

# INSTRUMENT CIRCUITS

THEIR DESIGN AND OPERATION

FAULT LOCATING



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## TERMINOLOGY AND DEFINITIONS

### Conductors:

Conductors (wires) provide a path for electricity to flow between two points.

### Insulation:

The insulator (or insulation) is the opposite of conductor in that it tends to prevent the flow of electric current.

### Resistance:

Resistance is the property that tends to retard the flow of electrical current. The unit of resistance is called an "ohm". The combined value of the resistance (in ohms) of a series circuit is equal to the sum of the individual resistances. The combined value (in ohms) of any two resistances in parallel (multiple) is equal to their product divided by their sum.

### Current Flow:

Current flow is electrical energy capable of being put to work. The unit of current flow is called the "ampere".

### Voltage:

Voltage is the force which causes the current to flow. The terms "voltage", "electrical pressure", and "electro-motive force" are synonymous; "electro" indicating electricity, "motive" as moving, and "force" as pressure. The unit of electrical pressure is called the "volt".

### Ohm's Law:

"Ohm's Law" states that a pressure of one volt is required to force a current of one ampere through a resistance of one ohm. Symbolically stated, this means that  $I = \frac{E}{R}$  or  $R = \frac{E}{I}$  or  $E = I \times R$  where  $I$  = current flow,  $R$  = resistance and  $E$  = voltage.

### Magnetism:

Magnetism is that property in permanent and electromagnets which causes

iron or steel to be attracted. It is present around a wire through which current is caused to flow.

### Induce Current:

Current is caused to flow through a winding of a coil when a voltage is induced in the winding by varying magnetic source.

### Circuit:

The term circuit means pieces of apparatus and power supply so connected as to form a continuous path from one side of the power supply to the other.

### Continuity:

The term "continuity" means that the conductor or circuit is continuous and will provide an electrical path between two given points.

### Short Circuit:

A short circuit is a shorter path for the current to flow than that which is normally provided for it.

### Grounds:

When a wire of a subscriber's line comes in contact (electrically) with a grounded conductor, such as a water pipe or grounded side of another telephone line the wire is said to be grounded.

### Crosses With Battery:

A cross with battery occurs when one or both sides of a subscriber's line comes into contact (electrically) with the battery side of another electrical circuit.

### Opens:

An open circuit occurs when a wire is broken or may be any other condition which breaks the continuity of the circuit.

## SECTION I

### INSTRUMENT CIRCUIT AND ASSOCIATED PARTS

#### PART I

It becomes necessary in describing the operating functions of the instrument circuit to study the various parts, their design, and operation, so that the complete circuit will be more easily understood.

The numbers in Fig. 1 relate to the following parts: (1) receiver, (2) transmitter, (3) induction coil, (4) condenser, (5) switchhook, and (6) ringers.

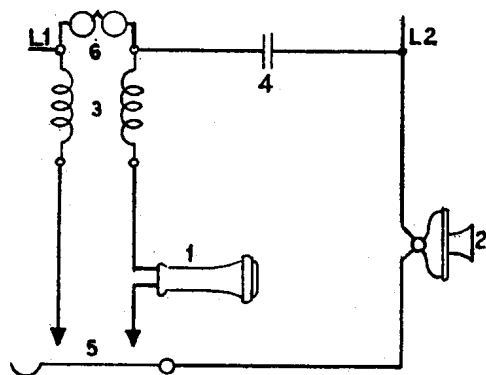


Fig. 1

NOTE: Fig. 1 illustrates the schematic drawing of the standard sidetone desk instrument circuit, and is for the purpose of showing the scheme of the circuit so that the operating features may be studied.

#### The Receiver

The telephone receiver, Fig. 2, consists of "M" a U shaped type permanent magnet, with a coil of insulated wire "W", wound on each pole. "D" is a thin iron diaphragm mounted with its center directly over the poles of the magnet, with a space of about twelve thousandths of an inch between the diaphragm and the magnet poles. The magnet and the diaphragm are enclosed in a hard rubber shell "S" and held in place by a hard rubber cap "C".

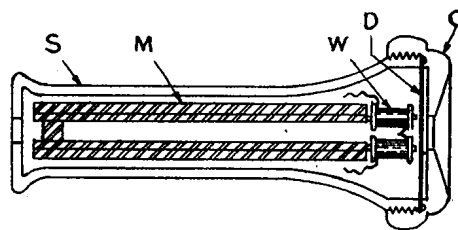


Fig. 2.

The permanent magnet exerts a pull on the diaphragm, causing it to be attracted to the pole pieces as shown in Fig. 2A.

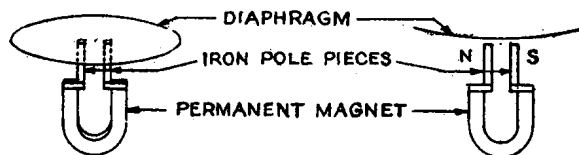


Fig. 2A

When a current flows through the receiver coils in one direction, the electromagnetic field setup in the pole pieces aids that of the permanent magnet, thus pulling the diaphragm closer to the pole pieces as shown in Fig. 2B.

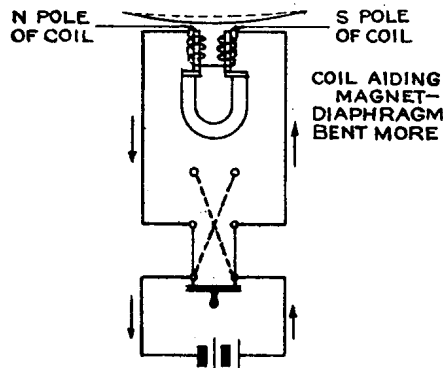


Fig. 2B

When a current flows through the receiver coils in the opposite direction, the electromagnetic field set up in the

poles opposes or tends to neutralize the permanent magnetic field, thereby resulting in the diaphragm moving away from the pole pieces as shown in Fig. 2C.

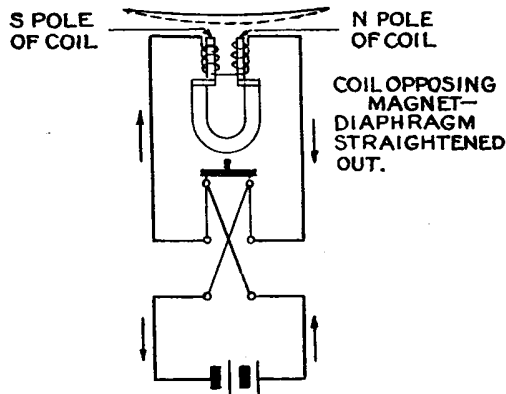


Fig. 2C

It can thus be seen that with the aid of the permanent magnet the receiver diaphragm can be made to move closer to or farther away from the pole pieces.

#### The Transmitter

The transmitter, Fig. 3, has a metal diaphragm "A", which is mounted so as to be capable of vibrating from impulses given it by sound vibrations. To its cen-

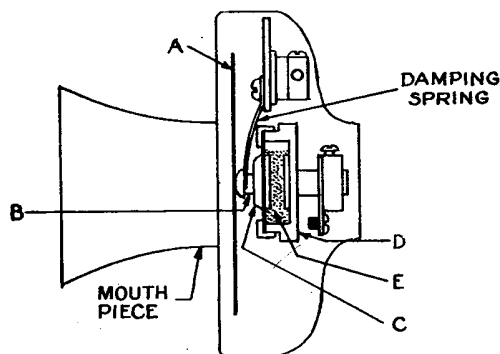


Fig. 3

ter is attached a stud "B" which is con-

nected to a small brass disc "C". The disc fits into a cup "D", which is filled with small grains of carbon "E". There is a thin insulating ring between the disc and cup so that the electrical contact is made between the disc and cup through the carbon granules. The electrical connections are made one on the disc and one on the cup. This transmitter is designed to change sound vibrations into electrical impulses, and is accomplished by varying the resistance of the carbon granules by the vibrations of the transmitter diaphragm.

With the transmitter, receiver, and battery connected in series, as shown in Fig. 4, a current flows through the circuit. The transmitter diaphragm is caused to move back and forth in unison with the sound vibrations of the voice. As the diaphragm moves inward, the disc crowds the carbon granules closer together thus reducing the resistance in the circuit so that more current will flow and strengthen the receiver magnet, drawing the receiver diaphragm closer to the pole pieces. Each of the carbon granules can be compared to a piece of cinder with many rough protruding points. When the carbon granules are crowded closer together, contact is made between the different granules at many more points so that more paths for the current are provided and the resistance is lowered.

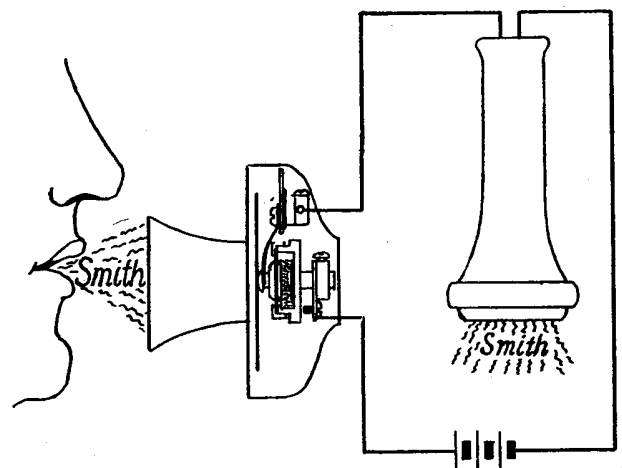


Fig. 4

When the transmitter diaphragm moves outward, the particles of carbon are loosened and the resistance of the path through them is increased so that less current will flow and the receiver magnet is weakened, allowing the diaphragm to move away from the pole pieces. In this way, the receiver diaphragm vibrates in unison with the transmitter diaphragm, so that the original sound is accurately reproduced.

The transmitter acts as a valve in the circuit, and varies the flow of current according to the movement of the diaphragm. Aluminum is generally used for the diaphragm and possesses little inertia and therefore will not vibrate from its own momentum.

### The Induction Coil

The use of the induction coil, properly connected in the circuit, greatly improves transmission.

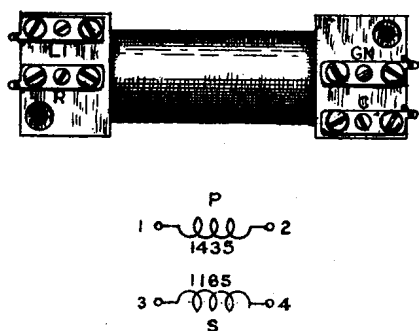


Fig. 5

The induction coil, Fig. 5, consists of a laminated iron core, upon which are wound two windings of insulated wire, known as the primary (1 & 2) winding and the secondary (3 & 4) winding.

There are approximately 1,435 turns of wire in the primary winding and 1,165 turns of wire in the secondary winding. The 46 type induction coil is provided with more turns of wire in the primary

than in the secondary so that the voltage at the terminals of the primary winding is greater than that at the secondary, thus causing a boosting effect, which will be described in detail in the complete circuit description.

### The Condenser

The condenser most commonly used in the instrument circuit consists of two sheets of tinfoil, known as the plates, separated from each other by paraffined paper. To each plate a terminal is fastened for making external connections. The plates and paper are rolled into a compact mass and placed in a metal container, which is filled with an insulating compound to exclude moisture.

When the condenser is connected to a battery, one plate charges positively and the other negatively until the voltage on them is equal to that of the battery, and no more current will flow. If the condenser is disconnected from the battery the charge (voltage) will remain on the plates until discharged. The plates of a charged condenser will discharge when connected together.

When the condenser is connected to an alternating voltage the current does not flow through it but passes from one plate to the other as the direction of the applied voltage changes. The amount of current that will flow in a circuit containing a condenser depends upon the voltage applied, the frequency of alternations, and the impedance i.e. the capacity of the condenser, the resistance and inductance of the circuit.

### The Switchhook

The switchhook is primarily a switch used to open and close certain parts of the circuit and advantage is taken of the fact that the receiver must be provided with some resting place when not in use. The weight of the receiver when placed on the hook operates a lever which causes spring contacts to open, opening the current supply to the transmitter.

Owing to the high impedance of the ringers to the voice currents, it is generally not necessary that the ringer be disconnected from the line during talking periods as not enough of the voice currents will pass through the ringer to affect transmission. Fig. 6 shows typical switchhooks.

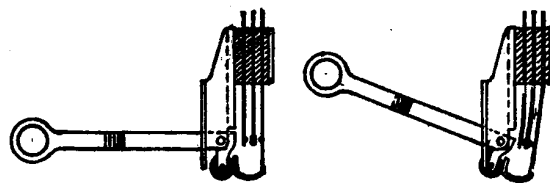


Fig. 6



## THE SIDETONE INSTRUMENT CIRCUIT

### PART II

The standard sidetone instrument circuit consists of two circuits, a primary and secondary. Fig. 7 shows the primary circuit.



Fig. 7

Fig. 8 shows the secondary circuit.

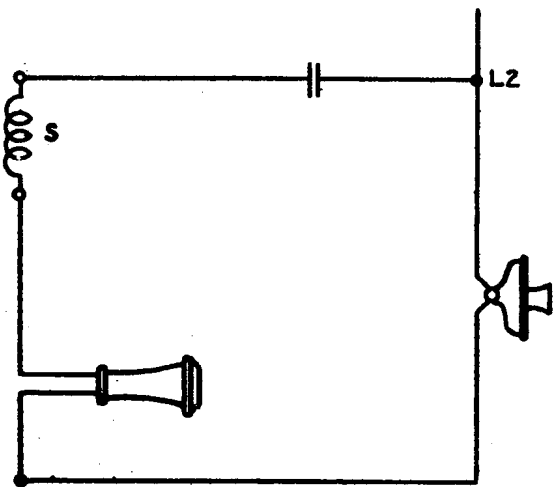


Fig. 8

Fig. 9 shows the two circuits combined to form the standard sidetone instrument circuit.

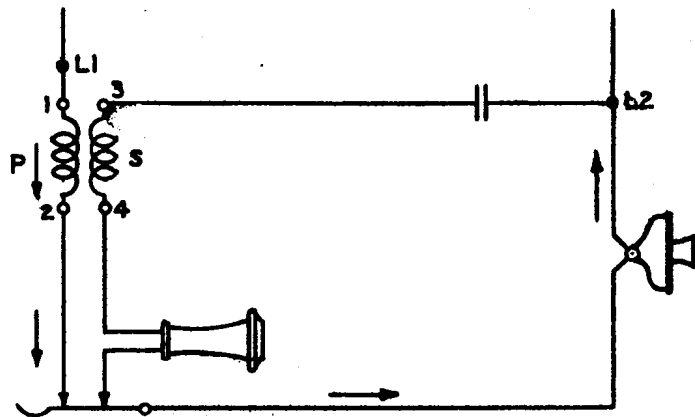


Fig. 9

The current flows from L1 through the primary 1-2 winding of the induction coil, switchhook, transmitter, and out on L2, as shown by the arrows in Fig. 9. Due to the resistance of the transmitter there will be a drop in voltage across its terminals. The receiver, 3-4 winding of the induction coil, and the condenser (in series) are connected in parallel with the transmitter, and the plates of the condenser will be at the same difference of voltage as the drop in voltage across the transmitter, and the condenser will be charged.

When the transmitter is spoken into, the diaphragm is caused to vibrate rapidly in unison with the sound waves. As the transmitter diaphragm moves inward, the carbon granules are compressed, lowering the resistance of the transmitter. The decreased transmitter resistance will cause an immediate increase in the strength of the line current flowing through the induction coil primary winding (1 & 2).

This decrease on the transmitter resistance disturbs the condition of

the secondary circuit. The condenser which has received an initial charge from the line discharges part of its charge through the path of the reduced resistance in the direction shown by the arrows in Fig. 10.

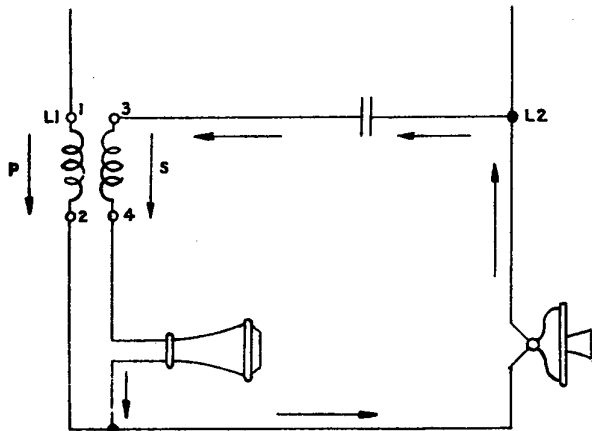


Fig. 10

The current caused to flow through the secondary winding of the induction coil by the discharge of the condenser will induce a voltage in the primary winding. Since the primary is wound in the opposite direction to that of the secondary, the induced current flow through the primary will be in the same direction as that flowing in the secondary and is added to the original increased line current flow caused by the decreased transmitter resistance.

As the transmitter diaphragm moves outward, the carbon granules are loosened, thereby increasing the resistance of the transmitter and that of the circuit, causing the line current to decrease. The increased transmitter resistance increases the voltage drop across its terminals and also the terminals of the condenser, causing the condenser to charge in the direction shown by the arrows in Fig. 11.

This flow of current in the secondary circuit through the 3-4 winding of the induction coil induces a voltage in the primary 1-2 winding, causing a cur-

rent to flow which will be in the direction shown by the arrows in Fig. 12.

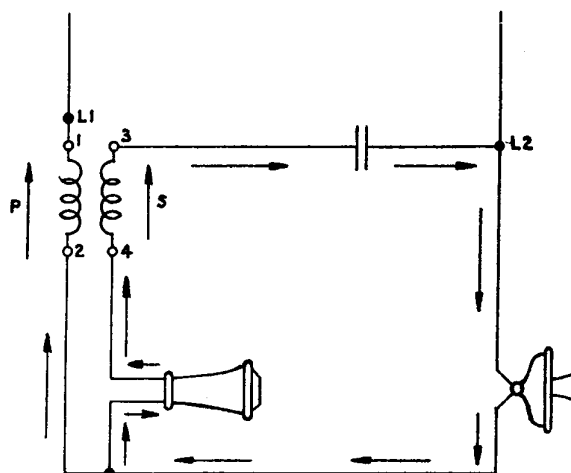


Fig. 11

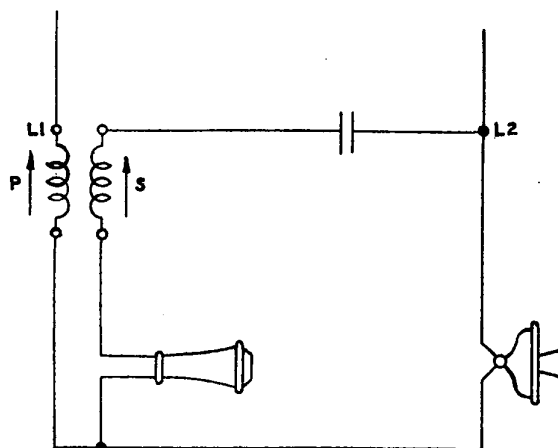


Fig. 12

The current flow through the primary caused by the induced voltage is opposed to that flowing in the line and the line current will be further decreased. Thus it is seen that the current flowing through the 3-4 winding of the induction coil into the condenser greatly aids (by induction) the transmitter in decreasing the flow of the line current.



Thus it can be seen that by the proper association of the induction coil windings and the condenser with the transmitter, the condenser can be made to charge and discharge through the induction coil in such a manner so as to aid the change in the line current caused by the varying resistance of the transmitter. This is called the "boosting effect."

#### Operation of Set at Distant Station

When the transmitter is spoken into, the station at the distant end receives the voice currents (alternating superimposed on the direct current), which flow through the set from L1 to L2, as shown by the arrows in Fig. 13.

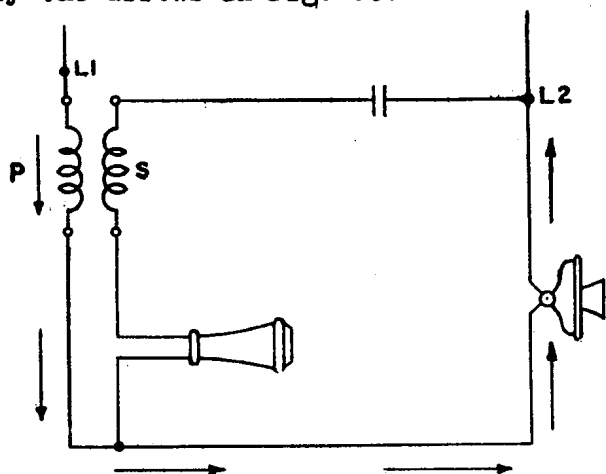


Fig. 13

These voice currents flowing through the primary 1-2 winding of the induction coil induce voltages of like characteristics in the secondary 3-4 winding causing currents to flow in the secondary circuit through the receiver, strengthening and weakening the receiver magnets. The receiver diaphragm, being attracted and released with varying intensity, causes it to vibrate and produce sounds similar to those affecting the transmitter at the sending station.

The incoming voice currents from the line do not flow directly through the receiver and 3-4 winding of the induction coil, charging and discharging the condenser, because the voltages induced in the 3-4 winding cause currents to flow in such

a direction as to oppose the line voice currents. When the impulse of current in the line is increasing in the 1-2 winding of the induction coil in the direction shown by the arrows in Fig. 13, the current flowing in the 3-4 winding (caused by the induced voltage) will be in the direction shown by the arrows in Fig. 14. The

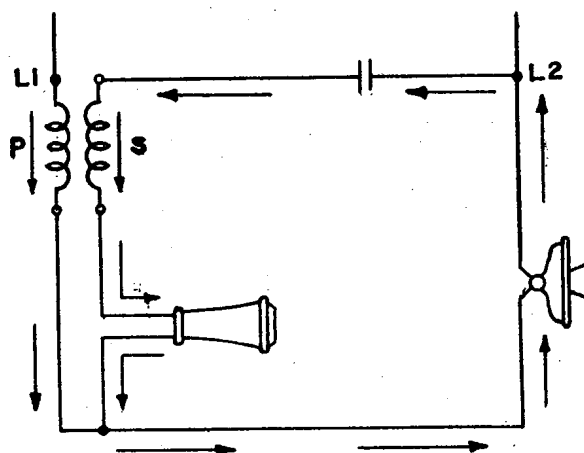


Fig. 14

two currents unite and flow together through the transmitter. This is also true when the line impulse is in the opposite direction. Therefore, the manner in which the incoming voice currents affect the receiver is by induction.

#### General Review of Station Parts and Circuits

The function of the parts are:

1. Transmitter: To produce electrically the characteristics of sound waves by setting up fluctuating, direct current.
2. Receiver: To reproduce or change the electrical variations into sound.
3. Switchhook: To connect and disconnect circuits.
4. Induction Coil: To induce electromotive forces and aid or boost transmission.

5. Condenser: To prevent the flow of direct current and to pass alternating current.

The parts contained in and the functions of the circuits are as follows:

1. The primary circuit, Fig. 15.

- a. Primary (1-2) winding of induction coil L1 to R.
- b. "R" conductor of instrument cord.
- c. Switchhook contacts.
- d. "YY" transmitter cord.
- e. Transmitter.
- f. "Y" transmitter cord.
- g. "Y" conductor of instrument cord to L2.

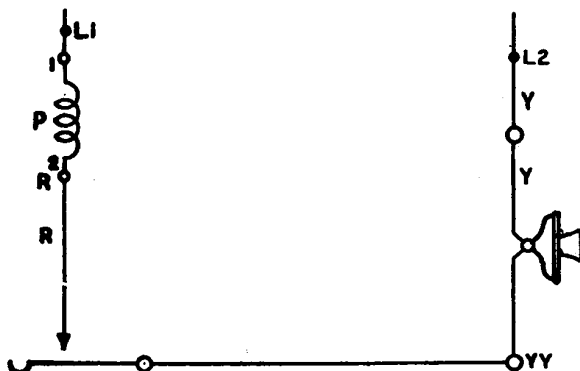


Fig. 15

The functions are:

- a. To signal operator.
- b. To fluctuate the current when acted upon by sound waves.
- c. To set up a variable magnetic field.
- d. To send voice waves electrically.

2. The secondary circuit, Fig. 16.

- a. Condenser to "C" post.
- b. Secondary (3-4) winding of induction coil "C" to "GN".
- c. "GN" conductor of instrument cord.
- d. "GN" conductor of receiver cord.
- e. Receiver.
- f. "W" conductor of receiver cord.
- g. Switchhook contacts.
- h. "YY" transmitter cord.
- i. Transmitter.
- j. "Y" transmitter cord.
- k. "Y" conductor of instrument cord to L2 and condenser.

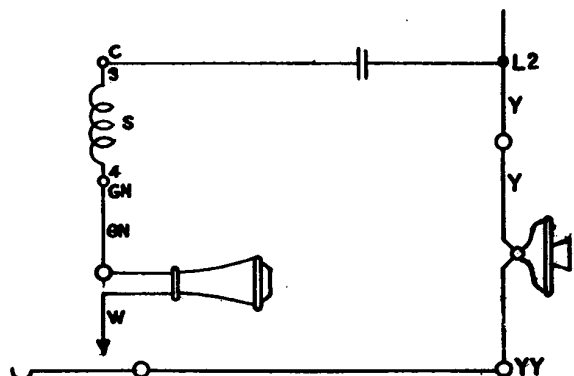


Fig. 16

The functions are:

- a. To receive the electrically transmitted voice waves.
- b. To convert the variable magnetic field into the reproduction of sound.

### THE SIDETONE REDUCTION CIRCUIT

"Sidetone" is the sound produced in the receiver by vibrations affecting the transmitter in the same set, and is encountered in all sets except anti-sidetone sets, which will be explained later. In common battery sets located near the central office a comparatively large amount of current passes through the transmitter, which in many cases causes EXCESSIVE sidetone. If extraneous noises are present, they may be reproduced in the receiver to such an extent as to interfere with normal incoming and outgoing transmission. This sidetone may be reduced to some extent by modifying the circuit arrangement as shown in Fig. 17.

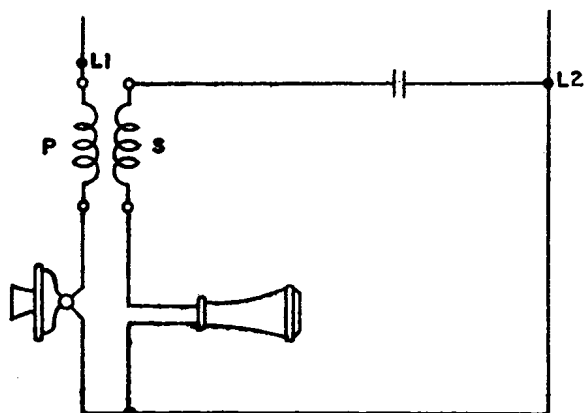
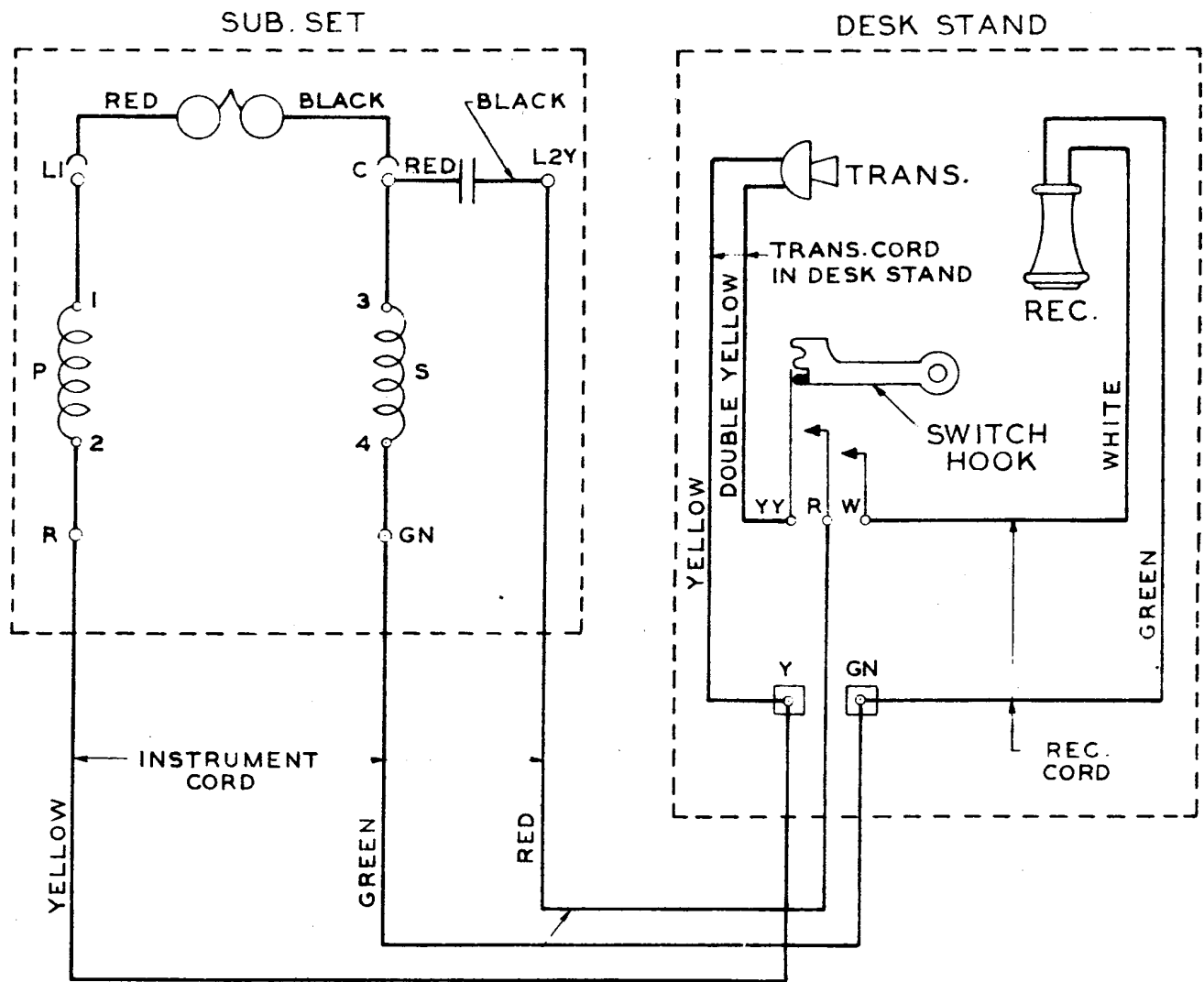


Fig. 17

This is accomplished by reversing the red and yellow cords in the subscriber's set.

The receiver, secondary winding of induction coil, and condenser are not connected across the transmitter when the sidetone reduction circuit is used. Therefore, the varying resistance of the transmitter does not charge and discharge the condenser through the secondary circuit and there will be no current flowing through the receiver, due to this action of the transmitter; consequently, the sidetone is much less. With the modified circuit (sidetone reduction) the voice currents are set up in the line by the varying resistance of the transmitter alone, and are not affected by the boosting action of the condenser and 3-4 winding of the induction coil. This results in a loss in the transmission volume of the set, and for this reason the sidetone reduction circuit should only be used where the extraneous noises are very objectionable. (See B. S. P. on Zoning.)

When locating faults on instrument with this type of connection, it is advisable to temporarily connect instrument back to standard sidetone connection by reversing the yellow and red cords back to their respective posts in the subset until fault is located. After trouble has been cleared reverse cords back again for sidetone reduction connection.



DESK STAND NON-DIAL  
SIDE-TONE REDUCTION  
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# FAULT LOCATING SIDETONE EQUIPMENT

## METHOD

### SECTION II

Fault locating can be divided into four general classifications corresponding to the four functions of the instrument circuit, namely:

1. Signalling the operator.
2. Signalling the subscriber.
3. Transmitting the message.
4. Receiving the message.

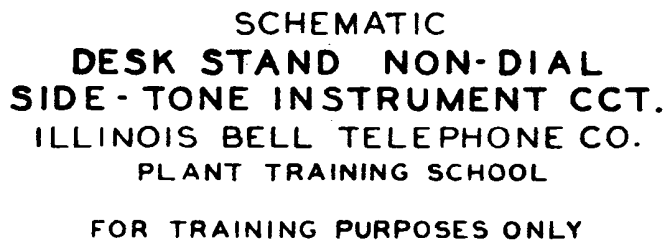
The repairman therefore, in locating these various faults, must devise a thorough testing method with the aid of his hand test receiver, and by proper analyzation can readily determine those portions of the circuit which are not functioning properly.

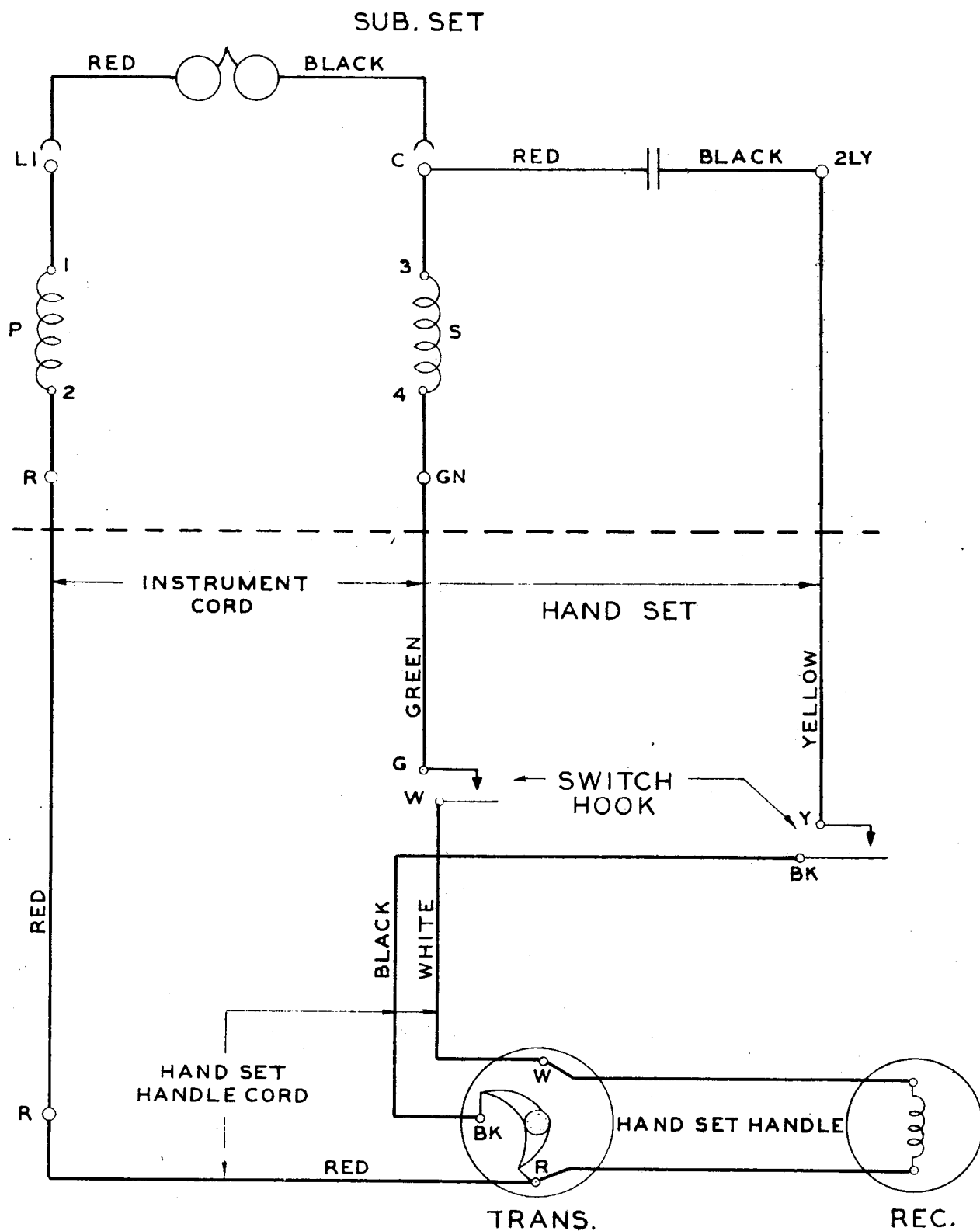
This section, including the following test-note sheets, one to six inclusive, is devoted entirely to the procedures and method referred to in the above mentioned paragraph.

On a reported case of trouble on a subscriber's line, the following items should be carefully considered:

- (1) The type of service and the number of stations involved.
- (2) Entire circuit; central office equipment involved in the line station circuit arrangement.
- (3) Type of apparatus involved.
- (4) What effect does trouble report have on subscriber's service.
- (5) The susceptibility of various parts of equipment and particular portions of subscriber's line circuit to certain faults, such as:
  - (a) Noisy line when subscriber moves handset cord indicates possible defective cord.
  - (b) Can't hear report indicates possible defective induction coil, receiver, or condenser.
  - (c) Can't be heard report indicates possible defective transmitter.

- (d) Can't raise operator report indicates tip or ring of subscriber's line open, or primary of instrument circuit.
- (e) Report of can be heard, but can't hear, indicates possible receiver, or secondary of instrument circuit open.
- (f) Report of phone is O.K. but bells don't ring indicates a possible open ringer or open signalling ground in case of party service.
- (6) Weather conditions in many instances should be considered at the time trouble is dispatched due to the effect of rain, sleet, and snow has on our outside drop and block wiring which causes permanents through shorts and grounds. These items mentioned, in many instances, and also the complete information obtained by the tester helps to guide the repairman in analyzing his trouble and to determine the most appropriate point to make his first tests. Upon completion of the test, he can readily determine the direction of the trouble (that is toward the central office or the subscriber's premises) and then following this direction with tests at other points until the source has been definitely established at which time he should make the necessary repairs or replacements to re-establish service for the subscriber in a permanent and workmanlike manner.





SCHEMATIC  
HAND SET NON-DIAL  
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# FAULT LOCATING SIDETONE EQUIPMENT

(CAN'T RAISE OPERATOR (C.R.O.)  
REPORTED TROUBLE -  
(NO DIAL TONE (N.D.T.)

## POSSIBLE CAUSE

### 1. Open Primary Circuit

#### 1. TEST - CAN'T RAISE OPERATOR OR NO DIAL TONE

#### Handset

#### Non-Dial

#### Dial

- (a) Open Bell Circuit at C post.
- (b) Open Yellow cord in Subset.
- (c) Remove receiver from Switch-hook.
- (d) Connect one clip of test set to L2Y post and with the other clip touch open Yellow cord in Subset. If no clicks are heard the test indicates an open in the primary circuit. Test back thru primary circuit toward Ll post until clicks are heard. When no clicks are heard on one test; and on the test at the next point clicks are heard, the fault (open) is located between the two points at which these tests were made.

Yel. CD at Subset  
Y. Base H. Set  
B.K. Base H. Set  
B.K. at H. Set  
(See Note)  
R. at H. Set  
Check contacts  
at Trans.  
R. Base H. Set  
R. Subset  
#2 Ind. Coil  
#1 Ind. Coil  
Ll Subset

Yel. CD at Subset  
Y Base H. Set  
B.K. Base H. Set  
Y. Dial  
B.K. Dial  
B.K. H. Set  
(See Note)  
R. H. Set  
R. Dial  
R. S. Set  
#2 Ind. Coil  
#1 Ind. Coil  
Ll Subset

NOTE: In testing black cord at handset, the transmitter unit would have to be removed breaking the path leading from Ll. After removing the transmitter to test black cord - close down Yellow in Subset and move clip of test set to Ll in Subset and test back from black cord at Handset toward L2Y in Subset.

#### POINTS TO BE TESTED IN PRIMARY CIRCUIT

#### Pedestal or Desk Stand

#### Non-Dial

#### Dial

Yel. CD at Subset  
Y. post at Ped.  
Y. CD at Trans.  
Y.Y. CD at Trans.  
Y.Y. at S. Hook  
R. post S. Hook

Yel. CD at Subset  
Y. at Dial  
B.K. at Dial  
Blk. CD at Trans.  
Y.Y. CD at Trans.  
Y.Y. CD S. Hook

R. post Subset  
#2 Ind. Coil  
#1 Ind. Coil  
Ll post in Subset

R. CD S. Hook  
R. Base Ped.  
R. Subset  
#2 Ind. Coil  
#1 Ind. Coil  
Ll Subset

## FAULT LOCATING SIDETONE EQUIPMENT

### REPORTED TROUBLE PERMANENT (PERM.)

#### POSSIBLE CAUSES

1. Shorted Condenser
2. Crossed Green and Yellow Cords
3. Crossed Red and Yellow Cords
4. Crossed Switchhook Contacts

Type of cross will be indicated by meter reading given to the repairman by the tester. A shorted condenser or a crossed Green and Yellow cord must go thru a portion of the equipment (ringer coils) while a cross Red and Yellow cord is directly across the tip and ring of the line.

#### 1. TEST - SHORTED CONDENSER - CROSSED GREEN AND YELLOW CORDS - SWITCHHOOK CONTACTS.

- (a) Open bell circuits at C post.
- (b) With receiver on the hook, connect one clip of test set on C post and with the other clip test Ll post several times. If clicks are heard each time Ll post is tested it indicates one of the above mentioned troubles. Continue with test C.
- (c) Open Green cord in Subset and retest Ll post several times with one clip of test set still on C post. If clicks are heard each time Ll post is tested the condenser is shorted. If no clicks are heard continue with test D.
- (d) Close down Green cord in Subset and open Green cord in pedestal or Handset base. Retest Ll post with one clip of test set on C post. If clicks are heard each time Ll post is tested the Green and Yellow cords are crossed. If no clicks are heard trouble is in the switchhook contacts.

#### 2. TEST - SHORTED RED AND YELLOW CORDS - SWITCHHOOK CONTACTS.

- (a) Open Bell circuit at C post.
- (b) Open Yellow cord in Subset.
- (c) Connect one clip of test set to L2Y post and with the other clip touch the open Yellow cord in Subset. If clicks are heard each time Yellow cord is tested it indicates one of the above mentioned troubles. Continue with test D.
- (d) Open Yellow cord in pedestal or Handset (leave Yellow open in Subset also). Retest the open Yellow cord in Subset (one clip of test set on L2Y post). If clicks are heard each time the Yellow cord is tested the Yellow and Red cords are shorted. If no clicks are heard the trouble is in the switchhook contacts.

## FAULT LOCATING SIDETONE EQUIPMENT

### REPORTED TROUBLE - BELL DON'T RING (B.D.R.)

#### POSSIBLE CAUSE OF TROUBLE

1. Open Condenser
2. Open Ringer Coils or Bell Jumper
3. Crossed Induction Coil
4. Crossed Red and Green Instrument Cords
5. Crossed Switchhook Contacts

#### 1. TEST OPEN CONDENSER.

- (a) Open bell circuit at C post.
- (b) Remove receiver from switchhook and listen for sidetone. If sidetone is heard condenser is O.K. If no sidetone is heard short circuit terminals of condenser (with test set) if sidetone is restored condenser is open. Replace receiver on switchhook in testing for other troubles.

#### 2. TEST FOR OPEN RINGER.

- (a) Open bell circuit at C post.
- (b) Connect clip of test set to L2Y post and with the other clip touch open bell jumper. If click is heard each time tested bells are O.K. If no clicks are heard - test connections at ringer coils - testing back toward Ll till click is heard.

#### 3, 4 & 5. TEST CROSSED INDUCTION COIL - CORDS (R & GR.) Sw. Hk. Contacts.

- (a) Open bell circuit at C post.
- (b) Connect one clip of test set on L2Y post and with the other clip test C post several times. If clicks are heard each time test is made it indicates one of the above mentioned troubles. Continue with test C.

- (c) Open Green cord in subset and retest C post several times with one clip still on L2Y post. If clicks are heard each time test is made the Induction Coil is Crossed. If no clicks are heard continue with test D.

- (d) Close down Green cord in subset and open Green cord at base of handset or pedestal. Retest C post (clip still on L2Y post), if clicks are heard each time test is made the Red and Green instrument cords are crossed. If no clicks are heard switchhook contacts are crossed.

FAULT LOCATING SIDETONE EQUIPMENT  
REPORTED TROUBLE TRANSMITTER DEAD OR CAN'T BE HEARD (C.B.H.)

POSSIBLE CAUSE

1. Crossed Red and Black Handset Cord
2. Crossed Black and White Handset Cord  
(Black and White Crossed Can't Hear)
3. Transmitter Cords Yel. and Yel. Yel.  
Crossed (Dsk. Stand)
4. Packed or Shorted Transmitter Unit

Yellow transmitter wire. If click is heard Yellow and Yellow-Yellow transmitter wires are crossed.

4. PACKED OR SHORTED TRANSMITTER UNIT.

1 & 2. TEST OF CROSSED HANDSET CORDS

- (a) Open bell circuit at C post.
- (b) Remove transmitter unit from handset.
- (c) Open White cord in handset handle and hold switchhook down.
- (d) Connect one clip of test set to L2Y post and with the other clip test Black cord in handset handle. If clicks are heard each time the Black cord is tested the Red and Black cords are crossed. If no clicks are heard continue with test E.
- (e) Close down White cord in handset handle. Test Black cord again (clip of test set on L2Y post). If clicks are heard each time Black cord is tested the White and Black handset cords are crossed. SEE NOTE.

If after all aforementioned possible causes have been eliminated, make comparison test with new transmitter.

NOTE: Black and White handset cord crossed would be referred to repairman as Can't Hear.

3. TEST OF SHORTED TRANSMITTER CORDS Y AND YY (DSK. STAND)

- (a) Open Yellow transmitter cord at Y post in base of desk stand and also at transmitter.
- (b) Remove receiver from hook.
- (c) Connect one clip of test set on L2Y post and touch open

# FAULT LOCATING SIDETONE EQUIPMENT

## REPORTED TROUBLE CAN'T HEAR (C.H.)

### POSSIBLE CAUSES

1. Open in Secondary Circuit
2. Crossed Cords  
Receiver Cord (Pedestal -  
Green - White)  
Handset Cord (Red - White -  
Black)
3. Shorted Receiver
4. Filings on Receiver Pole Pieces
5. Bent Receiver Diaphragm
6. Loose Receiver Cap
7. Low Volume Induction Coil

### 1. TEST OPEN SECONDARY CIRCUIT

- (a) Open bell circuit at C post.
- (b) Open Yellow cord in subset.
- (c) Remove receiver from switchhook.
- (d) Connect one clip of test set to L2Y post and with the other clip touch C post several times. If no clicks are heard each time the C post is tested the secondary circuit is open. Test back thru secondary circuit until click is heard. When no clicks are heard on one test and on the test at the next point clicks are heard the fault (open) is located between the two points at which these tests were made.

### POINTS TO BE TESTED IN SECONDARY CIRCUIT

#### Pedestal or Desk Stand

<u>Man.</u>	<u>Dial</u>
C Post Subset	C Post Subset
#3 Ind. Coil	#3 Ind. Coil
#4 Ind. Coil	#4 Ind. Coil
GN Subset	GN Subset
GN IN Pedestal	GN Base Pedestal
GN AT Receiver	GN AT Receiver
White at Receiver	White at Receiver
White at S. Hook	White at Dial
R. at S. Hook	B. B. at Dial
	B. B. at S. Hook
	R. at S. Hook

### POINTS TO BE TESTED IN SECONDARY CIRCUIT

#### Handset

<u>Man.</u>	<u>Dial</u>
C Post Subset	C Post Subset
#3 Ind. Coil	#3 Ind. Coil
#4 Ind. Coil	#4 Ind. Coil
GN Subset	GN Subset
GN Base H. Set	GN Base H. Set
W Base H. Set	W. Base H. Set (S Hook)
W. Handset	B. B. Dial
R. Handset	W. Dial
R. Base Handset	W. Handset
R. Subset	R. Handset
	R. Base Handset
	R. Subset

### 2. TEST CROSSED CORDS

Handset Cords (Red and White -  
Black and White)  
Pedestal Cords (White and Green  
Receiver Cords)

#### Handset.

- (a) Open bells at C post.
- (b) Open Yellow cord in subset.
- (c) Remove transmitter and receiver units from handset. Hold switchhook down.
- (d) Open White cord in handset handle.
- (e) Connect one clip of test set to L2Y post and with the other clip touch White post in handset handle. If clicks are heard the wires molded in the handset handle are crossed. If no clicks are heard continue with Test F.
- (f) If no clicks are heard in Test E touch open White cord at handset handle (clip still on L2Y and switchhook down). If clicks are heard each time tested, the White and Red handset cords are crossed. If no clicks are heard continue with Test G.

- (g) Replace receiver unit on handset handle. Close down White cord in handset handle and touch the Black cord at handset handle several times (one clip of test on L2Y and switchhook down). If clicks are heard each time the White and Black handset cords are crossed.

possible causes of trouble make comparison test with new induction coil, as stated in B.S.P. C61.792. Here again the same testman should be contacted on making comparison test with old and new induction coil.

Pedestal - Crossed receiver cord  
(Green and White).

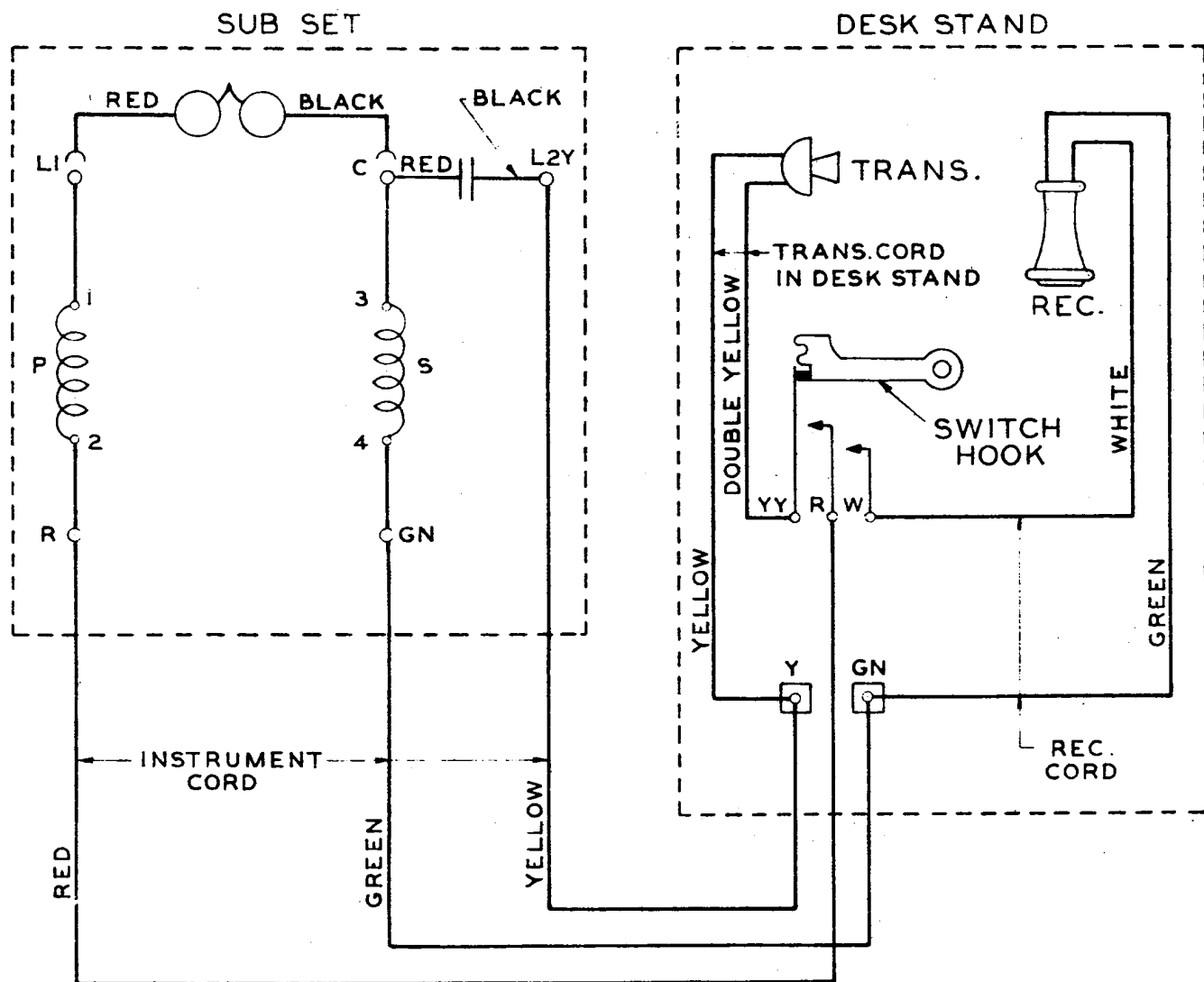
- (a) Open bell circuit at C post.
- (b) Open Yellow cord at subset.
- (c) Open Green cord at Pedestal and Receiver. (Leave receiver off hook).
- (d) Connect one clip of test set to L2Y post and with the other clip touch open Green cord several times. If clicks are heard each time Green cord is tested, the White and Green receiver cords are crossed.

3, 4, 5 & 6. LOOSE RECEIVER CAP -  
SHORTED RECEIVER-BENT RE-  
CEIVER DIAPHRAGM

- (a) Check for filings on receiver pole pieces.
- (b) Check for tightness of receiver cap.
- (c) Check condition of receiver diaphragm.
- (d) Shorted receiver - If after a test for open secondary circuit or a crossed cord no trouble is found substitute receiver with a new one and make comparison on test. This test should be made with same testman for both old and new receiver.

7. LOW VOLUME INDUCTION COIL

- (a) If after eliminating all other

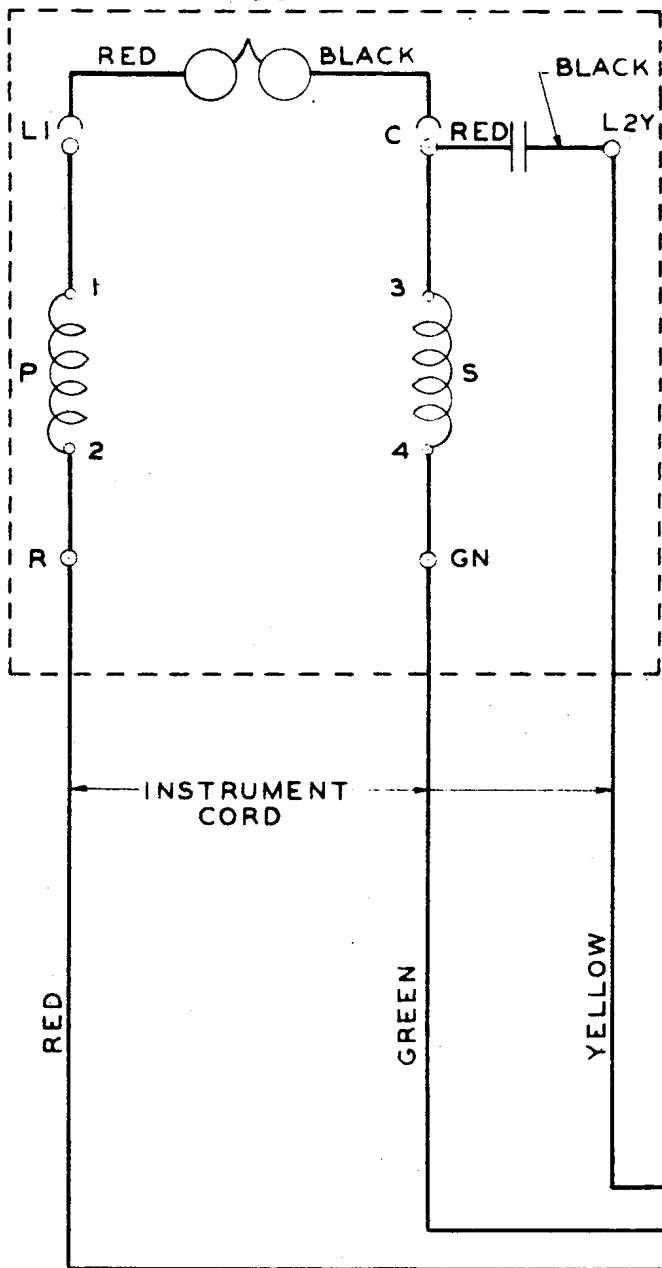


**DESK STAND NON-DIAL  
SIDE-TONE INSTRUMENT CCT.**  
ILLINOIS BELL TELEPHONE CO.  
PLANT TRAINING SCHOOL

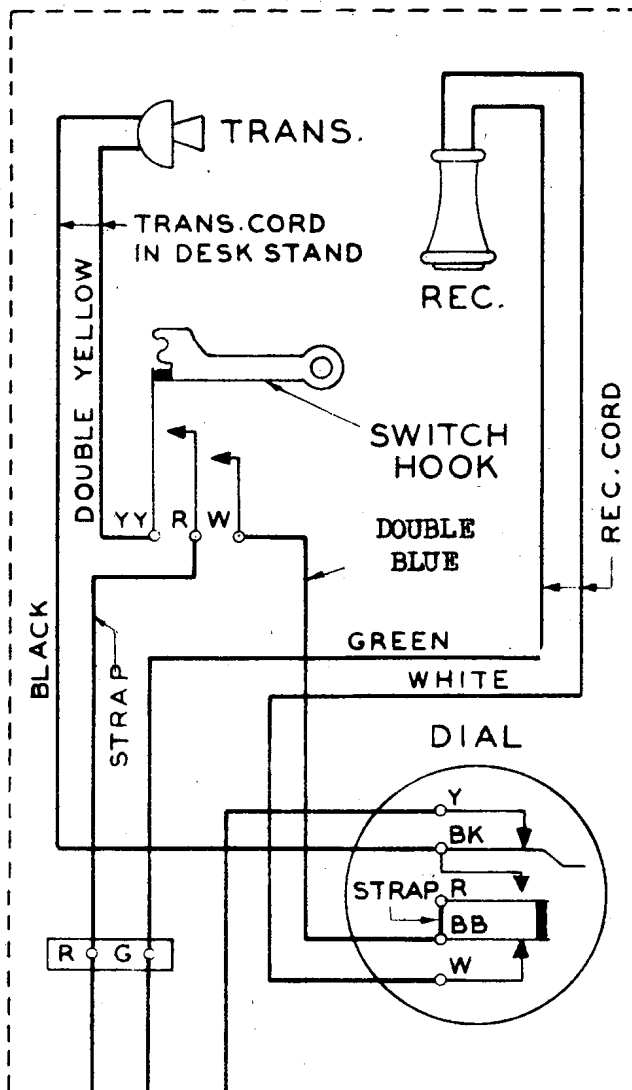
FOR TRAINING PURPOSES ONLY



# SUB SET

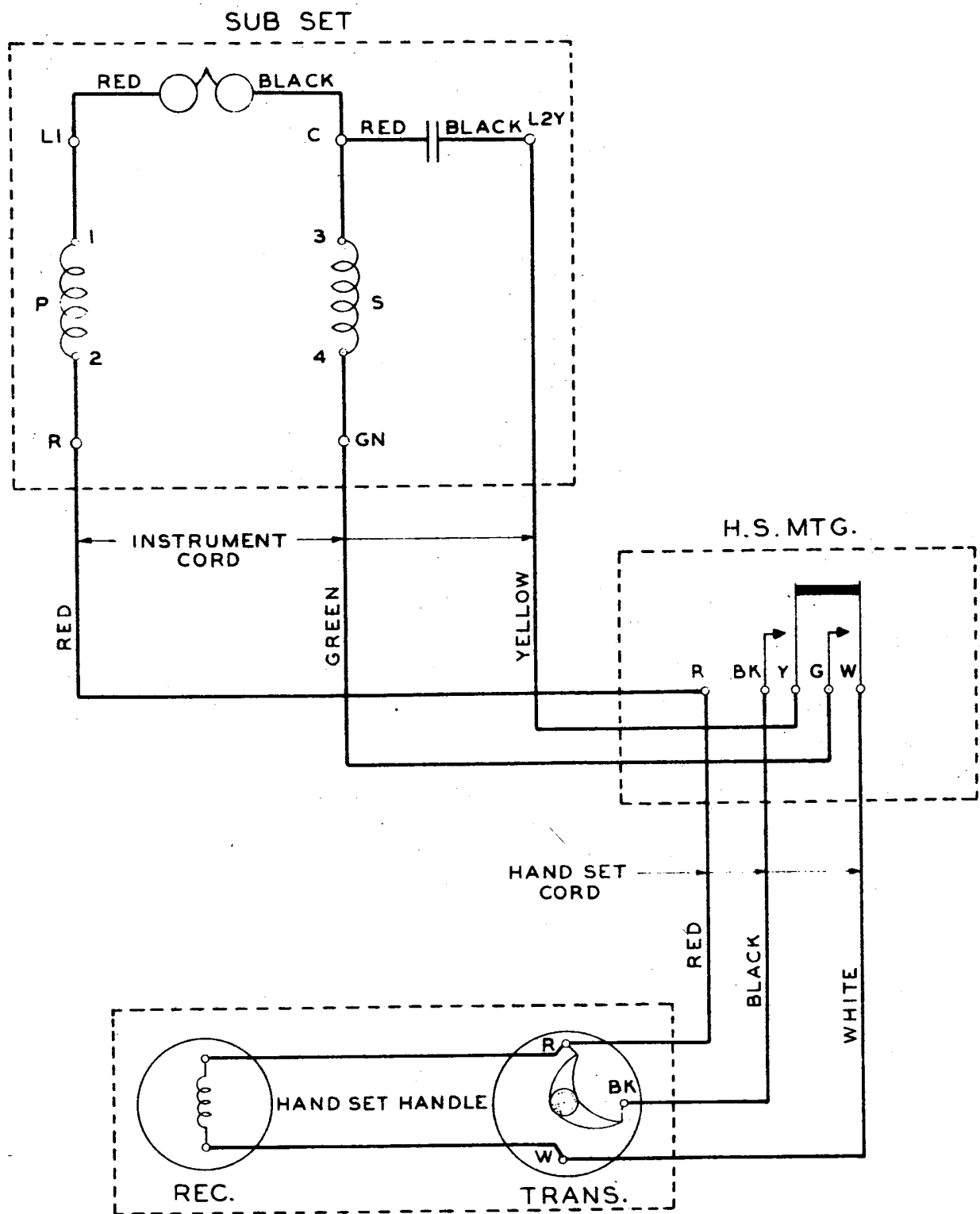


# DESK STAND



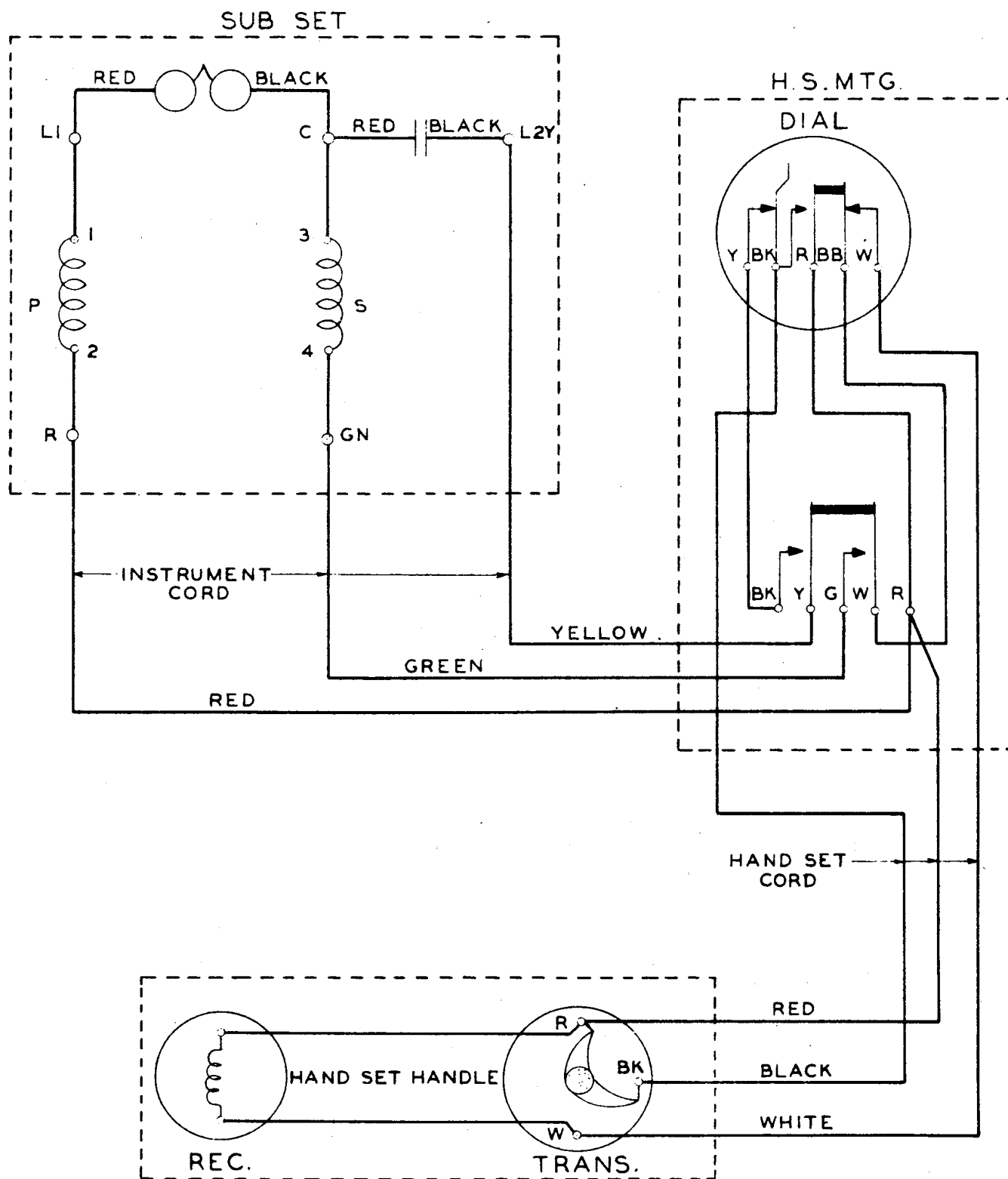
DIAL, DESK STAND  
SIDE-TONE INSTRUMENT CCT.  
ILLINOIS BELL TELEPHONE CO.  
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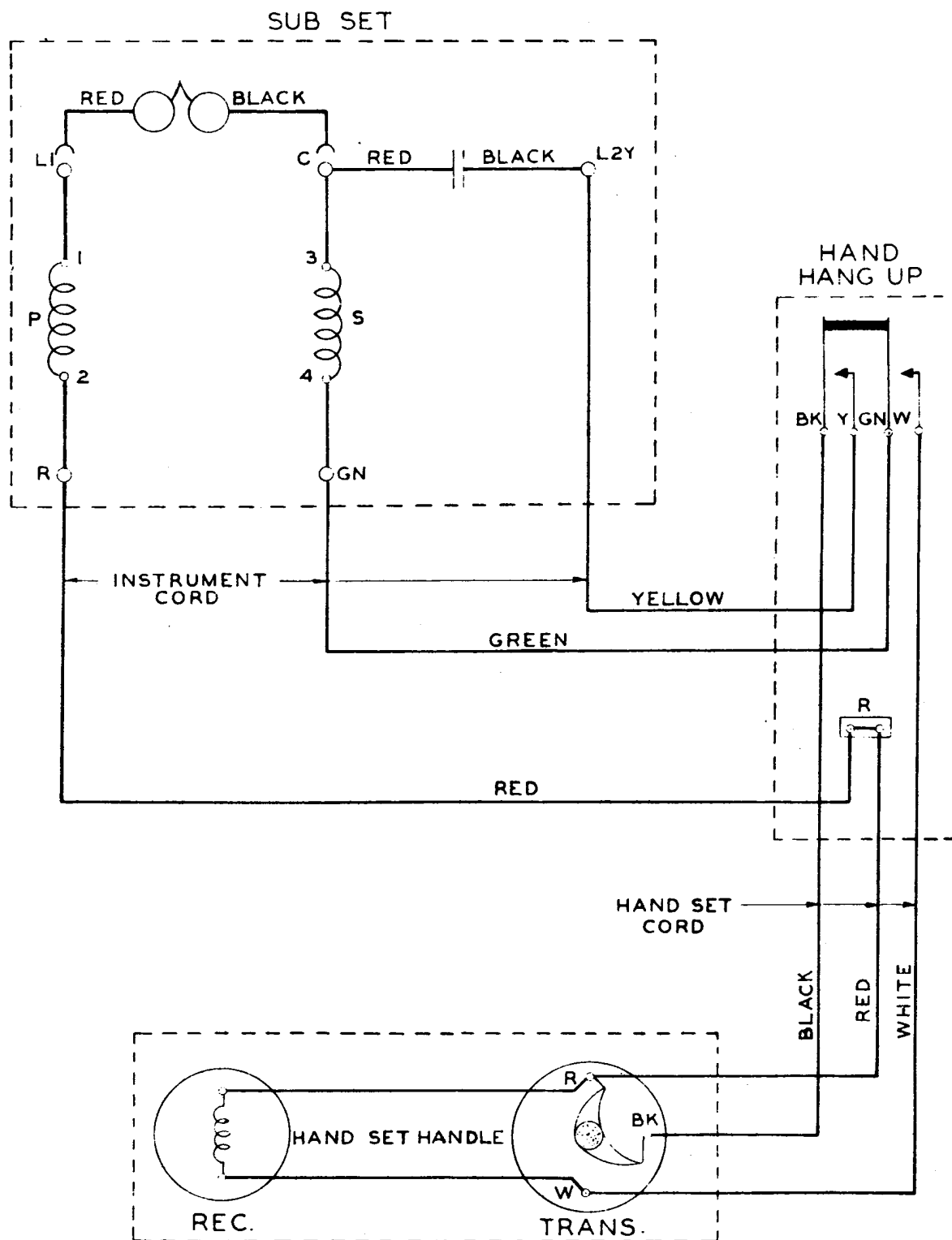


**HAND SET NON-DIAL  
SIDE-TONE INSTRUMENT CCT.**  
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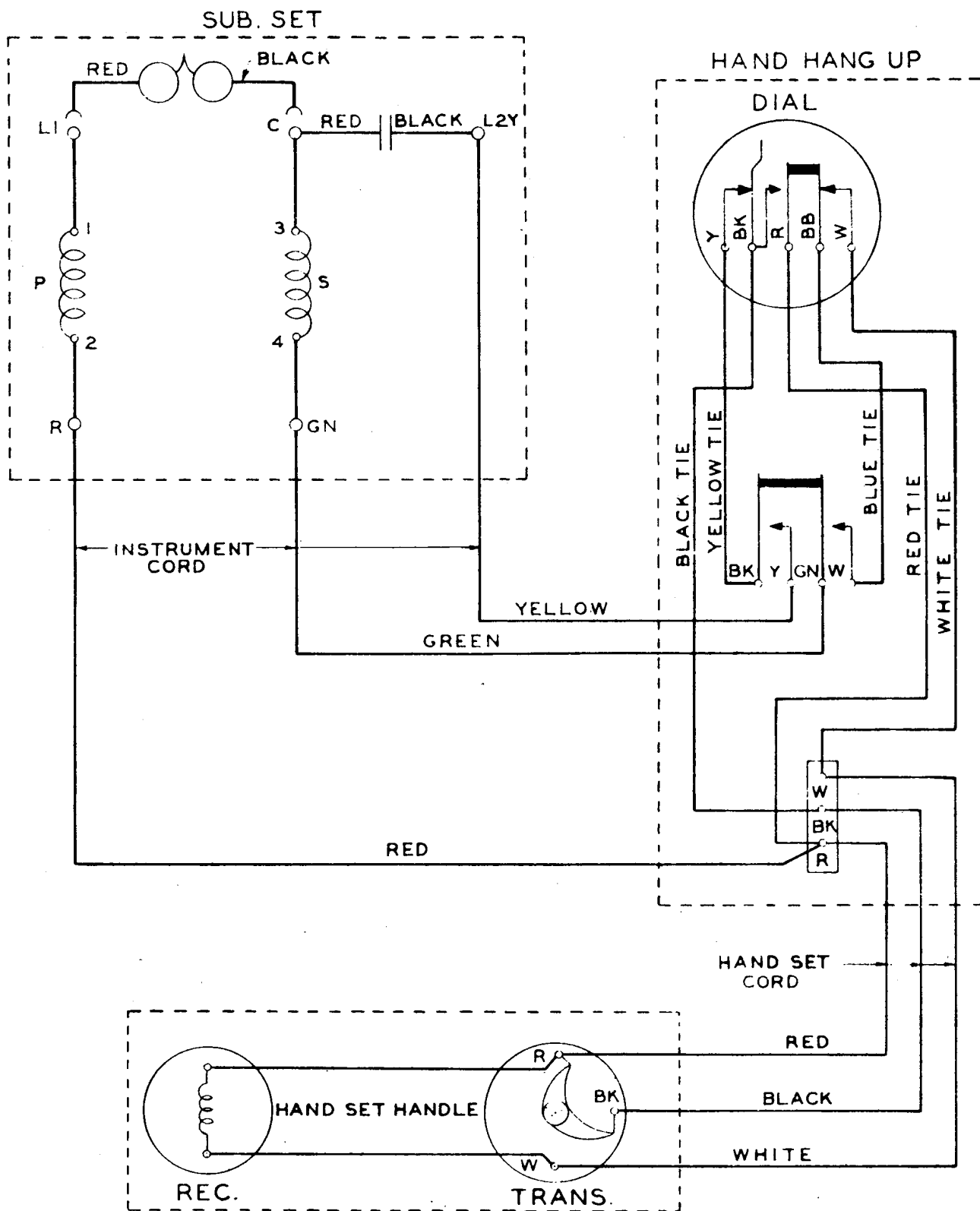


**DIAL HAND SET  
SIDE-TONE INSTRUMENT CCT.**  
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**HAND HANG UP SET NON-DIAL  
SIDE-TONE INSTRUMENT CCT.  
ILLINOIS BELL TELEPHONE CO.  
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**DIAL, HAND HANG UP SET  
SIDE-TONE INSTRUMENT CCT.  
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### SECTION III

#### COMMON BATTERY

##### ANTI-SIDETONE INSTRUMENT CIRCUIT

This section covers the general transmission features of the common battery anti-sidetone station sets; which differs somewhat with the features of the sidetone instrument circuit previously mentioned in Section I.

In the anti-sidetone instrument circuit, we have introduced a third winding, or balancing winding on the induction coil and a balancing network for the purpose of reducing sidetone, which is commonly found in sidetone station equipment.

Sidetone, as referred to in the station instrument circuit, is the transmission and reproduction of sounds through a local path from the transmitter to the receiver of the same telephone station.

Therefore, in summarizing the two standard types of common battery station circuits, we find the sidetone telephone set is one which does not include a balancing winding on the induction coil together with a balancing network for the purpose of reducing sidetone, and the anti-sidetone set which does include a balancing winding on the induction coil and a balancing network for the purpose of reducing sidetone.

Material improvements in transmitting and receiving performances are obtainable with the anti-sidetone sets. Room noises picked up by the local transmitter and reproduced in the receiver through the sidetone path tends to mask the incoming speech. The loudness with which the telephone user talks into the transmitter is influenced to a great extent by the loudness of the sidetone. The reduction in sidetone afforded by the anti-sidetone sets, results in a receiving improvement because of the reduction in the room noise reproduced in the receiver and a transmit-

ting gain inasmuch as it influences the telephone user to talk more nearly at a normal volume. As the volume transmitting and receiving circuit efficiencies of the anti-sidetone set are approximately the same as those of the sidetone set, the transmission improvements are due entirely to the effect of reduced sidetone as mentioned above.

The apparatus differences between anti-sidetone and sidetone set are as follows:

- (a) It employs an induction coil having three windings (Primary, Secondary and Tertiary) instead of two windings used in the sidetone equipment.
- (b) Separate ringing and transmission condensers are used which tends toward better and more uniform signalling conditions and improves pre-trip conditions. The condenser in the transmission circuit is of 2 m.f. capacity and the ringing condenser is of 1 or  $\frac{1}{2}$  m.f. capacity.
- (c) An additional switchhook contact spring is required on desk stands, wall sets, coin collectors, etc. None is required for hand telephone sets.
- (d) A fourth conductor is required in the cord from the desk stand or hand set mounting to the subscriber set.

## THE ANTI-SIDETONE INSTRUMENT CIRCUIT

The anti-sidetone instrument circuit has three parts instead of the customary two found in the standard sidetone instrument circuit. They are primary, Fig. 18, secondary, Fig. 19, and tertiary, Fig. 20.

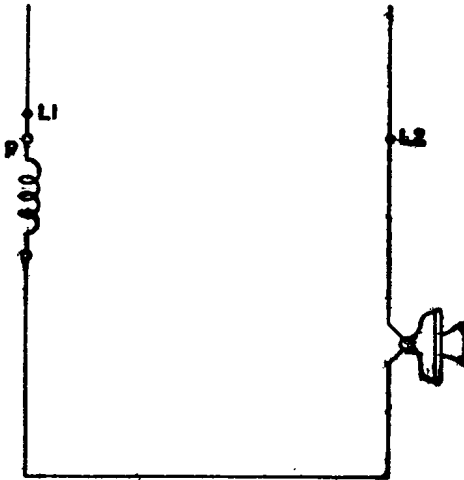


Fig. 18

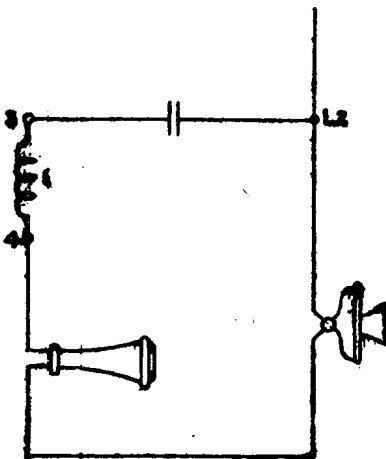


Fig. 19

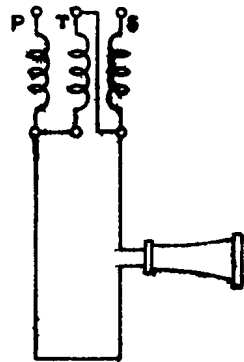


Fig. 20

The primary and tertiary windings are wound in the same direction and reversed to the secondary winding as shown in Fig. 20.

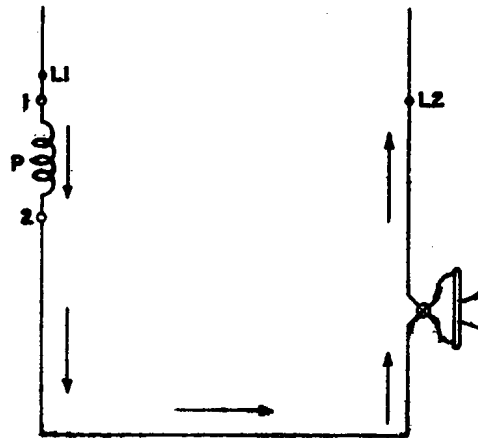


Fig. 21

When the transmitter diaphragm moves inward, the transmitter resistance is decreased, causing an immediate increase in strength of the current flowing in the primary circuit through the primary winding 1-2 of the induction coil and the transmitter, as shown by the arrows in Fig. 21. This decrease in the transmitter



resistance also allows the condenser to discharge in the direction shown by the

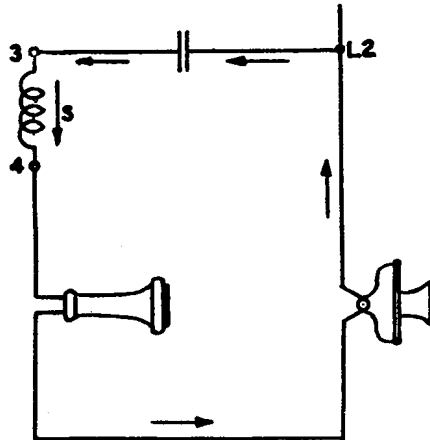


Fig. 22

arrows in Fig. 22, causing a current to flow in the receiver.

When a current is caused to flow in the 3-4 winding of the induction coil, a voltage will be induced in the tertiary winding of the induction coil, causing a current to flow through it in the same direction as that in the secondary, as shown by the arrows in Fig. 23.

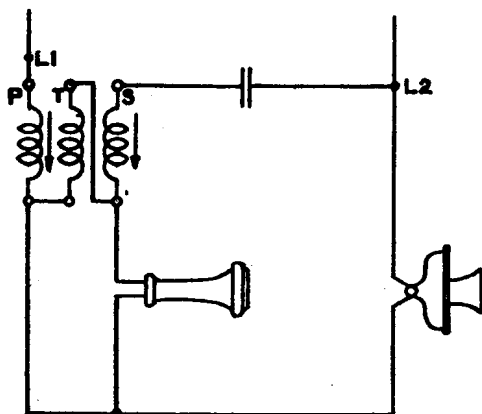


Fig. 23

Arrows in Fig. 24 show the direction of the current flow in the tertiary circuit. It can thus be seen that in the secondary circuit, Fig. 22, the

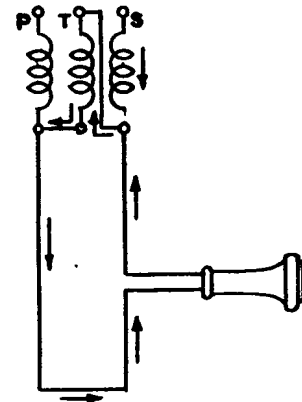


Fig. 24

current flowing through the receiver is in one direction while in the tertiary circuit, Fig. 24, the current flow through the receiver is in the opposite direction. When the primary, secondary, and tertiary circuits are combined they form the anti-sidetone instrument circuit, Fig. 25. It can now be seen that the receiver is in series with both the secondary and tertiary circuits. Since the currents flowing in the secondary and the tertiary circuits are of the same value, and their flow through the receiver is in opposite directions, no current will flow through the receiver at this time, the path taken being shown by the

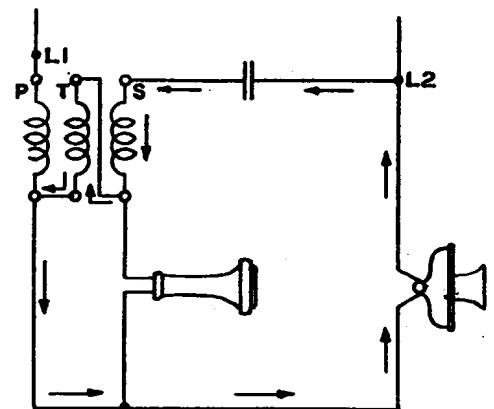


Fig. 25

arrows in Fig. 25. The current which flows through the secondary winding of the induction coil also induces a voltage in the primary causing a current

to flow in the primary in the same direction as that in the secondary, as shown by the arrows in Fig. 26. It can thus be

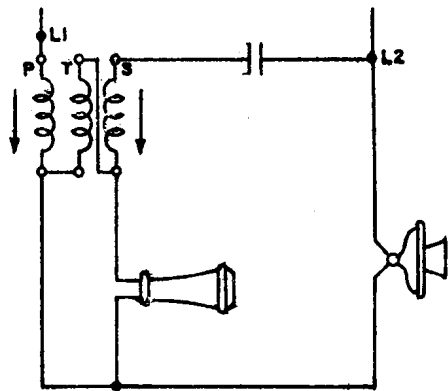


Fig. 26

seen that the flow of increased line current in Fig. 21, and the induced current in Fig. 25, will be in the same direction and will aid one another.

As the transmitter diaphragm moves outward, its resistance increases, retarding the line current flow. The condenser takes on more charge, causing a current to flow in the secondary winding in the direction shown by the arrow in Fig. 27. The

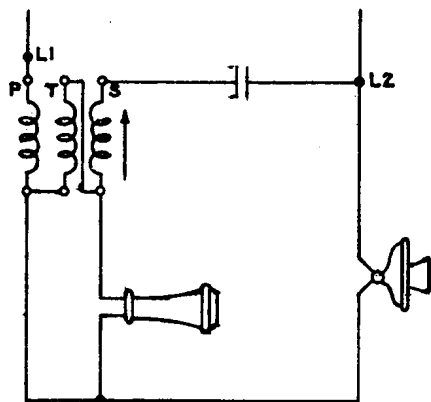


Fig. 27

current flowing in the secondary induces a voltage in the primary, causing a current to flow in the direction shown by the arrows in Fig. 28. The induced current flow

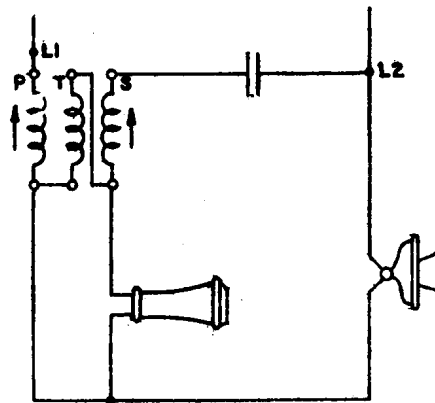


Fig. 28

in the primary is in the opposite direction to the line current, thus further retarding it. There will be no current flowing in the receiver at this time because the direction of the flow of current in the receiver portion of the secondary and tertiary circuits are in the opposite direction and of the same value.

#### Operation of Set When Distant Transmitter is Spoken Into

As the line current increases in the primary winding a voltage will be induced in the secondary, causing a current to flow in the secondary circuit, as shown by the arrows in Fig. 29. The increased flow of line current through the primary will also

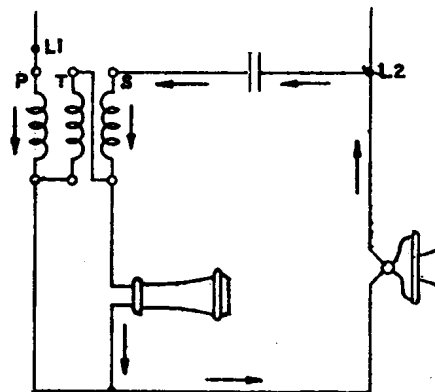


Fig. 29

induce a voltage in the tertiary. No additional current will flow through the receiver as a result of the voltage induced in the tertiary because the voltage drop across it at this time is equal, and of opposite polarity, to the induced voltage of the tertiary.

As the line current decreases in the primary, a voltage will be induced in the secondary, causing a current to flow in the secondary circuit, as shown by the arrows in Fig. 30.

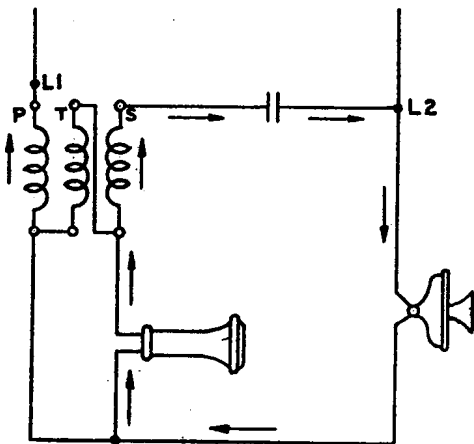


Fig. 30

The decreased flow of line current in the primary will induce a voltage in the tertiary. No additional current will flow in the receiver as a result of the voltage induced in the tertiary because the voltage drop across it at this time is equal, and of opposite polarity, to the induced voltage of the tertiary.

With this circuit arrangement, the manner in which the receiver is actuated is by induced current.

#### General Review of the Anti-Sidetone Station Circuit

The parts contained in the circuits are as follows:

##### 1. Primary circuit (Fig. 31).

- a. Primary winding L1 to "R" of induction coil.

- b. "R" conductor of instrument cord.
- c. "YY" transmitter cord.
- d. Transmitter.
- e. "Y" transmitter cord.
- f. Switchhook contacts.
- g. "Y" conductor of instrument cord to L2.

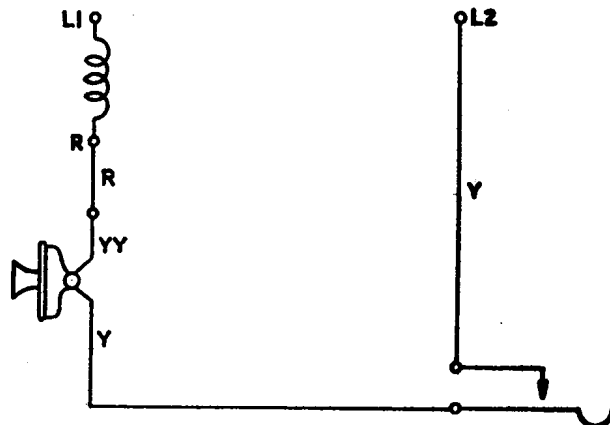


Fig. 31

##### 2. Secondary circuit (Fig. 32).

- a. Condenser to "C" post.
- b. Secondary winding of induction coil "C" to "GN".
- c. "GN" conductor of instrument cord to "GN" post in pedestal.
- d. Green receiver cord.
- e. Receiver.
- f. "W" receiver cord.
- g. Switchhook contacts.
- h. "YY" transmitter cord.
- i. Transmitter.
- j. "Y" transmitter cord.

- k. "BK" conductor of instrument cord to condenser.

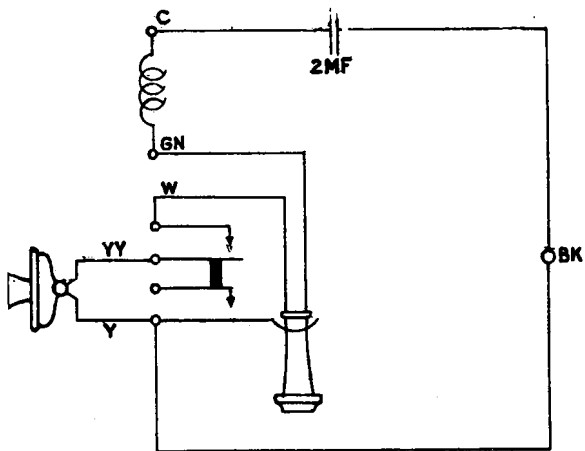


Fig. 32

### 3. Tertiary circuit (Fig. 33).

- a. Tertiary winding of induction coil "GN" to "H".
- b. "R" conductor of instrument cord.

- c. Switchhook contacts
- d. "W" receiver cord.
- e. Receiver.
- f. "GN" receiver cord.
- g. "GN" conductor of instrument cord.

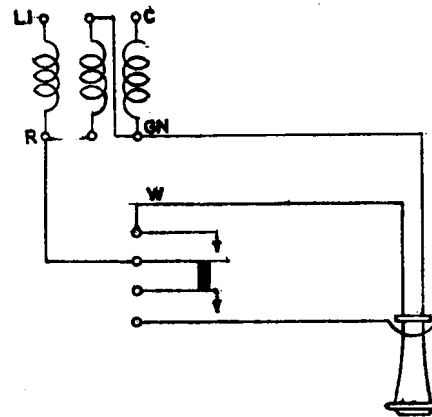
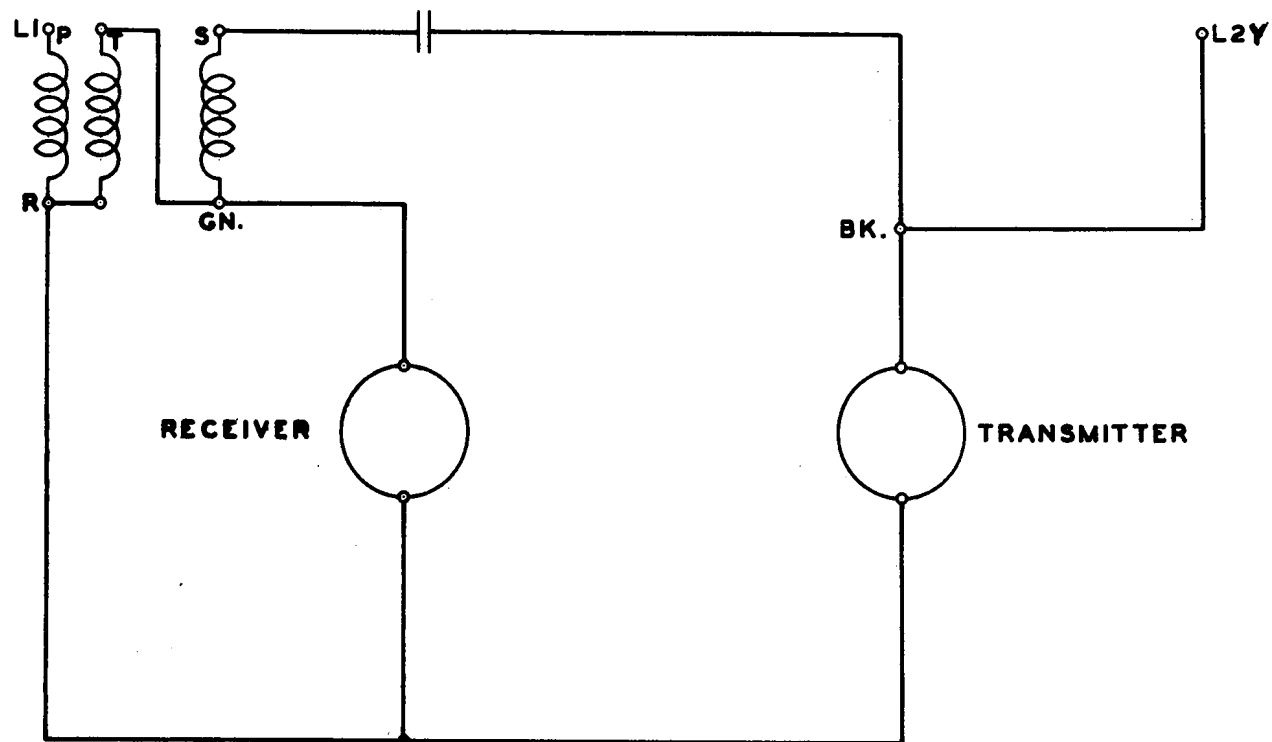
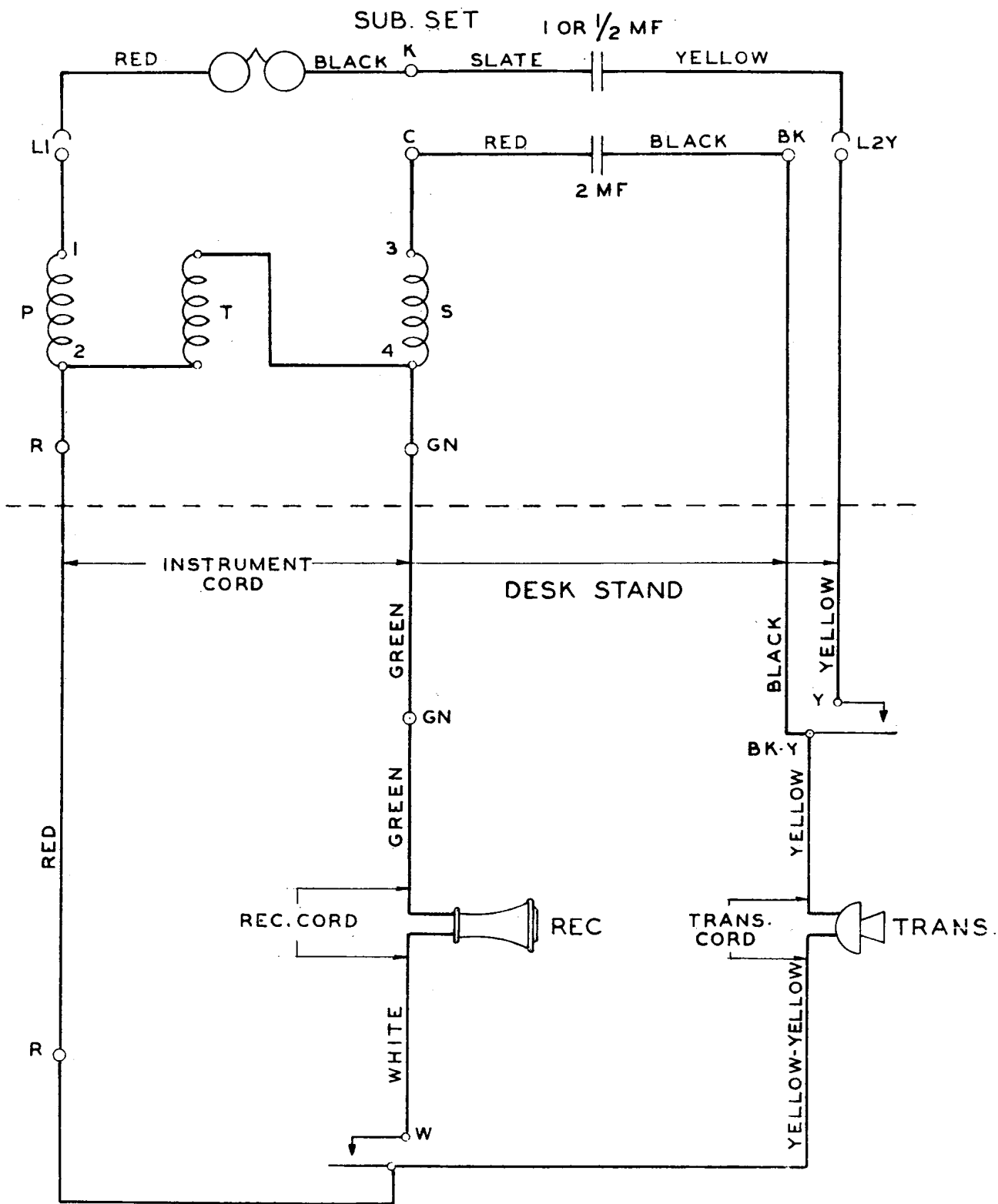


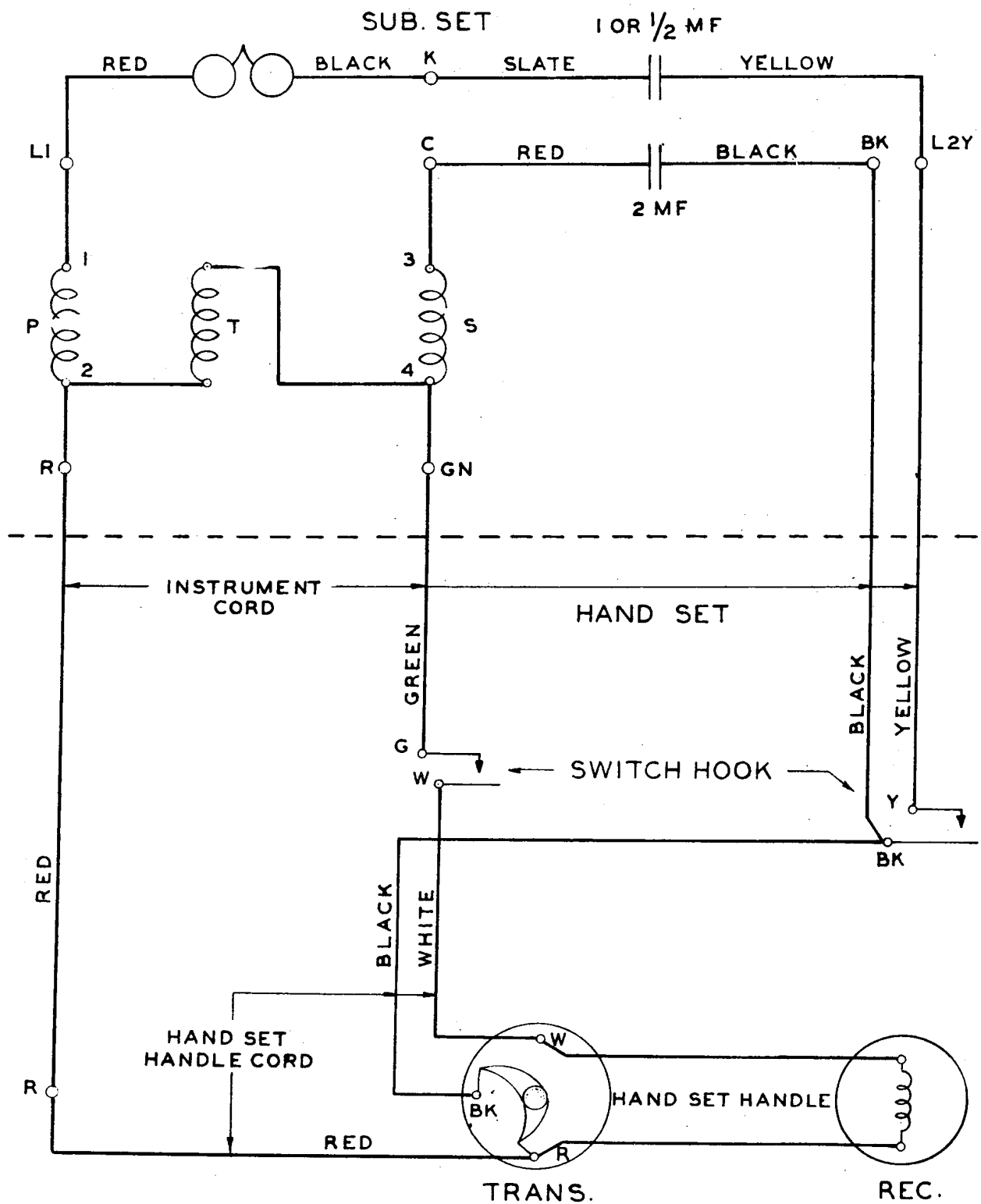
Fig. 33



**ANTI-SIDETONE INSTRUMENT CIRCUIT  
MINUS SWITCHHOOK AND DIAL CONTACTS.  
ILLINOIS BELL TELEPHONE CO.  
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SCHEMATIC  
 DESK STAND NON-DIAL  
 ANTI-SIDETONE INSTRUMENT CCT.  
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SCHEMATIC  
HAND SET NON-DIAL  
ANTI-SIDETONE INSTRUMENT CCT.  
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## SECTION IV

### FAULT LOCATING ANTI-SIDETONE EQUIPMENT

#### GENERAL DESCRIPTION

##### PART I

To locate faults in the standard anti-sidetone sets we must first familiarize ourselves with the changes that have been made in the instrument circuit in comparison to the standard sidetone instruments and what effect they have in the analyzing and locating of faults in the circuit. (See Page 35). For example, we have added a third winding (tertiary) to our induction coils and, in so doing, have connected line one to all parts of our instrument circuit except the yellow cord connecting L2Y post and Y post in the base of the handset or desk stand. We have added a fourth cord to the handsets and desk stands, (black cord) which connects the BK posts in the subset to the BK post in the base of the instrument. This cord completes part of the secondary circuit by terminating on the BK post in the subset with the block lead from the talking condenser, thus removing the condenser from L2Y post where it had previously terminated in the standard sidetone circuit. We have also introduced a separate ringing condenser which separates our ringer circuit entirely from our talking circuit, as we had in the sidetone instrument. Therefore, we can readily see that a new method of testing and locating faults must be applied in the anti-sidetone circuit as follows.

The continuity of the entire instrument circuit can be tested through the means of five simple tests with the receiver on the hook.

- (1) Connect one clip of the test receiver on L2Y post and with the other clip touch the C post several times. A click indicates the path to line 1 including the secondary, tertiary and primary windings of the induction coil and their respective ties are not open.

- (2) Clip still on L2Y post touch the BK post in the subset several times; a click indicating the path to line 1 through the black instrument cord, black handset cord, transmitter, transmitter contacts, red handset cord, red instrument cord and primary of induction coil is not open.
- (3) Clip on L2Y post touch the Gn post in the base of handset; a click indicating the green instrument cord, tertiary, and primary windings of induction coil are not open.
- (4) Clip on L2Y post touch the W post in base of handset; a click indicating the white handset cord, receiver, wires moulded in handset handle leading to receiver, red handset cord, red instrument cord, and primary of induction coil are not open.
- (5) Place one clip of test receiver on L1 and with the other clip touch the Gn post in the base of the handset with the receiver off the hook and red instrument cord open in subset. A click indicates path to Line 2 through <sup>switch</sup> receiver contacts in base of handset, white handset cord, handset handle, receiver, transmitter, black handset cord, contacts in base of handset for primary circuit and yellow cord are not open.

If no clicks were heard at any of these various points previously mentioned we would make tests at various testing points back through their respective paths to L1 or L2 and the fault

being located between the two points where the click is heard and not heard.

The continuity of the ringer circuit can be tested in the same manner by placing one clip of the test receiver on L2Y post and with the other clip touch the K post several times, a click heard indicating the path to L1, or to ground in case of party service, is not open.

The ringing and talking condensers are the remaining parts of apparatus to be tested for possible opens. To test the ringing condenser, open the slate wire of the condenser at the K post and with one clip of the test receiver on the open lead alternately touch L1 and L2, a click heard indicating the condenser is O. K. The talking condenser can be tested by the same method by opening the red condenser lead at C post in the subset and with one clip on the test receiver on the opened lead alternately touch L1 and L2. By making this test, we charge and discharge our condensers from bat. to grd. (L1 to L2).

In the case of a shorted talking condenser, with one clip of our test receiver on L2, we would touch the open red condenser lead several times indicating the direct current was passing through the condenser to the other side which has L1 connected to its BK terminal.

If our ringing condenser was shorted, it is obvious to see we would have a short on the line or a tip or ring ground in the event of party service. In testing, place one clip of the test receiver on L1 and with the other clip touch the open slate condenser lead several times, a click in the receiver each time indicating the direct current is passing through the shorted condenser to the other side which terminates on L2.

In analyzing our circuit for crossed instrument cords we can see that a yellow cord crossed with the black, green or red cords would result in a case of permanent line signal trouble, while crosses between the other three

cords, (Red, Green and Black), would give us various reports of "Can't hear", "Can't hear well", "Can't hear at times", and "Can't be heard", depending on which two cords were crossed.

Assuming we had a reported case of permanent and we suspected crossed instrument cords as mentioned above, we would test as follows:

With one clip of our test set connected to L2Y and receiver on the hook touch the BK and C posts in the subset and Gn and W post in the base of the handset; if clicks were heard at all points tested except the BK post it would indicate a crossed yellow and black instrument cord, in other words the closer we got to our short the less or no clicks we received in the receiver. The reason for this is the current flowing from L1 to L2 takes the path of least resistance which in this case was through the crossed cords rather than through the test receiver which is of higher resistance than the short in the cords. The same in the event of a crossed yellow and green cord, a click would be heard on the BK, C and W posts, but no click would be heard at the Gn post, indicating the green and yellow cords are crossed.

This method of testing may be used where the trouble indicates a solid short. In the event of a high resistance short between the cords, a process of elimination must be used, as follows: Open each individual cord in both the subscriber set and the base of the handset mounting or desk stand, and with one clip of the test receiver on L1 post touch open black cord several times with the other clip of test set. If click is heard black and yellow instrument cord is crossed. If no click is heard, touch open green cord, a click indicating green and yellow instrument cords are crossed. If no click is heard touch open red cord, a click indicating red and yellow are crossed.

Where the report indicates that there is a possible crossed green and black or red cords, such as a C.H. or

C.B.H. report, a process of elimination must be used; for example, let us assume the green and black cords were crossed. Connecting one clip of our test receiver on L2, instrument receiver on the hook and the green cord open at the subset, we would touch the open green cord, a click indicating the green cord was crossed with the black or red instrument cords; then by opening the black cord at the BK post in the base of the handset removing the path to L1 and again touching the open green cord a click would indicate the green and red cords were crossed, if no click was heard the green and black cords are crossed. The same method can be applied in the event of a crossed black and red or green and red cords.

Where the report and tests by the tester and repairman indicates possible crossed handset cords, (black, white and red), the same tests can be followed as were applied in the sidetone instrument circuit; also where the wires moulded in the handset handle are crossed.

Extreme caution should be exercised by the repairman when dispatched on "Can't hear well", or "Can't hear at times" report on an antisidetone instrument, and a complete continuity test of the entire circuit should be made for the following reasons. In analyzing the circuit, we will find that though the red instrument cord, red handset cord, secondary coil of the induction coil, condenser and black instrument cord were missing the subscriber could still use the phone in the usual manner, although they could not hear as well on suburban and long distance calls. This would be due to the fact that the balancing network of the circuit has been completely taken out, and the talking path would be from L1 through the primary and tertiary of the induction coil, green instrument cord, white handset cord, handset handle, receiver, transmitter, black handset cord, yellow instrument cord to L2, which is somewhat equivalent to bridging our headset across the line, except for the additional resistance of the pri-

mary and tertiary windings of the induction coil. Therefore, we would have the same results if only one of these above mentioned items were open, and the fault could be very easily passed up unless a complete continuity test was made as previously mentioned. Indication to the repairman of this type of trouble would be excessive sidetone and in the case of open red instrument or handset cord excessive clicks in the ear when flashing operator, or when dialing in a dial area.

If after eliminating all wiring defects by the routine method of testing previously mentioned and no trouble is found, a comparison test should be made with the individual units within the circuit, such as the transmitter and receiver units, or the induction coil; for example, on a "Can't be heard" report, after the repairman has made all the routine tests with his test receiver and no trouble is found, replace the transmitter unit with a new one and make a comparison test with the tester. It is advisable wherever possible to make this test with the same testman for both the old and new transmitter units. The same method should be followed when trouble indicates a possible shorted receiver, or low volume induction coil.



## FAULT LOCATING ANTI-SIDETONE EQUIPMENT

### REPORTED TROUBLE PERMANENT (PERM.)

#### POSSIBLE CAUSES

1. Crossed Yellow and Black Cords.
  2. Crossed Yellow and Green Cords.
  3. Crossed Yellow and Red Cords.
  4. Crossed Switchhook Contacts.
  5. Crossed Condenser Leads (Red and Yellow of Talking and Ringing Condenser).
  6. Shorted Ringing Condensers.
1. TEST - CROSSED YELLOW AND BLACK INSTRUMENT CORDS.
    - (a) Open bell circuit at K post.
    - (b) With receiver on the hook connect one clip of the test receiver on L2Y post and with the other clip touch the BK, C, Gn, and W post several times. If clicks are heard on the C, Gn, and W posts and no click on the BK post it indicates a crossed black and yellow instrument cord or switchhook contacts in base of handset (Y and BK contacts).
    - (c) Open black cord at BK post in base of handset or desk stand and with one clip of test set on Ll post touch open black cord if click is heard black and yellow cords are crossed, if no click is heard cross is in switchhook contacts of primary circuit.
  2. TEST - CROSSED YELLOW AND GREEN CORDS.
    - (a) Open bell circuit at K post.
    - (b) With receiver on the hook, connect one clip of test receiver on L2Y post and with other clip touch the BK, C, Gn, and W post several times. If clicks are heard on BK, C, and W posts and no click on the Gn post it indicates a crossed green and yellow instrument cord, or crossed switchhook contacts. (Receiver and transmitter contacts).
  - (c) Open green cord in base of handset and with one clip of test receiver on Ll post touch open green cord with other clip, if click is heard green and yellow cords are crossed, if no click is heard trouble is in switchhook contacts.
  3. TEST - CROSSED YELLOW AND RED INSTRUMENT CORDS.
    - (a) Open bell circuit at K post.
    - (b) With receiver on the hook, connect one clip of test receiver to L2Y post and with the other clip touch several times the BK post, C post, Gn, and W post. If no clicks are heard on these various test troubles indicates a solid short across the line shunting out Ll path to these points tested, indicating a crossed yellow and red instrument cord.
  4. TEST - CROSSED SWITCHHOOK CONTACTS.  
(SEE TEST #2.)
  5. TEST - CROSSED CONDENSER LEADS.  
(RED AND YELLOW OF TALKING AND RINGING CONDENSERS).
    - (a) Open bell circuit at K post.
    - (b) With receiver on the hook, connect one clip of test receiver to L2Y and with the other clip touch several times the BK, C, Gn, and W post. If clicks are heard on the BK, Gn, and W post and no click on the C post it indicates a possible crossed condenser lead (red of talking condenser and yellow of ringing condenser).



REPORTED TROUBLE PERMANENT (PERM.) (CONT'D.)

6. TEST - SHORTED RINGING CONDENSER.

- (a) Open slate condenser lead at K post.
- (b) With receiver on the hook, connect one clip of test set on Ll post and with the other clip touch open slate condenser lead several times, a click each time indicates a shorted ringing condenser.

This type of cross will be indicated by meter reading given to the repairman by the tester. A shorted condenser must go through the ringer coils and, therefore, will give a much higher resistance short than the previous mentioned reports of permanents on the line.

NOTE: In the event of a high resistance short between the cords, the process of elimination method should be used, as previously mentioned in the "General Description" of Fault Locating in anti-sidetone equipment. (See Note #1).

## FAULT LOCATING ANTI-SIDETONE EQUIPMENT

### REPORTED TROUBLE - BELL DON'T RING (B.D.R.)

#### POSSIBLE CAUSES

1. Open ringers, or ringer leads (Black and Red).
2. Open ringing condenser or condenser leads (S and Y).
3. Shorted ringer coils.
4. Mechanical defects.

#### 1. TEST OPEN RINGERS

- (a) Open bells at K post.
- (b) Connect one clip of test set on L2Y post and with the other clip touch open bell jumper at K post.

If no clicks are heard it indicates an open in ringer circuit. Then test back through circuit at various testing points until click is heard. When no clicks are heard on one test, and on the test at the next point clicks are heard, the open is located between the two points at which these tests were made.

#### 2. OPEN CONDENSER

- (a) Open condenser at K post (slate wire).
- (b) Connect one clip of test set on open condenser lead and alternately touch L1 and L2Y posts with the other clip of test set. If condenser charge and discharge clicks are heard each time posts are touched condenser is O.K., if no clicks are heard condenser or condenser leads are open.

NOTE: By alternately touching L1 and L2Y posts we charge and discharge the condenser from battery to ground.

#### 3. TEST FOR SHORTED RINGER COILS.

- (a) Open bells at K post.
- (b) Connect one clip of test receiver on L2Y post and with the other clip touch open bell jumper at K

post. A loud click would indicate ringers were completely shorted out due to the current passing through the short, rather than the high resistance winding of the ringer coils. When test indicates a partially shorted coil, a comparison test should be employed as a definite test in proving the trouble.

#### 4. TEST - MECHANICAL DEFECTS.

- (a) Mechanical defects and proper adjustments of ringer unit must also be taken into consideration on "Bell don't ring" reports, such as gauging of ringers, armature pivot screws too tight, loose gongs, clapper rod bent, filings between pole piece and armature and ringers improperly connected in the case of party service. The station ground clamp also plays an important factor in the ringer circuit and should be checked to see that it is not loose, corroded and is fastened to a cold water pipe.

## FAULT LOCATING ANTI-SIDETONE EQUIPMENT

### REPORTED TROUBLE - TRANSMITTER DEAD OR CAN'T BE HEARD (C.B.H.)

#### POSSIBLE CAUSES

1. Crossed red and black handset cords.
2. Crossed yellow and yellow-yellow transmitter cords (desk stand).
3. Shorted or packed transmitter unit.

#### 1. TEST - CROSSED RED AND BLACK HAND- SET CORDS.

- (a) Open bell circuit at K post.
- (b) Remove transmitter unit from handset.
- (c) Open white cord in handset handle and hold switchhook down.
- (d) Connect one clip of test set to L2Y post and with the other clip touch black cord several times in handset handle. If clicks are heard each time the black and red cords are crossed.

#### 2. TEST - CROSSED YELLOW AND YELLOW- YELLOW TRANSMITTER CORDS (DESK STAND).

- (a) Open bell circuit at K post.
- (b) Open yellow transmitter cord at transmitter and in desk stand.
- (c) With receiver on the hook, connect one clip of test receiver on L2Y post and with the other clip touch open yellow transmitter cord. If click is heard, it indicates a crossed yellow and yellow-yellow transmitter cords, shunting out transmitter.

#### 3. TEST - SHORTED OR PACKED TRANSMITTER UNIT.

- (a) If no trouble is found on previous tests, make comparison test with tester on old and new transmitter units.



## FAULT LOCATING ANTI-SIDETONE EQUIPMENT

### REPORTED TROUBLE - RECEIVER DEAD CAN'T HEAR (C.H.)

#### POSSIBLE CAUSES

1. Crossed wires moulded in handset handle.
  2. Crossed red and white handset cords.
  3. Crossed black and white handset cords.
  4. Open green instrument cord, white handset cord, wires moulded in handset handle, receiver unit, or dirty dial or handset receiver contacts.
  5. Shorted green and white receiver cords (desk stand).
  6. Shorted receiver unit.
1. TEST - CROSSED WIRES MOULDED IN HANDSET HANDLE.
    - (a) Open bells at K post.
    - (b) Open yellow cord in subset.
    - (c) Remove transmitter and receiver units from handset. Hold switchhook down.
    - (d) Open white cord in handset handle.
    - (e) Connect one clip of test receiver to L2Y post and with the other clip touch white post in handset handle. If clicks are heard, the wires moulded in the handset handle are crossed. If no clicks are heard, continue with test #2.
  2. TEST - CROSSED RED AND WHITE HANDSET CORDS.
    - (a) If no clicks are heard on test #1, touch open white cord at handset handle several times. If clicks are heard, it indicates the red and white handset cords are crossed. If no clicks are heard, continue with test #3.
  3. TEST - CROSSED BLACK AND WHITE HANDSET CORDS.
    - (a) If no clicks are heard on test #2, replace the receiver unit on handset handle, close down the white cord in handset handle, and touch the black cord at handset handle several times (one clip of test receiver still on L2Y post and switchhook down). If clicks are heard each time, the white and black handset cords are crossed.
  4. OPEN GREEN INSTRUMENT CORD, WHITE HANDSET CORD, WIRES MOULDED IN HANDSET HANDLE, RECEIVER UNIT, DIRTY CONTACTS, HANDSET OR DIAL.
    - (a) Open bell circuit at K post.
    - (b) Open yellow cord in subset.
    - (c) Remove receiver from switchhook.
    - (d) Open green instrument cord in subset.
    - (e) Connect one clip of test receiver to L2Y post and with the other clip touch open green cord several times. If no clicks are heard the fault (open) is located in one of the above mentioned parts. Test back through this portion of circuit to Ll post until clicks are heard. When no clicks are heard on one test, and on the test at the next point clicks are heard, the fault is located between the two points at which these tests were made.

CAN'T HEAR (CONT'D.)

POINTS TO BE TESTED

Pedestal or Desk Stand

Non-Dial

Dial

Open Green Cord	Open Green Cord
Gn Post at Ped.	Gn Post at Ped.
Gn Post at Rec.	Gn Post at Rec.
White Post at Rec.	White Post at Rec.
White Post at S Hook	W Post at Dial
Red Post at S Hook	BB Post at Dial
Red Post in Subset	BB Post at S.Hook
#2 of Ind. Coil	YY R.Post at S.Hook
#1 of Ind. Coil	R. Post at Ped.
Line #1	R. Post at Subset
	#2 of Ind. Coil
	#1 of Ind. Coil
	Line #1

eral times. If clicks are heard each time, it indicates green and white receiver cords crossed.

6. TEST - SHORTED RECEIVER UNIT.

- (a) If after all previous tests have been made and no trouble is found, substitute receiver with new one and make comparison test.

Handset

Non-Dial

Dial

Open Green Cord	Open Green Cord
Gn Post at S. Hook	Gn Post at S.Hook
W. Post at S. Hook	W. Post at S.Hook
W. Post at Handset	BB Post at Dial
Contacts at Rec.Unit	W. Post at Dial
R. Post at Handset	W. Post at Handset
R. Base of Handset	Cont. at Rec.Unit
R. Subset	R. Post of Handset
#2 of Ind. Coil	R. Post of Dial
#1 of Ind. Coil	R. Subset
Line #1	#2 of Ind. Coil
	#1 of Ind. Coil
	Line #1

5. TEST - SHORTED GREEN AND WHITE RECEIVER CORDS (DESK STAND).

- (a) Open bell circuit at K post.
- (b) Open yellow cord at subset.
- (c) Open green receiver cord at pedestal and receiver.
- (d) Remove receiver from hook.
- (e) Connect one clip of test receiver on L2Y post and with the other clip touch open green cord sev-

## FAULT LOCATING ANTI-SIDETONE EQUIPMENT

REPORTED TROUBLE	(CAN'T BE HEARD WELL - (C.B.H.W.)
	(CAN'T HEAR WELL - (C.H.W.)

### POSSIBLE CAUSES

1. Open or shorted talking condenser.
2. Open black instrument cord.
3. Open red instrument cord (see Note #4).
4. Open red handset cord (See Note #4).
5. Open secondary winding of induction coil.
6. Open tertiary winding of induction coil.
7. Red and white handset cords crossed.
8. Red and green instrument cords crossed.
9. Green and black instrument cords crossed (See Note #1).
10. Red and black instrument cords crossed (See Note #2).
11. Shorted primary winding of induction coil (See Note #3).
12. Shorted tertiary winding of induction coil (See Note #3).
13. Shorted secondary winding of induction coil (See Note #3).

NOTE #1: The trouble reported on test in this case would depend on the nature of the cross; a low resistance cross would result in a "Can't Hear, Receiver Dead," while a high resistance cross would be reported as "Can't Hear Well."

NOTE #2: Here again the nature of the cross would govern the trouble reported on test. A low resistance cross would be reported as "Can't Be Heard, Trans. Dead," while a high resistance cross would be reported as "Can't Be Heard Well."

NOTE #3: In locating these three types of faults, the repairman will have to resort to making a comparison test with the tester by replacing the old induction coil with a new one, making sure, if possible, to test with the same tester for both the old and new coil.

NOTE #4: These two types of trouble

might also be reported or dispatched as "Clicks in the ear while dialing," if in a dial office or "Excessive clicks when flashing operator" in a manual office. This is caused due to the fact that your handset is connected merely across the line through the tertiary winding of the induction coil and the receiver and transmitter are just in series like an ordinary headset. Therefore, on every make or break of the circuit, such as flashing the switchhook, the receiver will receive the primary surge of current when the circuit is closed or opened instead of being closed in on the circuit after the primary portion of the circuit has been closed through the transmitter, as normally takes place when there is no trouble on the instrument.

In the case of a desk stand, handset, or hand hang-up in a dial area, this type of trouble would be reported as "Can't break dial tone," due to the fact that the instrument short would be broken at the receiver contacts in the dial at the moment the dial is moved off normal and, of course, in turn releasing the central office equipment until the dial returned to normal and then again at the moment the dial returns to normal the dial tone would come back on the line.

### 1. TEST - OPEN OR SHORTED TALKING CONDENSER.

- (a) Open bell circuit at K post.
- (b) Open red condenser lead at C post of induction coil.
- (c) Connect one clip of test receiver on open red condenser lead and alternately touch L1 and L2Y post. A light click heard in the receiver each time indicates condenser is not open. If no clicks are heard, condenser is

CAN'T BE HEARD WELL - CAN'T HEAR WELL (CONT'D.)

open. If no trouble is found, continue with test (d).

- (d) With clip of test receiver still on open condenser lead successively touch L2Y post only two or more times; if clicks are heard each time, condenser is **shorted**.

2, 3 & 4. TEST - OPEN BLACK, RED INSTRUMENT CORD - RED HANDSET CORD.

- (a) Open bell circuit at K post.
- (b) With receiver on the hook, connect one clip of test set on L2Y post and with the other clip touch the BK post in subset several times. If no clicks are heard, it indicates one of the above mentioned troubles. Continue with test (c).
- (c) With clip of test set still on L2Y touch the BK post in base of handset with the other clip. If click is heard, it indicates black instrument cord is open. If no click is heard, continue with test (d).
- (d) Remove transmitter from handset handle and with one clip still on L2Y touch red post in handle. If no click is heard, touch red post in base of handset mounting. A click heard indicates red handset cord is open, if no click is heard red instrument cord is open.

5 & 6. TEST - OPEN SECONDARY, TERTIARY, WINDING OF INDUCTION COIL.

- (a) Connect one clip of test receiver on L2Y post and with the other clip touch the C post at induction coil. If no click is heard, touch Gn post on induction coil, if click is heard it indicates secondary winding is

open, if no click is heard tertiary winding is open.

7. TEST - RED AND WHITE HANDSET CORDS CROSSED.

- (a) Remove transmitter unit from handset handle.
- (b) Open white cord in handset handle.
- (c) With the receiver on the hook, connect one clip of test receiver on L2Y post and with the other clip touch the open white cord several times. If clicks are heard, red and white handset cords are crossed.

8, 9 & 10. TEST - CROSSED INSTRUMENT CORDS.

- (Red And Green)
- (Black And Green)
- (Black And Red)

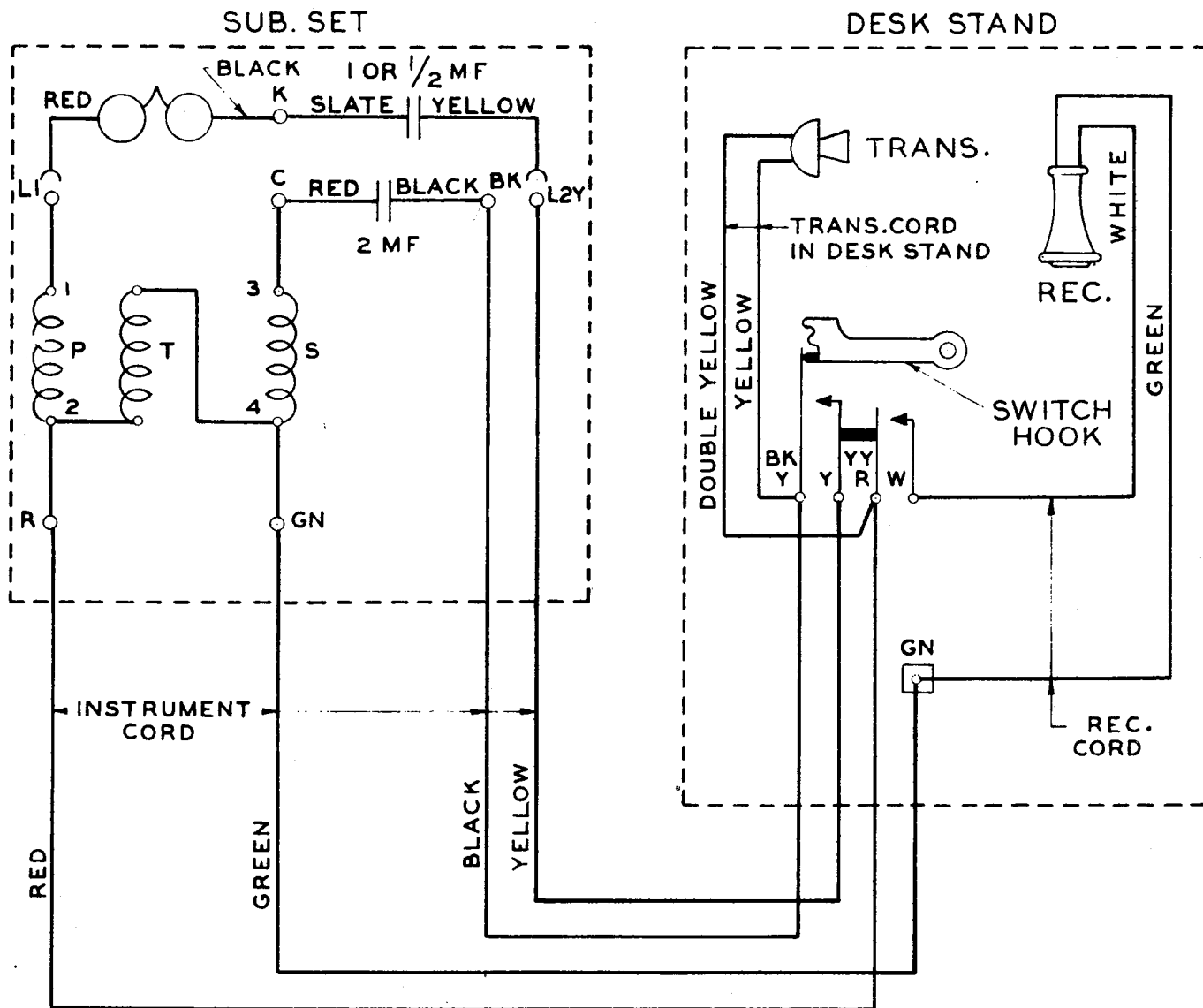
- (a) Open green instrument cord in subset.
- (b) With receiver on the hook, connect one clip of test receiver on L2Y post and with the other clip touch open green cord. If click is heard green cord is crossed with black or red instrument cord. Continue with test (c).
- (c) Open black instrument cord in base of handset and with clip still on L2Y post, again touch open green cord. If no click is heard, black and green instrument cords are crossed. If click is still heard, it indicates crossed green and red instrument cords. If no trouble was found in tests (a), (b) and (c) continue with test (d).
- (d) Close down green cord again in subset and with one clip still on L2Y post and receiver on the

hook touch open black cord several times with other clip of test receiver. If clicks are heard each time, black and red instrument cords are crossed.

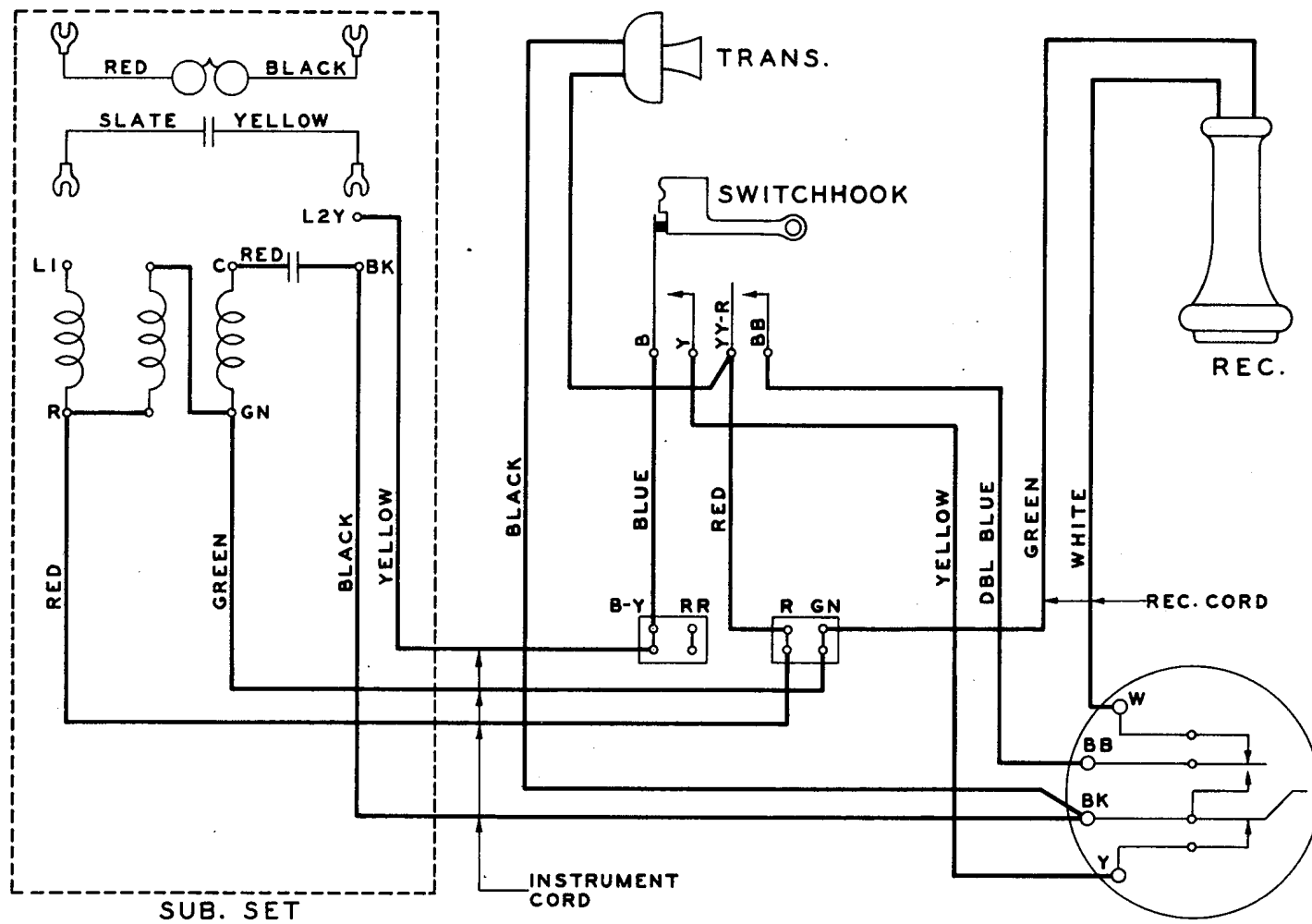
11, 12 & 13. TEST - SHORTED PRIMARY,  
SECONDARY, OR TERTIARY  
WINDING OF INDUCTION COIL.

- (a) If no trouble is found after all previous tests have been made, a comparison test must be made with a new induction coil, making sure that the same tester is contacted when testing both the old and new coil.

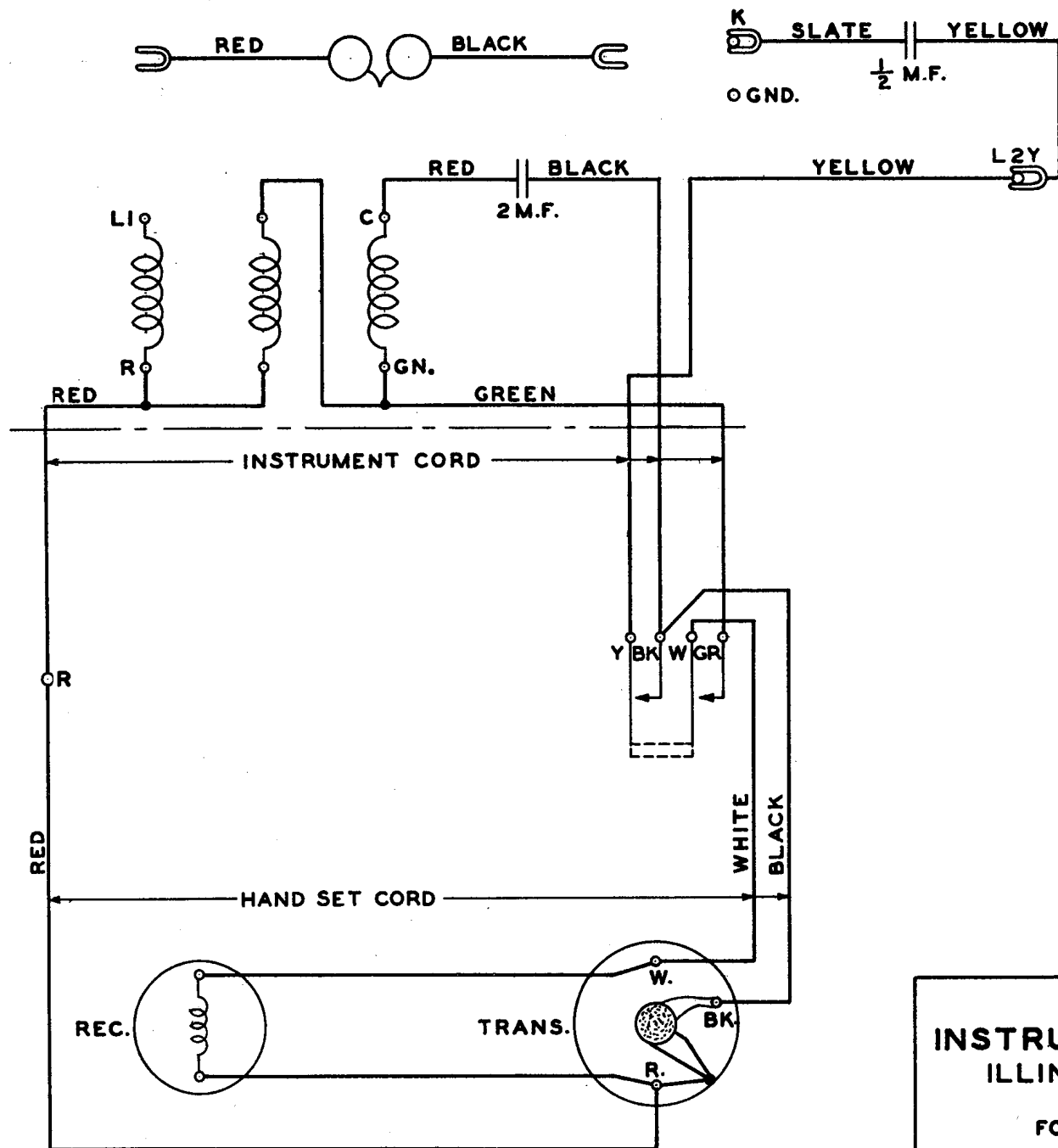
This method of testing must be resorted to, as the repairman or installer is not equipped with a test meter to test which of the particular windings are defective, or shorted. If trouble is found on comparison test of induction coil, it shall be referred in to the tester as a low volume induction coil.



**DESK STAND NON-DIAL  
ANTI-SIDETONE INSTRUMENT CCT.**  
ILLINOIS BELL TELEPHONE CO.  
PLANT TRAINING SCHOOL  
FOR TRAINING PURPOSES ONLY

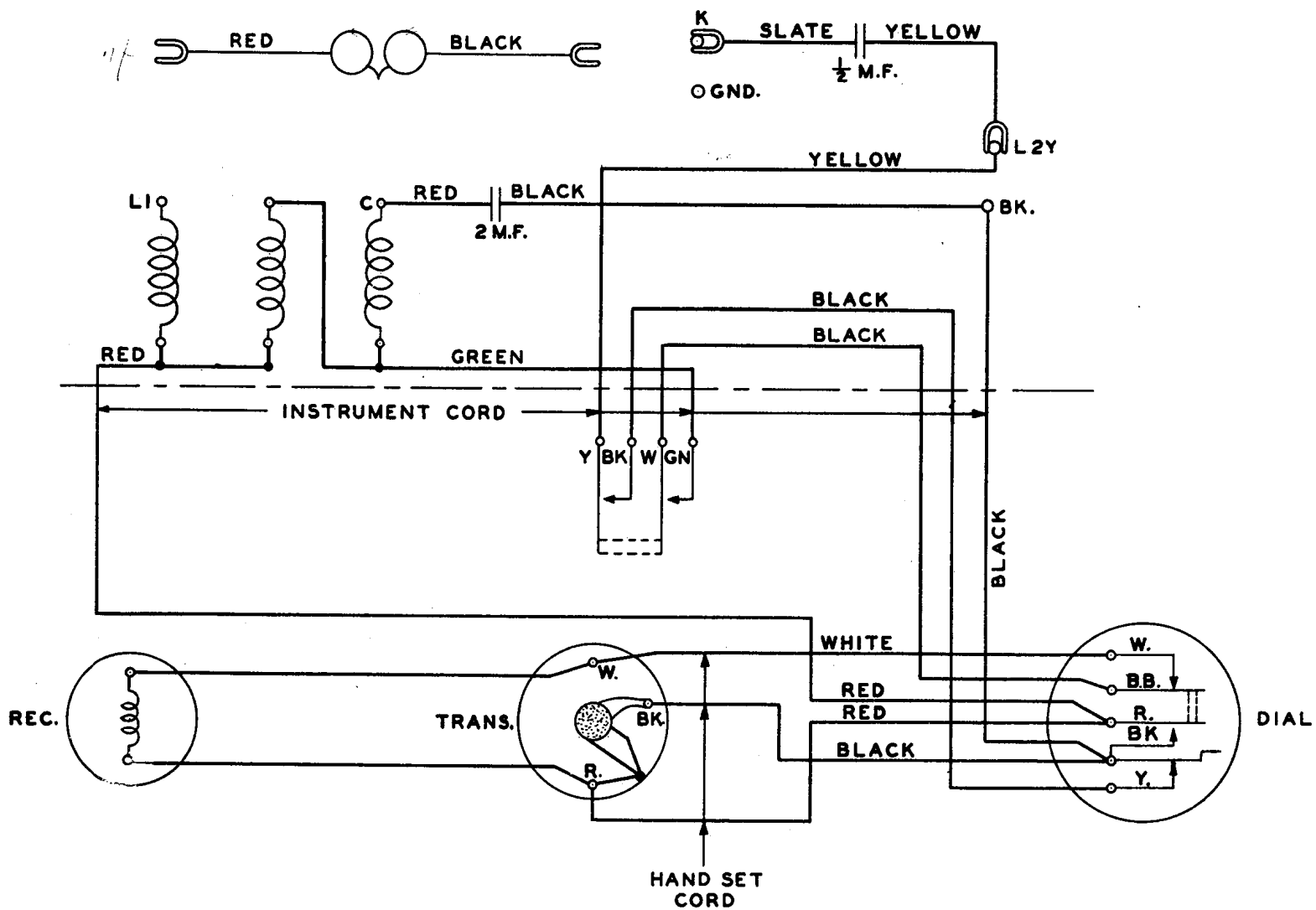


**ISIAL TYPE**  
**ANTI-SIDETONE INSTRUMENT**  
**CIRCUIT-DIAL DESK STAND**  
**ILLINOIS BELL TELEPHONE COMPANY**  
**PLANT TRAINING SCHOOL**  
**FOR TRAINING PURPOSES ONLY**

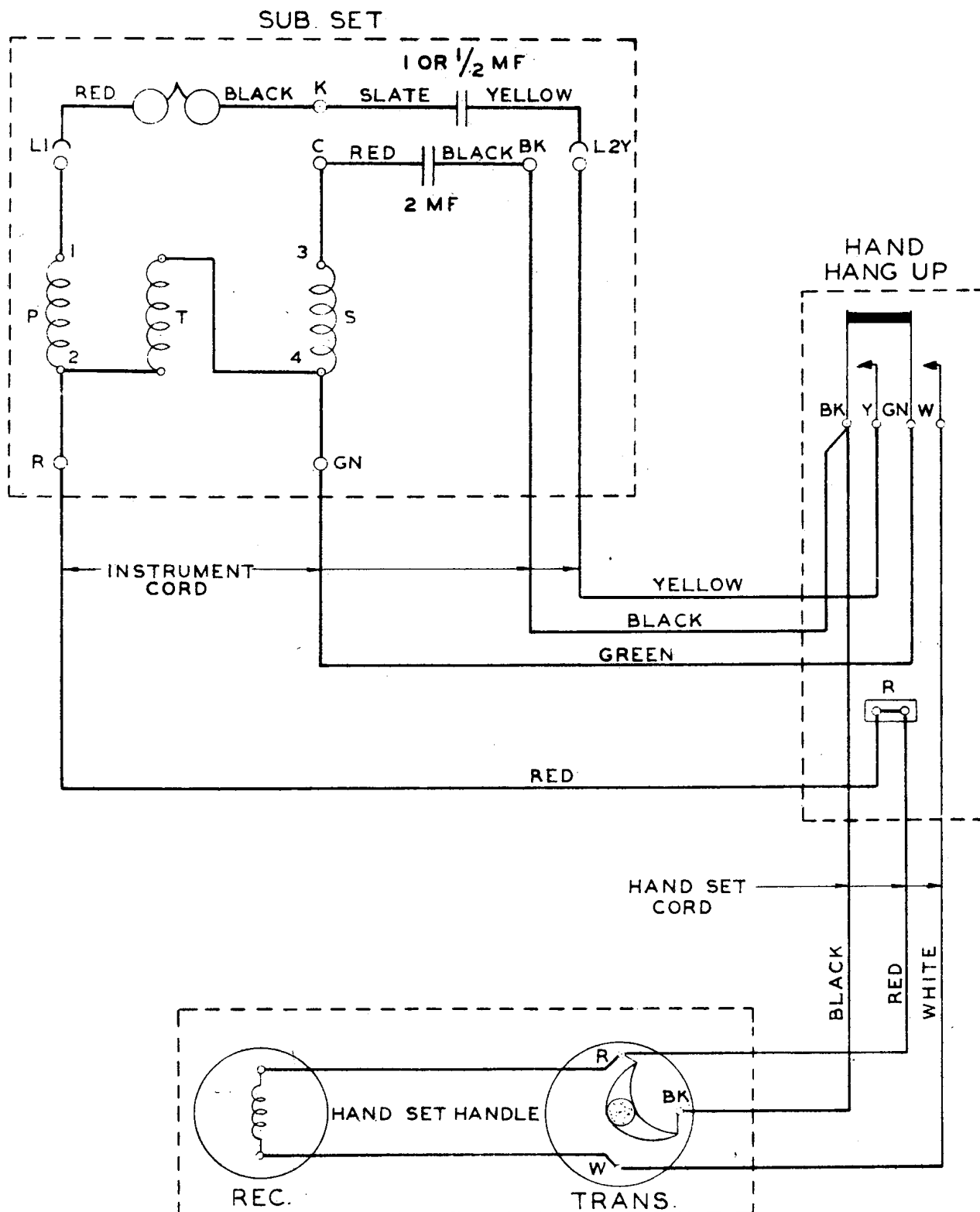


**ANTI-SIDETONE  
INSTRUMENT CIRCUIT HAND SET  
ILLINOIS BELL TELEPHONE CO.  
PLANT TRAINING SCHOOL  
FOR TRAINING PURPOSES ONLY**



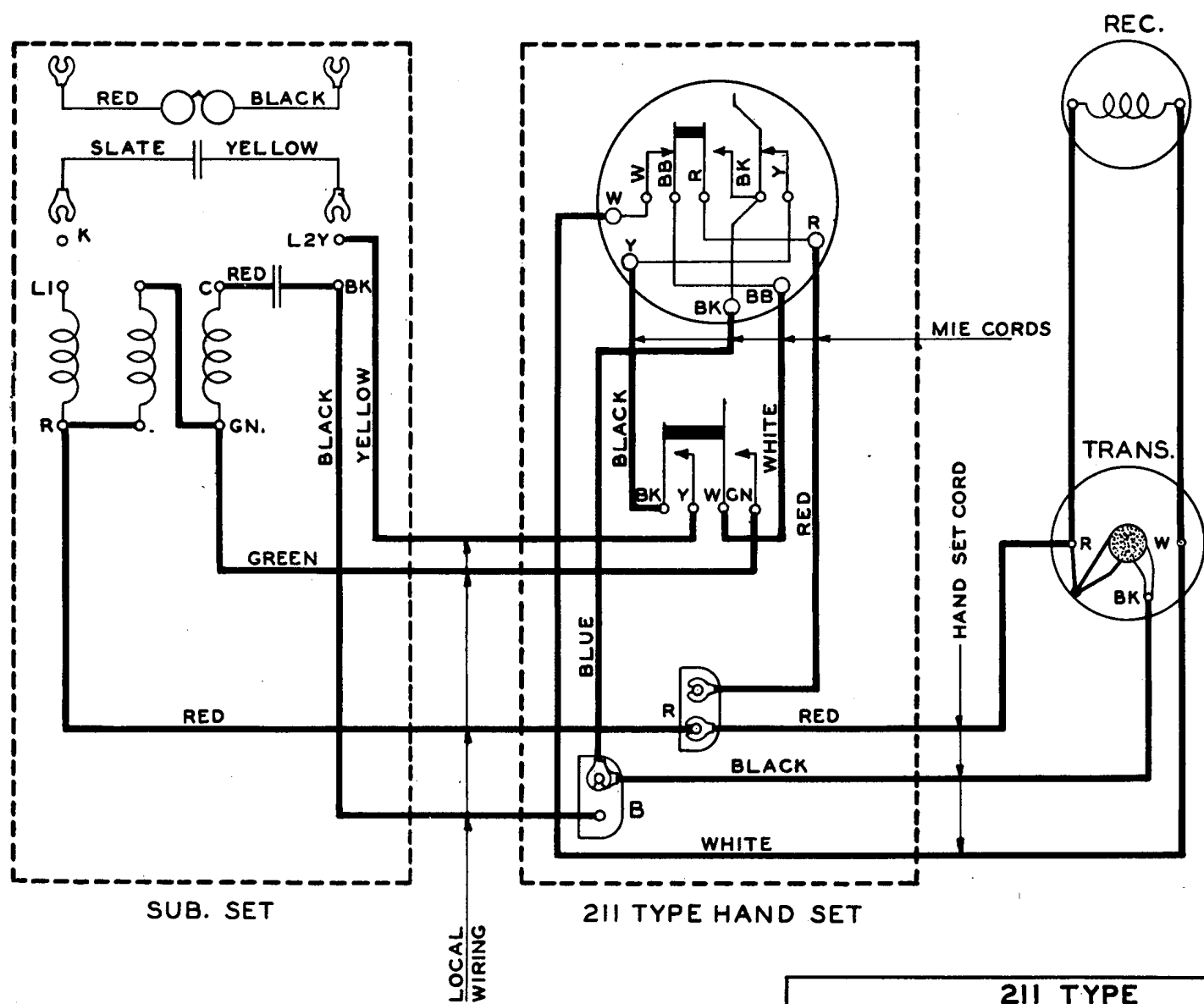


**ANTI-SIDETONE INSTRUMENT  
CIRCUIT-DIAL HAND SET  
ILLINOIS BELL TELEPHONE CO.  
PLANT TRAINING SCHOOL  
FOR TRAINING PURPOSES ONLY**



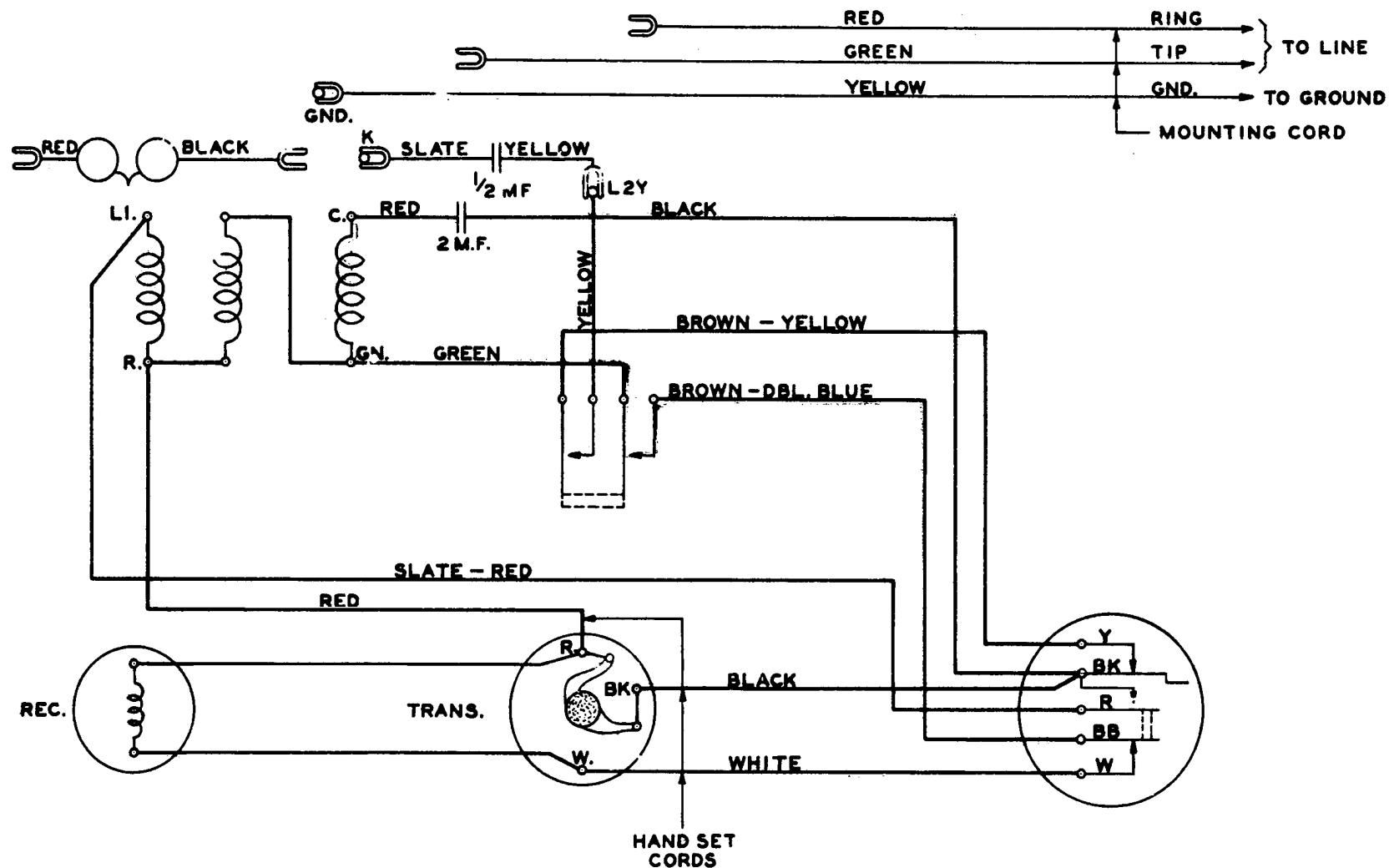
**HAND HANG UP SET NON-DIAL  
ANTI-SIDETONE INSTRUMENT CCT.**  
ILLINOIS BELL TELEPHONE CO.  
PLANT TRAINING SCHOOL

FOR TRAINING PURPOSES ONLY

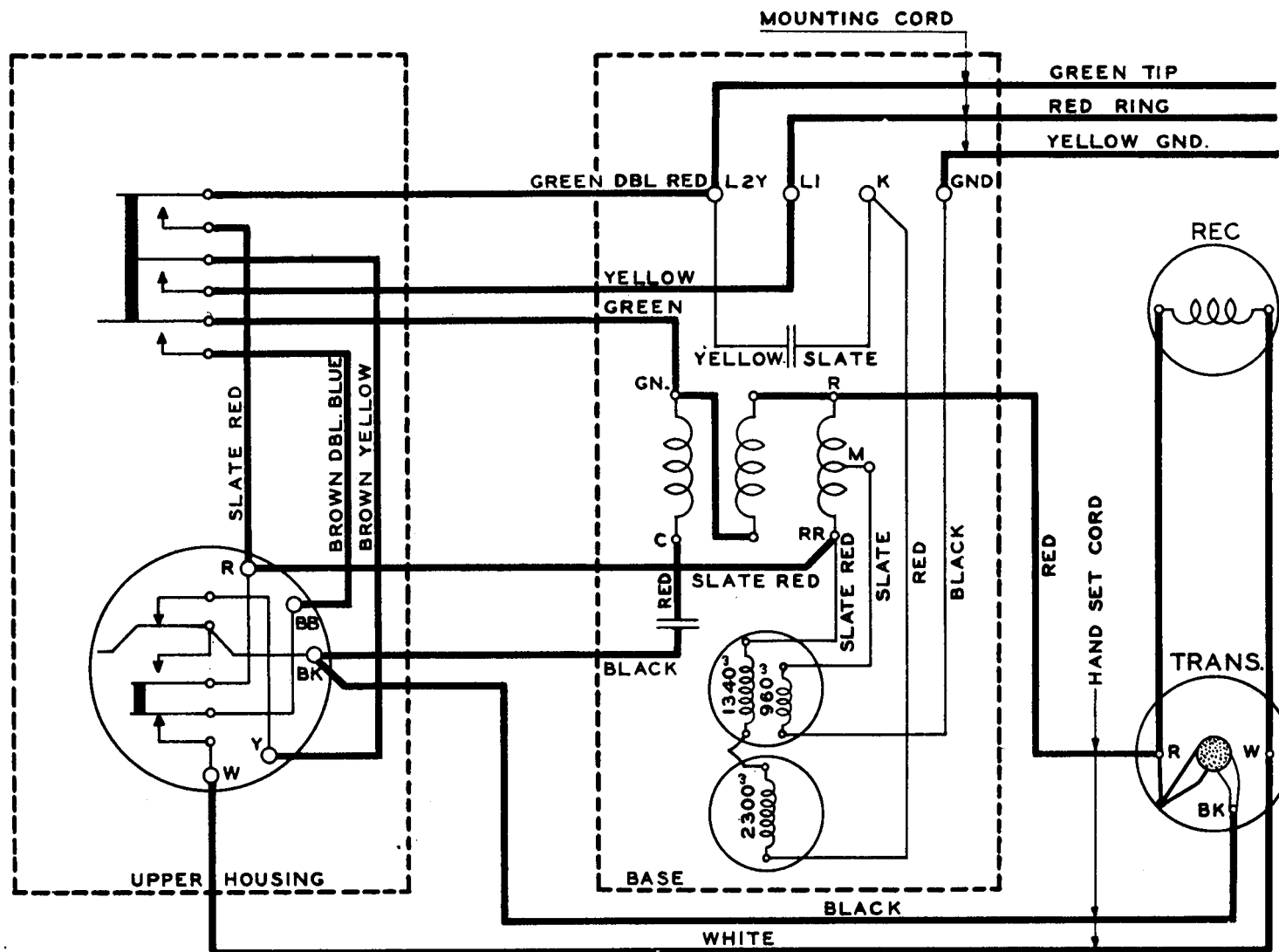


**211 TYPE**  
 ANTI-SIDETONE INSTRUMENT  
 CIRCUIT - DIAL HANG UP HAND SET  
 ILLINOIS BELL TELEPHONE COMPANY  
 PLANT TRAINING SCHOOL  
 FOR TRAINING PURPOSES ONLY





**DIAL ANTI-SIDETONE  
INSTRUMENT CIRCUIT  
HAND COMBINED TELEPHONE SET  
ILLINOIS BELL TELEPHONE CO.  
PLANT TRAINING SCHOOL  
FOR TRAINING PURPOSES ONLY**



**304 TYPE**  
 ANTI-SIDETONE INSTRUMENT  
 CIRCUIT - TIP PARTY DIAL H-C  
 ILLINOIS BELL TELEPHONE COMPANY  
 PLANT TRAINING SCHOOL  
 FOR TRAINING PURPOSES ONLY