The adjustment of these trimmers is rather critical, but when correct, will show a marked improvement in signal as noted on the tuning indicators of the respective receivers. (Whether tuning should be attempted with signals from the distant station depends on the rate of fading which is experienced. If the signal is fading rapidly, it is impracticable to obtain satisfactory trimming).

e. Turn AFC knob in AN/FGC1 cabinet to OFF. Press AFC DISCHG button momentarily. Wait a few seconds for frequency to stabilize.

f. Set BFO oscillator control to BFO and adjust BFO trimmer screw until zero beat is obtained. Turn the trimmer clockwise until an audio tone of 2125 cycles is obtained as indicated by the Frequency Indicator.

NOTE: Turning BFO trimmer clockwise a small amount will cause the frequency indicator meter to indicate toward the left. Readjust to zero on Frequency Indicator.

g. Turn AFC knob in AN/FGC1 cabinet to ON and note that the Frequency Meter indicates about zero. Assuming

that the AFC leads have been properly poled in the initial procedure, a high meter reading indicates that the BFO is improperly adjusted.

h. Calibrate AFC circuit in accordance with Paragraph 9 i (1) (e) of TM 11-356.

5.3 ADJUSTMENT FOR DIVERSITY RECEPTION AND FOR PROPER AUDIO OUTPUT.

a. With AVC "ON", DIV "OFF", and the sensitivity controls of both receivers advanced to maximum clockwise positions, measure the audio outputs of both receivers while listening to the distant station as it sends a steady "mark". Be certain that the AUDIO LEVEL controls are on the same step. Measure as follows:

1. Patch AC METER to RAD REC OUT jacks of both receivers and note the difference in levels.

2. Operate the Diversity Switches on both receivers to DIV "ON", and again note the audio output levels. If the outputs do not differ by more than 6 db, no further adjustment of the sensitivity control is required.

NOTE: A quick way to determine the number of degrees on the meter scale which equal 6 db, is to read the output of the receiver on the 1st audio step. Then, advance the Audio Level to the 2nd step. Since each audio step equals very nearly 6 DB, the change in reading on the AC METER will equal 6 DB. i.e. If on Step "one" the reading is 4, and on Step "two" the reading is 9, then 6 db is represented in the range 4 to 9.

3. If the difference is greater than 6 db, readjust the Sensitivity Control on the Receiver having the higher level until it is within the 6 db requirement. It is undesirable to operate with one receiver set at maximum sensitivity and the other receiver at a point near minimum sensitivity. If this occurs, it indicates an unbalanced condition, and the alignment of the RF portion of the receiver having the poorer sensitivity should be checked.

4. Adjust the individual audio outputs to obtain an average reading in RAD REC OUT corresponding to that obtained on NORMAL TEST LEVEL. THE SETTINGS OF THE AUDIO

LEVEL POTENTIOMETERS SHALL NOT DIFFER BY MORE THAN ONE STEP.

NOTE: When operating in Diversity, the two receivers must have a similar overall performance. If the receivers are more than 6DB apart, one of the sets will probably never contribute to reception and will, in fact, adversely effect the operation of the system.

6. MARK AND SPACE TURN-OVERS

One of the features of the Radio Teletype System is its symmetry. Except for the arbitrary designations "Mark" and "Space", there is no difference between the two conditions used for signalling.

If, however, a turn over occurs at some point in the circuit, marks and spaces will be reversed and unintelligible copy will be received. This could be corrected at any other point in the circuit as far as transmission results are concerned, and occasionally, it may be necessary to operate temporarily in this manner. Such operation will, in the long run, cause excessive confusion and make extra work for those in charge.

In a circuit where a turn-over can occur at any one of five points, there are 32 possible correction points, only one of which is the correct one. It isqquite improbable; therefore, that the correct arrangement will be found by random experiment. When difficulty is experienced, it is generally desirable to check each point.

In case of doubt, ask the transmitting station for a mark. Operate on manual BFO and adjust until marking detector current is received and the Frequency Indicator Meter indicates zero.

Increase the frequency of the BFO oscillator (Turn the screw counter-clockwise) and note whether the audio frequency is lowered or raised and the corresponding action of frequency indicator meter. Consult Table E to determine if BFO is below or above IF.

If the frequency of the BFO is above IF, retune the BFO until the signal is tuned in with the BFO below the IF.

Increase the frequency of the BFO by adjusting its vernier control, and from Table E, determine whether the BFO is above or below the carrier frequency. Except for an error in crystal frequency, it is

very improbable that the HFO will be below the listening frequency. If this should occur, however, it will be necessary to operate with the BFO above the IF frequency or to turn over the outputs of the detectors.

If the above tests indicate that the HFO is above the desired frequency, and that the BFO is below the IF frequency, ask the transmitting station to send a space signal and note the REC REL CURRENT.

If the marking and spacing currents correspond to those transmitted, the turn-over, if any, must exist in the DC portion of the receiving circuit.

If they do not correspond, the turn-over is at the transmitting end and may be due to improper connections to the keying equipment.

TABLE E

Condition - Receiving Marking Frequency

| HFO | BFO | HFO | BFO | IF | AUDIO FREQ. IND. |
|---|---|---|---|---|---|
| Above Carrier | Below IF | Fixed | Increase | Fixed | ← → |
| " | Above IF | " | " " | " | → ← |
| " | Below IF | Increase | Fixed | → | → ← |
| " | Above IF | " | " | → | ← → |
| Below Carrier | Below IF | Fixed | Increase | Fixed | ← → |
| " | Above IF | " | " " | " | → ← |
| " | Below IF | Increase | Fixed | ← | ← → |
| " | Above IF | " | " | ← | → ← |

→ Indicates increase in frequency or reading of frequency indicator.

← Indicates decrease in frequency or reading of frequency indicator.

Fixed-Indicates steady frequency

Increase - Turn adjustment in direction to increase frequency.

7. Note on Diversity Operation

With space diversity operation, two duplicate channels are used at the receiving end. The system will work, although in an inferior manner, if for some reason one channel becomes disabled. For example, one tube might become weak, a stage become detuned, or by mistake the sensitivity control of one receiver might be left at a low setting. It is desirable, therefore, to listen to the outputs of the two receivers occasionally to find out if they are similar. Another test which may be useful is to watch the received copy while disabling first receiver A and then receiver B and note that copy is similar in each case. This, of course, is not advisable on a working circuit.

8. Bias

The bias tolerance of the overall system in about 35%. That means that the transmitting end might introduce 5%, the receiving equipment 5% and the air path add 25% of bias. It will be recognized that bias should be kept as low as possible in order to cope with radio conditions which often rapidly change from ideal to poor.

If the cumulative bias is not kept within close limits, for example ± 5%, inferior operation will result during those periods which occur each day when signals start to become weak and spotty.

THE DESIRABILITY OF REMOVING BIAS CANNOT BE OVER-EMPHASIZED.

9. Remote Control

For control of the equipment from a remote point, connect a two wire line (telephone, telegraph, etc.) of NOT MORE THAN 950 OHMS RESISTANCE to the two terminals marked CONTROL LINE on the rear of the REMOTE CONTROL chassis. Short circuit the far end of this line and connect an ohm meter in series with the line at the receiver. Remove the plug button on the front of the REMOTE CONTROL panel and set the screw driver adjustment for a total line resistance of 950 ohms.

Connect the remote end of this land line to the auxiliary dial control box to be used at the Signal Center.

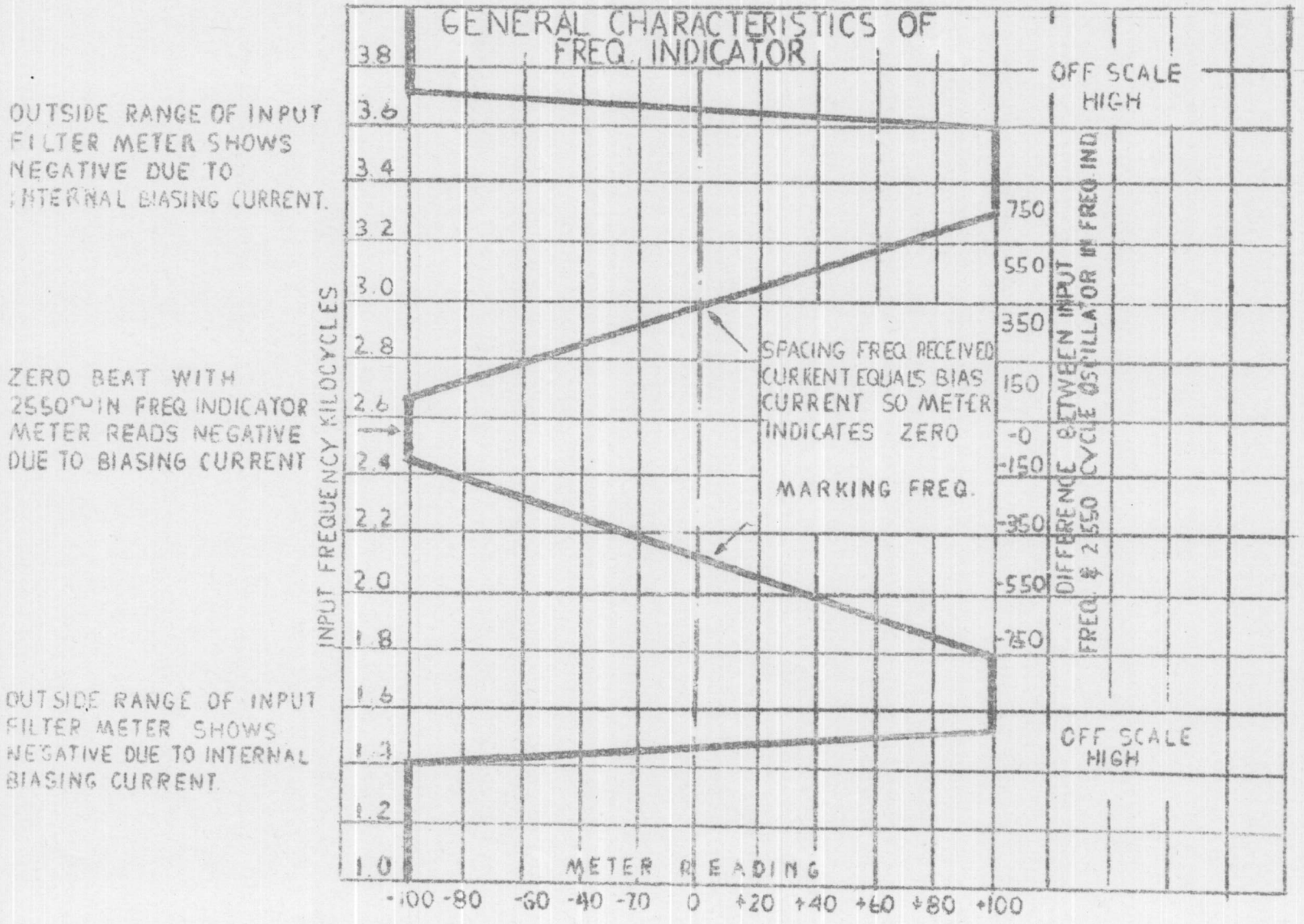
The control key switch for the associated transmitter may be used to disable the AN/FRR3.

10. Emergency Operation

Occasionally some part of the system will not function as desired. In this event, there is ample opportunity for the use of judgment and ingenuity. Quite frequently, a way will be found to maintain service, for the equipment has been designed for flexibility of operating circuits.

The attached Chart B gives recommended procedure which may be used as a general guide in work of this type.

Other similar arrangements will occur to those in charge of stations and it may be found helpful if they would tell their associates at other points of arrangements used with satisfactory results. Suggestions relative to improved operation should be forwarded to Plant Engineering Agency, SPSLP-33, Philadelphia, Pa., where they will be reviewed and published if they are of merit.


GENERAL CHARACTERISTICS OF FREQ. INDICATOR
OUTSIDE RANGE OF INPUT FILTER METER SHOWS NEGATIVE DUE TO INTERNAL BIASING CURRENT.
ZERO BEAT WITH 2550~ IN FREQ INDICATOR METER READS NEGATIVE DUE TO BIASING CURRENT
OUTSIDE RANGE OF INPUT FILTER METER SHOWS NEGATIVE DUE TO INTERNAL BIASING CURRENT
INPUT FREQUENCY KILOCYCLES
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
SPACING FREQ RECEIVED CURRENT EQUALS BIAS CURRENT SO METER INDICATES ZERO
MARKING FREQ.
OFF SCALE HIGH
750
550
350
150
-0
-150
-350
-550
-750
DIFFERENCE BETWEEN INPUT FREQ & 2550 CYCLE OSCILLATOR IN FREQ IND.
OFF SCALE HIGH
METER READING
-100 -80 -60 -40 -20 0 +20 +40 +60 +80 +100

## Section IV - Transmitting Station

### 1. General

1.1 This section of the specification covers the installation of the exciter for the transmitter of a Radioteletype system.

1.2 In most instances, the transmitters which are presently operating on CW service will be converted to two-frequency signalling. Adapting the new exciter may be compared with the installation of the familiar Meissner Signal Shifter.

1.3 The "two-frequency" exciter, FS-12A (Signal Corps #O-5FR) has been designed to be mounted adjacent to the transmitter, and to be rack or table supported. It is arranged to provide excitation for any one of three transmitters individually on any one of three frequencies. Switching of crystals is accomplished by means of a three position switch located on the front panel. A pin-jack transfer of output power to three coaxial sockets is available from the rear of the exciter. 70 ohm coaxial cables conduct the power from the exciter to the transmitters.

1.4 Primary power requirements.

| | |
|---|---|
| 125 | watts |
| 110/220 | volts |
| 50/60 | cycles, single phase |

Sketch TT-1S is a block diagram which portrays the electrical arrangement of the FS-12A.

1.5 Exciters may be installed on the basis of one per circuit or one per frequency assigned per circuit. For example, if station X has a single transmitter, and three frequencies have been assigned, one exciter and three crystals will be supplied. The operator will then calibrate and log the settings for each frequency and when shifting from one frequency to another will merely retune the exciter to the predetermined dial settings. If on the other hand, station Y operates two or more transmitters simultaneously, one exciter may be supplied for each transmitter. The exciters are then permanently aligned and permanently connected to their respective channels.

1.6 There are two general types of transmitters with which the exciter may be used;

a. Multi-channel types such as Wilcox 96C and Federal FT-300. Several channels are supplied to be individually aligned to a specific frequency. A common power supply and

modulator unit is provided.

b. Single unit type such as BC-642 and BC-339, wherein retuning (automatic or manual) is required for the various frequencies.

With arrangement a the CW controls of the channels used for a given circuit must be switched or paralleled.

1.7 Range

The output of the exciter is between 2 and 6 megacycles. However, all Signal Corps transmitters except the Federal Type FT-300 are designed for operation with crystals in the 2 to 4 megacycle range. Therefore, in order to satisfactorily resonate the stage in the transmitter which receives its excitation from the frequency shifter, the driving power must be within the regular oscillator frequency range. When computing the crystal frequency, the above must be considered.

1.8 Computation of Crystal Frequency

a. Frequency shifting takes place in a 200 KC self excited oscillator which is coupled thru a balanced modulator to additively mix this frequency with that of the crystal oscillator.

b. Solving for crystal frequency.

If we consider $f_x$ as the crystal frequency, then,

$f_x$=(assigned frequency plus 425 cycles) ÷ (multiplier) - (200 KC)

(or)

$$f_x \pm 200 \text{ KC} = \frac{\text{assigned frequency} \pm 425 \text{ cycles}}{1 \text{ or } 2 \text{ or } 4 \text{ or } 8}$$

Example: Assigned frequency 15821 kc
(transmitter requires 2 to 4 mc excitation.)

Solution: $f_x = \frac{15821 \text{ kc} \pm 425 \text{ cycles}}{4} - 200 \text{ KC}$

$$f_x = \frac{15821.425}{4} - 200$$

$f_x$=3955.356 - 200

$f_x$=3755.356 KC

c. In the case of the Federal transmitter, type FT-300 where crystals up to and including 6 MC are normally used, it will be necessary to compute the exciter's output frequency to this higher frequency. Also, for frequencies between 15.3 and 20 MC, tripling is performed and the divisor in the above formula is then 3.

d. The 200 KC oscillator referred to in Paragraph 1.8a is tunable over a range of plus or minus 1 KC. Therefore, when ordering crystals for this unit, it will be necessary to carry out the division to the nearest tenth of a KC only.

e. The amount of frequency shift may be adjusted by means of the calibrated control on the panel. Normal carrier shift of 850 cycles is desired. When excitation is being supplied at a sub-harmonic frequency, the amount of shift in the exciter is being multiplied by the number of doubling operations performed by the transmitter. This must be considered when setting up the frequency shift control. For one doubling operation, the exciter shall be set for 425 cycles shift, for two doublers, it shall be set at 212 cycles, for 8 multiplications at 106 cycles, etc.

f. In all exciters after Serial #90, a .01 mfd condenser is included in series with L5, and the coaxial conductor.

g. IT IS DIRECTED THAT TRANSMITTERS SHALL BE MODIFIED IN ACCORDANCE WITH DIRECTIONS IN ORDER THAT RAPID CHANGE-OVER TO CW MAY BE ACCOMPLISHED IN THE EVENT OF FAILURE OF THE FS/12A.

2. Sketches Attached

| | |
|---|---|
| Sketch TT1M | Exciter-Transmitter Connections |
| Sketch TT1S | Block Diagram of Exciter Arrangement |
| Sketch TT1V | Modification Details for PW Transmitters |
| Sketch TT1U | Exciter-Transmitter Connections |
| Sketch TT1W | Modification Details for BC-339 Transmitters |
| Sketch TT1T | Modification Details for Collins BC-642 Transmitters |
| Sketch TT1X | Modification Details for Aircraft Accessories Corp. Models T4/FRC and T5/FRC. |

## 3. Installation

3.1 Somewhat different modification kits are supplied for the various types of Signal Corps transmitters, and therefore, a separate installation procedure is furnished with the kit for the specific application. The following information has been prepared to supplement the above specifications.

3.2 Press Wireless Transmitters

In all cases, the excitation is fed directly into the grid of the 807 buffer tube. Since a capacitor is already provided in series with this lead, and is located within the buffer-keyer chassis proper, no external isolation is required.

a. PW 2.5 A (Sketch TT1V, Fig. 1, and TT1J, Note 5)

Adapter Kit contains:

1 ea. Length of coaxial cable, 6', terminated at one end with a SO-39 coaxial socket, and at the other end in a banana plug on the inner conductor, and a soldering lug on the shield.

1 ea. Bracket, for mounting the SO-39 fitting.

1 ea. Banana type socket.

1 ea. Banana plug. (in addition to the one mentioned above)

1 ea. Kit of nuts and screws.

Installation

Measure a point on the lower left side plate, 4" from the rear and 3" above the bottom of the panel. Cut a 1½" hole, mount the SO-39 socket, and run the length of coaxial line as indicated in Sketch TT1V, Figure #1.

Remove the lead which now interconnects the crystal oscillator oven and the buffer stage from the stand-off insulator. Tighten the nut on the insulator's terminal and screw thereon the special banana socket. Replace the lug on the wire just removed with a special banana plug.

Note: This arrangement facilitates change-over from shift frequency to normal CW operation.

The 110-220 volt switch in the exciter shall be placed in the 220 volt position, and the power cable shall be connected to terminals 53 and 54 on the transmitter's #2 Terminal Board.

Terminal #56 on #2 Terminal Board shall be connected to #5 terminal on the exciter. #8 terminal on the exciter is not used. The lines from the Signal Center are connected through the 63-C-2 jack box to terminals 2 and 4, as indicated in Sketch TT1V, Figure 1.

Cut a length of 5/8" coaxial cable sufficiently long to neatly interconnect the exciter and the transmitter, affix and solder the coaxial plug fittings and complete the circuit.

b. P.W. 15A (Sketch TT1V, Fig. 2, and TT1U, Note 5)

Adapter Kit contains:

1 ea. Coaxial socket, type SO-39.

1 ea. Bracket, for mounting the SO-39 socket.

1 ea. Special banana type socket.

2 ea. Special banana type plugs.

1 ea. Kit of nuts and screws.

Installation:

Measure a point on the left side plate of the transmitter, 25" from the front and 31½" from the base, and cut a 1½" hole. See Sketch TT1V, Figure #2. Mount the SO-39 socket and to its center contact, solder a 15" length of insulated wire. (Hook-up wire is satisfactory.) To the other end of this wire, solder one of the banana plugs.

Remove the lead which interconnects the oscillator oven and the buffer stage from the stand-off insulator on the buffer-keyer chassis, and replace its lug with the other banana plug. Tighten the nut on the insulator from which the wire has been removed, and screw on the special banana type socket.

The 110-220 volt switch in the exciter shall be placed in the 220 volt position, and the power leads connected to terminals A and B on the main switch of the transmitter. Terminal #44 on Transmitter Terminal Board #1 is connected to exciter Terminal #5.

Terminal #8 on the exciter is not used.

The lines from the Signal Center are connected through the 63-C-2 jack box to Terminals 2 and 4 on the exciter, is shown in Sketch TT1V, Figure 2.

c. P.W. 40A (Sketch TT1V, Figure 3, and TT1U, Note 5)

Adapter Kit contains:

1 ea. Length of coaxial cable terminated at one end with a SO-39 coaxial socket, and at the other end with a special banana plug on the center conductor, and a soldering lug on the outer shield.

1 ea. Banana plug (in addition to the one listed above)

1 ea. Banana socket.

1 ea. Bracket (for mounting the SO-39)

1 ea. Kit of nuts and screws.

Installation

Measure a point on the left side panel of the rectifier compartment 18" from the front of the transmitter and 30" from the base. Cut a 1½" hole, mount the SO-39 socket, and run the coaxial line as indicated in Sketch TT1V, Figure #3.

Use the same procedure in completing the installation as that described for adapting the P.W. 15A, except that the keying terminal #50 on Transmitter Terminal Board #3 is connected to the #5 screw on the exciter terminal strip.

3.3 Federal, Model BC-339 series (Sketch TT1W and TT1U, Note 5)

Adapter Kit contains:

1 ea. Link assembly, comprising an 18" length of twisted pair terminated at one end in a coaxial socket (SO-39), and at the other end in an FT-164 type adapter containing a .001 mfd condenser.

1 ea. Bracket for mounting the SO-39 socket.

1 ea. Kit of nuts and screws.

Installation

Measure a point on the upper left side panel, 8-1/4" above its bottom and 13" from the front of the transmitter. (See Sketch TT1W). Cut a 1½" hole and mount the coaxial fitting. Plug the FT-164 type adapter into the #1 crystal mounting clips, being certain that the black tipped end of the adapter is inserted in the clip on the right marked "crystal #1."

Note: If the adapter is reversed, the RF excitation voltage will be short-circuited.

The 110-220 volt switch in the exciter shall be placed in the 220 volt position, and the power cable shall be connected to terminals 1 and 2 on the rear terminal board of the transmitter. Terminals 8 and 9 on this same board shall be connected to terminals 4 and 8 respectively on the exciter terminal strip; connect terminals 2 and 4 on that strip. Cut the 5/8" coaxial cable to the proper length, solder the coaxial fittings to the ends, and interconnect the exciter and the transmitter.

3.4 Federal BC-340 See Paragraph 3.3 (Sketch TT1W)

3.5 Collins - BC-642 (Sketch TT1X, Fig. 1 and 2, and Sketch TT1M)

Adapter Kit contains;

3 ea. Plug-in adapters (similar to FT-249 crystal holders)

Installation

Cut a slot 3" x 1" in the rear panel of the exciter section of the transmitter directly back of the crystal oscillator location.

Mount the exciter or the rack of exciters immediately adjacent to the transmitter, and cut three lengths of 5/8" coaxial line sufficiently long to reach from the exciter, through the slot in the rear of the transmitter, to the crystal sockets. (Leave sufficient slack so the cables may be lashed to the transmitter frame to prevent internal short-circuiting.)

Solder the special 3 pin adapter to one end (center conductor to the single pin, (#2), outer conductor to the pin on the right (#3), looking at the bottom of the plug.)

To the other end, solder the SO-39 plug, center conductor to the center contact, outer conductor to the shell.

Connect the power cable to the live side of the main switch being certain that the 110-220 volt switch in the exciter is in the 220 volt position.

Full automatic control is available by dial operation, and Terminal #3 on unit B1 may be picked up for CW keying. Interconnect as shown in Sketch TT1X.

3.6 Wilcox Transmitters

a. Wilcox 96A (Sketches TT1M and TT1U)

Adapter Kit contains:

1 ea. SO-39 coaxial socket.

1 ea. Bracket for SO-39.

1 ea. 3/8" coaxial plug and socket

1 ea. Length of 3/8" coaxial line

Installation

Cut a 1½" hole in the rear of the transmitter directly in line with the crystal oscillator location, and mount the SO-39 socket. Drill a small hole in the oscillator chassis proper, adjacent to the 2nd 1852 stage and mount the smaller coaxial socket. Interconnect the SO-39 and the coaxial plug, and complete the plug-in circuit.

Remove the 1852 oscillator tube, and solder a .01 mfd condenser between the inner conductor of the coaxial socket and the grid of the 2nd 1852 tube. (If exciter Serial Number is above 90, solder a wire instead of the condenser between these points.)

Cut a length of 5/8" coaxial cable sufficiently long to interconnect the exciter and the transmitter, and solder to each end a 5/8" coaxial plug.

Set the 110-220 volt switch in the exciter to the 220 volt position, and connect the power cable to the line side of Switch #11.

Repeat this procedure for each of the channels.

Terminal 4 on the transmitter is the channel control and terminal 5 is the CW keying terminal.

Complete the wiring in accordance with Sketch TT1M or TT1U.

b. Wilcox Model 96C (Sketches TT1M and TT1U)

Adapter Kit contains:

1 ea. Prefabricated kit of telescoping tubing, conduit connectors, nipples, brackets, coaxial conductors and fittings, and hardware.

1 ea. Jones plug P-101

1 ea. Jones plug S-101

1 ea. Socket adapter containing a variable input control.

1 ea. Drawings, set of three

Installation

Facing the rear of an RF channel, measure a point 6-1/4" above the base of the unit and 6-5/32" from the left side. Using Wilcox Drawing #189 as a guide (not as a template), locate the bracket bolt connections. Drill the 7/8" hole and the three smaller ones, and mount the 80-39 coaxial socket, the box, the coaxial line, and the conduit. (See Wilcox Drawings #187 and 198.) Remove tube V-1 and insert the adapter in its place.

Repeat this procedure on each of the channels.

Mount the exciter or the rack of exciters immediately adjacent to the left end of the row, and interconnect each exciter with its respective channels with individual lengths of 5/8" coaxial cable to each end of which a coaxial fitting shall have been connected.

In addition, terminals #9 (transmitter control) and #10 (CW keying terminal) shall be wired to the respective exciters, and the Signal Center lines, as indicated in Sketch TT1M or TT1U.

Improved operation will result if the excitation controls in the exciters are advanced to "maximum" and the condensers in the plug-in adapters are adjusted for normal operating meter readings.

3.7 Aircraft-Accessories Corp. Transmitters, types T4/FRC & T5/FRC

Remove the front duct cover as noted in Sketch TT1X.

Attach the coaxial plug, supplied by the contractor, AAC number A-62414-1, Signal Corps number PL 259, to the low impedance coaxial line from the teletype exciter, and plug into the receptacle, noted on Sketch TT1X, of the unit to be used. From the plug board receptacle, the R.F. voltage is carried up to the oscillator by the flexible coaxial cable which plugs into the oscillator.

Turn the Master Oscillator - Xtal. - Tel. switch on the left side of the center panel of the R.F. unit to "TEL." This connects the grid of the 6V6GT/G crystal oscillator - doubler tube (VT15) to the center of the coaxial line.

Connect the control line to the "microphone local connect" terminal, and complete the circuit to terminal #5 on the exciter.

After following the above procedure tune the R.F. unit to the selected frequency. Repeat this sequence for each channel to be placed in service.

4. Tuning Procedure

4.1 Insert the crystals in the sockets in the temperature controlled oscillator chamber, starting with the lowest frequency in number 1 position. Close the oven door and energize the equipment. A period of about two hours will be required for the oven and its contents to reach the normal operating temperature, and for the oscillator components to stabilize themselves. (Complete stability will not be reached until the oven has been heated for several days. During this preliminary period, constant checks should be made to correct for drift.) The oven thermostat has been factory set at 55°C. This adjustment may be altered under extreme climatic conditions by advancing or retarding the knob control located on the upper left side panel inside the oven. Each notch equals approximately 1/2° C.

4.2 While the exciter is heating, the stations' frequency meter should be warmed up, and set according to the following formula:

$$\frac{\text{Carrier frequency plus 425 cycles}}{\text{No. of multiplications}}$$

Set the 200 KC Oscillator Control at 50°, the Crystal Selector Switch on #1 position, and rotate the Shift Control to 0°. Refer to the tuning chart and set the remaining tuning controls to the settings indicated for the desired frequency.

Note: The output of the exciter will be on a frequency equal to the crystal frequency plus 200 KC, plu 1/2 desired shift.

4.5 Carefully adjust the controls marked "Sideband" and "Amplifier" until the 6E5 "tuning eye" tube which is used as a resonance indicator is tightly closed.

4.4 It is possible to tune the mixer and amplifier to either sideband of the desired frequency, (plus or minus 200 KC of the crystal frequency). Due to the rejection circuits, it will never be possible to completely close the "eye" if the circuits are resonated on either the crystal frequency or the lower sideband.

4.5 With the frequency meter adjusted to the exact desired exciter frequency, rotate the 200 KC oscillator tuning control until the signal is zero beat. Log this setting.

4.6 Apply plate voltage to the low power stages of the transmitter and resonate. Note carefully the grid current of the stage being excited and that of the succeeding stage. If the grid current for "key-down" conditions is abnormal, return to the exciter and adjust the 807 screen grid potentiometer until normal driving power is obtained.

4.7 Refer to Fig. #3 and determine the amount of shift necessary to produce 850 cycles at carrier frequency and rotate the shift control to the calibration representing this value.

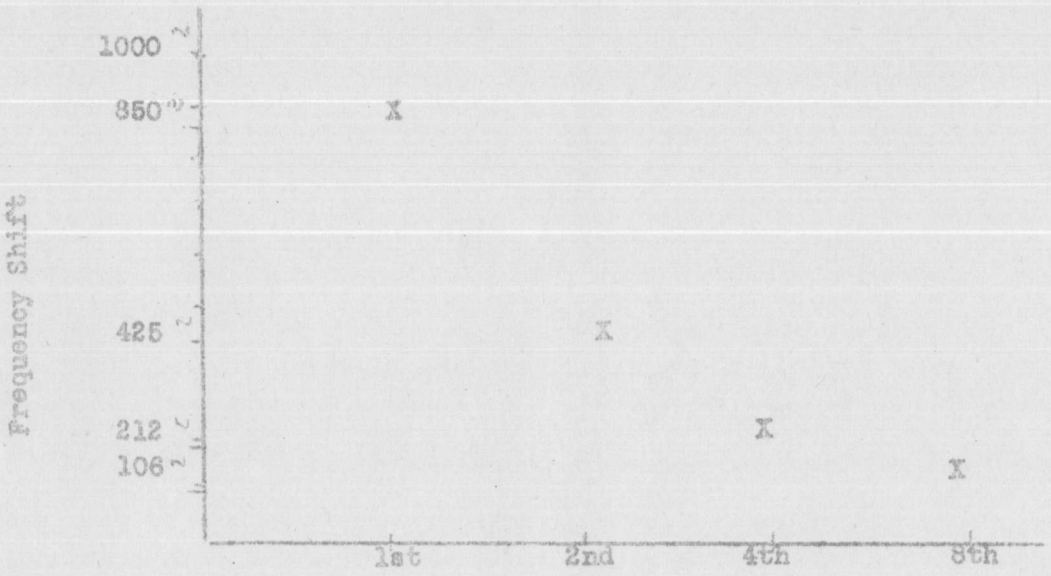
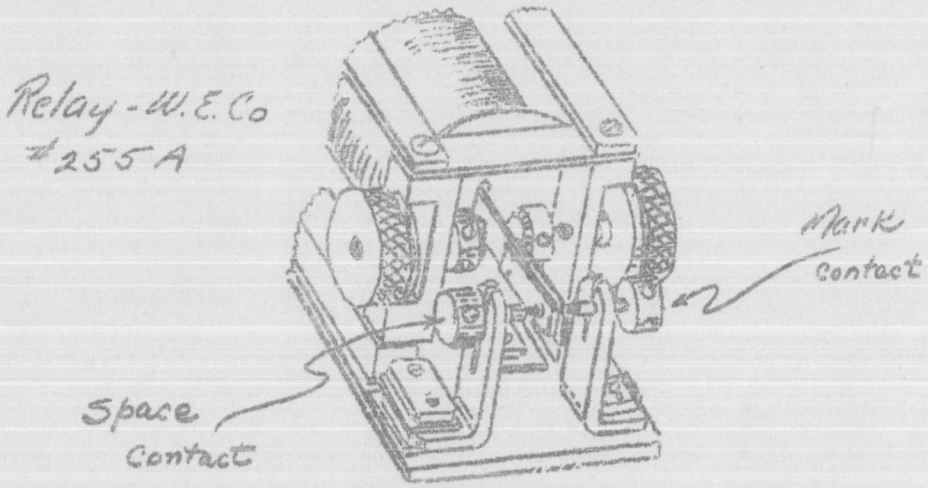



Table of frequency shift control settings for harmonic operation.

Fig. #3

4.8 Remove the cover from the 255A relay, and carefully move the armature to the contact on the left. (See Fig. #4) This operation will cause the carrier frequency to shift lower, and the installer shall measure the differential value to be certain that the carrier is shifting 850 cycles.




4.9 All of the transmitter's meters will remain unchanged on the new frequency, the slight detuning being insufficient to effect the adjustments.

5. Final Adjustment

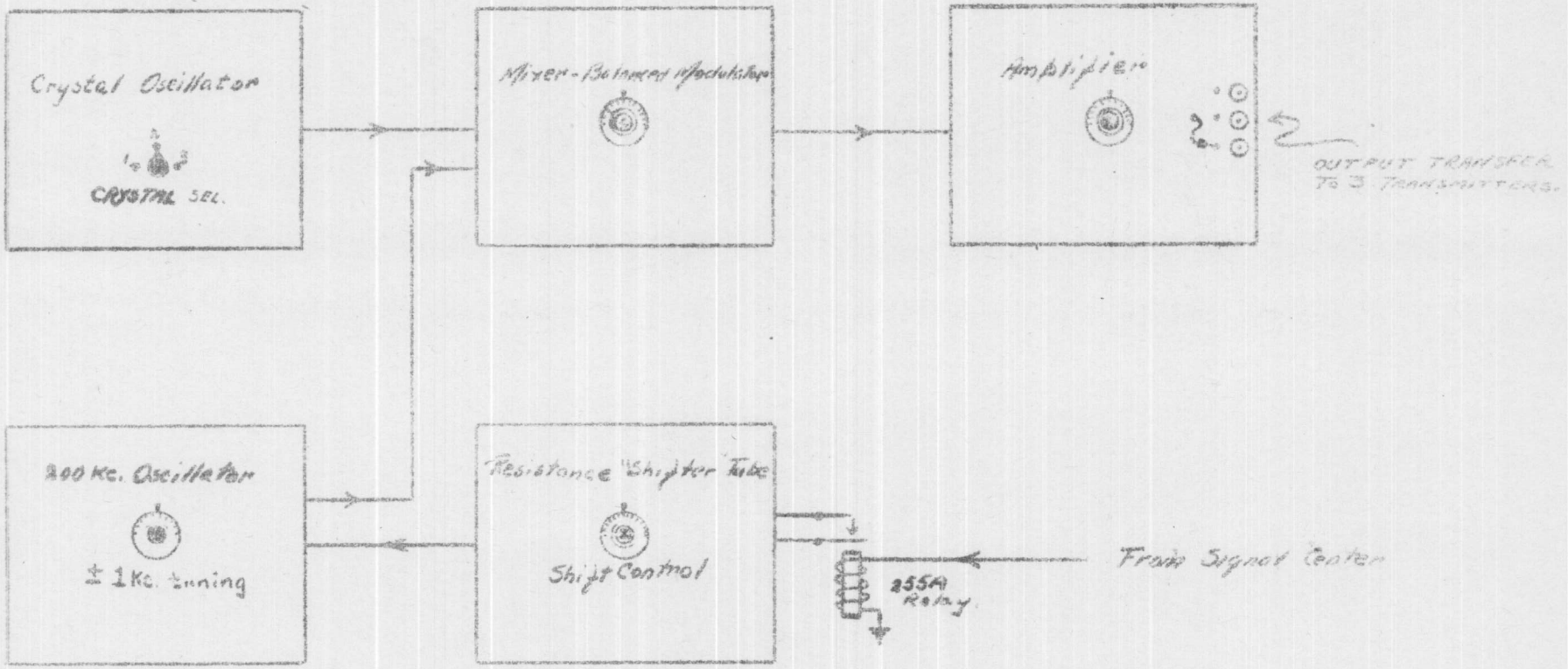
Since the frequency meter on hand will not be fully adequate to tune the exciter to the exact frequency, a certain amount of checking with the distant receiving station will be required. The receiver is also crystal controlled, and operating tolerance is critical. Once the exact position of the 200 KC oscillator tuning control is determined for each frequency, the calibration should be logged on the frequency chart for ready reference.

Overall bias tests can be made by using an I-193 test set at the Signal Center to send reversals over the loop to the transmitter and measured with the meter on the terminal equipment at the receiver location. The I-193 set can only be used where a polar relay transmits the signal to the radio transmitter.

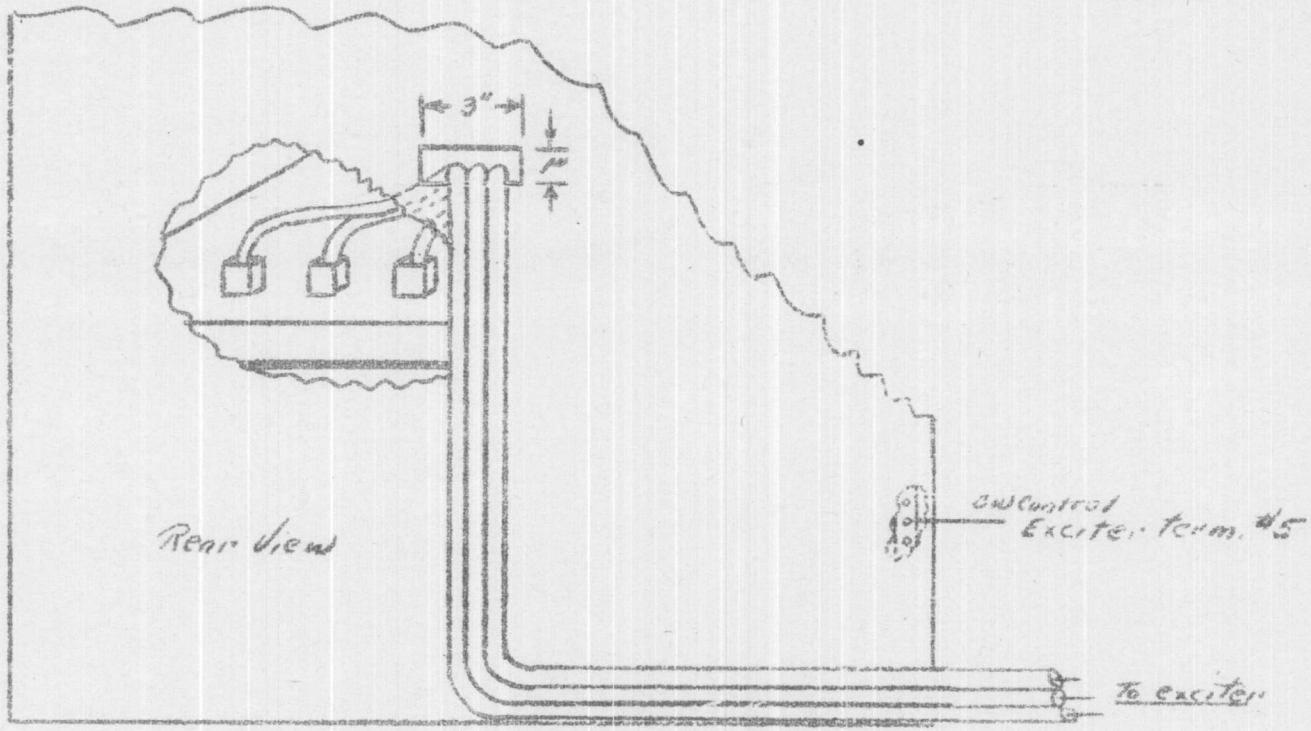
Therefore, the test set shall be patched into the 63-C-2 jack box, and the repeater in the 132A2 set utilized to provide the proper line currents.

## WEIGHTS AND CUBES OF MAJOR RADIOTELETYPE STATION EQUIPMENT

| Item | Class of Shipment | No. of boxes per Item | Largest Box | Total Weight | Total Displacement |
|---|---|---|---|---|---|
| Teletypewriter, Model 15 | air | 8 | 25" x 25" x 23" | 316 lbs. | 25 cu. ft. |
| | export | 2 | 49" x 26" x 30" | 430 lbs. | 35 cu. ft. |
| Teletypewriter, Model 19 | air | 9 | 40" x 26" x 30" | 639 lbs. | 46.7 cu. ft. |
| | export | 4 | 47" x 27" x 27" | 775 lbs. | 59.1 cu. ft. |
| Sub Set, W. E. 131-B2 | air | 3 | 27" x 24½" x 35½" | 299 lbs. | 16.3 cu. ft. |
| | export | 3 | 29" x 26" x 34¼" | 394 lbs. | 22.1 cu. ft. |
| Sub Set, W. E. 132-A2 | air | 3 | 38" x 29" x 32" | 652 lbs. | 35 cu. ft. |
| | export | 3 | 38" x 29" x 32" | 652 lbs. | 35 cu. ft. |
| Sub Set, W. E. 133-A1 | air | 3 | 38" x 29" x 32" | 492 lbs. | 32 cu. ft. |
| | export | 3 | 38" x 29" x 32" | 492 lbs. | 32 cu. ft. |
| Receiver AN/FRR3 | air | 3 | 88" x 21" x 28" | 1100 lbs. | 55.0 cu. ft. |
| | export | 3 | 88" x 21" x 28" | 1175 lbs. | 55.6 cu. ft. |
| Receiver Wilcox CW-3D | air | 7 | 26½" x 21" x 76" | 542 lbs. | 40.7 cu. ft. |
| | export | 7 | 26½" x 21" x 76" | 542 lbs. | 40.7 cu. ft. |
| Terminal AN/FGC1 | air | | 88" x 21" x 28" | 590 lbs. | 29.9 cu. ft. |
| | export | | 88" x 21" x 28" | 636 lbs. | 30 cu. ft. |
| Exciter O-5/FR | air | 1 | 16" x 16" x 25" | 138 lbs. | 6.35 cu. ft. |
| | export | 1 | 16" x 16" x 25" | 138 lbs. | 6.35 cu. ft. |

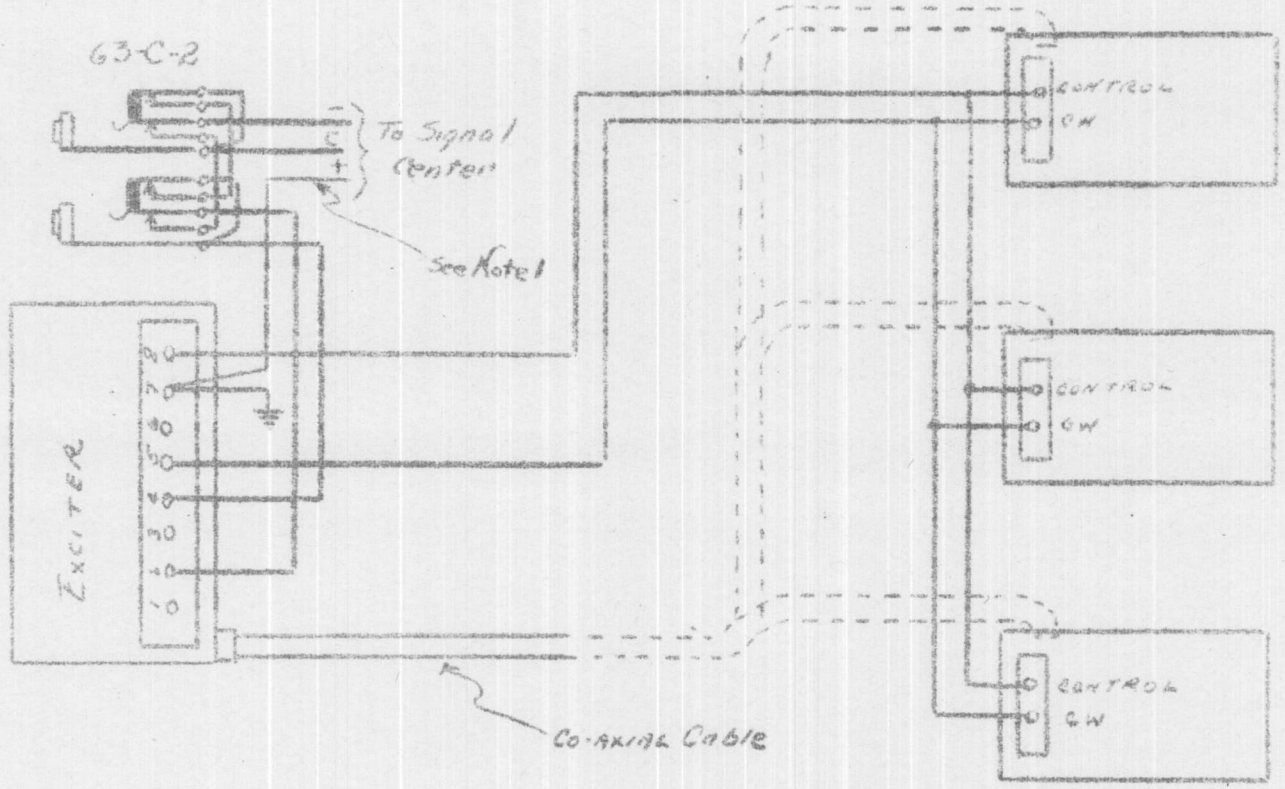



BLOCK DIAGRAM SHOWING SEQUENCE OF OPERATIONS OF FS12A (0-5/TR FREQUENCY SHIFTER)




MODIFICATION OF COLLINS BC-642 FOR USE WITH
O-5/FR FREQUENCY SHIFTER

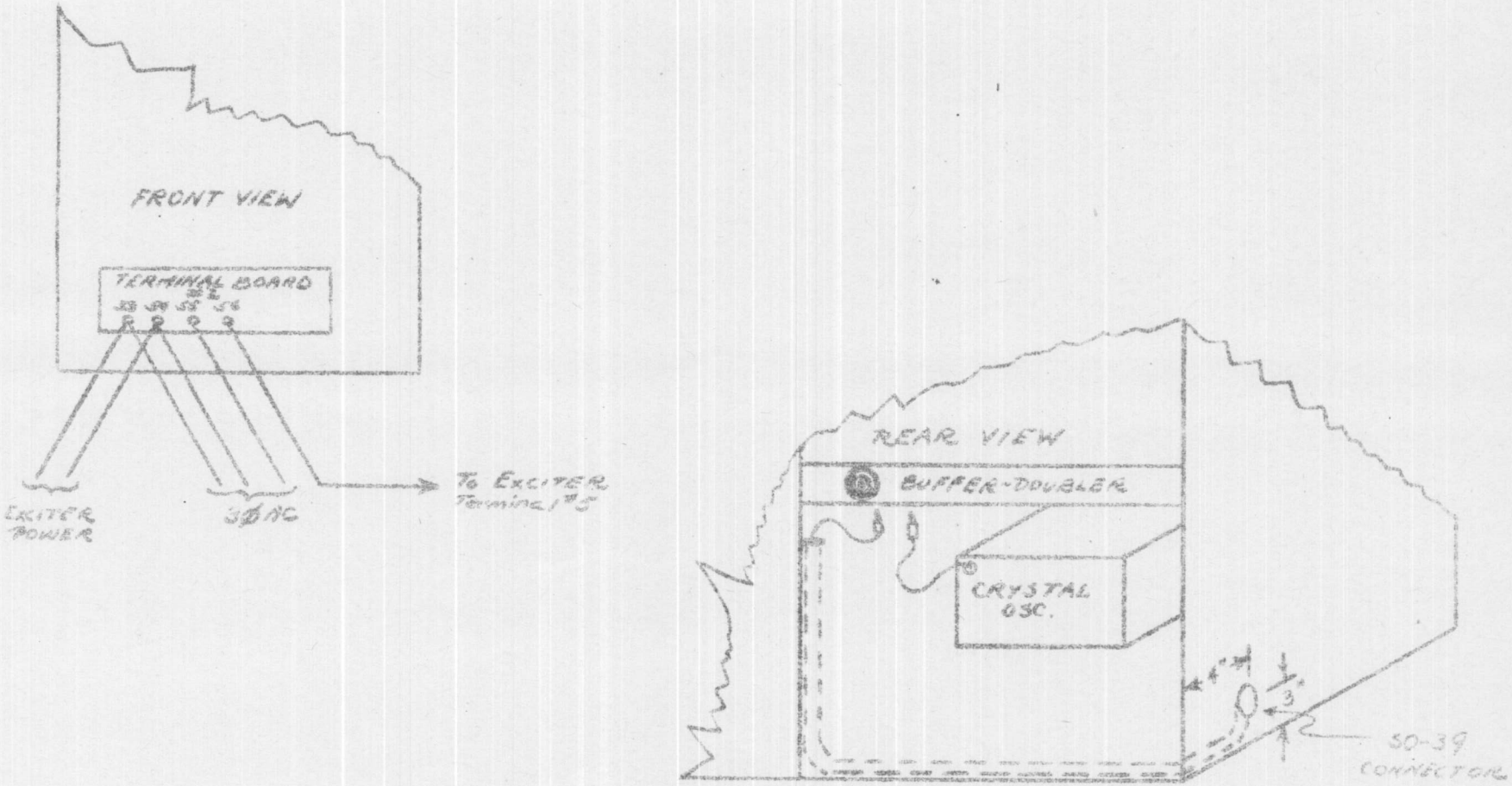
TT1-T




NOTES

1. Used when three wire operation to Signal Center is employed.
2. Arrangement showing single exciter unit used with more than one transmitter.
3. The coaxial cable shall be sufficiantly long to reach each of the transmitters.
4. The keyer terminals shall be wired in parallel and connected to #5 binding post on the exciter terminal strip.
5. The remote control terminals shall also be wired in parallel and connected to exciter terminal #6.
6. This arrangement may be used for a single transmitter and a single exciter. In this case, disregard transmitters 2 and 3.

TT 1-U



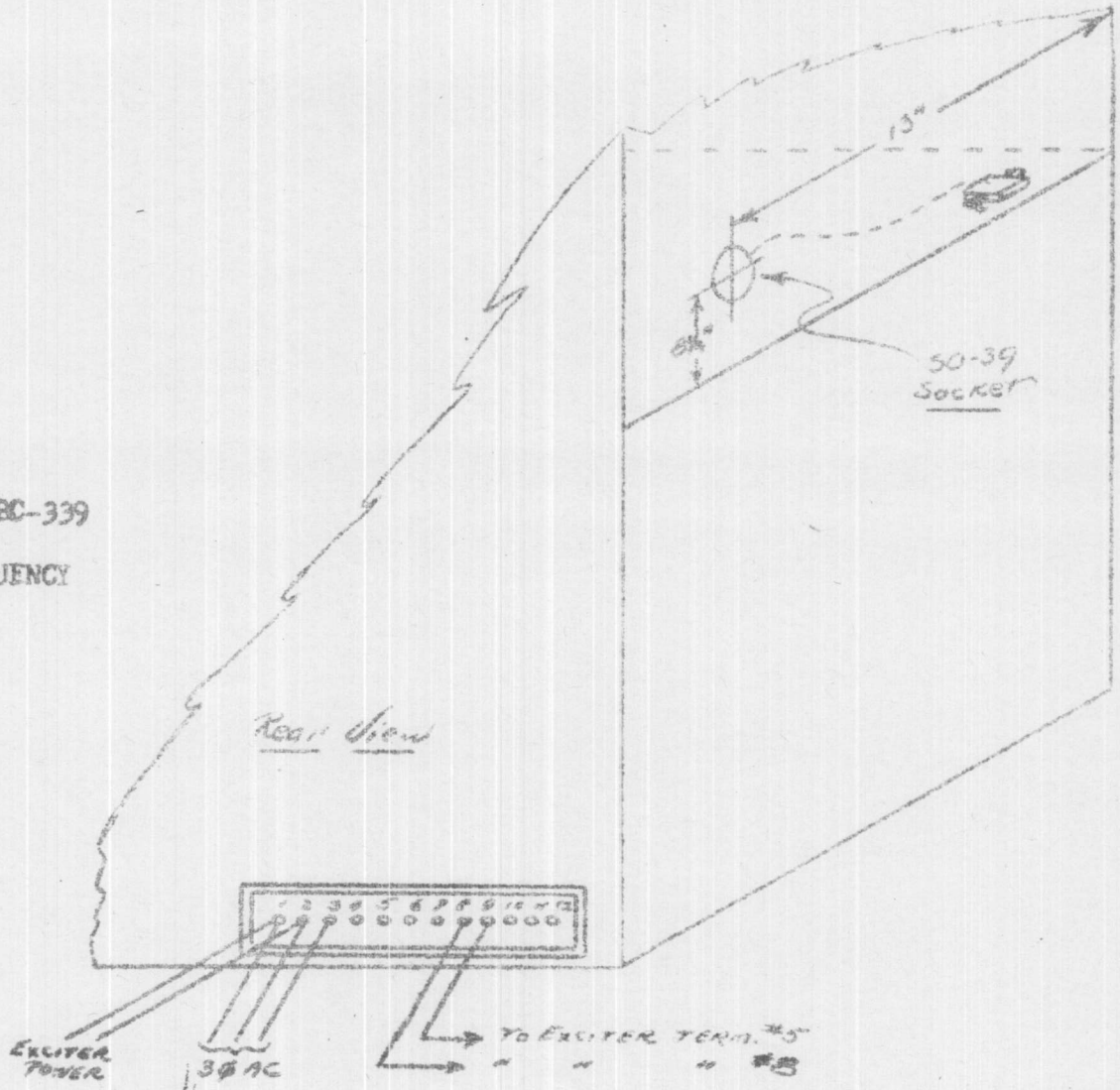

MODIFICATION OF PRESS WIRELESS 2.5 KW TRANSMITTER FOR USE WITH 0-5/FR FREQUENCY SHIFTER

TT1-V1

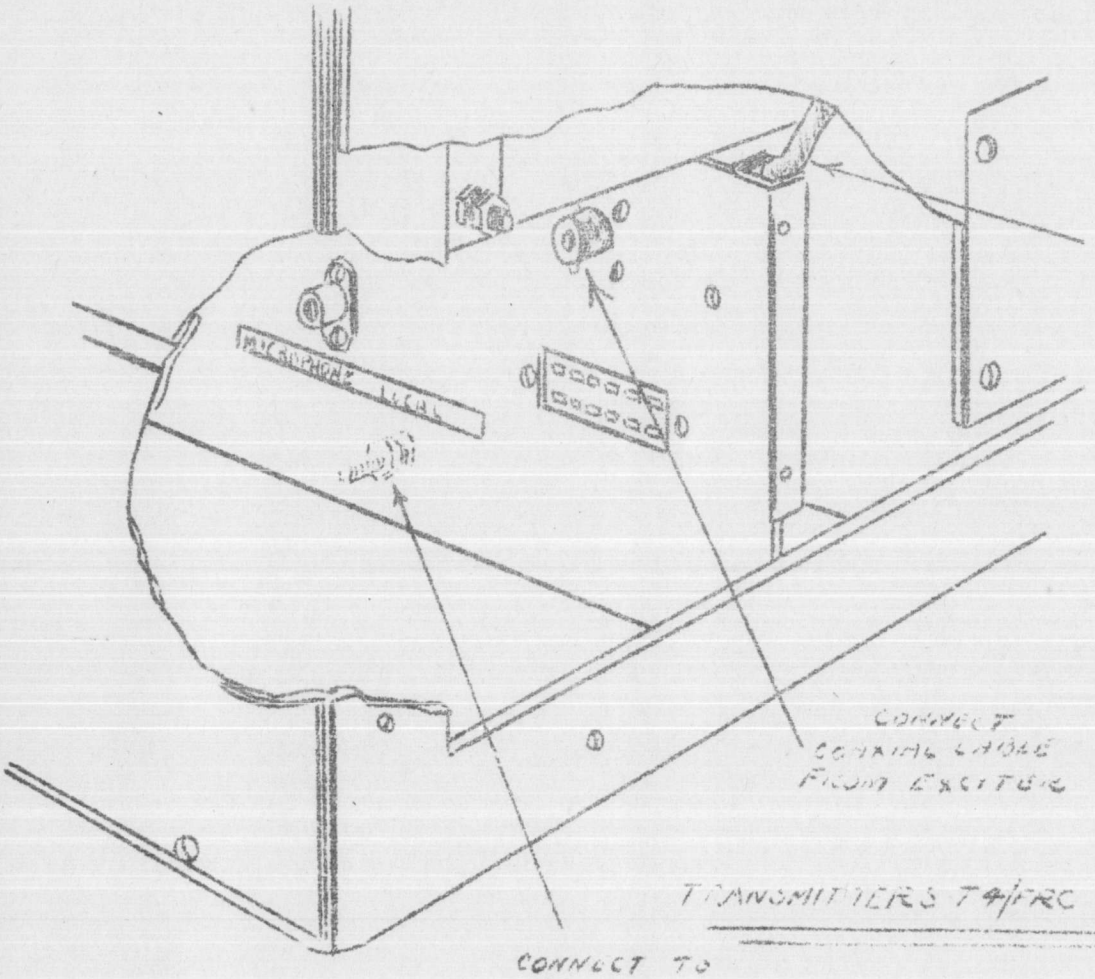
MODIFICATION OF FEDERAL BC-339

FOR USE WITH O-5/FR FREQUENCY

SHIFTER



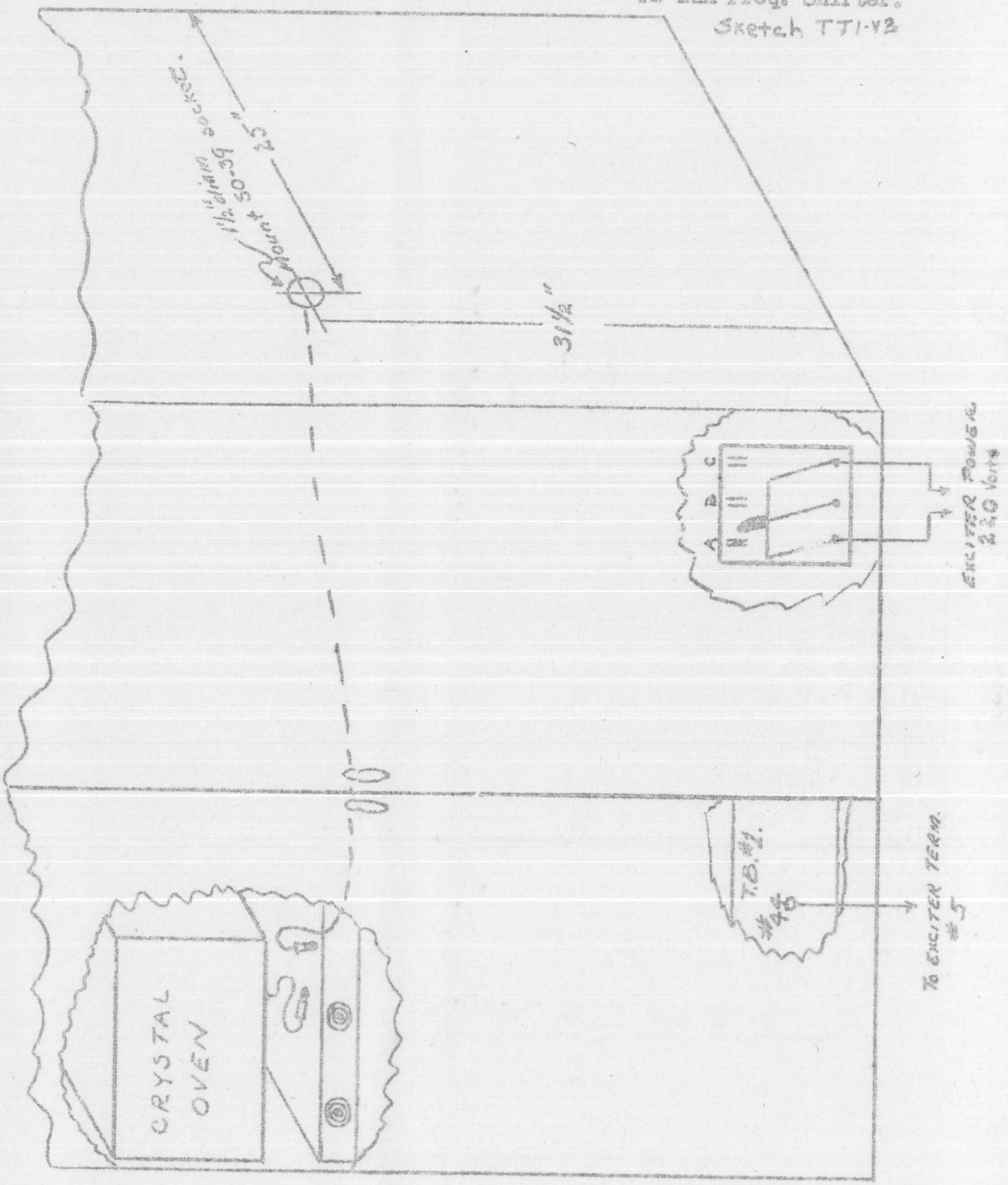

TTI-W



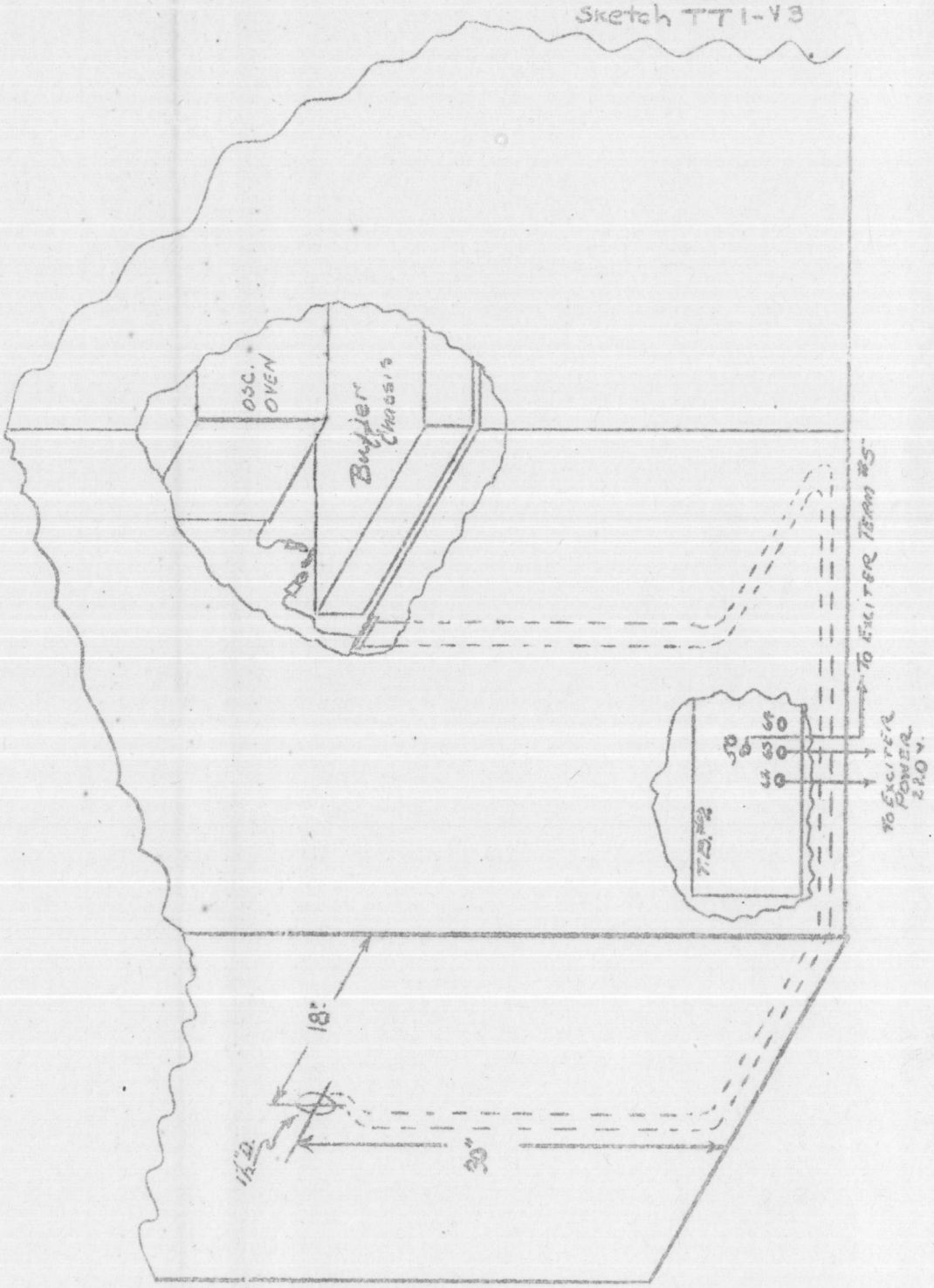

TRANSMITTERS T4/FRC AND T5/FRC

MODIFICATION OF AIRCRAFT ACCESSORIES CORPORATION
TRANSMITTER TYPES T4/FRC AND T5/FRC FOR USE WITH O-5/FR FREQUENCY SHIFTER

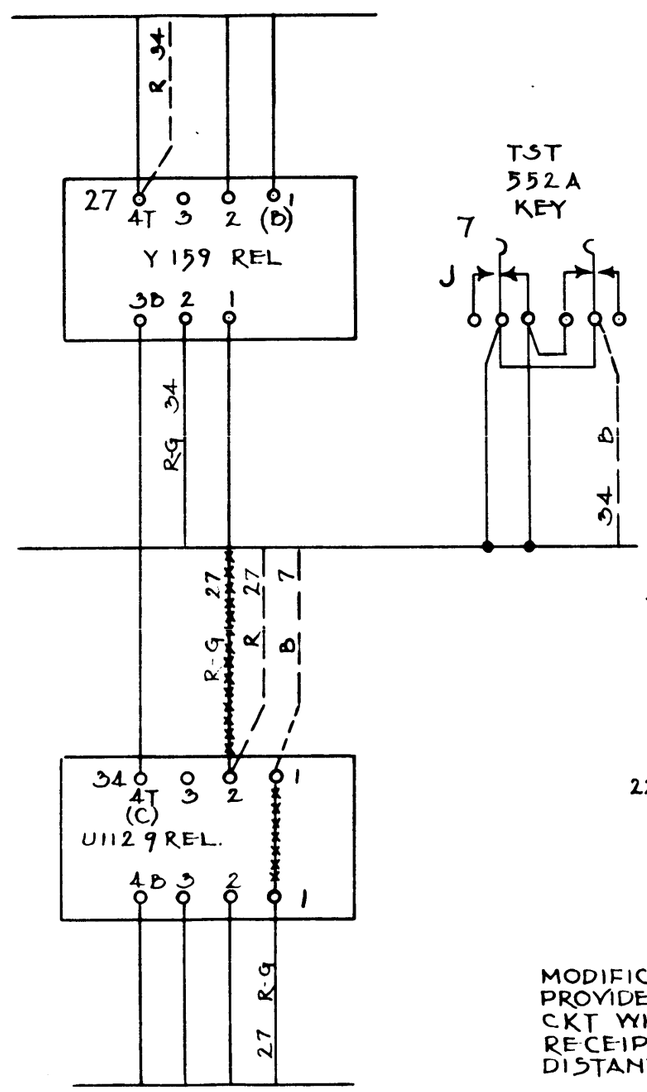
Radioteletype Spec. 1
Issue 4
Modification of PW 15
for use with
FS 12A Freq. Shifter.
Sketch TTI-V2

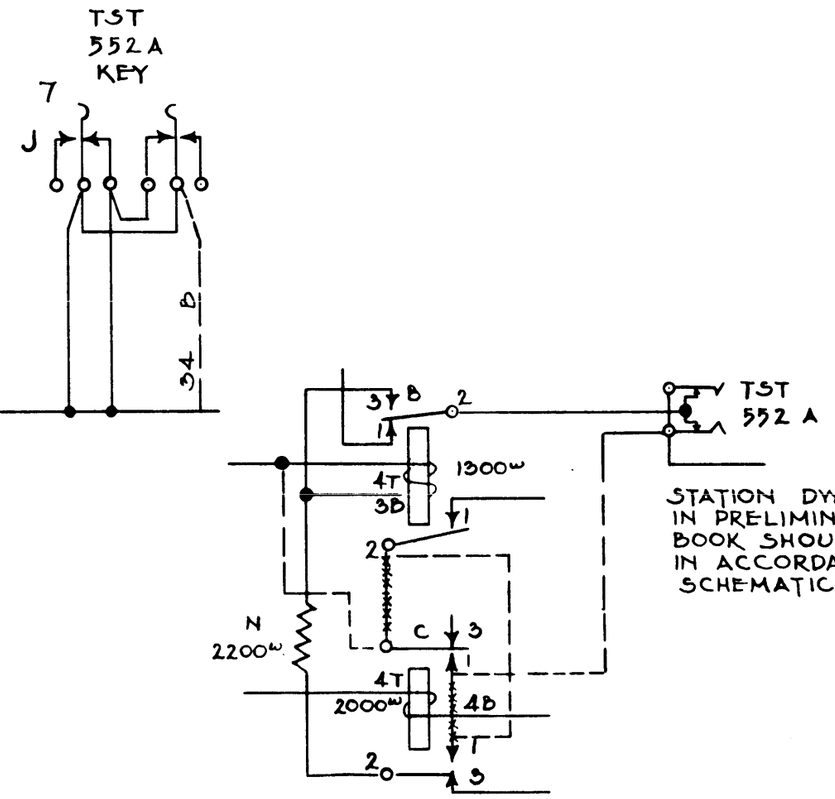


Radioteletype Spec. 1
Issue 4
Modification of FW 40
For use with
FS 12A Freq. Shifter.
Sketch TT1-V3



THIS MODIFICATIONS APPLIES TO UNITS BELOW SERIAL NO. 401 ONLY




STATION DWG. ES-712882 IN PRELIMINARY INSTRUCTION BOOK SHOULD BE CORRECTED IN ACCORDANCE WITH THIS SCHEMATIC CHANGE

MODIFICATION OF AN/FGCI TO PROVIDE FOR MONITOR LOCK UP C.K.T WHICH IS RELEASED UPON RECEIPT OF "MARK" SIGNAL FROM DISTANT TRANSMITTER

NOTES

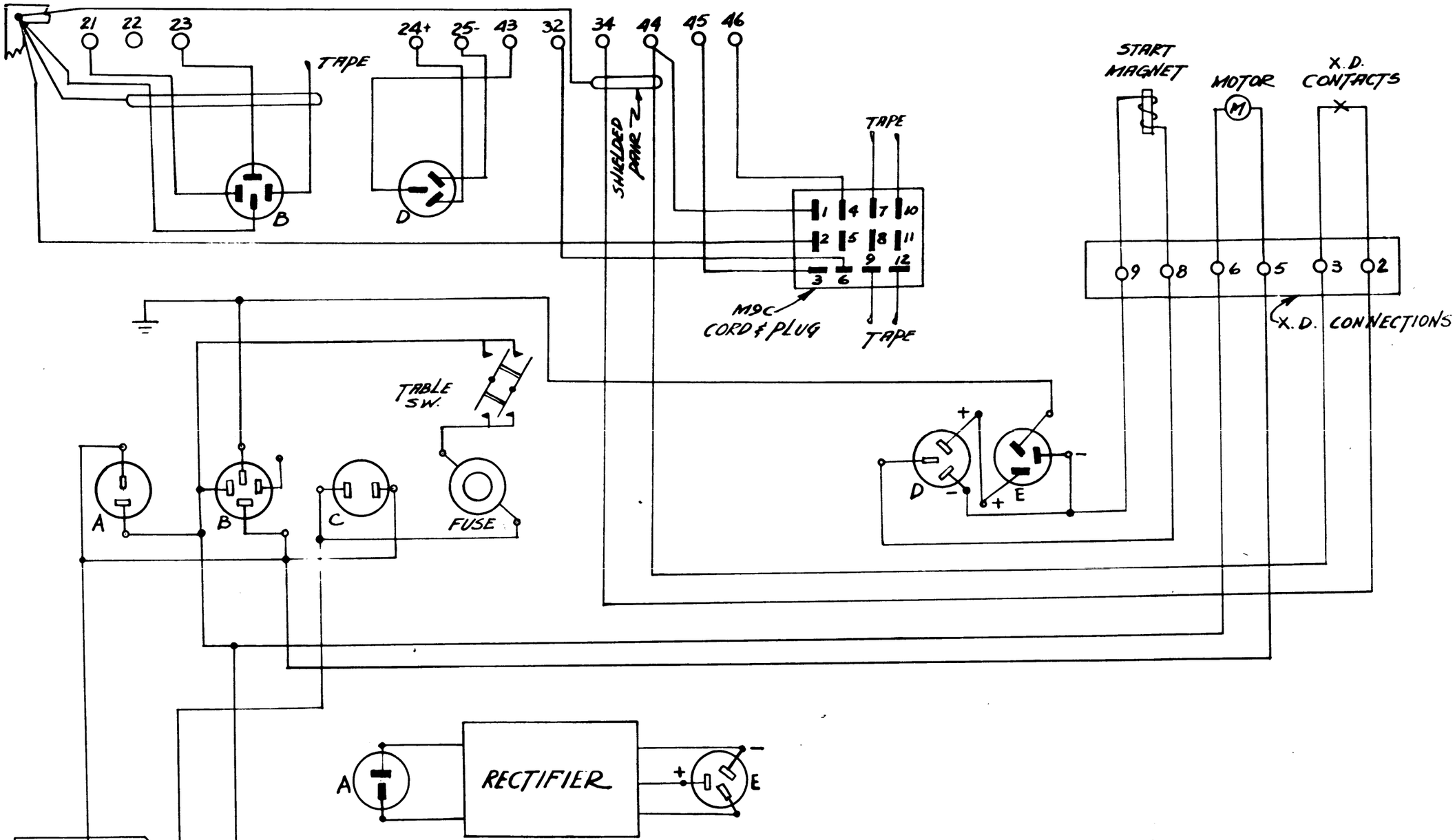
—— EXISTING WIRING - NO CHANGE

****** EXISTING WIRING - REMOVED OR RELOCATED

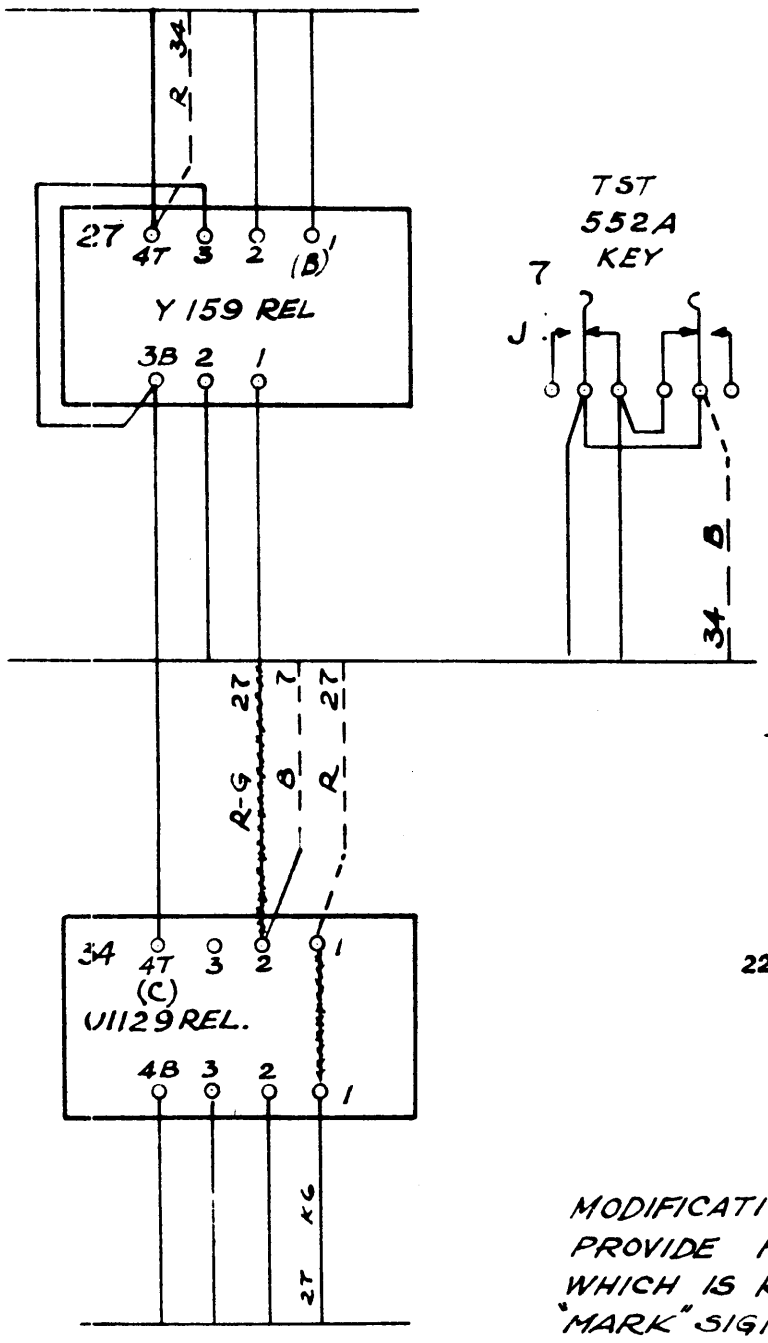
- - - - ADDITIONAL WIRING

1. REMOVE STRAPS BETWEEN #1 CONTACTS OF (C) RELAY
2. MOVE RG WIRE FROM TOP CONTACT #2 OF (C) RELAY TO BOTTOM CONTACT #1 OF (C) RELAY
3. RUN NEW LEAD FROM TOP CONTACT #2 OF (C) RELAY TO SPRING OF (TST) KEY
4. RUN NEW LEAD FROM TOP CONTACT #1 OF (C) RELAY TO TOP CONTACT #4 OF (B) RELAY
5. IF DIFFICULTY IS EXPERIENCED IN "KNOCK-ING-DOWN" THE MONITOR LOCK UP CIRCUIT, AND A BETTER BALANCE OF MARK AND SPACE CURRENTS IS NOT POSSIBLE, REMOVE THE STRAP ON THE 1705 ohm SECTION OF A "A" RESISTOR. (FIG 34) IN TM-11-356).

| MODIFICATION OF AN/FGC-1 TERMINAL FOR MONITOR LOCK-UP CIRCUIT | | | ISSUE |
|---|---|---|---|
| DATA LWS. | CHECKED GBM | APPROVED, | |
| DRAWN R.J.L | VERIFIED JE | DATE 2-17-44 | |
| OFFICE CHIEF SIGNAL OFFICER PLANT ENGINEERING AGENCY PHILADELPHIA, PENNA. | ES-E-32562 | | A |




| | | | |
|---|---|---|---|
| SINGLE CHANNEL RTT LOOP & POWER CONNECTIONS FOR TYPE 19-TTY (MODIFIED) | | | ISSUE |
| DRAWN-S.K. | CHECKED- | APPROVED- | |
| DATA- | VERIFIED | DATE-2/18/49 | |
| OFFICE CHIEF SIGNAL OFFICER PLANT ENGINEERING AGENCY PHILA. PA. | ES-B-32560 | | A |



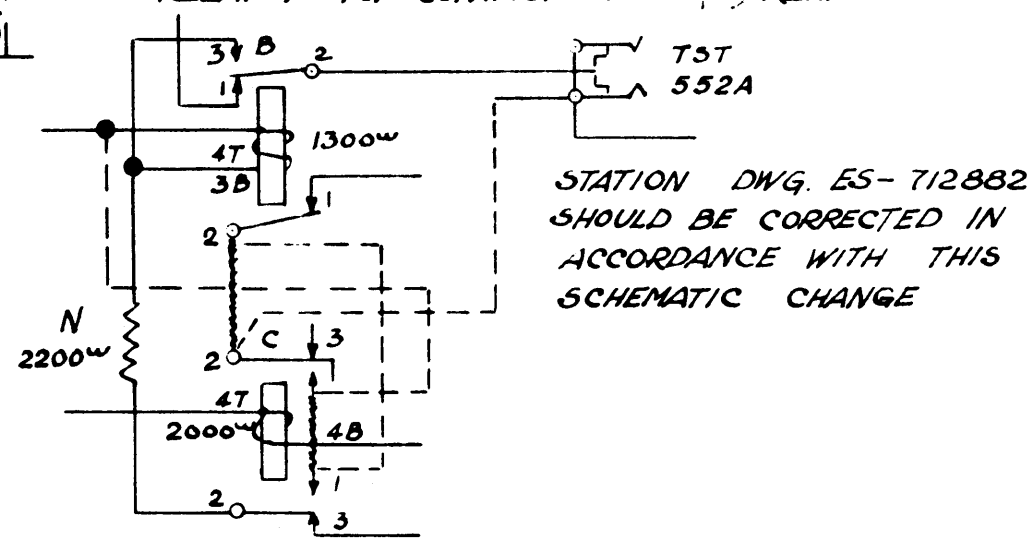

NOTES:

——— EXISTING WIRING - NO CHANGE

▪▪▪▪▪▪ EXISTING WIRING - REMOVED OR RELOCATED

---- ADDITIONAL WIRING

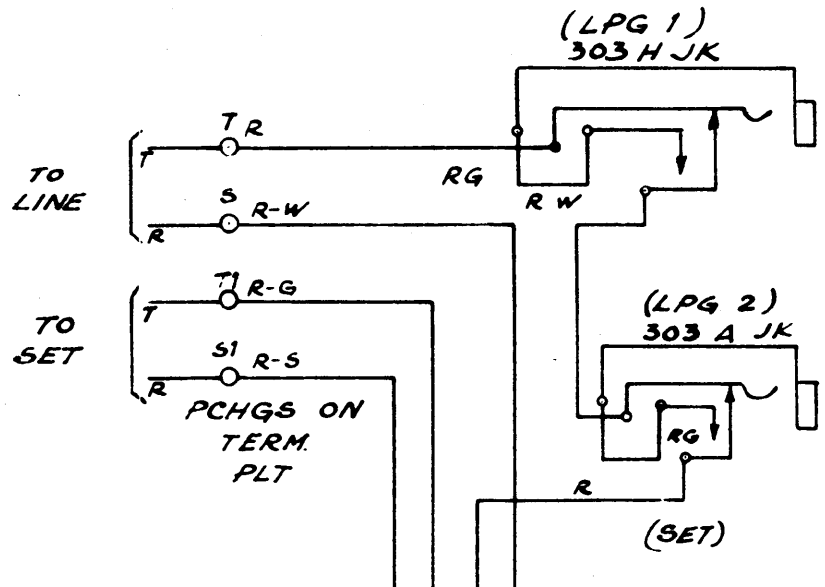
1. REMOVE STRAPS BETWEEN #1 CONTACTS OF (C) RELAY
2. MOVE RG WIRE FROM TOP CONTACT #2 OF (C) RELAY TO BOTTOM CONTACT #1 OF (C) RELAY
3. RUN NEW LEAD FROM TOP CONTACT #2 OF (C) RELAY TO SPRING OF (TST) KEY
4. RUN NEW LEAD FROM TOP CONTACT #1 OF (C) RELAY TO TOP CONTACT #4 OF (B) RELAY

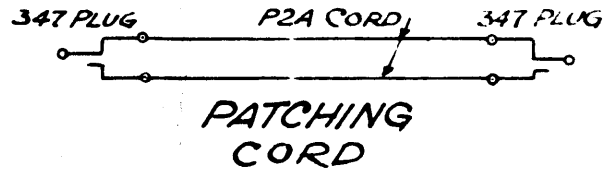



STATION DWG. ES-712882 SHOULD BE CORRECTED IN ACCORDANCE WITH THIS SCHEMATIC CHANGE

MODIFICATION OF AN/FGC1 TO PROVIDE FOR MONITOR LOCK UP CKT WHICH IS RELEASED UPON RECEIPT OF "MARK" SIGNAL FROM DISTANT TRANSMITTER

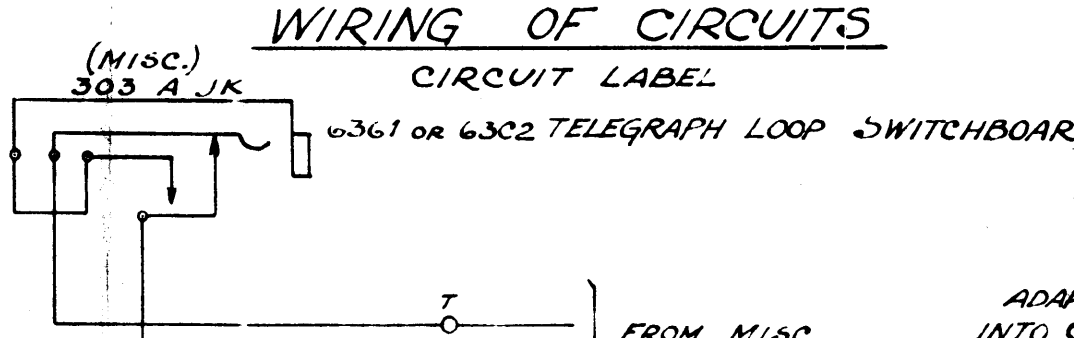
| DETAILED APPLICATION OF FS/12A EXCITER TO VARIOUS TRANSMITTERS | | |
|---|---|---|
| AIRCRAFT ACCESSORIES | 4TFRC | TT-1X |
| COLLINS | BC-64Z | TT-1T |
| FEDERAL | BC-339 | TT-1W |
| FEDERAL | FT-300 | TT-1Y |
| PRESS WIRELESS | PW-2,5 | TT-1V-1 |
| PRESS WIRELESS | PW-15 | TT-1V-2 |
| PRESS WIRELESS | PW-40 | TT-1V-3 |




PATCHING CORD

## WIRING OF CIRCUITS



AN/FRR3
RECEIVER

AN/FGC1 TERM. EQUPT.

FOR
ANTENNA
CONNECTIONS
SEE
RADIOTELETYPE
SPEC 1
ISSUE 4

600Ω
RADIO REC CHANNEL A
3RD
600Ω
RADIO REC CHANNEL B
3RD
MULTIPLER
1
A.F.C.
2
8B
7B
5B
CURRENT LIMITER CHAN. A
CHAN. B
SEE FIG 36
TERM STRIP ON BAY
2
1
9A
10A
11A
A.F.C. PANEL
INTN-11-356
DIAL CONTROL CIRCUIT
REMOTE CONTROL
AN/FGC1 CONTROL

3 TO SET JACK
4 TO SET JACK
TO LPG 1 JACK
TO LPG 1 JACK
8 TO SET JACK
9 TO SET JACK
TO LPG 1 JACK
TO LPG 1 JACK
63C2
JACK PANEL

# RADIO TRANSMITTER STATION

TERMINAL BOARD #1
ON EXCITER #1
1
2
3
4
5
6
7
8
TO EXCITER #2
(IF USED)
TRANSMITTER TERMINAL BOARD
CW KEYING
TRANSMITTER PRIMARY CONTROL

WITCHBOARD

ADAPTER TO PLUG
INTO CRYSTAL SOCKET
FURNISHED IN MODIFICATION

3 TO SET JACKS
4 TO SET JACKS
TO LPG 1 JACKS
TO LPG 1 JACKS
8 TO SET JACKS
9 TO SET JACKS
TO LPG 1 JACKS
TO LPG 1 JACKS

1 TO LPG 1 JACK
2
3 TO SET JACK
4
5 TO MISC JACKS
10
6 TO LPG1 JACK
7
8 TO SET JACK
9
11 TO LPG 1 JACK
17
13 TO SET JACK
14
16 TO LPG 1 JACK
17
18 TO SET JACK
19
15 TO MISC. JACK
20

63CZ JACK PANEL

STATION PROTECTORS IF REQUIRED

34 SEND CONTACTS
32
45 SEL MAGNETS
46

15 PRINTER ONE PER STATION TO BE PATCHED ONLY INTO MISC. JACKS SO AS TO PICK UP NEUTRAL TO POLAR REPTR FOR TRANSMISSION TO XTR IF MODEL 19 TTY IS USED THE XTR DIST KEY BOARD AND SEL MAGNETS SHOULD BE WIRED IN SERIES.

(RECTIFIER IN PRINTER NOT TO BE USED FOR LINE CURRENT)

C6
C7
C10
C11
C12
B1
B2
B8
B9 STATION KEY IN POS. 1
B12
B4
C15
B3
B5
C16
C17
C21
B20
B21
B18
B19

T.S. ON 132A2 SET

FRAME

AB
A1
A6
A5
A4
A3
A2 HS
A1 GS

TO OFFICE GROUND

TO A.C. POWER

79A
A.C.
115V

91A
A.C.

THIS PLACES TERM. B ON TER FILTERS 133A1 SEE FIG. 47

USE WITH FIG. B OMIT WITH FIG. A OMIT WITH FIG.

A
B
C
D

TO FIG. A OR B

TO MAIN FIG.

A 2
B 1
5
7
C 13
D 4
3
11
10
12
19
21

PLUG ON REPTR.

REPEATER. PANEL RELOCATED TO 132 A2 FROM 133A1 SET WHEN "REPT. & CONTROL CKT" IS NOT FURNISHED

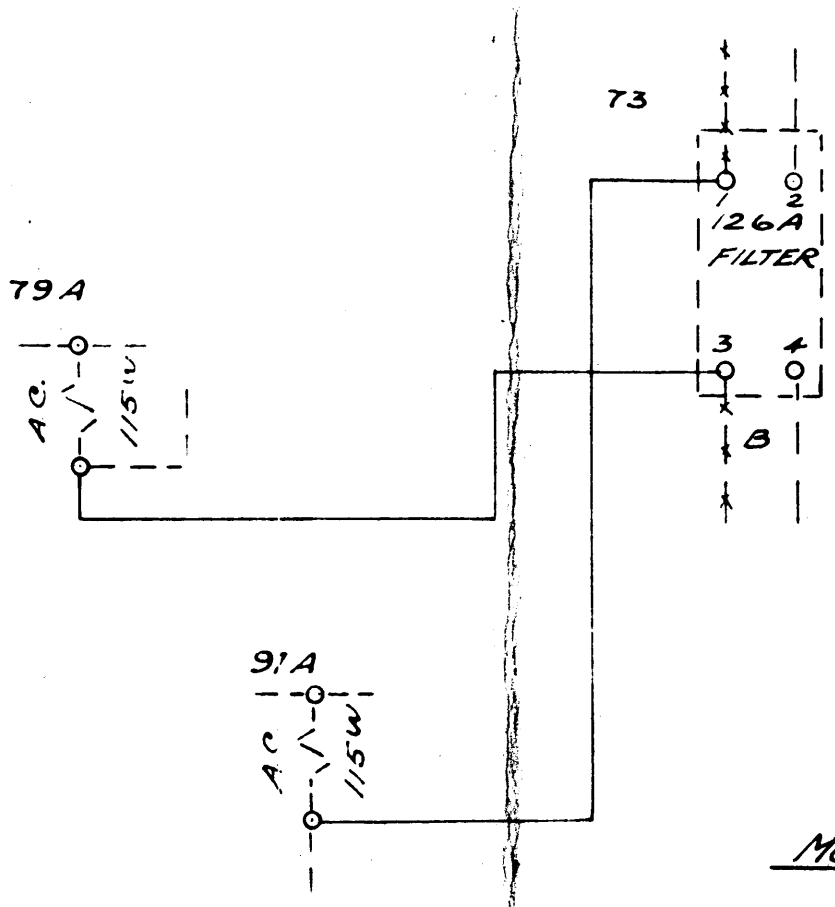
BASE ON 132A2 SET

FIG. A

TRANSMITTER CONTROL
SEND
BE 54A KEY MTG ON 132A2 SET

L1 L2 OP DIS

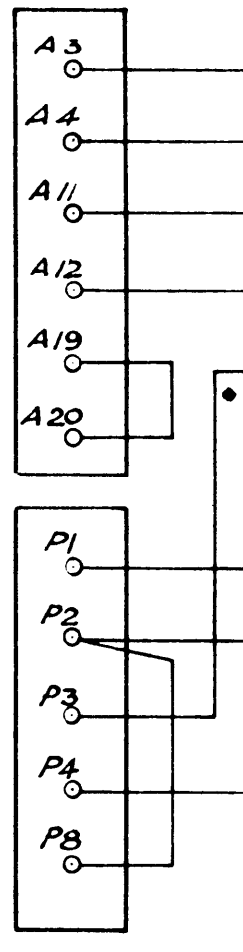
3800Ω



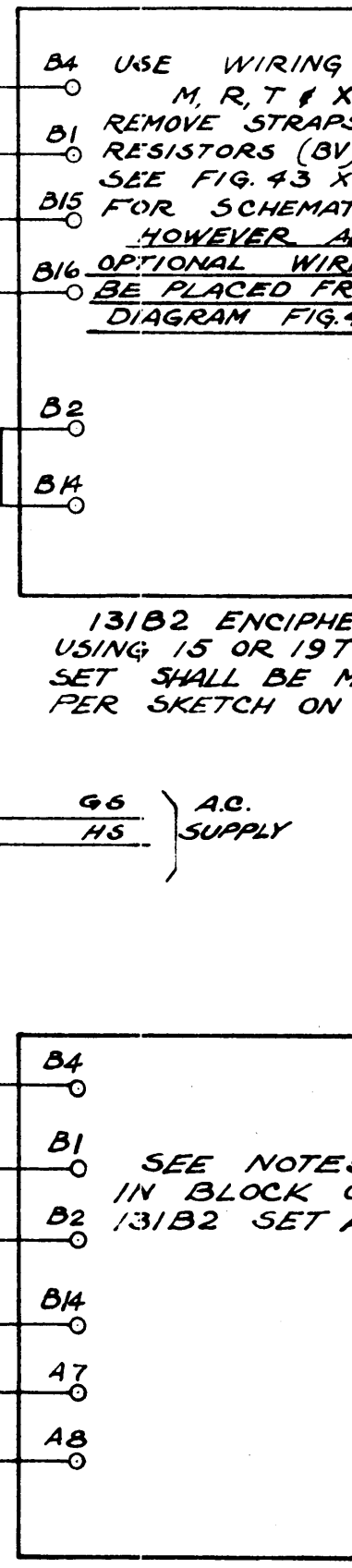

THIS MODIFICATION PLACES (+) POWER ON TERM. B16 AND (-) POWER ON TERM. B15 THROUGH FILTERS FOR USE IN 133A1 SET.
SEE WIRING DIAGRAM FIG. 47 X-63684

## MODIFICATION OF 131B2 SET

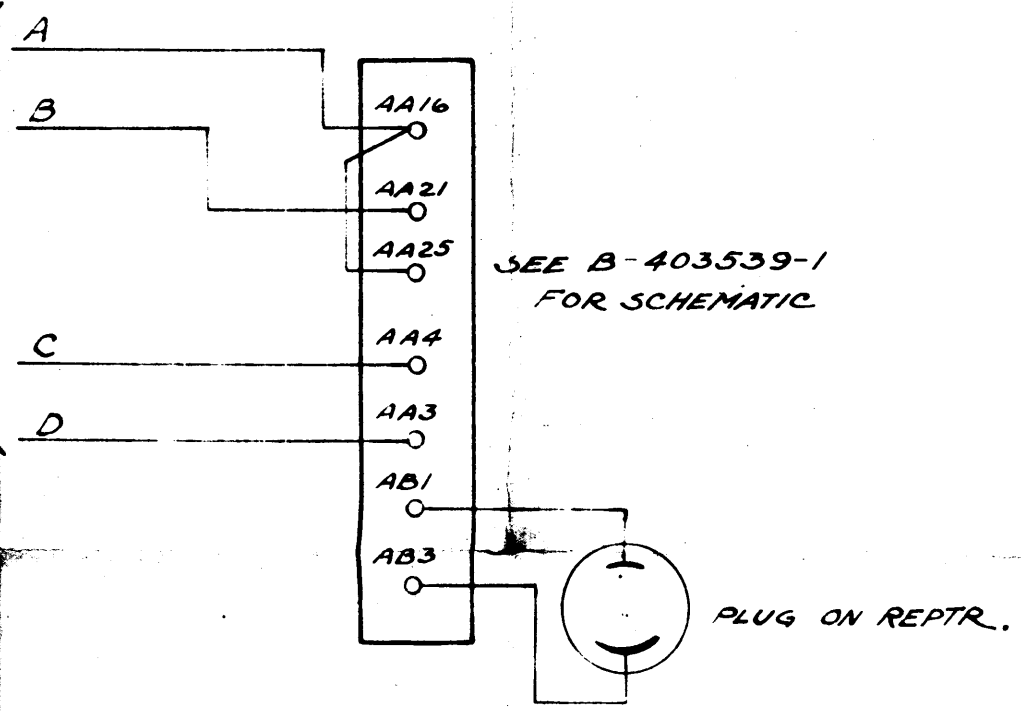
- - - EXISTING WIRING & EQUIPMENT
——— ADDITIONAL WIRING TO BE TAGGED FOR REMOVAL WHEN SET IS USED FOR OTHER PURPOSES THAN SPECIFIED.
* * * WIRING TO BE REMOVED AND ENDS TAPED




133A1 SET CORD IN FIG.D OF X-66097 FIG.20 SHALL USE (Y) WIRING AND PLUGGED INTO (A) E (B) RECEPTACLES



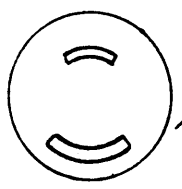

131B2 DECIPHER
USING 15 TTY
SET IS NOT
AS PER ABOVE




SEE B-403539-1 FOR SCHEMATIC

PLUG ON REPTR.

FIG. B



BASE ON 132A SET

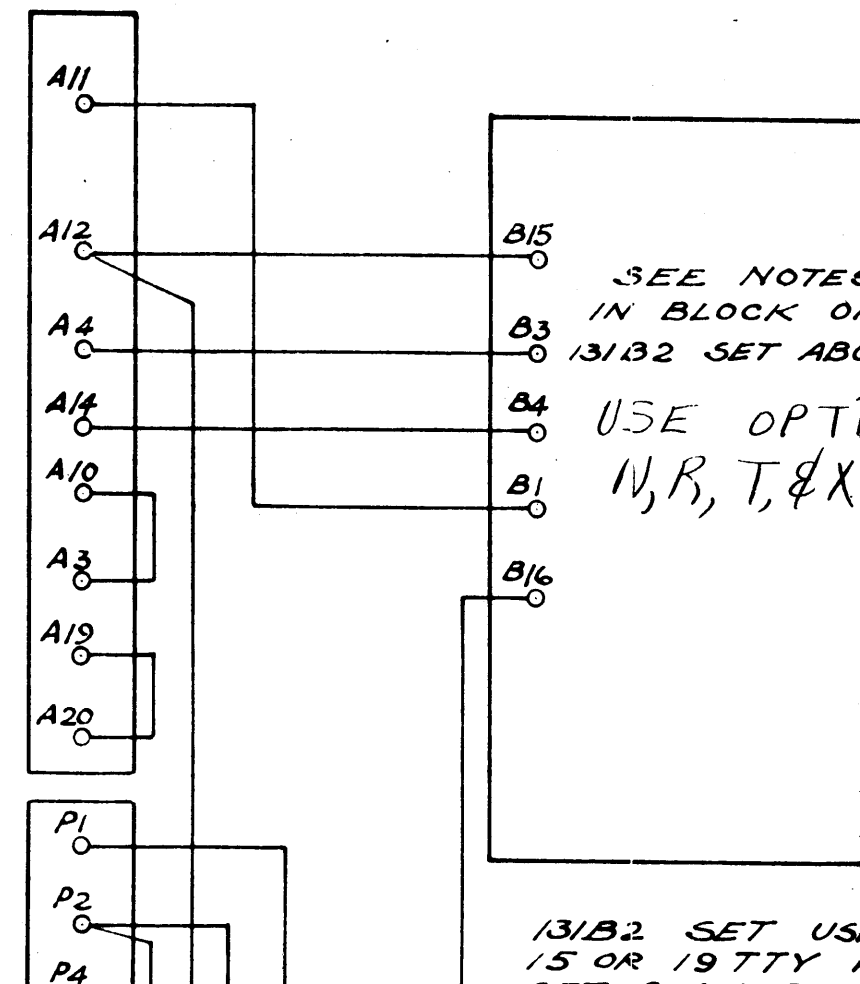
TED TO
BA1 SET WHEN
ROL CKT"
SHED

REPEATER AND CONTROL CKT WHEN INSTALLED IN 132A2 SET KEY ALWAYS IN "SEND" POSITION. REMOVE ONE LEAD FROM BELL AND TAPE END. REMOVE LAMP. STRAP OUT 92 AC BREAK KEY

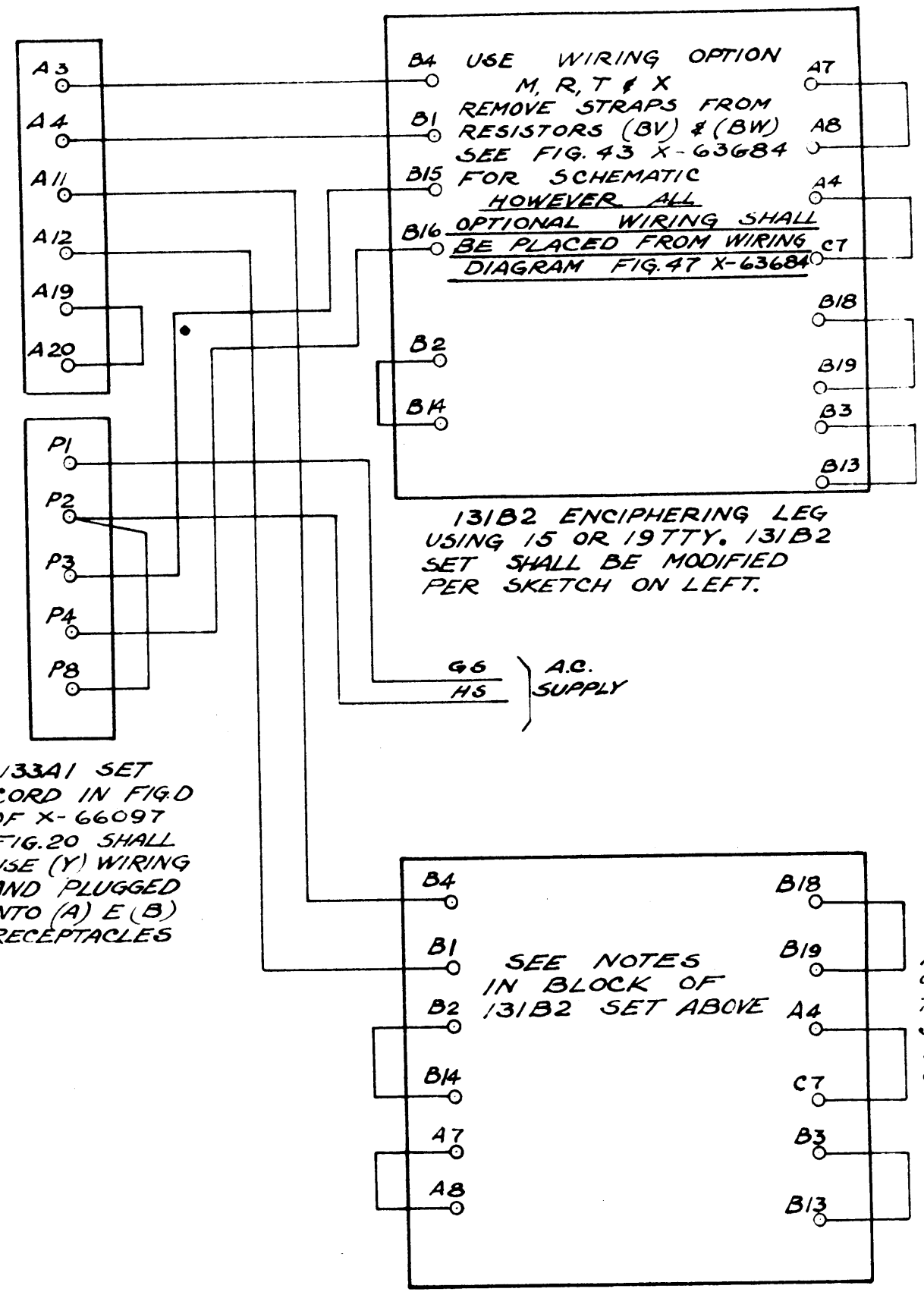
CONTROL

SIMULTANEOUS ENCODING & DECODING R

ALTERNATE ENCODING OR DECODING R




131B2 SET US
15 OR 19 TTY
SET SHALL BE
MODIFIED PER




## MODIFICATION OF 131B2 SET

- - - EXISTING WIRING & EQUIPMENT

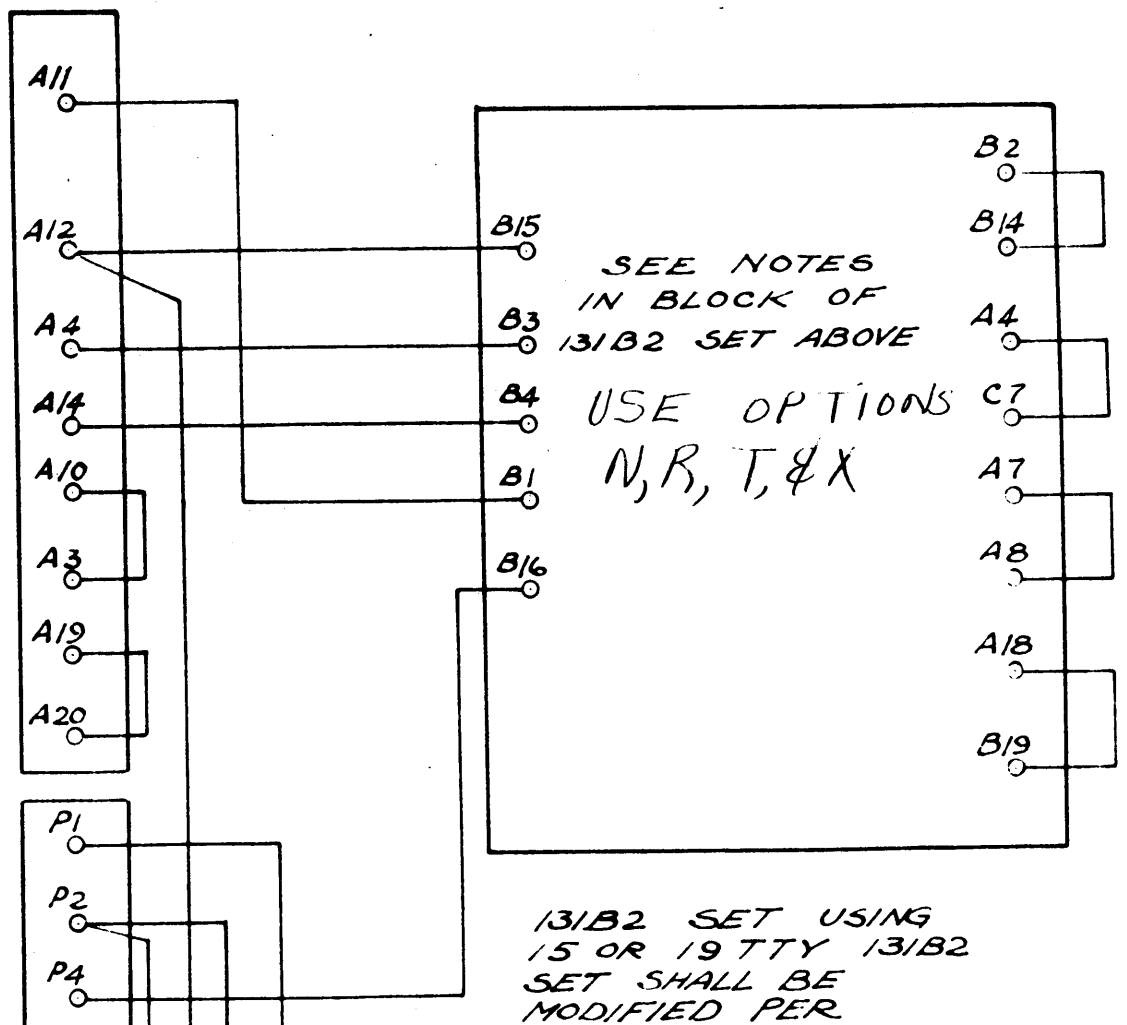
——— ADDITIONAL WIRING TO BE TAGGED FOR REMOVAL WHEN SET IS USED FOR OTHER PURPOSES THAN SPECIFIED.

* * * WIRING TO BE REMOVED AND ENDS TAPED

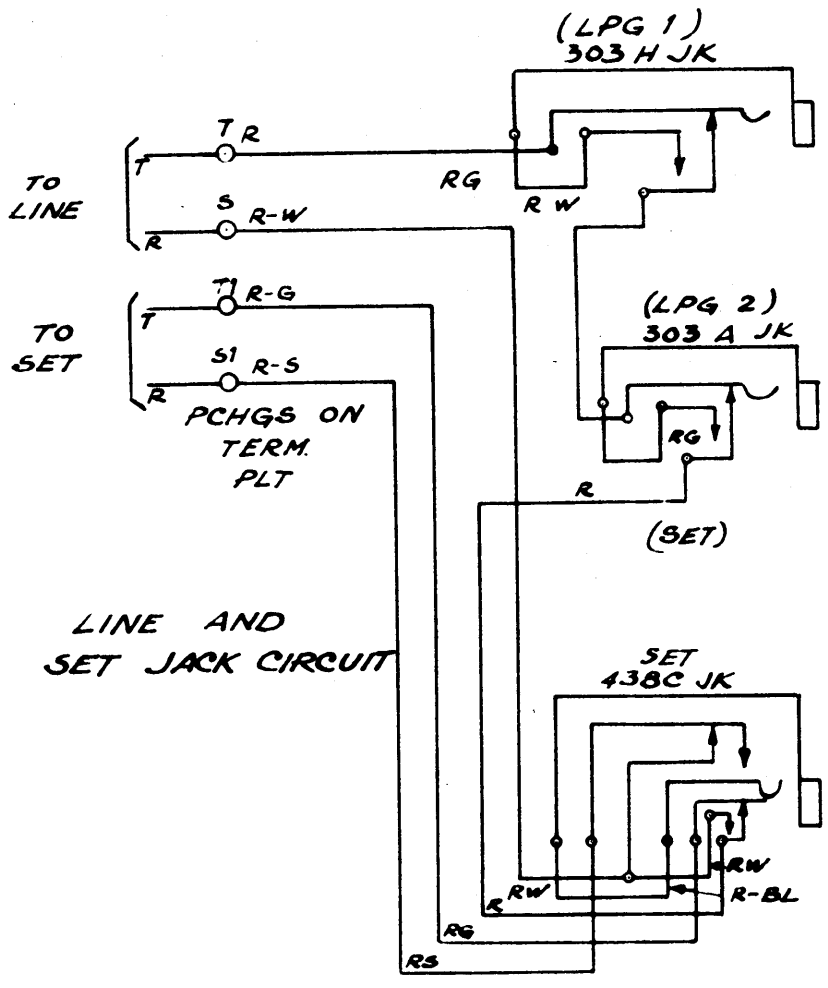
133A1 SET CORD IN FIG.D OF X-66097 FIG.20 SHALL USE (Y) WIRING AND PLUGGED INTO (A) E (B) RECEPTACLES

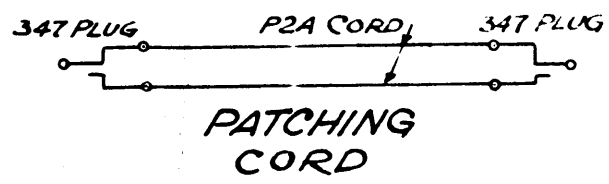
SIMULTANEOUS ENCODING & DECODING ROOM CIRCUIT

ALTERNATE ENCODING OR DECODING ROOM CIRCUIT



| DETAILED APPLICATION OF FS/12A EXCITER TO VARIOUS TRANSMITTERS | | |
|---|---|---|
| AIRCRAFT ACCESSORIES | 4TFRC | TT-1X |
| COLLINS | BC-64Z | TT-1T |
| FEDERAL | BC-339 | TT-1W |
| FEDERAL | FT-300 | TT-1Y |
| PRESS WIRELESS | PW-2,5 | TT-1V-1 |
| PRESS WIRELESS | PW-15 | TT-1V-2 |
| PRESS WIRELESS | PW-40 | TT-1V-3 |



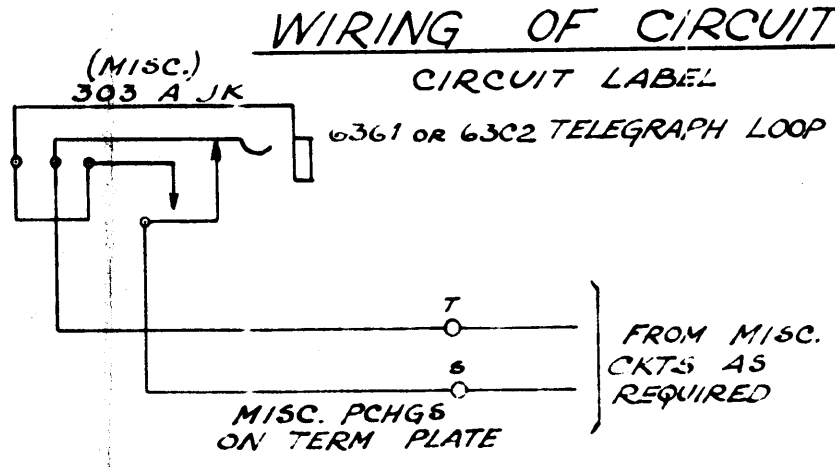




PATCHING CORD

## WIRING OF CIRCUITS

CIRCUIT LABEL

6361 OR 63C2 TELEGRAPH LOOP SWI

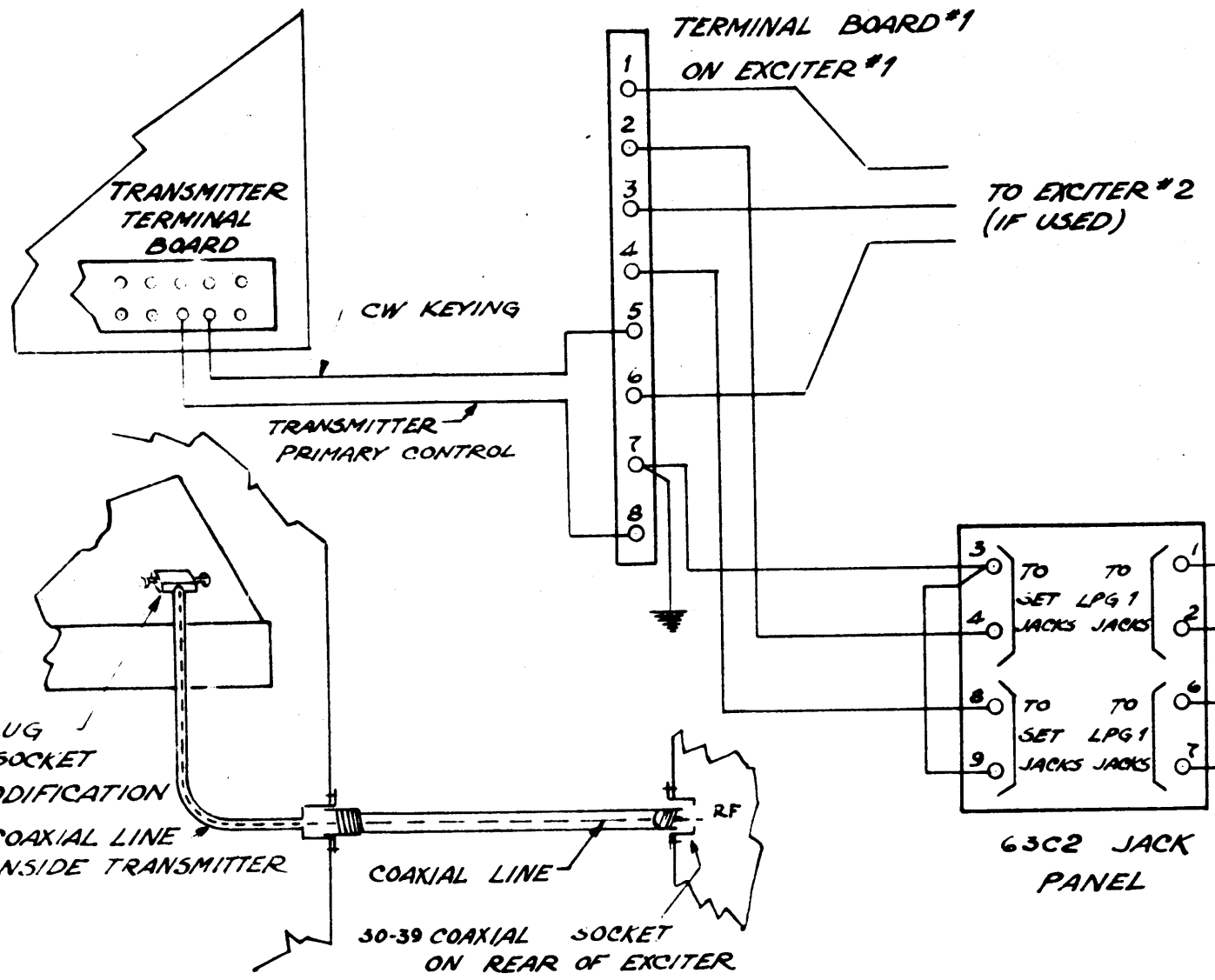



WIRES NOT OTHERWISE SPECIFIED ARE 22 D.S.C.L.

PATCHING CORDS SHALL IN ALL CASES BE INSERTED INTO THE (SET) JK BEFORE BEING INSERTED IN A (LOOPING) JK TO AVOID OPENING THE LINE CKT. IN DISCONNECTING REMOVE CORD FROM LOOPING JK BEFORE REMOVING IT FROM (SET) JK

| TERM. ASSIGNMENT TABLE | | | | | |
|---|---|---|---|---|---|
| CIRCUITS | | TERMINALS | | | |
| LOOP | MISC. | T | S | T, | S, |
| 1 | | 1 | 2 | 3 | 4 |
| 2 | | 6 | 7 | 8 | 9 |
| 3 | | 11 | 12 | 13 | 14 |
| 4 | | 16 | 17 | 18 | 19 |
| | 1 | 5 | 10 | | |
| | 2 | 15 | 20 | | |
| | 3 | 21 | 22 | | |
| | 4 | 23 | 24 | | |

# RADIO TRANSMITTER STATION




CIRCUITS

BEL

RAPH LOOP SWITCHBOARD

ROM MISC.
KTS AS
EQUIRED

| | |
|---|---|
| | |
| 5 | |
| | 5. |
| | 4 |
| | 9 |
| | 14 |
| | 19 |
| | |
| | |
| | |
| | |

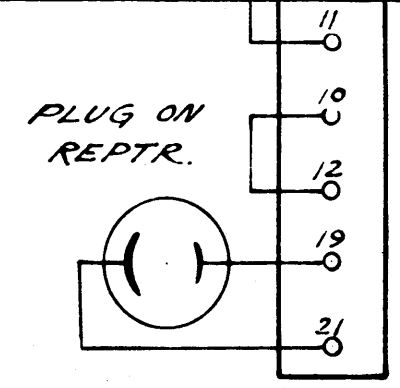
OPE
OR
FAC

M

SPARE
OR WIR
CAN BE
ON JAC
ONE P
CAN BE
TELEP
BETWE

15 PRINTER ONE PER STATION TO BE PATCHED ONLY INTO MISC. JACKS SO AS TO PICK UP NEUTRAL TO POLAR REPTR FOR TRANSMISSION TO XTR IF MODEL 19 TTY IS USED THE XTR DIST KEY BOARD AND SEL MAGNETS SHOULD BE WIRED IN SERIES.

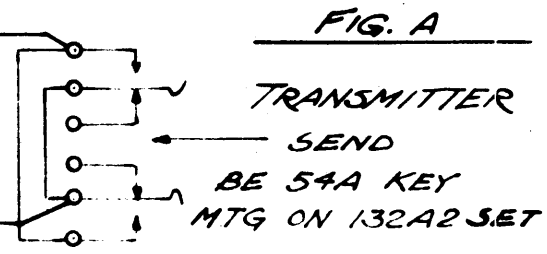
(RECTIFIER IN PRINTER NOT TO BE USED FOR LINE CURRENT)

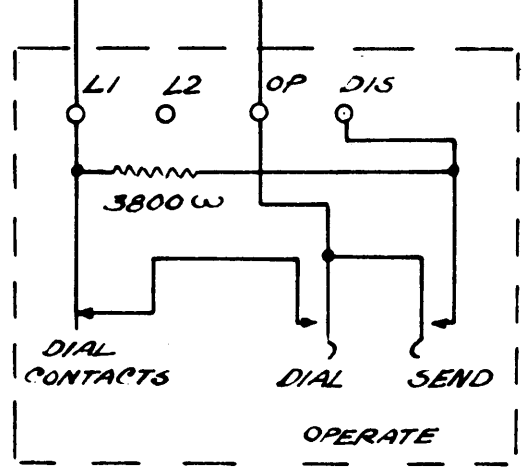



REPEATER. PANEL RELOCATED TO 132 A2 FROM 133A1 SET W "REPT & CONTROL CKT IS NOT FURNISHED

BASE ON 132A2 SET

FIG. A




REMOTE CONTROL UNIT MTG ON 132A2 UNIT SEND POS. USED TO DISABLE REL. AND LOCK UP MONITOR CKT IN TERM. EQUIPMENT.

OPEN WIRE OR CABLE FACILITIES

NOTE

SPARE CABLE OR WIRE FACILITIES CAN BE TERMINATED ON JACK PANELS ONE PAIR OF WHICH CAN BE USED FOR TELEPHONE BETWEEN STATIONS

SIGNAL CENTER

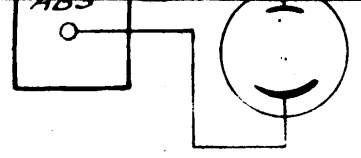
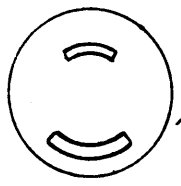



FIG. B




R.
OCATED TO
133A1 SET WHEN
NTROL CKT"
RNISHED

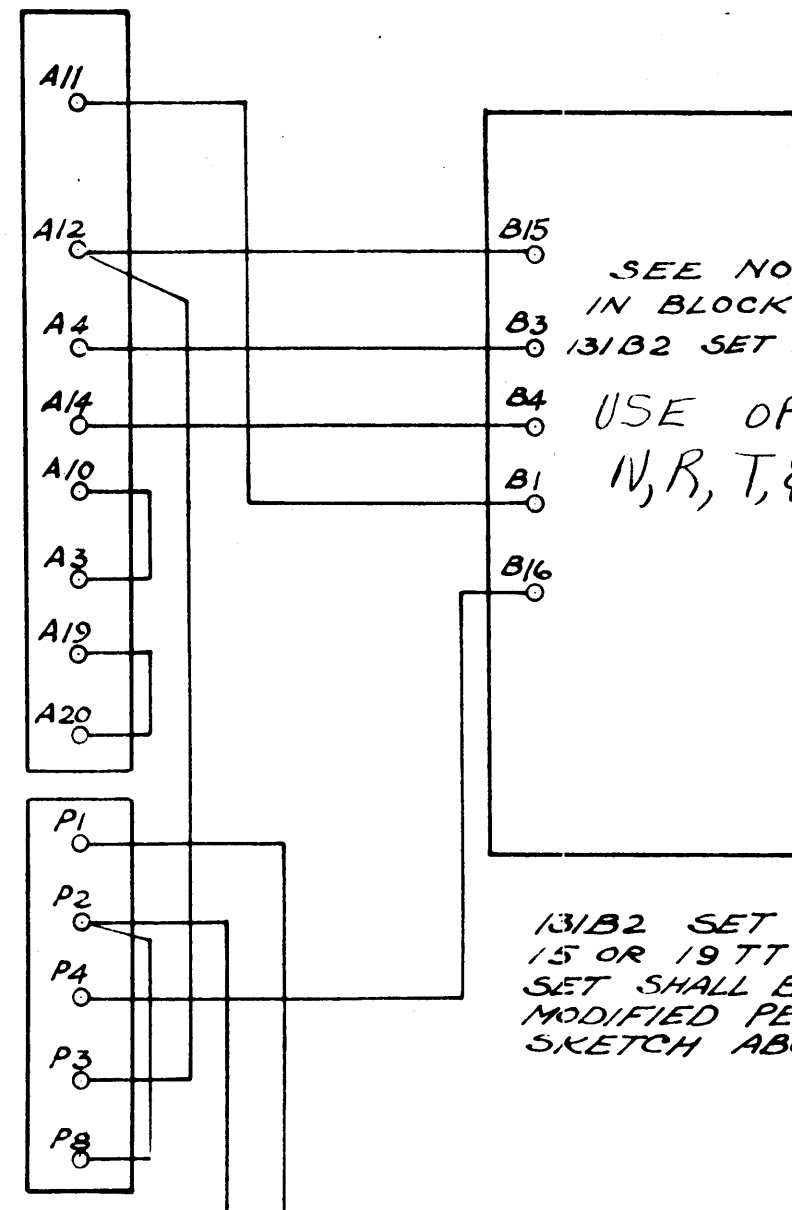
REPEATER AND CONTROL CKT WHEN INSTALLED IN 132A2 SET KEY ALWAYS IN "SEND" POSITION. REMOVE ONE LEAD FROM BELL AND TAPE END. REMOVE LAMP. STRAP OUT 92 AC BREAK KEY

CONTROL

ET

SIMULTANEOUS ENCODING & DECODING

ALTERNATE ENCODING OR DECODING




| INTERCONN<br>SINGLE C<br>DUPLEX OPER<br>WIRELESS AN/ | |
|---|---|
| DATA: A.T.S | CH |
| DRAWN: J.M.O | VE |
| OFFICE CHIEF SIGNA<br>, PLANT ENGINEE<br>PHILA. | |

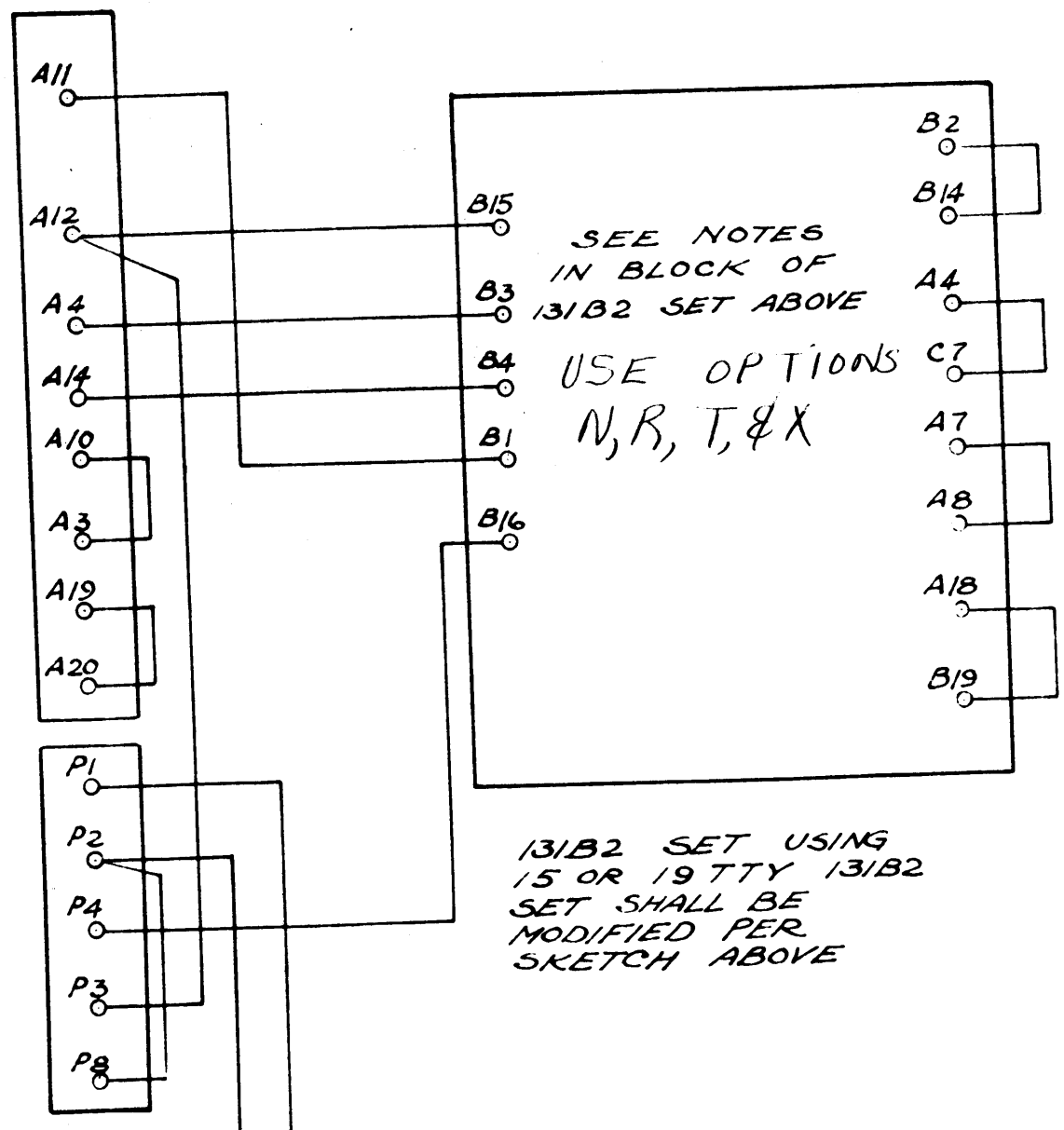
PLUG ON REPTR.

BASE ON
132A SET

R AND CONTROL CKT
STALLED IN 132A2
ALWAYS IN "SEND"
REMOVE ONE LEAD
LL AND TAPE END.
LAMP. STRAP OUT
REAK KEY

# SIMULTANEOUS ENCODING & DECODING ROOM CIRCUIT

## ALTERNATE ENCODING OR DECODING ROOM CIRCUIT




131B2 SET USING
15 OR 19 TTY 131B2
SET SHALL BE
MODIFIED PER
SKETCH ABOVE

133A1 SET
CORD IN FIG. D
OF X-66097
FIG 20 SHALL
USE 'Y' WIRING
AND PLUGGED
INTO (A) & (B)
RECEPTACLES

A.C.
SUPPLY

| INTERCONNECTING DRAWING<br>SINGLE CHANNEL R.T.T.<br>DUPLEX OPERATION USING PRESS<br>WIRELESS AN/FRR3 DIVERSITY RECEIVERS | | | ISSUE |
|---|---|---|---|
| DATA: H.T.S | CHECKED: J.H.M. | APPROVED: J.J.S. | |
| DRAWN: J.M.O. | VERIFIED: J.H.M. | DATE: 12-15-43 | |
| OFFICE CHIEF SIGNAL OFFICER<br>PLANT ENGINEERING AGENCY<br>PHILA. PA. | | ES-E-32533 | A |