

NuTone

SERVICE MANUAL



**DIRECT-A-COM SERIES 1
476-477 CONTROL/AMPLIFIER**

NuTone

DIVISION

Madison and Red Bank Rds., Cincinnati, Ohio 45227 U.S.A.

GENERAL DESCRIPTION DIRECT-A-COM

SERIES #1 MODEL 476 AND 477 CONTROL-AMPLIFIER

AND MODEL 486 SPEAKER

The Model 476 and 477 Control-Amplifiers are completely transistorized and designed for installation in the Entrance Directory or surface mounted at a remote location. Power is supplied by a NuTone Model 301-N 16 VAC 30 VA transformer which is also remotely mounted.

The control amplifiers use a plug-in terminal board which allows the Control-Amplifiers to be easily removed for servicing without disconnecting system wiring.

SERVICING

Removal of 476 or 477 if located in Entrance Directory, see Fig. 1.

1. Insert a narrow stiff card, paper clip, narrow metal ruler or similar tool between the panel and frame of Entrance Directory pushbutton panel next to speaker panel. Push down simultaneously on top and bottom latches while applying pressure to open panels. See Fig. 1 & 2.
2. Amplifier is mounted to "A" housing as shown in Figure 3 with two sheet metal screws.
3. Remove the 4 sheet metal screws holding the terminal board on the Control/Amplifier. See Fig. 4.
4. Unplug terminal board (with system wiring connected) from Control/Amplifier and set aside. Remove the two sheet metal screws holding amplifier to Directory "A" housing and remove Control/Amplifier.

OPERATION AND TESTING — SHOP SERVICE

MODEL 476

1. Test Terminal Board #40982 for Model 476 should be used for ease in wiring remote speakers, power connections and directory speaker.
2. An auxiliary low voltage transformer is required to furnish power to the Control/Amplifier for testing. Connect 16 VAC from NuTone 301N transformer or equivalent to terminal screws marked "16 VOLTS AC."
3. Connect test speaker to "DIR SPKR" terminals.
4. Connect NuTone Model 486 Speaker to "Aud 1" and "Aud 2" of terminal board. See Note.

Should a NuTone Model 486 Speaker not be available — follow test procedure outlined below.

1. Connect test speaker across Dir. Spkr. terminals of 40982 Terminal Board.

2. Connect a 45 ohm speaker across Aud 1 and Aud 2 terminals on terminal board. A SPST switch may be inserted in one lead as shown below to aid in controlling feedback until location of speakers as described in Note can be accomplished.

NOTE: Feedback will indicate operation of system. However, in order to determine proper operation, that is, Lobby speaker to Apartment speaker and, Apartment speaker to Lobby speaker, the speakers should be separated physically as far from each other as possible in order to eliminate or reduce squeal (feedback). In actual installation these speakers are separated by wiring from Lobby to Apartments which could run 50 to 500 feet or more.

3. Place 2.7K ohm resistor across Aud 2 and Common. This will simulate Talk/Listen switch on Apartment Remote speaker being placed in the "Listen" position.
4. Connect VTVM or Multimeter leads across "Door Release" terminals. Place meter on 50 V AC scale and place a 100 ohm resistor across Aud 2 and Common to simulate "Door Release" button on Apartment Speaker being pushed. Meter should deflect to approximately 24 volts showing "Door Release" circuit is functioning.
5. While watching contact of CR-2 — short across "Postal Lock" terminals. Relay will energize and latch-in until delay circuit deactivates causing relay to de-energize.
6. Place leads of 45 ohm speaker across RING and COMMON terminals of terminal board — tone should be heard in speaker. If 45 ohm speaker is not available — place a 47 ohm resistor in series with test speaker being used to prevent damage to components.



A typical installation showing Riser Wiring — Directory Wiring — and a block diagram of Floor Riser Wiring is shown on pages 5 and 6.

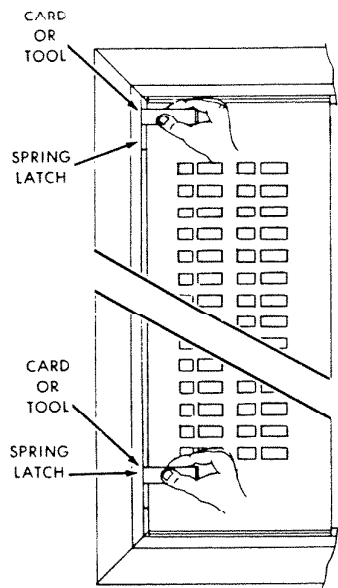


Fig. 1

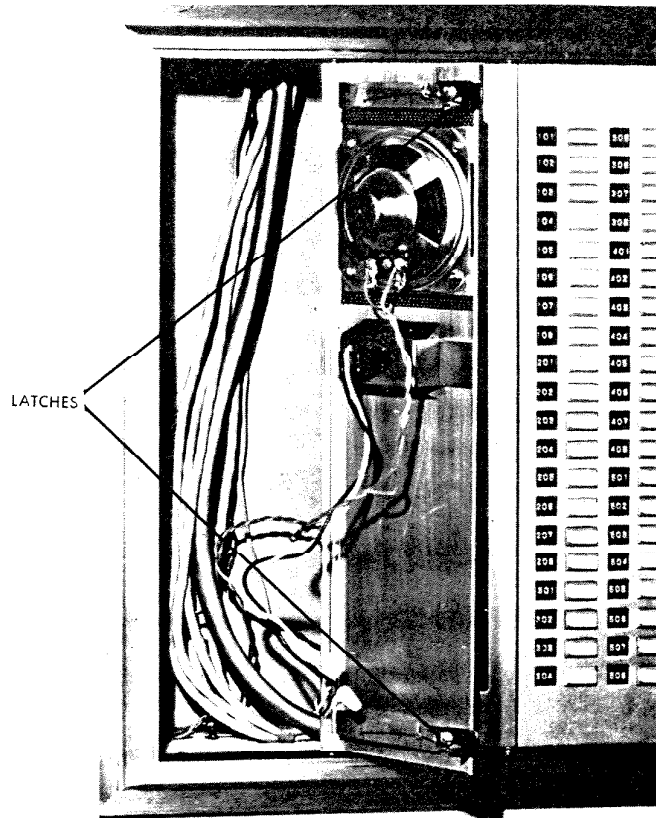


Fig. 2

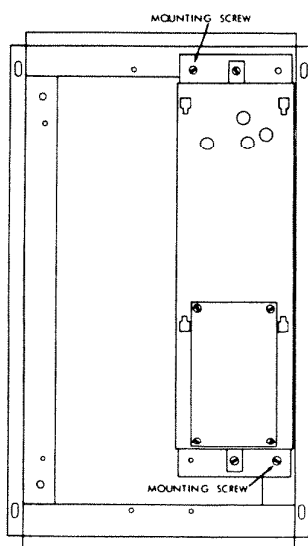


Fig. 3

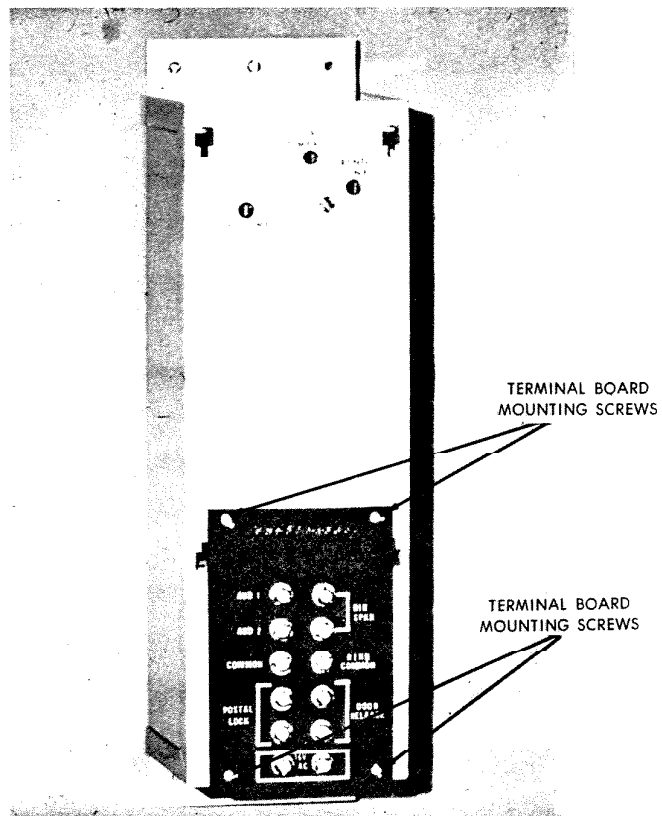
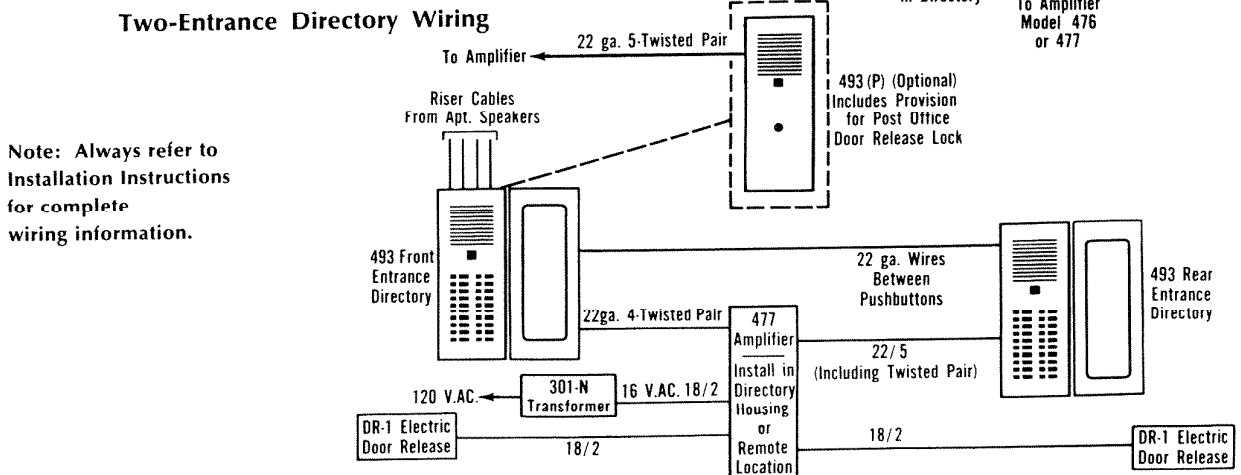
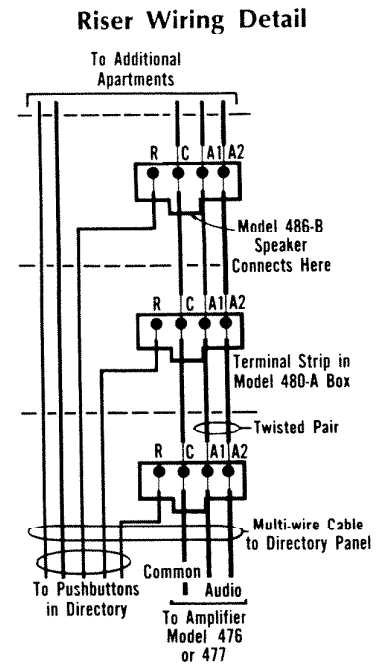
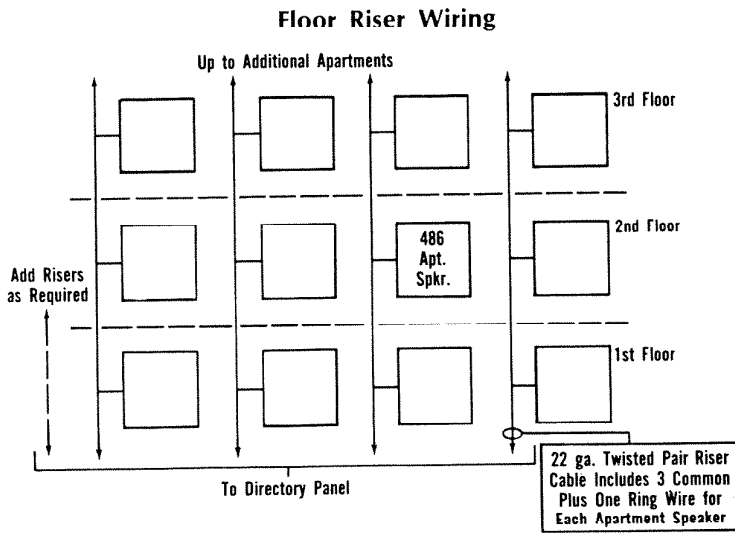
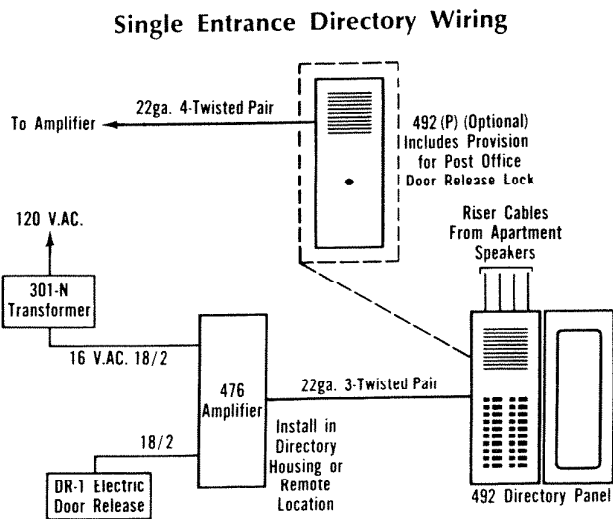


Fig. 4

Typical Wiring Diagrams for NuTone 'Direct-A-Com' - Series 1



Note: Always refer to Installation Instructions for complete wiring information.



Riser Cable Chart

Number of Apartments Served by each Vertical Riser Cable	Number of Wires Required in Riser Cable	Suggested Cable (or Equivalent Trade No.)	Nominal Cable O.D.
1 to 3	4 to 6	NuTone 6-wire (3 pr.) 447 or 448	7/32"
4 to 5	7 to 8	NuTone 8-wire (4 pr.) 2421, 2424 or 2425	1/4"
6 to 9	9 to 12	*Belden, 6 pr. No. 8743	3/16"
10 to 15	13 to 18	*Belden, 9 pr. No. 8744	3/8"
16 to 19	19 to 22	*Belden, 11 pr. No. 8753	13/32"
20 to 23	23 to 26	*Belden, 13 pr. No. 8754	7/16"
24 to 27	27 to 30	*Belden, 15 pr. No. 8745	15/32"

*Not available from NuTone — purchase locally

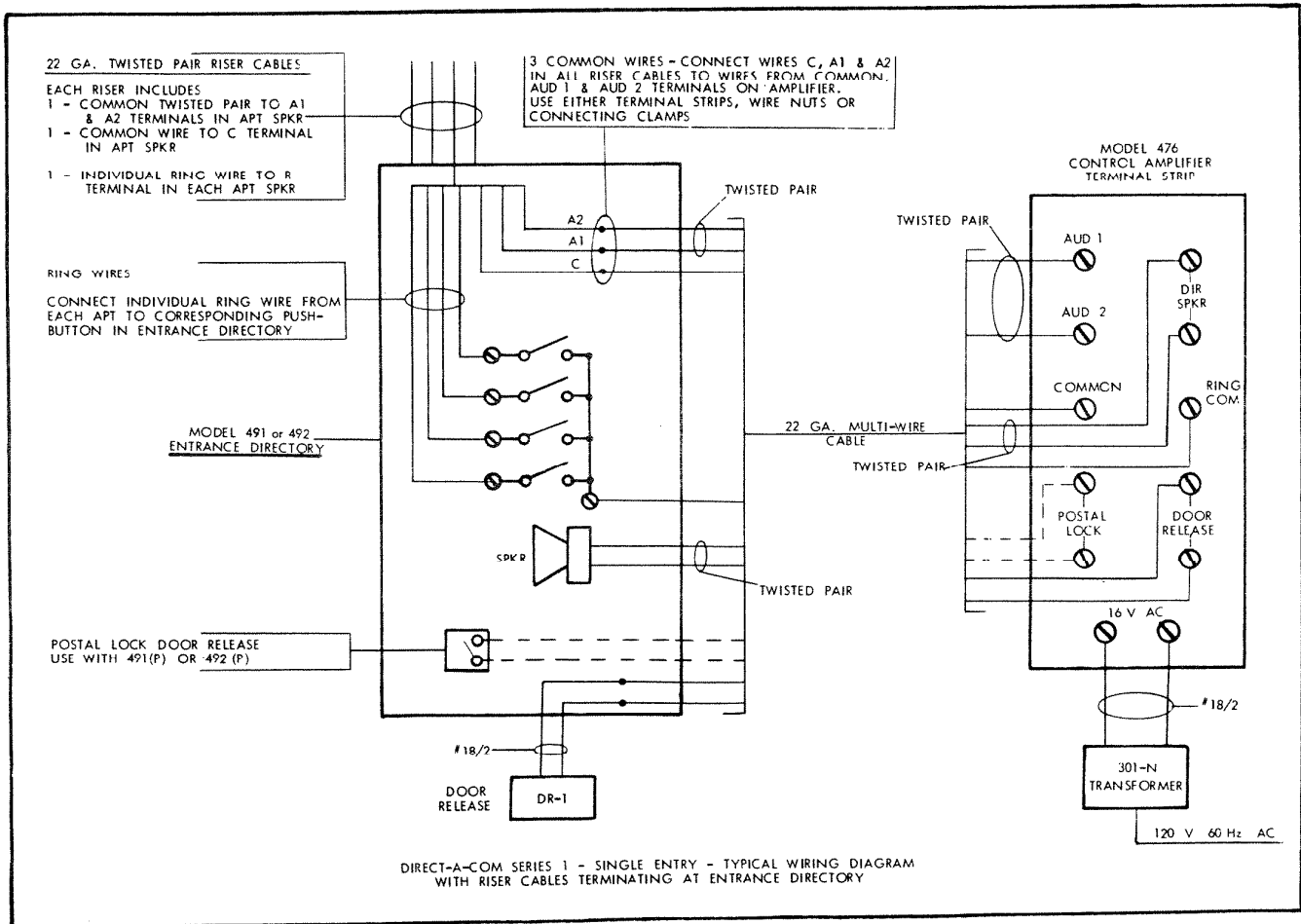


Fig. 5

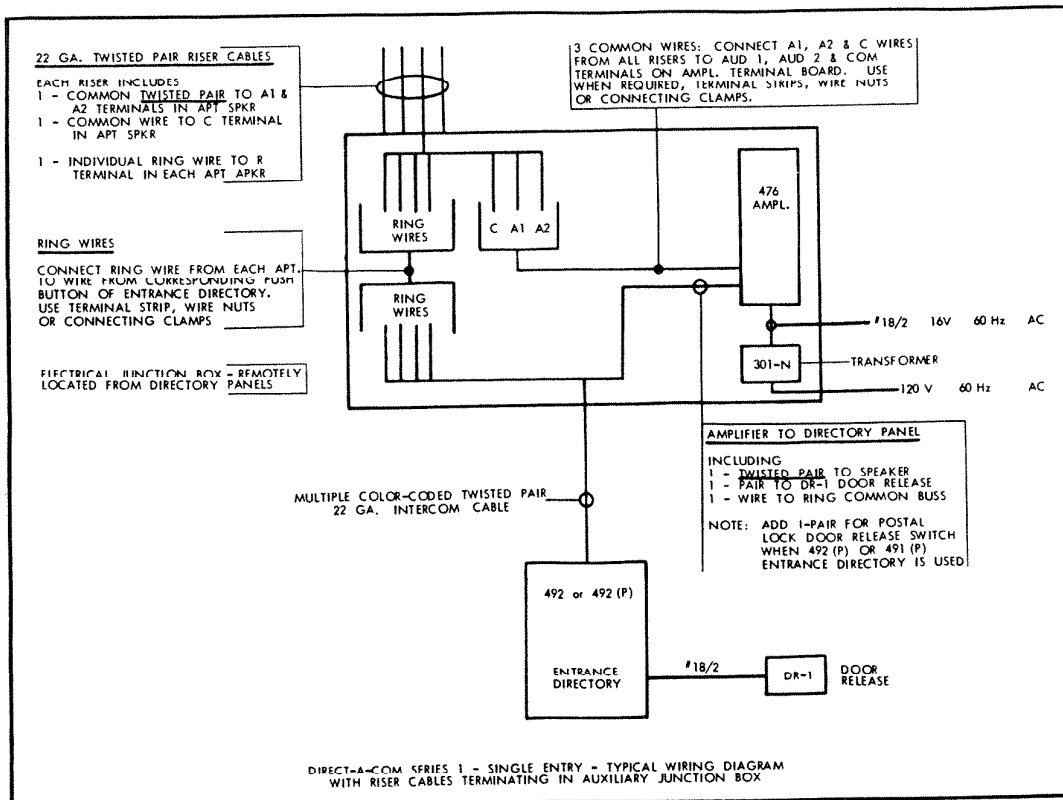


Fig. 6

SHORT GLOSSARY OF TERMS USED IN SOLID STATE EQUIPMENT

DEVICE:	Transistor — SCR (Silicon Controlled Rectifier) — Diode—FET (Field Effect Transistor) Zener Diode.
DARLINGTON:	Two Transistors in parallel.
SATURATION:	When the emitter and collector of a device are placed at the same potential.
SCR:	“Silicon Controlled Rectifier” is a device to switch high current by low voltage pulses.
ENERGIZE:	A relay coil which has current going through it.
TURN ON:	A device that goes into conduction or saturation.

MODEL 476 CONTROL

Theory of Operation

When the ring button is pushed for a certain apartment, the circuit is completed between the Ring Switch line and the Remote Common line through the Speaker in the selected Apartment. Pushing this ring button puts a voltage on TR-5 and turns it on. When TR-5 goes into conduction or saturates TR-4 saturates and supplies voltage to TR-1. TR-1 is a unijunction transistor and the tone oscillator. TR-5 also turns on TR-6 which goes into a high conduction condition and shunts R11, 2.2K ohms. This allows nearly the full supply voltage to go through the speaker of selected apartment, through the Ring Switch line and down to the Emitter of Darlington transistor, TR-3. TR-2 and TR-3 are a Darlington amplifier which amplifies the tone from TR-1. The amplified tone then goes out through the Ring Switch line, through the speaker of the selected apartment and back to the Remote Common line. This has now turned on enough transistors and selected circuitry to allow a tone signal to be heard in the selected apartment.

CR-1 is a Talk/Listen relay and as such switches the audio line between the input and output of the amplifier when the Apartment speaker Talk Switch is pushed to Talk, the Voice Coil is placed directly across the input of the amplifier through a set of contacts on CR-1. When the Listen Button is pushed it completes a circuit through a resistor, R-201, 2.7K ohms located on Apartment Speaker, between common line and A2 of the Audio line which is connected through resistors R-25 and R-26 100 ohms to ground and back to the amplifier through the remote common line. This circuit is as follows:

Theory Of Operation (cont'd)

From plus supply voltage through R-11, 2.2K ohm, through R-28, 27 ohm, out the remote common line to the speaker, through a 2.7K ohm resistor and back through A2 Audio line through the Audio amplifier which is grounded. A voltage is then presented across D-1, which is a 6.2 volt Zener diode and it goes into conduction. This puts a bias on the Base of transistor TR-7 which saturates and energizes CR-1A 12 volt relay. The Diode D3 across CR-1 is a spike voltage suppressor to keep the stored energy in the coil of CR-1 from producing a high enough voltage to destroy TR-7.

When the Door Release button is pushed, a resistor R202 100 ohm mounted on the Apartment speaker, is placed in the circuit completing a path between the Remote Common line and the Audio A2 line. This resistor divides the voltage with R-11, 2.2K ohm and R-28, 27 ohm so as to produce a higher voltage to diode D-2. Diode D-2 is a 5 volt Zener and enough voltage is presented to it to make it go into conduction. Diode, D-1 which is a 6.2 volt Zener, also has gone into conduction and energizes CR-1. This energizing of CR-1 is not necessary and is coincidental and does not indicate any malfunction of the circuit.

When D-2 goes into conduction it turns on TR-8 which allows current to flow through R-16, 560 K ohms and R-20, 470 K ohms. This puts a bias on TR-9 which then goes into conduction and energizes relay, CR-2. CR-2 is the door release relay which when energized, activates the door release through a set of contacts, CR-2B, that close the AC circuit. Another contact on CR-2, CR-2A, closes and puts current through D-5, R-17, 220K ohms, and R-30, 100K ohm pot, and then to the Emitter of the unijunction transistor TR-10. This same set of contacts keeps the bias on TR-9 and holds it in even though the Door Release button is released. The Emitter of TR-10 gets an increasingly built-up voltage on it due to the time delay of capacitor, C-3. This timing cycle is the action that keeps the door release activated. When the voltage across C-3 builds up sufficiently — TR-10 goes into conduction and shorts the junction of C-3 and C-2 and the Emitter of TR-10 to near ground potential. Capacitor C-2 carries a negative pulse voltage to the Base of TR-9 and turns it off. When TR-9 stops conducting, relay CR-2 de-energizes and in turn the door release is de-energized. The unit is now ready for the next caller.

POSTAL LATCH OPERATION

When the postman turns his key in the switch, the wire labeled Postal Latch is connected to ground and a circuit is completed through R-14, 47K ohms and R-21, 4.7K ohms which produces a bias on the Base of TR-8. TR-8 turns on and causes TR-9 to turn on which energizes CR-2. CR-2 closes and turns on the Door Latch and at the same time locks itself up with the Contact CR-2A. The timing circuit starts timing and charges up capacitor C-3 until the Emitter of TR-10 reaches it's firing voltage. When this happens — it shorts out C-3 and delivers a pulse through C-2 to the Base of TR-9 and turns TR-9 off. This de-energizes CR-2 and drops the Postal Lock contact out of the circuit.

476 CONTROL BOARD

SEE NOTE ON 476 SCHEMATIC.
CALL-OUT ON FIGURE 8 IS CORRECT.

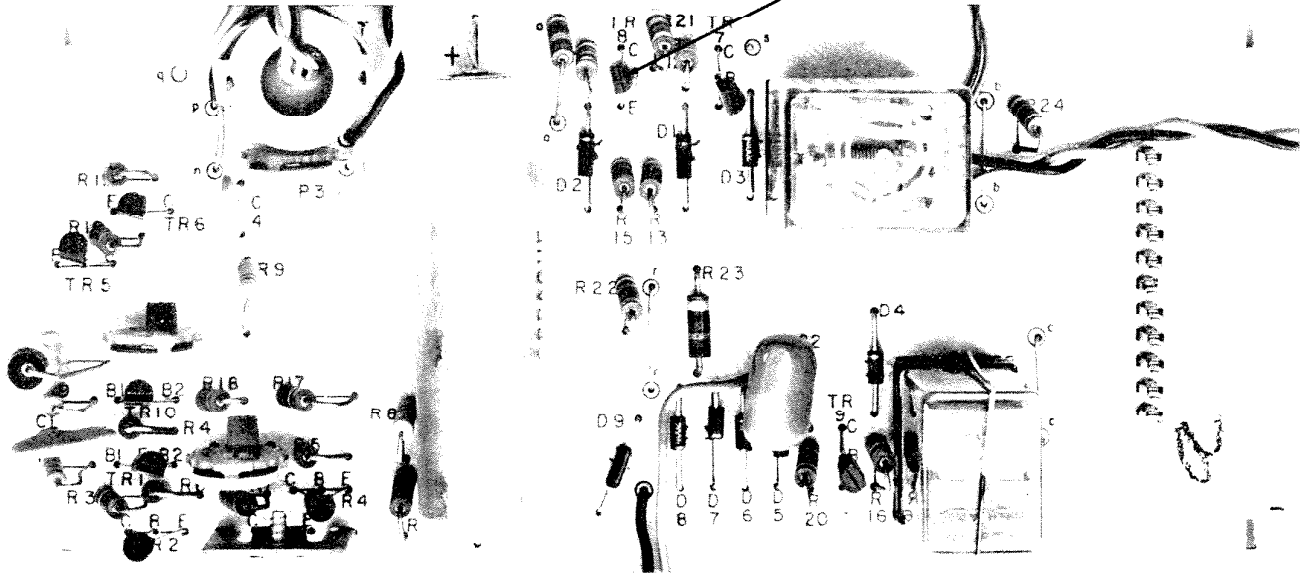


Fig. 7

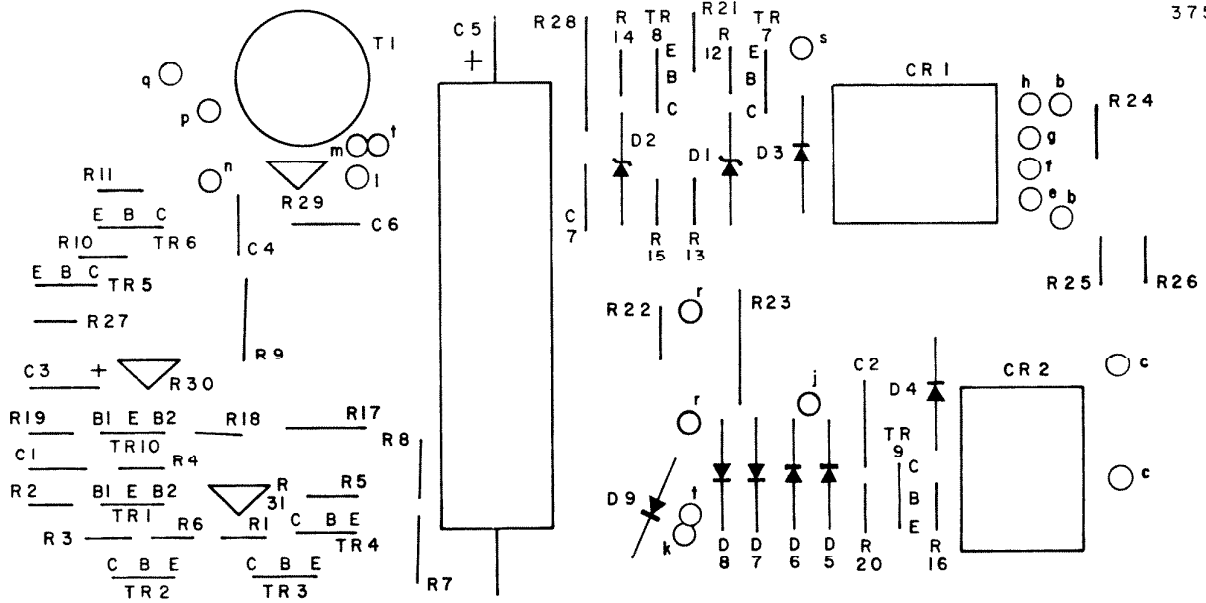


Fig. 8

AMPLIFIER P/C BOARD

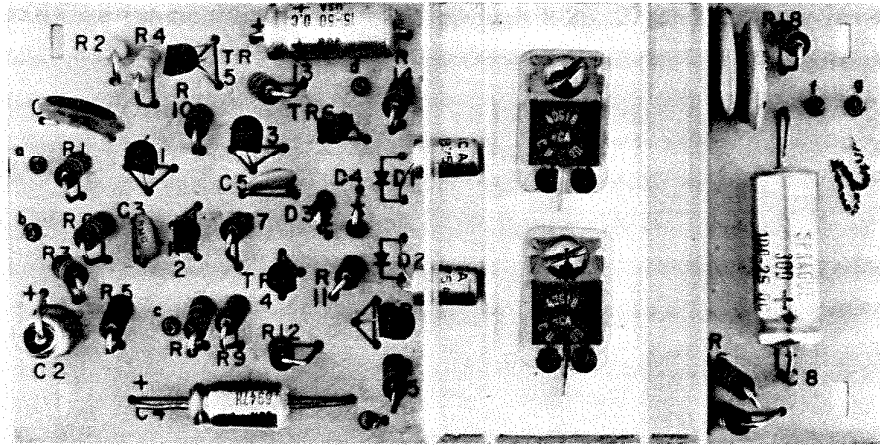


Fig. 9

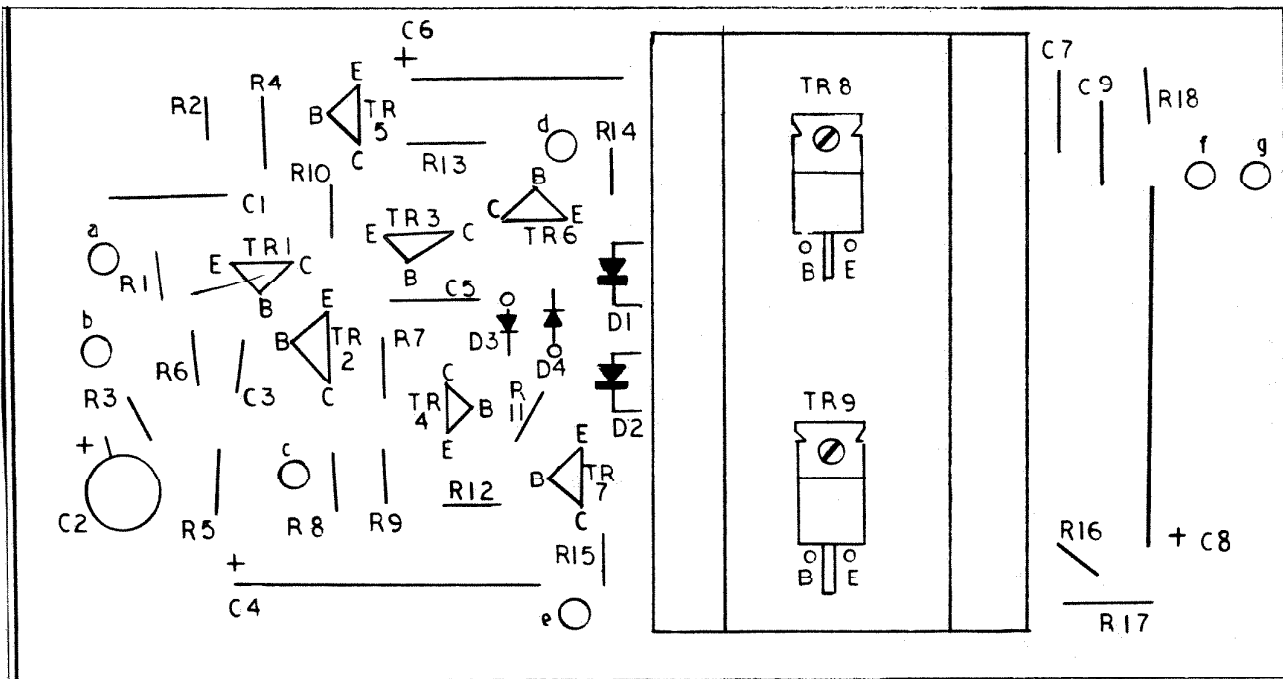


Fig. 10

CALL-OUTS FOIL SIDE 476 CONTROL BOARD

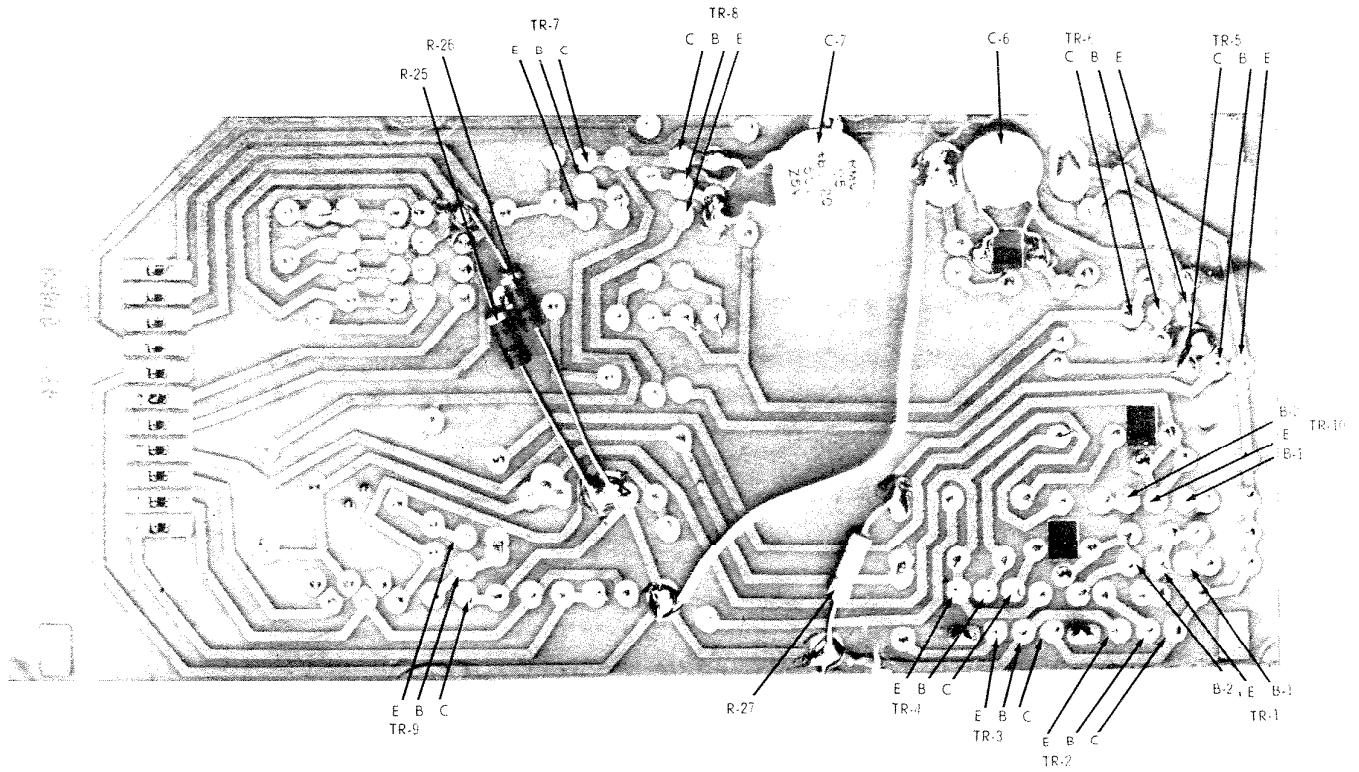


Fig. 11

CALL-OUTS 476 & 477 AMPLIFIER

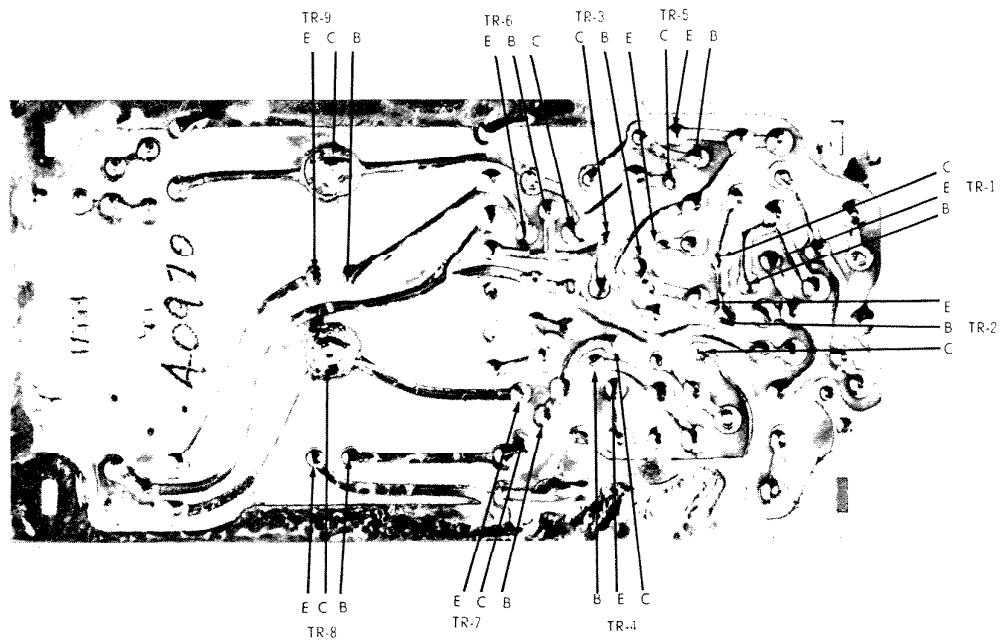
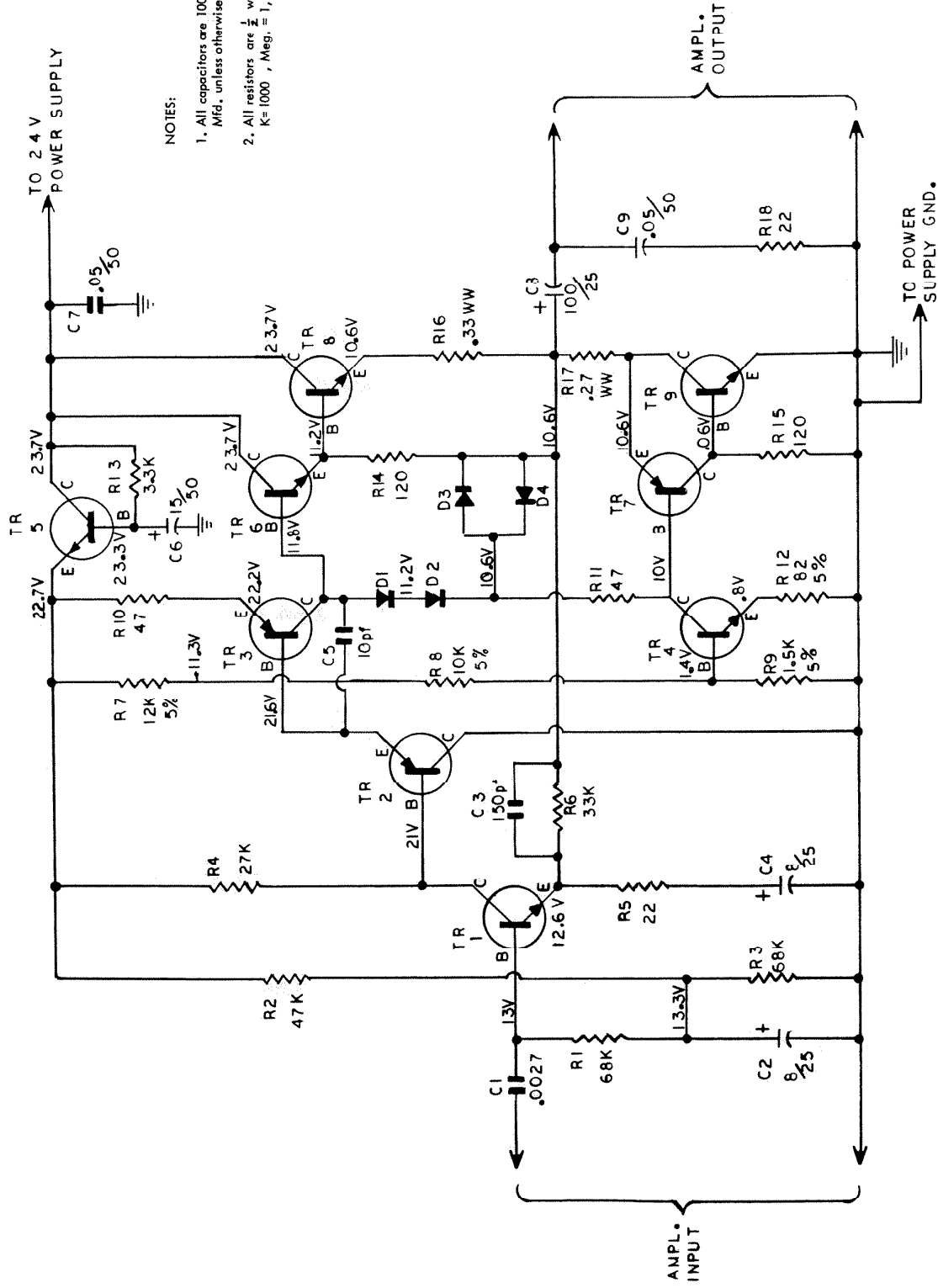


Fig. 12

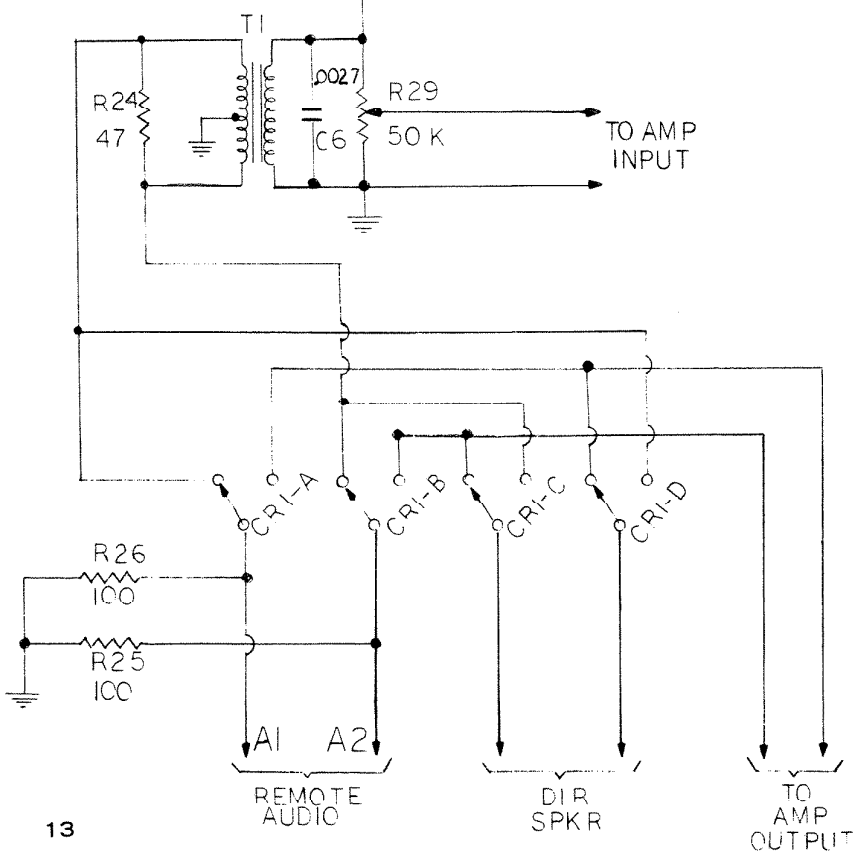
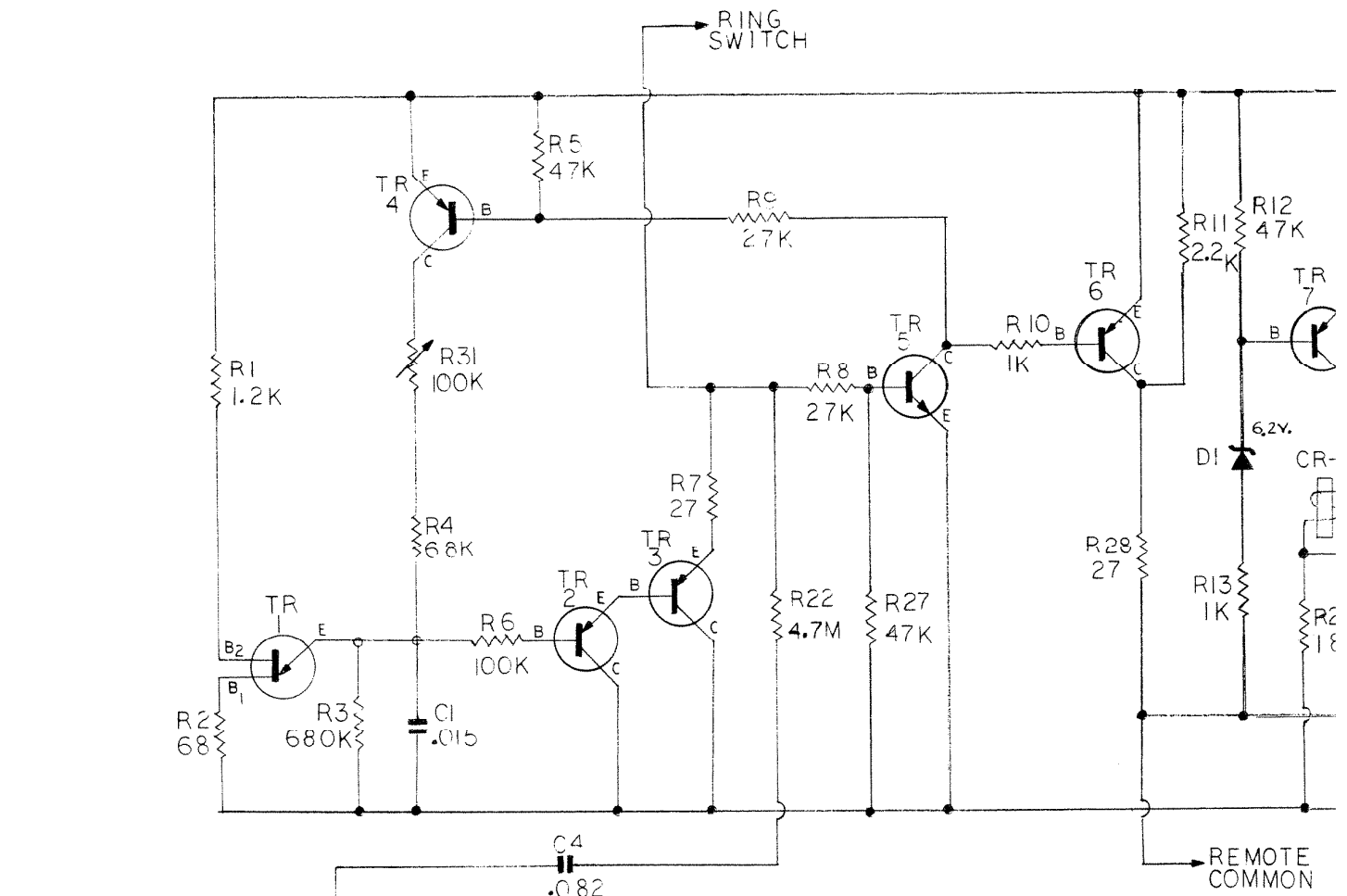
476-477 AMPLIFIER



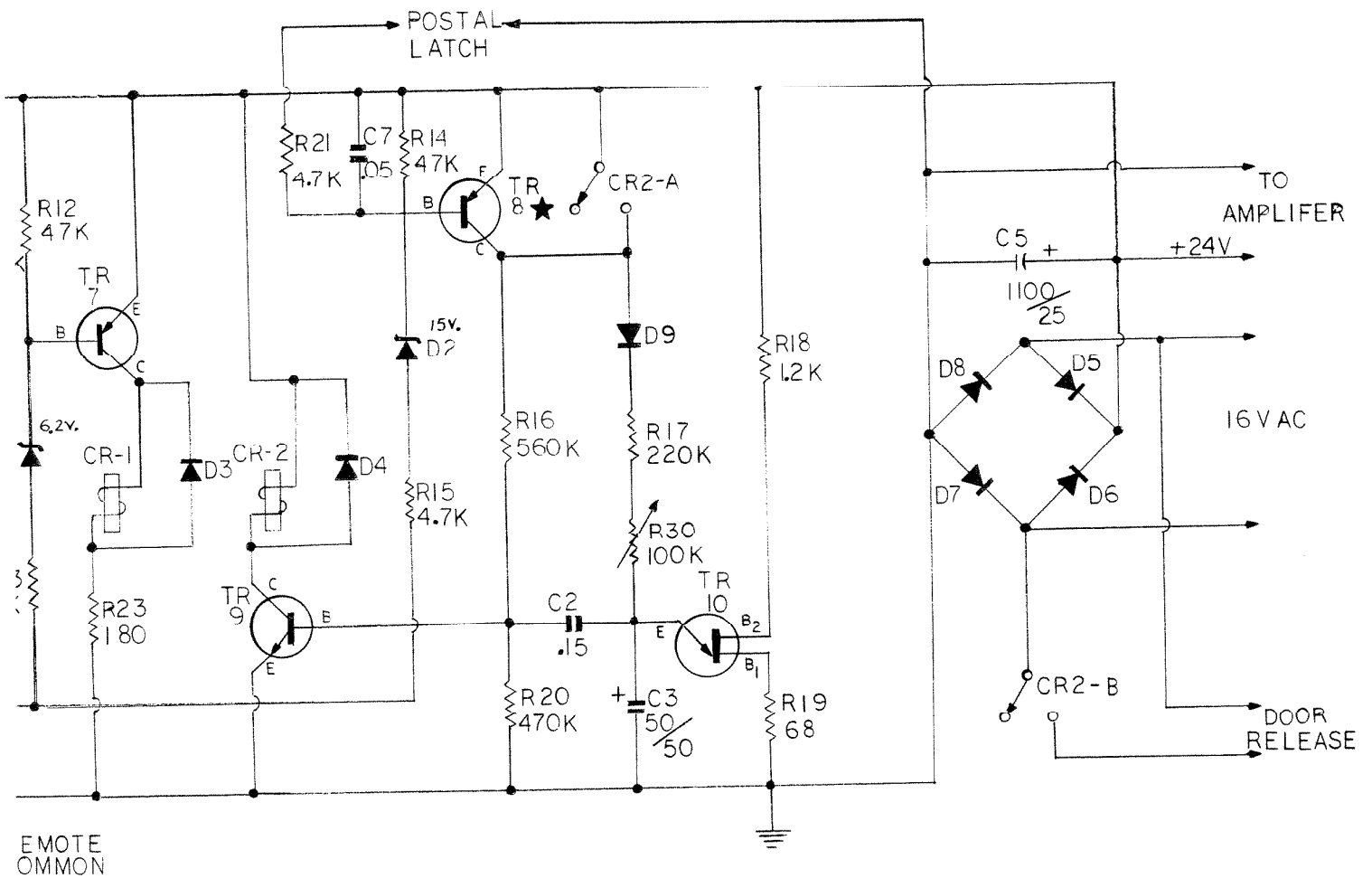
NOTES:

1. All capacitors are 1000 volt E.I.A. tolerance, value in Mfd. unless otherwise specified.
2. All resistors are $\frac{1}{2}$ watt, 10% tolerance, value in ohms, K=1000, Meg. = 1,000,000 unless otherwise specified.

Fig. 13



VOLTAGE CHART — TROUBLESHOOTING
 As amplifier is transistorized, caution must be taken to avoid damage to transistors. Turn power to amplifier OFF before making measurements. Use low voltage soldering equipment and solder or use a VTVM, with a DC scale of 0 to 10 volts and 0-50 ohms for base and emitter voltages. Components should be checked for correct polarity before making measurements to avoid incorrect polarity battery voltage. It is also important to avoid inadvertently shorting circuit components.



★ NOTE: P/C BOARD LABELED WRONG.
IT SHOULD READ - E B C -
FROM TOP TO BOTTOM

must be taken during servicing procedures to avoid accidental amplifier CFF before performing any soldering.

Remove or unsolder components as fast as possible.

50 volts will be required to measure most transistor resistance. Be removed from the circuit when making resistance measurements. battery voltage of the ohm-meter being applied to a transistor. Don't shorting circuit components.

NOTES:

1. ALL CAPACITORS ARE 1000 VOLT, E.I.A. TOLERANCE, VALUE IN MF, UNLESS OTHERWISE SPECIFIED.
2. ALL RESISTORS ARE 1/2 WATT, 10% TOLERANCE, VALUE IN OHMS, K=1,000, MEG=1,000,000 UNLESS OTHERWISE SPECIFIED.

NO LOAD
RINGING
TALK BUTTON DEPRESSED
LISTEN BUTTON DEPRESSED
DOOR RELEASE BUTTON DEPRESSED

TR 1	TR 2	TR 3	TR 4	TR 5	TR 6	TR 7	TR 8	TR 9	TR 10
B1 E B2	E B C	E B C	E B C	E B C	E B C	E B C	E B C	E B C	B1 E B2
.15 0 20	0 0 0	0 0 0	23 23 0	0 0 0	23 23 23	23 23 0	23 23 0	0 0 0	23 .15 .1 20
.15 8 18	9 8 0	10 9 0	21 20 21	0 .8 .3	21 20 21	21 21 0	21 21 0	0 0 0	21 .15 .1 20
.15 0 20	0 0 0	0 0 0	23 23 0	0 0 0	23 23 23	23 23 0	23 23 0	0 0 0	23 .15 .1 20
.15 0 20	0 0 0	0 0 0	21 21 0	0 0 0	21 21 21	22 21 20	22 22 0	0 0 0	22 .15 .1 20
.15 0 18	0 0 0	0 0 0	19 19 0	0 0 0	19 19 19	19 19 0	19 18 19	0 1.5 .7	.15 * 19

*VOLTAGE RANGES
FROM 0 TO 12V AS
C-3 CHARGES.

Fig. 14

MODEL 486-B SPEAKER

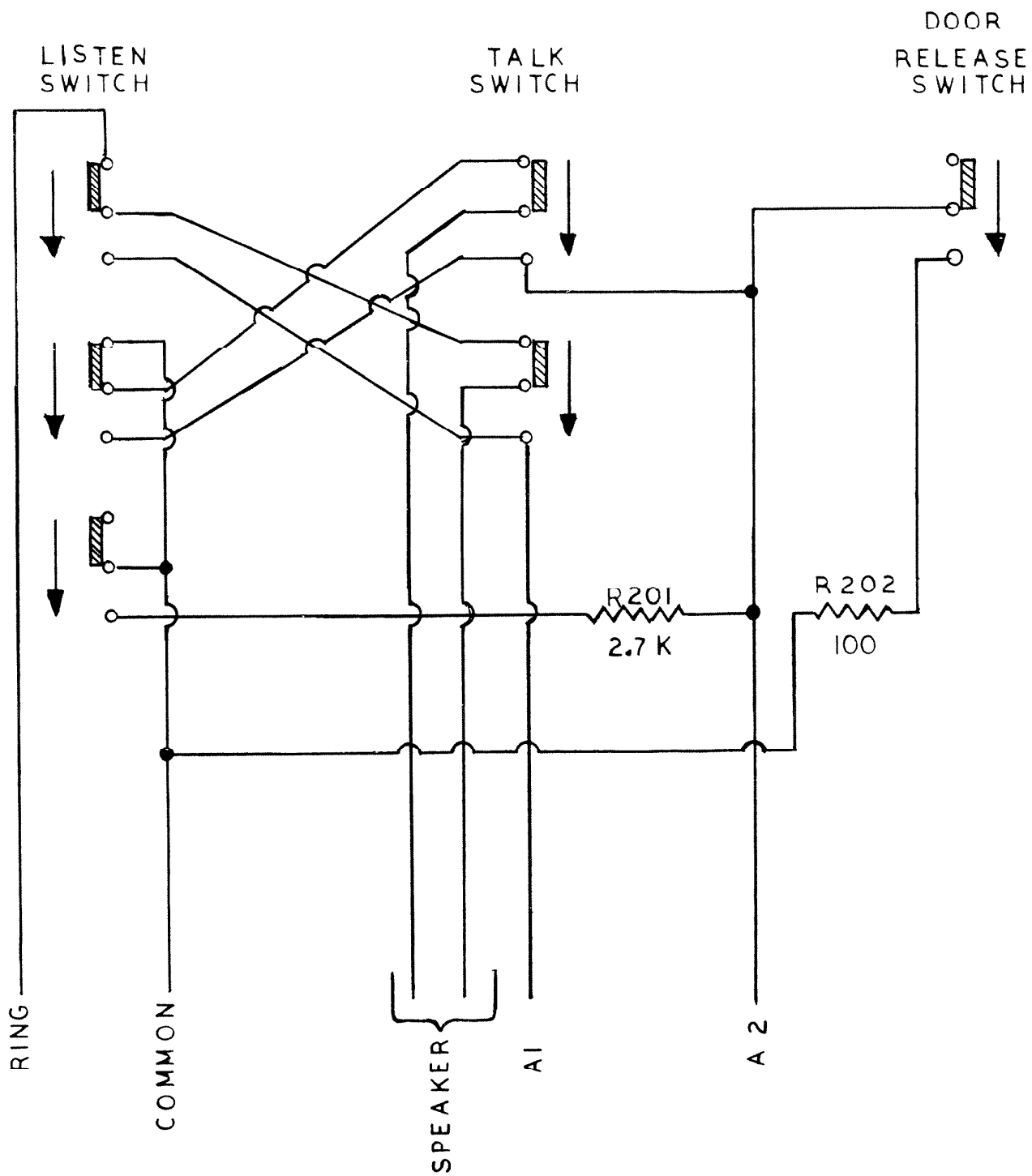


Fig. 15

PARTS LIST – AMPLIFIER FOR MODELS 476-477

DIRECT-A-COM SERIES 1

REF. NO.	NUTONE PART NUMBERS	DESCRIPTION
TRANSISTORS		
TR-1	36580	Voltage Amplifier
TR-2	36577	Emitter Follower
TR-3	36577	Pre-Driver
TR-4	36580	Current Source
TR-5	36580	Electronic Filter
TR-6	36586 (Motorola SPS 1315)	Driver
TR-7	36587 (Motorola MPS 6517)	Driver
TR-8	36585 (RCA 40618)	Output
TR-9	36585 (RCA 40618)	Output
DIODES		
D-1	36589 (RCA IN 3754)	Bias Diode
D-2	36589 (RCA IN 3754)	Bias Diode
D-3	36549 (Motorola IN 4002)	Current Limiting Diode
D-4	36549 (Motorola IN 4002)	Current Limiting Diode
CAPACITORS		
C-1		.0027 MFD 50V
C-2		8 MFD 25V
C-3		150 PF
C-4		8 MFD 25V
C-5		10 PF
C-6		15 MFD 50V
C-7		.05 MFD 50V
C-8		100 MFD 25V
C-9		.05 MFD 50V
RESISTORS		
R-1		68K ohms
R-2		47K ohms
R-3		68K ohms
R-4		27K ohms
R-5		22 ohms
R-6		33K ohms
R-7		12K ohms 5%
R-8		10K ohms 10%
R-9		1.5K ohms 5%
R-10		47 ohms
R-11		68 ohms
R-12		82 ohms 5%
R-13		3.3K ohms
R-14		120 ohms
R-15		120 ohms
R-16		.33 ohms Wirewound
R-17		.27 ohms Wirewound
R-18		22 ohms

PARTS LIST FOR MODEL 476 CONTROL

REF. NO.	NUTONE PART NUMBER	DESCRIPTION
TRANSISTORS		
TR-1	36597 (Motorola 2N4870)	Tone Generator
TR-2	36577	Darlington Amplifier for Tone
TR-3	*36588 (Motorola MPS U51) 36603 (Motorola MPS U55)	Darlington Amplifier for Tone
TR-4	36577	Switch to turn on Tone Generator
TR-5	36580	Switch to sense voltage on Ring Line and turn on TR-4 & 6
TR-6	*36592 (Motorola MPS 6533) 36603 (Motorola MPS U55)	Shunt device for R-11
TR-7	36587 (Motorola MPS 6517)	Control device for CR-1
TR-8	36577	Sensing device for Door Release and Postal Latch
TR-9	36590 (Motorola MPS A13)	Control for Door Release Relay CR-2
TR-10	36597 (Motorola 2N4870)	Timing device for Door Release
* Used in Early Production		
DIODES		
D-1	36594 (Motorola IN 5234)	Zener voltage sensing for CR-1
D-2	36595 (Motorola IN 5245)	Zener voltage sensing for CR-2
D-3	36549 (Motorola IN 4002)	Spike suppressor
D-4	36549 (Motorola IN 4002)	Spike suppressor
D-5	36549 (Motorola IN 4002)	Silicon Rectifier
D-6	36549 (Motorola IN 4002)	Silicon Rectifier
D-7	36549 (Motorola IN 4002)	Silicon Rectifier
D-8	36549 (Motorola IN 4002)	Silicon Rectifier
D-9	36553	Blocking diode for CR-2
CAPACITORS		
C-1		.015 mfd 50V
C-2	35024-102	.15 mfd 75V
C-3	35068-113	50 mfd 25V
C-4		.082 mfd 12V
C-5	35085-102	1100 mfd 30V
C-6		.0027 mfd
C-7		.05 mfd 50V
RESISTORS		
R-1		1.2K ohms
R-2		68 ohms
R-3		680K ohms
R-4		68 ohms

PARTS LIST FOR MODEL 476 CONTROL (cont'd)

REF. NO.	NUTONE PART NUMBER	DESCRIPTION
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RESISTORS (cont.)

R-5		47 ohms
R-6		100K ohms
R-7		27 ohms
R-8		27K ohms
R-9		27K ohms
R-10		1K ohms
R-11		2.2K ohms
R-12		47K ohms
R-13		1K ohms
R-14		47K ohms
R-15		4.7K ohms
R-16		560K ohms
R-17		220K ohms
R-18		1.2K ohms
R-19		68 ohms
R-20		470K ohms
R-21		4.7K ohms
R-22		4.7 Meg ohms
R-23		180 ohms
R-24		47 ohms
R-25		100 ohms
R-26		100 ohms
R-27		47K ohms
R-28		27 ohms
R-29	34041 Potentiometer	50K ohms Intercom Volume
R-30	34042 Potentiometer	100K ohms Tone Control
R-31	34042 Potentiometer	100K ohms Door Release Timer

RELAYS

CR-1	39038	4PDT Talk Listen Relay
CR-2	39039	2PDT Door Release Relay

TRANSFORMER

T-1	30536	Audio Input
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Parts may be ordered — by NuTone part number, direct from our factory — at the following address.

NuTone — Division of Scovill
P. O. Box 27
Cincinnati, Ohio 45227

Direct-A-Com Series 1 Model 477 Section For 2 Entrance Directories

SERVICING

**REFER TO APPROPRIATE SECTION ON PAGE 2.
OPERATING AND TESTING - SHOP SERVICE.**

MODEL 477 — DIRECTORY 1

1. Test Terminal Board #40976 for Model 477 should be used for ease in wiring remote speakers, power connections and directory speaker.
2. An auxiliary low voltage transformer is required to furnish power to the Control-Amplifier for testing. Connect 16 VAC from NuTone 301-N transformer or equivalent to terminal screws marked "16 VOLTS AC".
3. Connect test speaker to "DIR 1" Speaker terminals.
4. Connect NuTone Model 486 Speaker to "Aud 1" and "Aud 2" of terminal board. See Note. Should a NuTone Model 486 Speaker not be available — follow test procedure outlined below.

1. Connect test speaker across Dir 1 Speaker terminals of 40976 Terminal Board.
2. Connect a 45 ohm speaker across Aud 1 and Aud 2 terminals on terminal board.

NOTE: With speakers connected as outlined above — NO feedback will occur. Feedback will occur if Test Speaker is connected across "Dir 2" Speaker terminals instead of "Dir 1" Speaker. Operation of system using "Dir 1" and "Dir 2" terminals is outlined below.

3. Connect a pair of test leads as follows: One lead to Dir 1 Switch Ring terminal and one lead to Common terminal on the 40976 Terminal Board.
4. Momentarily short these leads together. (This simulates a directory pushbutton being pushed in lobby). This causes Talk/Listen relay, CR-1, to switch the talk path from the Apartment remote test speaker, which is connected across AUD 1 and AUD 2 terminals, to the test speaker connected across Dir 1 Speaker terminals.

5. After momentarily shorting these terminals again — placing a 2.7K ohm resistor across Common and AUD 2 terminals will simulate the Listen switch on the Apartment remote being pushed and the talk path is now from test speaker on Dir 1 Speaker terminals to test speaker across the AUD 1 and AUD 2 terminals.
6. Connect test leads of VOM across Dir 2 Lamp VOM set on MINUS DC volts, 50 Volt scale. Needle on meter will fluctuate between 10V and 20V signifying operation of lamp busy signal. This will continue until knock down timer de-activates the circuit. Should a 14 volt lamp bulb, GE 756, be available, it may be used for an indication of correct circuit operation.
7. Remove VOM test leads from Dir 2 Lamp and connect to Door Release Dir 1 terminals. Again momentarily short the Dir 1 Ring and Common leads together. Place a 100 ohm meter across AUD 2 and Common terminals of the terminal board which will simulate the Door Release button being pushed on the Apartment remote speaker. Place VOM switch on AC volts, 50 volt scale, meter should read approximately 14 volts which indicates Door Release #1 is activated. Again the 14 volt pilot lamp may be used as an indicator.
8. With the VOM on AC Volts, minus 50 volt scale — short across Postal Lock Terminals. A reading of approximately 14 volts will indicate operation of Postal Lock circuit.

DIRECTORY 2

1. Operation of Directory 2 is essentially the same as Directory 1 with the exception that feedback will be noticed immediately upon connecting the test speaker which was previously connected to "Dir 1" terminals, to the "Dir 2" terminals. The "talk path" is from the Apartment remote (AUD 1 and AUD 2) to the Lobby speaker.
2. Remove the test lead previously connected to Dir 1 Switch Ring terminal and connect this lead to Dir 2 Switch Ring terminal. Momentarily shorting these two leads together, Dir 2 Switch Ring and Common simulates a caller at Directory 2 and by placing the 2.7K ohm resistor across AUD 2 and Common terminals of test terminal board, the "talk path" is from Lobby test speaker to Apartment test speaker.
3. Connect test leads of VOM across Dir 1 Lamp VOM set on MINUS DC volts, 50 volt scale. Needle on meter will fluctuate between 10V and 20V simulating condition outlined in #6, Directory 1 operation.
4. Remove test leads from Dir 1 lamp and place across Door Release Dir 2 terminals. Follow procedure outlined in #7, Directory 1 operation.

A typical installation showing Riser Wiring — Directory Wiring — and a block diagram of Floor Riser Wiring is shown on pages 26 and 27.

MODEL 477 CONTROL - THEORY OF OPERATION

DIRECTORY 1

When an apartment is called from Directory #1, the Directory 1 Ring Switch terminal is connected directly to the ring line of the apartment being called. The activated circuit at this time is shown in Figure 16. Note that the Apartment speaker, Model 486-B, is connected between the Remote Common line and the Dir. Ring Switch line. When the pushbutton for an apartment is pushed the following occurs:

TR-16 conducts causing both TR-8 and TR-9 to conduct current.

TR-9 turns on the Tone Generator, TR-2.

TR-8 shorts out R-28, 2.2K ohm, which allows maximum signal of ring tone to be developed at the Apartment speaker. TR-1 and TR-17 are turned on to amplify the tone.

TR-12 conducts, causing CR-2 (Directory #1 Control Relay) to energize.

CR-2C contacts connect the apartment speaker to the Ring amplifier.

As soon as the pushbutton is released, TR-8 and TR-9 cut off. This turns off the Tone Generator and puts R-28, 2.2K ohms back into the circuit.

CR-2, Directory #1 Control Relay activates several other circuits when energized. Contacts CR-2D cause TR-13 to conduct which keeps CR-2D contacts energized. These contacts also disconnect the 24 volt supply from the warning lamp in Directory #1. They also power the TR-3 Timer circuit and turns on the lamp flasher to Directory #2. Contacts CR-2A and CR-2B select the proper directory speaker. When the "Talk" button is pushed on the Apartment remote speaker — it puts this speaker across the A-1 and A-2 lines which feed into the amplifier. To listen, the "Listen" button is pushed and this again places the apartment speaker across the A-1 and A-2 lines and also puts a 2.7K ohm resistor between the Remote Common line and the A-2 (AUD-2) line. The voltage dividing action of this resistor, R201, located on the speaker P/C board, and R28, 2.2K ohms, causes the voltage on the Remote Common line to drop to approximately 10 volts.

This causes D-11 to conduct and saturates, turns on, TR-15. This in turn causes CR-1, Talk/Listen relay to energize. When this relay activates, the following happens:

1. The directory speaker is placed across the amplifier input and the apartment speaker is placed across the amplifier output.
2. CR-1E resets the timer by discharging the capacitor C-2, 50 mfd, while at the same time, contact CR-1F closes providing a path to ground for CR-2 at the moment C2, 50 mfd, is being discharged thru CR-1E. This discharge produces enough negative pulse voltage thru C-5 to momentarily turn off TR-13. Since this is undesirable — CR-1F provides another path to ground to prevent TR-13 from being turned off.

When the Door Release button on the Apartment speaker is pushed to open the door, a 100 ohm resistor, R-202 located on the speaker P/C board, is placed between the Remote Common line and the A-2 (AUD-2) line which causes nearly all the supply voltage to appear across the Zener diode, D-1. D-1 immediately conducts causing TR-14 to conduct. This causes the Door Release Relay, CR-4 to energize. Contact CR-4A forces CR-4 to remain energized until the timer circuit causes both CR-2 and CR-4 to de-energize.

The timer functions as follows:

When CR-2 was energized, it supplied voltage through R-40, 500 K ohm pot, and R-17, 100 K ohms, to charge up C-2. When C-2 charges up to the firing voltage of unijunction transistor TR-3, it conducts, thus discharges C-2. A negative voltage pulse is then delivered through C-5 to TR-13 and turns it off, shutting down the call by de-energizing CR-2.

When CR-4 is energized, by pushing the Door Release button as stated above, and contact CR-4A delivers supply voltage to C-2 thru a lower resistance path, R-18, 47 K ohms, and R-41, 500 K ohm pot, thus charging up the timing capacitor faster. When TR-3 conducts and discharges C-2, a negative pulse is delivered via C-5 to the base of TR-13 and turns it off. CR-4 and CR-2 both de-energize since they were both connected to ground thru TR-13.

A "sneak circuit" which would keep CR-4 energized is prevented by R-54, 4.7 K ohms and D-25. This action is as follows:

1. During operation from Directory #1, CR-2 is energized by TR-13. TR-12 is normally turned off when the pushbutton is released.
2. When CR-4 energizes — contact CR-4A connects resistor R-54, 4.7 K ohms, to the 24 volt supply. TR-12 then goes into full conduction. After completion of the door release timing cycle, TR-13 is turned off by the Timer circuitry. CR-4 then de-energizes. At this time contact CR-4A removes the supply voltage from resistor, R-54, 4.7K ohms, and TR-12 turns off and CR-2 de-energizes. In this manner, CR-4 is assured of de-energizing before CR-2. If CR-2 were to de-energize before CR-4, CR-3 could accidentally be energized. Should CR-3 become energized it would switch contacts CR-3D thus energizing the wrong door release.

DIRECTORY 2

The operation that occurs in placing a call from Directory #2 are similar to those in the preceding explanation of Directory #1 operation.

The primary difference is that CR-3 becomes the directory control relay. TR-10 causes CR-3 to energize when the pushbutton is pushed and TR-11 keeps it energized.

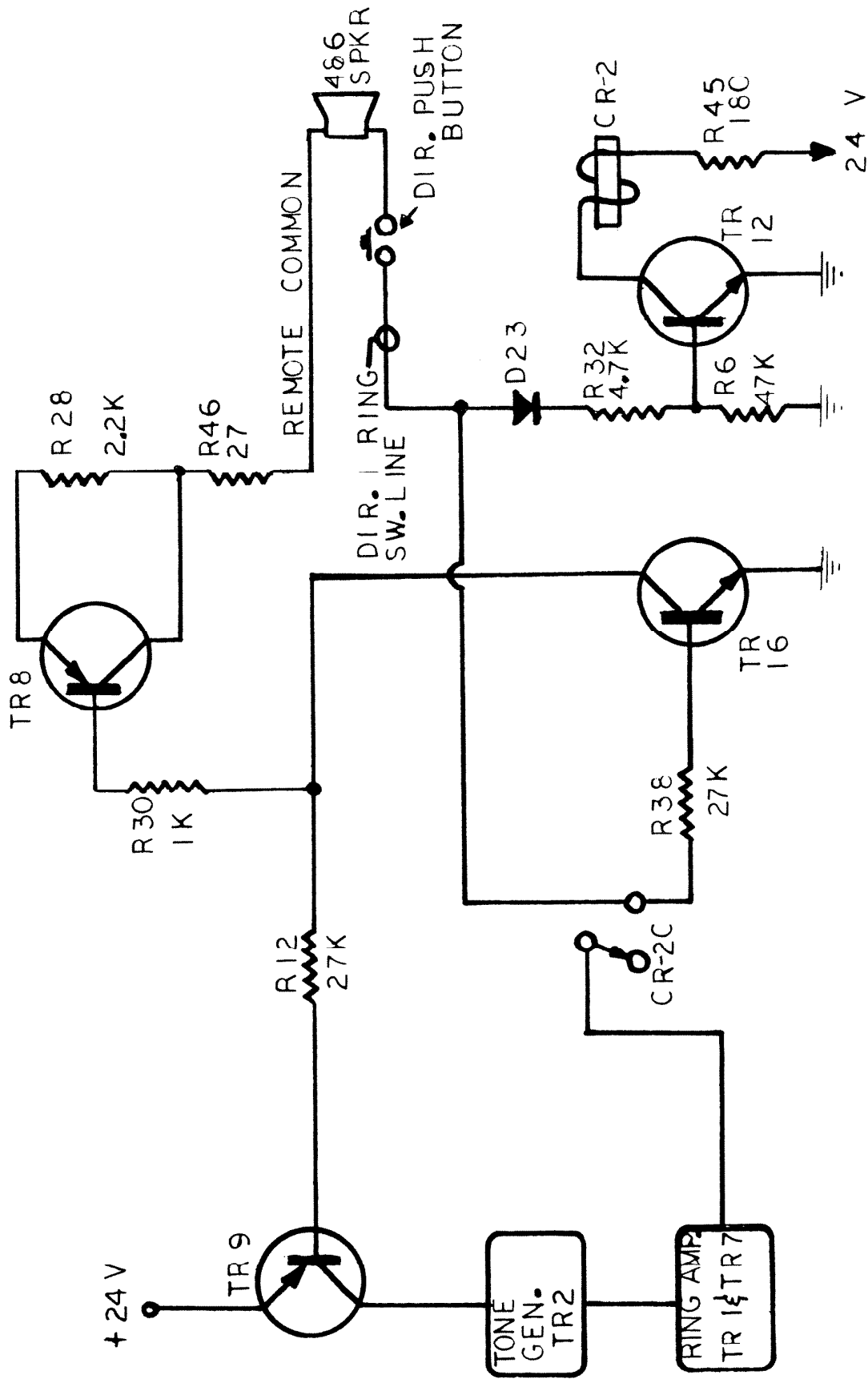


Fig. 16

An Explanation of some Miscellaneous Components:

(A) Diode D-16:

This diode is very important when the following conditions occur:

- (1) Neither directory is in use and the Door Release button is pushed in an apartment. At this time neither door release should operate. However, if D-16 were not in the circuit, the following would happen:
 1. Pressing Door Release button connects a 100 ohm resistor between the A2 line and Remote Common Line. The voltage on the Remote Common line is lowered enough to break over D1 and saturate TR-14.
 2. At this instant CR-4 doesn't energize because neither Directory Relay is energized (CR-2, CR-3).
 3. When TR-14 begins to conduct, current which would normally be blocked by D-16 flows through R-51 and saturates TR-10. This causes CR-3 to energize. CR-4 then has a ground path, therefore it energizes. The result is that the Directory 2 Door Release is activated.

(B) Capacitor C-9:

This capacitor limits the frequency response of the amplifier and prevents pickup and amplification of stray RF signals.

(C) Transistor TR-4:

This transistor resets the timer each time a ring button is pushed. This means that each time an apartment is called, the residents are allowed the full amount of pre-set time to answer the call before the knockdown timer resets the system.

(D) Diodes D-2, 7, 8 and 9:

These diodes absorb the inductive spike which is developed across the relay coils when the supply voltage to these coils is cut off. This prevents this spike from destroying the driver transistor.

(E) Resistor R-43 and Capacitor C-7:

These components inject a small amount of signal into the amplifier from the call tone. This allows the signal to be heard in the lobby when call is being placed.

FUNCTIONAL DESCRIPTION OF DIODES

- D-1 15V Zener to sense that a door release button has been pushed.
- D-2 Inductive spike suppression around CR-4.
- D-3 Provides ground path for CR-1 and for CR-4 when CR-3 is energized (Directory #2 in use).
- D-4 Provides ground path for CR-1 and for CR-4 when CR-2 is energized (Directory #1 in use).
- D-5 Provides ground path for both CR-2 and CR-4 when Talk/Listen relay is energized.
- D-6 Provides ground path to CR1-F for both CR-3 and CR-4 when Talk/Listen relay is energized.
- D-7 Inductive spike suppression around CR-1.
- D-8 Inductive spike suppression around CR-2.
- D-9 Inductive spike suppression around CR-3.

- D-10 Drives shut down timer when Directory #1 is in use and blocks a sneak circuit when Directory #2 is in use.
 - D-11 6.2V Zener to sense when a Talk/Listen button (and a Door Release button) is pushed.
 - D-12 Prevents voltage on TR-3 from getting to base of TR-10.
 - *D-13 Raises threshold voltage required to drive base of TR-4.
 - D-14 Isolates TR-10 and CR-4 to insure that CR-4 de-energizes before CR-3 does.
 - *D-15 Prevents a ground path for CR-4 through CR-2 and warning lamp.
 - D-16 Blocks the base of TR-10 and TR-12 from supply voltage when no call has been made and a Listen or Door Release button has been pushed.
 - D-17 Isolates CR-3 from a sneak circuit when Directory #2 lamp is energized.
 - D-18 19, 20 & 21 — Power Bridge rectifier circuit.
 - D-22 Like D-17, isolates CR-2 from a sneak circuit when Directory #1 lamp is energized.
 - D-23 & D-24 — Blocks TR-16 from conducting when Door Relay CR-4 is energized.
 - D-25 Blocks ring voltage from Directory #1 from turning on TR-10.
 - D-26 Blocks ring voltage from Directory #2 from turning on TR-12.
 - D-27 Like D-14, it isolates TR-12 and CR-4 to insure that CR-4 de-energizes before CR-2 does.
- * Used in early production. Late production has wire strap in place of diode.

FUNCTIONAL DESCRIPTION OF TRANSISTORS

- TR-1 Forms Darlington with TR-17 to amplify call tone.
- TR-2 Unijunction transistor — forms call tone generator.
- TR-3 Unijunction transistor — acts as Door Release Timer and Shut Down Timer.
- TR-4 Resets Shut Down Timer when a call is made. Gives the full shut down time to answer each call. This is important if a second apartment is called after no answer is received from first one.
- TR-5 & 6 — Form a multivibrator to flash warning lamp.
- TR-7 Switch for turning warning lamp on and off.
- TR-8 Shorts out R-28 during ringing.
- TR-9 Turns on call tone generator during ringing.
- TR-10 Causes CR-3 to energize when ringing from Directory #2.
- TR-11 Holds CR-3 energized and de-energized CR-3 when negative pulse is applied to the base terminal.
- TR-12 Causes CR-2 to energize when ringing from Directory #1.
- TR-13 Holds CR-2 energized and de-energizes CR-2 when a negative pulse is applied to the base.
- TR-14 Causes CR-4 to energize when voltage on remote common line is pulled low enough to break over D-1 into conduction.
- TR-15 Causes CR-1 to energize when voltage on remote common line is pulled low enough to break over D-11 into conduction, for Talk/Listen switching.
- TR-16 Senses calling from either directory, and biases TR-8 and TR-9 into conduction.
- TR-17 Forms Darlington with TR-1 to amplify call tone.

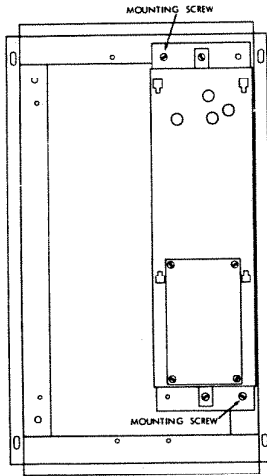


Fig. 17

TYPICAL FLOOR RISER WIRING

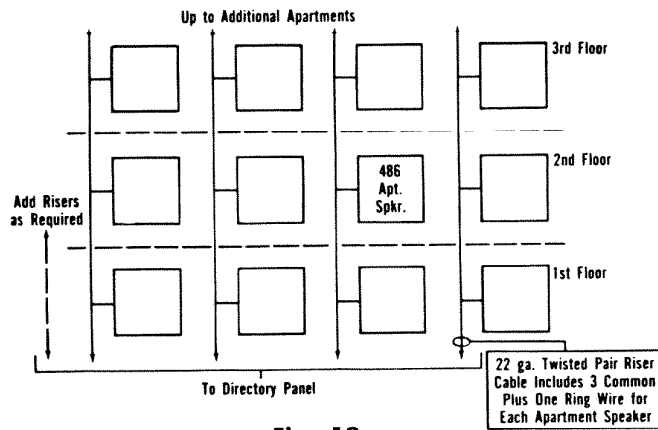


Fig. 18

RISER WIRING DETAIL

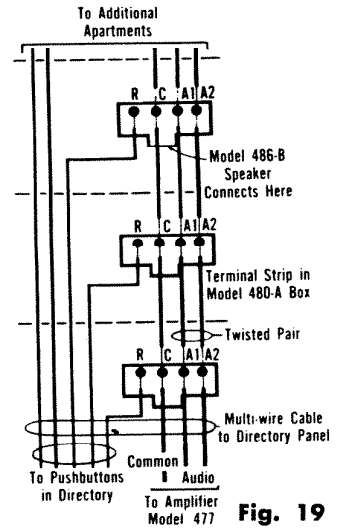


Fig. 19

RISER CABLE CHART

Number of Apartments Served by each Vertical Riser Cable	Number of Wires Required in Riser Cable	Suggested Cable (or Equivalent Trade No.)	Nominal Cable O.D.
1 to 3	4 to 6	NuTone 6-wire (3 pr.) 447 or 448	$\frac{7}{32}$ "
4 to 5	7 to 8	NuTone 8-wire (4 pr.) 2421, 2424 or 2425	$\frac{1}{4}$ "
6 to 9	9 to 12	*Belden, 6 pr. No. 8743	$\frac{5}{16}$ "
10 to 15	13 to 18	*Belden, 9 pr. No. 8744	$\frac{3}{8}$ "
16 to 19	19 to 22	*Belden, 11 pr. No. 8753	$\frac{13}{32}$ "
20 to 23	23 to 26	*Belden, 13 pr. No. 8754	$\frac{7}{16}$ "
24 to 27	27 to 30	*Belden, 15 pr. No. 8745	$\frac{15}{32}$ "

*Not available from NuTone — purchase locally

Fig. 20

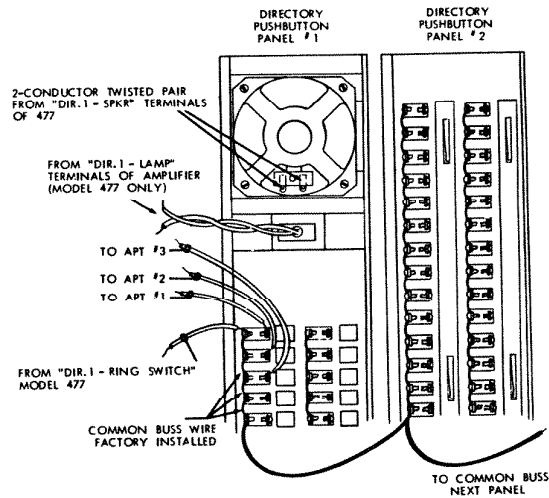


Fig. 21

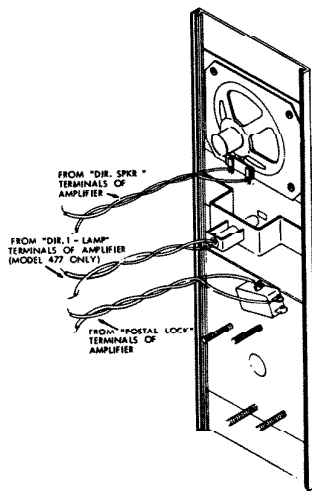


Fig. 22

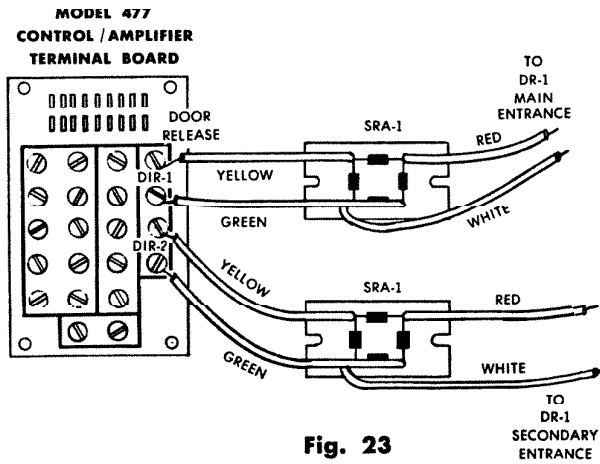


Fig. 23

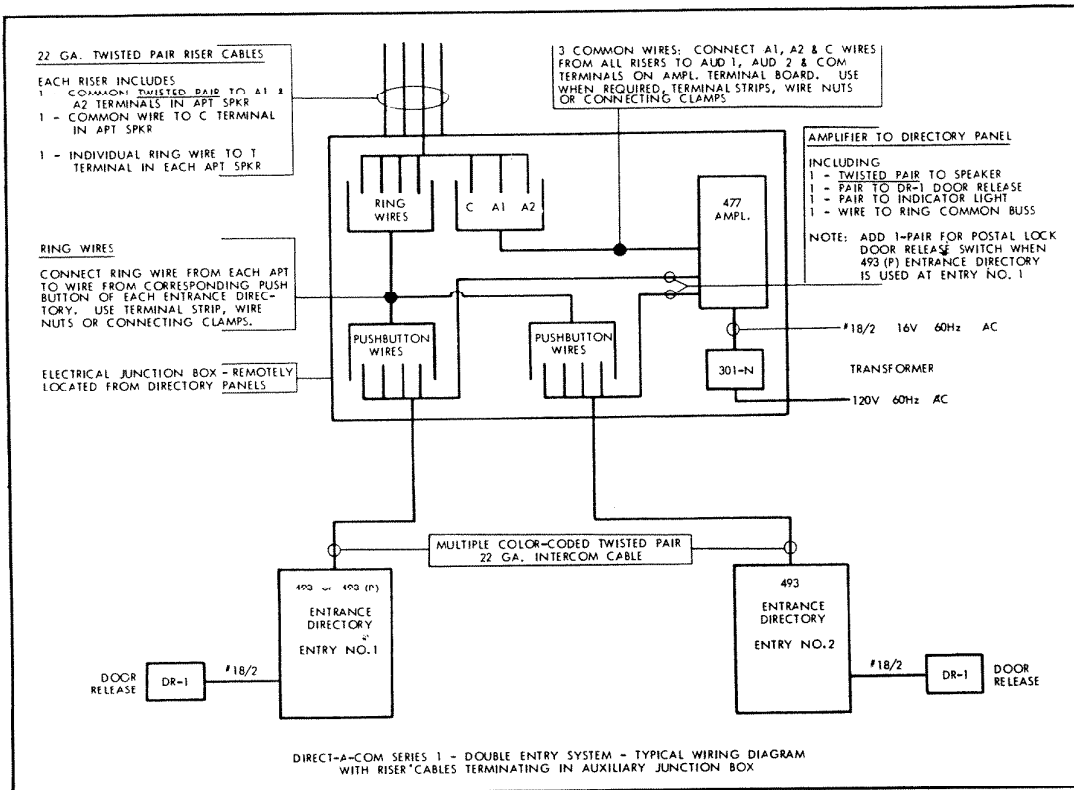
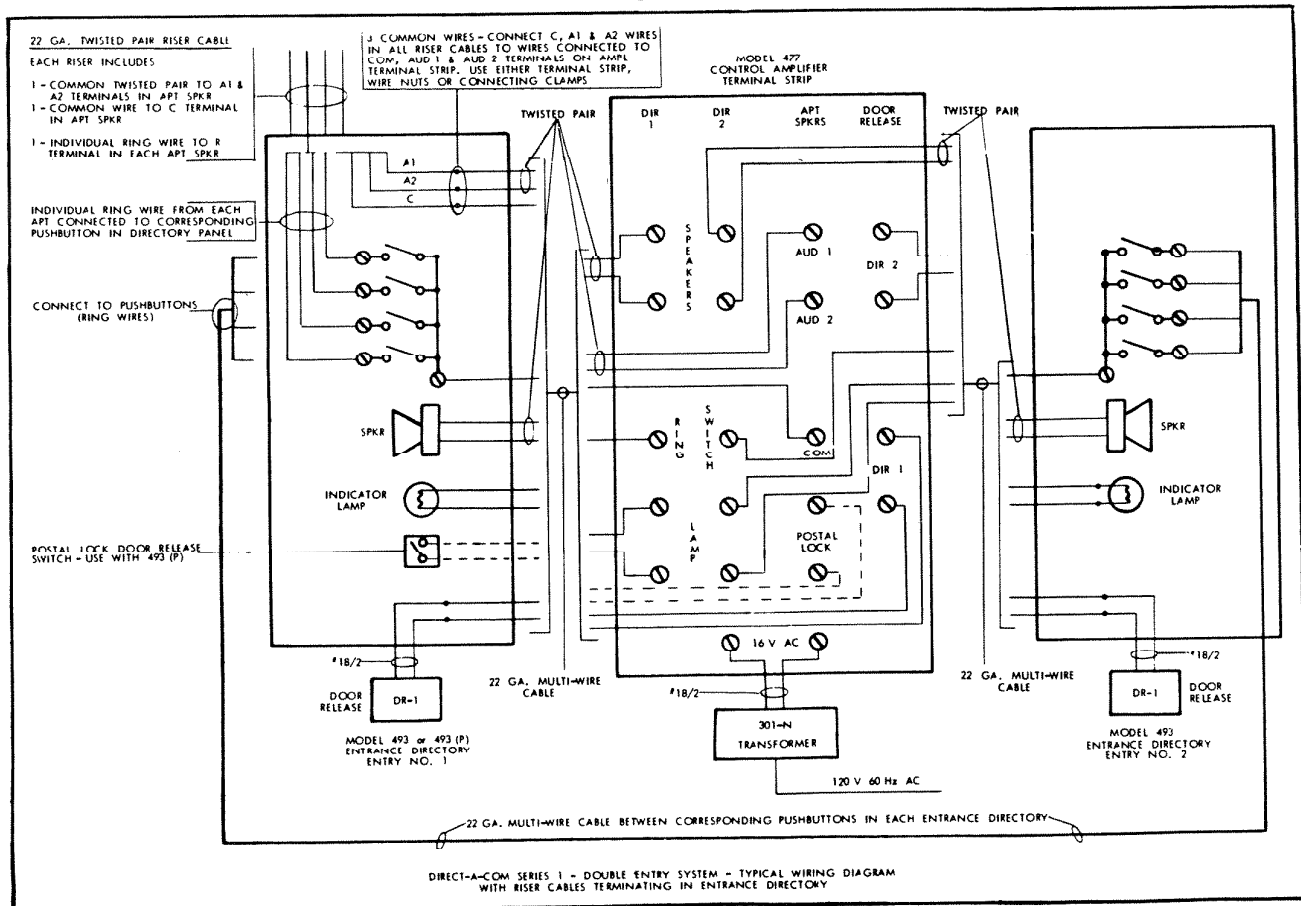


Fig. 24



477 CONTROL BOARD

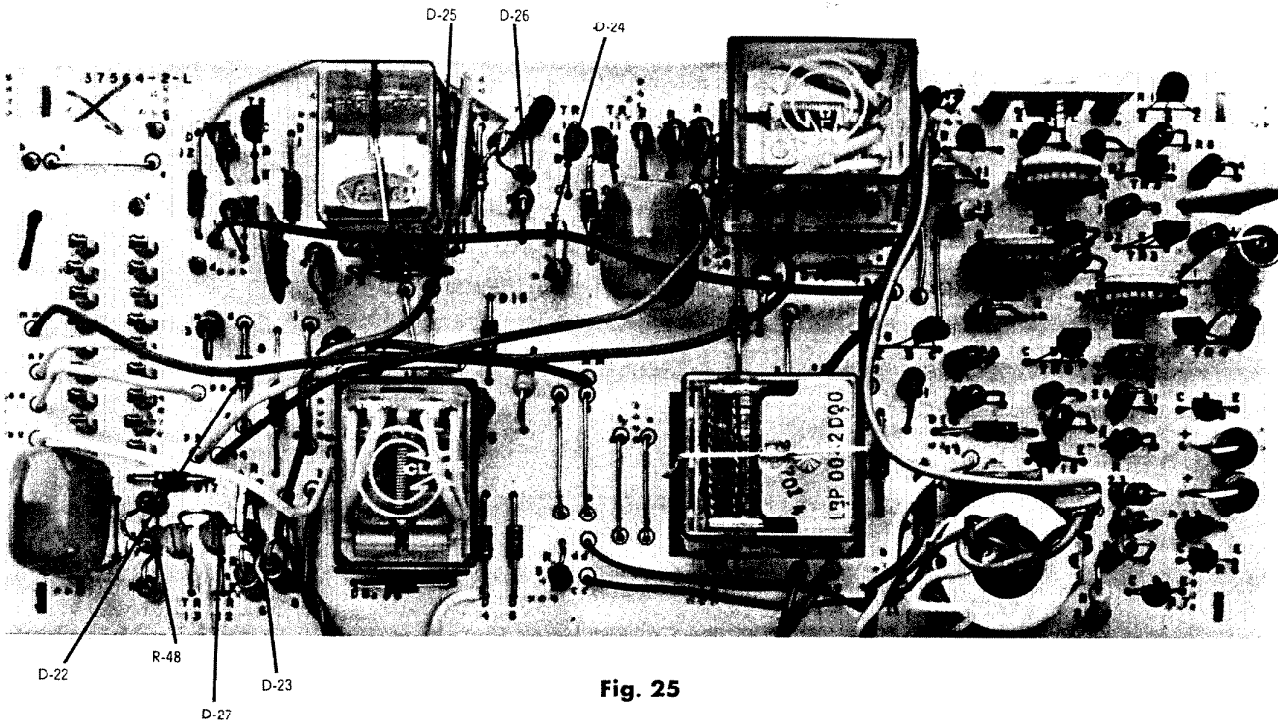


Fig. 25

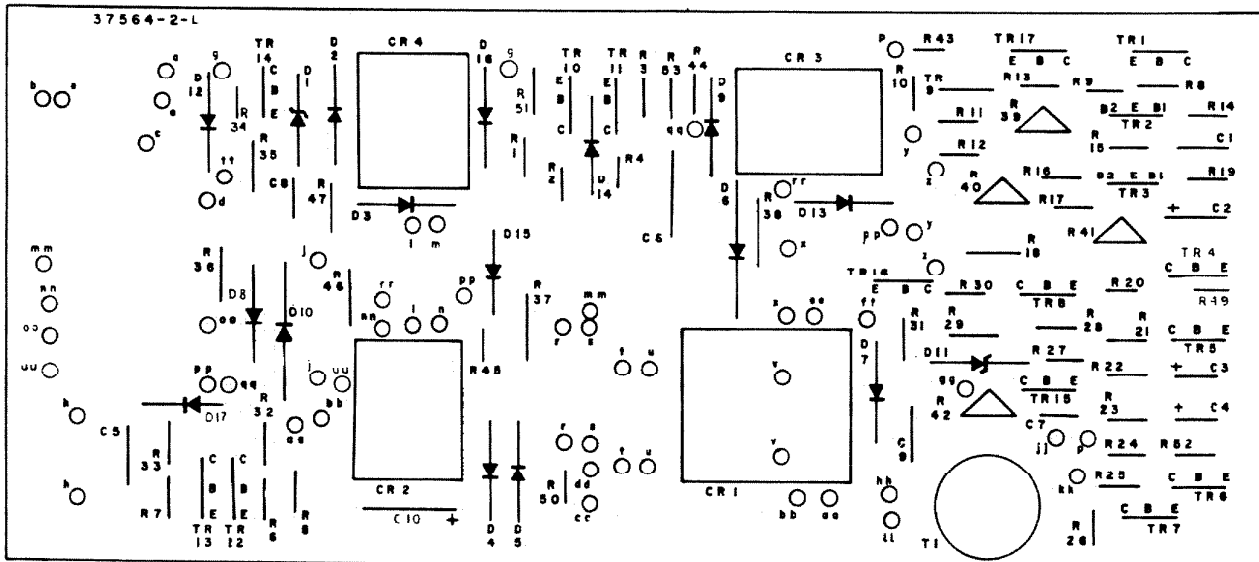


Fig. 25A

TRANSISTOR CALL-OUTS 477 CONTROL BOARD

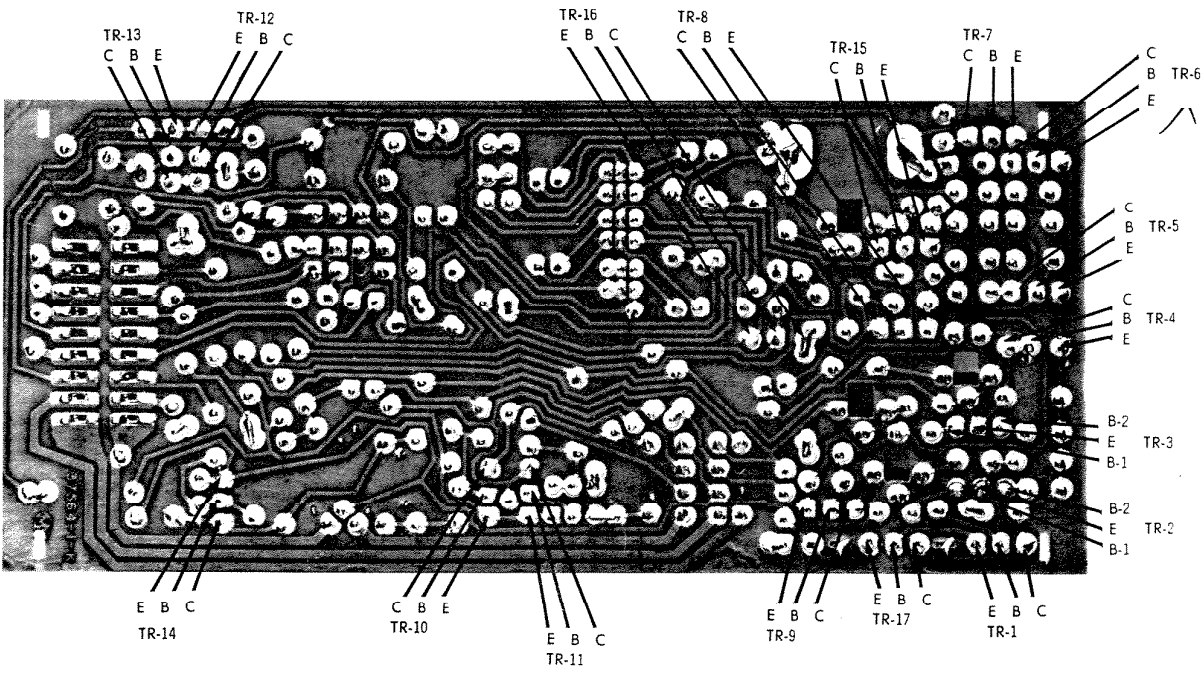


Fig. 26

CALL-OUTS - POWER SUPPLY FOR 477 CONTROL /AMPLIFIER

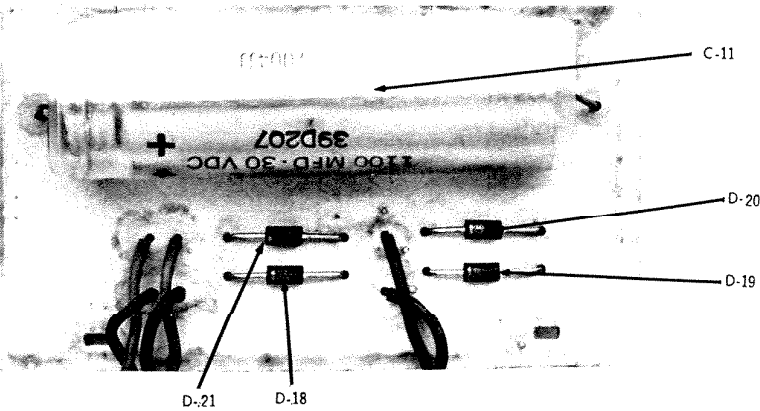


Fig. 27

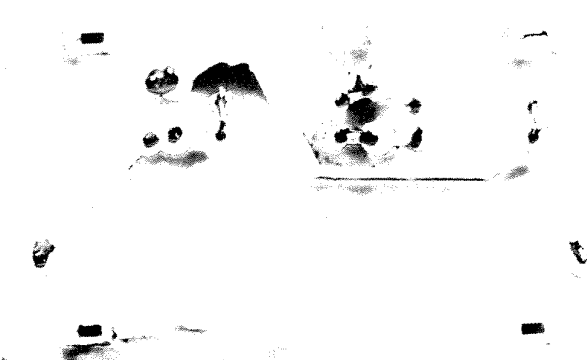


Fig. 28

VOLTAGE CHART FOR MODEL 477 CONTROL

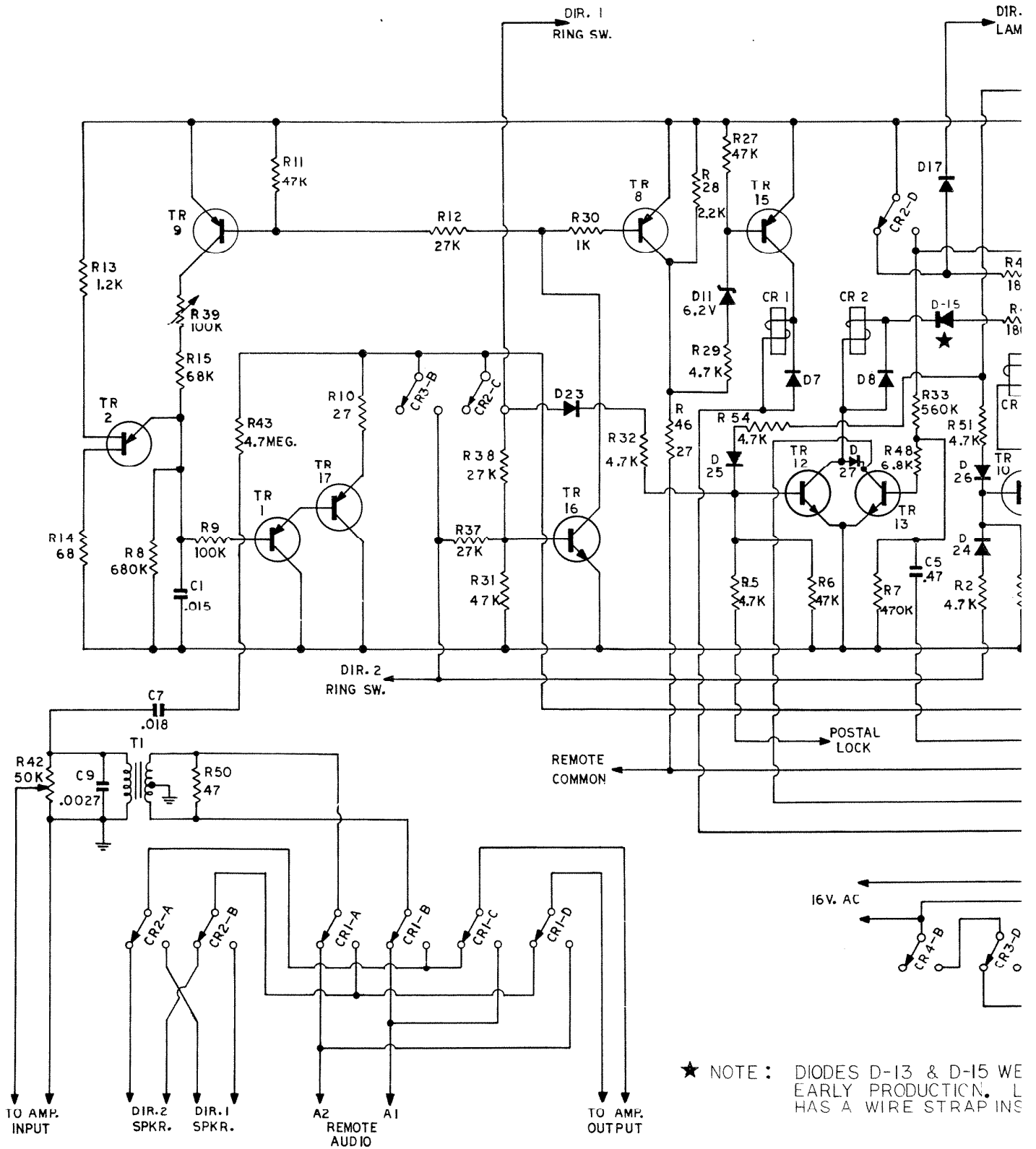
MODE		NO LOAD	RINGING DIRECTORY #1	RINGING DIRECTORY #2	AFTER RINGING DIRECTORY #1	AFTER RINGING DIRECTORY #2	TALK BUTTON DEPRESSED NOTE #1	LISTEN BUTTON DEPRESSED NOTE #2, #3	DOOR RELEASE BUTTON DEPRESSED AFTER RINGING DIR. #1	DOOR RELEASE BUTTON DEPRESSED AFTER RINGING DIR. #2, #3, #4	AFTER DOOR RELEASE IS ACTIVATED DIR. #1	AFTER DOOR RELEASE IS ACTIVATED DIR. #2 NOTE #5
TR-1	E	0	8.5	8.5	0	0			0		0	
	B	0	7	7.5	0	0			0		0	
	C	0	0	0	0	0			0		0	
TR-2	B-1	.15	.15	.15	.15	.15			.15		.15	
	E	.005	7.5	7.5	0	0			0		0	
	B-2	19.5	18	18	19	19			17		17	
TR-3	B-1	.15	.15	.15	.15	.15			.15		.15	
	E	.005	.3	.3	0 to 12 to 0	0 to 12 to 0			0		0	
	B-2	19	18	18	18	18			16		17	
TR-4	E	0	0	0	0	0			0		0	
	B	.005	.7	.7	0	0			0		0	
	C	0	.04	.04	0 to 12 to 0	0 to 12 to 0			0		0 to 12 to 0	
TR-5	F	0	0	0	0	0			0		0	
	B	0	-3 to +.5	-3 to +.5	-3 to +.5	-3 to +.5			-3 to +.5		-3 to +.5	
	C	21.5	1 to 17	1 to 17	1 to 17	1 to 17			1 to 17		1 to 17	
TR-6	E	0	0	0	0	0			0		0	
	B	.7	-4 to +.5	-4 to +.5	-4 to +.5	-4 to +.5			-4 to +.5		-4 to +.5	
	C	.1	1 to 10	1 to 10	1 to 10	1 to 10			1 to 10		1 to 10	
TR-7	E	0	0	0	0	0			0		0	
	B	.1	.2 to .7	.2 to .7	.2 to .7	.2 to .7			.2 to .7		.2 to .7	
	C	21.5	1 to 18	1 to 18	1 to 18	1 to 18			1 to 18		1 to 18	
TR-8	E	22	20	20	21	21		21	18		19	
	B	22	19	19	21	21		21	18		19	
	C	22	19.5	19.5	21	21		12	1.2		19	
TR-9	E	22	20	20	21	21			19		19	
	B	22	19	19	21	21			19		19	
	C	0	20	20	0	0			0		0	
TR-10	E	0	0	0	0	0			0	0	0	0
	B	0	.3	.8	.1	.8			.8	.8	.8	.8
	C	21.5	.4	.2	.75	1.5			0	.15	0	.12
TR-11	E	0	0	0	0	0			0	0	0	0
	B	0	0	1	.1	1.2			-.5 to 0	1.2	.1 Neg. Kick	1.2 Neg. Kick
	C	21	.4	.5	.75	.7			.7	.7	2	.7
TR-12	E	0	0	0	0	0			0	0	0	0
	B	0	.8	.25	0	0			.8	.8	.8	.8
	C	21	.2	1	.15	1.5			.1	0	.15	1
TR-13	E	0	0	0	0	0			0	0	0	0
	B	0	1	0	1.5	.08			1.2	-.5 to 0	1.2 Neg. Kick	.1 Neg. Kick
	C	21	.5	.85	.7	1.2			.7	2	.7	.8
TR-14	E	21.5	20	20	21	21			18		19	
	B	21.5	20	20	21	21			17		19	
	C	.6	0	0	0	0			18		19	
TR-15	E	21.5	20	20	21	21		21	18		19	
	B	21.5	20	20	21	21		20	17.5		19	
	C	.6	0	0	0	0		20.5	18.5		0	
TR-16	E	0	0	0	0	0			0		0	
	B	0	.8	.8	0	0			0		0	
	C	21.5	.25	.25	21	21			19		19	
TR-17	E	0	9.5	9.5	0	0			0		0	
	B	0	8.5	8.5	0	0			0		0	
	C	0	0	0	0	0			0		0	

NOTES: #1. Same as readings after ringing Directory #1 or #2.
 #2. Same as readings after ringing Directory #1 or #2.
 #3. Same as readings after ringing Directory #1 with the exceptions of TR-8 and TR-15.

#4. Same as readings after ringing Directory #1 with the exceptions of TR-10 to TR-13.
 #5. Same as readings after ringing Directory #1 with the exceptions of TR-10 to TR-13.

TONE GENERATOR AND ELECTRONIC SWITCH

TALK LISTEN RELAY DIR.1 CONTROL REL. DIR.2



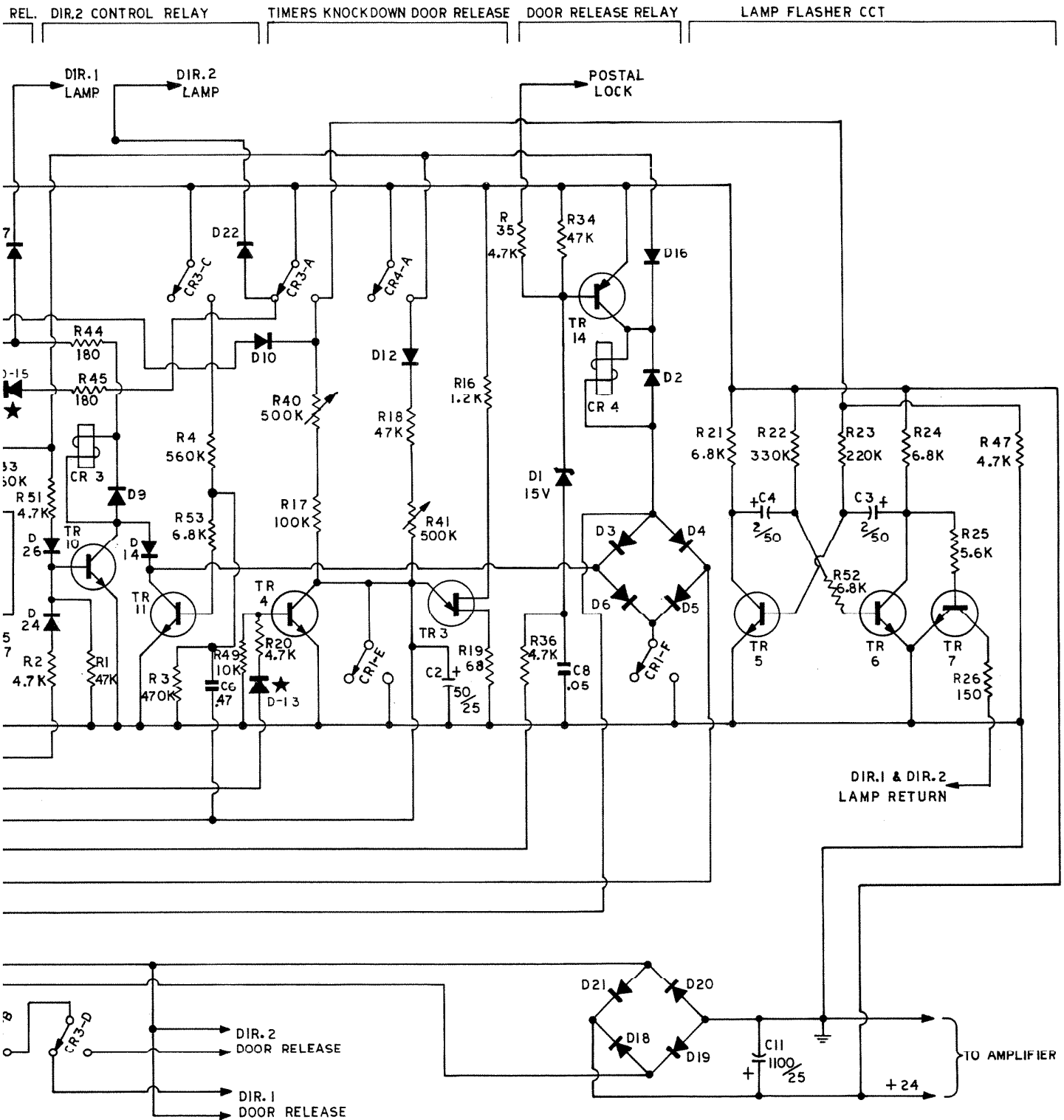


Fig. 29

PARTS LIST FOR MODEL 477 CONTROL

REF. NO.	NUTONE PART NUMBER	DESCRIPTION
----------	--------------------	-------------

TRANSISTORS

TR-1	36577	
TR-2	36597 (Motorola 2N4870)	
TR-3	36597 (Motorola 2N4870)	
TR-4	36580	
TR-5	36580	
TR-6	36580	
TR-7	36591 (Motorola MPS 6530)	
TR-8	*36592 (Motorola MPS 6533)	
	36603 (Motorola MPS U55)	
TR-9	36577	
TR-10	36586 (Motorola MPS 1315)	
TR-11	36590 (Motorola MPS A13)	
TR-12	36590 (Motorola MPS A13)	
TR-13	36586 (Motorola MPS 1315)	
TR-14	36587 (Motorola MPS 6517)	
TR-15	36587 (Motorola MPS 6517)	
TR-16	36580	
TR-17	*36588 (Motorola MPS U51)	
	36603 (Motorola MPS U55)	

* Used in early production

DIODES

D-1	36595 (Motorola 1N5245)	15V Zener
D-2	36549 (Motorola 1N4002)	
D-3	36549 (Motorola 1N4002)	
D-4	36549 (Motorola 1N4002)	
D-5	36549 (Motorola 1N4002)	
D-6	36549 (Motorola 1N4002)	
D-7	36549 (Motorola 1N4002)	
D-8	36549 (Motorola 1N4002)	
D-9	36549 (Motorola 1N4002)	
D-10	36553	
D-11	36594 (Motorola 1N5234)	6.2V Zener
D-12	36553	
D-13*	36553	
D-14	36549 (Motorola 1N4002)	
D-15*	36549 (Motorola 1N4002)	
D-16	36549 (Motorola 1N4002)	
D-17	36549 (Motorola 1N4002)	
D-18	36549 (Motorola 1N4002)	
D-19	36549 (Motorola 1N4002)	
D-20	36549 (Motorola 1N4002)	
D-21	36549 (Motorola 1N4002)	
D-22	36549 (Motorola 1N4002)	
D-23	36549 (Motorola 1N4002)	
D-24	36549 (Motorola 1N4002)	
D-25	36549 (Motorola 1N4002)	
D-26	36549 (Motorola 1N4002)	
D-27	36549 (Motorola 1N4002)	

* Early production only

PARTS LIST FOR MODEL 477 CONTROL (cont'd)

REF. NO.	MUTONE PART NUMBER	DESCRIPTION
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CAPACITORS

C-1	35100-148	.015 mfd 50V
C-2	35068-113	50 mfd 25V
C-3	35068-106	2 mfd 50V
C-4	35068-106	2 mfd 50V
C-5	35024-101	.47 mfd 75V
C-6	35024-101	.47 mfd 75V
C-7	35076-104	.082 mfd 12V
C-8	35100-141	.05 mfd 50V
C-9	35100-155	.0027 mfd 50V
C-10		
C-11	35085-102	1100 mfd 25V

RESISTORS

R-1		47K ohms
R-2		4.7K ohms
R-3		470K ohms
R-4		560K ohms
R-5		4.7K ohms
R-6		47K ohms
R-7		470K ohms
R-8		680K ohms
R-9		100K ohms
R-10		27 ohms
R-11		47K ohms
R-12		27K ohms
R-13		1.2K ohms
R-14		68 ohms
R-15		68K ohms
R-16		1.2K ohms
R-17		100K ohms
R-18		47K ohms
R-19		68 ohms
R-20		4.7K ohms
R-21		6.8K ohms
R-22		330K ohms
R-23		220K ohms
R-24		6.8K ohms
R-25		5.6K ohms
R-26		150 ohms
R-27		47K ohms
R-28		2.2K ohms
R-29		4.7K ohms
R-30		1K ohms
R-31		47K ohms
R-32		4.7K ohms
R-33		560K ohms
R-34		47K ohms
R-35		4.7K ohms
R-36		4.7K ohms
R-37		27K ohms
R-38		27K ohms

PARTS LIST FOR MODEL 477 CONTROL (cont'd)

REF. NO.	NUTONE PART NUMBER	DESCRIPTION
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RESISTORS (cont.)

R-39	34042	Potentiometer	100K ohms
R-40	34043	Potentiometer	500K ohms
R-41	34043	Potentiometer	500K ohms
R-42	34041	Potentiometer	50K ohms
R-43			4.7 Meg ohms
R-44			180 ohms
R-45			180 ohms
R-46			27 ohms
R-47			4.7K ohms
R-48			6.8K ohms
R-49			10K ohms
R-50			47 ohms
R-51			4.7K ohms
R-52			6.8K ohms
R-53			6.8K ohms
R-54			4.7K ohms

RELAYS

CR-1	36039		LPB.
CR-2	39038		4PDT
CR-3	39038		4PDT
CR-4	39039		2PDT

TRANSFORMER

T-1	30536		Audio Input
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Parts may be ordered — by NuTone part number, direct from our factory — at the following address.

NuTone — Division of Scovill
P. O. Box 27
Cincinnati, Ohio 45227

Our minimum service parts order is \$2.00. Allow (2) weeks for filling your service parts order at the factory.