

*BSM# 834 B-1*

# MULTISTATION PRIVATE LINE TELEPHONE CIRCUITS FOR THE FEDERAL AVIATION AGENCY DESCRIPTION

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## 1. GENERAL

1.01 This practice describes the equipment and circuit arrangements used at Federal Aviation Agency (FAA) stations in providing full period talking service between two or more FAA stations. Also included is a general description of over-all FAA circuits including transmission level considerations at a FAA station.

1.02 Other information concerning Federal Aviation Agency circuits can be found in Sections 310-410-300 and 310-410-500.

1.03 This section supplements the information contained in 310-405-100 which describes general multistation arrangements. An understanding of the information contained therein will be helpful when using this section. In some cases information found in 310-405-100 is duplicated herein.

## 2. DEFINITION OF TERMS

2.01 The layout of a multistation private line involves equipment and circuit features not commonly encountered in message circuit and direct private line layouts, and various terms

have been used to identify these features. The terms used in this section are defined or described below.

2.02 **Bridge:** A resistance network designed to interconnect three or more lines, and may be of either 4-wire or 2-wire type. These bridges are described in Section 310-405-100.

2.03 **4-Wire Bridge:** The 4-wire bridges most commonly used are the 44-type and the 46-type. The first digit indicates that it is designed to interconnect 4-wire facilities. The second digit indicates the number of legs. Each leg has an input terminal and an output terminal and provides a point of connection for a 4-wire facility or 4-wire repeater.

2.04 All unused input and output terminals of a bridge are provided with resistance terminations. Where the use of one 4-wire bridge does not furnish enough legs, tandem bridges are used.

2.05 **2-Wire Bridge:** The 2-wire bridge is provided with the number of legs required for each specific case. The transmission loss will vary with the type of bridge, and number of circuits to be interconnected.

2.06 **Branch:** A branch from a bridge is composed of all the facilities between a bridge leg and a customer's station set. This includes repeaters adjacent to the bridge and both toll and exchange line facilities, and the equipment at the customer's station up to the terminals of the subset. A branch may be either 4-wire or 2-wire or a combination of both.

2.07 **Loop or Local Channel:** A loop or local channel is that part of a branch between the last toll office and the customer's station set or key equipment. Where the bridge is in the

last toll office, the terminals of the branch and loop are the same.

**2.08 Interbridge Section:** An interbridge section is that portion of the multistation line between bridges at different offices. Any type of voice frequency or carrier facilities may be involved.

### **3. OVER-ALL CIRCUIT ARRANGEMENTS**

**3.01** Interphone circuits for the FAA fall into two general categories. One type of circuit has one terminal that appears on one or more key equipments at an Air Route Traffic Control Center (ARTCC). Usually these circuits extend along an airway route within a zone controlled by the ARTCC. Drops are provided on these circuits at Interstate Airway Communication Stations (INSAC) and at other stations (weather, air line, etc) along the route for communication between them and the ARTCC. The other type of circuit is for direct communication between adjacent ARTCC's. Nearly all of these circuits are completely 4-wire, i.e. 4-wire facilities, 4-wire branches, and 4-wire station instruments. When not completely 4-wire, the number of hybrids is kept to an absolute minimum.

**3.02** On circuits connecting an ARTCC with INSAC locations, the inward signaling to the INSAC stations is accomplished by loud-speaker paging. The inward signaling to ARTCC locations is on an equivalent ringdown basis. The arrangement frequently used at ARTCC's provides for a limited degree of selectivity in signaling. With this arrangement a ring of less than 1.5 seconds will signal the Controller positions and a ring of over 3.5 seconds will signal the Assistant Controller or Communicator positions. Drawing SD-69164-01 covers the equipment for this selective signaling arrangement. The selective equipment is located on the customer's premises. Dc or 20-cycle outward signaling is normally provided from an INSAC station to the nearest toll office and also from the toll office closest to the ARTCC to the ARTCC. The signals are transmitted over the toll facilities using standard toll signaling equipment.

**3.03** A modification of the selective signaling equipment per SD-69164-01 is sometimes made so that three different positions at an

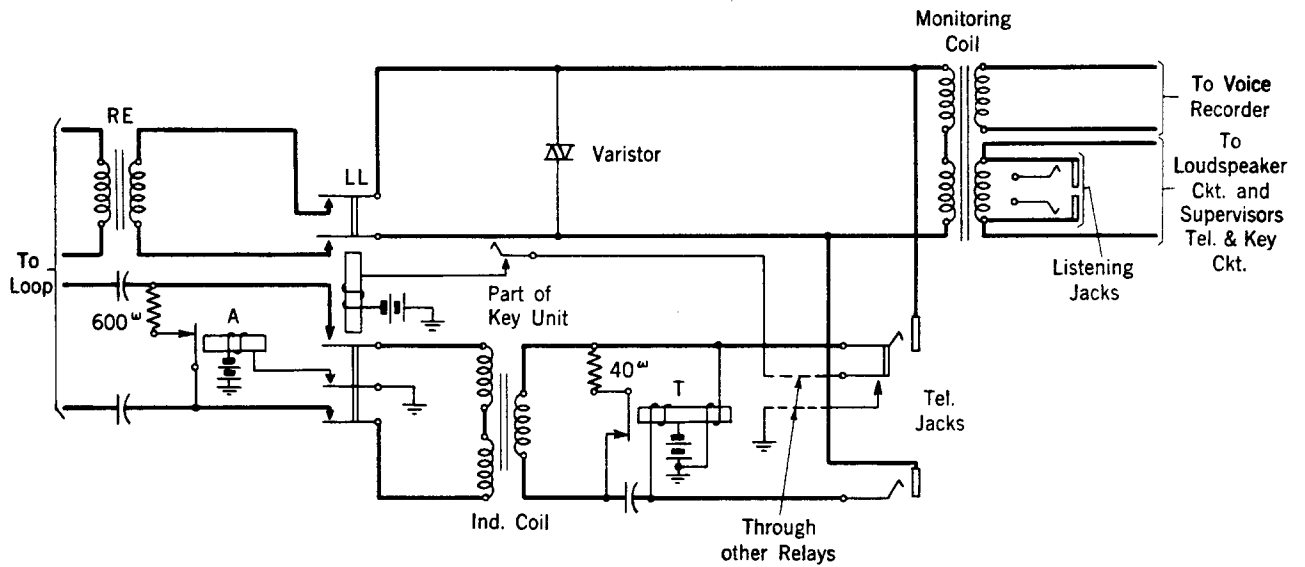
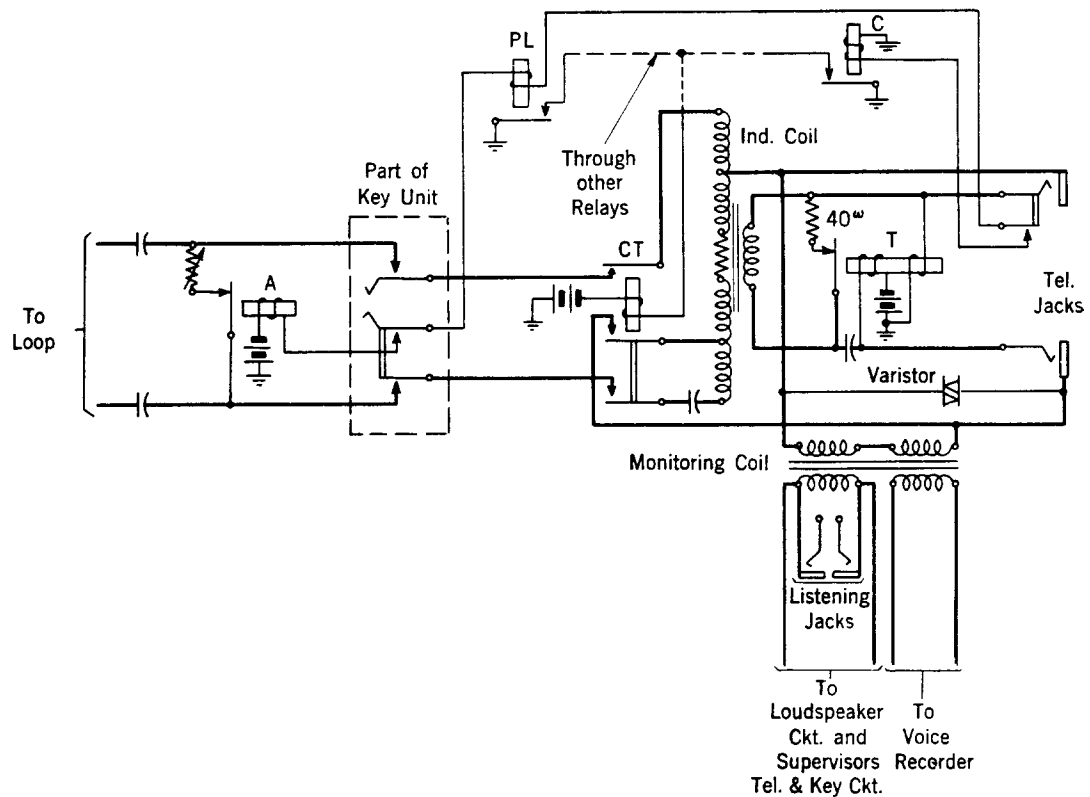
ARTCC can be selectively signaled. With this arrangement, a single ring will signal the Controller positions, two rings will signal the Assistant Controller or Communicator positions, and three rings will signal a third position as designated by the FAA. The length of rings should be at least one second and the interval between rings should not exceed one to one and one-half seconds. All selector equipment is located at the customer's location. Where this modification is desired the latest information should be obtained.

**3.04** Circuits connecting adjacent ARTCC's are normally two-point circuits and employ two-way signaling between the ARTCC's. Two-way ringdown or two-tone signaling is used. The selective signaling arrangement described in Paragraph 3.04 is frequently used.

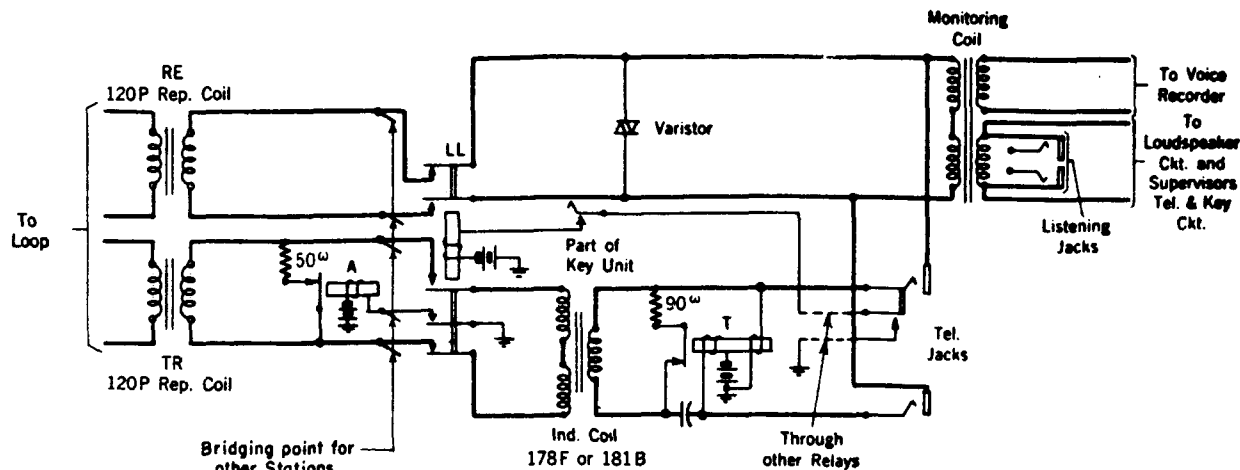
**3.05** Frequently an INSAC location will have access to two separate FAA circuits each for communication with a different ARTCC. Many times these circuits are arranged so that they can be switched together to provide communication between adjacent ARTCC's and all way stations enroute. Switching is usually accomplished on a 4-wire basis using switching relays at a toll central office through which both circuits are routed in the nonswitched condition. The switching relays are under control of the INSAC location that has access to both circuits to the ARTCC's. Dc channels are obtained by simplexing or compositing the station loops or by the use of separate cable pairs. The circuits are designed so that each station receives the same quality of service whether they are talking to a station on the same circuit or to a station that is connected through an operated switching relay.

### **4. STATION ARRANGEMENTS (FIGS. 1-6)**

**4.01** The arrangements shown in each figure are based on the standard circuits as indicated. Several variations in equipment and detail circuit wiring will be encountered at many of the older installations, however, these variations are all within the same general transmission pattern as the corresponding current arrangements. Since each testboard should have copies of the circuit drawings specifically covering the stations it serves, the older circuits may be readily clas-

**4-Wire Station Circuit****2-Wire Station Circuit**

**Fig. 1 — Station Circuits with 102A Key Equipment Arranged for Lamp and Buzzer Signaling. Old Type Arrangements for Use at Air Route Traffic Control Centers.**



**Fig. 2 — Station Circuits with 102A Key Equipment for Use at Air Route Traffic Control Centers. Designed to Reduce Level Variations As the Number of Bridged Stations Changes.**

sified in each instance. It is important that the type of station telephone circuit be properly identified as this may have a bearing on the method of using testing equipment at the station and the extent to which the observed level and net loss values are to be corrected.

**4.02** All of the circuit arrangements shown in Figs. 1 to 6 provide for a D-159797, 178F, or 181B station induction coil with F1 or N1 transmitters and HA3 (600-ohm) or HC4 (600-ohm) receiver units. On exception to these are the 2-wire arrangements provided by SD-69158-01 which use HA1 (300-ohm) receiver units. Section 310-410-500 discusses the transmission measuring technique for these arrangements.

#### **102A Key Equipment Arrangements at Air Route Traffic Control Centers**

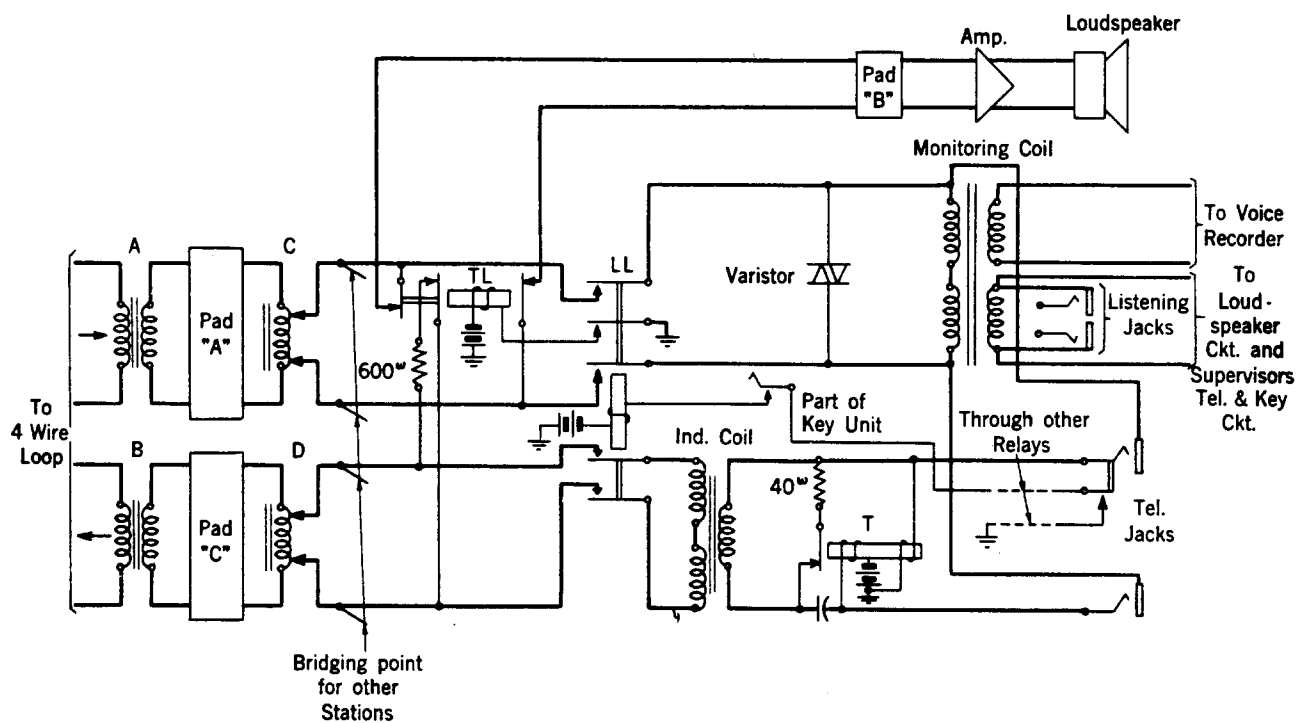
**4.04** Two such arrangements, one for 2-wire loops and one for 4-wire loops, are shown in Fig. 1. The line circuits for these arrangements are covered by SD-69164-01, Figs. 2, 5, 6, and 7. The key equipment and station circuits are covered by SD-69159-01.

**4.05** Shown in Fig. 2 is an additional 102A key equipment arrangement which is a modification of the 4-wire arrangement shown in Fig. 1. This new circuit is primarily for use at

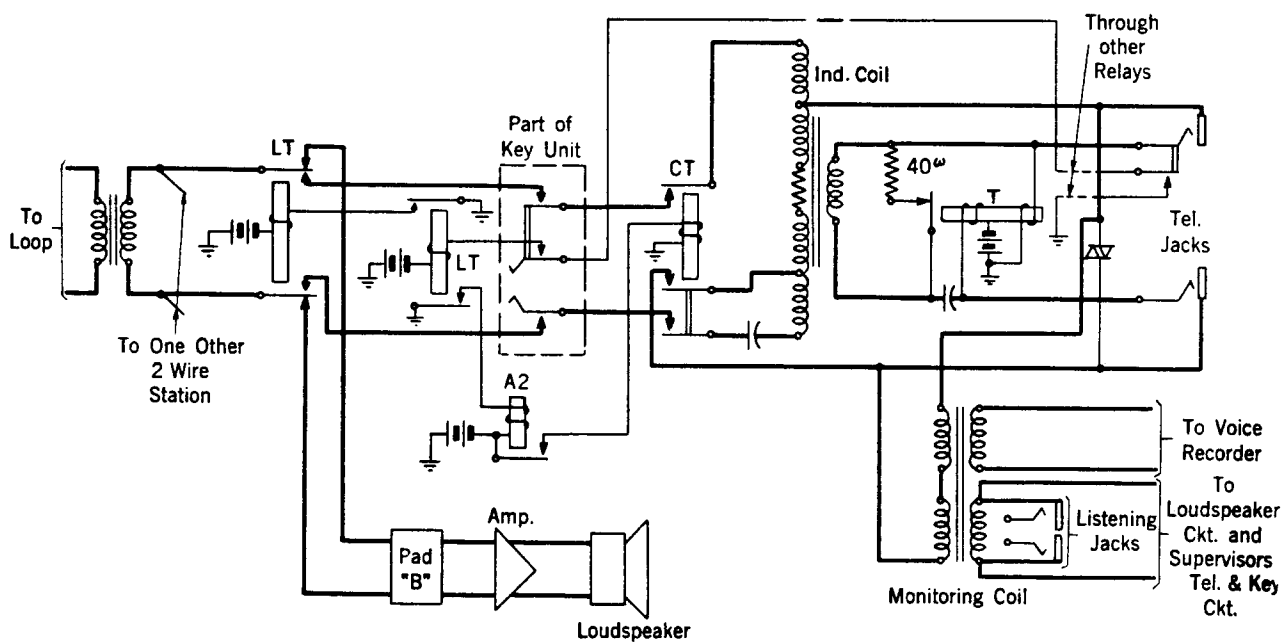
the centers and is designed to reduce transmission variations as operating positions are bridged on the loop at this point. It differs from Fig. 1 in that an inequality ratio transformer (120P transformer) has been inserted in the transmitting side of the line termination circuit and the existing transformer in the receiving side of the same circuit has been replaced by another 120P transformer. Both 120P transformers are arranged to give a 12:1 impedance stepup toward the line. To further reduce bridging variations the idle termination resistance in the attendant's telephone circuit of the 102A key equipment has been changed to 90 ohms. SD-69164-01, Figs. 13 and 14, cover this change in the line circuit for ringdown and telegraph or loop signaling facilities. SD-69167-01, Fig. 83, covers the same change for 600-1500-cycle (two-tone) signaling and SD-69159-01 covers the termination change in the attendant's telephone circuit. Fig. 2 is a simplified schematic of the modified line and attendant's telephone circuit. This arrangement is now used at nearly all ARTCC's instead of the arrangement shown in Fig. 1.

#### **102A Key Equipment Arrangements at Locations Other Than ARTCC's**

**4.06** These arrangements, shown in Fig. 3, are generally used at control towers. SD-69167-01 (Fig. 61) and SD-69158-01 cover the line circuits.



4-Wire Station Circuit



2-Wire Station Circuit

**Fig. 3 — Station Circuits with 102A Key Equipment at Other Than Air Route Traffic Control Centers. Loudspeaker Inward Signaling.**

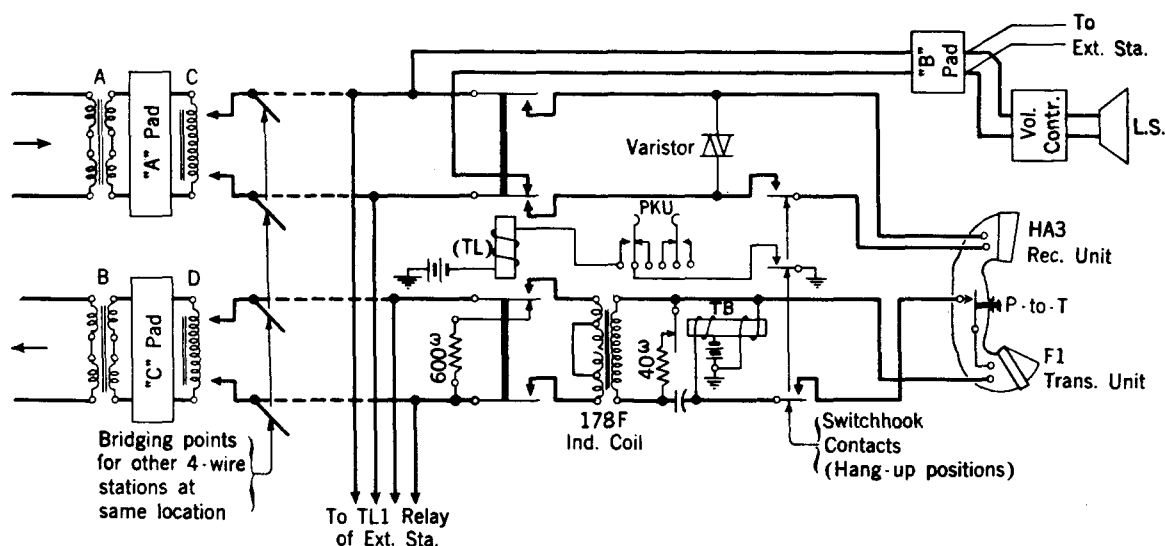


Fig. 4 — 4-Wire Station Circuit with 109A Key Equipment

#### Other Station Arrangements

4.07 Other station arrangements, both 4-wire and 2-wire, are shown in Figs. 4, 5, and 6 as follows:

Fig. 4—4-wire Station Circuits with 109A Key Equipment (per SD-69163-01).

Fig. 5—4-wire and 2-wire Station Circuits with 111A Key Equipment (per SD-69194-01).

Fig. 6—4-wire and 2-wire Station Circuits without Key Equipment (per SD-69158-01 for 2-wire and SD-69158-01 or SD-69167-01 for 4-wire).

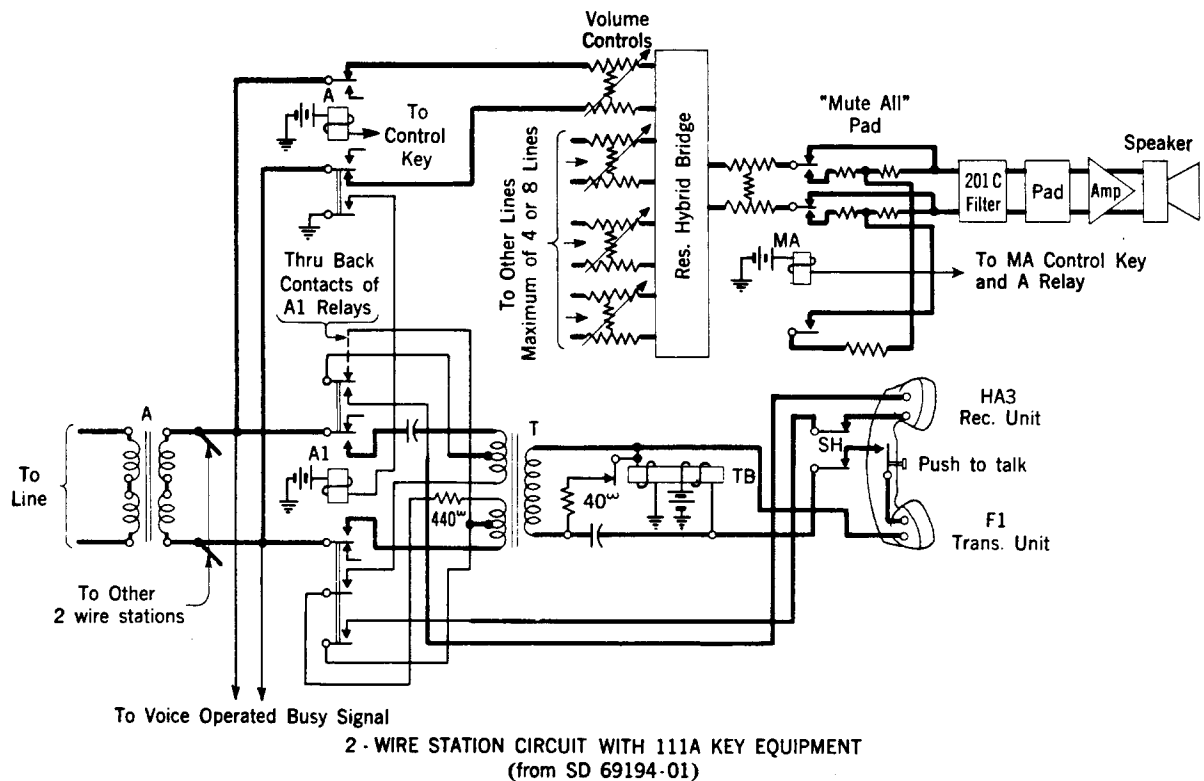
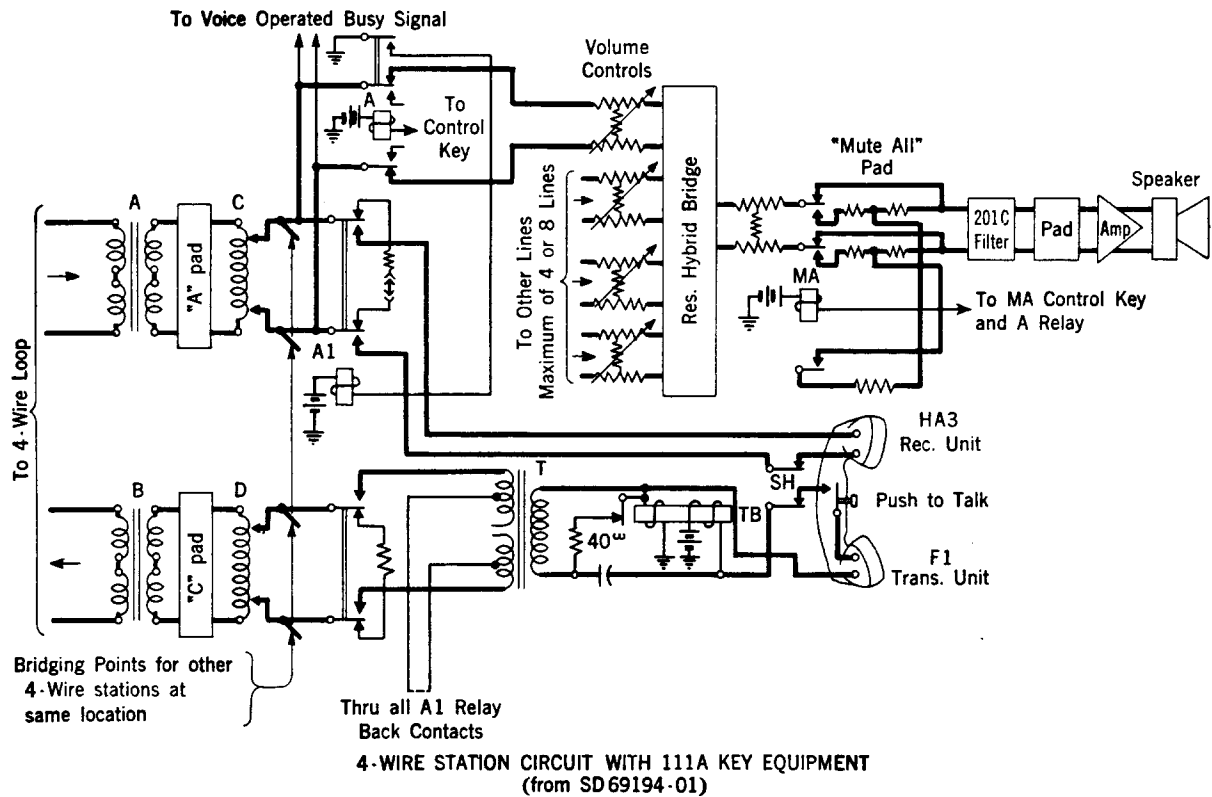
4.08 It is expected that the 2-wire and 4-wire package station equipment per Drawing SD-69254-01 will be used in the future for many stations without key equipment instead of the arrangements shown in Fig. 6. This equipment is described in Section 310-405-100.

#### 5. CIRCUIT LAYOUT LEVEL REFERENCE CONDITION

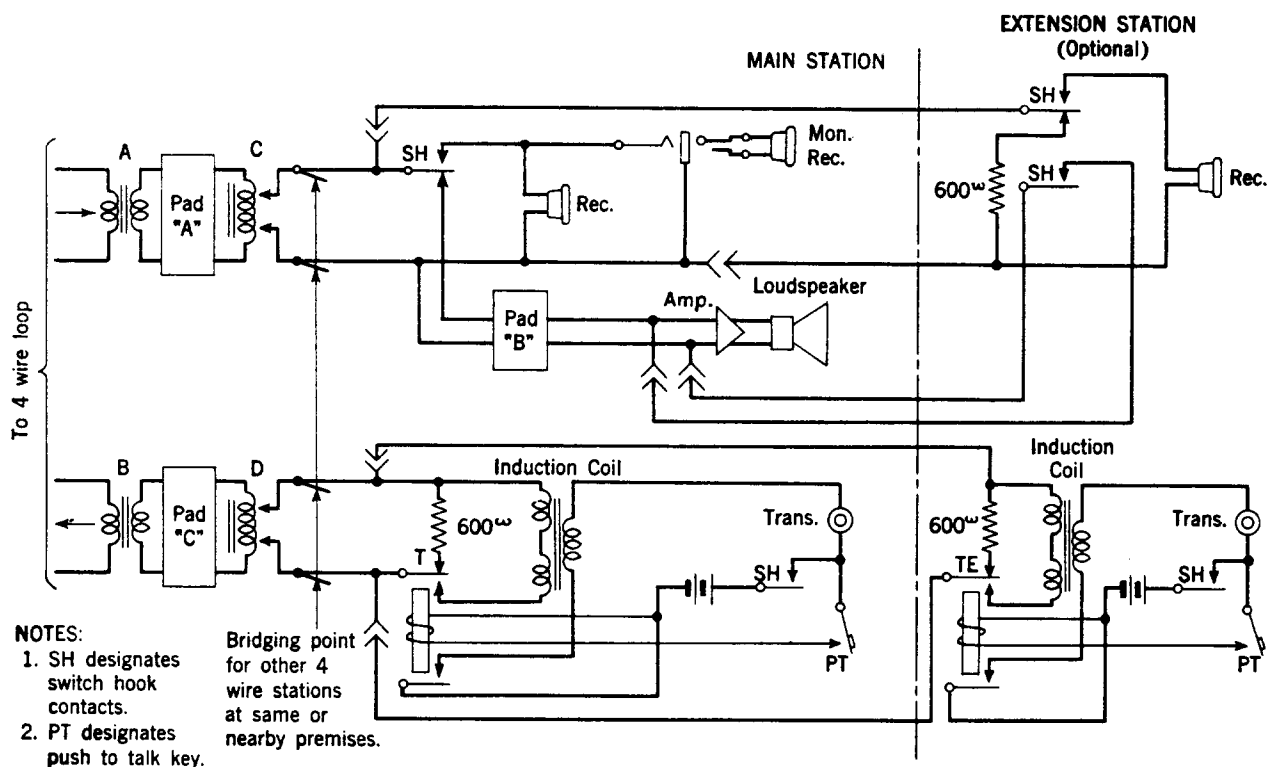
5.01 The transmission objective that has been used in the design of all the FAA interphone circuits is 10 db net loss between stations, assuming 2-wire operation. Zero db reference level was defined as the transmitting level at the

line terminals of the induction coil of the station set. At the receiving end of the circuit the design level at the line terminals of the induction coil was -10 db. Four-wire stations on the same 2-wire reference basis were assumed to provide a 3 db transmitting gain where the induction coil of the station set could be connected to eliminate the antisidetone network (coils such as the D159797 or 178F, but not the 102- or other 178-type induction coils). Also the 4-wire station was assumed to produce a 3 db receiving gain as compared to the 2-wire station, since no induction coil is connected in the receiving path of the 4-wire station circuit. Reflecting these gains, the output of a 4-wire station at the line terminals of its induction coil was +3 db and the receiving level for the same equivalent circuit as above was -13 db. The -13 db point was at the station set jacks. An exception to this was the 4-wire arrangement of SD-69150-01 where the 3 db antisidetone loss of the induction coil is still effective in the transmitting direction. This circuit was accordingly lined up from 0 db at the sending end to -13 db at the receiving end.

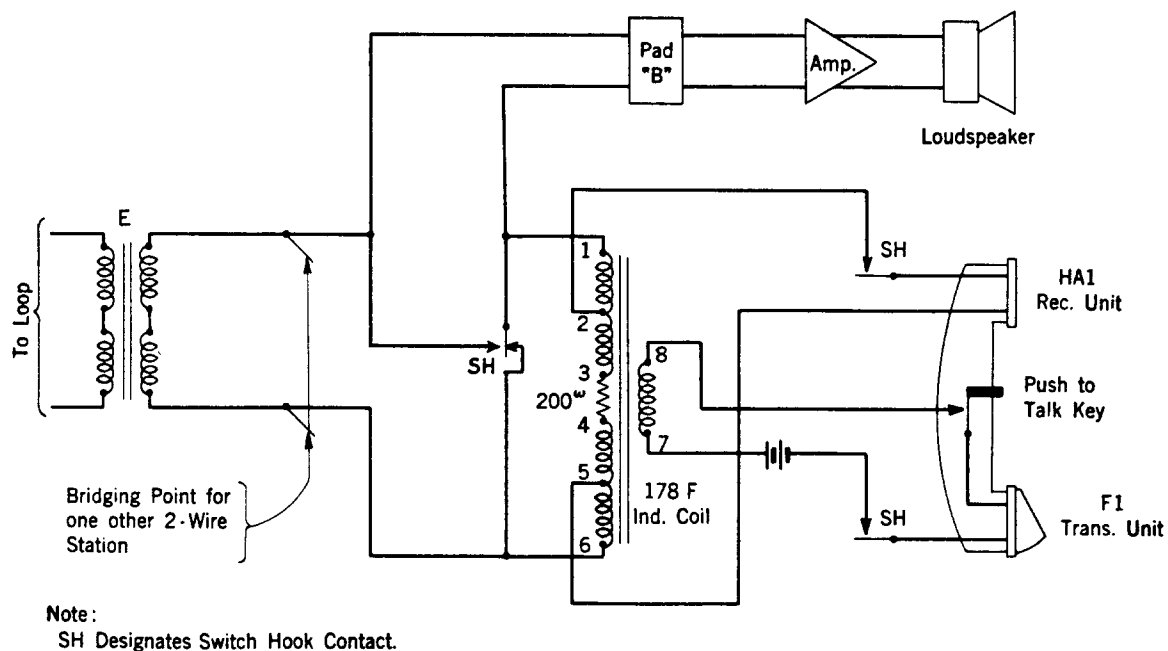
5.02 The foregoing levels and net losses do not take into account variations in station set efficiencies, and the FAA interphone circuits are equipped with two types of station sets whose efficiencies differ considerably. The ARTCC's



**Fig. 5 — Station Circuits with 111A Key Equipment (from SD-69194-01).  
Loudspeaker Inward Signaling.**



**4-Wire Station Circuit**



**2-Wire Station Circuit**

**Fig. 6 — Station Circuits without Key Equipment. Loudspeaker Inward Signaling.**

generally use 52-type headsets equipped with N1 transmitters and HC4 receivers while the way stations use F1 handsets equipped with F1 transmitters and HA3 receivers. Under FAA operating conditions the output of the N1 transmitter is approximately 3 db below that of the F1 transmitter while the efficiency of the HC4 receiver is about 3 db better than that of the HA3 receiver. In order to equalize this difference, 0 db reference level (2-wire operation) is specified as the transmitting level at the line terminals of the station induction coil at a station equipped with an F-type handset. On a 4-wire basis this is, as before, +3 db. At stations equipped with 52-type sets the transmitting level on a 4-wire basis is 0 db. Assuming the same net loss between stations as before, the receiving level at the station jacks of a station equipped with an F-type handset is -13 db. Reflecting the increased receiver efficiency, the receiving level at the station jacks of a station equipped with a 52-type headset is -16 db.

**5.03** The levels of the preceding paragraph are based on an equivalent 16 db net loss, station-to-station (4-wire) assuming single telephone sets at each station. This is generally not representative of operating conditions on the interphone circuits. The number of station sets bridged on the loop at an ARTCC, for instance, is variable; there may be from one to seven sets connected, with two sets as the average condition. [A controller (D), and his assistant controller (A).] Under poor weather conditions or

periods of heavy air traffic this number will increase, on the average one more set is added. Under severe operating conditions, however, additional positions in the center will be bridged on the loop. To give a favorable weighting to these abnormal operating conditions the interphone circuits are lined up with three positions bridged at the center. With the arrangement shown in Fig. 102 (SD-69164-01, Figs. 13 and 14 and SD-69167-01, Fig. 83) the loss in the transmit direction from the line terminals of the station induction coil to the line side of the 120P repeat coil is either 4.9 db or 4.3 db depending on whether 178F-type or 181B-type induction coils are used. For installation including both types of induction coils a compromise value of 4.6 db may be used. In the receiving direction the loss from the line side of the 120P transformer to the input of the receiver will be 6.3 db. All of the above losses are based on three positions being bridged at the station. The losses are 1.4 db less if only one position is connected. The number of sets bridged on the loop at the way stations is not as subject to wide variations as the above, but the normal operating condition is generally more than one set, loudspeaker, or idle circuit termination connected. The station loss is computed on the basis of this normal condition for each point and the circuit is usually engineered so that a constant load exists. That is, the equipment is designed so that each time one load is removed it is replaced by another load consisting of an idle circuit termination, loudspeaker, or station set.