THE P1T TRUNK CARRIER SYSTEM

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1. INTRODUCTION

1.01 This section provides a general description of the P1T trunk carrier system. The design procedures for applying carrier to the physical plant have been simplified in order to conserve engineering effort. The specific engineering layout, line-up and maintenance information will be covered in the appropriate Bell System Practices.

1.02 The P1T carrier system closely resembles the P1 carrier system. The basic differences are that in each terminal the subscriber signaling circuit (2 plug-in circuit boards) has been replaced by one simplified board and a new externally mounted SF unit (see Section 987.200.11). The basic transmission boards have not been changed. However, minor changes have been made in mounting arrangements.

1.03 The P1 carrier repeater boards will be used in the P1T carrier repeater without change. In addition, a modification of the line connector board will be made available so that the first cable repeater from the central office may be powered over the cable. Regulation for the P1T repeaters will be on total carrier output power for both directions of transmission.

2. GENERAL

2.01 The P1T carrier system has been designed to provide short haul exchange trunks and will have its greatest application on those trunks having open wire sections. However, it may be used on those cable routes where the small system size is advantageous and coordination with other systems permits its use. This system is completely transistorized and provides four 2-way channels superimposed on one pair of line conductors so arranged that it can be placed on open wire and/or cable. The channels may be applied in units of 1 to 4 with as many as 18 to 22 channels being applied to a 2 crossarm open wire lead, depending on the characteristics of the lead. However, in cable and/or B rural wire where no other carriers exist or have been proposed there is no restriction to the amount of P1T carrier that may be placed in one sheath. For example: a 26 pair cable may have 104 carrier channels or a B rural wire may have 24 carrier channels. Under the proper conditions each channel will give a toll connecting circuit capable of meeting the present transmission requirements.

2.02 Each channel consists of two terminals. One terminal is rack mounted in each central office. In addition to the terminal equipment, pole mounted equipment including repeaters, voice-frequency bypass filters, junction line filters, autotransformers, etc., are used. Each of these pieces of equipment will be explained in detail in later paragraphs of this section.

3. TRANSMISSION

3.01 The P1T carrier system consists of four independent 2-way channels which may be operated on a single pair of wires in the frequency range above the usual voice-frequency band. The terminals transmit a double sideband amplitude modulated signal for each direction of transmission. The frequencies on the line range from 8 to 100 kc with the individual carriers spaced at 12 kc intervals from 12 to 96 kc.

3.02 The P1T carrier employs a grouped frequency arrangement which is shown in Fig. 1. The use of the grouped frequency arrangement rather than the stackable frequency arrangement is mainly because the P1T carrier will not "prove in" over open wire and/or cable pairs for the distance permissible with the stackable system. Since the "prove in" point will be beyond the range of a nonrepeatered system the grouped frequency arrangement is employed so that all

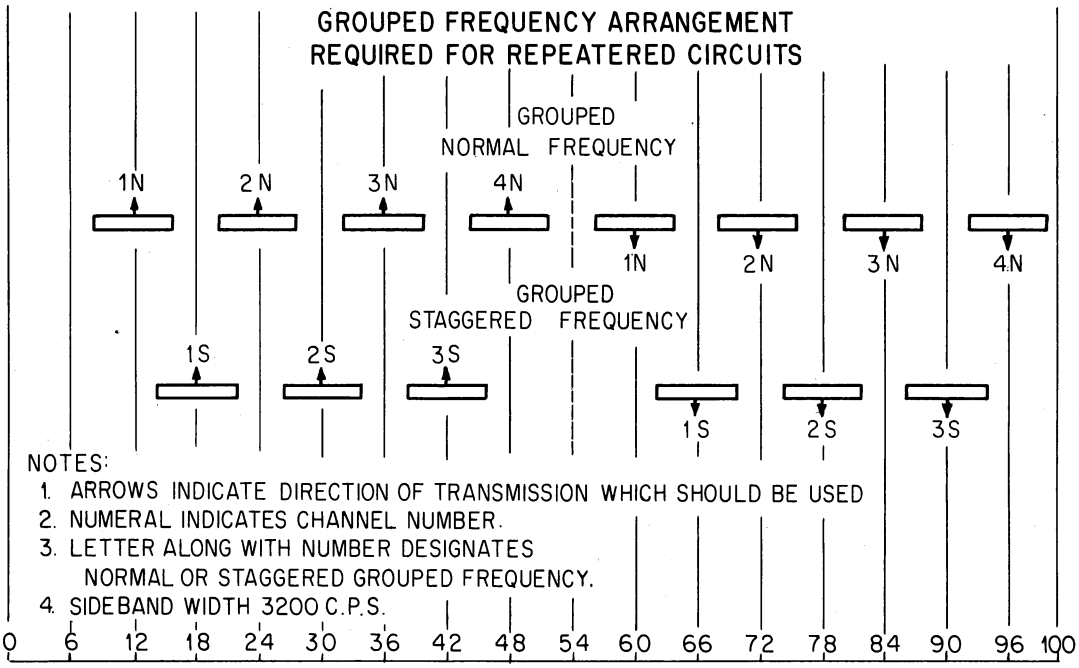

Fig. 1 — Frequency Kilocycles

four channels can be economically amplified in a single repeater.

3.03 In the grouped frequency arrangement shown in Fig. 1 two frequency plans are provided. These plans are the *normal* grouped and the *staggered* grouped. The *normal* grouped arrangement has the lower carriers (12, 36, 48 & 60 kc) grouped together in one direction of transmission and the upper carriers (60, 72, 84 & 96 kc) grouped together in the opposite direction of transmission. The *staggered* grouped arrangement employed to improve crosstalk performance particularly in open wire sections provides a 3-channel system with the lower carriers (18, 30 & 42 kc) grouped together in one direction of transmission and the upper carriers (66, 78 & 90 kc) grouped together in the opposite direction of transmission.

3.04 The control of crosstalk is of utmost importance as the number of carrier channels which may be derived on an open wire lead is dependent on the amount of crosstalk between the pairs involved. In the P1T carrier system this crosstalk noise is reduced through the use of *"compandors."* This compandor, which is an integral part of the P1T carrier, effectively reduces the crosstalk and noise by more than 20 db between compandored systems.

3.05 In addition to the use of compandors, crosstalk between two similar carrier channels on adjacent pairs may be reduced by using the *staggered* grouped frequency arrangement. It is expected that the staggering advantage will be at least 15 db between the adjacent channels. An example of this staggering is that the lower carrier of channel 1 is 12 kc for the *normal* grouped arrangement whereas the lower carrier of channel 1 of the *staggered* arrangement is 18 kc, thus giving a 6 kc separation between the channels.

4. REGULATION

4.01 To provide satisfactory transmission performance and to keep maintenance adjustments to a minimum, regulation has been provided both for the terminal (in each individual channel) and in the repeaters. Since the regulation is different for the terminal and repeater both are covered in the following paragraphs.

4.02 *Channel Regulation:* With the maximum of 30 db line loss it would be desirable to have regulation over the entire 30 db. However, since the 30 db regulation range is not practicable for this system a compromise was made by using a 15 db regulating range. With this 15 db range the received carrier power is adjusted to the center of the regulator range by the use of span pads.

4.03 *Repeater Regulation:* Repeater regulation will be furnished as an option where the variations in line loss would exceed the terminal regulating range. This regulation will usually be necessary on systems employing more than one repeater in order to control noise performance. The repeater regulation in both directions of transmission is controlled by the total carrier output power of the channels working on the particular system.

5. EQUIPMENT FEATURES

5.01 The carrier terminals and repeaters make use of transistors rather than electron tubes, the advantage being small size, small power requirements, and long life. A further advantage of this system is the "printed wiring" which permits components for complete stages or functions of the terminals and repeaters to be mounted on individual boards. This has a particular advantage from a maintenance standpoint since a complete stage, or "board," may be replaced if trouble occurs. Aside from the ease of replacing defective components this type of design makes possible some degree of automatic method in manufacture. Furthermore, as a result of this new technique in design, the equipment is simpler to install and maintain.

(A) Carrier Channel Terminals

5.02 The terminals at each of the central offices are identical except for the oscillator and channel filter frequencies. A block diagram of the terminal is shown in Fig. 2. In Fig. 2 each block has associated with it a capital letter. This capital letter represents the shelf position of the board on which the actual equipment is located. These letters, which are actually on the boards, are then arranged as shown in Fig. 3 to make up a central office terminal.

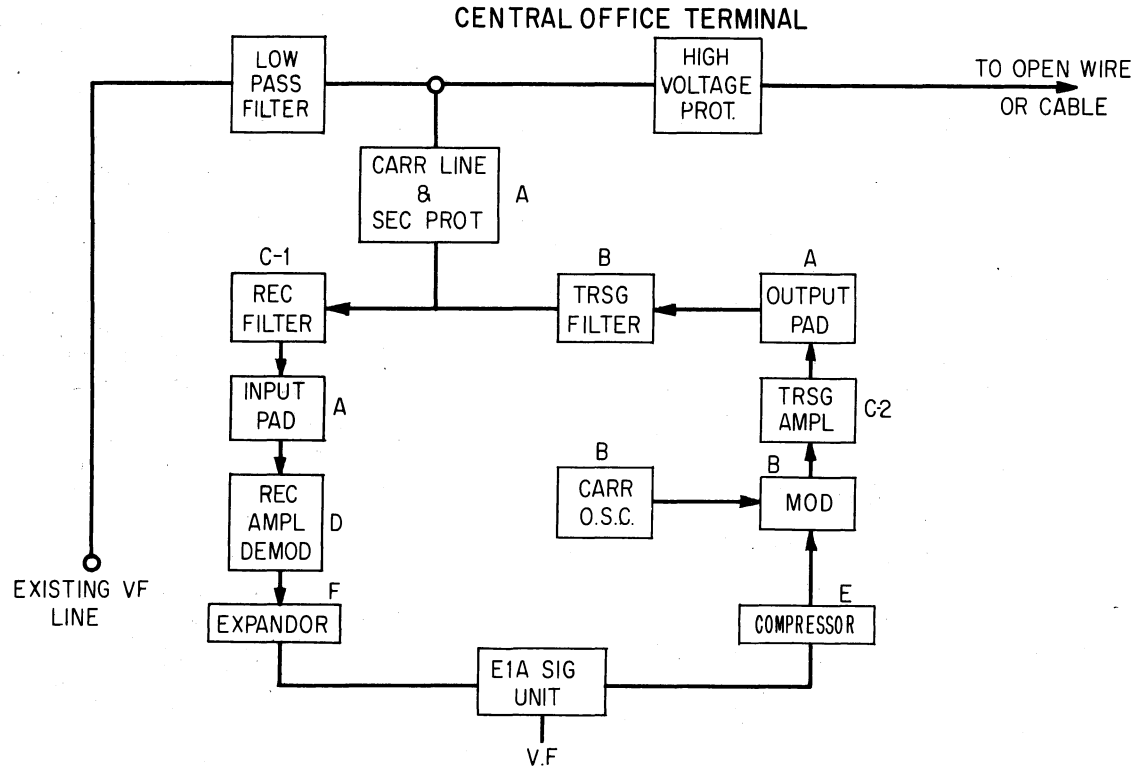

Fig. 2

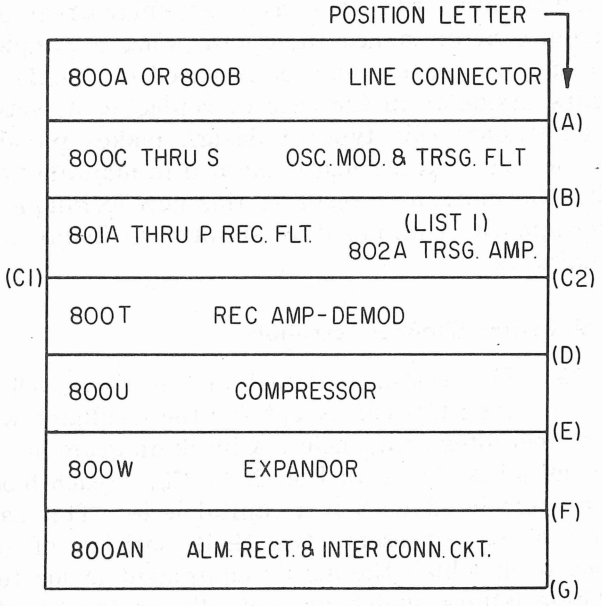

Fig. 3 — Location of Boards in a Terminal

5.03 To design these boards miniaturized components had to be used. A typical collection of the components are shown in Fig. 4. These components are placed on a "printed wiring" board, Fig. 5, and held in place by their own leads which are soldered to the wiring "lands."

After all the components are put in place and soldered, the board then looks like the one shown in Fig. 6.

5.04 After all "boards" have been manufactured they must be assembled into a terminal. A connector was therefore designed to house these boards. This connector has in the back of it a set of grid wires which are used to automatically make connection to the board when the board is inserted in the connector. This connector shown in Fig. 7 is coded 803A. The boards are then placed in the 803A connector to make one channel terminal. A typical channel terminal is shown in Fig. 8 without the cover and with the cover.

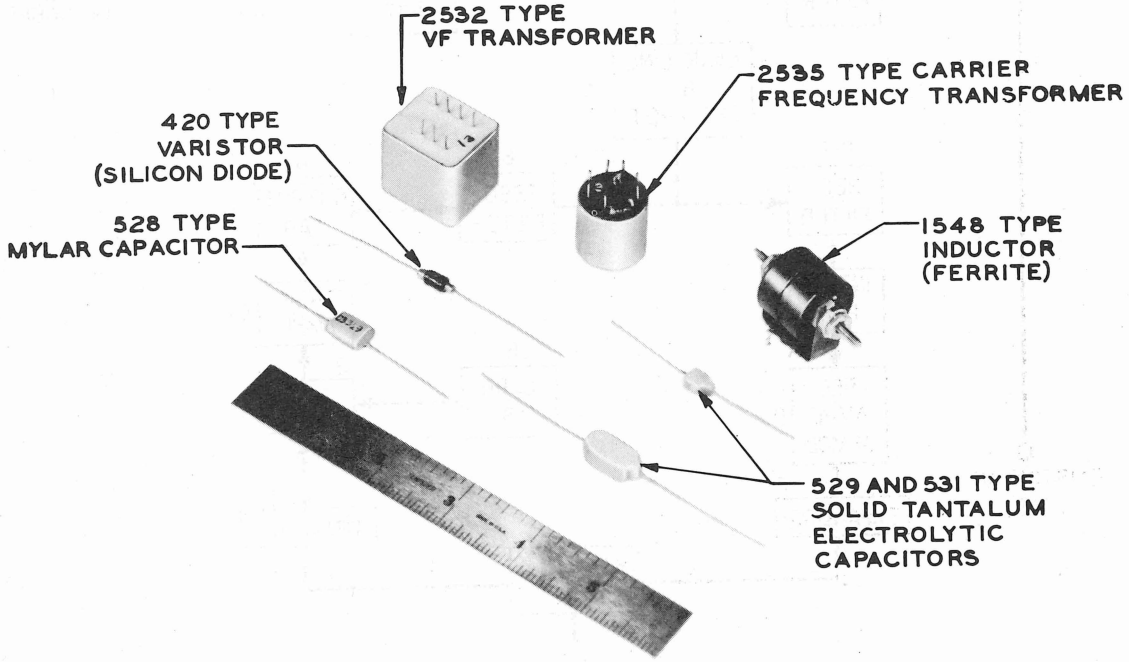

Fig. 4 — Typical Collection of Components

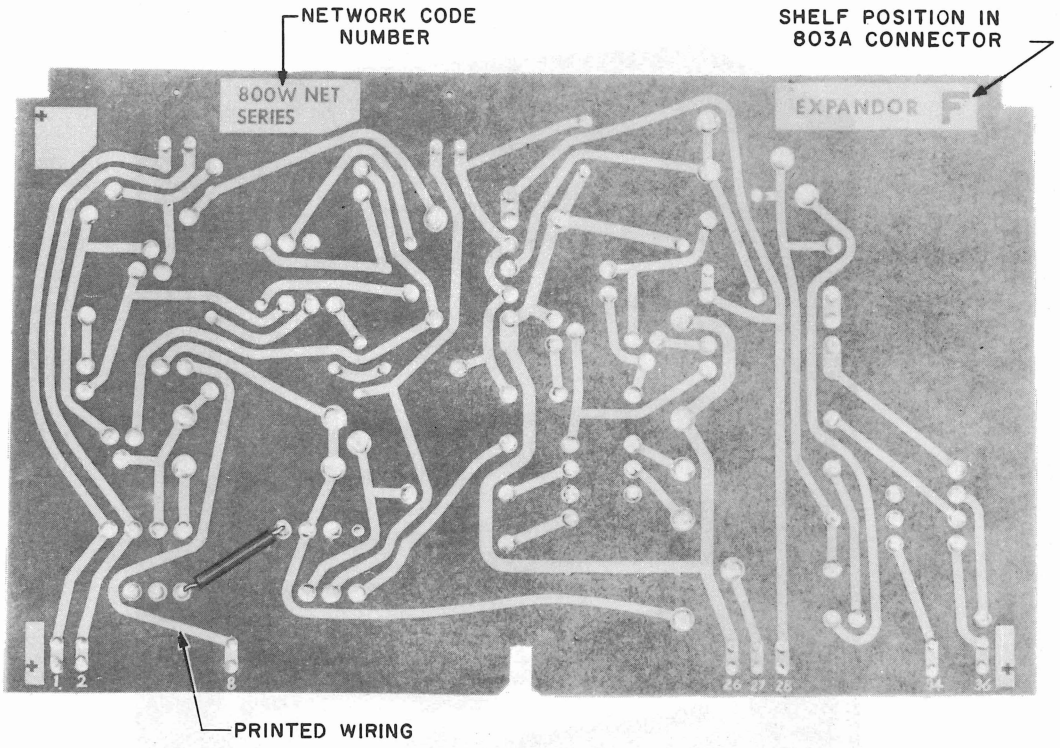

Fig. 5 — Bottom of Typical Printed Wiring Board

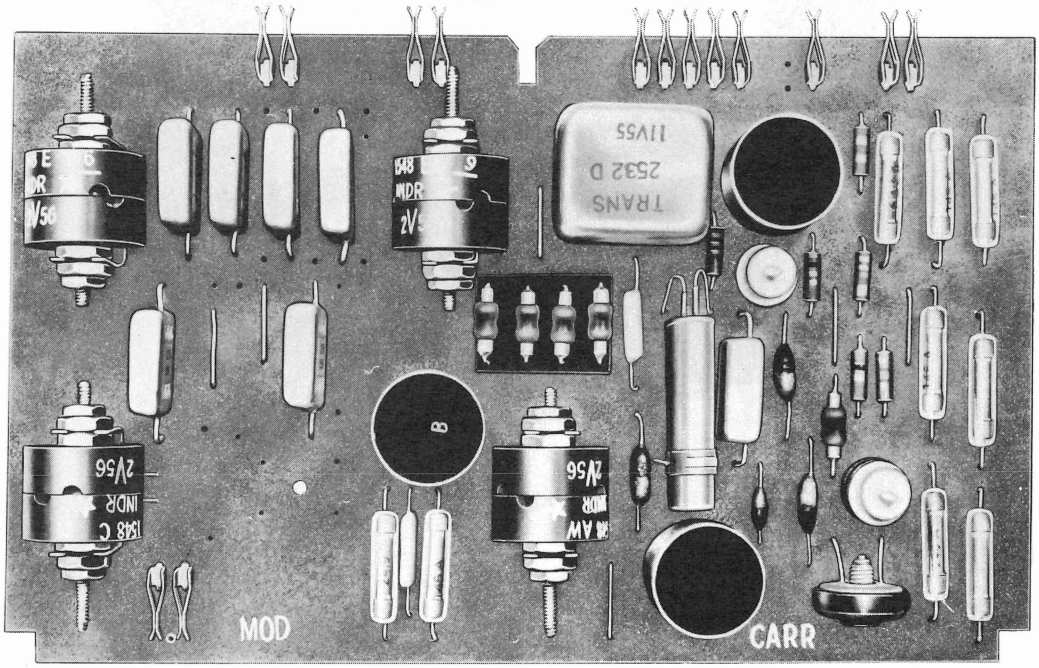

Fig. 6 — Top of "Printed Wiring" Board Showing Components

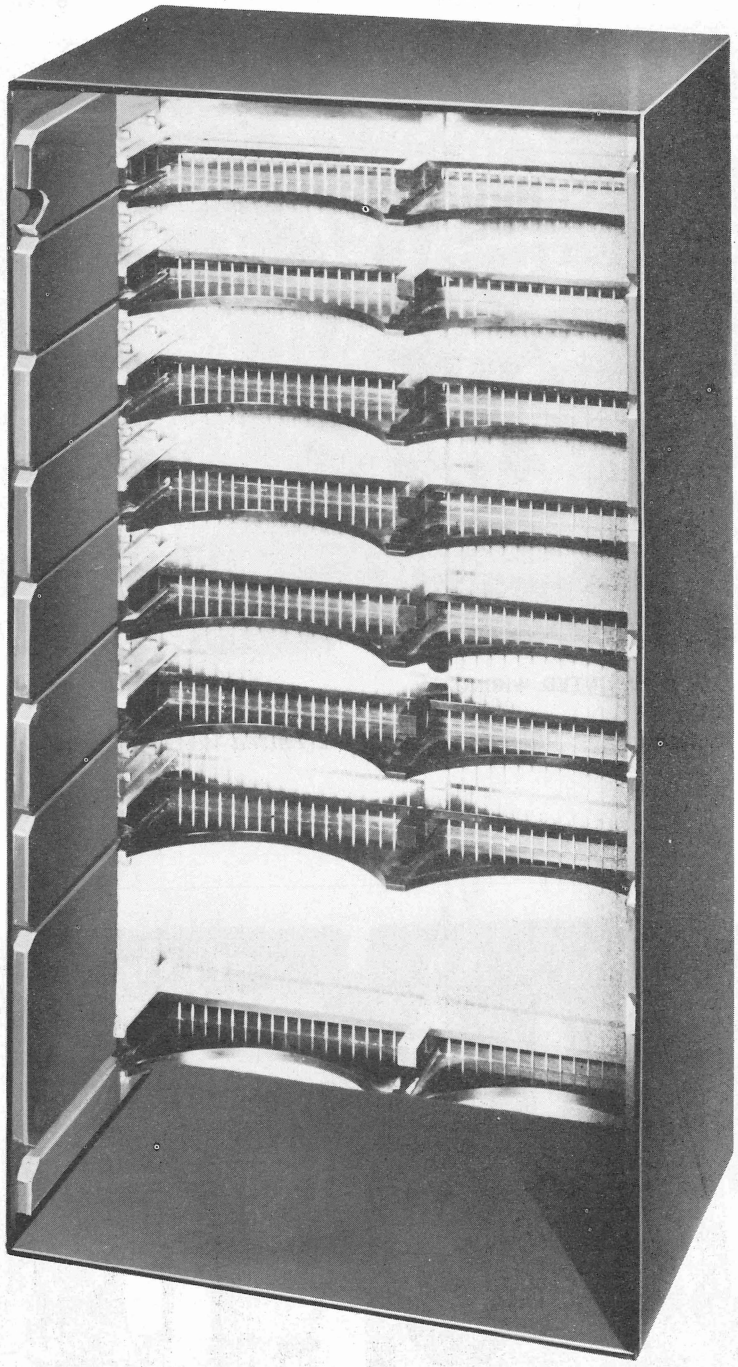

Fig. 7 — 803 Connector (Empty)

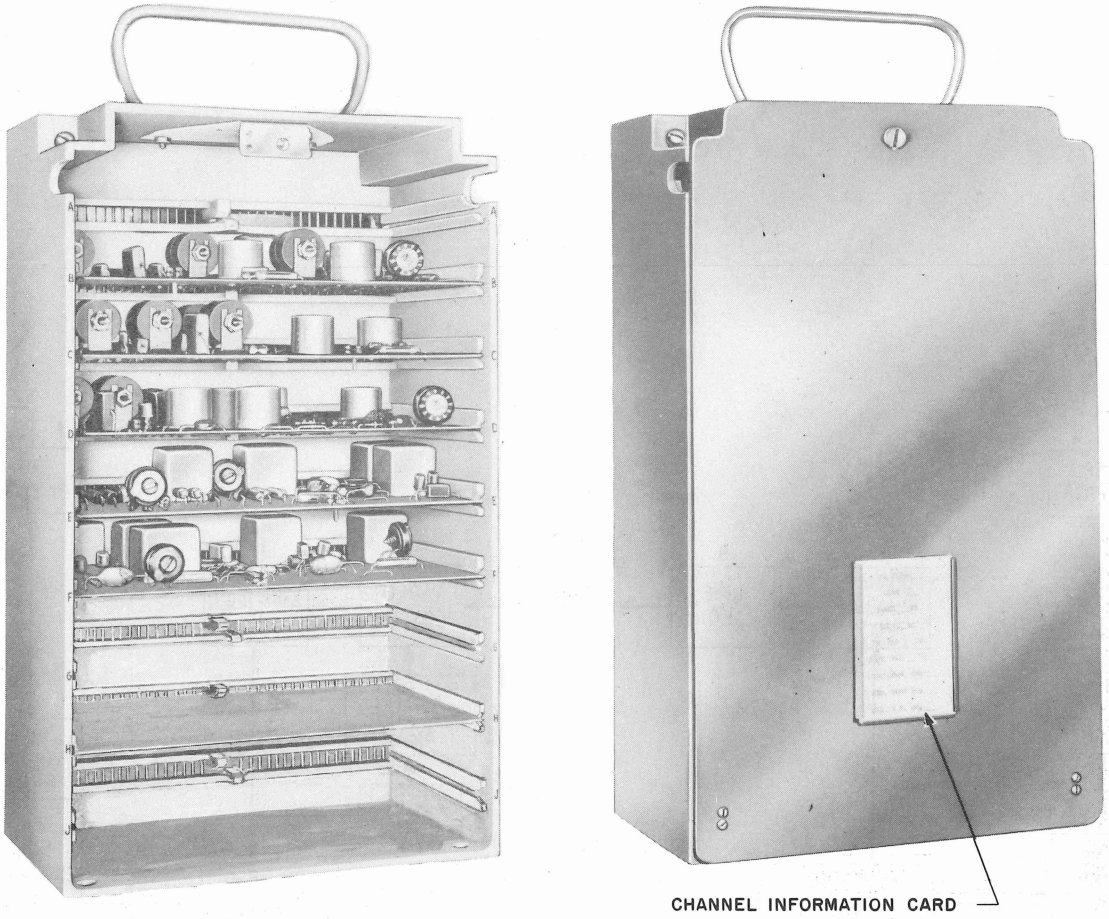

Fig. 8 — Fully Equipped 803A Connector (Without Line Connector Board)

(B) Carrier Repeater

5.05 The P1T repeater is electrically the same as the P1 subscriber carrier repeater. It may be modified, by the use of a different line connector board, to provide arrangements to supply power for the cable repeater via the cable pair from the adjacent central offices. A simplified block diagram of the repeater is shown in Fig. 9. In Fig. 9 it should be noticed that the block representing the repeater bypass is not an integral part of the repeater but instead is an external filter installed to enable the voice frequency to pass around the repeater. The blocks in Fig. 9 have associated with them a letter which represents the shelf position of the board on which the particular function or stage is located. These boards (being identified by the letters) are assembled as shown in Fig. 10 to make up a carrier repeater.

5.06 The components used in the repeater along with the "printed wiring" boards, on which they are mounted, are similar to those shown for the terminal in Figs. 4, 5 and 6. These boards, after all components are mounted, are installed in a connector similar to the one shown in Fig. 7. The main difference in the connector for the repeater over the one for the terminal is the wiring arrangement in the "grid wires." The connector for the repeater is coded the 803B.

5.07 This repeater has two amplifiers capable of amplifying the four frequencies in either direction of transmission. Provided as an option for each direction of transmission is a regulator board (total carrier output power regulation) which gives flat gain regulation over the group of frequencies used.

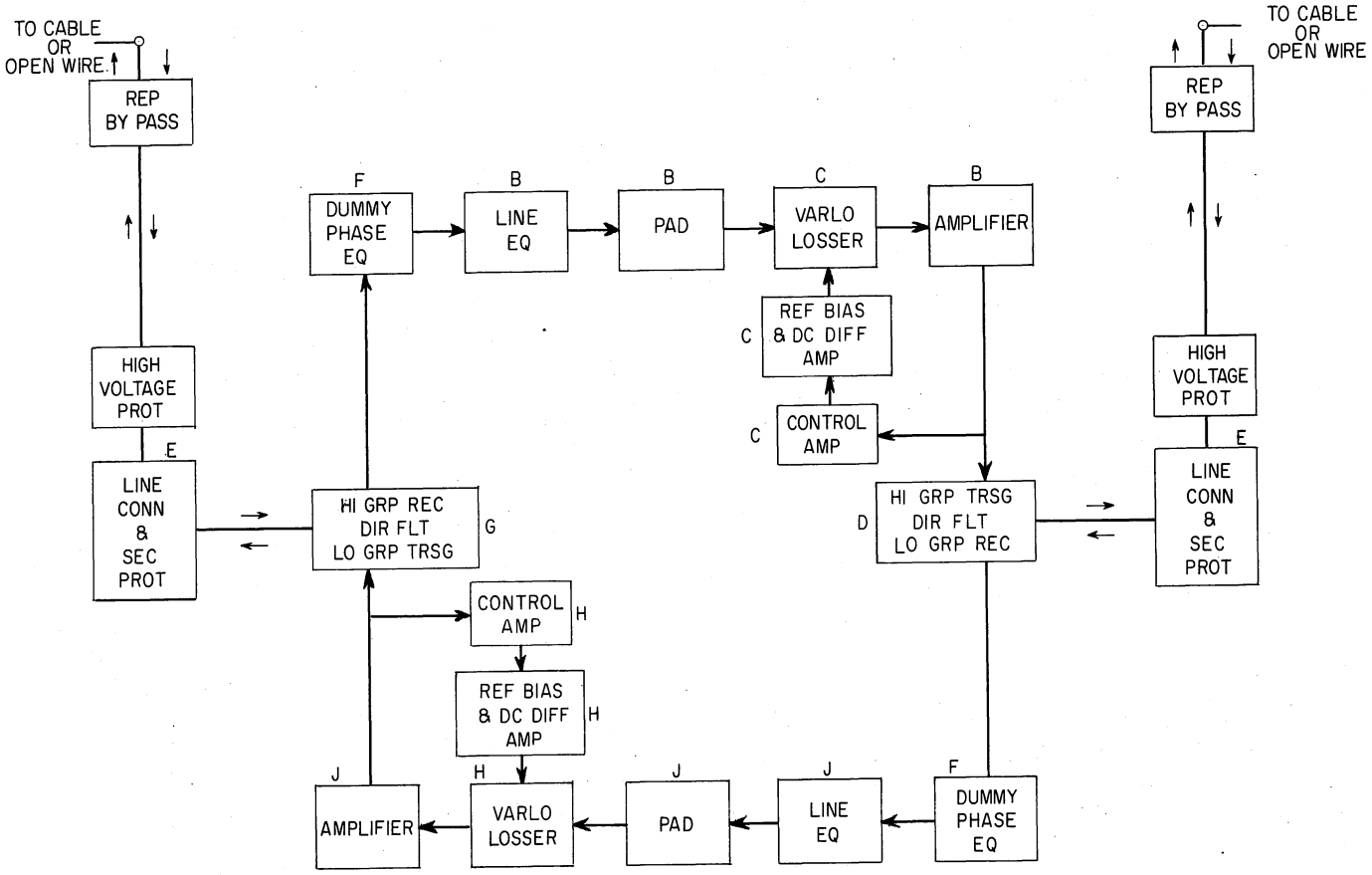

Fig. 9 — Block Diagram of Repeater

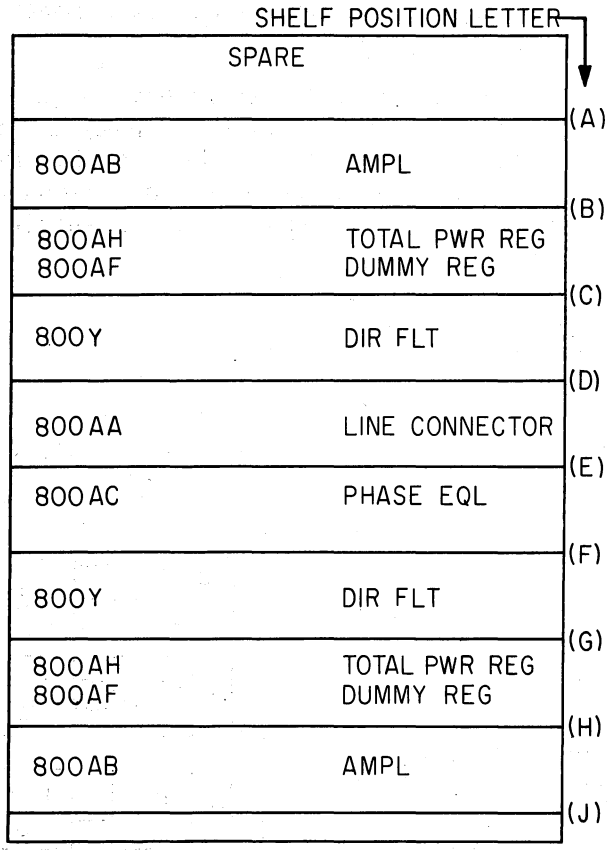

Fig. 10—Typical Arrangement of Network Codes and Locations in 803B Connector

5.08 An ac power supply with a small storage battery to give about one day reserve in the event of power failure is available for the repeater installation. However, as stated earlier the first repeater from the central office, if located on cable, may be powered via the cable pair from the central office.

6. APPLICATION

6.01 The P1T carrier system is to be applied to normal exchange facilities between central offices. These facilities may consist of mixed gauges of high capacitance cable extended to the other central office with 109 steel or 104 copper or copper steel wire.

6.02 To utilize this carrier system a transmission path meeting the requirements for this system must be determined. Then by being familiar with the general capabilities of the carrier system and using the necessary building blocks a carrier layout may be designed and installed. Some of these building blocks are:

1. Central Office Terminals
2. Repeaters
3. Repeater Power Supply
4. Carrier Line Networks and Filters

Fig. 11 shows in schematic form an application of these building blocks. As can be seen in the figure, in addition to the carrier channels, the physical voice-frequency circuit may be used. However, as loading cannot be used on the carrier circuits, it will frequently be impracticable to use the physical circuit because of transmission limitation.

6.03 In applying the "building blocks" mentioned above to a line, several ground rules should be observed.

(a) Each line section should be limited to 30 db at 96 kc for maximum loss condition, except for the repeater section nearest the office transmitting the high group frequencies which must be limited to 24 db.

(b) A maximum of four repeaters may be used per carrier system giving a total of 144 db loss from central office to central office.

(c) The repeaters should be limited to two on open wire in any one system, and the cable repeaters should be at least 1 mile back from the cable—open wire junction.

7. MISCELLANEOUS LINE EQUIPMENT

7.01 To install the terminals and repeaters on a line requires the use of certain miscellaneous equipment to condition the line for carrier operation. A list of this equipment along with an explanation is given below:

(a) *Junction Line Filters:* A junction line filter is used at the junction of long entrance cables and open wire to allow the non-loaded carrier pair and the loaded voice-frequency pair to be combined to use the same open wire pair. For short entrance cable the carrier

and voice-frequency circuit may come in on the same nonloaded pair. The arrangement of the junction line filters are shown in Fig. 12.

(b) *Autotransformer:* An autotransformer is required at the junction of the open wire and cable to eliminate reflection losses and reduce crosstalk at carrier frequencies due to impedance mismatch between the cable and open wire. The location of this autotransformer is shown in Fig. 11.

(c) *Repeater Bypass:* Two filters are used to pass the physical voice frequency around the carrier repeater. This is the same filter used at the junction of the open wire and cable. An example of the bypass filter is shown in Fig. 13.

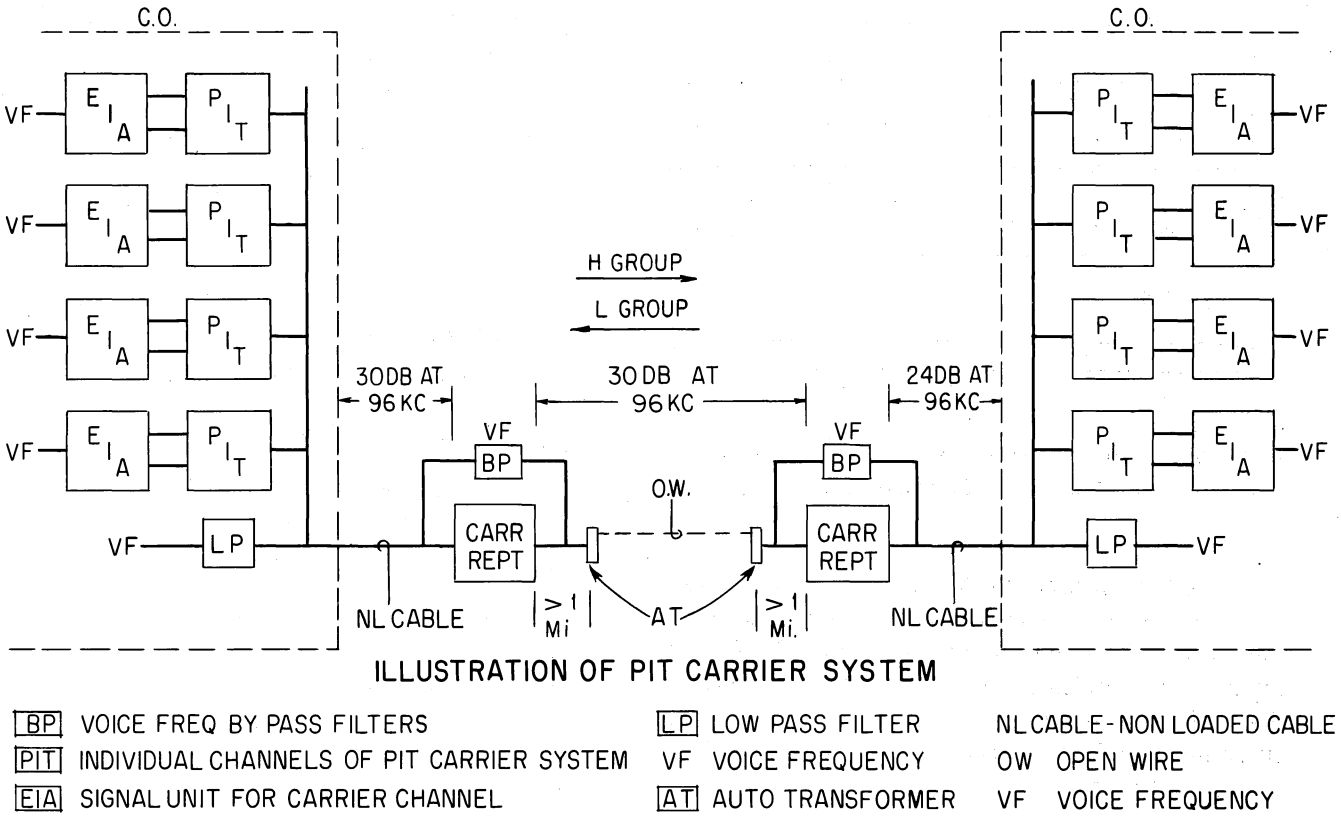

Fig. 11 — Illustration of P1T Carrier System

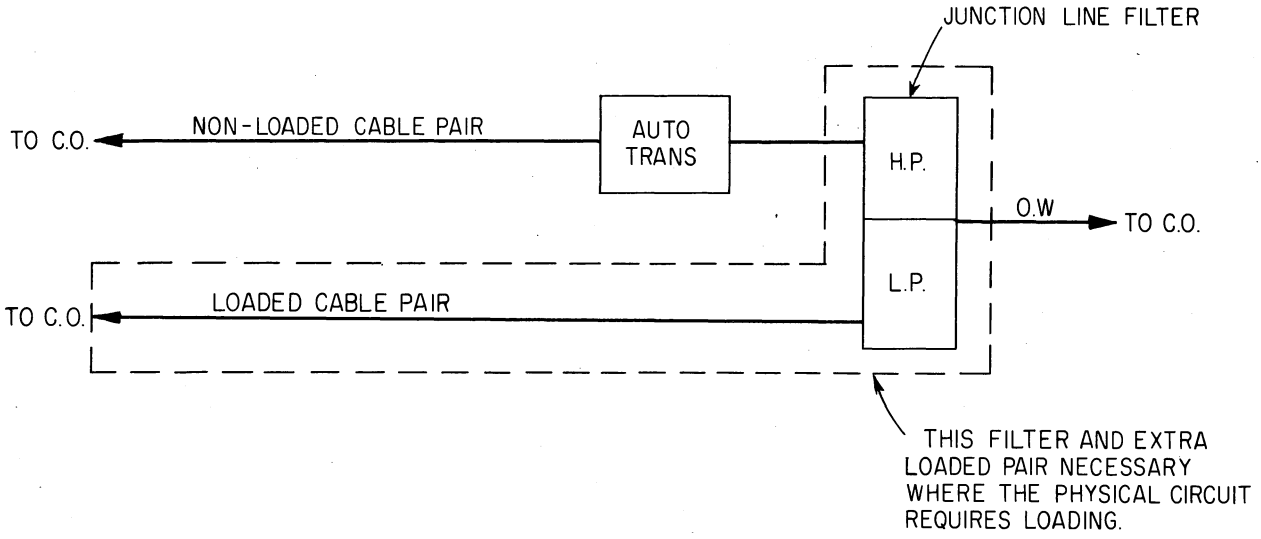
JUNCTION LINE FILTER
TO C.O.
NON-LOADED CABLE PAIR
AUTO TRANS
H.P.
O.W
TO C.O.
L.P.
TO C.O.
LOADED CABLE PAIR
THIS FILTER AND EXTRA LOADED PAIR NECESSARY WHERE THE PHYSICAL CIRCUIT REQUIRES LOADING.

Fig. 12

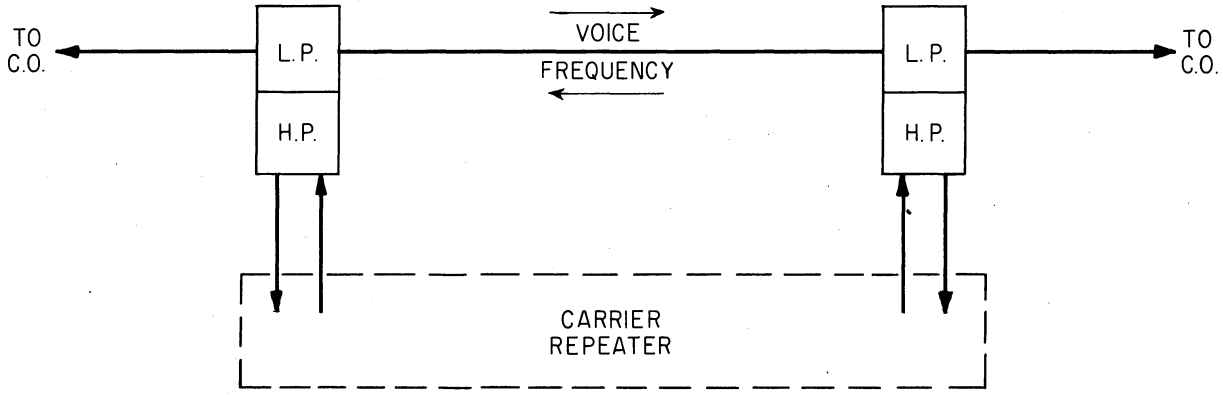
TO C.O.
L.P.
VOICE FREQUENCY
L.P.
TO C.O.
H.P.
H.P.
CARRIER REPEATER

Fig. 13