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HIGH SEAS AND OVERSEAS RADIO
LINCOMPEX MARK II TERMINAL
DESCRIPTION

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1. GENERAL

1.01 Lincompex Mark II channel terminal equipment (Fig. 1 and 2) is used in high-frequency radiotelephone systems to improve voice transmission so the quality approaches that obtained on coaxial cable carrier systems.

1.02 Conventional present-day radiotelephone systems switch between the send and receive conditions. The switching clips off portions of words and phrases, and can be locked up in either the send or receive condition by noise or other interference. Further, the poor signal-to-noise ratio and slow action of level-regulating devices in a system cause wide variations in received signal levels and high noise levels which are disturbing to the listener.

1.03 The ***Lincompex*** (linear compressor-expander) system provides previously unattainable radiotelephone voice quality by:

- Providing independent send and receive paths, that is, four-wire transmission.

- Loading the transmitter more efficiently which improves the signal-to-noise ratio at the receiver.

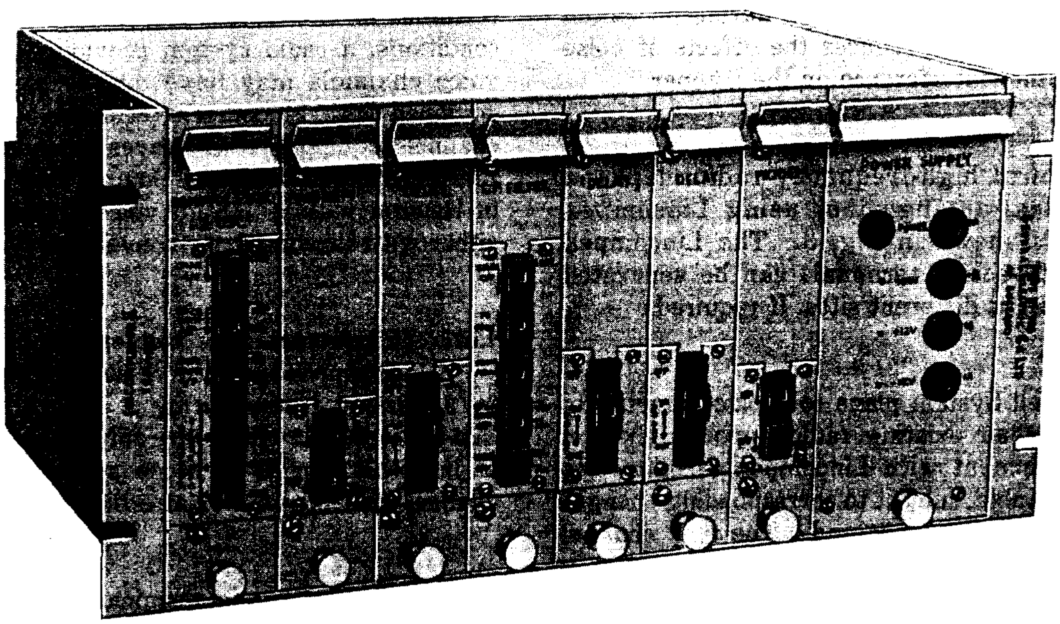

Fig. 1—Lincompex Transmit Terminal

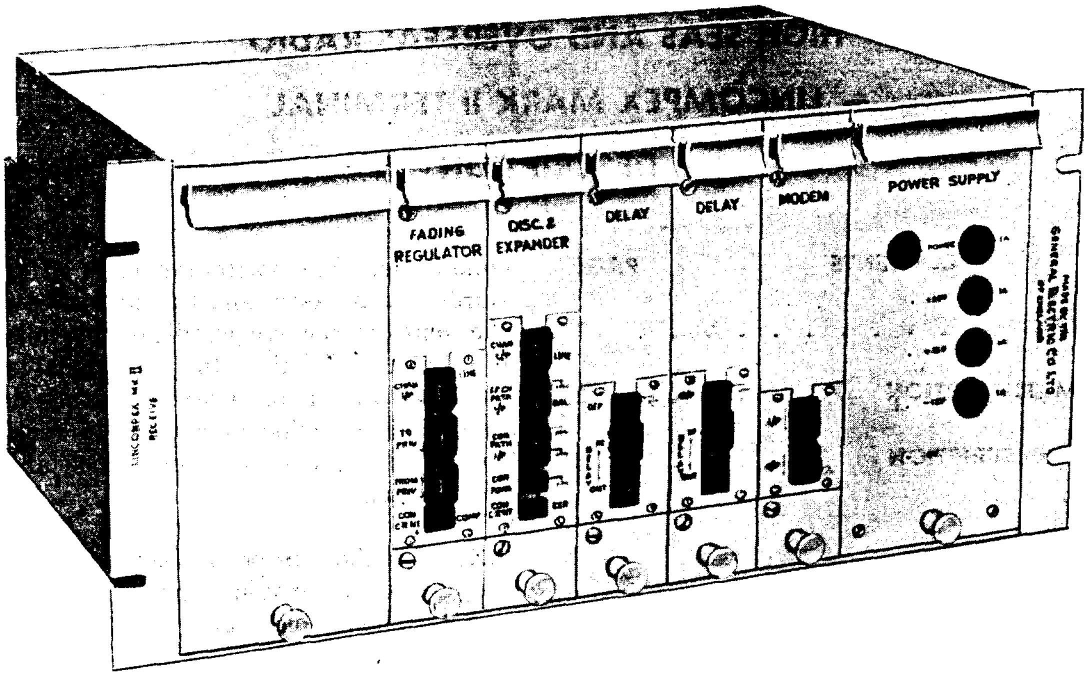

Fig. 2—Lincompex Receive Terminal

- Minimizing radio-circuit fading effects which cause wide variations in received signal levels.

- Silencing the voice channel during no-speech intervals which reduces the effects of noise and other interference on the listener.

1.04 A typical high-frequency radiotelephone terminal arrangement using Lincompex equipment is shown in Fig. 3. The Lincompex transmit and receive terminals can be separated for installation at different sites, if required.

1.05 The Bell System plans to replace practically all of their existing radiotelephone channel terminal equipment with Lincompex terminals as soon as practicable, subject to corresponding changes being made at the distant end. The new channel terminal equipment can be installed in existing radiotelephone systems to replace the present channel terminals, provided the associated transmission facilities, including the privacy equipment, are capable of 4-wire operation and meet certain minimum transmission requirements.

1.06 The new system requires identical equipment at both ends of a radio circuit; a radiotelephone voice channel cannot be equipped with a Lincompex terminal at one end and a conventional terminal at the other. However, under certain conditions, a radio system providing two or more voice channels may have one or more channels equipped with Lincompex terminals and the other channels equipped with conventional terminals. A Lincompex-equipped voice channel may be connected in tandem with a second voice channel equipped either with Lincompex or conventional terminals.

1.07 In contrast to a conventional system, the Lincompex system does not require adjustments by a radio operator during a call. It is expected that the terminals will require only routine maintenance at intervals similar to those now applied to voice channel modems of coaxial cable carrier systems.

1.08 The new channel terminal equipment requires a testboard arrangement to permit access to the radio circuit for daily system checks. This arrangement is to be provided locally and can vary in complexity depending upon the user's needs.

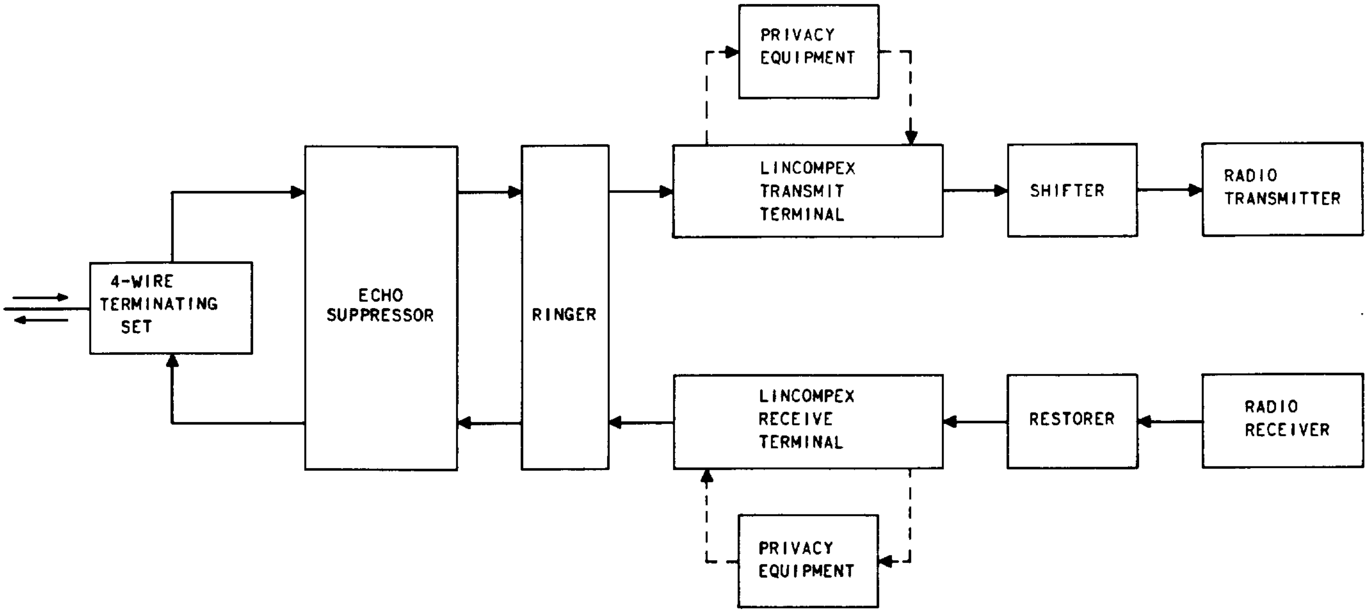

Fig. 3—Radiotelephone Terminal Arrangement

2. SYSTEM DESCRIPTION

2.01 The Lincompex system (Fig. 4) consists of a transmit terminal and a receive terminal which provide a constant net-loss voice channel in the radiotelephone system. ***Constant net-loss*** means that the loss of the voice channel from the transmit terminal input to the receive terminal output remains constant for a wide range of loss variations in the radio signal path.

2.02 The sending and receiving equipment at a given radio station are completely independent of one another; transmission can occur simultaneously in both directions. One direction of transmission is shown in Fig. 4. The Lincompex system provides two improvements previously unattainable in radiotelephone systems: constant net loss in the transmission path and simultaneous 2-way conversation.

2.03 System performance is based on compressor and expander circuits in the voice path and transmission of a control signal which serves as a continuous level reference.

Transmit Terminal

2.04 During conversation, the voice input level varies continually because of the nature of speech. This varying input is applied to two paths which prepare the composite signal to be transmitted. The ***voice path*** includes a compressor which accepts the varying input and provides a constant volume (compressed voice) output. The ***control path*** uses the varying input to change the frequency of an oscillator. The compressed-voice signal and the frequency-modulated control signal are applied to the radio transmitter.

Radio Path

2.05 The Lincompex system cannot provide a radio path where none exists because of propagation conditions. This system ***does*** extend the time that a radio path can be used and permits more efficient usage of a radio circuit, which results in more messages per hour.

2.06 A high-frequency radio path is subject to fading which includes both flat and selective fading. ***Flat*** fading affects all voice channels in the radio system at a given time. ***Selective*** fading does not affect all voice channels in the radio signal to the same degree at a given time.

2.07 Automatic gain control (AGC) circuits in the radio receiver minimize the effects of flat fading. Selective fading is compensated for by a fading regulator circuit in the Lincompex receive terminal.

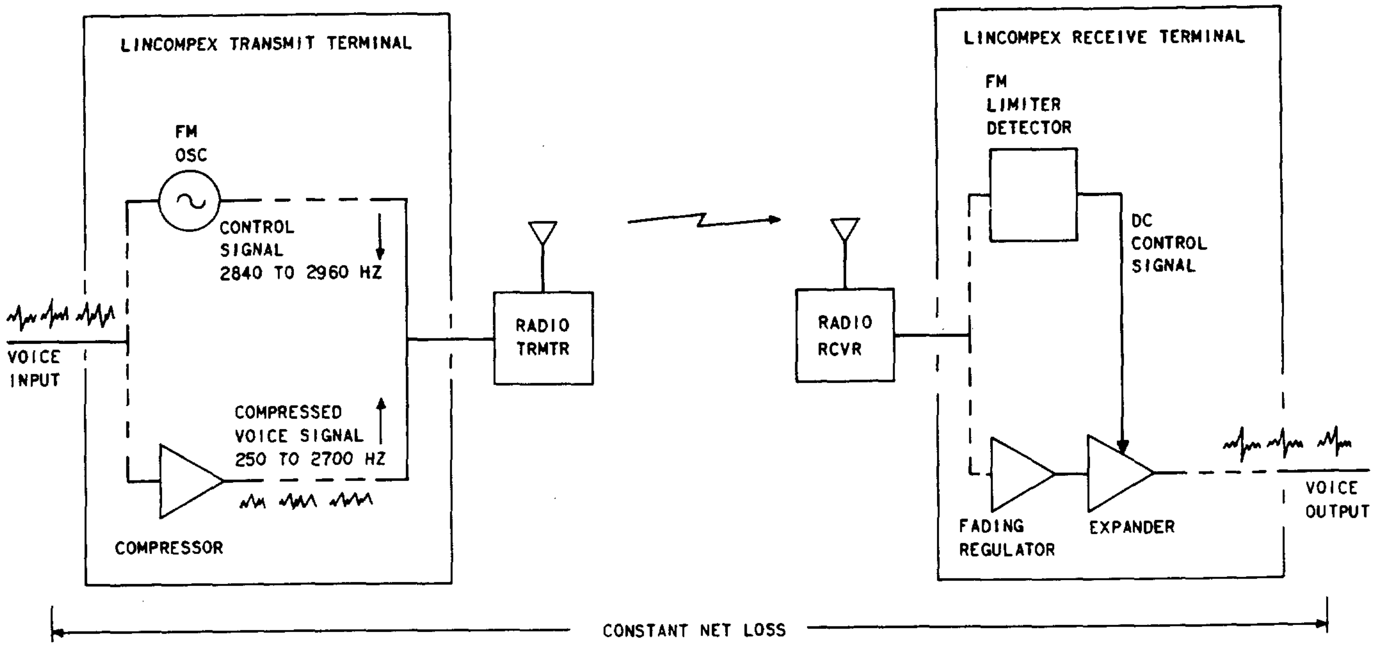

Fig. 4—Lincompex System

Receive Terminal

2.08 The compressed-voice signal at the output of the fading regulator is applied to an expander circuit. Simultaneously, the control signal detector provides a dc signal which sets the ***instantaneous*** gain of the expander circuit to the proper value. This results in an expander output which is an accurate reproduction of the compressor input. During intervals of no voice input, the expander has a high loss which blocks noise.

Facility Requirements

2.09 The composite signal between Lincompex terminals is composed of the amplitude-modulated ***compressed-voice*** signal and the frequency-modulated ***control*** signal. This composite signal is subject to the effects of both amplitude variations and frequency variations that may be introduced by the interconnecting transmission facility.

2.10 The interconnecting facility, exclusive of the high-frequency radio path, is composed of the voice-frequency landline circuit which may be physical pairs or a carrier channel, the shifter and restorer, if required, and the radio transmitter and radio receiver.

2.11 For optimum performance, the entire transmission facility should have an essentially flat frequency response over the voice-frequency band from 250 to 3000 Hz and should have an overall frequency-translation error of two cycles or less at the control signal rest frequency of 2960 Hz. In addition, the delay distortion introduced by filters over the control signal band, 2810 to 2990 Hz, should be less than two milliseconds.

2.12 It is recommended that the facilities interconnecting the Lincompex equipment and the radio transmitter and radio receiver be noncompandored, and have either transmitted-carrier or synchronized-carrier supplies. In addition, the absolute frequency, frequency stability, and bandpass characteristics of the shifter and restorer must be satisfactory.

2.13 The loading effect of the compressed-voice signal plus the control signal on the radio transmitter depends on the number of voice circuits per system. The high-frequency radio carrier used must be free from spurious frequency and amplitude modulation, or any other form of instability, regardless of cause.

2.14 Four-wire type privacy equipment must be used on circuits where privacy is required.

Inversion-type or splitband-type of privacy equipment may be used. If splitband privacy is used, the upper band must be in the normal condition. The delay of the Lincompex should be adjusted to compensate for the delay of the privacy equipment.

3. CIRCUIT DESCRIPTION

Transmit Terminal (Fig. 5)

3.01 The voice input signal is divided by the splitter and is applied to the voice and control paths. The amplitude assessor evaluates the voice signal amplitude and applies proportional dc signals to the compressor and to the log network. The log network translates the dc signal so that the gain change applied to the compressor is accompanied by a corresponding change in the frequency of the FM oscillator. A 1-dB change in compressor gain causes a 2-Hz change in oscillator frequency.

3.02 In the voice path, the voice signal passes through a delay network to the compressor. Delay is provided so that the voice signal and the associated dc output from the amplitude assessor are applied to the compressor at the same time. The compressor smooths out the voice signal amplitude at a syllabic rate and provides a nearly constant output over a wide range of input signal amplitudes. Compressor action is such that input signals from 5 dB above to 40 dB below transmission level (TL) are changed to a constant 0-dB TL output. Signals more than 40 dB below TL are attenuated linearly; that is, a signal 50 dB below TL will be 10 dB below TL at the compressor output. The limiter acts as a guard against speech peaks.

3.03 The constant-level compressed-voice signal is applied to the privacy equipment or to a delay network. The constant high-level signal at the privacy input ensures the best signal-to-noise ratio through this equipment. The delay network provides an appropriate delay if privacy equipment is not used.

3.04 The low-pass filter limits the voice path output to frequencies below 2700 Hz. If splitband privacy is used, the upper (E) band must be in the normal condition because a major portion of this band is not transmitted. The control path output contains frequencies between 2840 and 2960 Hz. The voice and control signals are combined in the output hybrid and the composite signal passes to the radio transmitter.

Receive Terminal (Fig. 6)

3.05 The combined voice-and-control signal from the radio receiver is divided at the splitter and applied to the voice and control paths. A 2700-Hz low-pass filter limits the voice path input signals to the effective voice channel bandwidth,

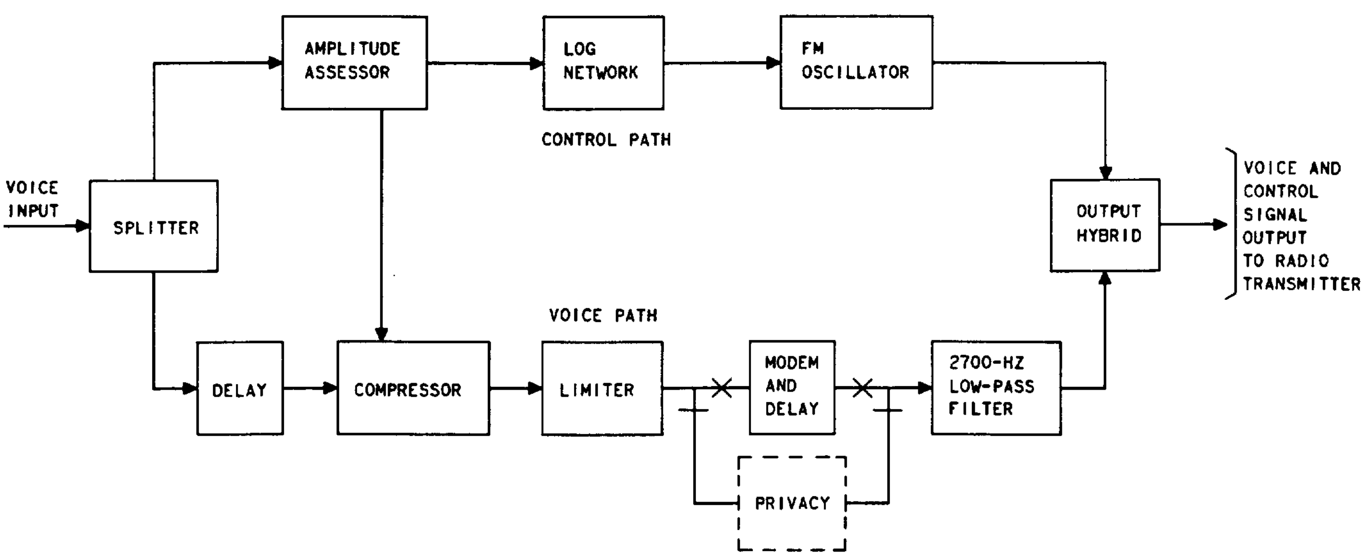

Fig. 5—Transmit Terminal

and the bandpass filter limits the control path input signals to 2810 to 2990 Hz.

3.06 The compressed-voice signal applied to the fading regulator is relatively constant, except for those level variations caused by fading in the radio path which are not removed by the AGC circuits in the radio receiver. The fading regulator examines the received voice signal level and, over a range of about 20 dB, adjusts its output to a constant level. The constant-level signal is applied to the input of the privacy equipment. A constant high-level signal input to the privacy equipment ensures the best signal-to-noise ratio. The delay network provides an appropriate delay if privacy equipment is not used.

3.07 In the control path, the FM limiter-detector demodulates the control signal and, together with the antilog network, converts the FM signal to a dc signal so that the instantaneous gain change applied to the expander compensates for that applied to the compressor at the transmit terminal.

3.08 The expander, under control of the dc signal from the antilog network, applies an instantaneous gain correction opposite that applied to the compressor. Thus, the expander output is a good reproduction of the voice signal at the transmit terminal input.

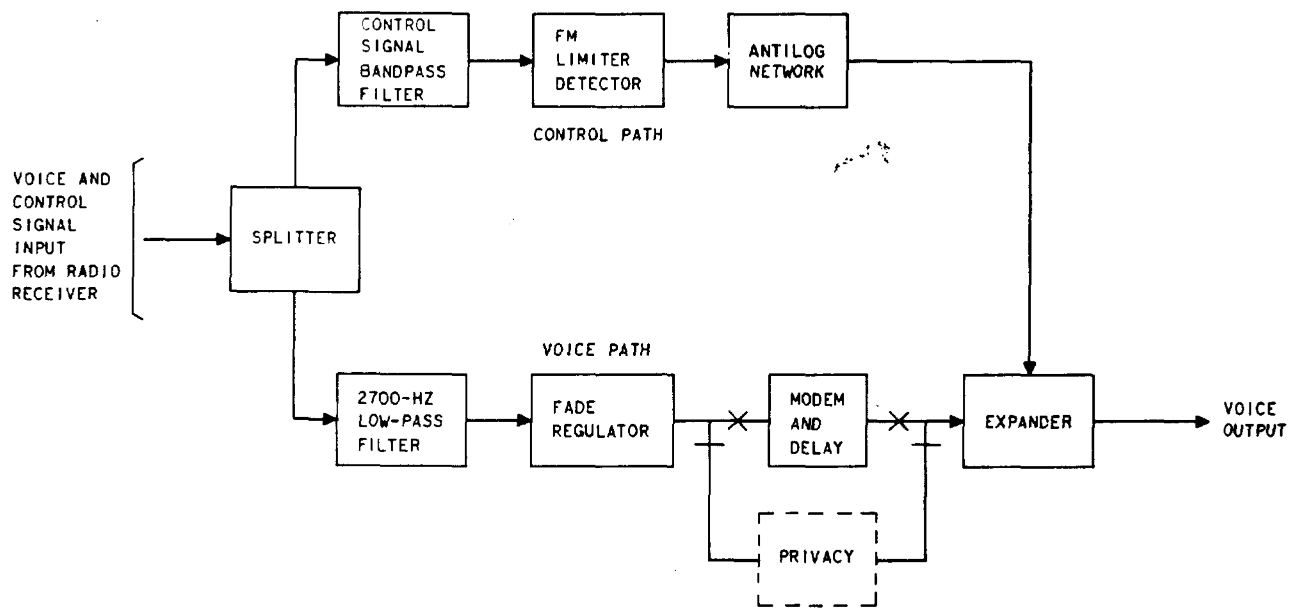

Fig. 6—Receive Terminal