

**PRIVATE LINE TELEPHONE SYSTEMS**  
**TWO-WIRE CHANNELS FOR POLLING TELEVISION RECEIVERS**  
**TROUBLE AND OVER-ALL TRANSMISSION TESTS**

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**1. GENERAL**

**1.01** This practice outlines the installation and routine maintenance tests to be performed on two-wire telephone channels for use in polling television receivers. It is important that the channels be put in correctly to begin with. Therefore, this practice outlines the circuit order tests to be performed. In order to keep the circuits working right, this practice also tells you what routine tests to make and how often they should be made.

**1.02** Since the circuits are in use almost continuously, it is necessary to coordinate routine tests with the control office. When clearing trouble, tests should be made by the control office to isolate the trouble as quickly as possible. ***AS MUCH OF THE CIRCUIT AS POSSIBLE SHOULD BE KEPT WORKING DURING TROUBLE HUNTING TESTS SO AS NOT TO DISRUPT SERVICE ANY MORE THAN IS NECESSARY.***

**2. TESTING APPARATUS**

**2.01** One of the most important aspects of good measurements is good testing equipment. ***YOU CAN'T MAKE GOOD TESTS WITH POOR EQUIPMENT.*** Before making these tests, then, check the equipment and make sure it is working properly. Ample warmup time for the equipment is also important so it will be stable in operation.

**2.02** The following test apparatus may be used:

13A TMS	
21A TMS	
40B Transmission System (TMS only)	Wheatstone Bridge or Rheostat on Local Test Desk
400-Type VTVM and isolating coil	
E Repeater Test Set	200CD Oscillator or Equivalent
2B Noise Measuring Set	Transistorized OSC or TMS
2AB Auxiliary Transmission Test Set	Telephone Test Set, Type 107A or B or Equivalent

**2.03** In some Companies, battery operated transistorized test sets may be available which are suitable for testing at the customer's premises. Two such instruments are the Northern Electric R18568B Volume Indicator and the Northeast Electronics Corporation Model 4 Transmission Test Set. If such test sets (oscillator or TMS) are available, it will simplify the testing procedure at the subscriber's premises considerably since power will not be required to operate the set. The use of such sets makes it possible to test from a cable terminal without bothering the subscriber.

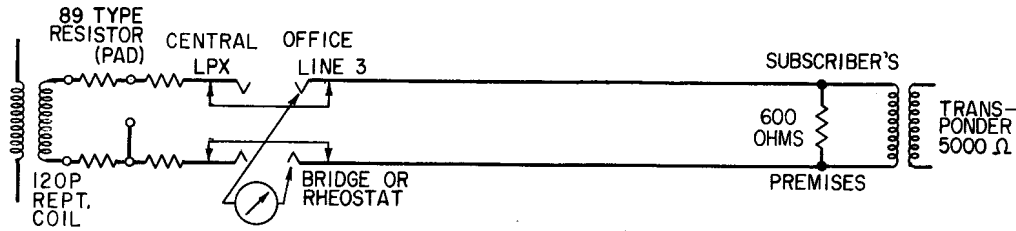


Fig. 1 — Measurement of Loop DC Resistance

**2.04** The 13A and 21A TMS's may be permanently damaged by the presence of dc. Therefore, if sealing current is simplexed to ground on the backbone route, it should be removed first.

**2.05** The loops should be tested on a 600-ohm basis since they are equipped with 600-ohm pads and terminated in 600 ohms. The backbone route should be tested on a 900-ohm basis since this approximates the impedance of those pairs. The 2AB set matches the 600-ohm sets to the 900-ohm backbone route.

**3. DC RESISTANCE MEASUREMENTS**

**3.01** The resistance of each loop should be measured as shown in Fig. 1 from its LINE jack at the central office with a Wheatstone Bridge or rheostat which is part of the local test desk. The measurement should include the 600-ohm resistance on the loop which is located at the subscriber's premises. If the transponder is installed by ARB, its resistance of about 540 ohms will be in parallel with the Telephone Company resistor and this should not be overlooked. The resulting resistance of each loop

when measured on the circuit order test should be given to the control office and filed with the circuit layout card or sketch for future reference.

**3.02** The resistance of the backbone route trunk pairs should also be measured with a bridge or rheostat and the values recorded. The over-all resistance of the backbone route should be measured from the most remote central office to the control office as well as from ARB headquarters to the control office. If the route branches off to other central offices, the resistance should be measured from each office on the branch to the control office. Fig. 2 shows the setup for measuring the trunk resistance where C.O. "A" is the control office. The trunk resistance measured by the procedure below includes the resistance of the 119E coils. All resistance measurements should be recorded for future reference.

**3.03** The dc trunk and loop resistances should measure within  $\pm 10\%$  of the calculated resistance at 68°F. This limit is for a temperature range of from -10°F to +110°F. Don't forget that the resistance increases as the temperature increases.

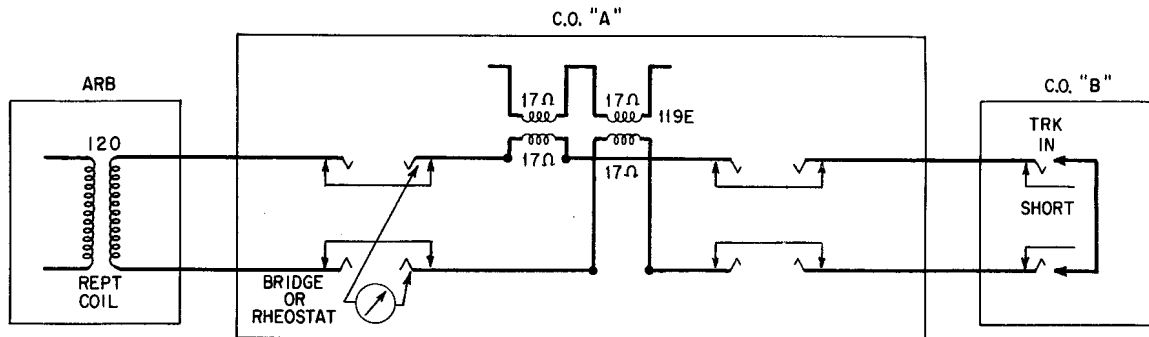


Fig. 2 — Measurement of Backbone Route DC Resistance

#### 4. RETURN LOSS MEASUREMENTS

**4.01** In order to determine that the backbone route cable pairs are good, electrically, it is necessary to measure the return loss. This will tell you if there are missing or misplaced load coils or improper end sections. **DON'T FORGET**, return loss measurements, if properly made and interpreted, will give you an idea of how much trouble to expect with singing repeaters in the future. Time spent in selecting good cable pairs for the backbone route is time well spent and will minimize maintenance headaches in the future.

**4.02** These measurements should be made between 300 and 2500 cycles in accordance with accepted testing procedures as outlined in other Bell System Practices. The E repeater test set provides one convenient method for making these tests.

**4.03** Fig. 3 shows a simple sketch for making return loss measurements. Tests should be made with the far end of the route terminated in the 115-type network. The network is shunted by a 59,700-ohm resistor, type 145A. This resistor makes it possible to check continuity of the cable pair from the control central office. The sketch shows the situation where the backbone route is split at office "B". If your route is not split, don't worry about it! The testing procedure will be easier.

**4.04** All return loss measurements should be coordinated with the control office. They should be made on repeater sections in the direction toward the most remote central office. In Fig. 3 it is assumed that the backbone E13 or E23 repeater normally located at office "A" is removed from the circuit since it is not shown in the sketch. All bridging circuits should also be patched out. **WHEN REMOVING THE REPEATER, MAKE SURE THE BUILDING-OUT CAPACITORS ARE NOT REMOVED WITH IT.**

**4.05** If the route is split as shown in Fig. 3, insert a 1000-ohm plug in the 02PX jack when testing to C.O. "D" from office "A". When testing to C.O. "F" from Office "A", insert the 1000-ohm plug in the 01PX jack. If the route is not split, just measure the return loss from office "A" to office "D". The corrected return loss requirement for a repeater section should be at least 25 db. If the backbone route is split the return loss should be at least 22 db.

**4.06** Measure the over-all return loss with the backbone repeaters in the circuit and strapped for normal gain. This loss should be measured from the central office serving the customer (ARB) with the bridging circuits strapped out. The corrected return loss should be at least 18 db.

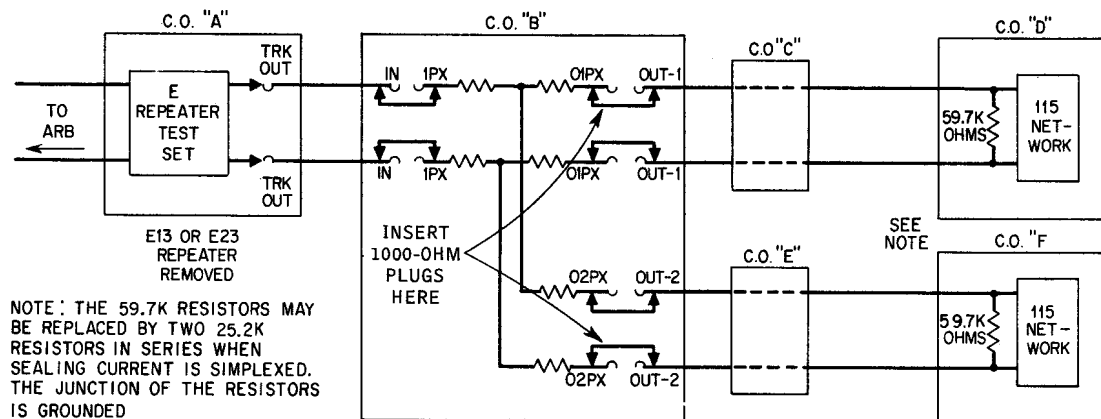
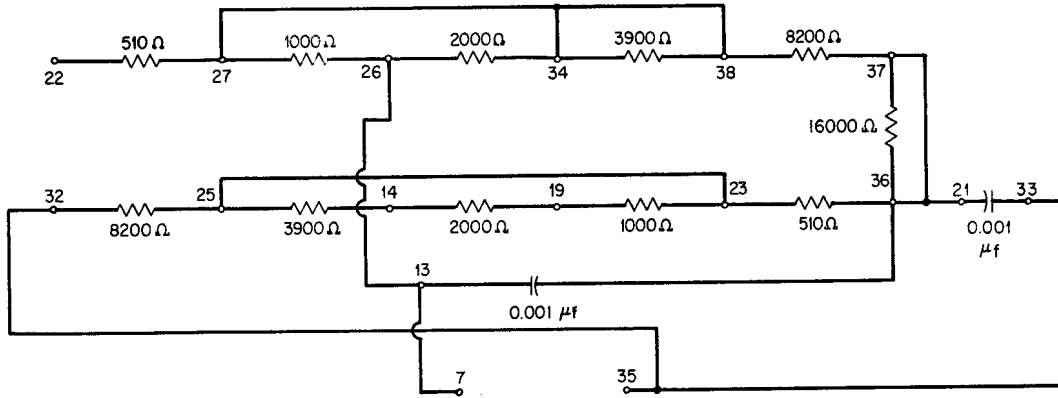


Fig. 3 — Return Loss Measurements



REPEATER NETWORK TERMINALS

Fig. 4 — Bridging Circuit Repeater Strapping

5. STRAPPING OF BRIDGING CIRCUIT

5.01 Fig. 4 shows the strapping to be used for the E repeater in the bridging circuit so as to present approximately zero bridging loss to the backbone route. **ALL BRIDGING REPEATERS SHOULD BE STRAPPED IN THIS MANNER.** A maximum of seven loops may be connected to a bridging circuit using this strapping.

5.02 Each subscriber loop is connected to the bridging circuit by means of a 120P coil strapped for a 1:3 ratio. The high impedance winding should be connected to the assigned

89-type resistor (pad) as shown in Fig. 5. The figure also points out that spare coils should be terminated in an infinite 89-type resistor (pad). All cross connections to the subscriber loop should be completed.

5.03 In order to present a constant load to the series repeater, a 234-ohm resistor, type 145A is used to simulate a 120P coil strapped for a 1:3 ratio. This simplifies the installation of new loops or rearrangements of existing loops since it is not necessary to change the repeater strapping. When a coil is added to the circuit, the 234-ohm resistor should be removed from the 227A terminal strip and a coil substituted.

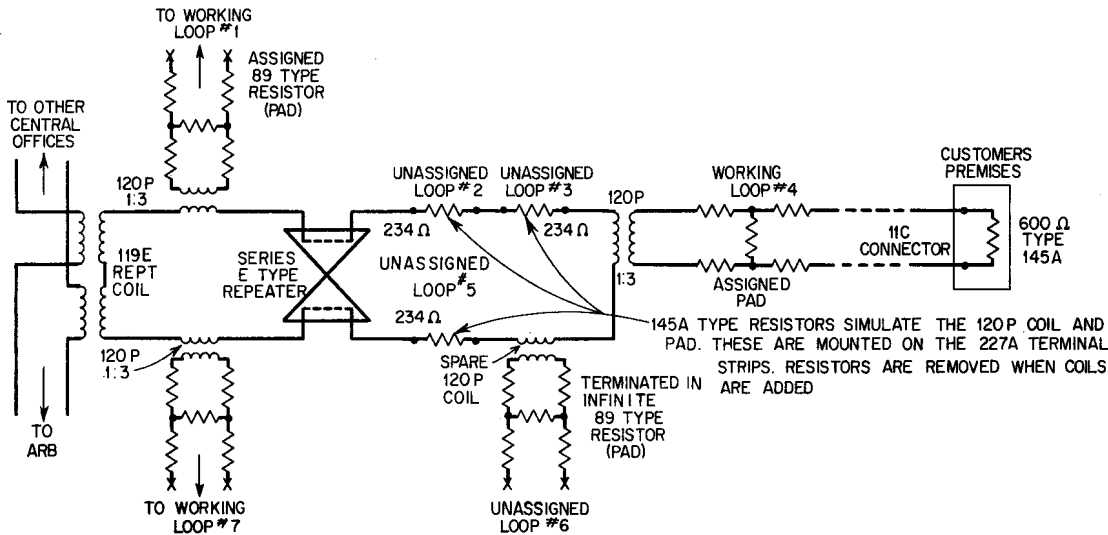


Fig. 5 — Connections to Bridging Circuit

## 6. FREQUENCY RESPONSE MEASUREMENTS

**6.01** The test arrangement for measuring the response of the bridging circuit is shown in Fig. 6A and 6B. If a 21A TMS is not available, the arrangement in Fig. 6B should be used. The 120 isolating coils or equivalent should be strapped for a 1:1 ratio. They are used to isolate the unbalanced VTVM and OSC from the circuit. The bridging circuit normally works into about 1000 ohms. However, it is tested on a 600-ohm basis since this provides a more critical test. The test procedure is outlined in Chart I.

**6.02** The frequency response of the backbone route should be measured from the most remote central office to ARB headquarters. If the backbone route is split, measurements should also be made from the most remote office on the branch. Measurements should be made in accordance with Fig. 7 which is a typical testing arrangement. **ALL BRIDGING CIRCUITS AND LOOPS SHOULD BE CONNECTED NORMAL BEFORE MAKING THE TEST.** All repeaters should be strapped for their normal operating condition.

CHART I

STEP	PROCEDURE	REMARKS
1	Connect 21A TMS or other test equipment to ac power.	Allow ample warmup time.
2	Adjust OSC of 21A TMS to send 0 DBM at 1,000 cycles. If 200-type OSC is used, adjust for 0 DBM with VTVM or other TMS.	13A TMS or 40B TMS may also be used.
3	Connect test equipment as shown in Fig. 6A or 6B.	
4	Sweep OSC from 300 to 1300 cycles and note peaks and valleys.	Requirement: $\pm 0.5$ db of 600-cycle reading
5	If requirement is not met, adjust resistance or capacity of network slightly.	If requirement can not be met, refer to supervisor.
6	Sweep OSC from 300 to 2500 cycles and note peaks and valleys.	Requirement: $\pm 1.0$ db of 1000-cycle reading. If requirement can not be met, refer to supervisor.
7	If circuit meets requirements, remove patch cords and restore bridging circuit to normal.	

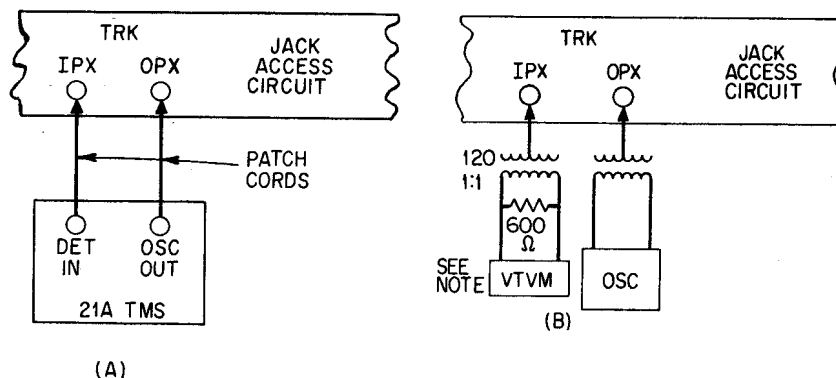
**6.03** The response should be measured by noting the peaks and valleys between 300 and 1300 cycles. The test procedure is outlined in

Chart II. The readings obtained on circuit order should be filed with the circuit order card or sketch for future reference.

CHART II

STEP	PROCEDURE	REMARKS
1	Connect the MEAS jack of the 2AB set to the TRK OPX jack of the jack access circuit as shown in Fig. 7.	
2	Connect test equipment to the 2AB set as shown in Fig. 7.	
3	Connect test equipment to ac power.	Allow ample warmup time.
4	Turn TEST switch to CAL OSC.	
5	Set oscillator frequency to 1000 cycles.	
6	Increase output of oscillator until TMS reads + 0.5 db.	This adjusts for 0.5 db through loss of 2AB set.
7	Turn TEST switch to SEND 900 ohms.	
8	Connect TMS to drop side of repeat coil at ARB headquarters.	
9	Measure the 1000-cycle loss and check circuit order card or sketch for requirement of backbone route.	Measured loss should agree within $\pm 1.0$ db.
10	Sweep OSC from 300 to 1300 cycles and note peaks and valleys.	Requirement: $\pm 1.5$ db* of 600-cycle reading.
11	If requirements are not met, check cable pairs, repeaters, etc.	
12	If requirements are met, dismantle equipment at central office "B" of Fig. 7.	
13	If backbone route is split, make similar measurements from most remote office of each branch to ARB headquarters.	
14	After tests are completed restore circuit to normal.	

\*Note: For routine tests this requirement may be relaxed to  $\pm 2.5$  db.



NOTE: If 13A or similar TMS is used, the coil is not necessary.

Fig. 6 — Test Setup for Measuring Frequency Response of Bridging Circuit

**6.04** The frequency response from the subscriber on each loop to ARB headquarters should be measured. To facilitate testing, a temporary tel set should be installed at ARB headquarters. The temporary set should be cross-connected at the serving central office to a talking pair to be used by the tester at the cable terminal. The talking circuit should be wired temporarily to the outgoing trunk test frame (OGT) or some other convenient test location. If necessary, a loudspeaker should be connected to the pair so that the testers can request assistance from the central office when needed.

**6.05** If battery-operated test sets are available, they should be used to test from a cable terminal in preference to testing from a customer's premises. This is good public relations. Tests in this case should be made from the

terminal serving the customer. Two temporary jumpers should be run from the cable terminal to the test equipment — one pair for talking and one for testing. Make sure you connect the test set to the pair to be used for the new circuit. If the drop has been connected, it should be removed before the test is started and reconnected after the test.

**6.06** The procedure for making an over-all frequency run from the end of the loop to ARB headquarters is outlined in Chart III. The test circuit is shown in Fig. 8.

**6.07 IF POSSIBLE**, the test equipment used at ARB should be calibrated against equipment used throughout the circuit. Another way to minimize errors in testing is to do all the sending OR receiving from ARB headquarters.

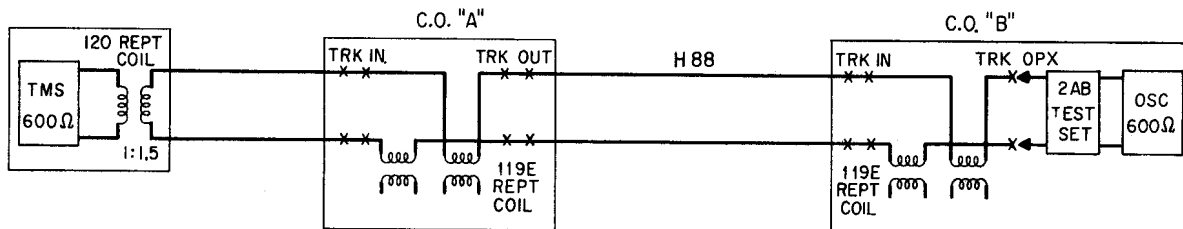


Fig. 7 — Frequency Response Measurements of Backbone Route

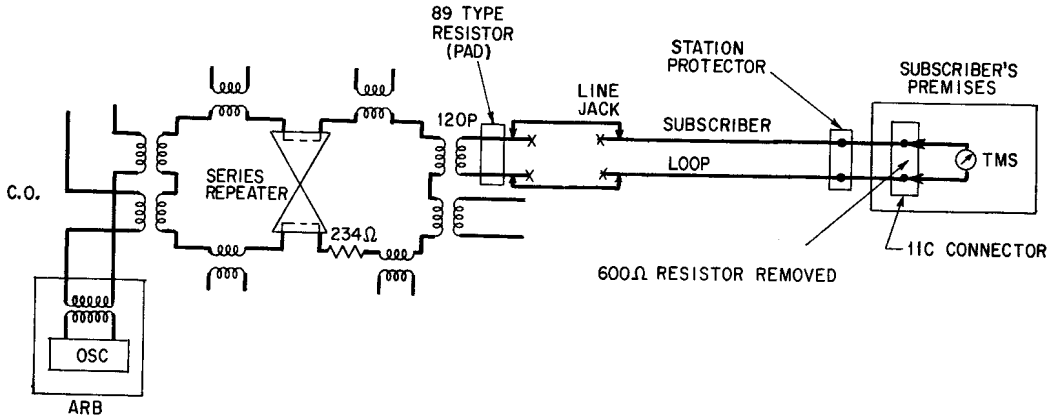


Fig. 8 — Frequency Response Measurement of Over-All System

CHART III

STEP	PROCEDURE	REMARKS
1a	If test is to be made from cable terminal, disconnect drop wire at cable terminal.	This is drop wire for ARB circuit.
1b	If test is to be made from customer's premises, remove 600-ohm resistor on 11C connector and inside wire.	The 600-ohm TMS acts as the termination.
2	If testing from cable terminal, run two jumpers from terminal to test location.	One pair is for testing and the other pair is for talking.
3	Connect test equipment to ac power.	Allow ample warmup time.
4	Connect test equipment as shown in Fig. 8.	
5	Measure the 1000-cycle loss and compare with circuit order card or sketch.	Requirement: $\pm 1.5$ of card value.
6	Send from ARB and sweep OSC from 300 to 1300 cycles. Note peaks and valleys.	Record readings for each loop. Requirement: $\pm 4.0$ db of 600-cycle loss on circuit order test and $\pm 5.0$ db on trouble hunting test.
7	If requirements are not met, consult your supervisor.	Subscriber loop may be in trouble.
8	If requirements are met, disconnect test equipment.	
9	Reconnect drop wire or 600-ohm resistor and inside wire.	Don't put too much stress on pigtail of resistor.



**7. NOISE MEASUREMENTS**

**7.01** Measurements of the over-all steady noise should be made at ARB headquarters using the 2B Noise Measuring Set in accordance with practices covering the use of the set. The steady noise should not exceed 35 dba with FIA weighting. The over-all circuit should be in the normal operating condition when the measurement is made. Fig. 9 shows a diagram for the test arrangement. The coil should be connected to the LINE jacks or terminals of the 2B set with the switch on FIA weighting. The circuit should be monitored with the 2B set receiver for crosstalk during the measurement. The presence of intelligible crosstalk is an indication of trouble.

**8. INTERVALS**

**8.01** The routine tests outlined in this practice should be performed quarterly. They are in addition to the routine tests performed on the repeaters. The asterisk (\*) in Table I below indicates the tests to be performed on a circuit order or routine basis. It may, however, be necessary to perform any one or all of these tests when clearing trouble.

**TABLE I**

TEST	CIRCUIT ORDER	QUARTERLY
Return Loss Measurements	*	—
Frequency Response of Backbone Route	*	*
Frequency Response of Loops to ARB	*	—
Frequency Response of Bridging Circuit	*	—
Strapping of Bridging Circuit	*	—
Dc Resistance Measurements	*	—
Noise	*	*

**9. TROUBLE HUNTING**

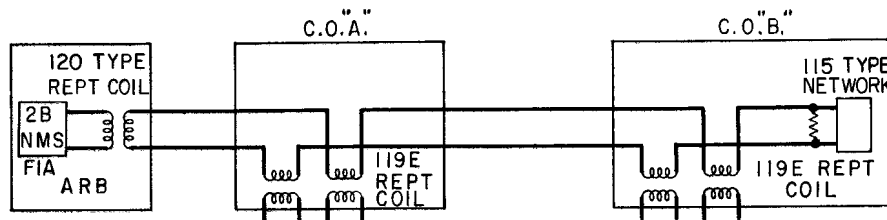
**9.01** The television polling circuit is in use almost continuously during the television broadcasting hours. For this reason, the trouble hunting procedures should be such as to locate and isolate trouble quickly. It is also important that as much of the circuit as possible be kept working.

**9.02** A good clear story from the customer (ARB) as to what the trouble is will help a great deal in isolating the trouble. For instance, are all stations in trouble or just certain ones? The trouble hints outlined below cover some of the more common troubles which may be encountered. Other possibilities should not be overlooked.

**9.03** Case No. 1—Customer complains circuit causes errors in data. This may be caused by noise.

**Trouble Hints**

- (1) If possible, isolate the trouble to a specific central office.
- (2) Check the Tip and Ring conductors of the backbone route for ground or crosses.
- (3) Monitor the loops for excessive noise at the LINE jack. If a 2B NMS set is available, measure at the same jack. Noise should not exceed 35 dba.
- (4) Check the subscriber loop for a ground or cross.
- (5) If all loops are noisy, check central office for recent rearrangements in power plant.



**Fig. 9 — Measurement of Over-all Noise**

## SECTION 310-525-500

- (6) Measure loop resistance as shown in Fig. 1.
- (7) Remove connection to transponder on 11C connector at subscriber's premises. If this clears trouble, leave the transponder inside wire disconnected.

### Remedial Measures

- (1) Change trunk pair.
- (2) Change subscriber loop pair.
- (3) Customer's equipment may need replacing.

**9.04** Case No. 2—Customer complains that the received levels are too low.

### Trouble Hints

- (1) Measure the net loss of the backbone route including the branches, if any.
- (2) Check backbone route for an open or disabled repeater.
- (3) Measure the 1000-cycle loss at each office and compare with circuit order card.
- (4) Measure the dc resistance of the subscriber loop or loops which appear to be in trouble.

### Remedial Measures

- (1) Replace repeater or tubes in repeater.
- (2) Change cable pairs. Put an open plug in LINE jack and refer to your supervisor.
- (3) Change 119E or 120P coils or coil at ARB headquarters, if required.
- (4) Output of transponder on TV set may be too low.

**9.05** Case No. 3—ARB complains that specific customers on a backbone route do not respond to interrogating frequencies.

### Trouble Hints

- (1) Request ARB for the location of subscriber or subscribers which do not respond to ARB signals.
- (2) Measure the dc loop resistance of the cable pair serving customer in accordance with Fig. 1. Compare reading with circuit order value. Don't forget there is a 600-ohm termination at the customer's premises.

### Remedial Measures

- (1) If loop resistance is satisfactory, **HAVE ARB CHECK TRANSPONDER** on TV sets.