



Installation and Maintenance
Procedures

Errors Shown on Page Two

Practice P356.318
Issue 2, October, 1961
Gen. Tel. Co. of Calif.

INSTALLATION
(INCLUDES CIRCUIT DESCRIPTION)
A.E. CO., 16A DIAL SELECTIVE SYSTEM

1. GENERAL

1.01 The attached C & M Practice, Section 55 Part 665, is the standard Practice to be used by the General Telephone Company of California.

1.02 To conform to the six digit numbering plan used by this Company, the attached Practice has been designated P356.318.

1.03 Certain features and equipment described in the attached Practice are not offered by this Company. The following should be noted:

- (a) All reference to one digit dialing should be disregarded.
- (b) Single Talking Link Unit - H883002-14 (Figure 7), and the Station Signal Unit - H883002-15 (Figure 8), are not used.
- (c) Single Digit Control Unit - H883002-67 (Figure 13 is not used).

may be required. He will also enter the necessary information in the special instructions section of the service order.

2.05 The installer will determine the actual need for long line units in the following manner:

- (a) Obtain a multi-meter (resistance measuring meter) from your foreman.
- (b) Short the station loop at the telephone set.
- (c) Measure the loop resistance from the equipment location.
- (d) If the loop resistance is 90 ohms, or more, the long line unit should be installed and the proper entries made on the service order.

2. INSTALLATION

2.01 The following standard installation procedures are not covered in the attached Practice.

2.02 When multiple power supply units are used to operate 16A equipment, the 10V AC return terminal (lamp ground) of the two units should be strapped together with #14 gauge wire or larger.

2.03 When more than one push button telephone is connected to a single cable, the number of cable conductors used for lamp ground should be increased in accordance with Table A.

2.04 If there is a possible need for long line equipment (H883002-25), the salesman will inform the customer additional equipment

<u>No. of Telephones on Home Run</u>	<u>No. of Conductors Required for Lamp Ground</u>
1	2
2	3
3	5
4	6
5	7
6	9
7	10
8	11
9	13
10	15

Table A. Lamp Ground Requirements

3. ADDITIONAL INFORMATION

3.01 Additional information on the 16A system became available after the attached Practice was printed. **Also errors in the circuit descriptions were found.**

3.02 When a station on a two talking link system is dial selected, and the calling party wishes to resignal, the calling station must hang up and both digits of the called station's number must be redialed.

3.03 There is an **error** in the circuit description of the Two Talking Link Unit (4.5.2-g-paragraph 2). The magnetic effects of windings 1 and 2 on relay J cancel each other so that relay J does not operate at this time, though both windings are energized. All reference to relay J being operated in section 4.5.2-g should be disregarded.

3.04 The Add-on Conference Control Unit circuit descriptions in sections 4.15-b, 4.15-c **are in error**, and should be disregarded. The following are revised circuit descriptions for these sections.

- (a) Seizure from the Main Link (Auxiliary link in use). Operation of the add-on button closes resistance battery through break contacts on relay B of the add-on unit. Relay B operates and locks to ground on lead H. This ground is extended through the "X" contacts of relay B, lead HC of the control unit, break contacts of relay A, rectifier MR1, to winding No. 2 of relay A. Relay A does not operate due to the H relay, in the link unit, being operated. Relay B of the add-on unit operates as described in 4.14. If the auxiliary link becomes free, relays G & H in the link unit restore. Release of relay H connects battery through resistor R3, lead CS to the No. 2 winding of relay A in the add-on control unit, operating the "X" contacts. As soon as the Auxiliary link is idle, the Main link call will

be transferred to the Auxiliary link, and relays G & H reoperate. Operation of relay H places ground on lead CA to winding No. 1 of relay A of the add-on control unit. Relay A operates fully, transferring the add-on talking leads (T4 & R4) from the Main link talking leads (T4 & R4) to the Auxiliary link talking leads (CT & RT). Full operation of relay A also opens the operating path to its No. 2 winding. The locking path for relay B (in the add-on unit) is transferred to lead HC, which is grounded by operated relay G in the link unit.

- (b) Seizure From Auxiliary Link. Operating the add-on button closes resistance battery through lead R to winding No. 2 of relay B in the add-on unit, after a brief delay relay B operates and locks to ground on lead H. This same resistance battery is closed through the break contacts of relay B (add-on unit), lead S, break contacts of relay B (add-on control unit), rectifier MR2, 100 ohm winding of relay B (add-on control unit) to ground at lead CG. When the add-on button was operated, the ground on the No. 2 winding of relay B (add-on unit) was connected through the R talking conductor of controlling station to the No. 1 winding of relay J in the link unit. This unbalance in the Auxiliary talking path caused relay J (link unit) to operate, placing ground on lead CG to the add-on control unit. Relay B (add-on control unit) operates its "X" contacts and locks to ground on lead CH from relay G in the link unit. Relay B (add-on control unit) closes ground on contacts 7 & 8 to the No. 1 winding of relay A (add-on control unit). Relay A operates and transfers the add-on talking leads (T4 & R4) from the main link talking leads (T4 & R4) to the Auxiliary link talking leads (CT & RT).

TYPE 16A

KEY TELEPHONE
SYSTEM

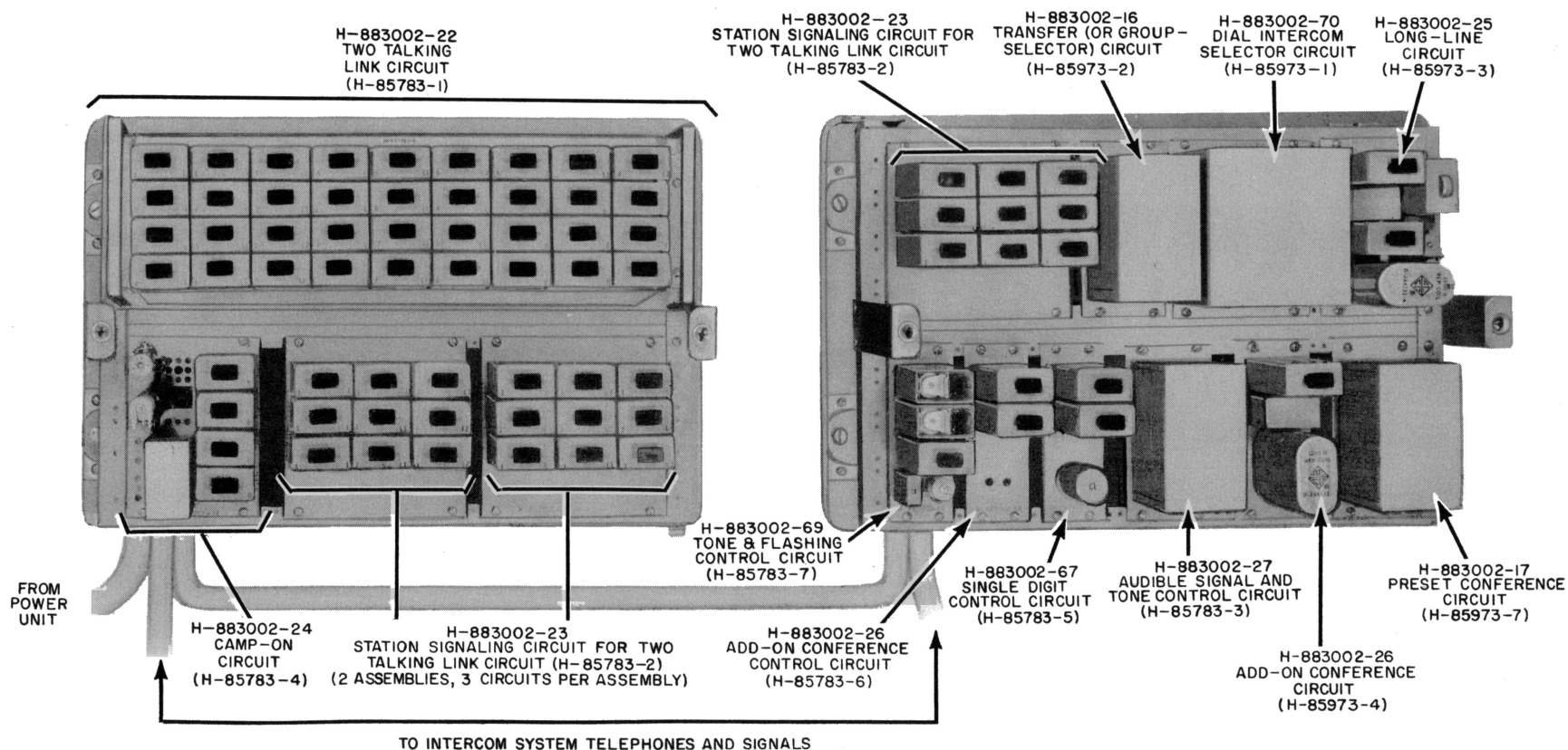


Figure 1. Housing units (covers removed) showing all 16A system units for two-digit, two talking link service for 18 intercom stations (includes one assembly of each auxiliary service).

KEY TELEPHONE SYSTEM

Type 16A

1. INTRODUCTION

The 16A key telephone system is an expanded and improved intercommunicating facility intended, primarily, for use with either the 10A or 10A1 type key telephone systems and apparatus. It is also possible to use 16A equipment alone for intercommunication purposes without 10A or 10A1 (or comparable) equipment, provided that proper power facilities are available.

The 16A system provides features similar to the W.E.Co. 6A system, and is usually used with key-type (push-button) telephone sets such as A.E.Co. type 86 and 860A (see figures 3 and 4).

1.1 General

The 16A key telephone system consists of a number of relay group assemblies which may be used, individually or in various combinations, to provide a variety of intercommunicating services between a number of associated telephones. The relay group assemblies are similar to and arranged for panel mounting in a manner like the type 10A1 key telephone system units. This system is intended to supplant and expand the intercommunication components and features of the 10A and 10A1 type key telephone systems. Figures 1 and 2 show views of two small but all-inclusive installations of 16A system apparatus.

1.2 Features and Services

The 16A key telephone system (assemblies used individually or in combinations) provide the following features and services:

- a. A common-talking intercommunication circuit with single-digit dial, selective signaling for up to nine stations, and including system-busy lamp signals at all stations.
- b. Expansion of the nine station, single-digit, common-talking, intercommunication circuit to two-digit dialing for more than nine stations. Fully selective audible signaling and system-busy lamp signals are still provided.
- c. A private-talking intercommunication channel with fully selective signaling, which is either dial controlled or push-button operated, or a combination of both; the dial controlled system uses a single digit for up to nine stations, and two digits for more than nine stations. System-busy lamps are still provided.
- d. Two private-talking intercommunicating channels with fully selective signaling, which is either dial controlled or push-button operated, or a combination of both; the dial system uses either one or two digits, for up to or more than nine stations. Also included are system-busy lamp signals and, when furnished, busy tone for indicating that a station is already busy on an intercom call.
- e. A busy station camp-on feature for the two-talking link circuit, so that when a busy station is dialed and busy tone is returned to the calling station, the calling station may remain (camp) on the busy station's circuit until the existing connection is cleared - at which time the desired station will be signaled in the normal manner. Other stations are blocked from entering or interfering with this camp-on circuit connection. The calling station may disconnect at any time during the camp-on period and clear the connection completely.
- f. A system-busy camp-on feature for both of the private-talking links (single and double) such that when no talking circuit is available (one conversation in progress on the single link circuit, or two conversations in progress on the double link circuit), a calling station may still seize the camp-on circuit, dial the desired station's one or two-digit code, and hold until a talking channel becomes available. This does not interfere with any existing conversation(s). Any subsequent callers attempting to use the camp-on feature at this time will receive busy tone at once and be denied access. When a talking channel does become available, the called station - if not busy - is signaled and allowed to answer; if the called station is busy, signaling is blocked and busy tone is returned to the calling station as usual.

The foregoing are the principle services and features of the 16A key telephone system. Below are given a number of additional, optional features and special services which may be obtained with the 16A key telephone system:

- g. Dial tone to the calling station when it seizes either the single or double link circuit (from an idle condition).
- h. A flashing control circuit for causing the intercom system-busy indication lamps to flash off and on rapidly at called telephone stations when there is an intercom system call for that particular station (in addition to any audible signaling). This is available only with single or double link private-talking circuits.
- i. A single-digit control circuit which makes possible, in a two-digit system (one having more than nine stations), the selection of a particular intercom station signal or operation of a special feature, used frequently, by the dialing of only one digit.
- j. A preset conference or group-call circuit which, by the operation of a single push-button (or the dialing of only one dial code: one or two digits), will simultaneously
 - signal up to a maximum of six preselected intercom stations for a conference call.
- k. A long-line circuit which permits the use, in the intercom system, of a station located at an unusually long distance from the rest of the intercom stations and equipment. Under most conditions, this also reduces to two, the number of conductors required between the intercom system equipment and the distant long-line station.
- l. A station or common audible signal control circuit which allows the audible signal at any intercom station or a common audible signal to be operated at different times, from two different power sources, and in response to more than one control signal. This will also permit a key telephone system audible signal to be operated by a 10A or 10A1 line circuit - or directly from a central office or P-B-X line - as well as from the 16A intercom circuitry.
- m. An add-on conference circuit which allows an intercom station to be connected, under the control of a properly equipped supervisory or master station, to a central office line, P-B-X, tie-line, or other similar circuit to which it otherwise does not have access.

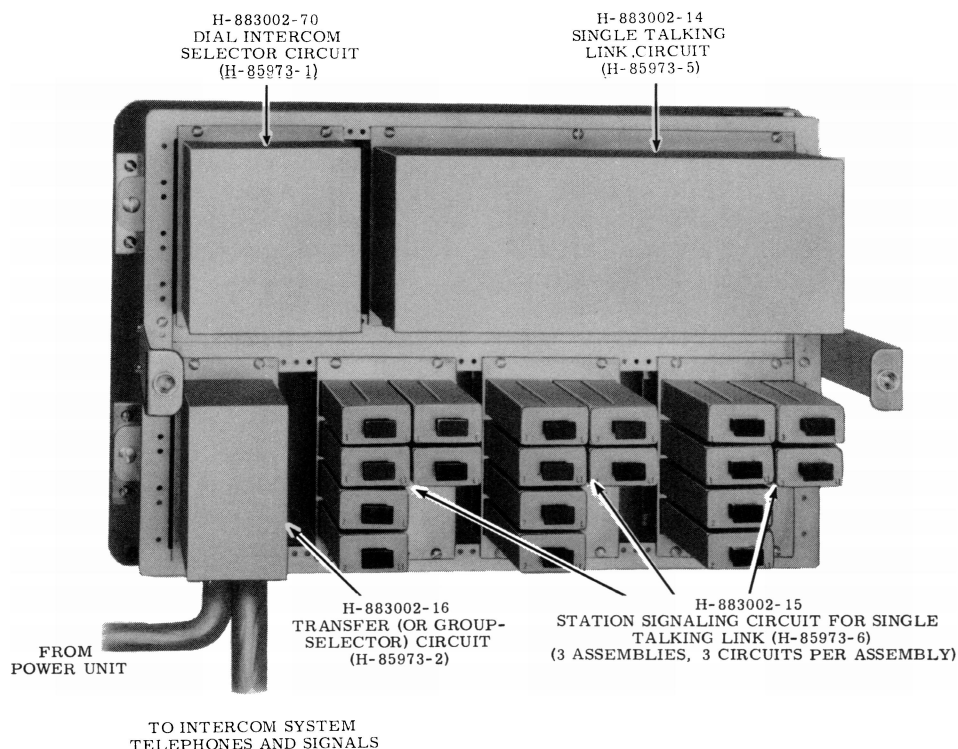


Figure 2. Housing unit (cover removed) showing six basic units for two-digit, single talking link service for 18 intercom stations.



Figure 3. Type 86 key telephone with six push-button keys.



Figure 4. Type 860A key telephone with 12 push-button keys and provision for one plug-in six-button unit.

2. APPLICATIONS AND REQUIREMENTS

Following is Table A showing the part number, circuit number, name, service provided, equivalent W.E.Co. KTU number, and width of the mounting plate of each of the relay assembly groups which make up the 16A communication system.

So long as the capacity of the power supply unit is not exceeded, a single power supply unit should be used for all the 16A system components. When a 16A system is used in conjunction with a 10A or 10A1 key system, it is preferable that a separate power supply unit be used for the 16A assemblies. In larger systems it may be necessary to use more than one power supply unit to adequately serve all the 16A system assemblies.

Below is a brief explanation of the specific services, features, functions, and detailed requirements of each relay assembly in the 16A key telephone system.

2.1 Dial Intercom Selector Circuit (Figure 5) (H-883002-70, H-85973-1)

The dial intercom selector circuit consists of a rotary switch and common control relays which furnish a common-talking intercommunication circuit, using one, common, battery-feed relay. It is normally furnished wired for single-digit selective dialing of a maximum of nine intercom stations. It is possible to connect more than nine stations to this common-talking system if other means of station signaling are available; in most cases, however, this is not practical and should be avoided. Common, audible, coded signaling of stations and/or individual push-button selective signaling of stations is also possible, though not recommended.

This unit can easily be modified for two-digit operation to serve more than nine stations; additional relays (section 2.2) are required for this modification.

All stations associated with this circuit have equal and unrestricted access; no privacy is provided. The first station to connect to this circuit, when it is idle, causes the intercom system-busy lamps at all intercom stations to be lighted; however, any station may at any time connect to the circuit and join the conversation.

A calling party, when connected to this circuit which is idle, dials the number of the desired station. This causes the rotary switch to step

and connect the wipers to the signal lead of the desired station; at the called station an audible signal sounds continuously for a brief period of time. At the conclusion of this signaling period, the rotary switch restores, and no further signaling takes place unless the calling party chooses to re-dial. The calling party may re-dial the called number to operate its audible signal as often as desired. In two-digit operation only the second digit need be re-dialed to resignal the called station. However, once the called station, or any other station on the system connects to the intercom, no further dialing is possible by any station (including the original calling station) except as noted under the long-line circuit, section 2.11. No ring-back tone is furnished, nor is there any intercept tone or other indication if an unused terminal (wrong number) is dialed.

2.2 Transfer (or Group-selector) Circuit (Figure 6) (H-883002-16, H-85973-2)

This assembly consists of two relays, each with a number of make combinations. These relays are required when a dial intercom selector circuit is expanded to serve more than nine intercom stations. One relay (T1 or T2) is required for each group of nine intercom stations having the same first digit; one two-relay assembly will serve a maximum of eighteen stations. Another two-relay assembly must be provided for each additional one to eighteen stations to be served. Each T() relay extends nine leads, either R leads or C leads, from the selector to the station audible signals or to the link or station signaling circuits associated with stations having the same first digit.

When the transfer circuit is used to extend the intercom system beyond nine stations, all station codes must be two digits. Individual digits which are not used as the first digit of a code may be used for the special services described in the following sections. There is no intercept or other signal given if an unused first (or second) digit is dialed.

2.3 Single Talking Link Circuit (Figure 7) (H-883002-14, H-85973-5)

This assembly consists of 24 relays; six relays (A-F) are common control relays associated with each call as it is placed. Two relays (L and L1) are required for each intercom station; this assembly provides station relays for nine intercom stations.

TABLE A. SERVICE LISTING

Part No. and (Circuit No.)	Figure No.	Name	Service Provided	W. E. Co. KTU No.	Mounting Width
H-883002-70 (H-85973-1)	5	Dial intercom selector circuit.	Common-talking, selective-signaling, dial-controlled intercommunication circuit for a maximum of nine individually signaled stations (expandable).	207C	5-11/16"
H-883002-16 (H-85973-2)	6	Transfer (or group-selector) circuit.	Provides two relays for expansion of dial intercom selector. One relay is required for each nine-group of individually signaled stations.	216A	3-1/2"
H-883002-14 (H-85973-5)	7	Single talking link circuit.	Provides one private-talking intercommunicating channel. Includes two station relays for each of a maximum of nine stations operated either by dial control or by push-button selection.	214A	1' 2-7/8"
H-883002-15 (H-85973-6)	8	Station signal circuit (for single talking link circuit).	Provides three pairs of station relays for expansion of single talking link for more than nine stations. One assembly - of three circuits - is required for each one to three stations added.	215A	4-13/16"
H-883002-22 (H-85783-1)	9	Two talking link circuit.	Provides two separate, private-talking channels; includes three station relays for a maximum of nine stations operated either by dial control or by push-button selection. (Requires use of H-883002-69.)	222A	1' 11"
H-883002-23 (H-85783-2)	10	Station signaling circuit (for two talking link circuit).	Provides three sets of three station relays to expand two talking link circuits for more than nine stations. One assembly - of three circuits - is required for each one to three stations added.	223A	7-7/16"
H-883002-24 (H-85783-4)	11	Camp-on circuit.	Provides camp-on feature for single or two talking link circuits.	224A	5-1/4"
H-883002-69 (H-85783-7)	12	Tone and flashing control circuit.	Provides dial tone and an interrupting action for busy tone and for operating flashing lamps at intercom stations.	19B	2-5/8"
H-883002-67 (H-85783-5)	13	Single-digit control circuit.	Permits use of single-digit dial codes in two-digit dial intercom system, for frequently called numbers or special features.	-	2-5/8"
H-883002-17 (H-85973-7)	14	Preset conference circuit.	Provides selection facilities for two fixed (preset) six-party conference groups.	217A	3-1/2"
H-883002-16(P) (H-85973-2A)	15	Preset conference ring control circuit.	Provides two relays to allow signaling over the R talking conductor when -17 is used with -14, -15; or -22, -23. IMPORTANT: See note in section 2.11.	-	3-1/2"
H-883002-25 (H-85973-3)	16	Long-line circuit.	Provides separate battery feed, dial circuit, and two-wire combined talking and signaling connection to an intercom station located at a longer than average distance from the rest of the system.	225A	3-15/16"
H-883002-27 (H-85783-3)	17	Audible signal and tone control circuit.	Provides means for operating one audible signal from two different power sources and/or under control of different control signals (two circuits). Also provides station-busy busy-tone control for two talking link circuit.	227A	3-1/2"
H-883002-26 (H-85973-4)	18	Add-on conference circuit.	Provides means for connection, under supervision, of an intercom link and station to a trunk circuit not otherwise accessible by the station.	226A	3-1/16"
H-883002-68 (H-85783-6)	19	Add-on conference control circuit.	Provides extra control relays permitting use of an add-on conference circuit with two talking link circuit.	-	2-5/8"

This circuit provides one intercommunicating channel with full privacy and control for nine intercom stations. If additional intercom stations are added to the system, these common control relays (A - F) will serve as many stations as are connected to the system. However, a pair of station relays (L and L1) must be provided for each intercom station added (see section 2.4).

When the intercom system is idle (system-busy lamps dark at all stations), the first party to connect to the system seizes it, causes the system-busy lamps at all stations (if provided) to be lighted, and assumes control over the system. No other intercom station can now enter the circuit unless selected and signaled to do so.

The calling party must now select and signal the called party; this is done by dialing either a one-digit or a two-digit code, or, when provided, by operation of a push-button key. Usually a dial intercom selector circuit (section 2.1) is used to select a called station, although push-button key selection of stations is possible without the dial selector. When a called station is selected, its audible signal, or a common audible signal, sounds. In addition, when a flashing circuit is provided, the busy lamp at only the called station will also flash rapidly off and on. These same circuit operations also prepare or set up the single link system so that the called station may answer; all other stations are prevented from entering the circuit, and their busy lamps remain continuously lighted. Once the called station has answered, no further dial controlled signaling is possible; however, push-button signaling of additional stations (to enter the conversation) is always possible.

This circuit is arranged so that two different signaling power sources can be used (simultaneously if necessary) to signal different intercom stations. Strapping terminals are provided so that the proper signaling power will always be connected to each station on the proper lead.

As noted, additional stations may be added as required, using the station signal circuit apparatus covered in section 2.4. The single talking link circuit CANNOT be expanded or converted to the two talking link circuit covered in section 2.5.

2.4 Station Signal Circuit (for Single Talking Link) (Figure 8) (H-883002-15, H-85973-6)

The station signal circuit assembly, for the single talking link circuit, consists of six relays and contains three intercom station signal circuits. One pair of relays (L and L1)

make up one station signal circuit to serve one additional station; this assembly will serve three additional stations.

When a single talking link circuit is expanded to serve more than nine stations, the common relays (A - F) continue to serve and control the connections for as many stations as may be associated with the single talking link circuit. Each additional intercom station, however, requires two station relays (L and L1); this circuit furnishes three such sets or pairs of station relays, to serve three additional intercom stations. One of these assemblies must be furnished for each additional one to three intercom stations.

Like the nine stations served by the relays in the single talking link circuit itself, these added intercom stations may also be signaled either by dial control or by individual push-button selection. It is possible to add one or two extra stations to a single-digit (basic 9-station) system, and select and signal these additional stations by push-button control only; but this, in general, is not economical and is not recommended. When the number of stations increases to any significant number greater than nine, two-digit dial selection control should be provided; this is covered in sections 2.1 and 2.2.

2.5 Two Talking Link Circuit (Figure 9) (H-883002-22, H-85783-1)

The two talking link circuit consists of 36 relays: 27 station relays and 9 common control relays (A - J). The 27 station relays make up nine groups of three relays each (L, L1, and L2); each such three-relay group serves one intercom station. This assembly, therefore, will serve a maximum of nine intercom stations, and will provide two separate private-talking, intercommunicating channels. It is neither necessary nor possible for the subscriber to choose between the two private-talking channels; selection of, connection to, and the transfer between the two channels is entirely automatic.

This circuit is similar to the single talking link circuit previously described. However, four additional common control relays are required, plus a third relay (L2) associated with each intercom station circuit, to provide control of and connection to the second talking channel.

Like the single talking link circuit, the two talking link circuit may be operated either by a one-digit or by a two-digit dial control or by an individual push-button key selection.

The talking channels are designated main and auxiliary; all intercom calls are initially

connected to the main talking channel (or link) when they first seize the system and until the desired talking connection or connections have been set up. When the desired connections are completed (all called stations have answered), all connected intercom stations are then transferred, automatically and simultaneously, to the auxiliary channel if it is not then in use. If the auxiliary channel is busy, but becomes free while a call is in progress on the main channel, the conversation in progress on the main channel is automatically transferred to the auxiliary. This transfer operation may be noticed by the talking parties - as a slight click in the transmission circuit - but will in no way interfere with their conversation.

When both channels are idle, the first party to connect to the intercom system causes the system-busy lamps at all intercom stations to be lighted, and access to the intercom system is denied to all other parties at this time. When the calling party selects a called station, by dial control or by push-button control, the audible signal at the called station sounds, and the system-busy lamp at the called station flashes rapidly off and on (assuming that the tone and flashing control circuit is provided). At this time the called station (or stations) may connect to and converse on the intercom channel, but no others may do so.

When the called station answers, and if the auxiliary channel is not busy, both (or all) parties are automatically transferred to the auxiliary channel. Once transfer to the auxiliary channel has taken place, however, no further signaling is possible, by any means, to call in any additional parties.

The intercom busy lamps at all stations are lighted while the main talking channel is occupied (even if the auxiliary channel is idle - while a call is being set up); however, if only the auxiliary talking channel is busy (after transfer has taken place), the intercom busy lamps at all stations are extinguished, and the system is free to process another call. The system-busy lamps at all stations remain lighted when both talking channels are occupied.

If a calling party selects a station that is already busy on an intercom call, the calling party will receive busy tone - assuming that the busy tone circuit has been included. NOTE: It is essential that the tone and flashing control circuit (section 2.8) be provided whenever the two talking link circuit is used. The camp-on circuit (section 2.7) and the audible signal and tone control circuit (section 2.13) assists the two talking link circuit in providing busy station camp-on service. This insures that when a busy station is called, the calling

station may remain (camp) on the called station's circuit until it becomes free. At this time the desired station will be signaled.

This circuit may be extended to serve an additional number of intercom stations; the common control relays (A - J) operate to set up and control all calls on both channels of the two talking link circuit. Three station relays (L, L1, and L2) must be furnished for each additional intercom station to be served.

2.6 Station Signaling Circuit (for Two Talking Links) (Figure 10) (H-883002-23, H-85783-2)

The station signaling circuit, for two talking links, consists of nine relays: three sets of three station relays (L, L1, and L2). Each three-relay set serves one additional station added to a two talking link intercom system.

Just as in the two talking link circuit (section 2.5) for the original nine stations, called stations may be selected either by a one-digit or two-digit dial control, or by an individual push-button control. The features of the two talking link circuit, described in section 2.5, apply to the additional stations served by these relays without significant change.

2.7 Camp-on Circuit (Figure 11) (H-883002-24, H-85783-4)

The camp-on circuit consists of relays, various diodes, transistors, and other components. When this circuit is used it is essential that the tone and flashing control circuit be provided.

This circuit provides a system-busy camp-on feature for either the single or two talking link circuits. When this feature is used, it is possible for an intercom station to override the intercom system-busy lamp indication, and connect to the intercom system camp-on circuit without interfering with an existing call or calls. It is possible for a calling party, at this time, to dial the one- or two-digit code of the intercom station he desires to call; no (further) action occurs at this time nor until a talking channel becomes available. When a talking channel does become available, the preselected called station is signaled audibly and visually as usual (if idle) and it may answer and connect to the intercom system. If the called station should happen to be busy, the calling party receives busy tone in the usual manner.

When any intercom station has seized the camp-on circuit and is waiting for a talking channel to become available, any additional stations that attempt to connect to the intercom

system (for camp-on) will not interfere with the camped-on party, but will receive busy tone at once. This informs the party that a camp-on call has already been set up. Only one camp-on call can be set up at any one time. Push-button operation is not possible during the camp-on period.

When used in conjunction with the audible signal and tone control assembly (section 2.13), this circuit assists in providing the busy station camp-on feature for the two talking link circuit.

2.8 Tone and Flashing Control Circuit (Figure 12) (H-883002-69, H-85783-7)

The tone and flashing control circuit provides dial tone and busy tone. Its use is essential with the two talking link circuit, and is recommended with the single talking link circuit. This circuit must be provided if the camp-on circuit is used.

This circuit is also used to obtain flashing lamp operation at the called intercom stations.

This feature is provided through the use of two slow-acting relays, that when properly energized, alternately operate and release each other at the rate of approximately 60 operations or interruptions per minute (I.P.M.) with 50 percent make and 50 percent break. One such circuit is all that is usually necessary in any 16A system installation.

2.9 Single-digit Control Circuit (Figure 13) (H-883002-67, H-85783-5)

The single-digit control circuit consists of two relays. This circuit is used with the dial intercom selector circuit (section 2.1) and the transfer or group-selector circuit (section 2.2) when more than nine intercom stations are in use with two-digit dial selection (link circuits may or may not be used). Since it is recommended that no more than 36 intercom stations be connected to any one intercom system (four groups of nine stations), normally only four prefix digits are used. Any one of the unused prefix digits may be used for single-digit selection of a frequently called number or other frequently used special features. By these means it is possible, in a two-digit system, to dial only a single digit in order to signal, connect to, or otherwise activate some special circuit or feature.

One single-digit control circuit must be provided for each station or special feature that is to be operated by the dialing of only one digit.

2.10 Preset Conference Circuit (Figure 14) (H-883002-17, H-85973-7)

In an intercom system installation, it may sometimes be desirable to have more than two parties join in a conversation. In most applications, however, it is not possible to operate the dial selector circuit after a called station has answered or connected to the intercom system. Conference calls (calls connecting more than two intercom stations) normally would be set up by dialing all the called stations before any called station answers (although they can also be set up, after a called station has answered, by a push-button selection of additional stations). Both of these methods, however, have certain undesirable features. In addition, when a certain group of intercom stations frequently engage in a conference call, it is desirable to minimize the amount of dialing and push-button operation necessary to set up such a conference connection.

The preset conference circuit assembly consists of three relays which provide two separate 6-party (maximum) conference selection circuits (5-party maximum when used with two talking link). These preset conference circuits may be activated either by the dialing of a one-digit or a two-digit code (either in a single-digit system, a two-digit system, or in a two-digit system with single-digit control) or by operation of a single push-button at a key telephone.

In common talking systems (dial intercom selector only, no link circuits), the preset conference circuit acts only to signal the required stations. In private-talking systems (one-link or two-link), the preset conference circuit acts to operate both the station signal and the connection relays of the several called stations, both signaling them and preparing circuitry to permit them to answer and connect to the private intercom channel. Use of this feature is the same as if each of the conference call stations had been individually selected and signaled by dial or by push-button control; this in no way interferes with other access to and operation of these stations and the system. When used in connection with the two talking link circuit, transfer from the Main link to the Auxiliary talking link (if it is to take place) is prevented until all called stations have answered.

Push-button signaling of additional stations (or dialing additional stations using a long-line circuit) is, as previously noted, possible so long as transfer to the auxiliary channel (of the two talking link circuit) has not taken place. However, once transfer (in a two-link circuit) has taken place, it is not possible to signal nor call in additional stations by any means.

This circuit provides facilities for two 6-party (maximum) conference groups. It is not possible for any intercom station to be a part of more than one group unless a preset conference ring control circuit is provided. It is recommended that no more than seven parties (one caller and six called parties) be connected on any conference call in order to maintain a satisfactory grade of transmission.

Additional preset conference circuit assemblies may be used in any 16A intercom system installation. In unusual circumstances it is possible to connect and activate both 6-party conference groups as a common 12-party circuit, although the grade of transmission would probably not be very satisfactory. This would have a value principally for an emergency alarm or a notification type service (and possibly in conjunction with a long-line circuit).

2.11 Preset Conference Ring Control Circuit (Figure 15) (H-883002-16(P), H-85973-2A)

The preset conference ring control circuit consists of two relays. The use of this circuit allows an intercom station that is part of a preset conference group to be signaled over its R talking conductor. The use of this circuit also allows an intercom station to appear in more than one conference group.

When this circuit is used, the "H" straps connecting the R() and R leads of the station at the link or station signaling circuit must be removed. Corresponding terminals of this circuit, that is terminals that are connected through make springs of the ring control relays, are then connected to the R() and R leads of the stations of the conference group. Ringing current is closed through the ring control relays T1 and T2 to the R lead and the intercom station. The ring control relays are operated only during the ringing period.

NOTE: This unit is actually a transfer unit -16 with the "M" straps removed in the field by the installer. It is ordered under the same part number as the transfer unit, H-883002-16. In order to avoid confusion in the text and on the circuit drawings the preset conference ring control circuit will be referred to as -16(P) and the transfer circuit as -16. When ordering the preset conference ring control circuit DO NOT use the suffix (P), use H-883002-16 only.

2.12 Long-line Circuit (Figure 16) (H-883002-25, H-85973-3)

The long-line circuit consists, principally, of some relays and a repeat coil. This is

intended to permit the use (in an intercom system) of a telephone station located at an unusually long distance from the rest of the intercom stations and the relay and power equipment, with maximum efficiency and a minimum of expense. This circuit provides a separate battery feed and pulsing circuit for one such station.

This circuit provides a means for signaling a station over the same leads as used for talking, rather than over a separate conductor or pair of conductors as is generally true for other intercom stations. Therefore, unlike other intercom stations, long-line circuit stations may require only two conductors if dial selective signaling alone is satisfactory; it is not necessary that visual busy (lamp) signals be provided.

However, it is possible to run additional conductors to the long-line station from the intercom system relay equipment for visual busy signals, separate ringing, push-button signals, and other features, if desired.

This circuit has its own battery feed relay which furnishes ground and battery potential to the long-line station independent of all other intercom stations. The voice currents of the long-line station are coupled to the intercom system through the repeat coil. Since only this one station is connected to this battery feed coil (not six or seven as in the case of other conference call stations), longer loop circuits may be used without an impairment of dialing or a decrease in the quality of transmission. The induction coil also serves to minimize the noise in the intercom transmission circuit.

Since visual busy signals are not normally provided, this circuit has been arranged so that the lifting of the handset and the closing of the loop to the battery feed relay, when the intercom system is busy (has previously been seized by another intercom station) will NOT interfere with other stations either talking or dialing on the intercom system. Likewise, when a long-line station has seized the intercom, the raising of a handset at any other intercom station will not interfere with dialing on the long-line circuit - although the operation of the long-line station does light the intercom system-busy lamps at all other intercom stations.

The above features (separate battery feed and separate dialing loop) also make this circuit useful for possible application as an executive or master station for conference calls, since it may communicate with a large number of other intercom stations without excessive loss or reduction in the grade of transmission.

2.13 Audible Signal and Tone Control Circuit (Figure 17) (H-883002-27, H-85783-3)

The audible signal and tone control circuit consists of relays and diodes to control the connection of power for audible signaling to an intercom system station and common audible signals under various special conditions. By use of this circuit it is possible to energize the audible signal at, or associated with, any intercom station from two different power supplies or power sources without interference, and to control the application of one of these sources from more than one control point or by more than one control signal without mutual interference. This circuit may be used to control the audible signal(s) at one (or more) intercom station(s), or it may be used to operate an audible signal which is common to a number of stations.

By use of this circuit it is also possible to have the telephone central office ringing power operate the audible signal of a particular intercom station, and still be able to operate the same signal from a local power source. In addition, the connection of the local power source to this station signal may be controlled, independently, from more than one circuit.

One circuit is required for each station that is to be signaled by different ringing power supplies or under control of different signals. Each assembly contains or consists of two such audible signaling control circuits (CA1 and CA2).

This assembly also provides - in conjunction with the tone and flashing control circuit and the camp-on circuit (section 2.7) - control for the station busy signal and camp-on features. Other strapping of the relay terminals and the lead connections can provide a variety of connections to meet any special or specific local conditions or other needs of a particular installation.

2.14 Add-on Conference Circuit (Figure 18) (H-883002-26, H-85973-4)

The add-on conference circuit consists of a single relay and a repeat coil; it provides a means for connecting an intercom system station or stations (one talking link) to a trunk or line circuit to a central office, P-A-B-X board, P-B-X board, tie-line, or other similar circuit to which the intercom station does not otherwise have access. This connection is

under the control of, and must be made by, a station which does have access to the trunk or line circuit, to the intercom system, and, also, has a push-button for operating the add-on conference circuit.

The controlling station completes a connection to the trunk or line circuit, and must, on outward calls, perform any dialing necessary on that circuit. The controlling station must place the line circuit in a hold condition, seize the intercom circuit, operate the add-on conference circuit control push-button, and, finally, dial the intercom station that is to be connected to the trunk or line circuit. The controlling station need not remain on the call once the connection has been established; the intercom station, alone, can hold the connection (and release it at the end of the conversation). If the controlling station does disconnect, it may still re-enter the call at any time.

This add-on conference circuit is designed for use with trunk and tie-line circuits of the type 10A1 key telephone system (using A and A1 leads). One add-on conference circuit must be provided for each trunk or line circuit that is to be able to connect to one intercom system. A separate push-button for operation of each add-on circuit must be provided at every intercom station that is to be permitted to operate any add-on circuit or circuits. Normally, the number of intercom stations allowed to perform or control this service feature is limited.

2.15 Add-on Conference Control Circuit (Figure 19) (H-883002-68, H-85783-6)

The add-on conference control circuit consists of two relays. This circuit is required when an add-on conference circuit is to be used with a two talking link circuit. These add-on control relays extend the add-on conference feature for use with a two talking link circuit by performing the functions necessary to transfer an add-on conference call that is in progress, from the Main link, to the Auxiliary link should the Auxiliary link become idle. This circuit also enables the controlling station to seize the add-on conference circuit while engaged in a call on either the Main or Auxiliary link.

One of these circuits (two relays) must be provided for each add-on conference circuit that is used in connection with a two talking link circuit.

3. INSTALLATION

3.1 Location of Relay Equipment

The 16A key telephone system relay equipment can be mounted in a housing unit (H-883001-2 or equivalent) of an already installed key telephone system if enough space is available. If there is not enough space available in existing installed housing units, or if it is desirable to have all 16A system relay equipment in a separate unit for maximum flexibility in possible future expansions, a separate housing unit should be provided. Some installations may require more than one housing unit to contain all of the 16A system assemblies necessary. When one or more additional housing units are needed, they should be located near to each other and, when 10A or 10A1 equipment is also used, near the existing housing unit(s) and power supply. Housing units should be mounted on a solid wall in an easily accessible area which is well ventilated and free of corrosive fumes.

3.1.1 Wall mounting of housing unit(s) H-883001-2.

- a. Loosen the two quick-lock fasteners on the housing unit and remove the cover.
- b. Mount the housing unit base on the wall with the long dimension running horizontally (see figures 1 and 2), and the hinged side of the mounting gate to the right. Allow a space in front of each unit and between units for opening the mounting gate to a right angle with the base. If units are to be mounted one above another, allow ample space vertically between units for the cables and for removing the cover.

3.1.2 Mounting relay assemblies in housing unit.

Using the four machine screws supplied, install the relay assemblies on the housing unit gate. The relays and other components should face forward, and the terminal strips face the rear of the housing unit. CAUTION: Mount all relay assemblies with the relay armature pivots in a vertical position.

3.2 Power Supply

3.2.1 Power units for key telephone systems.

The 16A key telephone system is recommended for operation between 20 and 26 volts, dc. It will also be advantageous to provide

power for operating 16A equipment from the same type power units as are used for operating 10A1 key telephone equipment. The voltage limits of these power units depends on the voltage of the commercial ac by which they are operated and also on the load of the 16A equipment on the d-c output of the unit. In order to permit the use of these power units for operating 16A equipment, the total current drain on the unit should be limited to 1.5 amps of which .6 amp could be filtered talking battery.

In the selector only system, a single power unit RT1B, RT3B or equivalent can be used for operating a 16A system of any capacity, a manual signaling intercom line of a 10A1 system and six central office or P-B-X lines.

If the selector only system is to be used with a relatively large 10A1 installation which uses automatic tie lines, ringdown tie lines or station lines, it would be advisable to operate the 16A equipment from an RT3B unit and the 10A1 equipment from a T1B unit, or operate both systems from an RT2B unit.

If the single talking link arrangement is used in combination with 10A1 equipment, an RT3B or equivalent unit should be supplied for the 16A equipment and a separate unit for the 10A1 equipment. The selector of the 16A system should be operated from the d-c supply of the 10A1 system. A single RT2B unit can also be used for operating both systems. Combined systems of any size can be operated with these power units.

If the two talking link arrangements are used in combination with 10A1 equipment, relatively large quantities of both types of equipment can be operated from the power supplied by two RT3B units or from one RT2B unit. The selector of the 16A equipment should be operated from the power unit used for operating the 10A1 equipment. If both camp-on and preset conference units are used with this system and it appears that the total current drain of 1.5 amps would be exceeded on either of the power units, an additional power unit should be supplied. However, combined 16A and 10A1 systems of practically any size can be operated from a single RT2B power unit.

When using two or more power units for combined 16A and 10A1 systems, the positive terminals of the d-c voltage supplies should be commoned. The negative terminals should not be commoned.

HOLD CURRENT DRAIN TABLE

Detail H-883002-	20 Volts			26 Volts			Remarks
	I Total	I Sig.	I Talk	I Total	I Sig.	I Talk	
Two Talking Link System							
-22 Two Link	.640	.420	.220	.830	.440	.390	Maximum for 2 stations on each link. Maximum at 100-ohm loop. Main link. } Maximum for each Auxiliary link. } station over 1. Maximum for 1 unit. Maximum for 2 or more units.
-25 Long-line	.093	.045	.048	.120	.058	.062	
-17 Preset Conf.	.034	.030	.004	.040	.035	.005	
-17 Preset Conf.	.040		.040	.065		.065	
-24 Camp-on	.500	.500		.650	.650		
-26 Add-on Conf.	.135	.135		.200	.200		
-26 Add-on Conf.	.185	.185		.265	.265		
-2 C.O. Line	.028	.028		.036	.036		
Single Talking Link System							
-14 One Link	.390	.255	.135	.505	.330	.175	Maximum for 2 stations on link. Maximum at 100-ohm loop. Maximum for each station over 1. Maximum for 1 or more units.
-25 Long-line	.093	.045	.048	.120	.058	.062	
-17 Preset Conf.	.039	.035	.004	.055	.050	.005	
-24 Camp-on	.500	.500		.650	.650		
-26 Add-on Conf.	.050	.050		.065	.065		
-2 C.O. Line	.028	.028		.036	.036		
Selector Only System							
-70 Selector	.235	.145	.090	.290	.190	.100	Maximum for 2 stations. Maximum at 100-ohm loop. Maximum for 1 or more units.
-25 Long-line	.093	.045	.048	.120	.058	.062	
-26 Add-on Conf.	.050	.050		.065	.065		
-2 C.O. Line	.028	.028		.036	.036		

NOTE: Approximately .850 amp additional current drain during pulsing. (When 16A equipment is used in conjunction with 10A1 equipment, the selector should draw its power from the 10A1 power supply.)

3.2.2 Hold current drain table.

The preceding hold current drain table can be used as a guide in determining the power requirements of a particular key telephone installation. It is difficult to determine the power requirements of an installation since the type and amount of equipment requiring power will vary from installation to installation, depending upon the customers needs.

The hold current drain table divides the 16A key telephone system into three groups, two talking link system, single talking link system, and the selector only system. For each of the three systems, the components listed are all the different components that can be in use simultaneously. However, the number of these components supplied will depend upon the requirements of the installation.

Using the two link system as an example, at an input of 20 volts, the two link circuit is shown drawing a total of .640 amp for a maximum of four stations which would indicate the Main and Auxiliary link are busy. Should one or more of the stations occupying either link be a long line station, an additional .093 amp must be added for each long line station. If one of the links is occupied by a preset conference group, an additional .034 amp for the Main link, or .040 amp for the Auxiliary link must be added for each station in the preset conference group. With both links busy or drawing .640 amp, it is possible for a station to camp on the system. The camped station would draw an additional .500 amp. Should an add-on conference circuit be in use, an additional .135 amp must be added or a maximum of .185 if two add-on conference circuits are used.

The above example indicates the method of using the hold current drain table to determine the amount of power drawn on the power supply. If the units or components require more amps than can be supplied by a single power supply, a second power supply must be added.

3.3 Connections

Following are a number of charts or tables which give the interassembly connections necessary to obtain the features and services described in section 2. Explanatory notes have been included where necessary to clarify optional, alternate, or multiple connections. Reference to the circuit drawings (section 5,

figures 5 - 19) might also be useful in this regard. No circuit explanations are given here - except to clarify different options. Complete circuit explanations are given in section 4.

There is a separate table for each assembly or unit. For maximum clarity each table lists all leads connected to the unit, all straps, and all terminals of the unit even if not used or not wired. Each interassembly lead, therefore, appears twice in the tables (on two different tables): once for each end of the lead. For some wiring options it may be useful to refer to both tables associated with one lead in order to make the correct connection(s).

In the connection tables - as in the circuit explanations and on the circuit drawings - the fifteen individual circuit figures are identified by their manufacturing part number suffixes or detail numbers. This has been done to simplify references, since two different circuit numbers are involved and they are similar. The basic part number of all 16A key telephone system assemblies is H-883002; the individual assemblies each have a detail number suffix (-70, -16, -69, etc.). This same basic part number (H-883002) is also used for many of the 10A1 (line circuit) key telephone system assemblies with other detail number suffixes. This makes it easy to reference 10A1 system assemblies when necessary. Both Table A (section 2), and the heading of each circuit explanation, give a complete cross reference of the part and detail number, circuit number and figure, and the illustration (figure) number in this bulletin. The detail number, when used in connection with the full part number, is underlined.

The columns of the connection tables containing the component part number suffixes, indicate the possible interconnecting points of the components to be tied together by the installer. As an example, in the selector table below, terminal 38A which is the RT lead is connected to terminal 16 of -24, camp-on circuit.

Every component to be installed in a particular system must be checked against its own individual connection table. For example: a lead originating from the selector circuit may connect to the selector transfer circuit, then pass through the transfer circuit and terminate at the long-line circuit. This may not be evident if only the selector table is consulted. In cases such as this, the circuit

SELECTOR -70				
Terminal	Lead Desig		-24	
38A	RT		16	

should be consulted along with each connection table involved in order to obtain a complete picture of all the components. Checking each connection table of the components involved helps to assure the installer that he has covered all possible connecting points.

In the following installation tables, terminals marked with an asterisk (*) indicate a possible connection to a terminal with the same designation in a duplicate assembly if supplied.

The following general information may be helpful in understanding the tables:

The single talking link circuit (-14) and its associated station signaling circuits (-15) can never be used in the same system with the two talking link circuit (-22) and its station signaling circuits (-23). Leads indicated as going to one of these circuits (-14 or -22) will go to only one, never to both, since they cannot be used in the same intercom system. Likewise, it is not possible to use more than one single-link circuit or more than one two-link (two talking link) circuit in one system.

For any given number of stations, the single-link circuit provides one talking channel; the two-link circuit provides two talking channels.

The difference is only in the grade of service. The two-link circuit is desirable where a larger number of stations is to be served.

One-digit dialing or two-digit dialing is unrelated to whether a single-link circuit or a two-link circuit is being used - or no link circuit at all. Single-digit dialing is used when there are no more than nine stations to be selected by dial operation; two-digit dialing is required when more than nine stations are to be selected by dial operation.

With nine or less stations, one of three combinations may be used: the selector (-70); the selector and single-link (-14); or, the selector and the two-link circuit (-22). The selection is based on the type and grade of service wanted.

With more than nine stations, a minimum of the selector (-70) and the transfer or group-selecting relays (-16) is required. Two additions are possible: the selector (-70) and transfer relays (-16) with the single-link circuit (-14), and as many station signaling circuits (-15) as required for the additional stations to be served; or the selector (-70) and transfer relays (-16) with the two talking link (-22) circuit, and as many station signaling circuits (-23) as required.

<u>PART NUMBER</u>	<u>NAME</u>	<u>CIRCUIT NUMBER</u>	<u>FIGURE</u>
H-883002- <u>70</u>	Selector Circuit	H-85973-1	5
H-883002- <u>16</u>	Selector Transfer Circuit	H-85973-2	6
H-883002- <u>14</u>	Single Talking Link Circuit	H-85973-5	7
H-883002- <u>15</u>	Station Signal Circuit, Single Talking Link	H-85973-6	8
H-883002- <u>22</u>	Two Talking Link Circuit	H-85783-1	9
H-883002- <u>23</u>	Station Signaling Circuit, Two Talking Link Circuit	H-85783-2	10
H-883002- <u>24</u>	Camp-on Control Circuit	H-85783-4	11
H-883002- <u>69</u>	Tone and Flashing Control Circuit	H-85783-7	12
H-883002- <u>67</u>	Single-digit Control Circuit	H-85783-5	13
H-883002- <u>17</u>	Preset Conference Circuit	H-85973-7	14
H-883002- <u>16</u> (P)	Preset Conference Ring Control Circuit	H-85973-2A	15
H-883002- <u>25</u>	Long-line Circuit	H-85973-3	16
H-883002- <u>27</u>	Audible Signal and Tone Control Circuit	H-85783-3	17
H-883002- <u>26</u>	Add-on Conference Circuit	H-85973-4	18
H-883002- <u>68</u>	Add-on Conference Control Circuit	H-85783-6	19

NOTE: Underlined suffixes identify their components in the installation tables.

3.3.1 Dial intercom selector (-70) (figure 5).

(H-85973-1)

a. Selector only. When this circuit is used by itself, the talking leads of all stations are connected, in multiple, to its T and R lead terminals. The audible signal lead of each station (maximum of nine) is connected to one R lead terminal from the rotary switch (MM) level A. If a long-line circuit (-25) or a preset conference circuit (-17) is used, the R lead from MM level A for that particular rotary position should be omitted, and the C lead from level B of the rotary switch for the same rotary position should instead be connected to either terminal 7 of the long-line assembly or terminal 7 or 17 of the preset conference circuit.

b. Selector and single or two talking link. When the selector is used with either link circuit (-14 or -22), but without the transfer relays (-16) and station signaling circuits (-15 or -23), the T and R lead terminals are not used (except for one lead Y), and the R leads from level A of MM are also not used. The C leads from level B of the rotary switch are connected to the C lead input terminals of the link circuit. The order or sequence of their connection is at the discretion of the installer (this connection determines the dial code for each station).

If a preset conference circuit (-17) is used, the C lead for that dial code (from MM level B) is connected to terminal 7 or 17 of the preset conference circuit assembly instead of to a terminal on -14 or -22.

When either link circuit (-14 or -22) is used with the selector, the audible signal and visual signal power connections to the selector should not be connected.

c. Selector and transfer relays. When the selector is used with the transfer (or group-selector) relays (-16, but without either link circuit), the talking leads of all telephones are connected in multiple to the T and R lead terminals of -70; the audible signal leads of all stations are connected to the transfer relay assembly. The R leads from level A of the selector circuit rotary switch are connected to terminals 1-9 of the transfer relay assembly, -16. The C leads from level B of MM are not used. Audible and visual signal power supplies are connected to the -70 circuit terminals as indicated.

Two S leads from level C of the rotary switch MM are connected, one per terminal, to terminals 10 and 20 of the transfer relay assembly, -16. Additional S leads, from MM level C to additional transfer (-16) relay assemblies, must be used if more than eighteen stations are to be served. The connection of the S leads (the terminals of MM level C to the transfer relays - T1 and T2 of one or more transfer assemblies) determines the first digit of two-digit dial codes. Still other S leads from other terminals of MM level C may be connected, one per terminal, to terminal 12 of one or more single-digit control circuits (-67), if used.

d. Selector, transfer, and either link circuit. When the selector is used with the transfer relays (-16) and either link circuit (-14 or -22) and one or more additional station signaling circuits (-15 or -23, for one or two link), the connections are much the same as when the link is used without the transfer relays. Leads T and R of -70 are not used, the R leads from MM level A are not used, and visual and audible signal power is not connected to -70. The S leads are connected to -16 units the same as in section 3.1.1 c above, and to -67 units also, if used.

The C leads from level B of rotary switch MM are connected, one per terminal, to the transfer relay assembly terminals 1-9. The audible signal (and talking) leads from all stations are connected to the link circuit or station signaling circuits' terminals.

e. Selector and either link circuit. When the selector circuit is used with either link circuit (-14 or -22) disconnect battery lead A from terminal 35A and strap terminal 35A to terminal 37A.

NOTE: Straps "A", "C", "D", "E", and "L" are always provided by the shop.

Strap	Term.	Note
"A"	11B	Terminal 11B is strapped to 12B for single-digit operation.
"B"	12B	For two-digit operation, remove strap "A" and strap terminal 12B to terminal 13B.
"B"	39A	When two-digit operation is used, strap terminal 39A to terminal 40A.
"C"	14B	Terminal 14B is strapped to GRD at terminal 36A. Remove strap "C" if -14 or -22 are used.
"D"	18B	Terminal 18B is strapped to 19B. Remove strap "D" if -14 or -22 are used.
"E"	29A	Terminal 29A is strapped to GRD at terminal 36A. Remove "E" strap if A lead to -8 is used.
"L"	20B	Terminal 20B is strapped to GRD at terminal 36A. Remove strap "L" if -14 or -22 are used.

Terminal	Lead Desig	Strap	Notes	-16	-14	-22	-24	-17	-25	-27	-26	Key Tel	-67
1A	T								3		1	x	
2A	R								4		2	x	
3A	Y					37B							
4A	AA			40			18						
5A	H												
6A	C(1)			1	24B	1B							
7A	C(2)			2	25B	2B							
8A	C(3)			3	26B	3B							
9A	C(4)			4	27B	4B							
10A	C(5)			5	28B	5B		7 or 17 As Req	7 As Req				
11A	C(6)			6	29B	6B							
12A	C(7)			7	30B	7B							
13A	C(8)			8	31B	8B							
14A	C(9)			9	32B	9B							
15A	B		All Station Ringers in Multiple **										
16A	R(1)			1									
17A	R(2)			2									
18A	R(3)			3									
19A	R(4)			4									
20A	R(5)		To Station Ringers for Single-digit Operation **	5						4 or 7 As Req			
21A	R(6)			6									
22A	R(7)			7									
23A	R(8)			8									
24A	R(9)			9									
25A	G		Audio Signal Power Supply **										
26A	±		Audio Signal Power Supply **										
27A	D												
28A	B(1)												
29A	- MB ±		Power Supply 10V or 20V 60~ for Lamps **										
30A	A												
31A	L or B		Station Signal Lamps **										

SELECTOR CIRCUIT H-883002-70, H-85973-1 (continued)

Terminal	Lead Desig	Strap	Notes	-16	-14	-22	-24	-17	-25	-27	-26	Key Tel	-67
32A	LG		Station Signal Lamps**										
	+ Grd, G		Power Supply 10V or 20V 60~ for Lamps**										
33A	LG		Station Signal Lamps**										
34A			"A" Ground										
35A***			"A" Battery										
36A			"B" Ground										
37A			"B" Battery										
38A	RT												
39A		"B"											
40A		"B"											
1B	H		-68 Term. 16****		30A	38B					6		
2B	S(1)												
3B	S(2)												
4B	S(3)												
5B	S(4)												
6B	S(5)												
7B	S(6)												
8B	S(7)												
9B	S(8)												
10B	S(9)												
11B	RC	"A"											
12B		"F" or "A"											
13B		"B"											
14B	V	"C"			4B	31B							
15B	K												
	U				1B	32B			13				
16B	J								11				
17B	DS				19B	35C							
18B	OP	"D"			5B	34B							
19B	CC	"D"			6B	35B					24		
20B	N	"L"			10B	36B							

** Not used with -14 or -22.

*** Refer to section 3.3.1 e.

**** -68 must be used with the two talking link.

3.3.2 Transfer (or group-selector) circuit (-16) (figure 6). (H-85973-2)

Nine R leads or nine C leads from the selector circuit (-70) rotary switch (MM) bank, level A or level B, respectively, connect to terminals 1 - 9; nine M straps (furnished) connect these terminals and leads, in multiple, to terminals 11 - 19. The R leads or the C leads for eighteen stations (two groups of nine) are connected to terminals 21 - 38. The R leads extend an audible signal power directly to the station audible signals; C leads extend a ground to one of the link circuits (-14 or -22) and one or more corresponding station signaling circuits (-15 or -23).

If more than eighteen stations are to be served, a second transfer circuit (-16) assembly is necessary. Terminals 11 - 19 of the first assembly must be connected to terminals 1 - 9 of the second assembly; and the nine M straps in the second assembly connect these leads to terminals 11 - 19 of the second assembly. Up to eighteen additional stations' R or C leads may now be connected to terminals 21 - 38 of the second assembly.

An R lead or a C lead from one terminal (21 - 38, of -16) may be connected to terminal 7 or terminal 17 of the preset conference circuit (-17) if a two-digit dial code is to operate the preset conference circuit.

When neither link circuit (-14 or -22) is being used, an R or C lead may be extended from one terminal (21 - 38) to terminal 7 of a long-line circuit (-25) when one is used.

An R or C lead may be extended from one terminal (21 - 38) to the audible signal and tone control circuit (-27), terminals 4 - 9, to operate a common audible signal or connect a different source of audible signaling power to a particular station's audible signal.

The T1 and T2 relays of the transfer circuit (-16) assembly (or assemblies) are each connected (terminals 10 and 20 of -16, respectively) to one S lead from the selector circuit (-70) rotary switch bank, level C. It is recommended that the digits 4, 5, 6, and 7 be used as the four first digits for two-digit 36-station dialing. All stations served by R or C leads passing through contacts of the same T() relay will have the same first digit.

Lead AA is connected in multiple to terminal 40 of all transfer circuit (-16) assemblies used in one 16A system.

NOTE: Strap "M" is always provided by the shop.

Strap	Term.	Note
"M"	1-9	Terminals 1 through 9 are strapped to terminals 11 through 19 to extend C or R leads to more than nine stations.

3.3.3 Single talking link circuit (-14) (figure 7). (H-85973-5)

NOTE: the following will apply to the next four circuits or assemblies: single talking link (-14), station signaling circuit for single talking link (-15), two talking link (-22), and station signaling circuit for two talking link (-23).

a. The T and R leads of these circuits connect directly to the intercom system talking leads (T and R) of the 16A intercom system telephones. This may be a one push-button choice on either a type 86 or 860A key telephone, or in a few instances, a non-key (type 80 or 90) telephone used for 16A intercom purposes only. However, when a long-line circuit is used, the T and R leads of the link or station signaling circuit instead are connected to the long-line circuit (-25) terminals 3 and 4.

b. Each of the L leads connect directly to the visual signal lead (L) of one key position of an intercom system telephone. It is also necessary that the visual signal ground return leads (LG) of all stations, and of any auxiliary visual signals used, be connected to the visual signal power supply ground terminal or to a good common system ground.

When a long-line circuit is used, the station visual signal and the visual signal leads (L and LG) are not required. They may, however, be used if such signals are desired. If these signals are used, the L and LG leads should still be extended from the link assembly and power supply, respectively, directly to the long-line telephone. No connection in the long-line circuit is provided or needed.

c. Telephones arranged for audible signal operating power to be forwarded over one side (R) of their talking circuit, require strap "H" to connect their R lead, at the link or station signaling circuit terminals, to the individual station audible signal power supply lead. ("H" straps are normally furnished, connected, on all circuits.) Telephones having a separate lead (R1) for the audible signal power must have the "H" strap removed from their terminals and the R1 lead connected in its place.

It is also necessary that the audible signal return leads (R2, or B1, or B, etc.) of all intercom system telephones, and of any auxiliary or common audible signals, be connected to the audible signal power supply ground - or to a good common, system ground.

When a long-line circuit (-25) or an audible signal and tone control circuit (-27) is used, the "H" strap must be removed and in its place a connection made to either the long-line circuit (-25) or the audible signal and tone control circuit (-27).

d. Whether a station is to be signaled over a talking lead (R) or over a separate signal lead (R1), the proper type of power for operating its

audible signal must be connected to its individual station audible signal power supply lead. This connection is made by and at the strapping field (shown in each circuit) by use of either "F" or "G" straps. There is one terminal in the strapping field associated with each station served by the link or station signaling circuit; two other terminals in the strapping field (called leads F and G) are connected to sources of station audible signaling power. Lead G normally provides 75 - 90 volts, ac, at 20 cycles per second (c.p.s.); lead F may provide any other voltage (10, 20, or 24 volts, dc or ac; if ac: at 60 c.p.s.) needed to operate other audible signals. The "G" straps are furnished installed on all circuits.

When a long-line circuit (-25) or audible signal and tone control circuit (-27) is used, ground (instead of either "F" or "G" straps) should be connected to the station audible signal power lead.

- e. The C lead input terminals of the link circuits (-14 and -22) should be connected to the selector circuit (-70) rotary switch bank, level B, leads - if no transfer circuit (-16) is being used. If a transfer relay circuit (-16) is being used, then the C lead terminals of either link and of the station signaling circuits (-15 or -23) should be connected to terminals in the 21 - 38 group of one or more transfer relay circuits (-16).

Any station that is to be selected by a single digit in a two-digit system, using a single-digit control circuit (-67), should have its C lead terminal connected, instead, to terminal 17 of the single-digit control circuit (-67). Any station that is also to be selected by and as a part of a preset conference circuit (-17) should have its C lead terminal also connected to the preset conference circuit (to one terminal within either the 1 - 6 or 11 - 16 group).

- f. Any telephone that is to be selected by push-button key operation directly from a 16A intercom system telephone, should have its C lead terminal connected to the S lead of one push-button (or key) of a key telephone or auxiliary push-button group. The SG lead of the system and of the key telephone should be permanently connected to positive main battery (system ground). Type 86 and 860A key telephones should have the push-button key used for this purpose, mechanically converted to a nonlocking key and rewired for signal use.

- g. The link circuits (-14 and -22) control the single link and two talking link operations, and each provides circuitry for nine 16A intercom stations. If additional stations are to be connected, no additional control facilities are needed, but additional relays (station signaling circuits) are required. A large number of leads must be extended from the link circuit (-14 or -22) to the associated station signaling circuits (-15 or -23) in multiple.

- h. Stations of a preset conference group that are to be signaled over their R talking conductor must have their "H" strap removed. Their R() and R terminals must be connected through preset conference ring control circuit -16(P).

NOTE: Straps "H", "G", and "Q" are always provided by the shop.

Strap	Term.	Note
"F"	14C	When stations are to be signaled with 10 volt 60 cycle ac or 24 volt dc, remove "G" strap and strap terminal 14C to terminals 6C through 10C and 16C through 19C.
"G"	12C	Terminal 12C is strapped to terminals 6C through 10C and 16C through 19C to signal stations with 75 volt 20 cycle ac.
"H"	11A - 19A	Terminals 11A - 19A are strapped to 21A - 29A for signaling called stations over the talking conductors.
"Q"	30A	Terminal 30A is strapped to terminal 19B for single-digit operation. For two-digit operation, remove "Q" strap and connect lead DS to terminal 30A.
"R"	15C	When -24 is not used, strap 15C to GRD.
"S"	8B	When -14 is used without lamp flashing at the called station, strap terminal 8B to terminal 9B.

SINGLE TALKING LINK CIRCUIT H-383002-14, H-85973-5

Terminal	Lead Desig	Strap	Notes	-70	-16	-15	-24	-69	-17	-25	-27	-26	Key Tel
1A	T									3			x
2A	T									3			x
3A	T									3			x
4A	T									3			x
5A	T									3			x
6A	T									3			x
7A	T									3			x
8A	T									3			x
9A	T									3			x
10A	T4											1	
	T2					17							
11A	R	"H"	-16(P) Term. 31-38							4			x
12A	R	"H"	-16(P) Term. 31-38							4			x

SINGLE TALKING LINK CIRCUIT H-883002-14, H-85973-5 (continued)

[illegible]

3.3.4 Station signaling circuit (for single talking link) (-15) (figure 8).

(H-85783-6)

For notes see section 3.3.3.

NOTE: Straps "H" and "G" are always provided by the shop.

Strap	Term.	Note
"F"	36	When the stations are signaled with 10 volt 60 cycle ac or 24 volt dc, strap terminals 27, 28, and 29 to terminal 36. Remove "G" strap when "F" strapping is used.
"G"	10	Terminal 10 is strapped to terminals 27, 28, and 29 to signal stations with 75 volt 20 cycle ac.
"H"	11 - 13	Terminals 11 - 13 are strapped to terminals 21 - 23 to signal stations over talking conductors.

STATION SIGNAL CIRCUIT, SINGLE TALKING LINK H-883002-15, H-85973-6

Terminal	Lead Desig	Strap	Notes	-16	-14	-67	-17	-25	-27	Key Tel	-16(P)
1	T							3		x	
2	T							3		x	
3	T							3		x	
4*	SC										
5*	A			11B							
6*	C1			21B							
				12B							
7											
8*	R3										
9				22B							

3.3.5 Two talking link circuit (-22) (figure 9). (H-85783-1)

For notes see section 3.3.3.

NOTE: Straps "H", "G", and "Q" are always provided by the shop.

Strap	Term.	Note
"F"	20B	When the stations are signaled with 10 volt 60 cycle ac or dc, remove "G" strap and strap terminal 20B to terminals 21B - 29B.
"G"	30B	Terminal 30B is strapped to terminals 21B - 29B for signaling stations with 75 volt 20 cycle ac.
"H"	11A - 19A	Terminals 11A - 19A are strapped to terminals 21A - 29A for signaling called stations over talking conductors.
"Q"	24C	Terminal 24C is strapped to terminal 35C for single-digit operation. Remove "Q" and connect lead DS for two-digit operation.
"R"	38C	When -24 is not used, strap terminal 38C to GRD.
"S"	10A	When -22 is used without lamp flashing at the called stations, strap terminal 10A to terminal 20A.

TWO TALKING LINK CIRCUIT H-883002-22, H-85783-1

Terminal	Lead Desig	Strap	Notes	-70	-16	-23	-24	-69	-17	-25	-27	-68	Key Tel
1A	T									3			x
2A	T									3			x
3A-8A	T									3			x
9A	T									3			x
10A	LB	"S"	Ungrounded (Hot) Side of Visual Signal Power Supply (± AC or - DC) As Required				9						
11A	R	"H"	-16(P) Term. 31-38							4			x
12A	R	"H"	-16(P) Term. 31-38							4			x
13A-18A	R	"H"	-16(P) Term. 31-38							4			x
19A	R	"H"								4			x

3.3.6 Station signaling circuit (for two talking link circuit) (-23) (figure 10).

STATION SIGNALING CIRCUIT, TWO TALKING LINK CIRCUIT H-883002-23, H-85783-2 (continued)

Terminal	Lead Desig	Strap	Notes	-16	-22	-67	-17	-25	-27	Key Tel	-16(P)	
36A *	L1				31C							
37A *	H				32C							
38A *	AT				33C							
39A *	TS				34C							
40A												
1B	C			21-38			1-6 or 11-16					
2B	C			21-38		17 As Req	1-6 or 11-16					
3B	C			21-38			1-6 or 11-16					
4B *		"G"										
5B *	G				40B							
6B *		"F"										
7B *	F				10B							
3B												
9B												
10B	- MB		"A" Talking Battery									
11B												
12B			Strap As Required and Connect to -17 As Required									
13B												
14B	R(1)	"F" or "G"										
15B	R(2)	"F" or "G"	As Required									
16B	R(3)	"F" or "G"										
17B												
18B	+ Grd		"B" + Ground for Relays									
19B												
20B	- MB		"B" - Battery for Relays									

* Possible connection to terminal with same designation in duplicate assembly.

3.3.7 Camp-on circuit (-24) (figure 11).
(H-85783-4)

CAMP-ON CIRCUIT H-883002-24, H-85783-4

Terminal	Lead Desig	Strap	Notes	-70	-14	-22	-69	-67	-27	-17
1	+ Grd		"B" Ground for Relays							
2	RS							11		
3	- MB		"B" Battery for Relays							
4	TS1							2		
5	IP				5C	28C				
6	TC				20B	15C				
7	CC				6B				28	
8	ST						2			
9	RC			11B						
	RC1									
10	BT							5		
11						4				
12	BT									
13	TG					13				
14						18				
15	OP									
16	RT				5B	34B				
17	RG			38A						
18	AA				15C	38C				
19				3A						
20										

3.3.8 Tone and flashing control circuit (-69) (figure 12). (H-85783-7)

3.3.9 Single-digit control circuit (-67) (figure 13). (H-85783-5)

The S lead (terminal 12) should be connected to the dial intercom selector circuit (-70), rotary switch bank level C (terminals 2B - 10B), to the terminal corresponding to the rotary switch position reached when the desired (single) digit is dialed.

This circuit may be used to select an intercom station on a single talking link (-14), or on a two talking link circuit (-22), or on either of their station signaling circuit (-15 or -23). Leads HG and C are used for this purpose; in this application, lead R1 and terminal 13 are not used. If this circuit is used to select an intercom station when no link (or station signaling) circuit is used, lead R1 is connected to the telephone's audible signal, and terminal 13 is connected to the ungrounded (hot) side of the proper audible signal power supply. Leads HG and C are not used. This circuit may also be used to initiate operation of a preset conference circuit. If a link circuit is included, leads HG and C are used; lead C is connected to the preset conference circuit (-17) terminal 7 or 17. If neither link circuit is used, terminal 15 must be connected to ground; lead C is connected to -17 circuit, terminal 7 or 17.

Strap	Term.	Note
"N"	11	When -24 is not used, strap terminal 11 to GRD at terminal 1.
"T"	15	When -14 and -24 are not used, strap terminal 15 to GRD at terminal 1.

3.3.10 Preset conference circuit (-17) (figure 14). (H-85973-7)

C leads, from terminals 1-6, should be connected to the link or station signaling circuits, to the C lead terminals of the stations in conference group 1. Likewise, the C leads from terminals 11-16 should be connected to the C lead terminals of the stations in conference group 2. Terminals 31-33, 35-37, and 28 should all be strapped to ground when either link circuit is used.

If neither link circuit is used, R leads from terminals 1-6 and 11-16 should be connected to the audible signal (R1) leads of the stations in conference groups 1 and 2, respectively. Terminals 31-33, 35-37, and 28 should be strapped to the proper audible signal power supply lead. If a long-line circuit (-25) is used (with no link circuit), the C lead for that station, instead of going to the audible signal of the long-line telephone, should be connected to the long-line circuit (-25), terminal 7. The associated terminal in the 31-33, 35-37, and 28 group should be connected to ground instead of audible signal operating power.

If a push-button key at an intercom station is to operate either preset conference circuit, an additional conductor is required from the push-button to terminal 7 or 17 of this circuit.

Terminals 7 and 17, for conference groups 1 and 2, respectively, should be connected to a C lead terminal of the selector circuit (-70), or of the transfer relay circuit (-16) if used, or of a single digit control circuit (-67) if used, associated with the one- or two-digit dial code assigned to operate each of the preset conference groups. If a push-button key at an intercom telephone is to operate either preset conference circuit, terminal 7 and/or terminal 17 should be connected to the S lead of the key assigned for this purpose. This key, if part of a key telephone (86 or 860A) should be converted to a nonlocking signal function. Leads SG of the system and key telephone must be connected to positive battery (system ground).

When non-busy stations of the preset conference group are to be signaled, the TS lead at terminal 8C of -22 must be connected to terminal 8 of this circuit and terminal 18 of this circuit must be connected to terminal 2 of -27.

Strap	Term.	Note
"J"	26	Strap terminal 26 to terminals 31 - 33 and 35 - 37 for stations to be signaled with battery or ground.
"K"	27	Strap terminal 27 to terminals 31 - 33 and 35 - 37 for stations to be signaled with 75 volt 20 cycle ac.

PRESET CONFERENCE CIRCUIT H-883002-17, H-85973-7

[illegible]

Connect terminals 21 through 38 of this circuit as required to the corresponding R leads at -14, -15, -22, or -23 of the stations in preset conference group 1 or 2.

PRESET CONFERENCE RING CONTROL CIRCUIT H-883002-16(P), H-85973-2A

Terminal	Lead Desig	Strap	Notes	-14	-15	-22	-23
1	(1)		To R(1) Through R(9) Leads of -14 or -22, R(1) Through R(3) Leads of -15 or -23 for Stations in Conference Group 1 or 2.				
2	(2)						
3	(3)						
4	(4)						
5	(5)			21A- 29A	21-23	21A- 29A	21A- 23A
6	(6)						
7	(7)						
8	(8)						
9	(9)						
10	CX			23B		4C	
11	(10)		To R(1) Through R(9) Leads of -14 or -22, R(1) Through R(3) Leads of -15 or -23 for Stations in Conference Group 1 or 2.				
12	(11)						
13	(12)						
14	(13)						
15	(14)			21A- 29A	21-23	21A- 29A	21A- 23A
16	(15)						
17	(16)						
18	(17)						
19	(18)						
20	CX		Strap to Term. 10 When More Than 9 R() Leads Are Used				
21	(1)		To Corresponding R Leads of -14, -15, -22, or -23 of Stations in Conference Group 1 or 2.				
22	(2)						
23	(3)						
24	(4)			11A- 19A	11-13	11A- 19A	11A- 13A
25	(5)						
26	(6)						

3.3.13 Audible signal and tone control circuit (-27) (figure 17). (H-85783-3)

Since the relays in this assembly may be applied to a variety of uses, one set of typical connections have been shown; other sets of connections and uses may be used. Relay CA2 has listed and is shown with connections for the use of an audible signal at one telephone primarily as a line signal on one line. A power supply for operating the audible signal is connected to terminals 17 and 20; control (ground) signal leads may be connected to terminals 7-9. Leads on which trouble might develop if a feedback (ground) signal were to appear should be connected to either terminal 7 or 9. The leads from terminals 18 and 21 should be connected to the R1 and B1 leads of a type 860A key telephone, or to the R1 and R2 leads of a type 86 key telephone, or to the separate ringing leads of a type 80 or 90 telephone having a four-wire line cord (two separate leads for the ringer).

If an audible signal is to be used to indicate a call on any one of several different lines or talking circuits, and this signal is not associated with any one particular station, its control power supply leads should be connected to terminals 13 and 16; the signal itself should be connected to terminals 12 and 15. A similar and uninterrupted power supply should be connected to terminals 11 and 14. Additional (ground) control signals should be connected to terminals 4-6; leads on which feedback must be avoided should be connected to terminals 4 and 6.

Connections to the CA1 and CA2 relays may be varied to fit any local conditions or desired operating circumstances. Likewise, the connections to relay MS, if not required for station busy tone and camp-on purposes, may be rearranged to meet any individual needs or requirements at the option of the operating company or customer.

NOTE: "Z" straps are always provided by the shop.

Strap	Term.	Note
"Z"(1)	2	Terminal 2 is strapped to terminal 37.
"Z"(2)	24	Terminal 24 is strapped to terminal 27.
"Z"(3)	40	Terminal 40 is strapped to BAT at terminal 10.
"Z"(4)	39	Terminal 39 is strapped to GRD at terminal 38.
"Z"(5)	26	Terminal 26 is strapped to terminal 35.

AUDIBLE SIGNAL AND TONE CONTROL CIRCUIT H-883002-27, H-85783-3

[illegible]

ADD-ON CONFERENCE CIRCUIT H-883002-26, H-85973-4

ADD-ON CONFERENCE CIRCUIT H-883002-26, H-85973-4

3.3.15 Add-on conference control circuit (-68) (figure 19).
(H-85783-6)

ADD-ON CONFERENCE CONTROL CIRCUIT H-883002-68, H-85783-6

Terminal	Lead Desig	Strap	Notes	-70	-22	-26
1	+ Grd		"B" Ground for Relays			
2	S					11
3	CA				26C	
4	CG				25	
5	HC					5
6	H					6
7	T4					1
8	T4				6C	
9	CT				7C	
10						
11						
12	CH				36C	
13						
14						
15	CS				27C	
16	H			11B		
17	R4					2
18	R4				16C	
19	CR				17C	
20	- MB		"B" Battery for Relays			

4. CIRCUIT EXPLANATIONS

Given below is a brief explanation of each assembly operation and its components. Insofar as possible each assembly will be discussed separately in order to keep the information as general and as widely applicable as possible. Since the number and variety of combinations of these assemblies is so great, no explanations will be made of the combined assemblies except where absolutely necessary. The circuit drawings of each of the individual assemblies (section 5) indicate the interconnections necessary between the various assemblies for most of the practical combinations possible.

Since this 16A key telephone system was designed primarily for use with the 10A1 key telephone equipment, references will be made to 10A1 apparatus assemblies where necessary. Whenever possible, references will be limited to appropriate assemblies of the 16A system.

4.1 Dial Intercom Selector Circuit (Figure 5) (H-883002-70, H-85973-1)

The dial intercom selector, by itself, provides common-talking service with single-digit, dial-controlled selective signaling for up to a maximum of nine stations. Additional stations may be connected if other means for signaling them is provided. This is not usually desirable. Normally no more than seven stations (one caller and six called) should be connected (in use) at one time in order to maintain a satisfactory grade of transmission. Each individual station loop should not be greater than 90 ohms. Separate ringing leads are provided for each station, with a common return. A single, separate pair of leads is used to provide a visual circuit-busy indication at each intercom station. This does not prevent additional parties from joining the connection and conversation.

This unit is normally furnished wired for single-digit operation (strap "A" in place) and with no extra, optional features (straps "C", "D", "E", and "L" in place). Two-digit operation may be obtained by changing one strap wire, ("A" to "B") adding an additional "B" strap on the terminal strip, and adding the group-selecting relays needed for the total number of stations to be served and the type of service. Extra, optional features may be added by installing the additional relay group assemblies and adding and/or substituting the necessary connections to the terminals of the selector (and to the stations).

Used alone, the service provided by this circuit is identical (and the operation similar) to that of the dial intercom selector of the 10A1 type key telephone system, which this replaces.

4.1.1 Single-digit dialing.

(Strap "A" - and straps "C", "D", "E", and "L" - all in place.)

- a. Seizure. Lifting of the handset at an intercom station telephone and operation of the intercom system push-button key at that telephone, when the intercom system is idle (busy lamps dark), closes a loop circuit through the telephone over the T and R leads to the windings of relay A and to talking ("A") battery and ground. Relay A operates, closes a circuit to relay B, and relay B operates after a brief delay due to its sleeve.

Relay B, in operating, closes a circuit to light the busy lamps associated with the intercom system at all intercom stations. This also removes a ground from lead J, closes a ground to lead H, and completes a circuit from ground on terminal 20B (strap "L"), through strap "A", to the two windings of relay D in series, aiding, causing relay D to operate. Relay B also prepares a pulsing path to the rotary switch MM.

- b. Dialing. As the calling party dials, opening and closing the loop, relay A follows the pulses, alternately restoring and reoperating; relay B is alternately energized and de-energized, but remains operated due to its sleeve. When relay A restores, a circuit is closed from ground through contacts of relay B and strap "D" to the motor magnet of the rotary switch MM. The rotary switch MM armature operates, but the wipers do not step at this time since this is an indirect drive switch. The interrupter contacts, however, do operate closing a circuit from the same ground, through rectifier MR1 and operated off-normal contacts 2 and 3, to the winding of relay T and relay C and, in parallel, to capacitor C1 through resistor R3 and operated contacts of relay D. Relay T operates, relay C also operates after a brief delay due to its heel-end slug, and closes a multiple holding ground from make contacts 2T and 3T of relay B to the winding of relay T. Relay C also completes a circuit to charge capacitor C2, and opens the signaling and group-selecting circuits.

When relay A reoperates, relay B is re-energized, relay C is de-energized but holds due to its heel-end slug, and maintains a holding ground to relay T. Rotary switch MM is de-energized, allowing its armature to restore and move the wipers one rotary step. Relay A follows the remaining pulses of the digit dialed by the calling party. Rotary switch MM follows the pulses of relay A and steps its wipers to a position corresponding to the digit dialed.

- c. Signaling. When dialing is completed, relay A remains operated, relay B is energized and stays operated as do relays D and T. Relay C is de-energized, but it is slow to release due to its slug. When relay C does restore, a circuit is closed from the audible signal power supply through contacts of operated relays D and T, contacts of relay C, restored, to level A of the rotary switch and to the signaling lead (R) to the dialed station. Over this path, and a common return, the audible signal of the called station is operated. Relay C, restored, removes the holding ground from relay T and from capacitor C2; capacitor C2 discharges through the winding of relay T, holding relay T operated for a period of 1-1/2 to 3 seconds. During this time, the called station is audibly signaled. When capacitor C2 has discharged sufficiently, relay T will restore, opening the signaling circuit to the called station. No further signaling will take place unless the calling station re-dials.
- d. Homing. When relay T restores at the end of signaling, a ground is closed from terminal 14B (strap "C") to the rotary switch motor magnet MM through the interrupter and off-normal contacts; the rotary switch steps, self-interrupted, to its home position where its off-normal contacts operate and open the stepping (homing) circuit. This circuit is now back to the condition just preceding dialing.
- e. Re-dialing. The calling party may re-dial the called number one or more times for additional 1-1/2 to 3 second audible signaling periods.
- f. Answer and talking. If the called party answers, both telephones are connected in parallel across the same talking ("A") battery source and relay A. They can now converse without difficulty. Other stations may also listen and talk by raising their handsets and, if necessary, operating their intercom system push-button keys. The seven party or seven station limit for participants in one conversation is

desirable to insure that there is adequate current and voltage for each station.

During conversation, relays A, B, and D remain energized and operated.

- g. Disconnect. When both (or all) parties disconnect, the loop to relay A is opened, and relay A restores. As during dialing, relay B holds, relays C and T, and switch magnet MM are energized and operate. After a sufficient delay, relay B restores; this de-energizes relays D, C, and the rotary switch motor magnet MM. When relay D restores, the rotary switch wipers step onto the first position, and relay C restores after a brief delay. No signaling takes place because relay D is restored and rotary position 1 on the switch is not used. When relay C restores, relay T is de-energized and since relay D has already restored and capacitor C2 is not connected, relay T will restore at once. When relay T restores, the rotary switch will home as before. When the rotary switch MM is in its home position, and all relays are restored and de-energized, this circuit is ready to handle another call.

4.1.2 Two-digit dialing.

(Strap "B", not "A" - and straps "C", "D", "E", and "L" - in place.)

- a. General. Two-digit dialing is necessary when there are more than nine stations to be signaled, and requires the use of one additional relay for each group of nine stations. These additional relays are T1, T2, etc., shown in figure 6. The first dialed digit operates rotary switch MM, without signaling, to select one group of nine stations by operating one "T" or group-selecting relay; the rotary switch then homes. The second dialed digit operates the rotary switch a second time to select the individual station and signaling lead within the previously selected group.
- b. Seizure. Lifting of the handset at an intercom station and operation of the intercom system push-button, when the system is idle, closes a loop through the calling telephone, over leads T and R, to the windings of relay A and to talking battery and ground ("A"). Relay A operates and closes a circuit to slow-to-operate relay B which operates after a delay. When relay B operates, the busy lamps at all stations light, lead J ground is removed, lead H is grounded, and a pulsing path to rotary switch MM is prepared.

Relay D does not operate, because with strap "A" removed, there is no circuit to the windings of relay D at this time.

- c. Dialing first digit. Relay A restores and reoperates, following the open and closed loop pulses. When relay A restores, relay B is de-energized, but holds due to its sleeve; relay A restored, energizes rotary switch motor magnet MM through strap "D". This same ground is closed through the interrupter contacts of the rotary switch, through MR1, through the operated off-normal contacts to the winding of relays T and C. Relay T is energized and operates. Relay C also operates after a brief delay due to its heel-end slug, and closes a holding ground to the winding of relay T from make contacts 2T and 3T of relay B.

Relay T closes a circuit from ground at terminal 14B (strap "C") through the unoperated contacts of relay D, through strap "B" at terminals 39A and 40A, to the two windings of relay D, connected in parallel, opposing. Winding No. 1 on relay D is connected by strap "B" to battery through 50-ohm resistor R2. The magnetic effects of windings 1 and 2 on relay D cancel each other so that relay D (though both windings are energized) does not operate its contacts at this time.

When relay A reoperates, relay B is re-energized and holds, rotary switch MM restores and steps the wipers, relay C is de-energized but remains operated during pulsing due to its slug, relay T is kept energized by relay C operated, and relay T maintains the ground to both windings of relay D, opposing. Relay D remains unoperated. At the end of the first digit, when relay A remains operated, relays B and T are held, and relay D is unoperated - with both windings still energized, opposing. Relay C is de-energized, but remains operated for a while due to its slug. When relay C does finally restore, it removes the holding ground from relay T and closes ground to level C of the rotary switch MM wipers.

- d. Group-selection. When relay C restores at the end of the first digit (in a two-digit operation: relay D unoperated), ground is removed from the winding of relay T. Relay T, however, does not restore at once. Relay T is held operated for a short period of time due to the flow of inductive current through rectifier MR2. Rectifier MR2 is connected to the 400-ohm non-inductive winding of relay C. The battery through this non-inductive winding has almost the same effect as if the rectifier were connected across the winding of relay T. Capacitor C2 does not enter into the circuit yet, since relay D is still unoperated.

During the period between relays C and T restoring, ground is closed from contacts of relay B through relay C, restored, through relay D unoperated, and relay T, holding operated briefly, to one S lead. This ground operates group-selecting relay T() of the transfer circuit. A locking ground is provided on lead AA when relay D operates to hold the selected slow-to-release T() relay operated after the S lead ground is removed - by relay T restoring and rotary switch MM homing.

- e. Relay D operation. When relay T restores, ground is removed from both windings of relay D which were connected in parallel, opposing, with D unoperated. The removal of ground from the windings of relay D generates an inductive kick voltage in the relay D windings; this kick is enough to cause the "X" contacts of relay D to close. Closing of the "X" contacts of relay D completes a circuit from ground at terminal 20B through contacts of relay B operated, and through the "X" contacts of relay D to the two windings of relay D - in series and aiding. The resistance battery to winding No. 1 is short circuited. Relay D then operates fully, opening the resistance battery path (through resistor R2) and its original operating path from contacts on relay T.
- f. Homing. When relay T restores at the end of the first digit, after grounding lead S and the operation of relay D, ground from terminal 14B (strap "C") causes the rotary switch MM to step, self-interrupted, to its home position as described in section d, above. When in the home position, the off-normal contacts open the homing circuit. The circuit is in the same condition now as under single-digit operation before dialing.

- g. Dialing second digit, signaling, and homing. Dialing of the second digit, of a two-digit code, is the same as dialing, signaling, and homing under single-digit operation (sections 4.1.1 b, c, and d). Relay A follows pulses, relay B holds, relay D is held, rotary switch MM steps, relay T operates, relay C operates and holds, and capacitor C2 charges. When relay A reoperates at the end of the last pulse of this digit, relays B and D are held, rotary switch MM completes its last step, relay T is being held by relay C operated which is now de-energized but holding operated due to its slug.

When relay C restores, relay T is de-energized, but relay T will hold operated due to the discharge of capacitor C2 through its coil. While relay T is holding operated,

and relay C is restored, the signaling power path from the audible signal power supply to a particular R lead is closed, operating the audible signal of the called station. When capacitor C2 discharges and relay T restores, the signal path is opened and the audible signal stopped. When relay T restores, ground from terminal 14B (strap "C") is closed to rotary switch MM which homes. When rotary switch MM is in the home position again, this circuit is in the same condition as immediately prior to dialing this second digit (the same as prior to dialing the only digit in single-digit operation).

- h. Re-dialing. As under single-digit operation, only one period of ringing occurs: 1-1/2 to 3 seconds. The calling party may resignal the called station one or more times by re-dialing the second digit only. Since the first digit selects the group in which the called station is located (the group-selection or transfer relay is locked operated) and relay D has now operated and is locked, only the second digit need be dialed to resignal the called station. Operations at this time will be the same as under section g, above.
- j. Answer and talking. This is the same as under single-digit operation. Relays A, B, and D are operated during conversation.
- k. Disconnect. This is the same as under single-digit operation. When relay D restores, it also removes the holding or locking ground from lead AA, to release the group-selecting relay(s).

4.2 Transfer (or Group-selector) Circuit (Figure 6) (H-883002-16, H-85973-2)

- a. Use. The transfer (group-selector) relays are used only in conjunction with the dial intercom selector (figure 5) and when more than nine intercom stations are to be selectively signaled by dial operation. One relay (T1 or T2) is required for each group of nine stations. Separate S leads must be connected from rotary switch MM, level C of the dial intercom selector circuit to each relay. Each relay (T1 or T2) serves one group of nine stations having the same first digit of a two-digit dial code. A single locking-ground (AA) lead of the selector circuit will serve both relays (T1 and T2).
- b. Operation. When the first digit (of a two-digit dial code) is completed, ground from level C of the dial selector rotary switch MM is placed on one S lead to operate the T relay (T1 or T2) serving the group in which the called station is located.

The T relay is slow to release due to the diode connected across its winding. The T relay (T1 or T2) locks to ground on lead AA through make contacts of relay D operated, to lead A (strap "E").

- c. Holding. The T relay will remain operated during dialing of the second digit, during any re-dialing, signaling, and throughout the conversation.
- d. Function. When a second digit is dialed and an intercom station is to be signaled, the dial selector circuit rotary switch MM, via level A, connects power for audible signaling to the R lead terminal associated with all intercom stations having the same second (final) digit. However, only one T relay is operated, so that only one station (in the previously selected group) will be signaled.

The action in this circuit is the same whether the R leads or the C leads are being switched.

- e. Release. The T relay will hold operated until the call is completed and relay D of the selector circuit restores, removing the ground from lead AA and allowing relay T1 or T2 to restore.

4.3 Single Talking Link Circuit (Figure 7) (H-883002-14, H-85973-5)

4.3.1 General.

The single talking link circuit provides complete privacy for one conversation between two or more intercom system stations, from a total or maximum of nine stations connected to the system. It provides continuous visual busy indications at each intercom station, and fully selective audible signaling (either over the talking leads or over a separate conductor or pair of conductors) to each station. This circuit also makes it possible to signal individual stations of the intercom system with either one of two different power supplies. Simultaneous signaling of different stations with the (different) power supplies appropriate for each is also part of this feature.

The single talking link circuit may be used by itself if each station is equipped with a separate push-button key for signaling each of the other stations; this is normally not desirable. Most often a dial intercom selector is used in connection with the single-link circuit to permit dial selection of the called station. Full privacy is still maintained when the selector is combined with the single-link circuit. Push-button signaling of stations, by stations equipped with one or more push-button keys, is also still possible. Push-button

signaling of one or more stations (by stations equipped for it) is possible at any time during a conversation (i.e., to call in another party or station for a conference type call). Dial selection of additional stations is not possible (either in the link circuit or selector only) once a second party has entered the connection.

If this circuit is used in connection with a flashing-lamp control circuit of any kind (of the 16A system, or of the 10A1 system, or of any equivalent) the flashing of the busy lamp at a called station is also provided.

Since only one call at a time can be placed on the intercom system using the single-link circuit, and visual busy (lamp) indications are usually provided at all intercom stations as long as any station is on the link, there is not much need for busy tone in association with the single-link circuit. References to the tone and flashing control circuit therefore will be kept to a minimum. It should be understood, of course, that busy tone may be used if so desired. When the camp-on circuit is provided, it is desirable to have busy tone as well.

These two circuits, the tone and flashing control circuit and the camp-on circuit will be explained more fully in connection with the two talking link circuit, since busy tone is essential when the two-link circuit is employed. Most other features and options are not integral to the operation of the link and/or dial selector circuits. Their application will be covered separately and independently.

Since the single-link circuit is rarely used without the dial selector, and the interactions between these two circuits are numerous, the single-link circuit explanation will be given as used in conjunction with the dial selector; note will be taken of different actions involved if the dial selector is not used.

The dial selector circuit, when used with a link circuit, must have its straps "C", "D", and "L" removed, strap "E" remains in place and the indicated connections between the two circuits completed. When a link circuit is used, the first level (A) of the selector circuit rotary switch MM is not used, and no signaling power leads are connected to the selector assembly terminals. Either strap "A" or strap "B" of the dial selector assembly will be used, depending upon whether one- or or two-digit dialing or dial codes are to be used.

4.3.2 Operation.

- a. Circuit idle. When the single-link (and dial selector) circuit is idle, all relays

are de-energized and unoperated; the rotary switch MM of the dial selector circuit is in its home position, and all lamps are dark.

- b. Seizure. Lifting of the handset at an intercom system telephone, and operation of the intercom system push-button key at that station (if necessary), closes a loop circuit through the telephone over the T and R leads. If the intercom system is then idle, this completes a circuit from ground at break contacts (3T and 4T) of the L relay associated with the calling station, through the calling loop, lead R, another break combination (5B-6B) on the same L relay, rectifier MR(), the No. 2 (2000-ohm) winding on relay L, breaks on the associated L1 relay, on relay B, on relay D, and resistor R1, to negative battery. Over this path the No. 2 winding of relay L is energized - but with only enough power to operate its "X" contacts. The "X" contacts 1B-2B complete a circuit from negative relay-operating ("B") battery through the No. 1 winding of relay L and resistor R4 to (positive) ground. At the same time, relay L contacts 1T-2T close ground from the calling loop and lead T through resistor R3 and winding No. 1 of relay A to negative talking ("A") battery. Relay L still does not operate fully; relay A does operate fully. Relay A closes ground to relay B which operates after a delay due to its sleeve.

Relay B completes a circuit from the visual busy signal (lamp) power supply lead (LB) to the L (lamp) leads of all stations, to light the busy lamps. Other contacts of relay B prepare a pulsing path to rotary switch MM in the dial intercom selector circuit, open the shunt on resistor R5 (putting R5 in series with winding No. 2 on relay L to prevent other stations from being able to seize or connect to the circuit), shunt resistor R3, and close a ground through rectifier MR10 and resistor R2 to lead Y to the dial selector circuit. Relay B (contacts 5T-7T) extends the ground-connected 10-ohm winding of relay C (in parallel with resistor R4) to winding No. 1 of relay L which will now operate fully. In operating fully, relay L closes the loop to both windings of relay A and to talking battery and ground, and opens all other connections to the loop and to the No. 2 winding of relay L. Relay L also opens the circuit from a ground connection at contacts of relay B to (unoperated) contacts of relay L1. Relay C is a marginal relay; it will not operate in series with one L relay. Relay C, therefore, though energized, is not operated.

Ground on lead Y to the dial selector completes a circuit to winding No. 1 of

relay A (in the selector) and to battery. Relay A operates and closes a circuit to relay B in the selector; relay B also operates after a brief delay due to its sleeve. Relay B closes a circuit from ground through break contacts (1-2) on relay F in the link circuit to lead N, terminal 20B of the selector, to the "X" contacts of relay D. This will operate D (through strap "A") with single-digit dialing or, with two-digit dialing, will prepare a holding circuit for relay D when it kicks at the end of the first digit.

At this point, relays A and B - and possibly relay D - of the selector are operated; relays A and B of the common control relays in the link circuit are operated, and relay L associated with the calling station circuit is operated. Relay C is energized, but not operated. All station busy lamps are lighted with a steady glow.

If dial tone is provided (with single-digit operation) when relay B of the selector circuit operates, ground is closed through lead H, to the link circuit, through strap "Q", break contacts 3 and 4 of relay E, through lead TG to the tone and flashing control circuit. Ground on lead TG starts the tone generator. The tone generator extends an uninterrupted tone through lead DT, to the link circuit, through capacitor C10, through operated contacts of the calling station's L1 relay to the R talking conductor.

If dial tone is provided (with two-digit operation) when relay B of the selector circuit operates, ground is closed through break contacts on relays C and D, unoperated, through lead DS, through contacts 3 and 4 of relay E of the link circuit, through lead TG to the tone and flashing control circuit. Ground on lead TG starts the tone generator. The tone generator extends an uninterrupted tone through lead DT, to the link circuit, through capacitor C10, through operated contacts of the calling station's L1 relay to the R talking conductor.

- c. Dialing. Opening and closing of the calling loop alternately restores and reoperates relay A in the link circuit. The link-circuit relay B remains operated during pulsing due to its heel-end slug. When relay A restores, it closes ground through contacts of relay B to lead U to the selector circuit, lead CC from the selector back to the link circuit, through unoperated contacts of relay E in the link circuit, on lead OP back to the selector circuit and to the rotary switch MM. Over this path, rotary switch MM will be stepped and relays T and C operated - just the same as if the selector circuit relay A were being pulsed.

Relays A and B of the selector do NOT respond to pulsing. At the end of the digit, relays A and B in the link circuit remain operated, while relays C and T in the selector restore. The action in this combined circuit is the same as if only the selector were being used - either for single-digit or two-digit dialing. If two-digit dialing is being used, one T relay (in the transfer or group-selector assembly) will operate and lock at the end of the first digit, and relay D in the selector (previously unoperated) will operate and lock to ground on lead N.

At the end of the second digit (or the first digit in single-digit dialing), ground from dial intercom selector circuit, terminal 29A, strap "E" is closed to one C lead through the wiper and one bank contact of level B of the selector rotary switch MM (and through contacts of one T relay, if used). This ground will remain on lead C for 1-1/2 to 3 seconds (i.e., until relay T restores).

- d. Signaling. Ground on one lead C completes a circuit to the L1 relay associated with the called station. L1 operates and locks through its make-before-break contacts and the unoperated break contacts on the L relay associated with the called station (relay L must be unoperated at this time in order to be signaled), to ground at contacts of relay B. Relay D in the link circuit also operates from ground on lead C through make contacts of the called party's L1 relay. Relay D operates relay E which locks to ground on lead H. Relay E, operated, removes ground (at terminal 15C) from lead V, and opens the pulsing circuit to selector circuit rotary switch MM by disconnecting lead OP from lead CC. Relay D closes the main leads from the two (different) signaling power supply units to the signaling option strapping field.

Relay L1, operated, shorts out relay C with a direct ground and transfers the busy lamp lead (L) of the called station from the continuous visual busy power lead (LB) to lead LF (for lamp-flashing feature if used). L1 also closes the signaling lead from the strapping field to the station signal lead R1. Lead R1 may be extended to the audible signal at the called intercom station, or may be connected (strap "H") to talking lead R for signaling over the talking lead or leads.

When relay T in the selector circuit restores, ground is removed from lead C, and relay D in the link circuit will restore, closing answer battery (from resistor R1)

to the No. 2 winding of the L relay associated with the called line. Relay D, restored, also opens the audible signal power circuits, stopping audible signaling. Relay D opens the operating path to relay E, which is locked and remains operated. Removal of ground from lead C has no effect on relay L1, since it is locked through contacts of relay L to ground at relay B.

Relay T in the selector, restored, closes lead V to the homing circuit of rotary switch MM - but relay E in the link circuit has opened the connection between lead V and ground (terminal 15C), so the rotary switch will not home at this time.

- e. Push-button selection and signaling. If, either in addition to or instead of dial controlled selection of the called station, push-button selection of a called station is provided, there must be one separate nonlocking push-button at each station for every station that is to be signaled by push-button operation. This is in addition to the locking push-button that must be used to seize or connect to the intercom circuit.

When a station has seized the intercom system, instead of dialing, one push-button may be operated to directly signal the desired station. This push-button connects a ground directly to the C lead of the called station's L1 relay which will operate and lock as under selector operation. Relay L1 also closes a circuit from its C lead through its own contacts (4B-5B) to relay D. Relay D will operate, and in turn operate relay E, which will lock, etc. - in the same manner as if the dial selector circuit were functioning. Relays L1 and E will be locked operated and relay D will remain operated as long as the push-button key is held operated, closing ground to lead C of the called station's L1 relay.

Push-button signaling of a called station may be repeated or it may be done in addition to dial control. Push-button signaling is also possible at any time during a conversation (to call in additional stations for a conference type call). Audible signaling of a called station will continue as long as the push-button is held operated.

When the push-button key is released and ground is removed from the C lead, relays L1 and E will remain operated, and relay D will restore - just as under dial controlled operation. Relay E will hold ground off lead V so that rotary switch MM in the selector circuit will not home.

- f. Answer and conversation. When a called (signaled) station answers, the station loop

is closed, completing a circuit very much like that of the calling station at the origin of the call (ground at break contacts of the L relay associated with the called line, lead T, loop, lead R, another set of break contacts on the same L relay, rectifier MR(), winding No. 2 of the same L relay, contacts 2B-3B of the operated L1 relay associated with the same station, resistor R1, and battery). Relay L associated with the called station closes its "X" contacts (1B-2B), energizing its No. 1 winding to a direct ground at relay L1 contacts to operate relay L fully. When relay L operates fully, it connects the called station to the windings of relay A in multiple with the calling station, so that they can converse. The operation of relay L also opens the holding circuit to the associated relay L1, so that it will restore.

When L1 restores, the called station's visual signal lead (L) is transferred back from the LF lead to LB - for an uninterrupted busy lamp signal. The station audible signal lead is also opened and the ground shorting the C relay is removed.

The No. 1 windings of two different L relays (that associated with the calling station and that associated with the called station) are now both connected, in multiple, to the C relay. The combined resistance of these two windings in parallel is low enough so that relay C will operate. When C operates, relay F is energized and operates.

Relay F closes the RG lead ground to lead V once again to home the rotary switch MM in the selector circuit, and removes ground from lead N, releasing relay D in the selector circuit.

- g. Calling in additional stations during a conversation. A push-button equipped station may call in another station at any time. Operation of the proper push-button closes ground to the C lead and L1 relay of the desired station. Relay L1 operates and locks, and closes a ground that shorts relay C. Relays C and F also restore. This circuit will now function just as in section 4.3.2 e.

When the called station answers at the conclusion of a push-button controlled signal, the L relay of the called station operates, relay L1 restores, and relays C and F operate.

- h. Holding and release. So long as any one station stays on the intercom channel (bridged across the A relay windings), relay A will remain operated, and relays B, C, F, and E (plus the L relay of all

stations connected on this call) will remain operated. The opening of the loop at any one intercom station does NOT disconnect that station from the intercom talking circuit. The station may, if it is a push-button type, connect to another line circuit, but if it reconnects to the intercom system while the same call is in progress, it will be connected to the talking circuit and not excluded as other stations are.

When all stations disconnect (open their loop circuits), the A relay will restore, and all other operated relays will restore until the complete circuit is back to its normal condition, and ready to process another call.

4.4 Station Signal Circuit (for Single Talking Link) (Figure 8) (H-883002-15, H-85973-6)

The station signal circuit, for the single talking link, provides three additional pairs of L and L1 relays to serve three additional intercom stations. These relays are connected to the six (A - F) control relays and control leads, etc., the same as the nine pairs of L and L1 relays which are part of the basic single talking link circuit. These relays function in exactly the same way as the nine other pairs. All connections necessary for them are extended from the single talking link circuit relays and leads. Additional assemblies, identical to this, may be used to serve as many intercom stations as are desired.

4.5 Two Talking Link Circuit (Figure 9) (H-883002-22, H-85783-1)

4.5.1 General.

The two talking link circuit provides the same services and features, etc., as the single talking link circuit, in addition to handling two separate conversations at the same time. For a maximum of nine stations, this circuit may be used alone with push-button signaling. However, the circuit is usually used with a dial intercom selector. Push-button selection and signaling of a few frequently-called stations is still possible for any station requiring such service, in addition to dial operation.

Full privacy is maintained by use of two separate talking channels or links: Main and Auxiliary. All calls first seize the Main link and selection of the called station can be made only while connected to the Main link. If the Auxiliary link is then idle when the called station answers the conversation is automatically transferred to the Auxiliary link. Once a call has been transferred to the Auxiliary link, no further selection of additional stations, even by push-button, is possible.

Since, in a two-link system, it is possible to dial a station that is already busy on the other link, it is essential that a tone be provided to notify the calling station that the dialed station is busy. A busy tone feature circuit is available as an option with this equipment (H-883002-69); this feature will be discussed, very briefly, in connection with the two-link circuit. The camp-on feature of the 16A key telephone system, will be discussed separately (section 4.7) - although its operation is very closely interwoven with the two-link circuit. Operation of the two-link circuit will be discussed in conjunction with the dial intercom selector, with notes on variations.

4.5.2 Operation.

Much of the circuitry of this two-link circuit is similar to the single-link circuit and repetition of identical operations will be kept to a minimum. Reference to the single-link circuit operation may sometimes be useful in seeing identical operations explained more fully. Differences will be covered as fully as other operations.

- a. Circuit idle. When the two-link circuit (with dial intercom selector) is idle, all relays in both circuits are de-energized and unoperated. Rotary switch MM in the selector circuit is in the home position and de-energized, and all lamps are dark.
- b. Seizure. Lifting of the handset and operation of the intercom system push-button key at any station, when the intercom is idle, closes a loop from ground at break contacts on the L relay associated with the calling line, over the T lead, station loop, R lead (relay L2 unoperated), rectifier MR(), other breaks on relay L, winding No. 2 of relay L, breaks on the associated relay L1, breaks on relay B, resistor R1, and battery. The "X" contacts of relay L operate, energizing the No. 1 winding of relay L in series with resistor R5 and energizing the No. 1 winding of relay A in series with resistor R4 over the station loop to ground. Relay L does not operate fully due to the high resistance (R5) in series; relay A does operate, which operates relay B after a brief delay. Relay B shunts resistor R4, connects uninterrupted visual signal power (lead LB) to the visual signal lead (L) to each station to light the busy lamps, opens the shunt on resistor R6, grounds lead Y through rectifier MR10 and resistor R2 to the selector circuit (to operate relays A and B, and possibly relay D, in the selector), and closes relay C in series with the No. 1 winding of relay L. Relay L operates, but marginal relay C does not operate in series with the resistance of one L relay.

When relay L operates fully, it closes the T and R leads from the calling station to the A relay, opens the circuit to winding No. 2 of relay L, and closes part of a still incomplete circuit from relay H to winding No. 2, of the associated L2 relay. Relay L also opens the holding path for its L1 relay.

If dial tone is provided (single-digit dialing) when relay B operates, ground at contacts 3B and 4B is closed through strap "Q", break contacts 1T and 2T of relay E, through lead TG, to the tone and flashing control circuit. Ground on lead TG starts the tone generator. The tone generator extends an uninterrupted tone through lead DT, to the link circuit, through capacitor C10, break contacts on relay F, (1T and 2T), make contacts of relay B (3T and 4T), through operated "X" contacts of the calling station's L relay to the R talking conductor.

If dial tone is provided (with two-digit operation) when relay B of the selector circuit operates, ground is closed through break contacts on relays C and D, through lead DS to the link circuit, through break contacts of relay E (1T and 2T), through lead TG to the tone and flashing control circuit. Ground on lead TG starts the tone generator. The tone generator extends an uninterrupted tone through lead DT, to the link circuit, through capacitor C10, break contacts on relay F, (1T and 2T), make contacts of relay B (3T and 4T), through operated "X" contacts of the calling station's L relay to the R talking conductor.

- c. Dialing. Opening and closing the calling station loop, pulses the A relay of the link circuit; relay B holds. Ground pulses are sent, when relay A restores, over lead U to the selector, on lead CC back to the link, through contacts of relay E unoperated, on lead OP to the selector, to rotary switch MM. Rotary switch MM and relays T and C in the selector operate as previously described, and relays A and B in the selector hold. At the end of the first digit (of a 2-digit code), ground on lead V, terminal 31B of the link (from lead RG, or ground strap), homes rotary switch MM, and relay D operates. The second digit is pulsed in a similar manner.

At the end of the second digit (or only digit of a 1-digit code), the selector (or selector and transfer relays) connects ground to one C lead for a period of about 1-1/2 to 3 seconds.

- d. Signaling. Ground on lead C, to an idle station (relay L2 unoperated), operates the L1 relay of the called station. Relay L1 locks through break contacts on the L relay of the same station to ground at relay B.

Relay D in the link circuit also operates from ground on terminal C through make contacts of relay L1 operated, opening the answer battery circuit (resistor R1), closing both of the audible signal main power supply leads (F and G), and operating relay E. Relay E operates, locks to ground at lead H, opens the OP and CC leads' pulsing path, and removes ground from lead V preventing homing of the selector circuit rotary switch MM. Relay L1 transfers the visual signal lead (L) of the called station from LB to LF for an interrupted (flashing) visual signal. Relay L1 also places direct ground between the No. 1 winding of relay L and relay C winding, shorting out relay C. Relay L1 transfers the path for the No. 2 winding of relay L of the called station from resistor R6 and resistor R1 to break contacts of relay D and resistor R1 to permit the called station to answer when signaling stops. Relay L1 also closes the lead from the signal power strapping field (leads F and G) to the audible signal lead R() to the called station. This completes the circuit for audible signaling at the called station.

When relay T in the selector restores, ground is removed from lead C. Ground removed from lead C allows relay D in the link circuit to restore. Relay D opens the two main audible signal power supply leads to stop audible signaling and extends answer battery (resistor R1) to the No. 2 winding of relay L associated with the called station. Relay E, originally operated by relay D, remains operated through its own holding circuit to ground on lead H.

- e. Push-button selection and signaling. Push-button signaling with the two-link circuit is also possible. The push-button key at the calling station closes ground to lead C of the called station. This operates relay L1 (if the called station is idle) which locks through contacts of relay L, to ground at relay B. Relay L1 closes the audible signal lead R(1) - R(9) at contacts 4B and 5B, transfers visual signal lead L from LB to LF. Relay L1 also transfers relay L (of the called station) winding No. 2, from high-resistance battery (through resistors R6 and R1) to low-resistance battery through break contacts of relay D and resistor R1, and places the shorting ground on relay C. Relay L1 (contacts 4T and 5T) also completes a circuit for ground from lead C directly to the winding of relay D. Relay D operates, opens the answer battery circuit, closes the power supply leads (F and G) and operates relay E. Relay E locks to ground at lead H. When the push-button is released, relays L1 and E hold; relay D restores, opening the audible signal power

supply leads, and reclosing the answer battery, through resistor R1 only, to winding No. 2 of relay L of the called station (allow it to answer). The audible signal of the called station will sound as long as the calling station push-button is held operated. The visual signal will remain on until the call is answered.

A called station may be resigaled by push-button operation, or additional stations signaled for a conference-type call, as long as the call remains on the Main link (once transfer to the Auxiliary link takes place, no further signaling or station selection is possible). Transfer from the Main link to the Auxiliary link, however, cannot take place while any selected station is being signaled nor while any selected and signaled station remains unanswered. Once a station is signaled, it must be answered or else the full cycle of relay operation cannot be completed (see section 4.5.2 f).

- f. Answer. When a called station answers, the station loop completes a circuit (relay L2 unoperated) from ground to rectifier MR(), through break contacts and the No. 2 winding on relay L, make contacts on relay L1 operated, through resistor R1 to battery. The "X" contacts (1B and 2B) on relay L close, completing a path from battery at its No. 1 winding to ground at operated contacts 6B and 7B of its corresponding L1 relay. Relay C is still short-circuited by the ground at contacts of operated relay L1, and remains unoperated.

Relay L operates fully, closing the called station's T and R leads to the windings of relay A in multiple with the calling station. This also disconnects the No. 2 winding of relay L, connects part of an incomplete circuit to the winding of relay L2, and opens the holding circuit of relay L1.

Relay L1 restores, opening the associated station's R() lead, transferring the L lead back from LF to LB, and removing the ground shorting relay C. Marginal relay C will operate now in series with two parallel-connected windings of L relays. Relay C operates, and operates relay F. When relay F operates, ground at terminal 38C of the link circuit (from lead RG or ground strap) is closed to lead V to the selector circuit to home the rotary switch MM. The low-resistance answer battery circuit (through resistor R1) is opened, and ground is removed from lead N to the selector circuit, allowing relay D in the selector circuit to restore. Relay F also closes its contacts 6T-7T in the Auxiliary link circuit (see section 4.5.2 g).

If more than one station has been selected and signaled (their L1 relays operated and locked), relay C will remain shorted and unoperated until all signaled stations have answered (all L1 relays restored and all shorting grounds, thereby, removed). When relay C does finally operate, the operations described above will follow in the same manner.

If the call remains on the Main link, additional stations may be signaled by push-button operation at any time to join the conversation. The operation is similar to the push-button operation for the original selection described under section 4.5.2 e. The C lead ground to an idle station operates the L1 relay of the called idle station. Relay L1 (at its contacts 6B-7B) closes a ground which shorts and restores relay C, and, in turn, opens and restores relay F. Relay D in the link circuit will operate and the usual signal and answer operations will follow (with relays C and F operating again when the last signaled station answers).

- g. Transfer to Auxiliary link. If there is no call on the Auxiliary link (relays G, H, J, and all L2 relays, unoperated) when relay F operates, ground is led from contacts of relay H, through contacts of relay F, contacts of all operated L relays (associated with all stations connected to this call), to the No. 2 windings of the L2 relays associated with all connected stations; all these L2 relays operate. The make-before-break combinations on the L2 relays transfer the loop of the connected stations, from the windings of relay A (Main link), to the windings of relays G and J (Auxiliary link) through the No. 1 windings of their corresponding L2 relays. The L2 relays are held operated through the station loop and also from an auxiliary holding ground. The auxiliary holding ground from make contacts 2 and 3 of relay G is closed through make contacts 1B and 2B of the operated L2 relays and resistor RH() to the No. 2 winding of the operated L2 relays. This auxiliary ground however, will not hold the L2 relays operated should their associated station disconnect, and open the loop to the No. 1 winding.

The closing of several loop circuits to the windings of relay G and relay J, operates both relays G and J. Relay G operates relay H after a brief delay. Relay H removes the ground through contacts of relay F that originally operated the L2 relays (preventing operation of additional, unwanted, L2 relays).

Removal of all the station loop circuits connected to relay A allows relay A to

restore. In turn, relays B, C, E, F, and all operated L relays, restore. All operated relays in the selector circuit also restore. The busy lamps at all stations are extinguished because the Main link is now free and ready to process another call. The busy lamps (visual busy signals) are lighted while the Main link is setting up a call, but go out when the Main link is free. The busy lamps remain on when both links are busy.

If the Auxiliary link had been busy when relay F operated, (relays G, H, J, and some L2 relays operated), there would have been no ground from relay H to operate the L2 relays of the call on the Main link. If, however, the Auxiliary link call is completed and all stations on the Auxiliary link open their loop circuits (hang up), relays G, H, J, and L2 relays will restore. The ground at springs of relay H will now be available, through contacts of relay F and the operated L relays, to operate the L2 relays of the stations then connected to the Main link and transfer them to the Auxiliary link just as previously described.

- h. Holding and release. So long as any one station remains connected to either the Main or Auxiliary link (bridged across either relay A or relays G and J), the A, or G and J relays will remain operated and hold the link. When all stations on the Auxiliary link release, relays G, H, J, and the operated L2 relays will all restore, freeing the link for another call. When all stations connected to the Main link release, relays A, B, C, E, F, and all operated L relays, restore. Also, all operated relays in the selector circuit restore, freeing the Main link for another call.
- i. Station busy. If a call is in progress on the Auxiliary link, and a calling party on the Main link, dials or selects by push-button a station that is already busy, busy tone is returned to the caller. Busy tone is supplied by a separate and optional assembly (H-883002-69); its use is recommended. However, since it is an optional circuit, and it is part of a separate assembly, its operation will be covered in the explanation of that assembly. Likewise, the application of busy tone is an important feature to any station attempting to override the busy lamp (or in case the lamp has burned out). This application is covered under the camp-on circuit.

4.6 Station Signaling Circuit (for Two Talking Links) (Figure 10) (H-883002-23, H-85783-2)

For use with the two talking link circuit, the station signaling circuit provides three

additional three-relay sets (L, L1, and L2) to serve three additional intercom stations associated with the two talking link circuit. These relays are connected to the nine (A - J) control relays and the control leads, etc., the same as the nine sets of L, L1, and L2 relays which are part of the basic two talking link circuit. These relays function in exactly the same way as the nine other sets. All connections necessary for them are extended from the two talking link circuit relays and leads.

Additional assemblies, identical to this and connected in multiple to the control leads and relays, may be used to serve as many more intercom stations as are desired.

4.7 Camp-on Circuit (Figure 11) (H-883002-24, H-85783-4)

Because this circuit will function mainly in conjunction with the two talking link circuit, (it can, if so desired, be used with the single link circuit), the following circuit explanation will discuss the use of this circuit with the two talking link circuit.

This circuit provides a means of accepting a one- or two-digit code when both links are already busy, and holding until one call is completed and a link freed. It then signals the preselected station (if it is not busy). Busy tone should be available to callers who attempt to use this camp-on feature if someone else has already seized it.

In the following operation, assume that the called station is busy and that the Main link is idle. The operations of the link and selector circuits during pulsing have been covered and will not be mentioned here.

- a. Operation with Main link idle. Ground from one C lead of the selector or selector transfer circuit is closed to the C lead of the called station in the link circuit (or station signaling circuit). This ground would normally operate the called station's L1 relay, however, for this example, we will consider the called station as busy or occupying the Auxiliary link (relay L2 operated).

Ground on lead C of the link circuit is closed through make contacts 2T and 3T of the called station's L2 relay, and through lead TS to the audible signal and tone control circuit. Ground on lead TS is closed to the winding of relay MS. Relay MS operates and at contacts 7 and 8 closes ground [strap "Z"(4)] through lead TM to the tone and flashing control circuit. Ground on lead TM is closed to the winding of relay B to start the flashing circuit. Relay H of the two talking link circuit (operated

while the Auxiliary link is busy) closes ground through lead TD, through make contacts 2 and 3 of relay MS, and through lead CC to the selector circuit to hold selector relays C and T operated. Ground on lead TD is also closed through strap "Z"(2), through make contacts 5 and 6 of relay MS, through strap "Z"(5), and through lead TG to the tone and flashing control circuit to start the tone generator.

The tone and flashing circuit will function as described in section 4.8.1 a.

Through the operation of the tone and flashing control circuit, busy tone is closed through lead DT to the link circuit, through capacitor C10, and through break contacts 1T and 2T of relay F to the R talking conductor to the calling station. Since relays C and T of the selector circuit are held operated by ground on lead CC, the calling party is camped on the Main link. When the Auxiliary link becomes idle, ground is removed from lead TD. Relay C of the selector restores, closing ground through the C lead to the called station's L1 relay. The called station will be signaled in the usual way, see section 4.5.2 d.

While the camp-on circuit is seized, any station attempting to camp on will receive busy tone. Continuous tone is closed through tone and flashing control circuit capacitor C1 and make contacts 1B-2B of relay B, and extended via lead BT to the two talking link circuit relay F contacts 3B-4B, relay J contacts 1-2, and break contacts of all unoperated L1 relays.

- b. Operation with both links (Main and Auxiliary) busy. At the link circuit, ground on lead R of the calling station is closed through break contacts of relay L2, the No. 2 winding of relay L, break contacts of relay L1, make contacts of relay E, to lead IP, through transistor T1 to resistance battery, causing transistor T1 to conduct. Ground is then closed through transistor T1, resistors R3 and R8 to transistor T2 and resistance battery, causing transistor T2 to conduct and relay A to operate. Relay A closes ground on lead TC, from operated relays B and F of the link circuit, to the winding of relay B. Relay B operates.

Relay A will follow the dial pulses similar to relay A in the selector circuit. Relay A pulses, relay B holds due to its heel-end slug. Ground on lead TC is closed to relay C, relay C operates. This same ground is also closed through make contacts 4T and 5T of relay B to lead OP and to the

rotary switch MM of the selector circuit. Relay C of this circuit closes ground through break contacts of relay MS of the audible signal and tone control circuit, through strap "Z"(2), through make contacts of operated relay T of the selector circuit to operate selector circuit relay C.

Relays A and B of the selector circuit are held operated by the call in progress on the Main link. Relay C of this circuit closes ground through break contacts of relay MS (unoperated) of the audible signal and tone control circuit, through strap "Z"(2), through make contacts of operated relay T of the selector circuit, to operate selector circuit relay C. Relay B of this circuit closes ground from break contacts of relay A, during pulsing, to lead OP to the selector stepping rotary switch MM (see section 4.1.1). When the second digit is dialed, ground on lead AA, through make contacts of relay D (operated) in the selector circuit, operates relay D of this circuit through make contacts of relay B operated. Relay D closes ground to lead RC to lock operated relay D of the selector circuit. Relay C of the selector circuit is locked operated to ground through make contacts of relay B (a pair of its own make contacts), lead RT, make contacts of relay D of this circuit, lead CC3, break contacts on unoperated relay MS, and lead CC2 to the selector circuit, through make contacts of operated relay T to the winding of relay C.

Rotary switch MM is now set in its selected position, and when relay C releases, ground at terminal AA will be closed to the called station. When the call in progress on the Main link is transferred to the Auxiliary link, the locking path for relay C through this circuit will be removed from lead CC3 of this circuit at the time relay D of this circuit releases. When the ground on lead TC of the link circuit is removed by relays B and F restoring, relay D of this circuit releases. When the call is completed and the called station answers, this circuit is returned to normal.

Any station attempting to camp, when the camp-on circuit is busy, will receive busy tone as discussed in section a, above.

4.8 Tone and Flashing Control Circuit (Figure 12) (H-883002-69, H-85783-7)

4.8.1 General.

This circuit provides approximately fifty percent break pulses, at about sixty pulses per minute (i.p.m.), on a number of leads which

may be connected to serve whatever functions necessary. This circuit provides busy tone to calling stations if the system is busy and an attempt is made to establish connection to the system, or if a calling party (on the Main link) attempts to select and signal a station that is already busy on the Auxiliary link.

The application of dial tone is explained in the circuit explanation for both link circuits, therefore it will not be discussed here.

- a. Busy tone. For this example, we will assume the called station is busy (relay L2 operated). Ground closed to the C lead of the called station that would normally operate the L1 relay of the called station, is closed instead to lead TS. Ground on lead TS operates the MS relay of the audible signal and tone control circuit. Relay MS operates and closes ground from strap "Z"(4) through its make contacts 7 and 8 to lead TM. Ground on lead TM is closed to relay B of this circuit. Relay B is slow to operate due to its heel-end slug; relay B operates after a slight delay. Relay B, operated, closes a number of make combinations for pulsing or for interrupted circuits.

The operation of relay B also closes a circuit to the winding of relay A which has an armature-end slug, making it slow to operate. Relay A operates after a delay and opens the circuit to relay B. Relay B is slow to release, and releases after a delay, opening the make combinations and, also, opening the operating circuit of relay A. Relay A will restore after a delay due to its armature-end slug.

Ground on lead TM is also closed through make contacts 3B and 4B of relay B, interrupted, to lead DT. This interrupted ground will short out the continuous tone (dial tone) creating a busy tone.

As long as ground remains on lead TM, relay B will be energized and the cycle will repeat (opening and closing the make combinations on relay B).

- b. Supervision. Another make combination on relay B is used to close the visual busy signal power supply (lead LB) to lead LF of the single and two talking link circuits. This will provide for a flashing busy lamp at intercom stations while being signaled.

Other contacts on relay B are available, at the terminals of the flashing control assembly, for interrupting or pulsing on other circuits.

4.9 Single-digit Control Circuit (Figure 13) (H-883002-67, H-85783-5)

4.9.1 General.

When more than nine intercom stations are served (requiring two-digit dialing and both the dial selector and transfer relays), it is possible to provide a single-digit dial code for a station if desired. This digit must be different from the first digit of all two-digit codes used.

This circuit, connected to a bank contact of the third (or C) level of the rotary switch MM in the dial selector circuit, acts to signal the single-digit station after only one digit has been dialed. It does not act when the single-digit station is placing (originating) a call.

4.9.2 Operation.

- a. General. The dial selector is seized from any station in the usual way. Its operation (up to the end of dialing the first and only digit) is identical to the two-digit dial operation explained in sections 4.1 and 4.2. Selector circuit relays A and B operate on seizure; rotary switch MM, and relays T and C operate during pulsing. Both windings of relay D are energized, opposing; relay D is not operated. At the end of the digit, relay C restores. With relay D unoperated and relay T operated, a ground is closed to level C of rotary switch MM to one S lead - until relay T restores and rotary switch MM homes. For two-digit codes, this would energize one relay T (transfer or group-selector relay); also, relay D would operate and lock. Ground on lead S, instead of operating a T relay, is closed to the S lead (input) of a single digit control circuit.

Ground on lead S is closed to the winding of relay A. Relay A operates and closes ground from lead RS (ground from break contacts 1T and 2T of relay B, camp-on circuit) or from strap "N", through its own make contacts, 7 and 8, to relay B. Relay B is energized and operates. Relay A, at make contacts 9 and 10, closes ground through resistor R2 to capacitor C1. Relay T, in the selector circuit restores, removing ground from lead S, causing relay A of this circuit to restore. Relay A in restoring opens the operating path to relay B. Relay B, however, is slow to release due to its sleeve and the discharge of capacitor C1.

- b. Operation without link circuit. When only the dial selector and transfer relays are used, audible signal power is connected to terminal 13, and terminal 3 (lead R1) is

connected to the audible signal of the single-digit station. When relay B operates, audible signal power is connected to the station audible signal. Audible signaling, therefore, continues until relay B restores. When both relays A and B have restored, this circuit is back to normal.

- c. Operation with link circuits. It is possible to use this circuit with either the single-link or the two-link circuits (along with the selector and transfer circuits). Ground from break contacts of relay F (single- or two-link circuit) is closed through lead HG, through operated contacts of relay B (5 and 6) of this circuit, through lead C to the L1 relay of the single-digit station in either link circuit. This causes the single-digit station to be selected and signaled after only one digit has been dialed. In all other respects the link circuit and selector will function normally.
- d. Operation with preset conference circuit. It is also possible to use this circuit with the preset conference circuit with a single or two talking link. Ground from break contacts of relay F (single or two talking link circuit) is closed through lead HG, through operated contacts of relay B (5 and 6) of this circuit, to relay S of the preset conference circuit. Operation of the preset conference circuit will be explained in section 4.10.

When this circuit is used with the preset conference without a link, ground must be connected to lead HG, (strap "T"). When the A and B relays have operated (see section 4.9.2 a), ground is closed from lead HG through make contacts of relay B, to lead C of the preset conference circuit.

- e. Operation with camp-on circuit. Ground on lead S is closed to relay A. Relay A operates. Relay B in the camp-on circuit is operated. There is no ground on lead RS to operate relay B of this circuit. Relay B in the camp-on circuit closes ground through lead RC1, through make contacts 5-6 of relay A of this circuit, to lead TS1 to operate relay D in the camp-on circuit. This same ground is closed through rectifier MR2 and lead RT to the selector circuit to hold relay T operated. Relay T in turn closes a holding ground through level C of rotary switch MM and through lead S to relay A of this circuit. When the Main link becomes idle, relay B in the camp-on circuit restores; closing ground through lead RS to relay B of this circuit. Relay B operates, closing ground from lead HG through its own make contacts 5-6 and through lead C to the link circuit and the L1 relay of the single-digit station.

Relay B of the camp-on circuit, in restoring, removes ground from leads RC1 and RT, causing relays T and D in the selector circuit to restore and also relay A of this circuit to restore.

4.10 Preset Conference Circuit (Figure 14) (H-883002-17, H-85973-7)

4.10.1 General.

This circuit provides for signaling a pre-selected group of intercom stations (not exceeding six) simultaneously for a conference call. This circuit may be energized either by a dial code (one or two digits), or by operation of a push-button. This assembly provides for two, six-station conference groups, but when used with a two talking link circuit, two, five-station conference groups are recommended. Relays C1 and C2, respectively, serve the first and the second six-party groups. Relay S is used by both.

Unless a preset conference ring control circuit is provided, stations of a preset conference group cannot be signaled over their (R) talking conductor.

4.10.2 Operation.

- a. Operation, group one. Ground on lead S from a push-button key at an intercom station, or ground on lead C from the dial selector circuit (or dial selector circuit and transfer relays), into terminal 7, energizes relay S through break contact on relays C1 and S; relay S is slow to operate. Relay S operates, closing its "X" contacts first, locking itself to ground through break contacts on relays C1 and C2. Relay S opens its own original operating path and closes the ground on lead C or S to the winding of relay C1. Relay C1 operates, opening both the original operating circuit and the holding circuit for relay S. Relay S is de-energized, but is slow acting due to its sleeve; relay S restores.

Relay C1, operated, closes either signaling power directly to the six intercom station audible signals - R() leads - when no link circuit is being used, or ground to the C leads and L1 relays of the desired (preset conference group) stations - and to relay D when a link circuit is being used. Either connection will cause the desired, pre-selected (preset) stations to be signaled, both audibly and, when flashing is provided, visually. If a link circuit is used, the L1 relays of the called stations will lock operated.

With relay C1 operated (relay S restored), there is no ground on the "X" contacts of

relay S to let relay S operate fully if energized from the S or C lead of the second conference circuit. Therefore, the second conference circuit cannot be used to call in the second preset (preselected) conference group while a call that used the first conference circuit is still in progress on the Main link. When the push-button key at the intercom station is released, ground is removed from lead S releasing relay C1.

- b. Operation, group two. If both conference circuits are available, and the second circuit happens to be operated first, relays S and C2, will function in exactly the same manner as relays S and C1, when the first circuit was operated (described in section 4.10.2 a, above).
- c. Busy indication with two talking link. If one or more stations (of the selected conference group) is busy and occupying the Auxiliary link (busy station L2 relay operated), ground is closed to the C leads through make contacts of relays C1 or C2 of this circuit. This ground on the C leads is then extended to link circuit relay L2 (of the busy station) contacts 2T-3T, lead TS, to preset conference relays C1 or C2 contacts 3B-4B, and lead TG. Ground on lead TG is closed to the tone and flashing control circuit to start the tone generator. The tone generator will return an interrupted tone to indicate one or more conference stations are busy.

4.11 Preset Conference Ring Control Circuit (Figure 15) (H-883002-16(P), H-85973-2A)

When the preset conference ring control circuit is used, the "H" straps of the station in either preset conference group must be disconnected and removed. The R() and R leads normally connected by the "H" straps will be connected through make contacts of ring control relay T1 or T2. These relays are operated under control of either the single or two talking link circuit, and only during the ringing period.

Relays T1 and T2 of this circuit operate under control of the D relay of either the single or two talking link circuit. Relay D is operated by ground closed to the link circuit over the C leads from the preset conference circuit. Relay D of either link circuit, at operated make contacts, closes ground through lead CX to relay T1 of this circuit. If more than nine R() leads are connected to this circuit, terminal 20, lead CX, must be strapped to terminal 10, also designated CX. Therefore, if more than nine R() leads are connected to this circuit, ground on lead CX from either link circuit will operate both ring control relays T1 and T2.

Audible signal power from either link circuit is closed through make contacts of the L1 relays of the stations in the signaled preset conference group to lead R(), through make contacts of relays T1 and/or T2 of this circuit, to the corresponding R leads of the stations in the preset conference group. Relay T1 and T2 will remain operated as long as ground remains on the CX lead, that is, until the push button at the intercom station used to initiate the conference call is released or relay T in the selector circuit restores, causing relay C1 or C2 in the preset conference circuit and relay D in either link circuit to restore.

4.12 Long-line Circuit (Figure 16) (H-883002-25, H-85973-3)

The long-line circuit serves, mainly, as an adapter between a dial intercom selector - or a single or two talking link circuit - and an intercom system station (telephone) located a greater than normal distance from the intercom relay equipment (at a distance requiring a loop resistance greater than 90 ohms). It provides a separate d-c talking-battery feed for this one station (not in multiple with all the other intercom stations) to maintain adequate transmission power for this station, even on conference calls involving a number of other stations (which might otherwise diminish the battery supply below acceptable values). It provides for operation of the station audible signal over the talking leads, if desired, to minimize the number of conductors required when used with the dial selector only. This circuit makes it unnecessary to have or use busy lamps at long-line stations.

4.12.1 Operation with dial selector only.

- a. Seizure. When the long-line station closes the loop between the T and R leads, a circuit is completed, through break contacts of relay C and two windings (2-1 and 4-3) of the repeat coil RC, to the windings of relay A which operates. Relay A closes its contacts 22 and 23, completing a circuit from the winding of relay B to lead J (terminal 11). If the dial intercom selector is already busy with a call, there will be no ground on lead J from the selector, and relay B will not operate. Contacts 24 and 25 of relay A close a talking circuit through capacitor C2 and two windings (6-5 and 8-7) of repeat coil RC, to selector battery-feed relay A. The long-line station may listen and talk, but it cannot hold the call or dial.

If the dial intercom selector is idle when the long-line relay A operates, ground on lead J from the selector operates relay B. Relay B locks to a multiple ground at its own contacts, prepares a pulsing path, and closes a d-c loop circuit - through

resistor R1, strap "T" and two windings (6-5 and 8-7) of repeat coil RC - to the windings of relay A of the selector (leads T and R from terminals 3 and 4). The dial selector is seized in its usual way, and when selector relay B operates, the ground on lead J is removed. The multiple holding ground at contacts of relay B keeps relay B operated.

- b. Dialing. When a long-line circuit seizes the dial intercom selector, dialing will follow. Opening and closing the long-line station loop pulses the A relay of the long-line circuit. Each time relay A restores, relay B holds due to its sleeve, and ground from contacts of relay B is closed to lead K to the selector (to operate the selector rotary switch MM, relay T, relay C, etc.). The same ground, through a 1500-ohm resistor, R2, is also closed to the No. 1 winding of relay A and battery. This circuit resistance is high enough so that relay A does not reoperate, but the current flowing in this circuit makes relay A faster to reoperate when the loop is reclosed. Relay B maintains a closed d-c loop to the A relay of the dial selector; selector relay A does not pulse.

It should be noted that the long-line circuit may pulse the selector rotary switch MM despite the fact that there is a d-c loop or bridge on the selector relay A. This makes it possible for the long-line station, when it originates a call, to call in additional stations after conversation has started and by dial pulsing.

- c. Conversation and release. Signaling and conversing with other stations is done the same as with selector only operation (without long line). Voice currents of the other intercom stations pass through two windings (6-5 and 8-7) of the repeat coil RC, and may be heard by the long-line station connected to the other two repeat coil RC windings (2-1 and 4-3).

When the call is over, opening the long-line station loop allows the A relay of the long-line circuit to restore and, after a delay, relay B will restore. Relay B opens the loop to relay A of the selector circuit, and the selector circuit restores.

- d. Calls to long-line station. When another station seizes the dial selector and calls the long-line station, ground on lead C from the selector (or transfer relays) operates relay C in the long-line circuit. Relay C grounds the T lead to the long-line station and closes audible signal power to the R lead to the long-line station. Relay C restores when ground on lead C is removed.

When the long-line station answers, the loop to long-line relay A is closed (relay C restored); relay A operates. Lead J is closed to the winding of relay B, but with no ground on lead J, relay B does not operate. Relay A also closes its contacts 24 and 25, completing a talking-only (no d-c) circuit through capacitor C2 and two windings (6-5 and 8-7) of the repeat coil RC, to the winding of relay A of the selector. The long-line station may talk and listen, but it cannot hold the circuit and cannot dial.

This is the same circumstance that is found if the long-line station handset is lifted while some other station is dialing or has previously seized the selector.

4.12.2 Operation with a link circuit and selector.

- a. Seizure and dialing. When the long-line station closes the loop between the T and R leads, relay A operates; ground (from strap "P" to terminal 11) operates relay B. Relay B closes a d-c loop through resistor R1, strap "U" and two windings of repeat coil RC, to the L relay and one station circuit of either the single- or two-link circuit. Relay A in this circuit pulses during dialing, and opens and closes the loop to relay A in the link circuit. Relay A in the link circuit will also pulse as the loop is opened and closed by relay A of this circuit. The link circuit will function as previously discussed in the dialing section for either link (single or two talking link).

When used in conjunction with a link circuit, re-dialing either before or after the called station has answered, is not possible. Although the long-line circuit relay A may pulse, the selector circuit rotary switch MM will not step because relay E of the link circuit has opened the pulsing path from leads K and OP to CC.

- b. Conversation and release. Signaling, conversing, release, etc., are done the same as in the selector and link circuit operation.
- c. Calls to a long-line station with link and selector. When a long-line station on a link circuit system is dialed, the ground on the C lead from the selector (or selector and transfer relays) to the link circuit (to L1) is multiplied to the C lead of the long-line circuit (terminal 7) to operate relay C of the long-line circuit. Relay C grounds lead T to the long-line station, and connects audible signal operating power to the R lead. The long-line station audible signal sounds until ground is removed from the C lead.

When the long-line station answers, it closes a loop to the A relay of the long-line circuit; relay A operates. Relay A closes ground (from strap "P", terminal 11) to relay B which operates. Relay B closes a d-c loop circuit through resistor R1, strap "U", and the two windings of repeat coil RC, to operate link circuit relay L. Operated, link circuit relay L completes the transmission path between the two circuits.

4.13 Audible Signal and Tone Control Circuit (Figure 17) (H-883002-27, H-85783-3)

The CA1 and CA2 relays are intended to provide a means for using the audible signal of one station both as a line signal and as a common signal (one which will sound if any one of several other lines has a call on it). This circuitry will also permit a common audible signal (one not permanently associated with any one particular line or telephone) to operate if there is a call on any one of several lines. One principle feature of this arrangement is that the different audible signal power sources and audible signal control circuits do not interact or "feedback" upon each other.

The use of diodes in the relay control circuits prevent an operating signal on one lead from "feeding-back" onto other control leads and into other control signal circuits. The use of transfer (C) combinations on these relays for the audible signal power circuits - and the switching of both sides of the power circuits - prevents the different power sources from interfering with each other.

Due to the great versatility of these circuits and the variety of applications to which they may be put, typical rather than specific circuit applications must be described. The circuit drawing (figure 17) shows relay CA2 arranged for operating an intercom station audible signal (over separate leads R1 and B1) directly from a central office or P-B-X trunk. At the same time, uninterrupted audible signaling power is connected to the make contacts of the transfer combinations; if a control signal is applied to the winding of the CA2 relay, it will operate and close audible signaling power from this secondary source to the station audible signal. The central office or P-B-X circuit might be a direct line to a central office or to a P-B-X; it might be a tie-line, or it might, very likely, be a 10A1 (or 10A) key telephone line or trunk circuit. Likewise, the control signal to the CA2 relay winding might be from a 16A system, a 10A1 or 10A system, or other special circuit.

The CA1 relay is shown with typical wiring for operating a common audible signal. An audible

signal is not associated with any one particular station nor any one particular line, trunk, or other talking circuit. It is usually located centrally with regard to a number of key telephone stations and arranged to sound if any one of several lines or talking circuits has a call on it. (All of the nearby stations can hear the signal and any one of them may answer the call; usually the specific line is indicated at each station by a flashing lamp associated with the push-button key.) The operation is identical to that of the CA2 relay, above.

The MS relay may be used for a variety of purposes. It is furnished strapped and with connections indicated for one specific application: control of the station busy tone (and camp-on) feature of a two talking link circuit. The five "Z" straps furnished to make this feature or application possible may be removed and any other application desired may be employed. Permanent connections to the coil and contacts of this relay have been kept to a minimum in order that it may be used in as many applications as possible. Only the above mentioned use or application will be explained. Other uses and connections are at the discretion of the operating company or customer. When the called station's L2 relay is operated, the ground closed to lead C that would normally operate the station's L1 relay, is closed through make contacts of relay L2 to lead TS, which in turn operates the MS relay of this circuit. Relay MS locks to ground through strap "Z"(1), its own make contacts, lead SC of the link circuit, and to ground at make contacts of operated relay D.

Ground on lead TM from MS relay make contacts and strap "Z"(4) is closed to the tone and flashing control circuit, to provide busy tone. Ground from the link circuit lead TD is closed through operated relay MS make contacts (this circuit) to selector circuit lead CC2, to keep relay C operated.

4.14 Add-on Conference Circuit (Figure 18) (H-883002-26, H-85973-4)

The station or stations controlling this circuit must have access to the intercom system as well as the trunk or line circuit. The use of this circuit requires the assignment of an extra key at the controlling station(s). On outgoing calls, all dialing must be performed by a controlling station.

Since this circuit requires the addition of an add-on conference control circuit for use with a two talking link circuit, its operation with the two talking link circuit will not be discussed in this section.

Operating the add-on conference key closes resistance battery through lead R to relay B.

(the add-on conference key is wired in series with the R talking conductor). Relay B operates after a brief delay and locks itself to ground on lead H from the dial intercom selector. Relay B completes a circuit from the intercom talking leads (T and R) to windings (2-1 and 4-3) of repeat coil RC, and capacitor C1, and completes a circuit from the line circuit (also leads T and R) through two other windings of repeat coil RC (6-5 and 8-7) and through capacitor C2 and resistor R1 in parallel. This permits conversation between the line circuit and the intercom circuit. Relay B also closes lead A to A1 of the line circuit. This indicates to the 10A1 key system relay equipment that the call has been answered; or, if already answered, will permit the intercom circuit and station to hold the add-on connection to this line.

4.15 Add-on Conference Control Circuit (Figure 19) (H-883002-68, H-85783-6)

- a. Connections. The add-on conference control circuit is used in conjunction with the add-on conference circuit when a two talking link circuit is used. When the control circuit (relay A) is used, the talking leads (T and R or T4 and R4) of the add-on circuit (relay B and coil RC) are connected to leads T4 and R4 of the control circuit. Leads T4 and R4 of the control circuit are connected to the Main link of the two-link circuit, and leads CT and CR are connected to the Auxiliary link of the two-link circuit. Terminal 6, lead H of the add-on circuit, instead of being connected directly to lead H of the selector circuit, is connected to terminal 6 of the control circuit, then through break contacts 4T-3T of relay A, terminal 16, to lead H and ground from contacts of relay B in the selector circuit, when operated.

Terminal 5, lead HC of the add-on circuit is multiplied to terminal 5 of the control circuit. Leads CA, CS, and CH of the control circuit are connected to the two-link circuit.

- b. Seizure from Main link. Operating the add-on conference button closes resistance battery through break contacts on relay B of the add-on circuit. Relay B operates and locks to ground on lead H. This ground is extended to add-on assembly terminal 5 (through "X" contacts on relay B) and to lead HC of the control circuit, through breaks on relay A, rectifier MR1, winding No. 2 of relay A, to lead CS (to the two-link circuit and 150-ohm resistance battery through breaks on relay H). The No. 2 winding of relay A (50 ohms) operates only the "X" contacts of relay A in series

with resistor R3. Relay B of the add-on circuit, however, operates fully and performs all the functions described in section 4.13. Relay B of the add-on circuit still locks to ground on lead H, but the ground on lead H first passes through break contacts on unoperated relay A. So long as the intercom call, which is now connected to a line circuit, remains on the Main link (talking leads T4 and R4) of the control circuit, relay B holds operated to ground on lead H through contacts of relay A. Relay A holds operated only its "X" contacts.

If the Auxiliary link is free or becomes free, and the two-link circuit automatically transfers the intercom call from the Main link to the Auxiliary link (relays G, H, and J of the two-link circuit operate), relay G of the two-link circuit grounds lead CH - but with no immediate effect. Relay H of the two-link circuit operates after a short delay, grounding lead CA. This energizes the No. 1 winding of relay A (in the control circuit) through break contacts of relay B, through the operated "X" contacts of relay A. Relay A in the control circuit operates fully, transferring the add-on circuit talking leads (T4 and R4) from the leads (T4 and R4) of the Main link to the Auxiliary link, leads (CT and CR). Relay A also transfers the holding ground for relay B from lead H (grounded at two-link circuit). This is necessary because relay B of the selector will restore soon after the transfer to the Auxiliary link takes place and ground is removed from lead H. Relay B remains operated during the transfer due to its sleeve. Relay A also opens the original operating path to its own winding No. 1.

- c. Seizure from Auxiliary link. Operating the add-on conference push-button closes resistance battery through lead R to relay B of the add-on conference circuit, relay B is energized and operates after a brief delay and locks to ground on lead H. This same resistance battery is closed through contacts 3T and 4T of relay B through lead S, breaks on relay B of the control circuit, rectifier MR2 to the No. 1 winding of relay B and ground at lead CG (from contacts 1 and 2 of relay J of the two-link circuit). Relay B operates its "X" contacts and locks to ground at lead CH, from contacts 4 and 5 of relay G (two-link circuit). Relay B at contacts 7 and 8 closes ground to the No. 1 winding of relay A. Relay A operates and transfers the add-on talking leads (T4 and R4) from leads (T4 and R4) of the Main link to the Auxiliary link, leads (CT and CR).

5. CIRCUIT DRAWINGS

Figures 5 through 19, following, are the circuits of the fifteen different relay assemblies used in the 16A key telephone (intercom) system. These are circuits H-85973 and H-85783; figure Nos. 1 - 7 of each. To avoid confusion, the manufacturing part number and the detail number have been used as the primary means for identifying the various circuits; the circuit number is also shown on each drawing for reference.

These drawings show, in full detail, the internal wiring of each of these assemblies. Also shown on each drawing, are the connections necessary and possible to and from each terminal. Where several options are indicated, it may be necessary to refer to the circuit drawing notes and/or the installation connection charts and their notes to determine precisely which connections are used under varying circumstances. Any special limits or operating conditions of the relays have, when possible, been indicated on the drawing or in the accompanying notes.

GENERAL NOTES

1. Two different direct current power sources must be used, each approximately 24 volts. One source must be used for talking or transmission purposes, the other source, for relay operation. The transmission battery and ground supply are distinguished by the designation "A"; relay-operating battery and ground are distinguished by the designation "B". The transmission, "A", source is always identified and does NOT occur on ALL assemblies. The relay operating, "B", battery and ground do appear on all assemblies, but are not necessarily always identified.
2. The power supply for operating the visual (lamp) signals of the 16A system (and of 10A1 or 10A, if included) may be any one of several possible d-c or a-c voltages, but will be uniform for all visual signals of the system.
3. There may be two different types of audible signals used in one 16A system or combined 10A1 (or 10A) and 16A system. Usually 20 or 30 cycle ringers, requiring 75 - 90 volts, ac, will be the principle audible signal operating in conjunction with ordinary lines. The secondary audible signals will probably be low voltage buzzers, requiring 10 or 20, or 24 volts, either dc or ac (at 60 cycles, if ac). These always operate from a local power source and usually in conjunction with the 16A intercom circuits. The individual voltages, frequency, etc., will not be identified in every instance on every drawing. It is to be understood that the two possible audible signal power supplies, whatever their values, will be the same throughout the installation and will be indicated only as to their applications.

NOTES - Figure 5 (-70)

1. Strap "A", for one-digit operation, is furnished installed; for two-digit operation, omit strap "A" and use "B" straps (2).
2. Straps "C", "D", and "L", for operation of the selector without either talking link, are furnished; remove and connect alternate leads indicated when either private talking link circuit (-14 or -22) is used.
3. Lead CC2 is used only when the two talking link circuit (-22) and the audible signal and tone control circuit (-27) are both used. Lead CC is used with either private talking link circuit (-14 or -22), if -27 is not used.
4. Strap "E" is furnished installed, and is always used with 16A systems.
5. Relay D will not operate with both windings energized in parallel, opposing. Relay D will close its "X" contacts, due to inductive effect, when ground energizing both windings in parallel opposing is removed; relay D will operate and lock.
6. Diode MR2, and capacitor C2, make relay T slow to release.
7. Lead DS is used only with two-digit dialing (and either link circuit).

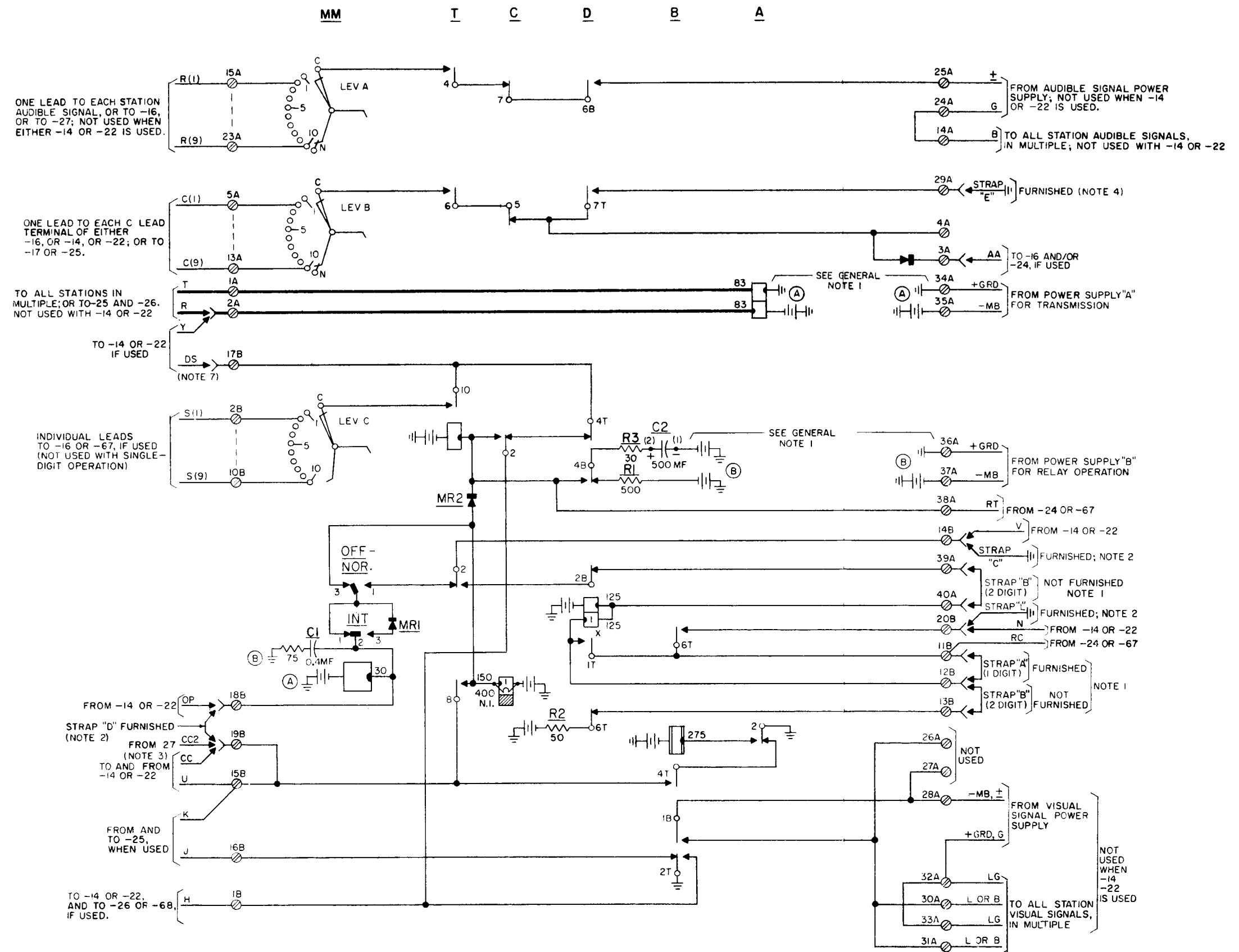


Figure 5. Dial intercom selector
H-883002-70; H-85973-1.

NOTES - Figure 6 (-16)

- 1. Nine 'M' straps (terminal links) are furnished installed.
- 2. Diodes MR1 and MR2 make relays T1 and T2 slow to release.

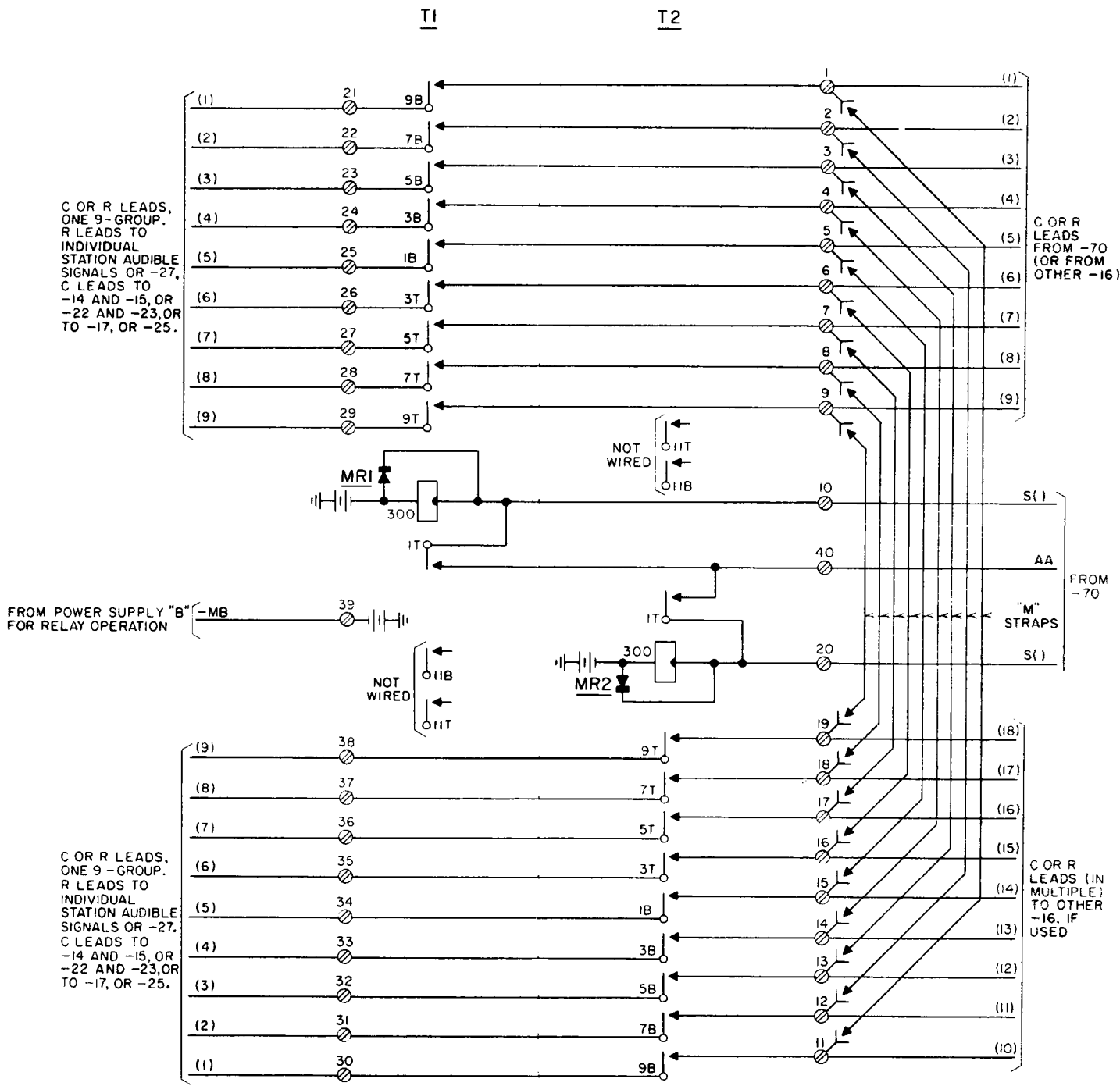


Figure 6. Transfer (or group-selector) circuit
H-883002-16; H-85973-2.

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Figure 7. Single talking link circuit
H-883002-14; H-85973-5.

NOTES - Figure 8 (-15)

- 1. Terminals 27-29 should be individually strapped to either terminal 36 ("F" straps) or terminal 10 ("G" straps) for the proper type of audible signaling current for the three stations served by this circuit. Ground may be strapped to any terminal if a special feature circuit is to be used. ("G" straps are furnished installed.)
- 2. The "H" straps should be used for telephones requiring audible signaling over the R talking lead; omit "H" straps and use lead R1 for stations requiring signaling over separate (R1) lead. ("H" straps are furnished.)
- 3. Stations of a preset conference group cannot be signaled over their R talking conductor unless a preset conference ring control circuit is provided.
- 4. Relay L contacts "X" (2 makes) operate on winding No. 2 in series with 100 ohms, but not in series with 3000 ohms. Relay L will operate fully with its No. 1 winding grounded or in series with 10 ohms, but not in series with 3000 ohms; relay L will hold its "X" contacts operated on its No. 1 winding in series with 3000 ohms.
- 5. Capacitors C1 - C3 are for tone bypass.

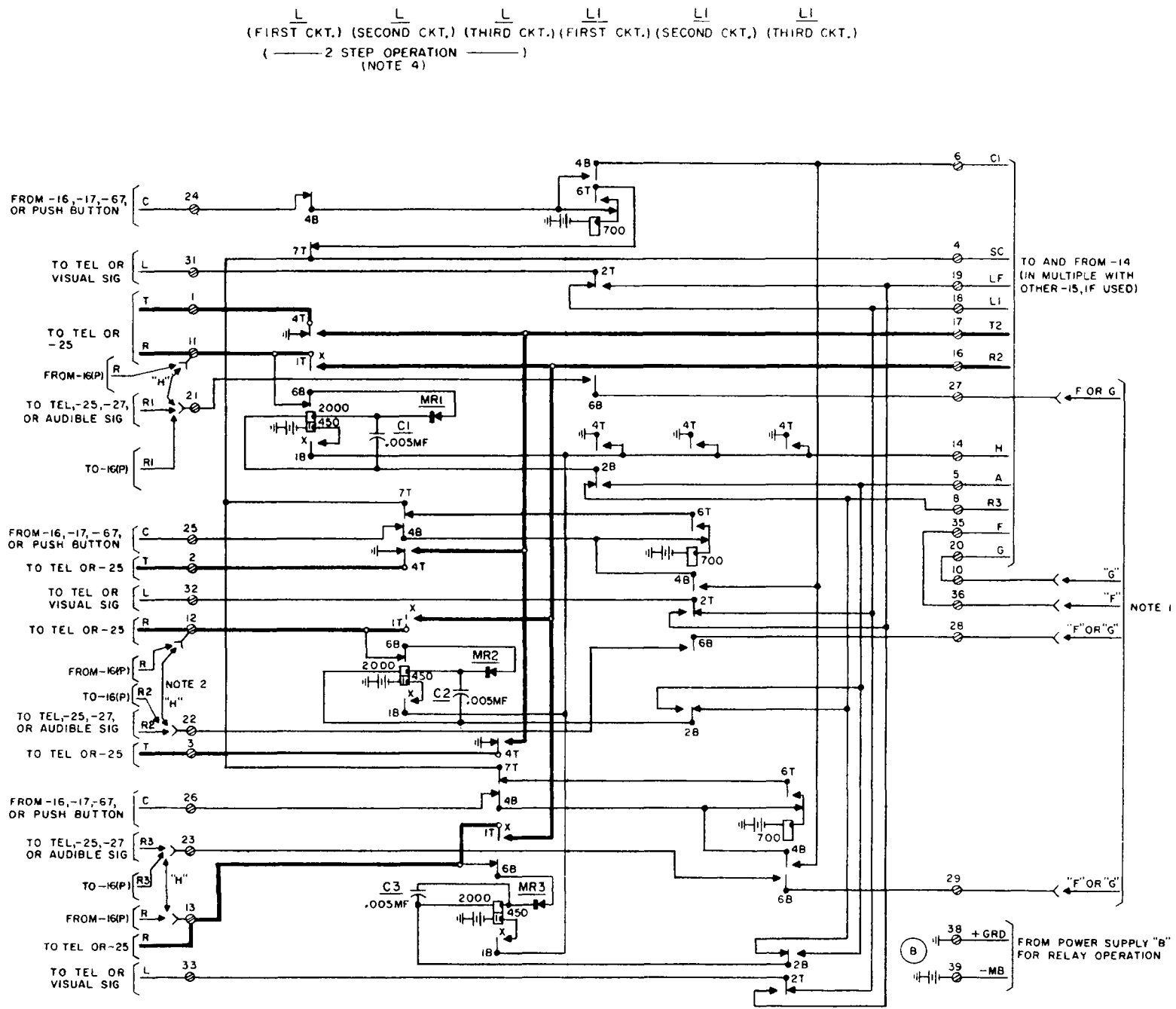


Figure 8. Station signaling circuit for single talking link circuit H-883002-15; H-85973-6.

1. Terminals 21B - 29B should be individually strapped to either terminal 20B ('F' straps) or terminal 30B ('G' straps) for the proper type of audible signaling current for each of the nine stations served by this circuit. Ground may be strapped to any terminal if a special feature circuit is to be used. ('G' straps are furnished installed.)
2. The 'H' straps should be used for telephones requiring audible signaling over the R talking lead; omit strap 'H' and use lead R1 for stations requiring audible signaling over a separate (R1) lead. ('H' straps are furnished installed.)
3. Stations of a preset conference group cannot be signaled over their R talking conductor unless a preset conference ring control circuit is provided.
4. Strap 'Q', furnished installed, is used with single-digit dialing; lead DS is not used. With two-digit dialing, omit strap 'Q' and use lead DS.
5. Strap 'R' is not furnished, and is used only when -24 (and lead RG) is not provided.
6. Strap 'S' is not furnished, and is used only when lamp flashing at called stations is not provided.
7. Relay L contacts 'X' (2 makes) operate on winding No. 2 in series with 100-ohms (resistor R1), but not in series with 3000-ohms (resistor R6). Relay L will operate fully with its No. 1 winding in series with 10-ohms (relay C), but not in series with 3000-ohms (resistor R5); relay L will hold its 'X' contacts operated on its No. 1 winding in series with 3000-ohms (resistor R5).
8. Relay C will not operate in series with the No. 1 winding of only one L relay; it will operate in series with two relay L No. 1 windings connected in parallel.
9. Only the ungrounded side of the audible and visual signal power supplies are switched by this circuit; the grounded side of each supply must be connected separately and directly to each of the signal devices.
10. The capacitors (C1 - C9), in parallel with the No. 2 winding of each L relay, are for tone bypass around the inductive windings.

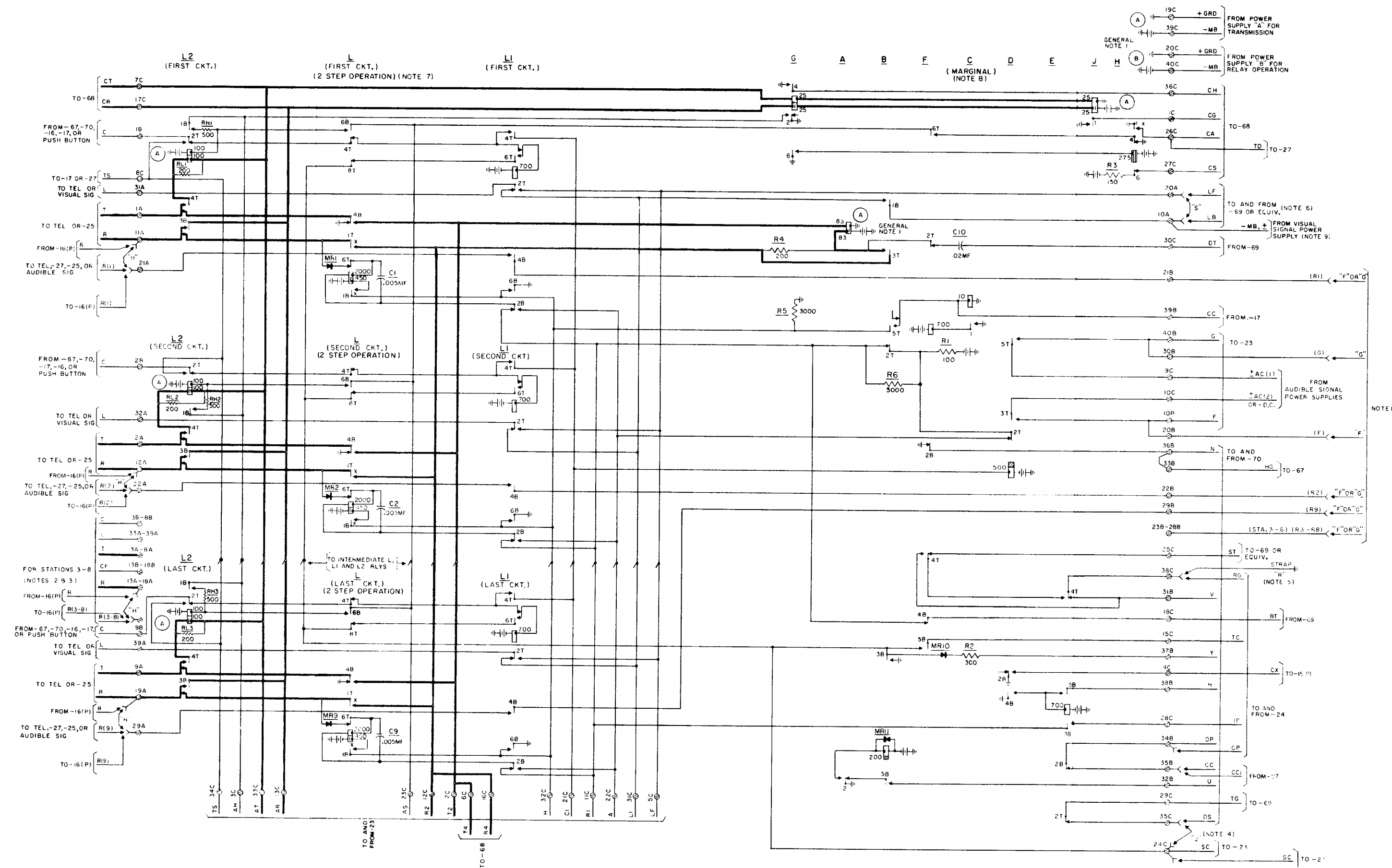


Figure 9. Two talking link circuit
H-883002-22, H-85783-1.