E2B AND E3B 2400- AND 2600-CYCLE SINGLE-FREQUENCY SIGNALING UNITS WITH E AND M LEADS COMMON SYSTEMS

1. GENERAL

1.01 The E2B and E3B single-frequency (SF) signaling units can be used in all classes of trunks that have the proper transmission levels and frequency band pass, and with trunk relay circuits having E and M leads. E3B 2600-cycle units may also be used with the SS-1 selective signaling system. The E3B unit replaces the E2B unit which is now "Mfr Disc." The suffix "2400-cycle and 2600-cycle" in the title refers to the received tone required by the units for proper operation. DC signals from the M lead of the trunk circuit are converted to 2400- (or 2600-) cycle signals for transmission over the line facility to an SF unit at the distant terminal. Conversely, 2400- (or 2600-) cycle signals received from the line facility (which are originated by the SF unit at the far end) are converted to dc signals on the E lead of the trunk circuit.

1.02 These units are capable of transmitting and receiving both supervisory signals and dial pulses. When associated with a trunk using MF pulsing, the signaling units are used only for supervision. They can also be used with ringdown circuits if the proper type signal converter is employed. These units will not pass the audible tone which accompanies flashes, and tone appliers must be used if simultaneous flashing and audible signals are required. When an E2B or E3B 2600-cycle unit is used at one end of a circuit, the distant end can be equipped with an E1A, E1B, E2B 2400-cycle, E2B 2600-cycle, E3B 2400-cycle, E3B 2600-cycle, E1C, E1D, or an electron tube type 2400- or 2600-cycle SF unit. The 2400-cycle units will function properly only if the distant terminal transmits 2400 cycles.

2. APPLICATION

2.01 The 2600-cycle units will function with any repeatered 2- or 4-wire line facility having the required transmission levels and frequency band pass, type C-5, J, K, L, N, or ON carrier systems, TD-2 radio transmission systems, or any microwave radio system multiplexed with terminals of the above carrier systems. The 2400-cycle units can be used on any repeatered 2-wire line facility which has the required transmission levels and frequency band pass. Office transmission levels for the transmitters and receivers of these units are −16 db and +7 db (or −13 db and +4 db), respectively. Normal signal tone (in the idle condition) is −20 dbm; high-signal tone (for pulsing) is −8 dbm. Both tones refer to 0-db transmission level.

2.02 On 4-wire line facilities both SF terminals send and receive 2600 cycles, whereas on 2-wire lines one SF terminal sends 2400 cycles and receives 2600 cycles, and the other sends 2600 cycles and receives 2400 cycles. The 2400-cycle units are therefore restricted to 2-wire lines while the 2600-cycle units are applicable to either 2- or 4-wire line facilities. The office (equipment) side of the units is designed for 4-wire office trunk circuits but can be used with 2-wire office circuits if an external 4-wire terminating set is added.

2.03 Two dc signaling leads (E and M) join the SF unit to the trunk circuit and eight additional leads are required to insert the transmitter-receiver between the office and line facilities. All ten leads may be cabled to an intermediate distributing frame for cross connection. Fig. 1 and 2 show typical circuit layouts for 4- and 2-wire line facilities, respectively. Both figures have one terminal equipped with an electron tube type 2600-cycle SF unit. The switching offices are considered to be class 4 or higher.

2.04 M lead pulses at speeds from 8 to 12 pulses per second with per cent break ranging from 46 to 76 per cent will be transmitted satisfactorily. The receiver portion of the signaling unit contains a pulse-correcting network to improve the characteristics of incoming SF pulses before they are applied to the E lead as dc signals.

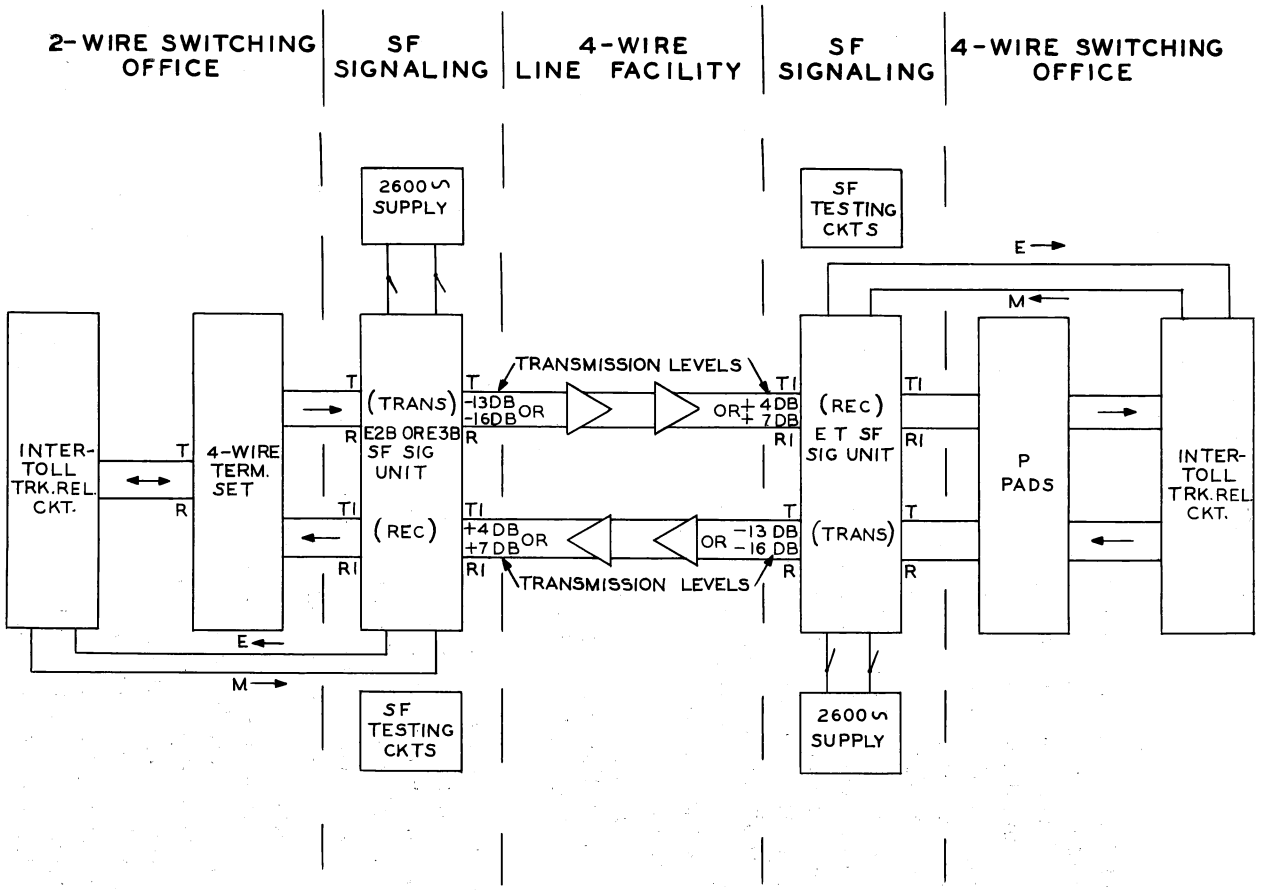

Fig. 1 – Single-frequency Signaling on 4-wire Line Facilities

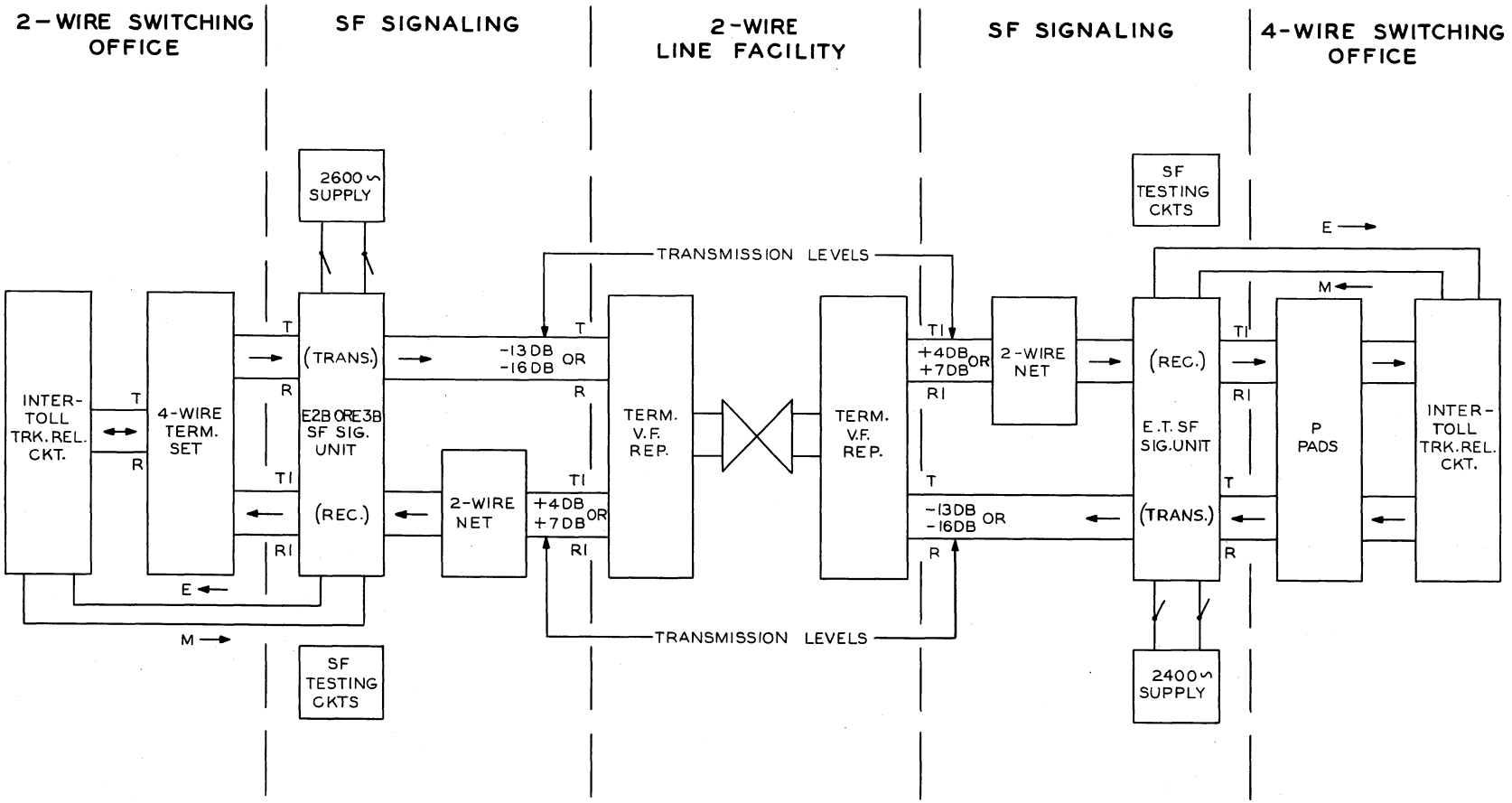

Fig. 2 – Single-frequency Signaling on 2-wire Line Facilities

3. OPERATIONAL PRINCIPLES

3.01 A block diagram showing the basic elements of the E2B and E3B circuits appears in Fig. 3. The transmitter converts dc signals from the M lead into SF signals to the T and R line-transmit leads. It consists of three relays (M, HL, CO), a 12-db pad, and a retardation coil. The M relay releases and operates with each dial pulse received on the M lead, thereby alternately applying and removing tone from the line. The M relay also operates the HL relay which short circuits the 12-db pad. The HL relay is slow releasing allowing it to remain operated while the M relay is following a train of dial pulses on the M lead. The use of higher level tone for pulsing provides a better signal to noise ratio during the critical dialing period. In addition, the M relay operates the CO relay which short circuits the T and R leads toward the equipment and terminates the T and R leads toward the line with 560ω. The short circuit and the 560ω termination are applied at the start of the first pulse in a train and are maintained throughout the remaining pulses of that train. This prevents noise from the drop entering the line facility not only at the time a high-amplitude pulse is being transmitted but during the open (tone off) interval between pulses as well. It is this added protection that permits the E2B and E3B units to be used with the earlier electron tube SF units. The retardation coil is bridged across the T and R leads and has its center tap grounded. This serves to drain off longitudinal currents that may develop in the office equipment and which might interfere with signaling.

3.02 To simplify the block diagram in Fig. 3, the voice amplifier is shown as part of the receiver although technically it is a separate circuit. The amplifier's primary function is to provide a high-loss path in a backward direction to prevent noise or speech originating in the office equipment from reaching the receiver (over the T1, R1 leads) and interfering with its operation. In addition, the amplifier makes up for the insertion loss of the receiver (approximately 0.1 db).

3.03 The receiver consists of: (1) an amplifier-limiter input stage, (2) a signal and guard frequency detector plus separate half-wave rectifiers, (3) a 2-stage dc amplifier and pulse-correcting circuit, (4) two relays (R, RG), and (5) two networks.

3.04 The amplifier-limiter stage receives ac signals from the line through either a third winding on the input transformer or the band elimination network. A potentiometer at the input of this stage permits setting the proper receiver operate sensitivity. When 4-wire line facilities are used, the receivers of the 2600-cycle units are adjusted to operate at −29 dbm referred to zero transmission level. Since nominal SF signal power is −20 dbm (at OTL), a 9-db operate margin is obtained. This compensates for variations in the sending power at the distant terminal, loss variations in the line facility, and sensitivity drift in the receiver itself. With 2-wire line facilities, the operate sensitivity of both the 2400- and 2600-cycle units is adjusted to −32 dbm (at OTL) giving a 12-db operate margin. The additional 3 db allows for loss in the 2-wire network (discussed in 4.01) and less favorable line conditions. At low input levels, the amplifier-limiter produces maximum gain, while at higher input levels limiting takes place and gain is reduced. An output transformer and capacitor arrangement forms a low-pass filter to sharply attenuate harmonics of the signal frequency that might be generated as a result of limiting. These harmonics, if not suppressed, would produce an excess amount of guard voltage which might prevent proper receiver operation, as described below.

3.05 The amplifier-limiter output voltages are then applied to the signal-guard detector where they are separated into signal and guard components. The signal network in this detector develops ac voltages proportional to incoming SF tone and/or signaling frequency appearing in speech. The guard network develops ac voltages proportional to all frequencies except SF tone and/or speech-simulated signaling frequency. These components are individually rectified, combined in opposing polarity, and are then fed to the dc amplifiers for control of the receiving relay (R). The R relay in turn controls the RG relay. The pulse-correcting feature mentioned in 2.05 consists of an RC network and is included in the dc amplifier circuitry.

3.06 The signal-guard relationship together with the time constants in the pulse corrector circuit determines the operate time of the receiver. A high-signal-guard ratio produces fast operate time; low-signal-guard ratio produces a slow operate time. This ratio is established

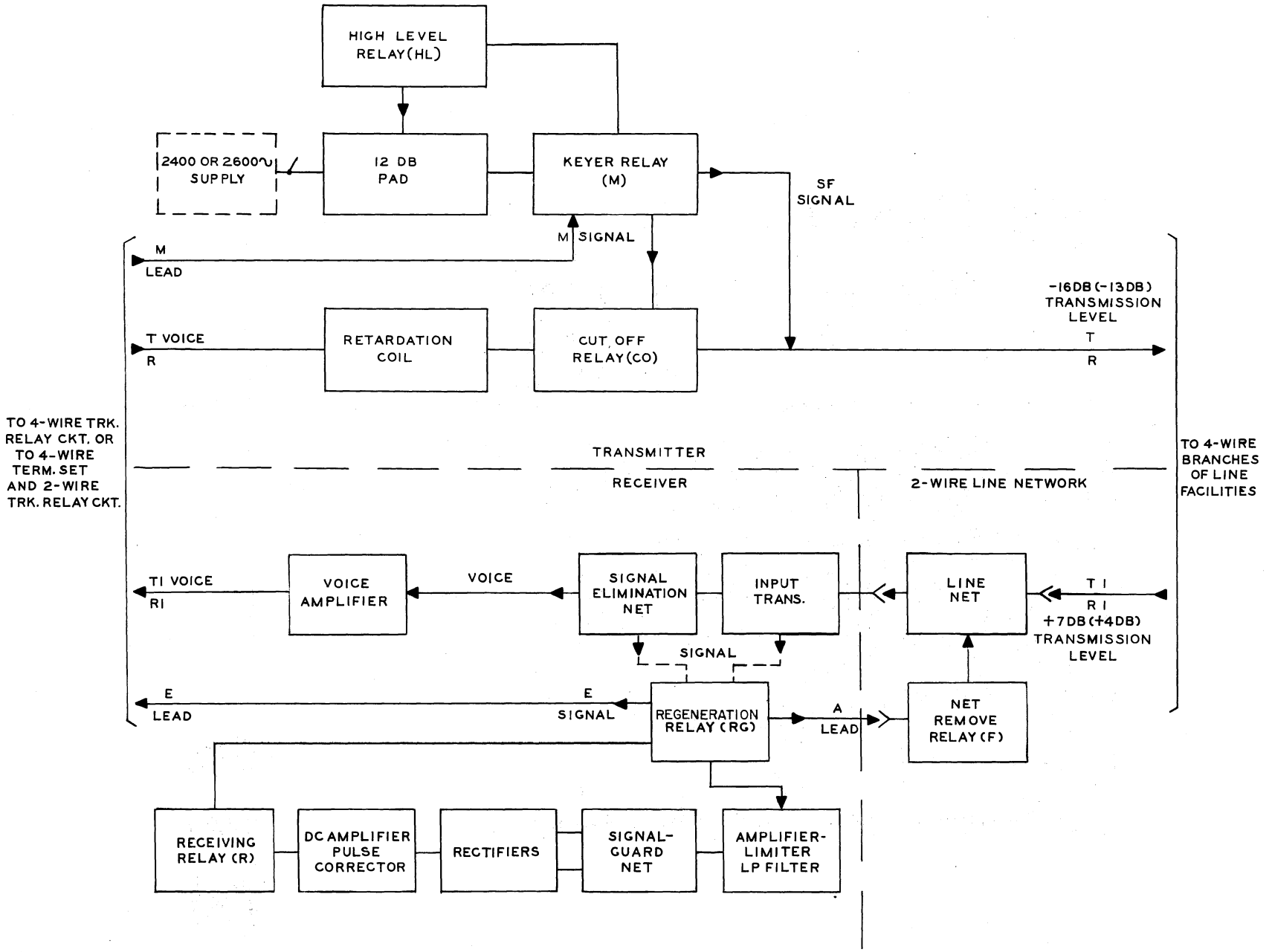

Fig. 3 – Basic Elements of E2B and E3B Circuits

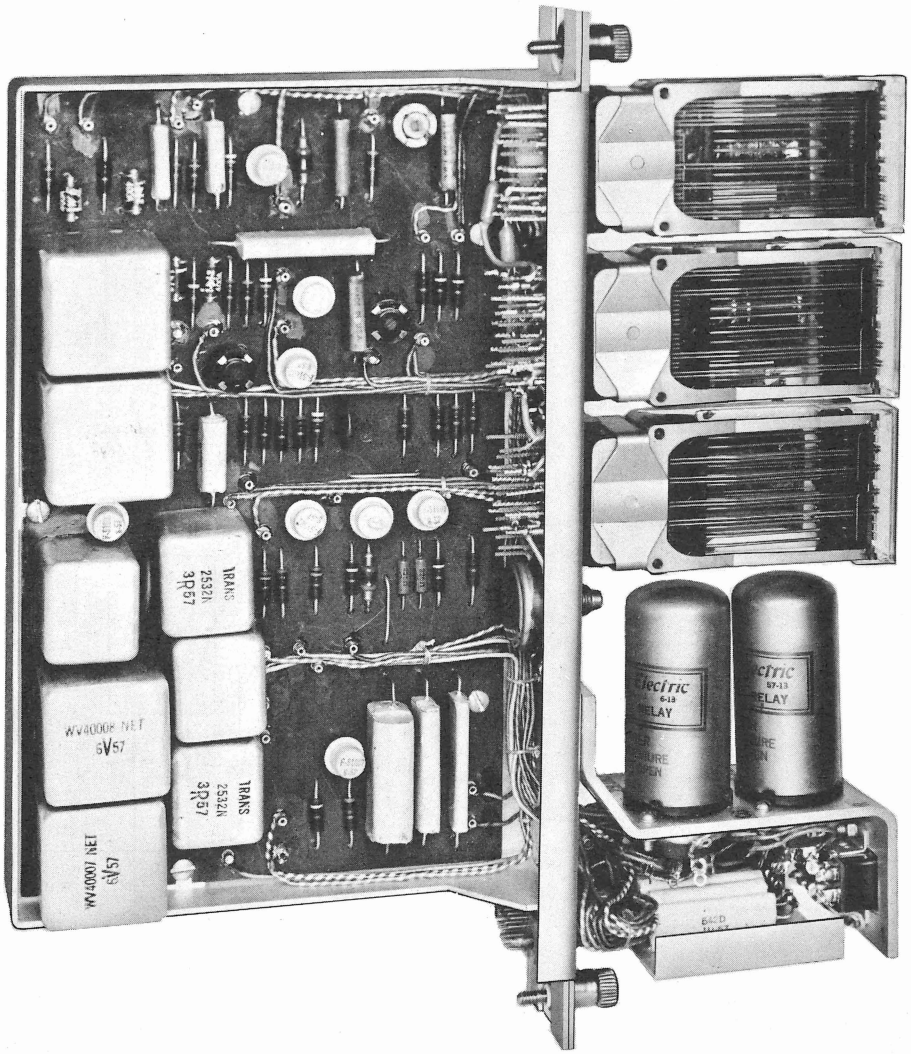

Fig. 4 – The E2B and E3B SF Signaling Units

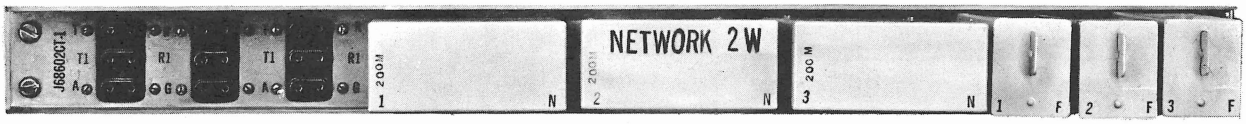

Fig. 5 – The 2400- or 2600-cycle Network for 2-wire Line

by the M and RG relays which control the efficiency of the guard channel, the frequency bandpass characteristic of the signal channel, and the signal elimination network. Whenever the RG relay is operated, the elimination network, consisting of two individually tuned circuits, is inserted into the 4-wire receive leg. One circuit is used to feed the receiver input and has maximum response at the SF frequency. The second circuit has maximum attenuation at the SF frequency and is inserted in series with the voice amplifier input to prevent received SF tone from passing through the office equipment. When the trunk is idle (M relay released, RG relay operated), the guard channel is at its lowest efficiency and the signal channel is broad band. The resultant signal-guard ratio is maximum and the receiver should not be released falsely by line noise. In the talking condition (M relay operated, RG relay released), the guard channel is at its maximum efficiency and the signal channel is narrowband. Signal-guard ratio is now minimum and any signal frequencies appearing in speech should not cause false operation of the receiver.

3.07 On a call terminating in intercept or a free line, the SF receiver at the terminal originating the call will have still another signal-guard ratio. The M relay will be operated and the RG will also be energized because on-hook supervision (SF tone on) is sent from the called end during conversation. The signal channel frequency characteristic is broad band and the guard channel is moderately efficient resulting in a signal-guard ratio slightly lower than for the idle condition. While this does not appear to provide maximum protection against false release of the receiver when it is needed most, it does insure proper response to flashing signals such as busyback and reorder where audible tone accompanies flashing. The RG relay in the calling end SF receiver will be operated during the on-hook portion of a flashing signal, and the receiver will be in the same condition described for intercept. Audible tone is applied during the off-hook portion of the flash and the receiver may be held operated by harmonics of this tone. The lower signal-guard ratio established in the on-hook period permits the receiver to release when SF tone is removed and audible tone is applied.

3.08 DC signals to the trunk relay circuit are furnished by contacts on the RG relay. The E lead is open when the RG is operated and is grounded when the relay releases.

4. TWO-WIRE LINE NETWORK

4.01 Whenever 2-wire line facilities are used with these signaling units, a 2-wire line network must be employed. This network prevents echoes of SF tone, applied to the line facility by the transmitter, from interfering with the receiver in the same signaling unit. The frequency option selected should correspond to whichever tone (2400 or 2600 cycles) is transmitted by the signaling unit with which the network is associated. It is automatically inserted in, or removed from, the line side of the receiver by a relay (F) which is included in the network circuitry. The SF unit in turn controls the F relay via the A lead (Fig. 3).

5. MISCELLANEOUS

5.01 The E2B and E3B units are 2 inches wide and 12 inches high. Ten units mounted side by side require the space taken by six 2- by 23-inch mounting plates. Typical relay rack bay arrangements are described and pictured in Section 987.200.20. Fig. 4 is a view of the unit.

5.02 Three 2-wire network circuits mounted on a 2- by 23-inch mounting plate comprise one equipment unit as shown in Fig. 5. Location of the equipment unit on a miscellaneous relay rack bay is recommended since its application is variable. The leads of each network circuit may be cabled to an intermediate distributing frame for cross connection as required.