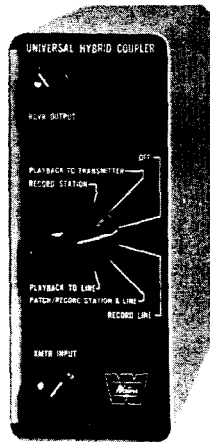
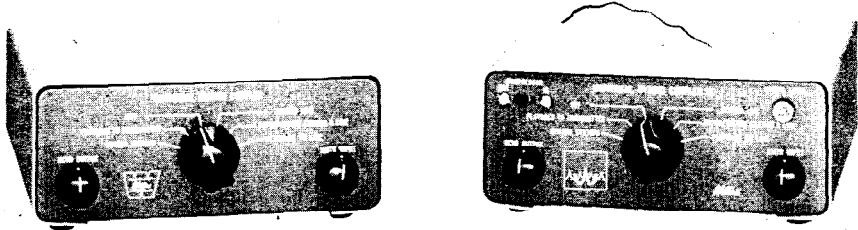


# UNIVERSAL HYBRID COUPLERS

MODELS 3001 AND 3002



*Waters* **MANUFACTURING, INC.**  
**WAYLAND, MASSACHUSETTS**

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## WATERS UNIVERSAL HYBRID COUPLERS

### MODELS 3001 and 3002

#### INSTRUCTIONS AND TECHNICAL DESCRIPTION

The WATERS Universal Hybrid Coupler is the successor to the phone patch. For the first time, it is now possible to make full use of a hybrid circuit beyond the obvious use as a phone patch. Now, through the use of the Universal Hybrid Coupler, the Tape Recorder becomes a useful and even necessary unit in the well equipped radio station. Your Tape Recorder is immediately ready to record, STORE, and playback conversations obtained from either the telephone line or from your own station. Unique to the Universal Hybrid Coupler is the ability to record not only what you hear from your receiver, but BOTH sides of the QSO (conversation).

As a phone patch, the Universal Hybrid Coupler operates either VOX (voice operated relay) or "Push-to-Talk" with equal facility and with any of the currently available combinations of commercial receivers and transmitters, including the very popular transceivers, such as the Collins KWM-1, or KWM-2/2A.

The Universal Hybrid Coupler 3002 differs from the Model 3001 Universal Hybrid Coupler only in that it incorporates the new WATERS Compreamp, fully transistorized speech preamplifier/limiter in the output circuit.

The purpose of the Compreamp is to increase the usefulness of the Universal Hybrid Coupler by making possible automatic VOX phone patch operation when the distant telephone signal is below the usual level required for full modulation and "Auto Vox" operation. At the same time, the Compreamp permits use of YOUR local telephone (as the station microphone during a patch) without overdriving the input to the exciter.

A second purpose of the Compreamp in the Universal Hybrid Coupler is to provide for speech compression in the normal operation of the station using a station microphone. When the function switch of the Universal Hybrid Coupler is turned to the "Off" position, the station microphone feeds through the Universal Hybrid Coupler circuits into and out of the Compreamp, and then into the microphone input of your transmitter. Proper use of the Compreamp speech compressor will afford a useful voice power gain at the distant receiving location equivalent to an increase in transmitter power of up to 4 times. This is especially useful during periods of high noise, interference, or other difficult transmission conditions.

The following tabulation of switch positions explains in detail the many functions of the Universal Hybrid Coupler:

Position 1 - Record Station In conjunction with the Tape Recorder, it is possible to record both sides of a radio conversation while the radio equipment operates normally.

Position 2 - Playback to Transmitter A recording can be played back to the radio transmitter and put on the air. The recording is automatically monitored during playback using the radio receiver loud speaker.

Position 3 - Off The Universal Hybrid Coupler is inactive and disconnected from the 600 ohm line (telephone). The station radio equipment and the telephone line operate normally and independently of each other.

Position 4 - Record Line Telephone conversations can be recorded with the Tape Recorder. While recording, all other radio equipment facilities operate in their normal manner independently of the telephone line.

Position 5 - Patch/Record Station and Line In this position, the Universal Hybrid Coupler acts as a "Phone Patch". Speech being received from the remote party on the telephone line is delivered to the radio transmitter and put on the air, and the output of the radio receiver is put onto the telephone line so that it can be heard by the remote party. The telephone at the radio station where the Universal Hybrid Coupler is installed is, of course, part of the circuit and acts as the station microphone and headphone, with the off-the-air received signal being heard only in the telephone receiver. The entire two-way conversation can be recorded simultaneously by the Tape Recorder. VOX operation is normal - that is, the remote party on the telephone line will turn on your transmitter when he speaks, as will you when you speak into your local telephone microphone.

Position 6 - Playback to Line In this position, tape recordings can be played back to the telephone line, independently of all other station radio facilities which are disconnected from the telephone line and can be operated normally.

### THEORY OF OPERATION

Referring to the Schematic, Figure 1,  $C_1$  is a blocking capacitor to prevent putting a dc load on the telephone line when the coupler is connected to the line.  $RFC_1$  and  $RFC_2$  in conjunction with  $C_2$  through  $C_5$ , form a filter to keep any RF on the telephone line from entering the speech system of the radio transmitter.  $T_1$  is a bridging transformer which is used to feed the Tape Recorder in Position 1, 4, and 5, and to feed the line and Hybrid in Positions 2 and 6.  $R_1$  through  $R_3$  form an attenuator with about 10 db of attenuation to isolate the Hybrid from the telephone line. Thus, the impedance presented to the phone line is constant across the speech band.

$Z_1$  is a special Hybrid network which prevents energy from the receiver output from feeding into the transmitter and tripping the VOX.  $T_2$  is a transformer used to feed the Hybrid, and  $T_3$  is the output transformer from the Hybrid to the transmitter speech amplifier.

The Balance Network resistance,  $R_7$  and  $R_{13}$ , can be adjusted to give a null over a range of line impedances having a resistive component from under 200 to over 1800 ohms.  $R_6$  is the receiver output control and adjusts the level into the Hybrid.

$R_8$  is the "XMTR INPUT" control and determines the level fed to the transmitter speech amplifier.  $R_9$  and  $R_{10}$  form a dividing network to provide a proper level to the speech amplifier in Position 2.

$R_{12}$  is used to prevent loading a high impedance microphone with the relatively low impedance of the secondary of  $T_1$ .  $R_{11}$  presents the proper load to the output transformer of the Tape Recorder in Position 6, while  $R_{14}$  prevents shorting out the receiver speaker when the "RCVR OUTPUT" control is turned all the way down.

The Compreamp unit, which is shown in the schematic as a separate block, is an instantaneous acting logarithmic compressor in which the compression is obtained by the use of back-to-back solid state diodes, together with suitably designed networks to avoid spikes and excess distortion. The Compreamp circuit comprises a two-stage transistor audio amplifier in which the first stage is an emitter follower with a variable compression/gain control,  $R_{21}$ , that feeds the second stage which operates in a grounded emitter configuration. The compressor diodes  $D_1$  and  $D_2$  are fed through a logarithmic network from the output of the second stage, and the output of the diodes are connected to an attenuator/filter network to reduce the output level of the Compreamp and provide for additional response shaping. Resistor  $R_{29}$  is included in the circuit but left shorted for use with dynamic microphones with a nominal 50,000 ohm output impedance. When crystal microphones are employed, the short across resistor  $R_{29}$  should be removed. Switch S-2 simultaneously turns on the battery supply and connects the Compreamp in series with the output of the Universal Hybrid Coupler and the "OUTPUT TO XMTR" terminal. Power for the Compreamp is from an external 9-volt battery.

### IMPEDANCE LEVELS

#### Models 3001 and 3002

#### INPUTS

"LINE" .....	600 ohms nominal
"RX OUTPUT" .....	4 ohms nominal, varies with setting of "RCVR OUTPUT" control
"MIKE" .....	High impedance, crystal or dynamic
"TAPE REC SPEAKER" .....	4 ohms nominal

#### IMPEDANCES

#### OUTPUTS

"TO TAPE REC" .....	1/2 megohm
"TO XMTR" .....	50K nominal
"RX SPKR" .....	4 ohms nominal

#### IMPEDANCES

## COMPREAMP IN UNIVERSAL HYBRID COUPLER MODEL 3002

Input Impedance .....	100K ohms (nominal)
Input Level .....	.005 to .020 volts
Gain (voltage) .....	10 db (nominal)
Output Level .....	.060 volts
Output Impedance .....	50K ohms (nominal)
Battery (9 volts) .....	Burgess 2U6 or equivalent

### ABBREVIATIONS USED

"RX", "RCVR" .....	Receiver
"XMTR" .....	Transmitter
"TAPE REC" .....	Tape Recorder
"SPKR" .....	Speaker
"GND" .....	Ground

### INSTALLATION

The following leads are necessary for installation of the Universal Hybrid Coupler. See inter-connection Diagrams for specific transmitters and receivers.

1) A twisted pair of #22 solid insulated wire of sufficient length to reach from the telephone junction box ( $L_1$ ,  $L_2$ ) to the "LINE" terminals of the coupler is satisfactory. When connecting, be extremely careful not to short out the telephone terminals or to allow either one to touch any other connection or ground. No attention need be paid to the polarity of the telephone line since the Universal Hybrid Coupler uses a non-polarized input condenser.

2) Single conductor shielded microphone cable, such as Belden 8411 with a phono plug at the coupler end (Cinch 13A supplied) and a mike connector to fit the radio transmitter at the other end.

3) A lead the same as #2 just described, except that the second connector must match the low-level microphone input of the Tape Recorder. The length of this cable should be as short as possible to avoid degrading high frequency response. This lead runs from the coupler output marked "TO TAPE REC" to the Tape Recorder input. The Cinch 13A connector for this lead is also supplied.

4) A twisted pair to run from the terminals on the coupler marked "SPEAKER OF TAPE REC" to the Tape Recorder. This pair of leads should have a connector to match the "EXTERNAL SPEAKER" output of the tape recorder. Care should be taken to make sure that the grounded side of the Tape Recorder "EXTERNAL SPEAKER" output is connected to the terminal marked "GND" of the two terminals labelled "TAPE REC SPEAKER" on the coupler.

5) A pair of leads (#22) from the receiver output terminals to the coupler and a pair from the coupler to the speaker. One lead from the receiver 4 ohm "SPEAKER" terminals is connected to the "RX OUTPUT" terminal on the coupler, and the other to the "GND" terminal on the coupler. (The "GND" terminal referred to is that between the terminals marked "RX OUTPUT" and "RX SPKR".) If one side of the "SPEAKER" output connection on the receiver is connected to the receiver chassis or ground in the receiver, this is the lead that must be connected to the "GND" terminal on the coupler, otherwise the speaker will be shorted out. Note that in some cases the "SPEAKER" output connection passes through the transmitter where it is connected through contacts on the VOX relay.

6) The microphone to be connected to the coupler must either be equipped with a phono plug (Cinch 13A supplied) or an adapter and plugged into the "MIKE" connection on the coupler.

7) The "GND" terminal of the Universal Hybrid Coupler should be connected to the station ground.

#### ADJUSTMENT

This section explains the method for adjusting the Null Balance and Gain Controls on the Universal Hybrid Coupler.

In the Model 3002 the Compreamp switch MUST be in the OUT position during the adjustment procedure.

Vox-Operated Installations: After completion of the connections as described, and with your receiver and transmitter Gain and VOX controls at their normal positions, call a friend on the telephone, and then put the Universal Hybrid Coupler switch in the "PATCH/RECORD STATION and LINE" position. Starting with the "RCVR OUTPUT" and "XMTR INPUT" controls of the Universal Hybrid Coupler fully counterclockwise, slowly advance the "XMTR INPUT" control until the voice of the party on the other end of the phone line just trips your transmitter VOX when he is speaking normally. Now begin to slowly turn the "RCVR OUTPUT" control clockwise to feed the output of the receiver to your friend on the phone line. As this is done, you will reach a point where the receiver will trip the VOX in the transmitter. When this occurs, slowly rotate the "NULL BALANCE" control until the VOX releases. By repeating this procedure in small increments, it will be possible to feed a good loud signal from the receiver to the phone line without tripping the transmitter VOX. Except under conditions where the impedance of the phone line is vastly different from that found during the set-up procedure set forth, it should not be necessary to readjust the "NULL BALANCE" control. Similarly, the "RCVR OUTPUT" and "XMTR INPUT" controls will require only infrequent adjustment.

The controls on the Universal Hybrid Coupler have now been set, and now the gain controls on the Tape Recorder can be set so a proper recording level is obtained, and a proper level is put back into the Universal Hybrid Coupler in the various positions. You will notice that when the Universal Hybrid Coupler is in the "RECORD STATION" position, the receiver output as heard from the speaker will drop slightly. This is normal and should cause no concern.

Compreamp Level Adjustment: (Model 3002 only). This section suggests methods for determining the proper amount of gain and compression of the Compreamp. First determine the type of microphone in use at your station. If it is a dynamic microphone, which we recommend, with an output impedance of 50,000 ohms, the compressor unit is correctly wired. If you contemplate using a ceramic or crystal microphone, it will be necessary first to remove the jumper wire across Resistor R-29, 1 megohm, on the printed circuit board inside of the Universal Hybrid Coupler.

In order to avoid creating interference on the band during this adjustment, it is suggested that the transmitter be tuned and loaded into a non-radiating dummy load, such as WATERS Model 334.

With the Compreamp switch in the OUT position, tune and load the transmitter in accordance with manufacturer's instructions. Then adjust transmitter microphone gain setting so that plate current in the exciter output amplifier AVERAGES 40% of the loaded value, and that maximum VOICE PEAK plate current swings do not exceed 50% of loaded value. A useful word voice phrase to use during adjustment is, "This is, this is . . . .".

Now, put compressor switch to the IN position and gradually increase Compressor Level potentiometer while saying, "This is . . . .", until AVERAGE plate current is about 45% - 50% of loaded value. Do not use more gain than this level to avoid excessive distortion. If an oscilloscope is connected to observe the output waveform, it will be seen that the compressor "fills up" the valleys between the peaks but will not at all increase the peak value.

With AM transmitters, care should be exercised to avoid over modulation by using excessive audio gain.

#### PUSH-TO-TALK INSTALLATIONS

To use the Universal Hybrid Coupler with "Push-To-Talk" transmitters, an adapter cable (see Fig. 3) is required to carry the "Push-To-Talk" control lead around the Universal Hybrid Coupler. When used in this manner, no adjustment of the "NULL BALANCE" control is necessary.

Fig. 6 illustrates the installation of the Universal Hybrid Coupler with Collins KWM-2 and KWM-2A equipment with two different types of microphones, those with, and those without "Push-To-Talk" switches. In either case, the front panel microphone jack is not used and the input connector on the rear of the Collins transceiver labelled "Phone Patch" is used instead. When using a microphone without a "Push-To-Talk" switch, the connections are made as shown in Fig. 6, and a momentary SPST toggle switch shown can be "pushed" to transmit, or the VOX circuitry can be adjusted for this purpose. The usual "Mobile" type of high impedance microphone with a "Push-To-Talk" switch (such as the Electro-Voice 600D) may be used with the Universal Hybrid Coupler, and the KWM-2, or KWM-2A, by making a simple adapter permitting use of the PL-68 three conductor plug on the microphone. In order to use a "Push-To-Talk" mobile microphone for VOX operation, it will usually be necessary to open the microphone case and disable that part of the "Push-To-Talk" switch that short circuits the microphone element when the "Push-To-Talk" button is released. The adapter circuitry is also shown in Fig. 6

and provides "Push-To-Talk" operation for either normal transmitting use or phone patch use. The adapter goes between the microphone and the Universal Hybrid Coupler and KWM-2 or KWM-2A for phone patch use. The lead from the adapter labelled "To Phone Patch" is connected to the "MIKE" input on the Universal Hybrid Coupler and a shielded lead connects the "TO XMTR" output of the Universal Hybrid Coupler to the "Phone Patch" input of the Collins transceiver. The lead from the adapter labelled "PTT" connects to the connector labelled "PTT" on the Collins KWM-2 or KWM-2A.

### OPERATING HINTS

When using your WATERS Universal Hybrid Coupler as a "Phone Patch" always keep it in the "OFF" position, disconnected from the telephone line while you place the call, so that there is no possibility of putting dial tone, dial clicks, busy signals, the telephone operator's voice or other extraneous signals on the air. Once your call has been put through, it is merely necessary to turn the Universal Hybrid Coupler function switch to the "PATCH/RECORD STATION and LINE", and you and the remote party are on the air.

The compressor in your WATERS Universal Hybrid Coupler II, Model 3002, is specifically designed to be used in conjunction with the phone patch feature of the Universal Hybrid Coupler and is intended to increase the level of a poor distant party telephone signal to permit automatic VOX operation of your transmitter. It also prevents overdriving your transmitter during a phone patch when you speak into your telephone handset which then operates as the station microphone.

It is not recommended that the compressor be used in conjunction with your dynamic or crystal microphone under normal transmitting conditions of your transmitter. Regard the compressor as a device that will assist in getting through when either atmospheric or crowded band conditions will not permit reliable communications.

R. F. Interference: It is possible to observe audio distortion when using the Compreamp-equipped Universal Hybrid Coupler due to R. F. leakage in your station. The Universal Hybrid Coupler should be grounded to the station ground and NO R. F. should be present on the microphone. In general, installation with transmitters that are well shielded and that use matched coaxial transmission lines will seldom give trouble.

### NOTES ON TAPE RECORDERS

The Universal Hybrid Coupler is capable of operating with most American Tape Recorders, as well as some foreign-made AC powered recorders: In general, it is



necessary that the recorder has available an "EXTERNAL SPEAKER" jack that disconnects the internal speaker when using the Universal Hybrid Coupler, and, further, that the speaker impedance is nominally 3.2 to 4 ohms. The recorder should also have a "MICROPHONE INPUT" jack with an input impedance of 50,000 to 500,000 ohms. If the recorder is furnished with a crystal microphone or a high impedance dynamic microphone, it may be presumed that the recorder will operate satisfactorily with the Universal Hybrid Coupler. Tape speeds from 1.87 to 3.75 inches per second are entirely adequate for the voice frequency range used in communications work. Typical American-made recorders such as VM, Revere, and Webcor have been found to work well. Avoid use of transistorized recorders because of different input and output impedances which are not suitable without special matching transformers.

**NOTE:** Federal law prohibits the recording of telephone conversations without the consent of the remote party on the telephone line. Always obtain permission from the remote party before recording a telephone conversation.

### MOUNTING

The Universal Hybrid Coupler is shipped with the front panel arranged for horizontal mounting. By removing the three knobs, and the three mounting nuts for the two controls and the switch, the front panel can be reversed, permitting vertical mounting to the side of a receiver or transmitter. The long screws holding the feet and cover on are removed and passed through the rubber feet and cover into the coupler. In the case of Collins "S-Line" equipment, the perforations in the cover can be used without drilling.

**NOTE:** When disassembling the front panel, the "RCVR OUTPUT" control potentiometer is mounted with two shouldered fibre washers to insulate the bushing of the control from the chassis. If these washers are not properly reassembled, or if the case of the potentiometer touches the chassis, the wiper arm of the control will short to the chassis and improper operation of the coupler will result.

### PANEL INSTALLATION

The WATERS Universal Hybrid Coupler is designed so that in addition to the normal cabinet use, it may be mounted on panels to provide a wide variety of individuality. Such panel mounting can be accomplished by drilling only control holes in the panel to which the Universal Hybrid Coupler is to be mounted. The cover of the Universal Hybrid Coupler still provides the normal shielding and mechanical protection for the Universal Hybrid Coupler.

To mount behind a panel, first remove the cover by removing the four screws holding the feet and cover on, and then the two screws holding the light grey trim strip across the bottom front of the unit. Remove the three knobs and the 3/8-32 nut and lockwasher securing the switch. Next, being careful to preserve the hardware in the order that it is removed, remove the 3/8-32 nuts and lockwashers from the two gain controls. Also remove the shouldered fiber washer from each gain control. Next,

remove the front panel of the unit. Remove the two very thin fiber washers which are between the back of the panel and the chassis. (Discard these washers). Gently pull both gain controls back through their mounting holes and remove the 1/8" fiber washers from all three bushings and discard. (2 gain controls, one switch). In the case of the "RCVR OUTPUT" control, note that a shouldered fiber washer must be removed to remove the 1/8" fiber washer. Replace the shouldered fiber washer on the "RCVR OUTPUT" control bushing making sure the smaller diameter portion faces away from the body of the control).

Using the Universal Hybrid Coupler front panel as a template, select the position on your panel where the Universal Hybrid Coupler is to be located. (Note that by reversing the front panel, the unit can be mounted either horizontally or vertically.) Next, drill two 7/16 diameter holes for the "XMTR OUTPUT" control, and switch, one 17/32 diameter hole for the "RCVR OUTPUT" control, and four holes for compressor level control and switch, in the location selected.

Push the Universal Hybrid Coupler controls through the Universal Hybrid Coupler chassis holes, and then through the holes in your panel. Also push the switch through the panel hole. Place the Universal Hybrid Coupler Panel over the three bushings and reassemble the hardware.

For the "RCVR OUTPUT" and "XMTR INPUT" controls, mount the shouldered fiber washer (smaller diameter toward the panel) and the 3/8-32 lock washer and nut. For the switch, mount the 3/8-32 locknut and washer.

(Note: On the "RCVR OUTPUT" control, the two shouldered fiber washers are necessary to insulate the bushing of this control from the chassis. If the hardware is reassembled incorrectly, the wiper of the control will be shorted to ground and improper operation will result).

Reassemble the three knobs, setting the pointers of the two gain controls at 7 o'clock when the controls are fully counterclockwise.

The cover may now be pushed on the Universal Hybrid Coupler from the rear and screwed down.

Note: If the Universal Hybrid Coupler is attached to the side of another piece of gear as described earlier, use the screw taped to the inside of the chassis for the foot which is located under the "RCVR OUTPUT" control. The original screw will be found to be too short and was provided to prevent damaging this control at factory assembly.

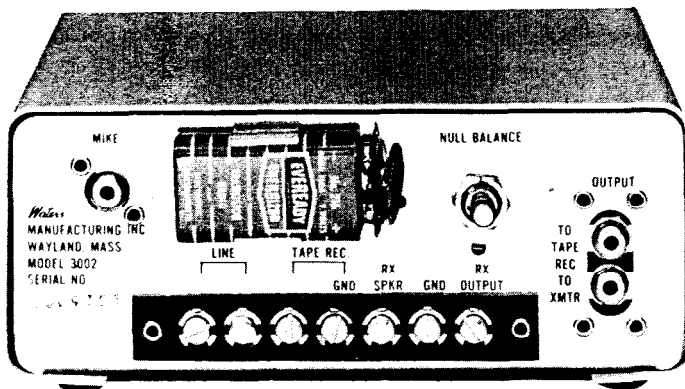
### STANDARD ELECTRONIC INSTRUMENT WARRANTY

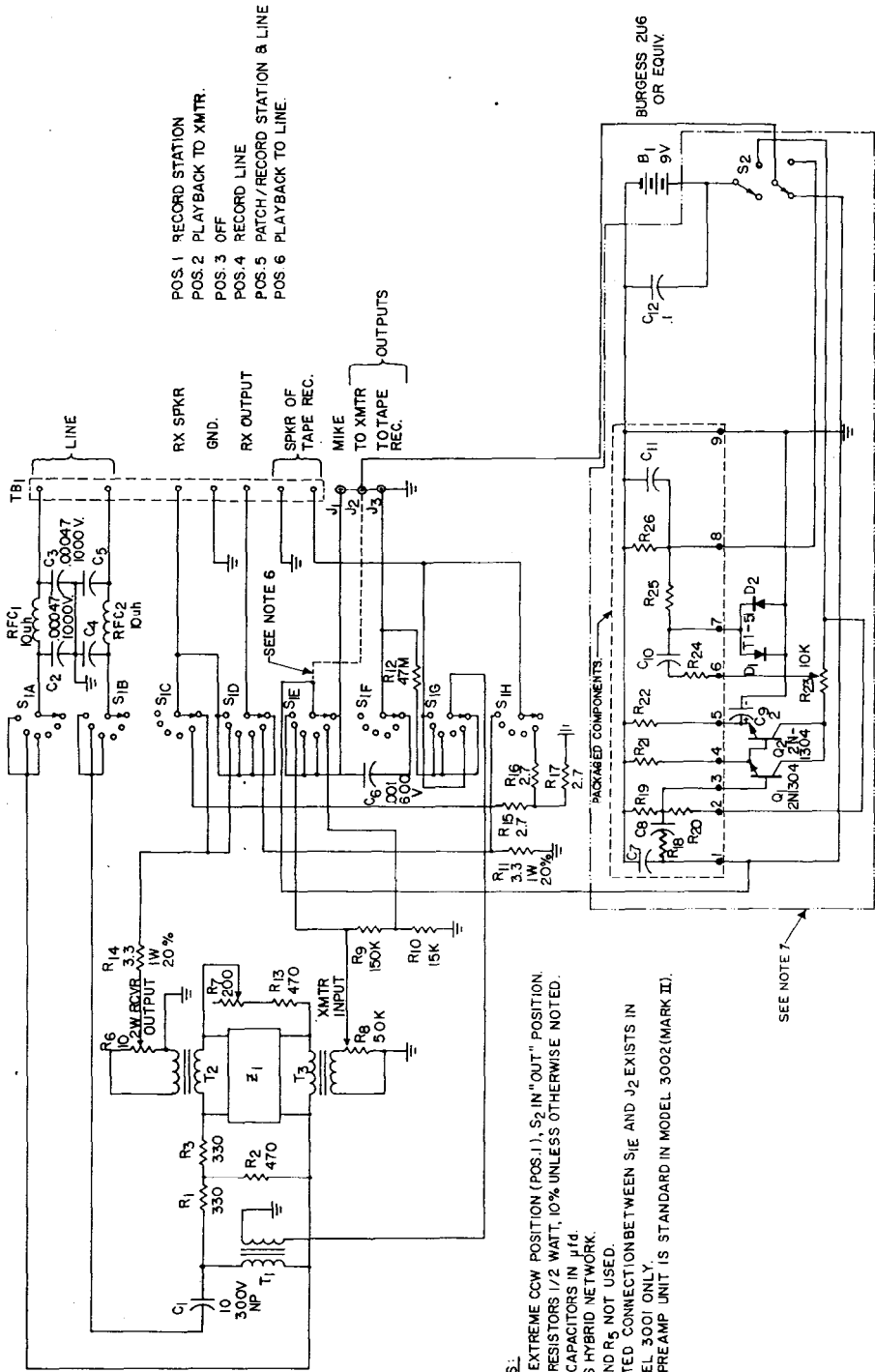
Each instrument, or part thereof, sold by Waters Manufacturing, Inc. is warranted to be free from original defects in material and workmanship.

The obligation under this warranty is limited to the repair or replacement of any instrument or part thereof, except tubes, semi-conductor devices, and batteries, which shall, within the period of one year from the shipment to the original purchaser, prove upon examination by Waters Manufacturing, Inc. to have become defective through normal use or handling.

In all cases where service or adjustment is required, please write first to the factory, giving full information concerning the nature of the failure, including type and serial number of the equipment. Written procedure for returning the instrument to the factory will be given.

The right is reserved to change the published specifications of equipment at any time, and to furnish merchandise in accordance with current specifications, without incurring any liability to modify equipment previously sold, or to supply new equipment in accordance with earlier specifications.





**NOTES:**

1. S1 IN EXTREME CCW POSITION (POS. 1), S2 IN "OUT" POSITION.
2. ALL RESISTORS 1/2 WATT, 10% UNLESS OTHERWISE NOTED.
3. ALL CAPACITORS IN  $\mu$ F4.
4. Z1 IS HYBRID NETWORK.
5. R4 AND R5 NOT USED.
6. DOTTED CONNECTION BETWEEN S1E AND J2 EXISTS IN MODEL 3001 ONLY.
7. COMP-AMP UNIT IS STANDARD IN MODEL 3002 (MARK II).

FIG. 1 SCHEMATIC  
 WATERS UNIVERSAL HYBRID COUPLERS  
 MODEL 3001, MODEL 3002.

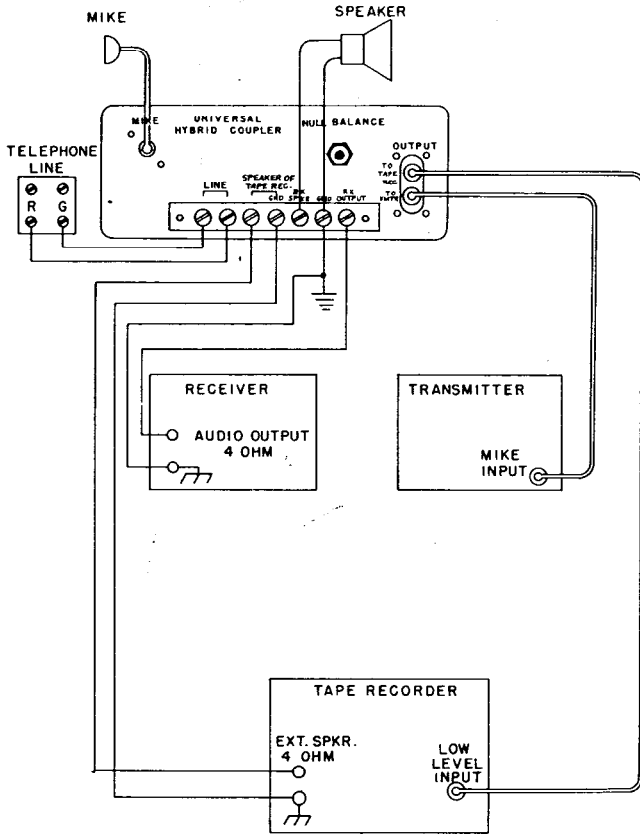


FIG. 2 TYPICAL GENERAL  
INSTALLATION

M-B348-20/0/10-63

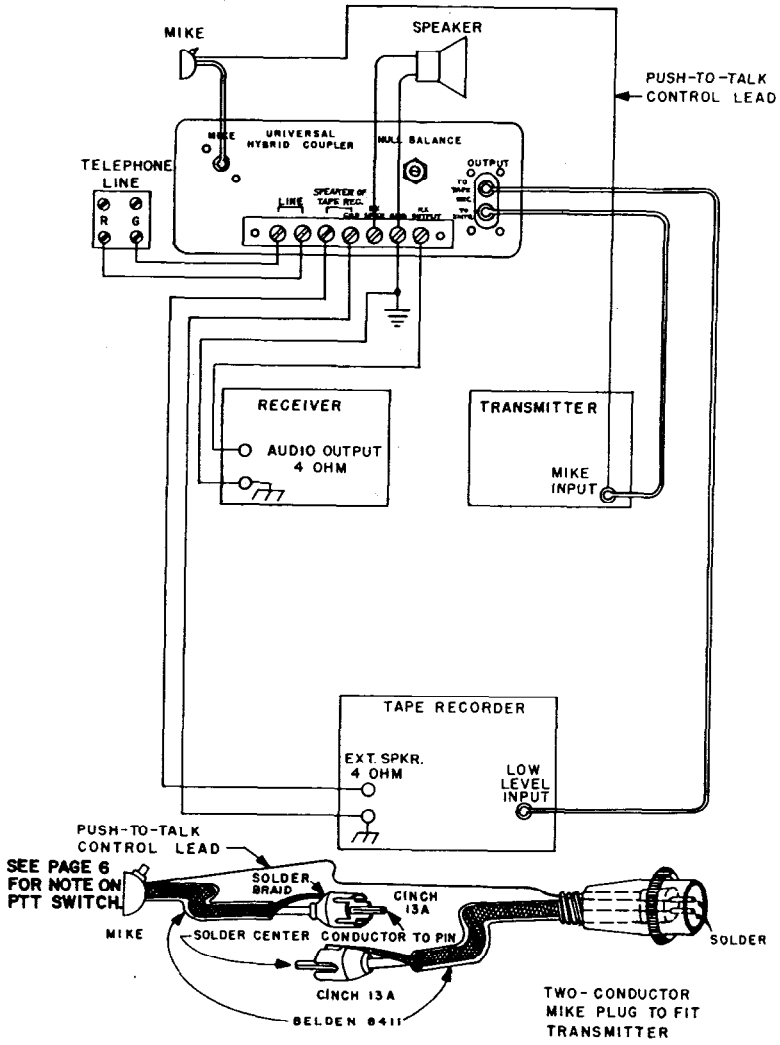
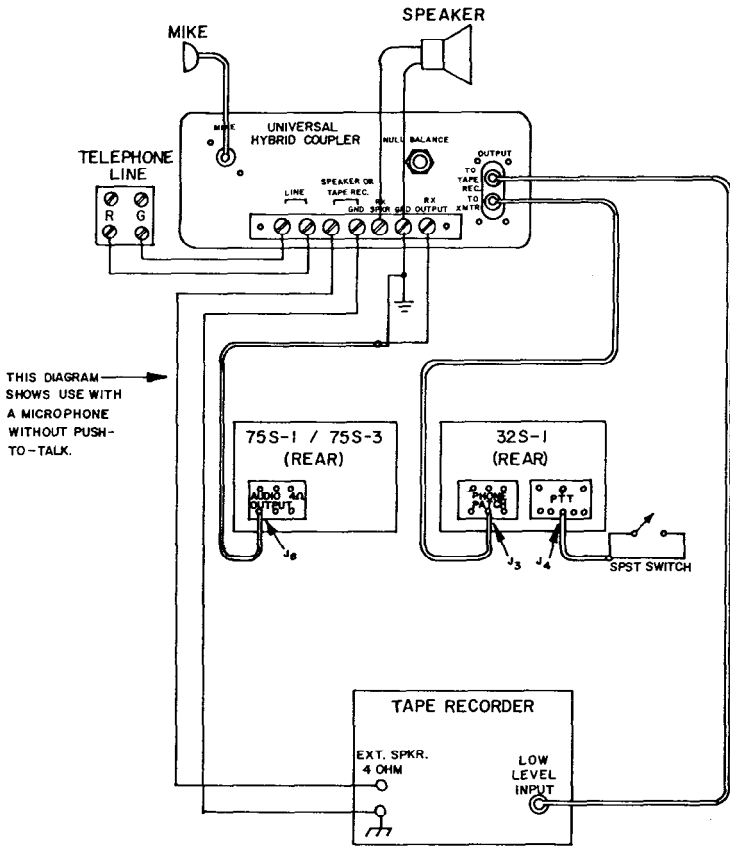


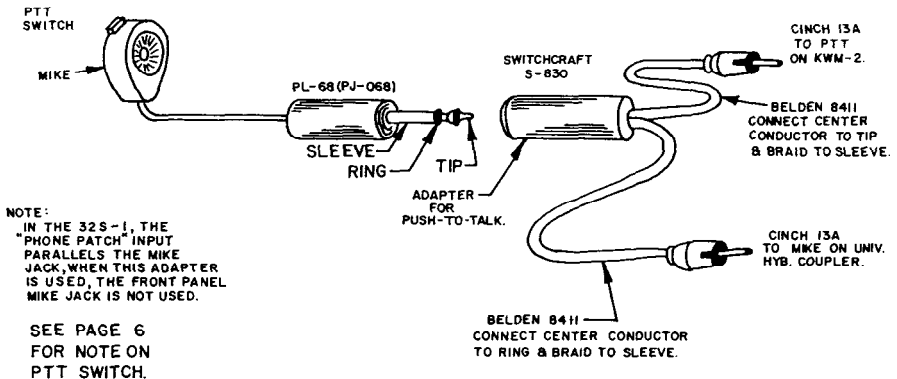
FIG. 3 TYPICAL GENERAL INSTALLATION USING PUSH-TO-TALK

M-B348-21/0/10-63



THIS DIAGRAM  
SHOWS USE WITH  
A MICROPHONE  
WITHOUT PUSH-  
TO-TALK.

FOR PUSH-TO-TALK OPERATION  
WITH TYPICAL PTT MIKE AND  
STANDARD PL-68 (PJ-068) PLUG  
USE ADAPTER SHOWN BELOW

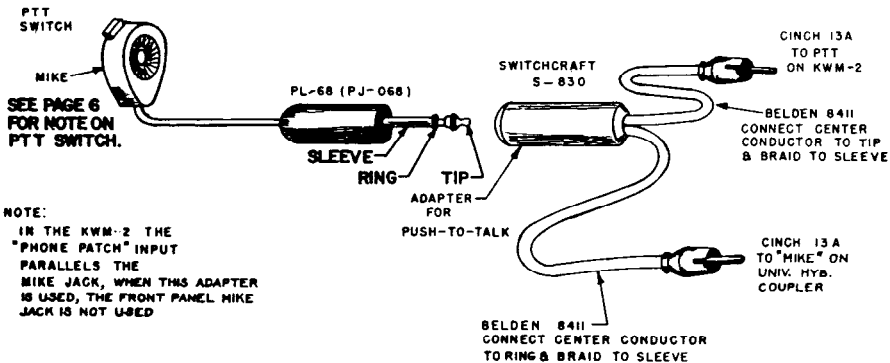
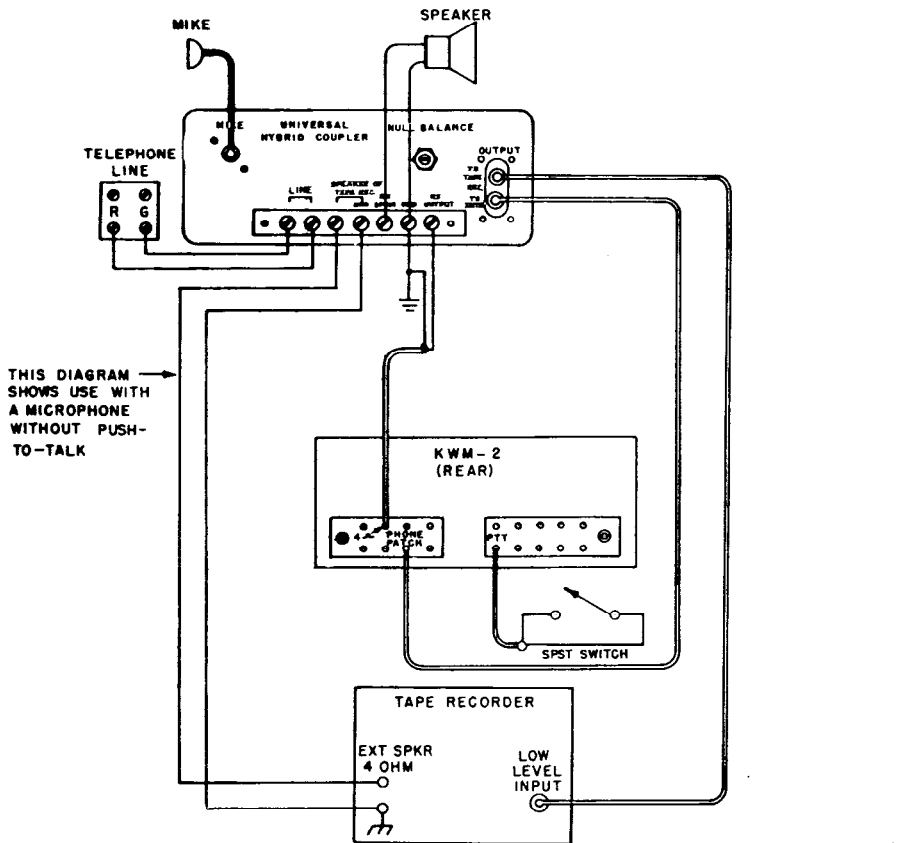


NOTE:  
IN THE 32S-1, THE  
"PHONE PATCH" INPUT  
PARALLELS THE MIKE  
JACK, WHEN THIS ADAPTER  
IS USED, THE FRONT PANEL  
MIKE JACK IS NOT USED.

SEE PAGE 6  
FOR NOTE ON  
PTT SWITCH.

FIG. 4 TYPICAL INSTALLATION  
WITH  
COLLINS 32S-1 & 75S-1/75S-3, "S" LINE.

M-B348-22/AA/5-66



NOTE:  
 IN THE KWM-2 THE  
 "PHONE PATCH" INPUT  
 PARALLELS THE  
 MIKE JACK, WHEN THIS ADAPTER  
 IS USED, THE FRONT PANEL MIKE  
 JACK IS NOT USED

FIG. 5 TYPICAL INSTALLATION  
 WITH  
 COLLINS KWM-2 & KWM-2A

M-B348-24A/10-63



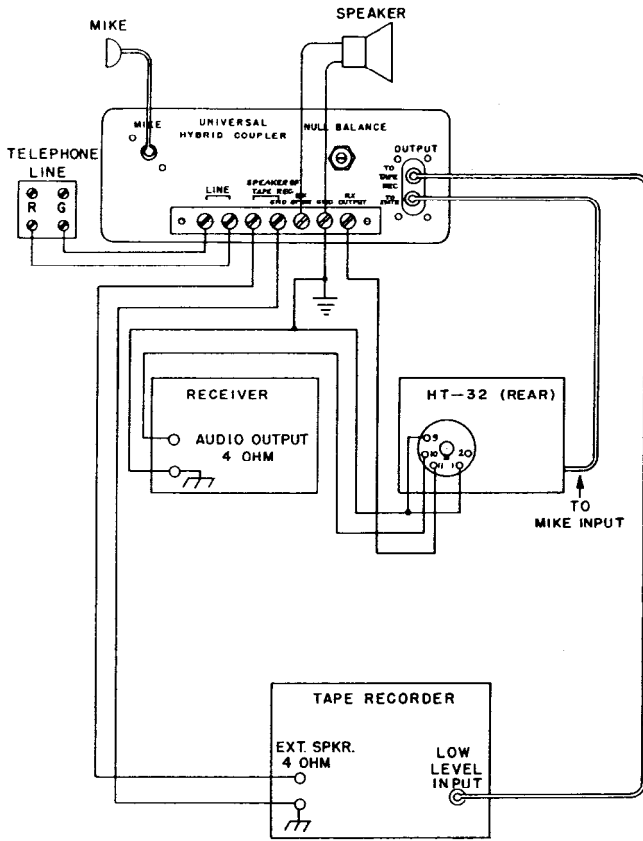


FIG. 6 TYPICAL INSTALLATION M-8348-25/AV10-63  
 WITH  
 HALLICRAFTERS HT-32 TRANSMITTER

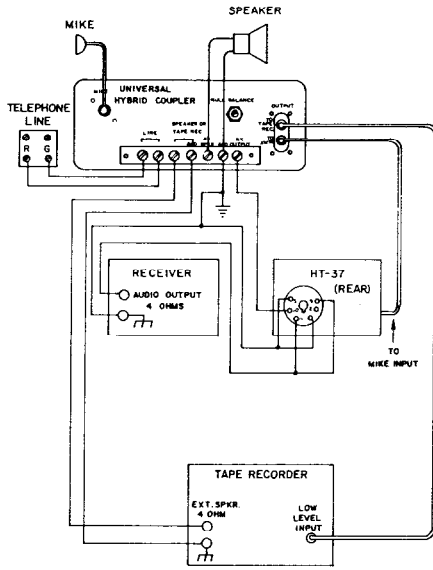


FIG. 7 TYPICAL INSTALLATION M-8348-26AA/5-66  
WITH  
HALLICRAFTERS HT-37 TRANSMITTER

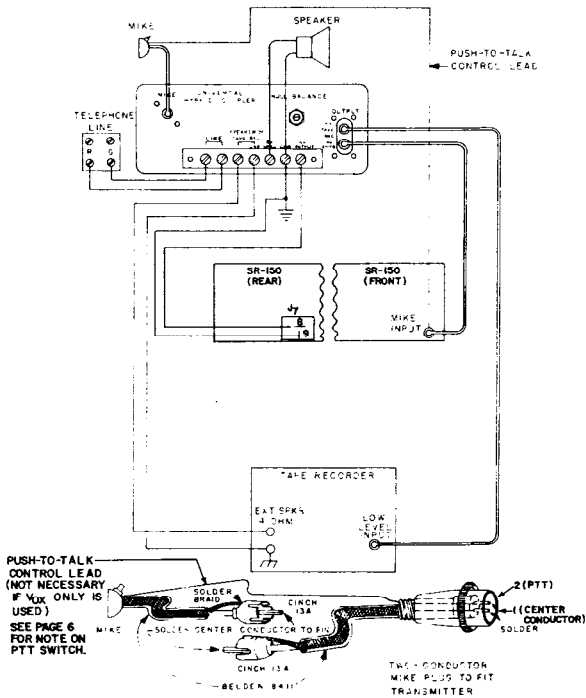


FIG. 8 TYPICAL INSTALLATION WITH M-8348-27AA/10-63  
HALLICRAFTERS SR-150

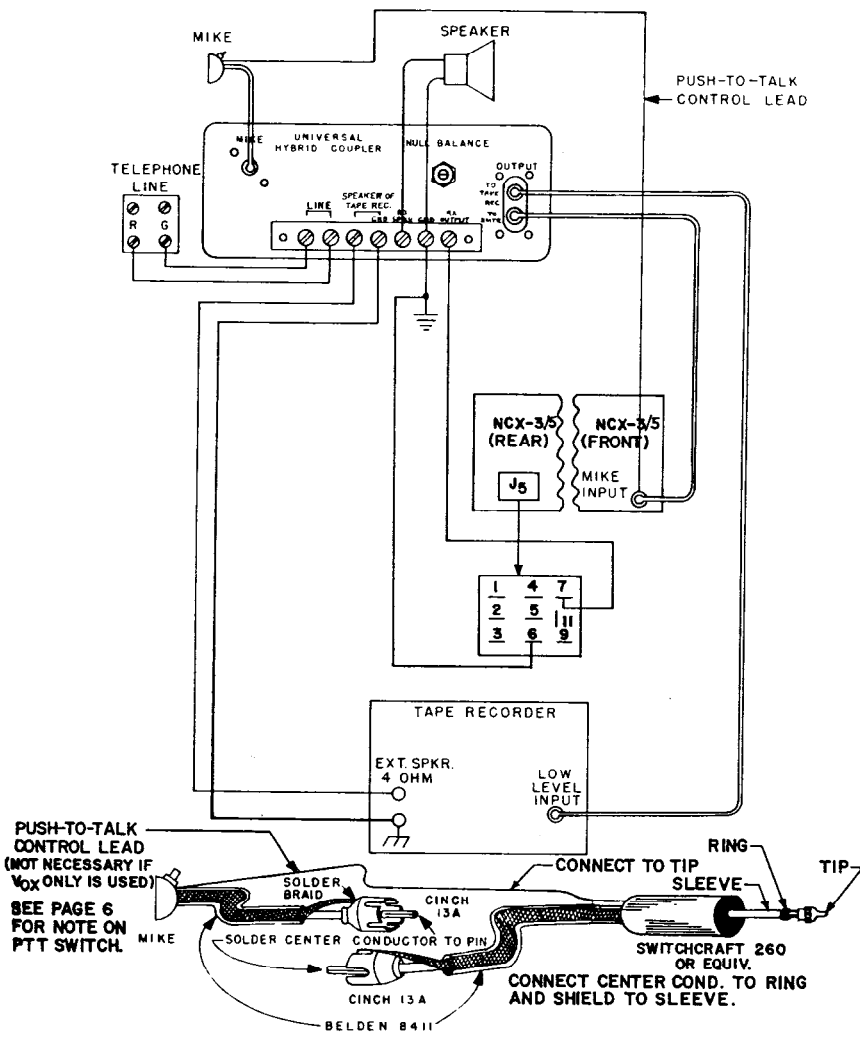


FIG. 9 TYPICAL INSTALLATION FOR NATIONAL NCX-3/NCX-5

M-8349-30/4/10-63

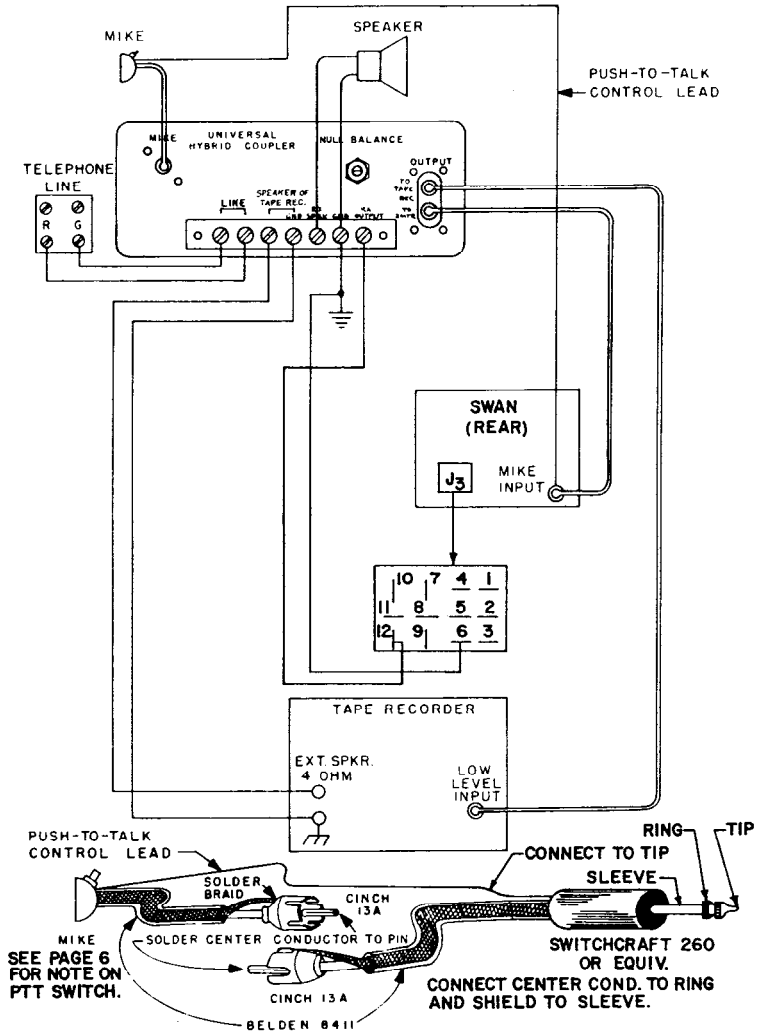


FIG. 10 TYPICAL INSTALLATION FOR SWAN TRANSCEIVERS

M-B346-31A/10-63

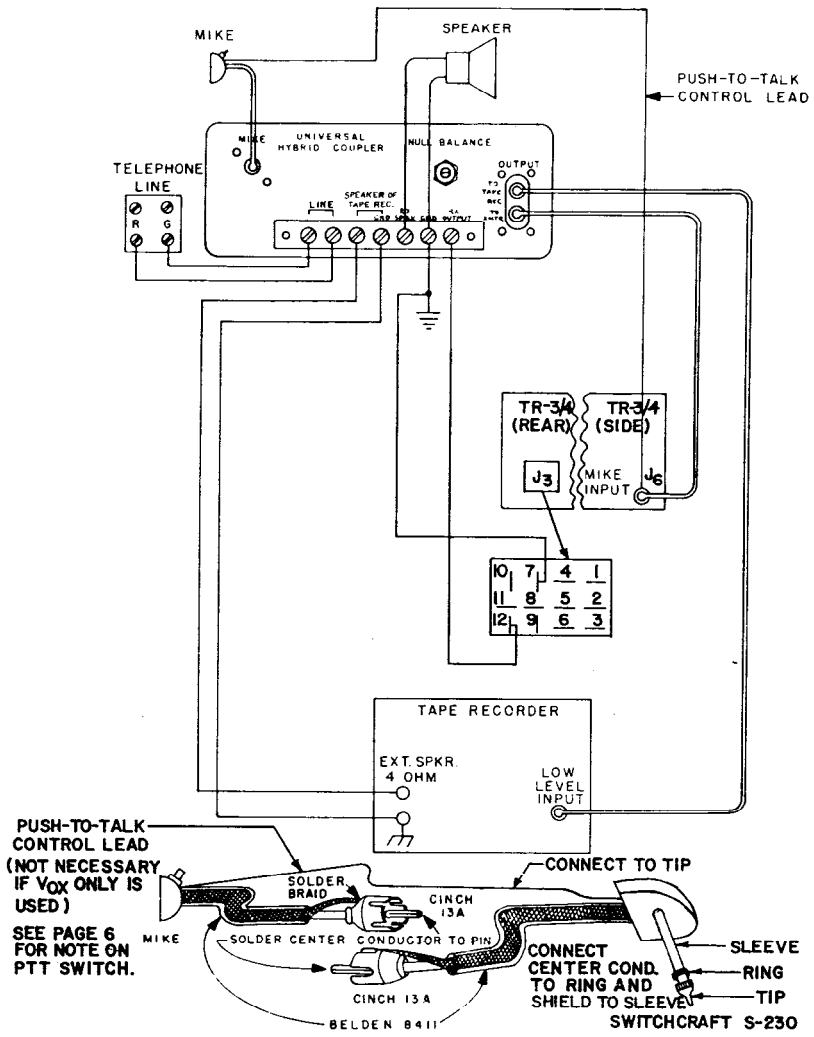


FIG. 11 TYPICAL INSTALLATION FOR DRAKE TR-3/TR-4 M-B348-32 4/10-63