Single-Frequency Signaling Equipment 860

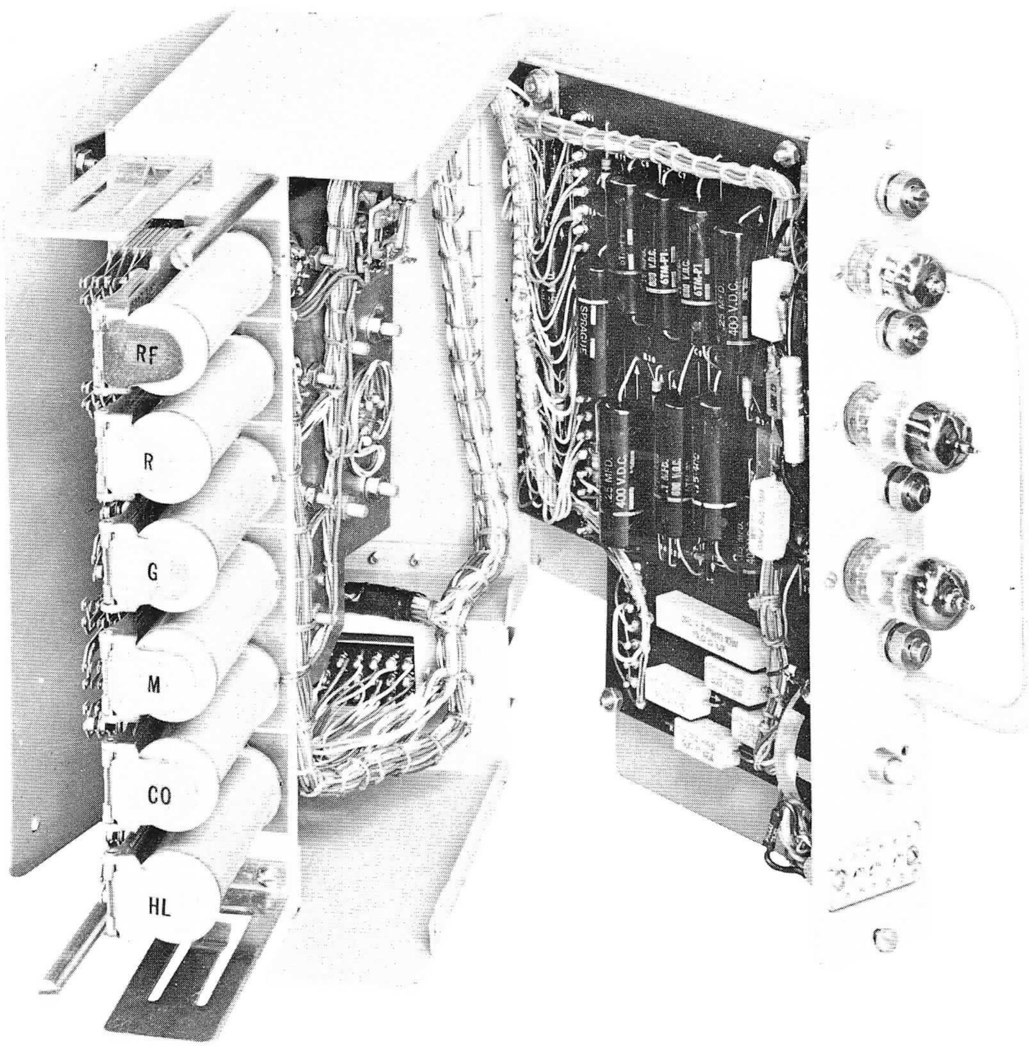
SINGLE-FREQUENCY SIGNALING EQUIPMENT

TYPE A.S.F.-1

Technical bulletin **860**

AUTOMATIC ELECTRIC
GENERAL SYSTEM
Subsidiary of
GENERAL TELEPHONE & ELECTRONICS

TABLE OF CONTENTS



Single-Frequency Signaling Unit

BULLETIN NUMBER 860

SINGLE FREQUENCY SIGNALING EQUIPMENT TYPE A.S.F.1

1. INTRODUCTION.

The primary function of any telephone circuit is to transmit information. This information is basically of two general types: voice-transmission and signaling. In this technical bulletin the emphasis is placed on signaling.

The frequency range for standard voice transmission over telephone circuits lies between 200 and 3000 cycles per second. The frequency range for signaling, over these same telephone circuits, is quite low. A familiar example of low-frequency signaling is a train of dial pulses, or just the opening and closing of the d-c circuit by means of the telephone hook or cradle switch. These signals can not be transmitted by carrier systems or by systems that employ voice frequency repeaters. The very design of carrier circuitry is such that it will handle only signals of voice frequency or higher.

2. SINGLE-FREQUENCY SIGNALING EQUIPMENT.

Automatic Electric Company's Single-Frequency Signaling Equipment Type A. S. F. 1 is designed to convert the standard d-c or low-frequency ringing signals into a-c tone spurts that are able to go out over a carrier channel. At the other end of the channel another Single-Frequency Signaling Unit reconverts the voice-frequency a-c back to the original signal form for the operation of the switching equipment.

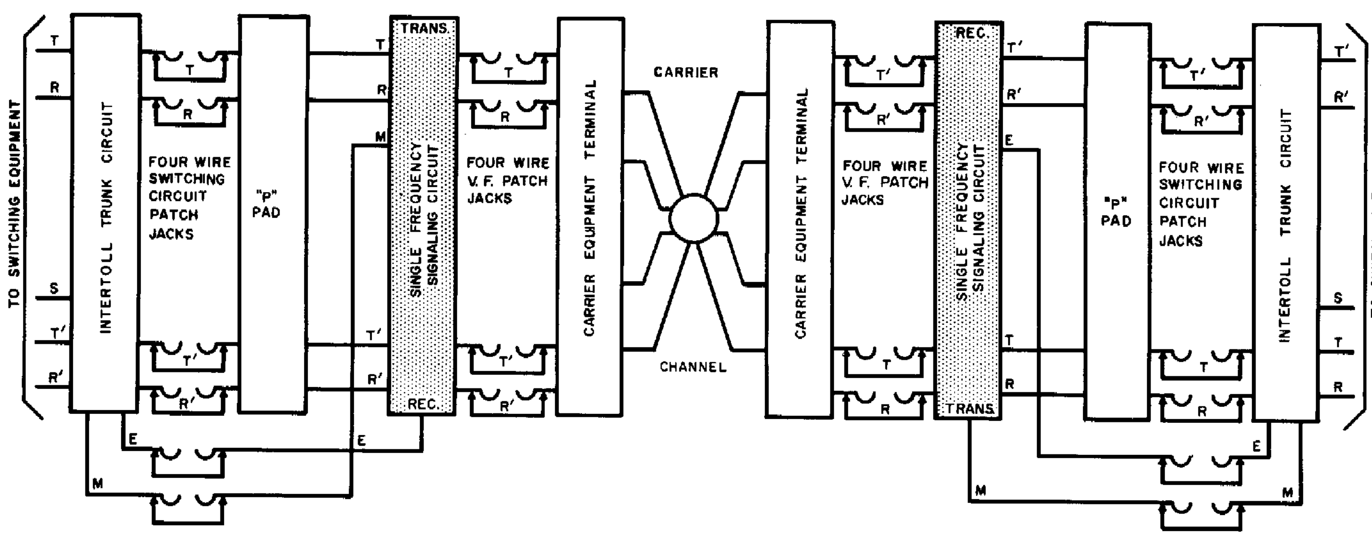


Figure 1. - Carrier Channel with Single-Frequency Signaling

Figure one illustrates the location of the Single-Frequency Signaling Equipment in a typical toll circuit.

2.1 Operating frequencies. The operating or signal-frequencies are 2600 and 2400 cycles per second. If the facility operates entirely on a four-wire basis, the 2600 cycle frequency is used in both directions. However, if there is any two-wire operation anywhere on the channel, then both frequencies must be used, 2600 cycles in one direction and 2400 cycles in the other. Wherever possible the 2600 cycle frequency should be used toward the larger office. This practice eliminates the need for 2400 cycle equipment in small offices, except for test purposes.

2.2 Terminology. The following three paragraphs define some of the more commonly used terms of telephony as applied to the Single-Frequency Signaling System. For the complete listing of these terms and an explanation see chart A on the fold out at the back of this bulletin.

2.2.1 ON-HOOK. This term indicates that the Single-Frequency Signaling Unit is at a stand-by basis; this can be compared to a subscriber's substation being at stand-by when the handset is on the cradle switch or hook. Instead of being open to d-c when ON-HOOK as is the subscriber's telephone, the signaling units send a steady low-level tone across the channel to the other unit. This condition is also called the Tone-On condition.

2.2.2 OFF-HOOK. This term is exactly the opposite of ON-HOOK. When the signaling unit is not sending the steady-low-level tone toward the other end, it is considered as OFF-HOOK. In the case of the subscriber's handset being off the cradle switch and the d-c circuit being closed, this term indicates that the equipment is in use. This condition is referred to as the Tone-Off condition.

2.2.3 IDLE. When both signaling units on a channel are ON-HOOK, the units are considered IDLE. In other words, both of the units are sending and receiving the steady low-level tone.

2.3 E and M lead signal transmission. In figure one notice the arrangement of the E and M leads. It is through these leads that the signaling equipment receives and transmits its signals. When dial pulses are sent to the signaling equipment by the switching equipment, they are sent via the M lead as applied ground or office battery. When the receiving end of the channel sends the reconverted signals from the carrier to the central office, this is accomplished over the E lead. The signals on the E lead are either applied ground or open circuit. A complete list of the possible conditions of both the E and M leads is shown on chart B at the back of this bulletin.

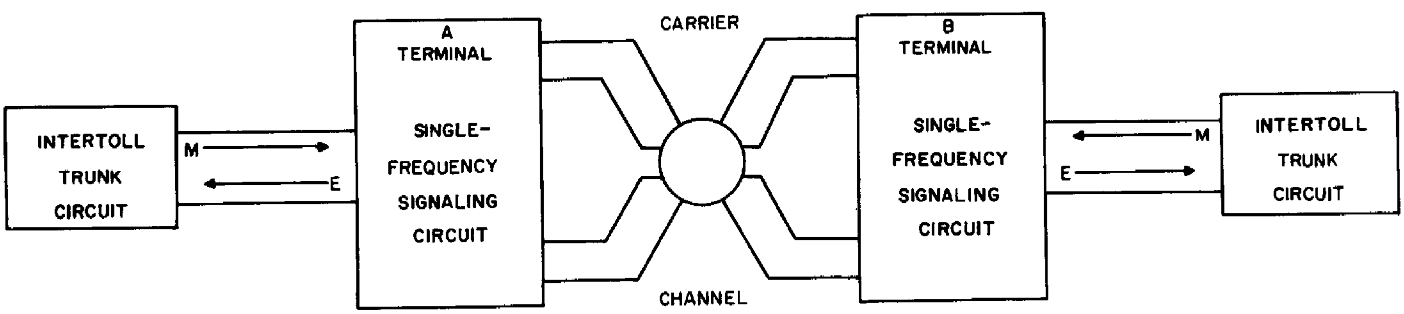


Figure 2. - Single-Frequency Signaling Circuit with E and M Signaling

Figure two is a block diagram showing the relationship of the E and M leads to the signaling equipment.

2.4 Signaling components. The signaling circuit of the Single-Frequency Signaling System is made up of five units. These units are: the stable oscillators, the miscellaneous jack strip, the tone transfer circuit, the tone resistance supply circuit, and the signaling units.

2.4.1 Oscillators. The oscillators used in the Single-Frequency Signaling System supply a signal tone, with no more than plus or minus five cycles deviation from the set frequency, to the signaling units. Each pair of oscillators is load rated at one hundred twenty signaling units. Actually either oscillator is capable of supplying all the one hundred twenty units but such an arrangement would not leave a margin of safety in case one oscillator should fail.

2.4.2 Miscellaneous jack strip. The oscillators are connected to four pairs of jacks on the miscellaneous jack strip. These jacks do not enter into the operation of the signaling equipment except for testing or if it is necessary to patch in an outside source of signal-frequency tone.

2.4.3 Tone transfer circuit. If one oscillator should fail the tone transfer circuit would operate and switch over the entire load to the remaining oscillator. At the same time this circuit would signal an alarm condition.

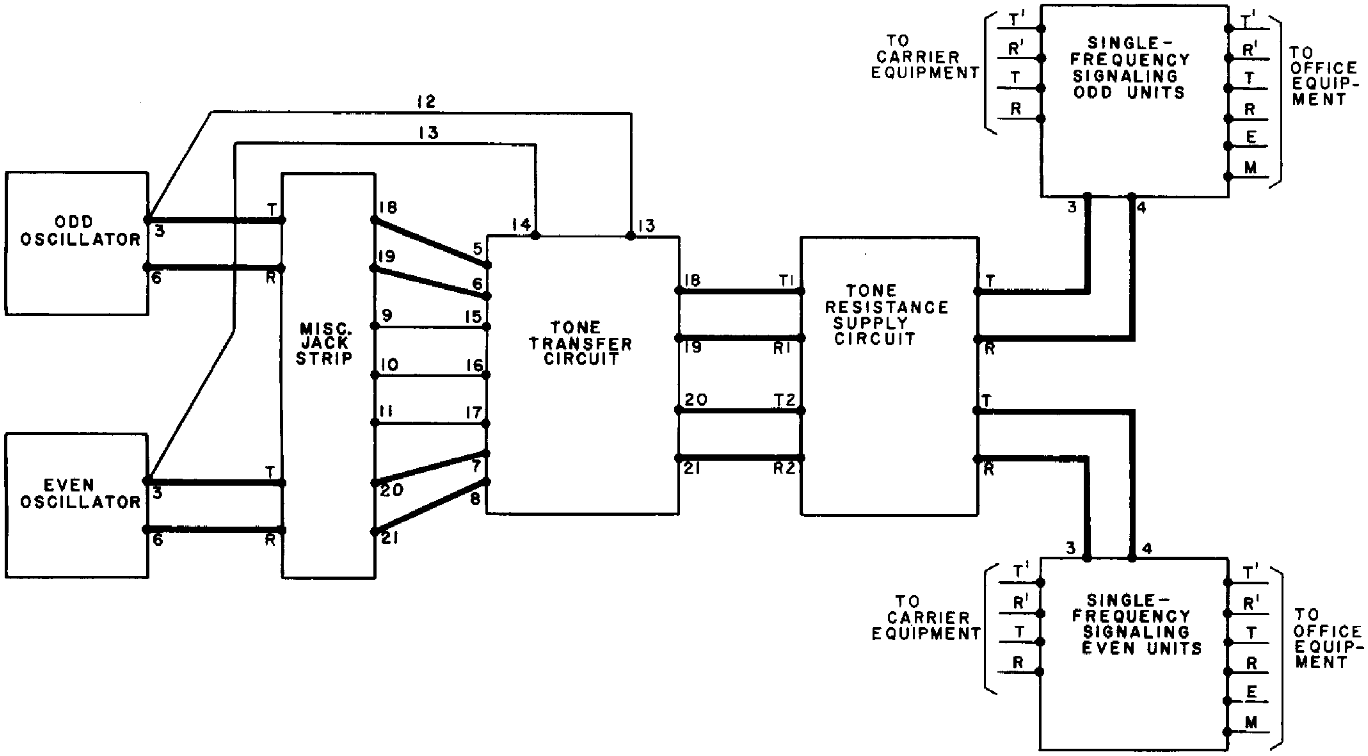


Figure 3. - Single-Frequency Signaling Equipment

Figure three is a block diagram of the components for supplying the signal-frequency tone to the Single-Frequency Signaling Units.

2.4.4 Tone resistance supply circuit. The tone resistance supply circuit is arranged to isolate the Single-Frequency Signaling Units by supplying tone through a pair of six hundred thirty-four ohm resistors to each unit. This circuit is also equipped with an auto-transformer which permits various levels to be tapped off while a single level is carried through the tone transfer circuit.

2.4.5 Single-frequency signaling units. The Single-Frequency Signaling Unit does the actual converting of the d-c signals to the tone pulses; it also reconverts the received pulses into d-c signals to operate the local switching equipment. It is necessary to have one of these signaling units at each end of the channel.

2.4.5.1 Two-wire filters. When the Single-Frequency Signaling System is to be used on a channel with two-wire operation, an echo-suppression filter network will be necessary.

2.4.6 Voltage requirements. The Single-Frequency Signaling Equipment requires a negative forty-eight volt source for the operation of the relays, and a positive one hundred thirty volt source for the plate voltage of the electron tubes.

3. CIRCUIT OPERATION.

The output of the oscillator, figure four at the back of the bulletin, is extended over the T and R leads. There is one such pair of leads for the odd oscillator and one pair for the even. The path of the Single-Frequency Signal Tone is shown by the heavy lines. As shown in figure four, the tone is extended through the miscellaneous jack strip to the tone transfer circuit.

In the tone transfer circuit, under normal conditions, the outputs of the oscillators are further extended via the contacts on the relays T1 and T2 to the tone resistance supply circuit.

Also from the output transformer of each oscillator, terminal three, a detector lead is extended to the grids of the detector tubes V-1 and V-2 of the tone transfer circuit.

Once through the tone transfer circuit the oscillator output is put across an autotransformer in the tone resistance supply circuit. The autotransformer gives several possible output levels and enables this equipment to be used with several different facilities without the need of major rewiring. In the tone resistance supply circuit a pair of six hundred thirty-four ohm resistors for each Single-Frequency Signaling Unit is provided for isolation and proper signal level. From the resistance network the signal tone is extended to the Single-Frequency Signaling Units.

3.1 Oscillators. The circuit of the oscillator (figure five) is essentially a Wein Bridge type. This circuit consists of a balanced bridge oscillator and an amplifier. The balanced bridge circuit is made up of four arms equipped as follows: (ARM 1.) the thermister TH and the resistor R-5 in series; (ARM 2.) resistor R-2 and the volume control resistor VOL in series; (ARM 3.) resistor R-4 and capacitors C-4A, C-4B, and C-4C in parallel; and (ARM 4.) resistor R-3 in series with capacitors C-3A, C-3B, and C-3C in parallel. The two parallel capacitor combinations are shunted by the FREQ. ADJ circuit which consists of a .0003 microfarad capacitor and a 35 micro-microfarad variable capacitor in series.

When the toggle switch is closed, battery is put on the plates of both halves of the twin-triode electron tube. This tube is a 5814-A, otherwise known as a 12AU7.

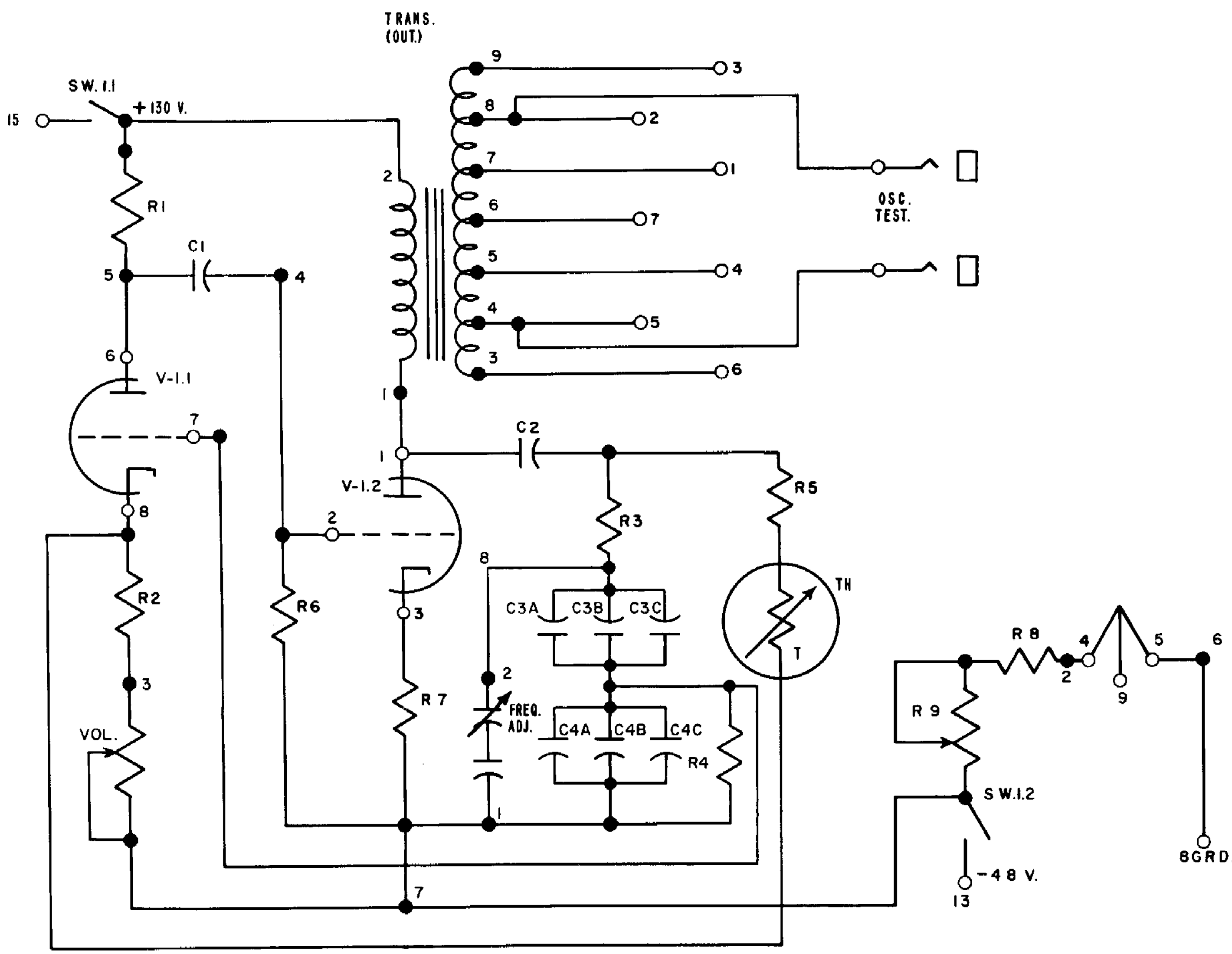


Figure 5. - Oscillator Circuit

The voltage across the heater can be adjusted to twelve and six-tenths volts by potentiometer R-9. When the oscillator first starts, a small amount of negative feedback is coupled to the cathode of V-1. 1 by the high resistance of the thermister TH. As the oscillator warms up, the thermister resistance decreases and increases the amount of negative feedback until the oscillator levels off. The thermister permits the oscillator to reach a stable condition very quickly and then limits its amplitude to reduce distortion. Both halves of the twin-triode are operated class A to reduce distortion.

The amplitude of the output voltages are controlled by the potentiometer VOL. The amplitude control is accomplished in this manner: an increase in the resistance of the potentiometer VOL. increases the negative feedback current of electron tube V-1. 1 and also increases the voltage negative feedback from electron tube V-1. 2 through the thermister TH. Both effects cause a decrease of amplitude.

The oscillator test jacks are connected to terminals 2 and 5, and are used to monitor the oscillator output without interfering with the signal tone being sent to the signaling units.

3. 2 Miscellaneous jack strip. The odd oscillator output is connected to the ODD OSC. OUT jacks and from there to the ODD LOAD jacks. The even oscillator is connected in the same manner to the even jacks. As indicated in figure four, the ODD or EVEN OSC. OUT jacks permit the testing of the oscillator output while removing the monitored oscillator from the signaling circuit. If a plug is inserted into either of the OSC. OUT jacks no alarm is signaled and the load is transferred to the other oscillator. For more information on this function of the signaling circuit see paragraph 3. 3 on the operation of the tone transfer circuit. If a plug is inserted into either of the ODD or EVEN LOAD jacks, relay D in the tone transfer circuit operates and signals a major alarm. This same action also lights the green load lamp. If these jacks are not used the tone is connected through to the tone transfer unit.

3. 3 Tone transfer circuit. From the ODD and EVEN LOAD jacks the oscillator output is extended to the input of the tone transfer circuit. The function of the tone transfer circuit is to act as a constant check on the output of the oscillators. This circuit uses two electron tubes as signal detectors. These are 6201 otherwise known as 12AT7 type twin-triodes. The tubes are connected so that if either oscillator fails, the load will be switched to the remaining oscillator and a minor alarm is signaled.

The Single-Frequency Signal Tone comes into the tone transfer circuit from the ODD and EVEN LOAD jacks on the miscellaneous jack strip. From the LOAD jacks, leads 5 and 6 carry the odd oscillator's output, and leads 7 and 8 carry the output of the even oscillator. Figure three shows these leads as heavy lines. Under normal conditions the signal tone is sent out from the tone transfer unit to the tone resistance supply unit over leads 18 and 19 for the odd oscillator, and 20 and 21 for the even.

The detector signal for the odd oscillator is brought directly from the highest level tap on the output transformer of the odd oscillator to the grid of the detector tube V-1 and likewise from the even oscillator to the grid of tube V-2.

A detector tube functions in this manner. Capacitor C-1 couples the signal tone to the grid (terminal 2). The triode elements one, two, and three of the left half of the tube amplify the tone which is coupled through capacitor C-2 to the plate and grid (terminals 6 and 7) of the right half of the tube. Positive halves of the signal tone sine wave cause current to flow through the cathode (terminal 8) to capacitor C-3. The positive charge on capacitor C-3 connected through resistor R-2 makes the left half grid (terminal 2) less negative. This causes a high plate current which in turn holds the plate relay B1 or B2 operated.

When the tone fails or becomes weak, the positive charge on capacitor C-3 is dissipated in resistor R-4 and the grid terminal 2 becomes negatively biased causing the plate current through relays B1 or B2 to become low, causing the relay to release.

When relay B1 for the odd oscillator or B2 for the even oscillator is restored, relay T1 or T2 will operate. This action will switch the entire load of signaling units to the remaining oscillator. At the same time a minor alarm will be signaled. Should both oscillators fail at the same time, then relays B1 and B2 in restoring will operate relay D to signal a major alarm. The leads on terminals 15, 16, and 17 are used to cause T1 or T2 relays to transfer the signal-unit load or to cause relay C to give an alarm when a plug is inserted into the OSC. OUT or LOAD jacks at the miscellaneous jack strip.

The tone transfer circuit is equipped with several safeguards to assist it in its job of monitoring the outputs of the oscillators. Should either detector tube fail, or should anything go wrong with either detector circuit, the load would be shifted and a minor alarm signaled.

There are two toggle switches in the tone transfer circuit. These switches are used to test the tone transfer circuit by restoring either or both relays B1 and/or B2. In this way the switching actions of the relays T1 and T2 can be checked.

The two red lamps of the face of the tone transfer unit are alarm lamps for the odd and even switching circuits. The green lamp is lighted when an outside source is supplying the signal tone to the signaling circuit. The white guard lamp is lighted when the alarm cutoff button is depressed and indicates that a minor alarm has been canceled but the necessary corrective action has not yet been taken.

3.4 Tone resistance supply circuit. From the output of the tone transfer circuit the signal-frequency tone is connected to the input of the tone resistance supply unit. The input of this unit is an autotransformer which serves an important function in this circuit. As discussed in paragraph 3.1, the tone transfer circuit is arranged for only one pair of leads from each oscillator. However, different communications systems require different dbm levels and the utilization of the autotransformer provides required levels of negative sixteen, negative thirteen, and negative four dbm.

This tone resistance supply circuit provides a pair of six hundred thirty-four ohm resistors for each Single-Frequency Signaling Unit in the system. These pairs of resistors are used to provide tone at the proper level to the signaling units and to isolate the units one from another in case of trouble in the signaling circuits of any particular unit.

3.5 Single-Frequency Signaling Units. The operation of the Single-Frequency Signaling Unit in its primary function of converting and reconverting the d-c dial pulse signals to and from a-c tones can be divided into three basic sections:

(1) the receiver section;
(2) the transmitter section; and
(3) the circuit control section.

NOTE: Starting with this point in this circuit description, it will be helpful to unfold the pull-out circuit drawing, figure 6, at the back of the bulletin and have it available for reference. This drawing is a complete wiring diagram and shows all the components used in a Single-Frequency Signaling Unit. For ease of reading, values of components have been omitted. These values are available from Automatic Electric Company's drawing H-85825. The upper left corner of this drawing shows the circuitry of the two-wire filter and its connecting leads. The signaling unit as shown in figure E is in the idle condition; that is, all the relays are restored except R and RF. This is an attached contact drawing.

3.5.1 Receiver section. The circuitry of the receiver section of the Single-Frequency Signaling Equipment can also be divided into three parts. These three working stages are:

(1) the input stage;
(2) the frequency selection stage, which consists of a signal detector, a guard detector, and a pulse correction unit;
(3) the d-c amplifier stage.

3.5.1.1 Input stage. The input stage of the signaling unit receiver consists of input transformer T-1; one-half of the twin triode electron tube, (V-2.1); output transformer T-3; a frequency-selective shunt feedback path; and various resistor-capacitor combinations explained in the text.

One of the more important functions of the input stage is to couple itself to the Line Receive pair of leads without causing excessive impedence mismatch or bridging loss. T-1 is designed to function as an isolation transformer and isolates the balanced-to-ground toll circuit from the unbalanced-to-ground voice input circuit. The resistor-capacitor combination is designed to give the circuit considerably less sensitivity at the low end of the voice-frequency range, as compared to the upper end. This is done to give comparative freedom from low-frequency interference.

The input stage of the receiver is designed to reject low-frequency noises by these means: at the lower frequencies, for instance twenty cycle ringing or sixty cycle inducted power noise, the impedence of the primary coil of transformer T-3 is quite low in respect to the resistor R-21 causing a large voltage drop across R-21. Capacitor C-4 couples this voltage to resistor R-18 in the grid circuit of the input amplifier tube. This causes a negative feedback and reduces the gain of the tube. Capacitor C-5 connects the primary of transformer T-3 to the cathode of tube V-2.1 at the high-frequencies eliminating the effect of resistor R-21 at frequencies in the audio range.

The amplifying characteristics of the circuit based on the triode electron tube V-2.1 are engineered so that the circuit is most effective as an amplifier at the low-level inputs of the voice-frequency band. As the input level rises, the gain drops off. This puts an upper limit on what is fed into T-3.

This output limiting system is apt to produce harmonics which could be rectified in the guard circuit. See paragraph 3.5.1.2. This action could possibly over-control the d-c amplifier to the point where it might disturb the service of the signaling unit by activating the guard circuit. These harmonics are eliminated before they can cause any trouble by the inductance of T-3 and the capacitive reactance of capacitor C-6.

In the aforementioned circuits, it may be assumed that above 3000 cycles per second, response will fall off. Since there is very little speech or signal input energy at these higher frequencies, the response here is not too important. In fact the falling off of the high-frequency response aids in the elimination of high-frequency noises.

3.5.1.2 Frequency selection stage. T-3 is both the last component in the input stage and the first component in the frequency-selection stage. From the secondary winding of T-3 the incoming signal is put across two tuned networks. One of these networks (F 1-1) is tuned anti-resonant at the signal-frequency and will develop an a-c voltage, known here as the signal voltage, which is directly proportional to the energy of the signal-frequency in the incoming speech or signal. All frequencies other than the signal-frequency (2600 or 2400 cycles per second) will not develop a voltage across terminals 1 and 2. The other filter network (F 1-2) is tuned to be series-resonant at the signaling frequency and also develops an a-c voltage. This voltage is called the guard voltage and is directly proportional to the energy of the frequencies other than the signal-frequency in the incoming signal. The guard voltage is generated across terminals 3 and 4. In the guard filter network (F 1-2) the signal frequency will not develop an a-c voltage.

Each of these two tuned filter network circuits is shunted by a half-wave rectifier, and a resistor and capacitor load circuit. The actual signal detection circuit consists of rectifier D-2, resistor R-27, and capacitors C-7 and C-8. The guard detection circuit is made up of the electron tube V-3.1 connected and operated as a diode rectifier, resistor R-26, and the capacitor C-9.

As shown in the circuit drawing, (figure six) the signal and guard voltages are in series and add their respective voltages. This còmbined voltage is placed on the grids of the d-c amplifier tubes V-3. 2 and V-2. 2 These two voltages are opposite in polarity. The guard voltage is intended to drive the grids of the amplifier tubes more negative than the normal negative tube bias. Thus, if the signaling unit receiver is prepared to receive speech, and a tone spurt of either off-signal-frequency or signal and off-signal-frequencies is received, the guard circuit will function and will generate a voltage that will tend to cancel out any incoming signal pulse unless it is a pure tone of only the signal-frequency. This arrangement is used to assist in preventing false signaling.

One of the conditions that was not covered on chart A, is the intercept or talk-between-operators. The signaling system is designed so that the intercept operators at the ends of a toll circuit can talk to one another without interfering with the signaling that may be going on over the same circuit. Because of this it is important to remove the frequency-selectivity as well as the guard circuit. This is done when the receiving ON-HOOK condition continues for more than two hundred thirty milliseconds, at which time relay G restores.

Relay G controls the selectivity spread of the input circuit. When relay G is restored to its unoperated condition, the selectivity of the receiver is broadened to include all of the voice-frequency band.

In this type of circuit the guard section of the receiver must be cut out when the unit is in the IDLE condition. Otherwise the guard would frequently respond to stray signals causing relay R to restore and seize the unit every time a burst of noise came in over the carrier. Relay G, which is shunted down when relay R is operated, shorts the F 1-2 guard network and places resistor R-23 in series with the F 1-1 signal network. This makes the receiver non-selective until the tone is removed and relay G operates, which it does quite fast. In addition, the band-elimination filter, which is always inserted under any ON-HOOK condition, will prevent the tone from interfering with voice transmission.

3. 5. 1. 3 D-C amplifier stage. Though the guard circuit mentioned in the previous paragraph is quite important in the elimination of false signaling, it is not able to do the job alone. As previously discussed, most of the energy in the voice-frequency transmission range when transmitting speech is in the lower frequencies, and so a relatively high signal-frequency was chosen; those frequencies were 2600 and/or 2400 cycles per second. However, it might still be possible for the speech transmission on the channel to, for a very short time, imitate the signal-frequency close enough to activate the exchange switching equipment and thus send false signals.

To prevent this, and thus to avoid toll or long-distance wrong numbers wherever possible, an electronic time delay circuit is used. Variable resistor OT and capacitor C-12 control this resistor-capacitor time delay circuit. The delay is set for approximately forty milli-seconds. This means that before the plate current of electron tube V-3. 2 rises enough to operate relay R, which puts the ground signal on the E lead, a pure signal-frequency tone must be received for at least thirty-five milliseconds. The minimum pulse necessary to just barely operate relay R is slightly less than the actual elapsed time before the E lead is grounded by relay R. This is because of the short length of time needed for the mechanical operation of the relay armature and the delay factor in the decay of the charge on capacitor C-12. In order to minimize this latter effect, the rectifier D-3 is bridged across the potentiometer OT. The rectifier is disconnected during the IDLE condition to remove the continuous reverse voltage which might shorten its working life through contacts 6B-7B of relay G.

This arrangement is very important from the standpoint of eliminating any interference with speech and dial pulsing. When any dial pulses are received by the signaling equipment it is most important that there should be no carry-over or memory effects from one pulse to the next. Such an effect is called "first-pulse distortion".

The two d-c amplifier electron tubes are controlled by the combination of the signal and guard voltages applied to the grids. The primary function of these two tubes is to operate the receiver relays R and RF. When a signal tone is not being received, both of these tubes are biased near to cut-off by a six volt drop across resistor R-37 which makes the cathodes more positive than their grids. Note that the resistor OT -capacitor (C-12) time delay circuit is connected only to the grid of the tube V-3. 2 and not to the grid of V-2. 2. This arrangement causes relay RF to operate in twenty milliseconds, and relay R to operate in forty milliseconds after the tone starts.

When this Single-Frequency Signaling Unit is used as a part of a built-up connection, such as might occur in the majority of toll calls, the early operation of relay RF inserts the F 1-3 and F 1-4 filter networks into the incoming talking path to prevent the incoming signal-frequency from passing on to a succeeding unit at the next office. The tuning filter network (terminals 5-6 and 7-8) in the Line Receive transmission path forms this blocking circuit. This network is actually a band-elimination filter which must be cut out of the circuit during speech.

There is still another safety device to protect a unit from false signaling. That is, when the receiver is set up to receive dial pulses at the incoming end, a negative voltage is momentarily produced in the grid circuit of tube V-2. 2 and V-3. 2. One side of capacitor C-15 is connected to ground through contacts 7B-8B of relay M, or to battery through the contacts 4T-5T of relay HL and the coil winding of relay HL. At the instant relay M restores in transmitting the start-dial signal toward the originating end, the potential on capacitor C-15 changes from ground to negative forty-eight volts. This change induces a negative surge through capacitor C-15 and resistor R-34 to the point between capacitors C-9 and C-10. This condition will hold the tubes V-2. 2 and V-3. 2 insensitive for about twenty milliseconds to prevent premature operation of relays RF and R.

3. 5. 1. 4 Pulse corrective system. In converting and reconverting the dial pulses the receiver section operates on a pulse-corrective basis. Should a pulse be received that is too short, it will be elongated. If a pulse is longer than it should be when it is received it will be shortened. In theory, the most perfect pulses are those where the release time is almost the same length as the operating time.

The pulse correction feature is a very important feature of the receiver section. This corrective action is designed to operate on a percentage basis; that is, the more distorted pulses are when they are received by a Single-Frequency Signaling Unit the more they will be corrected. This principle holds true for a train of pulses passing through several signaling unit receiver-transmitters in tandem. In fact the more signaling units that are on the channel the closer to perfection the pulses will become. The pulse corrective feature is more effective when the pulsing speed is higher, where it is more important that the pulses are accurate.

The pulse correction circuit operates in this manner. The R relay controls the E lead signaling through the 3B-4B contacts. The R and RF relays are arranged so that the RF relay will operate twenty milliseconds after the tone pulse is received. The R relay will operate forty milliseconds after the start of the tone pulse.

Relays R and RF are restored before the pulses begin. When a pulse comes into the receiver section, it comes on the Line Receive path. The pulse is rectified by the diode D-2 and the rectified pulses charge up the capacitors C-7 and C-8. As these capacitors charge they act as a filter and in turn put a positive or less negative potential on the grid of tube V-2. 2. As soon as this grid is driven positive the tube conducts. When V-2. 2 conducts, relay RF operates. Contacts 1T-2T of relay RF close the circuit that puts a positive one hundred thirty volt charge on capacitor C-14. This circuit is from battery through resistor R-13, through the above mentioned contacts, through contacts 5T-6T of relay R. When the pulse ends, if it is too short, the tube V-2. 2 will have its grid restored to the normal negative six volts. This will cut off the tube and restore relay RF. However, twenty milliseconds after relay RF operates relay R operates. Contacts 5T-6T of relay R disconnect capacitor C-14 from battery. Contacts 3T-4T put the positive one hundred thirty volt charge through resistor R-33, through the 4T-5T contacts of relay G, through variable resistor RT to the grid of tube V-3. 2. Variable resistor RT is part of the resistor-capacitor time delay circuit that determines the length of the pulses. This resistor is arranged so that the voltage drop across it lessens as the charge on capacitor C-14 decays. This circuit keeps a steady positive potential on the grid of tube V-3. 2, (in relation to the cathode). This bias is actually a negative forty-two volts, or six volts more positive than the negative forty-eight volt office battery. As long as there is a positive potential on the grid of tube V-3. 2, then relay R will remain operated and will signal the central office an open circuit on the E lead. Part of the positive charge from capacitor C-14 will drain off through the grid to the cathode of tube V-3. 2 to the office battery through resistor R-37. When relay RF restores more of this charge will drain off through contacts 1T-2T of relay R, through contacts 3T-4T of relay RF, through resistors R-17 and R-28 to battery.

Should the incoming pulses be overlong, then the resistor-capacitor time delay circuit mentioned in the previous paragraph is not used; however, capacitor C-14 and resistor RT still enter into the circuit. Since relay RF operates and restores very rapidly, it follows the tone pulses and operates and releases on the first pulse. The rectified and filtered positive pulse from the next incoming dial pulse will drive the grid of tube V-2. 2 very positive. This sudden and intensive change of the grid potential of tube V-2. 2 will cause it to conduct current through the winding of relay RF. This will suddenly make the plate of tube V-2. 2 only half as positive as it was just a moment before. The plate potential drops from a positive one hundred thirty volts to a positive sixty to seventy volts. This sudden drop in potential is connected to the tube side of capacitor C-14. When one side of a capacitor changes its voltage very suddenly the other side must also change. This very negative charge causes a bias through the 3T-4T contacts of relay R, the 3B-4B contacts of relay M, the 4T-5T contacts of relay G, through the variable resistor RT to the grid of tube V-3. 2. This negative charge on the grid of tube V-3. 2 pushes it far negative and stops the tube from conducting. Once the tube V-3. 2 stops conducting current, relay R restores, which puts a ground signal on the E lead. This method of restoring relay R very rapidly prepares it for the next incoming pulse.

The remainder of the negative charge drains off through resistor R-31, diode D-3, the 6B-7B contacts of relay G, and finally to the positively charged capacitors C-7 and C-8. After this negative charge has dissipated the positive charge on the capacitors C-7 and C-8, through variable resistor OT, resistor R-31 makes the grid of tube V-3. 2 positive again to operate relay R for the next pulse.

3. 5. 2 Transmitter section. As described in paragraph 3, the signal-frequency tone, either 2600 or 2400 cycles per second, is supplied to the signaling units by the oscillators. This tone is put across the Line Transmit circuit through the break contacts 5T-6T and 5B-6B of relay M. This relay is controlled by a direct ground or applied battery through the M lead by its associated switching equipment trunk circuit. While ground is applied to the M lead, it signals the IDLE or ON-HOOK condition. When battery is applied, relay M operates and signals the OFF-HOOK condition. See chart B for a chart of all conditions of the E and M leads.

The percent make of the tone pulses from relay M can be adjusted by means of potentiometer M. It and resistor R-14 place the coil of relay M slightly negative from ground. A more negative adjustment causes relay M to operate slower and restore faster.

Relay M is arranged to switch the band-elimination filter network into the Line Receive voice path. This action takes place whenever the M relay is restored and the transmit section is sending tone over the channel. In this particular function relay M shares the duties with relay RF. The contacts 1B-2B and 3B-4B of relay RF are connected with the contacts 7T-8T and 3T-4T of relay M in such a way as to permit either relay to switch it into the voice path; relay M when it restores, and relay RF when it operates. The circuit arrangement of these relays is such that if either of the two relays switches it in the voice path the other cannot remove it, but can hold it in the circuit should the first relay relax control.

In addition to the aforementioned functions, the contacts 1B-2B and 7B-8B of relay M control the line-splitting relay, relay CO, and the level-control relay, relay HL. During dialing, relay CO momentarily cuts out the Line Transmit path in both directions. This is done to prevent noises originating in the switching equipment from interfering with the signaling. The purpose of the HL relay is to raise the tone level of the outgoing signals during the actual dialing, by enabling them to override any noise that might happen to be on the channel. It also insures that the switching equipment at the far end of the channel will be operated correctly by the pulses. Retard coil D is in the circuit to provide a continuous drainage path to ground.

3.5.3 Circuit control sections. The guard detector circuit is switched out of the receiver circuit and the frequency response of the receiver is broadened after the Single-Frequency Signal Tone has been received for a period of two hundred thirty milliseconds. See chart D at the back of this bulletin for the explanation of the relay operation.

This action is under the control of the incoming tone signal. Should the signal-frequency tone go off the channel for fifteen to twenty milliseconds, the guard circuit and the frequency-selection circuits would be switched back into the receiver circuit and would remain there until a full two hundred thirty milliseconds of steady, pure, signal-frequency tone was received. This arrangement keeps the signaling unit free from false E lead seizure while the unit is in the IDLE condition.

3.5.4 Two-wire channel. Should this signaling equipment be used on a channel that has two-wire operation instead of the more common four-wire operation, different sending frequencies must be used in each of the two directions. One end of the channel sends 2600 cycles and the other sends 2400 cycles. In addition there must be a two-wire filter unit installed ahead of the Line Receive terminals of the signaling unit. The purpose of this filter is to prevent echoes of the transmitted frequency from reaching the receiver guard circuits.

This filter is a balanced band-elimination filter. The filters are mounted four to a panel (figure twenty-one). The wiring diagram of the filters is shown on figure six in the upper left-hand corner. Note the A lead and its connection to the F relay.

Relay F is operated over the A lead through the contacts 5T-6T of relay RF restored, and contacts 7B-8B of relay M. In order for relay F to operate, relay RF must be restored and relay M operated.

4. PHYSICAL DESCRIPTION OF THE SIGNALING EQUIPMENT.

The Single-Frequency Signaling Equipment and its associated test equipment is built to mount on the standard nineteen inch panel. For the arrangement of this equipment on the signaling and common equipment racks see the chapter on ordering information.

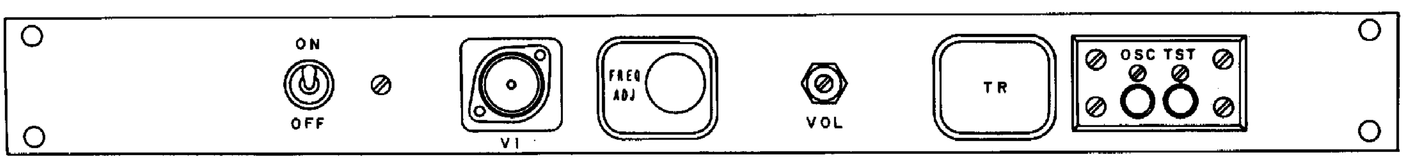


Figure 7. - Oscillator Panel

4.1 Oscillators. Figure seven represents the standard width one and three-quarter inch panel that the 2600 and 2400 cycle oscillator components are mounted on. As illustrated above, the on/off switch is at the far left. The 5814-A electron tube is mounted on the cover of a replaceable turret. This turret contains the components necessary to generate the 2600 or 2400 cycle signal tone. The factory adjusted frequency is marked on the side of this turret. The volume control potentiometer is a screwdriver adjustment located on the front of the panel between the frequency adjust turret and the output transformer turret. The frequency adjust turret has a snap-off cap that permits easy access to the variable capacitor inside. The test jack is mounted to the right of the output transformer.

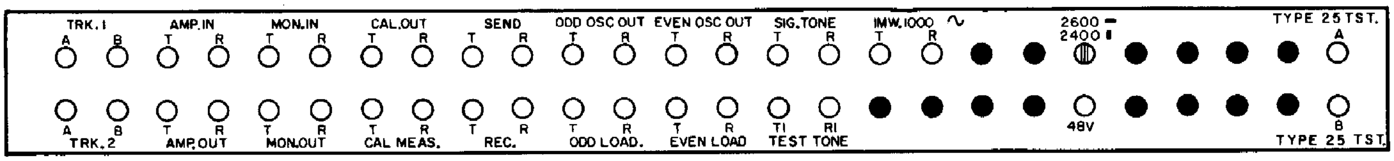


Figure 8. - Miscellaneous Jack Strip

4.2 Miscellaneous jack strip. The drawing of the miscellaneous jack strip shows all the jack positions on the strip that are used. Those jack spaces shown in figure eight as solid black dots are not being used and are equipped at the factory with plugs. The miscellaneous jack strip is the standard type of jack strip equipped with the special features necessary for operation with the Single-Frequency Signaling System.

The miscellaneous jack strip serves as an access for the test battery supply unit, the monitor amplifier unit, the sending and/or receiving sections of any of the signaling units, and the one thousand cycle office test tone. There is, on the strip, a means to calibrate the tone transfer unit. Also on the jack strip are four pairs of jacks which are connected so as to permit either of the two oscillators to be monitored from the jack strip and at the same time, if necessary, to switch either of the oscillators out of the signaling circuit. This same arrangement permits an outside source of signal-frequency tone to be put directly into the signaling circuit. This feature is especially useful in the instance where both oscillators fail at the same time. By using the LOAD jacks an immediate return to service can be accomplished with a minimum of down-time. Should more than two oscillators be used in a signaling system, some of the jack spaces that are plugged can be equipped to service these circuits. Notice the turn switch which permits a choice of frequencies at the SIG TONE and TEST TONE jacks. For a complete list of the functions of the miscellaneous jack strip see chart C at the back of this bulletin.

4.3 Tone transfer unit. Figure nine is a line drawing of the front of the tone transfer unit. This drawing shows the components mounted on a nineteen inch double width (three and one-half

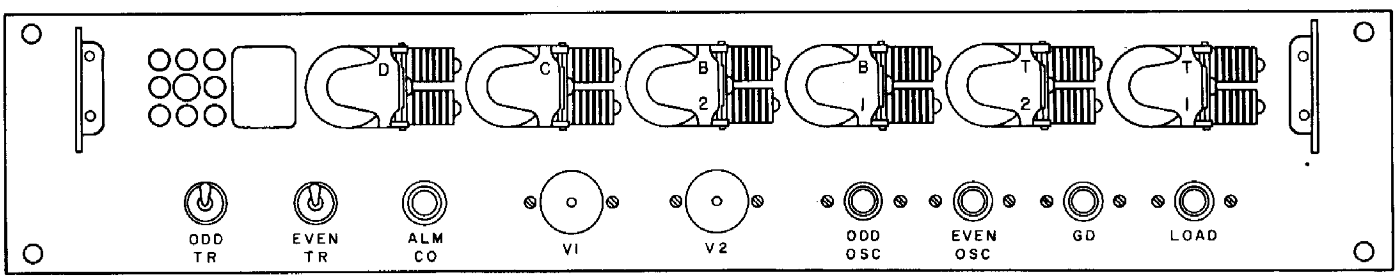


Figure 9. - Tone Transfer Unit Panel

inch) panel. The bottom half of this panel is equipped from left to right as follows: the toggle switch for testing the odd oscillator tone transfer circuit, the test switch for the even oscillator circuit, the minor-alarm cutoff push-button, the V-1 and V-2 electron detector tubes, the red alarm lamps for the odd and even tone transfer circuits, the white alarm lamp for the guard-out condition, and the green alarm lamp for the outside signal tone source condition.

4.4 Tone resistance supply unit. The tone resistance supply unit as shown in figure ten is mounted on the signaling rather than the common equipment rack. This panel has two transformers mounted on the front and a terminal-block mounted on the back. The terminal-block is equipped with the six hundred thirty-four ohm resistors. The tone resistance supply unit is mounted on a three and one-half by nineteen inch panel.

4.5 Single-Frequency Signaling Units. The frontispiece illustrates a Single-Frequency Signaling Unit removed from the rack and with the side-plates open. The relay cover has been removed and the six relays are visible. A printed circuit board is bolted on to the inside of the right side-plate. To this board are connected most of the resistors, capacitors, and other components that are used in this unit. Figure eleven (at the back of the bulletin) is an exact

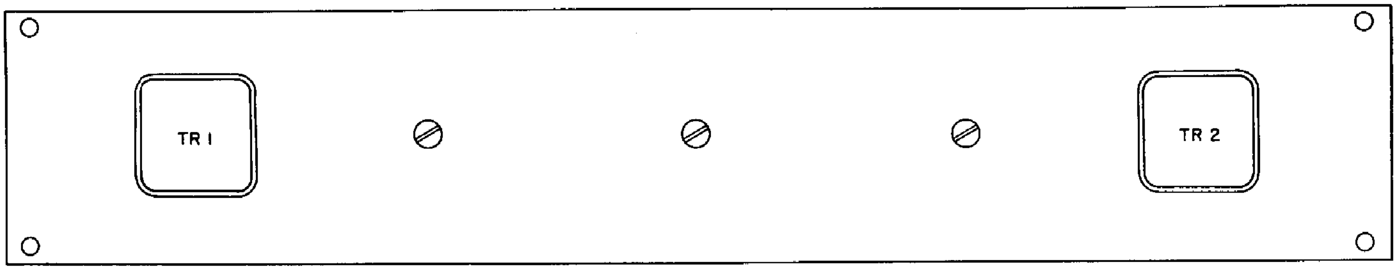


Figure 10. - Tone Resistance Supply Unit Panel

reproduction of the printed circuit board except for size. Figure twelve (at the back of this bulletin) shows the locations of the terminals and the components as seen from the front of the board.

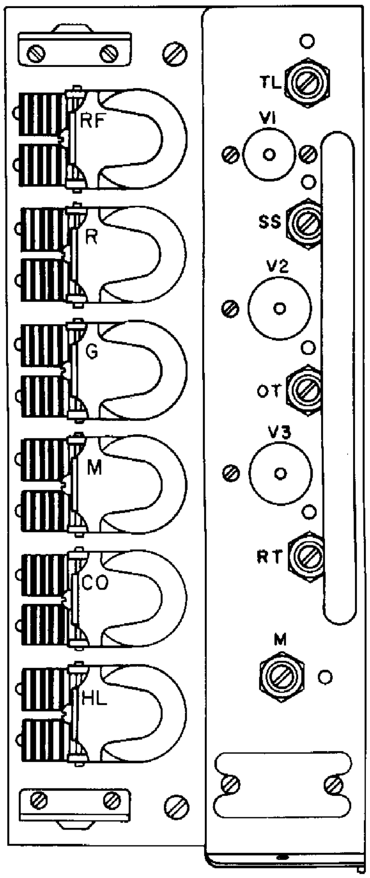


Figure 13. - Single-Frequency Signaling Unit

The unit controls are located on the right half of the front panel of the unit. From top to bottom the components are as follows: the TL potentiometer; the electron tube V-1; the SS potentiometer; the electron tube V-2; the RT potentiometer; the M potentiometer; and the twelve point test receptacle, (see figure 13a at the back of the bulletin). Along the far right edge of the signaling unit a handle is bolted to facilitate mounting and dismounting the unit. The front of the signaling unit with the controls and relays shown is line drawing figure thirteen.

4.6 Negative forty-eight and positive one hundred and thirty volt fuse panels. An option of two or three of four different fuse panels is available with the Single-Frequency Signaling Equipment. One of these fuse panels is for the common equipment and is always supplied. (Figure 14a) The other three panels are for the signaling equipment and it is here that the choice lies.

If a full complement of twenty-four signaling units is used, than a separate twenty-five fuse panel must be used for the negative forty-eight volts (figure 14c) and another twenty-five fuse panel must be used for the positive one hundred thirty volts. (figure 14b) If a maximum of twelve signaling units is used, then a combination panel can be used for both voltages. (figure 14d)

All fuse panels are equipped for the standard indicating alarm fuses. The alarm bar of each fuse panel is connected to a red alarm lamp, and can be connected to the office alarm circuits if desired.

4.7 Alarm lamp and alarm relay panels. Each Single-Frequency Signaling Unit is connected to the alarm relay group (see figure sixteen) via the B lead. (see figure six) The alarm relay group circuit is so arranged that if a ground signal should come to the alarm relays from the signaling units, this could signal an alarm.

However, there are some conditions that must be met before this alarm is signaled. The ground signal is put on the B lead when an individual signaling unit is seized from the distant end of a channel. The circuitry of the receiver is arranged so that any stoppage of the incoming tone will seize it, and this in turn will put a ground on the B lead to the alarm relays. In order to prevent every seizure of a signaling unit from sounding an alarm, the signaling units are arranged in groups of fours, by shelf, and all four units on a shelf must put a ground on the B lead at the same time in order to sound an alarm. Also just to prevent the possibility of all four

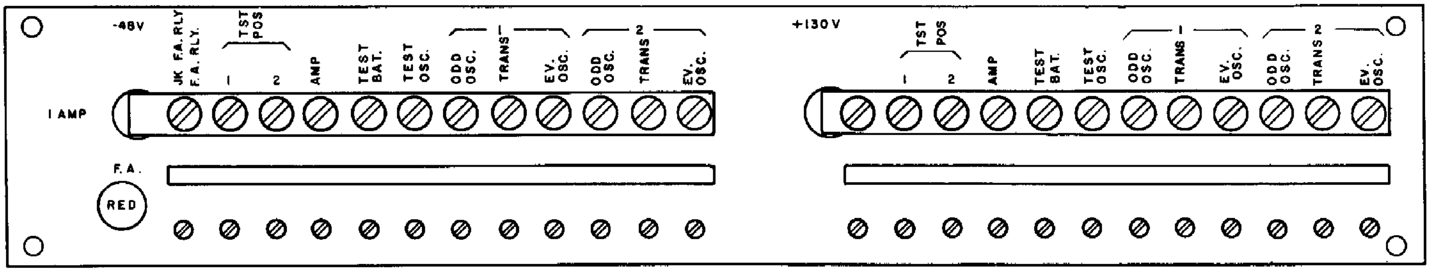


Figure 14a.

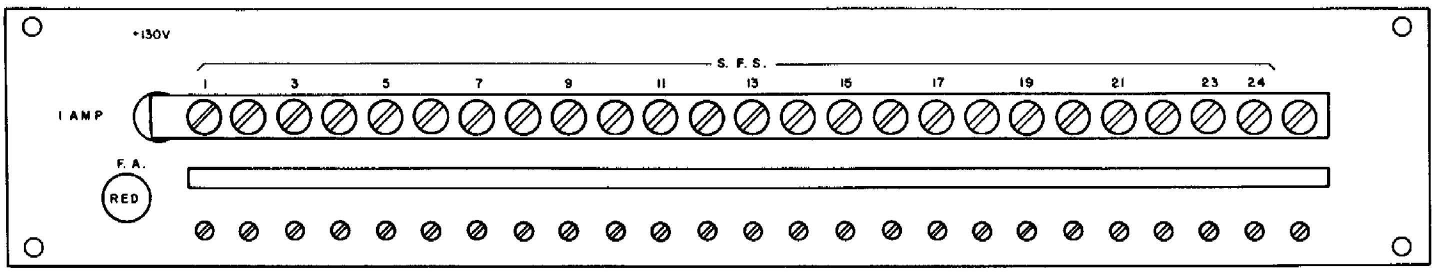


Figure 14b.

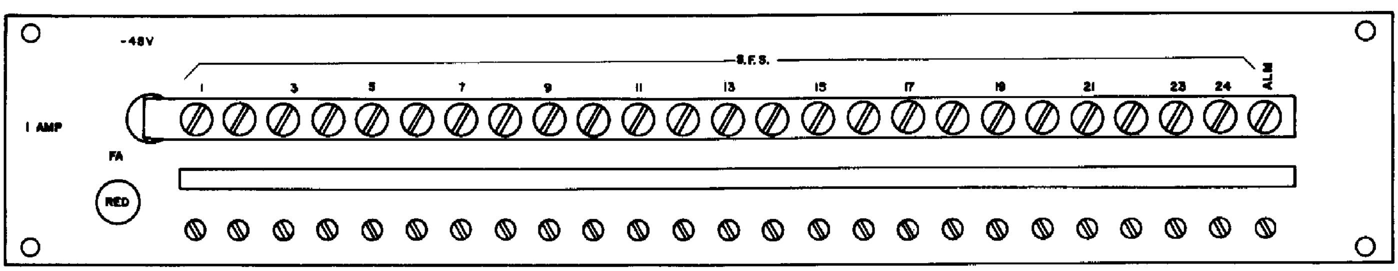


Figure 14c.

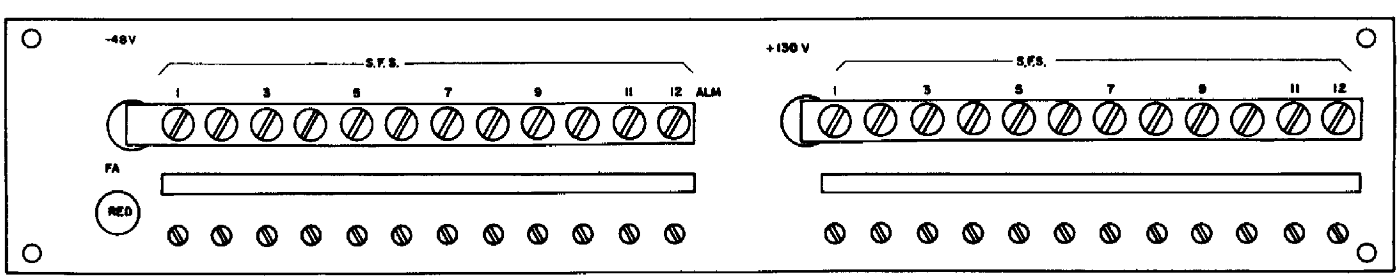


Figure 14d. - Fuse Panels

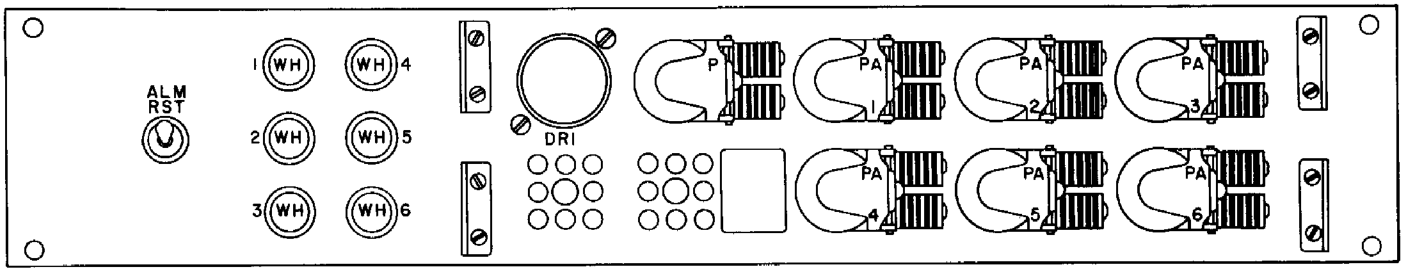


Figure 15a.

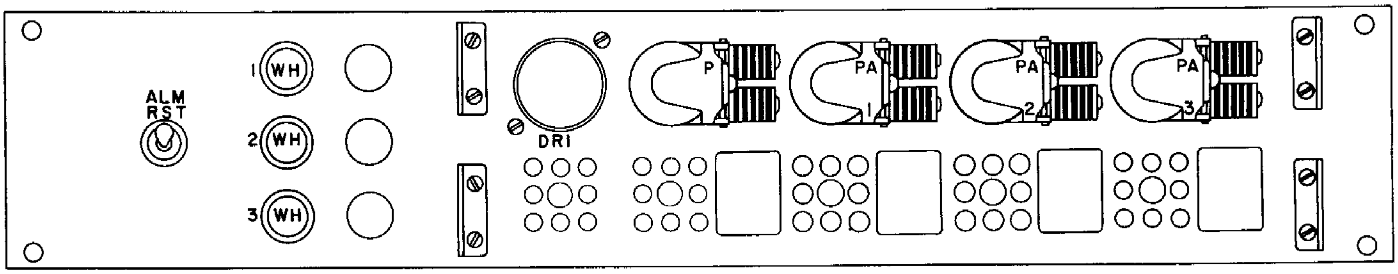


Figure 15b. - Alarm Relay and Lamp Panels

signaling units from being seized in the normal course of operation, and this condition sounding an alarm, a delay circuit is included in the alarm circuitry. This delay circuit operates under the theory that ordinary seizures of signaling units are of short duration in most cases, and it is very unlikely that all four signaling units on a shelf would be seized and held for more than an instant at any one time unless there is trouble on the line. The delay in this circuit is provided by an Amperite delay relay. This special relay will not operate until all four signaling units on a shelf have put ground on the B lead for a minimum of one hundred twenty seconds.

When this alarm circuit was designed it was intended that this alarm would operate only when the entire channel was cut off, such as by a severed cable. If a cable was cut then all tone in both directions would immediately cease and the units at both ends would be seized. After the two minutes waiting time, the Amperite time delay relay would operate and would signal an alarm.

The permanent alarm relay strips are available in two types. The type of strip that is chosen is determined by the number of signaling units that are equipped on a signaling rack. If there are twenty-four signaling units to each rack, then an alarm strip equipped with seven relays and six alarm indicator lamps is necessary. (figure 15a) If only twelve signaling units are used on a rack then the alarm strip that is equipped with only four relays and three alarm indicator lamps can be used. (figure 15b)

Optional additional circuits are available that will arrange the permanent alarm circuits for remote signaling. The remote arrangement is utilized when the signaling equipment is located in an unattended office. In this instance the alarm conditions are signaled to the nearest attended office. From the attended office a repairman will be dispatched to locate the trouble and correct it. The permanent alarm circuits can also be arranged to signal either a major or minor alarm as desired.

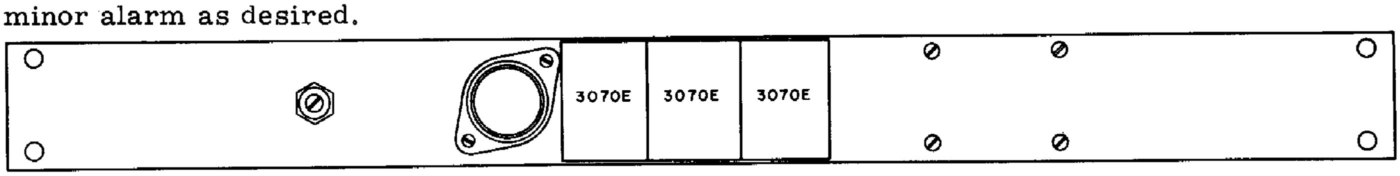


Figure 17. - Test Battery Supply Panel

4.8 Test battery supply unit. The test battery supply unit as shown in figure seventeen, provides power for the type twenty-five test set. This test set requires negative twenty-four volts, negative forty-eight volts, and positive one hundred thirty volts all well filtered. The input

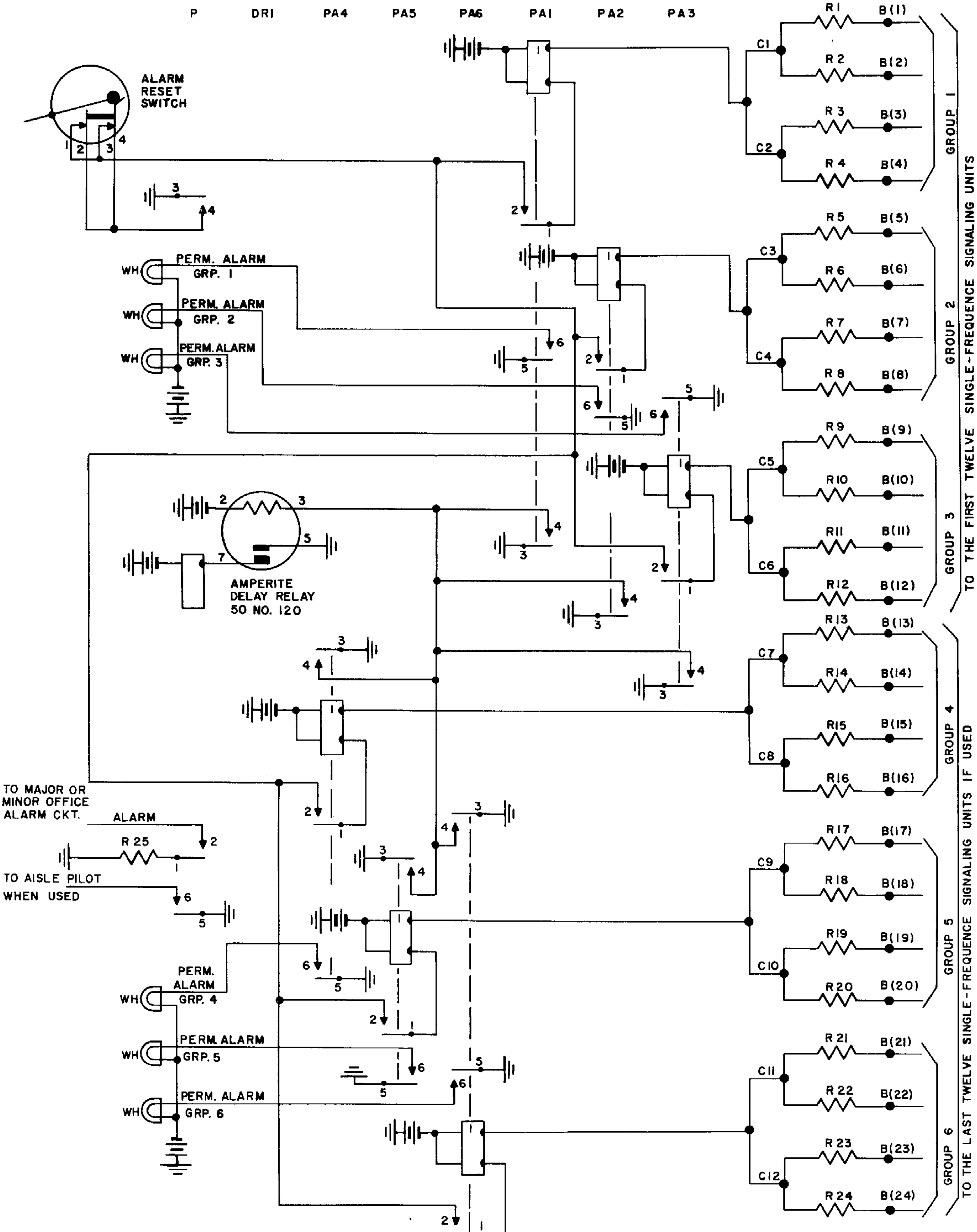


Figure 16. - Alarm Relay Circuit

power to the test battery supply unit is negative forty-eight volts and positive one hundred thirty volts. The negative twenty-four volts is obtained by a voltage dropping resistor which can be adjusted by the screw-driver adjustment on the front of the panel at the left. All three voltages are well filtered to avoid erratic operation of the test set.

The necessary voltages are supplied to the type twenty-five test set through the A and B jacks on the miscellaneous jack strip. (figure eight) On jack A, the tip and ring are grounded and the sleeve carries negative forty-eight volts. On jack B, the tip is positive one hundred thirty volts, the ring is not used, and the sleeve carries negative twenty-four volts. The hole diameter of the B jack is smaller than the hole diameter of the A jack. This prevents the A plug from being plugged into the high voltage of the B jack which would injure the equipment.

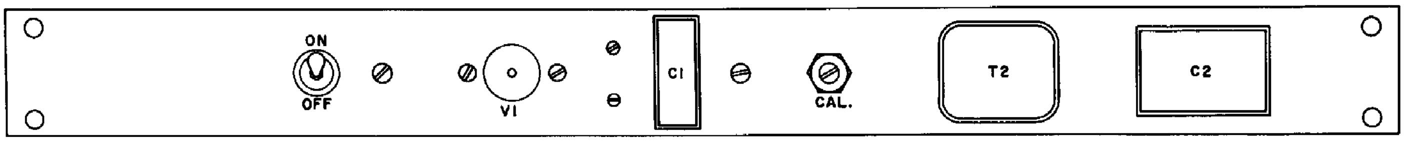


Figure 18. - Monitor Amplifier Panel

4.9 Monitor amplifier. The monitor amplifier is used for testing. It permits the input of the receiver section of the signaling unit to be monitored while it is in operation without affecting the operating voltages. Access is gained to the amplifier through the MON IN jacks on which there is a 9200 ohm input impedence which drops the input voltage thirty db. At the MON OUT jacks the signals are amplified thirty db and sent into a six hundred ohm load.

The monitor amplifier is also used with some test sets to provide the necessary thirty db gain. This access is through the AMP IN and AMP OUT jacks on the miscellaneous jack strip. Both input and out impedences are six hundred ohms at these jacks and the gain is thirty db.

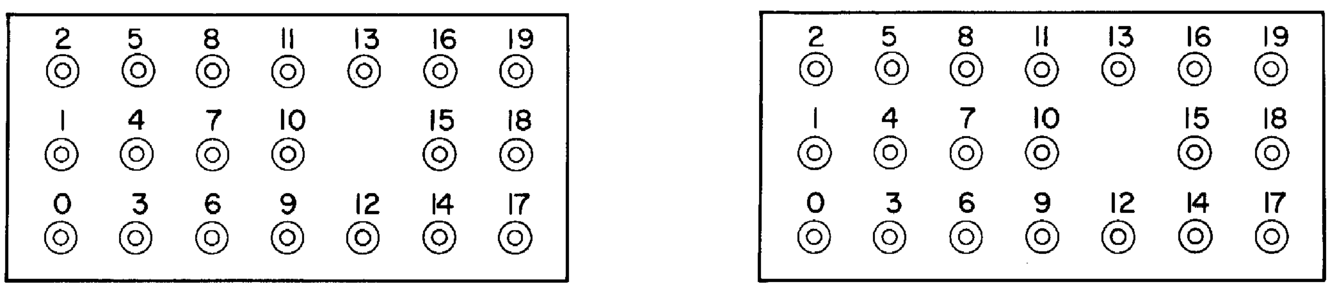


Figure 19. - Test Connectors

4.10 Test connector strip. The test connector receptacles are connected directly to their corresponding test positions. By this circuit arrangement it is possible to have direct access to the circuitry of a signaling unit while it is mounted in a test position. A patching test cable with twenty conductors is plugged between the test connector receptacle and the type twenty-four test set. This test arrangement is designed to permit the tests and adjustments that are a part of the out-of-service testing procedure to be made with the signaling unit in simulated operation.

Figure nineteen illustrates the numbering arrangement of the two each twenty hole receptacles as they look from the front. These receptacles are mounted on a one and three-quarter inch by nineteen panel.

4.11 Folding writing shelf. A standard nineteen inch wide wooden writing shelf is mounted on some of the common equipment bays. (See table E, chapter five ordering information, for locations of writing desk.) This desk is finished in a non-gloss black, and is hinged so as to fold down out of the aisle when not in use.

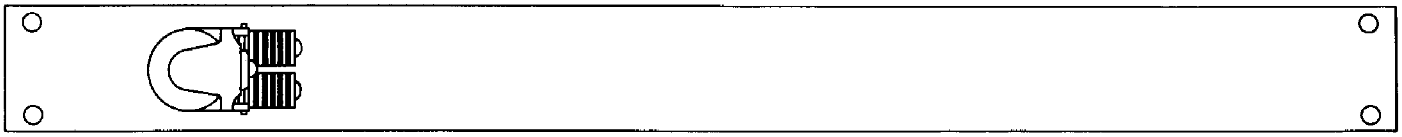


Figure 20. - Fuse Alarm Relay Panel

4.12 Fuse alarm relay equipment. The fuse alarm relay equipment consists of a single relay. This relay is arranged to operate when a positive one hundred thirty volt fuse is blown. By using a relay across the positive one hundred thirty volt fuse circuit, the high voltage is not put across a lamp or through the rest of the alarm circuit. If the office positive one hundred thirty volts were permitted to pass through the alarm circuit or through a lamp, there would be a good possibility of some part of the overloaded circuit burning out.

Figure twenty is a line drawing of the relay strip that is used for the fuse alarm equipment. This strip is a one and three-quarter inch by nineteen standard panel with one relay mounted at the left.

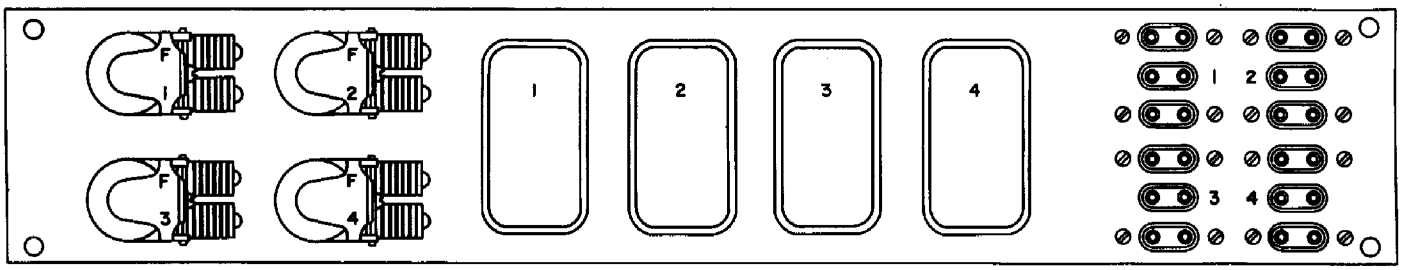


Figure 21. - Two-Wire Filter Network Panel

4.13 Two-wire filter unit. The two-wire networks are mounted four to a panel. Figure twenty-one shows one such panel with the relay F covers removed. The four filter networks are in the cans numbered from one to four. At the right of the panel are four sets of six-hole receptacles. These test point receptacles correspond by pin or hole numbers to the test points that are shown on the wiring diagram figure six.

5. ORDERING INFORMATION.

Information on the ordering of Single-Frequency Signaling Equipment is arranged here according to the individual requirements of each exchange. When ordering Single-Frequency Signaling Equipment these ten questions should be answered before any other steps are taken.

1. On the basis of one signaling unit per exchange per channel, how many signaling units will be required?
2. Will all the channels be operated on a four-wire basis?
3. Will all the channels be operated on a two-wire basis?
4. Will there be mixed two- and four-wire operation?
5. Is there existing four-wire equipment that will be converted to all or part two-wire operation?
6. If the operation is to be all or partly two-wire will it send on 2600 cycles?
7. If the operation is to be all or partly two-wire will it send on 2400 cycles?
8. Is the answer to question one more than one hundred twenty units?
9. Is the answer to question one more than two hundred forty units?
10. Is there the possibility of expansion?

The answers to the above ten questions will serve as an important guide in the selection of the proper stocklists. Since each channel requires one signaling unit at each end the answer to question one will affect most of the decisions that will be made in the selection of the proper types and amounts of signaling equipment.

The answers to questions two, three, four, five, six, and seven determine whether or not the two-wire networks will be necessary and the number and types of oscillators that will be required. The number of oscillators affects the number of tone transfer units that will be needed.

The capacity of the common equipment racks will be determined by the answers to questions eight and nine. Since the common equipment rack is arranged for one hundred twenty or a maximum of two hundred forty signaling units these two answers will determine the type of rack.

The possibility of future expansion affects the choices of both the signaling and common equipment racks. The Single-Frequency Signaling Racks are available in two types, those that are equipped for an ultimate of twelve signaling units and can not be expanded, and those that are designed for an ultimate of twenty four signaling units but are often equipped with only twelve with room available for the remaining twelve should it be desirable.

5.1 Use of tables in ordering information. The tables that will be referred to in this section of the chapter on ordering information are taken directly from the Automatic Electric Company's drawing, number H-883070. These tables are to be used in the actual ordering of Single-Frequency Signaling Equipment stock-lists. Later in this chapter there will be a step-by-step example of how to order signaling equipment.

5.1.1 Ordering information tables A, B, and C. Table A is the basic source of ordering information. It is organized in such a manner as to permit the simple and accurate choice of the proper equipment stocklists. The two types of equipment, common and signaling, are arranged across the top of this table. The common equipment section is divided into two parts: equipment with an ultimate of two hundred forty but only equipped for one hundred twenty, and equipment that is equipped for the ultimate of two hundred forty signaling units. The signaling equipment section is further divided into three separate subsections. One such subsection is for equipment that has an ultimate of twenty four signaling units, but only has twelve equipped. The second subsection is titled: equipment that is equipped for the ultimate of twenty four signaling units. The last subsection is for equipment racks that are arranged and equipped for an ultimate of twelve signaling units.

Arranged down the left side of table A are other equipment designations. These designations are concerned with the types of facilities that will be used in an individual exchange. These categories are divided into five groups of two rows each. The top row of each group is for initial installations, the bottom row is for additions.

The top group is for equipment that operates on either radio carrier or a strictly four-wire basis. The next two groups are for equipment that operates only on a two-wire basis. These two groups are further divided depending on the frequency that is used to send and receive. As mentioned in paragraph 2.1, if only four-wire facilities are used, then 2600 cycles is used in both directions. However, if two-wire operation is encountered then a choice must be made whether to send on 2600 cycles and receive on 2400 or the reverse. Sometimes this decision is influenced by the common practice of sending 2600 cycles toward the larger office from the smaller.

The last two groups are for equipment that will convert existing four-wire equipment to two-wire, or to two- and four-wire operation. These groups are also divided by the choice of the transmission frequency.

By using the information gathered from the ten questions in paragraph 5 it is possible to select from table A the necessary equipment stocklists for any situation. The first step is to determine the number of signaling units that will be necessary. Then the type of facility that will be used is chosen. By reading across and down table A the proper equipment stocklists should be arrived at for both common and signaling equipment.

TABLE A - ORDERING INFORMATION							
TYPES OF CIRCUITS AND FREQUENCIES UTILIZED			COMMON EQUIPMENT RACKS		SIGNALING EQUIPMENT RACKS		
			ULTIMATE CAPACITY FOR 240		ULTIMATE CAPACITY-24		ULTIMATE CAPACITY-12
			120 CIRCUITS	240 CIRCUITS	EQUIPPED 12 CIRCUITS	EQUIPPED 24 CIRCUITS	EQUIPPED 12 CIRCUITS
			STKL.	STKL.	STKL.	STKL.	STKL.
FOUR-WIRE FACILITIES CARRIER & RADIO	(1) EQUIPMENT FOR INITIAL RACK		51	59	6	16	1
	(2) ADDITION TO INITIAL RACK		52		7		
TWO-WIRE FACILITIES (PLUS FOUR WIRE CAPABILITIES)	2400~ SEND AND 2600~ RECEIVE	(1) INITIAL	53	60	8	17	2
		(2) ADDITIONAL	54		9		
	2600~ SEND AND 2400~ RECEIVE	(1) INITIAL	55	61	10	18	3
		(2) ADDITIONAL	56		11		
FOR CONVERTING EXISTING FOUR WIRE RACKS TO TWO-WIRE OR TO TWO AND FOUR WIRE OPERATION	2400~ SEND AND 2600~ RECEIVE	(1) INITIAL	57	62	12	19	4
		(2) ADDITIONAL			13		
	2600~ SEND AND 2400~ RECEIVE	(1) INITIAL	58	58	14	20	5
		(2) ADDITIONAL			15		

Table A - Ordering Information

TABLE B-SIGNALING EQUIPMENT BAY.

CIRCUIT CAPACITY & EQUIPMENT.

METHOD OF ASSEMBLY FIGS. ON H-883071 / STOCKLIST: columns 1–20, each divided into E and W.

CIRCUIT	FIG	WIR. DIAG. H-720382 FIG.	TITLE	REMARKS	1 E	1 W	2 E	2 W	3 E	3 W	4 E	4 W	5 E	5 W	6 E	6 W	7 E	7 W	8 E	8 W	9 E	9 W	10 E	10 W
H-85825	2	7	SINGLE FREQUENCY SIGNALING-(SHELF ONLY-NO. OF CKTS.)		12	12	12	12							12	12	12	12	12	12	12	12		
	1								12	12													12	12
H-85825	3	8A	TWO-WIRE NETWORK 2600~ SEND						12	12			12	12									12	12
H-85825	4		TWO-WIRE NETWORK 2400~SEND				12	12			12	12							12	12	12	12		
H-85835	1&3	5A	PERM. ALARM		0	1	0	1	0	1					0	1			0	1			0	1
H-85835	2&4	5B															0	1			0	1		
		6A	TONE SUPPLY		1	1	1	1	1	1					1	1			1	1			1	1
H-85828	2&3	6B	-48 VOLT															1				1		
		3A													1	1			1	1			1	1
		3B	FUSE PANEL																	1				1
		3C																1				1		
		3D																				1		
		4A	+130 VOLT												1	1			1	1			1	1
		4B	FUSE PANEL															1				1		
		10A	-48V & +130V		1	1	1	1	1	1														
		10B	FUSE PANEL				0	1	0	1	0	1	0	1										
H-83031	3	9A	FUSE ALARM												1	1			1	1			1	1
	HOO	9B	RELAY		1	1	1	1	1	1														
		1A	TERM BLK & CABLE OR APPLIQUE CABLE (WIRING IN CABLE & NO. OF FIGURES)			1		1		1						1				1				1
		1B						1		1		1		1						1				1
		2A																1				1		
		2B																				1		
		3A														1				1				1
		3B																		1				1
		3C																1				1		
		3D																				1		
		4A														1				1				1
		4B																1				1		
		5A				1		1		1						1				1				1
		5B																1				1		
		6A				1		1		1						1				1				1
		6B																1				1		
		7				12		12		12						12		12		12		12		12
		8A						3		3		3		3						3		3		3
		9A														1				1				1
		9B				1		1		1														
		10A				1		1		1														
		10B						1		1		1		1										

WIR. DIAG. H-720382 FIG.	11 E	11 W	12 E	12 W	13 E	13 W	14 E	14 W	15 E	15 W	16 E	16 W	17 E	17 W	18 E	18 W	19 E	19 W	20 E	20 W
7											24	24	24	24						
(fig. 1)	12	12													24	24				
8A (fig. 3)	12	12					12	12	12	12					24	24			24	24
(fig. 4)			12	12	12	12							24	24			24	24		
5A											0	1	0	1	0	1				
5B	0	1									0	1	0	1	0	1				
6A											1	1	1	1	1	1				
6B		1										1		1		1				
3A											1	1	1	1	1	1				
3B				1				1						1		1		1		1
3C		1										1		1		1				
3D		1				1				1				1		1		1		1
4A											1	1	1	1	1	1				
4B		1										1		1		1				
10A																				
10B																				
9A											1	1	1	1	1	1				
9B																				
1A												1		1		1				
1B				1				1						1		1		1		1
2A		1										1		1		1				
2B		1				1				1				1		1		1		1
3A												1		1		1				
3B				1				1						1		1		1		1
3C		1										1		1		1				
3D		1				1				1				1		1		1		1
4A												1		1		1				
4B		1										1		1		1				
5A												1		1		1				
5B		1										1		1		1				
6A												1		1		1				
6B		1										1		1		1				
7		12										24		24		24				
8A		3		3		3		3		3				6		6		6		6
9A												1		1		1				
9B																				
10A																				
10B																				

Table B - Signaling Equipment Bay

TABLE C - COMMON EQUIPMENT BAY

CIRCUIT CAPACITY & EQUIPMENT

62		61		60		59		58		57		56		55		54		53		52		51		METHOD OF ASSEMBLY FIGS. ON H-883071				
62		61		60		59		58		57		56		55		54		53		52		51		STOCKLIST				
E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	E	W	CIRCUIT	FIG	WIR.DIAG H-720381-A18 FIG.	TITLE	REMARKS
		2	2	2	2	2	2					1		1	2	1		1	2	1		1	2	H-85826	1	3B	ODD — OSCILLATOR PANEL	
		2	2	2	2	2	2					1		1	2	1		1	2	1		1	2			3C	EVEN	
1		1	1	1	1	0	1	1		1				1	1			1	1			0	1			3A	TEST	
4		1		4				1		2				1		2		2						H-85826	3	3A,3B OR 3C	2400- — OSCILLATOR TURRET	
		4		1		4						2		2				1		2		2			2		2600-	
		2	2	2	2	2	2					1		1	2	1		1	2	1		1	2	H-85827	1	4	TONE TRANSFER	
		1	1	1	1	1	1							1	1			1	1			1	1	H-85828	4&6	10A	TONE SUPPLY	
		2	2	2	2	2	2							2	2			2	2			2	2	H-85830-	1&3	8&7	TEST CONNECTOR & TEST POSITION	
		1	1	1	1	1	1							1	1			1	1			1	1	H-85829	1	6	MONITOR AMPLIFIER	
		1	1	1	1	1	1							1	1			1	1			1	1	H-85831	1	5	TEST BATT SUPPLY	
		2	2	2	2	2	2							2	2			2	2			2	2	H-85832	1		TELEPHONE JACK	
		1	1	1	1	1	1							1	1			1	1			1	1	H-85832	2,3 4,6 7&8	9A	MONITOR AMPLIFIER CALIBRATION TRANS. MEASURING TRK. 2B TEST BAT.SUPPLY TESTING S.F.S& 48V BATT.JACKS	
		1	1	1	1	1	1							1	1			1	1			1	1	H-85832	5		OSCILLATOR JACK	
		1	1	1	1	1	1					1		0	1	1		0	1	1		0	1			9B		
		1	1	1	1	1	1							1	1			1	1			1	1			2	-48V & +130V FUSE PANEL	
		1	1	1	1	1	1							1	1			1	1			1	1	H-83031	3 MOD	11	FUSE ALM RELAY	
			1		1		1								1				1				1			1,2,3A,4 5,6,7,8,9A 9B,&10A	TERM BLOCK & CABLE(WIRING IN CABLE & NO.OF FIGURES.)	
			2		2		2								2				2				2			3B,3C		

Table C - Common Equipment Bay

When the equipment stocklists are determined from table A, it will be necessary to refer to tables B and C for a complete breakdown of the individual components of each stocklist. Table B lists the equipment stocklists for the signaling equipment. Under each stocklist, in this table, is the circuit drawing number and the frequency of appearance in that stocklist. Table C has the same information for the common equipment. These two tables also show that equipment is wired and what is equipped. All the available racks are shown pictorially in chart E.

5.1.2 Ordering information tables D and F. After recording what equipment stocklists are to be ordered, the next phase is to select the correct racks. Table F indicates the minimum rack heights that can be used with various combinations of equipment stock lists.

Table D is used to identify the necessary rack or bay minimum heights by assembly or stocklist numbers on the Automatic Electric Company's drawings, numbers H-883074 and H-883075. The required minimum rack heights of table F are carried over to table D. On table D the assembly numbers and the number of required mounting plates are recorded.

It should be noted that the rack heights indicated on table F are the minimum required and should it be necessary or desirable to maintain a rack level that is higher than these specifications this should present no problem.

5.1.3 Ordering information table E. The associated equipment that is necessary to operate a Single-Frequency Signaling System is ordered from table E; this includes the individual signaling units of either 2600 cycle or 2400 cycle. These signaling units are not mounted permanently on the rack but are jacked in and out, and can be removed or switched without rewiring. The other associated equipment includes the permanent alarm unit, which is optional, the folding writing shelf, which can be either factory or field installed, and the test sets. These test sets are the Single-Frequency Test Set Type twenty-four and the associated patching cords, and the Signaling Test Set Type twenty-five and the associated patching cords.

Table E gives the drawing number and the assembly number of each piece of equipment. It also indicates the circuit drawings and the wiring diagrams. The signaling units are ordered separately from the signaling equipment rack and are jacked into their positions in the field rather than being mounted and wired at the factory. The test sets are ordered from table E as required.

5.1.4 Ordering information table G. Table G is the primary source of information for ordering blueprints. Once the required print stocklists are selected the information is transfered to the Automatic Electric Company's drawing, number H-883420.

5.1.5 Ordering information method of assembly tables. There are two separate methods of assembly tables supplied on drawing H-883070. These drawings, one for the signaling and one for the common equipment, show the piece numbers, locations, and the necessary amounts.

5.2 Steps in ordering Single-Frequency Signaling Equipment. The first step in ordering new or additional Single-Frequency Signaling equipment is to answer the ten questions in paragraph 5.

The second step is to determine the necessary equipment stocklists from tables A, B, and C.

The third step is to select the racks. This is done from the minimum rack heights given in tables D and F.

The fourth step is to order the selected equipment stocklists, from tables A, B, and C, mounted and wired on the racks.

The fifth step is to order the associated equipment from table E.

TABLE D ASSOCIATED RACK SPECIFICATIONS			
ASSEMBLY OR STKL.	OVERALL HEIGHT	TYPE	NO. OF MOUNTING PLATE SPACES
H-883074 ASSEM. 1	7'-0"	SINGLE SIDED SELF SUPPORTING	44
H-883074 ASSEM. 2	8'-01/4"	SINGLE SIDED SELF SUPPORTING	51
H-883075 STKL. 1	8'-8"	SINGLE SIDED SUPPORTED	54
H-883075 STKL. 2	9'-0"	SINGLE SIDED SUPPORTED	56
H-883075 STKL. 3	10'-6"	SINGLE SIDED SUPPORTED	66
H-883075 STKL. 4	11'-6"	SINGLE SIDED SUPPORTED	73
H-883075 STKL. 5	11'-8"	SINGLE SIDED SUPPORTED	73

Table D - Associated Rack Specifications

TABLE F		
STOCKLIST COMBINATION		MINIMUM RACK HEIGHT
SIGNALING EQUIPMENT BAYS	1 1 + 4 1 + 5 2 3 6 + 7	8'-0"
	6 + 12 6 + 14 6 + 7 + 12 6 + 7 + 14 6 + 7 + 12 + 13 6 + 7 + 14 + 15 8 + 9 10 + 11	10'-6"
	16	8'-0"
	16 + 19 16 + 20 17 18	0'-6"
COMMON EQUIPMENT BAYS	51 51 + 52 51 + 57 51 + 58 53 53 + 54 55 55 + 56 59 59 + 58 59 + 62 60 61	8'-0"

Table F

TABLE E-ORDERING INFORMATION-ASSOCIATED EQUIPMENT				
ASSEMBLY	DESCRIPTION	CIRCUIT	WIRING DIAGRAM	REMARKS
H-883043-1	SINGLE FREQUENCY SIGNALING UNIT-2400 CYCLE-FOUR-WIRE NETWORK (USED WITH SEPARATE TWO-WIRE NETWORK WHEN ALL OR PART OF CIRCUITS BETWEEN TWO SINGLE FREQ. SIGNAL UNITS ARE TWO-WIRE TO TRANSMIT 2600- AND RECEIVE 2400-)	H-85825 FIG.1	H-720398 FIG. 1 (UNIT)& H-720382 FIG.7 (SHELF)	ORDER AS REQ'D. SHIPPED SEPARATE FROM EQUIPMENT RACK
H-883043-2	SINGLE FREQUENCY SIGNALING UNIT 2600 CYCLE FOUR-WIRE NETWORK (USED ALONE WHEN ALL CIRCUITS BETWEEN TWO SINGLE FREQ.SIGNAL UNITS ARE FOUR-WIRE TO TRANSMIT & RECEIVE 2600-) OR (USED WITH SEPARATE TWO-WIRE NETWORK WHEN ALL OR PART OF CIRCUITS BETWEEN TWO SINGLE FREQ.SIGNAL UNITS ARE TWO WIRE, TO TRANSMIT 2400- & RECEIVE 2600-)	H-85825 FIG.2	H-720398 FIG.2 (UNIT) & H-720382 FIG.7 (SHELF)	ORDER AS REQ'D. SHIPPED SEPARATE FROM EQUIPMENT RACK
DH-85835-71A	PERMANENT ALARM UNIT (FOR.12 SIGNAL CKTS. ULTIMATE)	H-85835 FIG.1&3	H-720381 FIG.5A	ORDER ONE PER SIGNALING EQUIPMENT RACK WHEN SPEC'D. USED WITH STKL.1,2 OR 3
DH-85835-72A	PERMANENT ALARM UNIT(FOR 12 OR 24 SIGNAL CKTS.INITIAL & 24 CKTS. ULTIMATE)	H-85835 FIG.1,2, 3&4	H-720381 FIG.5A &5B	ORDER ONE PER SIGNALING EQUIPMENT RACK WHEN SPECIFIED USED WITH STKL.6,8, 10,16,17&18.
H-88628-20	WRITING SHELF FOR COMMON EQUIPMENT RACK.			ORDER ONE PER COMMON EQUIPMENT RACK WHEN SPECIFIED USED WITH STKL.51, 53,55,59,60&61
H-883354-1	SINGLE FREQUENCY TEST SET TYPE 24 & ASSOCIATED PATCH CORDS	H-85833 FIG.1,2, 3,4	H-720415	ORDER AS REQUIRED PORTABLE UNIT FOR ADJUSTMENT CKT. OPERATION & TROUBLE SHOOTING TESTS.
H-883355-1	SIGNALING TEST SET TYPE 25 & ASSOCIATED PATCH CORDS.	H-85834 FIG.1&2	H-720416	ORDER AS REQUIRED PORTABLE UNIT FOR TESTING SIGNALING EQUIPMENT.

Table E - Ordering Information - Associated Equipment

TABLE G - BLUEPRINT ORDERING INFORMATION

STOCKLIST	DESCRIPTION	ASSOCIATED EQUIPMENT	REMARKS
H-883420 STKL. 1	BLUEPRINTS FOR COMMON EQUIPMENT RACK - SINGLE FREQUENCY SIGNALING - TYPE A.S.F.-1.	H-883070 STKL. 51, 53, 55, 59, 60, 61.	ORDER ONE PER STOCKLIST.
H-883420 STKL. 2		H-883070 STKL. 52, 54, 56.	
H-883420 STKL. 3		H-883070 STKL. 57, 58, 62.	
H-883420 STKL. 4	BLUEPRINTS FOR SIGNALING EQUIPMENT RACK - SINGLE FREQUENCY SIGNALING - TYPE A.S.F.-1.	H-883070 STKL. 1, 2, 3, 6, 8, 10, 16, 17, 18.	ORDER ONE PER OFFICE.
H-883420 STKL. 5		H-883070 STKL. 7, 9, 11.	
H-883420 STKL. 6		H-883070 STKL. 4, 5, 12, 13, 14, 15, 19, 20.	

Table G - Blueprint Ordering Information

20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	METHOD OF ASSEMBLY FIGS. ON H-883071			
20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	STOCKLIST			
AMT.	AMT.	AMT.	AMT.	AMT.	AMT.	AMT.	AMT.	AMT.	AMT.	AMT.	AMT.	AMT.	AMT.	AMT.	AMT.	AMT.	AMT.	AMT.	AMT.	PIECE NO OR DRG. NO.	LOCATION POSITION	DESCRIPTION	ITEM
																	3	3	3	H-883073-1	14-19,20-25,28-33	SHELF-SIGNAL	1
		3	3	3					3		3		3							H-883073-1	2-7,8-13,14-19	SHELF-SIGNAL	2
		3	3	3						3		3		3						H-883073-1	20-25,28-33,34-39	SHELF-SIGNAL	3
																	1	1	1	H-883079-2	38-39	FUSE PANEL (48V & 130V)	4
																	1	1	1	H-883154-1	34-35	TONE SUPPLY	5
		1	1	1						1		1		1						H-883154-1	40-41	TONE SUPPLY	6
																	1	1	1	H-883337-1	40	FUSE ALARM RLY	7
		1	1	1						1		1		1						H-883337-1	48	FUSE ALARM RLY	8
																			1	H-981219-1	44-45	UNIT CABLE	11
																	1	1		H-981219-2	44-45	UNIT CABLE	12
															1	1				H-981219-3		APPLIQUE CABLE	13
														1						H-981219-4	50-51	UNIT CABLE	14
													1							H-981219-5		APPLIQUE CABLE	15
										1		1								H-981219-6	50-51	UNIT CABLE	16
									1		1									H-981219-7		APPLIQUE CABLE	17
				1																H-981219-8	50-51	UNIT CABLE	18
		1	1																	H-981219-9	50-51	UNIT CABLE	19
						1		1												H-981219-10		APPLIQUE CABLE	20
					1		1													H-981219-11		APPLIQUE CABLE	21
1	1																			H-981219-12		APPLIQUE CABLE	22
		1	1	1						1		1		1			1	1	1	D-311515-A	26,27	BLANK	24
																3		3		DH-85825-72A	8-9,10-11,12-13	NETWORK-2400-	26
	3		3				3				3									DH-85825-72A	55-56,57-58,59-60	NETWORK-2400-	27
	3		3					3				3								DH-85825-72A	61-62,63-64,65-66	NETWORK-2400-	28
															3		3			DH-85825-71A	8-9,10-11,12-13	NETWORK-2600-	29
3		3			3				3											DH-85825-71A	55-56,57-58,59-60	NETWORK-2600-	30
3		3				3				3										DH-85825-71A	61-62,63-64,65-66	NETWORK-2600-	31
		1	1	1						1		1		1						H-883079-1	44-45	FUSE PANEL (130V)	37
		1	1	1						1		1		1						H-883079-1	46-47	FUSE PANEL (48V)	38
		1	1	1						1		1		1			1	1	1	D-2743-A		FUSE-3 AMP	39
		48	48	48						48		48		48			23	23	23	D-2742-A		FUSE-1 AMP	40
		2	2	2						2		2		2			1	1	1	D-9497-A		LAMP *(FUSE PANEL)*	41
		2	2	2						2		2		2			1	1	1	MC-67705-A		LAMP CAP-RED *(FUSE PANEL)*	42
		4	4	4						4		4		4			2	2	2			12-24X3/4" R.H.I.M.S.(F.P.)	43
																	4	4	4			12-24X1/4 RHIMS (BLANK)	44
		1	1	1						1		1		1			1	1	1	H-883344-5		TERM BLK,MTG BRKT	45
		2	2	2						2		2		2			2	2	2			12-24X1/2" RHIMS(TERM BLK MTG.BRKT).	46
		2	2	2						2		2		2			1	1	1	D-284076-C1		*RESISTOR 500Ω 5W (FUSE PANEL)*	47

62	61	60	59	58	57	56	55	54	53	52	51	METHOD OF ASSEMBLY FIGS. ON H-883071			
62	61	60	59	58	57	56	55	54	53	52	51	STOCKLIST			
AMT.	AMT.	AMT.	AMT.	AMT.	AMT.	AMT.	AMT.	AMT.	AMT.	AMT.	AMT.	PIECE NO. OR DRG.NO.	LOCATION POSITION	DESCRIPTION	ITEM
							1		1		1	H-883035-1	25	TEST JACK STRIP ASSEMBLY	51
	1	1	1									H-883035-2	25	TEST JACK STRIP ASSEMBLY	52
	1	1	1				1		1		1	H-883073-1	29-34	SHELF-SIGNAL	53
	1	1	1				1		1		1	H-883079-2	46-47	FUSE PANEL (48V & 130V)	54
	1	1	1				1		1		1	H-883154-2	16-17	TONE SUPPLY	55
	1	1	1				1		1		1	H-883337-1	48	FUSE ALM.RLY UNIT	56
	1	1	1				1		1		1	H-883153-1	28	TEST CONN.	57
	1	1	1				1		1		1	H-981220-1	50-51	UNIT CABLE	60
						4		4		4		D-42607-A	25	IND.JK.	63
						4		4		4		D-42597-A	25	IND.JK.	64
	1			1			1					D-35294-A	37	OSC.TURRET 2400~	65
2		2			2				2			D-35294-B	38,41	OSC.TURRET 2400~	66
2		2						2				D-35294-B	42,45	OSC.TURRET 2400~	67
		1							1			D-35294-A	37	OSC.TURRET 2600~	68
	2		2				2				2	D-35294-A	38,41	OSC.TURRET 2600~	69
	2		2			2				2		D-35294-A	42,45	OSC.TURRET 2600~	70
			1								1	D-311540-A	37	BLANK	71
	4	4	4				4		4		4	D-311515-A	18-19,20-21, 22-23,26-27	BLANK	72
	1	1	1				1		1		1	D-311540-A	24	BLANK	73
	1	1	1				1		1		1	DH-85831-71A	36	TEST BATT SUPPLY	74
	1	1	1				1		1		1	DH-85829-71A	35	MONITOR AMPLIFIER	75
	1	1	1				1		1		1	DH-85827-71A	39-40	TONE TRANSFER	76
	1	1	1			1		1		1		DH-85827-71A	43-44	TONE TRANSFER	77
1	1	1		1	1		1		1			DH-85826-71A	37	OSC.PANEL-TEST	78
	2	2	2				2		2		2	DH-85826-71A	38,41	OSC.PANEL	79
	2	2	2			2		2		2		DH-85826-71A	42,45	OSC.PANEL	80
						8		8		8				6X3/8" P.K.Z.R.H.S. JKS.	83
	2	2	2				2		2		2			12-24X3/4 R.H.I.M.S.(FP.)	84
	8	8	10				8		8		10			12-24X1/4 RHIMS (BLANK)	85
	1	1	1				1		1		1	D-2743-A		FUSE-3 AMP	86
	23	23	23				23		23		23	D-2742-A		FUSE-1 AMP	87
	1	1	1				1		1		1	D-9497-A		LAMP	88
	1	1	1				1		1		1	MC-67705-A		LAMP CAP-RED	89
	1	1	1				1		1		1	H-883344-6		TERM BLK.MTG BRKT	90
	2	2	2				2		2		2			12-24X1/2" R.H.I.M.S.(TERM.BLK MTG BRKT.)	91
	1	1	1				1		1		1	D-284076-C1		RES 500~ 5W	92

Stock List For Common Equipment

The sixth step is to order the required blueprints from table G.

Conversion equipment stocklists are shipped as loose items and are mounted on the racks and wired out in the field. This equipment usually is mounted on existing racks in an office.

5.3 Ordering example. For the purpose of this illustration,it will be necessary to invent an exchange. This imaginary exchange will be a new branch exchange that will have no existing equipment that will have to be altered. It will have sixteen channels that will use the existing two-wire facilities. Since this exchange is a branch exchange,it will send on 2600 cycles to the main exchange. While there is the possibility of expansion, the number of channels that will be added in the next two years is estimated at less than eight.

In accordance with the instructions for ordering, the first step will be to answer the questions.

1. On the basis of one signaling unit per exchange per channel, how many signaling units will be required? *Sixteen*
2. Will all the channels be operated on a four-wire basis? *No*
3. Will all the channels be operated on a two-wire basis? *Yes*
4. Will there by mixed two- and four-wire operation? *No*
5. Is there existing four-wire equipment that will be converted to all or part two-wire operation? *No*
6. If the operation is to be all or partly two-wire will it send on 2600 cycles? *Yes*
7. If the operation is to be all or partly two-wire will it send on 2400 cycles? *No*
8. Is the answer to question one more than one hundred-twenty units? *No*
9. Is the answer to question one more than two hundred-forty units? *No*
10. Is there the possibility of expansion? *Yes*

Since the answer to question one is sixteen signaling units, the equipment stocklist selected from the signaling section of table A will have to be arranged for and equipped for twenty-four signaling units. The answers to questions two and three were a no and a yes, respectively. This indicates that four-wire equipment can be disregarded and concentration placed on two-wire equipment. In this case the answer to question four reaffirms what has been determined from the previous questions. Question five shows that since this is a new exchange there will be no existing four-wire equipment that will have to be converted to two-wire. The answers to questions six and seven determine the frequency on which the signaling units will transmit. Questions eight and nine are not important in this instance because the number of signaling units is quite low. Should the number reach one hundred twenty to two hundred forty, extra common equipment will become necessary. In the imaginary exchange there is an expected expansion of approximately eight channels in the next two years.

The second step is to select the required equipment stocklists from tables A, B, and C. The stocklists that fit the requirements of the imaginary exchange are fifty-five and eighteen. Equipment stocklist eighteen requires a minimum rack height of ten feet, six inches. Stocklist fifty-five has an eight foot minimum. It is desired in this case to keep a rack level of eleven feet, six inches. Therefore, two racks will be ordered as drawing number H-883075 stocklist four. These racks will have room for seventy-three mounting plates. The associated equipment that will be ordered from table E includes: eighteen signaling units, two spares, number H-883043-1; one permanent alarm unit for twenty-four signaling units, number DH-85835-72A; one writing shelf to be mounted in the field, number H-88628-20; one Single-Frequency Test Set Type twenty-four, number H-883354-1; and Signaling Test Set Type twenty-five, number H-883355-1. The blueprints that will have to be ordered are blueprint stocklist H-883420 stocklist one, for common equipment stocklist fifty-five, and H-883420 stocklist four, for signaling equipment stocklist eighteen.

6. SINGLE-FREQUENCY SIGNALING EQUIPMENT--TEST PROCEDURE

6.1 General information. This chapter of the Single-Frequency Signaling Bulletin contains the information for adjustment of the signaling equipment, and the test procedure for the out-of-service tests. Included in this chapter is a description of the tests to be made; the required results; a list of the required testing equipment; and a step-by-step test procedure.

6.1.1 Equipment tests and adjustments. The tests and adjustments listed in the following paragraphs are arranged in the order in which they will be found in the test procedure. For the best results these tests should follow the procedure as to the order of the tests run and the adjustments made. However, it is possible to go back in the procedure to check a previous result without jeopardizing the accuracy of the rest of the tests. Notice that the test descriptions are keyed to the section of the test to which they pertain.

The first section of the test procedure deals with the adjustment of the type twenty-five test set. This part of the adjustment procedure should be repeated at least once during the test for every thirty minutes the testing lasts.

6.1.1.1 Transmitter relay M pulsing. (§6.4.3) Section 6.1.1.1 is designed to permit the accurate adjusting of potentiometer M. This potentiometer controls the M relay and is adjusted so that this relay will follow the pulses properly.

6.1.1.2 Transmitter relay CO release. (§6.4.4) This section of the test checks the proper release of relay CO. It is most important to the operation of the signaling unit that the CO relay releases within the specified time limits. The adjustment of this release time is made by switching the strapping between the resistors R-6, R-6', R-7, and R-7'. (See figure twelve for location of resistors.)

6.1.1.3 Transmitted tone level. (§6.4.5) The level of the transmitted signal tone in dbm is checked in section 6.4.5 of this test procedure.

6.1.1.4 Receiver relay R cut-off current. (§6.4.6) This test is engineered to check for the presence of any input current through relay R.

6.1.1.5 Receiver voice amplifier gain and band elimination filter insertion. (§6.4.7) The transmission of the voice signals through the receiver is checked in this test. Also provided is a method of adjusting the TL potentiometer to arrive at the required level.

The second subsection of this test is designed to check on the blocking of the Single-Frequency Signal Tone when present on the line.

6.1.1.6 Receiver signaling amplifier sensitivity. (§6.4.8) Section 6.1.1.6 of the test procedure checks on the sensitivity of the receiver, and at the same time provides a method for adjusting the SS potentiometer.

6.1.1.7 Operation of relay R in the receiver (§6.4.9) This test is designed to check on the operating and releasing times of relay R. Another part of this subsection is the adjusting of the potentiometers OT and RT. The part of this subsection that covers the adjustment of the OT potentiometer is very critical. This phase may have to be repeated several times in order to get the proper results. If a particular signaling unit should prove difficult to adjust, it is possible to get the desired results by another method.

First set up the test equipment as in steps one to ten of test section 6.4.8. Then the OT potentiometer can be adjusted so that the pointer on the PERCENT BREAK meter shows steady kicks. Once this is done, the OT potentiometer can be backed off to the point where no kicks can be seed on the PERCENT BREAK meter. Caution: This system must be used with care in the adjustments. Once the setting is found, section 6.4.8 should be rerun.

6.1.1.8 Receiver regulation. (§6.4.10) This test is engineered to check on the limiting of the high-level signal tones in the signal amplifier section.

6.1.1.9 Receiver guard action and the permanent signal and the two-wire controls. (§6.4.11) This test is divided into two separate parts. The first part of this subsection checks on the effectiveness of the receiver guard action. This is the part of the receiver which prevents false signaling by voice impulses imitating the signal tone.

The second part checks on the operation of the permanent signal control. This circuit provides a failure alarm. The test also checks on the two-wire control circuit for the properly timed insertion of the two-wire filter circuit into the channel.

6.1.1.10 Final adjustment of receiver sensitivity. (6.4.12) The last subsection of the test procedure for the receiver provides, for the particular application, a method for adjusting the SS potentiometer to get the sensitivity necessary for the signaling unit to function properly.

6.1.2 Transmitted power levels and attenuator settings. Two separate transmission power levels are specified in the subsection 6.4.5, and four values of attenuation in test 6.4.1.1. The value or setting to be used in each case depends upon the channel transmission levels and whether two-wire or four-wire equipment is used.

6.1.2.1 Plus four, minus thirteen line, two or four-wire circuits. The plus four line indicates that the signaling receiver unit is connected to a signaling circuit at a point in the circuit where the transmission level is a plus four db.

The minus thirteen line shows that the associated signaling transmitter unit is connected to the signaling circuit at a point in that circuit where the transmission level is minus thirteen db.

6.1.2.2 Plus seven, minus sixteen, two or four-wire circuits. The plus seven line indicates that the signaling receiver unit is connected to the signaling circuit at a point in that circuit where the transmission level is plus seven db.

The minus sixteen line shows that the associated signaling transmitter is connected to the signaling circuit at a point where the transmission level is minus sixteen db.

6.1.2.3 Plus four, minus four line. (For type 33 carrier) The plus four line shows that the signaling receiver is connected to the signaling circuit at a point where the transmission level is plus four db.

The minus four line shows that the associated signaling transmitter is connected to the signaling circuit at a point where the transmission level is minus four db.

6.2 Test equipment. The test equipment discussed in the next paragraphs is used to make the out-of-service tests on the signaling units. Three test sets and several special patch cords are used.

6.2.1 Type twenty-four test set. The type twenty-four test set is the equivalent of and interchangeable with the Western Electric testing circuit J-68602CS. The one major difference is that the type twenty-four has one attenuator and the J-68602CS has two.

6.2.2 Type twenty-five test set. The type twenty-five test set is the equivalent of and is interchangeable with the Western Electric type 2-B test set. The type twenty-five test set is equipped with a PERCENT BREAK meter that is calibrated from 0 to 100 in black, reading clockwise, and 100 to 0 in red, also reading clockwise. All the associated controls are marked BREAK as is the type 2-B set. The meter of the type 2-B test set is calibrated as a PERCENT BREAK meter and as such has a black scale from 0 to 100 and a red scale from 100 to 0 reading clockwise.

The percent make or percent break readings can be switched back and forth by use of the following formula: percent make equals one hundred minus the percent break reading. Conversely: percent break equals one-hundred minus the percent make reading.

6.2.3. Transmission test set (TMS). TMS shall be W. E. Co. type 13A, or equivalent, having the same dynamic characteristics. The requirements are that the set have a six hundred ohm impedance at one milliwatt and a scale that is calibrated from 0 to minus 25 db.

6.2.4 Patch cords. All the necessary patching cords are furnished with the type twenty-four and type twenty-five test sets.

6.3 Preparation.

6.3.1 Equipment set up. (see figure twenty two) The eleven notes or steps that appear in this section with the block diagram of the test circuit represent all the information necessary to connect a test circuit. This testing circuit is for the out-of-service test procedure. There are some voltage and resistance measurements that are made under another circuit arrangement. This setup and all necessary information for these measurements will be found at the end of this chapter. (Chapter 6.5)

Step 1. The signaling unit to be tested is mounted in test position one or two. To provide access into signaling units when trouble-shotting, use D-543240-A plug assembly from test position one or two to signaling unit placed on a convenient work table.

Step 2. Each test position has been factory wired to a corresponding test connector receptacle on the test connector strip.

Step 3. The associated test connector receptacle is now a direct access to the circuit of the signaling unit.

Step 4. The test connector receptacle associated with the test position in use is cabled to the type twenty-four test set by a twenty conductor patching cable.

Step 5. The type twenty-four test set is patched to the transmission measuring set (TMS).

Step 6. The E and M jacks of the types twenty-four and twenty-five test sets are patched together by a pair of cords, one of which is black and the other red.

Step 7. The one thousand cycle office test tone has been installer wired to the access jacks on the miscellaneous jack strip.

Step 8. From the one thousand cycle jacks a patching cord with double plugs is run to the type twenty-four test set.

Step 9. The test battery supply unit has been factory wired to the A and B jacks on the miscellaneous jack strip.

Step 10. From the A and B jacks the power for the type twenty-five test set is patched to the set through a pair of grey cords with red plugs. One of these cords has a plug smaller than the other so they are not interchangeable.

Step 11. When necessary during the out-of-service tests a patching cord is run from the MA jack on the type twenty-five test set to the number one and two test points on the signaling unit. This patching cord is shown in dotted lines.

Once the equipment is completely connected there should be a warm-up time of at least thirty minutes. The 2400 and 2600 oscillators should warm up for at least two hours.

Caution: do not attempt to run tests if the power supply is irregular or if it is not at the proper levels.

Adjustments of the PERCENT BREAK meter for values more than forty on the black scale must be made very SLOWLY. If the ADJ % BK control is turned too quickly, the pointer will pulse very rapidly and make taking readings very difficult. The pointer may also kick over to the other side of the meter indicating that it is only measuring every other pulse. The proper method for restoring the meter to normal operation is to turn the ADJ % BK control completely counterclockwise. Then turn the control clockwise slowly until the proper reading is reached.

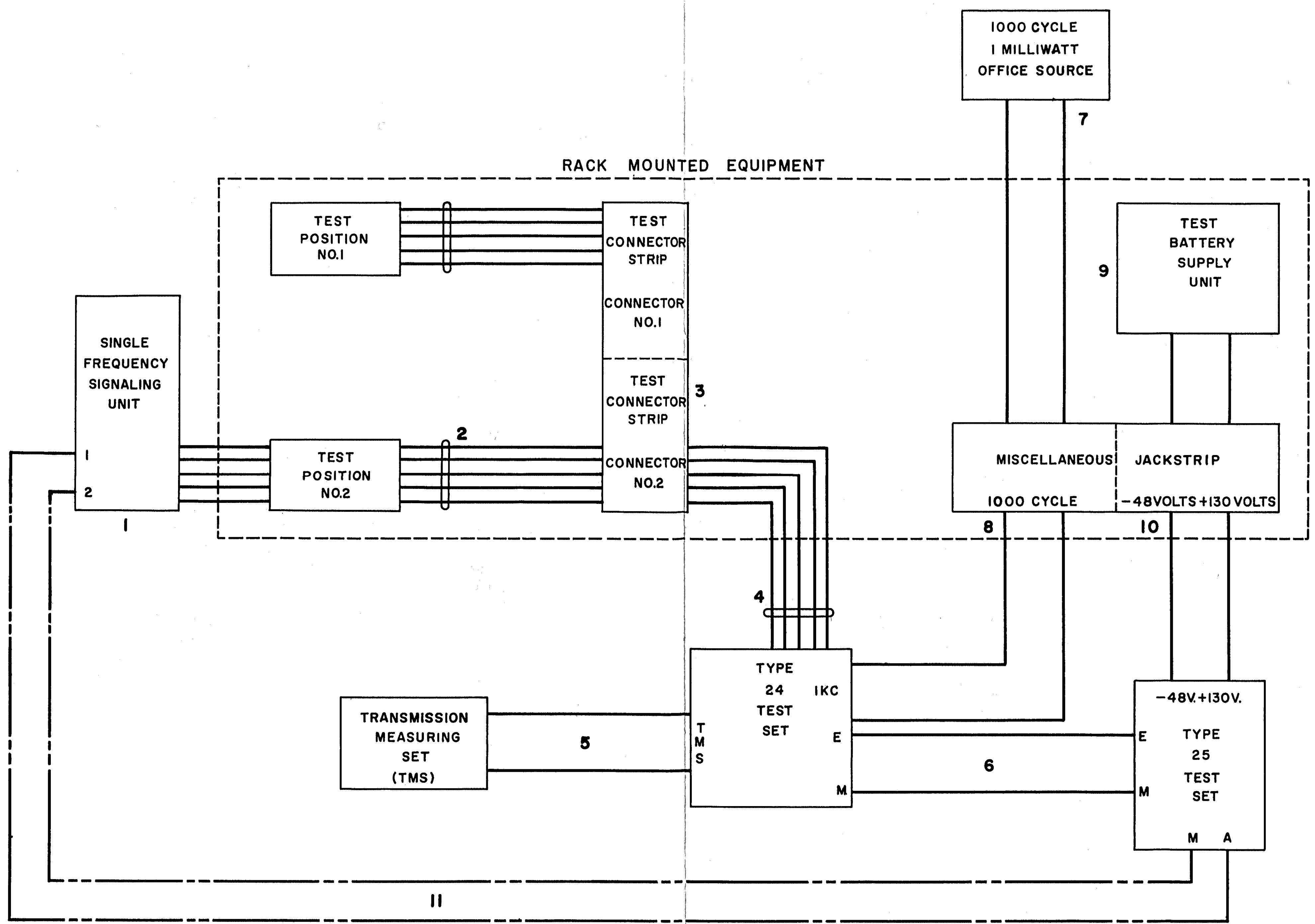


Figure 22. - Test Equipment Hook-Up

6.4 TEST PROCEDURE.

6.4.1 ADJUSTMENT OF THE TYPE TWENTY-FIVE TEST SET

STEP

1. Set all test set lever keys to normal.

2. Set SCALE SEL switch to 20 MA.

2. a PULSES PER SECOND meter reads 0.

3. If the requirement of 2. a is not met, adjust pointer adjustment screw of PULSES PER SECOND meter to obtain 0 reading.

4. Set SCALE SEL switch to PPS.

4. a PULSES PER SECOND meter reads other than 0.

5. Operate CONT PLS key to DIAL PLS.

5. a PERCENT BREAK meter reads 0 on black scale. PULSES PER SECOND meter reads 0 to 0.5

6. If the requirement of 5. a is not met, adjust pointer adjustment screw on PERCENT BREAK meter for 0 reading.

7. Insert D-59091 dummy plug into P jack. Note: Repeat steps 7, 7. a, 8 and 9 if testing interval exceeds 30 minutes.

7. a PERCENT BREAK meter reads 100 on black scale.

8. If requirement 7. a is not met, unlock CAL % BK control and adjust to obtain reading of 100. Relock control being careful not to disturb the reading of 100.

9. Remove the D-59091 dummy plug from P jack.

9. a PERCENT BREAK meter reads 0 on black scale.

10. Restore CONT PLS key to normal.

11. The correct performance of the tests covered in this section is dependent upon the correct pulses per second calibration.

6.4.2 PREPARATION FOR ALL TESTS

1. Calibrate Transmission Test Set according to the requirements of the equipment. The Transmission Test Set will be referred to as the TMS.

2. Out of service test-setup on signaling units should be made per sections 6.2 and 6.3.

3. Set the SF key of the miscellaneous jack strip to 2600 or 2400 cycles depending on the operating frequency of the signaling unit to be tested.

4. Set TL key of the type 24 test set to plus 4. The signal frequency signaling units are all tested at +4 dbm receiving level. When the unit is used on a line with +7 dbm receiving level, the proper receiver sensitivity adjustment is provided by test 6.4.12.

5. Set the KEYERS switch of the type 24 test set to 5 SIG OFF, and RECEIVER switch to 1 MEAS INPUT.

6.4.3 TRANSMITTER RELAY M PULSING (§6.1.1.1)

1. Set SCALE SEL switch of type 25 test set to PPS.

2. Restore all keys of test set to normal.

3. Adjust ADJ PPS control to get a reading of 10 pulses per second on PULSES PER SECOND meter (0 to 20 scale).

4. Set ADJ % BK switch to M. Adjust ADJ % BREAK control to get a reading of 45 on the black scale of the PERCENT BREAK meter.

5. Set KEYERS switch on the type 24 test set to 1 ADJ.

6. Operate the PLS, and MEAS % BREAK keys to LINE and the TWD LINE key to OFF HK on the type 25 test set.

6. a PERCENT BREAK meter reads 46 on the black scale.

7. If requirement 6.a is not met, adjust the M potentiometer of SF unit to get the required reading.

6.4.4 TRANSMITTER RELAY CO RELEASE (6.1.1.2)

1. Set SCALE SEL switch on type 25 test set to PPS.

2. Restore all keys of test set to normal.

3. Adjust ADJ PPS control to get a reading of 4 p.p.s. on the PULSES PER SECOND meter.

4. Adjust ADJ % BREAK control to get a reading of 40 on the black scale of the PERCENT BREAK meter.

5. Set the KEYERS switch on the type 24 test set to 2 SIG PLS.

6. Adjust the TMS for -25 dbm reading.

7. Operate the PLS key to LINE.

7. a No reading on the TMS (no TMS pointer kick).

8. If requirement in step 7. a is not met, strap resisotrs R-6, R-6', R-7, and R-7' until there is no TMS pointer kick.

9. Restore all keys on type 25 test set to normal.

10. Adjust the TMS for -25 (or -30) dbm reading.

11. Operate TWD LINE key to ON HK.

11. a TMS meter reads -25 to -35 dbm.

6.4.5 TRANSMITTED TONE LEVEL (s6.1.1.3)

1. Adjust TMS for -20 dbm reading.

2. Operate TWD LINE key on type 25 test set to OFF HK.

2. a No reading on TMS.

3. While observing TMS meter, momentarily set KEYERS switch of type 24 test set to 3 SIG ON.

4. The pointer on the dial of the TMS set will kick when the KEYERS switch is turned from 2 SIG PLS to 3 SIG ON. Switch the KEYERS switch back and forth several times to observe that the TMS reading is correct per section 4. a.

4. a Average peak reading of the TMS:

minus 13 line
minus 20.5, plus or minus 1.0 dbm

minus 16 line
minus 23.5, plus or minus 1.0 dbm

5. Set KEYERS switch to 3 SIG ON.

6. Adjust TMS to -30 dbm for the minus 13 line and -35 dbm reading for the minus 16 line.

6. a *Final reading of the TMS:*

minus 13 line
minus 33, plus or minus 1.0 dbm

minus 16 line
minus 36, plus or minus 1.0 dbm

7. Set KEYERS switch to 4 SIG OFF.

7. a *TMS reads less than minus 45 dbm.*

8. Restore TWD LINE key to normal.

6.4.6 RECEIVER RELAY R CUT-OFF CURRENT (§6.1.1.4)

1. Patch PLT CUR test points on the signaling unit (test points 1 and 2) to the MA jack on the type 25 test set (Use D-543154 cord assembly or equivalent).

2. Set SCALE SEL switch on type 25 test set to 20 MA.

3. Set KEYERS switch to 5 SIG OFF.

3. a *Milliammeter reads no more than 0.30 ma.*

4. Restore keys to normal. If the total time of the test to this point is more than thirty minutes, repeat section 6.4.1.

6.4.7 RECEIVER VOICE AMPLIFIER GAIN AND BAND ELIMINATION FILTER INSERTION.

(§6.1.1.5) Note: The SF unit under test shall be in operation at least 5 minutes before test is made.

1. Set KEYERS switch on the type 24 test set to 6 SIG ON, and RECEIVER switch to 1 MEAS INPUT.

2. Set attenuator on type 25 test set to 10 db.

3. Adjust GAIN potentiometer amplifier on type 25 test set to get a TMS reading of 0 dbm, plus or minus 0.2 dbm. Record reading.

4. Turn the TL potentiometer on the signaling unit fully clockwise.

5. Turn the SS potentiometer on the signaling unit completely counterclockwise.

6. Set RECEIVER switch to 2M OPR.

6. a *F lamp should light.*

7. Adjust the TL potentiometer on the signaling unit to get a TMS reading of 0.1 dbm under that of step 3.

8. Turn the SS potentiomenter clockwise until the F lamp on the type 24 test set just goes out.

8. a TMS reading of less than minus 29 dbm.

9. Set RECEIVER switch to 3 M RLS.

10. Turn the SS potentiometer completely counterclockwise.

10. a TMS reading less than minus 29 dbm.

<u>6.4.8 RECEIVER SIGNALING AMPLIFIER SENSITIVITY (§6.1.1.6)</u>. Note: The SF unit under test should be in operation at least 5 minutes before test is made.

1. Patch PLT CUR test points of the signaling unit to the MA jack of the type 25 test set (Use D-543154 cord assembly or equivalent).

2. Set SCALE SEL switch of the type 25 test set to 20 MA.

3. Set KEYERS switch to 6 SIG ON, RECEIVER switch to 3 M RLS.

4. Turn the SS potentiometer on the signaling unit fully clockwise.

5. When testing +4 (2 wire) SF units, set attenuator switches for 38.0 db or 40 db if brand-pass network is also to be used with the SF unit (figures 3 and 4 of H-85825).

5. a Milliammeter reads at least 5.5 ma.

6. When testing +7 (2 wire) SF units, set attenuator switches at 37.0 db, if brand-pass network is also to be used with the SF unit (figures 3 and 4 of H-85825).

6. a Milliammeter reads at least 5.5 ma.

7. Set the type 24 test set attenuator to 35 db.

8. Adjust the SS potentiometer for a meter reading of 5.5 ma, and lock SHAFT LOCKING bushing.

9. Set the type 24 test set attneuator to 26 db.

9. a Milliammeter reads at least 8.5 ma.

10. Remove the patch between the PLT CUR test points and the MA jack.

6.4.9 OPERATION OF RELAY R IN THE RECEIVER (6.1.1.7)

1. Set all lever keys on the type 25 test set to normal.

2. Set SCALE SEL switch of type 25 test set to PPS.

3. Adjust the ADJ PPS control to get a reading of 10 p.p.s. on the PULSES PER SECOND meter (0 to 20 scale). Note: If testing interval has extended beyond 30 minutes, see step 7 of section 6.4.1.

4. Adjust the ADJ % BREAK control for a reading of 55 on the black scale of PERCENT BREAK meter.

5. Set KEYERS switch on type 24 test set to 7 CAL.

6. Set the PLS and MEAS % BREAK keys to LINE and the TWD LINE key to OFF HK on the type 25 test set.

7. Adjust the K potentiometer on the type 24 test set to get a reading of 55 on the black scale of the PERCENT BREAK meter.

8. Set attenuator on type 24 test set to 14 db.

9. Adjust ADJ % BREAK control to get a reading of 34 on the balck scale of the PERCENT BREAK meter.

10. Turn the ADJ PPS control completely counterclockwise. Note: The SF unit under test should have been in operating condition at least 5 minutes before step 11.

11. Set KEYERS switch to 8 SIG PLS and the RECEIVER switch to 3 M RLS.

11. a No noticeable kicks of the pointer should show on the PERCENT BREAK meter (see step 17).

12. Set KEYERS switch to 7 CAL.

13. Adjust ADJ PPS control to get a reading of 10 p.p.s. on the PULSES PER SECOND meter.

14. Adjust ADJ % BREAK control to get an exact reading of 36 on the black scale of the PERCENT BREAK meter.

15. Turn the ADJ PPS control completely counterclockwise.

16. Set KEYERS switch to 8 SIG PLS and RECEIVER switch to 3 M RLS.

16. a Steady kicks should be noticeable by the pointer of the PERCENT BREAK meter (see step 17).

17. If the requirements of steps 11. a and 17. a are not met, perform the next six steps. (Steps 18 to 23.) If the requirements of steps 11. a and 16. a are met then start with step 25.

18. Set KEYERS switch to 7 CAL.

19. Adjust ADJ PPS control to get a reading of 10 p. p. s. on the PULSES PER SECOND meter.

20. Adjust ADJ % BREAK control to get an exact reading of 35 on the black scale of the PERCENT BREAK meter.

21. Adjust ADJ PPS control on the type 25 test set fully counterclockwise.

22. Set KEYERS switch to 8 SIG PLS and the RECEIVER switch to 3 M RLS.

23. Adjust the OT potentiometer on the signaling unit so that the pointer of the PERCENT BREAK meter just gives small but steady kicks.

24. Repeat steps 9 to 16.

25. Set KEYERS switch to 7 CAL.

26. Adjust the ADJ PPS control to get a reading of 10 p. p. s. on the PULSES PER SECOND meter.

27. Adjust ADJ % BREAK control to get a reading of 45 on the black scale of the PERCENT BREAK meter.

28. Set KEYERS switch to 8 SIG PLS and RECEIVER switch to 3 M RLS.

28. a PERCENT BREAK meter indicates 51 on red scale (see step 29).

29. If requirement 28. a is not met, turn the RT potentiometer completely counterclockwise. Then turn RT clockwise until a reading of 51 is obtained on PERCENT BREAK meter red scale.

30. Set KEYERS switch to 7 CAL.

31. Adjust ADJ % BREAK control slowly to get a reading of 70 on the black scale of the PERCENT BREAK meter.

32. Set KEYERS switch to 8 SIG PLS and RECEIVER switch to 3 M RLS.

32. a PERCENT BREAK meter should read not more than 70 on the red scale.

RERING RESPONSE OF RECEIVER

33. Set KEYERS switch to 7 CAL.

34. Adjust ADJ % BREAK control to get a reading of 65 on the black scale of the PERCENT BREAK meter.

35. Adjust ADJ PPS control to get a reading of 4 p. p. s. on the PULSES PER SECOND meter.

35. a PERCENT BREAK meter reads 26 on the black scale.

36. If requirement 35. a is not met, adjust the ADJ PPS control counterclockwise until a reading of 26 on the black scale is reached.

37. Set KEYERS switch to 8 SIG PLS and RECEIVER switch to 2 M OPR.

37. a PERCENT BREAK meter reads between 26 and 55 on the red scale.

38. Set KEYERS switch to 7 CAL.

39. Adjust ADJ % BREAK control to obtain reading of 50 on black scale of PERCENT BREAK meter.

40. Set KEYERS switch to 8 SIG PLS and RECEIVER switch to 2 M OPR.

40. a PERCENT BREAK meter reads not more than 56 on red scale.

41. Adjust TMS for 0 db reading.

42. Set LEVER key of the type 25 test set to normal.

6.4.10 RECEIVER REGULATION (6.1.18)

1. Set attenuator of type 24 test set to 26 db.

2. Set KEYERS switch to 7 CAL.

3. Set the PLS and MEAS % BREAK key levers to LINE and the TWD LINE key to OFF HK on the type 25 test set.

4. Adjust the ADJ PPS control to get a reading of 5 p. p. s. on the PULSES PER SECOND meter (0 to 20 scale).

5. Adjust ADJ % BREAK control to get a reading of 75 on the black scale of the PERCENT BREAK meter.

6. Patch PLT CUR test points on the signaling unit (test points 1 and 2) to the MA jack on the type 25 test set (Use D-543154 cord assembly or equivalent).

7. Set SCALE SEL switch on the type 25 test set to 20 MA. Note: The SF unit under test shall have been in operation at least 5 minutes before step 8.

8. Set KEYERS switch to 8 SIG PLS and RECEIVER switch to 3 M RLS.

8. a The fluctuating pointer of the MILLIAMMETER shows an average of not less than 6. 5 ma.

9. Set attenuator on type 24 test set to 0 db.

9. a MILLIAMMETER averages not less than step 8. a.

10. Set attenuator on type 24 test set to 26 db.

11. Move RECEIVER switch to 2 M OPR.

11. a The fluctuating pointer of the MILLIAMMETER shows an average of not less than 6. 5 db.

12. Set attenuator to 0 db.

12. a MILLIAMMETER averages not more than 0. 6 less than the average of step 11. a.

13. Set attenuator to 26 db.

14. Set KEYERS switch to 6 SIG ON and RECEIVER switch to 3 M RLS.

14. a MILLIAMMETER reads not less than 8. 5 ma.

15. Set attenuator to 0 db.

15. a MILLIAMMETER reads not less than the average indicated in step 14. a.

16. Remove the patching cord from between the PLT CUR test points and the MA jack.

17. Restore all lever keys to normal on type 25 test set.

6. 4. 11 <u>RECEIVER GUARD ACTION, PERMANENT SIGNAL, AND TWO-WIRE FILTER CONTROL (s6. 1. 1. 9).</u> Note: The SF unit under test shall have been in operation at least 5 minutes before the test is made.

1. Set attenuator on type 24 test set to 42 db.

2. Set TL key to +4 db.

3. Adjust TMS for -20 db reading.

4. Set KEYER switch to 5 SIG OFF and RECEIVER switch to 6 MEAS 1KCIN.

4. a TMS meter reads −22 ±0.5 dbm. If it does not give this reading, readjust amplitude control of 1000 cycle oscillator.

5. a Type 25 test set, lamp L out;
Type 24 test set, lamp F out;
Type 24 test set, lamp PS lighted.

6. Move KEYERS switch to 6 SIG ON.

6. a Lamp L out.

7. Set attenuator to 28 db.

7. a Type 25 test set, lamp L lighted;
Type 24 test set, lamp F out;
Type 24 test set, lamp PS out.

8. Set KEYERS switch to 5 SIG OFF and RECEIVER switch to 7 M OPR.

8. a Type 25 test set, lamp L out;
Type 24 test set, lamp F lighted;
Type 24 test set, lamp PS out.

9. Set attenuator to 26 db.

10. Move KEYERS switch to 6 SIG ON.

10. a Type 25 test set, lamp L out.

11. Set attenuator to 18 db.

11. a Type 25 test set, lamp L lighted;
Type 24 test set, lamp F out;
Type 24 test set, lamp PS out.

6.4.12 RECEIVER SENSITIVITY FINAL ADJUSTMENT (s6.1.1.10). Note: If test 6.4.8 (Receiver Signaling Amplifier Sensitivity) has been made and the SF unit is to be used on a 4-wire line with a +4 dbm transmitting level or on a 2-wire line with a +7 dbm transmitting level, the SF unit has been adjusted to the correct sensitivity and readjustment per this test is not necessarily required.

1. Patch PLA CUR test points on signaling unit (test points 1 and 2) to MA jack on type 25 test set (use D-543154 cord assembly or equivalent).

2. Set SCALE SEL switch to 20 MA on 25 type test set.

3. Set type 24 test set attenuator to db value indicated below for transmitting level, type of line and band-pass network (if provided) with which the SF unit is associated.

plus 4 line (four-wire) 35.0 db	plus 4 line (two-wire) with band-pass network 40.0 db
plus 7 line (four-wire) 32.0 db	
plus 4 line (two-wire) 38.0 db	
plus 7 line (two-wire) 35.0 db	plus 7 line (two-wire) with band-pass network 37.0 db

4. Set KEYERS switch to 6 SIG ON and RECEIVER switch to 3 M RLS.

5. Adjust the potentiometer SS on the signaling unit for a reading on the MILLIAMMETER of 5.5 ma, and lock SHAFT LOCKING nut.

6. Remove the patching cord between PLT and CUR test points and the MA jack.

7. Remove SF unit from testing set-up and install it in its signaling bay location and restore unit to service in accordance with approved procedures.

8. If no other SF units are to be tested and adjusted, restore all test equipment to normal.

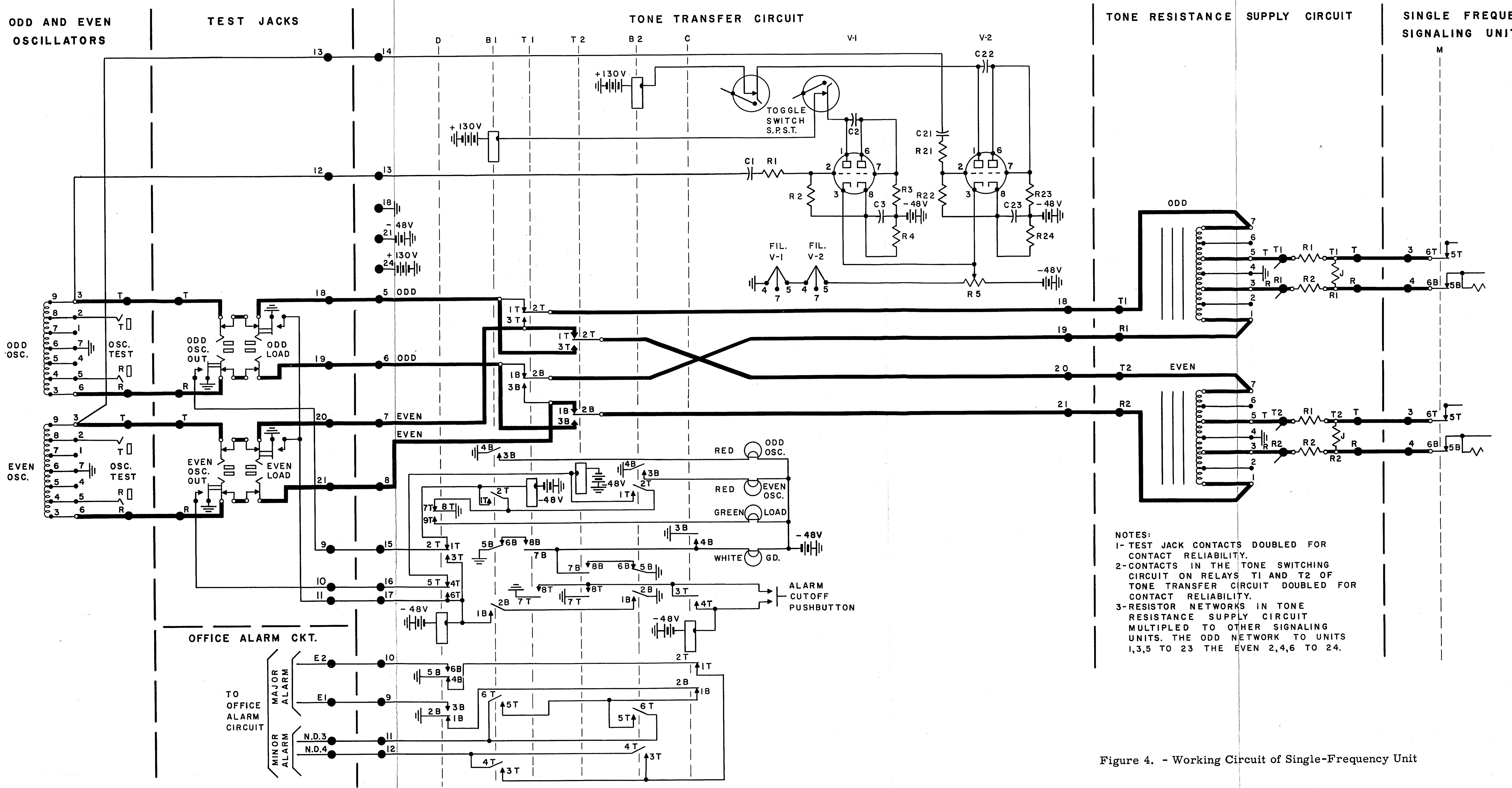


Figure 4. - Working Circuit of Single-Frequency Unit

Figure 6. - Circuit Drawing - Single-Frequency Signaling Unit

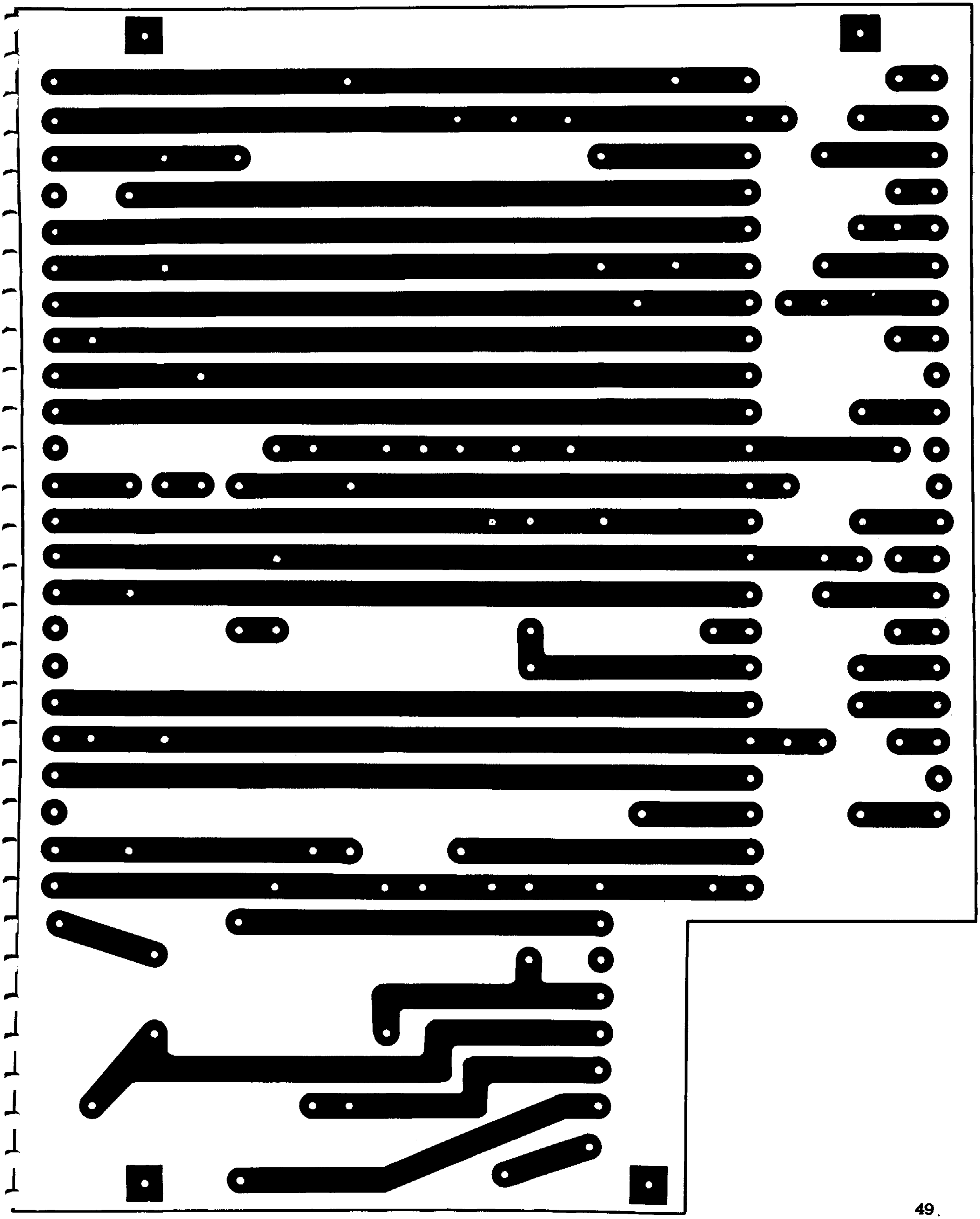


Figure 11. - Printed Circuit Board

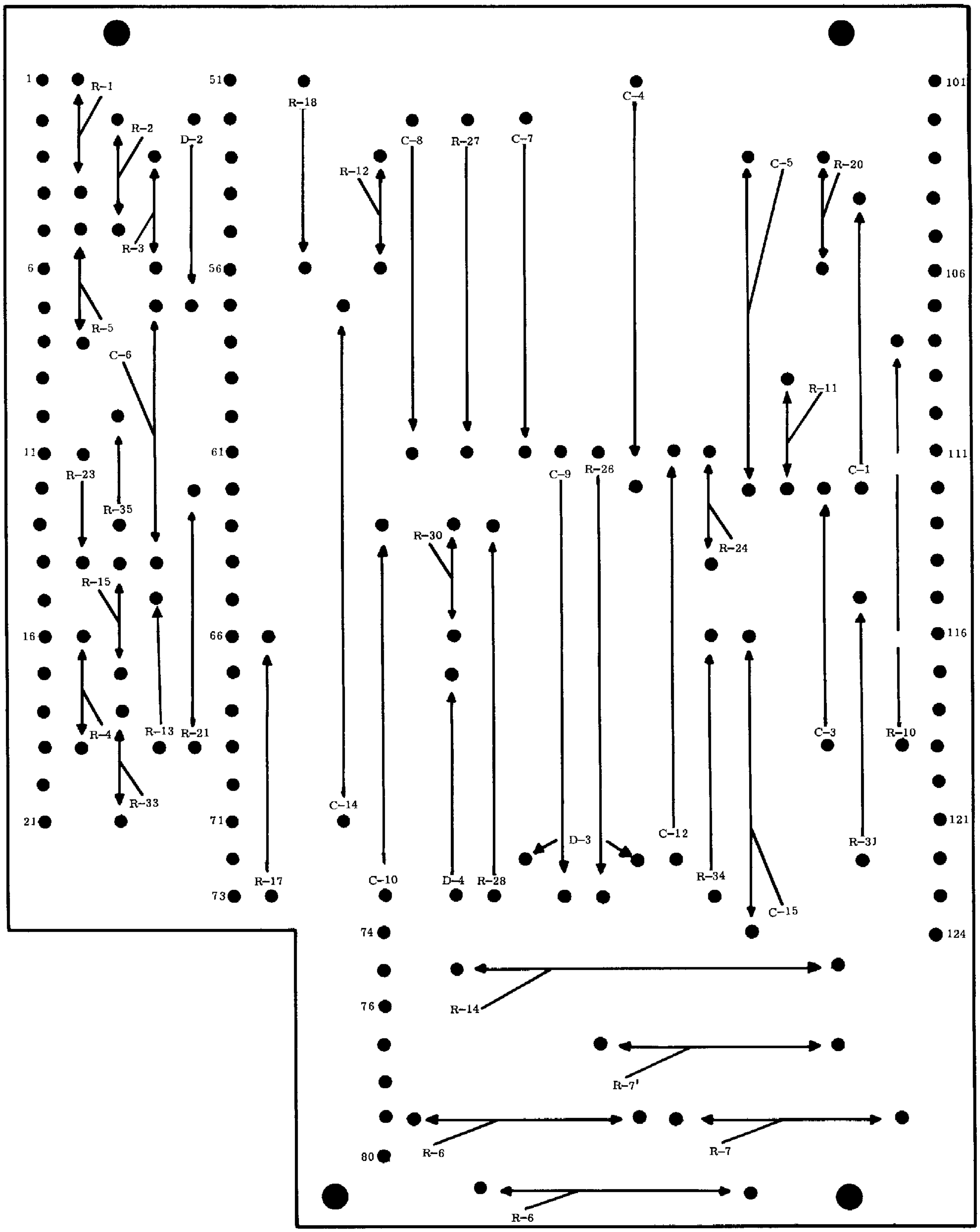
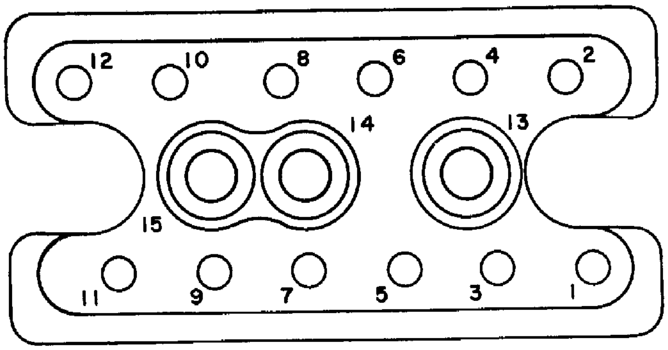


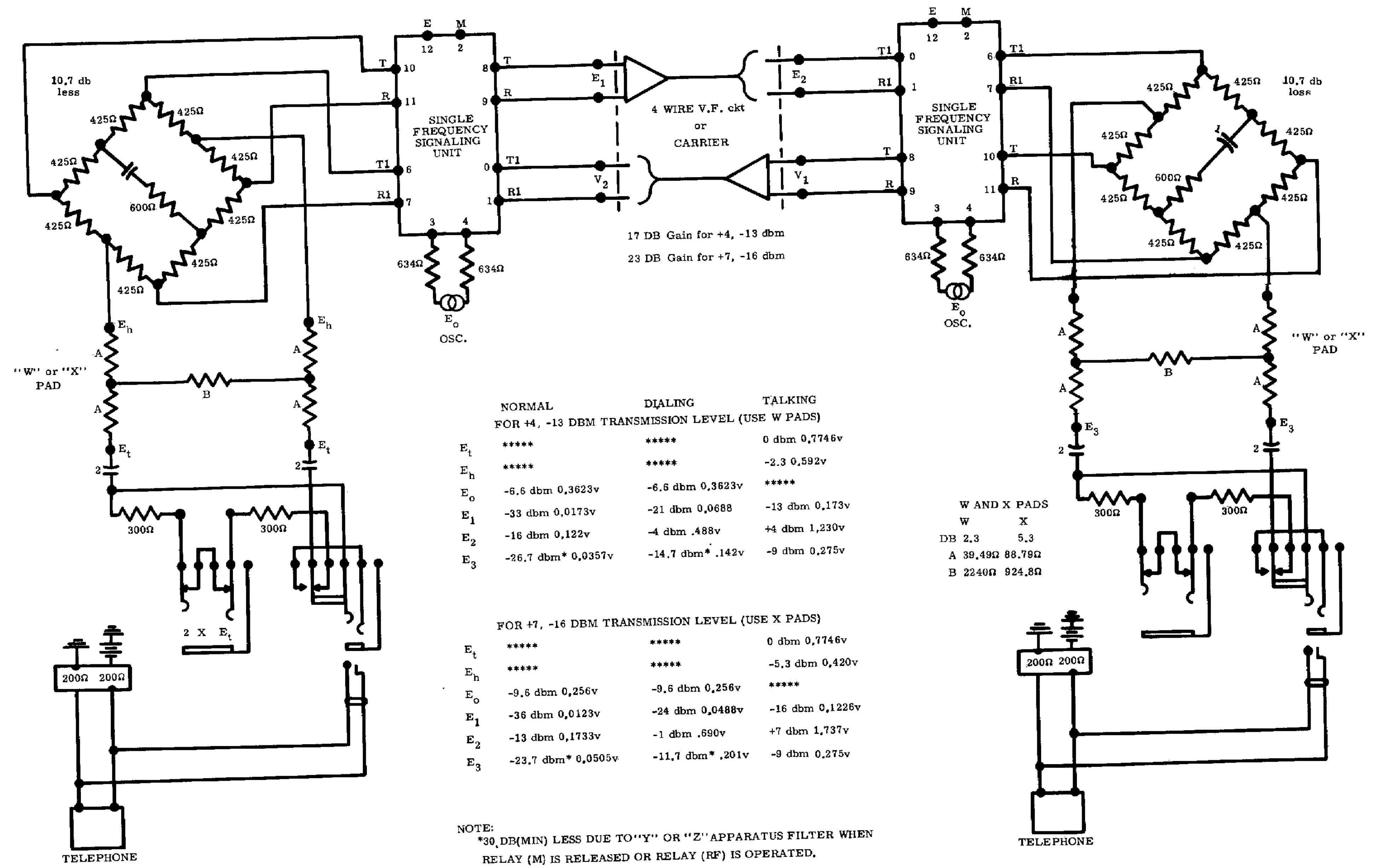
Figure 12. - Component Location

The test-point receptacle shown here is mounted on the front of each S. F. S. unit.



POINTS	LOCATION IN CIRCUIT
1 & 2	Plus & minus V-3
3 & 4	Drop T' & R'
5 & 6	Line T' & R'
7 & 8	Line T & R
9 & 10	"E" & "M" leads
11 & 12	Plus & minus V-2

Figure 13a. - Test Connector Information



	NORMAL	DIALING	TALKING
FOR +4, -13 DBM TRANSMISSION LEVEL (USE W PADS)			
E_t	*****	*****	0 dbm 0.7746v
E_h	*****	*****	-2.3 0.592v
E_o	-6.6 dbm 0.3623v	-6.6 dbm 0.3623v	*****
E_1	-33 dbm 0.0173v	-21 dbm 0.0688	-13 dbm 0.173v
E_2	-16 dbm 0.122v	-4 dbm .488v	+4 dbm 1.230v
E_3	-26.7 dbm* 0.0357v	-14.7 dbm* .142v	-9 dbm 0.275v

FOR +7, -16 DBM TRANSMISSION LEVEL (USE X PADS)			
E_t	*****	*****	0 dbm 0.7746v
E_h	*****	*****	-5.3 dbm 0.420v
E_o	-9.6 dbm 0.256v	-9.6 dbm 0.256v	*****
E_1	-36 dbm 0.0123v	-24 dbm 0.0488v	-16 dbm 0.1226v
E_2	-13 dbm 0.1733v	-1 dbm .690v	+7 dbm 1.737v
E_3	-23.7 dbm* 0.0505v	-11.7 dbm* .201v	-9 dbm 0.275v

W AND X PADS

	W	X
DB	2.3	5.3
A	39.49Ω	88.79Ω
B	2240Ω	924.8Ω

NOTE:
*30 DB(MIN) LESS DUE TO "Y" OR "Z" APPARATUS FILTER WHEN RELAY (M) IS RELEASED OR RELAY (RF) IS OPERATED.

Figure 23. - In-Service Test Set-Up - Tone Levels

LIST OF TERMS USED IN SINGLE-FREQUENCY SIGNALING

ORIGINATING END			SIGNAL CONDITIONS	CALLED END	
SIGNAL SENT	"M" LEAD "E" LEAD	SUPERVISORY CORD CIRCUIT	TONE ON LINE	SIGNAL SENT	"E" LEAD "M" LEAD
Disconnect	"M" Grd. "E" Open		1. <u>IDLE CIRCUIT</u> Steady low level Steady low level	ON-HOOK	"E" Open "M" Grd.
Connect***	"M" Batt. "E" Open	Lamp flashes	2. <u>CIRCUIT SEIZED</u> No tone Steady low level	ON-HOOK	"E" Open "M" Grd.
Connect	"M" Batt. "E" Open	Lamp dark	3. <u>DELAY DIAL</u> No tone No tone	OFF-HOOK***	"E" Grd. "M" Batt.
Connect	"M" Batt. "E" Open	Lamp lit	4. <u>START DIAL</u> No tone High-level spurt, then steady low-level	ON-HOOK***	"E" Grd. "M" Grd.
Disconnect & *** Connect	"M" Int. gds. -batt. "E" Open	Lamp lit	5. <u>DIAL PULSING</u> High level spurts Steady low level	ON-HOOK	"E" Int. opens "M" Grd.
Connect	"M" Batt. "E" Open	Lamp lit	6. <u>AWAIT SUBSCRIBER ANSWER-INTERCEPT</u> No tone Steady low level	ON-HOOK	"E" Grd. "M" Grd.
Connect	"M" Batt. "E" Grd. & open	Lamp flashes	7. <u>RINGBACK & VARIOUS FLASHING SIGNALS</u> No tone No tone, then high level spurts, dropping off	OFF & ON-HOOK***	"E" Grd. "M" Batt. & grd.
Connect	"M" Batt. "E" Grd.	Lamp dark	8. <u>SUBSCRIBER ANSWERS</u> No tone No tone	OFF-HOOK***	"E" Grd. "M" Batt.
Connect & *** Disconnect	"M" Int. grd. "E" Grd.		9. <u>RERING</u> High level spurt, then no tone No tone	OFF-HOOK	"E" Int. open "M" Batt.
Connect	"M" Batt. "E" Open	Lamp lit	10. <u>CALLED SUBSCRIBER HANGS UP</u> No tone High level spurt, then low level	ON-HOOK***	"E" Grd. "M" Grd.
Disconnect ***	"M" Grd. "E" Open		11. <u>DISCONNECT & CIRCUIT IDLE</u> High level spurt, then low level Steady low level	ON-HOOK	"E" Open "M" Grd.

*** Indicates originating point of signal.

SIGNAL A to B	SIGNAL B to A	CONDITION AT OFFICE A		CONDITION AT OFFICE B	
		"M" LEAD	"E" LEAD	"M" LEAD	"E" LEAD
ON-HOOK	ON-HOOK	GROUND	OPEN	GROUND	OPEN
OFF-HOOK	ON-HOOK	BATTERY	OPEN	GROUND	GROUND
ON-HOOK	OFF-HOOK	GROUND	GROUND	BATTERY	OPEN
OFF-HOOK	OFF-HOOK	BATTERY	GROUND	BATTERY	GROUND

To signal between the Single-Frequency unit and the central-office switching-equipment, leads "E" and "M" are marked:

ON LEAD "M" — Locally originated signals to be repeated to distant office.

(1.) -48 volts through lamp for OFF-HOOK.

(2.) Ground for ON-HOOK.

ON LEAD "E" — Signal from distant office, repeated to local trunk circuit.

(1.) Ground for OFF-HOOK.

(2.) Open for ON-HOOK.

Chart B - E and M Signaling Conditions

FUNCTIONS OF MISCELLANEOUS JACK STRIP

JACK CIRCUIT	FUNCTION OF JACK CIRCUIT	JACK LETTERING
Telephone jack circuit	This circuit is used as a means to get to the Toll Test Board or to other components of the central office. This is done to allow conversation while testing the Single-Frequency Signaling Equipment.	TRK. 1 A B A B TRK. 2
Monitor Amplifier	The MON. OUT jacks are used to monitor voice or tone. The MON. IN jacks are patched directly to the LINE REC. or LINE TRANS. of the signaling unit under examination. This circuit permits signaling tone level tests. The AMP. IN and AMP. OUT jacks provide a connection between the 600 circuits. A signal is put into the MON. IN jack and it is attenuated 30 db, amplified 30 db, and comes out the AMP. OUT jack at the same tone level.	AMP. IN MON. IN T R T R T R T R AMP. OUT MON. OUT
Calibration Circuit	The calibration circuit is used to adjust the amplifier gain with a TMS. (A 600 ohm input impedence transmission measuring set).	CAL. OUT T R T R CAL. MEAS.
Transmission Measuring Trunks	These trunks are provided to make it easier to make voice tests and to test the signaling units. These jacks go either to the Toll Test Board, the transmission measuring bay, or the Intermediate Distributing Frame.	SEND T R T R REC.
Oscillator	The output of the oscillators can be monitored through these jacks. If a plug is inserted into either the ODD or EVEN OSC. OUT jacks, the oscillator being monitored will be switched out of the signaling circuit. An outside source of signal frequency can be introduced into the signaling circuit through the ODD or EVEN LOAD jacks.	ODD OSC. OUT EVEN OSC. OUT T R T R T R T R ODD LOAD EVEN LOAD
Battery Supply	These jacks are the outlet for the test battery supply unit, and supply the proper voltages for the type 25 testset.	TYPE 25 TST A B TYPE 25 TST
Testing Circuit	The testing circuit consists of three pairs of jacks and a switch. One pair of jacks is the outlet for the office 1000 cycle source. The switch gives a choice of 2600 or 2400 cycles on the SIG. TONE and TEST TONE jacks. These jacks are between the oscillators and the signaling test circuit as described in the chapter on test procedures.	SIG. TONE IMW 1000 ~ 2600 — T R T R 2400 | T R TEST TONE
48 48 Volt Battery	This jack supplies office -48 volts to test equipment when needed.	48V

RELAY OPERATION SEQUENCE, SINGLE-FREQUENCY SIGNALING EQUIPMENT

THE SIGNAL	CONDITION AT OFFICE "A"	DIRECTION OF SIGNAL	CONDITION AT OFFICE "B"
<u>IDLE</u> ON-HOOK at offices "A" & "B"	Relays (RF) & (R) operated. Tone is on to office "B". Relays (G), (M), (HL), & (CO) are restored.	↔	Relays (RF) & (R) operated. Tone is on to office "A". Relays (G), (M), (HL), & (CO) are restored.
<u>CONNECT OFFICE "A" TO OFFICE "B"</u> Office "A" originates call OFF-HOOK "A" to "B"; ON-HOOK "B" to "A"	Trunk circuit puts battery on lead M. Relay (M) operates cuts off tone to office "B", and operates relay (CO). Relay (CO) operates relay (HL). Relay (HL) restores relay (CO).	→	Incoming signal of Tone-off restores first relay (R) then relay (RF). Restoration of relay (R) operates relay (G) and grounds lead E.
<u>DIALING</u> ON-HOOK & OFF-HOOK Signals — ON-HOOK (Tone-on)	The trunk circuit grounds lead M, restoring the relay (M). Relay (M) restoring operates relay (CO). Relay (HL), slow to release, holds during dialing. Restoration of relay (M) puts tone on the line.	→	The signal of Tone-on operates relays (RF) & (R). Relay (R) short-circuits relay (G), making relay (G) slow to release, and removes ground from lead E.
OFF-HOOK (Tone-off)	Battery on the lead M operates relay (M), Relay (M) cuts off the tone to office "B", releases relay (CO), and resaturates relay (HL).		The incoming signal of Tone-off restores relays (R) and (RF). Relay (R) grounds the lead E.
<u>CALLED PHONE ANSWERS</u> OFF-HOOK in both directions	The incoming Tone-off signal restores relays (R) & (RF), relay (R) operates relay (G), and grounds lead E.	←	Answer of the called phone grounds lead M. Relay (M) operates relay (CO) and then relay (HL), and cuts off the tone to office "A". Relay (HL) restores relay (CO).
<u>DISCONNECT</u> The calling phone disconnects Office "A" ON-HOOK--Office "B" OFF-HOOK	The replaced handset grounds lead M, which restores relay (M). Relay (M) puts tone on to office "B", operates relay (CO), and restores relay (HL). Relay (HL) restores relay (CO).	→	The Tone-on signal operates relays (RF) & (R). Relay (R) short-circuits relay (G), making relay (G) slow to release, and removes ground from lead E, and releases the local switch train. After about 230 ms relay (G) restores.
The called office reports disconnection Office "A" ON-HOOK--Office "B" ON-HOOK	The Tone-on signal operates relays (RF) & (R). Relay (R) short-circuits relay (G), making relay (G) slow to release. Relay (R) removes ground from lead E. After about 230 ms relay (G) restores. UNIT IS IDLE	←	Disconnection removes battery from lead M, restores relay (M), puts tone on to office "A", operates relay (CO), and opens the circuit of relay (HL). Relay (HL) restores, releasing relay (CO). UNIT IS IDLE

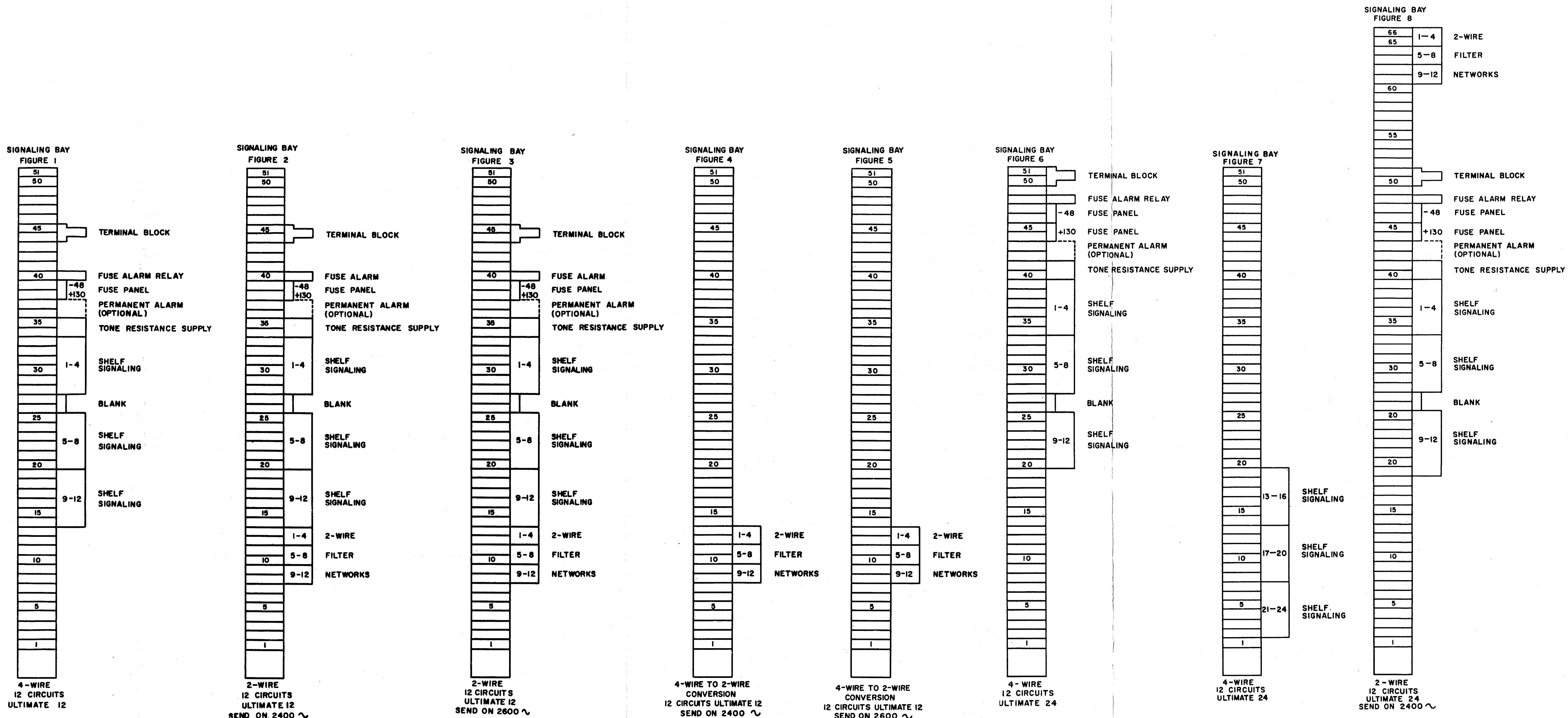


Chart E - Pictorial Representation Single-Frequency Signaling Racks

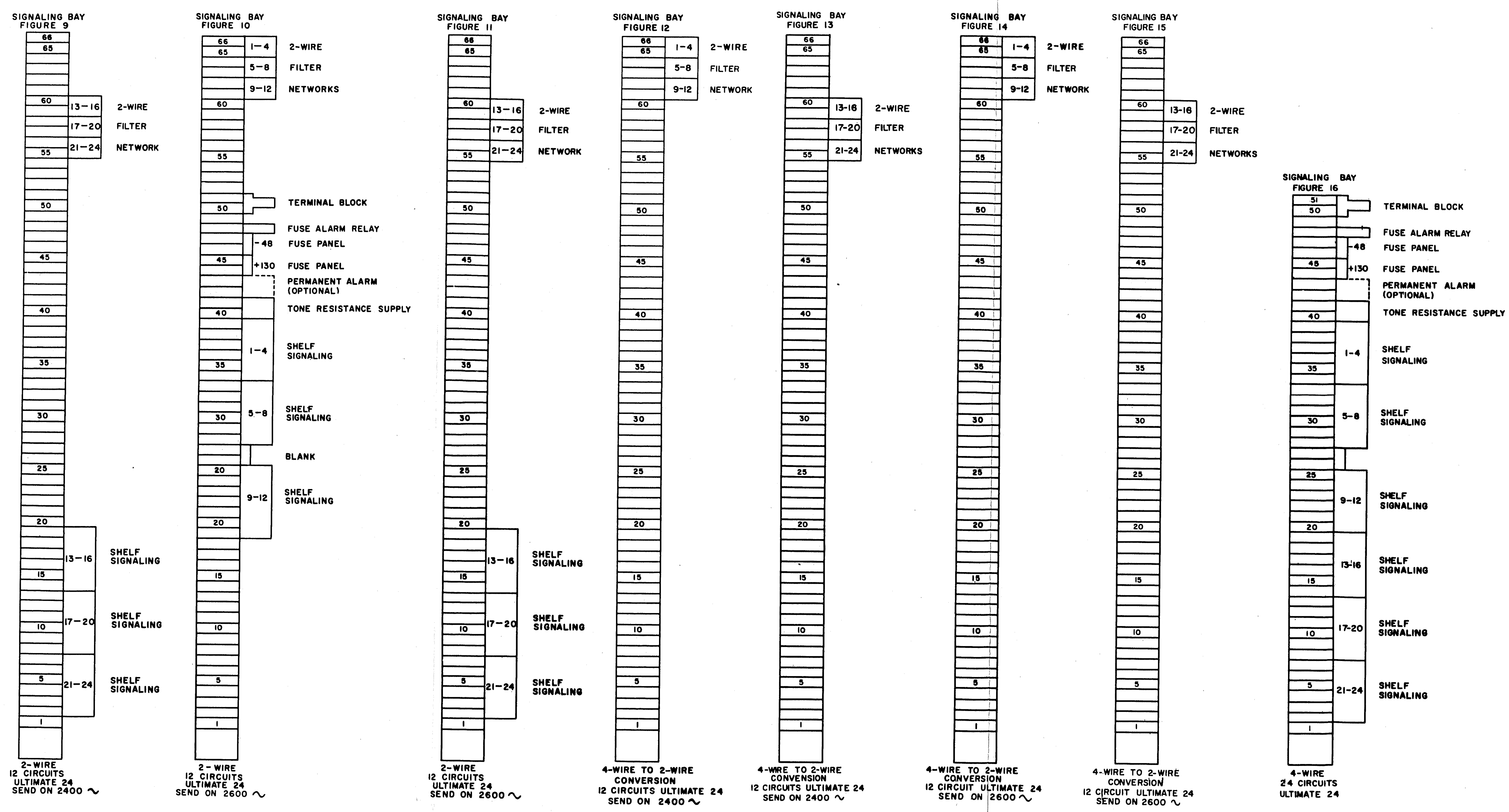


Chart E - Continued

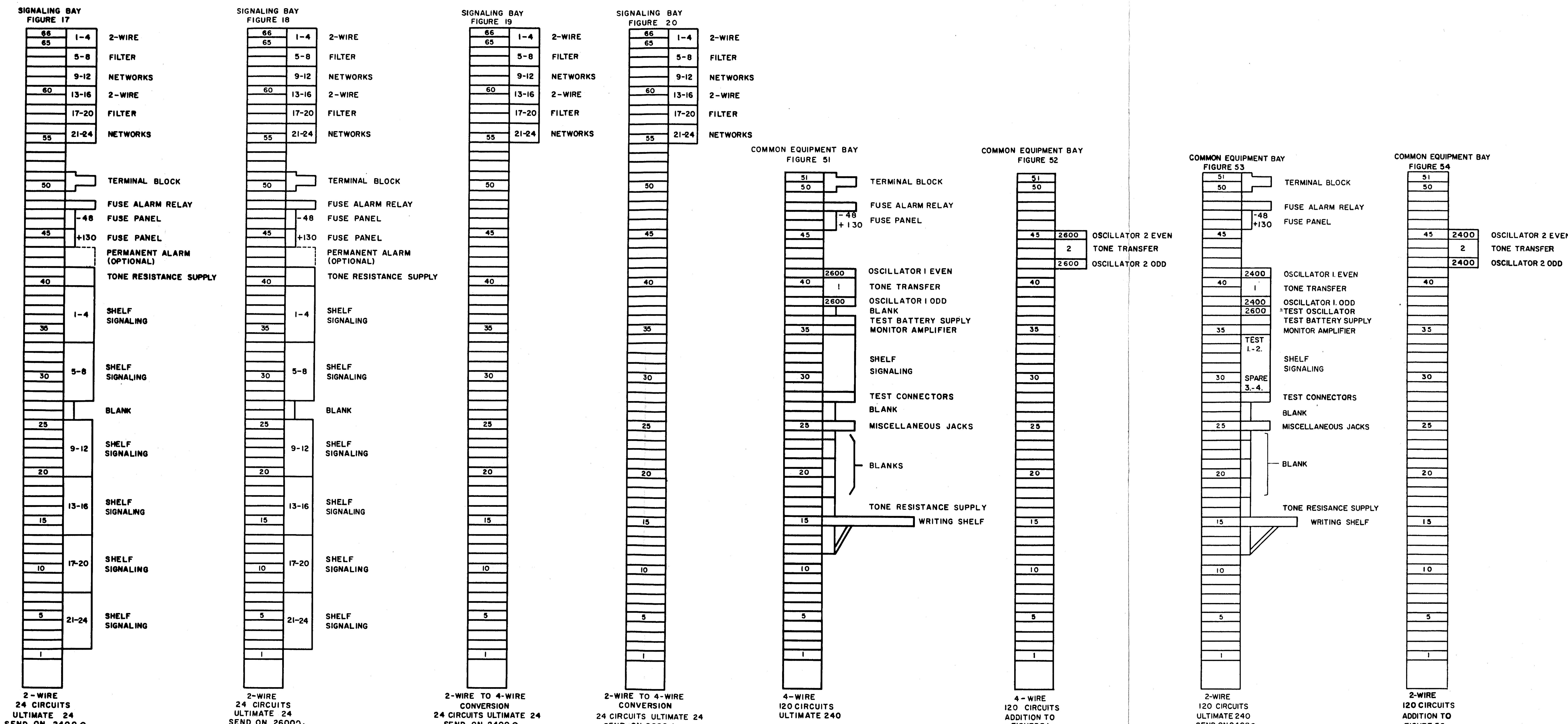


Chart E - Continued

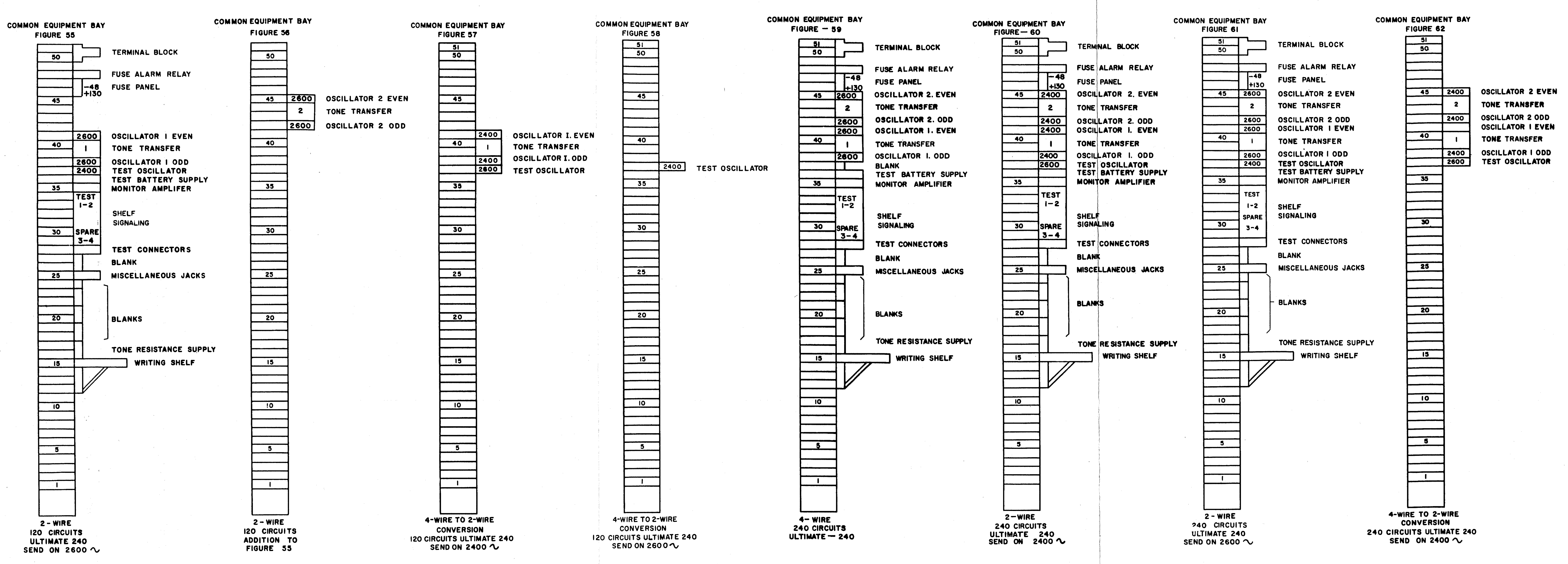


Chart E - Continued

Printed in U. S. A. by The Edward Keogh Printing Co.

AUTOMATIC ELECTRIC

Subsidiary of

GENERAL TELEPHONE & ELECTRONICS

Makers of Telephone, Signaling, and Communication Apparatus . . . Electrical Engineers, Designers, and Consultants.

Factory and General Offices: Northlake, Illinois, U.S.A.

•

ASSOCIATED RESEARCH AND MANUFACTURING COMPANIES

General Telephone Laboratories, Incorporated - - - - - - - Northlake, Illinois, U. S. A.
Automatic Electric (Canada) Limited - - - - - - - - - - - Brockville, Ontario, Canada
Automatique Electrique, S.A. - Antwerp, Belgium
Automatic Electric, S.A.T.A.P. - Milan, Italy

•

DISTRIBUTOR IN U.S. AND POSSESSIONS

AUTOMATIC ELECTRIC SALES CORPORATION
Northlake, Illinois, U.S.A.
Sales Offices in All Principal Cities

•

GENERAL EXPORT DISTRIBUTOR

AUTOMATIC ELECTRIC INTERNATIONAL
INCORPORATED
Northlake, Illinois, U.S.A.

•

REGIONAL DISTRIBUTING COMPANIES AND REPRESENTATIVES

ARGENTINA, URUGUAY, PARAGUAY, CHILE, AND BOLIVIA
D. C. Clegg
Sala 61
Rua Conselheiro Crispiniano No. 69
Sao Paulo, Brazil

AUSTRALIA
Automatic Electric Telephones Limited
86 Holdsworth Street, Woollahra
Sydney, Australia

BELGIUM AND LUXEMBOURG
Automatique Electrique, S. A.
22 Rue du Verger
Antwerp, Belgium

BRAZIL
Automatic Electric do Brasil, S. A.
Sala 61
Rua Conselheiro Crispiniano No. 69
Sao Paulo, Brazil

CANADA
Automatic Electric Sales (Canada) Limited
185 Bartley Drive
Toronto 16, Ontario, Canada

CENTRAL AMERICA
L. Pitigliani
Apartado Postal 21327
Mexico 7, D. F., Mexico

COLOMBIA
Automatic Electric de Colombia, S.A.
Apartado Aereo 3968
Bogota, Colombia

EUROPE, NORTH AFRICA, AND NEAR EAST
Automatic Electric International, Incorporated
P. O. Box 15 Geñeva Montbrillant
Geneva, Switzerland

ITALY
Automatic Electric S.A.T.A.P.
Via Bernina 12
Milan, Italy

MEXICO
Automatic Electric de Mexico, S.A.
Apartado Postal 21327
Mexico 7, D.F., Mexico

NETHERLANDS
Automatique Electrique, S.A.
Huygenstraat 6
's-Gravenhage, Netherlands

PERU AND ECUADOR
J. P. Maclaren
Apartado Aereo 3968
Bogota, Colombia

VENEZUELA
Automatic Electric De Venezuela, Compañia Anonima
Apartado 6362, Est. Caracas, Venezuela

Other Sales Representatives and Agents Throughout the World

Automatic Electric Company . . . A member of the General Telephone System

Single-Frequency Signaling Equipment 860
ISSUE 2 3 4