

LOUDSPEAKER ARRANGEMENTS FOR CONFERENCE SERVICE AND SERVICE OBSERVING

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1. GENERAL

1.01 This section describes loudspeaker arrangements for use in providing conference service as an adjunct to regular message or private line service. An arrangement of this type allows a group of people to hear a telephone conversation without the use of individual receivers. The several arrangements which are described should care for most of the situations which will be encountered.

1.02 The use of loudspeaker equipment in service observing — 6A and 6B equipment — is also discussed.

1.03 This issue includes applications of the KS-19134, L1 Conference Set. It may be used for either large or small conference arrangements. Reference is also made to the use of the 3A Speakerphone.

2. TRANSMISSION CONSIDERATIONS

2.01 The quality of a voice which has been transmitted over regular message grade circuits and reproduced by loudspeakers will not sound as good to a listener as it does on a telephone receiver. When speech is transmitted over regular message grade telephone circuits, the quality of the voice is altered somewhat by the loss of some of the low- and high-frequency components. The degree to which speech will be distorted in this manner will depend on the type and length of facilities in the circuit, condition of the telephone transmitter used, and the characteristics of the loudspeaker system employed. These factors must be appreciated by anyone attempting to provide a good system for reproducing speech from message circuits.

2.02 Where the loudspeaker and amplifier characteristics can be selected or controlled, the objective should be to provide a reproduction system covering the band of frequencies from 130 cycles to about 4400 cycles per second. In this range the system response should be reasonably uniform. The response may be flat or rising somewhat — up to 3 db per octave. The rising characteristic is desirable if the room in which the loudspeakers are located is reverberant or if there will be several kilofeet of non-loaded cable in the over-all connection.

2.03 Care must be exercised to prevent howling or excessive reverberation which is due to acoustic feedback. Where the loudspeakers are located at a point at which speech is only to be received, then the problem is relatively simple. If the location is to originate speech and this speech is to be carried over the local loudspeakers, it is almost mandatory that a close talking transmitter (such as that in an F- or G-type handset) be used.

2.04 Listening conditions will be improved and the acoustic feedback problem will be less severe if the contrast in volume between the

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local and distant talkers can be kept to a minimum. For small conference groups this is not a severe problem but for a large group of people it is important and fairly elaborate means to reduce contrast are justified. The various methods by which this can be accomplished are discussed in the parts below as they deal with the small and large conference groups.

2.05 For satisfactory listening conditions the acoustic level of the reproduced speech should be not less than 10 db above room noise at the place where listeners will be located. If there is contrast between local and distant talkers, then this figure should apply to the lower speech level.

3. ARRANGEMENTS FOR SMALL CONFERENCE GROUPS

(A) 5A Key Equipment

3.01 The 5A key equipment assembly provides a means whereby the subscriber can connect a regular telephone set to a telephone line or substitute a loudspeaker for the telephone set. The general use of this arrangement is expected to be in cases where the distant party is to do most of the talking, the telephone set being used to establish the connection and perhaps talk occasionally thereafter.

3.02 A 6017K key is used for transfer purposes. This key has two sets of contacts so adjusted as to give a make-before-break sequence to prevent opening of the line circuit during the switching operation. Other apparatus involved includes a 100-type loudspeaker set and either a 684A subscriber set and hand telephone set or a 440-, 460-, 500C-, 500D-, 540-, or 560-type telephone set. Drawing SD-69067-01 indicates the connections of this assembly. To minimize the chances of trouble resulting from permanent signals at the switchboard, the loudspeaker set is connected to the line through the contacts of the handset mounting. Since the loudspeaker set is connected to the line through the hookswitch, the handset or receiver must not be placed on the mounting or hook, respectively, until the conversation is completed. When the 6017K key is in the loudspeaker position, however, the telephone set is inoperative, thus eliminating the possibility of feedback between the loudspeaker and transmitter.

3.03 The following procedure should be employed in the use of this equipment:

- (1) The 100-type loudspeaker set should be turned on about one minute in advance of the time when its use is required.
- (2) Calls are answered or originated in the regular way with the standard hand telephone set with the 6017K key thrown to connect the telephone set to the line.
- (3) When it is desired to receive the incoming conversation on the loudspeaker, the 6017K key is thrown to the loudspeaker side.
- (4) When the conversation is completed, the 6017K key is restored to the telephone set position and the handset returned to the mounting so as to operate the switchhook.

3.04 The circuit arrangement with the telephone bell connected directly across the incoming line and the loudspeaker connected through the line contact of the switchhook insures that if the handset is restored after the conversation is finished, even though the 6017K key is not restored to the telephone set position, no permanent signal will result at the central office. If the handset is not replaced and the key is restored, a permanent signal results, but the subscriber can be reached in the regular way by means of the howler. If the handset is not replaced and the key is not restored, the loudspeaker is left connected across the line. However, unless the power has been turned off either talking, ringing current, or howler will adequately call attention to the improper condition through the loudspeaker.

3.05 It is possible to use the arrangement described in an alternate manner by throwing the 6017K key to the loudspeaker for reception and to the telephone set for talking. This is usually undesirable because clicks are caused in the loudspeaker and the receiver at the far end.

(B) 5B Key Equipment

3.06 The 5B key equipment is similar to the 5A key equipment but adds a third feature. Two positions of the key give the same conditions as No. 5A key. In the third position the telephone set is connected to the line with the loudspeaker bridged across the receiver. Both sides of the conversation are therefore amplified

and it is not necessary to change the position of the key to speak to the party at the distant end.

3.07 A 100-type loudspeaker set, 534BP or equivalent subscriber set, a telephone set (684A subscriber set and hand telephone set, or a 440-, 460-, 500C-, 500D-, 540-, or 560-type telephone set) and a 6017L key are used in the 5B arrangement. With the key in the normal position, the telephone is connected to the line for regular telephone service. With the key lever in one operated position the loudspeaker is bridged across the receiver, the telephone set remaining on the line, and in the third position of the key the loudspeaker is connected across the telephone line in the same way as described for 5A equipment in Paragraph 3.04.

3.08 When used as an adjunct to the regular telephone receiver to permit others to hear the telephone conversation, it is not possible to use nearly as much gain as in the case of terminating usage, and the volume output is sufficient for only a small group of listeners. This limitation is due to the existence of acoustic coupling between the loudspeaker and the transmitter of the local set which forms a feedback path. In order to reduce this feedback, an antisidetone set must be used. In addition, special networks are available which tend to inhibit the singing due to the feedback condition. These special networks are contained in the 534BP subscriber set.

3.09 The network bridged across the line terminals of the set consists of two 3B varistors connected in series with the 1-6 winding of the inductor (0.1 henry) and a 1 mf capacitor. Under normal conditions the impedance of this arrangement is so high as to cause considerably less than 1 db loss to telephone conversation. The other network is a combination of a potentiometer and damped resonant shunt. The fixed terminals of the potentiometer are connected to the receiver terminals of the induction coil. One of the fixed terminals and the variable terminal of the potentiometer are connected to the loudspeaker input. Since this pad is in the input circuit of the loudspeaker and is bridged around the receiver of the telephone set, it causes a loss in the receiver. This loss, however, is less than 0.5 db. The resonant network is composed of 150 ohms noninductive resistance in series with the 0.5 mf capacitor and the 1-5 winding of the inductor (0.015 henry). This network is designed

to provide an increased margin against feedback and to modify the quality of the received speech.

3.10 The operation of the line network occurs under the condition of poor sidetone balance where the line is effectively open or of high impedance. When a disturbance of large magnitude but short duration occurs, which would tend to build up to a continuous oscillating condition the voltage across the varistors is increased, which reduces their impedance, thereby tending to restore the balance condition of the antisidetone set and eliminate howling. When these two networks are used, about 15 db more gain can be employed in the amplifier than would otherwise be possible. With the networks supplied, the frequency characteristics of the reproduced speech in this arrangement are essentially like those in the one-way terminating arrangement.

(C) KS-19134, L1 Conference Set

3.11 The KS-19134, L1 Conference Set is a portable assembly of equipment providing all the features of the 5A and 5B key equipment. It is equipped with loudspeakers, and will also function with subscriber owned loudspeaker systems. It can be quickly and easily installed and is flexible enough for either large or small conferences.

3.12 The Conference Set does not require a key arrangement to operate with a station set. It is used in place of the station set and has built-in switching and supervisory features.

3.13 A description of the Conference Set and its particular transmission characteristics are included in Section AB22.334.1. Because of its flexibility and superior transmission characteristics, it should be specified for all additions and replacements.

(D) 3A Speakerphone

3.14 The 3A Speakerphone can provide very good performance on the conference call which takes place in the average business office. It has sufficient volume output for a few people gathered around a desk. There are no transmission adjustments to be made. The set is fully described in the C70.202 series of practices. It will not be satisfactory in large rooms with acoustic conditions requiring the use of the KS-19134, L1 Conference Set.

4. ARRANGEMENTS FOR LARGE CONFERENCE GROUPS

4.01 Where there is a requirement for many people to listen to a telephone conversation, or if the group is to be located in an auditorium, banquet hall, or similar large volume room, the KS-19134, L1 Conference Set should be used. If the system is to be used for receiving only, then the public address system may be connected in place of the 100-type loudspeaker using the 5A arrangement, but the KS-19134, L1 Conference Set will generally permit easier installation and better performance. The transmission problems which will be encountered in situations of this kind include acoustic feedback, contrast between local and distant talkers, variation in talker levels and the possibility that loudspeakers may be required at several locations (if a toll conference call is involved).

4.02 Since this service is frequently ordered on short notice, the discussion which follows will cover the more elaborate arrangements and suggest means of providing service with a minimum of transmission problems.

4.03 At locations where speech is originated, a transmitter should be used which has a flat frequency response characteristic in the band between 130 and 4400 cycles. This will result in a more pleasant quality in the speech as reproduced by loudspeakers. Flat frequency response over this band is generally obtained through the use of transmitters having an element other than carbon. The use of such transmitters presents few difficulties unless loudspeakers are to be operated at the same time and at the same location as the transmitter; in such cases it may be necessary to make special arrangements to avoid acoustic feedback.

4.04 Acoustic coupling (feedback) between the transmitter and loudspeakers must be carefully controlled. If this coupling is excessive, an oscillatory condition may develop in which singing occurs. A condition where the coupling is less than that required to sustain oscillation by only a small amount will result in excessive reverberation in the auditorium. This will impart a hollow sound to the speech as heard in other locations. There are several ways in which feedback can be controlled even though the person speaking is to remain in view of the assembly. One way is to provide an en-

closed booth for the speaker; such a booth can be provided with transparent walls and enough acoustic treatment to prevent feedback. A simpler arrangement is to use a transmitter in a telephone handset which will insure that the speaker's lips will be close enough to the transmitter so that close talking conditions are achieved. A close talking transmitter provides a margin of about 23 db against acoustic feedback as compared with distant talking types. In order to satisfy simultaneous requirements for flat frequency response and a close talking transmitter, a KS-16504 handset and preamplifier can be used, such as is provided in the Conference Set. This arrangement is less costly than a special booth and has the appearance and operating ease of a standard handset. When microphones must be used, it will be helpful to locate both the microphone and loudspeakers so as to take maximum advantage of their directional characteristics. Acoustic feedback is further controlled by careful adjustment of loudspeaker levels at transmitting locations. If people in several locations are to speak in rotation rather than conversationally, a means should be provided for disabling the transmitter when it is not being used.

4.05 Several methods have been used to control contrast between talkers. For the more elaborate arrangement, as shown in Fig. 1, the public address system is fed from one leg of a 4-wire bridge. This may be as a tap on the local receiving pair or on a separate pair. If several different people talk from the distant point or points, the level variation can be eliminated through the use of one of the B-type voads if available; this is also shown in Fig. 1. The voad will deliver a virtually constant output adjustable from 0 vu to +8 vu with an input speech volume ranging between -34 and +6 vu. Frequency response is essentially flat from 250 to 5000 cycles per second which is adequate for this application. While the voad is shown in a receiving branch, it might be located so that speech from all transmitters will pass through it before transmission to receiving locations. A less elaborate scheme is shown in Fig. 2. Here a hybrid circuit is provided to derive the separate directions of transmission. One of several hybrid arrangements can be used. Taps are provided at the 4-wire point for connection to separate input circuits to the public address system. Separate pads or gain controls should be provided

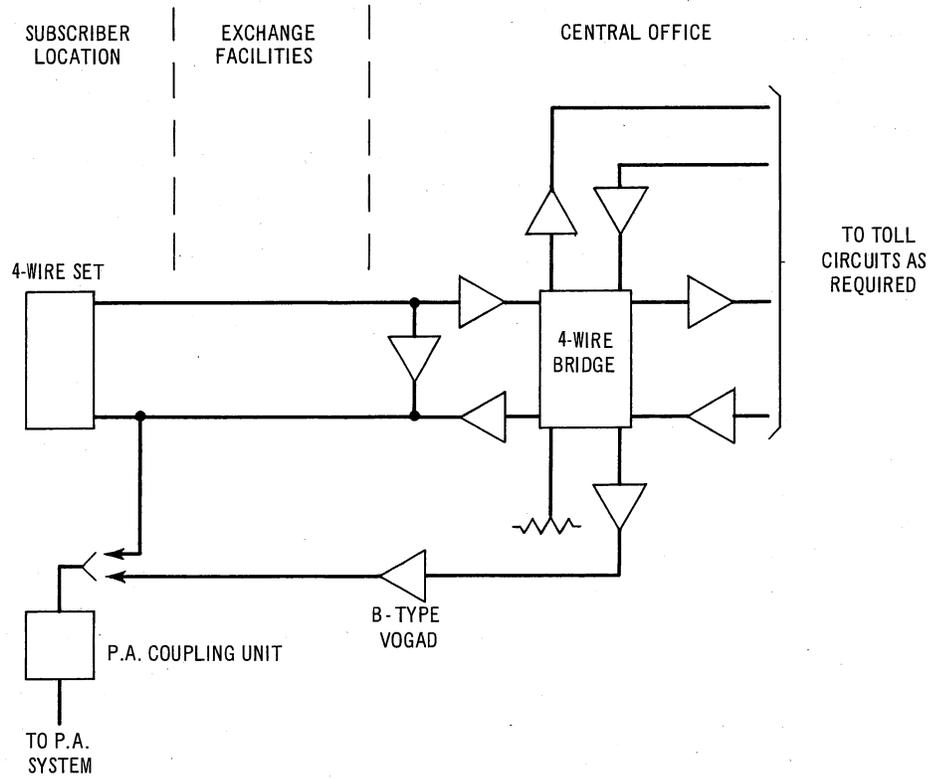


Fig. 1 - P.A. System Feed from 4-wire Layout

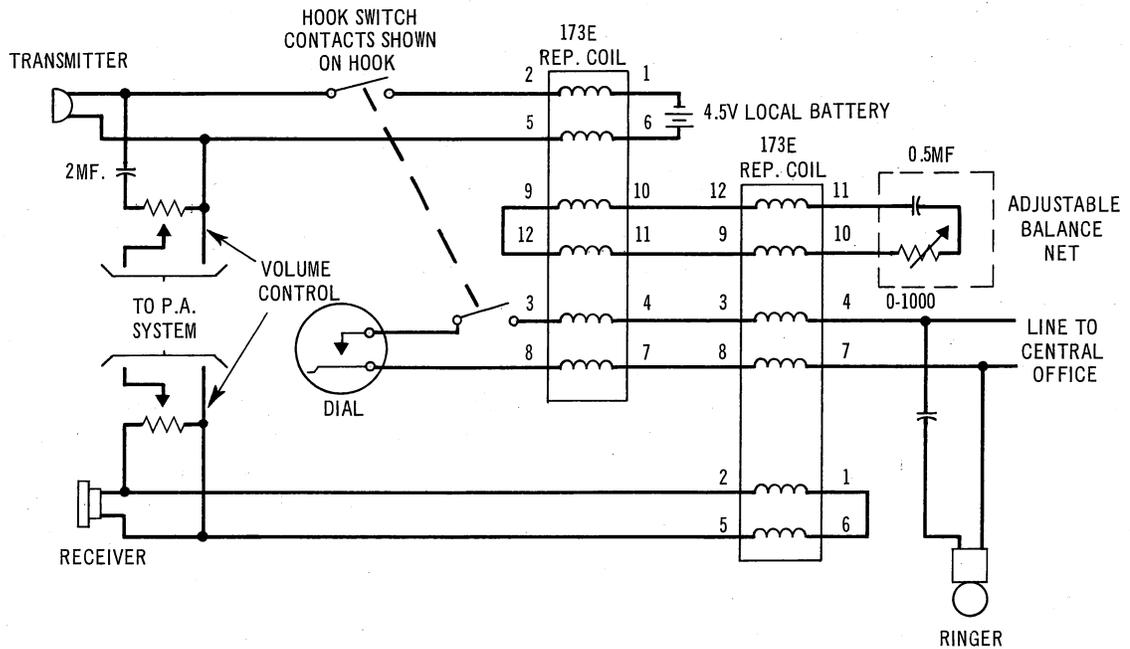


Fig. 2 - Local Hybrid Circuit Arrangement

if separate input circuits to the public address system are not available. The KS-19134, L1 Conference Set employs a hybrid and a wide range compression amplifier to provide a fairly constant volume level with both near-end and far-end speech.

4.06 Variation in levels between talkers and even in the level of an individual during a conversation can be considerable. The most accurate and reliable method of maintaining constant level at the output of the loudspeakers is through the use of the Conference Set as outlined in Paragraph 4.05. Other methods have made use of manual control or volume limiting devices. Amplifiers which have volume limiting characteristics have also been used to good advantage. These latter methods do not bring low level talkers up to normal levels but are of value in maintaining local P.A. system levels below the feedback point. In some cases, it may be desirable to provide technical operators at transmitting points. Volume indicators may be useful in some instances to enable a speaker to regulate his transmitting level.

4.07 Where two or more persons are to converse and loudspeakers are to be used at both locations, it is especially important that acoustic coupling be held to a minimum. Since acoustic feedback will sound like talker echo to persons at the transmitting location, the use of echo suppressors should be considered. About one millisecond of delay is added to the round-trip transmission time for each foot of separation between the nearest loudspeaker and the transmitter at a receiving location; reverberation at this location may easily double or triple this figure. This should be included in computations made to determine whether or not the echo suppressors should be used. Maximum advantage should be taken of directional characteristics of the loudspeakers and microphone. Equipment should be arranged so the speaker is well to the rear of the nearest loudspeakers.

4.08 In connecting telephone lines to public address systems, several factors must be considered. These include isolation of equipment unbalance, isolation of any dc (as when bridging on a subscriber's C.O. line), matching line and system impedances, and coupling at proper

levels. It is always advisable to provide a repeating coil at the point of connection to public address equipment. This coil can be used to isolate any unbalance (one side of the amplifier input circuit may be grounded) and any dc on the line (such as C.O. battery) can easily be isolated. Where present, such dc must be blocked by a capacitor of one or two mf which can be connected in series with the line winding of the coil at its midpoint; if this is overlooked, the permanent signal resulting will interfere with the operation of the line. Terminate the telephone line if sound is fed to the P.A. system over a separate circuit. If the working telephone line is tapped, the tap should be in the order of 2000 to 5000 ohms impedance. This impedance will transfer an adequate amount of energy to the paging system without causing an excessive loss in the telephone connection. The coupling arrangement should present the proper nominal impedance to the input of the P.A. system amplifier. Deviations from the nominal value should not exceed a factor of two, either on the high or the low side. For example, if coupling is made to a microphone input of 50 ohms nominal impedance, the telephone line and coupling arrangement should present an impedance of not less than 25 or more than 100 ohms to this input. Care must be exercised to see that the proper level is provided at the amplifier input. In most cases the level adjustment and impedance match can be provided through the use of an impedance matching pad designed for the required loss and connected between the repeating coil and the amplifier input terminals. Most of these problems can be avoided by making use of the Conference Set.

4.09 Where a separate line is used to feed the P.A. system from a C.O. amplifier it should be connected to an input circuit designed for a phonograph or radio tuner, if available. If a microphone input is the only one available, a pad having loss in the order of 40 to 50 db will be required. If the connection to the working line is made on the premises by means of a tap on the line, then the pad loss should be 30 to 40 db. Where the subscriber line is long (approaches limiting conditions) the lower loss figure should be used.

4.10 The public address or music distribution system used should meet the requirements for such systems as covered in Section AB22.335.

5. ARRANGEMENTS FOR SERVICE OBSERVING

(A) 6A Key Equipment

5.01 This arrangement is used for observing on up to 36 lines, the lines being selected manually. The line selected for observation can be monitored with a headband receiver or by means of a loudspeaker set.

5.02 Where the number of lines to be observed does not exceed 36, access to the lines can be obtained by means of manually operated keys, mounted in one or more small boxes arranged for location on the top or side of a desk. The key box (J53004A) contains six keys which are of the three-position type. The middle position of the lever is "normal"; in each of the operated positions the observer is connected to a line to be observed. Thus, each key box has a capacity of 12 lines, and two or three key boxes may be mounted side by side. In general, where more than two or three of the boxes would be used or where the observer is to be located at a distance it may be more economical to use the dial selective arrangement (6B key equipment).

5.03 In addition to the above apparatus, a receiver and subscriber set are provided to furnish a means of observing when use of the loudspeaker set is not desired. A 716D receiver equipped with a R2BT cord is used. The subscriber set, type 634CJ, consists of a repeating coil and a 0.5 mf capacitor. When both the receiver and loudspeaker are provided, a 6017B key must be used for switching from the receiver to the loudspeaker in order to prevent acoustic feedback between the two. This key should be mounted within convenient reach of the subscriber. The receiver and loudspeaker cords can be connected directly to the terminals in the key.

5.04 The circuit for the above apparatus is shown on Drawing SD-69068-01. A series connection between operated positions of the keys is provided so that the observing set can be connected to only one line at one time. If several keys are operated at once, the observing set will be connected across the line corresponding to the key electrically nearest the set.

5.05 In case it is desired to observe on a PBX attendant's set which is not equipped with monitoring taps, a repeating coil must be connected between the selecting key and the induc-

tion coil of the attendant's set to avoid unbalance and noise in the attendant's telephone set which would inform the attendant that she was being observed. It is intended that these repeating coils be mounted in the PBX.

(B) 6B Key Equipment

5.06 Where the number of lines to be observed is in the order of 36 to 100, it will usually be economical to obtain access to the lines by means of a dial which controls a step-by-step switch. The bank terminals of the switch are connected to the group of circuits to be observed upon by means of jumpers at the PBX switchboard main frame or cross-connecting box. Because of the potential required to operate a switch of this type, the application of this method of observing will be limited to dial PBXs of the step-by-step type and manual PBXs whose power plant voltage lies between the limits of 32 and 50 volts.

5.07 The apparatus at the observer's position consists of a switchboard type dial, a dial mounting, 634CJ subscriber set, receiver, loudspeaker set, if required, a 6017B key to switch between head receiver and loudspeaker, and a 6017D key for connecting the observing equipment and the dial to the leads of the selecting switch. These leads consist of two pairs of wires, one pair for connecting the monitoring receiver with the line through the switch and the second pair for transmitting the pulses from the dial to actuate the switch. Each switch is equipped with a four-conductor wiper and bank in order to provide duplicate contacts to reduce the possibility of introducing noise in the observing circuit. The connections from the bank terminals are made directly to the tip and ring conductors of lines and trunks and in the case of attendant's telephone sets to the induction coil through an added repeating coil located in the PBX position. The added repeating coil avoids unbalance and possibility of noise in the attendant's telephone circuit.

5.08 The observer, in order to select a particular line, will first have to consult a cross-index for the number to dial since it will not usually be possible to have the terminal number of the observing circuit correspond with the station number. The operation of the key will connect the dial to the actuating circuit of the mon-

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itoring switch over the pulsing leads and connect the monitoring equipment over the monitoring leads to the wipers of the switch. The monitoring leads are held open until connected to the line to be observed in order to avoid any noise in the monitoring receiver due to the passage of the wipers over terminals associated with busy lines. As the observer dials the number of the terminal desired, the switch will operate to connect the wipers to the terminal dialed. This operation is similar to that in a step-by-step "no test" connector in which no busy test is made and no ringing is applied to the dialed terminals. As soon as the dialed terminals are reached, the relay which opened the monitoring leads on the operation of the key will release to re-establish the circuit. The switch will remain in this operated position as long as the key at the monitor's position remains operated. To release the switch it is only necessary to release the key at the observer's position.

5.09 Key equipment arrangements discussed in this section are covered on drawings as follows:

- 5A — SD-69067-01
- 5B — SD-69070-01
- 6A — SD-69068-01, ED-69080-01
- 6B — SD-69069-01, ED-69069-01, ED-69058-01

The above key equipments are discussed in Section AA321.001 (J53004).

5.10 Bell System Practices which relate to the systems and equipment discussed herein are as follows:

- AB22.334.1 Loudspeaker Arrangements for Conference Service — KS-19134, L1 Conference Set
- AB22.335 Paging Systems
- AB22.335.1 Paging Systems — Characteristics of Loudspeakers
- AB22.335.2 Paging Systems — Characteristics of Carbon Transmitters
- AB47.250 Multistation Private Line Telephone System
- C53.261 5A and 5B Key Equipments
- C54.501 Loudspeaker Sets, 100-Type
- C70.210.00 } KS-19134, L1
- C70.210.01 } Conference Set
- C70.210.02 }
- 310-440-500 } Volume Limiter per SD-69174-01
- 310-440-100 }
- 024-101-100 100-Type Loudspeaker Sets
- R50.220 B1 and B2 Vogads
- C70.202.00 } 3A Speakerphone
- C70.202.01 }
- C70.202.02 }
- C70.202.03 }